### 3.4.5 Number of research papers per teacher in the journals notified on UGC website during the last five years.

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<td>Long term assessment of strength and heavy metal concentration in cement-fly ash stabilized electroplating waste sludge.</td>
<td>M. S. Ahmad, Civil Engineering</td>
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Application of Waste Ceramic Tile Aggregates in Concrete

Md Daniyal¹, Shakeel Ahmad²

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Professor, Department of Civil Engineering, Aligarh Muslim University, Aligarh, India ²

ABSTRACT: In recent constructions, the consumption of ceramic materials is increasing day by day in the form of tiles, sanitary fittings, electrical insulators etc. But a large quantity of ceramic materials changes into wastage during processing, transporting and fixing due to its brittle nature. Therefore, using these wastes in concrete production could be an effective measure in maintaining the environment and improving the properties of concrete. Hence, the crushed waste ceramic tiles were used in concrete as a replacement for natural coarse aggregates with 10%, 20%, 30%, 40% and 50% of substitution. After analyzing results, the optimum value of waste ceramic tile to be used within the concrete mix with a water/cement ratio of 0.5 was determined as about 30%. The compressive and flexural strength of optimal concrete was found 5.43% and 32.2% higher than reference concrete respectively. The findings revealed that using waste ceramic tile lead to enhancing the properties of concrete.

KEYWORDS: Waste ceramic tile, Aggregate, Concrete, Compressive strength, Flexural strength

I. INTRODUCTION

Aggregate and Cement, which are the most important constituents used in concrete production, are the essential materials needed for the construction industry. This certainly led to a continuous and increasing demand of natural materials used for their production. Parallel to the need for the utilization of the natural resources emerges a growing concern for protecting the environment and a need to preserve natural resources, such as aggregate, by using alternative materials that are discarded as a waste. Therefore, one of the most serious problems of the world has been related to remove the wastage and reusing of it. A large quantity of wastage is produced annually in all countries. In particular, Construction and Demolition (C&D) wastes contribute the highest percentage of wastes worldwide about 75%. Furthermore, ceramic materials contribute the highest percentage of wastes within the C&D wastes about 54%. The global production of ceramic tiles during 2011-12 in the world is about 11,166 million square meters. China is the largest ceramic tiles producer (5,200 million square meters) which is 46.6% of world production as well as consumer (4,250 million square meters) which is 38.9% of world consumption. Compared to China, India ranks third; accounting for just 691 million square meters tiles production which is 6.2% of world production and also ranks third in terms of consumption accounting for just 681 million square meters which is 6.2% of world consumption. This huge amount of productions has caused them to be among the most commonly-consumed materials in the world. Usually, the wastage related to tile, ceramic and sanitary ware are created in different forms some of which are produced in companies during and after production process due to errors in either construction, human activities, and also inappropriate raw materials. Some others are produced in transportation and distribution procedures and finally, the most bulk of them are created as a result of destroying constructions. It is predicted that about 30% of daily production of ceramic materials in India change into wastage and this amount reaches to millions ton per year. This waste is not recycled in any form at present. Therefore, they are useless in practiced and cause environmental and disposal problems. However, the ceramic waste is durable, hard and highly resistant to biological, chemical and physical degradation forces. The properties of these materials make them a good and suitable choice to be used in concrete. The use of waste ceramic tiles in concrete effects the properties of fresh and hardened concrete, and makes it economical and also solves some of the disposal problems.
Abstract

A comprehensive numerical study of wind effects using Computational Fluid Dynamics (CFD) techniques on the low-rise hipped roof building is presented in this paper. Two Reynolds Averaged Navier–Stokes Equations (RANS) techniques such as the Standard $k-\varepsilon$ turbulence model and the Renormalization group (RNG) $k-\varepsilon$ turbulence model were adopted in this study to predict the wind loads and the flow patterns around the hip-roof building. The computed wind pressure coefficients on the roof of the hip-roof buildings were compared with the wind-tunnel data. It was found that the results obtained using RNG $k-\varepsilon$ turbulence model are in good agreement with that of the wind-tunnel data than the Standard $k-\varepsilon$ turbulence model. It was also found that the CFD techniques are an effective and alternative tool, less time consuming, easy-to-handle, as well as low cost approach for evaluation of wind effects in comparison to wind-tunnel experiments, using the above turbulence models and with the available resources.

Keywords: CFD, Computational Fluid Dynamics, Wind force, Hip-roof building, Low-rise building, RANS approach, Wind Engineering.

DOI: http://dx.doi.org/10.4314/ijest.v7i2.4

1. Introduction

A hip-roof, or hipped roof as shown in Fig. 1, is a type of roof where all sides slope downwards to the walls, usually with a fairly gentle slope. Thus, it is a house with no gables or other vertical sides to the roof. Hip roofs are thus commonly seen in places of heavy wind such as in hilly regions, coastal regions, etc. and are subjected to drag forces. Corners receive a relatively large outward pressure. A flat roof experiences an outward pressure or uplift, in addition to drag forces. The pressure on a pitched roof varies depending on different factors such as the slope of the roof and the building dimensions. Eaves and overhangs are affected by entrapped wind underneath them which leads to a pressure stagnation on them (Taher, 2010).

Wind flow is turbulent in nature and consists of many complex flow patterns. The field of wind engineering generally comes across with these types of flows. Wind pressures on buildings and structures depend upon the velocity profile and turbulence characteristics of the upcoming wind. These factors in turn depend on the roughness and general conformation of the upstream terrain (Bitsuamlak et al., 2004). Wind loads generally govern the lateral strength of a building and this aspect is more evident in areas of severe wind (Ahmad et al., 2002).

Xu et al. (1998) carried out wind-tunnel tests on the models of hip-roof building on a scale of 1:50 (prototype dimension 14 m x 7 m x 2.9 m eave height) with pitch 15°, 20°, 30° and studied the wind pressures on the roof. The highest peak suction at the corner was experienced with a slope of 30°. The worst peak suction are much smaller on the hip-roof than on the gable roof for 15° and 20° roof pitches. A wind-tunnel study of the effect of geometry of hip-roof building on wind pressures on low-rise hip-roof buildings were also carried out by Shakeel et al (S. Ahmad et al., 2002) taking the same dimensions of the models of Xu et al. He concluded that variation of overhang ratio (0.17, 0.26 and 0.38) on the hip roof with 30° roof pitch have shown moderate effects on roof pressures. Both the overhang and aspect ratio were found to influence the magnitude and distribution of pressures on the hip-roof.
Performance of SFRC Beams under Combined State of Flexure and Compression

M S Jafri¹, and Mohd Israil²

Abstract—Present study is to investigate the behaviour of composite beams of M20 Grade of concrete mix having size of 100 mm x 100 mm x 500 mm with varying percentages of fibre content under a combined state of flexure and direct compression. Straight cylindrical fibres of length 28 mm and diameter of 0.28 mm with aspect ratio of 100 were used. Twelve beam specimens each with 0, 0.5, 0.75 and 1% fibre percentages by weight were cast. Therefore in total forty eight beams were cast. These beams were tested as simply supported beams in flexure along with direct compression of 0, 50, 100, and 125 kN. The beams were tested such that for each percentage of fibre content, all the four values of direct compression were applied for each set of three beams.

From the experimental study, it has been observed that the value of ultimate bending strength and deflection increases with the increase in the value of compression for a particular percentage of fibre content. The ductility increases as the value of compression increases for a particular percentage of fibres.

Keywords—Aspect ratio, compression, flexure, SFRC (Steel Fibre Reinforced Concrete), volume fraction

I. INTRODUCTION

Steel fibre reinforced concrete (SFRC) may be defined as a composite material made with Portland cement, aggregate, and incorporating discrete fibres. The need for addition of fibres to plain, unreinforced concrete arises because it is a brittle material, with a low tensile strength and a low strain capacity. Adding steel fibres to the concrete matrix, to make Steel Fibre Reinforced Concrete (SFRC), initially inhibits the propagation of cracks and then maintains some measure of load carrying capacity even after a visible crack pattern is established. Conventional reinforcement, in the form of bars or mesh, also provides load carrying capacity after cracking is established, but has a negligible effect in terms of slowing down or retarding crack development.

SFRC has been used for a wide variety of applications, namely, pavements and overlays, industrial floors, hydraulic and marine structures, repairing and rehabilitation works. However, there is still a lack of information on the modelling of SFRC structures.

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II. LITERATURE REVIEW

Shah and Rangan [1] worked on ductility and fracture toughness of concrete with and without steel fibres and concluded that the ductility as well as fracture toughness of concrete improves. The fibres also increase substantially the ultimate concrete strain in the beam.

C.B. Kukreja, et al. [2] carried out experimental investigations on the direct tensile strength, indirect tensile strength and flexural tensile strength of the fibrous concrete and compared with the various aspect ratios of the fibres as 100, 80 and 60 respectively. They observed that maximum increase in direct tensile strength obtained by fibres of aspect ratio 80 with 1% as volume fraction.

Niyogi and Dwarkanathan [3] studied the action of moment and shear on the behaviour of fibre reinforced concrete beams. The principal variables are the concrete mix proportions, fibre volume fraction and shear span. They concluded that shear capacity decreases as a shear span/depth ratio increases.

Kukreja and Chawla [4] after conducting experimental investigations on concrete by using straight bent and crimped steel fibres with aspect ratio 80, they published a paper on “flexural characteristics of steel fibre reinforced concrete”. They concluded that, based on steel fibre content, its type and orientation, behaviour can range from brittle to very ductile, all for the same range of flexural strength.

Gopalakrishnan et al [5] of Structural Engineering Research Centre (SERC), Chennai have studied the properties of steel fibre reinforced shotcrete namely the toughness, flexural strength, impact resistance, shear strength ductility factor and fatigue endurance limits. It is seen from the study that the thickness of the Steel Fibre Reinforced Shotcrete (SFRS) panels can be considerably reduced when compared with weld mesh concrete.

I.H. Yang, C. Joh, B.S. Kim [6] examined the basic behaviour of ultra high strength concrete beams reinforced with steel fibres. The test results from this study provide more information to help establish a prediction model for the flexural strength and deflection of ultra high strength concrete beams under bending conditions.

III. EXPERIMENTAL PROGRAMME

An extensive experimental program has been executed to ascertain the flexural behaviour of steel fibre reinforced concrete beams when the beams are under combined state of compression. The experiments were conducted on concrete
Behaviour of SFRC with Varying Mixes and Percentages of Fibres

Iqbal Khaleel Khan1, M.S. Jafri2

Abstract - Fibre reinforced concrete is a concrete mix that contains short discrete fibres that are uniformly distributed and randomly oriented. Fibre material can be steel, cellulose, carbon, polypropylene, glass, nylon, and polyester. Addition of steel fibres slightly increases compressive strength, but it considerably increases the tensile strength, toughness, ductility etc. It also increases the ability to withstand stresses after significant cracking (damage tolerance) and shear resistance.

Present study is to ascertain the behaviour of steel fibre reinforced concrete with varying mix compositions and percentages of fibres. The experiments were conducted on concrete mixes of M20, M25 and M30 grades. Straight fibres of length 28 mm and diameter of 0.28 mm with aspect ratio of 100 was used. Every grade of mix was further reinforced with different percentage of above mentioned fibres i.e. 0%, 0.5%, 0.75% and 1% by weight. A total of 36 cubes of standard size 150 mm x 150 mm x 150 mm and 36 cylinders of 150 mm diameter and of 300 mm height were cast, three samples each for a particular grade of mix and particular fibre content. The experimental program involved the evaluation of the compressive strength and ultimate compressive strains of concrete columns under uniaxial compression using two dial gauges placed on opposite faces. The cylinders were tested for splitting tensile strength and the tensile strains were recorded under uniaxial compression. Ultimate compressive strength, ultimate compressive strain, ultimate splitting tensile strength and ultimate splitting tensile strain were obtained with the variation in the percentage of fibre content.

From the experimental study, it has been observed that ultimate compressive and splitting tensile strength as well as strain increases with the increase in grade of concrete and percentage of steel fibres.

Keywords—Concrete mix, cylinder, compressive strength, splitting tensile strength.

I. INTRODUCTION

Many researchers have studied the effect of fibre addition on the mechanical and durability properties of ordinary Portland cement concrete. Review of literature of SFRC on workability, compressive strength, tensile strength and modulus of elasticity are given below.

V. Bindiganavalie, N. Banthia [1], carried out their research on “Some studies on the Impact Response of Fibre Reinforced Concrete” and made an attempt to examine two major issues related to impact loading on plain and fibre reinforced concrete. Firstly, within the context of drop weight impact tests, a number of machine parameters were examined including capacity size (150J – 15,000J) and drop heights (1.2m – 2.5m). It was found that the machine parameters strongly control the experiential material response to impact. Secondly, a comprehensive test program launched where steel and polymer fibres with widely different constitutive properties were compared as reinforcement in concrete under impact loading.

O. Kayali et al. [2] carried out experimental investigation on the effect of polypropylene and steel fibres on high strength light weight aggregate concrete. Sintered fly ash aggregates were used in the light weight concrete. By adding polypropylene fibres at 0.56% by volume of the concrete caused a 90% increase in the indirect tensile strength and a 20% increase in the modulus of rupture, whereas addition of steel fibres at 1.70% of volume of concrete increased the indirect tensile strength by about 118% and 80% increase in modulus of rupture. Finally there is a significant gain in ductility when steel fibres are used.

S.K. Kaushik, Y. Mohammadi [3] carried out experimental investigation on the mechanical properties of reinforced concrete by adding 1.0% volume fraction of 25mm and 50 mm long crimped type flat steel fibres. It was observed that short fibres acts as crack arrestors and enhances the strength, where as long fibres contributed to overall ductility. They concluded that best performance was observed with mixed aspect ratio of fibres.

P.H. Bischoff [4] studied the post cracking behaviour of reinforced tension members made with both plain and steel fibre - reinforced concrete. He concluded that specimens with steel fibres exhibited increased tension stiffening and smaller crack spacing, which both contributed to a reduction in crack widths. Also it is observed that cyclic loading did not have a significant effect on either tension stiffening (or) crack width control for the specimens tested.

Song, Hwang, Shou [5] carried out experimental investigations to study the impact resistance of steel fibre reinforced concrete using drop weight test method. They used hooked end fibres with 0.55mm in diameter and 35mm long. They concluded that steel fibrous concrete improved to various degrees to first crack and failure strengths and residual impact with standing capacity over the non-fibrous concrete.

II. EXPERIMENT PROGRAMME

A. Materials Used

Ordinary Portland cement of 43 grade, locally available coarse sand (grading zone II, fineness modulus: 2.83, specific gravity: 2.45) as fine aggregate, locally available crushed stone aggregate, mainly quartzite in mineralogical
Research Paper

Durability Properties of Self Compacting Concrete containing Fly ash, Lime powder and Metakaolin

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ABSTRACT

This paper investigates the durability properties of Self-compacting concrete (SCC), with different amounts of fly ash (FA), lime powder (LP) and metakaolin (MK). A total of 6 mixes were prepared that have a constant water-binder ratio (w/b) of 0.41 and superplasticizer dosage of 1% by weight of cement. In addition to compressive strength, the durability properties of SCC mixes were determined by means of Initial surface absorption test (ISAT) and Capillary suction test. The test results indicated that the durability properties of the mixes appeared to be very dependent on the type and amount of the mineral admixture used; the mixes containing MK were found to have considerably higher permeability resistance. Good co-relation between strength and absorption were achieved.

1 Introduction

Self-compacting concrete (SCC) is a highly flow-able, non-segregating concrete that can spread into place, fill the formwork and encapsulate the reinforcement without any need for vibration. It is a modified product that flows and consolidates under the influence of its own weight. Not only will it, thus, reduce the exposure of workers to noise and vibration of the vibrating equipment, it can also reduce the technical cost of in-situ cast concrete constructions, due to improved casting cycle, quality, durability, surface finish and reliability concrete structures and eliminating some of the potential for human error. It is a sensitive mix, strongly dependent on the composition and characteristics of its constituents. It consists of the same components as of conventionally vibrated concrete, which are cement, aggregates and water, with the addition of chemical and mineral admixtures in different proportions. Stability and flow ability of SCC is achieved by increasing the solid fraction of paste phase of concrete that can be achieved by employment of some mineral admixtures [12]. The use of mineral admixtures improves the hardened and especially durability properties of the concrete.

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Effect on Wind Pressures by Variation of Roof Pitch of Low-Rise Hip-Roof Building

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Abstract

The paper presents a numerical study of wind pressure on the low-rise hip-roof building by varying the roof pitch using computational fluid dynamics (CFD). A Texas Tech. University building models with hip roof, reduced at a geometric scale of 1:50 were numerically simulated for the present study. Various hip-roof building models of different roof pitches as usually used in different parts of the world, such as, 15°, 20°, 30° and 40° were selected with different wind angle attack i.e. 0°, 45° and 90°. The numerically computed wind pressure coefficients on the roof of the hip-roof buildings were compared with the wind-tunnel results. Two RANS (Reynolds Averaged Navier-Stokes) turbulence models such as the Standard $k - \varepsilon$ (SKE) and the Renormalization group $k - \varepsilon$ (RNG-KE) were adopted in this study keeping in mind the computational resources available. Result shows that roof pitch does affect the magnitude of wind pressures coefficients but the pattern almost remains same. The model with roof pitch 30° amongst the various models was found to have maximum wind pressure. It was also found that the results obtained using the CFD turbulence models and the wind-tunnel data are in good agreement with in certain limit.

Keywords: Computational fluid dynamics; wind force; hip-roof building; low-rise building; RNG; SKE; wind engineering.

1. INTRODUCTION

Building with a mean roof height less than about 20 m are categorized as low-rise. Majority of buildings the world over, whether residential or commercial, are low-rise. The effect of varying geometric configurations, surrounding topography and wind directions, etc. make analyses of wind load on low-rise buildings a bit complicated. Dynamic modeling of wind loads on low-rise buildings remains a very challenging task, which is critical for cost-effective design and reduction of wind-induced losses [1].

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A Review of Corrosion Control Methods in Ferrocement

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Abstract

Ferrocement is a composite material consisting of layered wire meshes and rich cement-sand mortar which imparts high degree of ductility and energy absorbing capacity. Although ferrocement has proven itself as an excellent material for low cost housing, its durability continues to be a matter of concern owing to the corrosion susceptibility of the small diameter metallic wire meshes. Protection of reinforcement in ferrocement is usually achieved through the galvanized wire mesh, increased effective cover and dense mortar. These methods give only partial protection to the reinforcement against corrosion. This article reviews the studies undertaken to control corrosion in the ferrocement composites and thereby improving the durability of the composites.

Keywords: Ferrocement; Cementitious composites; Corrosion of steel wire mesh; Corrosion inhibitors

Introduction

There is an alarming housing shortage in Asia and the Pacific region in general and in the Indian context in particular. An economical and simple alternative construction material will contribute greatly in solving the problem of housing. The provision of proper dwellings and basic infrastructure facilities along with earthquake resistant features, have been the constant endeavour of the previous researchers. Ferrocement has proven itself as an excellent material for low cost earthquake resistant housing. Various research organisations and non-government agencies viz. CBRI, SERC, AVBC, HUDCO and some other private sector organisations have also been involved in propagating the technology for effective use of ferrocement units. The corrosion susceptibility puts a question mark on the effective service life of ferrocement and its components. Any technique suggesting the enhanced life through use of corrosion inhibitors will definitely establish the effectiveness of the ferrocement material system for a wider range of application in diversified areas including housing, agriculture, industrial, terrestrial and marine etc. Success of ferrocement, as with other material depends largely upon its durability. Although the ferrocement has proven itself as an excellent material for low cost housing [1-20], reinforcement corrosion is one of the most important criterion governing durability of the ferrocement since the diameter of the wire meshes used in ferrocement are much smaller as compared to the conventional reinforced cement concrete.

Prevalent Corrosion Control Techniques

Protection of reinforcement is usually achieved through the use of galvanized wire mesh [21]. It has also been suggested that the corrosion of reinforcement can be checked to some extent by making dense mortar with the use of additives such as fly ash, silica fumes and blast furnace slag [22-24]. Some researchers have reported the improvement by increasing the effective cover [25]. These suggested ways have proved to be ineffective with the passage of time thereby reducing the strength of the ferrocement components [26,27]. Studies undertaken on the chemical reactivity of inhibitors by earlier investigators highlight the worthiness of its application [28-30]. ACI-549R strongly recommends that studies be undertaken to suggest durable and long term anti-corrosion techniques to prevent penetration of water and salts that could lead to the corrosion of reinforcing wire mesh [31]. In some of the recent studies carried out to protect rebar in concrete using different types of corrosion inhibitors, it has been clearly established that inhibitors are extremely effective in controlling/delaying onset of corrosion [32-39].

Use of Chemical Corrosion Inhibitors

Use of chemical corrosion inhibitor in ferrocement is rarely sighted in literature. Only a few studies are reported which deal with the chemicals like chromium trioxide to address a particular problem of galvanic cell, a patented admixture and a polymer-modified coating to control the reinforcement corrosion.

Use of chemical admixture for the control of corrosion in ferrocement has been explored by a very few investigators. The use of galvanized wire mesh along with the un-galvanized skeletal steel bars creates galvanic cell problem. Christensen and Williamson [40] were first to identify this problem and also gave the solution. They suggested the use of chromium trioxide at the rate of 100-300 ppm by weight of water in preparing the mortar. Iorns [41] also reported the use of chromium trioxide as an inhibitor of hydrogen gas generation when galvanized mesh is used in ferrocement. Rengaswamy, Saraswathy and Balakrishnan [42] recommended the use of a patented admixture inhibitor consisting of one or more of the chemicals, namely trisodium phosphate, sodium nitrite, sodium hydroxide and sodium carbonate, for the protection of reinforcement against corrosion due to chloride concentration in ferrocement. Shirai and Ohama [43] reported the performance of ferrocement with polymer-modified coating on reinforcement. The coating paste was prepared using styrene-butadiene rubber latex. It was concluded that the corrosion inhibiting property is remarkably improved.

In some of the recent studies attempts has been made to improve the corrosion resistance of the ferrocement. Akhtar, et al. [44] explored the
SOLID WASTE (CERAMIC TILES) AS A REPLACEMENT FOR CONCRETE AGGREGATE.


Author(s): Ahmad, Shakeel; Khan, Rehan A.; Daniyal, Md.

Abstract:
In modern way of construction, the consumption of ceramic materials is increasing day by day in the form of tiles, sanitary fittings and other electrical goods like insulators. But a large quantity of ceramic materials changes into wastage during processing, transporting and fixing due to its brittle nature. These waste materials are not reusable and recyclable due to their physical and chemical structure. However, the ceramic waste is durable, hard and highly resistant to biological, chemical and physical degradation forces. Using ceramic wastage in concrete production could be an effective measure in maintaining the environment and improving the properties of concrete. The present experimental study deals with the investigation of possibility of using waste ceramic tile in concrete. Waste ceramic tile is the least expensive of all the concrete constituents and is much less expensive than natural aggregates and thus the idea is to replace as much of the natural coarse aggregates as possible to save money and to reduce the amount of disposable wastes, as well, but care has to be taken in order not to weaken the concrete by adding too much ceramic tiles. The waste ceramic tiles were collected from the nearby commercial shops and were crushed to desirable size. The crushed waste ceramic tiles were used in concrete as a replacement for natural coarse aggregates with 10%, 20%, 30%, 40% and 50% of substitution. 18 concrete mixes were prepared with w/c ratio of 0.4, 0.5 and 0.6, while other components kept constant. Standard series of 36 slump tests, 54 density tests, 54 compressive strength tests and 6 flexural strength tests were conducted. After analyzing the output results, the optimum value of waste ceramic tile to be used within the concrete mix with a water/cement ratio of 0.5 was determined as about 30%. At the optimum percentage of waste ceramic tile, compressive strength of concrete was found 5.43% higher than the reference concrete. Flexural strength of optimal concrete was also tested and found to be 32.2% higher than the reference concrete. The findings revealed that using waste ceramic tile lead to enhancing the properties of concrete ultimately reducing 30% wastage.

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Research Paper

Effect of Lime Powder and Metakaolin on Fresh and Hardened properties of Self Compacting Concrete

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ABSTRACT

This study investigated the fresh and hardened properties of Self-Compacting Concrete (SCC) with different types and amounts of admixtures. Six mixes were prepared by replacing 30% of cement with different percentages of fly ash (FA), lime powder (LP) and metakaolin (MK). Water-Cement ratio was kept constant at 0.41 and superplasticizer dosage of 1% by weight of cement. The filling and passing ability were investigated through Slump Flow, J-Ring, V-funnel and L-box test before filling the moulds. The compressive strength of hardened SCC cubes was also measured after specified days of curing (7, 14, 28 & 60 days). The workability test results showed that as FA was replaced by increasing percentages of LP and MK, the mixes became dense and hence less workable. It was observed that the compressive strength showed an increase with increasing percentage replacement of FA with LP and MK. This increase was higher for mixes with MK than that of mixes with LP.

1 Introduction

Self-compacting concrete (SCC) is a highly flow-able, non-segregating concrete that can spread into place, fill the formwork and encapsulate the reinforcement without any need for vibration. It is a modified product that flows and consolidates under the influence of its own weight. Not only will it, thus, reduce the exposure of workers to noise and vibration of the vibrating equipment, it can also reduce the technical cost of in-situ cast concrete constructions, due to improved casting cycle, quality, durability, surface finish and reliability of concrete structures and eliminating some of the potential for human error. It is a sensitive mix, strongly dependent on the composition and characteristics of its constituents. It consists of the same components as of conventionally vibrated concrete, which are cement, aggregates and water, with the addition of chemical and mineral admixtures in different proportions. Stability and flow ability of SCC is

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Review Paper

Effect of Different Supplementary Cementitious Materials on Mechanical and Durability Properties of Concrete

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ABSTRACT

Concrete is the most widely used composite in the world. Ordinary Portland cement (OPC) is the most commonly used binding material but the energy required for its production is large and its production leads to release of greenhouse gases in the atmosphere therefore, the need for supplementary cementitious material is real. The utilization of Fly Ash (FA), Silica Fume (SF), Metakaolin (MK) and Ground Granulated Blast Furnace Slag (GGBS), as a pozzolanic material for concrete has received considerable attention in the recent years. This interest is a part of the widely spread attention directed towards the utilization of wastes and industrial byproducts in order to minimize the Portland cement consumption, the manufacture of which is being environment damaging. The paper reviews were carried out on the use of FA, SF, MK and GGBS as partial pozzolanic replacement for cement in concrete. The literature demonstrates that GGBS was found to increase the mechanical and durability properties at later age depending upon replacement level. Silica fume concrete performed better than OPC concrete even at early period for production of high strength concrete and high performance concrete. Fly ash increases the later age strength due to slow rate of pozzolanic reaction. Metakaolin was found to improve early age strength as well as long term strength but had poor workability.

1 Introduction

Cement production is one of the major sources of CO₂ emissions in the world. High cement content leads to an increase in greenhouse gases emission, which is highly relevant to global warming. Every ton of cement produced liberates about 1 ton of carbon dioxide [1], and the cement industry is responsible for almost 5% of the total global industrial energy consumption [2]. A reasonable solution for these problems is via the substitution of larger portions of the cement by supplementary cementitious materials without sacrificing its mechanical and durability properties [3]. Industrial wastes, such as blast furnace slag, fly ash and silica fume are being used as supplementary cement replacement materials. In addition to these, agricultural wastes such as rice husk ash, wheat straw ash, and sugarcane bagasse ash are also being used.

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Seismic Performance of a Heritage School Building

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Abstract
This study evaluates seismic performance of a heritage brick masonry building. For this purpose Nonlinear Time History Analysis is done using SAP2000 considering non-linearity of the material. Different mode shapes with their corresponding natural frequencies and stresses (normal and shear) are obtained. These stresses are compared with the permissible stresses given in code of practice for unreinforced masonry structures (IS1905-1987). Results revealed that building is unsafe under seismic loads and some weak failure zones are found.

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Keywords: Heritage building, Seismic Performance, Unreinforced masonry, Time History analysis

1. Introduction

Masonry is a composite, non-homogeneous and anisotropic material. It is a compound of the masonry units bonded together with mortar. These units may be of stones, bricks, adobe, tiles etc. Due to non-availability of codes at the time of construction the design of masonry building was based on Thumb Rules, resulting in very thick walls and uneconomical structures [1]. Analyzing of historical masonry structures have always been a challenging task because of the geometrical complexity, lack of knowledge about the used materials and structural modifications during the time and ageing of materials. It is an important issue to understand the gravity load transfer mechanism and lateral load resisting system of such structures for their comprehensive structural analysis. Nowadays, the Finite Element Analysis has become the most important tool for the analysis of historical structures [2]. The knowledge about failure of masonry structures under lateral loads is most important, since masonry structures fail miserably under lateral load.

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The effect of coal bottom ash (CBA) on mechanical and durability characteristics of concrete

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Abstract. The present paper would contribute to the efforts being made in the field of concrete technology towards development of concretes possessing good strength and durability properties along with economic and ecological advantage. In the present study it was found that with increase in amount of coal bottom ash, standard consistency, initial and final setting time increase at the same time workability of concrete decreases. Early age strength is less for bottom ash concrete compare to control mix, but as the age increases they show good improvement in strength due to pozzalanic reaction. Optimum dosage is observed to be 10% Grinded Bottom Ash (GBA) which shows about 14 % more strength compared to control mix at 56 days. Also 20% replacement by GBA gives results comparable to control concrete. GBA concrete shows more resistance to acid attack compared to Original Bottom Ash (OBA). Mix M7 with 30 % replacement by GBA shows highest resistance to acid attack. With the increase in amount of bottom ash water absorption capacity of concrete increases, also as the age increases for all the mix water absorption capacity decreases. It was also found that at optimum dosage i.e at 10% replacement of cement with GBA it is also economical and also less amount of CO2 is emitted that mean it is also environmental friendly compared to control mix.

Key words: Coal Bottom Ash, Workability, Mechanical, Durability.

1. Introduction

Natural resources of aggregate, due to high consumption in construction fields, are getting depleted rapidly. Therefore, in the present conditions of inadequate resources of aggregate and development in concrete industry, it becomes crucial and necessary to detect ideal substitute material in durable concrete for aggregate. The environmentally-friendly solution is to use low-cost industrial residues or solid wastes in the production of concrete. In so doing, in spite of a decrease in the amount of industrial wastes sent to landfills, the impacts of the depletion of natural resources, and sever environmental hazards, this is a positive advance in sustainable development and opens new market opportunities. Bottom ash (BA) is one of the renowned industrial wastes produced at the bottom of coal furnaces. It is originated from agglomerated ash particles that are not finer and lighter to be found in the flue gases. The chemical composition of BA includes heavy metals and arsenic. Due to this fact, the stockpiled piles of BA in ponds pose health hazards to human and the environment by spreading hazardous components and contaminating adjacent soil and underground water. Therefore, it becomes essential to recycle effectively and reuse BA due to deficiency of natural resources, economic problems and enormous negative impacts on the environment (Nikbin et al., 2016). BA is produced by combustion of coal. BA before and after being grounded was used as replacement of cement and its physical and chemical properties were studied, it was found that compressive strength of mortar containing 20-30% of BA as cement replacement was much less than that of cement mortar at all ages, but at 60 days BA concrete has more strength (Jaturapitakkul and Cheerarot, 2003). Grinded BA for different periods was used as replacement of cement and its mechanical properties, ecological and economical substation was studied. It was found that usage of BA in concrete industry help in reducing energy demand as well as CO2 emission; it also reduces the price of concrete by 10% (Bajare et al., 2013). Utilization of BA as fine and coarse aggregates in high-strength concrete was studied. Firstly, the chemical and physical
Characterization of Bitumen Mixed with Plastic Waste

Malik Shoeb Ahmad and Fareed Mahdi

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Abstract
Plastic (Polyethylene Terephthalate, PET) is now used as packaging material for a whole range of consumer products in addition to carbonated beverages. Although plastics are very useful products, but the disposal of these wastes has become a problem and is of great concern, particularly in our country. One of the solutions to the disposal of plastic wastes is recycling it into useful products such as it may be used in bituminous (asphaltic) pavements construction, resulting in reduced permanent deformation in the form of rutting of the pavement surface. The present study discusses in detail about the effect of PET on various engineering properties of bitumen. The PET waste was added in the bitumen from 2 to 14% and various tests such as penetration, ductility, softening point, viscosity, flash and fire point and stripping tests were performed for the characterization of plain bitumen and PET modified bitumen. The most effective percentage of Polyethylene Terephthalate (PET) waste was obtained between 10 to 12% by weight of the bitumen. The results of the study indicated that the modified mixture possessed better performance as compared to the non-modified bitumen. The experimental results were also authenticated by conducting Scanning Electron Microscopy (SEM) on the most effective percentages mixtures. It is observed that the addition of PET waste in the bitumen improves its engineering properties such as ductility, penetration, softening point and viscosity values by 32.43%, 14.56%, 26%, and 34% respectively. It has also been observed that addition of 12% PET waste results in zero percent stripping even after 48 hours.

Keywords: Bitumen, characterization, PET, SEM

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Abstract

In the present study, Mode-I fracture tests of hybrid fiber reinforced concrete (HFRC) composite beams were conducted and the fracture properties and other post peak strength characteristics of the HFRC composites were evaluated and analyzed. The HFRC composite was produced using three types of fibers namely steel, Kevlar and polypropylene. A total of 27 HFRC composite beam specimens were cast and tested using the RILEM recommended three point bending test. The main variables were the fiber volume content and combinations of different fibers. The load versus crack mouth opening displacement (CMOD) curves of HFRC composite beams were obtained. Inverse analysis was carried out to determine the tensile strength and crack opening relationship. Analytical models based on comprehensive reinforcing index were developed for determining the influence of the fibers on fracture energy, flexural tensile strength, equivalent tensile strengths and residual tensile strengths of HFRC composites. Based on the experimental results and inverse analysis, a model for predicting the tensile softening diagram of HFRC composite mixes was also developed. The analytical models show conformity with the experimental results.

Keywords

Fibers; Concrete; Fracture; Tensile strength; Inverse analysis; Reinforcing index
Analytical Study of Double Flight Stair Slab without Floor Landing

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Abstract

This paper presents an analytical analysis of double flight stair slab without floor landings with boundary condition fixed at extreme edges. The analysis is based upon finite element method using ANSYS software. The staircase specimen for one storey height of 3m, with mid landing height each at 1.5m from the floor and 100mm thick waist slab has been chosen for a horizontal projection of 2.475m attached with mid landings. The specimen has discretized in to 54 numbers of four noded structural shell elements (shell 181). The specimen has tested under incrementally applied uniformly distributed load over the complete area. Critical value of bending moment and deflection of support arrangement has been obtained. Variation in moments and deflections at critical locations, along the stair slab model has been presented in the graphical form.

Keywords

Double flight stair, stair without floor landings, analytical stair model, staircase.
A comparative study of the performance of self-compacting concrete using glass and polyvinyl alcohol fibres

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Abstract

Self-compacting concrete (SCC) is a high-performance concrete that is able to flow under its own weight, completely filling the formwork without any segregation or bleeding and consolidating without the need of vibration. SCC has a good surface finish, construction time is reduced and its production is environmental friendly (no noise, no vibration).

The objective of the current study is to investigate and compare the influence of glass and polyvinyl alcohol fibres on fresh and hardened properties of self-compacting concrete. For this purpose four mixes; control mix, SCC with viscosity modifying admixtures (VMA) only, SCC with VMA and glass fibres; and SCC with VMA and polyvinyl alcohol fibres were prepared with a water-powder ratio of 0.35. Experiments revealed that after the addition of fibres workability properties (i.e. flow-ability, passing ability and resistance to segregation) were reduced but the properties were still in the prescribed range. Hardened properties (i.e. compressive strength, split tensile strength, flexural strength and modulus of elasticity) were improved after the addition of fibres and this improvement was observed to be more in concrete with polyvinyl alcohol fibres.

Keywords: Self compacting concrete; polyvinyl alcohol fibres, glass fibres

1. Introduction

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Journal of Vibration and Control

On the internal resonance characteristics of curved beams
Badri Prasad Patel, Syed Muhammad Ibrahim, Yogendra Nath
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Abstract
In this article, the internal resonance characteristics of periodically excited curved beams are investigated. It was found that 2:1 internal resonance is predominant for a wide range of the linear frequency ratio of the first symmetric and antisymmetric modes. 1:1 internal resonance exists for a narrow range of the linear frequency ratio of the first two modes.

Keywords
Curved beam, internal resonance, shooting

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Strain Rate Dependent Behavior and Modeling for Compression Response of Hybrid Fiber Reinforced Concrete

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ABSTRACT

This paper investigates the stress-strain characteristics of Hybrid fiber reinforced concrete (HFRC) composites under dynamic compression using Split Hopkinson Pressure Bar (SHPB) for strain rates in the range of 25 to 125 s⁻¹. Three types of fibers - hooked ended steel fibers, monofilament crimped polypropylene fibers and staple Kevlar fibers were used in the production of HFRC composites. The influence of different fibers in HFRC composites on the failure mode, dynamic increase factor (DIF) of strength, toughness and strain are also studied. Degree of fragmentation of HFRC composite specimens increases with increase in the strain rate. Although the use of high percentage of steel fibers leads to the best performance but among the hybrid fiber combinations studied, HFRC composites with relatively higher percentage of steel fibers and smaller percentage of polypropylene and Kevlar fibers seem to reflect the equally good synergistic effects of fibers under dynamic compression. A rate dependent analytical model is proposed for predicting complete stress-strain curves of HFRC composites. The model is based on a comprehensive fiber reinforcing index and complements well with the experimental results.

Keywords: Hybrid fibers; Concrete; FRC; SHPB; Strain rate; Toughness; Reinforcing index; Stress-strain curve; DIF

1 INTRODUCTION

Hybrid fiber reinforced concrete (HFRC) composite is a mix of concrete matrix and fibers with different material and geometric properties that results in synergistic and superior performance compared to the use of only one type of fibers in concrete composites. Strong and stiff fibers (e.g. steel fibers, Kevlar fibers) can restrain micro-crack growth, thus improving the concrete strength, whereas relatively flexible fibers (e.g. Polypropylene fibers, Polystyrene fibers, Polyvinyl alcohol) improve material toughness by stress transfer mechanisms over larger crack openings (Abadel et al., 2015; Almusallam et al., 2013; Almusallam et al., 2014; Bolander et al., 2008). Some of the obvious advantages of the HFRC composites in construction practices are improved homogeneity, better crack management, possibility of slender structural members (Almusallam et al., 2013, 2014; Yu et al., 2014; Markovic et al., 2006). However, to ensure a balance between ultimate strength and strain capacity, optimum volume/weight
Sustainable use of copper slag in self compacting concrete containing supplementary cementitious materials

Rahul Sharma, Rizwan A. Khan

Abstract

Copper slag (CS) is an industrial by-product obtained in bulk quantity during matte smelting and refining process of copper metal. The current research is aimed to investigate the sustainable utilisation of CS as fine aggregates in Self Compacting Concrete (SCC) using fly ash (FA) and silica fume (SF) as Supplementary Cementitious Materials (SCMs). Total seven concrete mixes were cast in which one mix was binary blend containing 60% ordinary portland cement (OPC), 40% FA and 0% SF with 100% sand and 0% CS as control concrete. The other six mixes were ternary blends containing 60% OPC, 30% FA and 10% SF with 0, 20, 40, 60, 80 and 100% CS substitution. The fresh properties of SCC mixes were found to be escalating up to 100% CS substitution. The maximum improvements in compressive and splitting tensile strength with respect to control were obtained as 20% and 60% CS substitution. Ultrasonic pulse velocity of all ternary SCC mixes was found to be increased, whereas initial surface absorption and sorptivity reduced in comparison to control concrete. The results of scanning electron microscopy and energy dispersive spectroscopy illustrate the formation of uniformly distributed and compact C-S-H gel in presence of CS after 120 d, with Ca/Si ratio ranging between 0.77 and 1.11. The SCC mix with 100% CS substitution was found to be most economical with least consumption of embodied energy and emission of embodied carbon dioxide. This study authenticates that CS in combination with SCMs is promising alternative over the conventional sand in construction industry.

Keywords

Self compacting concrete; Copper slag (CS); Fresh properties; Mechanical properties; Durability properties; Microstructural analysis
Research Paper

Fresh and mechanical properties of self compacting concrete containing copper slag as fine aggregates

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ABSTRACT

An investigation is carried out on the development of Self Compacting Concrete (SCC) using copper slag (CS) as fine aggregates with partial and full replacement of sand. Six different SCC mixes (60% OPC and 40% Fly Ash) with 0% as control mix, 20%, 40%, 60%, 80% and 100% of copper slag substituting sand with constant w/b ratio of 0.45 were cast and tested for fresh properties of SCC. Compressive strength and splitting tensile strength were evaluated at different ages and microstructural analysis was observed at 120 days. It has been observed that the fluidity of SCC mixes was significantly enhanced with the increment of copper slag. The test results showed that the compressive strength increases up to 60% copper slag as replacement of sand, beyond which decrease in strength was observed. The highest compressive strength was obtained at 20% copper slag substitution at different curing ages among all the mixes, except for 7 days curing. The splitting tensile strength of the CS substituted mixes in comparison to control concrete was found to increase at all the curing ages but the remarkable achievement of strength was detected at 60% copper slag replacement. The microscopic view from Scanning electron microscopy (SEM) demonstrated more voids, capillary channels, and micro cracks with the increment of copper slag as substitution of sand as compared to the control mix.

1 Introduction

Self Compacting Concrete (SCC) is a special concrete, characterized for its unique quality to flow and compact by itself under its own weight in highly dense reinforcement without any application of external or internal vibration. The use of relatively high content of binder as well as high dosages of chemicals admixtures (superplasticizer) as compared to conventional concrete, enhances fluidity and maintains its stability without segregation and bleeding. Nowadays, SCC is widely used in the development of infrastructure due to various benefits such as high-speed construction, less man power, better surface finish and effortless placing. Numerous research work has been carried out to escalate the strength and
Durability assessment of self compacting concrete incorporating copper slag as fine aggregates

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HIGHLIGHTS

- Increase in the content of copper slag enhanced the fresh properties.
- Minimum depth of carbonation was noticed for 100% copper slag substitution.
- Change in weight and compressive strength were used to assess Sulfate attack.
- The maximum electrical resistivity was observed at 20% copper slag content.
- Sorptivity and initial surface absorption reduced up to 60% copper slag substitution.

ABSTRACT

The present study intends to evaluate the durability of Self Compacting Concrete (SCC) containing copper slag as fine aggregates. A total of six SCC mixes were cast with 0%, 20%, 40%, 60%, 80% and 100% copper slag substitution at constant w/b ratio of 0.45. The various tests conducted on SCC mixes included fresh properties, compressive strength, sulfate attack, accelerated carbonation, electrical resistivity, ultrasonic pulse velocity, initial surface absorption and sorptivity. Results showed that fresh properties enhanced with increment in copper slag substitution. The maximum compressive strength was noticed for 20% copper slag. In sulfate exposure, gain in weight and decrease in compressive strength was observed for concrete mixes. Incorporation of copper slag has significant effect in the reduction of carbonation. The benefit of utilizing copper slag in construction industry bestows as substitute to fine aggregates, preserves natural resources and no land management for disposal of copper slag. This study suggests that 60% copper slag is an optimum content as partial replacement to conventional sand for either enhanced or comparable durability behavior of SCC.

1. Introduction

The construction of large structures and mega projects with highly dense reinforcement has led to the introduction of revolutionary concrete in the construction industry namely Self Compacting Concrete (SCC) in 1988 [1]. SCC does not require any vibrators or external source of energy to fill the formwork, narrow openings and congested reinforcement. SCC flows due to its self weight and high mortar content while maintaining homogeneity without segregation and bleeding. One of the drawbacks related to SCC is its high cost which is due to the utilization of superplasticizer and huge amount of cement content. To overcome the limitation of SCC, supplementary cementitious materials are used as partial replacement of cement to reduce the cost and improve the durability as well as sustainability.

Durability may be defined as resistance of the concrete to the chemical attack, biological attack and physical disintegration [2-4]. The chemical attack may occur in any form such as sulfate attack [5], acid attack [6], carbonation [7], alkali silica aggregate reaction and many more depending up on the concrete subjected to the environmental conditions. The physical disintegration may be due to overloading of the concrete structures, abrasion, impact, frost attack and natural calamities such as earthquake, flood, fire etc. [8]. The biological attack involves deterioration caused by bacteria, mosses, lichens, marine borers, boring shells and sponges [9,10]. However, chemical attack is mostly responsible for the core destruction of concrete structures [11-13] and durability is the urgent need to be worked by the researchers [14-16].

Increasing infrastructural growth as a result of mounting urbanization, demand for the huge amount of construction materials such
Seismic Response of RC Framed Buildings Resting on Hill Slopes

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Abstract

Framed structures constructed on hill slopes show different structural behavior than that on the plain ground. Since these buildings are unsymmetrical in nature, hence attract large amount of shear forces and torsional moments, and show unequal distribution due to varying column lengths. In present study, two different configurations of hill buildings have been modelled and analyzed using ETABS v 9.0 finite element code. A parametric study has been carried out, in which hill buildings are geometrically varied in height and length. In all, eighteen analytical models have been subjected to seismic forces along and across hill slope direction and analyzed by using Response Spectrum Method. The dynamic parameters obtained from analyses have been discussed in terms of shear forces induced in the columns at foundation level, fundamental time periods, maximum top storey displacements, storey drifts and storey shear in buildings, and compared within the considered configurations of hill buildings. At last, the suitability of different configurations of hill buildings has been suggested.

Keywords: Hill buildings, Step-back and Step-back setback, Response Spectrum method, Earthquake analysis.

1. Introduction

Economic development of hill areas in the last century has led to the reconsideration of building style, optimum use of construction material and method of construction. Due to scarcity of the plain land on hills, houses built on steep slopes, pose special structural and construction problems. RC framed structures constructed on hill slopes show different structural behavior than on the plain ground. Because of steep slopes, buildings are constructed generally in
Analysis of existing masonry heritage building subjected to earthquake loading

M. Shariq*, S. Haseeb and M. Arif

Abstract

In the present study, the finite element analysis has been carried out on masonry building subjected to earthquake loading. For this purpose, an existing masonry heritage building situated in Aligarh city has been chosen. The time history method using El-Centro earthquake data has been employed for seismic performance of the chosen building. The maximum principal tensile stress and maximum shear stress has been observed and compared with permissible stresses. It has been found that these stresses exceed the permissible limit at few locations such as dome-wall junction, wall-roof junctions and the minarets. It has also been found that these locations are the most critical portion of the building under earthquake forces.

Keywords: Masonry heritage building; FEM; earthquake loading; maximum principal tensile stress; maximum shear stress

1. Introduction

It is well known fact that the effect of earthquake forces on building is unpredictable and can occur at any time and at any place. Masonry building whether residential or historical/heritage have high compressive strength but low tensile strength. Analysis and strengthening of heritage building subjected to earthquake loading has always been a challenging task because of its geometrical complexity and lack of knowledge about the used material, structural modifications during the time and ageing of material. Past studies [1-6] show that the critical issues affecting the
Controlled failure warning and mitigation of prematurely failing beam through adhesive

Mohammad Arsalan Khan *, Vadim V. Silberschmidt *, Jamal El-Rimawi *

Abstract

In plated beam, an adhesive is used primarily to adhere the external plate to the concrete beam to achieve a composite action. Even though some work has been found to indicate that the choice of softer adhesive increased the capacity of beam (MacDonald & Calder, 1982), relatively stiffer adhesives have been largely assumed to provide better strengthening. Largely, due to the fact that adhesive has been widely considered as an insignificant structural component towards the capacity of a composite beam; material capabilities (if not structural) of adhesive have also been ignored for further research towards studying its effects on premature failures (particularly debonding). Under mixed-mode loading, the adoption through discretisation of Cohesive Zone Model as a bulk material (indicative of adhesive component) and to simulate interfacial cracks is shown here to achieve the objectives. The outcomes of the research indicate the critical material properties of adhesive in all directions, such as stiffness, strength and crack energy, play crucial role in controlling the behaviour of modes of failure. Further, based on this study, recommendations have been proposed on the choice of adhesive type at different locations of plated beam so as to capture a failure warning and avoid catastrophic failure.

Keywords

Premature failure, Cohesive zone model, Retrofitting, Debonding, Brittleness of failure
Dynamic response of articulated towers under correlated wind and waves

Mohd Moonis Zaheer a, *, Nazrul Islam b

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https://doi.org/10.1016/j.oceaneng.2017.01.019

Highlights

- Wind contribution on the response is governed by the size of wind driven waves.
- In the presence of waves, drag force causes sub- and super harmonic responses.
- Correlated response assumes significance for fatigue life of the articulated joint.

Abstract

This paper deals with the dynamic behavior of a double-hinged articulated tower to wave alone, and correlated wind and waves. The analysis includes the nonlinearities due to nonlinear drag force, fluctuating buoyancy, variable added mass and instantaneous tower orientation. The fluctuating wind load is modeled by Ochi and Shin spectrum, while the wave load is characterized by Pierson–Moskowitz (P–M) spectrum. The nonlinear dynamic equation of motion is derived by Hamilton's principle. The equations of motion are solved in time domain by using Wilson-θ method. Power spectral density function (PSDF) of surge, tilting motion, hinge shear and bending moment are presented under high, moderate and low sea states. Studies of correlated wind and waves are found to be imperative for double hinged articulated towers to serve and survive in the extreme ocean environment. The response PSDF highlights the wind induced dynamic responses of the tower.

Keywords

Correlated wind and waves; Hinge shear; Articulated tower; Dynamic response
Energy dissipation in plastic deformation of thin aluminum targets subjected to projectile impact

P K Gupta, M A Iqbal, Zaid Mohammad

Highlights

- Thin monolithic and layered in-contact target of equivalent thickness were impacted by ogive nosed projectile.
- Ballistic performance of each target was studied at 0°, 30° and 45° obliquity.
- Energy absorption in different modes of plastic deformation was obtained.
- Results of different configurations at different oblique angles were compared.

Abstract

The present study explores the energy absorption in plastic deformation due to work done in radial, circumferential, axial and tangential directions in monolithic and layered aluminum 1100-H12 targets subjected to oblique impact by ogive nosed projectile. Circular targets of 255 mm span diameter and 0.5 mm thickness were modelled in ABAQUS as a deformable body in the configuration of two and three layers in contact. Also, to compare the ballistic performance of single and layered configurations, the monolithic targets of 0.5, 1.0 and 1.5 mm were impacted at same incidence velocities and ballistic limit was obtained. The projectiles were modelled as a rigid body and impacted at normal as well as 30° and 45° oblique angles. ABAQUS/Explicit solver was used to simulate all the problems. The mode of failure was observed to be petal formation in all the targets. However, due to oblique impact, the number and shape of petals were changed. Both monolithic and layered targets showed enhanced ballistic limit when angle of incidence was increased. The ballistic resistance of 1 mm thick monolithic target was found to be 9.1%, 10.4% and 5.7% higher than equivalent double layered in-contact target, at 0°, 30° and 45° angles of incidence, respectively. Further, the plastic work done in 1 mm thick monolithic target was about 19%, 22% and 28% higher in comparison to the energy absorbed by equivalent in-contact layered configurations impacted at 0°, 30° and 45° oblique angles, respectively.

Keywords

Ballistic impact; Layered in-contact targets; Obliquity. Energy dissipation in plastic deformation

Energy Absorption in Metallic Targets Subjected to Oblique Impact

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Abstract

The present study investigates mode of failure and energy absorption in impact of 1 mm thick Al 1100 H12 monolithic and double layered targets of 0.5 mm thickness in-contact with each other. The 255 mm span diameter circular targets were impacted by EN-24 steel ogive nosed projectile of 19 mm diameter and 52.5 g mass at different angles of incidence viz., 0\(^{\circ}\), 30\(^{\circ}\), 45\(^{\circ}\). Three dimensional modelling of targets and projectiles were carried out in ABAQUS/CAE module. The targets were modelled as a deformable body whereas, rigid body behavior was assumed for the projectiles due to negligible deformation observed in impact. ABAQUS/Explicit solver was used to simulate all the problems and results were discussed in terms of ballistic resistance, failure mode of the target and energy absorption during the impact.

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Keywords: Ballistic impact; Plate; Layered in-contact targets; Obliquity; Johnson Cook elasto-viscoplastic model.

1. Introduction

Due to vast applications of metallic plates in military and domestic usage, the mode of failure and ballistic performance under impact loading were studied by many researchers in past [1-10]. The comparison of ballistic resistance of layered with monolithic targets has been investigated by many renowned authors but the performance of monolithic over layered targets under different loading conditions remains debatable.

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Fatigue Damage Assessment of RC Column using PZT Sensors
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Abstract

Due to ruggedness, cost-effectiveness and high damage sensitivity, PZT sensors have been effectively used for structural health monitoring. Health monitoring is the continuous measurement of the loading environment and the critical responses of systems or its components. The present work deals with mainly the application of EMI technique to assess damage in RC Column using concrete embedded PZT sensors. Two vertical RC Columns of different characteristics with embedded CVS are tested under fatigue loading conditions through shake table and their peak voltages were observed with time history till failure. The scope of the project is to full fledge damage prognosis of RC Column under fatigue load with an attempt to forecast system performance assessing the current damage state of the system (i.e. Structural Health Monitoring) and ultimately predict through simulation and past experience the remaining useful life of the system. Through this experiment it is concluded that in SHM, the CVS are effective to quantify local damage in RC structure. Natural frequency of column is a direct measure for stiffness and is observed decreasing with increasing damage & remaining life of RC Column specimen under fatigue loads is estimated. A formula has been devised for this purpose.

The future objective of this project includes quantification of damage by modelling the structure as a combination of mass, spring and damper components and comparing both the experimental and analytical values to derive empirical relation to estimate remaining life of structure under fatigue.

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Keywords: Fatigue, SHM of RC Column, EMI Technique, CVS, PZT sensors.

1. Introduction

Fatigue characteristics of the RC specimen were first investigated using two techniques, namely, the global dynamic technique and the local EMI technique In Global dynamic technique, the test-structure is subjected to low-frequency excitations, either harmonic or impulse, and the resulting vibration responses such as displacements, velocities or accelerations are picked up.

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Properties of Normal Concrete, Self-Compacting Concrete and Glass Fibre-reinforced Self-Compacting Concrete: An Experimental Study

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Abstract

Hardened properties of normal concrete (NC) and self-compacting concrete (SCC) are compared. Also, the influence of glass fibres on fresh and hardened properties of SCC is investigated. Three concrete mixtures; normal concrete (NC), SCC and SCC with glass fibres were prepared with a water-cement ratio of 0.35. It was found that addition of glass fibres slightly reduced the workability properties of SCC. Compressive strength and splitting tensile strength of SCC were found to be slightly higher than NC. However, modulus of rupture and modulus of elasticity of SCC was found to be lower than NC. Addition of glass fibres in SCC had limited effect on compressive strength and modulus of elasticity but increased modulus of rupture and splitting tensile strength significantly.

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Keywords: Self-compacting concrete; Fly ash; Glass fibre; Mechanical properties

1. Introduction

Self-compacting concrete, also referred to as self-consolidating concrete, is the concrete that is able to flow under its own weight and completely fill the formwork, while maintaining homogeneity even in the presence of congested reinforcement, and then consolidating without the need of vibration [1]. Self-compacting concrete was developed in Japan in 1980’s [2].

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Relative behaviour of premature failures in adhesively plated RC beam using controllable and existing parameters

Mohammad Arsalan Khan a, Jamal El-Rimawi a, Vadim V. Silberschmidt b

Abstract

Retrofitting of RC beam by gluing a steel plate at the soffit has been a widely adopted technique due to its ease of use, calculations and having minimal variations on structural aesthetics; hence, a large number of such retrofitted structures exist today. However, such structures have also failed frequently due to the formation of premature failures such as peeling and debonding. The further investigations conducted in literature indicated that such undesirable failures can be effected by a large number of geometrical and material parameters. Although, the characterisation and relative influence of such parameters on modes of failures remain unknown; as the past studies have been largely case sensitive or focussing on a small set of parameters. Therefore, to address these issues, a simple but focussed numerical model has been validated through literature for multiple modes of failures over wide range of possible parameters. Further, targeting the response of beam and its critical locations, the authors of this study suggest that the understanding of relative impact of effective parameters, in terms of beam capacity and brittleness of modes of failure, can be broadly utilised to re-evaluate the cause(s) of failure(s) through case studies, or to predict the future of retrofitted structures/beams.
Development of analysis curves for reinforced concrete beam sections based on simple approach of mechanics

Arshad K. Hashmi, Syed Muhammad Ibrahim, Mohammed Jameel and Alok Madan

A mechanics based simple approach is presented to develop curves which illustrate primarily the relation between stresses in not yielded reinforcement (fst), coefficient of moment of resistance (Ru) and the percentage of tensile and compressive reinforcement (fst) for reinforced concrete (RC) sections. The basic principles of mechanics such as equilibrium of forces, constitutive relationship of different constitutes materials RC sections and compatibility of strains are used to develop the different curves. Prime gain of the proposed approach is that it surpasses the requirement of iterative procedure needed for strain compatibility. Accuracy of the method is demonstrated by comparing the results with the actual curves derived based on iterative procedure of stain compatibility method. Step wise calculations are illustrated through determining Ru for particular value of Pr (e.g. for singly beam sections) and determining Pt and Pc for particular value of Ru (e.g. for doubly beam sections).

Keywords: Force equilibrium; strain compatibility; constitutive law of materials; ultimate moment of resistance; doubly RC beam; singly RC beam.

1. INTRODUCTION

Due to the ductile behaviour of steel, the reinforcing steel can sustain very high tensile strains. Following yielding, the ultimate strain in the reinforcing steel can be in the range of 0.12 to 0.2. However in comparison to reinforcing steel the concrete can accommodate very less compressive strains; the ultimate compressive strain of concrete is in the range of 0.003 to 0.0045 only. Thus the final collapse of a RC beam section at ultimate limit state of collapse is caused inevitably by the crushing of the concrete in compression, regardless of whether the tensile steel has yielded or not [1].

When the steel has not yielded, the true location of neutral axis is obtained by a trial-error method, called strain compatibility method involving following steps

- Assuming the suitable initial trial value of neutral axis (xu1)

- Determine the strain at tensile reinforcement level by considering strain compatibility.

- From constitutive law find the reinforcing stress in steel at the corresponding strain.

- Using equilibrium condition (i.e. equating tensile force with compressive force) the actual depth of the neutral axis (xu) can be found out.

- If the values of xu and xu1 are with the chosen range of proximity, it is assumed that the assumed trial value of neutral axis i.e. xu1 is correct for finding out the stress in the unyielded reinforcement. Otherwise repeat the all above steps with the improved (i.e. average) trial value of xu1

Thus determining the strain distribution that is consistent with the assumed position of neutral axis is a laborious procedure. Generating the Ru - Pr and Pt - Pc curves for particular value of Ru involves iterative process and is computationally rigorous. To avoid this rigorous procedure...
Efficient preliminary design of reinforced concrete frames with vulnerability indices

Arshad K. Hashmi, Syed Muhammad Ibrahim and Alok Madan

Designing a structure is an iterative process, wherein preliminary trial designs have to be evaluated and iterated till the performance objectives are achieved. From this viewpoint, development of an efficient (i.e. near optimum) preliminary design approach for performance based seismic design considering different structural irregularities with minimum number of trials is an important objective. Vulnerability indices can be used as good indicators for the evaluation of the structures; thus can be a handy tool for designing the structures. The current paper presents an efficient preliminary design procedure for Reinforced Concrete (RC) frames based on vulnerability indices. The efficient design procedure was implemented for trial performance based seismic design of regular frame (i.e. Bare RC Frame) and irregular frame (i.e. Open Ground Storey RC Frame). The linear (i.e. equivalent static analysis) and nonlinear static analysis (i.e. pushover analysis) were used for the investigation of the design procedure. The results show that the proposed efficient design procedure is effective in attaining the objectives of the performance based seismic design framework.

Keywords: Vulnerability index; optimization; near optimum; uniform inter-storey drift; equivalent static method, pushover analysis.

1. INTRODUCTION

In general, stability, strength and serviceability are the requisite for the design of the structure. It is a complex and iterative process. Limit state method of analysis and design, imposed many definitions for the failure of structures; such as Limit Sate of Collapse in Bending, Shear, Bond, Compression and Tension. However, in Limit State of Serviceability, it is Deflection, Cracking, Fire Resistance and Durability etc. Latest seismic code requirements have made the design more difficult and complex [1, 2]. The serviceability criterion for lateral deflection is one of such requirement which plays a vital role in the iterative design process [3]. Satisfying all these requirements is a tedious process. Preliminary design with the satisfied serviceability requirement of lateral deflection can reduce the iteration trials.

The structural members should be designed for optimum use of it’s constitute materials i.e. steel and concrete. Similarly, at global level of the structure, design should be such that, each member should be used optimally. The first step in this direction is capacity based design method that is ‘strong column and weak beam’ pattern of strength [4]. The method assures the failure sequence of the members of the structures under extreme seismic event. But it does not assure uniform deformation under
Strength and Durability Characteristics of Rice Husk Ash Concrete Reinforced with Polypropylene Fibres

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ABSTRACT

This study was conducted to investigate the strength and water permeation properties of Rice Husk Ash (RHA) concrete reinforced with polypropylene fibres (PP). The properties evaluated include compressive strength, splitting tensile strength, flexural strength, initial surface absorption test (ISAT) and capillary suction test (sorptivity). An experimental program was planned, in which thirteen concrete mixes were prepared. Ordinary Portland Cement (OPC) was partially replaced by RHA at 10%, 15% and 20% with addition of PP at 0.5%, 0.75% and 1% by weight of binder. The water/binder (w/b) ratio was kept constant at 0.38. Super-plasticizer was varied from 0.3% to 0.7% by weight of binder for different concrete mixes. The use of RHA in concrete mixes was found to increase the compressive strength at later ages and inclusion of higher amount of PP decreases compressive strength. The splitting tensile strength was found to increase with RHA as well as PP for all concrete mixes. There was significant enhancement in flexural strength with increase in PP content, especially at later ages. Initial surface absorption test and capillary suction test showed that as the replacement of cement by RHA in concrete mixes increases, water absorption in concrete mixes was found to decrease compared to control mix. Addition of PP also decreases ISAT-10 and initial rate of absorption (IRA) values, but RHA has more effect on the reduction of absorption characteristics than PP.

KEYWORDS: Rice husk ash (RHA), Polypropylene fibres (PP), Hardened and durability properties.

INTRODUCTION

The microstructure of cement paste in the interfacial transition zone (ITZ) can be significantly improved by adding (super) fine materials, such as Fly Ash (FA), Silica Fume (SF), Metakaolin (MK) and Rice Husk Ash (RHA). India is the second largest producer of rice in the world. Rice husk is obtained from the outer covering part of the rice grains which consists of two interlocking halves (Xu et al., 2011). It is estimated that 1,000 kg of rice grains produce 200 kg of rice husk. After rice husk is burnt, about 40 kg would become RHA. It contains about 80-85% silica, which is highly reactive depending upon the temperature of incineration. It also improves the properties of fresh concrete, reduces heat evolution, reduces permeability and increases strength at later ages (Kishore et al., 2011; Ganesan et al., 2007; De Sensale et al., 2006; Sharma, 2013). RHA is a highly reactive pozzolanic material produced by controlled burning of rice husk. The utilization of RHA as a pozzolanic material in cement and concrete provides several advantages, such as improved strength and durability properties, reduced material costs due to cement savings and environmental benefits related to disposal of waste materials and to reduced carbon dioxide emissions (Khan
Numerical Investigation of the Turbulent Wind Flow Through Elevated Windbreak

Ashish Agarwal¹ · Hassan Irtaza¹

Abstract Analysis of airflow through elevated windbreaks is presented in this paper. Permeable nets and impermeable film increases considerable wind forces on the windbreaks which is susceptible to damage during high wind. A comprehensive numerical investigation has been carried out to analyze the effects of wind on standalone elevated windbreak clad with various permeable nets and an impermeable film. The variation of airflow behavior around and through permeable nets and airflow behavior around impermeable film were also been investigated. Computational fluid dynamics techniques using Reynolds Averaged Navier–Stokes equations has been used to predict the wind force coefficient and thus wind forces on panels supporting permeable nets and airflow behavior around impermeable film. The permeable nets were modelled as porous jump media obeying Forchheimer’s law and an impermeable film modelled as rigid wall.

Keywords CFD · RANS · Windbreak · Solidity ratio · Pressure coefficient

Introduction

When the wind encounters a porous obstacle, air pressure increases on the windward side and decreases on the leeward side. So the wind approaching the obstacle is retarded, and the wind flows through the obstacle with minimum speed in leeward side. Thus the porous obstacle is termed as windbreak as it retards wind flow significantly [1].

The windbreak panel consists of steel/timber frame covered by a permeable woven or knitted net that provides protection of erodible areas such as open fields, agricultural fields, industrial stockpiles, and dusty industrial operations against high wind. As erosion is proportional to wind speed, a reduction of wind speeds up to 50% using windbreak would reduce erosion by over 80% [1].

The permeable net cladding increases wind loads on the windbreak panel leading it susceptible to damage or collapse under high wind. The determination of wind forces is quite important for the safe design of framed windbreak panels. Very few experimental and numerical analysis have done in past concerning the aerodynamic characteristics and the wind pressure distribution on windbreak panels. The air permeability characteristics of the cladding material determine the performance of windbreak, therefore, the aerodynamic behavior of the permeable net should be optimally analyzed.

The efficiency of windbreak has been studied on few net types by Raine and Stevenson [2] and Gandemer [3], and concluded that the efficiency of windbreak is directly related to leeward wind velocity as well as leeward turbulence intensity. By examining velocity drop and turbulence intensity variations with parameters like porosity, geometry and shape of the windbreak and presented a number of results on protection area that each windbreak
Energy absorption in thin metallic targets subjected to oblique projectile impact: A numerical study


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Highlights

- Oblique impact of single and double nosed projectiles on thin metallic targets was studied.

- Ballistic performance, mode of failure and energy absorption in the targets were compared at different oblique angles.

- Energy absorbed in various modes of plastic deformation in the target was obtained.

- Influence of obliquity on the energy absorption was discussed.

Abstract

The present study investigates the ballistic performance and energy absorption in plastic deformation due to work done in radial, circumferential, axial and tangential directions in 1 mm thick aluminum 1100-H12 targets. The targets were impacted by single nosed; ogival, blunt and double nosed; ogival-blunt and blunt-blunt, EN-24 Steel projectiles at 0°, 15°, 30° and 45° oblique incidence angles. Three-dimensional models of both projectiles and the targets were created and numerical analyses were performed in Abaqus Explicit solver. Ballistic performance, mode of failure and energy absorption in the target were compared within the configurations. Targets impacted with double nosed projectiles exhibited higher ballistic limit, followed by single nosed blunt and then by ogive nosed projectile. Single nosed ogive projectiles, showed increase in ballistic limit with the obliquity, whereas blunt, ogival-blunt and blunt-blunt projectiles displayed opposite behavior. The energy absorption in targets subjected to ogival-blunt projectile was found to be highest, followed by targets subjected to blunt-blunt projectile, then single nosed blunt and ogive projectile in the last. Further, total energy absorption in the targets subjected to ogive nosed projectile was increased with the obliquity, whereas, in case of blunt and double nosed projectiles, the energy dissipation was reduced.

Keywords

Oblique Impact. Johnson-Cook material model. Plastic deformation. Aluminum targets
Influence of copper slag and metakaolin on the durability of self compacting concrete

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Abstract

Now-a-days, researchers are endeavoring to discover new substitute materials to elucidate the scarcity of natural aggregates in the construction industry. One such alternative is copper slag (CS) obtained as byproduct during the matte smelting process of copper metal. The present investigation is aimed to assess the durability of self compacting concrete (SCC) incorporating copper slag (CS) as fine aggregates and metakaolin (MK) as substitute to fly ash (FA). A total of seven concrete mixes were prepared. The control concrete contains 60% ordinary portland cement (OPC), 40% FA and 0% CS whereas other six mixes contain constant percentage of 60% OPC, 30% FA, 10% MK with different proportions of CS from 0% to 100%. Results revealed that fresh properties declined with inclusion of MK although escalated with increment of CS content. All SCC mixes exhibited higher compressive and splitting tensile strength in comparison to control concrete. The minimum carbonation depth was marked for 100% CS substitution with 10% MK as replacement to FA. The maximum electrical resistivity and resistance to sulfate attack were obtained for 20% CS substitution while UPV values of whole mixes were under the excellent quality of concrete beyond 7 days of curing. On full replacement of sand by CS with 10% MK, initial surface absorption and sorptivity were significantly lower than control concrete at each curing period. This study suggests that CS together with MK can be a potential substitute to natural sand in the construction sector to overcome the scarcity.

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1. Introduction

Self compacting concrete (SCC) is an innovative concrete, developed for the first time in 1988 with unique characteristics of flow and compaction under its own weight (Okamura and Ouchi, 2003). SCC has gained prominence in the construction industry with time due to its wide applications and advantages over the conventional concrete. SCC differs from the conventional concrete in terms of the inclusion of higher proportion of cement, mineral admixture, fine aggregates, superplasticizer and lower content of coarse aggregates. Unlike conventional concrete, SCC does not require any source of vibration or external energy for the compaction process. In past three decades, SCC has proved its benefits in exalting the durability of concrete. Though SCC’s are mostly developed with higher w/b ratios which affect the durability of concrete and present need is to work on durability especially when new alternative materials either cement or fine aggregate are utilized.

The construction of concrete infrastructures such as buildings, bridges, dams and roads in the developing countries leads to the requirement of huge amount of materials obtained from natural resources. To preserve the natural resources in present scenario and forthcoming decades turn out to be challenging while booming in the construction field. Today’s need of construction industry is to transform into the sustainable rather than consumable industry. Many countries are witnessed with indigent natural resources and nations rich in these resources have utilized the same for the construction purposes. This has marked in the depletion of natural resources across the world. It has been estimated that about 48.3 billion tons of construction aggregates were produced globally in the year 2015 (Freedonia, 2012). Now-a-days, extraction of natural sand from the parent rocks and river beds has been banned in numerous countries due to over exploitation of instinctive resources. This will lead to the lack of fine aggregates in the construction sector which can be elucidated by utilizing unconventional materials. To overcome the scarcity of natural fine aggregates, alternative materials in the form of industrial by-product, artificial and man-made materials must be consumed in
CFD Simulation of Turbulent Wind Effect on an Array of Ground-Mounted Solar PV Panels

Hassan Irtaza · Ashish Agarwal

Abstract Aim of the present study is to determine the wind loads on the PV panels in a solar array since panels are vulnerable to high winds. Extensive damages of PV panels, arrays and mounting modules have been reported the world over due to high winds. Solar array of dimension 6 m × 4 m having 12 PV panels of size 1 m × 2 m on 3D 1:50 scaled models have been simulated using unsteady solver with Reynolds-Averaged Navier–Stokes equations of computational fluid dynamics techniques to study the turbulent wind effects on PV panels. A standalone solar array with 30° tilt angle in atmospheric surface layer with the Renormalized Group (RNG) turbulence closure subjected to incident wind varied from −90° to 90°. The net pressure, drag and lift coefficients are found to be maximum when the wind is flowing normally to the PV panel either 90° or −90°. The tilt angle of solar arrays the world over not vary on the latitude but also on the seasons. Keeping this in mind the ground mounted PV panels in array with varying tilt angle from 10° to 60° at an interval of 10° have been analyzed for normal wind incident i.e. 90° and −90° using unsteady RNG turbulence model. Net pressure coefficients have been calculated and found to be increasing with increase in array tilting angle. Maximum net pressure coefficient was observed for the 60° tilted PV array for 90° and −90° wind incident having value of 0.938 and 0.904 respectively. The results can be concluded that the PV panels are subjected to significant lift and drag forces under wind loading, which needs to be quantified with sufficient factor of safety to avoid damages.

Keywords CFD · Wind loads · Solar arrays · Unsteady RNG turbulence model

Introduction

Photovoltaic solar panels harness the solar energy and provide one of the most suitable alternatives of fossil fuel based energy sources. In recent year production cost of solar photovoltaic panels have reduced exponentially which results solar energy as leader in annual installation of electricity generation and will surpass the conventional energy sources by 2030. Till June 30th, 2017 India has crossed 15.614 GW installed capacity of electricity production, out of which 1660 MW on rooftop solar and 13,954 MW as utility scale solar [1]. Government of India has planned to attain 100 GW installed solar energy capacity by 2022, out of which 40 GW capacity installation on rooftop solar projects and 60 GW as ground-mounted solar farms projects (utility scale solar).

Utility scale solar have much higher installed capacity as well as annual capacity addition, than that of rooftop solar globally. In 2016 global solar capacity addition for rooftop solar was 21.6 and 55 GW for utility scale solar [2].

Ground mounted solar arrays are immersed within the lowest region of the atmospheric boundary layer (ABL) where the flow of the wind is highly unpredictable due to the intense turbulence actions by the ground roughness. PV panels are vulnerable to wind loading and extensive damages have been reported the world over, due to high wind.
Effect of Elevated Temperature on the Residual Properties of Quartzite, Granite and Basalt Aggregate Concrete

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Abstract In the present study, experimental investigations have been carried out to determine the effect of elevated temperature on the residual properties of quartzite, granite and basalt aggregate concrete mixes. Ultrasonic pulse velocity and unstressed residual compressive strength tests on cube specimens have been conducted at ambient and after single heating–cooling cycle of elevated temperature ranging from 200 to 600 °C. The relationship between ultrasonic pulse velocity and residual compressive strength of all concrete mixes have been developed. Scanning electron microscopy was also carried out to study microstructure of quartzite, granite and basalt aggregate concrete subjected to single heating–cooling cycle of elevated temperature. The results show that the residual compressive strength of quartzite aggregate concrete has been found higher than granite and basalt aggregate concrete at ambient and at all temperatures. It has also been found that the loss of strength in concrete is due to the development of micro-cracks result in failure of cement matrix and coarse aggregate bond. Further, the basalt aggregate concrete has been observed lower strength due to low affinity with Portland cements ascribed to its ferro-magnesium rich mineral composition.

Keywords Rock aggregates · Single heating–cooling cycle · Ultrasonic pulse velocity · Residual compressive strength · Scanning electron microscopy

Introduction

When we design any structural system, the first consideration is function or use of structure. In the designing of ware-house structures for storing timber, adhesives used for pasting soles in foot-wear industry, nut shell storage structures are prone to fire especially in third world countries where safety measures are poorly followed. Moreover, the structures such as nuclear reactor vessels, missile launching pads, turbo jet runways, and aircraft engine test cells, where temperature suddenly sore to very high levels. The behavior of concrete structures exposed to high temperature depends on many simultaneously interacting factors ranging from composition of materials to the characteristics of fire and stress conditions. Several investigations were carried out to investigate the effect of elevated temperature on concrete made with different types of rock aggregates and under different stress conditions. It was concluded that the tests result under residual condition produced less strength loss than the unstressed and stressed condition up to 300 °C. Beyond this temperature, the trend is reversed, and the residual tests showed more strength loss than the unstressed and stressed tests [1]. Similarly, under unstressed condition and after heating at 800 °C, the limestone aggregate concrete has retained 40% strength and the gravel and sandstone aggregate concrete retained 20% strength as compared to the strength at ambient temperature condition [2]. The performance of light weight aggregate concrete by testing simultaneously under fire up to 500 °C and under stressed condition was observed better than the granite aggregate concrete [3].

The colour changes in concrete after heating are due to the physical and chemical transformation in the material. Beyond 400 °C, significant cracking and variation in mechanical properties of concrete has been observed by
Stabilization of Concrete using Rubber Tyre Waste

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Abstract: With increase in urbanisation and industrialisation disposal of rubber tyre waste has created a lot of problems to the society. The International Rubber Study Group (IRSG) 2017 report revealed 12.9 million tonnes of global rubber production as increased from 12.4 million tonnes in 2016. The objective of this research is to investigate the use of used rubber tyre waste pieces of three different dimensions used as coarse aggregate in the concrete consecutively searching an alternate method for disposal of non-biodegradable solid tyre wastes. This research mainly focus on the performance of concrete strength parameters by incorporating relatively lower percentages i.e. 0.5%, 1% and 2% of discarded tyre rubber pieces of coarse aggregate as compared to percentages taken in previous studies compiled in literature and ultimately finding a replacement for cement results in reducing cost of construction. Compressive strength test, split tensile strength test and workability test are conducted on concrete specimens and results are compared and discussed along with advantages and disadvantages. The results showed that with up to 1% replacement, in each set, no major changes on concrete characteristics would occur, however with further increase in replacement ratios considerable changes were observed.

Keywords: Discarded Rubber Tyre waste, Concrete Stabilisation, Rubber disposal using lower percentages, Rubcrete strength test

I. INTRODUCTION

Concrete can be distinguished in its different types by changing proportions of the main ingredients or substituting the cement and aggregate phases. The finished product can be tailored to its application by taking strength, density, as well chemical and thermal resistances as variables. The use of recycled materials as concrete ingredients has been gaining popularity because of increasingly stringent environmental legislation, and the discovery that such materials often have complementary and valuable properties. Mineral admixtures such as fly ash, ground granulated blast furnace slag, silica fumes are becoming more popular for partial replacement in recent decades. With reduction in amount of industrial waste, displacement of expensive cement production is displaced ultimately results in attaining sustainable development.

The aim of investigation was to study the deformation properties of Portland cement concrete with rubber waste additives. A lot of rubber is produced worldwide. For example, 3.6 million tons rubber is produced annually only in US. It is not possible to discharge the rubbers in the environment because they decompose very slowly and cause lots of pollution. So, it is necessary to have a relevant use of these wastages.

These waste materials can be used to improve some mechanical properties of concrete. The present study provided the test results on the mechanical and physical properties of lightweight concrete obtained by replacing portions of the conventional fine aggregates with crumb rubber pieces from recycling waste tyres. Addition of rubber to concrete results in the improvement of some mechanical and dynamical properties, such as more energy adsorption, better ductility, and better crack resistance. The mechanical properties like compressive, tensile strength and workability are determined as per Indian standards code provisions. The test program was carried out to develop information about the mechanical properties of rubberized concretes. A control Portland cement concrete mix (PCC) is designed using mix design methods and crumb rubber contents were chosen by partially replacing the fine aggregate with used rubber pieces. In this paper, the 7-day and 28-day compressive strength as well as split tensile strength of concrete specimens containing 0%, 0.5%, 1% and 2% by weight rubber tyre pieces of 3mm thickness and dimension 1cm x 1cm, 1cm x 2cm & 1cm x 3cm are investigated. For this purpose, 228 concrete specimens (114 cubic & 114 cylindrical specimens) were prepared.

Future objectives of using discarded rubber tyre waste in concrete include quantification of energy absorption capacity of rubcrete material under vibrations during earthquake and fatigue.
Nonlinear dynamic and bilinear fatigue reliability analyses of marine risers in deep offshore fields

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\textbf{ABSTRACT}

Depleting oil reserves in shallow water are opening the avenues of new ventures in deep sea conditions. India is no exception; deep sea explorations are highly recommended and exercised. As part of the design process, there are requirements of structural failure criteria, such as rupture by over loading, fatigue failures, buckling or an unstable fracture. Three-dimensional nonlinear dynamic analysis of riser is obtained in time domain using finite-element solver ABAQUS/Aqua. The response histories so obtained are employed for the study of fatigue reliability assessment of risers. Fatigue model is based on a bilinear relationship that gives the crack growth linked failure criterion to describe the interaction between fracture and plastic collapse. Uncertainty modelling, especially fatigue crack growth parameters, is undertaken with the help of recently published data in support of bilinear crack growth relationship. Results pertaining to fatigue reliability and fatigue crack size evolution are presented using Monte Carlo simulation. The bilinear crack growth model is found to lead to higher fatigue life estimation as compared to linear fracture mechanics model. Sensitivity behaviour pertinent to limit state adopted has been thoroughly investigated. These findings implicate inspection schemes for components of the marine structures to ensure minimisation of the surprises due to wide scatter of the fatigue phenomenon in marine environment.

\textbf{Notations}

- $E_I$: flexural rigidity
- $T_e(z)$: effective tension
- $m_s(z)$: total mass of riser and its content
- $f_{sx}$: externally applied hydrodynamic forces
- $f$: frequency in cycles/s
- $H_s$: significant wave height in metre
- $T_z$: zero crossing periods in seconds
- $S_{10}(f)$: PM (single-sided) sea surface elevation spectrum
- $S_o$: static offset
- $S_t, \omega_1, \alpha_1$: long-term drift motion amplitude, frequency and phase
- $U_i, \dot{U}_i$: water particle velocity and acceleration
- $p_j$: probability of occurrence of an environmental loading during the structure life.
- $[E(n)]_j$: expected value of number of stress cycles acting on the structure, for environmental condition $j$.
- $[E(S^{k}_{a1})]_j$: expected value of $S^{k}_{a1}$, for environmental condition $j$.
- $f_q$: fraction of time in qth state
- $\nu_q$: mean zero crossing frequency of random stress process in qth state
- $\sigma_q$: R.M.S of stress process in qth state
- $P_f$: probability of failure
- $\Phi$: cumulative distribution function (CDF) of standard normal variable
- $\beta$: reliability index
- $\text{COV}$: coefficient of variation
- $f(z)$: joint probability density function
- $(\frac{da}{dN})$: crack growth rate
- $a$: crack depth
- $N$: number of cycles
- $A_i$: crack growth rate parameter for segment $i$
- $m$: slope
- $\Delta K_h$: threshold of the stress intensity factor range
- $\Delta K_i$: point of intersection of two consecutive segments
- $S$: far-field stress due to applied load
- $Y(a)$: geometry function
- $E[a_{\text{th}}]$: threshold crack depth
- $\Omega$: stress parameter $\alpha_1, \alpha_2, ..., \alpha_5$: sensitivity factors

\section{1. Introduction}

In order to exploit deeper waters in Indian offshore has resulted in the installation of a wide variety of deeper and more flexible offshore platforms under severe environmental conditions. Marine risers are predominantly subjected to oscillatory environmental loads and hence, fatigue characterises a primary failure mode for their design. The fatigue damage at any point in the structure will depend on the complete stress history during its lifetime. The calculation of the stress history and its effects on
Article

Experimental investigation on bottom ash concrete using alkali activators and steel fibres
January 2019 · Indian Concrete Journal 98(1):60-66

N. Agrawal · Mohammed Arif · A. Umar · Mohd - Shariq

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Abstract

Ferrocement Composites and Reinforced Concrete, Earthquake Bottom ash is a waste material derived from the burning of coal in thermal power plants. Since its disposal is costly and environmentally unsound, enhanced research activity is currently underway to propose efficient utilization of this waste material in concrete composites without any compromise on their structural integrity. In the present study, experimental tests were performed for strength assessment of concrete cubes using bottom ash as fine aggregate replacement with and without addition of alkali activators and fibres. Concrete composite with 50% fine aggregate replaced by bottom ash and 1% straight steel fibres shows about 18% increase in compressive strength.
Mechanical and durability performance of concrete incorporating graphene oxide

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ABSTRACT

This current investigation was conducted to explore the influence of graphene oxide (GO) on the mechanical and durability properties of normal concrete. A total of five mixes were prepared in addition of laboratory synthesized GO ranging from 0-0.8% with an increment of 0.02% by weight of cement. The synthesized GO was characterized using SEM, FT-IR and XRD techniques. The workability, initial surface absorption and sorptivity values were observed to have reduced with increase in GO content in the cement matrix. Whereas, the ultrasonic pulse velocity (UPV), compressive and tensile strength were observed to enhance with percentage increment of GO in the concrete compare to control mix. The microstructural analysis was performed using SEM/EDX at 90 days curing age. The mix with 0.08% GO showed better result compared to rest of the mixes with GO and control mix.

1 Introduction

Nanotechnology has changed the abilities, expectations and vision to control the material world. The advance in nano science may have a great impression in the field of construction materials. The potential of ordinary Portland cement (OPC) which is one of the largest possessions consumed by mankind is not completely explored. A new generation of concrete which is stronger and more durable with desired stress strain behaviour can be achieved through a better understanding and engineering of complex structure of cement-based composites at nano-level. And possibly the whole range of newly introduced material might definitely result in “smart” properties [1]. Inclusion of nanomaterials such as carbon nanotubes (CNTs), carbon nanofibers (CNFs) nano silica, graphene based derived, graphene oxide (GO) etc. in cement-based composites and the study of its influence in the cement matrix was carried out by many researchers [2-3]. The experimental
Original Article

Effect of nano-TiO₂ on the properties of cementitious composites under different exposure environments

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A B S T R A C T
This article presents the effect of 1%, 3% and 5% content of nano-TiO₂ (NT) on the fresh, hardened, microstructural and corrosion resistance properties of cementitious composites under different exposure environments (tap water, saline water and acidic solution). Various investigations such as setting time, compressive strength, scanning electron microscope (SEM), energy dispersive X-ray (EDX), X-ray diffraction (XRD) and potentiodynamic polarization studies were carried out. The setting time test confirmed that the NT acts as an accelerator. The 28 days-compressive strength of mortar increased with the addition of NT. The results of SEM and XRD analyses indicate that NT improved the microstructure and increased the amounts of desirable hydration products. The 360 days-compressive strengths of NT admixed mortar exposed under tap water, saline water and acidic solution were found to be higher than control mortar. The corrosion inhibition efficiency of NT was observed to be increasing with the increase in the dosage, in all the exposure environments.

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1. Introduction

Reinforced cement concrete is considered as an ideal composite material and has been used extensively for the construction of all types of structures. This is mainly because of high compressive strength of concrete and excellent tensile strength of steel. Steel-reinforced concrete structures were viewed as maintenance-free and unlimited service life until the mid-1970s. Conversely, since then, several durability related problems have emerged primarily due to sulphate, acid, chloride and carbon dioxide attacks [1]. However, sulphate and acidic environment mainly degrade cementitious composite through the chemical reactions between hydration products of cement and these aggressive environments [2–4]. On the other hand, the chloride and carbon dioxide generally cause corrosion of steel reinforcement. The Cl⁻ ions usually do not attack the concrete integrity but pass through concrete pores and attack the steel reinforcement [5–7]. The CO₂ decreases the alkalinity of concrete by reacting with the hydrated cement and makes favourable environment for corrosion of steel [8–10]. However, among all durability related problems in steel-reinforced concrete structures, corrosion of
Performance of self-compacting concrete at room and after elevated temperature incorporating Silica fume

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Abstract. This paper evaluates the workability and hardened properties of self-compacting concrete (SCC) containing silica fume as the partial replacement of cement. SCC mixtures with 0, 2, 4, 6, 8 and 10% silica fume were tested for fresh and hardened properties. Slump flow with T500 time, L-box and V-funnel tests were performed for evaluating the workability properties of SCC mixtures. Compressive strength, splitting tensile strength and modulus of rupture were performed on hardened SCC mixtures. Experiments revealed that replacement of cement by silica fume equal to and more than 4% reduced the slump flow diameter and increased the T500 and V-funnel time linearly. Compressive strength, splitting tensile strength and modulus of rupture increased with increasing the replacement level of cement by silica fume and were found to be maximum for SCC mixture with 10% silica fume. Further, residual hardened properties of SCC mixture yielding maximum strengths (i.e., SCC with 10% silica fume) were determined experimentally after heating the concrete samples up to 200, 400, 600 and 800°C. Reductions in hardened properties up to 200°C were found to be very close to normal vibrated concrete (NVC). For 400 and 600°C reductions in hardened properties of SCC were found to be more than NVC of the same strength. Explosive spalling occurred in concrete specimens before reaching 800°C.

Keywords: self-compacting concrete; silica fume; mechanical properties; elevated temperature

1. Introduction

Self-compacting concrete does not need external vibration for its compaction, resulting in better durability, reduced time required for placing, environmental friendly and improved aesthetics (Okamura and Ouchi 2003, Salhi et al. 2017, Lenka and Panda 2017). Key properties of self-compacting concrete are filling ability, passing ability and segregation resistance which are achieved by reducing the coarse aggregate content, limiting the maximum aggregate size, reducing water-binder ratio and using superplasticizers. The increased flow-ability of SCC may cause segregation and bleeding during its transportation and placement which can be overcome by using viscosity modifying admixtures (VMA) (Okamura and Ouchi 1998, Ahmad and Umar 2018a, Khayat et al. 1999, Ahmad and Umar 2018b).

Silica fume is very fine noncrystalline silica obtained from electric arc furnaces as a by-product in the manufacturing of elemental silicon or alloys containing silicon. It is generally a grey coloured powder, slightly similar to some fly ashes or Portland cement. It exhibits both cementitious and pozzolanic properties (ACI 234 1995). Mazloom et al. (2004) studied the compressive strength of NVC by replacing 0, 6, 10, and 15%, of cement by silica fume with a water-powder ratio 0.35. They observed that 28 days compressive strength of concrete containing silica fume was 21% higher than that of control concrete. Sobolev (2004) found that NVC with 15% silica fume yielded highest compressive strength of 91 MPa at 28 day followed by 90 MPa at 10 and 20% of silica fume. Almusallam et al. (2004) concluded that NVC containing silica fume has more splitting tensile strength that of plain concrete. They also observed that highest splitting tensile strength was found in NVC specimens containing 15% silica fume followed by those prepared with 10% silica fume. Some researchers showed that use of silica fume in SCC as a partial replacement of cement enhances its mechanical properties. Bhanja and Sengupta (2005) observed that splitting tensile strength and modulus of rupture at 28 day of NVC mixtures increased significantly when 5, 10 and 15% of the cement was replaced by silica fume. This increase was found to be insignificant beyond 15% replacement. Yazici (2008) replaced 30, 40, 50 and 60% of cement in SCC by silica fume and fly ash. Compressive strength was found to be increased by 26% and 7% over control mix for 30% and 50% replacement. For 50 and 60% replacement, compressive strength was reduced by 4% and 16%, respectively over control mix. Splitting tensile strength was found to be increased by 20% when 30% of cement was replaced by silica fume and fly ash. When 40% of cement was replaced by silica fume and fly ash, splitting tensile strength was found to be reduced by 15%. Jalal et al. (2012) observed that incorporation of 10% silica fume in SCC reduced its workability properties. They also observed the improvement in compressive and splitting tensile strength after the addition of 10% silica fume in SCC. Sabet et al. (2013) found that replacement of cement by 10% of silica fume increased 28 day compressive strength of SCC by 25%. Further, 10% replacement of
Effect of diameter of MWCNT reinforcements on the mechanical properties of cement composites

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Abstract. Application of nanotechnology can be used to tailor made cementitious composites owing to small dimension and physical behaviour of resulting hydration products. Because of high aspect ratio and extremely high strength, carbon nanotubes (CNTs) are perfect reinforcing materials. Hence, there is a great prospect to use CNTs in developing new generation cementitious materials. In the present paper, a parametric study has been conducted on cementitious composites reinforced by two types of multi walled carbon nanotubes (MWCNTs) designated as Type I CNT (10-20 nm outer dia.) and Type II CNT (30-50 nm outer dia.) with various concentrations ranging from 0.1% to 0.5% by weight of cement. To evaluate important properties such as flexural strength, strain to failure, elastic modulus and modulus of toughness of the CNT admixed specimens at different curing periods, flexural bending tests were performed. Results show that composites with Type II CNTs gave more strength as compared to Type I CNTs. The highest increase in strength (flexural and compressive) is of the order of 22% and 33%, respectively, compared to control samples. Modulus of toughness at 28 days showed highest improvement of 265% for Type II 0.3% CNT composites. It is obvious that an optimum percentage of CNT could exists for composites to achieve suitable reinforcement behaviour and desired strength properties. Based on the parametric study, a tentative optimum CNT concentration (0.3% by weight of cement) has been proposed. Scanning electron microscope image shows perfect crack bridging mechanism; several of the CNTs were shown to act as crack arrestors across fine cracks along with some CNTs breakage.

Keywords: carbon nano tubes; nano materials; nanotechnology; flexural strength; toughness; ductility

1. Introduction

In the past decade, nanotechnology research can be thought as the most encouraging area in the field of material science. Of late, many types of carbon nano filaments have raised attention of research community in construction industry due to their unique chemical, mechanical and electrical properties and remarkable performance in reinforcing cementitious materials (Wang et al. 2006, Marrs et al. 2007). A high aspect ratio and exceptionally high strength of 60 GPa is the characteristic of CNTs (Manzur and Yazdani 2016). It also has very high elastic modulus around 1 TPa and ductility of 12% (Jean 2002). Such exceptional properties confirm the potential of CNTs as an excellent reinforcing agent within the cement matrix. Therefore, exploration on developing suitable nanotechnology using CNTs in mortar is of significant interest in the past decade. Mechanical properties of mortar, particularly flexural and compressive strength, depends on mass transfer and microstructure at nano level (Aiu 2006). Moreover, it is established that hydration products can be modified through nanotechnology. Addition of CNTs can, therefore, enhance strength properties apart from improved density of composites, as well as lower ductility values.

Whereas extensive studies on carbon nano tubes has been focused on their integration in polymers, less consideration has been given on using nano tubes in cement mortar. Further, limited research of nano tube effectiveness in augmenting flexural strength or toughness has been done. Within recent past, several investigators obtained improved mechanical properties of cementitious composites by incorporating CNTs. Khater and Gawwad (2015) investigated the effect of firing temperatures on alkali activated geopolymer mortar incorporated with MWCNTs and showed reduction in mechanical strength with temperature. Manzur and Yazdani (2016) investigated the effect of different sizes and dosage rates of MWCNTs on the properties of cement composites, and recommended a CNT concentration between 0.1-0.3%. In another study, Al-Rub et al. (2012) studied the influence of CNT aspect ratio on the mechanical properties of composites. It was found that 28 days strength in flexure with short and long CNTs was improved by 269% and 65%, respectively. Hallad et al. (2017) obtained 88% increase in flexural strength by adding both carbon micro fibers and MWCNTs as compared to the control samples. Manzur and Yazdani (2010) investigated the effect of two different MWCNT sizes on compressive strength and found 15-25% increase in compressive strength. Later, Manzur and Yazdani (2015) in a similar study with treated MWCNTs recommended a CNT concentration by weight of cement for strength aspects. For
Effect of gender difference on sleeping comfort and building energy utilization: Field study on test chamber with thermoelectric air-cooling system

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Highlights
- Evaluation of sleeping comfort in test-rooms fitted with thermoelectric coolers.
- Thermoelectric coolers can provide sleep thermal comfort in an energy efficient way.
- Females prefer warmer room conditions as compared to males.
- Optimizing room temperature according to gender can save 485 kWh/year.

Abstract
In this study we have examined the gender-wise differences in sleeping behavior of volunteers subjected to thermo-electric air conditioning test-room conditions. For this purpose, fifteen males and fifteen female subjects were recruited. After filling the Pittsburgh Sleep Quality Index (PQSI) questionnaire, each subject was required to sleep in the room under all the three study conditions i.e. normally ventilated room (NH), thermoelectrically cooled room at input power supply of 600 W and thermoelectrically cooled room at power input of 720 W. Each subject was required to complete one night’s sleep in each of the study conditions. Objective sleeping parameters such as body movement, heart rate, sleeping quality were measured using a Fitbit Alta HR watch. A subjective assessment of the sleep quality was also done after each session. The observed findings were compared for all the three conditions for each subject. It was found that male subjects had an overall better sleep quality at a lower surrounding temperature as compared to the female subjects. For female subjects the indoor environment was found to be comfortable to slightly cold when the thermoelectric cooling system was operated at 600 W. On the other the male subjects had a better sleep quality at 720 W. Based on these cooling requirements, males are estimated to consume 485 kWh more energy annually (which would result in CO₂ emissions in excess of 6 tons) as compared to females to maintain comfortable sleeping environment.

Keywords
Sleeping comfort, Sleep quality, Gender difference, Thermoelectric air cooling, Energy-efficiency
Effect of curing condition on the mechanical properties of fly ash-based geopolymer concrete

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Abstract

In the present study, the mechanical properties of geopolymer concrete (GPC) has been investigated. GPC represents a novel technology that is giving significant concern in industrial construction, especially in term of the current emphasis on sustainability. In this study, the NaOH and Na2SiO3 solutions were used as an alkaline solution in all GPC mixes. Na2SiO3 with 10 concentration of molarity, activator-to-FA ratio of 0.4, Na2SiO3/NaOH ratio of 1.75, and two curing regimes viz., ambient curing, and heat curing at 75 °C for 26 h were employed. The experimental results indicated that the geopolymer concrete strengths, modulus of elasticity, and other mechanical properties increased with heat curing as compared to ambient temperature curing. The elastic modulus of GPC was associated with the compressive strengths and similar to those of OPC concrete. Furthermore, the geopolymer concrete mixture requires proper mix proportion and temperature-controlled curing conditions to accomplish good results.

Keywords Geopolymer concrete · Sustainable materials · Mechanical properties · Flexural strength · Modulus of elasticity · Fly ash

1 Introduction

The manufacture of ordinary Portland cement (OPC) contributes about 10% of CO2 emission to the environment and because of a significant demand for construction in various sector of industries such as, buildings, transportation, dams, tunnels, and sewage, etc., there is an urgent need for an alternate material binder which can replace OPC for a cleaner and sustainable construction [1–6]. Geopolymer materials are a novel construction technology that could be employed for green construction purposes [7–9]. There are two significant ingredients of geopolymer concrete, namely the source material with rich Alumina–Silica content such as fly ash (FA), metakaolin or GGBFS), and alkali activator, which consists of sodium silicate and sodium hydroxide solutions [10–13]. The raw material which is rich in Aluminium (Al) and silica (Si) such as GGBFS, fly ash, or metakaolin reacts with an alkaline solution to produce alumina silicate gel [14–16]. This gel behaves as a binder which binds unreacted materials (sand and coarse aggregates) to manufacture geopolymer concrete (GPC) [17].

The geopolymer concrete is considered as an ideal choice not only because it is a sustainable material, but because it utilizes waste materials from industries as a source material contrast OPC which uses virgin materials [9, 18]. Although usage of geopolymer concrete is still in the beginning stage, however, recently, many structures have been successfully constructed utilizing geopolymer concrete [19]. Some of these geopolymer composites are reinforced box culverts, concrete pipes, pavements, structural...
Use of geopolymer concrete for a cleaner and sustainable environment – A review of mechanical properties and microstructure

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A B S T R A C T

Geopolymer concrete (GPC) has been researched during the past few decades as an alternative to sustainable construction materials, which can minimize CO2 emission for its use of industry by-products. Past researches on GPC show that it can be suitable for the structural applications, with a workable slump, and comparable grade of strength to ordinary Portland cement concrete. In this review paper, the mix design, mechanical properties, durability and microstructure of GPC have been discussed to outline and report the last data and information regarding geopolymer concrete. In addition to that, the microstructure of GPC and OPC concrete have been investigated to understand the internal structure of GPC and evaluate its engineering properties such as strength and durability etc. Review of literature revealed that the production of geopolymer concrete requires great care and correct material composition. During the activation process in making the geopolymer, high alkalinity also requires safety risk and enhanced energy consumption and generation of greenhouse gases. Furthermore, the production of GPC is also affected by the curing time and curing temperature. Therefore, there is an urgent need to develop user-friendly design geopolymer concrete procedure/code that can be used in a variety of construction areas. In summary, this literature review offers guidance for civil engineers and industrial community in future researches regarding geopolymer concrete.

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Nonlinear Dynamic and Probabilistic Risk Analysis of Titanium Marine Riser

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Abstract

Titanium has numerous good properties such as high strength, high corrosion resistance and it has low density allowing weight savings thus making it attractive for use in oil and gas applications. Paper presents the dynamic and probabilistic analysis of Titanium Riser under the loading effects caused by random sea waves of different heights. The dynamic analysis of method using ABAQUS/ AQWA. Using the Fracture Mechanics model and stress vs number of cycles (S-N) model various sea states were investigated and reliability of Ti estimated. The approach based on reliability considers various uncertainties which helps to make effective designs of risers. Results are presented which shows variation in depth of riser. The stress-time history and PSF (Power Spectral Density) curves shows the effect of nonlinearities on bending stress. The variation of reliability also presented.

Keywords

Probabilistic, Nonlinear, Titanium, Riser, Reliability, Fatigue, Fracture

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Performance of high-volume fly ash concrete after exposure to elevated temperature

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Abstract

The purpose of the present research is to investigate the sustainable performance of fly ash concrete at elevated temperature. Initially, the optimum level of cement replacement with class F fly ash was determined. The concrete mixes, i.e., plain concrete (0% fly ash), 25% fly ash, and optimum level of cement replacement with fly ash (i.e., 40%), were chosen to determine the residual compressive strength of concrete after a single heating-cooling cycle of elevated temperature ranging from ambient to 400 °C at an interval of 200 °C under unstressed and stressed conditions. The microstructure by scanning electron microscopy (SEM) was also examined for all the concrete mixes. During the heating-cooling process, the hysteresis loop at 400 °C is found larger than the hysteresis loop at 200 °C and ambient temperature. The 40% fly ash concrete showed a lower reduction in the residual compressive strength after heating at 400 °C under the unstressed condition. The 40% fly ash concrete has shown maximum residual compressive strength than 25% fly ash and plain concrete after heating at 200 °C and 400 °C under the unstressed and stressed conditions. The SEM analysis indicates a massive change in the morphology at 400 °C for plain and fly ash concrete mixes.

Keywords

RESEARCH ARTICLE

Corrosion assessment and control techniques for reinforced concrete structures: a review

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Abstract
Steel corrosion is the main source of damage and early failure of reinforcement concrete structures that in turns create huge economical loss and creating environmental problems. In the past, several corrosion assessment techniques such as potential measurement, gravimetric weight loss measurement, electrical resistivity measurement, sensors and electrochemical methods for instance potentiodynamic polarization, linear polarization resistance, galvanostatic pulse, and electrochemical impedance have been developed to detect corrosion condition of steel in concrete. Though the potential measurement, resistivity measurement and sensors can only provide the qualitative information about the steel corrosion. The weight loss measurement is an efficient technique for corrosion rate measurement of steel, but it is destructive and requires long exposure times. The electrochemical techniques are non-destructive in nature and are used to determine corrosion rate of steel in laboratory as well as field studies. However each of these methods possesses certain advantages and limitations, therefore a combination of these techniques is recommended to use to obtain the corrosion condition of steel. As far as corrosion control techniques for steel reinforced concrete are concerned, several methods such as cathodic protection, electrochemical chloride extraction, surface treatments of the steel, surface treatment of concrete, utilization of mineral admixtures and chemical corrosion inhibitors have been developed in the past. Each of these methods offers some advantages and disadvantages. Thus, more researches are required to develop such methods of corrosion protection of steel that are economical, durable, environment-friendly and do not cause any adverse effect on the structural performance of concrete and steel.

Keywords Steel corrosion · Economical loss · Environmental problems · Corrosion assessment techniques · Corrosion control techniques

1 Introduction

Prior to the invention of cement, mortars were made by mixing water, sand and slaked lime [1]. John Smeaton discovered hydraulic lime mortars in 1754 [2]. A British mason named Joseph discovered the cement in 1824 and filed the first patent on Portland cement [3]. However, the objects prepared with the use of Portland cement were extremely brittle and incapable to tolerate shocks. Joseph Monier, a French gardener in 1867 made flowerpots with embedded iron nails and consequently observed a remarkable enhancement in the durability of his pots. Afterward, efficient scientific developments in concrete manufacture took place. In 1911, American Society for Testing and Materials (ASTM) formulated a detailed specification for the utilization of steel in concrete [4]. Subsequently, various developments ensued in designing the steel reinforcement bars in order to produce stronger and durable concrete structures. Consequently, the steel-reinforced concrete became the most widely used structural material in the world because of its economical, strength and durability properties. Steel-reinforced concrete structures were viewed as maintenance-free and unlimited service life until the mid-1970s. Conversely, since then, several durability related problems have emerged, such as alkali-silica reactions, sulphate attacks and corrosion of steel reinforcement. Among all durability related problems in steel-reinforced concrete structures, corrosion of steel reinforcement has been recognized as the main source of deterioration [5].

Generally, the corrosion affects our daily lives directly as well as indirectly. In direct, it shortens the useful service
Effect of graphene oxide on mechanical and durability performance of concrete

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A B S T R A C T

Graphene oxide (GO) may have a huge impact in construction industry in near future. Because of the oxygenated functionalities attached on the aromatic structure, it has better dispersibility property than any other graphene-based derived. Many of the researchers have given their views on the influence of GO on the mechanical and durability properties in ceramic matrix. Five mixes were prepared with inclusion of GO (0%, 0.02%, 0.04%, 0.06% and 0.08% by weight of cement). Tests on mechanical and water permeation properties were conducted. The compressive and tensile strength of the mix with 0.08% GO has shown a better result compared to rest of the mixes. The sorptivity and permeability of the nano-reinforced concrete mixes in addition of GO were observed to have reduced with increasing GO content in the concrete compared to the control mix. The synthesized GO was structurally characterized by means of FE-SEM/EDX, FT-IR and XRD. Microstructural analysis was carried out using SEM/EDX on 90 days old concrete mixes and the quality of the concrete mixes was checked with UPV test.

1. Introduction

Cement is the basic binding material used in concrete with the major drawback of being brittle with low tensile strength. With due course of time these drawbacks were taken care with the introduction of steel reinforcement and fibers. But the introduction of nanomaterials in cement-based composites have enhanced the properties such as toughness, flexural, tensile and durability properties by improving at the nanoscale of the concrete. Nanotechnology has proved that composites can be modified/re-engineered with a small inclusion of nano-materials [1]. Carbon Nano-Tubes (CNTs), graphene-derived, Carbon nanofibers (CNFs), nanosilica, etc. are very popular among all the nanomaterials. Nanocomposites has proven its ability to enhance the properties of the parental material. Nanomaterials in concrete industry have become a trend as it has many advantages from enhancement in mechanical strength to filling the voids at nano-level. The chemistry of cement and nanomaterials such as CNTs, graphene, graphene oxide (GO), graphene-based nanomaterials are observed to have improved the mechanical, thermal, electrical, optical etc. properties of the cement composites. Many of the researchers have worked on the mechanical and durability properties on nano-reinforced cement composites. And as usual it has shown better results than the conventional cement composites [2,3].

Graphene oxide is also a carbon-based nanomaterial. Graphene oxide was first-hand prepared by Benjamin C. Brodie [4] in 1859 by chemical exfoliating graphite (further modified by Hummer). Like graphite, graphene oxide has aromatic structure like any other graphene based-derived, but due to the chemical reactions occurred, some of the covalent bonds were broken down and functional groups such as epoxy, carbonyl, hydroxyl, phenol etc. were attached on the sp2 aromatic monolayer structure (about one atom-thick) [5,6]. The functionalities have its perk when introduced to cement-based composites. These oxygenated functionalities are hydrophilic in nature and easily adsorbs free radicals of water from the cement composite prepared. Graphene oxide has large specific surface area with higher aspect ratios. Generally, nanomaterials have one big disadvantage with their dispersibility property but in case of GO, it has dominance over any other nanomaterials because of the oxidative functionalities which allow to disperse easily in water. Chaan et al. have mention that the degree of sonication was independent for GO dispersion in water but tend to reagglomerate as the abhorrent forces provided by oxygenated functional groups at GO sheets was overpowered by van der Waals forces between the GO nanosheets [7]. However, a compatible surfactant (polycarboxylate ether-based) stabilized the GO dispersion in cement-based...
A Comprehensive Analysis of The Advances in Green Buildings Sector
Rizwan A Khan, Milind Sharma, Snimardeep Singh

Abstract

The realization that much of the conventional, modern approaches to building construction are not sustainable over the long term is not new. As a consequence, the concept of green building is gaining importance in the present energy scenario and related environmental issues. This paper seeks to review the developments in the context of green buildings that have occurred in the past decade or so. These developments in turn are poised to serve as benchmarks for the research which is yet to be done and technologies yet to be explored. We restrict our study to four important elements of green buildings namely; sustainability, green materials, environmental impact assessment and emerging technologies. In our endeavour, we seek to review the developments that have taken place in these particular areas and subsequently, how they have contributed to the concept of ‘Green Building’.

Keywords: Green building, sustainability, green materials, energy efficient, climate change

Cite this Article


Keywords

Green Building, Sustainability, Green materials, Energy efficient, Climate Change

Full Text:

PDF
Discharge characteristics of lateral circular intakes in open channel flow

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ABSTRACT

Intakes are widely used for flow diversion and its control in the open channels. Circular intakes with bellmouth transitions are used to enhance the discharging capacity of the intakes. Analytical and experimental studies for flow through lateral circular intakes with and without bellmouth in open channels are presented in this paper. This study indicates that the coefficient of discharge for the lateral intake under uniform flow is dependent on the Froude number of the approach flow in the main channel and the ratio of width of the orifice to the width of the main channel. Collected data in this study are used to develop regression equation for the coefficient of discharge. The computed discharges using the proposed equations in this study are within ±10% and ±7% of the observed ones for intake with and without bellmouth, respectively. The discharging capacity of an intake with bellmouth is higher than the intake without transition. Sensitivity analysis indicates that the discharge through bellmouth intake is more sensitive to the flow head, as the head increases, the sensitivity for a particular size of intake decreases.

1. Introduction

Water intake is one of the most common diversion structures which are used for the safe withdrawal of water from open channels. The basic principle of design of an intake is to pass higher discharge at minimum head over the intake. Intakes structures can be classified based on the source of water, their geometry, positioning, orientation etc. and can be provided with transitions for minimizing the head losses. Bellmouths are one of the most common transitions which are widely used. Design criteria of various types of the bell mouth are well documented in the literature [10,12,2,3,9].

An intake is a pipe of short or long length having more than three times its diameter connected to the face of an orifice, which is provided in the side or bottom of a vessel or channel. The jet, on entering the pipe will first contract, then expand and fill up the whole pipe as shown in Fig. 1a. This study includes circular pipe intake without bellmouth (Fig. 1a) and with bellmouth (Fig. 1b).

The coefficient of discharge of any intake is the most important characteristic which governs the discharging efficiency of that structure. Use of bellmouth transitions helps in achieving a streamlined flow at the intake which improves the coefficient of discharge. Discharge through an intake is given by

\[ Q_i = C_d \sqrt{2gH} \cdot \frac{5}{4} D_i^2 \]  

(1)

where \( C_d \) is the coefficient of discharge, \( Q_i \) is the discharge through the intake, \( H \) is the available head at the intake and \( D_i \) represents the diameter of intake pipe. Knowledge on the coefficient of discharge and its variations for various operating condition is important for the performance estimation of an intake structure. Though there have been a number of attempts in the past to study theoretically the variation of coefficient of discharge of intakes, no simple, explicit and satisfactory expression has been obtained so far. Naderi et al. [12] carried out experimental studies on the coefficient of discharge of a vertical intake with anti-vortex plates at the condition of critical submergence and suggested that increasing the length of vertical plate is more effective to obtain higher value of coefficient of discharge rather than extending the height of the vertical plate. Ahmad et al. [1] studied the condition of critical submergence at laterally placed horizontal intakes under open channel flow. Hussain et al. [5–7] conducted experimental studies for the coefficient of discharge of lateral circular and rectangular orifices, respectively. They presented regression equations for the estimation of coefficient of discharge of the lateral orifices that produce results with ±5% error.

In this paper, the coefficient of discharge \( (C_d) \) for intakes with and without bellmouth transitions under the condition of uniform
APPLICATION OF GENE EXPRESSION PROGRAMMING IN FLOOD FREQUENCY ANALYSIS

Mohd. Muzzammil¹, Javed Alam² and Mohd Danish³

ABSTRACT

Flood frequency and its magnitude are essential for the proper design of hydraulics structures such as bridges, spillways, culverts, waterways, roads, railways, flood control structures and urban drainage systems. Since, flood is a very complex natural event depending upon characteristics of catchment, rainfall conditions and various other factors, thus its analytical modelling is very difficult to pursue. Recently, artificial intelligence techniques such as gene expression programming (GEP), artificial neural network (ANN) etc. have been found to be efficient in modelling complex problems in hydraulic engineering. The performance of GEP model has been reported to be better than that of the ANN. Moreover, GEP provides mathematical equation which makes it more superior over other soft computing techniques that do not give any analytical mathematical equation. Therefore, in present study, GEP is implemented in flood frequency analysis for typical Indian river gauging station. The results obtained in the present study are highly promising and suggest that GEP modelling is a versatile technique and represents an improved alternative to the more conventional approach for the flood frequency analysis.

Keywords: Flood frequency analysis, GEP, ANN, Gumbel’s distribution

INTRODUCTION

Flood is usually high level flow of water in a river which is overflowing over its banks while submerging the nearby area. Flood problem in India is mostly confined to the states located in the Indo-Gangetic plains, north-east India and occasionally in rivers of central India. As the bulk of summer monsoon rainfall occurs within the period of four months (June to September), thus majority of floods occur only during these months (Dhar et al. 2003). Flood forecasting and its estimation play key role in design of hydraulics structures such as bridges, spillways for dams, culvert waterways, roads, railway, flood plain zoning, urban drainage systems and economic evaluation of flood protection works. Since flood is a very complex natural event depending upon characteristics of catchment, rainfall conditions and various other factors, thus its analytical modelling is very difficult to pursue. However, various statistical methods are available for the prediction of peak flood. One such method which is widely used in India and UK is Gumbel’s extreme value distribution method whereas Log-Pearson type III distribution method is used in USA. Nadarajah et al. (2005) analysed 39 years of flood data of Pachang River in Taiwan and concluded that the Gumbel’s method provides a reasonable model for both flood volume and flood peak. Rostami et al. (2007) used L-moment approach for the regional flood frequency analysis of Halir river basin. Jery Stedinger et al. (2008) was of the opinion that Expected Moments Algorithm (EMA) be adopted by the US flood management community for flood frequency analysis because it provides a direct fit of the LP3 distribution using the entire data set. Ladislav Gaal et al. (2010) reviewed methods to incorporate historical floods into the at-site flood frequency analysis based on Bayesian inference where a likelihood function is built to handle the information on historical floods. Mujere (2011) analysed the 30 year peak flood data of Nyanyadzi River in Zimbabwe and concluded that Gumbel’s distribution predicts river flood magnitudes very efficiently. Abbulu et al. (2013) carried out flood frequency analysis for reservoirs in Vishakhapatnam in India using probability weighted moment methods. They concluded that the L-moment method gives better plotting position but have some limitations, so Gringorten formula is the best plotting position method with the Gumbel’s distribution.

Recent advancement in soft computing techniques and its application in hydraulic engineering have challenged the conventional methods of the analysis. Various hydraulics engineering problems in general and flood frequency analysis in particular, are now being solved using several Artificial Intelligence (AI) techniques, viz. Artificial Neural Networks (ANN), Genetic Algorithm (GA), Genetic Programming (GP), Gene Expression Programming (GEP), Group Method of Data Handling (GMDH) etc. The soft computing tool of Genetic Programming which is essentially classified as an Evolutionary Computation (EC) technique has found its foot in the field of Hydraulic Engineering in general and modelling of water flows in particular since last 12 years (Shreenivas, 2012). Khalid et al. (2008) build a hydraulic jump model using Multiple Linear Regression (MLR), compared it with Gene Expression programming (GEP) and found that GEP model gave higher correlation coefficient than MLR, but was more complicated than the MLR model. They have also concluded that GEP is a promising AI approach for hydraulic data modelling. Azamatullah et al. (2011) used GEP for estimating stage discharge relationship for Pahang River in Malaysia and compared his results with the conventional methods. They observed that the performance of the GEP model was found to be substantially superior to both GP and the conventional models. Neslihan Seckin et al. (2012) applied GEP and linear genetic programming (LGP) in addition to logistic regression (LR) to forecast peak flood discharges and found that prediction made by GEP was more precise than the LGP and LR methods. Mujahid et al. (2012) concluded that the performance of GEP was found to be satisfactory and encouraging when compared with regression and ANN models in predicting bridge pier scour depth. They also mentioned that GEP has the unique capability of providing a compact and explicit mathematical expression for computing bridge scour. Zahiri et al. (2012) used GEP for the prediction of flow discharge in compound channels and compared the results with vertical divided channel method (VDCM), and concluded that GEP model predict discharge more accurately than VDCM, as this conventional approach over estimates the discharge ratios.

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Abstract—Delhi has witnessed a recent blow up in urbanization along river Yamuna passing through Wazirabad to Okhla section leading to the shrinkage in the flood plain that has considerably reduced the water levels within the river section. The present study quantifies the changes that have taken place over a period of ten years within the flood plains of river Yamuna by using two IRS LISS III images of year 2001 and 2011. Land Use Land Cover maps of the study area were prepared and areas covered in each land cover class in the two images were evaluated and compared in terms of percent increase or decrease. Results from the analysis revealed that agricultural area lying within the flood plain has been increased to 234.52 hectares in the year 2011 as compared to 164.5 hectares in 2001, thereby indicating an overall increase of 42.6%. A significant reduction of 61.6% in areas covered under dense trees has also been observed during the study period. Further, a notable increase of 39.5% in the built up/settlement areas within the flood plain has been observed. The overall shrinkage of the flood plain during a period of 10 years is observed to have been reduced by almost 20%. The present study therefore reveals the spatial changes that have taken place within the flood plain of river Yamuna passing through the Delhi corridor during 10 years and finds its usefulness in efficient planning and management of ever shrinking flood plain.

Keywords: Change detection, Flood plains, GIS and Remote Sensing, Urbanization, Yamuna river, Delhi corridor

1. INTRODUCTION

Studies have shown that there remains only few landscapes on the Earth that are still in their natural state. Due to anthropogenic activities, the Earth surface is being significantly altered in some manner and man’s presence on the Earth and his use of land has had a profound effect upon the natural environment and ecology thus resulting into an observable pattern in the land use/land cover over time. Land use and land cover change has become a central component in understanding the interactions of the human activities with the environment and thus it is necessary to be able to simulate changes. Inventory and monitoring of land-use/land-cover changes are indispensable aspects for further understanding of change mechanism and modeling the impact of change on the environment and associated ecosystems at different scales [1]. Remote sensing is a valuable data source from which land-use/land cover change information can be extracted efficiently.

Urbanization is one of the most widespread anthropogenic causes of the loss of arable land [3], habitat destruction [4], and the decline in natural vegetation cover. One of the major reasons of urbanization is rapid population growth in the urban areas or metropolitan cities. Apparently, the urban population has grown exponentially and by 2030, for the first time in human history, more people in the world will be living in cities and towns than in rural areas. Furthermore, by 2025 the developing world is likely to have become more urban in character than rural, therefore, the vast majority of urban growth is now occurring in the developing world [6]. The spatial information from the remote sensing satellites provides more effective solution for sustainable environment and urban development [5]. Land use and land cover is an important component in understanding the interactions of the human activities with the environment and thus it is necessary to be able to simulate changes. Inventory and monitoring of land-use/land-cover changes are indispensable aspects for further understanding of change mechanism and modeling the impact of change on the environment and associated ecosystems at different scales [1]. Remote sensing is a valuable data source from which land-use/land cover change information can be extracted efficiently.

The phenomena of accelerated urbanization is the main culprit, wherein besides bringing higher standard of living has also brought problems of growth of dense and unplanned residential areas, environmental pollution, non-availability of services and amenities and solid waste generation and growth of slums. Therefore, the present study is aimed at assessing the effect of urbanization in the flood plains of Yamuna river crossing through Delhi corridor over the period of 10 years (i.e., from 2001 to 2011) by using remote sensing data and spatial functionalities technique in Geographical information system (GIS).

2. STUDY AREA

The study area covers the flood plain of river Yamuna crossing the Delhi corridor, stretching out through the densely urbanized region between Wazirabad to Okhla Barrage and covering a total span of 22 km. Delhi, the capital city of India
SCOUR PREDICTION AT THE CONTROL STRUCTURES USING ADAPTIVE NEURO-FUZZY INFERENCE SYSTEM

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ABSTRACT

An assessment of maximum scour depth with reasonable accuracy at a grade control structure is of paramount importance for its proper planning, design and management. Most of the scour depth prediction formulae available in the literature have been developed based on the analysis of the laboratory/field data using the statistical method such as the regression method (RM). Conventional statistical analysis is generally replaced in many fields of engineering by the alternative approaches such as artificial neural network (ANN) and adaptive neuro-fuzzy inference system (ANFIS). These recent techniques have been reported to provide better solutions in cases where the available data is incomplete or ambiguous by nature. An attempt has been made herein to develop an ANFIS model for the prediction of scour depth at the grade control structures on the bed of non-uniform sediments using the sizable amount of data and make the comparative study for the performance of ANFIS model over the RM model for the scour depth prediction at the grade control structures. It was found that the AFIS models performed better than the regression models.

INTRODUCTION

Scour is a natural phenomenon caused by the erosive action of the flowing stream on the sediment beds. Grade-control structures (Fig. 1) are generally constructed to prevent degradation in alluvial channels where the general bed slope is high. However, the local scour occurs significantly downstream of the structures due to the erosive action of the flowing water, which may undermine the foundation leading to the structure failure. An assessment of maximum scour depth with reasonable accuracy is, therefore, an essential for proper planning, design and management of such hydraulic structures.

A number of attempts have been made to model the local scour downstream of the hydraulic structures based on the various approaches in the past[1]. The laboratory investigations on local scour under various flow conditions and structure configuration have been carried out extensively in the past and results of these investigations are available in the literature. Veronese[2] analyzed the scour mechanism downstream of a spillway furnishing empirical relations to evaluate the main geometric parameters of scour depth and length. The scour induced by plane jets in different hydraulic conditions were investigated extensively by Rajaratnam[3] and Rajaratnam and Macdougall[4]. Ali and Lim[5] investigated the local scour caused by submerged wall jets. An extensive study and comparison of all the existing scour depth equations for different structures was carried out by Mason and Arumugam[6]. Bormann and Julien[7] reviewed the experimental research on scour downstream of the hydraulic structures due to free and submerged jets. They investigated the scour downstream of grade control structures with large-scale experiments using unit discharge up to 2.5 m³/s and scour depths exceeding 1.4 m. They also carried out a theoretical investigation based on two-dimensional jet diffusion and particle stability, proposing equations for the equilibrium scour depth. Mossa[7] carried out experimental study on the scour downstream of grade-control structures. D’Agostino and Ferro[8] deduced the physically based dimensionless parameters controlling the geometrical pattern of the scour profile at the control structures based on the self-similarity (ISS) theory and proposed the scour prediction equations on these parameters using the comprehensive laboratory scour data and the field data available in literature with different bed grain-size distributions and scales of the erosive phenomenon. Lenzi and Comiti[9] analyzed local scouring downstream of 29 drop structures, and Marion et al.[10] conducted a series of tests to determine the effect of bed sill spacing and sediment grading on the potential erosion by jets forming over the sills.

Most of the scour depth prediction formulae available in the literature have been developed based on the analysis of the laboratory/field data using the statistical method such as the regression method (RM). Conventional statistical analysis is generally replaced in many fields of engineering by the alternative approaches such as artificial neural network (ANN) and adaptive neuro-fuzzy inference system (ANFIS). The ANN and ANFIS are generally preferred by various investigators due to so many relative advantages. Some of the important advantages are: the physics of the underlying phenomenon need not be known beforehand; no mathematical model needs to
Application of spreadsheet to estimate infiltration parameters

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KEYWORDS
Infiltration; Kostiakov’s model; GRG solver; Conventional method

Summary Infiltration is the process of flow of water into the ground through the soil surface. Soil water although contributes a negligible fraction of total water present on earth surface, but is of utmost importance for plant life. Estimation of infiltration rates is of paramount importance for estimation of effective rainfall, groundwater recharge, and designing of irrigation systems. Numerous infiltration models are in use for estimation of infiltration rates. The conventional graphical approach for estimation of infiltration parameters often fails to estimate the infiltration parameters precisely. The generalised reduced gradient (GRG) solver is reported to be a powerful tool for estimating parameters of nonlinear equations and it has, therefore, been implemented to estimate the infiltration parameters in the present paper. Field data of infiltration rate available in literature for sandy loam soils of Umuahia, Nigeria were used to evaluate the performance of GRG solver. A comparative study of graphical method and GRG solver shows that the performance of GRG solver is better than that of conventional graphical method for estimation of infiltration rates. Further, the performance of Kostiakov model has been found to be better than the Horton and Philip’s model in most of the cases based on both the approaches of parameter estimation.

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Introduction

Estimation of infiltration rates is of paramount importance in water resource engineering as it is required for estimation of effective rainfall, groundwater recharge, and designing of irrigation systems. Infiltration rates are input for deduction of abstractions in hydrograph analysis which in turn, is utilized in design of hydraulic structures, design of urban drainage system, estimation of design flood, development of flood forecasting and flood warning systems. Wide applications of infiltration theory have, therefore, led to development of several infiltration models by the researchers and scientists which include Green-Ampt model (1911), Kostiakov (1932), Horton (1938), Overton (1961), Modified Kostiakov (1972), Smith and Parlange model (1978) and Singh and Yu (1990) (Mishra et al. (2003)). The suitability
Influence of thickness and position of the individual layer on the permeability of the stratified soil

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KEYWORDS
Permeability;
Stratified soils;
Porous media;
Porosity;
Seepage

Summary Flow of fluid through a porous media is a very important phenomenon that occurs largely in many physical situations such as flow in an aquifer, flow through filters for water purification in sewage treatment plant, flow in packed bed chemical reactor, etc. Permeability is a characteristic parameter for a porous media and it tells about the ease with which water flows through the interconnected voids. Since it directly influences the rate of flow of water in a soil, it has a decisive effect on problems involving excavations of open cuts in sand below water table, seepage through embankment dams, sub-grade drainage, rate of consolidation of compressible soil, etc. In a soil profile, each layer may have its own properties which may or may not be same as compared to the layer below or above it. The relative position and the thickness of a soil layer of a stratified soil system are some of the important parameters which affect the permeability of the composite soil layer. In the present study the experiments have, therefore, been conducted to investigate the influence of position and thickness of the individual layer on the permeability of the composite soil. It has been found that thickness of end layer has significant effect on the permeability of stratified soils.

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Introduction

Permeability of soil is one of the most important soil property which allows the water to pass through the interconnecting voids. Soil, a naturally occurring material present on the surface of the earth is of utmost importance in various civil engineering works such as construction of multi-story buildings, bridges, highways, canals, etc. In nature, soil is present in the form of layers and each layer having its own set of properties which makes it different from the layers above or below it. In the present study, the effect of thickness and position of the individual soil layer on the permeability of the two layered stratified soil has been investigated. The permeability of soil when soil profile
Regional flood frequency analysis: comparison of L-moment and conventional approaches for an Indian catchment

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ABSTRACT
A realistic estimation of flood magnitude for a given return period is essential for successful operation and economical design of pivotal hydraulic structures such as dams, reservoirs and spillways, bridges, small culverts, urban drainage systems, flood plain zoning, economic evaluation of flood protection projects, etc. The flood frequency analysis is generally used for flood estimation, entirely based on the assumption that the floods are random and the floods in future are supposed to bear similar statistical properties that have occurred in the past. If adequate data are available at-site flood frequency analysis is used, otherwise regional flood frequency analysis (RFFA) is preferred for flood estimation. The RFFA for various small and medium catchments of India with different approaches have been carried out and reported in the literature. The focus of the present study is to carry out the RFFA using different approaches i.e. conventional method and L-moment and comparing the results for the Krishna and Penner subzone 3(h) of India. It was found that the values of growth factors obtained by the conventional method are higher than those of L-moment methods, thus leading to conservative estimate of the peak floods.

1. Introduction
Successful operation and economical design of any water resource project is possible only with correct estimation of future hydrologic events. Pivotal hydraulic structures such as dams, reservoirs and spillways, bridges, small culverts, and urban drainage systems are designed using flood magnitudes and their frequencies occurred in the past using flood frequency analysis. Frequency of occurrence of a hydrological event is related to its magnitude. The occurrence of severe storm is lesser than storm of lesser magnitude. Plotting Position formules such as California, Modified California, Gringorten and Weibull, etc. are used to calculate the probability of being equaled or exceeded at least once, reciprocal of which is return period of the flood of that magnitude. For smaller values of return period, plotting position formule can be used but when larger extrapolation is involved theoretical probability distribution or frequency distribution have to be used. Some of the commonly used theoretical frequency distributions are Normal, Log Normal, Gumbel, Pearson type-III, Log Pearson type-III, generalized extreme value distribution (GEV), etc.

When no data are available at the site, or the data available are too short, or the data available are not representing the present condition of the basin due to change in basin characteristics like urbanization, all three conditions are very common in developing nations, regional flood frequency analysis (RFFA) is used for reliable estimation of floods. Dalrymple (1960) developed a method to carry out homogeneity test to define the region as a whole. Upper and lower limit of 95% confidence curves are plotted on a curve of year of record on ordinary scale as abscissa and return period as ordinate in log scale. The stations falling outside the 95% upper and lower limit curves are considered non-homogeneous and therefore discarded for further analysis. Tasker (1979) applied a network analysis for regional information to Northern Arizona using network analysis for regional information quite similar to the regional regression. Greenwood et al. (1979) found GEV distribution as the base distribution suiting best and method of probability weighted moment (PWM) as the parameter estimation method for short length available record samples, or highly skewed, or highly kurtotic data. Hosking and Wallis (1997) state that L-moments (can be referred as modification of PWMs) are an alternative system of describing the shapes of probability distributions. Kumar et al. (1999) developed regional flood frequency curves for seven subzone of zone 3 and combined Zone 3 of India. They used PWM-based at-site, at-site and regional, and regional methods using extreme value-1, GEV, and Wakeby distributions and USGS for comparative flood frequency studies and found PWM based at-site and regional GEV method to be robust for comparative flood frequency studies. Kumar et al. (2003) applied L-moment based RFFA on middle Ganga plain subzone 1(f) of India. Discordancy and Homogeneity of the region was tested using the L-moments based discordancy measure and heterogeneity measure; 8 out of 11 bridge sites found to constitute a homogeneous region. GEV distribution was found to be robust among various distributions based on L-moment ratio diagram and [Z_{i}^{*}] Kumar et al. (2005) compared the flood frequency estimate of gauged and ungauged catchments; with and without meeting the criteria of regional homogeneity. GEV distribution was found to be robust. Soft computing techniques have been used for
Reliability Analysis of Pier Scour at Gravel-Bed Rivers Using FORM

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Abstract- A correct and reliable assessment of scour depth at bridge pier is of prime importance in safe and economical design of bridge pier foundation. An attempt was made to develop a reliability-based scour depth prediction model at bridge pier in gravel bed-rivers. A developed deterministic scour predictions model by Melville and Sutherland (1988) and an object oriented constrained optimization using spread sheet algorithm for FORM have been used for the reliability analysis in present study. To achieve a desired safety level in the design of pier foundation, reliability based safety factor is proposed. It was found that the reliability index increases rapidly with the increase in safety factor whereas, an increase in safety factor results in decrease in failure probability at faster rate.

Keywords—Reliability, First order reliability method, Bridge Pier, Gravel bed-rivers.

I. INTRODUCTION

Scour at the bridge foundation is the most common cause of bridge failure in the world. Bridge pier scouring is, therefore, an important issue in the safety evaluation of bridges. To avoid such failures, the pier foundation has to be deeper than the maximum possible scour depth. Hence a reliable estimate of maximum possible scour depth around a bridge pier is essential to assure a safe and economic bridge foundation design. The process of scour around bridge pier is extremely complex because it involves three-dimensional flow with the sediment transport. The boundary layer flow past a bridge element undergoes a three-dimensional separation. This separated shear layers rolls up along the obstruction to form a vortex system in front of the obstructing element, which is swept downstream by the flow. When viewed from the top, this vortex system has the characteristic shape of a horseshoe and is thus called a horseshoe vortex. The formation of a horseshoe vortex and the associated down flow around the bridge element results in increased shear stress and hence a local increase in sediment transport capacity of the flow. This leads to the development of a deep scour hole around the bridge element. The estimation of the scour extend and is depth at bridge sites therefore continue to be a major concern of the bridge designers. The process of bridge pier scour has been investigated extensively and many relationships are now available for estimation of the design scour depth for bridge piers in alluvial streams. The study on bridge pier scour in gravel bed-rivers is relatively scanty.

II. CHARACTERISTICS OF GRAVEL BED-RIVERS

The bed material of gravel bed-rivers is usually characterized by relatively large median size and large geometric standard deviation. During relatively large flood, all the finer particles in the bed material of such rivers move. When the discharge reduces, the coarser particles, which cannot be moved, accumulate on the bed surface and form a layer of non-movable particles on the bed. This is known as armour layer or paving. For lower discharges there is no sediment transport, since original bed material is overlain by the armour layer. The bed material can then be termed as layered or stratified material. The standard deviation of the top layer is much smaller than that of the original bed material and the sediment is usually coarser in size, and the top layer that has a thickness of one or two times the largest size in the bed material. In case of bridge pier founded in gravel-bed rivers, as the scour progresses during the passage of flood, coarser particles will accumulate in the scour hole than that in alluvial rivers which is generally have relatively finer bed material size and more uniform gradation [1]. In the upper reaches, riverbeds are commonly composed of a mixture of different sizes of sand and gravel. Under the varied stream flow velocities, a process of armoring on the riverbeds commences, resulting in an exposure of coarser particles due to washing out if the finer fraction. The armour layer is of concerns to estimate scour depth at bridge pier where the pier is embedded in the sand bed overlain by layer of gravels. A larger scour depth develops at pier embedded in an armored bed unless a secondary armor layer developed within the scour hole. This scouring potential was first recognized by [2] and the scour at circular piers in armored beds was studied by [3]. The codes namely [4] and [5] that are to be followed in engineering practice in India for design against scour, recommended the use Lacey’s formula for computation of the regime depth and involving discharge intensity q, with a silt factor of 24 for scour computation in gravel bed-rivers. The scour depth below the high flood level (HFL) is estimated to be equal to twice the Lacey’s depth of flow in the river. This raises the basic equation as to whether gravel-bed river data follow Lacey’s relation for depth.

Analytical, semi-empirical or empirical scour equations based on the mechanics of scour, the dimensional analysis and the data correlation of laboratory experiments or field observations were developed [6], [7], [8], [9], and [10]. Scour Phenomena are complex in nature and consequently experimental investigation were limited to certain aspects by
ABSTRACT

Evaluation of morphometric characteristics of watershed is the fundamental requirement for sustainable planning and development of its resources. Quantitative morphometric characteristics (viz. linear, relief and aerial) of Kosi river sub watershed in Ramnagar, Uttarakhand are evaluated by utilizing Cartosat-1 Digital Elevation Model (Carto DEM) with 30 meter resolution downloaded from BHUVAN (ISRO’S GEOPORTAL) using Arc Hydro tools in Arc GIS 9.3 software. Drainage map of the study area prepared reveals a dendritic drainage pattern with sixth order stream network comprising of a total of 315 numbers of streams. The length of the major sixth order stream of the sub watershed is 4.78 km. The average bifurcation ratio of the basin is 3.2 which is indicative of the fact that the drainage pattern is not influenced by the geological evolutions and disturbances in the recent past. The drainage density of 1.15 km/km² indicates impermeable subsoil material with dense vegetative cover and moderate mountainous relief with low infiltration. The elongation ratio of 0.62 infers that the basin is closer to a circular shape. In all, a total of 21 morphometric parameters including all aspects of the sub watershed have been evaluated and discussed in the present study. Hence, the study concludes that GIS techniques prove to be a competent tool in morphometric analysis which is further useful for planning rainwater harvesting and watershed management.

Keywords: Morphometric analysis, Drainage characteristics, GIS and Remote Sensing, Aerial, Linear, Relief aspects

1. INTRODUCTION

Watershed morphometric analysis provides the necessary parameters for the assessment of the ground water potential zones, identification of areas for implementation of water harvesting structures, water resource planning and management, surface runoff characteristics of the drainage system etc. In other words, morphometric analysis of a watershed provides a quantitative description of the drainage system, which is an important aspect for the characterization of watersheds through the measurement and mathematical analysis of the configuration of the earth's surface, shape, dimension of its landforms ([1],[2]). Morphometric analysis requires measurement of linear features, aerial aspects and gradient of channel network of the drainage basin ([3]).
DISCHARGE COEFFICIENT FOR SIDE COMPOUND WEIRS IN OPEN CHANNEL

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ABSTRACT

A side compound sharp crested weir is a flow diversion structure provided in one or both side walls of a channel to spill/divert water from the main channel. Experimental programme for this study were conducted in Advance Hydraulic Laboratory of Department of Civil Engineering, Aligarh Muslim University, India. Dimensional analysis is carried out to estimate the functional relationship for the coefficient of discharge for side compound weir. It is found that the coefficient of discharge depends on the approach flow Froude number, the ratio of the weighted crest height of the side weir to the length of the side weir and the ratio of the upstream depth in the channel to the length of side weir. On the basis of F-test, it is observed that $P/L$ is the most significant parameter for the prediction of $C_d$. The developed relationship using regression approach for the coefficient of discharge for side compound weir gives root means square error is 0.0634. The performance of the present model is based on the coefficient of correlation of the non-linear regression line between predicted values from the present model and desired output ($R=0.8609$), average percentage error (APE=-2.356), Absolute average deviation (AAD=13.406), Standard deviation (STDV=10.13) and scattering index (SI=0.1675).

Keywords: Coefficient of discharge, Side compound weir, Froude number, Rectangular channel

I. INTRODUCTION

A side weir is a flow diversion structure, which is widely used in irrigation, environmental and hydraulic engineering as a head regulator of distributaries and escapes. Side weirs are also used in channel systems river-control structures, irrigation canals, water and wastewater-treatment plants and for storm water overflow from urban drainage systems. Other hydraulic structures used to divert flow are weirs (Ramamurthy et al. [1]); spillways, sluice gates (Swamee et al. [2]); orifices (Hussain et al. [3], [4], [5]) etc. The flow over a side compound weir is a special case of spatially varied flow. A side weir is designed to divert a certain amount of flow, and therefore knowing an accurate flow is important.

Due to the use of numerous geometric and hydraulic shapes of the side weir, and the various cross sections of channel in which the compound weir is placed, extensive research work has been conducted from various points
view for numerous types of side weir. Most of the earlier experimental studies and theoretical analyses were limited to the flow over side weirs in rectangular channel (e.g., De Marchi [6], Emiroglu et al. [7]), triangular channel (Vatankhah [8]), trapezoidal channel (Vatankhah [9]), and circular main channels (Uyumaz and Muslu [10]). Normally, weirs are rectangular in shape and have a restriction in cases where there is a need to divert flow varying from high to low-water levels. Therefore, a new shape of side weirs have been presented known as side compound weirs.

Some researchers have studied flow hydraulics in compound normal weirs, which are built across the channel. The first of them was the work of USBR [11], Martinez et al. [12] and Jan et al. [13] on different shapes of compound weirs. Their study describes the calibration and design of a normal compound sharp-crested weir consisting of two triangular parts with various notch angles. Rahimpour M. et al. [14] used experimental and theoretical approach to estimate the best flow of trapezoidal side weir under subcritical flow conditions. Aydin M. C. [15] studied the water surface profiles of the (triangular labyrinth side weirs) to describe the flow characteristics in the case of sub-critical flow, using CFD with Fluent code. They compared the discharge coefficients found from CFD results with experimental data of Aydin et al [16]. Zahiri et al. [17] carried out an experimental study on a rectangular compound side weir with variable heights and widths. They found that the discharge coefficient of compound side weirs has a high correlation with three dimensionless parameters including upstream Froude number \( F_1 \), ratio of weighted crest height to upstream flow depth \( \bar{P}/y_1 \) and the ratio of weir length to upstream flow depth \( L/y_1 \).

The present study conducted laboratory experiments on free flow over side weirs that are composed of three rectangular weir. The lower weir is suitable for diversion and measurement of low-flow discharges, while the upper sections are appropriate for high-flow discharges. The main advantage of this special kind of side weir is that overflow discharges are measured and regulated with a reasonable sensitivity over wide flow ranges.

**II. DIMENSIONAL ANALYSIS**

There are different parameters involved in achieving the discharge coefficient of side compound weir. The physical characteristics of the experimental condition could be mentioned such as average velocity of flow over the cross section of the basin \( \bar{V} \), upstream depth of flow in channel \( y_1 \), acceleration due to gravity \( g \), crest length of side weir \( L \), width of main channel \( B \), weighted crest height of side weir \( \bar{P} \), dynamic viscosity of water \( \mu \) and density of water \( \rho \). The schematic view of side compound is shown in Fig. 1. Due to different crest heights of upper and lower weirs in a compound weir, the crest height should be replaced with the weighted crest height \( \bar{P} \) as following

\[
\bar{P} = \frac{w_1L_1 + w_2L_2 + w_3L_3}{L}
\]

Where, \( w_1, w_2, w_3, L_1, L_2 \) and \( L_3 \) are the parts of side compound weir as shown in Fig. 1.
The functional relationship for the compound side weir may be expressed as

\[ C_d = f(\bar{P}, B, g, v, y, \rho, \mu, L) \]  

(1)

Non-dimensional equations in functional forms can be written as below:

\[ C_d = f\left(\frac{\bar{P}}{L}, \frac{B}{L}, \frac{y}{L}, \frac{F}{\rho g}, \frac{\mu}{\rho v}\right) \]  

(2)

So that \( F_1 \) represents the approach flow Froude number. Influence of the Reynolds number, \( Re=\rho vL/\mu \) is relatively insignificant, and \( B/L \) is constant in the present study, hence, may be dropped from Eq. (2). The final functional relationship for \( C_d \) may, therefore, be expressed as

\[ C_d = f\left(\frac{\bar{P}}{L}, \frac{y}{L}, \frac{F}{\rho g}\right) \]  

(3)

To see the effect of various parameters on the coefficient of discharge, \( C_d \) and to establish relationship among the dependent and independent parameters of Eq. (3), experimental programme are carried out in present study.

III. EXPERIMENTAL PROGRAMME AND ANALYSES

1. Set-up and working principle

Experimental programs have been carried out in the Advanced Hydraulics laboratory of Department of Civil Engineering, Zakir Hussain College of Engineering & Technology (A.M.U.), Aligarh, India. The schematic representation of experimental set-up i.e. plan are shown in Fig. 2. The set-up consisted of a main channel and diverted channel. The length, width, and height of main channel were 12.8 m, 0.29 m, and 0.39 m, respectively. From the upstream end of the main channel at a distance 8.20 m, the side compound weir was provided in the right wall of the main channel. Discharge through the side weir was passed into a diversion channel of length, width, and height were 4.18 m, 0.2 m width, and 0.35 m, respectively and, then, move to a return channel. Discharge flowing through the side weir \( (Q_3) \) was measured by a rectangular sharp-crested weir \( -A_2 \) provided at the end of diversion channel. The total discharge measured by a rectangular sharp-crested weir \( -A_1 \) was provided at the end of the channel. Height of weir \( -A_1 \) and weir \( -A_2 \) are 20 cm and 10 cm respectively. Weir \( -A_1 \) and weir \( -A_2 \) were calibrated using well. Theoretical discharge through side compound weir has been calculated as Zahiri et al. [17].
In the present work four different weighted crest height i.e. 11.5 cm, 12.5 cm, 13.5 cm and 15.0 cm of side compound weir have been used. The width of each side weir was 20 cm. All side weirs were placed in the groove and levelled with wall of channel.

For each set of $\bar{P}$ twenty three to twenty five discharge $Q_1$ in the main channel were measured. The nappe were fully ventilated during the experimentation. Experiments were performed under free flow through the side weir and conducted under subcritical flow conditions only. The range of data collected in the present work have been listed in Table 1.

![Fig. 2 Layout of the experimental setup](image)

Table 1: Range of data collected for side weir in the present study

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Range of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q_1$</td>
<td>m$^3$/s</td>
<td>0.0028 - 0.0780</td>
</tr>
<tr>
<td>$Q_3$</td>
<td>m$^3$/s</td>
<td>0.002 - 0.031</td>
</tr>
<tr>
<td>$B$</td>
<td>m</td>
<td>0.39 - 0.39</td>
</tr>
<tr>
<td>$y_1$</td>
<td>m</td>
<td>0.125 - 0.340</td>
</tr>
<tr>
<td>$L$</td>
<td>m</td>
<td>0.20 - 0.20</td>
</tr>
<tr>
<td>$\bar{P}$</td>
<td>m</td>
<td>0.115 - 0.15</td>
</tr>
<tr>
<td>$F_1$</td>
<td>-</td>
<td>0.003 - 0.531</td>
</tr>
</tbody>
</table>
2. F-Test

To seek the importance of different independent parameter in predicting Coefficient of discharge, feature selection and parameters screening i.e. F-test have been carried out. When F-value of any variable compared to the F-value of other variable is very low. Then the least F value variable is dropped because this variable is considered as not affecting the whole value of the equation (Hussain et al. [18], Lomax [19]). All the three variables of Eq. (3) were taken for feature selection and variable screening process with Cd as dependent variable. The effect of different dimensionless variable i.e., \( \frac{P}{L} \), \( \frac{Y_1}{L} \) and \( F_1 \) on the coefficient of discharge (Cd) was examined by F-Test is shown in Fig. 3. Figure 3 shows that \( \frac{P}{L} \) possesses a high F-value i.e. it is the most effecting variable followed by \( \frac{Y_1}{L} \) and \( F_1 \).

![Fig. 3 Importance of various independent inputs in predicting output (Cd)](image)

3. Effect of various parameters on coefficient of discharge

The effect of the dimensionless parameter \( \frac{P}{L} \), \( \frac{Y_1}{L} \), \( B/L \) and \( F_1 \) as obtained by dimensional analysis on this computed \( C_d \) is examined. A thorough data analysis reveals that \( F_1 \), \( \frac{P}{L} \) and \( \frac{y}{L} \) is the predominant parameters which can affect the \( C_d \). For the range of data used in present study, \( C_d \) is unaffected by parameter \( B/L \). Variation of \( C_d \) with upstream Froude number is shown in Fig. 4, which clearly indicates a decrease in \( C_d \) with increase of \( F_1 \). Variation of \( C_d \) with \( \frac{y}{L} \) is shown in Fig. 5, which clearly indicates an decrease of \( C_d \) with increase of \( \frac{y}{L} \). Variation of \( C_d \) with \( \frac{P}{L} \) is shown in Fig. 6, which clearly indicates an increase of \( C_d \) with increase of \( \frac{P}{L} \).
Fig. 4 Variation of $C_d$ with upstream Froude number

Fig. 5 Variation of $C_d$ with $y/L$

Fig. 6 Variation of $C_d$ with $P/L$
IV. RESULT AND DISCUSSION

The present study is aimed at compiling the past observations on coefficient of discharge for side compound sharp crested weir, supplement them with new experimental results pertaining to effect of $P/L$, $y/L$ and $F_1$ on $C_d$ and reanalyzing resulting data bases by applying the technique of non-linear regression analysis with a view towards seeing if better prediction are possible. On the basis of the dimensional analysis (Eq. 3) and the existing relationships, $C_d$ can be expressed in the following linear model form:

$$C_d = k_1 + k_2 \left( \frac{P}{L} \right) + k_3 (F_1) + k_4 \left( \frac{y}{L} \right)$$

(4)

where $k_1$, $k_2$, $k_3$ and $k_4$ are constant. Using the available experimental data the values of constant $k_1$, $k_2$, $k_3$ and $k_4$ of above equation may be computed. Regression analysis has been carried out to obtain the values of constant $k_1$, $k_2$, $k_3$ and $k_4$ for the prediction of coefficient of discharge of side compound sharp crested side weir, in which 80% of the available data were selected randomly and contains maximum and minimum values. Following equation for the prediction of coefficient of discharge of side compound sharp crested weir has been obtained.

$$C_d = 0.738 + 0.899 \left( \frac{P}{L} \right) - 0.785 (F_1) - 0.231 \left( \frac{y}{L} \right)$$

(5)

Observed and calculated values of coefficient of discharge of rectangular sharp crested weir using Eq. (5) or the test data are compared graphically in Fig. 7, which revealed that the computed discharge is within ±10% of the observed ones, which is a satisfactory prediction of coefficient of discharge for side rectangular sharp crested weir. The qualitative comparison in terms of the performance parameters such as coefficient of correlation of the linear regression line between predicted values from the present model and desired output ($R$), mean absolute percentage error (MAPE), and root mean square error (RMSE) is shown in Table 2 for proposed relationship.

**Table 2 Performance parameters of proposed models**

<table>
<thead>
<tr>
<th>Source</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R$</td>
</tr>
<tr>
<td>Proposed Eq. 5</td>
<td>Training</td>
</tr>
<tr>
<td></td>
<td>Testing</td>
</tr>
<tr>
<td></td>
<td>All</td>
</tr>
</tbody>
</table>
Fig. 7(a) Comparison between computed and observed values of $C_d$ using present model for Training
V. CONCLUSIONS

In this study, an experimental investigation was performed to evaluate the discharge coefficient of side compound weir. Variation of $C_d$ with Froude number which clearly indicates the decrease of $C_d$ with increase of Froude number. It should be noted that the ratio of weighted crest height to crest length is an important parameter in the flow over a side weir. Therefore, its effect on $C_d$ for side weir is apparent. The variation of $C_d$ with $P/L$ indicates $C_d$ increases as $P/L$ increase. The variation of $C_d$ with $Y_1/L$ indicates that $C_d$ is inversely proportion to $Y_1/L$. Coefficient of discharge value decreases with increase of upstream Froude number which shows that coefficient of discharge is inversely proportional to upstream Froude number. Observed and calculated values of coefficient of discharge of side compound sharp crested weir using Eq. (5) for the test data are compared graphically, which revealed that the computed discharge is within ±20% of the observed ones, which is a satisfactory prediction of coefficient of discharge for side compound sharp crested weir. The proposed equation in found to produce results with a maximum error of ±20% for almost 100% of the total data. The qualitative performance of the present predictor indicates that it has lowest MAPE (14.284), RMSE (0.0634) and highest R (0.8609) as compared to other existing predictors.

REFERENCES


Study Of Submersible Hydraulic Structures, A Critical Review

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ABSTRACT

Submersible hydraulic structures such as Fords and Raptas are preferred mainly in mountainous regions where hilly roads cross many torrential rivers enroot to save the cost of the highway projects. The proper design and location of these structures are an important issue as these structures have to serve two main purposes i.e. passing of river water and also to cater the traffic demand simultaneously. In this paper a critical review of few important causeways are carried out. An attempt has been made to critically examine the nature of scour and deposition around them in various flow conditions and changing geometry of the natural streams. It is found that generally there are two types of causeways, one in the form of plane concrete slab without any vent over which water and traffic both move while in another type there are vent for passing water from u/s side to d/s and traffic move over the causeways. In both types there is scour and deposition which depends upon many factors such as type of causeways, intensity of discharge, sediment size and curvature of natural stream. Suitable precautionary measures are also suggested to reduce the scour.

KEYWORDS: Submersible structures, fords, causeway, scour, deposition

INTRODUCTION

Causeway is a road or railway route across a broad body of water or wetland raised up on embankment. Some causeways may only be usable at low tides and the distinction between causeways and via-ducts can become blurred when flood-relief culverts are incorporated in the structure. A causeway is however primarily supported on earth or stone, whereas a bridge or via-duct is mainly supported by free-standing piers or arches. Causeways (or Rapta) were constructed in ancient times by the people to save the enormous cost of construction of bridges and culverts at many locations where a single highway crosses many water bodies. The Traffic and cattle can easily cross the ever flowing rivers at very low depths throughout the year. At very high flow (Monsoon flood), a Rapta may wash away or a subsidized causeway has double functions:
(a) It allows the normal dry weather flow of a river/stream to pass through the culverts(vents) below the roadway and,
(b) The occasional floods pass both through the culverts and over the roadway. Because they have this dual functions, causeways present hydraulic problems which are peculiar to this type of structure and great care should be taken with their construction. Many causeways have failed because of improper location or an improper design. If the culverts (vents) are concentrated in the centre of the causeway, the high speed water jets coming out of these culverts will cause heavy scour at the sides of the culverts. This implies that in designing causeways the culverts (vents) should be distributed evenly throughout the length of the structure.

TYPES OF CAUSEWAYS

According to IRC: SP: 82-2008(Guidelines for design of causeways and submersible bridges) there are mainly three types of causeways:
Computation of Scour Depth Due To Rock Sills in Alluvial Channels

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Mohammad Athar
ZHCET, AMU, ALIGARH

ABSTRACT
The flow conditions variation around river bends or meanders can lead to riverbanks and structures failure, such as bridges, river passing pipe lines, diversion dams, water intakes and invert siphon. Rock sills are grade-control structures which are used to stabilized riverbed, riverbanks and improving aquatic habitat. In this paper an attempt has been made to develop empirical relationships for maximum scour around the rock sill for the data collected from literature using various software techniques. Statistical analysis has been done using MINITAB and IBM SPSS Statistics software to predict the nonlinear equation between the maximum scour depth and flow conditions. The equations predicted by both the softwares gave satisfactory results. The results predicted by IBM SPSS Statistics software are more accurate than the MINITAB software. Also Artificial Neuron Network (ANN) technique has been applied to verify the results obtained by the software. It is found that the so developed relationships predict the values of maximum scour within 10% tolerance limit. The ANN results are better than the two software analysis, thereby, ANN can be used in designing and solving complex field problems in water resources engineering.

Keywords Rock Sills, MINITAB, ANN, Scour, IBM SPSS.

INTRODUCTION
Most of the alluvial rivers generally meanders and take sinuous paths on its way. When the flow in such rivers passes through curved path, secondary flow develops on account of centrifugal force. Thus in the bend portion the main velocity or the longitudinal velocity overlaps with the transverse velocity thus generating helical motion throughout the bend.

Secondary flow induced by the streamline curvature to redistribute mass, momentum, boundary shear stress, and sediment transport and thereby plays an important role with respect to the water quality, velocity distribution and river morphology.

Due to the transverse velocity, phenomena of scouring and deposition at the outer bend and the inner bend respectively occurs. The outer banks in channel bends are most vulnerable to scour. Bend effects redistribute the flow velocity over the river width, causing a velocity increase in the outer half of the cross section and thus an intensified attack on the outer bank. Moreover they create a typical bar-pool bed topography, with significantly increased depth near the outer bank due to bend scour, which may undermine the outer bank.

Both bend effects can, to a large extent, be attributed to the secondary flow which is a characteristic feature of flow in open channel bends. Since secondary currents develops at the bends, their general tendency is to scour at its outer edge and deposit the same materials at it inner bend. This may lead to the damage of any hydraulic structures such as bridges, river passing pipelines, diversion dams, water intakes and invert siphons.

Grade control structures are used to stabilized riverbed, riverbanks and improving aquatic habitat. Various measures have been taken to minimize the scour effects at the curve by protecting the outer bank by footing, spur dike or by the introduction of J-hook vanes at the curved channels. The protection of river banks against
Storage Tanks for Rain Water From Roof Catchment in A.M.U. Campus, A Case Study

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ABSTRACT
With the increase of population in urban areas, the demand of water is also increasing drastically. Rain water is the fresh water available in plenty amount which if harvested will be asset for the use of people in many ways. Aligarh Muslim University (AMU) is situated in district Aligarh. The rain fall condition of the city including AMU area is moderate. During rainy season of four months from June to September, scanty amount of water is available in the area coming as rain. The ground water table is going below and below drastically due to larger use of this water. This paper presents the need, design and cost estimate of a surface and sub-surface reservoirs to store rain water during monsoon periods which may be used in number of ways. For this purpose few larger buildings of AMU are selected and only detailed design and estimate of one new building (Bibi Fatima Hall for girls students) in Aligarh Muslim University Campus has been discussed.

KEYWORDS: Rainwater, Rainwater Harvesting System, Storage Tank, Dugwell.

INTRODUCTION
Rain Water Harvesting is an artificial technique which makes use of the collection (trapping) of rain water during monsoon period from the paved surfaces such as roofs of the buildings, towers and roads where water cannot infiltrate into the ground directly. The rain water which is a precious commodity and needed everywhere for a sustainable livelihood for living beings (human and animals) may be used in many ways such as washing, bathing, irrigating lawns and gardens in general and improving ground water table in particular by recharging this water directly into ground through various ground water recharging systems. This technique is also used in many countries such as America, Kenya, Japan, Thailand, Egypt, Indonesia, Pakistan, Brazil, China etc. For water collection wooden made tanks were used in USA. Fero-cement tanks were used in Kenya. Roman Villas and even whole cities were designed to take advantages of rainwater as the principal water sources for drinking and domestic purposes since at least 2000 B.C. In the Negev desert (Israel), tanks (ground reservoirs) for storing runoff from hill sides for both domestic and agricultural purposes. In India in many metropotan cities like Bombay, Delhi, Chennai etc. the rain water harvesting system from roof catchment of multistoried buildings are in practice. In Darjeeling it is mandatory for each house hold not to allow rain water to fall the road aside but to collect it and then either use it or let it to pass through side drains. In this thesis an attempt has been made to plan, design and construct rain water harvesting as well as recharging systems for A.M.U. Campus. Few selected buildings of AMU campus have been selected for the study. The design details of water collecting tanks and estimates of cost of only only one new building has also been presented here.
Experimental Studies of Scour and Protection around Causeways

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Abstract: Causeways also known as Raptas are the raised surface generally made of concrete laid on river bed across it, where river crosses the roads or highways. Whenever water flows over the causeway, it scours the upstream as well as downstream edges of the causeways leading to its structural failure. In this paper an attempt has been made to carry out extensive experimental studies on scour around the edges of the causeways on its upstream as well as downstream sides. Experiments have been carried out in 20m long, 0.74m wide and 0.60m deep laboratory flume. Models of Rapa were constructed by concrete blocks in 0.20m width with overall depth changing from 0.06m to 0.23m. A constant discharge of 1l/s was passed over the causeway maintaining a constant velocity of 0.135m/s and Froude No. as 0.379. Data of scour depths have been collected on predetermined nodal points along the edges of the causeways with time varying from one hour to 24 hours. The results of scour are presented in the form of graphs. Also, methods have been suggested for its mitigation.

Keywords: Causeway, Scour, Protection, Depth of Flow, Scour depth

1. INTRODUCTION

Causeway is a road or railway route across a broad body of water or wetland raised up on embankment. Causeways mainly serve two functions. Firstly, it allows the normal dry weather flow of a river/stream to pass through the culverts (vents) below the roadway and the occasional floods pass both through the culverts and over the roadway. Some causeways may only be usable at low tides and the distinction between causeways and via-ducts can become blurred when flood-relief culverts are incorporated in the structure. A causeway is however primarily supported on earth or stone, whereas a bridge or via-duct is mainly supported by free-standing piers or arches.

Causeways (or Raptas) were constructed in ancient times by the people to save the enormous cost of construction of bridges and culverts at many locations where a single highway crosses many water bodies. The Traffic and cattle can easily cross the ever-flowing rivers at very low depths throughout the year. At very high flow (Monsoon flood), a Rapta may wash away or a subsidized. Few typical views of few causeways may be seen in Fig.1.

Garouti -Tindwari Causeway, Dist. Banda, U.P (India) 
Kewai Causeway at River Kewai M.P (India)
Mechanism of vortex motion

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ABSTRACT
Present paper deals with the experimental investigation of flow mechanism such as velocity and water surface profile inside the vortex chambers. Extensive data have been collected in the laboratory on two types of vortex chambers, one being simple model chamber and other was a pilot model of the vortex chamber. In model vortex chamber, only the tangential velocity and water surface were measured with pitot tube and vertical pressure gauge meter respectively while in pilot model of the chamber, these parameters were measured using Programmable Electro Magnetic Shunt flow meter and vertical pressure gauge meter respectively. It is found that in both type of the chambers, the tangential velocity conforms the free and forced vortex laws i.e. for forced vortex $\omega \propto r$ and for free vortex $\omega \propto 1/r$. Water surface profiles for free and forced vortex motions are the hyperboloid and paraboloid of revolution, respectively.

1. Introduction
A rotating mass of fluid is known as vortex and the motion of rotating mass of fluid is known as vortex motion. The vortex motion is of two types viz. free vortex motion and forced vortex motion. A free vortex motions is that in which the fluid mass rotates without any external force being impressed on it. In this motion the whole of the moving mass of fluid rotates either by virtue of some internal action or due to rotation previously imparted to it. Hence, in a free vortex motion no expenditure of energy from any external source takes place. Some of the examples of free vortex motion are: a whirlpool in a river, the flow of a liquid drained through an outlet provided in the bottom of a shallow vessel such as a wash basin or a bath tub draining water through an outlet at a bottom, flow around a circular bend in a pipe system, flow of liquid in a centrifugal pump casing after it has left the impeller, flow of water in a turbine casing before it enters the guide vanes etc.

A forced vortex motions that in which the fluid mass is made to rotate by means of some external source of power, which exerts a constant torque on the fluid mass, thereby causing the whole mass of fluid to rotate at constant angular velocity $\omega$. As such in a forced vortex motion there is always a constant external torque required to be applied to the fluid mass resulting in an expenditure of energy. A most common example of a forced vortex motion is that of vertical cylinder containing liquid rotated about its central axis with a constant angular velocity. Some of other examples of forced vortex motion are the flow of liquid inside the impeller of a centrifugal pump, flow of water in a runner of a turbine etc.

A vortex motion may also be characterized as cylindrical vortex motion and spiral vortex motion. A cylindrical vortex motion, is that in which the fluid mass rotates in concentric circles i.e. this motion may be described by concentric circular streamlines. A spiral vortex motion is a combination of cylindrical vortex motion and radial flow that is, when a cylindrical vortex motion is superimposed over the radial flow, then the resulting vortex motion is known as spiral vortex motion.

All these types of vortex motions can exist independent of each other so that any of the four types of the combination of vortex motions is possible, viz. (a) Cylindrical free vortex (b) Cylindrical forced vortex (c) Spiral free vortex and (d) Spiral forced vortex. In actual field conditions such as in vortex tube, vortex chamber type sediment extractor, tornados, cyclone etc., a combined affect if free as well as forced vortex motion is observed, which is known as Rankine vortex.


A brief review has been presented concerning the flow development in vortex chambers by mainly observing the tangential velocities (Table 2). A smaller numbers of studies are however available in which both the tangential and radial velocities are measured for study of flow pattern (Table 3).

Very few investigators have studied about water surface profile inside the vortex chamber (Table 4). Anwar (1965), Julien (1985) and Vatistas and Odgaard have presented equations to predict water surface elevation in small vortex model chamber.
Developing Stage-Discharge Relations using Optimization Techniques

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ABSTRACT

Accurate estimation of discharge in rivers forms the basis of efficient flood management and surface water planning. However, continuous measurement of discharge in a stream is impractical, therefore, discharge in natural streams is generally estimated using the stage-discharge relationship. The reliability of discharge predicted from rating curve depends on the accuracy of the method used in developing stage-discharge relationship. Generalized Reduced Gradient (GRG) solver has been reported as a powerful optimization tool for handling nonlinear optimization problems, therefore, present work is an implementation of Generalized Reduced Gradient technique to determine rating curve parameters. Spreadsheet based nonlinear optimization has been applied to model the rating curve for two gauging sites viz. Walton site on Chocatwahatchee river and Philadelphia site on Schuylkill river, USA. The stage-discharge relationships for the two sites were also developed by using Genetic Algorithm (GA) and classical rating curve approach rating curve. Comparison of results shows that rating curve equations developed by using GRG technique are as effective as those developed by GA and more accurate than classical rating curve approach. The goodness of fit criteria for both the sites shows that the rating curves obtained by using GRG technique fit the observed data better than classical rating curve approach.

Keywords: discharge, rating curve, optimization, GRG, conventional method

INTRODUCTION

Streamflow measurement is the basic data required for most of the hydrologic studies such as flood frequency analysis, flood plain zoning, sediment studies, water demand and computation of standard project flood. Accurate stream flow measurement plays a vital role in accurate determination of peak discharge required for the safe and economic design of various hydraulic structures.

Developing rating curves has remained an area of interest of hydrologists and has been interchangeably studied by hydrologists. Stage discharge relationship was established using graphical method by Herschy (1995). Polynomial models for stage discharge relationships were also proposed by Herschy (1995, 1999). Tawfik et al. (1997) applied multilayer artificial neural network (ANN) for modelling the rating curve. Jain and Chalisgaonkar (2000) used ANN for modelling stage discharge relationship for Kolar river and Jamtara site on river Narmada. They also successfully utilised ANN to model the hypothetical hysteresis loop curve for unsteady flow condition. To assess the performance of radial basis function (RBF) neural network for modelling the rating curves Sudheer and Jain (2003) analysed the data set of Jain and Chalisgaonkar (2000) and reported RBF to be better than back propagation multilayer perceptron model. Deka and Chandramouli (2003) presented the application of fuzzy integrated neural network for developing a reliable stage discharge relationship (Zakwan et al., 2017). Bhattacharya
Application of Data Driven Techniques in Discharge Rating Curve - An Overview

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ABSTRACT

Establishing a reliable rating curve is an integral part of water resource engineering. The present paper is a review of data driven techniques used for modelling the stage discharge relationship over the last two decades. Over the year’s several data driven techniques such as ANN, SVM, MT, fuzzy logic and GA have been applied by researchers in quest of arriving at a reliable technique to model the stage discharge relationship. Although, during this period several techniques have been used to establish the stage discharge relationship but the application of modern optimization tools such as ACO, PSO or PS has remained limited in this field. Therefore, application of modern optimization techniques and their comparison with existing literature would be appreciated in near future.

Keywords: data driven techniques, optimization, rating curve, review

INTRODUCTION

Management of water resources require input in the form hydrologic variables such as rainfall, runoff or discharge in streams. Over any given region, the quantity of water flowing in streams may vary widely in both time and space. The fluctuation in discharge and water level results from variation in duration, frequency, intensity, areal cover of precipitation and variation in the catchment characteristics. Knowledge of river flow and its variability is an essential requirement for assessment, management and control of surface water resources. Records of discharge measurement in a river are the basic data required for flood frequency studies, flood inundation modelling, design of flood protection and warning systems, river sediment management, water supply engineering, drought studies and geomorphologic studies.

Stage discharge relationships or rating curves are generally modelled by two approaches. One is the numerical approach which requires accurate information regarding channel geometry and flow boundary conditions. The other approach is a data driven approach based on non-linear regression. The review of the later approach is the main focus of this paper.

Conventional method of establishing stage discharge relationship through application of linear regression on log transformed data often fails to provide a reliable estimate of discharge. This led to the application of several data driven techniques such as Artificial Neural Network (ANN), Support Vector Machine (SVM), MT, Takagi-Sugeno (TS) fuzzy inference, Genetic Algorithm (GA) and Generalized Reduced Gradient (GRG) by researchers in quest of reliable modelling of stage discharge rating curves. Several researchers have compared various modelling techniques applied for modelling stage-discharge relationship but the comparison among the modelling techniques yielding functional form of stage-discharge has been limited. Although machine learning techniques such as ANN and SVM have been found to estimate discharge with fair accuracy yet, at times when functional form of stage-
Flow Characteristics in a Curved Channel: Review Paper

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ABSTRACT
Flow in a curved channel is very complex which follows a helicoidal path. In the curved channel due to the generation of secondary flow or curvature induced flow the flow characteristics changes significantly. Secondary flow induced by the streamline curvature redistribute mass, momentum, boundary shear stress and sediment transport. Therefore, secondary flow plays an important role in water quality, velocity redistribution and river morphology. This paper reviews work published about the flow characteristics in a curved open channel. Various hydraulic and geometrical parameters like bend radius, Froude number, sinuosity, width of the channel, angle of the bend has been taken into account by the previous researchers to study its effect on the lateral velocity, longitudinal velocity, shear stress distribution etc.

Keywords
Curved channel, Secondary flow, Shear Stress, Lateral velocity

INTRODUCTION
In a river corridor system, rivers play an important role in the provision of water and habitat to the surrounding fauna and flora. Natural alluvial rivers and streams often exhibit a curved main river and one or two corresponding floodplains. When a flood occurs, the flow depth increases and the floodplains are submerged to convey the extra flow, leading to overbank flow in the meandering compound channel. It is important to note that the flow characteristics in a curved channel are very different to that in a straight one, especially with regard to the generation mechanism of main channel secondary flows. Accordingly, it is necessary to assess the changes of the velocity, secondary flow, bed shear stress and discharge in the meandering compound channels. To determine sediment transport, channel morphology and bank erosion, the lateral distributions of depth-averaged velocity and bed shear stress are crucial. These researchers showed that the secondary flows affect the predictions of velocity and bed shear stress significantly.

Rivers is the main source of providing water supply for domestic, irrigation, industrial consumption or transportation and recreation uses. River channels do not remain straight for any appreciable distance, the major problems encountered in many hydraulic structures is the flow separation.

Flow in a curved open channel follows a helicoidal path. Secondary flow is defined as the flow component perpendicular to the channel axis. Secondary flow induced by the streamline curvature is known to redistribute mass, momentum, boundary shear stress, and sediment transport and thereby plays an important role with respect to the water quality, velocity distribution and river morphology.

LITERATURE REVIEW
A brief review of work published about the characteristics of flow in an open curved channel is listed below:-
Sankalp, S. et al. (2015) studied the shear stress distribution in meandering channels from the analysis of data of previous researchers. Various hydraulic and geometrical parameters such as sinuosity, aspect ratio, Reynolds no., Froude’s no. have been considered for establishing its relationship with the shear stress. The results obtained from the study shows that 60% of the total shear force acts on the inner wall of the bend. The
DISCHARGE CHARACTERISTICS OF SEMI LABYRINTH SLUICE GATE

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ABSTRACT

Sluice gates are generally used for measuring, controlling and diverting the discharge through open channels in different branches of engineering like irrigation, flood control, chemical, environmental etc. The discharge passing through a sluice gate mainly depends on upstream water depth, sluice gate opening, channel width and discharging conditions. Influence of the ratios of upstream depth to gate opening and tail water depth to gate opening on discharge coefficient has been investigated for normal, side and skew sluice gates. Skew sluice gate provides more lip length in the limited channel width and hence passes more discharge as compared to the normal sluice gate. Lip length can also be increased by providing keys at the bottom of normal sluice gate. In the present study, rectangular keys have been provided at the lip of sluice gate to enhance its discharging capacity. Three different configurations have been tested and the results of this study have been reported herein. It has been found that the discharge through semi labyrinth sluice gate increases with the increase in number of keys as compared with the normal sluice gate. Further, afflux is reduced with the increase in number of keys.

Keywords: Labyrinth Sluice gate, Discharge coefficient, Gate opening, upstream depth, rectangular keys.

1. INTRODUCTION

Hydraulic structures are constructed across and under the open channels and most significantly used to disrupt, control and divert the flow. Weir, flumes, dams, sluice gate are some examples of the hydraulic structures. Sluice gates are mainly used to measure, divert and control the flow in various branches of engineering like water supply, irrigation, power generation etc. Shape and alignment of sluice gate play an important role in affecting the discharge characteristics of sluice gate. Normal sluice gate is orthogonal to flow direction, side sluice gate is aligned along the flow direction and a skew sluice gate has a certain angle with the channel axis.

A review of literature shows that, lot of work has been done on normal and side sluice gates. Henry (1950) from his experimental work showed that for flow under the sluice gate the coefficient of discharge mainly depends upon two factors: (i) the ratio of upstream flow depth to gate opening (ii) ratio of tail water depth to gate opening, for free and submerged flow condition. Henry’s findings were later confirmed by Rajaratnam and Subramanya (1967). Rajaratnam et. al., (1997) provided an equation for the calculation of discharge coefficient by using the theoretical approach for free submerged and free flow conditions. They also provided the criteria to differentiate between submerged and free flow. Hager & Volkart (1986) proposed an equation for discharge variation in terms of energy and flow depth through side sluice gate. Swamee et al (1993) utilized the concept elementary discharge coefficient to evaluate the discharge through rectangular side sluice gate. Ghodsian et. al., (2003) carried out experiment on side sluice gate and obtained that the specific energy in the main channel remains constant and discharge coefficient for free flow under the side sluice gate is a function of Froude number and ratio of upstream...
Lateral flow through the sharp crested side rectangular weirs in open channels

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1. Introduction

Flow through side weir represents gradually varied flow with non-uniform discharge. The discharge in the channel varies along the length of channel due to lateral withdrawal of water from the channel. The side weirs are widely used in river-control structures, river-intake facilities, irrigation canals, water and wastewater-treatment plants, reservoirs and dams. They commonly convey excess flows into an offstream storage (for flood control) or to divert clean water into a diversion channel. The study of diversion of flow from main channel to sub-channel, main river to another river or main canal to sub-canal are important aspects for the hydraulic engineering. The various hydraulic structures used to divert flow are weirs, spillways, sluice gates, intakes, orifices etc. [15,17,18,20,28,29]. Typical example of flow with decreasing discharge is channel side weir used for diverting water for drainage or irrigation, flood schemes relief etc.

A side weir, also known as lateral weir, is a free overflow weir set into the side of a channel, allowing part of the liquid to spill over the side when the free surface of the liquid in the channel rises above the weir crest. This type of structure is usually a long rectangular notch installed along the side of channel. In irrigation engineering, side weirs of broad crests are used as head regulators of distributaries and escapes.

In previous studies, side weirs were studied extensively because of their wide range of applications in hydraulic and environmental engineering. Probably the first theoretical approach to the hydraulics of a side weir in a rectangular channel was reported by De Marchi [8]. Most of the earlier experimental studies and theoretical analyses were limited to the flow over side weirs in rectangular channel [8,11–13,25,27,31,7]; triangular channel [32], trapezoidal channel [33], and circular main channels [31,14].

Many Researchers have formulated coefficient of discharge equation for side weirs [2]. Expression for coefficient of discharge for simple rectangular sharp-crested side weirs have been developed by Subramanya and Awasthy [27], El-Khashab [10], Ranga Raju et al. [25], Hager [14], Singh et al. [26], Jallili and Borghesi [21], Borghesi et al. [7], Emiroglu et al. [12] and Honar and Javan [16] investigated the effect of oblique side weirs on the coefficient of discharge under subcritical flow condition in rectangular channels. Aghayari et al. [1] investigated

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Causes of Failure of Earthen Dams and Suggested Remedial Measures

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ABSTRACT

Dam is a solid barrier constructed at a suitable location across a river valley to store flowing water. Earth Dams are mainly built with clay, sand and gravel, hence they are also known as Earth fill dam or Rock fill Dam. They are trapezoidal in shape. They are constructed where the foundation or underlying material or rocks are weak to support the masonry dam. Earthen dams are relatively smaller in height and broad at the base. Earth Dams are less rigid and hence more susceptible to failure. Earth Dams may fail, like other engineering structures, due to improper designs, faulty considerations, lack of maintenance etc. The various causes leading to the failure of earth dams can be grouped into three categories i.e. Hydraulic failure, Seepage failure and Structural failure. About 40% of earth dams failure have been attributed to hydraulic failure. The failure under this category may be due to overtopping, wave erosion, top erosion and gullying. Uncontrolled or concentrated seepage through the dam body or through its foundation may lead to piping or sloughing and the subsequent failure of the dam. More than 1/3rd of the earth dams have failed because of these reasons. About 25% of the dam failures have been attributed to structural failures. Structural failures are generally caused by shear failures, causing slides. Various remedial measures has been suggested for controlling dam failures. This includes treatment of control of excessive seepage, structural defects failure and non-structural defects failure. This paper deals with the various causes of failure of earthen dams and the various remedial measures.

Keywords  
Earth Dams, Hydraulic failure, Seepage Failure, Structural Failure, Clay core

INTRODUCTION

Earthen Dams are the dams which are built with highly compacted soil or rock fragments. Earthen dams and earthen levees are the most ancient type of embankments, as they can be built with the natural materials with a minimum of processing and primitive equipment. This dam is classified as a type of embankment dam, being built in the shape of an embankment or wedge which blocks a waterway. These dams have been built by various human societies for centuries, and they continue to be produced in some regions of the world when they appear to be suitable for the location and intended use. Earth dams can be very cost effective to build, which makes them appealing in some regions of the world. They can be made with local materials, cutting down on the expenses involved in acquiring and transporting materials to the dam site. In addition to earth, earth dams also often contain rock, and may be filled with a core of rock. Clay is another building material utilized in the core region of the earth dams to fully cut the seepage through the body of the dams.

The design of an earth dam may be solid and consistent all the way through, or it may include layers of material. Layered materials may create an avenue for drainage which is designed to relieve pressure in emergencies. The weight of the dam as a whole creates a tight seal which secures the bottom and sides of the dam and the pressure of the water behind the dam can also act to seal the dam in place. Likewise mass concrete dams, earthen dams may also be utilized in number of purposes such as flood control, irrigation, domestic water supply and power generation etc. Numerous designs can be used and software programs designed for engineering earth dams can be utilized to test possible scenarios to confirm that the earth dam will be safe once it is finished. For earthen
Velocity Distribution in Vortex Settling Basins

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ABSTRACT

Present paper deals with the results of the experimental investigation regarding the velocity distribution inside the vortex settling Basins. Data are collected in the laboratory on vortex chamber type settling basins with two geometric configurations. A Programmable Electro-Magnetic Shunt (P.E.M.S.) flow meter is used to measure the tangential and radial components of velocity along vertical, tangential and radial directions at well defined nodal points inside the basins. Graphs for tangential and radial velocities are plotted, at various depths along radius of the basins at 8% water abstraction ratio. It is found that velocity distribution throughout the chamber is not uniform due to unsymmetrical positions of inlet, outlet channels and under flow outlet. In some part of the chamber it follows the law of Rankine vortex type velocity distribution.

KEY WORDS
Velocity Distribution, Vortex Chamber type settling basin, Rankine Vortex, Water Abstraction Ratio, Tangential and Radial Velocities.

1. INTRODUCTION

To trap the silt from the canals, many silt trapping devices such as conventional settling basin, tunnel type extractor, vortex tube are in common use. All these devices have their inherent advantages and disadvantages. It was found after extensive literature survey that about 20 to 25 % canal discharge is needed to extract the silt from the canal. A vortex chamber type settling basin/extractor is a device which requires only about 8 to 10 % canal discharge to extract same amount of silt with same silt gradation and silt charge. It is a fluidic device, which makes use of the vortices of the flow in a chamber or a basin for separation of sediment particles from the flow. A higher velocity flow is introduced tangentially into a cylindrical chamber/basin having an orifice/outlet at the center of its bottom. This gives rise to combined vortex conditions (Rankine vortex) with forced vortex near the orifice at the center and free vortex in the outer region towards the periphery. Sediment particles being heavier than water are forced towards the periphery of the chamber due to centrifugal force imparted by vortex flow to them. The secondary flow resulting due to combined vortex causes the fluid layers near the chamber periphery to move towards the outlet orifice at the center along the chamber bottom, as a result the sediment particles from the chamber periphery move with the flow along a helicoidal path towards the orifice, thereby obtaining a settling length which is longer than basin dimensions. Thus relative higher inflow velocities can be allowed into the chamber. The sediment reaching the center of the chamber can be flushed out through the orifice continuously. Relatively sediment free water is allowed to leave the chamber through an outlet channel/pipe taking off from the chamber at a location of relatively higher elevation.

2. BRIEF REVIEW

The flow mechanism in a vortex chamber sediment extractor is similar to the Rankine Vortex in which a forced vortex core is surrounded by an irrotational or free vortex zone (Julien, 1985 a & b). Several investigators for investigating the flow structure and similarity in vortex chambers have conducted experimental studies. Notable amongst these includes those by Anwer (1965), Cecen (1977), Daggett and Keulegan (1977), Julien (1985 a and b), Odgaard (1986), Vasistas et al. (1989) and Hite & Mih (1994), Mujib et al. (2008, 2012). A brief review presented herein indicates that most of the investigators mainly observed
Reliability Analysis of Local Scour at Bridge Pier in Clay-Sand Mixed Sediments

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ABSTRACT
Bridge pier scouring is an important issue for safety evaluation of bridges. The existing equations for bridge pier scour prediction are mostly deterministic in nature, which do not incorporate the uncertainties in various parameters of scouring. A methodology for reliability analysis of bridge pier against scour in cohesive sediments incorporating the uncertainties of the model and input parameters are presented herein using efficient spreadsheet algorithm for first order reliability method (FORM). The influence of uncertainties, the nature of probability distribution and correlation of basic input parameters on failure probability and reliability index has been studied and described briefly herein. A sensitivity analysis was also carried out to obtain the effect of the individual random variables on the reliability of pier scour. To achieve the desired safety level in the design of pier foundation, the reliability-based safety factor is proposed.

Keywords: bridge pier, scour, failure probability, cohesive bed, safety factor

INTRODUCTION
The removal of soil material surrounding a bridge foundation (piers and abutments) caused by flowing water is termed as local scour. High flow of water erodes and carries away material not only from around the piers and abutments of bridges but also from the bed and banks of streams. However, the rate of scour does not equal for all types of the bed materials but it is different for different materials. The scouring process is not only affected by nature and type of bed materials but it also depends upon type, shape, size of obstruction and on the angle of attack. The safety evaluation of bridges are very important issue. The pier foundation should be deeper than maximum possible scour depth for the safety of bridges. Hence for safe and economical design of a bridge pier foundation, a reliable assessment of possible scour depth is required.

Eiterna (1980), Jain (1981), Raudkivi (1986), Melville and Sutherland (1988), Melville (1997), Coleman and Melville (2001), Muzzamnil and Gnagadhariah (2003), Lank (2004), Sheppard and Miller (2006) carried out comprehensive experimental investigation and they proposed model for prediction scour depth around bridge piers in noncohesive bed materials. Various form of soft computing techniques have been used to develop more refined scour prediction models at various types of hydraulics structures (Shin and Park, 2010; Balouchi et al., 2015; Ebtehaj et al., 2017; Ghazanfari-Hashemi et al., 2011; Sharafi et al., 2016; Moradi et al., 2017).
INTRODUCTION

The amount of discharge through a particular section of river is the basic data required for planning and design of various structures and water resource projects, such as culverts, bridges, operation of hydro power plants, flood plain zoning, flood protection works, flood warning systems and assessment of available water resource potential (Zakwan 2017). Accurate stream flow measurement is of paramount importance for economic and safe design of water resource project. Development of the rating curve for a gauging site is a two step procedures. First step is to develop stage discharge relationship using historical stage discharge data of the gauging site by plotting the graph between the observed stage (G) and observed discharge (Q) at the gauging site. Second step involves the measurement of stage and the transforming it to discharge using the established rating curve. It is easy to maintain a continuous record of stages rather than maintaining continuous record of discharges in a river.

The accuracy of discharge estimated using the stage-discharge relationships depends on the accuracy of method used for stage measurement and development of the rating curve. The classical approach of developing rating curve by employing regression analysis often fails to give stage-discharge relationship accurately as the logarithmic transformation of rating curve equation introduces a bias in the measurement (Ferguson 1986, Zakwan 2016). The main objective of the present study was, therefore, to implement nonlinear optimization techniques which do not require logarithmic transformation to determine the parameters of the stage-discharge relationship and compare their performance with the classical method of establishing rating curves. The stage discharge relationship is generally a single valued relation for majority of streams and rivers, especially non alluvial rivers represented as

\[ Q = K(G - a)^n \]  

(1)

\[ Q = \text{stream discharge}; \ G = \text{stage height}; \ a = \text{constant} \]

representing the gauge reading corresponding to zero discharge; K and n are rating curve parameters.

Being a hypothetical parameter ‘a’ cannot be determined in field. Following methods are available to find the value of gauge height corresponding to zero discharge.

Stage discharge relationship has always remained an area of interest for hydrologists and many attempts have been made by hydrologists to establish reliable rating curves. (Herschy, 1995) used graphical method to develop stage discharge relationship. Polynomial models for stage discharge relationships were proposed by (Herschy, 1999). Application of Artificial Neural Network (ANN) for modelling hysteresis affected rating curves was introduced by (Tawfik et al., 1997) which was followed by (Jain and Chalisgaonkar, 2000). (Jain,
Morphometric analysis and sub-watersheds prioritization of Nagmati River watershed, Kutch District, Gujarat using GIS based approach

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Abstract

Morphometric analysis of any watershed and its prioritization is one of the important aspects of planning for implementation of management programmes. Present study evaluates the quantitative morphometric characteristics of Nagmati River watershed in Kutch District of Gujarat by utilizing Cartosat-1 data (CartoDEM). In all 19 aerial and 6 linear morphometric parameters of the watershed have been evaluated. Drainage map of the study area reveals a dendritic drainage pattern with sixth order stream network comprising 492 numbers of streams and confining an area of 129.41 km². Mean bifurcation ratio (Rb) and stream length ratio (Rs) of the watershed evaluated are 3.44 and 0.54 respectively which corroborates the fact that drainage pattern is not influenced by the geological evolutions and disturbances in the recent past. The drainage density of 2.68 km/km² indicates impermeable subsoil material with sparse vegetation and moderate to low relief. Elongation ratio of 0.956 infers the basin to be closer to a circular shape. The geologic stage of development and erosion proneness of the watershed is quantified by hypsometric integral (HI) bearing value as 0.5, indicating the landscape to be uniform and in early mature stage. The study prioritizes eight sub-watersheds as high, medium and low for taking up soil and water conservation activities. Hence, remote sensing applications proved to be highly useful in extracting the precise data for the evaluation and analysis of watershed characteristics.

Key words: hypsometric analysis, morphometric analysis, Nagmati watershed prioritization

INTRODUCTION

Geomorphometry is the science of quantitative land surface analysis that consolidates various mathematical, statistical and image processing techniques for quantifying morphological, hydrological, ecological and other aspects of any geographical area. Morphometry is the measurement and mathematical analysis of the configuration of the earth’s surface, shape and dimensions of its landforms [CLARKE 1996]. This analysis can be achieved through measurement of linear, aerial and relief aspects of basins by using remote sensing and GIS. Morphometric characteristics such as stream order, drainage density, aerial extent, watershed length and width, channel length, channel slope and relief aspects of watershed are important in understanding the hydrological aspects of a region. The stream order, stream pattern, and drainage density have a profound influence on watershed as to influence runoff, infiltration, land management etc. They also influence the flow characteristics and thus erosional behaviour. The hypsometric integral (HI) is a geomorphological parameter classified under the geologic stages of watershed development. It assumes importance in estimation of erosion status of watershed and subsequent prioritization for taking up soil
Discharge coefficient of oblique sharp crested weir for free and submerged flow using trained ANN model

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Abstract

In the present study, ANN models have been developed to predict the discharge coefficients of oblique sharp-crested weirs for free and submerged flow cases using Borghesi et al.’s experimental data. The discharge coefficients predicted by ANN models are then used to predict the discharges. The results so obtained are compared with the traditional regression model analysis performed by Borghesi et al. (2003) in which the prediction error in the discharge was found within the range of ±5%. On the other hand, the developed ANN models predict the discharge coefficients as well as discharges within the error range of ±1%. Furthermore, sensitivity analysis of developed ANN models have been carried out for all the parameters (weir height, oblique weir length, head over weir and downstream head over weir) involved in the study and it was found that the weir length ($L$) is the most and weir height ($P$) is the least sensitive input variable to ANN-1 model. In the case of ANN-2 model, weir length ($L$) is the most and downstream head over weir ($H_{d}$) is the least sensitive input variable.

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Keywords: Artificial neural network; Oblique weir; Discharge coefficient; Free flow; Submerged flow; Discharge measurement

1. Introduction

Sharp-crested weirs are widely used flow measuring device especially in the field of irrigation and drainage engineering. Use of oblique weir is advantageous over normal weir in the case of limited channel width when higher discharge is required at relatively lower head. Oblique alignment of weir increases the effective weir length beyond the channel width which consequently increases the efficiency of weir. Weirs having crest thickness equal to or less than 2 mm in the direction of flow are classified as ‘sharp-crested’ weirs. Among the various shapes of sharp-crested
Experimental and numerical studies for estimating coefficient of discharge of side compound weir

Mujib Ahmad Ansari, Ajmal Hussain, Ali Shariq, and Fakre Alam

Abstract: A sharp-crested side compound weir is a flow diversion structure provided on one or both side walls of a channel to divert water from the main channel. Compound sharp-crested weirs are widely used in irrigation, hydraulics, and environmental engineering. This article presents results of experimental and numerical studies conducted on sharp-crested side compound weirs in open channels. Owing to the complex mechanism of flow through a side compound weir it is difficult to establish a regression model to accurately predict the coefficient of discharge ($C_d$). In this study, an alternative approach to the conventional regression modelling in the form of artificial neural network (ANN) has been used to predict the values of $C_d$. A network architecture with trained values of connection weights and biases is recommended to predict $C_d$. The input to ANN model consists of grouped parameters pertaining to the ratio of weighted crest height to the length of the side compound weir ($W/L$), the ratio of upstream depth to length of the side compound weir ($Y/L$), and upstream Froude number ($F_r$). The results of the ANN model applied herein were found to be superior to those obtained through regression modelling by previous researchers. The sensitivity analysis of the ANN model shows that $W/L$ is the most important parameter for the estimation of $C_d$, followed by $Y/L$ and $F_r$.

Key words: side compound weir, coefficient of discharge, Froude number, artificial neural network (ANN), rectangular channel.

Introduction

Side weirs are used in channel systems, river-control structures, river-intake facilities, irrigation canals, and wastewater treatment plants; for diverting storm water overflows from urban drainage systems (S. Hussain et al. 2014; Hashid et al. 2015). Other hydraulic structures used to divert flow include spillways, sluice gates (Swamee et al. 1994), and orifices (A. Hussain et al. 2010, 2011a, 2011b, 2014). Flow through a side compound weir represents a gradually varying flow with non-uniform discharge. A side compound weir is designed to divert a certain amount of flow from a main channel to a sub-channel or from one river to another river. Thus, accurate measurement of flows through side weirs is of considerable practical significance.

Different researchers have conducted extensive studies on the flow characteristics of different shapes of side weirs and side weirs with different cross sections. De Marchi (1934) was the first to provide a theoretical explanation of the hydraulics of a side weir in a rectangular channel. Numerous experimental studies and theoretical analyses have been conducted on side weirs used in rectangular, triangular, trapezoidal, and circular channels (Ameri et al. 2015; Uyumaz et al. 2014; Roushangar et al. 2016; Emiroglu et al. 2011; Rangaraju et al. 1979; Uyumaz and Smith 1991; Vatankhah 1982; Hager 1987). Generally, rectangular weirs have limitations where there is a need to divert the flow having variation in water levels. To overcome this limitation, side compound weirs have been introduced (Zahiri et al. 2013).

The flow characteristics of normal compound weirs with various shapes have also been studied by different researchers (United States Bureau of Reclamation 1963; Martinez et al. 2005; Piratheepan et al. 2007; Jan et al. 2006). Many researchers focused on the design and calibration of a normal compound sharp-
Numerical analysis for free flow through side rectangular orifice in an open channel

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ABSTRACT
Side orifice is a hydraulic structure provided in the walls of a channel to divert flow from the main channel to another channel. It is used widely in environmental engineering and irrigation engineering. In the present study, numerical simulation has been performed to analyze the flow characteristics of a rectangular side orifice using the CFD program with ANSYS-CFX code. Finite volume method is used to solve the governing equations of the standard k-ε turbulence model in prismatic channels. The CFD model developed has been verified with the available experimental studies of Hussain and his associates. On comparing with experimental observations, it is found that the CFD model simulates the flow through the orifice with good accuracy. Flow pattern for a side orifice has also been analyzed for streamline pattern, velocity distribution, velocity contours. Further, a reverse flow in the main channel has been noticed near the vicinity of the orifice in the main channel.

1. Introduction
Side orifice is used for diverting flow from the main channel to its secondary channels for irrigation purpose. Other widely used hydraulic structures used in irrigation engineering are side sluice gates (Ghoshian 2003), side weirs (Sharig et al. 2018) and side intakes (Hashid et al. 2015). These hydraulic structures are also used in wastewater treatment plants to distribute the incoming flow to parallel processing units such as sedimentary tanks, flocculation tanks, and aeration basins. Side slots and side orifices in pipes are used for distributing chemicals in industries. Knowledge of diverting discharge from a channel with better accuracy is quite important from the water management point of view.

Analytical and experimental studies related to side orifices and side slots have been carried out by several investigators (Hussain et al. 2010, 2011, 2014, 2016; Bryant et al. 2008; Tanwar 1984; Gill 1987; Ramamurthy et al. 1986; Panda 1981). Discharge characteristics of sharp-crested rectangular side orifices have been studied by Hussain et al. (2011). They concluded that the coefficient of discharge depends mainly on the approach flow Froude number and ratio of the width of the orifice and the width of the channel. Hussain et al. (2014) reformulated the coefficient of discharge equation for side rectangular slot presented by Ojha and Subbaiah (1997) and found better accuracy for calculating discharge. Ramamurthy et al. (1987) studied the flow through side orifice-weir units in a channel and concluded that orifice weir units can be designed to ensure an outflow that is a prescribed percentage of the channel inflow. The discharge coefficient relationship for trapezoidal side weirs has been developed by Farzaneh et al. (2015).

However, with the advancements in computational modeling for solving the governing equations of fluid flow, the numerical solution of the Reynold’s averaged Navier-Stokes (RANS) equations using turbulence models is an alternative. Kra and Merkley (2004) carried out mathematical modeling of open channel velocity profiles by solving the Reynolds-averaged Navier-Stokes (RANS) equations and an algebraic model for turbulent stresses. Kim (2007) investigated the flow through a sluice gate using CFD program Flow-3D. Chen et al. (2002) employed the k-ε turbulence models to simulate the turbulent overflow on stepped spillways. Mangarulkar (2010) used k-ε RNG turbulence model and simulated the free surface flow along a side weir in subcritical flow regime. Aydin (2012) used FLUENT software for the simulation of triangular labyrinth side weir in a rectangular channel and validated the numerical analysis with the experimental data of Emiroglu et al. (2010). Azimi et al. (2014) simulated the free surface flow changes and velocity field, along with a side weir on the circular channel in supercritical flow conditions using the k-ε RNG turbulence model.

This study presents an investigation of flow through a rectangular side orifice in order to describe the flow characteristics in the subcritical flow condition. A commercially available CFD program ANSYS-CFX code, which solves the RANS equations, has been used in the present study. The simulation results are compared with the existing experimental works performed by Hussain et al. (2011) for side rectangular orifice in an open channel. The experiment performed by them consists of a rectangular channel of 915 cm length, 50 cm width and 60 cm depth. The channel comprises of a sluice gate at the end of the channel to regulate the depth of flow in the channel. Experiments were performed for three sizes of square orifice equal to 4.4, 8.9, and 13.3 cm and crest height (W) 5, 10, 15 and 20 cm under free-flow conditions. For complete information
A reliability-based assessment of live bed scour at bridge piers
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ABSTRACT
Bridge pier scour is an important issue for safety evaluation of bridges. The existing scour depth prediction equations for bridge piers are mostly deterministic in nature, which do not incorporate the uncertainties due to scour parameters, selection of model and limited information about data. To incorporate these uncertainties, a reliability-based assessment of bridge pier scour is required. An attempt has been made herein to develop a reliability-based scour depth prediction model for live bed scour at bridge piers. An object-oriented constrained optimization technique of the first-order reliability method has been used for the reliability analysis. The influence of uncertainties, type of probability distribution and correlation among the basic input parameters on the failure probability have been studied in detail. To achieve the desired safety level in the design of pier foundation for the live bed scour, the reliability-based safety factor is proposed. A sensitivity analysis has also been carried out to obtain the effect of the individual random variables on the reliability of pier scour.

1. Introduction
Scour is a natural phenomenon caused by the erosive action of flowing water, which excavates and carries away materials around piers and abutments of bridges. It may cause reduction in the bed supports to the pier foundations which may lead to bridge failure. Deng and Cai (2010) reported that, in the United States, approximately 60% of bridge failures are related to scour-based hydraulic deficiencies. The majority of bridge failures take place under live-bed condition due to high flow during flood events. As such the failure of bridge pier due to scour is an important issue in the safety evaluation of bridges. The depth of pier foundation should be deeper than the scour depth to prevent bridge pier failure. A reliable estimation of maximum possible scour depth around a bridge pier is required to assure a safe design of bridge pier foundations.


Chabert and Engeldinger (1956) reported that the maximum scour depth decreased slightly with mean velocity after reaching its peak at threshold conditions for a given pier width and sediment size, and thereafter remained constant. Laursen (1958) found that the depth of local scour does not depend on the contraction ratio until the scour holes from neighboring piers start to overlap. The data of Laursen (1958) for live bed scour showed a similar trend as Chabert and Engeldinger (1956). Jain and Fischer (1980) concluded that there was similar slight decrease in scour depth at flows just greater than threshold, and scour depth increased again at higher velocities eventually becoming larger than that at threshold condition. Chee (1982) explained that the shorter and higher the bed forms, the lesser the observed scour depth and live bed peak occurs at about the transition flat-bed condition when the bed form is very long and of negligible height. Melville (1984) explained that the relationship between scour depth and flow velocity depends on bed formation whether it was ripple forming or non-ripple forming and scour depth exhibits two peaks which occur at the threshold and transition flat-bed conditions. They found that the maximum scour depth occurs at the transition flat-bed condition in the case of ripple forming sands and at threshold for non-ripple forming sediments. Raudkivi (1986) concluded that estimation of scour depth for given flow at a bridge pier is a function of flow intensity \( (V/V_c) \) and sediment parameters. They observed that scour depth reached its maximum when flow conditions persist at just below the limiting critical shear stress for the armored bed in non-uniform gravel. Kothyari et al. (1992) proposed a method for evolution of the temporal variation of scour depth during live-bed condition by considering the primary vortex as a prime agent causing scour at bridge piers. They also developed maximum scour depth prediction model in uniform sediments during live-bed condition. Sheppard and Miller (2006) carried out live bed local pier scour experiment and proposed scour depth prediction equation for wide range of flow intensity \( (V/V_c) \) up to 6. They also compared the proposed equation between several commonly used local scour equations and the measured data. Sheppard’s equations appear to perform well for the range of conditions covered by the experiments. Zhao et al. (2010) carried out experimental and numerical investigation of local scour around a circular cylinder in a steady current. They concluded that the vortex shedding plays an important role in the scour process. They also found that scour depth decreases as the cylinder height reduces and has independent effect when cylinder height to diameter ratio exceeds 2.0. Sumer et al. (2013) carried out experimental study to observe the backfilling of scour hole around pile under live-bed
Land Use Change Detection of Yamuna River Flood Plain Using Geospatial Technique

Nehal Ahmad, Saif Said, Naved Ahsan

Abstract—The present study intends to quantify the changes and transformations in features classes of Yamuna River Flood Plain in Delhi. ERDAS imagine 9.2 and Terrset geospatial software were used for image processing and quantitative assessment, transformation, gain and loss, contribution of net change and spatial trend analysis. The Landsat 8 (2018), TM (2000) and MSS (1989) images were acquired for assessing LULC change detection using Maximum Likelihood Classifier. LULC classification was achieved with kappa coefficient and overall accuracy for Satellite images of MSS (1989), TM (2000) and Landsat 8 (2018) as 0.781, 0.892 and 0.804 and 86.00%, 92.31%, 86.00% respectively. Analysis reveals the addition of built up area up to 25% from year 2000 onwards and loss in dense forest from 40% to 30%. Vegetation areas recorded a reduction of 15% from 1989 to 2000. Spatial trend reveals the qualitative vulnerability of vegetation classes during the study period. During 1989-2000, dense forest, vegetation and water classes contributed maximum to settlement class and during 2000-2018 an interchange of dense forest and vegetation was witnessed. The study provides an insight to the sustainable planning and management of the river ecosystem that is affected by population expansion.

Keywords: Land use land cover, Change detection, MLC algorithm, geospatial techniques, Terrset, Yamuna River.

I. INTRODUCTION

A precise land use and land cover map is critically necessary for sustainable resource utilization and for modeling and analyzing the land as a holistic system (Ahmad et al., 2012). The exercise of satellites data for the mapping of land use was widely appreciated in the last decade by researchers (Beuchle et al., 2015). Analysis of the data creates impressions of human interaction and nature towards land use evolution thereby, assisting in identifying the optimal land cover (Ghebrezgabher et al., 2016). Changes in flood plain of Yamuna River along Delhi due to anthropogenic involvement in unplanned manner have shaped the fragile ecosystem whilst posing a severe environmental threat to the surrounding areas (Zanetti et al., 2018).

With the advancements in geospatial techniques, monitoring, mapping and modeling of land use cover has afforded a way to enhance the capacity in decision making towards sustainable development and management of an area involving low cost and higher accuracy (Wu et al., 2017). However, concerns over land form classification accuracies have been addressed by various researchers detecting change of flood plains in varied environments. Image classification techniques based on algorithms provides satisfactory results subject to condition of large the sample size. However, in Maximum likelihood classification (MLC), training sample per pixel signature file is created from the real ground information for clustering of those pixels having maximum likelihood of the digital numbers (DN) falling in a particular land use class (Afify, 2011; Butt et al., 2015b). Landsat images offer relatively precise analysis of change detection for supervised classification performed using maximum likelihood classifier (Lv, Z et al., 2017).

The Land Change Modeler (LCM) in TerrSet is used for map change analysis and spatial trend analysis for a relatively stable land cover which requires relatively low data with dynamic utility (Mishra, V.N et al., 2014; Yasmine Megahed et al., 2015). Based upon transition potential modeling, change prediction and change analysis, future land use land cover can also be predicted with the historical change of maps (Krishna Rajan et al., 2018).

This study intends to appreciate the Land cover changes over a period of 30 years by utilizing Landsat images and employing MLC via supervised classification scheme and Land Change Modeler (LCM) in TerrSet. The study furnishes an insight towards understanding the changing trends that constitutes a crucial prerequisite for efficient interdisciplinary policies leading to sustainable regeneration of an ecologically fragile flood plain.

II. MATERIALS AND METHOD

Study Area

The study area stretches 22 km flood plain of Yamuna River flowing along Delhi state entering at Wazirabad barrage and exiting at Okhla barrage confining within geographical coordinates from 77°10'00" E to 77°20'00" E longitude and 28°32'00" N to 28°43'00" N latitude and extending an study area of 51.15 km² (Fig. 1). The topography of the area is gently sloped in southwestward direction bounded between semi meandering river course coupled with straight and curved paths. The climate encountered by Yamuna River flowing along Delhi extend...
Pollution mapping of Yamuna River segment passing through Delhi using high-resolution GeoEye-2 imagery

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Abstract
River Yamuna is the largest tributary of river Ganges and has been acclaimed as a heavenly waterway in Indian mythology. However, 22-km segment of river Yamuna passing through Delhi from downstream of Wazirabad barrage up to Okhla barrage is considered as the filthiest stretch having been rendered into a sewer drain. The present study employs high-resolution GeoEye-2 imagery for mapping and monitoring pollution levels within the river segment by testing correlation between water quality parameters (WQPs) and the corresponding spectral reflectance values of the image. A total of 100 water samples collected from random sampling locations along the river segment were analyzed for 12 WQPs in the laboratory and grouped into two classes, namely (WQP)organic and (WQP)inorganic. Several spectral band combinations as well as single bands were tested for any significant correlation with the two formulated WQP classes by performing multiple linear regression analysis. Results reveal that spectral band combination, i.e., \(\{(RGB) \times \sqrt{B/R}\}\), and the two formulated WQP classes exhibit strong positive correlation with \(R = 0.92\) and \(0.91\) (\(R^2 = 0.85\) and 0.82; RMSE ~ 1.03 and 1.12) for calibration data and 0.85 and 0.84 (i.e., \(R^2 = 0.74\) and 0.72; RMSE ~ 1.45 and 1.64) for validation data, respectively. The spatial distribution maps depicting pollution levels of two WQP classes were generated in GIS framework, substantiating to the actual in situ pollution concentration levels in the river segment. The methodology adopted in the present study and results obtained validate the potential of high-resolution GeoEye-2 imagery for monitoring and mapping pollution levels in the water bodies.

Keywords Yamuna River · Water quality parameters (WQPs) · Multiple linear regression (MLR) · Spectral reflectance · Digital number (DN) · Untreated wastewater

Introduction
River Yamuna originates from Yamunotri glacier in Himalayas and is the largest tributary of river Ganges in India. Along its entire traveling length of about 1380 km, it passes through many states such as Himachal Pradesh, Uttar Pradesh, Uttarakhand, Haryana and Delhi. Almost around 60 million people depend for their livelihood on this river.

There has been a radical change in Yamuna River water quality as it enters Delhi from Wazirabad barrage and leaves at Okhla barrage which is attributed to the fact that untreated wastewater from 17 small and big sewer drains is discharged directly into the river besides the largest Najafgarh industrial drain. Rapid urbanization and encroachments all along the flood plains of the river are also one of the causes for widespread surface water eutrophication and severe deterioration of the water quality.

Monitoring water quality is recognized as the first step toward understanding the characteristics of water pollution and devising effective mitigation strategies. The quality of water is referred by its physical, biological and chemical compositions. Chemical composition includes the organic and inorganic substances such as heavy metals, pesticides, detergents and petroleum. The physical composition comprises turbidity, color and temperature, whereas the biological composition includes plankton and pigments (Allee and Johnson 1999). In addition, some of the parameters
Full length article

Slope mass rating and kinematic analysis of slopes along the national highway-58 near Jonk, Rishikesh, India

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\textbf{ABSTRACT}

The road network in the Himalayan terrain, connecting remote areas either in the valleys or on the hill slopes, plays a pivotal role in socio-economic development of India. The planning, development and even maintenance of road and rail networks in such precarious terrains are always a challenging task because of complexities posed by topography, geological structures, varied lithology and neotectonics. Increasing population and construction of roads have led to destabilisation of slopes, thus leading to mass wasting and movement, further aggravation due to recent events of cloud bursts and unprecedented flash floods. Vulnerability analysis of slopes is an important component for the “Landslide Hazard Assessment” and “Slope Mass Characterisation” guide planners to predict and choose suitable ways for construction of roads and other engineering structures. The problem of landslides along the national highway-58 (NH-58) from Rishikesh to Devprayag is a common scene. The slopes along the NH-58 between Jonk and Rishikesh were investigated, which experienced very heavy traffic especially from March to August due to pilgrimage to Kedarnath shrine. On the basis of slope mass rating (SMR) investigation, the area falls in stable class, and landslide susceptibility score (LSS) values also indicate that the slopes under investigation fall in low to moderate vulnerability to landslide. More attention should be paid to the slopes to achieve greater safe and economic benefits along the highway.

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1. Introduction

Himalayan orogeny is the result of collision of Indian and Eurasian plates. This zone is extensively deformed, having major thrust faults as discontinuities, such as Himalayan Frontal Thrust (HFT), Main Boundary Fault (MBF) and Main Central Thrust (MCT). Landslide along the national highway-58 (NH-58) in the Himalayan terrain is a very common and frequent natural disaster, causing loss of life and property. Slopes along this highway failed many times at different locations and have become more vulnerable to sliding due to unplanned development, as witnessed during the Uttarakhand hazard. The hill slopes in Lesser Himalayas are well known for their instability due to the dynamic nature of slopes, geomorphology, snowfall, heavy and sustained rainfall, and ongoing neotectonic activity. Increasing anthropogenic activities in recent years appear to be an additional factor for instability of slopes in the Himalayan terrain. There are many major or minor landslides that happened at different places (Sati et al., 2011). Unplanned excavation and vibrations caused by blasting along the NH-58 near Badarinath and Rishikesh for construction and road widening project during last few years have enhanced the vulnerability of slopes to landslide. Stability studies of road cut slopes in Rudraprayag area have identified critical slopes at certain locations by numerical simulation with the factor of safety (FOS) less than 1 (Singh et al., 2008). For safer construction and reducing slope failure, proper investigations and slope characterisation are required. The analysis of slope characterisation depends upon many parameters and database related to slope, rock mass, meteorology, etc. (Pradhan et al., 2011, 2014; Trivedi et al., 2012). Stability studies were conducted for 50 road cut slopes using rock mass rating (RMR) and geological strength index (GSI) classification systems in the region of Garhwal Himalayas to identify the vulnerable slopes along the NH-58 (Sarkar et al., 2012a). Rishikesh has an average elevation of 372 m (1245 ft). According to the latest weather update by Skymet Meteorology Division in India, the temperature is around 20 °C–22 °C. According to the Koppen-Geiger climate classification system, Rishikesh lies in humid to sub-tropical area. Rainfall in Rishikesh
The geochemistry of Permo-Carboniferous black shales from Spiti region, Himachal Pradesh, Tethys Himalaya: A record of Provenance and change in climate

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Abstract: The Permo-Carboniferous siliciclastic sedimentary sequence from the Tethys Himalaya, Spiti region, Himachal Pradesh has been studied thoroughly for field investigations and geochemistry. The Kanawar and Kuling groups, representing the Permo-Carboniferous sequence in this area, consist primarily of alternate sequence of sandstones and shales with variable thickness. Present study is focused mainly on the fine grained grey to black shales from the Kanawar Group, which is associated with medium to coarse grained sandstones consisting of Liptak, Po and Gammachidam formations, from bottom to top in chronological order. The concentration of major oxides and their ratios (e.g., Al2O3/TiO2, K2O/Na2O etc.) suggest unroofing of dominantly felsic components during the deposition of these sediments. The chemical index of alteration (CIA) values (ranging from 54 – 74) reveals that the source rock of the Spiti sediments had experienced contrasting climatic conditions from warm and humid during Carboniferous to arid to semi-arid during Permian. This study thus not only determines the provenance characteristics of the sediments but also documents a shift in climate during Permo-Carboniferous.

Keywords: Tethys Himalaya, Black shales, Geochemistry, Provenance, Paleoclimate

INTRODUCTION

Mineralogical and chemical compositions of clastic sedimentary rocks are controlled by different factors including (1) the composition of their source rocks, (2) environmental parameters influencing the weathering of source rocks (e.g., chemistry of atmosphere, temperature, rainfall and topography), (3) duration of weathering, (4) mode of transportation mechanisms of the clastic materials from source to depositional area, (5) depositional environment (e.g., marine vs. fresh water), and (6) post depositional processes (e.g., diagenesis, metamorphism). Shales are considered to indicate the average crustal composition of the provenance much better than a few other silicic rocks (e.g., Taylor & McLennan 1985; Hayashi et al. 1997). Shales preserve most of the mineral constituents of the source and their bulk chemistry conserves near original signature of the provenance and more precisely suggest palaeoweathering conditions (e.g., Graver & Scott 1995).

The Tethys Himalaya, sandwiched between Higher Himalayas and Trans-Himalayas, are well-known for many significant features including consistent sedimentary record from Cambrian to Cretaceous and up to Paleocene, spanning a sedimentation history of 500 Ma and persistent occurrence of fossils throughout the sedimentary deposits. Due to these reasons, it has been under intense examination by various geologists but little attention has been paid towards geochemical investigations of these sedimentary rocks. Tethys Himalaya occurring at the Northern Indian margin, preserves important information about the paleogeography of the Indian margin, prolonged and progressive paleoclimatic history, plate tectonics (i.e., active vs. passive margins) weathering of source rocks which in turn explains the carbon cycle or CO2 abundance that facilitates chemical weathering, etc. The earlier workers have concentrated mainly on the stratigraphical and structural aspects of the Tethys Basin (Haydn 1904; Fuchs 1982; Bagati 1990; Singh et al. 1995; Garzanti et al. 1996; Bhargava & Bassi 1998; Arora et al. 2002). Krystyn et al. (2004) and Bhargava (2008) dealt with regional geology and stratigraphy of this region and very few studies are available on the geochemistry of these sediments (Williams et al. 2012; Javid et al. 2013). Despite the Tertiary Himalayan orogeny, the sediments have undergone negligible to very low grade of metamorphism and thus can be very well studied for geochemical aspects. The present paper examines the geochemistry of Permo-Carboniferous black shales of the Tethys Himalaya from the Spiti area, Himachal Pradesh, north India. Evaluation of paleoweathering conditions, besides characterising paleoclimate and provenance, using major element geochemistry is the main aim of the present paper.

GEOLOGICAL SETTING

The Spiti Valley, popularly known as cold desert, is a remote part of Himachal Pradesh in the North-Western Himalaya that lies between longitude 77°38’-78°36’ E and latitude 31° 42’-32°29’ N, covering an area of nearly 7500 sq km. The altitude of the area ranges from 3200 m to 6500 m. The Spiti Basin is one of the classical areas, which exposes a continuous sequence of fossiliferous Paleozoic and Mesozoic periods resting on a crystalline Precambrian basement (Haydon 1904) (Fig.1). The Tethyan Himalayan sediments occur essentially in three basins, namely, Kashmir Basin, Zanskar-Spiti-Kinnuar Basin and Kumaun Basin. Among these, Zanskar-Spiti-Kinnuar Basin is the largest one and is considered as a south-western extension of the greater Tibetan Basin (Arora et al. 2002). These sediments represent deformed remnants of
Provenance, Tectonics and Paleoclimate of Permo-Carboniferous Talchir Formation in Son-Mahanadi Basin, Central India with Special Reference to Chirimiri: Using Petrographical Interpretation

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ABSTRACT

The present study deals with the petrographic interpretation of Talchir Formation sandstone, in and around Chirimiri area, Koriya district, Chhattisgarh state India located in Son-Mahanadi basin. This basin is an elongate graben showing northwest-southeast trend and considered to be one of the largest intra-cratonic rift basins of Indian peninsula. Talchir Formation is the lowermost unit of thick classical Gondwana sedimentary succession and rests unconformably on Precambrian basement. The petrographic studies consisting of point count show the presence of quartz as a dominant framework mineral with subordinate amounts of feldspars and rock fragments. The data plot in the fields of cratonic interior and transitional margin of continental block provenance. In the Qt (quartz)-F (feldspar)-L (lithic fragments) triangular diagram, indicating the source of these sediments was located in transitional margin and continental block provenance. The petrographic classification suggests that this formation in the study area dominantly contains compositionally immature to submature arkosic, sub-arkosic and lithic-arkosic sandstones. The bivariate plot between Qp/(F+R) vs. Qt/(F+R) indicates changes in climatic conditions from semi-arid to semi-humid during Permo-Carboniferous period.

KEYWORDS

Son-Mahanadi; Talchir Formation; Chirimiri; Provenance; Tectonics; Petrography; Paleoclimate

1. Introduction

The compositions of sandstone have been widely used by sedimentologists during past several decades to decipher the provenance, paleoclimate and tectonic setting of the source areas [1-9]. The characters of detrital framework grains are substantially affected by the nature of processes that act in the depositional basin and also by the type of transporting medium and distance of transport [8,10]. Determination of different aspects of provenance viz its location with respect to depositional basin, lithology, climate and tectonic setting is some of the important parameters of basin analysis [11].

The Gondwana sediments of Peninsular India mark the resumption of sedimentation during Permo-Carboniferous after a long hiatus since Proterozoic. The sedimentation in Gondwana basins of India evolved through a complex interplay of faulting, changes in sea level and climate [12]. The basinal geometry was modified by tectonic movement during different periods. Indian plate is an assembly of several micro continents, sutured along early/middle Proterozoic Mobile belts [13-15]. These mobile belts became the locales of rift nucleation and played a fundamental role in the mechanism of rift propagation along reactivated ancient shear zones [15-18]. These intra-cratonic rifts are referred to as Gondwana basins.
Provenance, Tectonics and Paleoclimate of Permo-Carboniferous Talchir Formation in Son-Mahanadi Basin, Central India with Special Reference to Chirimiri: Using Petrographical Interpretation

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1. Introduction
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Model tests on single and groups of stone columns with different geosynthetic reinforcement arrangement

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ABSTRACT: Stone columns have proved to be a useful technique for supporting flexible structures resting on soft soils. However, in the case of very soft soils, stone columns have encountered excessive settlements due to insufficient lateral resistance offered by the soft soil against bulging of the columns upon loading. The bulging may be reduced to a great extent by reinforcing the columns either by encasing them with geosynthetics or by placing horizontal circular discs of geosynthetics within the columns at a regular interval. In the present study, model tests have been carried out on long floating and end-bearing single and groups of columns with and without reinforcement to evaluate the relative improvement in the failure stress of the composite ground due to different types of reinforcement. The exhumed deformed column shapes were used to understand the failure mechanism for different types and configurations of reinforcement. The geogrid was the best geosynthetic type for encasement for end-bearing columns; for floating columns, geotextile and geogrid were equally good for horizontal circular discs and encasement configurations.

KEYWORDS: Geosynthetics, Soft clay, Stone column, Ground improvement, Reinforcement


1. INTRODUCTION

Stone columns are a versatile and cost-effective foundation type for soft soil ground, especially to support flexible structures that can tolerate some settlement (Bergado et al. 1991). When a soft soil ground-reinforced with stone columns is loaded, the stone columns deform laterally into the surrounding soft soil and the failure occurs due to bulging on top of the stone columns. FIWA (1983) recommends the use of the stone column technique in soft soil with undrained shear strength $c_u$ between 15 and 50 kPa. In such cases, the stone columns derive load-carrying capacity by mobilization of lateral earth pressure from the surrounding soft soil against bulging. However, in very soft soils ($c_u < 12$ kPa), the lateral confinement offered by the soil is not adequate and the stone columns may not develop the required load-carrying capacity. In such cases, the load-carrying capacity of the stone columns may be increased by reinforcing the stone columns with geosynthetics.

The stone columns can be reinforced either by encasement (Figure 1a), that is, enveloping the columns with a geosynthetic or by placing horizontal circular discs of a geosynthetic within the column body at a regular interval (Figure 1b). In the case of encasement, higher resistance against bulging vis-à-vis that offered by unreinforced column is obtained by mobilisation of hoop stresses in the geosynthetic. In the case of horizontal circular discs, the bulging is resisted by mobilisation of frictional stresses on the surface of the geosynthetic and in the case of geogrids, also due to strike-through of the stone chips from one side of the geogrid to the other. The reinforcement effect in each of these cases has been confirmed through various numerical studies, analytical studies, laboratory triaxial tests and small-scale model tests.

Van Impe and Silence (1986) were probably the first
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ABSTRACT

The present study deals with the petrographic interpretation of Talchir Formation sandstone, in and around Chirimiri area, Koriya district, Chhattisgarh state India located in Son-Mahanadi basin. This basin is an elongate graben showing northwest-southeast trend and considered to be one of the largest intra-cratic rift basins of Indian peninsula. Talchir Formation is the lowermost unit of thick classical Gondwana sedimentary succession and rests unconformably on Precambrian basement. The petrographic studies consisting of point count show the presence of quartz as a dominant framework mineral with subordinate amounts of feldspars and rock fragments. The data plot in the fields of cratonic interior and transitional margin of continental block provenance. In the Qt (quartz)-F (feldspar)-L (lithic fragments) triangular diagram, indicating the source of these sediments was located in transitional margin and continental block provenance. The petrographic classification suggests that this formation in the study area dominantly contains compositionally immature to submature arkosic, sub-arkosic and lithic-arkosic sandstones. The bivariate plot between Qp/(F+R) vs. Qt/(F+R) indicates changes in climatic conditions from semi-arid to semi-humid during Permo-Carboniferous period.

KEYWORDS

Son-Mahanadi; Talchir Formation; Chirimiri; Provenance; Tectonics; Petrography; Paleoclimate

1. Introduction

The compositions of sandstone have been widely used by sedimentologists during past several decades to decipher the provenance, paleoclimate and tectonic setting of the source areas [1-9]. The characters of detrital framework grains are substantially affected by the nature of processes that act in the depositional basin and also by the type of transporting medium and distance of transport [8,10]. Determination of different aspects of provenance viz its location with respect to depositional basin, lithology, climate and tectonic setting is some of the important parameters of basin analysis [11].

The Gondwana sediments of Peninsular India mark the resumption of sedimentation during Permo-Carboniferous after a long hiatus since Proterozoic. The sedimentation in Gondwana basins of India evolved through a complex interplay of faulting, changes in sea level and climate [12]. The basin geometry was modified by tectonic movement during different periods. Indian plate is an assembly of several micro continents, sutured along early/middle Proterozoic Mobile belts [13-15]. These mobile belts became the locales of rift nucleation and played a fundamental role in the mechanism of rift propagation along reactivated ancient shear zones [15-18]. These intra-cratonic rifts are referred to as Gondwana basins.
Effect of Elevated Temperature on the Residual Properties of Quartzite, Granite and Basalt Aggregate Concrete

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Abstract In the present study, experimental investigations have been carried out to determine the effect of elevated temperature on the residual properties of quartzite, granite and basalt aggregate concrete mixes. Ultrasonic pulse velocity and unstressed residual compressive strength tests on cube specimens have been conducted at ambient and after single heating–cooling cycle of elevated temperature ranging from 200 to 600 °C. The relationship between ultrasonic pulse velocity and residual compressive strength of all concrete mixes have been developed. Scanning electron microscopy was also carried out to study microstructure of quartzite, granite and basalt aggregate concrete subjected to single heating–cooling cycle of elevated temperature. The results show that the residual compressive strength of quartzite aggregate concrete has been found higher than granite and basalt aggregate concrete at ambient and at all temperatures. It has also been found that the loss of strength in concrete is due to the development of micro-cracks result in failure of cement matrix and coarse aggregate bond. Further, the basalt aggregate concrete has been observed lower strength due to low affinity with Portland cements ascribed to its ferro-magnesium rich mineral composition.

Keywords Rock aggregates · Single heating–cooling cycle · Ultrasonic pulse velocity · Residual compressive strength · Scanning electron microscopy

Introduction

When we design any structural system, the first consideration is function or use of structure. In the designing of ware-house structures for storing timber, adhesives used for pasting soles in foot-wear industry, nut shell storage structures are prone to fire especially in third world countries where safety measures are poorly followed. Moreover, the structures such as nuclear reactor vessels, missile launching pads, turbo jet runways, and aircraft engine test cells, where temperature suddenly sores to very high levels. The behavior of concrete structures exposed to high temperature depends on many simultaneously interacting factors ranging from composition of materials to the characteristics of fire and stress conditions. Several investigations were carried out to investigate the effect of elevated temperature on concrete made with different types of rock aggregates and under different stress conditions. It was concluded that the tests result under residual condition produced less strength loss than the unstressed and stressed condition up to 300 °C. Beyond this temperature, the trend is reversed, and the residual tests showed more strength loss than the unstressed and stressed tests [1]. Similarly, under unstressed condition and after heating at 800 °C, the limestone aggregate concrete has retained 40% strength and the gravel and sandstone aggregate concrete retained 20% strength as compared to the strength at ambient temperature condition [2]. The performance of lightweight aggregate concrete by testing simultaneously under fire up to 500 °C and under stressed condition was observed better than the granite aggregate concrete [3].

The colour changes in concrete after heating are due to the physical and chemical transformation in the material. Beyond 400 °C, significant cracking and variation in mechanical properties of concrete has been observed by
Petro-mineralogical Studies of the Paleoproterozoic Phosphorites in the Sonrai basin, Lalitpur District, Uttar Pradesh, India

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The Paleoproterozoic phosphorites constitute an economically significant component of the Sonrai basin of Lalitpur district. These are associated with ferruginous shale, ironstone, limestone and quartz breccia. Petro-mineralogical studies of samples of the phosphorites, using X-ray diffractometry and scanning electron microscopy, reveal that the collophane (carbonate-fluorapatite) is the dominant phosphate mineral. Calcite, dolomite, quartz, mica and haematite are the dominant gangue constituents. The phosphate minerals occur as oolites mutually replaced by carbonate and silica. The presence of iron oxides has been found in most of the thin sections. There is meagre evidence of organic matter in the form of filaments of microbial phosphate laminae in the samples of phosphorite. The mineral assemblages, their texture and various forms in these phosphorites may be due to some environmental vicissitudes followed by replacement processes and biogenic activities.

KEY WORDS: Petro-mineralogy, Paleoproterozoic, Sonrai basin, Phosphorite, Carbonate-fluorapatite.

INTRODUCTION

Phosphorite or rock phosphate is used mainly as an intake for the manufacture of phosphatic fertilizers. To promote the modernisation of agriculture, phosphate deposits had been in great demand because they contain adequate concentrations of phosphorus (P) which is a critical and non-renewable element for fertilizer production upon which global fertility depends (Filippelli 2011; Khan et al. 2011a, b, 2012c; Dar 2013). Because of the paucity of natural phosphates, Lalitpur, Sagar and adjoining areas in India have been subjected to prospecting from time to time. The main phosphate deposits are concentrated in the Sonrai basin of Lalitpur district (Blatt and Tracy 1996; Daeselle and Carriquiry 2008; Khan et al. 2012a, b; Dar 2013). Generally, a major proportion of P in the earth’s crust occurs in the mineral apatite, which is a phosphate of calcium with fluorine and chlorine. The most widespread mineral species of phosphorite belong to the apatite family and they contain at least 1% $P_2O_5$.

Earlier investigators have discussed various aspects of phosphorites and associated rocks at Sonrai basin of Lalitpur district such as geology, sedimentation, exploration strategy and origin (Srivastava 1989; Dar 2013), clay mineralogy (Jha et al. 2010), Precambrian phosphorites in the Bijawar rocks (Banerjee et al. 1982), lithotectonics (Banerjee 1982), petro-mineragraphy and mineral chemistry (Roy et al. 2004), geochemistry of phosphate bearing sedimentary rocks (Khan et al. 2012a, b), uranium concentration and genetic significance in phosphorites (Dar et al. 2014). In this paper, emphasis is laid on detailed mineralogical studies based on X-ray diffraction (XRD) and scanning electron microscope
Tectono–sedimentary and climatic setup for Dhosa Sandstone Member (Chari Formation) of Ler dome, Kachchh, western India

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ABSTRACT


The Ler Dome situated in the south of Bhus District, Kachchh, holds a well exposed Dhosa Sandstone Member which is a unit of Chari Formation. Petrographical studies of the sandstones exposed in the river section near Ler Village were carried out to analyse the petrofacies, tectono–provenance and palaeoclimate. The Dhosa Sandstones are composed predominantly of monocrysaline and variable amount of polycrystalline quartz, potassium and plagioclase feldspars with meta–sedimentary rock fragments. The identified petrofacies suggest a hybrid continental block–cum–recycled provenance comprising granite–gneiss with metamorphic supra crustals, exposed in the craton interior. The source rocks were exposed in the early stage of thermal doming prior to incipient rifting and drifting associated with Gondwanaland breakup. Sediments underwent short transportation under moderate relief condition and humid–semi humid to temperate climate, complying with the climatic setup of this region during the Jurassic times.

Key–words—Tectono–provenance, Palaeoclimate, Dhosa Sandstone Member, Chari Formation, Kachchh.

लेर गुंबँड, कच्छ, पश्चिमी भारत के धोसा बलुआपाल्थर सदनश (चरी शीतलमूह) हेतु विवरित–अवसादी एवं 
जलवायुवाली व्यवस्थापन

आसमा ए, गजनबी, एम.मसूरू आलम एवं ए.एच.एम. अहमद

सारांश

जिला मुज़, कच्छ के दक्षिण में स्थित लेर गुंबँड, सुप्रात्मिक होने वाले बलुआपाल्थर सदनश है जो कि चरी शीतलमूह के क्षेत्र है। लेर गाँव के नजदीक नदी खांड भवित रहने लगे बलुआपाल्थर के नदीवन्य व संस्कृति अवसादी के साथ है। धोसा बलुआपाल्थर में–अवसादी व नदीवन्य के साथ है। नदीवन्य अवसादी को विवरित करने के लिए रचित की गई है। धोसा बलुआपाल्थर में अवसादी व प्रांत के साथ है। अवसादी के विवरित करने के लिए रचित की गई है। धोसा बलुआपाल्थर में अवसादी व प्रांत के साथ है। अवसादी के विवरित करने के लिए रचित की गई है।

सूचक शब्द—विवरित–अवसाद, पुरातात्विक, धोसा बलुआपाल्थर सदनश, चरी शीतलमूह, कच्छ।
Tectono–sedimentary and climatic setup for Dhosa Sandstone Member (Chari Formation) of Ler dome, Kachchh, western India

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ABSTRACT


The Ler Dome situated in the south of Bhuj District, Kachchh, holds a well exposed Dhosa Sandstone Member which is a unit of Chari Formation. Petrographical studies of the sandstones exposed in the river section near Ler Village were carried out to analyse the petrofacies, tectono–provenance and palaeoclimatic. The Dhosa Sandstones are composed dominantly of monocrystalline and variable amount of polycrystalline quartz, potassium and plagioclase feldspars with meta–sedimentary rock fragments. The identified petrofacies suggest a hybrid continental block–cum–recycled provenance comprising granite–gneiss with metamorphic supra crustals, exposed in the craton interior. The source rocks were exposed in the early stage of thermal doming prior to incipient rifting and drifting associated with Gondwanaland breakup. Sediments underwent short transportation under moderate relief condition and humid–semi humid to temperate climate, complying with the climatic setup of this region during the Jurassic times.

Key–words—Tectono–provenance, Palaeoclimate, Dhosa Sandstone Member, Chari Formation, Kachchh.

लेर गुंबद, कच्छ, पश्चिमी भारत के धोसा बलुआपाल्पर सदरस्थ (चरी शैलसमूह) हेतु विवरण—अवसादी एवं जलवायुवाच्यापाखण

आर्मा ए. गजनवी, एम.मसूर आलम एवं ए.ए.एम. अहमद

सारांश

जिला बुध, कच्छ के दक्षिण में स्थित लेर गुंबद, सूक्ष्मावरित धोसा बलुआपाल्पर सदरस्थ है जो कि चरी शैलसमूह की दक्षिणी है। लेर गाँव के नजदीक मरी खंड अविह्लकता से बतूरा के शैलबिंदु वन्द्री अवसादी खंड दक्षिण शैलबिंदुओं के परवर्तकों के समान को विवरण करने के लिए गोपनीय धोसा बलुआपाल्पर सदरस्थ के विवरण का साधन है। धोसा बलुआपाल्पर नदी—अवसादी, शैल जंगलों में भूमी पर प्राणी तथा पृथ्वी पर जीवन के अवसादी एवं जलवायुपाखण विवरण है। ग्रीनबॉर्ड एवं आयरनक्रिस्टल में बिञ्जी रोपण की सीमावर्ती प्राकालिक मात्रा सम्मिलित है। हालाँकि इस शैलबिंदुओं के अवसादी एवं जलवायु पाखण विवरण दक्षिण शैलबिंदु और उत्तर शैलबिंदु विवरण से सम्बन्धित होगा। जलवायुपाखण विवरण पूर्व नदी—नदी के अवसादी के अवसादी एवं जलवायुपाखण विवरण से सम्बन्धित होगा। जलवायुपाखण इस क्षेत्र के जलवायुपाखण के अवसादी एवं जलवायु तथा जल-द्राक्ष्य के अवसादी एवं जलवायु के अवसादी एवं जलवायुपाखण विवरण (अनुसरण) हुआ।

सूचक शब्द—विवरण—उदगम क्षेत्र, पुराज्ञात, धोसा बलुआपाल्पर सदरस्थ, चरी शैलसमूह, कच्छ।

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Slope mass rating and kinematic analysis of slopes along the national highway-58 near Jonk, Rishikesh, India

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This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.
Slope mass rating and kinematic analysis of slopes along the national highway-58 near Jonk, Rishikesh, India

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Abstract: The road network in the Himalayan terrain, connecting remote areas either in the valleys or on the hill slopes, plays a pivotal role in socio-economic development of India. The planning, development and even maintenance of road and rail networks in such precarious terrains are always a challenging task because of complexities posed by topography, geological structures, varied lithology and neotectonics. Increasing population and construction of roads have led to destabilisation of slopes, thus leading to mass wasting and movement, further aggravation due to recent events of cloud bursts and unprecedented flash floods. Vulnerability analysis of slopes is an important component for the “Landslide Hazard Assessment” and “Slope Mass Characterisation” guide planners to predict and choose suitable ways for construction of roads and other engineering structures. The problem of landslides along the national highway-58 (NH-58) from Rishikesh to Devprayag is a common scene. The slopes along the NH-58 between Jonk and Rishikesh were investigated, which experienced very heavy traffic especially from March to August due to pilgrimage to Kedarnath shrine. On the basis of slope mass rating (SMR) investigation, the area falls in stable class, and landslide susceptibility score (LSS) values also indicate that the slopes under investigation fall in low to moderate vulnerability to landslide. More attentions should be paid to the slopes to achieve greater safer and economic benefits along the highway.

Keywords: slope mass rating (SMR); kinematic analysis; landslide susceptibility score (LSS); vulnerability to landslide

1. Introduction

Himalayan orogeny is the result of collision of Indian and EurAsian plates. This zone is extensively deformed, having major thrust faults as discontinuities, such as Himalayan Frontal Thrust (HFT), Main Boundary Fault (MBF) and Main Central Thrust (MCT). Landslides along the national highway-58 (NH-58) in the Himalayan terrain is a very common and frequent natural disaster, causing loss of life and property. Slopes along this highway failed many times at different locations and have become more vulnerable to sliding due to unplanned development, as witnessed during the Uttarakhand hazard. The hill slopes in Lesser Himalayas are well known for their instability due to the dynamic nature of slopes, geomorphology, snowfall, heavy and sustained rainfall, and ongoing neotectonic activity. Increasing anthropogenic activities in recent years appear to be an additional factor for instability of slopes in the Himalayan terrain. There are many major or minor landslide that happened at different places (Sati et al., 2011). Unplanned excavation and vibrations caused by blasting along the NH-58 near Badarinath and Rishikesh for construction and road widening project during last few years have enhanced the vulnerability of slopes to landslide. Stability studies of road cut slopes in Andhra Pradesh area have identified critical slopes at certain locations by numerical simulation with the factor of safety (FOS) less than 1 (Singh et al., 2008). For safer construction and reducing slope failure, proper investigations and slope characterisation are required. The analysis of slope characterisation depends upon many parameters and database related to slope, rock mass, meteorology, etc. (Pradhan et al., 2011, 2014; Trivedi et al., 2012). Stability studies were conducted for 50 road cut slopes using rock mass rating (RMR) and geological strength index (GSI) classification systems in the region of Garhwal Himalayas to identify the vulnerable slopes along the NH-58 (Sarkar et al., 2012a). Rishikesh has an average elevation of 372 m (1745 ft). According to the latest weather update by Skymet Meteorology Division in India, the temperature is around 20 °C to 22 °C. According to the Koppen-Geiger climate classification system, Rishikesh lies in humid to sub-tropical area. Rainfall in Rishikesh varies significantly in different seasons; the maximum precipitation happens from July to September with the magnitude of approximately 490 mm, while the minimum precipitation up to 10 mm can be seen in April. Slope mass characterisation is necessary for geotechnical studies, which is based on different parameters of rock/mass rock, aiming to classify a terrain into different kinds of slope classes and also their vulnerability to landslide, so that corresponding support measures can be proposed. The quantification of all the intrinsic properties of rock mass and external factors acting on the slope can be used to illustrate the present condition of slopes and to predict their behaviours in future.

The NH-58 is the lifeline for the people living in the cities of Rishikesh, Devprayag, Srinagar, Rudraprayag, Gochar, Chamoli and Joshimath. Several cases of obstructions due to landslides along the road were reported and created lots of difficulties to travellers and pilgrims. This investigation was carried out to identify the safe zones and the areas affected by the geo-hazards, their present situation and future vulnerability to landslides, and to characterise the rock mass along NH-58 near Laxman Jhula between Jonk and Rishikesh.

Geological investigations were conducted at the start of 2014, a period without rainfall. The values of rock mass parameters were recorded for slope stability analysis by RMR proposed by Bieniewski (1979), slope mass rating (SMR) geomechanics classification by Romana et al. (2003) and landslide susceptibility score (LSS) by Central Building Research Institute (CBRI), Roorkee. Such methods for slope stability analysis have been applied for understanding the stability and probability of failure for natural and engineered slopes (Singh et al., 2010, 2013; Gupte et al., 2013; Vishal et al., 2010, 2015).

The present study incorporates the assessment of slopes along the NH-58 near Jonk, Rishikesh. Field investigations include data collection from five locations on the either side of the road. The characterisation of rock mass is also presented in this paper and corresponding support measures are proposed.

2. Investigation area

The area under investigation (Fig. 1) is a part of Lesser Himalayas, lying in between longitudes of 78°19’–78°21’ and latitudes of 30°8′–30°9′. The rock
Crash analysis of military aircraft on nuclear containment

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Abstract

In case of aircraft impact on nuclear containment structures, the initial kinetic energy of the aircraft is transferred and absorbed by the outer containment, may causing either complete or partial failure of containment structure. In the present study safety analysis of BWR Mark III type containment has been performed. The total height of containment is 67 m. It has a circular wall with monolithic dome of 21 m diameter. Crash analysis has been performed for fighter jet Phantom F4. A normal hit at the crown of containment dome has been considered. Numerical simulations have been carried out using finite element code ABAQUS/Explicit. Concrete Damage Plasticity model have been incorporated to simulate the behaviour of concrete at high strain rate, while Johnson-Cook elasto-visco model of ductile metals have been used for steel reinforcement. Maximum deformation in the containment building has reported as 33.35 mm against crash of Phantom F4. Deformations in concrete and reinforcements have been localised to the impact region. Moreover, no significant global damage has been observed in structure. It may be concluded from the present study that at higher velocity of aircraft perforation of the structure may happen.

Keywords

nuclear safety; containment buildings; aircrafts crash; Phantom F4

References

Behavior of Critical RCC Structures under Crash Induced Fire

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Abstract—The nuclear power is considered to be an efficient, reliable and cheapest source of energy, however, due to the associated risk of nuclear radiation, the production of nuclear energy is considered to be highly controversial throughout the globe. In view of the previous incidents of missile and aircraft attacks on important structures and the associated very high risk of failure the present study has been designed to evaluate response of nuclear containment structure against aircraft crash. The outer containment of a typical BWR nuclear power plant has been modeled. The numerical simulations have been carried out using the implicit and explicit integration schemes of ABAQUS finite element code. The effect of fire induced due to aircraft crash has been studied against Boeing 707-320 aircraft. The Concrete Damaged Plasticity model for concrete and Johnson-Cook elastic-visco plastic model for reinforcement were employed to predict the behavior under impact loading, while for heat transfer and thermal stress analysis, the concerned material properties have been taken at elevated temperature form Eurocode 2. The impact of aircraft was considered to occur up to the point the engines came in contact. Thereafter the fire was assumed to have spread out since majority of the aircraft fuel is stored in and around the wings. The fire effect was considered to be most severe at the bottom of containment up to 10 m height from the base. After 15 mint of exposure to fire the temperature in the concrete element at the height of 10 m from the base of the containment has been noticed to be 1094 °C against the selected fire scenario. However, due to sharp fall in the thermal gradient across the thickness of the containment, the damage has been limited to few centimeters depth only.

1. INTRODUCTION

As of now the fire is not considered a design parameter for the nuclear containment structure. Hence, the assessment of fire resistance has not been established yet for nuclear safety related structures. As such the temperature limits have been well established for the normal operation and the shutdown conditions during a test. However, the most severe temperature in case of an internal accident such as loss of coolant and main line break (175 °C) is significantly lesser than the fire spread due to an aircraft crash. According to Nuclear Energy Institute (2009) guideline both external and internal fires may be erupted as a result of an aircraft crash over a containment structure. The response of the containment structure exposed to the external fire due to an aircraft crash will depends upon the size, velocity and fuel capacity of aircraft as well as the strike location and weather conditions.

Although the fire spread in a containment structure due to aircraft crash has been studied earlier (Contri et al., 2005; Jeon et al., 2005 & 2012) however, a coupled analysis of aircraft crash and the induced fire effect has not been dealt in the literature. The crash induced fire will be ignited as a result of the breach of the fuel tank as soon as the wings come in contact. Therefore, in order to obtain a more realistic response of containment for the crash induced fire the effect of impact loading must be considered. In the present study therefore initially the Boeing 707-320 and Boeing 747-400 aircrafts have been considered to hit the containment at the mid height of the cylindrical wall (23 m from the base) and the fire has been assumed to break out as soon as the wings come in contact. The impact analysis has been carried out using the reaction-time response approach discussed in the previous chapter. The deformed state of the containment obtained through the impact analysis has been considered as the initial state for the thermal stress analysis. Before performing the thermal stress analysis however, the heat transfer analysis has been carried out in order to obtain the nodal temperature variation with respect to time in the containment structure. It should be noted however, that the heat transfer analysis is not supported by the ABAQUS/Explicit. Therefore the impact analysis performed in the previous chapter was repeated using the ABAQUS/Implicit. Thereafter the heat transfer analysis and thermal stress analysis was carried out using ABAQUS/Implicit.
Safety Analysis of Nuclear Containment Structure against Aircraft Crash and Induced Fire

A. Rawson, M.A. Iqbal and M.R. Sadique

Abstract—Nuclear energy presently contributes more than 17% of global energy demand. There are 20 working, 7 proposed and 3 under construction Nuclear Power Plants (NPP) in India. In view of the recent nuclear disasters, safety concern in nuclear structures is on the rise. In this study, safety analysis of the outer containment of a typical NPP has been carried out using finite element code ABAQUS 6.10. To maximise the impact effect, the wall is considered as flat in the present study. However, to perform a system efficient simulation, only a quarter of the wall has been modelled. A 1.2 m thick doubly reinforced concrete wall has been simulated. The behaviour of concrete has been incorporated using Concrete Damaged Plasticity model while that of the reinforcement Johnson Cook elastic-visco plastic model. The material parameters at elevated temperature have been taken from Eurocode 2. Reaction time response curves of Boeing 707-320 have been employed to find the response of containment against aircraft crash. Thermal stress analysis has been performed by combining the impact and heat effect together. It has been assumed that fire starts 0.16 sec. after the application of impact load. A maximum deformation of 48 mm has been noticed. Maximum temperature found to be 974 °C.

1. INTRODUCTION

The safety assessment of important structures, such as a nuclear power plant, for the crash of a large commercial aircraft has been performed worldwide after the terrorist attack that occurred in the U.S. on September 11, 2001. However, many important studies on this subject were carried out much before these attacks in order to study the effect of accidental crash of various aircraft on important structures (e.g. Riera 1968, 1980; Abbas et al. 1996; Arros and Doumbalski 2007). The nuclear containment is constructed in two layers of reinforced concrete shell. The purpose of the inner containment is to control the emission of radioactive radiation while the outer containment provides safety against possible external threat. For the external containment wall, aircraft crash and its subsequent fire effects on a nuclear containment structure may present the most serious threat to its integrity and stability. However, taking into consideration the massive cost and human efforts required, it becomes extremely difficult to study the behaviour of the containment for both the impact and thermal effect through experiments. Therefore, many researchers have attempted to numerically simulate the response of containment during an aircraft crash. An analysis of an air-craft crash on an outer containment of a nuclear power plant by taking into account the result of target yielding simultaneously with the reaction time in a time marching scheme was done by Abbas et al. 1995. Studies have also been performed for determining the response with changed cracking strains and different locations of aircraft impact for different aircraft. Kukreja 2005 analysed Indian nuclear containment using load by time history for Boeing 707-320 and other aircrafts. Similarly, Jeon et al. 2012 evaluated the fire resistance of a nuclear power plant subjected to a large commercial aircraft crash. A 3-D FEM model of the containment and auxiliary building was prepared and used for the heat transfer and thermal stress analysis, taking in account the material properties at an elevated temperature. It was found that a considerable magnitude of section forces such as bending moment and axial force were generated by the internal and external restraints imposed by the thermal deformation. The magnitude of these forces was quite large; thereby, these were regarded as the primary forces in safety assessment.

The present study focuses on the studying the behaviour of a nuclear containment of outer concrete layer 1.2 m thick and 30m high against the impact of an aircraft and its subsequent fire induced stresses. As discussed earlier, some work has already been done on this type of problem where the force history curves obtainable by many authors or an actual/ arbitrary model of an aircraft was made to hit over the outer containment wall to see the behaviour of the structure and its failure. It has also been known by many researchers that the concrete material exhibits dissimilar behaviour under different conditions of loading such as compressive or tensile loading, rate of loading, strain rate variation, temperature etc. Aircraft crash on containment is a complicated subject where such varied behaviour is encountered. Thus the plastic behaviour of the concrete has been integrated in the present study using the concrete damaged plasticity model available in Abaqus/Implicit, a finite element solver software. The change...
Load Settlement Behaviour of Fly ash Mixed with Waste Sludge and Cement

Malik Shoeb Ahmad · S. S. Shah

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Abstract One of the effective utilization strategies for fly ash and waste sludge is to use it as a fill material to raise low lying areas. Bearing capacity and settlement are the required input for the design of foundations on such fills. To determine the bearing capacity, plate load tests were carried out on the compacted beds of fly ash, fly ash-waste sludge and fly ash-waste sludge–cement. The tests were conducted by keeping 90, 95 and 100 % relative compaction, fresh and fresh submerged conditions, aged (28 days) and aged (28 days) submerged conditions as variables of the tests. The load-settlement curves were plotted for fly ash and mix blends. The minimum load was obtained for fly ash under submerged condition, further the test results show that the fly ash becomes flowable on submergence. On the other hand when the fly ash was mixed with waste sludge and cement, the load carrying capacity was found to improve to a greater extent. Test beds prepared with fly ash–cement-waste sludge under as compacted condition (fresh) show very high load carrying capacity (1600–2180 kN/m²). An analytical method has also been validated for fly ash–cement–waste sludge mix which was developed to estimate the settlement of footing resting on fly ash taking into account the pre-consolidation stresses. The non-linearity of load-settlement behavior was appropriately modeled, on the basis of available plate load test data incorporated in the method. The method requires as input, the pre-consolidation stress and Young’s modulus of compacted mix of fly ash-waste sludge–cement. A comparison of load-settlement values observed in plate load tests and predicted values for the mix 47 %FA + 45 %S + 8 %C, using the proposed method shows good agreement. Hence, this relationship may also be useful to the field engineers to check the reported load-settlement values for such types of mixes in the field.

Keywords Bearing capacity · Fly ash · Load-settlement · Plate load test · Waste sludge

1 Introduction

Nearly 73 % of India’s total installed power generation capacity is thermal, and 90 % of it is coal-based. The power requirement of the country is rapidly increasing with increased growth in the industrial sectors. As a result, the quantity of ash produced is also on the increase. The World Bank has cautioned India that by the end of 2015, disposal of coal ash would require 1000 m² of land per person. Fly ash management therefore, poses a serious environmental problem for India and requires considerable research and development. At present, approximately 10 % of the ash is used for ash dikes and brick and cement

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Petrographical and geochemical signatures of Jurassic rocks of Chari Formation, Western India: implications for provenance and tectonic setting

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Abstract The sandstones of the Ridge and Athleta members of Chari Formation (Callovian-Oxfordian) exposed at Jara have been analyzed for their petrographical and geochemical studies. Texturally, these sandstones are medium to coarse grained, poorly to well sorted, sub-angular to sub-rounded, and show low to medium sphericity. These sandstones were derived from a mixed provenance including granites, granite-gneisses, low and high-grade metamorphic, and some basic rocks of Aravalli range and Nagarparkar massif. The petrofacies analysis reveals that these sandstones belong to the continental block and recycled orogen tectonic regime. The studied sandstones are modified by paleoclimate, distance of transport, and diagenesis. Mineralogically and geochemically, sandstones are classified as quartzarenite, subarkose, arkose, sublithic arenite, and wacke, respectively. The A-CN-K ternary plot and CIA, CIW, PIA, and ICV values suggest that the similar source rocks suffered moderate to high chemical weathering under a hot-humid climate in an acidic environment with higher PCO₂. Generally good to strong correlations between Al₂O₃ and other oxides in these sediments indicate clay mineral control. The K₂O/Na₂O versus SiO₂ diagram indicates that the studied samples occupy passive margin fields but the SiO₂/Al₂O₃ versus K₂O/Na₂O plot suggests that the Athleta Sandstone and Ridge Sandstone fall within the passive margin field, while Ridge Shale falls within the active continental margin field.

Keywords Petrography · Geochemistry · Jurassic rocks · Chari Formation · Kachchh · Gujarat

1 Introduction

Kachchh is a peri-continental, paleo-riift basin on the westernmost fringe of the Indian peninsula (Biswas 1987). The basin occupies the entire district of Kachchh in the Gujarat State of western India, close to its western border with Pakistan, between latitude 22°30’–24°30’N and longitude 68°–72°E (Fig. 1). The basin is situated at the southern edge of the Indus shelf perpendicular to the southern Indus fossil rift (Zaigham and Maliuck 2000). It is bounded by the Nagar Parker fault in the north, Radhanpur–Barmer arch in the east and Kathiawar fault towards the south (Biswas 1982). The Mesozoic sediments are exposed in the form of six discontinuous domal areas: (a) Kachchh Mainland, (b) Pachham Island, (c) Khadir Island, (d) Bela Island, (e) Chorar Island, and (f) Wagad. Mesozoic sediments ranging in age from Bajocian to Albian (Rajnath 1932; Singh et al. 1982; Fürsich et al. 2001) (Table 1) lay unconformably on the Precambrian basement (Bardan and Datta 1987). The Kachchh Basin is a collage of three lithopackages viz. Mesozoic, Tertiary and Quaternary. The Mesozoic package comprises of Late Triassic to Early Jurassic continental, Middle to Late Jurassic marine, and Late Jurassic to Early Cretaceous fluviodeltaic sediments. Mesozoic sediments are rift fill sediments and constitute the major part of the basin fill. The Tertiary sediments, on the other hand, are mostly shallow marine shelf sediments in the peripheral and
Characterization of Bitumen Mixed with Plastic Waste

Malik Shoeb Ahmad\textsuperscript{1} and Fareed Mahdi\textsuperscript{1}
Received: 09.10.2014 \hspace{1.5cm} 31.01.2016

Abstract
Plastic (Polyethylene Terephthalate, PET) is now used as packaging material for a whole range of consumer products in addition to carbonated beverages. Although plastics are very useful product, but the disposal of these wastes has become a problem and is of great concern, particularly in our country. One of the solutions to the disposal of plastic wastes is recycling it into useful products such as it may be used in bituminous (asphaltic) pavements construction, resulting in reduced permanent deformation in the form of rutting of the pavement surface. The present study discusses in detail about the effect of PET on various engineering properties of bitumen. The PET waste was added in the bitumen from 2 to 14\% and various tests such as penetration, ductility, softening point, viscosity, flash and fire point and stripping tests were performed for the characterization of plain bitumen and PET modified bitumen. The most effective percentage of Polyethylene Terephthalate (PET) waste was obtained between 10 to 12\% by weight of the bitumen. The results of the study indicated that the modified mixture possessed better performance as compared to the non-modified bitumen. The experimental results were also authenticated by conducting Scanning Electron Microscopy (SEM) on the most effective percentages mixtures. It is observed that the addition of PET waste in the bitumen improves its engineering properties such as ductility, penetration, softening point and viscosity values by 32.43\%, 14.56\%, 26\%, and 34\% respectively. It has also been observed that addition of 12\% PET waste results in zero percent stripping even after 48 hours.

Keywords: Bitumen, characterization, PET, SEM

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Rock Mass Rating and Kinematic Analysis for Slope Stability Investigation of Utari Dam, Lalitpur District, Uttar Pradesh

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Abstract: Rock mass characterization of Utari dam in Lalitpur district of Uttar Pradesh was done to identify different stability classes of rock mass. For better stability of Utari dam, foundation conditions were carefully studied by detailed field investigations of the site supplemented by laboratory tests. During feasibility and preliminary stages, rock mass characterization of slopes was conducted to identify the vulnerable zones of failure. Rock mass characterization was done by compilation of information obtained from intact rock as well as from rock mass to determine its grade and long term slope stability of the site. On the basis of Rock Mass Rating (RMR) and Geological Strength Index (GSI) slope stability is identified which lies under good quality rock mass. Kinematic analysis was conducted to find out the probability for different types of structurally controlled slope failure. Microscopic analyses were conducted to identify the degree of chemical alteration of feldspar. Clay formation by sericitization along joint planes is harmful for the stability of dam structure. Remedial measures must be taken to reduce the extent of chemical alteration. Granitoids at dam site forms a compact and stable foundation consisting of four sets of joints in which two sets were prominent which are dipping on the upstream side of the dam which reveals good condition on the dam site as leakage from reservoir will be minimum and least up-thrust on the dam structure.

Keywords: Slope stability, Rock Mass Rating, Utari dam, Surikalan – Lalitpur, Bundelkhand, Uttar Pradesh.

INTRODUCTION

Rock mass characterization is an integral part of slope stability investigation. Analysis of slope for characterization includes strength of rock mass, nature and orientation of discontinuities, groundwater condition, overburden, lithology etc. Vulnerability analysis of slope is an important component of landslide risk assessment. For safer construction and reduced slope failure, proper investigations and slope characterization are required. Rock mass characterization guides planners to predict and choose suitable ways for construction of any civil engineering structure (Siddique et al., 2015). Rock mass characterization of Utari dam was done to identify different stability grades of slopes. Rock mass rating is a realistic classification system which provides comprehensive understanding of rock mass applicable to field condition. Geotechnical investigation was carried out in January, 2011. Utari dam is constructed on hard and massive granitoid rocks of Bundelkhand gneiss-mylonite complex. These rocks contains four sets of joints out of which only two sets were prominent dipping in upstream direction of dam. Thus, the orientation of discontinuities at the site indicates favourable conditions, formulating better stability and least leakage from the reservoir. Utari dam is a small water conservation dam constructed for the purpose of irrigations, so huge reservoir is not required and some adverse condition related to slope instability can be managed.

Rock mass rating for characterization of slope revealed that the rock mass lies under good grade. However, the discontinuities intersecting the upstream face of the Utari dam should be analysed properly and treated using rock mass

| Table 1: Specifications of Utari dam (source: www. irrigation.up.nic.in) |
|--------------------------|-----------------|
| Type                     | Earthen dam     |
| Length                   | 3.10 Km         |
| Purpose                  | Irrigation      |
| Catchment area            | 30.8959 Mile    |
| Gross Storage capacity    | 1081.98 Ha-M    |
| Live storage capacity     | 1116 Ha-M       |
| Types of gates            | Vertical        |
| Number of gates           | 4               |

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Petrofacies and Tectono Provenance of the Sandstones of Jara Dome, Kachchh, Gujarat

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Abstract: The Ridge and Athleta Sandstone members of Jara Dome have been analyzed for their petrofacies, provenance and tectonic setting. Various factors responsible for modification of the original detrital composition of the sandstones have been critically examined. In addition, heavy minerals have also been studied to strengthen the interpretation of the provenance. These sandstones were derived from a mixed provenance including granites, granite-gneisses, low and high-grade metamorphic and some basic rocks of the Aravalli Range and Nagarparkar Massif. The petrofacies analysis reveals that these sandstones belong to the continental block, recycled orogen and rifted continental margin tectonic regime. The first cycle and recycled detritus was further intensely modified as a result of weathering under warm humid climate and transport before burial, thereby providing mineralogical maturity to the sandstones of the Jara Dome.

Keywords: Petrofacies, Tectono-provenance, Ridge and Athleta Sandstone, Jara Dome, Kachchh, Gujarat.

INTRODUCTION

The goal of provenance studies is to deduce the characteristic of sediment source areas. Petrographic analysis is a standard method for studying provenance (Dickinson and Suczek, 1979; Ingersoll and Suczek, 1979). During the last two decades, several authors (Schwab, 1975; Dickinson and Suczek, 1979; Dickinson et al., 1993; Valloni, 1985) have demonstrated a close correlation between composition of terrigenous sediments/ sedimentary rocks and plate tectonic settings. The relative proportions of detrital framework grains plotted on triangular diagrams are believed to discriminate among variety of plate tectonic settings (Ingersoll, 1983; Lash, 1986; Jett and Helier, 1988; Akhtar and Ahmad, 1991; Ahmad and Bhat, 2006; Quasim and Ahmad, 2015). However, the correlation between tectonic setting and sandstone petrofacies may not always be valid due to modification of its composition by recycling, transport and post-depositional processes. The most notable modifying agents are intense chemical weathering under tropical humid climate and low relief (Suttner et al., 1981; Basu, 1985; Grantham and Velbel, 1988; Girty, 1991), differential abrasion during predepositional and pre-burial transport (Lucchi, 1985; Espejo and Gamundi, 1994) and diagenesis (McBride, 1985). Sediment recycling (Cox and Lowe, 1995), mixing of detritus derived from two sources, temporal change in tectonic style (Mack, 1984) and long sediment transport across the ‘mother’ plate to tectonically alien basins also hinder the identification of ‘generic’ tectonic setting and provenance. This paper attempts to study petrofacies, provenance and tectonic setting of the sandstones of Jara Dome. The petrofacies of this basin is interpreted in the light of known geotectonic of the Aravalli craton, keeping in view the various modifying factors that control and influence the original detrital composition.

TECTONIC SETTING

The Jurassic sediments of Kachchh represent a thick pile of rocks ranging in age from Bajocian to Tithonian (Singh et al., 1982), which rest unconformably on the Precambrian basement (Table 1). The basin developed primarily due to rifting of Africa and India in the Late Triassic time during the fragmentation of the Gondwana Superplate (Biswas, 1987). The total thickness of Mesozoic sediments in Kachchh ranges from 1525 to 3050 m (Biswas and Deshpande, 1983). The sequences were developed due to repeated marine incursions during the Middle Jurassic to Lower Cretaceous period followed by major tectonic movements and Deccan Trap volcanism in the Late Cretaceous time. The basin is bordered by the subsurface Nagarparkar massif in the north, Radhanpur-Barmer Arch in the east and Kathiawar uplift to the south (Biswas, 1982). The Mesozoic sediments are exposed in the Kachchh Mainland, Patcham, Khadir, Bela, Wagad, Chorad Islands in the “Great Rann of Kachchh” (Fig. 1). These sediments are dominantly represented by siliciclastics. Fursich et al. (1991) interpreted these siliciclastics representing a wide range of depositional settings including coastal and estuarine environments; subtidal bar-storm influenced shallow shelf and mid-shelf...
BEHAVIOUR OF SKEW FOOTINGS RESTING ON CLAYEY AND SANDY SOIL

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Abstract-Sometimes foundations of bridges, aqueducts and culverts need skew footings. Shape factors for rectangular, circular and square footings have been given by various investigators. To the knowledge of the author, neither any analytical or empirical formula for ascertaining the ultimate bearing capacity nor shape factor has so far been given by any one for skew footings. The author, therefore had attempted to investigate the behaviour of such footings experimentally. In the present study, an effort has been made for the stability and settlement behaviour of the skew model footings of width, B = 60 mm, 80 mm and 100 mm each having skew angles of 10°, 20° and 30° resting on bed of clay, sand and sand-clay layers. This study is based on non-dimensional technique. The physical variables included in theoretical analysis are the width and skew angle of the skew footings and soil parameters, angle of shearing resistance and unit weight of clay, sand and sand-clay layers.

Keywords- Skew Footings, Non-dimensional technique, Prototype and small-scale model tests.

I. INTRODUCTION

Sometimes foundations of bridges, aqueducts and culverts etc. need skew footings. For foundation shapes other than strip footings, analytical solutions of ultimate bearing capacity problem is considerably difficult. Based on some published (Goldthwait, 1941-42, and skempton, 1942) and unpublished test results, Terzaghi (1943) gave semi empirical formulae for ultimate bearing capacity of circular and square footings. De Beer and Vesic (1975) have also suggested shape factor for rectangular, circular and square footings, based on extensive experiments. To the knowledge of the author, neither any analytical or empirical formula for ascertaining the ultimate bearing capacity nor shape factor has so far been given by any one for the skew footings. Experimentally also, no investigation seems to have yet been carried out for studying the behaviour of skew footings. The author, therefore, has attempted to investigate the behaviour of such footings experimentally. The design of bridges on straight alignments with support skews between 0 and 60 degrees. For bridges on straight alignments with support skews exceeding 60 degrees, the designer should use a skew footing to more accurately capture true load distribution. For the superstructure, it was assumed that support skew does not affect the distribution of loading response across the section with the exception of skew. In a skewed bridge, loads tend to distribute to the supports in a direction normal to the supports. This causes a greater proportion of the load to concentrate at the obtuse corners of the span and less at the acute Corners. Depending on the contract, the centrelines of construction, structure, and roadway may be the same line or three different lines. For example, a two-lane bridge with no shoulders or with shoulders of equal widths would probably have one line for all three references. In most cases, however, one or more centrelines is different from the other centrelines. Centrelines of bearing are transverse lines that bisect the bridge seats or bearing areas on abutments and piers and intersect the longitudinal centrelines. Generally, if the centrelines of bearing intersect the longitudinal centrelines at an oblique angle (an angle other than a right angle), the bridge is said to be skewed or built on a skew. If the centrelines of bearing intersect the longitudinal centrelines at right angles, there is no skew. For this study, investigations were carried out by small-scale model footings tests on clay, sand and sand-clay layers, in laboratory. Three sizes of footings, 60 mm, 80 mm and 100 mm, each having skew angles of 10°, 20° and 30° were tested. Since the test results of small-scale model tests are quite often looked with suspicion, the dimensional analysis was carried

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Resol based chitosan/nano-hydroxyapatite nanoensemble for effective Bone tissue engineering


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Highlights:

- Novel, low cost and effective system where Resol is employed for the first time in ternary nanoensemble hybrid with nano-hydroxyapatite and Chitosan for Bone tissue engineering applications.
- Hemocompatible system with adequate mechanical strength.
- Excellent in-vitro bioimineralization and in-vivo studies demonstrated outstanding ability to repair critical size defect (8mm) in albino rat with latent period of 2 weeks.
- The comparison with a commercial formulation Cerabone further highlighted its potential use in orthopedic applications.

1.

Introduction
Full length article

Response of outer containment of an NPP against aircraft crash and induced fire

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A R T I C L E   I N F O

Keywords:
Reinforced concrete
Impact
Cracking
Aircraft crash
Nuclear containment
Fire resistance
Fire endurance time

A B S T R A C T

Nuclear energy presently contributes more than 17% of global energy demand. In order to avoid the nuclear disasters, safety concern in nuclear structures is always of high concern. In the present study, response analysis of the outer containment of a typical Nuclear Power Plant (NPP) has been carried out against aircraft impact using finite element code ABAQUS. To maximise the effect of collision, the wall is considered as flat in the present study. Moreover, to maintain computational economy, only a quarter of the wall has been modelled. A 1.2 m thick doubly reinforced concrete wall has been simulated in the present study. Behaviour of concrete has been incorporated using Concrete Damaged Plasticity model while the Johnson Cook elastic-viscoplastic model has been used for reinforcement. Material parameters at elevated temperature have been taken from Eurocode 2. Reaction time response curve of Boeing 707-320 has been employed to find the response of containment against aircraft crash. Thermal stress analysis has been performed by combining the impact and heat effect together. It has been assumed that fire starts at 0.16 s after the application of impact load. A maximum deformation of 48 mm has been noticed. Maximum temperature was found to be 974 °C.

1. Introduction

The safety assessment of important structures, such as a nuclear power plant, for the crash of a large commercial aircraft has been performed worldwide after the terrorist attack that occurred in the U.S. on September 11, 2001. However, many important studies on this subject were carried out much before these attacks in order to study the effect of accidental crash of various aircraft on important structures [1–9]. The nuclear containment is constructed in two layers of reinforced concrete shell. The purpose of the inner containment is to control the emission of radioactive radiation while the outer containment provides safety against possible external threat. For the external containment wall, aircraft crash and its subsequent fire effects on a nuclear containment structure may present the most serious threat to its integrity and stability. However, taking into consideration the massive cost and human efforts required, it becomes extremely difficult to study the behaviour of the containment for both the impact and thermal effect through experiments. Therefore, many researchers have attempted to numerically simulating the response of containment during an aircraft crash.

An analysis of an aircraft crash on an outer containment of a nuclear power plant by taking into account the result of target yielding simultaneously with the reaction time in a time marching scheme was done by Abbas et al. [10]. Studies have also been performed for determining the response with changed cracking strains and different locations of aircraft impact for different aircraft. Kukreja [11] analysed Indian nuclear containment using load-time history for Boeing 707-320 and other aircraft. Similarly, Jeon et al. [12] evaluated the fire resistance of a nuclear power plant subjected to a large commercial aircraft crash. A 3-D FEM model of the containment and auxiliary building was prepared and used for the heat transfer and thermal stress analysis, taking in account the material properties at an elevated temperature. It was found that a considerable magnitude of section forces such as bending moment and axial force were generated by the internal and external restraints imposed by the thermal deformation. The magnitude of these forces was quite large; thereby, these were regarded as the primary forces in safety assessment. Wherein the obtained force history curves of aircrafts were applied over the outer containment wall to observe the response of the structure.

The study of aircraft crash on containment structure is quite complicated due to material as well as structural non-linearity. Moreover, the behaviour of concrete under high strain loading and at elevated
Response of Pile foundation to Horizontal Load: A Review

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ABSTRACT
Deep foundation has a significant role in sustainable and safe development of infrastructure. The present study dealt about the behavior of laterally loaded pile foundation. Initially, a review of several recommendations and guidelines made by industry consultants for lateral bearing capacity of pile in clay has been summarized. A typical inconsistency has been found in these hypotheses. The paper further investigated the various factors influencing the behavior of laterally loaded pile foundation. It may be concluded that the interaction of vertical loads reduces bearing capacity of laterally loaded pile. Furthermore, the presence of clay layer in sand deposit effects lateral behavior significantly. Extra deflection may be observed when pile installed in group as compared to single pile due to increase in flexibility.

Keywords: Pile foundation, Lateral loading, Layered soil, Bearing capacity, Group effect.

I. INTRODUCTION
Pile foundations have been in practice since long, to transfer the load of superstructures to the deep compatible soil or rock strata. High rise buildings, offshore platforms, bridges, defence structures, dams, metro projects, transmission towers, earth retaining structures, wharfs and jetties were few important structures, where pile foundation were frequently used to support vertical and lateral loads. Nevertheless, in all these structures, piles had to carry not only the axial loads, but also the lateral (horizontal) forces and moments. More precisely, in structures like oil production platforms, earth retaining structures, wharfs and jetties, the primary function of piles is to resist the lateral loads for safety of the structure. For tall buildings and transmission towers, wind action may be regarded as the main source of horizontal loading, while, in case of offshore structures, oil extraction platforms, quays, harbors, wharfs and jetties, wave action has the significant contribution as horizontal force. Further, in design consideration seismic forces may come into picture according to the seismic zonation of particular project.

II. MECHANISM OF LOAD TRANSFER IN LATERALLY LOADED PILES
Laterally loaded piles have load transfer mechanism similar to a transversely loaded beam. They transfer the load to the adjacent soil mass by using the lateral resistance of soil. When a pile is loaded laterally, a part or whole of the pile tries to shift horizontally in the direction of the applied load, producing bending, rotation or translation of the pile (Fleming et al.1992, Salgado 2008). The soil in the front i.e. in direction of applied load has been pushed by the pile, which generates compressive and shear stresses and strains in the soil that offers...
Impact Analysis of Fighter Jet Near the Nuclear Containment Base

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Abstract

Complete or partial failure of nuclear containment structures, if targeted during war or terrorist attacks, may cause heavy radiation leakage. Safety analysis of BWR Mark III type containment has been performed in the present study against possible crash of military jet Phantom F4. Numerical simulations have been carried out using finite element code ABAQUS/Explicit. A normal hit of the aircraft has been considered near the base of containment. Loading of the impact force has been provided through reaction time response curve. Concrete Damage Plasticity model have been incorporated to simulate the behaviour of concrete at high strain rate, while Johnson-Cook elasto-visco model of ductile metals have been used for steel reinforcement. Effect of contact area has been evaluated. Maximum deformation in the containment building has reported as 64.77 mm for 28 m\textsuperscript{2} contact area, while for contact area of 10 m\textsuperscript{2} it has been observed about 135 mm. Very high local deformations has been noticed in the impact region. Tension damage at the inner face of the containment are more significant than the compression damage at the loading face. Moreover, no significant global damage has been observed in structure. At higher velocities Phantom F4 may perforate the structure.

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Keywords: aircrafts crash, nuclear safety, concrete damage, ABAQUS

1. Introduction

The role of nuclear energy production has been identified worldwide in recent energy outlook highlights as an potential sustainable energy source. Exposure to higher dose of radiation can impart worst kind of disaster to human life, which will spread to generations after generation. To satisfy the high measures of safety and to shield the limit

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STRESS ANALYSIS OF TUNNEL IN SOFT SOIL: A STATE OF ART REPORT

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ABSTRACT

Underground facilities are an important part of the infrastructure of modern world and are used for extensive range of applications, including material storage, sewage, subways, railways, highways and water transport. In general, various factor are essential to consider while designing the tunnel in soft soil to optimise the cost of construction and safety also. Loads for underground structures are considered in terms of the strains and deformations imposed on the structure by the adjacent ground, often due to the collaboration between the two. The report discusses the various factor responsible for the stresses in tunnel lining in soft soil. This paper also gives brief idea about the method of analysis and construction of tunnel developed in recent year.

Keywords: Method of tunnelling, Numerical modeling, Seismic effect on tunnel, Soil-structure interaction, tunnel boring machine

I. INTRODUCTION

A tunnel has been described as a long, narrow, mostly linear excavated underground opening, in which one dimension i.e. length greatly exceeds other two i.e. opening width or height. (Walhstrom, 1973). Factors like urban development, population growth and limited space have emphasised a considerable growth in tunnel construction for subways, underpasses and urban highways for providing the better services to transportation all around the world. Engineers and Planners has shown interest in shallow tunnels for modern sustainable development of cities due to the fact that underground structure performed better than superstructure during an earthquake. However, limiting the surface and subsurface settlement and stresses in lining produced due to tunnelling in shallow and soft ground has been perceived as the main challenge of any geotechnical engineer. Due to the advancement and development of technology better solution are available to overcome the problems faces during the tunnelling. The present paper is an attempt to summarize the importance of tunnel construction, method of soil tunnelling and analysis of stresses in tunnel lining to economise the tunnel construction. Several essential parameters influencing the planning and design of tunnel in soft soil has been discussed.

II. METHOD OF TUNNELLING

Construction of tunnel in soft ground has always been challenging due to stability issue of tunnel face, settlement of nearby sub-surface soil and tunnelling-induced damage to superstructures. It is essential to select the suitable technique of excavation by keeping the various factor in mind regarding stand-up time, access for
Impact Analysis of Fighter Jet Near the Nuclear Containment Base

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Abstract

Complete or partial failure of nuclear containment structures, if targeted during war or terrorist attacks, may cause heavy radiation leakage. Safety analysis of BWR Mark III type containment has been performed in the present study against possible crash of military jet Phantom F4. Numerical simulations have been carried out using finite element code ABAQUS/Explicit. A normal hit of the aircraft has been considered near the base of containment. Loading of the impact force has been provided through reaction time response curve. Concrete Damage Plasticity model have been incorporated to simulate the behaviour of concrete at high strain rate, while Johnson-Cook elasto-visco model of ductile metals have been used for steel reinforcement. Effect of contact area has been evaluated. Maximum deformation in the containment building has reported as 64.77 mm for 28 m² contact area, while for contact area of 10 m² it has been observed about 135 mm. Very high local deformations have been noticed in the impact region. Tension damage at the inner face of the containment are more significant than the compression damage at the loading face. Moreover, no significant global damage has been observed in structure. At higher velocities Phantom F4 may perforate the structure.

Keywords: aircrafts crash, nuclear safety, concrete damage, ABAQUS

1. Introduction

The role of nuclear energy production has been identified worldwide in recent energy outlook highlights as an potential sustainable energy source. Exposure to higher dose of radiation can impart worst kind of disaster to human life, which will spread to generations after generation. To satisfy the high measures of safety and to shield the limit
Diagenetic evolution vis-a-vis reservoir characteristics of Dhosa sandstones, Ler dome, Kachchh, western India

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Abstract
The detrital mineralogy as well as diagenetic characters of the Dhosa Sandstone Member of Chari Formation exposed at the Ler dome, south of Bhuji was studied. In order to assess the potential of the Dhosa Sandstone as a reservoir, it is substantial to understand the diagenetic processes that are controlled largely by post-depositional cementation and compaction in addition to framework composition and original depositional textures. The petrologic analysis of 33 thin sections was carried out to discern primary composition and diagenetic features including primary and secondary porosity patterns. Monocrystalline quartz dominates the detrital mineralogy followed by polycrystalline quartz. Among the polycrystalline variety recrystallized metamorphic quartz surpasses stretched metamorphic quartz in terms of abundance. Feldspars comprise microcline and plagioclase where the former is dominant over the latter. Orthoclase too comprises a very small percentage. Mica, chert, rock fragments, and heavies form the remaining detrital constituent in descending order of their constituent percentage. The diagenetic precipitates are mainly carbonate (8.3%) and iron (7.8%) followed by clay (0.66%) and silica (0.88%) that are minor constituent of the total cementing material. The main paragenetic events identified are early cementation, mechanical compaction, late cementation, dissolution, and authigenesis of clays. The overall reservoir quality seems to be controlled by compaction and authigenic carbonate cementation. The minus cement porosity average 29.4%. The porosity loss due to compaction is 21.92% and by cementation is 29.71%. The loss of original porosity was due to early cementation followed by moderate mechanical compaction during shallow burial. Preservation of available miniscule primary porosity was ascribed to dissolution of carbonates and quartz overgrowth which resisted chemical compaction during deep burial. The studied sandstones may have low reservoir quality owing to existing porosity of less than 9%. More carbonate dissolution and its transformation in dolomite in sub-surface condition and macro-fracture porosity may result in enhanced secondary porosity and good diagenetic traps.

Keywords Diagenesis · Porosity · Mechanical compaction · Cementation · Clays · Reservoir

Introduction
The Kachchh basin holds a unique stature in India for its geological diversity. The multiplicity of geologic facets is evident in the wide range of sedimentary facies and diverse fossil biota. The pericratonic basin had a long history of sedimentation during Mesozoic and Cenozoic times. The Directorate General of Hydrocarbons, Government of India (GOI) recognizes the basin as a category II type, i.e., with known accumulation of hydrocarbons (Directorate General of Hydrocarbons (DGH) 2012). The study of siliciclastic sedimentary rocks is an important component in revealing the tectonic evolution of basin and provenance which can be linked to source-reservoir-cap rock trinity and its spatial evolution (Singh and Singh 1994; Ahmad et al. 2017; Khan et al. 2018; Quasim et al. 2018).

Diagenesis plays a key role not only in generating the hydrocarbons but also in preserving them. The physicochemical and biochemical and physical processes occurring at low temperature and pressure at the surface and near-surface environment are very much controlled by depositional environment, rate of deposition, and basin subsidence. The migration of fluids, chemical potential of the system, and inherent fluids within the basin are key factors of diagenesis (Giles 1997).
Stability Analysis of Rock Slope having Transmission Tower

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ABSTRACT: The need for electricity and communication network connectivity is increasing with the day. The erection of transmission towers in remote hilly areas is a challenging task due to difficult terrain and topology. Therefore, the study of the stability of slope having a foundation on top of it is necessary. In this paper, the maximum deflection in slope is studied by varying joint dip and distance of footing from the edge of the slope by keeping the footing size at 4.5 m x 4.5 m. The maximum footing size for the transmission tower is taken from the standards. The number of joint sets considered is one. The slope taken is a stair-steps slope having a road on one step and bottom step as riverbed and with the slope angle taken as 75 degrees with the horizontal. The analysis is done using ABAQUS, a finite element method based software. It is found that the maximum deflection is observed in the case when the distance of footing from the edge is 4.5 m (d=1) and the joint set angle is 45 degrees with respect to the slope. The maximum deflection observed is 2.66 mm on the far extrema from the edge of top horizontal extent and deflection just beneath the footing is 1.71 mm.

KEYWORDS: Slope Stability, Transmission Tower, Footing, ABAQUS, FEM

1 INTRODUCTION

The rapid increase in population in the recent decades has made the people move to farther places in search of living space. Thereby, increasing the electricity demand, leading to the execution of hydroelectric power projects. The hydropower plants work on the principle of harvesting the potential energy of falling water. This necessitates the construction of the reservoir. The location of reservoir and dam are normally in the mountainous region. Therefore, the transmission of electricity needs erection of the transmission towers on the hills and slopes. The construction of transmission tower in the hilly region is a challenging task, it needs the excavation of slope and its stability for the successful erection and working of these towers. The stability of slope depends upon its material properties, geological conditions, topology and the structural elements like joints, fault system, folds and shear zones etc. The presence of joints is one of the parameters controlling the stability of slope [1]. In addition to joints, the bedding plane and foliation also affect the stability of rock slope under static or dynamic load [2]. Therefore, the analysis of slope stability is an important task before the proper design of the system. Hence, in this paper, the instability of slope due to discontinuities and foundation of transmission tower has been considered.

Numerical methods like finite element analysis are widely used to analyze the stability of rock slopes [3]. Finite element methods have proved accuracy, robustness and fast computing over the conventional method of limit equilibrium [4]. The assumptions made in limit equilibrium methods can lead to unreliable results for anisotropic rocks [5]. Therefore, the FE methods are becoming a handy tool for practising engineers [4]. The analysis of rock or soil slope can be done using finite element packages like ABAQUS, ANSYS, Phase2, etc [6]. This paper presents a case study of slope from the site at Karcham – Wangtoo in Himachal Pradesh, India. The stability of slope having a foundation of transmission tower is studied in terms of maximum deflection for the varying joint set orientation and the distance of foundation from the tip of the slope. The most unstable combination of these two parameters is found out, though factor of safety is not calculated. The main reason behind this is to focus only on finding the condition which will lead to minimum FOS for slope stability. Another reason to avoid the calculation of FOS is to speed up the computation without compromising the end result.

2 NUMERICAL MODEL

2.1 Geometry

The geometry of the model is based on the actual geological conditions of the slope at Karcham Wangtoo. The slope is having 75-degree dip angle and the width of the road as 15 meters and the width of a neighbouring river as 20 meters. The elevation at which the transmission tower is established from the river bed is 40 meters. The analysis is carried forward for basalt rock mass. The footing of the transmission tower is taken as 4.5m x 4.5m. Joint orientation parallel to the slope named as 0 degrees. The orientation is
Damage assessment of nuclear containment against aircraft crash

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HIGHLIGHTS

- Damage assessment of nuclear containment is studied against aircraft crash.
- Four impact locations have been identified at the outer containment shell.
- The mid of the total height has been found to be most vulnerable location.
- The crown of dome has been found to be the strongest location.
- Phantom F4 caused more localized and severe damage compared to other aircrafts.

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ABSTRACT

The behavior of nuclear containment structure has been studied against aircraft crash with an emphasis on the influence of strike location. The impact locations identified on the BWR Mark III type nuclear containment structure are mid-height, junction of dome and cylinder, crown of dome and arc of dome. The containment at each of the above locations has been impacted normally by Phantom F-4, Boeing 707-320 and Airbus A320 aircrafts. The loading of the aircraft has been assigned through the corresponding reaction-time response curve. ABAQUS/Explicit finite element code has been used to carry out the three-dimensional numerical simulations. The concrete damaged plasticity model was used to simulate the behavior of concrete while the behavior of steel reinforcement was incorporated using the Johnson–Cook elasto-viscoplastic material model. The mid-height of containment has been found to experience most severe deformation against each aircraft. Phantom F4 has been found to be most disastrous at each location. The results have been compared with those of the available studies with respect to the containment deformation.

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1. Introduction

The air traffic in the last two decades has increased many folds imposing increased risk of accidents. An accidental or deliberate hit of aircraft may lead to local or global failure of critical structures. Particularly the nuclear containment structures are highly vulnerable to such attacks due to the immediate and long-term aftereffects associated to their failure (Abbas, 1992). Hence, the damage assessment of the existing nuclear containment structures needs a careful investigation against such unpredictable events.

The nature of problem is highly complex as a matter of fact that the two interacting bodies demonstrate different mechanical behavior and damage response due to their distinct stiffness and material properties. In order to avoid these complexities Riera (1968) uncoupled the problem by obtaining the reaction time response curve of Boeing 707-320 aircraft against a flat rigid target assuming conservation of momentum. The subject was further extended by Riera (1980) through the incorporation of target flexibility and oblique incidence in the reaction time response curve. Abbas et al. (1996) also concluded that the containment thickness of 1.2 m will be sufficient to resist the horizontal crash of Boeing 707-320. However, the dome of the containment will not remain safe if the thickness is reduced to 0.6 m (Paul et al., 1993). The strike of Boeing 707-320 near the junction of dome and cylinder has been found to damage the containment locally but no significant deformation was noticed at the crown and at the region 180° azimuth from the position of impact (Kukreja et al., 2003; Kukreja, 2005).

The studies in the literature led to the conclusion that a fair estimate of the response of containment can be obtained with the help of reaction-time response as the loading criterion. Further, the junction of dome and cylinder has been significantly studied as a location of impact. However, the other locations at the dome...
An experimental and analytical investigation into age-dependent strength of fly ash mortar at elevated temperature

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HIGHLIGHTS

- Studied the effect of high temperature on age-dependent strength of fly ash mortar.
- Fresh, age-dependent, microstructure properties were investigated up to 500 °C.
- Fly ash mortar after exposure to elevated temperature showed better performance.
- Formation and growth of micro-cracks is larger in OPC than fly ash mortar at 500 °C.
- A model is proposed to predict fly ash mortar strength at elevated temperature.
- Model is useful in concrete construction, contributes in sustainable development.

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ABSTRACT

The impact of high temperature on the fresh, age-dependent strength and microstructure properties of low and high content fly ash mortars has been examined in the current investigation. Cement was replaced with fly ash by 0%, 10%, 25%, 40% and 50% on an equal weight basis. The mortar specimens were prepared using blended cement (i.e. cement + fly ash): fine aggregate proportion of 1:3 and water to binder proportion ranging from 0.415 to 0.44 and cured under water for the ages varying from 7 to 90 days. Then, the specimens were dried and then exposed to one heating-cooling cycle of high temperatures starting from 100 °C to 500 °C at an interval of 100 °C for 3 h. The residual strength of blended mortar in compression was measured and compared with plain mortar strength. The morphological characteristics using scanning electron microscopy has also been observed. The blended mortar containing 10% fly ash when exposed up to 500 °C temperatures gives better performance. The microstructure analysis showed that plain mortar at 500 °C is having larger micro-cracks formation and growth than blended mortar containing 10% fly ash. A model is proposed for the prediction of age-dependent compressive strength of blended mortar after heating at high temperature and found good agreement with experiments. The proposed model will be useful in concrete construction and also contribute to sustainable development. Using the proposed model, the age-dependent strength of fly ash mortar at elevated temperature can be predicted, when 28 days strength of plain mortar at ambient temperature is available.

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1. Introduction

The cement mortar plays an important role in concrete construction and can be used to cover the gaps between construction units, grouting in the pre-stressed concrete works and repair of concrete works. In addition, cement mortar can also be used to prepare building units such as bricks made with cement mortar. Thus, cement mortar properties may directly influence the concrete properties. The Portland cement is prominent amongst the most expended materials in mortar and concrete. It is utilized as the fundamental binder material in civil engineering construction work over the globe but also responsible for CO₂ gas emission. Therefore, to decrease the utilization and reliance on cement, usage of pozzolanic materials, for example, fly ash (FA) as valuable cementitious material has turned into the vital research in the field of civil engineering materials such as concrete in late pasts. Extensive research revealed that the accumulation of FA into mortar improves the mechanical and durability properties of concrete.

In past research, it was discovered that the properties of mortars with FA substitution is influenced by the hydration response, materials packing and pozzolanic activity [1]. The FA properties may vary and rely on the container from where it is procured.
GIS Application for Groundwater Management and Quality Mapping in Rural Areas of District Agra, India

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Abstract: With the advent of powerful personal computers and the advances in space technology, efficient techniques for land and water management have evolved of which RS (remote sensing) and GIS (geographic information system) are of great significance. These techniques have fundamentally changed our thought and ways to manage natural resources in general and water resources in particular. Spatial variations in groundwater quality of Agra rural areas have been studied using Geographic Information System (GIS) technique. For this study, water samples were collected from various bore wells. The objectives of this investigation were (1) to provide an overview of present groundwater quality, (2) to interpret spatial distribution of groundwater quality parameters such as TDS, Total Hardness, Iron and Fluoride concentrations and (3) to map groundwater quality in the study area using GIS. The groundwater quality information maps of the entire study area have been prepared using Distance Weighted (DWD) interpolation technique approach in GIS for all the major parameters. The results obtained in this study and the spatial database established in GIS would be helpful for monitoring and managing groundwater pollution in the study area. Mapping was carried for potential zones, in the absence of better alternate source and sub-potable zones in the study area, in terms of water quality.

Key words: Spatial Variation - GDW - Groundwater - GIS and DWD

INTRODUCTION

Groundwater is one of the most valuable natural resources, which supports human health, economic development and ecological diversity. The groundwater resources play a very significant role in meeting the ever-increasing demands of the agriculture, industry and domestic sectors [1].Because of its several inherent qualities (e.g., consistent temperature, widespread and continuous availability, excellent natural quality, limited vulnerability, low development cost, drought reliability, etc.), it has become an immensely important and dependable source of water supply in all climatic regions including both urban and rural areas of developed and developing countries [2]. Over exploitation and uncontrolled pollution of this vital resource is threatening the ecosystem and even the life of future generation. In recent years, it has been recognized that the quality of groundwater is of nearly equal importance to quantity. Unfortunately, the excessive use and continued mismanagement of water resources to supply ever-increasing water demands to population have led to water shortages, increasing pollution of freshwater resources and degraded ecosystem worldwide [3,4, 5, 6]. The required quality of ground water supply depends upon its purpose; then, the needs for drinking water, industrial water and irrigation water very widely. In recent years, the use of the Geographic Information System (GIS) has grown rapidly in groundwater management and research. GIS is now widely used to create digital geographic databases, to manipulate and process data as input for various modeling processes and to display model outputs.

Waste quality monitoring has one of the necessary priorities in environmental protection policy [7]. Understanding the quality of groundwater with its temporal and seasonal variation is important because it is the factor that determines the usability for drinking, domestic, agricultural and industrial purpose.
A STUDY ON ECONOMIC TREATMENT OF DISTILLERY EFFLUENT

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ABSTRACT

The present study was conducted to find the economic pollution reduction technique of distillery effluent that possesses a serious environmental problem. The distillery effluent is generally highly acidic (pH 3.8 - 4.4) with high rates of BOD 45000-60000 mg/l & COD 70000 - 98000 mg/l and also suspended solids (2000 - 14000 mg/l). Currently different treatment techniques are used to treat distillery effluent which includes fungal treatment, adsorption techniques, Electroosorption, filtration, biological treatment, etc. But no treatment method alone give the desired goal to treat the distillery effluent effectively and efficiently therefore further research study in this area should be carried out to prevent surface and ground water pollution.

Key Words: BOD, COD, Adsorption, Electroosorption, Filtration etc.

INTRODUCTION

Water is one of the most important compounds required for every existing of life therefore adequate supply of fresh and clean water is a basic need for all human beings but According to the Natural Environmental Engineering and Research Institution (NEERI) Nagpur about 70% of all available water in India is polluted and therefore two thirds of all ailments in India such as Typhoid, Jaundice, Cholera, Diarrhea and Dysentery system is caused by contaminated water. These water borne diseases claims 1.5 million lives in India every year, which means three people die every 10 minutes due to contaminated water. [9] The fact behind this is rapid industrialization which is one of the major causes of water pollution. The discharges of untreated and partially treated wastewater from various industries like chemical, pesticides, fertilizer, pulp and paper and sugar, etc., have polluted the aquatic bodies such as a river, pond and ditches. [10] Alcohol production from sugarcane molasses is an important distillery industry posses a high load of water pollution. In India there are around 295 distilleries with a total installed capacity of 3198 million liters per annum and a current yearly production of 1587 million liters alcohols [1]. Liquid wastes from breweries and distilleries possess a characteristic high pollution load and have continued to pose a critical problem of environmental pollution. The high temperature of the waste waters may instantaneously kill fish and other aquatic organisms, thus destroying the flora and fauna of a river, when the wastewater is discharged into it. The spent wash generated is highly acidic in nature (pH 4.0-4.3), Due to decomposition of soluble and suspended organic matters present in the wastewaters, high BOD (Biochemical Oxygen Demand) (45000-60000 ml/l) and COD (Chemical Oxygen Demand) (750000-98000 mg/l) of the wastewaters results, causing rapid depletion of the oxygen content of the water, thus creating a foul smell (289). This required that the effluents of the distillery are either treated or utilized profitably.

SCHEMATIC OF ALCOHOL MANUFACTURING PROCESS [3].

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Sorption Studies of Synthesized Horticultural Waste Seeds for Removal of Hexavalent Chromium from Aqueous Solutions

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Abstract

The main objective of the present study was to synthesize various horticultural seeds and shells like Mangifera indica Kernel, Mangifera indica kernel shell and Carica papaya Seeds. The various horticultural seeds and shells can be used as low cost adsorbent after a little and simple synthesis. The synthesis was carried out by thermal method through carbonization temperature of 150⁰ C for 2 hours. It was found that the specific surface area of the adsorbents were 1.4541 ± 0.0414 m²/g, 1.2653 ± 0.0616 m²/g, and 1.3452 ± 0.0414 m²/g, for a particular average size ranging from 300 μm to 600 μm. The synthesized adsorbents were studied for adsorption of Chromium (VI) from aqueous solutions for the investigation of effects of varying pH, adsorbent dose, initial concentration of chromium, contact time, grain size of adsorbent, temperature and start-up agitation speeds. Based on laboratory adsorption batch experiments it can be concluded that the adsorbents developed in the present study are considerably effective for the adsorption of chromium (VI) from aqueous solutions. The exhaustive capacity of the sorbent was higher in case of column process than the batch process.

Keywords: Sorption, Kernel, Sorbent, Shell, Sorbate, Horticultural Waste Seeds, MSW, MSSW, PS.

INTRODUCTION

The environmental impact of chromium (Cr) discharged from tanneries and electroplating industries etc. has always been a subject of extensive scientific and technical dispute. All chromium compounds are responsible for the majority of the health problems. Normally chromium salts are used in chrome tanning in tanneries and being corrosion resistant it is also used in electroplating and other industries for making the products surfaces anti corrosive. Nevertheless, under certain condition the Cr (III) can be transformed into Cr (VI). Many studies report the effluents from tanning industry are often adversely affecting human life, agriculture and livestock as well as aquatic life when disposed off in natural water streams. The residents, especially the tannery workers have been the victims of this pollution, which has led to severe ailments such as eye diseases, skin irritations, kidney failure and gastrointestinal problems. The World Health Organization (WHO) standard for the acceptable amount of Chromium in drinking water is 0.05 mg/L. The ground water has been stated polluted with chromium up to 5 times of the WHO standard with a varying depth of up to 165 meters. Chromium, extensively used in tanning process, is carcinogenic. So as a result of chromium (VI) being carcinogenic and toxicological, its removal by some low cost agro based adsorbents has become today's burning need (Ayub et al., 1993; 1999; 2001(a) and(b); 2002).

In developing countries like India the adsorption process has been proved an effective and economic method for the removal of heavy metals from wastewaters as it offers flexibility in design and operation to produce high quality treated effluents of desired standards for disposal and moreover the adsorbents can be regenerated by suitable desorption methods.
Removal of Hexavalent Chromium from Sewage Produced by Small Scale Industries in Aligarh

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Abstract
In the present study, the adsorption potential of activated carbon for removal of (Cr$^{6+}$) ions from effluents of electroplating areas has been investigated by using the active compound onto the activated carbon surface under mild conditions. Hexavalent Chromium (Cr$^{6+}$) in the wastewater under analysis is higher than the permissible limits of World Health Organization (WHO), Bureau of Indian Standards (BIS) and Central Pollution Control Board (CPCB) at only one location Industrial Estate in Aligarh. The study involves batch experiments to investigate the effects of adsorbent dose, pH of solution and contact time on adsorption process and the evaluation of optimum conditions. In batch studies, the adsorption process has best fit to Freundlich isotherm. Freundlich adsorption isotherm model was applied to analyse adsorption data and was found to be applicable to this process. Finally, it can be concluded that activated carbon was more effective for the removal of (Cr$^{6+}$) ions from the wastewater.

Keywords: Heavy Metals, effluent from electroplating industry, adsorption, activated carbon

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INTRODUCTION
Heavy metals are elements those have atomic weights between 63.546 and 200.590 gram and a specific gravity greater than 4.0 i.e., at least 5 times that of water. They exist in water in colloidal, particulate and dissolved phases with their occurrence in water bodies being either of natural origin (e.g., eroded minerals within sediments, leaching of ore deposits and volcanism extruded products) or of anthropogenic origin (i.e., solid waste disposal, industrial or domestic effluents, harbour channel dredging).

They constitute an ill-defined group of inorganic chemical hazards and those that are most commonly found at contaminated sites are lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni).

Nowadays, there has been a growing concern with environmental protection. This can be achieved either by decreasing the afflux of pollutants or by their removal from the contaminated media. The former is feasible choice only for pollutants of anthropogenic origin, whereas the latter is unavoidable for those of natural origin. Process waste streams from the mining operations, metal-plating facilities, power generation facilities, electronic device manufacturing units, and tanneries may contain heavy metals at concentrations exceeding the local discharge limits. These waste streams contain toxic heavy metals such as chromium, cadmium, lead, mercury, nickel, zinc and copper. The use of secondary treated wastewater, rather than raw effluent water, appears to have had few adverse physical, chemical, or biological effects on vegetables and fruits.
MUNICIPAL SOLID WASTE DUMPING PRACTICE AND ITS IMPACT ASSESSMENT

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A STUDY ON ECONOMIC TREATMENT OF
DISTILLERY EFFLUENT

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ABSTRACT

The present study was conducted to find out the economic pollution reduction technique of distillery effluent that possesses a serious environmental problem. The distillery effluent is generally highly acidic (pH 3.8 - 4.4) with high rates of BOD 45000 - 60000 mg/l & COD 70000 – 98000 mg/l and also suspended solids (2000 - 14000 mg/l). Currently different treatment techniques are used to treat distillery effluent which includes fungal treatment, adsorption techniques, Electrosorption, filtration, biological treatment, etc. but no treatment method alone give the desired goal to treat the distillery effluent effectively and efficiently therefore further research study in this area should be carried out to prevent surface and ground water pollution.

Key Words: BOD, COD, Adsorption, Electrosorption, Filtration etc.

INTRODUCTION

Water is one of the most important compounds required for every existing of life therefore adequate supply of fresh and clean water is a basic need for all human beings but According to the Natural Environmental Engineering and Research Institution (NEERI) Nagpur about 70% of all available water in India is polluted and therefore two third of all ailments in India such as Typhoid, Jaundice, Cholera, Diarrhea and Dysentery system is caused by contaminated water. These water borne diseases claims 1.5 million lives in India every year, which means three people die every 10 minutes due to contaminated water. [9] The fact behind this is rapid industrialization which is one of the major causes of water pollution. The discharges of untreated and partially treated wastewater from various industries like chemical, pesticides, fertilizer, pulp and paper and sugar, etc., have polluted the aquatic bodies such as a river, pond and ditches. [10] Alcohol production from sugarcane molasses is an important distillery industry posses a high load of water pollution. In India there are around 295 distilleries with a total installed capacity of 3198 million liters per annum and a current yearly production of 1587 million liters alcohols [1]. Liquid wastes from breweries and distilleries possess a characteristically high pollution load and have continued to pose a critical problem of environmental pollution. The high temperature of the waste waters may instantaneously kill fish and other aquatic organisms, thus destroying the flora and fauna of a river, when the wastewater is discharged into it. The spent wash generated is highly Acidic in nature (pH 4.0 - 4.3), Due to decomposition of soluble and suspended organic matters present in the wastewaters, high BOD (Biochemical Oxygen Demand) (45000 - 60000 ml/l) and COD (Chemical Oxygen Demand) (750000 - 98000 mg/l) of the wastewaters results, causing rapid depletion of the oxygen content of the water, thus creating a foul smell [2&9]. This required that the effluents of the distillery are either treated or utilized profitably.

SCHEMATIC OF ALCOHOL MANUFACTURING PROCESS [3].
Studies on application of Fe based binary oxide nanoparticles for treatment of lead (Pb²⁺) contaminated water- A batch study

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ABSTRACT

Water & wastewater remediation using nanoparticles has received increasing interests in recent years. In the present study, a binary metal oxide of Fe-Ca was synthesized & used for the removal of Pb²⁺ from aqueous solution. Batch technique was performed to investigate the effects of variation of initial Pb²⁺ concentration, adsorbent dose and pH of solution on the removal efficiency of Pb²⁺. The synthesized nanostructured material presented an outstanding ability to remove Pb²⁺ due to high surface area, low particle size and high inherent activity. The extent of Pb²⁺ removal increased with increasing dosage of nanoparticles (0.5 g/L – 2.5 g/L) whereas decreased with initial Pb²⁺ concentration (1 mg/L – 20 mg/L) and pH of (4-8). The experiments were carried out for 12 hrs to attain the equilibrium. The adsorption of Pb (II) ions fit a pseudo-second-order kinetic model and adsorption isotherms can be described using the Langmuir & Freundlich equations. The results obtained from this research provides compelling evidence that the Fe-Ca binary oxide nanoparticles may be used for in situ reducive ability of Pb²⁺ contaminated groundwater which may lead to an innovative remediation technology proving to be cost effective and less environmental concerning. The prepared material was characterized using powder XRD & SEM. It showed that the Fe-Cu binary oxides were formed in single phase. SEM micrograph showed aggregates with many nano-sized particles.

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Keywords: Groundwater Remediation, Pb²⁺ removal, Binary oxide, Adsorption, XRD, SEM
Application of Fe-Cu binary oxide nanoparticles for the removal of hexavalent chromium from aqueous solution

Saif Ullah Khan, Rumman Zaidi, Saeed Z. Hassan, I. H. Farooqi and Ameer Azam

ABSTRACT

The adsorption process has been used as an effective technique for the removal of metal ions from aqueous solutions. Groundwater remediation by nanoparticles has received interest in recent years. In the present study, a binary metal oxide of Fe-Cu was prepared and used for the removal of hexavalent chromium from aqueous solution. Batch experiments were performed to investigate the effects of initial Cr(VI) concentration, dose of adsorbent, and pH of solution on the removal efficiency of Cr(VI). The prepared nanostructured Fe-Cu binary oxides were able to reduce the concentration of Cr(VI) in aqueous solution. Binary metal oxides nanoparticle exhibited an outstanding ability to remove Cr(VI) due to high surface area, low particle size, and high inherent activity. The percentage removal efficiency of Cr(VI) increased with nanoparticles doses (0.1 g L\(^{-1}\) to 2.5 g L\(^{-1}\)), whereas it decreased with initial Cr(VI) concentration (1 mg L\(^{-1}\) to 25 mg L\(^{-1}\)) and with pH (3-9). The Freundlich model was found to be the better fit for adsorption isotherm. The prepared nanomaterial was characterized using powder X-ray diffraction, scanning electron microscopy (SEM), and ultraviolet (UV-visible) spectroscopy. It showed that the Fe-Cu binary oxides were formed in single phase. SEM micrograph showed aggregates with many nano-sized particles. UV-visible spectroscopy showed quantum confinement effect.

Key words | adsorption, bimetallic, binary oxide, groundwater, hexavalent chromium

INTRODUCTION

Heavy metals are the main pollutants discharged to the environment as a result of industrial activities. The increasing contamination of groundwater by toxic metal ions is a significant environmental hazard to drinking water supplies. High toxicity of these metals causes serious problems to the ecosystem even at low concentrations (Luo et al. 2013). Chromium (Cr) is one of the most widely used heavy metal that has many applications in the metal cleaning and plating baths, painting, tannery and fertilizer industries (Lv et al. 2012). Chromium essentially exists in two oxidation forms namely Cr(III) and Cr(VI). Over a narrow concentration range, Cr(III) is proved to be biologically essential to mammals as it maintains an effective glucose, lipid, and protein metabolism, whereas Cr(VI) is reported to have a toxic effect on humans and it is considered to be genotoxic and carcinogenic in nature (Cheetham & Sankaranarayanan 2011). Moreover, Cr(VI) has been classified as a potential mutagen and teratogen and has acute toxicity for different biological systems. According to the Bureau of Indian Standards’ desirable limit for drinking water, the maximum acceptable limit for Cr(VI) is 0.05 mg L\(^{-1}\).

The different methods such as membrane filtration, electrochemical precipitation, ion exchange, adsorption, reduction of Cr(VI) to Cr(III), reverse osmosis, evaporation, chelating, solvent extraction, electrolysis, and cyanide treatment are employed for the removal of Cr(VI) from water and wastewater (Lv et al. 2012; Luo et al. 2013; Jung et al. 2013). Most of these methods have some drawbacks such as low efficiency, high demand for energy, high cost, requiring special chemicals, and the problems related to the disposal of sludge (Valpoupolou & Gikas 2012; Jung et al. 2013). Regarding biological treatment, bioremediation by the strains of bacteria can effectively degrade Cr(VI) and is economically favourable, but the presence of bacterial toxins at many waste sites would limit their growth and effectiveness (Chen & Hao 1998). Chemical reduction is
Removal of Chromium (VI) From Aqueous Solutions Using Discarded Solanum Tuberosum as Adsorbent

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Abstract: Industrial polluting effluents containing heavy metals are of serious environmental concern in India. Chromium is frequently used in industries like electroplating, metal finishing, cooling towers, dyes, paints, anodizing and leather tanning and is found as traces in effluents finding their way to natural water bodies causing hazardous toxicity to the health of humans, animals and aquatic lives directly or indirectly. Many methods for the removal of Chromium such as chemical reduction, precipitation, ion exchange, electrochemical reduction, evaporation, reverse osmosis and adsorption using activated carbon etc. have been reported but all being expensive and complicated to operate. Experimental practices reveal that adsorption by agricultural and horticultural wastes are quite simple, inexpensive and efficient method. Agra is famous for Potato farming, a lot of discarded potato waste from cold storages is thrown along road side drains causing solid waste generated which either creates solid waste disposal problem or otherwise it finds way to Yamuna river resulting high BOD and posing a serious threat to the aquatic environment. For developing countries like India adsorption studies using discarded potato (Solanum tuberosum) waste from cold storages (DPWC) a solid waste as low cost adsorbent for Chromium removal was dual beneficial i.e., an ideal solution to these solid wastes disposal problem of Agra and removal of Chromium from tannery effluents and thereby saving aquatic life from Chromium contamination in Yamuna river. Keeping this in view batch experiments were designed to study the feasibility of discarded potato waste from cold storages to remove chromium (VI) from aqueous solutions. During the study various affecting parameters, such as pH, adsorbent dose, initial concentration, temperature, contact time, adsorbent grain size and start up agitation speed were optimized as 5.0, 10-20 g/l, 50 mg/l, 25°C, 135 minutes, average size and 80 rpm respectively on chromium removal efficiency. Various isotherms such as Langmuir, Freundlich, Temkin also fitted suitably and various corresponding constants determined from these isotherms favor and support the adsorption. Thermodynamic constants ΔG, ΔH and ΔS were found to be 0.267 KJ/mole, 0.288 KJ/mole and 0.0013 KJ/mole respectively.

Keywords: Adsorbent, Toxicity, Discarded, Potato, DPWC, Disposal, Cold Storage and BOD.

1. Introduction

Developing countries like India have a serious environmental concern of industrial effluents containing trace quantities of heavy metals such as nickel, manganese, lead, chromium, cadmium, zinc, copper, iron and mercury. Though some of these in micro content act as essential nutrients for biological growth (Metcalfe and Eddy et al, 1994) but larger concentrations cause harmful effects on living beings like humans, animals and plants. Right under the district administration around 50 illegal tanneries are functioning in the city of Taj Agra, causing immense damage to the storm water drain system as well as posing a serious health hazard to the locals as well as for aquatic life. Tanneries are located in the heart of Agra city-Khatipada near Raghunath Cinema. This is a quite congested area and entry of outsiders is closely scrutinized, while doing photography or collecting samples for investigation (TOI, Jan 02, 2016). Hence, it is desirable to adopt preventive measures so as to control and reduce the concentrations of these toxic substances. Many investigations regarding heavy metal concentrations and their toxicity in the aquatic environment have attracted the researchers attention and the general awareness. Chromium causes Nausea, vomiting, epigastric pain, severe diarrhoea, haemorrhage, dermatitis by skin contact, nasal mucous membrane, ulcer (Sathyarayyan et al, 1995), lung cancer and tissue necrosis in humans, reduction in fish production at high concentrations, chromium accumulates in fish tissues and reaches to consumers. Gold fish and trout are killed at a concentration of 180 mg/l in Aquatic life and reduction in Soil fertility if chromium-bearing effluents are discharged on land (Sohail, 1997) and this way Chromium affects human beings, aquatic life and soil.
CIVIL & ENVIRONMENTAL ENGINEERING | RESEARCH ARTICLE

Isotherms describing physical adsorption of Cr(VI) from aqueous solution using various agricultural wastes as adsorbents

Pushpendra Kumar Sharma*, Sohail Ayub† and Chandra Nath Tripathi†

Abstract: Various agricultural wastes such as peels of pea (Pisum sativum) pod, tea (Camellia sinensis), and ginger (Zingiber officinale) and banana (Musa lacaona) waste were used to adsorb Cr(VI) from the aqueous solutions. A comparative adsorption efficiency study for all these adsorbents was done in laboratory for various pH, adsorbent doses, initial chromium concentrations, contact time, adsorbent sizes, temperature, and mixing speeds up to the optimization. The equilibrium sorption data were fitted into Langmuir, Freundlich, and Temkin isotherms and also the various thermodynamic parameters were determined. The value of R² was determined for Freundlich, Langmuir, and Temkin as 0.964, 0.963, and 0.858 (pea pod peels waste (PWP)), 0.965, 0.986, and 0.841 (tea & ginger waste (TGW)), 0.985, 0.982, and 0.886 (banana peel waste (BW)). The maximum monolayer coverage (Qm) from Langmuir isotherm model for pea pod, tea & ginger and banana peels waste were found to be 4.33 mg/g, 7.29 mg/g, and 10 mg/g, respectively, with separation factors (R²) 0.0331, 0.0343, and 0.0756 which are well within favorable sorption. From Freundlich isotherm model, the sorption intensity (n) for the same adsorbents was also less than unity showing normal sorption. The heat of sorption (ΔH) was also determined from Temkin isotherm model as 0.215, 0.271, and 0.271, respectively, vividly proving a favorable physical sorption. The Gibbs free energy was found maximum for BW as 5.0679 joule/mole. Out of the above said combination, BW was found the best low-cost adsorbent with high potential for the removal of hexavalent chromium from aqueous solutions.

Subjects: Pollution; Waste & Recycling; Water Engineering

Keywords: agricultural wastes; adsorbents; aqueous solution; isotherms; thermodynamic parameters; environmental sustainability engineering

1. Introduction

There has been a worldwide public awareness for the heavy metal contamination and toxicity in aquatic environment. Many heavy metals like lead (Pb), mercury (Hg), cadmium (Cd), arsenic (As),

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PUBLIC INTEREST STATEMENT
The study reveals that agricultural wastes such as pea pod peels, used tea and ginger, and banana peels can be reused as potential adsorbents for the removal of hexavalent chromium from tannery and metal finishing wastewaters. It is beneficial for protection water quality in rivers and ground waters.

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Biodegradation of Methylene Blue Dye by Sequential Treatment Using Anaerobic Hybrid Reactor and Submerged Aerobic Fixed Film Bioreactor

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Abstract. Laboratory scale experiments were carried out to access the feasibility of sequential anaerobic/aerobic biological treatment for the biodegradation of Methylene Blue (MB) dye. Anaerobic studies were performed using anaerobic hybrid reactor (consisting of UASB and Anoxic filter) whereas submerged aerobic fixed film reactor was used as aerobic reactor. Degradation of MB dye was attempted using neutralized acetic acid (1000 mg/L) as co-substrate. MB dye concentration was stepwise increased from 10 to 70 mg/L after reaching steady state in each dye concentration. Such a gradual increase in the dye concentration helps in the proper acclimatization of the sludge to dye, thereby avoiding the possible inhibitory effects to biological activities at high dye concentrations. The overall treatment efficiency of MB through sequential anaerobic–aerobic reactor operation was 90% at maximum attempted dye concentration of 70 mg/L. The effluent from anaerobic reactor was analysed for intermediate biodegradation products through HPLC. It was observed that catechol, quinone, amino pyrine, 1,4 diamino benzene were present. However, they were absent in final effluent.

Keywords Azo dye · Methylene blue · Anaerobic hybrid reactor · Submerged aerobic fixed film reactor

Introduction

Dyes are coloured, ionizing, aromatic organic compounds. A wide variety of dyes is used by industry and is released into the environment as industrial effluents. Wastewater generated from various industries creates severe detrimental effects to the environment leading to bio-systems imbalance. Azo dyes are synthetic colours that contain an azo group, −N=N−, as part of the structure. Azo groups do not occur naturally. Most azo dyes contain only one azo group, but some contain two (disazo), three (trisazo) or more. Azo dyes account for approximately 60–80% of all dyes used in food and textile manufacturing. The effluents from these industries are considered to be carcinogenic and toxic to living beings [1]. Azo compounds with hydroxy or amino group are more likely to be degraded than those with methyl, methoxy, sulfo, or nitro groups [2]. These Azo dyes are hydrophilic in nature and usually are not biodegraded by conventional activated sludge process. However under complete anaerobic conditions they can be degraded [3]. Azo-reactive dyes decompose under anaerobic conditions due to the cleavage of the azo bond eliminating consequently the colour of the wastewater. But the intermediate aromatic amines results in slowdown in further biodegradation and may be toxic or genotoxic [4]. This toxicity can be removed through bacterial fission of aromatic ring structure in the presence of oxygen therefore necessitating secondary aerobic treatment to detoxify dyes [5]. It is reported that if electron donating and external carbon source is provided the reduction of azo dyes becomes faster due to the formation of reduced cofactors (Flavin Adenine Dinucleotide FAD, Flavin Mononucleotide FMN, Nicotinamide Adenine Dinucleotide NADH) [6]. There are different type of treatment methods that are used for dye containing industrial wastewater like...
Status And Impact Of Brewery Effluent On Ground Water Quality Of Adjoining Communities- A Case Study

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Brewery wastewater, Physico-chemical analysis, ground water quality.

ABSTRACT
A field study was conducted at Atmarsha, located 30 km from Aligarh for the communities residing near the distillery and brewery industry. To know the current status and impact of brewery wastewater, discharge on ground water quality, water samples were drawn from government and private hand pumps surrounding villages and at discharge point. The effluent concentration increases after the industry treated effluent mixed in river. The effluent from the industry contains high values of TDS, BOD and COD. However with time and distance the COD, BOD values start decreasing. In ground water the concentration of SO4, Na+, K+, Total hardness and total dissolved solids in some of villages are observed beyond permissible limit.

INTRODUCTION
Industries discharge a wide range of wastewater pollutants, which are not only difficult but costly to treat. Characteristics of wastewater and concentration of pollutants vary significantly from industry to industry. To overcome this problem emphasis is laid on waste minimization and revenue generation through by-product and energy recovery. Pollution prevention focuses on preventing the toxic effect of produced wastewater on the environment, while waste minimization refers to reducing the volume or toxicity of hazardous wastes by water recycling and reuse, process modifications and by by-product recovery (Vandana Patyal, 2015; Ajmal, M, and U.K. Ahsan, 2013; Orhue, E.R., et al., 2005). Production of ethyl alcohol in distilleries based on cane sugar molasses constitutes a major industry in Asia and South America. The aqueous distillery effluent stream known as spent wash is a dark brown highly organic effluent and it is approximately 12-15 times by volume of the product alcohol. It is one of the most complex, troublesome and strongest organic industrial effluents, having extremely high COD and BOD values (Pathiolla & Ashwarya, et al., 2014). The brewing industry is one of the largest users of water. The coliform bacteria were recorded (1-2 MPN 100 mL-1) during monsoon seasons due to run off and possibility of mixing of sewage water (Sathirakaj, K., et al., 2013; Henry Owusu-Dadie and Tsiettie Ehyains Kgata, 2013). Release of industrial effluents causes indicative changes in nutrient cycling and organic matter processing (Sohail Ayub and S. Usmani, 2014; Ali, N., SohailAyub and J. Ahmad, 2015; Prasanna, C., Triwari, 2015). The wastewater become scidic in nature, and had high BOD and COD due to the presence of large amounts of solids. The effluent rich in ammonia-nitrogen, nitrate-nitrogen, phosphorus and potassium, its increases the values of available nutrients in the soil (Sohail Ayub and S. Usmani, 2014; APHA, 1980; Avinash Shivaji Rao, P., 2012).
AN ENVIRONMENTAL STUDY ON AIR QUALITY, WATER QUALITY AND SOLID WASTE ANALYSIS AT DHANIPUR MANDI

Sohail Ayub, Diwakar Sharma and Aryan Upadhyay

Abstract: The study is concerned with the composite analysis for air quality, water quality and solid waste analysis at Dhanipur Mandi vegetable market, Allahgarh. Allahgarh is medium sized city located in fertile tract of Ganga-Yamuna doab in the western part of the Uttar Pradesh, India. It was found that the present study site is more prone to adverse air impact because of higher concentration of PM10 and does not require any extent of treatment of water as concentration of most of water parameters fall within the permissible limit. Study site generated large amount of biodegradable solid waste, which can be compost to recover energy.

Keywords: PM, Water quality, Solid waste, Sample.

1. INTRODUCTION

Particulate matter (PM) is major growing environmental problem in the developed and developing countries of the world among the many other pollutants, the impacts of PM pollution on human health and ecology are the largest and its impacts in the urban and rural areas is studied and documented the most (Gupta and S. S., 2007). Among all critical air pollutants, the respirable suspended particulate matter (PM10) pollution is being awarded greater significance over the past decade. Along with vehicular traffic and meteorological phenomenon, construction works are the major source for release of PM10 in the atmosphere. It is a major source for acute, chronic and respiratory health problems. It produces short term as well as long term health problems in day to day life style. Multiple studies confirms PM10 and PM2.5 can affect lung growth and development in children and adolescents, number of medical visits, and hospital emergency admissions due to the asthma, respiratory symptoms, and upper and lower respiratory tract disorders (Brown et al. 2013; Dinan and Díaz 2010; Pramuk and Pramukar 2012; WHO 2013).

Water is the most significant and abundant compound of the Earth. Water is life. No life can live without water. Groundwater is employed for domestic and industrial facility and jointly for irrigation purpose (Banerji et al. 2018). The crisis of natural water resources and environmental deterioration (Gochick and Zheng, 2015; Zhang et al. 2017). Groundwater plays a vital role in the survival and development of human beings, because it accounts for about one third of global fresh water and is currently the world’s largest source of accessible fresh water (Siewert et al., 2010; Howard, 2011). However, it was widely mismanaged and poorly protected due to increasing population, expanding agricultural irrigation area, and rapid industrial development worldwide (Zeng and Liu, 2013; Foster et al., 2013). In many parts of the world, extraction of ground water exceeds groundwater recharge which has seriously affected the production of crops on a sustainable basis (Ellsasser et al., 2010; Foster and Garduno, 2013). For improving the groundwater utilization and protecting groundwater from further pollution, a series of groundwater monitoring schemes have been established in many parts of the world (Jorgensen and Stachnik, 2009).

Water plays an essential role in human life. Although statistics, the WHO reports that approximately 36% of urban and 65% of rural Indian were without access to safe drinking water. Fresh water is one the most important resources crucial for the survival of all the living beings. It is even more important for human being as they depend upon it for food production, industrial and waste disposal, as well as cultural requirement. Human and ecological use of ground water depends upon ambient water quality. The consequences of urbanization and industrialization leads to spoil the water for agricultural purposes ground water is exploit in rural specially in these areas where the sources of water like dam and river or a canal is not considerable (Nagamani et al. 2015).

Fruit and vegetable wastes are produced in large quantities in market and constitute a major source of nuisance in municipal landfills because of their high biodegradability and create problems of safe disposal. The study area is very prone to pollute the environment as numbers of people come to this place for selling and buying vegetables, cereals, fruits etc. As there are lots of vegetable is wasteage, thrown directly to open land thus it becomes important to have qualitative analysis of this waste in selection of a suitable waste treatment scheme. Thousands of vehicles come to this place daily and it is necessary to monitor the air quality of this place. Since peoples come to this place and also live besides this place and they require potable water to drink. The potable water is sunk from ground water reservoir but it becomes necessary to check the ground water quality.
Short communication

Treatment of Adsorbable Organic Halide (AOX) from pulp and paper industry wastewater using aerobic granules in pilot scale SBR

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Keywords: AOX; SBR; Aerobic granules; Pulp and paper industry wastewater

ABSTRACT

Aerobic granulation of activated sludge was achieved in a pilot scale column type sequencing batch reactor (SBR) employed for the treatment of pulp and paper industry wastewater containing Adsorbable Organic Halide (AOX) in the range of 15-20 mg/L. Throughout the 780 days of operation the biomass tends to remain in between 7 and 8 g/L MLVSS and SVI reduced to 60-80 mL/g MLSS. After applying different selection pressure the average size of aerobic granule in the SBR was in the range of 2-4 mm. After achieving steady state conditions in the pilot plant, at an organic loading rate of 4.6 kg COD as "VS" at 8 lb HRT the degradation of AOX was significant and the effluent AOX concentration of below 5 mg/L was achieved. The results achieved in the study exhibit the viability of formation of aerobic granules in pilot scale SBR and maintenance of long-term strength of aerobic granular sludge with a high reduction of AOX in pulp and paper industry wastewater.

1. Introduction

The pulp and paper industry is a water demanding production and ranks only third in the world, after the primary metals and the chemical industries, in terms of freshwater consumption (1). Around 560 diverse chlorinated organic compounds have been identified including chloroform, chlorate, resin acids, chlorinated hydrocarbons, phenols, catechols, guaiacols, furans, dioxins, styrenes, vanillin, etc (2,3). The discharge of the Halogenated Organic Compounds in the environment is increasingly becoming a matter of concern due to their carcinogenic/ toxic effects. Most of these compounds are adsorbable and in wastewater, these compounds are estimated in a group as "Adsorbable Organic Halides" (AOX).

The formation of these compounds is due to the use of chlorine and chlorinated compounds in the various industrial processes including the bleaching process in the pulp and paper industries. The pulp and paper industries also being one of the major consumers of chlorine and its compounds need main concern in the perspective of removal of AOX discharges in their effluents. The toxic effects of AOX (e.g. chlorophenols, guaiacols, furans and dioxins) range from carcinogenic and mutagenic effects to acute and chronic toxicity and can act as inhibitors of microorganism growth (4-5). Conventional wastewater treatment systems such as activated sludge process have been used for treatment of pulp and paper mill wastewater. The process has disadvantage of excess sludge production and fluctuations in removal efficiency for recalcitrant compounds (6). Activated sludge process for treatment of pulp and paper mill wastewater have bulking problem, which in result causes poor settling of sludge and effluent have more suspended solids (7,8). The use of chemicals such as chlorine, hydrogen peroxide, metal ions (Fe, Ca, Mg) are effective in getting better settling properties of sludge in paper mill wastewater treatment (9,10). Moreover these chemical addition methods are not cost effective and they do not provide long term solutions for bulking problem. Conventional adsorption technique, post treatment using a granular activated carbon (GAC) has been widely used for removal of AOX from pulp and paper mill wastewater. However GAC have to be regularly regenerated, because adsorption sites are exhausted by pollutants after some time (11). Ozman et al. (11) have used GAC in sequencing batch biofilm reactor (GAC-SBR) to treat recycle paper mill wastewater and results showed high AOX removal efficiency by maintaining longest hydraulic retention time (HRT). The advantage of the biofilms in these systems save energy and less area is required, efficient to handle toxicity and can withstand high organic loading rate (12).

These days a new technology of aerobic granulation in column type Sequential Batch Reactors (SBR) have been widely explored based on modified activated sludge process. Due to the excellent settling capacity of aerobic granules, large area for a settling tank will not be required, which in turn reduces the wastewater treatment plant area by 80% (13). Aerobic granules have unique structure and microorganisms that can withstand high loading rate as well as high toxicant concentration. Aerobic granulation can be considered as a special type of self-aggregation of microorganism, without any carrier medium for growth of
Status And Impact Of Brewery Effluent On Ground Water Quality Of Adjoining Communities- A Case Study

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ABSTRACT
A field study was conducted at Atrauli situated 30 km from Aligarh for the communities residing near the distillery and brewery industry. To know the current status and impact of brewery wastewater discharge on ground water quality water samples were drawn from government and private hand pumps surrounding villages and at discharge point. The effluent concentration increases after the industry treated effluent mixes in river. The effluent from the industry contains high values of TDS, BOD and COD. However with time and distance the COD, BOD values starts decreases. In ground water the concentration of alkalinity, fluoride, total hardness and total dissolved solid in some of villages are observed beyond permissible limit.

KEYWORDS: Brewery wastewater, Physico-chemical analysis, ground water quality.

INTRODUCTION
Industries discharge a wide range of wastewater pollutants, which are not only difficult but costly to treat. Characteristics of wastewater and concentration of pollutants vary significantly from industry to industry. To overcome this problem emphasis is laid on waste minimization and revenue generation through by-product and energy recovery. Pollution prevention focuses on preventing the toxic effect of produced wastewater on the environment, while waste minimization refers to reducing the volume or toxicity of hazardous waste by water recycling and reuse, process modifications and by by-product recovery [8][2][3]. Production of ethyl alcohol in distilleries based on cane sugar molasses constitutes a major industry in Asia and South America. The aqueous distillery effluent stream known as spent wash is a dark brown highly organic effluent and is approximately 12-15 times by volume of the product alcohol. It is one of the most complex, troublesome and strongest organic industrial effluents, having extremely high COD and BOD values[9]. The brewing industry is one of the largest users of water. The coliform bacteria were recorded (1-2 MPN 100 mL-1) during monsoon season due to run off and possibility of mixing of sewage water [15][5]. Release of industrial effluents causes indicative changes in nutrient cycling and organic matter processing[1][12][6]. The wastewater become acidic in nature, and had high BOD and COD due to the presence of large amounts of solids. The effluent rich in ammonia-nitrogen, nitrate-nitrogen, phosphorus and potassium, its increases the values of available nutrients in the soil [10][4][7].

MATERIALS AND METHODS

Physisorption of Chromium from Aqueous Solutions Using Agro and Horticultural Wastes as Adsorbent

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Abstract

Batch experiments were conducted at room temperature to evaluate the performance and feasibility of various agro and horticultural waste sorbents such as Petha (Benincasa hispida) waste (PW), discarded potato (Solanum tuberosum) waste from cold storages (DPWC) and almond seed (Prunus dulcis) shell waste (ASSW) to remove chromium (VI) from the aqueous solutions. Impacts of pH, adsorbent dose, initial adsorbate concentration, temperature, contact time, adsorbent grain size and start up agitation speed on chromium removal efficiency were investigated. The highest adsorption was found at pH 4.5-5.0 with initial chromium concentration of 50 mg/L, at startup agitation speed 80 rpm, with adsorbent grain size 1.18 mm with adsorbent doses 10 g/L for PW and ASSW and 20 g/L for DPWC in first 45 - 135 minutes of contact time. Equilibrium adsorption isotherms and kinetics were analyzed. The adsorption isotherm data were fitted to Langmuir, Freundlich and Temkin isotherms. The Langmuir maximum monolayer coverage capacities have been observed as 2.75 mg/g, 2.00 mg/g and 11.11mg/g for PW, DPWC and ASSW respectively with separation factors (R₁) as 0.0299, 0.0151 and 0.0985 showing favorable adsorption influenced by pH of metal solution. From Freundlich isotherm model the sorption intensity (n) less than unity also revealed the normal adsorption. The heat of sorption (B) was also determined from Temkin isotherm model as 0.282, 0.161 and 0.179 respectively, vividly proving a favorable physical sorption. The positive Gibbs free energy was found maximum for PW as 0.3295 KJ/mole. Out of the above combination of adsorbents of this study petha waste was comparatively the best economic and suitable adsorbent for the removal of hexavalent chromium from aqueous solutions.
BIOLOGICAL NITROGEN REMOVAL FROM SLUDGE DIGESTER EFFLUENT USING CANON PROCESS IN A COLUMN TYPE SEQUENCING BATCH REACTOR

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ABSTRACT

Studies were carried out to evaluate the performance of CANON process for the treatment of nitrogen containing digester effluent. The experimental studies were performed in a laboratory scale column type sequencing batch reactor. Anammox microorganisms were successfully enriched in the mixed culture. The microorganisms were acclimatised by systematically feeding the digester effluent. The maximum TKN, ammonium and COD removal of 90%, 98% and 91% respectively was achieved at maximum organic loading.

KEY WORDS: Anammox, CANON, Nitrogen, Sequencing batch reactor

INTRODUCTION

Nitrogen and phosphorus are essential nutrients for plant growth but when released in excessive amount in the water bodies they become water pollutants as excessive discharge of nitrogen and phosphorus in water streams leads to uncontrolled eutrophication, major loss of oxygen and undesirable changes in aquatic population. The wastewater must be treated for excess nitrogen and phosphorus removal before discharge into water streams (Jafarzadeh et al., 2014). In addition, the increase in algal production leads to increased disinfectant doses of drinking water, which results in higher levels of disinfection by-products (Fisher et al., 2004; Jack et al., 2002) that have been found to be carcinogenic (Wang et al., 2007). Excessive amounts of nutrients can also enhance the activity of harmful microorganism, like Pfiesteria (Hasselgren et al., 2008).

Nitrogen is present in large concentrations in the effluent of various industries, landfill leachates, slaughter house wastewaters and sludge digester effluent. Sludge digestion and centrifugation processes are also one of the sources of highly concentrated ammonium streams. During this process a protein breakdown occurs and about 50% of the sludge bound nitrogen is released to a wastewater stream in the form of ammonium. Recycling of such a stream to the head of a Wastewater treatment plant contributes to the average increase in the total nitrogen load by about 15-20%. Nitrogen is mostly present in wastewater as ammonium and is removed by physiochemical and biological processes. Biological treatment to remove nitrogen from wastewater is less expensive and more effective than physiochemical treatment and thus has been used more often to achieve nitrogen removal from domestic and industrial wastewaters (Khin et al., 2004).

Environmental laws have become much strict for the discharge of nutrient containing wastewater. Lots of research work has been done on the new improved, innovative, sustainable and cost effective biological nutrient removal processes. In order to avoid eutrophication problem major emphasis has been given on reducing the quantities of nutrient discharged as it stimulated the growth of algae and other photosynthetic aquatic plants. Conventional biological nitrogen removal is

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Comparison between Electrochemical Treatment of Landfill Leachate by Using Graphite and Silver Electrode

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Abstract: Municipal solid waste management continues to be a dilemma for India with high population, lack of public awareness, climate diversity, poor financial status and unscientific approach of the municipal corporations the quantity of municipal solid waste has been constantly rising over the years. One of the major environmental problems of MSW is the generation of leachate which contaminates the surface water and ground water aquifers. Leachate is usually characterized by high values of pH, ammonia nitrogen, COD and heavy metals with pungent smell. Many physical, biological and chemical methods are being studied and implemented for leachate treatment so that the treated leachate can be safely let into the atmosphere. Electrochemical method of leachate treatment is a relatively new concept in which electrons provide a means of removing pollutants by redox reactions. Electrochemical methods are based on anodic oxidation and cathode reduction of impurities present in leachate. In the present study leachate samples were collected from MSW landfills of Karvar in Uttar Karnataka district of Karnataka. Since the composition of leachate varies with seasonal changes, leachate samples were collected in both rainy and summer seasons and were studied separately. The electrochemical oxidation method was employed for leachate treatment using two different electrode materials-graphite rod and silver plate. The leachate samples were tested for different parameters and found the pH, conductivity, COD were not within the disposable standards.

Keywords: Leachate, Neutralization, Oxidation, graphite, Electrode.

Introduction
Leachate generation from MSW landfills has presented a major threat to the current and future quality of ground water. Leachate from MSW landfills typically has high values for total dissolved solids and chemical oxygen demand (COD) and a slightly low to moderate pH. MSW leachate contains hazardous constituents such as volatile organic compounds and heavy metals [1]. The characteristics of leachate differ with the age and composition of MSW. Climatic changes also influence the composition and volume of leachate. The leachate if not properly disposed in the landfills(with liners) might enter the ground water table and when this reaches the ground water table, if imparts adverse effects on the water stream[3]. Today ground water is the only water source in many areas in India as well as in many countries[4]. The Leachate from the solid waste on the surface of the ground enters the soil and reaches the groundwater table, thereby affecting it and preventing it for further use[5].

Electrochemical Oxidation
Several wastewater treatment processes have been applied to treat leachate: aerobic and anaerobic biological degradation, chemical precipitation, chemical oxidation, coagulation- flocculation, activated carbon adsorption and membrane processes [6,7]. Electrochemical method has recently received significant attention due to its effectiveness and ease of operation [8]. Electrochemical technology offers ideal tools for addressing environmental problems. The main reagent used here is electron and therefore no need for adding extra reagent. In addition, the high selectivity of the electrochemical process prevents the production of unwanted by-products. It is operated in room temperature and pressure and power is supplied by a D.C. Supply, when unwanted it can be easily cut off. For these reasons, electrochemical oxidation methods are likely to gain a better public acceptance than the alternative methods for environmental cleanup both for organic waste degradation and metal recovery. When leachate is treated by action of direct current a number of physical chemical processes take place. Anodic oxidation and cathodic reduction of impurities present in wastewater, electrophoresis which is the passage of ions through semi permeable membranes, precipitation of metallic ions on cathode and desalination of water [9].

The major advantages of electrochemical process are less land area required, Pollution free, does not leave any residue, no additional reagents are required, continuous process with relatively high flow rates can be designed, no phase changes are required and high current efficiencies can be attained. However
Evaluation of adsorptive capacity of Various Agricultural Wastes for the Removal of Cadmium from Electroplating Wastewater

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ABSTRACT
An attempt has been made in the present study to evaluate the agricultural wastes such as coconut shell, walnut shell and almond shell for the removal of cadmium from electroplating industrial effluent. Adsorption experiments were performed to evaluate the performance. The maximum removal efficiency for Cd (II) is 83.7% at pH 6.5 for coconut shell. The percentage removal of cadmium increases with decrease in metal concentration. The extent of removal depends on the metal concentration, adsorbent dose, contact time, and particle size. Coconut shell is found to be most effective with respect to removal efficiency. Cadmium adsorption follows second order rate equation for coconut shell. The isotherm data obtained more closely follows the Freundlich isotherm for coconut shell, while walnut shell and almond shell follows the Langmuir adsorption isotherm better. The powder of coconut shell has the potential to remove cadmium ion from electroplating wastewater. The present experimental study evaluates and compares the potentials of agricultural waste materials that have been used as adsorbents for investigating the removal of cadmium from the electroplating wastewater.

INTRODUCTION
Water pollution due to toxic heavy metals has been a major cause of concern to engineers, scientists and researchers. Many mishaps because of heavy metal contamination in aquatic environment increased the awareness about heavy metal toxicity. Public awareness for pollution caused by heavy metals has been a worldwide now. These metals have wide spread usage in industries and enter the environment wherever they are produced, used or discarded. All these metals become seriously toxic as ions or compound being soluble in water and readily absorb by living organisms. Different adsorbents have been used for the removal of many types of wastewater, depending on the type of pollutants that exist in water and wastewater. Natural adsorbents due to their abundance, low cost and high removal efficiency have been used by many researchers for the removal of various pollutants from aqueous solutions. Many researchers including[1][2][3][4][5][6]; [7]; [8]; [9]; [10], have studied different adsorbents for the removal of heavy metals from wastewater by use of adsorption process. The present experimental study evaluates and compares the potentials of agricultural waste materials such as coconut shell activated carbon (CSAC), walnut shell activated carbon (WSAC) and almond shell activated carbon (ASAC) has been used as adsorbents for investigating the removal of cadmium from the electroplating wastewater.

MATERIALS AND METHODS
The wastewater samples were brought from the electroplating industry, located at Shah Jamal, 6 km from Aligarh. Various agro-based waste material such as, coconut shell activated carbon (CSAC), walnut shell activated carbon (WSAC) and almond shell activated carbon (ASAC) has been used as adsorbents for investigating the removal of cadmium from the electroplating wastewater. The adsorbents used in the present study are widely available in Iran and other counties. After drying it was grinded and then sieved to obtain average a particle size of 0.3 mm and 0.6 mm and 1.181 mm. Adsorbents were washed several times with distilled water in order to remove the lighter materials and other impurities. The adsorbents were then dipped in 0.1N NaOH for a period of 6.0 hours and washed several times with distilled water to remove the colour and lignin content and then dried. The adsorbents were again washed separately with double distilled water and dipped into 0.1N H2SO4 for a period of 6.0 hours to removes its alkalinity. The acid treated adsorbents are washed thoroughly with double distilled water. Finally these were dried in an oven at 110C for 3 hours and stored in desiccators.
GEOTECHNICAL PROPERTIES OF SOIL SUBJECTED TO LONG-TERM EFFLUENT CONTAMINATION

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Abstract: This research describes the results of a scientific examination focusing whether effluent thermal power plant can absorb by semi contaminated soil and can affect the geotechnical properties of natural contaminated soils. Undisturbed soil samples used for this experimental study are treated with the thermal power plant effluent and examined the effect of the engineering properties after 7 days, 30 days, 100 days and 150 days. The results show more decreased in geo-environmental properties for testing soil with the soaking period. Knowledge of the effect of chemicals on the geotechnical properties of contaminated soil is essential to reduce the problems that geotechnical engineers face while placing new structures on sites with contaminated soils. This will facilitate the invention and introduction of site specific technologies.

Key Words: Thermal power plant effluent, geotechnical properties, geo environmental properties, contaminated soil.

Introduction:

The particular kinds of metal contaminants available in a polluted soil is directly related to the action that happened at the location. The variability contaminant amounts and the physical and chemical forms of pollutants as well based on actions and dissemination of metal contaminants include soil and ground-water chemistry and regional commuting processes [1]. In this part, toluene heavy metal amount and its impacts on soil properties were assessed in soil samples obtained from semi polluted site at depth (3m) with known long-term pollution matters. The chemicals included in the landfill are subjected to many different transformation and collapsed conditions they flow with the soil and into the deep strata. The effectiveness of every one soil to attenuate effluent varies, and not all features or formulations are equally taken out or decreased in concentration. A few of the contaminants could possibly adsorbed with the soil media within the movement of effluent across the soil [2]. The long-term results of recultivations sometimes pollutants subjected to the soil are extremely hard to evaluate, as there exists less investigations and this means less state. In this study, the soil samples have been selected from sites with known pollution problems where heavy metals and other contaminants have been exhausted by effluent for more than 20 years. This area is especially influenced with the discharge of liquid effluents provided by thermal power plant waste. At this place heavy metals can be found in equilibrium in the soil solution and knowing that the existence of chemicals correlates generally to their happening and dissemination in the soil solution, these ecosystems supply a great media for analyzing the impact of heavy metals on soil properties [3]. The provision of heavy metals in soil possibly be controlled by physical and biological technics performing inside the soil. Metal ions inside the soil solution from these different kinds of mixture in several amounts can potentially either stay in solution or move within the outflow water or be pickup by plants developing located on the soil or be reserved by the soil in sparingly soluble or insoluble forms. The organic matter of these soil include more like to heavy metals cations that will form control structures thus causing decreased in nutrient content [4]. Every kinds of effluent include directly or indirectly impacts on soil characteristics. Soil-effluent connection modifies soils activity plus can lead to partial or total suppression of pollutants. Soil-effluent activities are able to result in soil properties like, effective grain size of soil particles, liquid limit, plastic limit, shrinkage limit, specific gravity, hydraulic conductivity, compaction properties, consolidation and strength properties of soil. The improvement of soil features can lead to different geotechnical matters for instance: landslides, ground subsidence, settlement, erosion, progressive failure, underground structural stability, foundation durability and corrosion. The polluted water attacks foundation structures. It effects the workability and durability of concrete if applied in preparing concrete [5]. (Grafton I. and Towhata I., 210) examined the consequence of sulfuric acid (H2SO4) with pH=3 on compressibility characteristic of clays in Japan. This sulfuric acid pass into the soil specimen with for various amounts of time, directly from 1 to 9 months. It’s actually showed that clay mineralogy and soil arrangement created a considerable result toward the compressibility of clays at low pH [6]. (George M., 2014) studied the seepage from the MSW landfill pass through the two types of test soils first type was low compressible and second type was high compressible. The soils are subjected with synthetic chemicals at different amounts and described its
Specific oxygen uptake rate gradient – Another possible cause of excess sludge reduction in oxic-settling-anaerobic (OSA) process

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HIGHLIGHTS

- Increased sludge recycle to anaerobic reactor caused diminished sludge yield.
- Sludge reduced to 51% at 3.8–9.8 gVSSrecyl/gVSS in oxic-settling-anaerobic process.
- Sp. oxygen uptake gradient between sludge recycle and absence is the new parameter.
- Gradient induced high energy uptakes in feeding stimulated by prolong fasting.

GRAPHICAL ABSTRACT
IMPACT OF GEOTECHNICAL PROPERTIES DUE TO INDUSTRIAL AND HYDROCARBON CONTAMINATED SOIL

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ABSTRACT

The soil contamination by industrial effluents and hydrocarbons contaminant has affected adversely both soil health and crop productivity. Such actions have an impact on the engineering properties of soils, such as the shear strength and the volume change (compressibility and swelling), and the chemical properties (adsorption and retention of heavy metals), which calls for better understanding of the behavior of such soils, so that they could be used for construction activities. This paper reviews works published about both industrials and hydrocarbons soil contamination and their effect on geotechnical properties of the soil. Similarly the methods of preparing the contaminant soil samples are also presented.

KEY WORDS: Geotechnical Properties of Contaminated Soil, Industrials Contaminants, Hydrocarbons, Contaminants.
Constructed Wetlands for Domestic Wastewater Treatment – A Promising Technology for Rural Areas in India

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ABSTRACT
With the rapid increase in population as well as all round development in India during the recent years, there has been a competing demand of water for irrigation, domestic use and power generation which are exerting enormous pressure on the country’s existing water resources as the water reserves are also depleting at a fast pace. The precarious balance between growing demands and supplies has brought forward the importance of recycling and reuse of water and thereby reducing the fresh water demand supply. The paper highlights the wastewater treatment in the country in the recent years for the urban and rural areas. The present focus of the paper is the latest trend for wastewater treatment which has been recently proven as an efficient technology is the adoption of artificial wetlands or constructed wetlands (Shauns, 2001) in developing countries. An attempt has been made to provide an overview on the comparative analysis of various treatment technologies. In comparison to the conventional treatment systems, the constructed wetlands involve low cost and can be operated and maintained easily. In terms of initial cost, operational cost and maintenance cost, the constructed wetlands having the least expenditure amongst the other conventional processes can prove to be the most suitable option for wastewater treatment for developing countries where cost is the most critical parameter.
Dependence of enhanced biological nitrogen removal on carbon to nitrogen and rbCOD to sbCOD ratios during sewage treatment in sequencing batch reactor

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Reduced sludge growth at high bulk liquor dissolved oxygen induced by increased secondary cell maintenance


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Constructed wetlands and solar-driven disinfection technologies for sustainable wastewater treatment and reclamation in rural India: SWINGS project


ABSTRACT

SWINGS was a cooperation project between the European Union and India, aiming at implementing state of the art low-cost technologies for the treatment and reuse of domestic wastewater in rural areas of India. The largest wastewater treatment plant consists of a high-rate anaerobic system, followed by vertical and horizontal subsurface flow constructed wetlands with a treatment area of around 1,900 m² and a final step consisting of solar-driven anodic oxidation (AO) and ultraviolet (UV) disinfection units allowing direct reuse of the treated water. The implementation and operation of two pilot plants in north (Aligarh Muslim University, AMU) and central India (Indira Gandhi National Tribal University, IGNTU) are shown in this study. The overall performance of AMU pilot plant during the first 7 months of operation showed organic matter removal efficiencies of 87% total suspended solids, 95% BOD₅ and 90% chemical oxygen demand, while Kjeldahl nitrogen removal reached 89%. The UV disinfection unit produces water for irrigation and toilet flushing with pathogenic indicator bacteria well below WHO guidelines. On the other hand, the AO disinfection unit implemented at IGNTU and operated for almost a year has shown to produce an effluent of sufficient quality to be reused by the local population for agriculture and irrigation.

Key words | anodic oxidation, developing countries, hybrid treatment wetland, UV disinfection, water reuse
Development of denitrifying phosphate accumulating and anammox microorganisms in anaerobic hybrid reactor for removal of nutrients from low strength domestic sewage

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ABSTRACT

Low strength domestic sewage was treated in an Anaerobic Hybrid Reactor. The first phase was focused on the enhancement of denitrifying phosphate accumulating organisms (DPAsOs) for the concurrent removal of nitrogen and phosphate. 16S rRNA gene confirmed the presence of Flavobacterium spp and Pseudomonas Cauldronilus spp, which are dominant DPAOs. The second phase was the anaerobic ammonium oxidation (anammox) enrichment phase, and it exhibited much higher chemical oxygen demand (COD) and nitrogen removal (NRR) as compared to the first phase. However, it had failed to remove the phosphate from the system. In case of anammox, the dominant species detected was Candidatus Brocadia, along with minor variants of Candidatus Kuenenia and Anammoxoglobus Frequentia. Apart from that, anammox utilizing bacteria (F. oxalaticus, A. nitrooxidans, and anammox nitrite) and methanogens (Methanobrevibacter ruminantium) were also detected in the system. This study showed the feasibility of anammox species over UPFA in treating domestic sewage.

1. Introduction

Eutrophication is instigated by the presence of nutrients (nitrogen and phosphorus) in domestic sewage, which is a serious environmental issue. Therefore, it is necessary to treat wastewater for nutrients and organic matter before discharging it into water bodies. The conventional system of biological nitrogen removal comprises of two steps. In the first step, nitrification occurs in which ammonia is transformed to nitrite through ammonium oxidizing bacteria (AOB), which further is transformed to nitrate through nitrite oxidizing bacteria (NOB) under aerobic condition. This requires considerable energy to meet oxygen demand. In the second step, nitritification occurs which requires organic matter. Autotrophic nitrogen removal using anaerobic ammonium oxidation (anammox) is more sustainable as it doesn’t require organic matter (Ma et al., 2016). Anammox process is a promising tool (energy producing or energy neutral) in the treatment of sewage (Iotti et al., 2016). Ammonium is oxidized by anammox bacteria using electron acceptor in the form of nitrite. Nitritation (ammonium oxidation to nitrite) is done to get nitrite. From partial denitrification (nitrate reduction to nitrite), nitrite can also be obtained. Anammox results in decrease of 60% aeration demand, decrease in 100% organic source demand, marginal or no NOx emission (Ali and Ghalbi, 2015). The stoichiometric anammox reaction is given as (Kosten, 2008)

\[ \text{NH}_4^+ + 1.25\text{NO}_2^- + 0.25\text{HCO}_3^- + 0.13\text{H}^+ \rightarrow 1.25\text{N}_2 + 0.25\text{H}_2\text{O}^+ + 2\text{H}_2\text{O} \]

Anammox process is a chemolithotrophic process in which anammox bacteria mediates CO2 fixation (Iotti et al., 2016). Generally, anammox develops at 6–43°C. At < 10°C or > 40°C, there is a rapid drop in the reaction rate (Huang et al., 2008). Though, high removal percentage of nitrogen was achieved by (Iotti et al., 2016) in the low strength wastewater treatment at 16°C using anammox. In reactors where dissolved oxygen (DO) is increased gradually in reactors that have DO limited condition, coexistence of ammonia oxidizing archaea (AOA) and AOB with anammox is reported. In this coexistence, oxygen is taken up by AOA and AOB, whereas anammox bacteria take nitrite (toxic for AOA and AOB) and contributes in nitrogen removal (Liv et al., 2008). Huang et al., (2015). In a study conducted by Yang et al. (2015), it is shown that anammox can exist even when DO is > 2 mg/L as an aerobic part of domestic wastewater treatment plant. For good retention of anammox, solids retention time (SRT) should be greater than doubling period of anammox. In anammox reactors, 15–30 days are the typical doubling time (Iotti et al., 2015). Thus, a high solids retention time is desirable for the growth of anammox.

One established approach used for phosphorus elimination is enhanced biological phosphorus removal (EBPR). Specialized microorganisms
Aerobic granulation technology: Laboratory studies to full scale practices

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Abstract

Aerobic Granulation Technology for treatment of wastewater is developed in last two decades. Aerobic Granules are special type of self-immobilization of microorganisms, without any surface medium for growth of microbial film. They have compact cores and have high diffusional confrontations to external particles and hence have high acceptance of the toxic compounds to their integral cells. Most aerobic granules are large and have a compact core and so are recommended for use in the biological treatment of high-strength industrial wastewaters. This technology requires small footprint, 25% of the area of conventional activated sludge setup and this process can reduce up to 50% in energy costs. This paper reviews on start-ups, advances in aerobic granulation technology from laboratory studies to pilot scale and to its full-scale application for treatment of different types of domestic and industrial wastewater. Gaps in knowledge and new ideas for future work of aerobic granulation technology are also being discussed.

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1. Introduction

Since its inception in early 1980s, anaerobic granules developed in Up-flow Anaerobic Sludge Blanket Reactor (UASB) make it a sturdy technology and by today the most extensively used anaerobic process for sewage and industrial wastewater treatment. A granular bed is developed in the bottom of the reactor, where all biological conversions take place. Under controlled and favorable conditions, bacteria agglomerate in flocs and granules. These anaerobic granules have good settling properties and are not vulnerable to failure from the arrangement under applied reactor settings. However, the effluent from UASB reactor is devoid of oxygen and possess odour which necessitate additional treatment.
INVESTIGATION ON AMBIENT AIR QUALITY IN J.N MEDICAL COLLEGE ENVIRONMENT

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ABSTRACT
A study has been performed to investigate the ambient air quality in hospital environment at Jawaharlal Nehru Medical College & Hospital Aligarh Muslim University Aligarh. Seven locations in the surrounding of JNMC & Hospital were selected to determine the concentration of major pollutants such as Nitrogen Dioxide (NO2), Sulphur Dioxide(SO2), and Suspended Particulate Matter (SPM). The outdoors are prone to high RSPM concentration due to prevailing urban air quality of Aligarh city and heavy traffic movement at medical road nearby the Hospital. The concentration of SO2 in the hospital environment ranges from 2.91 µg/m³ to 28.39 µg/m³ and NO2 concentration at all locations varies from 1.87 µg/m³ to 35.06 µg/m³.

Key words: JNMC, Hospital Air quality, NO2, SO2 and SPM.

http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=9&IType=1

1. INTRODUCTION
The complex hospital environment requires special attention so as to ensure healthy air quality to protect patients and healthcare workers from hospital-acquired occupational diseases.

The Jawaharlal Nehru Medical College & Hospital is a 1269 bedded tertiary care hospital which is providing affordable medical care. Very few studies have been performed to investigate the ambient air quality in hospital environment some of them are listed below:

Research study in a university hospital in the eastern province of Saudi Arabia shows that outdoor levels of all air pollutant levels, except volatile organic compounds (VOCs), were higher than the indoor levels which meant that the IAQ inside healthcare facilities (HCFs) were greatly affected by outdoor sources, particularly traffic. Levels of particulate matter
Application of horizontal flow constructed wetland and solar driven disinfection technologies for wastewater treatment in India

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Abstract

The present study was conducted to treat primary and secondary treated sewage for its reuse in irrigation, soil enrichment and aquaculture activities. The study involves treatment of this sewage through a subsurface horizontal gravity-fed gravel filter bed with an area of 35 m². The effluent was then subjected to filtration by zeolite medium and disinfection by inline electrolytic production of chlorine. In order to provide pathogen-free water, an anodic oxidation (AO) disinfection system was implemented, treating a flow of up to 10 m³/d. The gravity-driven constructed wetland and solar-driven disinfection systems were evaluated for their treatment capacity for various physico-chemical and biological parameters. The wetland removed almost 84% of the nitrate (NO₃⁻) and 77% of the phosphate (PO₄³⁻). Five-day biological oxygen demand was reduced from 48 mg/l to 10 mg/l from the secondary treated wastewater. The wetland was able to remove 65–70% of bacteria in the wastewater, whereas the AO disinfection system removed the bacterial content to below the detection limit. The implementation of the systems will provide a suitable option for the treatment of wastewater in a very economical and sustainable way.

Key words: constructed wetland, disinfection technology, electrochemical disinfection, sewage treatment, solar energy supply, wastewater treatment

INTRODUCTION

Current scenario of wastewater treatment in India

Water resources in India are under serious threat due to the discharge of wastewater into aquatic ecosystems. With the rapid expansion of cities and domestic water supply, the quantity of domestic wastewater is increasing day by day. As per recent estimates made by the Central Pollution Control Board of India (CPCB), about 70% of total water supplied for domestic use is then disposed of as...
Assessment of UASB-DHS Technology for Sewage Treatment: A Comparative Study from a Sustainability Perspective

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INVESTIGATIONS ON THE IMPACT OF DISCHARGE OF BREWERY WASTEWATER ON SURFACE AND GROUND WATER QUALITY

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ABSTRACT

An attempt has been made to study the impact of treated brewery wastewater discharge on surface and ground water quality. Surface water samples were drawn from upstream and downstream of discharge point from the Kali Nadi river water situated near the brewery industry. Ground water samples were drawn from government and private hand pumps surrounding villages and nearby location around the brewery industry. The surface water samples were found high concentration of alkalinity, total dissolved solid, BOD and COD. The effluent concentration increases after the industry treated effluent mixes in river. However with time and distance the COD, BOD values starts decreases. In ground water the concentration of alkalinity, fluoride, total hardness and total dissolved solid in some of villages are observed beyond permissible limit.

KEY WORDS: Brewery wastewater, Physico-chemical analysis, Surface and ground water quality.

INTRODUCTION

Most of the environmental problems faced by the world are management of waste water. Industries discharge a wide range of wastewater pollutants, which are not only difficult but costly to treat. Characteristics of wastewater and concentration of pollutants vary significantly from industry to industry. To overcome this problem emphasis is laid on waste minimization and revenue generation through by-product and energy recovery. Pollution prevention focuses on preventing the toxic effect of produced wastewater on the environment, while waste minimization refers to reducing the volume or toxicity of hazardous wastes by water recycling and reuse, process modifications and by by-product recovery (Vandana, 2015. Ajmal 1984. Orhue, 2005). Production of ethyl alcohol in distilleries based on cane sugar molasses constitutes a major industry in Asia and South America. The aqueous distillery effluent stream known as spent wash is a dark brown highly organic effluent and is approximately 12-15 times by volume of the product alcohol. It is one of the most complexes, troublesome and strongest organic industrial effluents, having extremely high COD and BOD values (Pattlota, 214). The brewing industry is one of the largest users of water. The coliform bacteria were recorded (1-2 MPN 100 mL-1) during monsoon seasons due to run off and possibility of mixing of sewage water (Senthilraja, 2013; Henry, 2013). Release of industrial effluents causes indicative changes in nutrient cycling and organic matter processing (Sohail, 2014 and 2015). The physico-chemical properties of effluent from Mohan Meakin Breweries Ltd, Ghaziabad, UP, India (MMBL) have been determined, and its effects, directly on fertile soil and indirectly on wheat *Triticum aestivum* and pea *Pisum sativum* crops, have been studied. The effluent was found to be acidic in nature, and had high BOD and COD due to the presence of large amounts of solids. The effluent was rich in ammonia-nitrogen, nitrate-nitrogen, phosphorus and potassium, so that its application to the soil increased the values of available nutrients in the soil. The upper soil had high values of N, P, K and organic matter compared with the lower soil in the pots used. The highest perturbance was observed in the available potassium of the soil, when 100% effluent was used for irrigation followed by 75%, 50% and 25%, and
Performance evaluation of agro-based adsorbents for the removal of cadmium from wastewater

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ABSTRACT

An effort has been made in the present research to evaluate the agro-based adsorbents such as coconut shell, walnut shell, and almond shell for the removal of cadmium from electroplating industrial effluent. Adsorption experiments were conducted to evaluate the performance. The highest removal efficiency for Cd(II) is 83.7% at pH 6.5 for coconut shell-activated carbon. The percentage removal of cadmium increases with the decrease in metal concentration. The extent of removal depends on the metal ion concentration, adsorbent dose, contact time, and particle size. Coconut shell is found to be more effective with respect to removal efficiency. Cadmium adsorption follows second-order rate equation for coconut shell. The isotherm data obtained more closely follow the Freundlich adsorption isotherm for coconut shell, while walnut shell and almond shell follow the Langmuir adsorption isotherm better. The coconut shell has the highest potential to remove cadmium ion from electroplating wastewater.

Keywords: Cadmium; Wastewater; Agro based; Adsorption

1. Introduction

Wastewater pollution due to lethal heavy metals has been a major cause of concern to scientists, engineers, and health policy makers. Many disasters happen because of heavy metal contamination in aquatic environment [1–3]. Public awareness for pollution caused by heavy metals has been worldwide now. These metals have widespread application in industries and enter the environment wherever they are produced, used, or discarded [4–7]. All these metals become seriously toxic as ions or compound being soluble in water and readily absorbable by living organisms [8,9]. Cd(II) may be introduced in aquatic environments through untreated wastewater discharge from various industrial processes such as mining, phosphate fertilizers, pigments, alloy industries, electroplating, cadmium and nickel batteries, and sewage sludge [10–14].

Cadmium is highly toxic and categorized as carcinogenic to human beings by International Agency for Research on Cancer [15]. Cadmium mainly accumulates in the liver and kidney [16]. Other body organs exposed to cadmium are bones, heart, pancreas, testes, and hematopoietic system. These organs are affected following chronic exposure to cadmium, their functions are impaired, and anemia occurs. It can also cause some other chronic and acute disorders like skeletal deformity, pulmonary problems, kidney stone formation, behavior disturbance, and cognitive impairment [16–18]. The Iasi disease is well known to be caused by cadmium toxicity. So maximum permissible limit of cadmium in drinking water is 0.003 mg/L [19].

Various adsorbents have been used for the treatment of many types of wastewater, depending on the type of pollutants that exists in water and wastewater. Natural adsorbents

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Recent trends in disposal and treatment technologies of emerging-pollutants- A critical review

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ABSTRACT

Recently, pharmaceuticals are emerging as a major source of pollution for the environment. It has been well observed that the effluent discharge from hospitals has an eminent quantity of chemical waste as antibiotics, disinfectants, and other treatments waste. Pharmaceutical effluents are bioactive and their existence in the environment has become harmful for both aquatic life and humans. In developing countries, untreated wastewaters are discharged to local water bodies by just following the local regulations. The current global challenges including high population growth rates and climate change have contributed to the widespread epidemics and emergence of diseases. Besides, intractable and decaying antibiotic system, hospitals must manage wastewater during treatment processes that can lead to situations where a total ban on hospital effluent is needed. For instance, in multiple cases, where discharge lead to strain on nature and quality of water. In case of pharmaceutical residues, it has been observed that only 18–32% of the pharmaceutical residues could be degraded by the secondary treatment of these seven technologies and it has been increased to 30–65% by tertiary treatment. As far as the pharmaceutical residues are concerned, it is observed that MBR removes the effluents with the efficiency of 28–100%, varying for each pharmaceutical. This paper reviews the existing treatment processes, their advantages and future perspective of this emerging area.

1. Introduction

The Environmental Protection Agency (EPA) says that emerging organic micropollutants as a new type of chemicals without any regulatory status and its impact is not fully known. Based on advanced analytical technologies [1], emerging organic micropollutants are generally defined as non-regulated organic trace pollutants just recently introduced or newly detected in the environment. Due to their reported deleterious effects on both humans and the environment [2], the study of this new class of pollutants is imperative [3]. The hospital wastewater generated during various treatment processes like surgeries, laboratories, wards, administrative offices, laundries and kitchens. It was well detected that the concentration of micropollutant in HHW is 4–150 times higher than domestic wastewater [2] and is considered as a pool for pathogens and increase Ab resistance. HHW is usually treated with reference to BOD, COD and suspended solids with, but usually, another micropollutant treatment is ignored [4–6]. In many countries, it is treated as domestic sewage and no specific characteristic where judged in it and it contributes up to 28% of wastewater for treatment in WWTP [7] but their treatment along with domestic wastewater is non-efficient [8,9]. The types of HHW is presented in Fig. 1.

1.1. Antibiotic and its classification

The use of Antibiotics in daily life has increased so much that detection of their residues will be felt in every field of the environment. The effect is not only restricted to humans or animals but also to micro level creatures. The new type of resistant bacteria towards Ab
Smart ways of hospital wastewater management, regulatory standards and conventional treatment techniques

A short review

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Abstract

Purpose – The purpose of this paper is to cover some aspects about the disposal and regulatory standard around the world toward hospital effluent discharge, its managements and treatment technologies that are adopted and best suitable nowadays.

Design/methodology/approach – Due to large and variety of antibiotics available in the market nowadays it is difficult to control its use, thereby risking the whole ecosystem and its components. The regulation pattern is variable depending upon the various factors in different countries. The permissible limit of these pharmaceutical ingredients is very narrow and is a debatable issue.

Findings – The disparity in the available legislation for hospital waste management in different countries makes it difficult to compare pro’s and con’s of methods adopted. Strict laws need to be framed for hospital wastewater management and its treatment, as it contains harmful compounds in higher concentrations resulting in development of resistant genes. The guideline applicable nowadays makes it clear that, specific management guidelines with respect to HWW, but also indicate certain characteristics that can be represented to specify their nature and indicator.

Authors acknowledge and are thankful to the Mewat Engineering College as well as Aligarh Muslim University by providing instrumentation facilities for this research.
Performance evaluation of column-SBR in paper and pulp wastewater treatment: optimization and bio-kinetics

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ABSTRACT

Pulp and paper industry generates effluent containing harmful compounds like chlorophenols which are difficult to biodegrade. It requires an appropriate treatment in order to meet the stringent discharge standards. In this work, a bench scale column type sequential batch reactor (SBR) was employed for treating pulp and paper wastewater. The performance of SBR, seeded with acclimatized sludge, was optimized and analysed for maximizing COD and AOX removal. The process parameters viz. pH, initial COD, cycle time, and MLSS were optimized and their effects on response variables: COD removal efficiency, AOX removal efficiency and SVI were investigated. The optimum conditions were determined to be: initial COD 1200 mg/L, pH 7.5, MLSS 2000 mg/L and cycle time 15 h, for 73.2% COD removal, 78% AOX removal and 122.3 mL/g SVI. The complex compounds were broken down into numerous intermediate compounds thus enhancing COD and AOX removal with low SVI. The bio-kinetics of the optimized system was also analyzed in order to understand the bacterial nature towards substrate utilization. Two kinetic models namely Grau second-order model and Stever-Kincannon model were found to be fit well with high correlation coefficients (R² = 0.99) for COD as well as AOX.

Keywords: Paper and pulp; SBR; RSM; CCD; Bio-kinetics; COD; AOX removal

1. Introduction

The enormous rising population and speedy industrialization, has resulted in reckless discharge of effluents garnering attention all over the world [1]. Moreover, excessive demand of water by pulp and paper industries has depleted this priceless commodity, thus raising concerns of water shortage all over the globe. Due to huge water intake in manufacturing processes, the paper and pulp industry discharges large quantity of effluents with potential adverse effects on our environment. Due to excessive use of
Performance evaluation of column-SBR in paper and pulp wastewater treatment: optimization and bio-kinetics

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Received 10 September 2018; Accepted 9 January 2019

ABSTRACT

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1. Introduction

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Liquid Effluent Discharge and Control Management of Surrounding Soil

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ABSTRACT: The effluent generated from a thermal power plant waste is a mixture of several chemicals and to identify the effect of these chemicals on soil, a case study on naturally contaminated sites at Al-Musayyib region, Hilla city in Iraq has been carried out. Soil and water samples were collected from the sites and analyzed to identify the pollutants and their effect on soil characteristics. Laboratory experiments were formulated to model the field around a channel collecting effluent for about 20 years and the pollutant transport pattern through the soil using soaking process was studied. Experiments were also conducted to study the effect of pollutants on engineering properties of the soil. For environmental management, permeable reactive barriers are used as stabilization and solidification technology to control the pollution through the soil. In this study, the suitability of locally available materials like activated granular carbon was also investigated as reactive media in permeable reactive barrier. The results have shown higher change in geo-environmental properties of soil with the soaking period and it has also been proved that granular carbon improves the geo-environmental properties of polluted soil.

Keywords: contaminated soil, soaking period, thermal power plant, granular carbon.

INTRODUCTION

Difficult environmental issues linked with urban expansion have a developing impact towards the environment. Contaminated liquid, if discharged directly or indirectly into a water system with no suitable remedial measures will have a negative impact on the surrounding soil. These contaminants getting into the mainstream water system could be a complex activity and need employing specific limitations and managing techniques. Containment applications are secure and extremely cost-effective techniques useful to manage contaminants available in the subsurface. Containment is established by applying physical, hydraulic, or chemical bounds that eliminate the external transfer of pollutants (Zahid et al., 2017). In case of soils polluted by heavy metals, the physical and chemical structure of the heavy metals in soil clearly decides the choice of the suitable remedial technique. Details regarding the physical properties of the field, type and concentration of pollution at location are needed to allow reliable evaluation of field pollution and treated solutions. After the place has been recognized, the intended element in soil need to be established (Wuana & Okisimen, 2011). Hilber & Bucheli (2010) provided a
Geo-Environmental Assessment for Naturally and Artificially Contaminated Cohesive Soil Remediated with Granular Carbon

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Abstract: The present study is focused on the ability of granular activated carbon (GAC) for reduction of contaminants in polluted soils and its effect on physical and chemical properties of these soils. The effect of thermal power plant effluent on soil characteristics was also evaluated by conducting physical and chemical laboratory experiments. The contaminant was industrial effluent obtained from Al-Masayyib thermal power plant located in Iraq which is disposed as side product. With percolization of effluent from drainage into the soil, many processes like physico-chemical decomposition process, ion exchange reactions, chemical alterations, oxidation, hydrolysis etc. lead to the changes in natural soil properties. For these reasons, two types of soils have been proposed, first is naturally contaminated soil obtained from the site nearby of drainage channel which is located in Al-Masayyib power plant discharging industrial effluent for nearly 20 years. The second soil is artificially contaminated soil obtained from Aligarh (India), at depth “3 m”; the soil was contaminated by mixing with the 15% of the effluent collected from Al-Masayyib thermal power plant and contaminated for seven days. Granular carbon was added to the naturally and artificially contaminated soil in proportions of 5 and 10%, by dry weight of the soil and thoroughly mixed to ensure homogeneity. For physical properties of each percentage performed by specific gravity, compaction, natural water content, filled and dry density and chemical properties for two percentages performed by pH, EC, TDS, ORG, CI, SO4, NO3 and heavy metals. The soil samples were air dried and crushed and then sieved by 4 mm sieve, then the contaminated soil was mixed with GC which passed through sieve (1.17 mm). The results in this research showed slight changes in soil properties when mixed with effluent whereas in naturally contaminated soil, the results showed more changes in geo-environmental properties.

Key words: Granular carbon, contaminant soil, geo-environmental properties, naturally contaminated, artificially contaminated, thermal power plant.

Introduction

Contaminated place carries a number of compounds into the environment that could be a hazard to human health or the surroundings. These compounds might be chemicals, which can include heavy metals or solvents, or other pollutants like medical waste materials. Land contamination will probably be an outcome of: (1) manufacturing techniques after being transferred to the site, (2) materials preserved or disposed on the site, (3) several farming normal practices on the site, like sheep dip or where agriculture chemicals have been prepared for usage, (4) pollutants in selected fill, (5) destruction (Worksafe et al., 2005), (6) rainfall, like

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THE COST ANALYSIS AND ECONOMIC FEASIBILITY OF AGRO WASTES TO ADSORB CHROMIUM (VI) FROM WASTEWATER

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ABSTRACT

In the present study biodegradable agro and horticultural waste materials have not only been used to adsorb pollutant Cr (VI) from wastewater but it will help in the agro waste management also. Using agro waste materials to purify water for reuse indicates indirect social welfare for the organization which is not directly measured. Low cost sorbent used by tanneries, electroplating industries and other metal finishing industries that release Cr (VI) in effluent wastewater joining natural streams it is sure that these industries will control this pollution at the source itself. So the Cr (VI) removal comparatively at a low cost will be the financial benefit to such type of industries. This benefit will certainly lower the overall costing of the process and products as well.

First time an attempt has been made to estimate the cost of adsorption while studying economic feasibility of various agricultural and horticultural wastes like pea (Pisum sativum) pod peels, tea (Camellia sinensis) & ginger (Zingiber officinale) mix and banana (Musa leonina) peels to adsorb Cr (VI) from wastewater. The removal cost of 1g of Cr (VI) from wastewater using these adsorbents like; Pea Pod Peels, Tea & Ginger mix and Banana peels waste were estimated as Rs. 9.14, Rs. 4.71, Rs. 3.11 respectively. The findings indicate that the cost of using these agro wastes as adsorbents is lesser than that of commercial activated carbon which is Rs. 142.145. The developed adsorbents were prepared from agricultural wastes which undoubtedly require proper waste management.

Adsorbents pea pod peels waste; tea & ginger waste and banana peels waste the positive enthalpy ΔH values 1.089, 1.627 and 1.494 respectively showed the endothermic sorption and the strong binding, the positive free energy change ΔG; 1.31632, 1.946 and 1.752 showed the random feasibility. Adhering fixing adsorbate on the interface between two phases result in loss of the degree of freedom showing a
Biological wastewater treatment (anaerobic-aerobic) technologies for safe discharge of treated slaughterhouse and meat processing wastewater

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HIGHLIGHTS

- SVW is rich in proteins, fats, lipids, fibres, and carbohydrates.
- Anaerobic treatment can be used for production of biogas, and removal of organic.
- Intermittent sequencing batch reactor is ideal for slaughterhouse waste treatment.
- Aerobic granulation technology can be used to remove N and P in SBRs.
- Sequential anaerobic-aerobic treatment can produce biogas and remove C, N and P.

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ABSTRACT

Slaughterhouse industry generates considerable amount of wastewater rich in proteins, lipids, fibres, and carbohydrates. Numerous technologies such as electrocoagulation, membrane separation, advanced oxidation, physico-chemical processes, and biological treatment have been implemented for reducing the concentrations of these compounds. Nevertheless, this review aims to provide extensive information solely on the biological treatment (anaerobic and aerobic) of slaughterhouse wastewater. The advantages of anaerobic treatment are excellent organic matter removal, less sludge production, low energy requirement, execution of higher loading rates, and considerable production of biogas. Aerobic treatment on the other hand is a less sensitive process, possesses lower start-up period, and efficient nutrient removal process. Numerous case studies are described to

Abbreviations: ARB, anaerobic baffled reactor; ABR, anaerobic contact reactor; AD, anaerobic filter; AFBR, anaerobic fixed film reactor; AIP, aerated facultative pond; AOB, ammonia oxidizing bacteria; APEDA, Agricultural and Processed Food Products Export Development Authority; ASP, activated sludge process; BOD, biochemical oxygen demand; COD, chemical oxygen demand; CPR, central pollution control board; CWS, constructed wastewater; DMF, dissolved air flotation; DO, dissolved oxygen; EU, European Union; HRT, hydraulic retention time; IRR, intermittent sequencing batch reactor; LPPA, long chain fatty acids; N,N,N-trimethyl-N,N,N-trimethyl-N,N,N-trimethyl ammonium; MB, moving bed biofilm reactor; MSS, mixed liquor suspended solids; MLSS, mixed liquid volatile suspended solids; NF, nitrogen and phosphorous; NOX, nitrite oxidizing bacteria; ORP, dissolved oxygen; OX, aerobic sludge; ORP, oxidation reduction potential; RBC, rotating biological contactor; SBR, sequencing batch reactor; SDO, volatile biodegradable oxygen demand; SO2, soluble oxygen demand; SDOC, sludge dissolved oxygen content; SOD, simultaneous stabilization and desulfurization; SOUR, specific oxygen uptake rate; ST, sludge retention time; SVL, sludge volume index; SVW, slaughterhouse wastewater; TCD, total chemical oxygen demand; TSS, total suspended solids; TS, total solids; TSP, total phosphorus; TOC, total organic carbon; TSS, total suspended solids; USHA, upflow anaerobic sludge blanket; US EPA, United States environmental protection agency; UV, ultraviolet light; and hydrogen peroxide; WHA, volatile fatty acids; VSS, volatile solids; VSS, volatile suspended solids.

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Hexavalent chromium removal in an electrocoagulation column reactor: Process optimization using CCD, adsorption kinetics and pH modulated sludge formation

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ABSTRACT

In this study, hexavalent chromium (Cr(VI)) removal from aqueous solutions by electrocoagulation, using iron electrodes, was optimized for process variables: applied current, initial pH, initial chromium concentration and application time. A four-factor central composite design (CCD) together with response surface methodology (RSM) was used for investigating the effects of the process parameters on response variables: hexavalent chromium removal efficiency and energy consumed per gram removal of chromium. The optimum conditions were determined to be pH 3.0, 1.48 A applied current, 49.96 ppm initial Cr(VI) concentration and application time of 21.17 min for 100% Cr(VI) removal. The corresponding value of energy consumption was found to be 12.97 W-hour per gram removal of Cr(VI). Adsorption kinetics study showed that the removal followed pseudo-first order kinetics and the adsorption fitted the Langmuir isotherm very well. Moreover, the sludge generated under the optimized conditions showed the best settling characteristics between the pH range of 6–9.

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1. Introduction

With the increasing growth of urban population and rapid industrialization, the problem of incoherent release of untreated wastewater has garnered considerable attention in many parts of the world (Khan et al. 2015a). Several civil societies and regulatory authorities have become increasingly concerned due to the pollution caused by heavy metals, primarily chromium. Many countries have thus adopted stringent laws and regulations to control water pollution. Consequently, there has been growing interest in the removal of toxic pollutants from wastewater (Nashtad et al. 2014; Mam et al. 2010; Ma et al. 2017; Alghazmi et al. 2017; Khan et al. 2017). Contamination of groundwater with chromium is chiefly due to the effluents from various industries like chrome plating, dyes, pigments and leather tanning (Heidmann and Cahnano 2008; Zarouali et al. 2009). Chromium occurs principally in either hexavalent (Cr(VI)) or trivalent (Cr(III)) state. Of the two, Cr(VI) is more toxic and has higher solubility in aqueous medium (Omet 2009). Cr(VI) has also been reported to be as carcinogenic (Cheruvu and Sankararamakrishnan 2011).

Hexavalent chromium removal has been achieved through several processes, like adsorption (Khan et al. 2016; Sharma et al. 2017; Naushad et al. 2017), membrane filtration (Korus and Loska 2009), chemical reduction and precipitation (Kaygusuz et al. 2015; Mirzakas et al. 2011), photo-reduction (Kumar et al. 2016) and electrochemical precipitation (Kurniawan et al. 2006). Nowadays, with technological advancements, nano based adsorbents and ion exchange methods are being extensively analyzed for heavy metal removal (Wang et al. 2018; Redong et al. 2018; Khan et al. 2015a; Gog et al. 2018; Huang et al. 2018; Gu et al. 2018; Al-Othman et al. 2015a,b). But most of these methods have one or the other shortcomings like high operational cost or formation of secondary pollutants by adding chemicals. It is, therefore, the need of the hour to develop an economical and efficient treatment process for the wastewaters containing heavy metals.

Electrochemical based methods have engrossed considerable attention as sustainable and eco-friendly processes. Amongst the electrochemical methods, electrocoagulation (EC) is the most commonly used method for wastewater treatment. It requires very few chemicals (in small amounts) thus reducing the amount of sludge generated for disposal (Adhoun et al. 2004). It is a potential alternative to all those processes that require large volumes, and sophisticated facilities (Moliar et al. 2004). Several studies have been pursued to evaluate the applicability of electrocoagulation for
Performance of horizontal sub-surface flow constructed wetlands with different flow patterns using dual media for low-strength municipal wastewater: a case of pilot scale experiment in a tropical climate region

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