

N I R M A N A

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DEPARTMENT OF CIVIL ENGINEERING



VISION OF THE INSTITUTE

To become a globally recognized Institution that develops professionals with integrity who excel in their chosen domain making a positive impact in industry, research, business, and society

MISSION OF THE INSTITUTE

- To provide the ambiance necessary to achieve professional and technological excellence at the global level.
- To undertake collaborative research that fosters new ideas for sustainable development.
- To instill in our graduate's ethical values and empathy for the needs of society.



VISION OF THE DEPARTMENT

To transform into a centre creating change agents in civil engineering with professional competency, integrity and ethical values for serving the society with the highest level of proficiency through their chosen domain.

MISSION OF THE DEPARTMENT

1. Provide ambience to create civil engineers of global standards to serve the society collaboratively, competently and ethically.
2. To provide an academic environment for lifelong learning nurturing the skills in research and development for the benefit of all stakeholders.
3. To inculcate professionalism in students through team work, effective communication and leadership skills.
4. To encourage and empower the faculty in the field of engineering education and mentoring for enhancing the teaching-learning process.
5. To impart hands on experience to aspiring undergraduates through interdisciplinary research projects, industrial training and consultancy work.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The graduates of Civil Engineering will

1. Apply technical expertise to identify and resolve any complex civil engineering problems with the help of modern engineering tools and lifelong learning to meet the specified needs of their chosen domain viz. employment, higher studies or research and development.
2. Develop cost-effective solutions for a sustainable environment with deep insight in societal and ecological issues by adhering to professionalism.
3. Exhibit professional ethics, management and leadership qualities with good communication skills facilitating to work in a multidisciplinary team for evolving as an entrepreneur.

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A. Project and seminar Abstracts

DEFLUORIDATION OF GROUND WATER USING ACTIVATED ALUMINA AND BONE CHAR

Sneha Thambi (S8,CE)

ABSTRACT

Since the surface water sources are getting depleted, people of certain areas have started depending largely on ground water sources. So it becomes important to monitor and maintain ground water level in adequate quantity as well as quality. In order to achieve the same, removing excess fluoride present in the ground water is a long time challenge. Any water resource having fluoride concentration above permissible limit of 1.5 mg/l (WHO standards) requires treatment before usage. When the fluoride ion exceeds permissible limit it causes health problems like dental fluorosis, skeletal fluorosis etc. There are different techniques for defluoridation such as adsorption, precipitation, ion exchange etc. This seminar is intended to study the defluoridation of groundwater using the adsorbents activated alumina and bone char. Activated alumina is widely preferred because of its cost effectiveness and high defluoridation capacity. Due to the feasibility as a green adsorbent bone char can also be widely used. Bone char is prepared by treating bone waste. It is an environment friendly and cost effective method to remove fluoride from ground water.

Keywords: Ground water, Fluoride, Defluoridation, Adsorbents, Activated alumina, Bone char.

STILT FRAME CONSTRUCTION TECHNIQUE IN SLOPED REGION

Aslam M U (S8 CE)

ABSTRACT

This seminar deals with stilt frame construction technique in sloped region and the methods adopted for steep slope building construction. If possible, buildings are usually constructed on level ground. In regions like Western Ghats, the terrain is extremely steep. There are two types of configuration of buildings on sloping ground, the one is step back and the other is step back setback. The sloping ground is cut and excavated in the form of terraces. Retaining wall is provided to prevent soil erosion. Weep Holes are provided on the retaining wall as per requirement, to drain off the water penetrating through the fill. Footings are provided, from which columns are raised. Columns should be taken care from being slender. This can be achieved by adopting 'Stilt Frame Construction Technique'. The floors below road level, commonly known as Cellars, lack proper lighting, ventilation, balcony view etc. Hence, to limit the Floor-Area Ratio (FAR), cellar rooms are limited and more number of rooms are provided from above the road level. The Stilt Framed Cellar Rooms can be used for the construction of parking facilities, water tank, and Sewage Treatment Plants (STP) etc.

Keywords: Sloping terrain, Step back, Step back setback, Retaining wall, Weep holes, Stilt frame, Cellar, FAR

GLASS FIBER REINFORCED GYPSUM (GFRG) PANELS

Lekshmi Nambiar (S8,CE)

ABSTRACT

There is a huge growing requirement of building materials in India due to the existing housing shortage of 68.53 million units (2012) mainly for the low income groups in India. To meet this challenge, India requires innovative, energy efficient building materials for strong and durable housing in fast track method of construction at affordable cost. It is also important that housing and buildings are disaster resistant to protect the lives and properties of people. All these concern are involved in sustainable and inclusive development.

The seminar gives an overview of research and development carried out at IIT Madras, using glass fiber reinforced gypsum (GFRG) panels, to provide an innovative solution for rapid and affordable mass housing. FACT & RCF, two fertilizer giants under public sectors are together setting up rapid wall and plaster products manufacturing plant at Ambalamugal using rapid wall technologies of Australia called FACT - RCF Building Products Ltd.(FRBL). The GFRG panels (124 mm thick), made from recycled industrial waste gypsum (from the fertilizer industry), are prefabricated in 3 m x 12 m sizes with cellular cavities inside, which can be filled with reinforced concrete wherever required and can be used as walls as well as floor slabs. The test carried out (over the past 12 years) establish the performance of GFRG building systems to resist gravity and lateral loads as a load-bearing system in multi-storeyed buildings up to 8-10 storeys, with adequate strength, serviceability, durability and ductility. A two-storeyed four-apartment demonstration building has also been successfully constructed in the IIT Madras campus and presently a mass housing (40 apartment units) using this technology is being demonstrated at Nellore. A structural design code has also been approved by the Bureau of Indian standards, based on the extensive studies carried out on GFRG building systems.

Keywords: *Mass housing, Concrete infill, Load bearing, Earthquake resistant*

EVALUATE THE DURABILITY PROPERTIES OF HYBRID FIBRE REINFORCED CONCRETE AND TO ACHIEVE MAXIMUM STRENGTH OF CONCRETE BY USING OPTIMUM CONTENT OF POLYPROPYLENE FIBRES.

M Sanjay (S8,CE)

ABSTRACT

Concrete is a brittle material which is strong in compression but very weak in tension. To increase the tensile strength of concrete normally steel is provided. However steel bars reinforce concrete against local tension only. Cracks in reinforced concrete members extend freely. Fibre reinforcement gives the solution for this problem which provides multidirectional and closely spaced steel reinforcement. So to increase the tensile strength of concrete a technique of introduction of fibres in concrete is being used. Steel fibre is one of the most commonly used fiber. These fibres act as crack arrestors and prevent the propagation of the cracks. Polypropylene (PP) fibre reinforcement is considered to be an effective method for improving the shrinkage cracking characteristics, toughness, and impact resistance of concrete materials. The addition of more than one type of fibre is called hybrid fibre reinforced concrete. Reinforcement with randomly distributed short fibres presents an effective approach to the stabilization of the crack and improving the ductility and tensile strength of concrete. The aim of the study is to evaluate the durability properties of hybrid fibre reinforced concrete and to achieve maximum strength of concrete by using optimum content of polypropylene fibres.

Keywords: Fibre reinforcement, Steel fibre, Polypropylene (PP) fibre, hybrid fibre reinforced concrete

LASER IRRADIATION DRILLING

Pranav T Subran (S8 CE)

ABSTRACT

Recently, in Japan, safety measures such as earthquake-resistant reinforcement work and tile-reinforcement work are increasing. Current concrete drilling methods have issues such as noise, vibration, dust, and reaction force. These methods are causing stress for the residents. Consequently, solutions are being sought for work taking place on skyscrapers and at facilities that cannot shut down during construction, such as hotels, schools, hospitals and geriatric facilities for instance. This study investigated how laser drilling change the conditions, depending on the type of concrete in order to determine the possibility of using laser drilling for tile-reinforcement work and repairing concrete on building exterior. The results confirmed that it's possible to successfully drill holes for drilling diameters of 4 to 6 mm and depths of around 50 mm in concrete with a compressive strength within the range of 20 to 100 N/mm² by adjusting laser conditions. In case of deep holes the CW-mode should be chosen. Furthermore, by controlling laser irradiation conditions, it is possible to change the shape of the holes. It is expected that laser irradiation drilling will be applied to new construction methods.

KEYWORDS: Laser Drilling, Laser Irradiation Condition, Tile Reinforcement

SELF COMPACTING CONCRETE BY THE INCORPORATION OF MAGNETIZED WATER AND THE PARTIAL REPLACEMENT OF CEMENT BY FLY ASH.

Shaharin Marva (S8,CE)

ABSTRACT

Cement is the second most consumed material by human being, first being the water. In concrete production industry, more than one billion tones of water is consumed every year. Water used in concrete production plays a vital role in the concrete mix, hydration process of cement, managing workability and durability of structure. Limited availability of drinking water raised the importance of optimizing the use of water in concrete construction. By using magnetized water, water consumption can be reduced in concrete construction. Under the influence of magnetic action the properties of normal water can be changed. Magnetized water enhances the properties such as compressive strength, crack resistance, split tensile strength and slump. The fly ash is a fine powder that is a byproduct of burning pulverized coal in electric generation power plants. Fly ash is a pozzolanic substance containing aluminous and siliceous material. Self compacting concrete is described as the revolutionary development in concrete construction. This study aims the characterization of M40 grade self compacting concrete by the incorporation of magnetized water and the part replacement of cement by fly ash.

KEYWORDS: *Concrete strength, Magnetized water, Self compacting concrete, M40, fly ash*

DIAGRID STRUCTURAL SYSTEM FOR HIGH-RISE BUILDINGS

Anjali P G (S8,CE)

ABSTRACT

In the architecture of high-rise buildings there are a multitude of architectural forms, such as twisted, tilted, tapered and free forms. The diagrid is a framework of diagonally intersecting metal, concrete or wooden beams that are used in the construction of buildings and roofs. It requires less structural steel than a conventional steel frame. It is also beneficial to build high rise steel towers without steel. This kind of design will also help in protecting the environment from pollution caused by conventional construction method. Diagrid structures of the steel members are efficient in providing solution both in term of strength and stiffness. But nowadays a widespread application of diagrid is used in the large span and high rise buildings, particularly when they are complex geometries and curved shapes. The use of diagrid reduces the steel up to 20% compared to brace frame structure. It doesn't need technical labour as the construction technology is simple.

Keywords: *Diagrid, Steel towers, Steel frame.*

GROUNDWATER QUALITY MAPPING USING GIS

Adithya Menon (S8,CE)

ABSTRACT

Groundwater is an important component of our nation's fresh water resources. It plays a key role in meeting the water needs of various user-sectors in the country. The natural resource cannot be optimally used and sustained unless the quality of water is assessed. Geographical Information System (GIS) based groundwater quality mapping has been carried out in Mulanthuruthy Gram panchayat, Ernakulam. Groundwater quality for drinking water purposes was analyzed by considering the IS 10500: 2012. A total of 38 samples were collected from 10 wards of the study area. The groundwater samples were analyzed for the major parameters viz. pH, Nitrate, Nitrite, Ammonia, Chloride, Fluoride and Total hardness. The purposes of this project were to provide an overview of present groundwater quality, to determine spatial distribution of groundwater quality parameters and to map groundwater quality in the study area based on WQI by using GIS. The ArcGIS 10.4 was used for generation of various thematic maps and final map based on WQI. An interpolation technique called Inverse distance weighted method was used to obtain the spatial distribution of groundwater quality parameters. Seven thematic maps with parameters such as pH, Nitrate, Nitrite, Ammonia, Chloride, Fluoride and Total hardness having desirable and undesirable classes were integrated and the final groundwater quality map for drinking purposes has been prepared based on the WQI.

Keywords: ArcGIS

CRACK DETECTION OF THE CONCRETE BRIDGES BASED ON IMAGE PROCESSING AND LASERSCANNING

Ananthu Biju (S8 CE)

ABSTRACT

Cracks on the concrete surface are one of the earliest indications of degradation of the structure which is critical for the maintenance as well the continuous exposure will lead to the severe damage to the environment. The accurate assessment of the state of conservation of concrete bridges is extremely important to define maintenance strategies and to optimize interventions. In this regard, crack detection and characterization plays a important role. However, several limitations are found in current evaluation techniques. In fact, these are work-intensive, prone to human error, and they often require the use of expensive inspection means, such as under-bridge trucks. In this scope, the development of automatic methods based on image processing and laser scanning to assess crack in bridges has significant advantages.

In this seminar a method, M crack-TLS, is proposed to automatically assess cracks in concrete bridges, based on the combination of image processing and terrestrial lasers scanning(TLS) technology. The images captured are orthorectified by geometric information surveyed by TLS, solving one of the major drawbacks of applying image processing for crack characterization on large structures. After an experimental characterization, the method was tested on a concrete viaduct at IC2 road, in Rio Maior, Portugal, herein adopted as case study for onsite validation. It should be noted that capturing images with the required characteristics involves the use of different equipment, depending on both location and type of structural members. The results show the high potential of MCrack-TLS, namely its increased productivity and the possibility of record all data processed, and add it to 3D point clouds, creating 3D models of the state of conservation of bridges. In addition, it avoids the exposure of bridge inspectors to dangerous situations.

KEYWORDS : *Crack detection, Concrete bridges, Terrestrial laser scanning, Image processing*

EXPERIMENTAL STUDY ON THE EFFECT OF RUBBER FIBRE AND CRUMB RUBBER POWDER ON KUTTANAD CLAY

Naveen Giri (S8,CE)

ABSTRACT

Soil stabilization is the alteration of the soils to enhance their properties. Stabilization can increase the shear strength of a soil and / or control the shrink swell properties of a soil, thus improving the load bearing capacity of a soil. The rubber tyre manufactures uses synthetic rubber to make tyres. The source of synthetic rubber is the sap of rubber tree. The used tyres are being discarded and accumulated in large volumes causing an increasing threat to the environment. This experimental study involves the effect of rubber fibre and crumb rubber powder on clayey soil. Rubber tyre are cut into fibres with size of 15mm length and 3mm width. Kuttanad clay is used for this experiment. Particle size analysis, Atterberg's limit, specific gravity of kuttanad clay is to be determined. Two samples shall be prepared for the experiment, one with rubber fibre and another with rubber powder. Rubber fibre and crumb rubber powder are added in varying percentages of 0, 2.5, 5, 7.5, 10% of clay by weight. Standard proctor test, unconfined compressive strength (UCS), consolidation, california bearing ratio(CBR)are to be done on clay with rubber fibre and rubber powder. The properties of kuttanad clay with rubber fibre and crumb rubber powder is to be found.

Keywords: *Kuttanad Clay, Waste Tyre Rubber fibre, Crumb rubber powder, Atterberg limit, UCS, Compaction, Consolidation, CBR*

CONSTRUCTION CHALLENGES AND MANAGEMENT OF BRIDGES IN HILLY AREA

Jithendran P M (S8 CE)

ABSTRACT

India, a country with a total area of approx. 3.2 million sq. km. has around 23 % of its area covered with densely forested, thinly populated hills. In order to exploit enormous potential of hilly areas like mineral deposit, scenic beauty, valuable medicinal herb, forest resources, bracing climate & hydel power for its renewable & non-polluting nature a new network of road is essential. Road network in hilly areas comprise bridges as an integral part of them, though hilly region pose unique problems for bridge construction. In a restricted hilly area itself geological features, climatic conditions and hydrological parameters vary considerably. Various challenges that come across while constructing bridges in hilly areas are dealing with deep gorges, extremely low temperature conditions, rivers with boundary beds, high winds, landslides etc. and these require special attention to complete the exercise of bridge planning and construction. This aims on discussing every issue faced, starting from the idea of constructing a bridge until its completion.

Keywords: *Bridge, Hilly, Landslide, Gorges.*

CONCEPT DESIGN AND DEVELOPMENT MODEL OF UNDERGROUND VILLAS

Saneen Fahlan (S8 CE)

ABSTRACT

With the rapid development of society, modern buildings have been consuming excessive amount of energy and resources. Development of underground space in cities means efficient use of available underground space to develop infrastructural facilities underneath the city in order to avoid surface congestion and environmental conflicts. Underground space can solve many issues that are faced by the developing cities. Lack of urban area, constant population growth, traffic jams, inability of urban infrastructure to cope with the constantly increasing loads, environmental deterioration require more and more extensive use of underground space in the construction of residential building, including transport systems, placement, trading objects, water houses, etc. Underground villa, as a type of energy efficient architecture, has widely drawn humans' attention. This seminar describes several typical underground villas and briefly states the advantages and shortcomings of underground villas; discusses the design of style-planning, inner-space design, lighting and ventilation, and waterproof and fireproof of underground villas; also puts forward how to improve the living environment of underground villas.

KEYWORDS:- *Underground villa, environmental deterioration, traffic jams, lighting and ventilation*

PLANNING, ANALYSIS AND DESIGN OF A G+3 SHOPPING COMPLEX

Amal Mohan (S8 CE)

ABSTRACT

The project aims in the planning, analysis and design of a G+3 shopping complex. A shopping complex is a commercial building in which numerous stores are housed. They provide multiple facilities such as groceries, cloths, reading materials, food courts, cinema and entertainment arcades. Due to large scale air conditioning, lightening etc there will be lot of green house effects in shopping complexes. To avoid this, we are planning to make a sustainable shopping complex which has low impacts on environment. The project includes conceptual plan and architectural plan using AutoCAD, analysis and design of multi- specialized concrete building using STAAD Pro and by manual method, preparation of 3 D modelling and cost estimation. The complex is designed such a way as to reduce the artificial lightening to the maximum extend.

KEYWORDS: *Sustainable, AutoCAD, STAAD Pro, 3D modelling*

PHOTOVOLTAIC TECHNOLOGY

Shani E B (S8 CE)

ABSTRACT

Modern photovoltaic technology transforms buildings from energy users to energy producers. From the older concept of photovoltaic installation, which includes the addition of solar panels to a building's roof, the construction technology has merged with the photovoltaics technology. The result is Building Integrated Photovoltaics (BIPV), in which integrating the architectural, structural and aesthetic component of photovoltaics into buildings. This allows the incorporation of energy generation from each component into all types of buildings such as homes, schools, offices, hospitals, etc. BIPV technology refers to the photovoltaic (PV) utilization method that uses PV cells to substitute traditional building materials by integrating them into different elements of buildings such as roofs, windows, facades, balcony, and skylights. The components in BIPV systems can carry out multi-functions including thermal insulation, noise prevention, being weather proof, on-site electricity production as well as offsetting the system initial cost, which is the main advantage over non-integrated PV system. Building-integrated photovoltaics (BIPV) have a major role in the ongoing transition towards nearly zero energy buildings (nZEBs). BIPV technology is a renewable technology that incorporates aesthetic function with the reduction of carbon emission.

Keywords: *Building Integrated Photovoltaics, photovoltaics technology, nearly zero energy buildings, overall performance*

USE OF RECYCLED MIXED COLOUR WASTE GLASS AS ARCHITECTURAL MORTAR

Sarah Mathew (S8 CE)

ABSTRACT

Conventional concrete aggregate consists of sand and various sizes and shapes of gravel or stones. While there is significant research on many different materials for aggregate substitute such as granulated coal ash, blast furnace slag etc, and recycled waste glasses are used for fine and course aggregates replacement in concrete. Using glass waste instead of virgin natural aggregate in the composition of mortars is feasible and it indicates many benefits such as minimal cost of quarrying, greater eco – sustainability and more architectural value of mortar. The three different types of glass produced are flat glass, hollow glass and wool and glass yarn. Here mixed colour scrap glass in its unaltered state is used to manufacture decorative architectural mortars without any other inorganic addition. At present this kind of reuse is still not popular due to the risk of alkali-silica reaction (ASR) between alkalis of the cement and silica of the waste glass. To mitigate the possible alkali-silica reaction, mixes with a hydrophobic admixture were also compared. This work is aimed at studying the use of recycled mixed colour waste glass as architectural mortar.

Keywords : *Waste glass, Architectural mortar, Alkali-silica reaction, Recycling, Durability*

EXPERIMENTAL STUDY ON EFFECT OF WASTE PLASTIC BOTTLE STRIPS ON MARINE CLAY

Mohammed Ajmal VI (S8 CE)

ABSTRACT

Soil stabilization is a process which improves the engineering properties of weak soils, such as an increase in shear strength, bearing capacity etc. which can be done by the use of controlled compaction or addition of suitable stabilizers like cement, lime and materials like fly ash, phosphogypsum etc. With rapid advancements in technology globally, the use of plastics such as polyethylene bags, bottles etc. is also increasing. The disposal of thrown away wastes cause a serious challenge since most of the plastic wastes are non -biodegradable and unfit for incineration as they emit harmful gases. Plastic reinforced soil behaves like a fiber reinforced soil. This experimental study involves the investigation of the effect of plastic bottle strips on marine clay. Polyethylene Terephthalate (PET) plastic bottle strips are used to improve the engineering properties of soil. PET bottles are cut in to strips with size of 5x 5mm, 5 x 10 mm and 5 x 15mm. Standard proctor test, Consolidation test, California bearing ratio (CBR) test and Unconfined compressive strength tests are conducted without plastic strips and same set of tests are performed on reinforced soil with plastic strips with varying percentages of 0.2, 0.4 and 0.6 % of clayey soil respectively.

Keywords: Polyethylene Terephthalate (PET) Plastic bottle strips, Standard proctor test, Consolidation test, California bearing ratio (CBR) test, Unconfined compressive strength test.

DESIGN OF SYSTEMS OF FLOOD CONTROL TECHNIQUES

Alan Prince (S8 CE)

ABSTRACT

Kerala has witnessed the most devastating flood and related losses in its history in the years 2018 and 2019. This project intends to make a flood risk map of amballor using ArcGIS, Digital Elevation Model (DEM) and by considering various parameters such as precipitation, soil characteristics, land use, topography, slope and population. The preparation of flood risk maps employed in the study includes the following steps: (1) digitization of topographical data and preparation of digital elevation model using ArcGIS, (2) simulation of flood lows of different return periods using a hydraulic model, and (3) preparation of flood risk maps by integrating the results. Geographic Information Systems (GIS) are successfully used to visualize the extent of flooding and also to analyze the flood maps to produce flood damage estimation maps and flood risk map. The study highlights the potential for the detection of flood prone areas which will be flooded during heavy downpour and when the river water level rises and various information that could be extracted from it for disaster management.

Keywords: Hydrological applications, Geographical Information System (GIS), Digital Elevation Model.

PRODUCTION OF LAMINATED NATURAL FIBRE BOARD FROM BANANA TREE WASTES

Rinza Pareekunju(S8 CE)

ABSTRACT

Laminated boards are produced by laminating banana stem fibre boards with banana leaf tapes. Various laminated boards were created by changing the number of layers of leaf tape used. The tensile strength, elongation at break, flexural modulus and impact strength of the laminated boards increased with increasing number of the leaf tapes. Utilization of the banana stem fibre not only benefits the environment, but it will also reduce the overall resource consumption while sustaining national economic growth and introduction of green technology to the rural areas. The method of making banana stem fibre based bio composite involved extracting the fibre from the banana stem. The fibre was then cleaned and processed based on the type of bio composites to be produced. One of the methods of making bio composites is by lamination. Lamination will ensure that the distribution and the orientation of the fibre can be controlled precisely in the bio composites. Fibre orientation plays important role in bio composites because the properties measured along the fibre orientation are usually higher than the properties measured in the perpendicular direction. Bio composites of uniform properties can easily be produced by crossing the fibre orientation in the different layers of the laminates

Keywords: *Banana wastes, fibre board, lamination*

FEASIBILITY STUDY ON INTERLOCKING CONCRETE PAVEMENTBLOCKS WITH GEOPOLYMER SEA SAND CONCRETE.

Devika Sudarshanan (S4 M.Tech)

ABSTRACT

Interlocking Block Pavement (IBP) has been extensively used in a number of countries as a problem-solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environmental constraints. Portland cement concrete is a major material used in interlocking pavement blocks. But its increased use in construction is exhausting natural resources used in its production and also cause environmental effects, making it necessary to find alternative materials. One potential method is to use sea sand as fine aggregate to produce alkali activated fly ash/GGBS concrete. Sea sand has various advantages, it is more rounded or cubical similar to river sand, the grading is generally good and consistent, contains no organic contaminant or silt and can be mined at a low cost, also the utilization of fly ash and GGBS as an alternative to Portland cement in producing alkali-activated slag concrete (ASC) contributes to environmental protection by reducing CO₂ emissions. In this project an attempt is made to study the Feasibility of Geopolymer Sea Sand Concrete in Interlocking Concrete Pavement Blocks.

Keywords: *Geopolymer concrete, Sea sand, Interlocking concrete pavement block*

***MATHEMATICAL MODEL FOR COST ESTIMATION INCORPORATING SOCIAL COST
DURING PILING IN URBAN CONGESTED AREAS***

HISANA SALIM (S4 M Tech)

ABSTRACT

Completion of construction projects has a direct positive impact on the growth of national and local economies as well as humans' wellbeing. As well as construction projects generate serious environmental nuisances for the adjacent residents and have unintentional adverse impacts on their surrounding environment. Construction causative adverse impacts on the neighboring communities are known as the social costs. Piling works in major infrastructure work causes serious structural damages to the adjacent residential areas. The major problem is various pollutions. This reduces the human comfort criteria. Piling works also leads to traffic problems like parking loss, prolonged closure of roads, time delay cost, business loss etc. This study aims to identify the factors affecting social cost during pile construction works and to quantify and analyze the social cost occurred to the adjacent areas due to the impact of piling. Thus a model can be proposed for the incorporation of social cost in structure associated with piling. The analysis gives an idea about impact of piling work in adjacent building. Proposed mathematical model helps to quantify social cost.

Keywords: Social cost, Piling works, Adverse impacts, Damages, Quantification, Model

***PREDICTION MODEL FOR GHG EMISSION DURING MULTI-STOREY BUILDING
CONSTRUCTION***

Crissa Mariam George (S4 M Tech)

ABSTRACT

Environmental changes pose a great threat against attaining sustainability. Construction related energy use and associated Greenhouse gas (GHG) emissions from construction processes are a serious concern globally. Environmental measures are therefore becoming an increasingly important indicator for evaluating the performance of construction projects. The emissions caused by building construction initiates from material manufacturing, the construction activities, the use phase and maintenance, demolition, and recycle and reuse. The construction phase, including material manufacturing, transportation of materials, equipment and waste and construction processes accounts a majority of total GHG emissions during a building life cycle. In this project, factors contributed to carbon emission during pre-use stage of multi storey building construction using Structural Equation Modelling (SEM) are identified. This project also develops a statistical model that incorporates project specific data into the assessment and prediction of associated GHG emissions during pre-use stage of construction projects.

Keywords: Building life cycle, Greenhouse gas (GHG), Structural equation modeling (SEM), Statistical model

THE EFFECT OF PROPERTIES OF AC DEVELOPED BY PARTIALLY REPLACING CEMENT WITH GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

Magida Ruby P P (S4 M Tech)

ABSTRACT

Aerated concrete (AC) is either a cement or lime mortar, classified as light weight concrete, in which air-voids are entrapped in the mortar matrix with the aid of suitable air entraining agent. Aerated concrete is relatively homogeneous when compared to normal concrete, as it does not contain coarse aggregate phase. In this study aluminium powder is used as air entraining agent to make aerated concrete. It has many advantages when compared with conventional concrete such as reduced dead load, good sound insulation and considerable savings in material as a result of air voids with in aerated concrete. But the major problem faced by the AC is that it is notorious for its insufficient strength and high water absorption leading to problems during the construction phase. To tackle such problem the paper examines the effect of properties of AC developed by partially replacing cement with Ground Granulated Blast Furnace Slag (GGBS)

Keywords: Aerated concrete, Ground Granulated Blast Furnace Slag(GGBS).

INVESTIGATION ON THE EFFECT OF HOOKED END STEEL FIBRES IN SELF CURING CONCRETE

Sifana Nazrin (S8,CE)

ABSTRACT

Concrete curing is one of the most important processes in achieving the desired properties of concrete. External curing is achieved by wetting the exposed surface thereby preventing the loss of moisture from concrete. But when the mineral admixtures are added to concrete, the demand for curing water will be much greater than that in a conventional ordinary Portland cement concrete. When this water is not readily available, significant autogenously deformation and cracking may result. In order to overcome these draw back the attention is focused on advanced technology in curing i.e., self-curing concrete. Self-curing or internal curing is a technique in which no additional water is required to enhance the rate of hydration. These self-curing concretes are also weak in resisting tensile forces, but by incorporating fibers on self-curing concrete both the tensile strength as well as the durability can be increased. In this study, self-curing concrete is achieved by incorporating Polyethylene Glycol (PEG-400) at different dosage (0.5%, 1%, 1.5% and 2%) by weight of binder content of M40 grade of concrete. To its optimum dosage the steel fibres are added to this self-curing concrete at different percentage (0.5%, 1%, 1.5%, and 2%) by volume of concrete. The optimum steel fibre content is then determined with respect to strength parameters and then durability properties of self-curing concrete with optimum mix of steel fibers are determined.

Key Words: Self Curing Concrete, Polyethylene Glycol, Steel fibers.



B. Articles

HIGH STRENGTH STEEL AT UNPRECEDENTED LEVELS OF FRACTURE RESISTANCE

Steel is a common alloy. Material scientists and engineers are continually seeking to develop new generation steel materials which are easier to extend and elongate (ductility) into different forms and structures, higher in resistance to deformation (strength) and fracture (toughness), light in weight and low in production cost.

The conventional view is that raising the performance of one metallic property, whether in strength, ductility or toughness, will undermine one or more of the others. For example, an increase in strength will inevitably make the metal more brittle (known as the strength-toughness trade-off); or less flexible to be extended or elongated into different shapes. (Strength-ductility trade-off). It attained an unprecedented strength toughness combination which can address a major challenge in safety-critical industrial applications to attain ultra-high fracture toughness so as to prevent catastrophic premature fracture of structural materials. The breakthrough also changes the conventional view that attaining high strength will be at the expense of deteriorating toughness, which invariably leads to the brittlement of structural materials and greatly limits their application. It attains excellent performance in all three metallic properties at an unprecedented high-level not reached by any steel materials before.

Generate prototypes of high-strength bridge cable, bullet proof vest and car spring with the super steel for further tests and trials to be conducted. The steel a yield strength resistance against deformation of ~2GPa, a superior fracture toughness of 102MPa \sqrt{m} , and a good uniform elongation of 19%.

The super steel has a unique fracture feature in which multiple micro-cracks are formed below the main fracture surface, through a novel "high-strength induced multi-delamination" toughening mechanism. These micro-cracks can effectively absorb energy from externally applied forces, resulting in the steel's much higher toughness resistance compared to existing steel materials.

Currently, high strength steel for bridge cables has a yield strength lower than 1.7 GPa, and a fracture toughness lower than 65 MPa \sqrt{m} ; high strength armoured steel used in armoured cars has a similar maximum strength toughness combination. The toughness level that can be attained by the D&P steel is hence much higher than that of existing steel materials, while maintaining super strong in strength.

Steel piano wire, for instance, has an ultra-high strength ranging from 2.6 to 2.9 GPa to resist deformation and to keep the instrument in tune, which is achieved at the expense of toughness and is in turn very brittle. The cost of raw materials of the D&P steel is only 20% of the managing steel currently used in aerospace (e.g. Grade 300, whose yield strength and fracture initiation toughness are 1.8 GPa and 70 MPa \sqrt{m} , respectively).

Jinu paul (S8 CE)

SAVING ENERGY AND LIVES: HOW A SOLAR CHIMNEY CAN BOOST FIRE SAFETY

A solar chimney optimized for both energy saving and fire safety, as part of the sustainable features. Modelling shows the specially-designed solar chimney radically increases the amount of time people have to escape the building during a fire extending the safe evacuation time from about two minutes to over 14 minutes. A solar chimney is a passive solar heating and cooling system that harnesses natural ventilation to regulate the temperature of a building.

With an estimated 19% of the world's energy resources going to heating, ventilating and cooling buildings, integrating solar chimneys into new builds and retrofitting to existing structures offers great potential for reducing this massive environmental cost. It is designed a solar chimney to maximize its efficiency for both ventilating fresh air and sucking smoke out of a building in case of fire.

In an emergency situation where every second counts, giving people more time to escape safely is critical; Delivering on two important functions could boost the already strong cost-effectiveness of this sustainable technology. Creating new and innovative ways of reducing energy consumption in our building design.

The solar-chimney that has been installed at the new state-of-the-art Mentone Reserve Pavilion not only allows us to harness clean green energy to heat and cool the building, helping Council achieve its environmental goals, but it also has the potential to save lives in the event of a fire. While calculations around the 6-fold increase in safe evacuation time were specific to the new building, solar chimneys can successfully achieve both functions ventilation and smoke exhaustion. The passive design approach behind solar chimneys operates on the well-known principle that hot air always rises.

Modern solar chimneys usually feature a wall of glass next to a wall that is painted black, to maximize the absorption of solar radiation. Vents at the top and bottom control the airflow in and out of the chimney for heating or cooling. As the sun warms the chimney, this heats the air inside it. The hot air rises and is vented out of the top of the chimney, which draws more air in at the bottom, driving ventilation through a building to naturally cool it down. When it's cold outside, the chimney can be closed, to direct the absorbed heat back into the building and keep it warm. It's an ingeniously simple concept that is relatively cheap to retrofit and adds almost no extra cost to a new build, but can drive energy consumption down.

During a fire, the same principle hot air rises enables the solar chimney to suck smoke out of the building. Less smoke means better visibility, lower temperatures and reduced carbon monoxide all of which contribute to increasing the amount of time people have to safely evacuate. This will differ from building to building, but we know that any extra time is precious and improves fire safety, which could ultimately help to save lives. It optimizes the design and engineering of solar chimneys in real buildings, to expand their application across the two functions.

Mincy jose(S8CE)

CARBON DIOXIDE SENSOR CAN LOWER ENERGY USE, REDUCE UTILITY COSTS

Climate control and proper ventilation are especially important because most people spend considerably more time indoors than outside. Climate control and ventilation are also huge sources of energy consumption in the United States and around the world. It is a lower-cost, lower-energy carbon dioxide sensor that could change the way energy is used to heat, cool and ventilate large buildings and eventually homes.

The technology identifies when carbon dioxide is released into the air by a person, or people entering and breathing inside that space. The Purdue sensor detects the carbon dioxide so that heating and ventilation systems can control the climate and air turnover in spaces that are occupied, instead of using energy to control rooms that are empty. It leverages two technologies with our innovative device: resonant sensing and resistive sensing. Purdue sensor also helps address privacy concerns about using camera technology for detecting when someone enters and leaves a room. It is a vibration-control devices based on Formula 1 technology so "needle-like" high-rise skyscrapers which still withstand high winds can be built

Current devices called tuned mass dampers (TMDs) are fitted in the top floors of tall buildings to act like heavyweight pendulums counteracting building movement caused by winds and earthquakes. But they weigh up to 1,000 tons and span five storeys in 100-storey buildings adding millions to building costs and using up premium space in tight city centers. Lightweight and compact inerters, similar to those developed for the suspension systems of Formula 1 cars, can reduce the required weight of current TMDs by up to 70%. Such slender structures will require fewer materials and resources, and so will cost less and be more sustainable, while taking up less space and also being aesthetically more pleasing to the eye. In a city, where space is at a premium and land is expensive, the only real option is to go up, so this technology can be a game-changer.

Tests have shown that up to 30% less steel is needed in beams and columns of typical 20storey steel building thanks to the new devices. Measure of occupants' comfort against seasickness can be reduced by 30% with the newly proposed technology. It means the devices are also more effective in ensuring that buildings can withstand high winds and earthquakes. Even moderate winds can cause seasickness or dizziness to occupants and climate change suggests that stronger winds will become more frequent. The inerter-based vibration control technology we are testing is demonstrating that it can significantly reduce this risk with low up-front cost in new, even very slender, buildings and with small structural modifications in existing buildings. As well as achieving reduced carbon emissions through requiring fewer materials, can also harvest energy from wind-induced oscillations. At the moment to have a building that is completely self-sustaining using this technology, can definitely harvest enough for powering wireless sensors used for inner building climate control.

Maya v Krishnan (S4CE)

ROLE OF SEA ICE IN CONTROLLING ATMOSPHERIC CARBON LEVELS

A new study has highlighted the crucial role that sea ice across the Southern Ocean played in controlling atmospheric carbon dioxide levels during times of past climate change, and could provide a critical resource for developing future climate change models. Seasonal growth and destruction of sea ice in a warming world enhances the amount of marine life present in the sea around Antarctica, which draws down carbon from the atmosphere and stores it in the deep ocean. Having captured half of all human related carbon that has entered the ocean to date, the Southern Ocean around Antarctica is crucial for regulating carbon dioxide levels resulting from human activity, so understanding the processes that determine its effectiveness as a carbon sink through time are crucial to reducing uncertainty in future climate change models.

During this period, CO₂ rose rapidly from around 190 parts per million (ppm) to 280 ppm over around 7,000 years, but one period in particular stands out; a 1,900 year period where CO₂ levels plateaued at a nearly constant level of 240 ppm. The cause of this plateau, which occurred around 14,600 years ago, is unknown, but understanding what happened during this period could be crucial for improving climate change projections. Developed new techniques in cell biology to find, collect and analyses the rare and very tiny particles and cells that had been frozen in the ice for millennia.

Like flies in amber, these minute fragments give us a unique window into past events, enabling our colleagues in the Earth, Atmosphere and Ocean sciences to develop a better understanding of climate change then, and now. The cause of this long plateau in global atmospheric CO₂ levels may be fundamental to understanding the potential of the Southern Ocean to moderate atmospheric CO₂. Created by fierce, high-density katabatic winds, the top layer of snow is effectively eroded, exposing the ice below. As a result, ice flows up to the surface, providing access to ancient ice below.

Instead of drilling kilometers into the ice, we can simply walk across a blue ice area and travel back through time. This provides the opportunity to sample large amounts of ice for studying past environmental changes in detail. This provides the first recorded evidence of increased biological productivity and suggests that processes in the high latitude Southern Ocean may have caused the CO₂ plateau. However, the driver of this marked change remained unknown, and the researchers used climate modelling to better understand the changes in the Southern Ocean to understand the potential cause. This modelling revealed that the plateau period coincided with the greatest seasonal changes in sea ice during a pronounced cold phase across the Southern Ocean known as the Antarctic Cold Reversal. During this period, sea ice grew extensively across the Southern Ocean, but as the world was warming rapidly, each year the sea ice would be rapidly destroyed during the summer.

Jinsha Hareendran (M Tech)

***THE FRAMEWORK ALLOWS FOR COORDINATION OF ROAD AND WATER REPAIRS
A COST-SAVING SOLUTION FOR CITIES***

Canada is experiencing an enormous infrastructure deficit that was estimated at \$123 billion in 2007 and is increasing by about \$2 billion annually. Thus, there is a need for more efficient use of municipalities' budgets to enhance the level of service delivered to taxpayers.

To prove to city departments that it's worth it for them to coordinate their efforts, the study created an original asset management framework with multiple objectives. It considers the physical state of infrastructures, lifecycle costs, user expenses, and replacement value.

The framework uses three core models: a database model containing detailed asset inventory for road and water networks; key performance indicator (KPI) computational models for measuring the impact of intervention plans; and an optimization algorithm to schedule activities. The algorithm simulates thousands of scenarios to reach an optimal one.

It applied their system to road and water networks in Kelowna, B.C., where the results showed lifecycle costs could be cut by 33 per cent and user costs halved. Their test also showed the potential to include sewer, electricity, gas and telecom networks, provided information can be shared.

Better coordination would cause less disruption, which has been increasingly obvious this year, especially in the roads sector, where 2,000 potholes are repaired every day. A more integrated approach would result in an optimized expenditure of our annual budget along with an enhanced level of service, which is urgently needed given the deteriorating condition of our infrastructures.

Reshmi Ramesan (S8CE)

USE SMARTPHONES TO IMPROVE DISMAL RATING OF NATION'S CIVIL INFRASTRUCTURE

Smart phone-based technologies that can monitor civil infrastructure systems such as crumbling roads and aging bridges. Based on estimations, researchers say the failure of civil infrastructure systems, such as roads and bridges, could cause a 1 percent reduction in the U.S. GDP. In 2017, that number was \$200 billion. The challenges of the aging civil infrastructure systems suggest the need for developing innovative monitoring solutions. By using various sensors on smart phones such as a gyroscope, an accelerometer to measure speed, and camera, or tiny external sensors such as an infrared sensor, scientists can determine the specific makeup and deterioration of a road's surface in real-time. However, scientists won't be collecting all of the data. Once the sensor is plugged into a smart phone, any person will be able to effortlessly transmit the data wirelessly to a database while riding on a road. The large amount of data collected by crowds sourcing this technology will allow for better informed decisions about the health of roads and bridges.

Many of the existing methods to monitor our civil infrastructure systems have technical issues and are not user-centered. People are looking for smart, cost effective, scalable and user-centered approaches. With current advances in technology, people can help monitor or detect problems using their own devices, and smart phone technology allows us to do that with civil infrastructure.

Assessing roads, bridges and airfields with affordable sensors, such as those found in smart phones, really works. With a smart phone, can stitch together many inexpensive measurements to accurately assess things like the roughness or deterioration of a road surface. It can accurately assess the condition of airport runways and taxiways.

P S Harikrishnan (S8 CE)

WATER-BASED, ECO-FRIENDLY AND ENERGY-SAVING AIR-CONDITIONER

A new water-based air-conditioning system that cools air to as low as 18 degrees Celsius without the use of energy intensive compressors and environmentally harmful chemical refrigerants. This game-changing technology could potentially replace the century old air cooling principle that is still being used in our modern day air conditioners. Suitable for both indoor and outdoor use, the novel system is portable and it can also be customized for all types of weather conditions. Air-conditioning system is cost-effective to produce, and it is also more eco friendly and sustainable. The system consumes about 40 per cent less electricity than current compressor based air conditioners used in homes and commercial buildings. This translates into more than 40 per cent reduction in carbon emissions. In addition, it adopts a water based cooling technology instead of using chemical refrigerants such as chlorofluorocarbon and hydrochlorofluorocarbon for cooling, thus making it safer and more environmentally-friendly.

For buildings located in the tropics, more than 40 per cent of the building's energy consumption is attributed to air-conditioning. This rate to increase dramatically, adding an extra punch to global warming. Vapour compression air conditioning is the most widely used air-conditioning technology today. This approach is very energy intensive and environmentally harmful. In contrast, our novel membrane and water-based cooling technology is very eco-friendly it can provide cool and dry air without using a compressor and chemical refrigerants.

Current air conditioning systems require a large amount of energy to remove moisture and to cool the dehumidified air. By developing two systems to perform these two processes separately, engineering team can better control each process and hence achieve greater energy efficiency. The novel air conditioning system first uses an innovative membrane technology a paper like material to remove moisture from humid outdoor air. The dehumidified air is then cooled via a dew point cooling system that uses water as the cooling medium instead of harmful chemical refrigerants. Unlike vapour compression air conditioners, the novel system does not release hot air to the environment. Instead, a cool air stream that is comparatively less humid than environmental humidity is discharged negating the effect of micro climate. About 12 to 15 liters of potable drinking water can also be harvested after operating the air-conditioning system for a day.

While it can be used for indoor living and commercial spaces, it can also be easily scaled up to provide air conditioning for clusters of buildings in an energy efficient manner. This novel technology is also highly suitable for confined spaces such as bomb shelters or bunkers, where removing moisture from the air is critical for human comfort, as well as for sustainable operation of delicate equipment in areas such as field hospitals, armoured personnel carriers, and operation decks of navy ships as well as aircrafts. It can incorporate smart features such as pre-programmed thermal settings based on human occupancy and real-time tracking of its energy efficiency.

Aishwarya Vijayan (S6CE)

GREEN ROOFS COULD REDUCE INDOOR AIR POLLUTION

Green roofs that are planted with vegetation may improve the indoor air quality of commercial buildings by cutting the amount of ozone coming into the buildings from the outside

The findings add to the already known environmental benefits of green roofs, including reducing carbon dioxide, decreasing storm water runoff and cutting down on urban heat. They set up measuring devices on the roof of a big-box retail store in North Portland that was split between a green roof and a more conventional white membrane roof. They measured the air coming into the building from outdoor intake vents, and found that the air coming in from the green roof area had modestly lower ozone levels than the air coming in from the unplanted area. They found that the vegetation trapped and filtered the ozone in the outdoor air.

The trapping effect is a process known as dry deposition, in which airborne particles collect or deposit themselves on solid surfaces. It's a natural process that is key to removing pollutants from the atmosphere. The study was conducted over a two-day period. Findings warrant a longer term study one that could include measuring other pollutants as well as ozone.

Deepthi varier(S4 CE)

CONCRETE HELP SOLVE THE PROBLEM OF AIR POLLUTION

According to the World Health Organization, as many as seven million premature deaths of people worldwide may be linked to poor air quality and pollution. Sulfur dioxide emissions are among the most common pollutants into the air globally, with power plants emitting the most sulfur dioxide. Cement kilns also produce approximately 20 percent of all sulfur dioxide industrial emissions. Sulfur dioxide, a major contributor to air pollution, is removed from the air by concrete surfaces.

Even though producing concrete causes air pollution, concrete buildings in urban areas can serve as a kind of sponge adsorbing sulfur dioxide to a high level. Findings open up the possibility that waste concrete coming from building demolitions can be used to adsorb these pollutants.

Concrete remains the most widely used material in the world and is inexpensive. The strategy of using pollution causing material and turning it into an environmental solution could lead to new thinking in urban design and waste management. The capacity for concrete to adsorb pollutants diminishes over time as the material ages. Crushing concrete, however, can expose new surfaces and restore its pollution removing properties.

The researchers used various cement and cement-based building materials to conduct their experiments, details of which are in the paper, titled "Reactions of SO₂ on hydrated cement particle system for atmospheric pollution reduction: A DRIFTS and XANES study. They employed Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS) and X-ray absorption Near Edge Spectroscopy (XANES) to identify the levels of sulfur dioxide adsorption on the materials.

Neha Noushad (S8CE)

ALUMINUM MAY AFFECT LEAD LEVELS IN DRINKING WATER

It is not uncommon to find aluminum in municipal water systems. Its part of a treatment chemical used in some water treatment processes. Recently, however, it has been discovered in lead scale, deposits that form on lead water pipes. The aluminum presence in pipes is both unsurprising and, in the quantities researchers saw in water pipes, not a health concern, But no one had looked at how it might affect the larger municipal system. Find out What is that aluminum doing to the behavior of the lead in the scale. As long as the lead is bound to the scale, it doesn't enter the water system. Aluminum does have a small but important effect on lead's solubility under certain conditions.

In simplified models, the researchers took a look at how phosphate, aluminum and a combination of the two, affected a strip of lead in a jar of water with a composition close to that of water found in many water systems. The aim: to better understand lead's solubility, or the amount that would dissolve and make its way into the water when impacted by those chemicals.

In the jar in which only aluminum was added, there was no effect on the solubility of the lead strip; lead had dissolved into the water at a concentration of about 100 micrograms per liter.

In the jar in which only phosphate was added, the concentration of lead in the water decreased from about 100 micrograms per liter to less than one.

In the jar in which both aluminum and phosphate were added, the concentration of lead in the water decreased from about 100 micrograms per liter to about 10 micrograms per liter.

Ten micrograms of lead per liter of water is still below drinking water standards, but it's still more lead in the water than was seen in the jar without aluminum. This tells us what our next experiment should be. Do these experiments with real lead pipes, as they have done in the past. Some people would have thought that aluminum wasn't doing anything because it's inert. But then in our work, we saw that it actually affects lead solubility.

Aishwarya T B (S8CE)

DOUBLE HELIX OF MASONRY

Researchers analyzed how cupolas like the famous dome, part of the Cathedral of Santa Maria del Fiore in Florence, were built as self-supporting, without the use of shoring or forms typically required.

Quantitatively prove the physics at work in Italian renaissance domes and to explain the forces which allow such structures to have been built without formwork typically required, even for modern construction. Previously, there were only hypotheses in the field about how forces flowed through such edifices, and it was unknown how they were built without the use of temporary structures to hold them up during construction.

The project advances two significant questions. "How can mankind construct such a large and beautiful structure without any formwork mechanically, what's the innovation? Secondly, "What can we learn?" Is there some "forgotten technology that we can use today?"

The detailed computer analysis accounts for the forces at work down to the individual brick, explaining how equilibrium is leveraged. The technique called discrete element modelling (DEM) analyzed the structure at several layers and stages of construction. A limit state analysis determined the overall equilibrium state, or stability, of the completed structure. Not only do these tests verify the mechanics of the structures, but they also make it possible to recreate the techniques for modern construction.

Applying their findings to modern construction, the researchers anticipate that this study could have practical applications for developing construction techniques deploying aerial drones and robots. Using these unmanned machines for construction would increase worker safety, as well as enhance construction speed and reduce building costs.

Another advantage of unearthing new building techniques from ancient sources is that it can yield environmental benefits. The construction industry is one of the most wasteful ones, so that means if we don't change anything, there will be a lot more construction waste, who is interested in using drone techniques for building very large span roofs that are self-supporting and require no shoring or formwork.

Overall, this project speaks to an ancient narrative that tells of stones finding their equilibrium in the wonder of reason dome to the mechanical arms of modern-day robotics where technology is per formative of spaces and its social use.

Anju Raju (S8CE)

LIGHTER AND GREENER BRIDGES

The past 60 years have not seen any fundamental change to the design of bridge decks for suspensions bridges best known in Denmark from the Great Belt Link. Studied how to optimize structures to reduce the weight of the bridge deck, in particular increasing the span. Applied different methods for examining how to better utilize materials, which primarily consist of steel and concrete. Initially, we sought to optimize their use in traditional structures by using transverse diaphragms in the bridge deck, thereby achieving a theoretical weight reduction of up to 14 per cent.

With a view to achieving additional savings, the researchers looked at the possibility of altering the structural design. That was done by using topology optimization, a method known in car and aircraft industries that had not previously been used for large-scale building structures.

In popular terms, it's about 'emptying' a bridge girder of its existing elements, providing complete freedom for choosing a new design. The inner volume of the bridge girder is then divided into a structure of very small voxels (3D pixels), like small dice. The topology optimization method is then used for determining whether each individual voxel should consist of air or steel material. The result is a bridge girder design that uses the least possible steel without impairing the strength of the structure. Specifically, a bridge element measuring 30 x 5 x 75 meters was analyzed, divided into two billion voxels, each no bigger than a few centimeters. The result was an incredibly extensive calculation performed by a supercomputer, which would have taken an ordinary computer 155 years to do and is the largest structural optimization ever carried out.

The computer calculation presented input for how to best structure the design space of the bridge deck. Among other things, that meant curving part of the currently straight transverse diaphragms, making it possible to shave off 28 per cent of the material that is used for bridge decks and thereby achieve a corresponding reduction of the CO₂ emissions generated by the production and transport of concrete and steel. Interpreted and adjusted calculations so the result became a suggested bridge girder structure with the optimum design that can be carried out without too costly production methods. The economic aspect is important in order for the design to be a realistic option for future bridge projects.

Naturally, additional analyses will be required before the new design can be used for building bridges, but COWI is confident that the results of the research project add valuable knowledge to tomorrow's suspension bridges. The new bridge girder design can be converted into a weight and CO₂ reduction of up to 20 per cent for the entire bridge, which of course benefits the climate. COWI is also involved in a wide range of the world's largest bridge projects, so a potential new design will also benefit our customers and society

There are huge perspectives to using topology optimization for ensuring the sustainable design of other large building structures, such as high-rises, stadiums or highway bridges. The construction industry accounts for 39 per cent of global CO₂ emissions, almost any reduction can be of interest.

Fathima T S (S8CE)

A SOCIAL TOOL FOR EVALUATING THE ENVIRONMENTAL IMPACT OF RESIDENTIAL BUILDINGS

For the first time an open-source computing tool which can, simply and intuitively, calculate the CO₂ emissions in each phase of a building project, in order to obtain a global picture of its carbon footprint from its conception and to help decide every variable in the construction process.

The first step in managing and reducing the CO₂ emissions associated with building construction is to calculate them, to know the importance of this environmental aspect and apply measures to improve the situation. To better understand the environmental impact and work on it, it is important to measure the CO₂ emissions from the design and conception of the building and, according to its measurements, know the different possibilities for reducing its carbon footprint and making a more sustainable, low-carbon building.

It is vital to be aware of the CO₂ emissions that are generated in the first phases of a project, so that early preventative actions can be taken by means of the choice of different materials, mean of transport, construction methods, and use during the life of the building, deconstruction systems, reuse, etc., so contributing to reducing the building's emissions. They work towards the concept of sustainable construction, taking into account, also, concepts related to the recycling and reuse of materials, and putting this tool at the disposal of all the agents involved in the construction sector, such as students, professionals and the users of the house themselves.

One of the applications of this online tool is that it allows for buildings of similar characteristics to be compared from an economic and environmental point of view, so knowing which of them is more sustainable and better respects the environment.

Jibi kurien (S8CE)

NEW APPROACH TO SUSTAINABLE BUILDING TAKES SHAPE

Wood construction has tended to be limited to single-family houses or smaller apartment buildings with just a few units, narrowing the impact that it can have in urban areas. Large buildings made from mass timber and assembled using the kit-of-parts approach he and his colleagues have been developing have a number of potential advantages over conventionally built structures of similar dimensions. For starters, even when factoring in the energy used in felling, transporting, assembling, and finishing the structural lumber pieces, the total carbon emissions produced would be less than half that of a comparable building made with conventional steel or concrete. Modeled nine different versions of an eight-story mass-timber building, along with one steel and one concrete version of the building, all with the same overall scale and specifications. The first question people tend to ask about the idea of building tall structures out of wood is: What about fire? In fact, a mass-timber building retains its structural strength longer than a comparable steel-framed building. That's because the large timber elements, typically a foot thick or more, are made by gluing together several layers of conventional dimensioned lumber. These will char on the outside when exposed to fire, but the charred layer actually provides good insulation and protects the wood for an extended period. Steel buildings, by contrast, can collapse suddenly when the temperature of the fire approaches steel's melting point and causes it to soften.

It's possible to use a series of preconfigured modules, assembled in different ways, to create a wide variety of structures of different sizes and for different uses, much like assembling a toy structure out of LEGO blocks. These subunits can be built in factories in a standardized process and then trucked to the site and bolted together. This process can reduce the impact of weather by keeping much of the fabrication process indoors in a controlled environment, while minimizing the construction time on site and thus reducing the construction's impact on the neighborhood. It's a way to rapidly deploy these kinds of projects through a standardized system. It's a way to build rapidly in cities, using an aesthetic that embraces offsite industrial construction.

Because the thick wood structural elements are naturally very good insulators, the Roxbury building's energy needs for heating and cooling are reduced compared to conventional construction. They also produce very good acoustic insulation for its occupants. In addition, the building is designed to have solar panels on its roof, which will help to offset the building's energy use.

It's really a system, not a one-off prototype. With the on-site assembly of factory-built modules, which includes fully assembled bathrooms with the plumbing in place, he says the basic structure of the building can be completed in only about one week per floor. It is very competitive with concrete and steel for buildings of between eight and 12 stories. Such buildings are likely to have great appeal, especially to younger generations, because "sustainability is very important to them. This provides solutions for developers that have a real market differentiation."

Aswathy Manoharan (S6 CE)

TWO NEW TREE SPECIES CAN BE USED IN NEWSUSTAINABLE BUILDING MATERIAL

Two tree species native to the Northeast have been found to be structurally sound for use in cross laminated timber (CLT) a revolutionary new type of building material with sought-after sustainability characteristics. The manufacturing of CLT, a type of mass timber used for wall, floor and roof construction, could create jobs, improve rural and forestry economies and support better forestry management, which is a strategy to address climate change, the research says.

This is the future prefabricated, panelized wood. It's far more efficient and there's far less waste than site construction. It's less time and labor intensive than building with cast-in-place concrete and has a much lower carbon footprint.

When the structure opened in 2017 to house academic departments and offices, it was considered the most technologically advanced CLT building in the country. All the CLT for the Design Building was FSC-certified, ensuring it came from responsibly managed forests that deliver environmental, social and economic benefits.

They made the composite building panels by gluing together wooden boards from hemlock and pine trees that were grown in the region. Then broke them in a strength-testing machine to find out if they would be safe to use in a university-size building. Both tree species met building standards, with eastern hemlock outperforming pine.

Salvaging wood from eastern hemlock is a key forest-management priority because the trees are under attack by an insect, the hemlock wooly adelgid. The insect doesn't harm the wood, but it kills the tree, which in five to 10 years will rot and fall down, becoming hazardous fuel for forest fires.

Eastern hemlock also is considered low-value because it's prone to a wood defect called ring shake and isn't used in structural framing. Turning this particular species into CLT turns a very low-value material into a very high-value building product. Identifying low-carbon materials for construction is an emerging buzz among architects, and the timing is right to encourage CLT production in the Northeast

Sarin Xavier(S6CE)

SMART TECHNOLOGY FOR SYNCHRONIZED 3D PRINTING OF CONCRETE

Robots can work in unison to 3D-print a concrete structure. This method of concurrent 3D-printing, known as swarm printing, paves the way for a team of mobile robots to print even bigger structures in future. Using a specially formulated cement mix suitable for 3-D printing, this new development will allow for unique concrete designs currently not possible with conventional casting. Structures can also be produced on demand and in a much shorter period.

Currently, 3D-printing of large concrete structures requires huge printers that are larger than the printed objects, which is unfeasible since most construction sites have space constraints. Having multiple mobile robots that can 3D print in sync means large structures like architectural features and specially-designed facades can be printed anywhere as long as there is enough space for the robots to move around the work site.

The NTU robots 3D-printed a concrete structure measuring 1.86m x 0.46m x 0.13m in eight minutes. It took two days to harden and one week for it to achieve its full strength before it was ready for installation.

Envisioned a team of robots which can be transported to a work site, print large pieces of concrete structures and then move on to the next project once the parts have been printed.

Printing concrete structures concurrently with two mobile robots was a huge challenge, as both robots have to move into place and start printing their parts without colliding into each other.

Printing the concrete structure in segments is also not acceptable, as joints between the two parts will not bond properly if the concrete does not overlap during the printing process. This multi-step process starts by having the computer map out the design to be printed and assign a specific part of the printing to a robot. It then uses a special algorithm to ensure that each of robot arm will not collide with another during the concurrent printing.

Using precise location positioning, the robots then move into place and print the parts in good alignment, ensuring that the joints between the separate parts are overlapped. Finally, the mixing and pumping of the specialized liquid concrete mix have to be blended evenly and synchronized to ensure consistency. This multiple robot printing project is highly interdisciplinary, requiring roboticists to work with materials scientists to make printable concrete. To achieve the end result of a strong concrete structure, we had to combine their expertise with mechanical engineers and civil engineering experts.

Such an innovation demonstrates to the industry what is feasible now, and prove what is possible in the future if we are creative in developing new technologies to augment conventional building and construction methods. Moving forward, look at integrating even more robots to print larger scale structures, optimizing printing algorithm for consistent performance and to improve the concrete material for faster curing.

Anjali Ravi (S8CE)

INNOVATIVE NEW 'GREEN' CONCRETE USING GRAPHENE

A new greener, stronger and more durable concrete that is made using the wonder-material graphene could revolutionise the construction industry. It is a pioneering new technique that uses Nano engineering technology to incorporate graphene into traditional concrete production.

The new composite material, which is more than twice as strong and four times more water resistant than existing concretes, can be used directly by the construction industry on building sites. The new grapheme reinforced concener material also drastically reduced the carbon footprint of conventional concrete production methods, making it more sustainable and environmentally friendly.

The new technique could pave the way for other nanomaterials to be incorporated into concrete, and so further modernize the construction industry worldwide.

Our cities face a growing pressure from global challenges on pollution, sustainable urbanization and resilience to catastrophic natural events, amongst others. This new composite material is an absolute game-changer in terms of reinforcing traditional concrete to meets these needs. Not only is it stronger and more durable, but it is also more resistant to water, making it uniquely suitable for construction in areas which require maintenance work and are difficult to be accessed.

By including graphene can reduce the amount of materials required to make concrete by around 50 per cent leading to a significant reduction of 446kg/tonne of the carbon emissions. This unprecedented range of functionalities and properties uncovered are an important step in encouraging a more sustainable, environmentally-friendly construction industry worldwide.

Previous work on using nanotechnology has concentrated on modifying existing components of cement, one of the main elements of concrete production. In the innovative new study, the research team has created a new technique that centers on suspending atomically thin graphene in water with high yield and no defects, low cost and compatible with modern, large scale manufacturing requirements.

It can be applied to large-scale manufacturing and construction. The industry has to be modernized by incorporating not only off-site manufacturing, but innovative new materials as well. Finding greener ways to build is a crucial step forward in reducing carbon emissions around the world and so help protect our environment as much as possible. It is the first step, but a crucial step in the right direction to make a more sustainable construction industry for the future.

Meenakshi R(S4CE)

MULTIPLE USES FOR EMPTY PLASTIC BOTTLES DURING DISASTER RELIEF AND BEYOND

Powerful hurricanes and earthquakes have wreaked havoc in the United States and around the world in recent years, often leaving people stranded for months and even years without access to water, food, and shelter. A unique collaborative project at Rensselaer Polytechnic Institute seeks to provide a sustainable solution, while also considering the environment.

After a disaster strikes, first responders and other aid organizations mobilize to send needed supplies such as water, food, and medicine. Bottled water is sent by the tons, but all too often, the empty plastic bottles end up in the trash stream.

The goal of the project is to re-use the empty bottles to construct and structurally test different structural components (walls, columns, and roofs) and then design and build a prototype for emergency shelters for displaced populations under conditions of distress. The structure will be approximately 15 square meters in size

The aim is to foster dialogue on topics relating to recycling of industrial products as building materials and on sustainable building construction. During the design studio, we are investigating several prototypes presenting variable solutions of construction and deconstruction of small inhabitable spaces using the bottles manufactured by Friendship LLC. The idea is to use the bottles as sturdy, low-cost, easily assembled building blocks. Each modular unit slide-locks with other units to form strong wall and building structures that can be filled with dirt, sand, or other materials to form a sturdy structure without the use of mortar. The Friendship bottles are able to interlock without joints due to their embedded creases. Presents a unique collaboration to optimize function and shape. The structural engineering research focusing on studying all the mechanics of the interlocking between the bottles and its scaling up to the full structural scale provides the architectural engineers with the needed properties to create not only an aesthetically appealing structure, but also a structurally sound and safe one.

The trend in dealing with these plastics is to shred them and then either recycle the material or put it in landfills. Without any additional energy costs to transform the bottles for further use, his research provides additional lives to these bottles as permanent parts in buildings. His students are investigating strength and thermal insulation properties of the bottles for their incorporation into concrete sandwich walls and hollow block slabs to save on materials and energy consumption. Taking the bottles from our landfills and putting them sustainably into our structures to reduce weight and provide insulation for better energy consumption. Goals include environmental sensing and data frameworks for comfort and well-being in transitional shelters; the role of Friendship bottles in waste reduction and reuse within disaster relief logistics; and the use of Friendship bottles as a performative building system.

Sajinu C R (S6 CE)

STRONGER CONCRETE WITH 'SEWAGE-ENHANCED' STEEL SLAG

A by-product of steel making can be used to both treat wastewater and make stronger concrete, in a zero-waste approach to help advance the circular economy. Produced during the separation of molten steel from impurities, steel slag is often used as a substitute aggregate material for making concrete. Steel slag can also be used to absorb contaminants like phosphate, magnesium, iron, calcium, silica and aluminium in the wastewater treatment process, but loses its effectiveness over time.

Engineering researchers at RMIT University examined whether slag that had been used to treat wastewater could then be recycled as an aggregate material for concrete.

The concrete made with post-treatment steel slag was about 17% stronger than concrete made with conventional aggregates, and 8% stronger than raw steel slag. Investigate potential applications for "sewage-enhanced" slag in construction material.

The global steel making industry produces over 130 million tons of steel slag every year. A lot of this by-product already goes into concrete, but we're missing the opportunity to wring out the full benefits of this material. Making stronger concrete could be as simple as enhancing the steel slag by first using it to treat our wastewater.

While there are technical challenges to overcome, we hope this research moves us one step closer to the ultimate goal of an integrated, no-waste approach to all our raw materials and by-products.

In the study, civil and water engineering researchers found the chemical properties of the slag are enhanced through the wastewater treatment, so it performed better when used in concrete. The things that we want to remove from water are actually beneficial when it comes to concrete, so it's a perfect match. Steel slag is currently not in widespread use in the wastewater treatment industry just one plant based in New Zealand uses this by-product in its treatment approach.

But there is great potential here for three industries to work together steel making, wastewater treatment and construction and reap the maximum benefits of this by-product.

Jessy felix (M Tech)

C.

Puzzles

1. Read the following information and answer the questions that follow.

There are five brothers — Stephan, Kevin, Mason, Aaron and Ryan. Mason is the tallest. Stephan is shorter than Kevin but taller than Ryan. Aaron is a little shorter than Kevin and little taller than Stephan.

Who is the shortest?

If they stand in the order of their heights, who will be in the middle?

If they stand in the order of increasing heights, who is the second?

Who is the second tallest?

Who is taller than Aaron but shorter than Mason?

Brain teaser

- ❖ This object has holes in its top and bottom. It also has holes on its sides and bottom, not only that it is riddled with holes in the middle. Despite this, it can still hold water. What is it?
- ❖ You're in a boat and you throw out a net. Does the water level increase?
- ❖ Given 9 balls all of which weigh the same except for one, what is the minimum of weighings necessary to find the ball that weighs more (or less)?
- ❖ You toss two coins. If you get heads with the first coin, you stop. If you get tails, you toss it again. The second coin is tossed regardless. What is the ratio of heads to tails?
- ❖ There are 50 bikes with a tank that has the capacity to go 100 km. Using these 50 bikes, what is the maximum distance that you can go?

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