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An Analytical and Experimental Investigation of SCC Slab with Partial Replacement of Foundry Waste Sand

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Abstract: *Foundry waste sand is one of the most active research areas that encompass a number of disciplines including civil engineering and construction materials. In this study an attempt has been made to evaluate the usage of this waste material in production of reinforced concrete slab to identify the flexural behavior of the slab. The constant depletion of sand beds at all major sources of availability is a major concern and thus efforts are taken in order to replace sand in construction activities. This paper demonstrates the possibilities of using foundry waste sand as a partial replacement of sand in self –compacting concrete. From the experimental investigation the performance of compressive strength , split tensile strength, flexural strength are reached higher by replacing 25% of foundry waste sand. This replacement is used in self- compacting concrete to achieve its higher strength with economical construction of slab. The various percentage replacements off oundry waste sand as 10%, 20%, 30%, 40% and 50% by weight of fine aggregate. But the replacement of 20 – 30% of foundry waste sand which increases the strength and further replacement decreases the strength. Making slab from recycled materials saves energy and conserves resources which lead to a safe sustainable environment.*

Keywords: *Foundry waste sand, self compacting concrete, slab, chemical properties of foundry waste sand, fresh and hardened properties of cube, cylinder and prism.*

1. INTRODUCTION

Foundry sand is high-quality uniform silica sand that is used to make moulds and cores for ferrous and nonferrous metal castings. For land filling of foundry waste sand creates environmental problems and affects fertility of soil in surrounding areas so an alternate method is to be introduced to use in construction fields. In self compacting concrete the foundry sand is replaced as a partial replacement for fine aggregate in construction of slabs to avoid porosity in concrete slabs to increase the binding property of the materials. So in this project the abundant waste material is used to avoid the landfill at nearer areas and effectively used in the construction areas to minimize the use of river sand which is obtaining rarely in earth. The Reinforced concrete slabs is an efficient economical structural component in any structural frames used in buildings. Modern structural systems are highly complex in configurations and are highly stressed due to heavy loadings and large spans. This results in larger sections for structural members and thus dense reinforcement to resist forces with normal strength concrete which intern increases the dead load on the foundation. So the foundry waste sand is used in construction of slabs to increase the strength and reduce the dead load of the slab.

1.1. Self Compacting Concrete

Self compacting concrete has been described as "**the most revolutionary development in concrete construction for several decades".**

The characteristics of self-consolidating concrete (SCC) are **flow ability, segregation resistance and passing ability**. Quality control of flow ability is typically predicted by the final diameter of a slumpflow test; a larger diameter indicates higher flowability. Segregation resistance concerns the ability to retain homogenous distribution of aggregates; segregation can occur both during and after casting. The ability to keep the homogeneity of the aggregate distribution is governed by the volume fraction, distribution and physical properties of the aggregates.

1.2. Foundry Waste Sand: A Scenario in India

The Indian foundry industry is the fifth largest in the world. There are more than 6,000 foundries in India, and they have a combined installed capacity of approximately 7.5 metric tonnes per annum (MTPA). Most foundries (nearly 95%) in India fall under the small and medium scale category and are located in clusters. These units produce a wide range of castings that include automobile parts, agricultural implements, machine tools, diesel engine components, manhole covers, sewing machine stands, pump-sets, decorative gates and valves.

1.3. Research Objective

Overcoming technical barriers to reuse excess foundry sand in SLABS to reduce the porosity and increase the binding property is the primary goal of this research. The research will result in substantial energy and cost savings for both foundries and user industries, as well as provide an environmental benefit at the local and National level.

A universally acceptable and open database is to be developed to address the characterization of excess foundry sand. Large numbers of datasets addressing the environmental, chemical and physical property of excess foundry sands are pooled from industrial partners. The variations of foundry sand characteristics, chemical and physical aspects and how it performs as a component of SCC in slabs. Most of the research is carried out using statistical methodology and corresponding software. The inference from this part is statistically concluded supported by nationwide data resources. It deserves to be an acceptable reference for the state’s characterization of excess foundry sand. The research eliminates the gap between excess foundry sand and other byproducts after successfully developing SCC in slabs containing excess foundry sand.

Two general types of binder systems are used in metal casting depending upon which the foundry sands are classified as,

- clay bonded systems (Green sand)
- Chemically bonded systems.

2. Finite Element Analysis

Finite element analysis is the most common tool used for stress and structural analysis of the complicated structures. Finite element procedures are at present very widely used in engineering analysis, and we can expect this use to increase significantly in the years to come. The procedures are employed extensively in the analysis of solids and structures and of heat transfer and fluids, and indeed, finite element methods are useful in virtually every field of engineering analysis. The main advantages are that it can be applied to arbitrary shapes in any number of dimensions. The material properties can be non-homogeneous or isotropic. Finite element analysis is used for the discretization of complex object to simple analysis.

2.1. Modelling of Slab

In the present study, reinforced concrete slab of size 1000 x 1000 x 50 mm thickness slabs are taken and simply supported boundary conditions is analyzed using finite element method.

In this approach solid plate and link elements are used to model the concrete slab and steel reinforcement. Solid element is defined by eight nodes having three degrees of freedom at each node X, Y and Z, while link element is a tri axial tension compression element with three degrees of freedom at each node. Slabs are modelled using 8 nodded solid 65 elements and link 8 elements are modelled as reinforcements. Steel behaviour is modelled using bilinear stress strain curve and multi linear curve is used to characterize the behaviour of concrete. Displacement boundary conditions are needed to constrain the model to get a unique solution. To ensure that the model acts the same way as the experimental slabs, boundary conditions need to be applied at where the supports and loading exist. Loading was applies at loading point. Since the whole model was analyzed by the support conditions whereas experimental was restrained to ensure roller support conditions at all its ends.

2.2. Description of Reinforced Concrete SCC Slab

Reinforced self compacting concrete slab of size 1m x 1m x 100mm is created by using ANSYS v14.5. and simply supported boundary condition is analysed using finite element method.

Slabs are modeled using 8 nodded solid 65 element and link 8 elements are modeled as reinforcements.

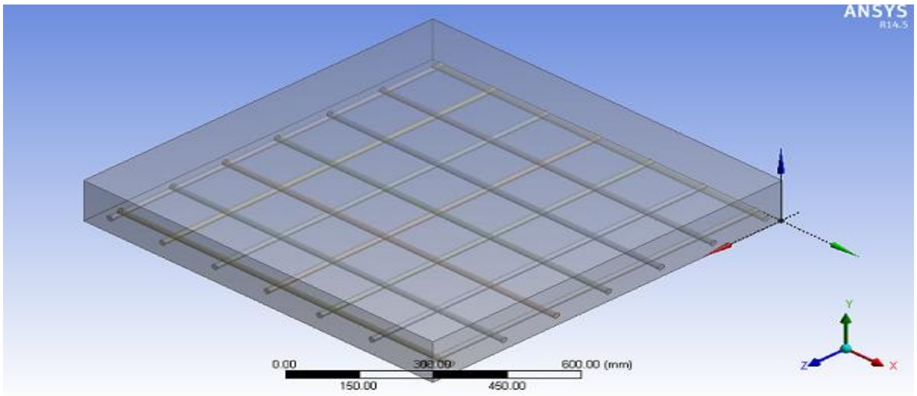

Fig2.2.1. *Design of slab using ansys*

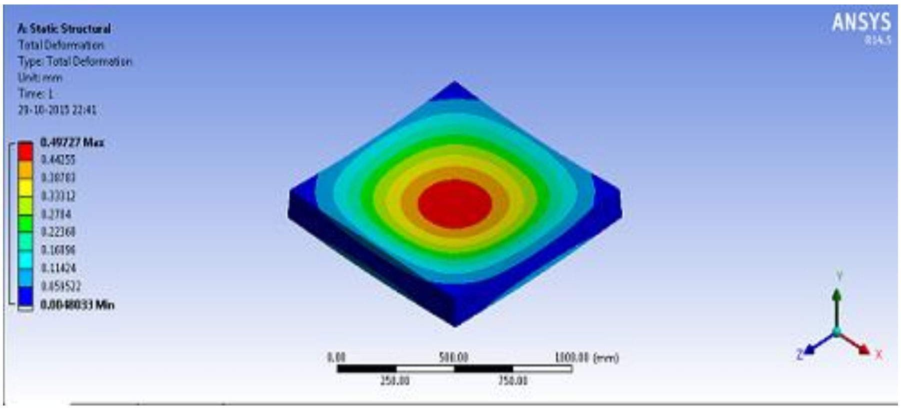

Fig2.2.2. *Deformation of the slab*

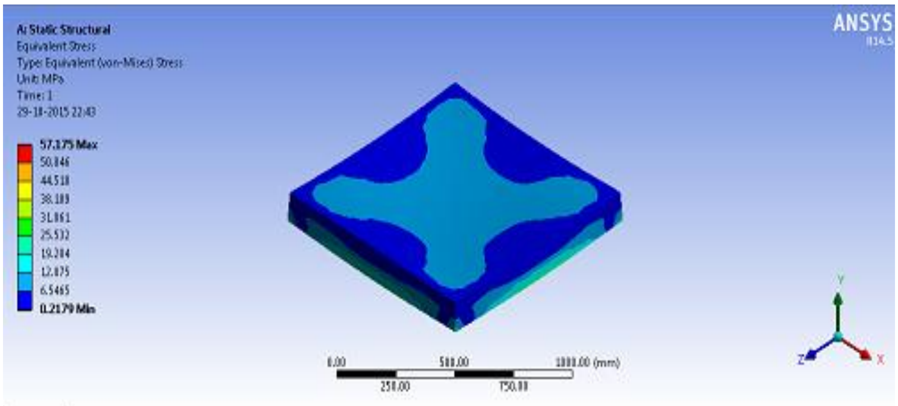

Fig2.2.3. *Von- Mises Stress*

3. Results and Discussions

3.1. Conclusion

- The replacement of river sand by foundry sand is possible in concrete mix for various grades and the optimum sand replacement proportion is generally 20-25%.
- It has been observed that the compressive strength, split tensile strength modulus of elasticity and flexural strength of self compacting concrete produced with the combination of admixtures keep on increasing up to 20% addition of foundry waste sand. After 20% addition of foundry waste sand, the compressive strength starts decreasing.

- It is observed that 20% addition of foundry waste sand generally gives higher strength compared to normal concrete.

3.2. Future Scope

This research can be further investigated in 20% replacement of foundry waste sand in casting of slabs to attain higher strength and to reduce the deformation of slabs.

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