Proceedings of Peer-Reviewed Abstracts
ERTSE 2022

International Virtual Conference on Emerging Research Trends in Structural Engineering (ERTSE 2022)

March 24-25 2022

VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

Organized By

School of Civil Engineering
Vellore Institute of Technology, Chennai

Edited by
Dr. Vasugi V & Dr. Helen Santhi M
Conference Chairs

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PREFACE

Civil and Structural Engineers are the builders of a nation. They always have played a significant role in providing the infrastructure required for the society. Ever increasing population, rapid urbanization and industrialization, global warming and climate change, increasing incidents of natural and manmade hazards and environmental degradation have become major concerns of the society today and these concerns pose several challenges to the Civil and Structural Engineers. There has been a noticeable change in the environment within which civil and structural engineers carry out their work. There is a growing concern on the adverse consequences of the development activities. There is a need for Civil and Structural Engineers to rise up to face these challenges and contribute to the development and betterment of the nation in all core areas. A multitude of threats confront us in our effort to achieve the same. Civil and Structural engineers have always been looking for innovative tools and techniques for solving the challenging problems that they face during planning, analysis, design and construction of structures. It is in this context that the School of Civil Engineering, Vellore Institute of Technology Chennai has come out with the proposal of organizing an *International Virtual Conference on Emerging Research Trends in Structural Engineering (ERTSE 2022)* for the second time. This conference is aimed to provide a forum to all Civil and Structural Engineers to deliberate on the emerging research trends and techniques that are needed to face the challenge in the fields of Structural Engineering.

We received an overwhelming response to our call for submission of abstracts to this conference. We received more than 150 abstracts from across the country. It is heartening to note that several of the contributions that we received are from young researchers/ faculty. Through our review process we ensured that only quality papers were selected for presentation during the conference. After the peer review about 79 full length papers were accepted for presentation during the conference. It is proposed to publish those papers which will be selected based on reviewer comments and the evaluation during presentation.

We hope that this two day conference will provide a platform, especially for young budding researchers to share their ideas and vision, notwithstanding the fact that it is being conducted in the online (virtual) mode. New and innovative technologies that are needed for Civil and Structural Engineers to face the challenges in the present world are the focus of this conference. We hope that this conference will help in building a network of researchers, faculty and practicing engineers who will work towards the goal of achieving the same.

Editors

Dr. V. S. Kanchana Bhaaskaran
Pro Vice Chancellor

I am happy to observe that the School of Civil Engineering has organized the Second Virtual International Conference on Emerging Research Trends in Structural Engineering (ERTSE 2022) held on 24-25 March 2022. This Conference will definitely be a significant attempt to assemble the leading professionals and learners in the field. Research is the fuel for advancement and development. I hope that this conference would certainly stimulate innovative ideas among the participants paving way for new developments and technologies in Structural Engineering. I Congratulate, Dr. S. Elavenil, Dean, School of Civil Engineering, and her team for initiating the conduction of such a conference in our esteemed University.

I wish the conference a grand success.

Dr. V. S. Kanchana Bhaaskaran.

Dr. S. Elavenil
Dean, SCE

Virtual International Conference on Emerging Research Trends in Structural Engineering (ERTSE 2022) held on March 24-25, 2022 provides an environment to all researchers to exchange the information on research and innovations and enhance the quality of research. High quality deliberations that happen in conference will lead to high standard publications at international level. I am confident that over these two days, new joint ventures, stronger associations and even more helpful relationships will be established. I hope that this conference will ignite the development of applications in the area of structural engineering to address the various needs of infrastructure development. I also thank the conference chairs for their efforts in the conduction of such a fruitful conference in our Institution. I wish that all the participants will benefit from the technical contents of this conference, and wish you a very successful conference.

Dr. S. Elavenil


Day 1, 24th March 2022
Time
National / International Keynote Speaker
Title
9.30 - 10.15 AM
Er. N. G. Muralidharan
Consultant, Radcrete Pacific Pvt Ltd.,
Chairman, ICI Chennai Center, Chennai
Material Performance in Ready Mix Concrete
10.15 - 11.00 AM
Dr. S.R. Hegde
Professor, Penn State University, USA
Innovations in Sustainability Initiatives in Cement Industry with Particular Reference to India
Digital Break
11.30 AM - 12.30 PM
Mr. Lawrence Yun
Global Product Segment Manager- Admixtures
FOSROC Chemicals International
Key Practical Roles of Admixtures in Diverse Global Projects
12.30 - 1.15 PM
Dr. Priyadarshini P
Adjunct Professor, Faculty of Technology,
University of Oulu, Finland
Potential use of Mining Waste for Circular Economy
3.45 - 4.30 PM
Dr. Sreevalsa Kolathayar
Faculty, Department of Civil Engineering,
NIT Surathkal
Earthquake Hazard Assessment
Day 2, 25th March 2022
10.30 - 11.30 AM
Dr. Smitha Gopinath
Principal Scientist, CSIR-SERC
Emerging Trends of Textile Reinforced Concrete in Construction
2.00 - 2.45 PM
Dr. U. Johnson Alengaram
Professor, Department of Civil Engineering,
University of Malaya, Malaysia
Enunciation of Industrial By-Products as Viable Alternatives Through Demonstration Projects
No registration fee
Registration link:
E-Certificates will be provided
Join Zoom Meeting
Meeting ID: 941 0794 1578 | Passcode: 330580
Conference Chairs
Dr.M.Helen Santhi,
Professor,
School of Civil Engineering
Mob: 94442 60260
Dr.V.Vasugi,
Associate Professor (Sr.)
School of Civil Engineering
Mob: 94441 78778
VIT
Vellore Institute of Technology
CHENNAI
2nd International Virtual Conference On
Emerging Research Trends in Structural Engineering
(ERTSE - 2022)
24-25th March' 2022
Organized by
School of Civil Engineering
In association with
Indian Concrete Institute - Chennai Centre
Indian Concrete Institute
Chennai Centre
With Industrial Partner
FOSROC
VIT - Recognized as an Institution of Eminence (IoE) by Govt. of India
VIT - A place to learn; A chance to grow

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Technical Papers

Technical Paper's Abstracts

International Virtual Conference on Emerging Research Trends in Structural Engineering (ERTSE 2022)
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ERTSE_01

ENHANCING THE STRENGTH OF BRICKS BY USING WASTE MATERIALS

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Concrete blocks have been a significant material in the construction industry because of their high compressive strength. However, the growth in urbanization has led to severe problems such as a shortage of construction material, and an increase in waste. Blocks made from waste have a wide transition compared to conventional blocks. In recent times, eco-friendly bricks are accepted among the citizens, because of their environmental impact. To reduce the cost of concrete blocks, and to protect the environment, many countries have implemented eco-friendly bricks. Nowadays, bricks can be made from different waste materials such as organic sludge, paper sludge, agriculture waste, and much more. Considering the current scenario, discarded PPE kits, and masks are increasing therefore, this study will emphasize the reduction in biomedical wastes by using them to make the concrete blocks and examine the tests on the block, also comparing the results with the conventional block.

Keywords: *Concrete blocks, Biomedical waste, Strength enhancement*

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ERTSE_02

REVIEW ON PROPERTIES OF ENGINEERED CEMENTITIOUS COMPOSITES MATERIALS

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Fibrous material is present in the concrete, which improves its structural integrity. It is made up of short discrete fibres that are uniformly dispersed and orientated randomly. Steel fibres, glass fibres, synthetic fibres, and natural fibres are examples of fibres. The character of fibre reinforced concrete varies with different concretes and fibre constituents within these distinct fibres. The diverse features of ECC material and their effect in concrete with different efficiency are discussed in this research. The kind, geometry, and volume percent of elements utilised in the mix determine the mechanical properties of ECC. Hybrid fibre composites are better equipped to meet the material performance requirements for a variety of structural applications than monofiber composites for the particular application.

Keywords: *Engineered cementitious composites, Fly Ash, Silica Fume, GGBS, Conplast – SP430*

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ERTSE_03

EXPERIMENTAL STUDY ON THE BEHAVIOUR OF LIGHTWEIGHT CONCRETE

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Lightweight Concrete is a Non-Conventional Concrete using Lightweight Fine and Coarse Aggregates as a Partial or Full Replacement along with Cement, Sand, Gravel and Water. Lightweight Concrete when used as a Reinforced Member can be used to reduce dead load of a structure and reduces the section of a structural member. Here Pozzolanas such as Silica Fume, Metakaolin and Fly Ash are used as partial replacement (50 %) and full replacement of Fine Aggregate (M-Sand) along with Three Lightweight Aggregates, Lightweight Expanded Clay Aggregates (LECA), Lightweight Cinder Aggregates and Vermiculite as full Coarse Aggregate Replacement. They are to be tested for Compressive, Tensile and Flexural Strength along with Scanning Electron Microscope (SEM) and X-Ray Diffraction Testing. The Results are to be analysed to find out the best combination of Lightweight Aggregate Concrete, which can be used as a Structural Member.

Keywords: *Lightweight Concrete, Strength, Aggregate Replacement, Pozzolanas*

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ERTSE_04

RESIDUAL COMPRESSIVE STRENGTH OF THERMALLY DAMAGED CONCRETE: A REVIEW

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Concrete structures are subjected to elevated temperatures in case of building fires and many industrial applications. Numerous researches are reported in the literature to understand the behaviour of concrete under high temperatures. Residual compressive strength of concrete is of primary interest to have an insight into the residual strength and fire resistance of a structure. Residual strength of concrete is influenced by the type of aggregate, rate of heating or cooling, presence of mineral admixtures and fibres used in the concrete. This paper discusses the effect of the above-mentioned factors on the residual compressive strength of concrete.

Keywords: *Residual compressive strength, Building fires, Damages*

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ERTSE_05

EFFECT ON PROPERTIES OF SELF COMPACTING CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE AND HYBRID FIBERS

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The concrete that flows and gets compacted by its weight which does not require any external vibration for compaction is known as self-compacting concrete. It is used in construction where it is hard to use vibrators for consolidation of concrete. The current area of research in self-compacting concrete is introducing foundry sand and hybrid fibres. Fine aggregate plays a major role in concrete mix. Generally, river sand, M-sand and P-sand are used as fine aggregate in the construction field. These sands are in demand and costly. Foundry sand which is the by-product of metal casting industries is considered to be used as partial replacement of fine aggregate. The fine aggregate is replaced with 40% of foundry sand. To increase the property of concrete 1% of hybrid fibres namely glass and polypropylene fibres were added by weight of M30 Grade concrete. The glass fibre is highly resistant to bending, tensile, compressive, non-flammable, high temperature and humidity resistance, and pp fibre is resistant to drying shrinkage and plastic shrinkage and helps reduce water bleeding in concrete. The VMA 1.5%weight of cement is used to increase the workability of SCC. This paper aims to study the fresh properties of hybrid fibre reinforced SCC such as flow spread (mm), L-box, U-box, V- funnel time (sec) reinforced with different hybrid fibres and partial replacement of fine aggregate by foundry sand. And the hardened properties such as compressive strength, split tensile strength at ages of 7,14 & 28 days that also investigated

Keywords: *SCC, Hybrid Fibres, Foundry Sand, VMA.*

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ERTSE_06

A STUDY ON PARTIAL REPLACEMENT OF LIME SLUDGE FOR SAND IN CONCRETE

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The sand necessity for construction activities enlarged consistently but, all the materials required for constructing concrete are attained from the earth's crust only. Hence, the natural resources are broken in an enormously high manner and resulted in reduction of the same and making environmental strain. The sugar and paper industries are generating a enormous quantity of lime sludge as waste, this waste may create biological problems because of its discarding in open places causing environmental pollution. A proper deployment of lime sludge from sugar industry is to be used in concrete. This investigational study is meant to utilize such lime sludge as a partial replacement material for sand in concrete and to study the appropriateness of this waste material for sand replacement. M25 grade of concrete is taken for examination. The sand is replaced by lime sludge of 0%, 10% and 20%. The concrete mix design is done as per IS 10262- 2009. The possessions are studied including the workability features of fresh concrete such as Slump, Compaction factor and strength possessions of hardened concrete including Compressive strength, Split tensile strength and flexural strength for numerous percentage of replacement of sand by lime sludge.

Keywords*: Lime Sludge, Compressive strength, Split tensile strength, Flexural strength.*

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ERTSE_07

EXPERIMENTAL INVESTIGATION IN MAKING LOW COST CONCRETE FROM PAPER INDUSTRY WASTE

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Concrete is power and hard material but it is spongy material also which relates with the neighboring environment. The toughness of concrete depends essentially on the drive of water and gas enters and moves through it. To harvest low cost concrete by combination various proportions of cement with hypo sludge & to decrease disposal and pollution difficulties due to hypo sludge it is most important to develop gainful building materials from hypo sludge. This project grants result of an investigational carried out to appraise effects of changing cement by hypo sludge which is an industrial waste by-product on concrete strength. The primary aim of this research was to estimate the durability of concrete made with hypo sludge. The partial replacement by changing cement via 10%, 20%, 30%, and 40%, of Hypo Sludge for mix design of M_{20} , M_{25}, M_{30}.The Examination was supported out for the subsequent test like compressive strength and split tensile strength ,flexural strength. Paper manufacture commonly produces a large amount of solid waste. Paper fibers can be reprocessed only a partial number of times before they become too short or weak to make high class paper. It means that the broken, low- quality paper fibers are detached out to become waste sludge. Keeping this in view, investigations were commenced to produce low cast concrete by blending various ratios of cement with hypo sludge.

Keywords: *Hypo-sludge concrete, Compressive strength, Split strength, Flexural strength***.**

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ERTSE_08

MICROBIAL CATALYTIC INFLUENCE AND EFFICACY OF BACTERIA AS A SELF-HEALING AND STRENGTHENING AGENT IN BIO CONCRETE – A REVIEW

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Concrete becomes an indispensable material in construction industry. Formations of micro-cracks in concrete are inexorable throughout their service life due to the influence of several external and internal factors. Propagation of cracks in concrete must be restricted to increase the service life of the structure. Umpteen repair methods have been followed to restrict the development of cracks in concrete. Among several repair methods, usage of bacteria is one of the prominent solutions to repair and heal the cracks developed in the concrete. State of art research mainly focuses on the usage of bio-influenced material to induce the self-healing of cracks in concrete. Numerous researches have been conducted to explore the viability of bacteria to increase the strength and durability of concrete. However, some studies revealed that bacteria have self-healing capability still there is a need to conduct a comprehensive review about the recent developments in self-healing mechanism of concrete. Hence this review article can reveal the existing problems, impending research gap and necessary developments for future of bio-influenced self-healing bacterial concrete.

Keywords*: Bio concrete, Bacteria, catalyst, Self-healing agent, Microencapsulation, Strengthening*

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ERTSE_09

BEHAVIOUR OF DIFFERENT CONFIGURATION SHAPES OF RCC FRAME STRUCTURE WITH LEAD RUBBER BEARING BASE ISOLATOR

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Earthquakes are occurred in the building and caused many seismic actions such as shaking, vibration at the base of the structure. The vibration at the base of the structure is more damaged in tall structures due to seismic actions. In order to reduce the seismic shock of the various shape of structures and control the response of the structure by providing an LRB (Lead Rubber Bearing) Base Isolator in the building. The Base isolator is used to control the amount of energy is transferred to the foundation during earthquake action. In this present study, the Lead Rubber bearing isolator building is considered for analysis under seismic loads. A typical G + 10 (11 stories) RCC frame structure in earthquake zone III (Z – 0.16) is considered. ETABS software is used for creating a model and analysing a building frame with LRB Base Isolator as per IS 1893- 2016 code. The Lead Rubber bearing isolator building was analysed by using the Static Analysis of Pushover method. From the analysis, the results predicted that the seismic behaviour of the Different configuration shapes with base isolator was studied. The results showed that the rectangular shape building has less seismic action parameters compared to the other (H and T) shapes of the building.

Keywords: *Lead Rubber Bearing Base Isolator, Pushover Analysis, Different configuration shapes*.

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ERTSE_10

EXPERIMENTAL INVESTIGATION ON CONSTRUCTION SAFETY USING WIRELESS SENSOR TECHNOLOGY

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A civil construction site is a relevant field that deals with the majority of the day-to-day practical aspects of living. This field is completely reliant on indirect cash flows such as weather, insufficient materials, unexpected incidents, and so on. This paper provides a thorough overview and analysis of the hazards in the construction business, as well as their solutions. This innovative breakthrough is made possible by establishing a link between the Internet of Things (IoT)and the construction sectors. The goal is to automate some aspects of construction management, such as safety and quality control. The research has been focused on the disasters that engineers face regularly at the construction site. Sensors are the least expensive and most reusable. This device uses sensors to detect damage and avoid mishaps on the job site. An ultrasonic sensor, a moisture sensor, an Arduino board, and a WIFI module are included in the setup, which allows engineers to readily estimate the damage to scaffolds and formwork while keeping labours safe. Furthermore, this research uses a unique philosophy of employing a moisture sensor to test the quality of concrete. This concept is being adopted to prevent industry corruption. The implemented idea gave us success towards the partial automation in the building sector in an economic and very efficient manner.

Keywords*: IoT, Construction safety, WIFI module, Sensor, Automation.*

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ERTSE_11

MECHANICAL PROPERTIES OF CONCRETE BLENDED WITH SUPPLEMENTARY CEMENTITIOUS MATERIALS

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Portland cement industry involves high energy consumption and is liable for CO_2 emission. The one tonne production of cement produces around CO2 of about 1 tonne which contributes global CO_2 emission of about 7%. Therefore, reduction of cement consumption is also one of the solutions for CO_2 emission. On the other hand, the escalation of industrialization has prompted the generation of the huge quantity of industrial waste or by-products. The utilization of these waste as artificial or natural pozzolana as substitution of cement is notable approach to decrease the CO_2 emission, as Supplementary Cementitious Materials (SCM). Composite Cement is mostly not recommended in RCC because of its higher effects on carbonation and chloride attack. In order to fill this gap, concrete with COC and alccofine is required to be developed to improve the durability properties of concrete. In order to achieve this goal, an attempt has been made to study the mechanical properties of OPC 53, COC and COC + 10% Alccofine for M25, M40 and M60 grade concrete.

Keywords: *Composite Cement, Alccofine, Super Plasticizers, Compressive Strength*

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ERTSE_12

MIX OPTIMIZATION FOR CONCRETE MADE WITH LC3 CEMENT BY VARYING CLINKER AND GGBS CONTENT

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Cement is expected to play a vital role in the expansion of the built environment, especially in emerging economies. Global cement production is set to increase to over 5 billion tonnes a year over the next 30 years. Cement is an important construction ingredient around the world, and as a result, cement production is a significant source of global carbon dioxide (CO_2) emissions, making up approximately 8 percent of global CO_2 emissions from industrial and energy sources. Carbon dioxide is emitted as a by-product of clinker production, an intermediate product in cement manufacture, in which calcium carbonate ($CaCO_3$) is calcinated and converted to lime (CaO), the primary component of cement. CO_2 is also emitted during cement production by fossil fuel combustion. In this research work, an attempt is made to develop a mix design to achieve M30 and M50 grade with Low Carbon Cement by varying clinker and GGBS content.

Keywords: *LC3 Cement, GGBS, Super Plasticizers, Compressive Properties*

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ERTSE_13

STATISTICAL STUDY ON MATERIAL STRENGTH OF LIGHT GAUGE STEEL SECTIONS

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The light-gauge steel sections are manufactured without the application of heat in a cold-forming method. Moreover, this technology is used to create lightweight, high-tensile steel sections. This study mainly focuses on the load-carrying capacity of light gauge steel sections under axial loads as per IS 801-1975, EN 1993-1-3, AISI-S100-16 and BS 5950-5-1998 by the theoretical method. In addition, Euro code EN 1993-1-3, American code AISI-S100-16 and British Standard BS5950-5-1998 are compared with Indian standards. The study is carried out by assuming three shapes such as Channel, Hat and 'Z' section with the lip having varying cross-sectional dimensions and thicknesses with a constant height of the section. The results show that the sections with thicknesses of 1.60mm, 2.00mm and 2.30mm show higher load carrying capacity for Channel and hat sections and thicknesses of 2.00 mm and 2.55mm show higher load-carrying capacity for the 'Z' section. By comparing, the ultimate load determined by IS 801-1975 and AISI-S100-16 are 80-90% lesser than the load obtained by EN 1993-1-3 and BS 5950-5-1998. It was found that ultimate loads for all the sections calculated based on EN 1993-1-3 show better results than other codal provisions.

Keywords: L*ight gauge steel, Load-carrying capacity, Ultimate load, IS 801-1975, EN 1993-1-3, AISI-S100-16, BS 5950 -5-1998.*

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ERTSE_14

VARIOUS TREATMENT TECHNIQUES TO IMPROVE RECYCLED COARSE AGGREGATE IN CONCRETE: A REVIEW

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Managing the waste becomes the prime task of our day-to-day activities. So, recycling occupies major part of construction domain. Making use of the recycled coarse aggregate instead of natural aggregate is one of the basic issues in the smart waste management. The variation in the mix proportion, mechanical property, physical property etc., makes best solution for replacing natural aggregate with recycled coarse aggregate. Such replacement must save the environment cycle in the proper chain process thus, enabling to a sustainable technology development. Even though, it is a time consumption process, recycled aggregate takes more steps to reach final state of expected quality. With reference to national and international proofs and the issues recognized the paper deals with the study of various applications of Recycled Aggregate Concrete. The main disadvantage of recycled aggregate is excess water absorption due to porous content in old mortar attached to it. In order to overcome the problem treatment methods are done to the recycled aggregate. Some of the RAC applications are listed as rubblized, revetments, manure substitute, fencing, stacked gabions and base gravel etc., each of the application has particular requirement of RAC and hence new process/techniques are adopted to frame good quality structured RAC product.

Keywords: *Recycled Aggregate, Waste management, Treatment methods.*

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ERTSE_15

EXPERIMENTAL STUDIES ON THE BENEFICIATION OF FLY ASH AS BINDER USING LIME AND ACTIVATORS

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The large scale release of fly ash from thermal power plants has necessitated a serious concern to dispose it safely in the construction segments. However, over decades many research work has primarily focused to use fly ash as supplementary cementitious material and this has been practiced in many important construction practices. But the necessity for adding cement remains an important constituent since its hydration product helps the fly ash to hydrate at later ages and makes the resultant product stronger. Traditionally lime was used along with fly ash in the production of fly ash lime bricks; since lime has excellent binding property with the silica present in fly ash. In the present study an attempt was made to study the influence of lime in the hydration of fly ash. Also to trigger the hydration reaction to proceed faster; accelerators such as sodium sulphate and calcium sulphate were added in the present study. The setting properties of fly ash with lime was studied at different proportions (up to 100% of fly ash and 60% of lime) and the influence of accelerators were studied at 3% and 5% of total constituents. The test results showed that the addition 3% Na_2SO_4 showed earlier setting time than 5% Na_2SO_4, where it was entirely different in $CaSO_4$. Overall the research results showed that the addition of $CaSO_4$ at 5% was found to initiate the early initial setting time (10 minutes) than Na_2SO_4 at 3% (300 minutes). The use of fly ash – lime composite as mortar was investigated by volume batching; the fly ash: lime of 80:20 was found to be the optimum composition based on compressive strength of mortar samples. The fly ash – lime concrete mix proportions are then arrived and cubes were casted and the compressive property and durability characteristics were evaluated.

Keywords: *Fly ash, Hydration, $CaSO_4$, Na_2SO_4*

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ERTSE_16

PROBABILISTIC ASSESSMENT OF CODAL PROVISIONS FOR THE DESIGN OF AN OPEN GROUND STOREY STRUCTURE

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Open ground storey structures have become widespread in the contemporary era, to facilitate car parking. Such structures are at high risk to seismic excitations, due to absence of infill walls in the ground storey. Open ground storey structures are designed by a bare frame analysis, ignoring stiffness of infill walls in the upper storey levels. This may lead to an underestimation of inter-storey drift and force demand in the ground storey columns. To compensate for the loss of strength and stiffness in the ground storey levels, seismic codes have proposed measures that are to be adopted while designing such structures. Therefore, the present investigation is focused on understanding the performance of an open ground storey structure designed as per the provisions of the Indian seismic code. A performance-based design approach, involving non- linear analysis is adopted. Both non-linear static and dynamic analysis have been performed for the structures. Capacity curves obtained from analysis, is used to study the performance of the structures. The curve obtained from the incremental dynamic analysis is used to develop fragility curves for different performance levels of the structures considered. The study reveals that the open ground storey structure designed as per the provisions of IS-1893:2016 shows better seismic performance in comparison to the structure designed with a multiplication factor of 2.5. The structure designed as per the provisions of IS 1893:2002 could not meet the seismic performance level of the fully infill framed structure.

Keywords: *Vertical irregularity, Open ground storey structure, Performance-based design, Pushover analysis, Incremental dynamic analysis, Seismic fragility assessment.*

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ERTSE_17

COMPARATIVE PERFORMANCE EVALUATION OF AN EXISTING BUILDING USING DIRECT DISPLACEMENT-BASED DESIGN AND FORCE-BASED DESIGN APPROACH

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This study investigates the direct displacement-based design (DDBD) and force-based design (FBD) approach for 3 storey RC building. After calculating the time period, effective stiffness, and equivalent viscous damping of the RC building, base shear is obtained. According to DDBD and FBD approach, the designed frames are analyzed using nonlinear pushover analysis to obtain the pushover curves and response reduction factor R. Results of the analysis and comparison of 'R' factor indicate the effectiveness of the DDBD approach. The Base shear derived from the DDBD method is 76% inferior than the FBD method.

Keywords*: Direct displacement-based design, Force-based design, Non-linear pushover analysis, Response reduction factor*

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ERTSE_18

DEVELOPMENT OF FLYASH – GGBS BLEND GEOPOLYMER PAVER BLOCKS

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Industrialization and rapid growth in population have led to sustainable construction practices. Geopolymers, free from cement, made from various waste materials rich in silica and alumina evolved as an eminent material for sustainability purposes. They were also preferred due to the lesser emission of greenhouse gases as compared to ordinary Portland cement (OPC). In this study, low calcium Flyash and Ground granulated blast furnace slag (GGBS) were used for the development of Geopolymer paver blocks for medium traffic requirement(M40Grade) under ambient curing. Geopolymer concrete mixes blended with an equal proportion of flyash and GGBS, along with coarse aggregate of size 6mm activated with the solution of sodium hydroxide and sodium silicate. Paver block moulds of size 195 mm x 95 mm x 80 mm were taken. GP paver blocks were subjected to investigate the parameters like visual inspection, dimension, compressive strength, split tensile strength, flexural strength, water absorption and abrasive resistance. Geopolymer paver blocks attained targeted compressive strength within 3 days of curing. The developed Geopolymer paver blocks satisfied all the requirements as mentioned in IS 15658:2021 and can be adopted for various pavement applications in construction industries.

Keywords: *Geopolymer paver blocks, GGBS, Fly ash*

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ERTSE_19

INFLUENCE OF RISE ON EDGE DISTURBANCE IN SHALLOW FUNICULAR SHELLS OF SQUARE GROUND PLAN

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Shells be in the right place to the class of internally resisted membrane structures which, since of their geometry and minimum flexural rigidity of the membrane, be liable to bear loads first and foremost by axial stresses subjected in their plane where thickness is minimum when compared to further two dimensions. It is normally curved in geometry. It is an acknowledged that a curved geometrical shell can withstand loads performing perpendicular to the mid-surface by the condition of membrane forces. In these conditions where the skin responses can be opposed and the consequent deformation of the shell can liberally take place, a force allocation outline represented merely by membrane forces is an excellent estimation of the transfer of forces that really take place for a stress sharing in which bending and torsion are kept away, to generate least amount strain energy in the structure. Hence the customary practice is to scheme the sharing of forces in shell according to membrane theory. A set of acceptable forces have to be applied for the boundaries where the displacements due to membrane stresses are barred. Thus the computation of these edge disturbances which must be overlay upon the state of membrane stress is carried with the help of theory of flexure. An investigation is made to compute the influence of edge disturbance for the shallow funicular shells with a variety of rises of r1, r2 and r3. Analysis is conceded by discretizing the shell structure using four nodded quadrilateral elements. Suitable geometrical and material properties are included in the analysis. From the analysis the bending stresses are computed. Conclusions are arrived for the coverage of the edge disturbance on the shallow funicular shells of square plan, double Gauss curvature with a range of rises influenced by concentrated load.

Keywords: *Edge disturbance, Shell, Funicular shells.*

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ERTSE_20

ANALYSIS AND DESIGN OF THE STRUCTURE SUPPORTED ON A SINGLE COLUMN

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The rapid increase of population leads to land scarcity and also an increase in land rate. Multi-storey structures are constructed to avoid the land problem by accommodating more houses in a small area. Mono column structure is one technology that satisfies the spacing requirements and provides an aesthetic view. The structure has significant cantilever portion elements compared to other multi-column structures. This study mainly concentrates on the dynamic analysis and design of RCC multi-storey structure supported on a single column using STAAD.Pro. A building with G+8 storey was prepared based on the codal provisions. The dynamic loads mainly affect the structure due to its height and the cantilever portion. So, to have a stable structure, it must be balanced for dynamic and static loads. The study aims to analyze and design the single column structure for the dead, live, and dynamic loads. The structure is mainly studied for the maximum bending moment, maximum shear force, base shear, and material quantities with different zones.

Keywords: *Mono column, Dynamic analysis, Base Shear, STAAD.Pro*

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ERTSE_21

THEORETICAL AND NUMERICAL STUDY ON FLEXURAL BUCKLING BEHAVIOUR OF GFRP ANGLE CROSS-SECTION

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This paper presents the theoretical and numerical study on flexural buckling behaviour of glass fiber reinforced polymer (GFRP) angle cross-section. The critical buckling load of GFRP angle cross-section was theoretically studied using the various formulas developed by Euler, Timoshenko, Haringx, Strong well Corporation and Fiberline composites. The finite element analysis of the GFRP angle cross-section was modelled using ABAQUS FE software and the simulated model was solved by linear buckling analysis. The linear buckling analysis was carried out to predict the flexural buckling loads and the corresponding buckling shapes. The theoretical predictions and numerical results were compared with experimental results. From the comparison of theoretical predictions and numerical results with experimental results, the effect of the slenderness ratio and leg width to thickness ratio on the flexural buckling load and buckling shape was investigated. A total of 14 specimens with slenderness ratio varying from 50.6 to 102.55 and leg width to thickness ratio varying from 8 to 12.5 were taken.

Keywords: *Flexural bucking, GFRP, Buckling shape.*

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ERTSE_22

EXPERIMENTAL STUDY OF PARTIAL REPLACEMENT OF CEMENT USING BOTTOM-ASH

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The consumption of concrete is increased worldwide. The commonly used cementitious material the concrete is cement and fly ash. The usage of cement is decreased because of high energy consumption, emission of greenhouse gasses during production and the supply of flyash is also reduced due to the closure of coal –fired poer plants. This study aims to examine partial replacement of cement using bottom ash. Bottom ash is the waste material from coal power plants. This waste material contains many particles like SiO2, FeO3, Al2O3, CaO, TiO2 etc. This can be used in construction to enhance the performance of concrete in building. By leaving these elements in ground can be hazardous to our environment. The bottom –ash was collected from Neyveli Lignite Corporation, Neyveli, Tamil Nadu. The experimental investigation was carried out for replacing cement with 20 % and 25 % of bottom ash by weight. Test on concrete was conducted for 7,14 and 28 days. The results shows that Mechanical properties, Compressive strength and modulus of rupture and durability properties like water absorption; Test results indicated that concrete span, concrete strength etc. have been increased significantly. However, no significant effect on mechanical properties was observed. Furthermore, the additions of wastes have increase concrete properties and it is used to reduce pollution and dust resistant too. Therefore, it can be concluded that cost of cement can be minimized and environmental burden leading towards more economical and stable construction. By this we can reduce the space acquired by unused bottom-ash. By using copper wire, we can reduce e-waste which was one of the land pollution, and that can be reduced

Keywords: *BottomAsh, Nominal, Silicon dioxide, Magnisum Oxide, Aluminium trioxide, Taitanium Dioxide, Ferric trioxide*

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TRANSLUCENT CONCRETE: A REVIEW

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Concrete, a proportionate mixture of Cement, aggregates include fine and coarse with sufficient amount of water. Saving different energies used by us is most necessary these days which in turn saves the nature. Translucent or Transparent concrete is an innovative and novel architectural material with light transmission properties using optical fibers and glass rods inscribed in different patterns that provides an aesthetic view. This can be used in partition walls, reception desk and other important places that attract the mankind. This new kind of building material integrates the concept of green energy saving overcoming the image of concrete as a dull and pale material. The thickness of optical fiber where light transmits may be varied from 2 μm and 2 mm which is almost equal to diameter of human hair is used in the concrete for a volume of is 4%-5%. Also, strength characteristics play a major role in estimating the durability of the concrete structure. This paper reviews the properties of optical fibers, studies on different strengths and comparison with conventional concrete.

Keywords*: Transparent Concrete, Optical fibers, Light transmission, Glass rods, Green energy, Durability.*

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FLEXURAL BEHAVIOR OF RECTANGULAR TUBULAR STEEL BEAMS PARTIALLY FILLED WITH CONCRETE

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Concrete filled steel tubular (CFST) beams exhibits high ductility, improves fire resistance and minimize the use of formworks. CFST beams have the advantage of both steel and concrete similar to CFST columns, except that the concrete in tension zone is non-functional. In this study, a partially concrete filled steel tubular beam (P-CFST) is developed. Here, concrete is filled only in the compression zone of the CFST beam thereby optimizing the cross-section for moment resistance. The neutral axis depth of the CFST is determined using plastic section analysis in order to develop the PCFST cross-section. In this paper, flexural behavior of PCFST beam is studied numerically and compared with CFST beam behavior. It is found from the moment-deflection plots that the behavior is almost the same in terms of initial stiffness, ultimate load capacity and ductility. The weight reduction in PCFST compared to CFST is 20%. In real-time structures the weight reduction in PCFST will be considerable while the moment resistance is the same. The procedure of numerical modeling, validation and parametric study on PCFST is explained in this paper. The main parameters varied in present paper are grade of concrete and yield strength of steel. From the parametric study, it is observed that the influence of concrete compressive strength on PCFST beams is not significant compared to yield strength of steel. Therefore, it is appropriate to place concrete in the compression zones of beam to develop an optimal cross-section.

Keywords: *Partially filled, Moment resistance, Ductility, Numerical study.*

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GFRP STRENGTHENED DEEP BEAMS WITH OPENINGS

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Web apertures in RCC deep beams are required to enable accessibility for doors and windows, as well as to accommodate vital services like as ventilation and air conditioning ducts, which reduces the element's shear capability. The present experimental investigations deal with the comparative study of deep beams containing openings and failed deep beams strengthened using Glass Fiber Reinforced polymer. Deep beams with openings are cast and tested under two-point loading in order to determine concrete parameters using load vs deflection. The test specimens of the deep beam were being cast as per the codal provision. Two circular openings, one in each shear span are placed symmetrically about the centroidal axis of the beam. The test beam was subjected to two-point static loads and displacements were measured till the specimen collapsed. The degree of interruption to the natural load path affects the structural response of reinforced concrete deep beams. The beams are further to be strengthened with the CSM and WR mats in order to prevent the development of further cracks. Strengthened beams are tested under the two-point loading condition again in order to find the loading capacity of the strengthened deep beams. The beams strengthened with WR mats showed improved deformation characteristics than CSM bounded beams.

Keywords: *Deep beam, Shear capacity, Crack pattern, Glass Fiber Reinforced Polymer (GFRP), Strengthening*

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CHARACTERIZATION OF GEOPOLYMER CONCRETE BY PARTIAL REPLACEMENT OF C & D WASTE

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It is verifiable truth that the substantial is broadly involved material for development from one side of the planet to the other. To remunerate the requests, the utilization of economical materials in concrete. The C&D squander, geopolymer concrete is utilized in this task. The different diaries gathered gives clarting about utilizing C&D squander in concrete. In this investigation concrete is supplanted by fly debris, GGBS, subterranean insect basic activators, while the fine total and coarse total is somewhat supplanted by (reused substantial total) development and destruction squander. This kind of substitution might bring about less Co2 discharge in the environment. Thus, it is Said to be a reasonable cement. It is found that the geopolymer concrete lessens the CO2 emanation up to 26% to 46%. The substantial is tried for the pressure test at 7 days, 14 days, 28 days, and the strength varieties are finished.

Keywords: *Fly Ash, GGBS, C&D Waste, Compressive strength, Split tensile strength, Flexural strength*

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ERTSE_27

SEISMIC ANALYSIS OF MULTI-STOREY PREFABRICATED BUILDING

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Prefabricated buildings are the future of construction industries but we all know prefabricated RCC buildings are struggling compared to conventional building in terms of structural integrity. As prefabricated RCC buildings have to be connected in situ they lack the monolithic property in beam-column joints as that of conventional buildings. This project discusses about the seismic response of prefabricated building members and its cost estimation in detail. The material consumption in both conventional and prefabricated construction methods are compared and found that concrete of 578 Cu.m and 587 Cu.m are consumed for conventional and prefabricated construction, respectively. In terms of steel, 24 T and 29.3 T are consumed for conventional and prefabricated construction, respectively. Conventional construction requires up to 667.55 Sq.m per floor of shuttering but this is not required for prefabricated construction. The material alone costs around Rs. 48,82,000 and Rs.53,66,900 for conventional and prefabricated construction, respectively.

Keywords*: RC Prefabricated building, Seismic analysis, Seismic response; Beam-column joint.*

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NUMERICAL ANALYSIS OF REINFORCED CONCRETE BEAM COLUMN JOINT RETROFITTED USING CARBON FIBER REINFORCED POLYMER (CFRP) SHEETS

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The beam column joint is the critical zone in a reinforced cement concrete (RCC) moment resisting frame. It is subjected to large forces during severe ground shaking and its behavior has a significant influence on the response of a structure. Improper design and detailing of joint will result in brittle failures. To avoid such failures and meet specific beam column joint requirements, existing reinforced concrete structures must be strengthened. Retrofitting and strengthening are the most sustainable methods for improving the performance of reinforced concrete frame buildings. There are several methods for retrofitting beam column joints, the most common of which is Carbon Fiber Reinforced Polymer (CFRP). CFRP is a popular material for retrofitting due to its superior properties such as high corrosion resistance, high strength, high stiffness, and good resistance to chemical attack etc. Thus, it is important to examine more about retrofitting using carbon fiber reinforced polymer. This work is set out to study and provide insights about what is retrofitting, importance of retrofitting a beam column joint, and effectiveness of using of CFRP as a retrofitting agent for beam column joint based on numerical analysis. In this study, reinforced beam column joint retrofitted using CFRP is considered. Numerical investigation is done on normal beam column joint and CFRP retrofitted beam column joint. The numerical investigation is done using ABAQUS software. This study focuses on the influence of the number of layers of CFRP sheet on the performance of retrofitted joint. The comparison of the performance of retrofitted joint models in terms of ductility, first crack load and load carrying capacity were also studied.

Keywords: *Reinforced Cement Concrete (RCC) structures, Beam Column Joint, Retrofitting, Carbon Fiber Reinforced Polymer (CFRP), Abaqus.*

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A LABORATORY INVESTIGATION ON FLYASH BASED BACTERIAL CONCRETE

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Concrete is the only construction material which satisfies the properties of strength and durability. Concrete, which is brittle, by the nature has a tendency of developing cracks with the passage of time. The development of cracks induces problems on the reinforcement with the intrusion of salts, chlorides and water through these cracks. So in order to counteract this problem, the concept of Bacterial Concrete can be used by which concrete heals itself, the micro cracks developed at the early stage. This type of concrete can also be called as a Self-Healing Concrete. From the various studies, it is observed that 10% replacement of flyash with the cement in concrete production gives the better results. In this project work, Bacteria is prepared using Bacillus Subtillus, the culture which is laboratory developed in the institution using the raw bacteria. Along with the Bacterial Concrete, Flyash of 10% is added as a replacement of cement and the concrete is produced. 5%, 10% and 15% of water is replaced with the developed bacteria and added to the flyash concrete. Laboratory tests viz., Compressive Strength Test and Split Tensile Test are carried out and the results are compared.

Keywords: *Bacillus subtillus, Flyash Concrete Bacterial Concrete, Bacteria Culture, Cracks.*

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EVALUATION OF STRENGTH CHARACTERISTICS OF FIBRE REINFORCED CONCRETE WITH THE INCORPORATION OF MARBLE SLUDGE POWDER

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Marble Sludge Powder (MSP) is a new composite material that will save money in the concrete industry by reducing material consumption. Marble sludge powder is used in conventional concrete as a sand replacement, and it is extremely effective at increasing strength without affecting its properties in both the fresh and hardened states. A concrete mix is used to partially replace sand with marble sludge powder. Cubes, cylinders, and prisms are cast and cured after 28 days to undergo compressive, split tensile, and flexural strength tests. To calculate mix design, IS 10262:2019 is used. Marble dusts are mixed in at 5%, 10%, 15%, 20% and 25% concentrations. Polypropylene fibre is added to concrete at 1.5 % concentrations. The compressive strength, split tensile strength, and flexural strength of the concrete mixtures were determined after 28 days. The results of the experiments show that marble sludge powder and Polypropylene fibre reduce the workability of fresh concrete.

Keywords: *Polypropylene fibre, Mechanical Property, Marble Sludge Powder, Fibre reinforced concrete.*

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SEISMIC DESIGN AND COST COMPARISON BETWEEN L-SHAPED COLUMN AND SQUARE COLUMN IN A TALL INDUSTRIAL BUILDING

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In a Reinforced Concrete (RC) building, columns are the vertical structural elements which are predominantly used to transfer total load from the super structure to substructure and are subjected to axial compressive forces and moments. Generally, for tall RC buildings the lateral loads such as wind and earthquake loads are to be considered in the design to ensure the safety of the buildings. In this study, L shaped column and square shaped column are considered for the seismic analysis and design for an industrial building to satisfy its functional requirement in addition to its safety. Also cost comparison between the RC Industrial buildings with L shaped column and square shaped column is carried out.

Keywords*: RC industrial building, Seismic load, L shaped column, Square shaped column, Cost analysis*

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ERTSE_32

EFFECT OF GREY WATER IN PRODUCTION OF CONCRETE

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Water plays an undeniably crucial role in civil engineering, and there is currently no viable substitute. Chemical water limits for concrete, as suggested by various concrete rules, imply that non-potable water can be used as mixing water. Non-potable water, such as grey water, can be reused to relieve demand on fresh water supplies. The purpose of this research is to see how the usage of grey water affects the qualities of concrete. To boost the strength of the concrete, a M40 concrete mix was combined with silica fume. The effect of both treated grey water and tap water samples on concrete strength is next investigated.

Keyword: *Treated grey water, Mechanical properties, Electroreduction*

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STUDY ON SEISMIC ANALYSIS AND VARIOUS ASSESSMENT METHODS FOR MASONRY ARCH BRIDGES

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In the last few decades or more precisely about a century around, there were formations of so many road bridges, railway bridges, in central Asia, South America, almost all over world. All such types of bridges are very important regarding conveyance and support in growth of any country. Many of them are still supporting load for which it has been designed. As the time passes, material of bridge was deteriorated, so continuous monitoring is important for such types of bridges because structural behaviour is getting changed day to day due to wear and tear of bridge. This paper helps us to draw information about masonry arch bridges by considering various defects. For seismic assessment of arch bridges there is no comprehensive method which is acceptable world-wide. There are two types of analysis of any type of structure namely linear analysis and nonlinear analysis. In linear analysis, load and displacement are directly proportional to each other, so calculation of all parameters will be very easy in linear analysis. In nonlinear analysis case is just opposite because here load and displacement are non-proportional to each other so calculation is not as easy as much it was in linear analysis. There are so many methods of analysis of masonry arch like nonlinear static, nonlinear dynamic. So a deep understanding of masonry arch bridge is important for us to design and rehabilitate masonry arch bridge using certain modern methods because it has been designed using traditional methods. Modeling, results shows that how these parameters (rise to span ratio, brick defect shifting of abutments etc) affect the masonry arch bridges properties like failure mechanisms, ultimate load capacity. To know the behaviour of arches for different loading conditions finite element method based investigation is also done which has been carried by different researchers in the past years. This manuscript provides the thorough survey and investigation of arch-bridges done by previous researchers and focused on the review of various methods and parameters which may affect its failure mechanism.

Keywords: *Masonry, Arch-bridges, Seismic-Assessment, Incremental Dynamic Analysis, Failure Mechanism, Non- linear analysis*

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COMPARISON OF FLEXURAL BEHAVIOUR OF ROLLED STEEL SECTION BEAM WITH REINFORCED CONCRETE BEAM

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The flexural members are the beam that support loads applied in a transverse direction. Structural steel beams are typically used in load-bearing actions that are more sophisticated than other structural parts. Steel concrete composite beam is the subject of this project. The primary purpose of composite concrete and rolled steel I-beams is to develop the ability of moment of inertia, section depth and section modulus, while reducing weight. Two-point loading is used to test the behavior of composite concrete and structural steel beams. The deflection in the centre of the beam is investigated, as well as various failure patterns. The beams casted were tested with two-point loading method, with the results compared to those of a standard concrete specimen. The changes in dimensions and the maximum bearable strength results are in acceptable accord with the allowable values.

Keywords: *I-section, Flexural behaviour, Rolled Steel, Deflection of beam, Two-point loading*

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BEHAVIOR OF NEW COLD-FORMED STEEL BUILT-UP COLUMN SECTION UNDER AXIAL COMPRESSION

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Cold-formed steel columns are widely used in the low-rise building construction industry due to their light-weight and ease of installation and assembly. Cold-formed steel structures use continuously cold-formed channels and box sections. In this study, a new built-up column consists of a total of four individual CFS channels, in which two individual CFS lipped channels are placed back-to-back at the web using two self-drilling screw fasteners at specified spacing along the column length, while another individual unlipped are placed around the boundary of the back-to-back channel at the flange using two self-drilling screw fasteners at specified spacing along the column length. A finite element model is created and buckling analysis is performed using Abaqus 6.14 software by changing the height of the columns while keeping the cross-section and thickness constant.

Keywords: *Cold-formed steel, back-to-back, box section, built-up column, and Abaqus 6.14*

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EXPERIMENTAL STUDY ON THE AXIAL COMPRESSIVE BEHAVIOUR OF SAND-FILLED SINGLE-SKIN AND DOUBLE-SKIN STEEL TUBULAR STUB COLUMNS

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Tubular steel has higher torsional rigidity and better corrosion resistance over an open steel cross-section like I and channel sections. In addition to this, the hollowness in the tubular section provides space for adding fillers to improve the local and global stability of the steel member. Concrete has been the most preferrable filling material over the decades as it develops composite action within the cross-section and increases the axial compressive strength. However, in some of the constructions, especially in steel bridge piers, steel tubular member is filled with concrete so as to resist vehicular impacts without accounting for their strength contribution in design. Sand filling is a possible cost-effective alternative for concrete in these structures. However, the structural behaviour of sand filled steel tubes is not studied so far. In this paper, axial compressive tests conducted on sand filled hollow steel tubes (HT) and concrete sandwiched double steel tubes (CSDST) are reported. Due to the higher axial stiffness of the steel tube compared to the sand filling, the load is resisted by steel section till its yielding followed by plastic buckling. The post-yield behavior shows that the sand filling enhances the energy absorption even though the ultimate capacity of the section is not increased.

Keywords: *Sand filling, compressive strength, energy absorption, composite construction*

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A REVIEW ON: EFFECT OF GRANITE POWDER IN CONCRETE

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Granite waste (GW) dust which is generated from the polishing and cutting of granite from the industry, which is a non-biodegradable material and cause serious environmental and health risks. As many research has been done on the replacement for cement and fine/ coarse aggregate with industrial waste by-product. Based on a published research paper, this paper discussed how waste can be used to replace a significant amount of cement in concrete, as well as study the mechanical and durability properties of concrete, even reduce the environmental pollution, construction cost and has positive impact on engineering properties. From this study can conclude that more research has to be done on cement, fine or coarse aggregate replacement and even combination replacement with industrial waste (GW) has to be studied under room temperature and elevated temperature. Hence, granite waste can be utilized as replacement in concrete and produce eco-friendly concrete.

Keywords*: Concrete, Granite powder, Compressive Strength, Tensile Strength, Flexure Strength, Durability.*

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ERTSE_38

ASSESSMENT OF EMBODIED ENERGY AND CARBON EMISSION OF AN INSTITUTIONAL BUILDING

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Manufacturing and transportation of various building materials consume a significant amount of energy. When it comes to reducing the amount of greenhouse gases released into the environment, energy conservation becomes important. The heart of the sustainability crisis has been discovered to be material consumption. The main problem is to lower material output while yet fulfilling the material expectations of the world's growing population. Embodied Energy and Embodied Carbon are two of the most important factors to consider when evaluating the environmental performance of building materials. High energy usage and CO2 emissions have significant negative environmental issues. The study focuses on several issues related to Embodied energy in buildings, especially in the context of India. It presents the findings of Embodied Energy and Embodied Carbon in a two-story institutional building in Sivakasi. The total useable floor space of this structure is 1264m2. A detailed estimation of Embodied Energy is carried out by considering the use of material during building construction. The Inventory of Carbon and Energy, University of Bath (ICE database lists almost 200 different varieties of building materials with their Embodied Energy and Embodied Carbon values) is used to calculate Embodied Energy and Embodied Carbon. The alternative materials are found by comparing the Embodied Energy and Embodied Carbon values and are replaced with the conventional building materials. It has been discovered that changing building materials may cut roughly 24% of both Embodied Energy and Embodied Carbon. As a result, building sustainability should also focus on reducing Embodied Energy and Embodied Carbon in design and construction phase.

Keywords: *Embodied Energy, Embodied Carbon and material replacement.*

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ERTSE_39

STUDY ON THE EFFECT OF DAMAGE LOCATION ON DYNAMIC BEHAVIOUR OF MULTI-STOREY RC FRAME STRUCTURE

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The present work is concerned to study the dynamic behaviour of the damaged structure. Damage is a change in structure, either by intentional or by unintentional, which effect the current or future performance of that structure. Dynamic loading is also one causes the in structures, is directly related to frequency of the structure. In this paper, two-dimensional frame is used carry the analysis. The damages are introduced by reducing the Young's modulus of concrete. The modal analysis can be performed in order to obtain the dynamic behaviour. The explicit relationship between the dynamic parameter like natural frequency and time period is obtained by the simulation results. Results shows that the damage in the lower level, contribute more significant effects on structures, gives more variation in the natural frequency of the RC frame. From this study, effectively identify the critical damage level in the frame.

Keywords— *Damage, Dynamic behaviour, Young's modulus, Modal analysis, Natural frequency and Time period, Critical damage level*

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ERTSE_40

UTILIZATION OF POLYPROPYLENE IN CONCRETE

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Polypropylene fibres are new generation chemical fibres. They are manufactured in large scale and have the fourth largest volume in production after polyesters, polyamides and acrylics. Polypropylene fibres were first suggested for use in 1965 as an admixture in concrete for construction of blast resistant buildings meant for US corps of Engineers. Polypropylene fibres can be used in much lower content than steel fibres. Addition of polypropylene fibres progress the topmost ductility strength, flexural strength, collapse performance. Usually the polypropylene fibres are generally added to increase the mechanical properties such as Compressive strength, flexural strength and tensile strength. Adding fibres in concrete as mentioned in literature review affects the workability of concrete, as the fibres tends to absorb water in a considerable amount.

Keyword: *Polypropylene, Fibres, Acrylics, Strength*

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ERTSE_41

STUDY ON PROPERTIES OF HIGH STRENGTH SCC BY REPLACING NANO MINERAL ADMIXTURES

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Concrete is in higher demand across the world these days due to its ease of construction and other benefits. To survive the great strength, extra reinforcement is used in the construction of the buildings. SCC can be utilized because of the congestion in the reinforcing. On the other side, because of the increased use of cement, CO2 emissions are increasing. Many studies are being conducted to discover alternatives to cement concrete. The features of high strength Self Compaction Concrete (SCC) with partial replacement of cement employing nano-mineral admixtures such as Fly ash, Phospho-gypsum, and Silica fume are investigated in an experimental investigation. These admixtures are replaced in cement to the tune of 30%, with fly ash accounting for almost 25% of the replacement and phospho-gypsum and silica fume accounting for the remaining 5%. Various new concrete tests are performed, including the L-box test, V-funnel test, J ring test, and V-funnel at T5 minutes. The design mix is created based on the test findings, and concrete specimens are cast to determine the hardened concrete qualities. The findings of the toughened properties suggest that 2.50 percent substitution of phospho-gypsum produces better outcomes than 5 percent replacement of phospho-gypsum.

Keywords: *Self compaction concrete, Fly ash, Phospho-gypsum, Silica fume, CO2*

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ERTSE_42

STRUCTURAL BEHAVIOR AND PERFORMANCE ON HIGH PERFORMANCE CONCRETE

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High performance concrete (HPC) is that concrete meets special performance and uniformity requirements that cannot always achieved by conventional materials, normal mixing, placing and curing practices. Special performance requirements using conventional materials can be achieved only by adopting low W/C, which necessitates use of high cement content. But judicious choice of chemical and mineral admixture can reduce the cement content and this result in economical HPC. However, the effect of a mineral admixture on the strength of concrete varies significantly with its properties and replacement levels. Mix proportioning method of normal concrete cannot adequately account for the large variations in the properties of ingredients. The paper presents a laboratory study on the influence of three mineral admixtures, silica fumes (SF), fly ash (FA), and hydrated lime and Conplast-SP430 on the properties of high performance concrete. The strength and durability properties are carried out for various mix designations and compared with normal conventional concrete. In present project work M40 grade considered and the fly ash (FA) at 45, 40 and 35% volume and silica fume(SF) at5,10 and 15% volume and hydrated lime 5% of cement content are introduced into high performance concrete. Based on the results will find the increase of compressive strength than conventional and flexural beam has been tested and beam has low deflection and comparison between numerical and experimental has been done These results will show whether the HPC is suitable for structures subject to extreme load conditions.

Keywords*: High performance concrete, Fly ash, Silica fume, Water/cement ratio*

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ERTSE_43

SOIL STABILIZATION USING SISAL FIBRE AND RICE HUSK ASH

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Soil is the fundamental requirement of all types of structures. In some places soil could also be weak that cannot resist the oncoming masses. The method of exchanging the whole soil is not effective and efficient, soil stabilization is an efficient technique in terms of both cost-effective and wealthy. Natural materials and waste materials are often accustomed to investigate stabilization of the soil characteristics. The increasing construction price of standard stabilizers in addition as demand for a budget utilization of commercial and agro-wastes for expensive transactions has aggravated a pursuit into the helpful eventual of Rice husk Ash with the percentage of 0 to 12.5% with the increment of 2.5% and sisal fibre with the percentage of 0 to 1% with the increment of 0.25%. The soil characteristics have determined by the following experiments like Standard proctor compaction test, unconfined compression strength, direct shear strength, CBR and Permeability. Optimum percentage of Rice husk ash was identified as10%. Coefficient of permeability decreases with the use of sisal fibre addition in the soil. Unconfined compressive strength shows increasing trend up to 0.75% sisal fibre content that is considered as identical percentage.

Keywords: *Stabilization; Rice Husk Ash; Sisal Fibre; Unconfined Compressive Strength; California Bearing Ratio*

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ERTSE_44

EXPERIMENTAL STUDY ON GEOPOLYMER BLOCKS WITH PARTIAL REPLACEMENT OF M-SAND USING FOUNDRY SAND

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The utilization of fly ash in brick as partial replacement of cement is gaining immense importance today, mainly on account of the improvement in the long-term durability of brick combined with ecological benefits. Fly ash and a mixture of alkaline activators namely sodium silicate and sodium hydroxide solution was used for preparing Geopolymer blocks. Class F Fly Ash was mixed with the alkaline activator solution. The Geopolymer block was made using class F fly ash, M-sand and Alkaline activator solution, and during the study the M-sand was replaced with foundry sand at a percentage of 5%, 10%, 15% and 20%. Then the blocks with varying percentage of foundry sand were compared with fly ash blocks by conducting various laboratory tests like compression test, water absorption test, hardness test and efflorescence test. The test results that were obtained were used for the study and the optimum percentage of replacement of foundry sand, which produces the highest strength, was determined.

Keywords: *Geopolymer blocks, Flyash Blocks, Foundry sand.*

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ERTSE_45

STUDY ON REPLACEMENT OF AGGREGATE WITH WOOD WASTE IN MORTAR

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Wooden chips and saw dust are the by-product of wood. It is considered as waste material but now a days this waste material is utilized in the construction of the building as wood waste mortar. It is utilized to make light-weight concrete and possess long duration heat transfer. Experimental result shows that waste wood can effectively been used in concrete as partial replacement of aggregate. loss of strength in concrete due to poor bonding between concrete and waste wood aggregate, so saw dust mixed with wooden chips fraction (gradation) is done to improve compressive strength. The objective of this work is to establish the mortar using waste wood as a replacement for fine aggregate. It is to study the property of fresh mortar using mortar flow table test and hardened mortar as compressive test, sorptivity test and water absorption test, further it is used to determine the optimum mixing proportion based on compressive strength. Ingredients of mortar consist of Binder as cement and fly ash, fine aggregate as M-sand (0.75mm to 4.75mm) with that replacement of fine aggregate by waste wood mixed with saw dust weight by 5%, 10%, 15% and 25%. Casted specimens were tested after 7and 28days curing period. With the replacement of M-sand in the mortar by sawdust is feasible as it increases strength than the initial percentage of replacement. At 15% replacement of M-sand, the increase in compressive strength is optimum and at 20% replacement, the compressive strength is lower than that of conventional mortar, further addition decreases compressive strength.

Keywords: *Saw dust,Ffly ash, Compressive strength, Sorptivity*

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ERTSE_46

A SYSTEMATIC STUDY ON 3-D PRINTING TECHNOLOGY

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3-dimensional printing technology is a system which allows simulation of complex structures into objects and buildings. It is a computer-controlled printing process which uses different technologies such as Building Information Modelling (BIM), contour crafting and material extrusion to mention a few. The main objective of this paper is to thoroughly analyze the techniques used and suggest the best suitable method to follow it in construction field. 3D printing is beneficial in comparison with traditional construction procedure, in terms of cost, time, environmental feasibility, safety, structural complexity etc., Though it has its merits, it also possesses few disadvantages like high initial cost, difficulty in material selection and power consumption. Few case studies have been illustrated to show the applications and implementation of 3D printing in buildings. It was concluded that material extrusion method is the most appropriate technology that can be applied and future scope of it in India.

Keywords*: Complex structures, BIM, 3D printing.*

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ERTSE_47

EXPERIMENTAL INVESTIGATION ON SUPER WORKABLE CONCRETE WITH PARTIAL REPLACEMENT UFNSP FOR CEMENT

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In this research, the fresh characteristics and hardened properties of super workable concrete (SWC) containing ultrafine natural steatite powder (UFNSP) as a replacement for cement were investigated experimentally. The tests were carried out on specimens with 5%, 10%, 15%, 20%,25% and 30% UFNSP substitution to the weight of cement, and they were compared to the control specimens. All specimens flow characteristics were examined and their limits were determined using existing criteria. All specimens were tested for compressive strength, tensile strength and flexural properties of concrete at 7 days, 14 days and 28 days. The results demonstrate that the addition of UFNSP effects the flow property by lowering flow and increasing compressive strength up to 20% replacement.

Keywords: *Fresh properties, Hardened properties, UFNSP*

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SOIL STABILIZATION BY USING COIR FIBRE

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To make use of locally a variable soils, soil strength should be increased because every time it is not possible to find required or specified strength in locally available soils. Soil strength can be increased by adding stabilizing agents like lime, cement, flyash, fibre etc. Use of fiber in technology for rising soil properties is advantageous as a result of their low-cost, domestically accessible, perishable and eco-friendly. The coir fibre reinforcement causes significant improvement in bearing capacity and shear strength and alternative engineering properties of soil. The experimental study is conducted on domestically accessible soil reinforcement with coconut fibre. Soil sample is ready at it's most dry density appreciate it's optimum wetness content (OMC). The proportion of fibre by dry weight of soil is taken as 0.25%, 0.5%. The index properties of soil tests is conducted and shear strength of soil is compared before and after adding of coir fibre to soil.

Keywords: *Soil Stabilization, Coir fibre, OMC, Shear Strength.*

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ERTSE_49

ANALYTICAL STUDY ON STRENGTHENING OF REINFORCED CONCRETE BEAMS USING EXTERNALLY BONDED ALUMINIUM ALLOY PLATES

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The major problem in the reinforced concrete beam is no longer to be considered as safe due to various reasons such as temperature variation, chloride attacks etc., so this RC beams are either need to be replaced or strengthened. Recently developed high strength aluminium alloy have the potential to overcome some of these drawbacks by providing strengthening to the reinforced concrete beam. Compared to steel and FRP, aluminium alloy have superior properties such as ductility, good thermal and corrosion resistance. Externally bonded reinforced concrete beam with epoxy-bonded aluminium alloy plates were tested to failure using a symmetrical two point concentrated static loading system. A beam with 2 layers and 3 layers of aluminium alloy plates are externally bonded with the use of epoxy resin and the conventional beam is casted and tested under two point loading system, and analyzed by the ANSYS Software. The results clearly show that, the 3 layers of externally bonded aluminium alloy plates significantly increases the strength than the conventional beam

Keywords*: RC beam, Aluminium alloy plates, ANSYS analysis, Epoxy resin, Aluminium alloy, Two point loading*

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ERTSE_50

220KV GFRP TRANSMISSION LINE TOWER: DESIGN AND ANALYSIS

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The paper aims at studying stress and deflection behaviour of transmission line towers made with GFRP. The various combinations such as (1) all-steel, (2) all-GFRP, (3) tower body steel and GFRP cage and (4) tower body steel and GFRP-crossarm are analyzed. A 220kV tower was designed as per Indian Standard codes and modeled in STAAD software. The wind load, conductor load and self-weight were applied on the model and analyzed. Based on the analysis, observations are made regarding the stress in the bottom most leg member and deflection at points in the cross-arm and peak. The analysis results suggest that the transmission line tower with steel tower body and GFRP crossarms performs better when compared to all other combinations considered.

Keywords*: GFRP, Transmission line tower, Analysis, STAAD, Stress, Deflection, 220 kV.*

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ERTSE_51

A STUDY OF SHEAR STRENGTH PARAMETERS OF SOIL BY BOREHOLE INVESTIGATION

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Before the starting of the civil engineering structures, site investigation and lab analysis are must be required in order to find the suitability of the site for the proposed structure. The obtained values of test results providing the detailed information of the proposed structure such as soil profile, water table points and various information's etc. The Standard Penetration Test (SPT) is played an important vital role in borehole investigations. The SPT was conducted in the different locations of proposed area to find the soil type, index properties and engineering parameters. The SPT is done by as per IS 2131(1981), the test is performed by driving the split spoon sampler into the ground by a drop of hammer of mass 63.5 kg falling from 750mm at rate of 30 blows per minute. The hammer blow counts, disturbed and undisturbed soil samples collected during the test are processed and interpreted. This site of study is investigated in six places such as BH1, BH2, BH3, BH4, BH5 and BH6 at near manali in Chennai. The BH-1, BH-2, BH-3, BH-6was driven up to 20.0m depth and BH-4, BH-5 was driven up to 21.0m depth and terminated after encountering very dense condition of soil with at least 3 successive SPT's of "N" values are 50.These results show that variations of soil type and shear strength parameters.

Keywords*: SPT, Soil, Soil type, Water table, Index properties and Shear strength parameters*

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STUDY OF CALIFORNIA BEARING RATIO VALUES ON IMPROVEMENT OF WEAK SOIL USING RUBBER TYRE CHIPS AND POWDER

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Generally, the weak soils have low bearing capacity for the construction of any civil engineering structures. This low bearing capacity of soils is refined by adding admixtures into the weak soils. Refining of this kind of weak soil can take up by the of soil stabilization techniques. In this learning work, shredded rubber from waste in form of both powder and chips are selected for stabilizing materials. The study has been concentrated on the study behavior of soil on the California bearing values of the weak soils by adding the various percentages of the both tyre powder and chips. This study carried out in the percentages of 0%,4%,6% and 8% of both tyre powder and chips on weak soils. The results shows a better attainment for pavement and shallow foundation works as reinforcement with benefits of cost effective manner by partial replacement of these additives. The low strength and high compressibility of clayey soils were established to improve by addition of shredded rubber powder when compared to tyre chips. It can be finalized that shredded rubber powder can be as a better earth stabilizing material.

Keywords*: Weak Soils (Clayey Soil), Waste tyre powder, Waste tyre chips, OMC, MDD, Swelling Index and CBR.*

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PARTIAL REPLACEMENT OF FINE AGGREGATES IN CONCRETE USING HIGH DEFINE POLY ETHYLENE PLASTIC WASTE

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In this modern era, there are two major exertions viz., insufficient raw materials for construction and concerns with waste disposal which pose as key environmental problem. Steel, unwanted tyres, glass, plastics and combustion coal based derivatives are some of the examples of such wastes. These waste yields are being premeditated for their prospective use in concrete. The current study covenants with the experimental study of the use of plastics in concrete. Each of the type of plastic by-products have had an impact on the properties of concrete. Through use of plastic by-products in concrete not solitary renders it more cost effective, nevertheless it also helps to shrink the disposal concerns. Reusing plastic waste is observed as one of the utmost environmentally approachable explanations to the clearance problem. In this study, partial replacement of fine aggregate with High Define Poly Ethylene plastic waste (HDPE) is done for a nominal mix of M20 concrete at various percentages such as 1%, 2% and 5%. The design mix has been carried out according to the Indian Codes. The cubes are casted as per the standard codes and cured for 7, 14 and 28 days respectively. The strength parameters were studied. It was found that the plastic replacement at 3% gave the best results on comparing to the standard mix. Moreover, determinations partake been through to investigate its application in concrete. Both the construction and plastic recycling industries profit from the development of new construction materials made from recycled plastics.

Keywords: *Plastic, Compressive Strength, Concrete, Mix design, Fine aggregate.*

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SOIL STABLIZACTION USING JUTE FIBRE AT MANNIVAKKAM NEAR TAMBRAM

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This focuses on soil adjustment through the use of jute fibre in soil stabilizers. Stabilization is the process of altering the characteristics of soil in order to improve its structural performance and make it acceptable for a wide range of construction operations. The potential for soil stabilisation utilising jute fibre cut into 30mm lengths as a stabiliser is investigated in this study area. Various proportions of jute fibre were used and miscellaneous with soil, including 0.5%, 0.75%, 1% and 1.25%. As per the results, 1% of soil mix with jute is good in optimum moisture content, maximum dry density and CBR. The research has undertaken tests such as the California Bearing Proportion (CBR) test and Proctor density changes in the soil's building qualities. Arranged the foundation of the grades of the researches, it can be determined that stabilising soil with 30mm Size of bits of jute as a stabiliser advances the soil's quality appearances, allowing it to be used as a reinforcing material the construction of roadways, stopping ranges, and location advancement extend.

Keywords*: Soil stabilizers, Jute fibre, CBR.*

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ERTSE_55

HEAVY METAL REMOVAL FROM AQUEOUS SOLUTION USING ADVANCED CARBON NANOTUBES

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Recently, the contamination of drinking water due to the presence of heavy metals is being analyzed by scientists. Most of the heavy metals adulterate both surface water and subsurface water and transform the quality as these metals are highly toxic, persistent and dangerous to human and environment. Hence, in this study the Aqueous solution was analyzed using UV Spectrometer and Atomic Adsorption Spectrometer (AAS) method to estimate the heavy metal concentration in the Aqueous Solution. The solutions are prepared at the lab by using lead nitrate and potassium dichromate and dissolving in distilled water. After the solution is tested the values are checked with the before solution. Tests are done by the variation of time, dosage, pH, temperature. Results are compared with before and after solution

Keywords*: Aqueous solution, Heavy Metal, UV spectrometer, Heavy atomic adsorption spectrometer, Lead, Chromium*

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ERTSE_56

PARTIAL REPLACEMENT OF CEMENT BY GROUND GRANULATED BLAST-FURNACE SLAG IN CONCRETE

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Concrete making is continuously seemed for additional cementitious material with the purpose of dropping the throws away solid difficulty. This project studies the inspection attempts about the probability by means of nearby accessible GGBS as partial replacements for cement in concrete. The tests such as compressive, split tensile and flexural strength were done in Cubes, cylinder and beam. Ground Granulated Blast furnace Slag can recover the stability characteristic to control mix. Amongst the various mixes the substitute level as 0%, 10%, 20% and 30% of Ground Granulated Blast furnace Slag is improved with respect to strength and durability. It is originated through 20% replacement of cement with GGBS helps in improving the strength of the concrete significantly evaluated to Control concrete.

Keywords - *GGBS, Compressive strength, Flexural strength.*

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STRENGTH AND BEHAVIOUR OF CONCRETE SANDWICH PANEL WITH OPENINGS UNDER AXIAL COMPRESSION

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A precast concrete sandwich panel walls with openings are test in one way action. Expanded polystyrene (EPS) is take as insulation material and Self compacting concrete for casting concrete wythes. EPS panel act as a load bearing element with includes welded reinforcing meshes of high strength wire. The use of Self compacting concrete to enhance workability and to improve cohesiveness of concrete. Continuous shear connectors provide to achieve a composite action. In order to investigate the openings in sandwich panels for door and windows on the control of cracking and compression capacity of the specimen were manufactured and a series of tests were performed. An Analytical Investigation is carried out to identify the axial load and behavior of wall panel. Empirical equations are used to detect the load carrying capacity panels with different openings. Modified equations of AS3600 – 01(Australian Standard) and ACI318 – 02 (American Concrete Institute) are used to find ultimate load of different panels with different openings. Software Analysis are also used to find the behavior of the wall panel with openings. The analytical work is done manually by earlier researches for reinforced concrete solid wall and results will be compared.

Keywords: *Concrete sandwich panels, Axial compression, Concrete mix design, Expanded polystyrene, Shear connectors, Opening.*

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ERTSE_58

A REVIEW ON INTRINSIC SELF SENSING CONCRETE: PRINCIPLES, MATERIALS, METHODS AND FACTORS INFLUENCING

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Intrinsic Self-sensing cementitious composite is an emerging material in structural health monitoring area, which is an alternate to the conventional sensors. It possesses both mechanical and sensing properties. It involves a real-time monitoring of stress/strain of the structural element, by measuring the electrical resistivity of the material. Self-sensing cementitious materials are composed of conductive fillers embedded in nonconductive cementitious material, that exhibit both sensing ability and enhanced mechanical properties. The states of stress, strain, displacement, and damage in the structural elements can be investigated by measuring the change in their electrical resistivity. This paper reviews the principle involved in self-sensing concrete, materials used, methods adopted for measuring the sensing parameters, and factors influencing. Finally, the conclusions are made based on the topics discussed, and future recommendations are suggested.

Keywords: *Structural Health monitoring, Self-sensing cementitious materials*

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ERTSE_59

COMPARATIVE STUDY ON ANALYSIS AND DESIGN OF STRUCTURAL STEEL ELEMENTS WITH INDIAN STANDARD CODES AND AMERICAN INSTITUTE OF STEEL CONSTRUCTION CODES

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The intended satisfactory performance, safety, and attractiveness of a building are highly concerned in the field of structural engineering. The sustainability of a building towards loads, wind load, and seismic loads play a vital role in the designing of the construction. Safe, low-cost construction is always a big challenge for structural engineers in the countries like India. The aim of this project steel structure are analyzed and designed, in this project, the steel structure is analyzed using STAAD pro-2007 and validated by manual calculation. The minimum design load followed for American is AISC7-05 and for the seismic loads AISC 7-2005 and for the Indian structure IS 875, IS 1893 respectively. The steel structures are designed with the specifications of India IS 800-2007 and later with the specification of American AISC 360 – 05. To the American design, AISC 360 is applied for foundation and AISC 05 is given as connector design. In the case of Indian design IS 456, IS 800 -2007 are applied respectively. The bill of quantity and analysis for the comparison is based on the IS and later is AISC. An integrated comparative analysis especially stresses ratio in the structure and bill of quantity will help to take important decisions to construct an efficient building.

Keywords: *Steel Structures, Limit State Design, Stress Ratio, Impact load, Energy absorption, Low velocity impact load*

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ERTSE_60

PROBABILISTIC SEISMIC PERFORMANCE EVALUATION OF RCC BUILDING

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In India, North-West and central Himalayan region have active faults. Peninsular Indian shield region was earlier considered as stable continental zone. The earthquakes occurred in 1967 at Koyana (M_w = 6.5), 1993 at Killari (Latur) (M_w = 6.3) (Maharashtra) and 1997 at Jabalpur (M_w = 6.1) (Madhya Pradesh) change entire approach. Investigations along rupture zone identified fault. In addition to this, Kachchh rift basin region (Gujarat) subjected to many moderate to severe earthquakes. Bhuj earthquake (M_w = 7.7) is notable earthquake occurred in 2001. Many active faults were observed in the Kachchh region. The subduction zone of Sumatra-Andaman (M_w=9.0) struck an earthquake in 2004 which is resting on fault. Besides these active fault regions, Himalayan and Gujrat plateau are tectonically active in nature. All these imply that active faults and tectonic movements may have probable chances to cause severe earthquakes. Hence, according to seismic zone map of India prescribed by Indian seismic standard, more than 60% of region is vulnerable to earthquake. Indian seismic standard specified seismic performance analysis by conventional 'strength base approach'. It is 'deterministic approach' which does not capture the uncertainties and variability of progressive collapse of the structure and it does not consider seismic hazard due to future probable earthquakes. To overcome this difficulty, Pacific Engineering Research Centre (PEER), California has proposed a novel technique based on 'Probabilistic approach'. This method accounts both the aleatory variability and epistemic uncertainties associated in the process of seismic evaluation. The approach is well established in developing countries and accordingly amended in the design codes. The present work is aims to determine uncertainties in damage assessment of RCC buildings. Fragility analysis is a powerful tool of probabilistic based seismic performance evaluation which is used to assess the probability of seismic risk of the structural system.

Keywords: *Fragility Analysis, Incremental Dynamic Analysis, Probabilistic Approach*

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ERTSE_61

METHODOLOGY OF STRUCTURAL AUDIT AND STABILITY ANALYSIS OF AGE OLD R.C ELEVATED WATER TANKS

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R.C elevated water tanks are important components of the piped water supply schemes. These structures are useful in maintaining sufficient residual pressure at the tail end of the pipeline to ensure gravity flow in the distribution network and also for balancing the difference between demand and supply in the distribution system. However structurally elevated water tanks may be classified as inverted pendulum structures and are prone to overturning failure under the impact of lateral forces such as wind and earthquake. Many R.C elevated water tanks have collapsed under the impact of severe earthquakes and cyclonic storms. However, the tendency of collapse get much enhanced when the structure is age old and it is structurally weak. The importance of an elevated water tank for a piped water supply project is also important from the economic point of view. The capital cost of construction of such structure is about 15 to 20% of the total cost of a particular water supply project. Generally, the functional life of piped water supply schemes may be assessed as 30 years as per practice. However, such structures continue to function much beyond the design period. It is a rather useful that the residual strength of age old elevated water tanks of piped water supply schemes should be periodically evaluated through structural audit, and as per recommendation of the audit report the structure should undergo special repair, maintenance or retrofitting as the case may be to increase the service life of the structure. In this paper a methodology of structural audit of R.C elevated water tank has been developed which may prove helpful for effective structural audit and stability analysis of this class of structure.

Keywords: *Structural audit, Stability analysis, Elevated water tank, Lateral force, Inverted pendulum*

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ERTSE_62

NOISE ABSORBING TIMBERCRETE BLOCKS

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The demand for sound absorption has risen in recent years in the field of architecture and construction, resulting in a massive reduction in resources, increasing prices, and developing countries concerned about noise pollution in metropolitan areas. The sound absorption capabilities of timbercrete blocks made with sawdust as a partial replacement for fine aggregates are discussed in this research. At various replacement percentages, several properties such as transmission loss, water absorption and density were investigated. An experimental study was carried out to evaluate the performance of timbercrete blocks at various replacement percentages. As a result, blocks with dimensions of 150mm*200mm*400mm were tested for the aforementioned characteristics at various replacement percentages (5 percent, 10%, 15%) of fine aggregates. As a manoeuvre, a concrete mixture of 1:2:4 was used, with sawdust being used to gradually replace 5%, 10%, and 15% of the aggregates. A proper block making machine was used to cast the blocks. After a 21-day curing and drying experiment, the NRC values for 5%, 10%, and 15% blocks were recorded as 0.134, 0.168, and 0.225, respectively.

Keywords: *Timbercrete Blocks, saw dust, NRC value.*

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ERTSE_63

LABORATORY STUDIES ON MECHANICAL AND DURABILITY PROPERTIES OF BLENDED SUSTAINABLE GEOPOLYMER CONCRETE

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Around 5% of worldwide anthropogenic greenhouse gas emissions are due to cement sector. Without addressing this major source of emissions, atmospheric levels greenhouse gas emissions cannot be stabilized. Cement manufacturing is extremely energy intensive, and as a result it is major global carbon dioxide emitter. As a better alternate for Portland cement concrete, Geopolymer concrete is widely used as they are environmental friendly. Here the Geopolymer concrete is casted with different quantities of Ground Granulated Blast Furnace Slag (GGBS) and Micronized Biomass Silica (MBS). Micronized Biomass Silica which comprises of high silica content obtained from agricultural waste. Laboratory studies on compressive strength and split tensile strength of the geopolymer concrete is done

Keywords: *GGBS, Micronized Biomass Slica, Compressive strength.*

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STUDY OF GFRP BAR REINFORCED HIGH STRENGTH CONCRETE FILLED GFRP TUBE COLUMNS UNDER DIFFERENT LOADING CONDITIONS

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Abstract - A new type of column is proposed in this study. As a viable steel reinforced ordinary Portland cement concrete (OPC) column substitute, a glass fibre reinforced polymer (GFRP) bar reinforced high performance concrete filled GFRP tube column is proposed. This study looked at different types of longitudinal reinforcement bars namely steel and FRPs of glass type, and the type of transverse reinforcement compared with steel helix and Glass Fiber Reinforced Polymer tube. Specimen having diameters of 200 mm and length of 800 mm were subjected to various loading conditions. The experimental load-axial deformation, load-lateral deformation, and flexural load-midspan deflection of the tested specimens are reported and analysed. In addition, the load eccentricity increased the ductility of GFRP bar reinforced HPC. The ductility of steel reinforced specimens, on the other hand, deteriorated as the load eccentricity increased.

Keywords: *GFRP, Mid span deflection, Axial deformation.*

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DEVELOPMENT OF GEOPOLYMER CONCRETE MIXES

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This paper represents the development of geopolymer mixes of various ratios of fly ash and GGBS. Low calcium class F fly ash from ennore port and locally available slag are used in 65:35, 50:50, 35:65 ratios. The workability, strength and percentage of water absorption were determined. The geopolymer mixes with 4M and 5M casted to obtain 30MPa strength. The highest strength was attained by GM-2 concrete with 50% slag and 50% fly ash for 5 Molar and GN-3 of 65% slag and 35% fly ash with 5M under ambient curing with a constant silicate to Hydroxide ratio as 0.65. Other Mechanical and durability properties of the geopolymer concrete mixes developed have been reported.

Keywords: *Fly Ash, GGBS, Molar, Ambient curing*

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ERTSE_66

DESIGN AND ANALYSIS OF EARTHQUAKE RESISTANT BUILDING USING DIFFERENT TECHNIQUES

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Earthquakes are one of the most destructive forces of nature, that's why seismic loadings must be takeninto account while designing the structures. The unpredictability and sudden occurrence of earthquakesmake them somewhat mysterious, both to the general public and to professional structural engineers. The main objective of making earthquake resistant building to minimize the adverse impact of earthquake. This can be done in various ways like providing lead rubber bearing, damping at base levelor by providing shear wall or by providing diaphragms to horizontal structures. This research is done to compare the storey drift due to seismic force on three different types G+5 storey building. In this study, seismic analysis of multi storey RC building frames have been carried out considering floor diaphragm and shear wall along with one bare RC building frame. The analysis of multi storey RC building frame is carried out in building frame with rigid floor diaphragm and another model is analyzed by placing the shear wall symmetrically. STAAD Pro software has been used for the analysis purpose. Then results are collected in terms of maximum moments in beams, shear force, maximum displacement and storey drift which are critically analyzed to quantify the effects of various parameters.

Keywords: *Diaphragm, Shear Wall, Storey drift*

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RESPONSE STUDIES OF WIND LOAD ON HIGH RISE BUILDING INVOKING A CASE STUDY OF PHAILIN CYCLONE, ODISHA, INDIA

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Tall buildings are slender and flexible structures that need to be scrutinized for wind induced deflections along the direction of the wind. Detailed procedure of wind load determination, static and dynamic analysis is given in IS 875(Part3). The design methods used is Limit State Design conforming to Indian Standard Code of Practice. The present study includes six building models categorized on the basis of aspect ratio and height. Three aspect ratios of 1:1, 1:1.5 and 1:2 are taken, each with height of 45m and 90m respectively. The loads considered are Gravity Loads and Wind Loads. Static analysis of the buildings is conducted using STAAD Pro. Load combinations are taken as per IS 456 The results are studied to compare the lateral deflection of structure with respect to aspect ratio and height. A case study for deflections induced on the building due to cyclonic winds of Phailin (2013) is also conducted.

Keywords: *High rise buildings, Wind analysis, STAAD Pro., IS 875(Part 3), Static Analysis*

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STUDY ON THE BEHAVIOUR OF BASALT FIBER, CFRP STRENGTHENED SCC COLUMN UNDER CYCLIC LOADING

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Over the past decades, the construction industry has seen a growing need for Strengthening the damaged concrete structure and also Strengthening the existing concrete structure. This may be due to environment degradation, design inadequacies, faulty construction, irregular maintenance, requirement of revision code in practice, increase in the load, due to sudden accident such as cyclone, earthquake etc. An Analytical study was carried out to identify compression and ductility behaviour of Un-Strengthened SCC column and SCC column Strengthened with Basalt Fiber Reinforced Polymer (BFRP) and Carbon Fiber Reinforced Polymer (CFRP) Wrapping under Half cyclic loading. Self Compacting Concrete (SCC) is highly flowable, resistant to segregation. Superplasticizer (Conplast SP430) is used in SCC to enhance workability. Fly Ash is used as mineral admixture to improve its cohesiveness in the concrete. The square column cross section is 150mm x150mmx1000mm.Totally 5 specimen, One Un-Strengthened Self Compacting Concrete (SCC) column, 1 strengthened by single wrapping of BFRP, 1 SCC column is strengthened by single wrapping CFRP, 1 SCC column is strengthened by double wrapping of BFRP and 1 SCC column is strengthened by double wrapping CFRP of 0.2mm thickness is analysed under Half Cycling Loading using ANSYS software. The stress, strain, deformation, Stiffness and ultimate load carrying capacity, load – deflection curve is observed. The results clearly showed that, the load carrying capacity of the BFRP Strengthened singly wrapped Column, BFRP Strengthened doubly wrapped Column, CFRP Strengthened Singly wrapped Column CFRP Strengthened Doubly wrapped Column is higher than the UnStrengthened SCC column. In that doubly wrapped CFRP strengthened SCC column load carrying capacity is higher than the other strengthened SCC column and Unstrengthened SCC column.

Keywords: *Basalt Fiber Reinforced Polymer, Carbon Fiber Reinforced Polymer, Self Compacting Concrete, Cyclic loading, ANSYS*

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INVESTIGATION OF BOND STRENGTH OF DIFFERENT TYPES OF STEEL REBAR PATTERNS IN CONCRETE

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The performance of reinforced concrete structures is mainly due to the bond between the rebar and concrete. In the interface zone the strength of bond mainly depends upon on the configuration of surface, types of rib configuration to improve the bond strength in high yield rebars. This study analysis the strength of bond behavior of different types of rib pattern available in the market. The experimental analysis was done to finding the strength by pull-out behavior of rebar in concrete as per IS 2770 code. Concrete of M25 grade was used and a total of eighteen specimens were tested. The size of 150mm cube was cast with centrally embedded rebar. The resistance of high friction was developed in the bond strength due to the better mechanical interlocking.

Keywords: *Concrete rebar, Pull out test, Mechanical interlocking.*

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EFFECT OF CROSS-SECTIONAL PARAMETERS ON THE FIRST YIELD SURFACE OF CFS ZED PURLIN UNDER BIAXIAL BENDING

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Cold-formed steel zed sections are used extensively as purlins in metal roof systems. These sections are often subjected to bending about the non-principal axis, termed biaxial bending. Hence, the first yield surface is an essential parameter for the design of such sections. The present study investigates the effect of different cross-sectional parameters (flange width, web height, lip depth, and thickness) on the first yield capacity of cold-formed steel zed purlins subjected to biaxial bending. The study shows that the web height to flange width ratio (h/b) of cross-section significantly influences the first yield capacity. The maximum first yield strength is observed when the zed section is bending about its major geometric axis (x-x axis). As the h/b ratio moves closer to one, the first yield capacity will be a maximum of about 1.35 times the yield moment capacity about the major principal axis (M11y). The present study will help the designers' select appropriate zed sections and their orientation as purlins in metal roof systems.

Keywords: *Steel zed sections, Biaxial bending, Yield strength*

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INVESTIGATIONAL STUDY ON CONCRETE BY REOCCURRENCE OF NONBIODEGRADABLE EXCESS

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Discarding of waste plastics is a momentous matter in today's world, as the use of plastics is increasing all the time, and plastic material takes hundreds of years to disintegrate. So many practical methods for recycling and reusing plastics are being developed. This study looks into replacing natural fine aggregate in concrete with non-biodegradable plastic aggregate made out of High-Density Polyethylene waste (HDPE plastics). Replacement of fine aggregate weight by 10%, 20%, 25%, 30% in order to derive the optimum replacement. To determine the qualities and performance of concrete utilizing plastic aggregate, several tests are carried out, including compressive strength, split tensile strength, and flexural strength in hardened state of concrete and basic tests on fresh concrete were taken care of which are slump cone test and compaction factor test. The results of concrete created strength in hardened state of concrete and basic tests on fresh concrete, such as slump cone test and compaction casted specimens were tested for 7 days, 14 days, and 28 days. The results of concrete constructed using plastic aggregate are compared to those of normal concrete after being tested for 7 days, 14 days, and 28 days.

Keywords: *Plastic waste fine aggregate, Compressive strength, Split tensile strength, Flexural strength.*

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AN EXPERIMENTAL STUDY OF SOIL STABILIZATION USING WASTE COPPER SLAG IN LOW VOLUME ROAD CONSTRUCTION

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Construction of roads or any civil engineering structure on weak soil is risky due to its low shear strength and high permeability. To overcome this problem, soil properties must be improved and one effective way to do so is by soil stabilization. The foundation of any structure is important and has to be strong enough to support the entire structure. This paper investigates the feasibility of utilizing waste copper slag as a stabilizer in soils to be used in low volume road construction. The copper slag used in this study was finely crushed, and added to the soil in varying percentages of 25%, 30%, 35% and 40% by dry weight of soil. The soil was sampled from ZNS borrow pit and the tests conducted were; Sieve Analysis, Atterberg Limits Test, Modified Proctor Test and Unconfined Compression Test. Results showed a decrease in the plasticity index of the copper slag stabilized soils from 10% to 6% at varying stabilizer content. The UCS of the stabilized mix decreased due to the increase in fines of the mixture. An increase in the maximum dry density value was recorded from 1.8 g/cm^3 to 2.08 g/cm^3.

Keywords: *Copper slag, Atterberg Limits, Modified Proctor Test, Unconfined Compression Test*

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EXPERIMENTAL INVESTIGATION ON THE STRUCTURAL RESPONSE OF CONTINUOUS HOLLOW CORE SLAB UNDER SUCCESSIVE IMPACT LOADING

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Some structures may be subjected to impact loading while in service. This may cause severe damage or failure to the structural elements and or human losses. Experimental investigations have been carried out to study the structural behavior of continuous hollow core slabs under successive impact locations located at different positions of the slab: Edge-right side of the intermediate support, Edge-left side of the intermediate support, mid span -center of the first span and mid span. Experimental results are presented to analyze the structural response of the slab in terms of: Experimental observations, damage and crack assessment, impact resistance to shear strength ratio, acceleration response, damping ratio and design considerations.

Keywords: *Hollow core slab, Impact load, Crack assessment, Damping ratio*

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ANALYTICAL STUDY ON SEISMIC BEHAVIOUR OF G+9 BUILDING WITH SHEAR WALLS USING ETABS

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Earthquakes are most explosive and misery of all natural disasters. Amongst all methods applied for earthquake resistant multi stored structures shear walls are the mostly preferred and is provided for resisting parallel lateral forces of the wall and for supporting gravity forces simultaneously. Shear walls will play a major role in resisting loads generated by seismic forces. Shear walls are considered as an important earthquake resisting element in the design of buildings subjected to seismic forces. The slandered shear wall makes more bending deformations to resist the load, due to cantilever action and controls the torsional effects at the high-rise RC Structure. For an effective performance of the structures, the position and shapes of the shear wall have a major contribution and influences the structure's behavior towards seismic loadings. In this analytical research, the effect of location of shear walls in RCC structure is being examined on the basis of storey drift, storey displacement, storey shear forces and base shear of multistory buildings. This paper proposes the behavior of building with the location of shear wall by using Response Spectrum Method and Seismic Coefficient Method. This paper also examines the effect of axial force, shear force and bending moment with change in different locations of shear wall by using ETABS software. From the analytical results, it is proved that the higher values of bending moment and shear force and minimum value of axial forces was found in model 3 for the beams in storey 9 as compared to all other models.

Keywords: *ETAB Software, Shear wall, Multistorey building, Response Spectrum Method, Bending Moment*

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UTILIZATION OF SOFT DRINK BOTTLE CAPS AS FIBRE IN CONCRETE

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The advancement of development materials have presented issues and challenge that started overall exploration programs and proceeded with ordinary and non-traditional applications prompting extreme economy. Scientists created Strategies for waste management to apply for benefits for explicit requirements. The utilization of soda bottle container caps in concrete gives both in terms of the environment and the economy advantages for every connected industry, especially in regions where a lot of soda bottle container caps are created. Because of the application of reinforcing steel in the preparation of reinforced concrete, the use of soda bottle container caps as additional reinforcing material in concrete has been tried. The bottle container caps of the sodas and refreshments and from a few different sources are utilized as the extra supporting material. Concrete cubes' compression strength, concrete cylinders' split tension strength, and concrete beams' flexural strength for standard conventional concrete test results were contrasted with caps of soda bottle container. The M20 grade of cement was utilized to make concrete. Before checking the stability compression, tension, and flexural tests for 28 days, all specimens were cured. The specimens were casted with 0.25% and 0.3% level of container caps fortifications and we can expect the testing specimens will give preferred outcomes over the standard regular concrete. Among the two ratio of adding soda bottle container caps as fibres, 0.30% will give preferred outcome over 0.25%.

Keywords: *Fiber reinforcement, Compressive strength, Flexural strength*

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EXPERIMENTAL AND ANALYTICAL STUDY ON FLEXURAL BEHAVIOUR OF COLD FORMED STEEL CORRUGATED SECTION ENCASED IN CONCRETE

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Cold formed elements have been utilized for built-up beams, and built-up beams are often designed with thin webs. However, if the web is extremely thin, the plate buckling issue may develop. The danger of failure may be reduced by using thicker plates, web stiffeners, or web strengthening. Corrugation in the web part can be used instead of stiffeners to provide additional stability. Because of its profile, corrugated web is stiffer than plain web. Needing corrugated web to generate appropriate out-of-plane stiffness and shear buckling resistance without using stiffeners is an inherent way. The webs normally endure the highest compressive stress and transmit shear in the beam in building application, while the flanges handle the largest external loads. Thus, a bigger portion of the material might be used for the flanges, which would support the significant external loads and save material without compromising the beams's load carrying capabilities. The plain web, on the other hand, loses stability and deforms transversley when compressive forces in the web exceed the critical point prior to yielding. Corrugated we, as an alternative to plain web, can improve stability and strength without the need for additional stiffening or significant thickness. The flexural behaviour of cold formed steel beams with plain and corrugated webs encased in concrete was investigated using experimental and analytical methods in this study. The load carrying capacity deformation of the beams with plain, corrugated and concrete encased webs are discussed. The primary aim of this study is to get a better understanding of the behaviour of a concrete-encased built-up steel beam. To do this, the study is separated into two parts: an experimental programme and an analytical programme, with both results being compared.

Keywords: *Cold-formed steel section, Triangular corrugated steel section, Trapezoidal corrugated section, Corrugation angle, Flexural behaviour, Ansys*

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ERTSE_77

ANALYSIS AND DESIGN OF TWISTED TOWER WITH VARIOUS ANGLE OF ROTATION

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In the present investigation is compared between the twisted tower and regular structure. In current investigation considered building height of 20 storied, 40 storied, and 60 storied structure and twisted angles are considered as 1 degree, 2 degree and 3 degree and two plans as symmetric structure and asymmetric for all different heights of building. The symmetric plan consist of number of bays kept 8 along both the direction and bay size kept as 4m with storey height being 3m. the asymmetric plan consist of 8 bays along x direction and 6 bays along y direction and bay size kept as 4m with storey height being 3m. The building is analysed by considering zone IV by response spectrum method using Etabs 2016 software. The parameters are studied are lateral storey displacement, storey drift, base shear, storey stiffness and modal time period. We can conclude that the conventional structure performs better than the twisted structure under the seismic actions.

Keywords: *Response spectrum, Storey displacement, Storey drift, model time period.*

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INVESTIGATION ON ULTRAFINES AND NANO-PARTICLES IN FRESH AND HARDENED PROPERTIES OF SELF COMPACTING CONCRETE

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Self Compacting Concrete (SCC) is considered as a better product-cum-technology to give shape to the Planner/Designer's visualization and provide solution to construction engineers to meet their objectives without constraints. SCC, a flowable concrete, by virtue of its uniqueness is very sensitive to variation in materials' types and properties. Even a single variation if not dealt with proper approach, could result in defeating the purpose of robust construction. Availability of Ultrafine Flyash / GGBS commercially in India and potential of Nano-Particles playing an important role, there is opportunity to consider these two finer materials (of varying scale) in SCC to meet the objective of "Uniform and Robust Design and application of Self Compacting Concrete". The main objectives of the research is 1) To measure the influence of Ultrafines and Nano-Particles separately, and in combination on Fresh Concrete Properties of SCC in Low, Medium and High flow ranges, 2) To study the influence of Ultrafines and Nanoparticles separately and in combination on a Select Hardened Concrete Properties such as Compressive Strength, Tensile Strength, Shrinkage and Durability and 3) Compare the performance of improvised SCC in Column-Beam Joint with conventional concrete.

Keywords: *Self Compacting Concrete, Ultrafines, Nano-Particles, Fresh Properties, Mechanical Properties, Column-Beam Joint.*

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PRE-ENGINEERED CONSTRUCTION- A REVIEW

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Pre-Engineered buildings are distinctive steel structures which are pre-fabricated and the designs are pre-determined which are contemplated to be more cost efficient because of the tapered sections being utilized, in accordance with its bending moment requirement. The various literature concerning to PEB, spells out the concept of pre-engineered construction which arose in 1960s with standardized engineering design protocol. A pre-engineered building's primary frame structures have traditionally been an assembly of I-shaped members, unlike the conventional structures which are hot rolled. Structures like ware houses, industrial buildings, workshops, airport hangars, storage houses, Abattoirs and Parking garages could be executed through this type of construction. It also summarizes the different sort of analyses such as Seismic, wind, dynamic on a PEB to make sure the quality of performance. Recently the research has also been carried out on the behavior of PEB under structural blast load. At present, attempts are being made to yet reduce the structural weight of the PEB through sectional and connectional replacements, which could be more sustainable in every aspect.

Keywords: *Pre-engineered; Steel structure; Seismic analysis; Structural Blast load*

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