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Effect of Waste Foundry Sand, Waste Glass and Glass Fiber on Mechanical Properties of Concrete- A Review

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Abstract: *Admixture or material other than cement, sand, and aggregate is mostly added in concrete to produce economical concrete construction, to improve concrete properties or to produce high performance concrete. The research is conduct to compare concrete performance and behavior by addition of Waste Foundry Sand, Waste glass, & Glass fiber in different concrete mix trial and evaluating and comparing the effect on properties of concrete. Waste foundry sand is a by-product of ferrous and non-ferrous metal industries. Foundries reuse the sand time after time in casting process when sand can no longer used it is called as Waste Foundry Sand. In recent time waste glass in crushed and powdered form are used in concrete to improve performance of concrete, some glasses due to its different composition and color cannot be reused by glass industries and is generally disposed in landfill rather than disposing in landfill we used them in concrete to improve concrete performance in hardened state. Glass fiber is provided as reinforcement in concrete, glass fiber improves tensile and flexural strength quite efficiently but compression strength is marginally increasing but it somehow greater than conventional concrete.*

Keywords: Conventional concrete; waste foundry sand; Waste glass; glass fiber; alkali-silica reaction

1. Introduction

Now a day's there are two commonly used structure material concrete and steel. They often complement each other and sometime oppose each other. Mostly concrete have high compressive strength, but on other side tensile strength is very low. That's why it is mix with some admixture or material which are high in tension to prevent concrete from shrinkage and eliminates cracks develop in concrete in early age. Waste Foundry Sand is generally used as an alternative of fine aggregate in concrete to reused foundry sand rather than disposing it. Crushed waste glass in concrete give rise to alkali-silica rection because alkali in cement and silica in glass when mix together give rise to alkali-silica reaction which will deteriorate concrete. Glass fiber consist of number of fine fiber of glass, concrete which are reinforced with fiber of glass is also known as glass-reinforced plastic (GRP). Glass fiber is generally manufactured in the same way as window glass in our kitchen or drinking glass. The glass is heated until it is molten, and then it is passed through small holes creating glass filament that are thin in shape.

1.1 Waste foundry sand-

Today major concern in the world is disposal of solid waste management, construction industries produces tones metric of waste product every year. Disposal of these product directly to environment or anywhere else create lot of hazardous effect to environment and human being also. Instead of disposing them we can use them further in construction material. Waste foundry sand by name itself we can easily understand it is waste produce by industries when the sand in the industries is no longer used it is called waste foundry sand. Waste foundry sand is a by-product of ferrous and non-ferrous metal industries. Foundries reuse the sand time after time in casting process when sand can no longer used it is called as Waste Foundry Sand (WFS). Classification of waste foundry sand depends upon binder process used for casting. The properties of WFS depends upon the metal which industries used for casting process, technology used, furnaces type and final processing. "Mostly two types of WFS are their clay bonded sand (green sand) and chemically bonded sand (off white). Commonly clay bonded sand is used for mould making and it contains mostly silica sand (80-95%), bentonite clay (4-10%), carbonaceous additives (2-10%) and water (2-5%). Chemically bonded sand is obtained by mixing of silica sand with binder (1-3%). After mixing sand with binder, it will start the chemical reaction that cures the chemical resin and hardens the sand core or mould". (singh & siddique, 2011, pp. 416-422)

1.2 Waste glass -

Glass is made by heating sand (silica sand), lime and soda together in furnace. Glass is made primarily of silicon dioxide, SiO2, additionally referred as silica. Glasses we usually see such as in windows, soda bottles, and glasses is soda lime, is made of borosilicate. Mostly all glass consists of Soda lime and borosilicate. Only 35% glasses are recycled as glass are non-biodegradable, they will cause harm to environment rather than disposing we can used them in concrete.

1.3 Glass fiber -

According to the need of the fiberglass, the glass fiber can be made of different types of glass such as (A glass fiber, C glass fiber, E glass fiber, AR glass fiber S glass fiber). Glass fiber is lightweight, durable and less brittle.

2. LITERATURE

Literature review has been conducted based on the study of previous research papers published in various journals, corresponding to Waste Foundry Sand, Silica fume, and Glass fiber.

Gurpeet Singh et al. Examined abrasion resistance on properties of concrete. Five specimens are made with various percentage (0%, 5%, 10%, 15%, and 20%). Result indicates that there is significant improvement in compressive strength by 17% during 28 days at 15% replacement and abrasion resistance also increases with the age as depth of wear decreases by inclusion of WFS. There is continuous progress in properties of concrete up to 365 days.

Vikas et al. Examined behaviour of silica fume on Ordinary Portland Cement. The silica fume was replaced by cement by (5-35%) by weight. It concluded that by adding 5% of silica fume increases compressive strength and in case of workability it is slightly improved.

Muhammed et al. In this study the application of Glass fiber on concrete. Addition of GFRC enhance greater compressive strength than conventional concrete but excessive amount reduces workability, Glass fiber also have positive effect on stress-strain behaviour of GFRC and flexural strength because of increase of aspect ratio of fiber.

Aysha et al. studied the performance of concrete with replacement of silica fume and WFS. In which geopolymer is used as an alternative of Portland cement and WFS as partial replacement of natural sand. Properties of concrete were evaluated. Compressive strength split tensile strength, & flexural strength for 28 days of cured concrete made with normal & geopolymer concrete was (23.2 N/mm^2 & 36.4 N/mm^2), (2.97 N/mm^2 & 3.8 N/mm^2), & (4.4 N/mm^2 & 4.55 N/mm^2).

Francesa Tittarelli Study effect of waste foundry sand on engineering properties depends upon type of foundries industry from where it is collected. This study concluded that WFS can be used for making quality concrete.

Rahul Roy et al. Examined behaviour of silica fume & waste foundry sand on strength of concrete. Sand is replaced with WFS by 0%, 5%, 10%, & 15% & cement is replaced by silica fume by 0%, 5%, 10%, & 15% by mass weight. Compressive strength was 30.24 MP_a (0% replacement) & 36.4 MP_a (15% replacement) for 28 days cured concrete. Split tensile strength was 2.14 N/ mm^2 (0% replacement) & 3.76 N/mm^2 (15% replacement). Flexural strength was 7.95 N/mm^2 (0% replacement) & 10.98 N/mm^2 (15% replacement). He also concluded that ferro cement panel made with steel r/f is highly prone to corrosion hence geogrid is used as an alternative.

Thiruvenkitam et al. Study concluded engineering properties utilising used sand. In this investigation total 6 specimen were prepared, the replacement percentage of natural sand was (0%, 5%, 10%, 15%, 20%, & 25%) by Waste Foundry Sand (WFS) by weight. Study examined mechanical, durability, & micro-structural properties of concrete for various curing period. The compressive strength 26.5 MP_a show significant improvement, split-tensile strength was 2.8 MP_a and modulus of elasticity was 25.4 GP_a for concrete with 20% replacement. The optimum percentage was found to be 20% at which mechanical properties significantly increased.

Maria et al. Addition of Waste Foundry Exhaust Sand (WFES) as a substitute of fine aggregate. WFES is generally foundry pieces in automotive industry. The natural sand was replaced upto 50 % in order to attained compressive strength more than 25 MP_a. The hardened concrete sample show better result at 40% replacement. Compressive strength for specimen was found to be 46 MP_a. for 28 days curing period. Present study also conclude that 50% fine aggregate replacement give good result than the conventional concrete.

Hemavathi et al. Examined behaviour of concrete containing silica fume and glass fiber as an additive. Cement replacement was 20% with silica fume and addition of glass fiber 1% to produce high performance concrete. By addition of silica fume and glass fiber can help in improve strength and properties of concrete. The maximum strength is experience in concrete which has silica fume 20%, 1% glass fiber.

Kamal Ranout et al. Researcher study included behavior of concrete using waste glass as partial replacement of sand and also internal behavior by SEM & XRD. Replacement of waste glass was (3%-15%), In this study alcofine is also used as an additive to provide strength to concrete. The optimum value was found to be 9% after that there was decrease in strength due to reduction in workability of design mix (M40). XRD also show intermolecular attraction between glass molecule increases due to alcofine.

3. CONCLUSIONS

This study of different research paper concluded following

1. Mechanical properties of concrete increases with addition of Waste foundry sand in concrete.
2. Good construction can be made with WFS.
3. 15% replacement of Waste foundry sand with sand was found to be optimum.
4. By utilising Waste Foundry Sand, we will create eco-friendly environment.
5. Waste glass increases mechanical properties but it somehow gives rise to alkali-silica reaction in concrete.
6. Addition of supplementary material like metakaolin, fly ash, silica fume and waste foundry sand in waste glass is necessary otherwise it will deteriorate concrete in hardened state due to rise in alkali silica reaction.
7. As waste glass percentage increases in concrete water absorption of concrete decreases.
8. Concrete containing waste glass achieve higher strength than conventional concrete quite easily and is used for good quality concrete.
9. Slump flow increase in concrete containing waste glass.
10. 20% replacement of waste glass replacement with aggregate improve concrete properties in hardened state.
11. Glass fiber in concrete lead to higher tensile and flexural strength but compression strength increases marginally.
12. Addition of glass fiber increases durability properties of concrete, it eliminates cracks develop in concrete at early age.

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