1.3.2: Number of course that include experiential learning through project work/field work/internship during the year

Dept: ME -Structural Engineering **Academic Year:2023-2024**

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1.3.2: Number of courses that include experiential learning through project work/field /internship during last year

Dept : Civil **Academic Year 2022-2023**

S.No	Name of the Course	Course Code	Program Code	Program Offering	Project Work	Field Work	Internship	Page no
1	Advanced Concrete Structures	ST4202	413	M.E structural Engineering	✓			3,13,18,30
2	Maintenance, Repair & Rehabilitation of Structures	ST4073	413	M.E structural Engineering	✓			13-16
3	Advanced Steel Structures	ST4201	413	M.E structural Engineering	✓			3-6,9-12,26-29
4	Finite Element Analysis in Structural Engineering	ST4203	413	M.E structural Engineering	✓			26-30
5	Advanced Concrete Technology	CN4071	413	M.E structural Engineering	✓			3-6
6	Advanced Construction Engineering and Experimental Techniques Laboratory	ST4161	413	M.E structural Engineering	✓			19-22
7	Numerical and Finite Element Analysis Laboratory	ST4211	413	M.E structural Engineering	✓			3-6

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SUSTAINABLE UTILIZATION OF SEWAGE SLUDGE ASH WITH INDUSTRIAL WASTE IN CEMENT AND MORTAR

A THESIS

Submitted by

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in partial fulfilment for the award of the degree of

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August 2024

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ABSTRACT

Cement is the most widely used construction material in the world, as it is one of the most versatile, durable and cost-effective building material, utilized today. Cement manufacturing is cost and energy-intensive process contributes to greenhouse gas emissions. Construction activities are unavoidable and essential for society's overall requirement across the globe. Furthermore, the environmental damage, caused by construction activities is evident. Specially, the depletion of natural resources is a concern with the fulfillment of cement demand. As a result, infrastructural development must priorities sustainability in order to minimize degradation to the environment and consumption of natural resources. Economically and ecologically, the use of waste materials such as blast furnace slag (BFS) and fly ash (FA) generated by the steel industry and coal based thermal power plants respectively, have proven to be very beneficial as sustainable alternatives to construction materials for the production of cement with certain constraints. But, sewage sludge from the wastewater treatment plant is one of the most interesting wastes that can be used in an efficient and environmentally friendly manner in various construction materials. In most of the previous studies the utilization of sewage sludge ash (SSA) in cement and mortar up to a limited dosage (5-30%), gas been reported. However, the issue of possible applications of SSA more than 30% has not yet been effectively explored. Thus, this dissertation accounted utilization of SSA along with industrial waste as additive which is carbide lime sludge (CLS) in cement. To observe the feasibility of SSA in cement and mortar for saving natural non-renewable resources, a scientific approach and series of experiments were performed with various SSA percentages along with fixed percentages of CLS. Investigations reveal the effect of various blends on the percentage increase/decrees in the compressive strength as per the norms establish in the Indian Standard. Evaluation of carbon dioxide (CO_2) emissions during green cement production, thus produced, has also been carried out.

Keywords: Sewage sludge ash (SSA); Carbon dioxide (CO_2) emissions; carbide lime sludge (CLS); Sustainable development; Waste management.

CHAPTER 7

CONCLUSION

The experiments on cement and various mixes of mortar for the determination of utility using SSA along with CLS in replacement of OPC, have given the following conclusions:

- Higher water absorption of SSA and CLS particles, induces higher water demand in cement paste and also for mortar mixes to maintain the normal consistency of cement paste.
- The initial and final setting time of cement paste rises slightly with addition of OPC substitutions derived from SSA along with CLS. Though the setting times are well within the limits given in IS 1489 (Part-1): 2015, which is minimum of 30 minutes for initial setting time and maximum of 600 minutes (10 hours) for final setting time.
- However, the strength of mortar having SSA along with CLS and its derivatives is lower to that of reference mortars, but well under the minimum required strength given in IS- 2250, 2000, as per which the 1:3 mortar mix prepared with cement as binding material must have at least 7.5 N/mm^2 of compressive strength at an age of 28 days of curing.
- SSA along with CLS can be used in mortars to have sustainability in construction. SSA along with CLS is capable for 70% utilization in mortar, while a significant saving in OPC can also be achieved.
- The application of SSA along with CLS results in a decrease in the transportation cost as sewage sludge is locally available waste material, reduce the manufacturing cost of cement due to utilization of waste from

various waste streams, less energy consumption during production because sewage sludge is incinerated at 730°C only for the decomposition of organic matter in it which is relatively less than that of cement clinker production. Waste management and conversion of waste to wealth because the incineration is the suitable solution of sewage sludge disposal rather than dumping and landfilling in low lying area.

- More usage of SSA will contribute to the reduction in the consumption of natural resources.
- Furthermore, SSA emits lesser CO2 as compared to FA.
- Up to 50% to 70% replacement of SSA along with CLS in OPC exhibits reasonable compressive strength as compared to 33 to 43 Grade Ordinary Portland Cement respectively and also tensile load results are significantly improved. Since it can withstand tensile stresses caused by shrinkage and thermal movements on the exterior surfaces of masonry structures, this mortar mix can be used for plastering the surfaces.
- It can be concluded that SSA with CLS exhibits higher compressive strength than that of PPC containing only FA.
- As per the IS 1486 (Part 1) 2005, up to 35% addition of FA is permitted but in the current study, it is also concluded that the utilization of SSA with CLS up to 45% can achieve desired 28 days compressive strength (33 MPa) of PPC.

EXPERIMENTAL INVESTIGATION ON THE BEHAVIOUR OF CFS BUILT-UP SECTIONS UNDER AXIAL COMPRESSION

A THESIS

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ABSTRACT

Cold-formed steel members are widely used in the construction industry worldwide due to their advantages, such as a high strength-to-weight ratio and ease of assembly and fabrication .This project focuses on the experimental investigation and finite element modelling of a Cold Formed Steel built-up I section (consisting of two lipped channel sections) under compression .The experimental investigation elaborates study of two members of built-upsection fabricated from two lipped channel section of size 100 x 40 x 15 x 2mm each under flexure which includes load vs deflection characteristics and failure modes. The FEM modelling consists of the analysis of same sectionS using finite element package ABAQUS and the results are compared with the result from the experimental study. In Phase-I, the sections are identified from theliteraturereviewandaredesignedusingIS801andIS811.Withthearriveddimensions, the specimens are given for fabrication. ABAQUS modelling is earnt and developed for the typical cross-sections identified.

CHAPTER 7
CONCLUSION

7.1 CONCLUSION

An experimental and numerical investigation of cold formed steel built up section with intermediate stiffener has been described. The test specimen was fabricated using high strength zinc coated grade and with nominal yield stress of 240 N/mm^2 respectively. The failure mechanisms and load vs. deflection characteristics were studied. The experimental findings and the analytical result from ABAQUS 6.12 are compared.

The findings lead to the following conclusion:

- According to a finite element analysis, built-up I section column collapse due to lateral torsional buckling.
- The experimental results shows that the column with stiffener decreases the strain by 15.9 % to that of a normal column without stiffener.
- The experimental results shows that the stiffened columns deflect 19.43% lesser than that of normal column. This proves that V shaped stiffener is effective in improving the structural integrity of the column.
- The numerical result shows that the stiffened column deflects 26 % lesser than that of normal column. This proves that the intermediate stiffener is improving the structural integrity of column.
- From the comparison of experimental and ABAQUS results a variation of less than 15 % is observed in all the cases which is within the permissible limit.
- From the results of comparisons, the ultimate load obtained from the FEM was slightly lesser than the experimental ultimate load and the design strength calculated from the required code was conservative with the experimental ultimate load.

STRENGTH EVALUATION OF EPOXY MODIFIED CONCRETE AND SILICA FUME CONCRETE: A COMPARATIVE ANALYSIS

A THESIS

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STRENGTH EVALUATION OF EPOXY MODIFIED CONCRETE AND SILICA FUME CONCRETE: A COMPARATIVE ANALYSIS

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ABSTRACT

This study presents an experimental investigation and comparative analysis of two distinct concrete formulations: epoxy concrete and silica fume concrete. Concrete is one of the most widely used construction materials due to its versatility and durability. Epoxy concrete and silica fume concrete represent two innovative approaches towards enhancing concrete properties, each with unique characteristics and potential applications. It involves the formulation and testing of epoxy concrete and silica fume concrete for 5%,10%,15%,20%,25%and30% specimens under various conditions, including compressive strength and Split Tensile Test. The findings suggest that epoxy concrete is suitable for applications requiring high strength, such as structural members, while silica fume concrete is ideal for applications where durability and resistance to chemical attacks are crucial, such as in industrial floors and pavements. The results of this study provide valuable insights for selecting the appropriate concrete type for specific engineering applications.

CHAPTER 7

CONCLUSION

In conclusion, the comparative analysis of epoxy concrete and silica fume concrete reveals significant differences in their mechanical properties. Epoxy concrete exhibits superior strength, durability, and resistance to degradation, making it an ideal choice for applications requiring high performance and longevity. Silica fume concrete, on the other hand, offers improved workability and sustainability, but its strength and durability are compromised compared to epoxy concrete. The findings of this study can inform the selection of concrete materials for various construction projects, balancing the need for strength, sustainability, and cost-effectiveness. Further research can explore hybrid materials combining the benefits of both epoxy and silica fume concrete. "Epoxy Concrete offers Higher Compressive Strength, but at a higher cost. Silica fume Concrete provides a more Cost-effective solution, with a reasonable strength gain. The Choice between the two depends on the specific application and priorities. If high Strength is critical, Epoxy concrete may be the better Choice. However, if Cost Effectiveness is a major Concern, silica fume concrete be a more Suitable Option.

7.1 Cost Effective for Epoxy Concrete and silica fume concrete.

- **Epoxy Concrete:**
  - Higher Material Cost due to Epoxy resin.
  - Specialized labor required for application
  - Total cost: Rs 10,022.4 - Rs12,528 per cubic meter.
- **Silica Fume:**
  - Lower material cost compared to Epoxy resin.
  - No specialized Labor required.
  - Total cost: RS 6,681.6 – Rs 8,352 per cubic meter

Silica Fume Concrete is more Cost Effective than Epoxy Concrete, despite Having lower Compressive Strength

OPTIMIZING THE USE OF UNEXPANDED PERLITE IN CEMENT MORTAR

A THESIS

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In partial fulfillment for the award of the degree of

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ABSTRACT

In this study, the use of unexpanded perlite as a partial replacement for natural river sand in cement mortar was investigated. The research aimed to balance the benefits of lightweight and insulating properties with the potential drawbacks related to strength and durability. The study conducted sieve analysis, compressive strength tests, electrical resistivity measurement, sorptivity tests, acid resistance tests, and specific gravity determination to evaluate the performance of unexpanded perlite in cement mortar.

Sieve analysis revealed that unexpanded perlite is predominantly medium to coarse in size, making it suitable for lightweight construction applications. However, the compressive strength of mortar decreased with increasing perlite content, from 23.58 N/mm^2 without perlite to 12.19 N/mm^2 with 35% perlite, due to increased porosity and reduced density. The electrical resistivity of the mortar was relatively high at 10.1 kilo ohm•cm, indicating good moisture resistance. Sorptivity tests showed that higher perlite content reduced water absorption, while acid tests revealed increased vulnerability to acid damage with more perlite. The specific gravity of unexpanded perlite was determined to be 2.3, confirming its lightweight nature. Overall, the findings suggest that while unexpanded perlite offers benefits in reducing weight and enhancing insulation, its impact on compressive strength and durability requires careful consideration to ensure it meets the specific demands of construction applications.

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CHAPTER 6

CONCLUSION

6.1 CONCLUSION

- The study evaluated unexpanded perlite as a partial replacement for natural river sand in cement mortar to explore its benefits and limitations.
- Sieve analysis revealed that unexpanded perlite is predominantly medium to coarse in size, making it suitable for applications that require lightweight and insulating materials.
- The addition of perlite decreased the mortar's compressive strength from 23.58 N/mm^2 in the control sample to 12.19 N/mm^2 with 35% perlite, due to increased porosity and reduced density.
- The electrical resistivity of the mortar was measured at 10.1 kilo ohm•cm, suggesting good resistance to moisture and electrical currents.
- Sorptivity tests indicated that mortars with higher perlite content absorbed less water, thereby showing improved water resistance.
- However, the acid resistance tests showed that specimens with more perlite lost more weight after being immersed in acid, indicating increased vulnerability to acid damage.
- The specific gravity of unexpanded perlite was determined to be 2.3, confirming its lightweight nature.

Future research should focus on:

- Finding methods to minimize the reduction in compressive strength and acid vulnerability while enhancing the insulating properties of perlite.
- Investigating the optimal perlite content and exploring combinations with other additives to improve the mortar's strength and durability.
- Developing new applications that utilize perlite's lightweight and insulating characteristics without compromising the structural integrity of the mortar.

INVESTIGATING THE PERFORMANCE OF BIOENGINEERED BREAKWATER UNDER REALISTIC WAVE LOADING

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ABSTRACT

A breakwater is a permanent structure constructed at a coastal area to protect against tides, currents, waves, and storm surges. Bioengineered breakwaters utilize a combination of natural and synthetic materials to create coastal structures that integrate with the environment while providing shoreline protection. The natural materials rocks in gabions and the synthetic material geogrids, sandbags are considered for the performance analysis of bioengineered breakwater. In this project a 3D model of the breakwater in ABAQUS is developed, incorporating the complex geometry and material properties of natural material rocks as well as synthetic material geosynthetics. The reinforced foundation with Bio engineered mound is taken to analyse the structure. Gabion box is used in toe mound for increasing the stability of breakwater. The four types of models were taken and Compare the stability of the breakwater when the caisson filled with Demolished waste + steel slag and Sand + aggregates. The depth of sheet pile is finalised. The structural responses including stresses, strains, and displacements are analysed under various wave scenarios and the behavior of a bioengineered breakwater under realistic wave loading conditions using ABAQUS. The basic properties of gabions, geosynthetics, geogrids, sandbags etc. are determined through experimental investigation.

Sand and aggregate filling caisson gives high stability when compared to the demolished waste and steel slags. The stability of the breakwater is increased and the displacements are reduced due to reinforced sheet pile foundation and mounds with the usage of bio engineered materials.

CHAPTER 8

CONCLUSION

The following are some of the main conclusions, which could be derived, based on this research.

1) Due to wave action, the deformations of the rubble mound and foundation soils were the major causes of damage of conventional (unreinforced) breakwater.

2) One of the major causes of breakwater settlement is the lateral deformation of foundation soils during the seismic loading. The sheet pile reinforced foundations could restrict the deformation of foundation ground, and thus, can be an effective countermeasure for mitigating the wave induced damage of breakwater.

3) During the wave action, seepage flow takes place through the rubble mound and the foundation soils, due to the water level difference between sea side and harbor side. Seepage flow disturbs the foundation soils beneath the breakwater, and causes significant settlement and tilting of breakwater with unreinfocered foundation.

4) Sheet piles and gabions were found to be effective in reducing the seepage to a greater extent. However, complete blockage of seepage is not easy to achieve.

5) Overflowing waves scours the harbor side rubble mound of unreinforced foundation. Gabions provide protections to the toe mound from the thrust of overflowing and thus can prevent scouring induced damage to breakwater.

6) Geo grids and the sand bags in the rubble mound provides an extra protection for the caisson breakwater. Demolished waste and steel slag combination reduced the

7) Comparatively sand+aggregate combination of caisson filling gives good results for reducing the horizontal displacements. It can be seen that, more than 40% reduction of the displacements could be achieved in the bio engineered reinforced foundation with sand aggregate filling when compared to unreinforced breakwater.

8) Various reinforcing methods for breakwater foundation developed, tested and suggested in this research, could reduce the settlement and horizontal displacement of breakwater when subjected to wave and seismic action. However, they have their own merits and demerits, which need to be explored well before applying those methods in practice.

AN EXPRIMENTAL AND ANALYTICAL EVALUATION OF GFRP REINFORCED CONCRETE BEAMS IN THE MARINE ENVIRONMENT

A THESIS

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ABSTRACT

In the present years, due to enhanced properties of Glass Fiber-Reinforced Polymers (GFRP) there has been a rapid increase in usage of GFRP reinforcingbars for concrete structure. The GFRP bars have been used extensively in the marine structures where the conventional steel reinforcement which is affected by corrosion is more overriding. Deterioration of structures due to corrosion can be solved by the GFRP rebar which is reinforced in concrete structures were subjected to harsh environments, namely high-temperature and marine conditions. After all these years of investigation and implementation, researchers have concluded GFRP as the corrosion resistant reinforcing material in the corrosion protection policies. The present study made the comparative analysis of concrete cube of size 150 mm x 150 mm x 150 mm which was cured with saline solution as well as potable water were compared to investigate the strength characteristic of test specimens. Further, concrete beam of size 1700 mm x 150 mm x 150 mm with 12 mm diameter GFRP rebar and conventional steel rebar which was cured in saline solution for 21 days. Then the Flexural test has been conducted experimentally for both the beams and the results which were obtained from experimentally are compared with analytical results which are obtained using Ansys.

CHAPTER 6

CONCLUSION

FRP bars are considered as a very important topic in recent years because of its performance. In this study the material characteristics and the properties of the GFRP bars (Mechanical) in RC structures under marine conditions. It is more obvious that GFRP and other FRP rebar are used in structures in or close to marine environment which are prone to corrosion and durability problems.

Therefore, it requires to carry out the detailed study on performance of GFRP rebar and their durability effects on GFRP rebar which is embedded in concrete structures in marine conditions.

- The GFRP rebar have more tensile strength compared to the steel reinforcement.
- Maximum deflection occurs in GFRP reinforced beam compared to the Steel reinforced beam.
- From this study, the GFRP reinforced beam has less flexural strength compared to the steel reinforced beam.
- This can be minimized by using different varieties of synthetic fibres.
- From this study, though GFRP reinforced beam has less flexural strength compared to the steel reinforced beam the GFRP rebar will increase the durability behaviour when compared to steel rebar especially in the marine structures.

Thus, the flexural strength of GFRP reinforced beam can be attained by the addition of micro synthetic fibres. By adopting this method, the structures in the marine environment can be prevented from corrosion.

This study is evident that GFRP rebar can be effectively used for construction under marine conditions. Finally, the importance of GFRP bars in reinforced concrete construction brings new challenges for strengthening the reinforced concrete structures.

THE FEASIBILITY OF USING FOUNDRY SAND AS FINE AGGREGATE IN CONCRETE

A THESIS

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ABSTRACT

Concrete is a composite material made from cement, water, fine aggregate and coarse aggregate. One of the more recent developments in the production of concrete is the use of additions, resulting in a significant improvement to the mechanical and durability performances of concrete. Further more, to the extent that it leads to a reduction in concrete material consumption, the use of additions contributes to solving environmental problems in a simple and economical manner.

In this study process, The over exploitation of non-renewable materials is becoming a threat and therefore water cement ratio of 0.45 was investigated at different limited curing periods (7, 14 and 28 days). The percentage of foundry sand used for replacement were 0%, 10%, 20% , 30%, and 40% by weight of fine aggregate. Effect of foundry sand as fine aggregate replacement on the compressive strength, flexural strength and split tensile strength of concrete with a grade of concrete M30:Test showed impressive results, showing capability of foundry sand for being a component in concrete for imparting strength. Making concrete from recycled materials saves energy and conserves resources which lead to a safe sustainable environment.

This study investigates replacing traditional fine aggregate with foundry sand and adding nano silica to concrete. Foundry sand, a byproduct of metal casting, offers a sustainable alternative to natural sand, while nano silica enhances concrete properties. The integration aims to enhance concrete performance and sustainability. Through comprehensive analysis, including experimental evaluation, the study assesses the effects on compressive strength properties for various proportions of 30 and 40 percentage with adding of 3 and 4 percent of nano silica. Results show that substituting fine aggregate with foundry sand improves mechanical properties, further refined by nano silica. Additionally, this approach offers cost savings and environmental benefits by utilizing industrial byproducts and reducing natural resource consumption.30% of foundry sand replacement and 4% nano silica gives better result Overall, integrating foundry sand and nano silica into concrete mixtures presents a promising strategy for sustainable enhancement of concrete structures, warranting further research for Optimization and widespread adoption.

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CHAPTER 7

CONCLUSION

- The study was conducted to investigate as the partial replacement of fine aggregate in concrete.
- Improves the mechanical properties of concrete materials such as compressive strength, flexural strength, split tensile strength test.
- The optimum utilization of used foundry sand at 30% gives high compressive strength compared to conventional concrete.
- The compressive strength in14 days to be 335 kN/m^2 and the compressive strength in 28 days to be 625kN/m^2
- The study for the replacement of foundry sand as fine aggregate .in concrete and their properties of compressive strength of concrete observed for various percentage of replacement of foundry sand in concrete..
- The casted beam cured for 28 days and the flexural strength of the beam with different percentage of foundry sand(30%&40%) with addition of nano silica(3%&4%).
- For beam test results maximum load of 83 kN and shear strength of 41.5kN was observed. the shear capacity of the beam comparatively improved than conventional concrete.
- Replacement of fine aggregate with foundry sand (30%) and nano silica (4%) gives maximum strength at 28 days.
- Use of waste foundry sand in concrete reduces the production of waste through metal industries; it is an eco friendly building material.
- Integrating foundry sand and nano silica into concrete mixtures presents a promising strategy for sustainable enhancement of concrete structures.

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