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To Study the Effect on Mechanical Behavior of Concrete using Fly Ash and Foundry Sand

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Abstract: **Worldwide development in overall Scenario will be carbon lessening and vitality sparing. Most extreme utilization of assets, proficient development, practical development and quality enhancements costs have turned out to be dire issues which advances general monetary improvement endeavors to enhance expectations for everyday comforts and takes care of the issues of deficiencies in assets. Reusing is acknowledged to be one of the vital bases of supportability. Presently days we are attempting to use all sort of item, regardless of whether they are metal, solid, plastic, wood, or even glass, will in the end transform into squanders that must be arranged. The most ideal approach to manage such sort of squanders is to reusing, recuperation and reuses them as crude materials or modifiers. This will lessen the deplete on the common assets of the crude materials, and it will decrease the spaces utilized as landfills. Among all these fly ash debris and waste foundry sand squander create by the Industrial enterprises.In this study fly ash and waste foundry sand were used to replace natural aggregate depending on the fineness of particles. Concrete has become the most widely accepted and used construction material in civil engineering industry, the incorporation of fly ash and foundry sand particles in concrete would be a very good and promising way to utilize the large quantities of wastes like fly ash and foundry sand. Fly ash and waste foundry sand used as particles in concrete would not only make a use of such waste materials but also help to improve some concrete properties. The concrete containing fly ash and foundry sand have excellent ductility and improved mechanical properties as compared with conventional or controlled concrete. This work studies the effects of fly ash (5%,10%) and foundry sand (10%,15%,20%) as aggregate and filler as a partial replacement of natural aggregate in the cement concrete. The primary aim of this study was to evaluate the strength property of concrete. This Study has shown that replacing some percentage of natural aggregates by fly ash and foundry sand causes significant change in properties of concrete. The properties studied are 7days, 28days compressive strengths and flexural strength, etc.**

Keywords: **Fly Ash, Foundry Sand, Varying Percentage, Effect, Concrete**

I. INTRODUCTION

Concrete is most widely used man-made construction material in the world, and is second only to water as the most utilized substance on the planet. Concrete is primarily made up of four fundamental ingredients, i.e. coarse aggregate, fine aggregate (i.e. sand), cement and water. It has been used for over a century. Concrete occupies a unique place among modern construction materials. It gives freedom to mould the structure to any shape which is not possible with other material. When the concrete mixture is placed in mould and allowed to cure, it hardens into a rock-like mass. The hardening of the mixture is caused by chemical reaction between water and cement and it continues for a long time. The concrete grows stronger with age. More than 90% of the structures ranging from buildings, retaining walls, dams, roads and bridges etc. utilize the concrete as a construction material. Good concrete should be able to resist corrosion; wear and it should be water-tight and economical. The concrete is most important construction material which is manufactured at site. The concrete must be strong enough to withstand all the imposed stresses without injury and the required factor of safety.

II. FLY ASH

Fly ash (FA) is a by-product of the combustion of pulverized coal in thermal power plants. It is removed by the dust collection systems from the exhaust gases of fossil fuel power plants as very fine, predominantly spherical glassy particles from the combustion gases before they are discharged into atmosphere. The size of particles is largely dependent on the type of dust collection equipment. Diameter of fly ash particles ranges from less than 1μm–150μm. It is generally finer than Portland cement. The chemical composition of fly ash is determined by the types and relative amounts of incombustible material in the coal used. The major chemical constituents in fly ash are silica, alumina and oxides of calcium and iron. Because of its fineness and pozzolanic and sometimes self-cementitious nature, fly ash is widely used in cement and concrete.

III. FOUNDRY SAND

A foundry produces metal castings by pouring molten metal into a preformed mold to yield the resulting hardened cast. The metal casts include iron and steel from the ferrous family and aluminum, copper, brass and bronze from non-ferrous family. Foundry sand is high quality silica sand with uniform physical characteristics. It is a by-product of ferrous and non-ferrous metal casting industries, where sand has been used for centuries as a molding material because of its thermal conductivity. Foundries successfully recycle and reuse the sand many times in a foundry. When the sand can no longer be reused in the foundry, it is removed from the foundry and is termed as foundry sand. The physical and chemical characteristics of foundry sand depend on the type of casting process and the industry sector from which it originates. In modern foundry practice, sand is typically recycled and reused through many production cycles. For example, in United States alone, Industry estimates that approximately 100 million tons of sand is used in production and approximately 6–10 million tons is discarded annually and is available to be recycled into other products and in industry. The automotive industries and its parts are the major generators of foundry sand. Foundries purchase high quality size-specific silica sands for use in their molding and casting operations.

IV. LITERATURE REVIEW

Mehta, P.K. (2000) concluded that fly ashes are amongst the group of pozzolans that significantly increase the life expectancy of concrete exposed to sulfate attack. In general, Class F type fly ash meeting the specification requirements will improve the sulfate resistance of any concrete/mortar mix in which it is included, although the degree of improvement may vary with either the cement used or the fly ash. The situation with Class C fly ash is different. A few studies indicated that some Class C fly ashes may rather reduce sulpate resistance when used in normal proportions.

Siddique, R. (2003) studied the abrasion resistance of concrete proportioned to have four levels of fine aggregate replacement (10 to 40%) with Class F fly ash. A Control mixture with ordinary Portland cement was studied at 28 days compressive strength of 26 MPa. Concrete specimens of size 65 9 65 9 60 mm were made for the purpose. The abrasion resistance of concrete mixtures was determined at the ages of 28, 91, and 365 days in accordance with BIS Specifications. The variation of depth of wear versus percentage of fine aggregate replacement with Class F fly ash, at 60 min of abrasion time concluded that with the increase in fly ash content, depth of wear decreased, which indicated that the abrasion resistance of concrete increased with the increase in fly ash content. This showed that for a particular percentage of fine aggregate replacement with fly ash, depth of wear decreased with increase in age, which means that abrasion resistance increased with age.

Saraswathy et al. (2003) investigated the influence of activated fly ash on the compressive strength of concrete. Various activation techniques, such as physical, thermal and chemical were adopted. Concrete specimens were prepared with 10, 20, 30 and 40% of activated fly ash replacement levels with cement. Compressive strength was determined at 7, 14, 28 and 90 days. They concluded that (1) activation of fly ash improved the strength of concrete. However, the compressive strength of fly ash concrete was less than that of ordinary portland cement (OPC) even after 90 days of curing; and (2) among the activation systems, chemically activated coal fly ash (CFA) improved the compressive strength to a certain extent, only with 10 and 20% replacements. Since the CFA surface layer is etched by a strong alkali to facilitate more cement particles to join together and also the addition of CaO which is further promoting the growth of CSH gel and $Ca(OH)^2$ which is more advantageous to enhance the strength development.

Guney et al. (2010) investigated the potential re-use of waste foundry sand in high-strength concrete production. The natural fine sand is replaced with waste foundry sand (0%, 5%, 0%, and 15%). The modulus of elasticity is also calculated according to the equation suggested by the ACI 318 at the age of 28 and 56 days, as follows: $E= 0.043 \times W^{3/2} \times \sigma^{1/2}$Where E is the modulus of elasticity in MPa, W is density in kg/m3, and σ is the unconfined compressive strength in MPa. The calculated moduli of elasticity have been decreased from o to 5% and start increasing from 5% to 10%. It is obvious that the static modulus of elasticity is a function of the compressive strength of the concrete. If the compressive strength of the concrete increases, the static modulus of elasticity will also increase, and vice versa.

Kolawole S (2012) conducted a set of laboratory test including sieve analysis, chemical analysis and strength test were conducted on concrete made by natural as control sample and concrete produced at different percentage of founder sand ranging from0% to 100% in of 25% of dry weight of fine aggregates All sample were submerged for7,11,21 and 27 days as curing age. The result demonstrate that at 28 days, the compressive strength decreases by 5.63%,29.92%,42.2% and 50% at 25%,50%,75% and 100% foundary sand replacement respectively when compared to ordinary mix with foundary sand.

Smit M. Kacha1 , Abhay Nakum (2014) This state of art review represents the development in the field of utilization of used foundry sand in cementitious concrete. The paper reviews the utilization of foundry sand as the concrete constituent and the noticeable and important findings from the experimental works of various researchers. The historical development is also discussed as a part of introduction in the review. After a careful study of large number of research papers on the topic it was felt by the authors to integrate all the important results for streamlining the potential of this area of research. The paper summarizes conclusions of experiments conducted for the properties like strength and durability. It was observed the results have shown positive changes and improvement in strength and durability properties of the conventional cementitious concrete due to the addition or replacement of fine sand with used foundry

sand in different proportions. However in couple of cases such addition has reported reduction in the values of properties. From the review of past research works it could be concluded that utilizing the used foundry sand holds a great potential towards the development of environment friendly and sustainable cementitious concretes.

Ms. Minakshi B. Jagtap Mr. Vikram B(2015) Gadade In this study, effect of waste foundry sand over fine aggregate replacement on the compressive strength and split tensile strength of concrete with M-20 mix proportion of 1:1.82:2.89:0.5 is investigated at different curing periods (7 days, 14 days and 28days). The percentage of waste foundry sand used for replacement are 10%, 20%, 30%, 40%, 50% and 60% by weight of fine aggregate. Test shows magnificent results, showing capability of waste foundry sand for being a component in concrete for imparting strength. Making eco-friendly concrete from recycled materials saves energy and conserves resources which lead to a safe sustainable and economical environment.

Deepak Chaurasiya Kiran Koli (2016) Low cost concrete production by replacement of fine sand with Foundry sand is a new trend and makes effectively use of Waste foundry sand as engineering material by reducing disposal and pollution problem. Waste foundry sand are by-products which appears to possess the potential to partially replace regular sand as a fine aggregate in concretes, providing a recycling opportunity for them. The fine aggregate has been replaced by used foundry sand accordingly in the range of 10%, 20% & 30% by weight for M-30 grade concrete. Concrete mixtures were produced, tested and compared in terms of workability and strength with the conventional concrete. These tests were carried out to evaluate the Compressive strength for 7, 14 and 28 days. As a result, the compressive increased up to 20% addition of used foundry sand. This research work is anxious with experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing fine aggregate via 10%, 20%, and 30% of used foundry sand. Keeping all this view, the aim of investigation is the behavior of concrete while adding of waste with various proportions of used foundry sand in concrete by using tests on Compressive strength and workability

Bavita Bhardawaj and pardeep kumar(2017) Concrete is the most extensively used construction material in the world, second to water. Increasing rate of urbanization and industrialization has lead to over exploitation of natural resources such as river sand and gravels, which is giving rise to sustainability issues. It has now become imperative to look for alternatives of constituent materials of concrete. Waste foundry sand, a by-product of ferrous and non ferrous metal casting industries is one such promising material which can be used as an alternative to natural sand in concrete. In last few decades, several studies have been conducted to investigate the effect of addition of waste foundry sand as partial and complete replacement of regular sand in concrete. It has been found suitable to be used as partial replacement of sand in structural grade concrete. A number of properties have been reviewed in the current paper, the results observed from the various studies depict that replacement of foundry sand to a certain extent enhance the durability as well as strength properties of the concrete but simultaneously decreases the slump value with the increase of replacement level of waste foundry sand.

Maria Mavroulidou David Lawrence(2018) Foundry sand (FS) waste creates a serious solid waste management problem worldwide due to the high volumes produced, necessitating alternatives to landfilling. A possible route is its use in concrete; however, the current consensus is that FS can only be used for modest sand replacements, based mostly on evidence on concrete with clay-bound FS (greensand). Conversely, this study assessed salient properties of structural concrete with chemically bound FS (polymeric resin binder), for which there is very little information. Concrete mixes were prepared in which FS replaced regular concrete sand partially or fully. The results showed that unlike greensand, the tested chemically bound FS could replace regular concrete sand fully, giving highly workable mixes with good mechanical properties (compressive, splitting and flexural strengths and static modulus of elasticity) similar to those of mixes with regular concrete sand; the effect of FS content on these properties was not statistically significant

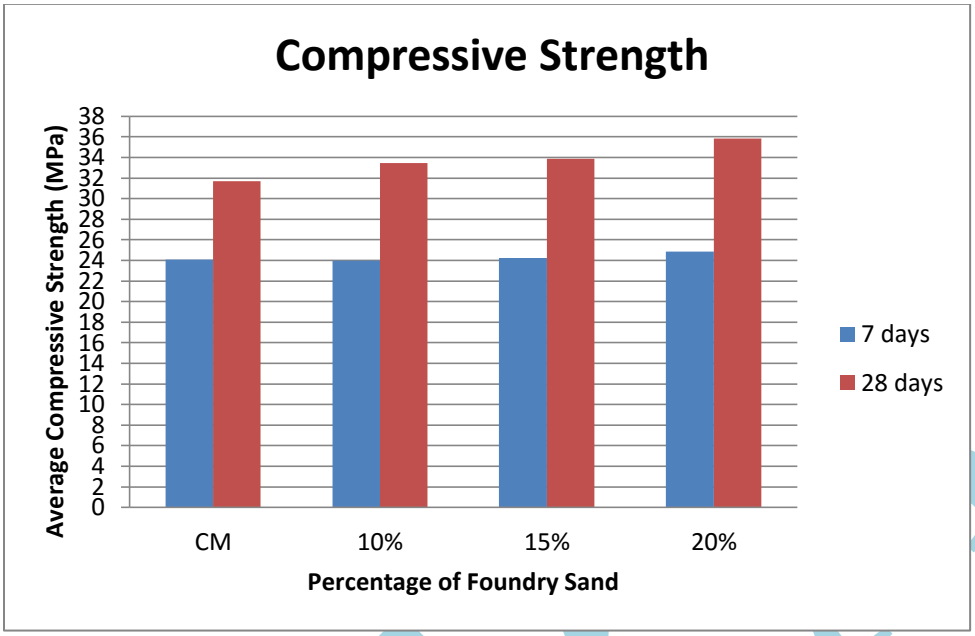

Figure 1- Compressive Strength of Concrete with 5% Fly ash as replacement of Cement and variation of Foundry sand as replacement of Fine Sand.(CM= Controlled Mix)

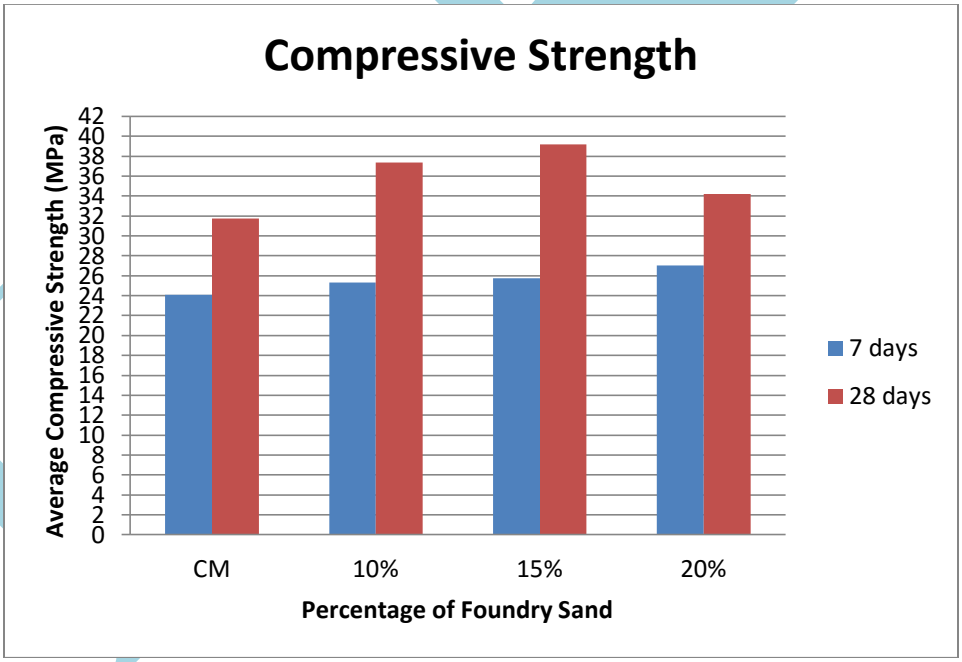

Figure 2- Compressive Strength of Concrete with 10% Fly ash as replacement of Cement and variation of Foundry sand as replacement of Fine Sand. (CM= Controlled Mix)

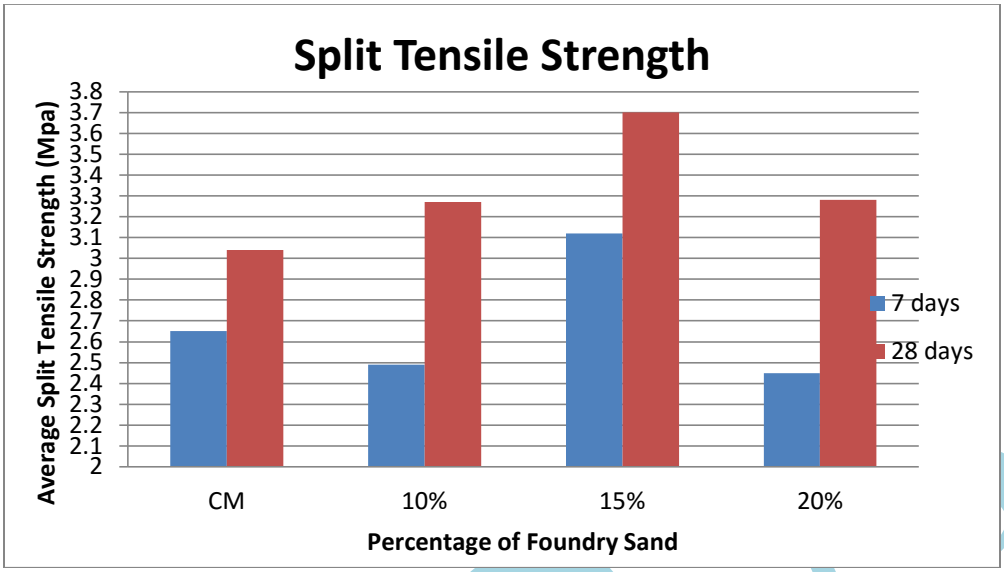

Figure 3- Split Tensile Strength of Concrete with 5% Fly ash as replacement of Cement and variation of Foundry sand as replacement of Fine Sand.

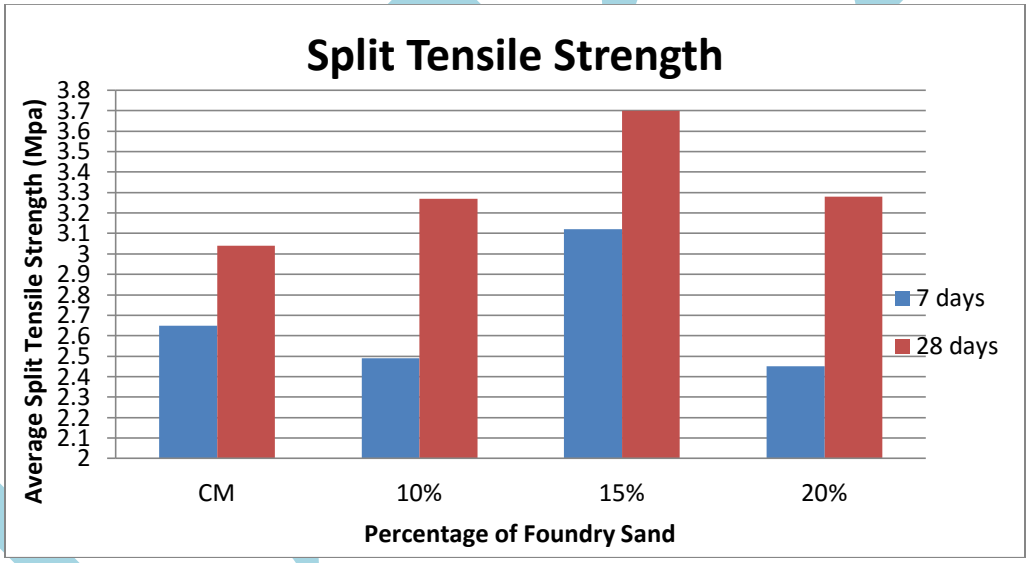

Figure 4- Split Tensile Strength of Concrete with 10% Fly ash as replacement of Cement and variation of Foundry sand as replacement of Fine Sand

V. CONCLUSIONS

- The Compressive strength tends to increase with increase percentages of foundry slag in the mix.
- The compressive strength increases as compared to control mix as the percentage of foundry sand is increased with fly ash as constant 5%. After adding 10% foundry sand in the mix, there is an increase of 6% increase after 28 days as compared to the control mix. By adding 15% and 20% foundry sand (fly ash as 5%), there is not such large amount of increase in percentage i.e. 1%, 2% and 7%, 13% after 7 and 28 respectively.
- The results indicate that the strength of design mix goes on increased by 24% as the percentage of foundry sand increases up to 15% at 28 days as compared to that of control mix, but after 15% there is marginal decrease in strength at by 15% as compared to 20% replacement of foundry sand at 28 days. But this value is 8% higher than the control mix.
- The Split tensile strength also tends to increase with increase percentages of foundry sand
- The split tensile strength increases with the percentage increase of foundry sand at 5% fly ash as replacement of cement as compared to control mix. After adding 10%

foundry sand in the mix, there is an increase of 2% increase after 28 days. By adding 15% and 20% foundry sand, there is increase in percentage i.e. 5%, 8% and 4%, 9%after 7 and 28, respectively.

- The split tensile strength increases with the percentage increase of foundry sand at 10% fly ash as replacement of cement as compared to control mix. After adding 10% foundry sand in the mix, there is an increase of 8% increase after 28 days. By adding 15% and 20% foundry sand, there is increase in percentage i.e. 18%,-8% and 28%, 8% after 7 and 28, respectively.

VI. FUTURE SCOPE

- ❖ In the present study only up to 20 per cent replacement of fine aggregate by foundry sand has been considered. The other percentages i.e. 25 and 30 per cent need investigation.
- ❖ In the present study only design mix w/c ratio have been considered. The other ratios i.e. 0.4, 0.45 and 0.55 need investigation.
- ❖ Sulphate resistance of concrete containing foundry sand and fly ash needs to be investigated for larger exposure time.
- ❖ In the present study only up to 10 per cent replacement of cement by fly ash has been considered. The other percentages i.e. 15 and 20 per cent need to be investigation.
- ❖ Fresh concrete properties of concrete is not studied, need to be more investigation

Durability properties are also not studied in this research work.

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