



KMCT
POLYTECHNIC COLLEGE, KUTTIPURAM

PROJECTION

Department of Civil Engineering
Technical Magazine, Vol.II-2021-2022

About The College

KMCT Polytechnic College, Kuttippuram was established in 2014 with a key determination to provide quality technical education for socially and economically backward classes at this area. The college is rising progressively as one of the top notch Polytechnic Colleges in Kerala.

Approved by AICTE and affiliated to Directorate of Technical Education, Govt. of Kerala, KMCT Polytechnic College encourages and gives better technical education for students to excel in the highly volatile marketplace.

A vast number of students from different parts of the state are trained within the portals of our institution. The college is situated at Pazhoor, in Kuttippuram, Kerala.

Vision of the Civil Engineering Department

Emerge as a department of excellence to produce technically competent and ethically strong Civil Engineering Professionals for serving the industrial and societal needs.

Mission of the Civil Engineering Department

- M01 :- *To prepare the students to excel in their profession with technical expertise.*
- M02 :- *To provide conducive learning environment to mould civil engineers of high standard.*
- M03 :- *To develop professional responsibility among students to uphold ethical values and principles of sustainable development.*

Principal's Message



I am happy to meet all of you through "PROJECTION" and I thank all the staff who strived to give professional education in a new perspective manner and achieve perfection in all the fields. The main reason for our tremendous performance in various activities is the involvement of the faculty members who motivated students whole heartedly to participate in the seminars, industrial visit, inter activity session and other extracurricular activities to inculcate in them sound moral values, strong personality and eagerness to work in the society. Because of these efforts we have been successful in molding the personality of our students and imbibe in them moral values and the spirit to team work.. I wish this solidarity continues for successive years and we would be proud to release many more magazines like this, highlighting our student's activities.



P H Subair
Principal



HOD's Message

The greatest asset of the department is its highly motivated and learned faculty. The available diversity of expertise of the faculty with the support of the other staff prepares the students to work in global multicultural environment. We have hoped that we will continue to deliver our best to serve the society and mankind. It is also expected and that our students will continue to pass-on the skills which they have developed during their stay at this department to whole of the world for a better society. We will be happy to receive your suggestions for further improvement and development of our department.



Sumayya K P

HOD, Civil Engineering

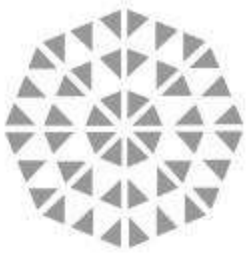


Editorial

It gives me an immense pleasure to present you the second edition of PROJECTION. *Projection* has been published after a lot of efforts by the whole editorial team. *Projection* is nothing but the outcome of creativity and seriousness in the technical field showed by both the students of civil department and staff. It is and always will be a platform for the students to showcase their talent whether it be technical, cultural or sports field. Here students get the chance to post articles on their area of interest and also the trending topics in the field of Civil Engineering. *Projection* focuses not only the trending topics in civil engineering but also the achievements of students and staff which reflect the emerging talents of Civil Department. As a promising branch at KMCT, the Department of Civil has ensured to provide an overall growth and development of the students in all aspects.



Uthara K
Editorial Desk



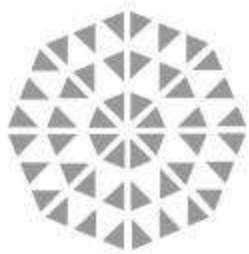
PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Program Educational Objectives (PEOs) are Broad Statements that describe what Graduates are expected to attain within a few years of Graduation. Program Educational Objectives are based on the needs of the program's Constituencies.

PEO1 : Shall excel in Industry, in higher studies, research and as entrepreneurs.

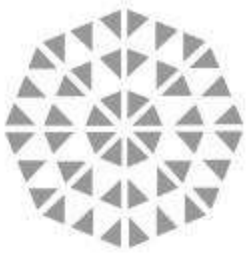
PEO2 : Shall acquire profound knowledge in civil engineering leading towards innovation and creativity in solving societal problems.

PEO3 : Shall have good communication skills, interpersonal skills, managerial skills, leadership skills, ethical values and understand the need for lifelong learning.



PROGRAMME OUTCOMES (POs)

- PO1 : **Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.
- PO2 : **Problem analysis:** Identify and analyse well-defined engineering problems using codified standard methods.
- PO3 : **Design/ development of solutions:** Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.
- PO4 : **Engineering Tools, Experimentation and Testing:** Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.
- PO5 : **Engineering practices for society, sustainability and environment:** Apply appropriate technology in context of society, sustainability, environment and ethical practices.
- PO6 : **Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
- PO7 : **Life-long learning:** Ability to analyse individual needs and engage in updating in the context of technological changes.



PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1 : **Field Practice and Social Worth:** Apply the acquired knowledge of civil engineering in field practice for betterment of society.

PSO2 : **Successful career and entrepreneurship:** Apply knowledge and understanding of engineering principles to excel in career or entrepreneurship.

STUDENT'S ARTICLES



Contour Crafting

Student : Midhun K Jayendran (CS4B)

As we already know the world population has now exceeded the 7 billion mark, and if the prognosis of the United Nations comes true, there will be 9.2 billion people in 2050. As the case is today, most of the people will want to live in the megacities because they promise a better life and wealth. Due to this, the population density in the cities would increase like never before. This would lead to redevelopment and slum rehabilitation projects to be under taken on large scale. Imagine a situation wherein a huge bunch of people will need an urgent space to live in. Thus, a situation will arise whence the cities will have to grow rapidly but also sustainably, keeping in mind the environmental effects and also the economy. Contour Crafting is an emerging technology that uses robotics to construct free form structures by repeatedly laying down layers of material such as concrete. This has a great potential in automated construction of whole structures as well as sub-components. Using this process, a single house or a colony of houses, each with possibly a different design, may be automatically constructed in a single run. Tool path planning and optimization benefits the technology by increasing the efficiency of construction of complicated structures. This research has intended to provide a systematic solution for improving the overall system efficiency and realizing the automation of the CC technology for building custom-design edhouses. CC can automatically construct custom-designed structures by repeatedly laying down construction material. CC has the capability to fabricate with thick layers using various materials and without compromising surface quality unlike other automation methods.

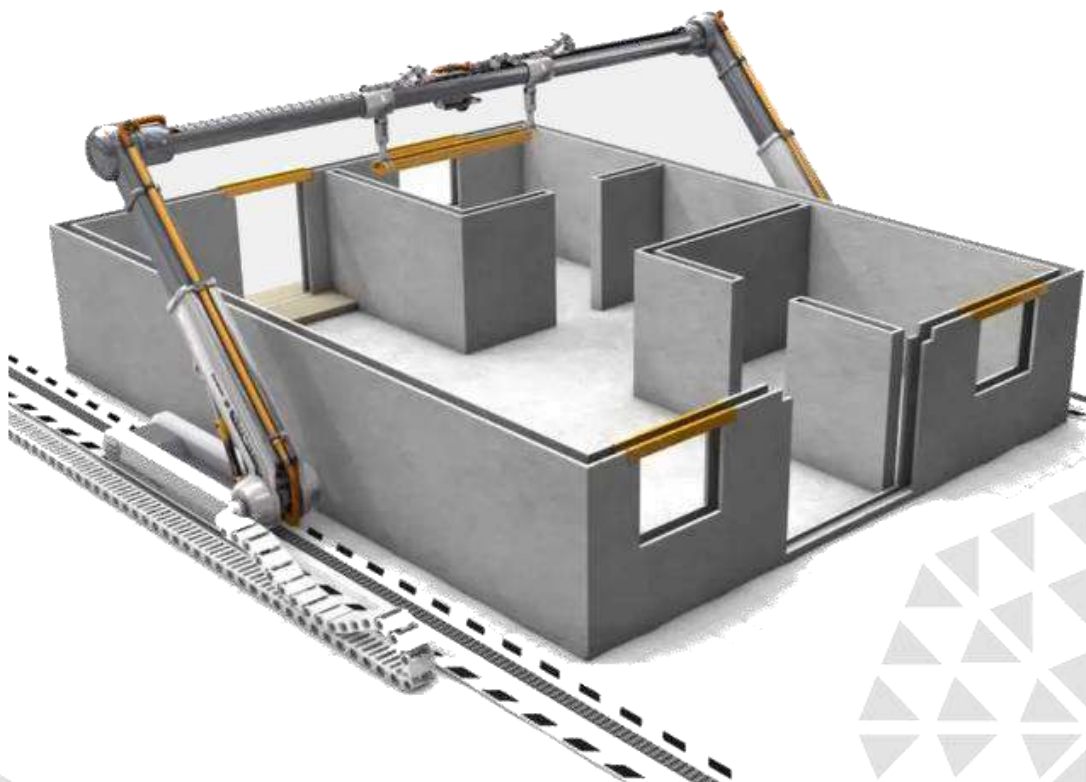


Fig. Symbolic image

Bamboo As A Construction Material

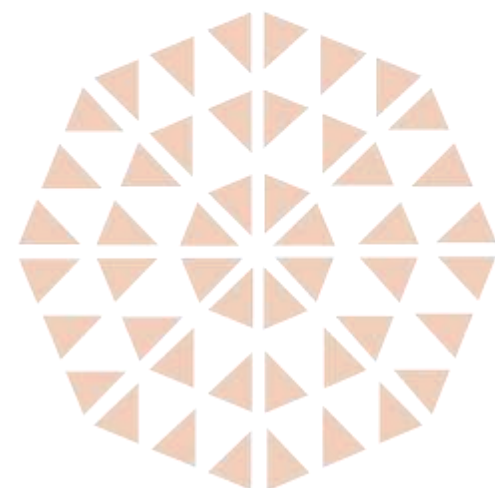
Student : Midhun K Jayendran (CS4B)

Bamboo has always been considered a weak building material to be used in construction. The diminishing wood resource and restriction imposed on felling in natural forests, particularly in the tropics, have focused world attention on the need to identify a substitute building material that should be renewable, environment friendly and widely available. In view of its rapid growth and ready adaptability to most climatic conditions and properties superior to most juvenile fast growing plants, bamboo emerges as a very suitable alternative. This report deals with some of the main properties and the major uses of bamboo and its culms. It also recommends on the various preservation techniques to be adopted in order to enhance the durability. The bamboo Column or stem has been made into an extended diversity of products ranging from domestic household products to industrial application. Examples of bamboo products are food containers, handicrafts, toys, furniture, flooring, pulp and paper, boats, charcoal, musical instruments and weapons. Bamboo is quite common for bridges, scaffolding and housing but it is usually used as a temporary exterior structural material. In many overpopulated regions of the tropics, certain bamboos supply the one suitable material that is sufficiently cheap and plentiful to meet the extensive need for economical housing. Bamboo can be used for full products and elements such as flooring, ceiling, partition walls, walls, trusses, domes etc.



Fig. Symbolic image

Since time immemorial, bamboo has played an important role in the development of mankind. It is used for a wide range of day-to-day purposes, both as a woody material and as food. It has been the backbone of much of the world's rural life and will remain so as the population increases. The properties as top grade building material and increased availability of bamboo in our country makes it possible to use, bamboo in the field of construction extensively. Its high valued utilization not only promotes the economic development, but also saves forest resources to protect our ecological environment as a wood substitute. As an economic building material bamboo's rate of productivity and cycle of annual harvest outstrips any other naturally growing resource, if today you plant three or four structural bamboo plants, then in four or five years later you will have mature clumps, and in eight years you will have enough mature material to build a comfortable, low cost house.



Parking Management System For KMCT Institutions

Student Name : Sayyid Fazil (CS₆B)

Parking is the act of stopping and disengaging a vehicle and leaving it unoccupied. As we all know that world's population is increasing day by day. Increasing population increases the vehicle use too. So, now parking has become a major issue now a day. We need to study the parking pattern so that we can improve the parking facilities. This project consist of planning, analysis and design of parking lots for five college of KMCT institute Kuttippuram. In each college the number of students and their ground is different, so five colleges needs five different parking lots. In off street parking, there are so many types of parking available. Here we take Surface parking (parking lot). Also we consider future, so we planning electric charging stations inside the lots.

Having a proper parking system will reduced Congestion, operational and management costs increase driver's experience, safety and also city development. With efficient parking management solution, drivers can spot parking spaces faster which reduces the fuel cost, saves time and not to forget reduces the frustration level. As parking management solution help find vacant spaces faster therefore it boosts vehicle park occupation levels.

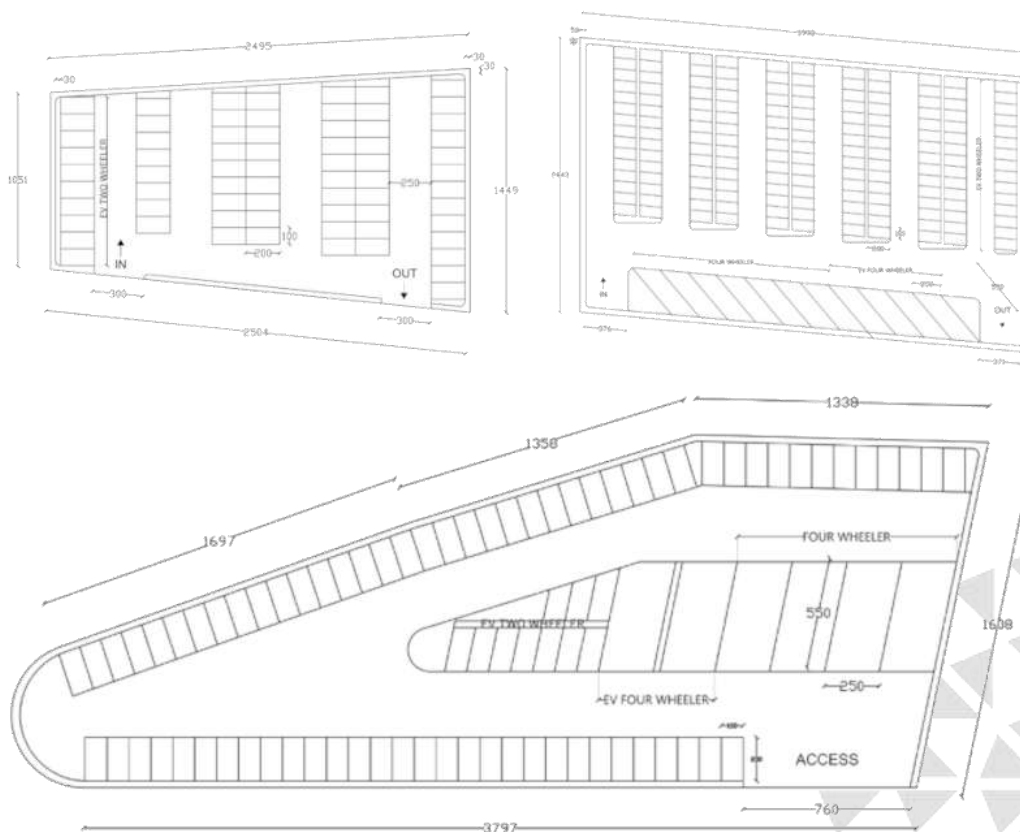
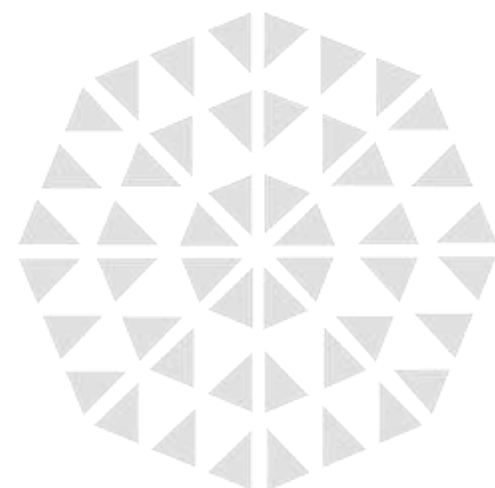


Fig. Symbolic image

Planning Analyzing And Designing Of Commercial Building

Students : Abhijith AS, Midhunlal K, Safla PV, Harwin T I, Faseeha CM, Hisham Abdul VM

This project includes the layout of G+3 residential building using AutoCAD, Analysis and Design using STAAD Pro and concludes the entire project. The layout of the proposed G+3 residential building is according to the new plan it will be used as a multistoried residential building. The 4 floors will be divided into 8 apartments each having an area. All the drafting was done using AutoCAD. Also these drawings made on AutoCAD also served as a base for transfer of the structure for analysis and design into STAAD The analysis and design of the entire structure has been completed using STAAD pro. The results include the various forces acting on various members as well various schedules for various members. Also using the software we got the concrete take-off as well as the weight of the various reinforcement bars thus easing the load of cost estimation. The foundation has been designed as an isolated footing using soil condition as medium. The foundation design values were calculated using STAAD Foundation.



Comparitive Study of AAC Block with Laterite Stone, Hollow Concrete Block and Clay Brick

Student : Sudi CP (CS6B)

Cement Blocks are widely used construction and building material around the world. Many researchers are actively working to find new and improved methods of compacting the waste disposal concern, particularly by establishing useful and economic utilization of waste material.

tion. Cement is an extremely important component of building materials which is used for housing and infrastructures. Cement processing requires a high level of energy consumption.



Fig. Testing Facility

Efforts to improve the environment, through conversion of waste materials into useful construction products and this has created a large scope for sustainable development among building material suppliers and high-end contractors. A block is a single unit of a kneaded concrete material cured and it is used in masonry construc-



Fig. Testing Facility

Despite all the developments made by this industry, environmental and health problems arising from cement production are present all over the world. Emissions from the cement manufacturing processes degrade air quality and result in environmental pollution. The aim of this study is to synthesize some aspects regarding methods of greening concrete, such as alternative fuels, incorporation of agricultural waste, etc., characteristics of this type of concrete, and short and long term benefits to the environment, in line with the most important recommendations of the present legislation. The importance of this review comes from the fact that it shows several aspects about greening cement production, given that the environmental pollution level is directly influenced by the increased demand for this materials.

STAFF ARTICLES



Stabilization of expansive soil treated with tile waste

Lecturer, HOD : Sumayya KP

Expansive soils are so widespread that it becomes impossible to construction. Many avoid them highway for agencies, highway private organizations and researches are doing extensive studies on waste materials and research projects concerning their feasibility and environmental suitability. Swelling of expansive soils causes serious problems and produces harm to many structures. Many research organizations are doing extensive work on waste materials concerning the viability and environmental suitability. Expansive clays are the most problematic soils due to their unique alternate swell-shrink behavior with fluctuations in moisture content. World over, many case studies of failed structures built on expansive soils have been reported. The situation in India is also no different with extensive coverage of expansive soils that occupy almost one fifth of the geographical land area. It is an established fact that suitable site conditions are not available everywhere due to wide variations in the subsoil specially the presence of treacherous soils pose a challenge to the civil engineers. To put the infrastructure in position, there is no other-go but to improve the sub soil for expected loads and make them suitable for the type of construction planned. Further, it is to be stated that the road alignment is constrained due to accessibility and connectivity criteria, which invariably may encounter expansive soils enroute and hence it becomes imminent to improve their load carrying capacities due to traffic operations with suitable treatment to the in-situ soil in general and expansive soils in particular. The earlier ceramics were pottery objects made from clay, either by itself or mixed with other materials, hardened in fire. Later ceramics were glazed and fired to create a colored, smooth surface. The potters used to make glazed tiles with clay, hence the tiles are called as "ceramic tiles".

Objectives and Scope

Objective

- To study the effect of tile waste on the properties of soil.
- To determine the suitable material for the soil samples collected.
- To study the subgrade strength characteristics of stabilized clayey soil by studying the variations of California Bearing Ratio (CBR) values under soaked and unsoaked conditions

Scope

In many areas of Kerala, the main problem in construction is the poor bearing capacity of the expansive soil. Most of these areas are covered with clay of very soft consistency. Hence it is necessary to find some methods to improve the expansive soil and thereby make it suitable for construction. Now day's tile wastes are widely used for soil stabilization. Tile waste is readymade material, cheap, easy laying in field and biodegradable.

Methodology

The material used in this project is expansive soil which is taken from the paddy field. Tile wastes are used throughout this project to reinforce the soil. Tile waste was obtained from Euro-Tech Pvt. The natural water content of the given expansive soil is obtained. Consistency limits were obtained. Liquid limit was obtained using Casagrande's apparatus. Plastic limit was determined by rolling soils into threads of 3 mm diameter. Shrinkage limits was found out by preparing shrinkage pats and using mercury. The soil samples are compacted using Modified proctor test. About 6 kg of soil passing through 4.75 mm sieve is compacted in a mould of 150 mm diameter and 127.3 mm height using a rammer of 4.89 kg with a free drop of 450mm. The Optimum Moisture Content (OMC) of the soil sample was determined.

California bearing ratio test under unsoaked condition was done using the obtained optimum moisture content (OMC) to evaluate the suitability of subgrade soil. A graph was plotted between penetration (mm) and load (kg) using the obtained values. California bearing ratio (CBR) values corresponding to 2.5mm and 5 mm penetration was calculated. The higher of these values was taken as the CBR value.

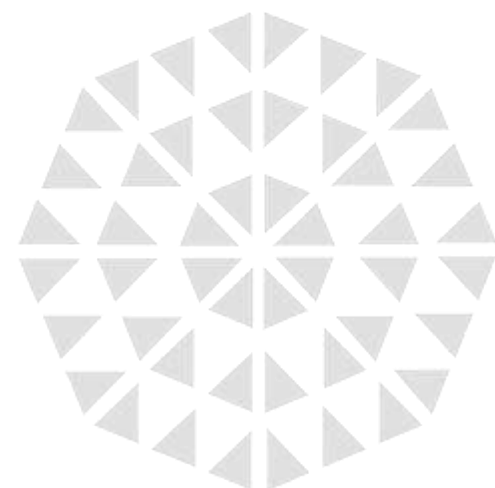
Sample was prepared by replacing the expansive soil by hand rammed tile waste of 4.25mm passing and 75 micron retained. The rammed tile waste replacing in percentage of 10%, 20%, 30%, 40%. The each sample is compacted using Modified proctor test and Optimum Moisture Content (OMC) of the each soil sample was determined. California bearing ratio test was done by replacing expansive soil with tile waste. The California bearing ratio (CBR) values were noted. The California bearing ratio (CBR) test is also to be conducted under soaked condition. Then, the test was repeated by replacing of tile waste by percentages of 10%, 20%, 30%, and 40%. California bearing ratio (CBR) values corresponding to 2.5mm and 5 mm penetration was calculated.

Conclusions

The various samples of soils were collected from paddy field.

- The natural water content of expansive soil sample was obtained as 75.3
- The specific gravity of the expansive soil sample was found to be 2.68.
- The liquid limit, plastic limit and the shrinkage limits was found to be 65.56

- Using the Indian standard classification system, the soil was classified as expansive soil (inorganic clay of high plasticity).
- The optimum moisture content for the expansive soil sample is 20.02
- Using this optimum moisture content, the California bearing ratio test was done and its value is 3.406
- Addition of tile waste up to 30% decreases the values of liquid limit, plastic limit and optimum moisture content. And increases the values of shrinkage limit, maximum dry density, unconfined compressive strength and California bearing ratio (CBR).
- After 30% addition of tile waste the values are opposing the corresponding values and lose the soil properties.
- So that from the obtained results preferable addition of tile waste is 30% having maximum stabilization and economic considerations for expansive soil.



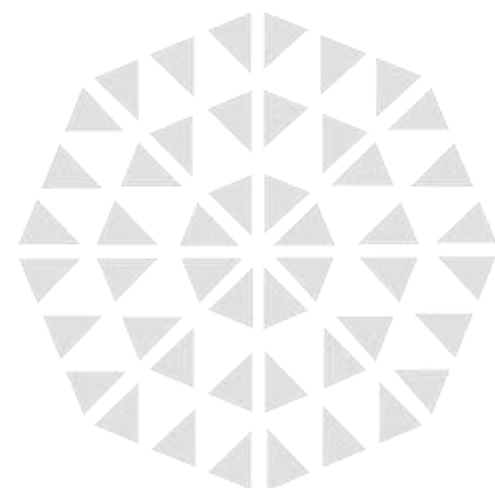
History of Civil Engineering

Lecturer : DhyuthiRaj A

Civil engineering is the application of physical and scientific principles for solving the problems of society, and its history is intricately linked to advances in understanding of physics and mathematics throughout history. Because civil engineering is a wide ranging profession, including several separate specialized sub-disciplines, its history is linked to knowledge of structures, materials science, geography, geology, soils, hydrology, environment, mechanics and other fields. Throughout ancient and medieval history most architectural design and construction was carried out by artisans, such as stonemasons and carpenters, rising to the role of master builder. Knowledge was retained in guilds and seldom supplanted by advances. Structures, roads and infrastructure that existed were repetitive, and increases in scale were incremental. One of the earliest examples of a scientific approach to physical and mathematical problems applicable to civil engineering is the work of Archimedes in the 3rd century BC, including Archimedes Principle, which underpins our understanding of buoyancy, and practical solutions such as Archimedes'screw. Brahmagupta, an Indian mathematician, used arithmetic

in the 7th century AD, based on Hindu-Arabic numerals, for excavation (volume) computations.

In general, civil engineering is concerned with the overall interface of human created fixed projects with the greater world. General civil engineers work closely with surveyors and specialized civil engineers to design grading, drainage, pavement, water supply, sewer service,dams, electric and communications supply. General civil engineering is also referred to as site engineering, a branch of civil engineering that primarily focuses on converting a tract of land from one usage to another. Site engineers spend time visiting project sites, meeting with stakeholders, and preparing construction plans. Civil engineers apply the principles of Construction and Building Materials, Structural and Earthquake Engineering, Rock Mechanics and Geotechnical Engineering, Environmental Engineering, Water Science and Engineering, Transportation Engineering, Ocean and Marine Engineering, Urban Engineering, and Surveying Engineering to residential, commercial, industrial and public works projects of all sizes and levels of construction.



Assessment Of Weather Impact On Traffic Charecteristics

A Case Study In Thiruvananthapuram

Lecturer : Uthara K

Adverse weather conditions significantly affect traffic flow patterns and travel behaviour of commuters. The paper examines the influence of inclement weather conditions (rainfall and hot climate) on traffic flow parameters (traffic volume, speed, road capacity) and traffic density (occupancy and composition) in different road sections in urban, semi urban, and rural areas in Thiruvananthapuram city, Kerala. The variation of traffic volume, speed, composition, capacity, volume-capacity ratio, vehicle occupancy examined in three different road sections. The continuous monitoring system of traffic patterns in the city is not available; henceforth, the observation was made manually and tried to observe the same during normal and inclement weather conditions. An understanding of the impact of weather on traffic is necessary for a realistic estimation of traffic conditions. It was observed that reduction in traffic volume predominantly found in the rural section. In the rural road, about 8% reduction took place in case of two wheelers composition and 13% increase was observed in case of cars. In the urban & semi-urban roads, the reduction in two-wheelers and an increase in car composition was about 5%-10% when the weather changed from clear to rainy.

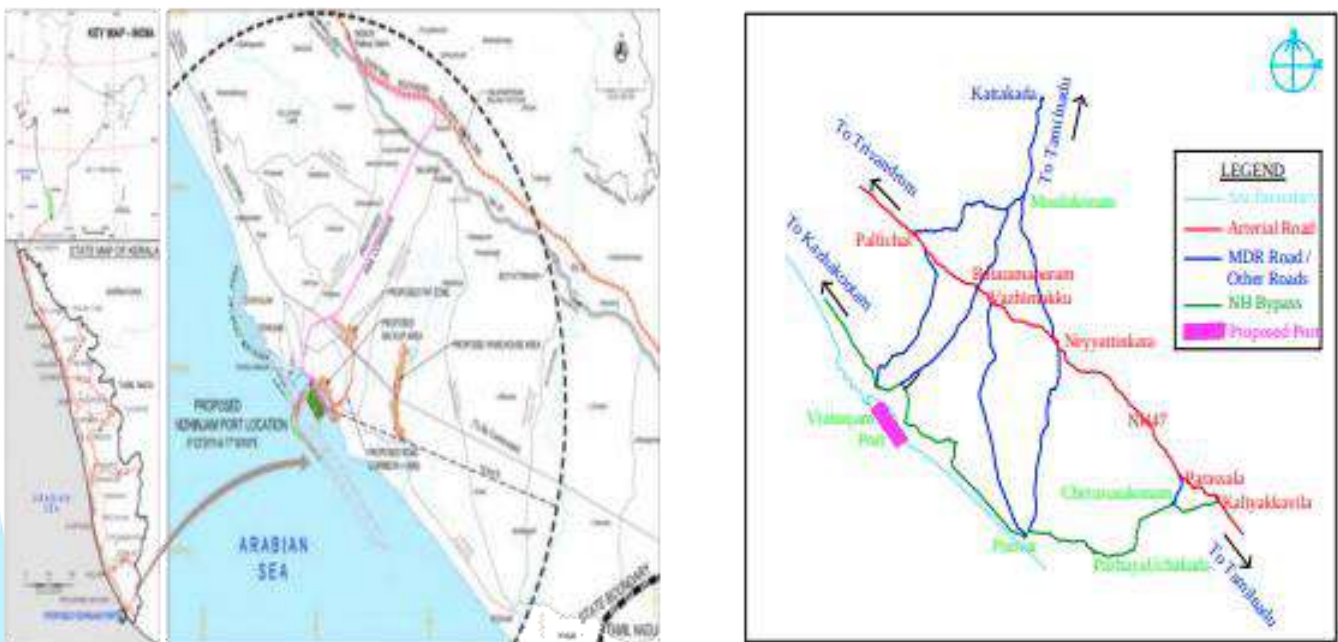


Fig. Study Area

The Latest Trends in Concrete Technology

Lecturer : Najiya sherin MV

Technology plays a bigger role in our lives every day, and it is no different for the concrete industry. Contractors and construction companies know they must embrace new concrete technology in order to survive.

Reasons include climbing construction costs, the always-increasing need for improvements in efficiency, and a shortage of skilled labor. A recent US Commercial Construction Index found that more than 90 percent of contractors, construction managers, and builders surveyed had a hard time finding skilled workers.

Contractors and companies can overcome these challenges by leveraging the latest trends in concrete technology.

The top 10 trends in concrete technology

Building Information Modeling (BIM)

At the most basic level, BIM is 3D design and modeling software that gives architecture, engineering, and construction (ACE) professionals tools and insight into the planning, design, construction, and management of projects.

BIM has been around for decades, but as the technology has advanced, it has become more than just a 3D model. It is a collaborative process that allows all relevant parties on a project to work together. Within a BIM model, there are BIM objects which have a layer of intelligence built into them. If an element in the model changes, the BIM software updates the model, creating a collaborative and consis-

tent environment in which architects, engineers, and contractors can work together. The BIM model stores data, which is kept in a common data environment (CDE). The data provides valuable and actionable information, not only during the planning and design process, but throughout the build and beyond. It can even be referenced for renovation work in the future.

There are different levels of BIM, ranging from zero to three. A higher level indicates an increased flow of information and knowledge sharing during the entire process.

For the construction industry, BIM enables you to digitize the work site and connect important information for all phases of the project. It improves the supply chain and reduces waste, mistakes, and delays.

The specific benefits of BIM include:

- Improved communication and collaboration throughout the project
- Improved productivity
- Simpler and more reliable design process, reducing errors in the execution phase
- Increased transparency of information that can be used during the bidding and procurement process
- Earlier identification of errors
- Fewer change orders
- Shorter project timeline
- Higher quality product

Leading BIM software includes Autodesk BIM 360, Revit, and BIMx. As



Figure 1: Symbolic image

the construction industry moves more towards collaboration and digital technology, BIM will become increasingly popular. In fact, in some countries the use of BIM is already mandated on certain projects. In response to this increased use, the International Standards Organization (ISO) recently published the first set of global standards for BIM to help contractors around the world collaborate more effectively.

Intelligent equipment

IoT sensors and GPS trackers on concrete construction equipment can improve the production cycle and allow for predictive maintenance. Contractors can monitor cement mixers and other equipment for health, receiving an alert when something is askew. Assets can be tended to at the first sign of an issue. Problems can be addressed before they become a major

headache and hold up a job. GPS trackers keep foremen up to date in real time when cement trucks are on the move. This data empowers foremen to plan jobs accordingly and react quickly, working around delays when they happen.

Ultra-High Performance Concrete (UHPC)

UHPC is a new concrete technology that contains several novel ingredients, including fibers, but retains 80% stainless steel, with each delivering additional strength and durability to the end product. UHPC has a longer useful life of more than 75 years, compared to traditional concrete with its useful life of 15-25 years. It also has a compressive strength of roughly 30,000 psi as compared to the typical 4,000 psi for traditional concrete. Additional benefits include remarkable resistance to moisture penetration and environmental degradation, flexibility, ductility, and adhesiveness. UHPC has been around since

2000, but over the past few years, the US Federal and state governments have advocated for its use, specifically in US bridges and highways. Due to the governmental support for UHPC combined with its superior quality and durability, we expect adoption to spread quickly. In fact, the global market for UHPC is expected to grow at a Compound Annual Growth Rate (CAGR) of 6.92 percent between 2017 and 2023.

Off-site construction

Off-site construction refers to the design, fabrication, and assembly of elements at a location other than at the actual site where they will be installed. Precast/prefabricated concrete is one of the most common off-site techniques used during construction jobs. This approach used to be reserved for larger projects, but as skilled labor dwindles and projects need to be done more quickly, the move to off-site has increased. Benefits include efficiency, improved safety, cost reductions, speed, and more consistent quality.

Self-healing concrete

When concrete cracks, water and air get in, which speeds up the degradation of the concrete. What if concrete could stop the degradation process and heal itself? Innovations are taking shape with a concrete that contains bacteria which produces limestone when it comes into contact with water and air, repairing the crack. This self-healing concrete is being made for new mixtures, as well as a repair mortar for existing structures. Other self-healing techniques being researched include hydrogels that swell when water gets

in and capsules of polymers that break when cracks form. Once broken, the polymers inside the capsule seal the crack. Of course, these more advanced types of concrete will cost more money initially—but if they can extend the life of concrete structures, they may be less costly in the long run.

Graphic concrete

Visual interest and design are united in graphic concrete. This technology is used on precast concrete to create a patterned surface. Images can be applied as well. The concrete itself lasts just as long as the plain version. The addition of this aesthetic element to concrete makes it a more favorable choice on projects where plain concrete would seem too plain or boring.

3D printing

Concrete 3D printing provides many benefits. Unique concrete designs can be crafted that may have formerly been impossible. Affordable homes can be made for lower-income families or those recovering from a disaster. Production time on projects can be drastically reduced. Of course, this is still a newer technology, and we don't expect to see its use in large-scale projects, as the size of the printer limits the size of the item that can be created. However, cost savings, the ability to produce complex structures, and urbanization will all drive the adoption of 3D concrete printing.

Light-generating cement

Cement that can absorb and radiate light has been developed by José Carlos Rubio Ávalos in Mexico. The cement can be created at room temperature, which is a huge

energy saver. It can light up roadways, bridges, bike paths, and more—all without electricity. So how does it work? The cement absorbs solar energy during the day and can then emit light for about 12 hours. In order for this to be possible, the crystallization in the cement was removed so light could pass inside. It was replaced with a gel consistency. The product can currently emit either green or blue light, and the brightness can be adjusted during production.

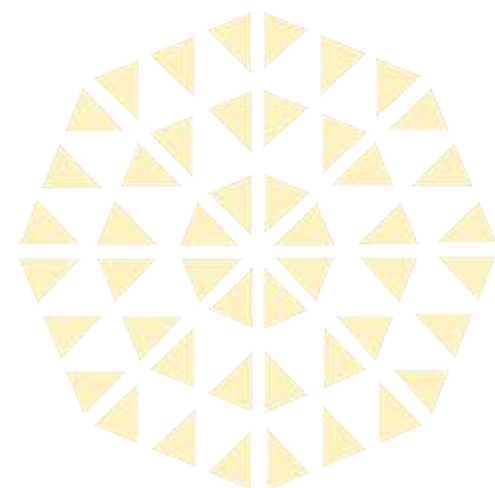
Translucent cement

Slightly different from light-generating cement, translucent cement allows light to transmit through it. This quality comes from optical fiber strands within the concrete. Just how translucent is it? You would be able to clearly see the outline of something on the other side of the ce-

ment block or wall, yet it still offers the same strength as regular concrete. It is being used in structures such as partition walls and stairs to add a design element to what would have been an otherwise plain concrete structure.

Drones

Drones are already being used on construction sites. We expect usage to increase. A primary use is site surveys, which can be done in a fraction of the time with drones. While some companies were reluctant to use drones at first, their increased accuracy, ease of control, and time savings have made them attractive to many construction companies. As we look ahead, knowledge of new approaches, tools, and innovative materials can make the difference between a winning and losing bid.



Seismic Performance of Soft Storey Behaviour in Irregular Steel Frames using Different Bracing Systems

Lecturer : Shajeea

Nowadays, the earthquake and seismology is of utmost importance for structural engineers around the globe. Braced frames are popular ones to resist seismic excitation with less deformations in comparison with gravity load resisting system as there is a formation of stiff systems. This paper mainly presents innovative braced frames such as hexa and octa-braced frames to know the effect of soft storey in a steel frame. The steel frame used in this paper is (G+20) irregular frames. A comparison is made between a symmetrically irregular and asymmetrically irregular frame.

As there are no proper methods to know the time and intensity of earthquakes, it is of utmost importance to have a proper infrastructure. In this paper, V, Hexa, Octa and Zipper braced frames are used. Dynamic analysis is performed for irregular frames and the parameters considered are Storey displacement, Storey drift and Storey shear. ETABS 2017 Software is used for analysis. From the analysis performed results reveal that there is a better improvement in seismic performance with the addition of bracings.

Introduction

Steel structures generally needs less construction time and larger span feasibility and has better seismic resistance than reinforced concrete structure, which are known facts and thereby popularity of steel is increasing nowadays. Braced

frames are generally classified into concentrically braced and eccentrically braced frames. Members of steel frames are made by using structural steel and thereby it works effectively intension and compression zone. Softstories may be located at top, bottom or intermediate points, so that the floor above or below may be stiffer compared to itself. Structures in seismically active areas are subjected to lateral earthquake forces, in addition to primary gravity loads. The intensity and properties of earthquake are generally detrmind by the performance of a building during earthquake. For the first time in a study, N.Mashhadiali and A.Kheyroddin[2] investigated the structural behaviour of hexagrid system, thereby the idea of hexa-braced frame is arisen which is used in this paper.

The simple parameters that are used to determine the stiffnes of frames are storey displacement, storey drift and Storey shear. Storey displacement is defined as the displacement of a storey with respect to the base of a structure. Storey drift is the lateral displacement of one level of multistoried building relative to the level below. The seismic force to be applied at each floor level is defined as Storey shear. Bracings are economical method to laterally stiffen the frame structures against wind and gravity loads. As the trend of constructing tall buildings is increasing, it is of utmost importance to find cost effective structural forms.

In this paper, four different types of bracings are analysed under dynamic analysis with same frame property. The analytical study is carried out by using ETABS 2017.

Scope and Objective of the Study

Various types of bracing are selected for the study. Work is restricted to irregular frames with geometric irregularity. The main objective of the study are as follows:

- To investigate the performance of symmetrically irregular and asymmetrically irregular frames with and without bracings.
- To investigate the dynamic performance of V, Hexa, Octa and Zipper braces for symmetrically and asymmetrically irregular frames.

Modelling and Analysis of Frames

A 20-storey structure which is not actually constructed, but they meet with seismic code representing low, medium and high rise buildings which are designed for Los Angeles, California region is selected for the study.

Specifications

20 storey benchmark building which is 30.48m by 36.58m in plan and 80.77m in elevation. Bays are 6.1m on center with 5 bays in North-South direction and 6 bays in East-West direction. The building has two basement levels. The level directly below the ground level is first basement (B-1) and level below this is second basement (B-2).
Basement level height : 3.65m
Ground level height : 5.49m
1st – 19th level height : 3.96m

The interior and corner columns are same. Columns are box columns with ASTM A500 Column Splices, which are seismic or tension splices to carry bending and uplift forces. Beams are of section W30x99 at B2 – 4th level and 11th-16th level. W30X108 at 5th-10th level, W27X84 at 17th-18th level, 19th and 20th level has beam sections W24X62 & W21X50. The brace members are square hollow sections : HSS5X5X1/4; D.E Nassani.et.al. The steel yield stress is $f_y = 250$ and 345 MPa.

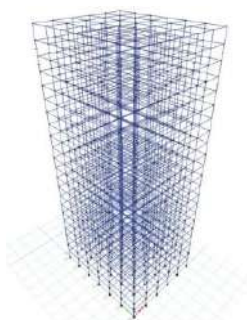


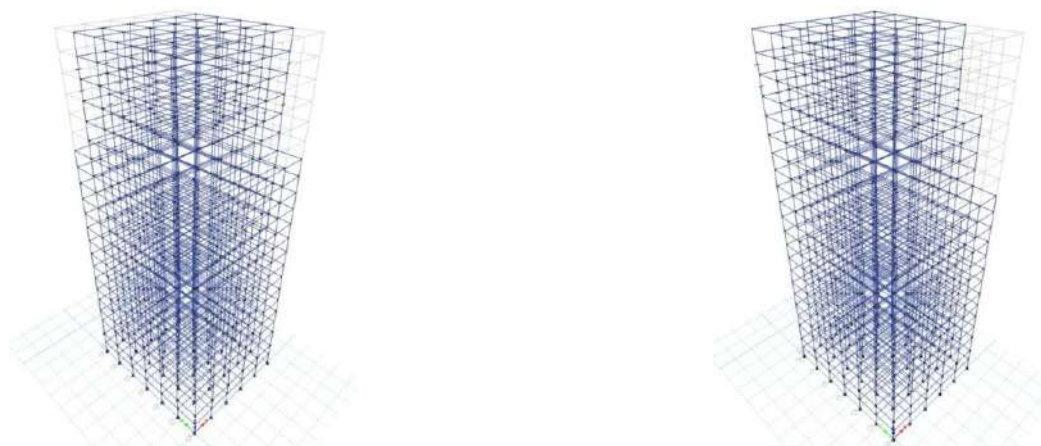
Figure 2: 3-D View of Bare Frame

Modelling of Frames

For the evaluation of seismic response of frames under seismic loading in case of time history analysis, frames were subjected to earthquake ground acceleration of El-Centro 1940 NS earthquake. As per the specifications above, the bare frame is as given in Figure 1.

In this paper, symmetrically irregular and asymmetrically irregular frames were modelled. For modelling symmetrically irregular frames, 10 bays were removed from 20th to 15th storey and for modelling asymmetrically irregular frame, 10 bays were removed from 20th to 17th storey and 5 bays were removed from 16th to 13th storey. Thus a total of 60 bays were removed from each frame. Result analysis were as shown in Table1. For analysis purposes, braces were inserted into the middle frames and dynamic analysis were performed. Parameters considered are Storey Displacement, Storey Drift and Storey Shear.

Elevation view of Asymmetrically irregular frame with different types of bracings are shown in fig4, fig5, fig6 and fig7.



(a) 3-D View of Symmetrically Irregular frame

(b) 3-D View of Asymmetrically Irregular frame

Figure 3: Elevation view of Irregular frame

Model	Storey Displacement	Storey Drift	Storey Shear
Symmetrically Irregular	155.939mm	0.006263	1522.22kN
Asymmetrically Irregular	192.19mm	0.007175	1521.37kN

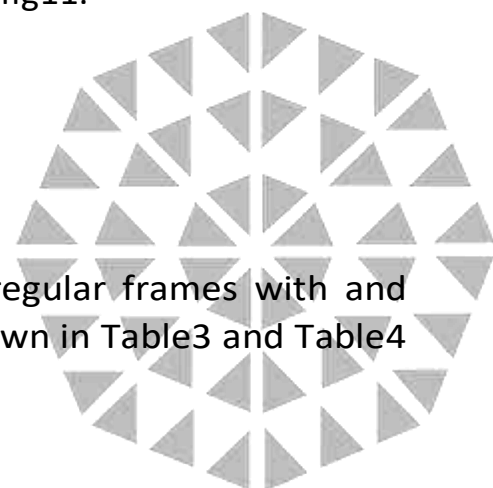
Table 1: Result Analysis of irregular frames

Braces were inserted from top to bottom and in case of V and Zipper bracing whereas in case of Hexa and Octa bracings, hexagonal and octagonal pattern of configuration is as shown in fig5 and fig6 with soft storey in between. Similar analysis is done for symmetrically irregular frames. Elevation view of Symmetrically irregular frame with different types of bracings are shown in fig8, fig9, fig10 and fig11.

Model Description

Results

Analysis is done by using ETABS 2017. Comparison of irregular frames with and without bracings are done. Result analysis of Braces are shown in Table3 and Table4 and respective graphs are shown in graph 1 & 2.



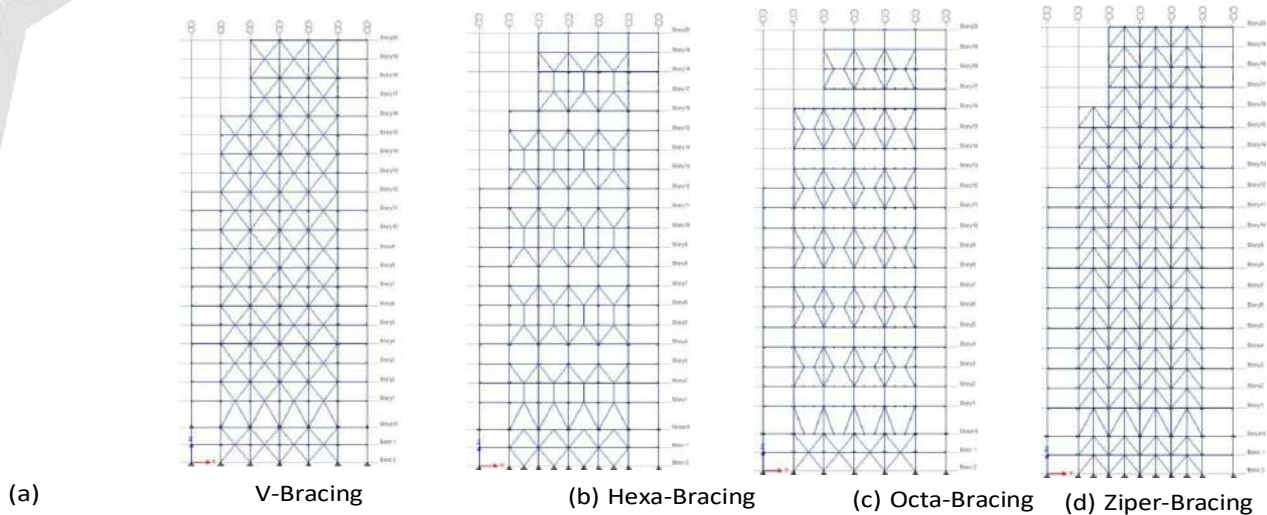


Figure 4: Elevation view of asymmetrically irregular frame

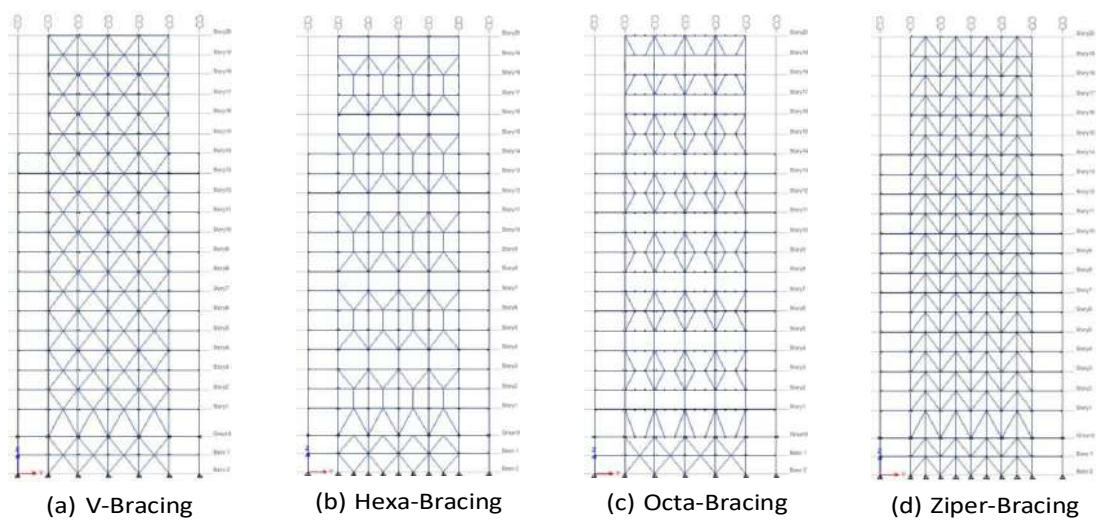


Figure 5: Elevation view of symmetrically irregular frame

The maximum storey displacement occurred at 20th storey. The maximum storey displacement of symmetrically irregular building at 20th storey without bracing is 155.939 mm. From Table 3, it is clear that storey displacement is reduced in case of octa bracing and has a storey displacement of 120.326mm. So, this bracing has more stiffness compared to others. The maximum storey drift of symmetrically irregular building at base 1 storey without bracing is 0.006263. Storey drift is reduced in case of hexa bracing and has a storey drift of 0.00355. The maximum storey displacement occurred at 20th storey. The maximum storey displacement of symmetrically irregular building at 20th storey without bracing is 192.19 mm. From Table 4, it is clear that storey displacement is reduced in case of V-bracing and has a storey displacement of 90.038mm. So, asymmetrically irregular V-bracing has more stiffness compared to all other bracings. The maximum storey drift of asymmetrically irregular building at base 1 storey without bracing is 0.007175. Storey drift is reduced in case of V-bracing and has a storey drift of 0.00277.

With the introduction of bracings, Storey shear is gradually increasing. Symmetrically

MODELS NAME	MODELS DETAIL
<i>S</i>	Symmetrically irregular frame
<i>S_V</i>	Symmetrically irregular frame with V- bracing
<i>S_{HEXA}</i>	Symmetrically irregular frame with V- bracing
<i>S_{OCTA}</i>	Symmetrically irregular frame with Octa-bracing
<i>S_{ZIPPER}</i>	Symmetrically irregular frame with Zipper-bracing
<i>AS</i>	Asymmetrically irregular frame
<i>AS_V</i>	Asymmetrically irregular frame with V-bracing
<i>AS_{HEXA}</i>	Asymmetrically irregular frame with V-bracing
<i>AS_{OCTA}</i>	Asymmetrically irregular frame with Octa-bracing
<i>AS_{ZIPPER}</i>	Asymmetrically irregular frame with Zipper-bracing

Table 2: Model Abbreviations

Models name	Storey Displacement (mm)	Storey Drift
<i>S</i>	155.939	0.00626
<i>S_V</i>	131.465	0.00468
<i>S_{HEXA}</i>	121.588	0.00355
<i>S_{OCTA}</i>	120.326	0.00369
<i>S_{ZIPPER}</i>	133.842	0.00367

Table 3: Result analysis of symmetrically irregular frame with and without bracings

Models name	Storey Displacement (mm)	Storey Drift
<i>AS</i>	192.19	0.00718
<i>AS_V</i>	90.038	0.00277
<i>AS_{HEXA}</i>	125.093	0.004215
<i>AS_{OCTA}</i>	123.054	0.00432
<i>AS_{ZIPPER}</i>	104.679	0.003055

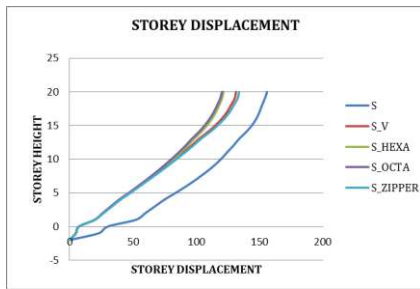
Table 4: Result analysis of asymmetrically irregular frame with and without bracings

irregular octa bracing has maximum storey shear and asymmetrically irregular zipper bracing has maximum storey shear.

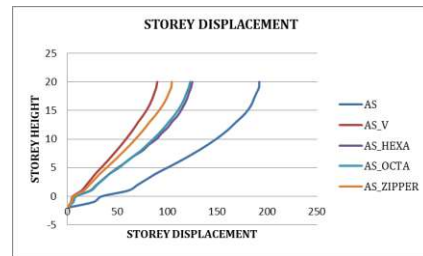
Conclusion

In this work, different type of bracings are used in irregular frames and dynamic analysis are performed. Storey drift and storey displacement are compared.

- Storey displacement is greatly reduced in asymmetrically irregular frame with V-bracing.
- In case of soft-storey mechanism, storey displacement is reduced in symmetrically irregular frame with octa- bracing and has a percentage reduction of 41.087

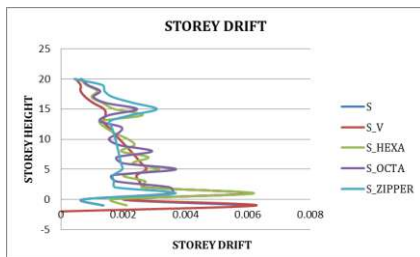


(a) symmetrically irregular frame

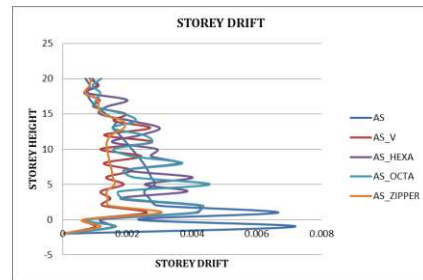


(b) asymmetrically irregular frame

Figure 6: storey displacement of frames



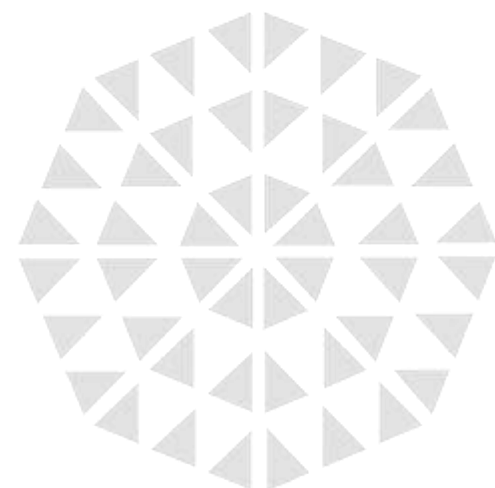
(a) storey drift of symmetrically irregular frame



(b) storey drift of asymmetrically irregular frame

Figure 7: storey drift of frames

- Storey displacement has a percentage reduction of 53.15
- Storey drift is also reduced in presence of bracing system. V-bracing has a percentage reduction of 61
- In case of soft-storey, drift is reduced in case of symmetrically irregular hexa-bracing, and has a percentage reduction of 43.221
- Storey Shear is increasing with the addition of bracings.



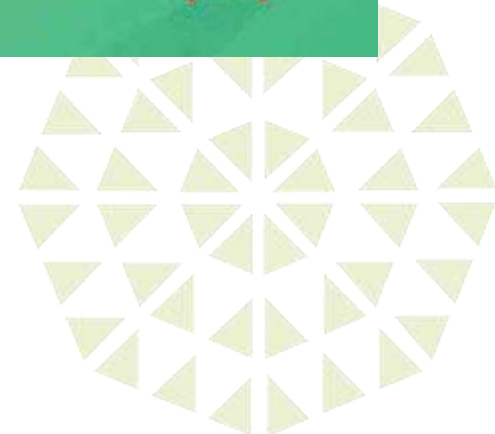
Kerala Silver line Project: What Is It and Why It Is Facing Protests

Lecturer : Minna Rayon

K-Rail, a joint venture between Government of Kerala and Ministry of Railways - Government of India, is all set to revolutionize the very concept of travel in Kerala, with its path-breaking projects that will connect people to places and opportunities like never before. K-Rail will lend a new dimension to the railway infrastructure in Kerala with its super-fast, safe rail services, which will not only make intra-state travel easy and convenient for millions, but also help fast-track the socio-economic development of State – especially the less developed regions. K-Rail will be undertaking end-to-end development and execution work for an identified basket of projects, which include site surveys, preparation of Detailed Project Reports (DPR), attaining mandatory approvals/sanctions and implementation of the sanctioned projects.



Fig. Symbolic Image



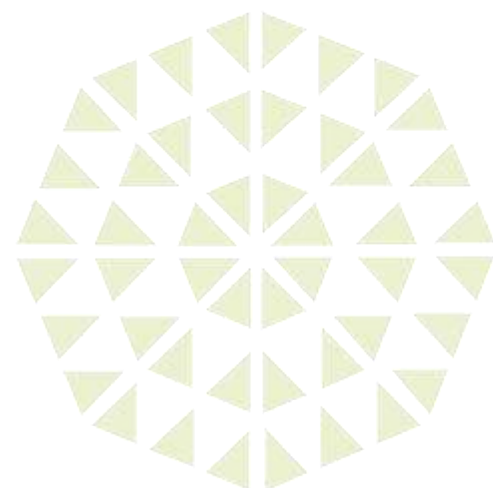
Silver Line: Semi High Speed Rail Corridor

“Silver Line”, K-Rail’s Semi High Speed Rail project, will connect the North and South regions of the State with train services that will operate at a maximum speed of 200 km/hour, reducing the total travel time to less than 4 hours. Silver Line will redefine intra-state travel in Kerala with its high quality, time-saving services and provide efficient last mile connectivity through aggregate and feeder services. This will ensure maximum passenger convenience and encourage more and more people to use public transport. Silver Line is expected to bring about host of positive changes to the way people in Kerala travel by creating a fast, efficient and reliable mode of long-distance transport, which will decongest roads, reduce accidents, minimize air pollution and most importantly, ease the current rail passenger rush.

Why has it led to a major controversy?

- The project has stirred a massive row in Kerala, with experts reportedly saying that the project will displace thousands of families and will also damage the environment.
- The Congress-led opposition members strongly argued in the state Assembly that the mammoth project would cause a huge financial burden and severe environmental damage to the state and would not be beneficial for common men.
- Over 20,000 families have to be displaced for the project and the state has to find out a whopping amount of one lakh twenty-four thousand crore rupees for its implementation. As per NITI Aayog, it might cost Rs 1.24 lakh crore when it nears completion in 2025.
- The state administration claims that the railway line will cut greenhouse gas emissions, while environmentalists have voiced concerns about potential ecosystem harm. They are concerned about the state’s waterways, paddy fields, and

wetlands being irreversibly damaged. They believe this will result in future floods and landslides. Despite the controversy, the Kerala government has said those who oppose the project will not be able to stop it by removing the survey stones. CM Vijayan has also stressed that an attractive compensation would be paid to people when their land is acquired for the K-Rail project- up to four times the price of land in rural areas and twice as much in urban areas.



Cell Filled Pavements

Lecturer : Uthara K

Cell-filled concrete pavement is the technology developed by IIT Kharagpur, which has proved to be a very promising solution for overloaded vehicles, inadequate drainage facilities, and waterlogging problems. Cell-filled concrete pavement consists of formwork of plastic cells over the compacted subgrade/sub-base, filled with concrete or stones.

Components of Cell filled Concrete Pavement

1. Plastic Cells :

The plastic cells act as both the form and reinforcement for the pavement. The plastic cells are made from reclaimed high-density polyethylene (HDPE) sheets of thickness 0.22 mm to about 0.25mm. These plastic cells can be supplied as rolls of strips 50mm to 100mm wide, depending upon the depth requirement. The strips can be heat-welded or stitched to form cells. A pair of strips can be welded at 300 mm intervals. The third strip is welded to the first pair at 300 mm intervals so that the stitch lies at the center of the previous stitching. The third and the fourth ones are again welded like the first two. Figure 4 shows the plan of a cell.

2. Subgrade :

The subgrade forms the top 300 mm thick portion of the embankment. The embankment subgrade is compacted in two layers, usually to a higher standard than the embankment. If the embankment soil is poor, the top 300mm of the subgrade may consist of good quality material from borrow pits with CBR exceeding five. The subgrade shall be compacted to at least 100 percent of Maximum Dry Density per IS:2729 (Part 7). The expansive black cotton soil (BCS) should be compacted to a minimum of 95% of the maximum dry density with moisture content 2% higher than the optimum.

The subgrade soil of existing roads is expected to have attained the required stability due to traffic, and the CBR test should be done at in situ dry density and moisture content after four days of soaking. A dynamic cone penetration test is carried out to determine CBR values of subgrade quickly, and CBR values corresponding to soaked condition can be obtained from records of similar soils.

3. Subbase :

The subbase consists of laterite boulder consolidation, water-bound macadam, wet mix macadam, crusher run macadam, lime-fly ash-aggregate mixtures, lime sta-



Figure 1: Cell Filled Concrete Pavement.

bilized soil, cement stabilized soil, and others with proprietary stabilizers. Locally available aggregates such as murrum and kankar mixed with lime fly ash may also be used. The locally available materials such as natural gravel/soil aggregate or blended with suitable aggregate fractions of stone, gravel, moorum, sand, or a combination of these materials depending on the grading required.

If the number of commercial vehicles is more than fifty per day, 150mm of cementitious sub base with a minimum 7-day strength of 1.5 MPa is recommended. The subbase should be provided with stone/concrete block, or Brick on edge should be laid on either side of the carriageway projecting 50 to 100 mm above the subgrade/subbase for the confinement and protection. Stone/ concrete block or Brick on end edge should be laid on either side of the carriageway projecting 50 to 100 mm above the subgrade/subbase for confinement and protection.

4. Concrete :

Conventional pavement concrete with 28-day strength of 30 MPa with a slump of about 30 to 50mm can fill up the cell. Super-plasticiser should be used to reduce water requirements for the desired slump. The Roller Compacted Concrete (RCC), as specified in clause 1502 of Specifications for Rural Roads, can also be used for filling up the plastic cells and compacted with a roller.

Construction Procedure of Cell-filled pavement concrete:

1. The construction of embankment, subgrade, and subbase should be done as per Specifications for Roads.
2. A proper camber as applicable to rural roads shall be provided. Drainage layer should be provided in high rainfall areas (annual rainfall exceeding 1000 mm) as laid down in Road Manual.
3. Stone/concrete block or Brick on end edge should be laid on either side of the carriageway projecting 50 to 100 mm above the sub-



Figure 2: Plastic Cells.

- grade/subBase for the confinement and protection of cell-filled concrete.
4. A hard shoulder with proper cath is necessary for the concrete block's stability since trucks traveling close to the edge may damage the unconfined concrete blocks.
5. The width of the hard shoulder should be about 0.85 m on either side of the pavement.
6. Formwork of plastic cells shall be laid across the compacted subbase and put under tension with iron spikes so that cells are close to squares in plan.
7. Nylon threads passing at 10 mm below the top of the cells shall prevent the cells from collapsing while filling the cells with concrete.
8. If any stitch of the cells opens up during tensioning, it should be stapled near the top, middle, and bottom.
9. The concrete shall be filled into the cells to a depth of 120 mm, which is about 20 mm higher than the cell's depth.
10. The iron spikes shall be removed after the cells are filled up with concrete. For RCC, two passes of the roller in static mode followed by two passes in vibratory and another pass in static mode shall be sufficient compaction and a good finish.
11. The number of passes in static and dynamic modes depends upon the texture of aggregates and moisture content.

12. Pan vibrators can be used to compact the conventional concrete having a slump of about 30 to 40 mm.
13. The number of roller passes, the amplitude of vibrations, the depth of loose concrete in cells, and the amount of water to be added shall be determined from the trial run.
14. The concrete's surface shall be covered with wet jute mats or paddy straw to prevent drying during hot weather.

Curing

As the camber of 3 to 3.5% is given for rural roads- wet jute/coir mats and wet paddy straw shall provide better water curing option and light traffic to move on the surface. Water accumulates on the lower side of the mud enclosure in the water ponding method, whereas the higher part becomes dry soon.

Advantages of Cell Filled Concrete Pavements:

1. Use of recycled plastic.
2. As the expansion or contraction joints are not required, and hence maintenance of joints is eliminated.

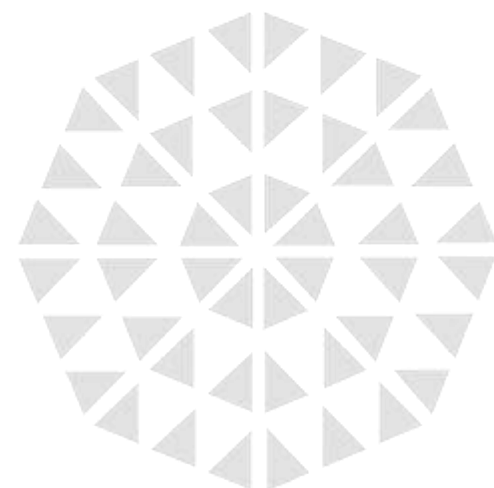


Figure 3: Laying of Cell filled Concrete Pavement.

3. The cost of construction is considerably reduced when compared to conventional cement concrete pavement.
4. The consumption of aggregates is almost reduced to 50 pavements.
5. If the individual block fails, it can be easily replaced without much effort and with the least cost.

Disadvantages of Cell Filled Concrete Pavements:

1. The preparation of the cells is cumbersome.
2. There are high chances of cells getting disturbed while placing the concrete, and hence proper care is required.
3. Due to slow progress, the men and machinery's efficiency is less than the normal construction.



Experimental Study of Using Organic Waste Ash (OWA) Instead of Cement in Concrete

Lecturer : Vijay K

Introduction

Based on the growing need for energy, “waste-to-energy” (WTE) programs seem to be a proper solution, which will use organic wastes as fuel to provide energy and at the same time help to control global warming by reducing the greenhouse gases produced due to improper landfilling of organic materials. Remaining organic waste ash from this process could be used for other purposes such as producing compost or as construction materials. Due to the high price of cement, an eligible replacement for cement would seem a good solution to reduce the final costs of civil projects, in specific in third world countries where economic factors role the main part in the construction of industry. Wood ash (WA) is the residue generated due to combustion of wood and wood products (such as chips, sawdust, bark, etc.), it is organic and inorganic residue remaining after the combustion of wood or unbalanced wood fiber. Wood ash can be used in controlled low strength materials, low and medium strength concrete, masonry products, materials for road base, and blended cement.

Organic waste ash (OWA) used in this study is the residue generated due to combustion of about 80% waste wood (from oak, almond, milk vetch, etc.) and 20% animal waste with total density of 890 kg/m³ which is used in a common WTE program in rural regions of Iran for many years. The generated OWA in rural regions mostly is used as compost, the remaining is landfilled or used to reduce the PH of the soil. On the other hand, for WA, approximately 70% of it is land filled, 20% is applied on land as a soil supplement, and remaining 10% is used for miscellaneous applications including construction materials, and pollution control

Methods and materials

The cement used in this experiment is Portland type 2 with a specific gravity of 3500 kg/m^3 . Saturation density of sand used as fine aggregate in this study is 2440 kg/m^3 . Sand compliance with ASTM standards is shown in Figure 1. In this study scoria with the saturated density of 2550 kg/m^3 is used as coarse aggregate in accordance with ASTM standards. This compliance is shown in Figure 2. OWA used in this study is a mixture of milk vetch ash, oak and almond wood ash, and animal waste ash. The amount of OWA used in this study passing sieve #100(150 μm) and sieve #200(75 μm) was found to be 34.5% and 21.67% respectively.

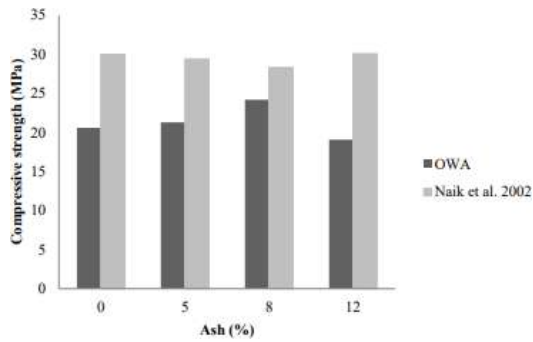
Properties of concrete including OWA Slump test results of concrete containing different percentages (0, 5, 8, and 12% by weight of cement) of WOA are shown in Table , which indicates the inverse relationship between the workability and the percentage of used OWA.

OWA instead of cement(%)	0	5	8	12
Slump(mm)	42	35	29	4

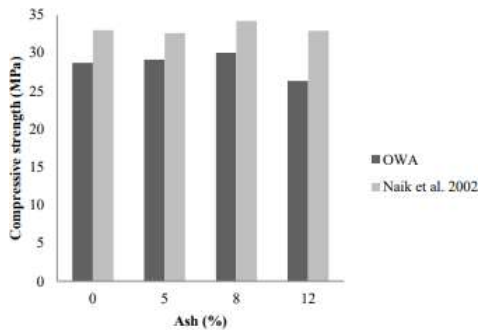
Obtained results showed that by using 5, 8, and 12% by weight of cement of OWA, slump reduced respectively 16, 31, and 90%. It should be noted that by using 20% of OWA instead of cement, slump result was insensitive and all of the concrete samples manufactured by this rate of ash suffered from severe bleeding.

Compressive strength

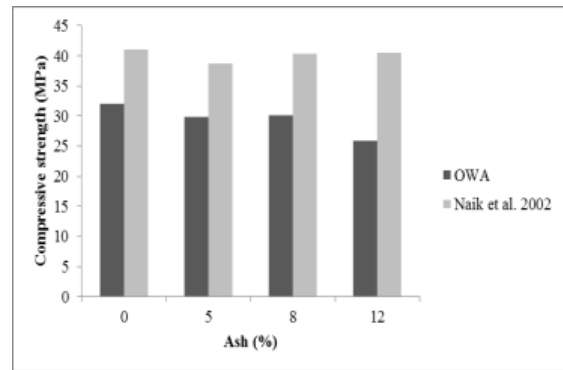
In this experimental study the effect of using 5, 8 and 12% of OWA instead of cement on the compressive strength of produced concrete mixtures have been determined. Naik et al. evaluated the effect of using 5, 8 and 12% of the total cementitious materials of WA as a replacement on the compressive strength of concrete mixtures. Figures indicate the attained compressive strength results using OWA and WA in concrete at the age of 7, 28 and 91 days, respectively.



(a) at age of 7 days



(b) at age of 28 days



(c) at age of 91 days

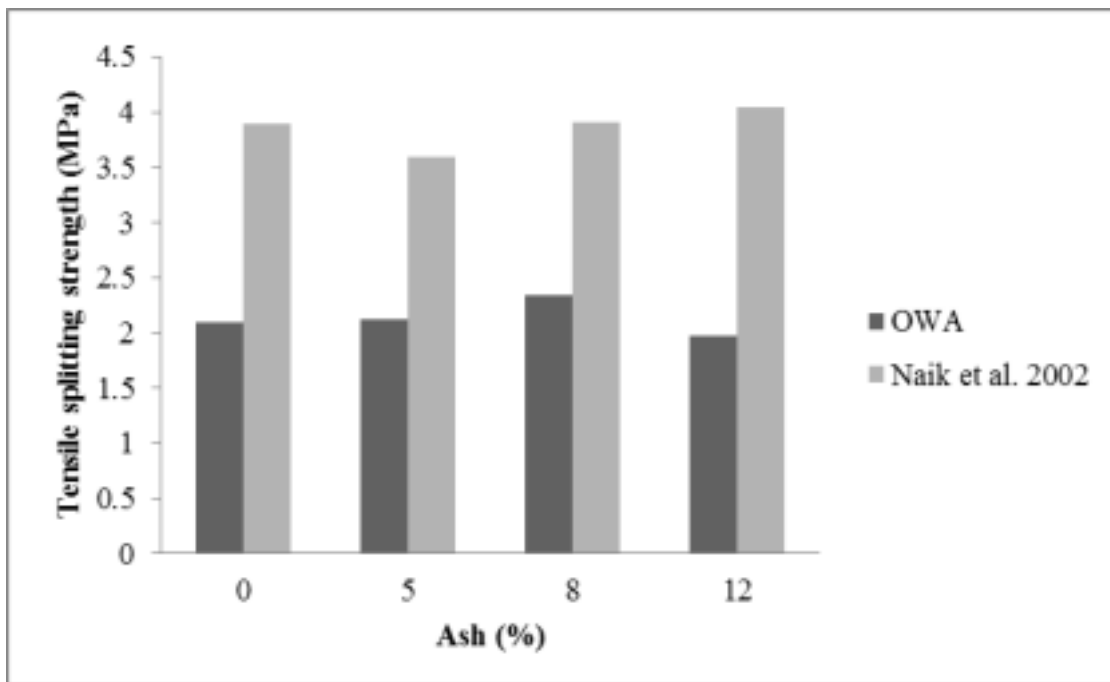
Figure 8: Compressive strength of concrete with OWA and WA

Compressive strength of concrete using 5, 8 and 12% of OWA to the normal mixture were respectively 0.97, 0.85, and 0.93 for the age of 7 days and 0.99, 0.96, and 0.92 for the age of 28 days. Based on the results of both experiments, the highest compressive strength was obtained at the age of 28.

Tensile splitting strength

In this experimental study the effect of using 5, 8 and 12% of OWA instead of cement on the tensile splitting strength of produced concrete mixtures have been determined. Naik et al. evaluated the effect of using 5, 8 and 12% of the total cementitious materials of WA as a replacement on the tensile splitting strength of concrete mixtures

Tensile splitting strength of concrete using 5, 8 and 12% of OWA to the normal concrete mixture were respectively 0.99, 0.9, and 0.94. Based on the results, by using 8% of OWA compressive strength and tensile splitting strength in 28 days would increase respectively 17 and 11%, which makes it the optimum among the rest.



Relationship between compressive strength and tensile splitting strength

To determine the relationship between compressive and tensile splitting strength of concrete, results of following mixtures have been used: Water/Cement ratio = 0.35: mixtures with 5 and 8% of OWA by weight of cement Water/Cement ratio = 0.45: mixtures with 5, 8 and 12% of OWA by weight of cement.

Conclusion

Results of this study can be explained in follow:

1. The optimum ratio of OWA to be used in concrete mixtures as a replacement for cement is 5 to 8 percent by weight of cement which is in compliance with results on the WA from other experimental studies.
2. Slump test results decreased by increasing the ratio of OWA in concrete mixtures. Concrete mixtures containing 20 percent of OWA by weight (with constant water to cement ratio) suffered from severe bleeding and lack of workability.
3. Compressive strength results at 91 days proved that organic waste would cause no severe hazard or threat on the mechanical properties of concrete.
4. By increasing the OWA ratio from 0 to 8 percent instead of cement by weight, the ductility of concrete would be increased respectively

Cost Overrun Prediction of Road Construction Project Using MATLAB Software

Lecturer : Reshma KP

Introduction

Construction industry is considered to be as the largest industry and also it includes many other types. Construction industry sectors are categorized into Building construction (residential and non-residential), Infrastructure construction, and Industrial construction. Cost overrun, also known as a cost increase or budget overrun, involves unexpected incurred costs. When these costs are in excess of budgeted amounts due to an underestimation of the actual cost during budgeting, they are known by these terms. While in construction industry there are many types of mistakes and errors are occurring due to small changes. MATLAB software providing Fuzzy logic system used for developing a model for analysis. The Fuzzy logic has made many things simpler and helped in saving time, cost and energy. Cost overrun can be predicted using different ways, Fuzzy logic system is used for analyzing cost overrun of a project.

Methodology

In this, the methods and steps used for the work are explained.

- Deciding cost overrun factors through a detailed literature and preparing a questionnaire for rating factors.
- Selection of topmost cost overrun factors by ranking them using Relative Importance Index (RII) method.
- Applying fuzzy logic technique for the development of cost overrun assessment model using fuzzy toolbox of MATLAB program software.
- Validation of model by applying it to a case study.

Questionnaire survey

In this research, 21 factors responsible for cost overrun in highway construction projects are identified through vast literature survey. A Questionnaire form which is consisting of factors has been developed. This was aimed to obtain information about causes of cost overrun in road construction industry. It was asked to rate those initially identified 21 factors according to their severity level on the given scale i.e. 1- Very low effect 2-Low effect 3-Medium effect 4-High effect

Relative Importance Index (RII)

The relative importance index (RII) is calculated by using the relation given below:

$$RII = W/AXN$$

Where W is the weighting given to each factor by the respondent (ranging from 1 to 4), A is the highest weight and N is the total number of respondent. e.g. Considering factor Material related problem, $RII = 73/420 = 0.9125$

Tensile splitting strength of concrete using 5, 8 and 12% of OWA to the normal concrete mixture were respectively 0.99, 0.9, and 0.94. Based on the results, by using 8% of OWA compressive strength and tensile splitting strength in 28 days would increase respectively 17 and 11%, which makes it the optimum among the rest.

Fuzzy logic system

The term fuzzy refers to the fact that the logic involved can deal with concepts that

cannot be expressed as the true or false but rather as partially true. A fuzzy logic system (FLS) can be defined as the non-linear mapping of an input data set to a scalar output data. A FLS consists of four main parts: fuzzifier, rules, inference engine, and defuzzifier. Firstly, a crisp set of input data are gathered and converted to a fuzzy set using fuzzy linguistic variables, fuzzy linguistic terms and membership functions. This step is known as fuzzification. Afterwards, an inference is made based on a set of rules. Lastly, the resulting fuzzy output is mapped to a crisp output using the membership functions, in the defuzzification.

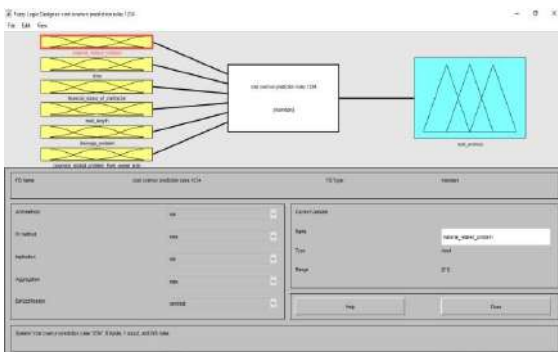
Cost Overrun Prediction Model using Fuzzy toolbox of MATLAB software.

Development of cost overrun assessment model in fuzzy Inference system involves steps such as FIS editor, membership function editor, Formation of rules (Rules editor), Weighing of rules and defuzzification. a) Fuzzy Inference Editor The FIS Editor displays general information about a fuzzy inference system. In this step, input and output parameters are fixed. We have considered six input and one output system. So from edit option, six inputs are added. Editing and nomenclature of each of six inputs and single output is done. Thereafter, file is saved by exporting it to workspace. In this way, FIS editing is completed. Mamdani and sugeno are two types of inference systems used. Mamdani type of inference system is used here. FIS editor from fuzzy toolbox is shown in the figure 1.

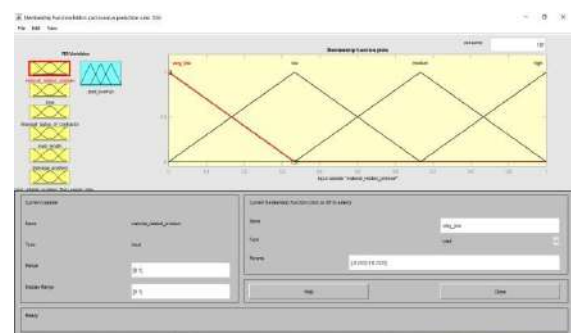
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Membership Function Editor: The Membership Function Editor is the tool that lets you display and edit all of the membership functions associated with all of the input and output variables for the entire fuzzy inference system. Membership function editor from fuzzy toolbox is shown in the figure 2.



(a) Fuzzy Inference Editor

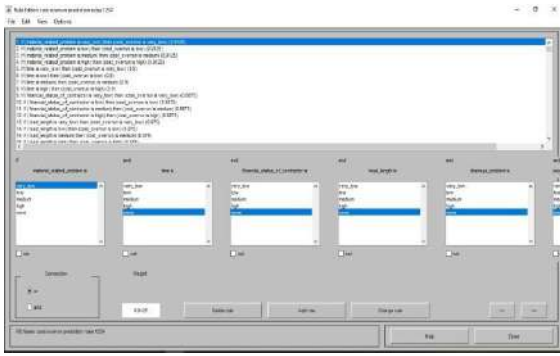


(b) Membership Function Editor

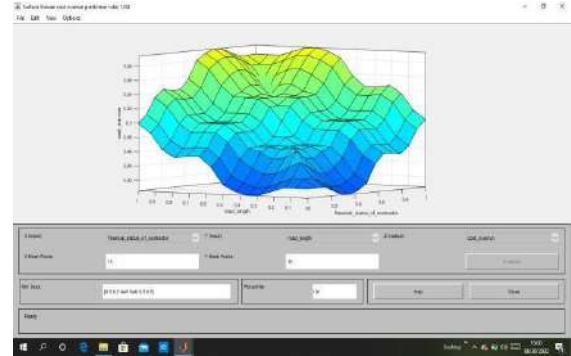
Rule Editor: At this point, the fuzzy inference system has been completely defined, in that the variables, membership functions, and the rules necessary to analyze cost overrun are in place. Total 248 rules are created using all six input variable factors and one output variable. While creating rules, as maximum as possible possibilities and combinations of input variable factors are taken as uncertainty involved is maximum. While inserting rules by combination of two input variable factors, assign weight as average of relative importance index of both the factors.

Rule Viewer: The Rule Viewer displays a roadmap of the whole fuzzy inference process. It is based on the fuzzy inference diagram described in the previous section. The Rule Viewer allows you to interpret the entire fuzzy inference process at once. The Rule Viewer also shows how the shape of certain membership functions influences the overall result.

Surface Viewer: In surface viewer, we can see variation of any two cost overrun factors acting in combination with respect to cost overrun.



(a) Rule Editor



(b) Surface Viewer

Model Validation

Model validity concerns the degree to which the variables, as measured by the research reflects the hypothesized construct. A detailed case study analysis of road construction project is carried out to validate the survey findings on most significant factors contributing to cost overrun. The completed road construction project located in Malappuram district. Following are the major factors due to which project suffered cost overrun with the percentage loss caused by each factor.

Results of this study can be explained in follow:

1. Specification change- 20%
2. Delay of approving design document during construction by consultant-15%
3. Contractor or subcontractors problems- 9
Payments delay- 3%

Results obtained by implementing the developed model to a case study. Results show that for different Percentage loss of each of the input variable i.e. factors responsible for cost overrun, the increase in estimated cost of the project (cost overrun) in percentage can be found out. This model gives us prediction about cost overrun due to worst activity of different factors. The estimated cost of project would have been predicted as 11.5%.

Conclusion

Cost overrun phenomenon is very common in road construction industry. Only some projects are completed within the budget. To avoid construction cost overrun, there is need to develop a cost overrun prediction/assessment model as a decision support tool for the project managers, cost estimators for the construction projects before bidding stage. The fuzzy logic has a great prediction capability given by many researchers; it has bright scope in civil engineering research (optimization).

- Cost overrun can be estimated at the planning stage itself and suitable preventive measures can be adopted to overcome the situation and to avoid serious consequences.

- The factors that are responsible for increase in cost are identified in this report. The percentage of affectability of factors changes from project to project. So for different projects, this model can be applied effectively only by allocating value of RII corresponding to factors considered keeping all parameters same.
- The fuzzy logic handles the uncertainties which reside during construction projects and it can handle multiple inputs easily and quantify more realistically the classical problem analysis.
- One of the shortcoming of this method is that as fuzzy rules are based on expert judgement and literature survey findings, it is clear that a completely different model may be proposed by other researchers based on different expert opinions.

