

AN EXPERIMENTAL INVESTIGATION ON STRENGTH PROPERTIES OF PLAIN CONCRETE USING WASTE FOUNDRY SAND

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Abstract- A huge amount of sand is being used by the metal foundries within the metal casting process, the sand is successfully recycled and reused by the foundries. After some time, foundries are not able to use the same sand again, then sand is taken off the foundry and known as "Foundry Sand". There is almost 6 to 10 million tons production of foundry sand annually. Similar to lots of waste materials, used sand has helpful implementation to additional industries. Used WFS contains mainly of silica sand, which is coated with a thin layer of burnt carbon, remaining binders and mud. To enhance the strength and other durability aspects, WFS can be utilized in concrete. So, it can be utilized as a partial alternative of cement or while a partial alternative of natural aggregates or fully substitute of natural fine aggregate and as a supplementary addition for accomplishing different properties of cement concrete.

In this study, the effect of used foundry sand as a substitution of fine aggregate on the compressive strength, split tensile strength and Flexural strength of cement concrete of M20 grade and M40 grade was investigated. There were six percentages of replacement to which foundry sand was replaced by weight of fine aggregates i.e. 0, 20, 40, 60, 80 and 100% by weight of the fine aggregate. Tests were conducted for mechanical properties of all replacement levels at different curing periods (7-days, 28-days).

I. INTRODUCTION

Solid waste management has become one of the global environmental issues, as there is continuous increase in industrial by-products and waste materials. Due to lack of land filling space and its ever increasing cost, utilization of waste material and by-products has become an attractive alternative to disposal. Waste foundry sand (WFS) is one of such industrial by-product.

Ferrous and non ferrous metal casting industries produce several million tons of by-product in the world. In India, approximately 2 million tons of waste foundry sand is produced yearly. WFS is major by-product of metal casting industry and successfully used as a land filling material for many years. But use of waste foundry sand for land filling is becoming a problem due to rapid increase in disposal cost.

Metal foundries use large amounts of sand as part of the metal casting process. 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 "Waste Foundry Sand".

Foundry industry produces a large amount of by-product material during casting process. The ferrous metal casts in foundry are cast iron and steel, non ferrous metal are aluminum, copper, brass and bronze. Over 70% of the total by-product material consists of sand because moulds consist usually of molding sand, which is easily available, inexpensive, resistance to

heat damage and easily bonded with binder and other organic material in mould. Foundry industry use high quality specific size silica sand for their molding and casting process. These WFS is black in color and contain large amount of fines. The typical physical and chemical property of WFS is dependent upon the type of metal being poured, casting process, technology employed, type of furnaces (induction, electric arc and cupola) and type of finishing process (grinding, blast cleaning and coating).

Objectives of the study

1. To investigate the effect of waste foundry sand as a partial replacement of fine aggregate on strength properties of M_{20} and M_{40} grades of concrete
2. To reduce the problem of disposal of industrial waste.
3. The present experiment is carried out to investigate on strength properties of concrete mixes of grade M_{20} and M_{40} in which fine aggregate (river sand) is to be partially replaced with Waste Foundry Sand.
4. Fine aggregate will be replaced with six percentages (0%, 20%, 40%, 60%, 80% and 100%) of WFS by weight. Some of the strength properties such as Compressive strength, Split tensile strength and Flexural strength of Plain Concrete.

II. LITERATURE REVIEW

Khatib and Baig investigated fresh and hardened properties of concrete containing waste foundry sand (WFS) replaced with 0 to 100% with fine aggregate. The water to cement for all mixes was kept constant. Testing on hardened properties was mainly conducted at 14, 28 and 56 days. The results show that the incorporation of waste foundry sand in concrete causes a systematic decreases in workability, ultrasonic pulse velocity and strength and an increase in water absorption and shrinkage of concrete.

They also reported that an acceptable concrete strength can be achieved using foundry sand.

Kumbhar investigated the various mechanical properties of concrete containing used foundry sand. Concrete was produced by replacing natural sand with UFS in various percentages (10%, 20%, 30% and 40%). Based on the test results they concluded that (i) workability goes on reducing with increase in UFS content; (ii) At 28-days, Compressive strength, splitting tensile strength and flexural tensile strength for different replacement levels of UFS is increased whereas flexural tensile strength goes on reducing for UFS content more than 20%; (iii) At 28-days, the modulus of elasticity values increases with replacement of UFS up to 20%. They also concluded that the UFS can be utilized as a replacement to regular sand in concrete up to about 20%.

L Da Silva and their team investigated the influence of the use of foundry sand waste (FSW) on concrete properties. The properties on the fresh state were evaluated by means of flow table test and the determination of the incorporated air content. On the hardened state, compressive strength tests were performed. Their initial results have shown that the use of FSW leads to an increase in the air content and cracking, caused by expansive reactions. As a result of that, a reduction in the compressive strength has been noticed. They added that the application of mixtures made with FSW becomes risky as to the structural and durability requirements. However they also added that their work may not be generalized, because the FSW composition varies according to the manufacturing process and in all cases it is advisable to carry out preliminary tests in order to verify the effects caused by the use of FSW in the concrete production.

III. MATERIALS AND METHODOLOGY

Cement

The raw materials required for make of Portland cement are calcareous materials, for example, limestone or chalk, and argillaceous material, for example, shale or clay. There are two procedures known as wet and dry procedures relying on whether the blending and crushing of crude materials is done in wet or dry condition.

Aggregates

Aggregates are the main constituents in concrete. They offer body to the concrete, diminish shrinkage and impact economy. Aggregates are inactive granular materials, for example, sand, rock or smashed stone that are a final result in their own crude materials. They are additionally the crude materials that are a fundamental fixing in concrete.

Aggregates are divided into two categories from the consideration of size.

- i). Coarse aggregate
- ii) Fine aggregate

Coarse aggregates

Coarse aggregates are particles more note less than 4.75mm however for the most part run between 9.5mm to 37.5mm in measurement. They can either be from essential, auxiliary or reused sources. Essential or virgin aggregates are either land or marine-won. Rock is a coarse marine-won total, arrive won coarse aggregates incorporate rock and smashed stone. Rock constitute the dominant part of coarse aggregate utilized in concrete with pulverized stone making up the greater part of the rest of.

Fine aggregate

Fine aggregates are fundamentally sands won from the land or the marine condition. Fine aggregates by and large comprise of normal sand or smashed stone with most particles going through a 4.75mm sieve.

Water

Water is a vital element of concrete as it effectively takes an interest in the compound response with bond. Since it shapes the strength giving concrete gel, in the amount and nature of water is required to be investigated deliberately. C3S requires 24% of water by weight and C2S requires 21%. It has additionally been evaluated that on a normal 23% of water by weight of bond is required for substance response with Portland concrete intensifies. This 23% of water synthetically joins with bond and, consequently, it is called bound water. It has been additionally evaluated that 15% by weight of concrete is required to top off the gel-pores.

Waste foundry Sand

Foundry sand is high quality silica sand with uniform physical characteristics. It is a By-product of ferrous and nonferrous metal casting industries, where sand has been used for centuries as a molding material because of its thermal conductivity. It is a by-product from the production of both ferrous and non-ferrous metal castings. In modern foundry practice, sand is typically recycled and reused through many production cycles. Industry estimates that approximately 10 million tons of sand is used in production annually of that 6 - 8 million tons are discarded annually and are 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.

Water

New and clean water is utilized for throwing and restoring of example. The water is generally free from natural issues, residue, oil, sugar, chloride and acidic material according to necessities of Indian standard. Consolidating water with a cementitious material structures a bond glue by the procedure of hydration. A bond glue sticks the total together fills voids inside it, and makes floor openly.

Mix Design of Concrete

1. Final trial mix for M20 grade concrete is 1:1.82:2.83 at w/c of 0.45
2. Final Trial mix for M40 grade concrete is 1: 1.63; 2.54 at 0.45

IV. EXPERIMENTAL INVESTIGATION

Casting of cubes and cylinders

Throwing of concrete shapes and barrels as improved the situation M20 review concrete, the blend extent is for which we are cubes, cylinders and prisms for ordinary cement, with the incomplete substitution.



Filling the mould (for 150 mm cube 3 equal layers)

Compacting with compacting bar

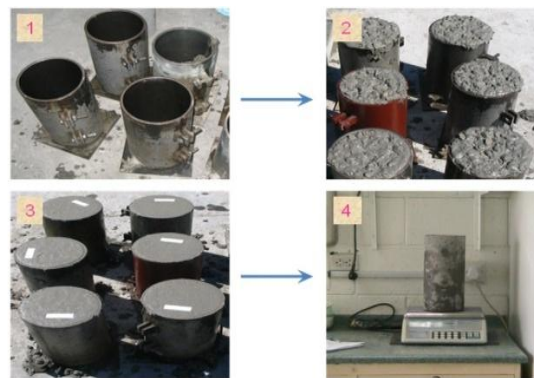
150 mm molds ought to be filled in three around break even with layers (50 mm profound). A compacting bar is accommodated compacting the solid. It is a 380 mm long steel bar, weighs 1.8 kg and has a 25 mm square end for smashing. Amid the compaction of each layer with the compacting bar, the strokes ought to be disseminated in a uniform way finished the surface of the solid and each layer ought to be compacted to its full profundity.



Compacting the concrete in the cube mould (For 150 mm cube at least 35 tamps per layer)



Finishing



Cylindrical moulds

Curing

The solid samples were restored utilizing six unique procedures until when their compressive strengths were resolved at ages 7, 28 days and 56 days.



Curing of cubes and cylinders

Tests to be conducted on concrete

Tests to be conducted on fresh concrete

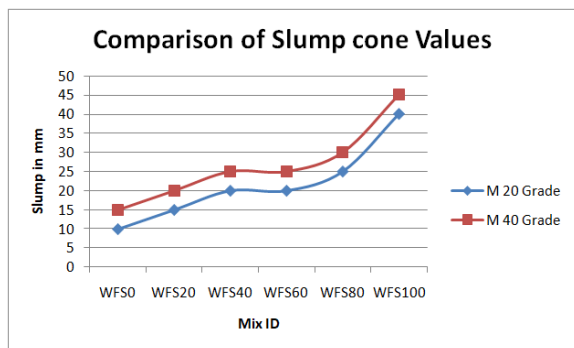
1. Slump cone test
2. Compaction factor test

Tests to be conducted on Hardened concrete

1. Compressive strength of concrete
2. Split tensile strength of concrete

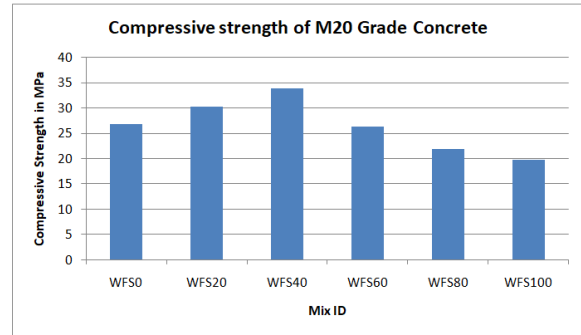
V. RESULTS AND ANALYSIS

Slump cone test

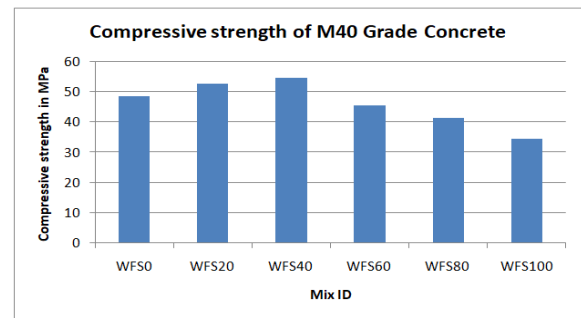


Comparison of slump cone test

Compressive strength

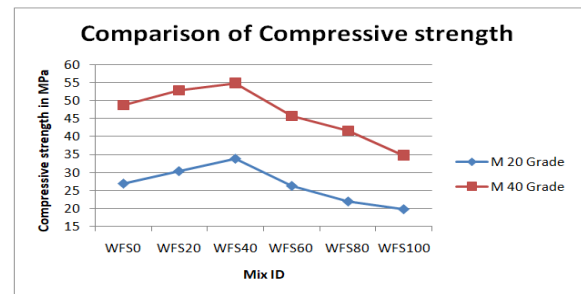


Compressive strength of M20 Grade Concrete



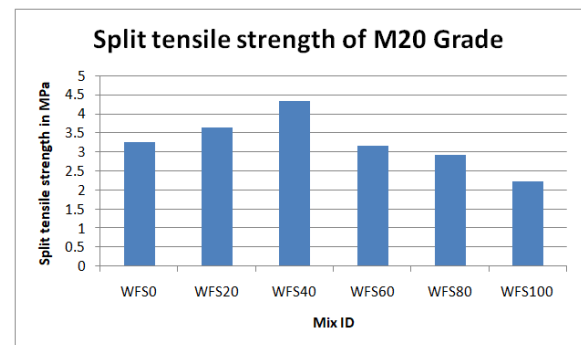
Compressive strength of M40 Grade Concrete

Split tensile strength

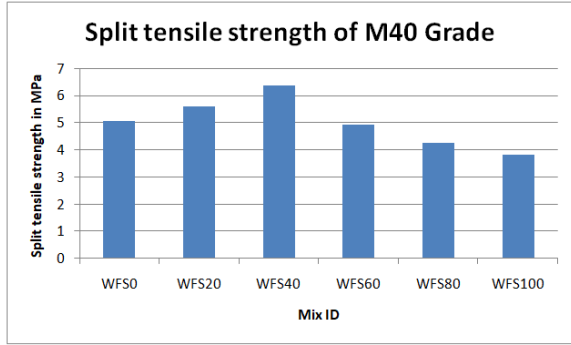


Comparison of Compressive strength

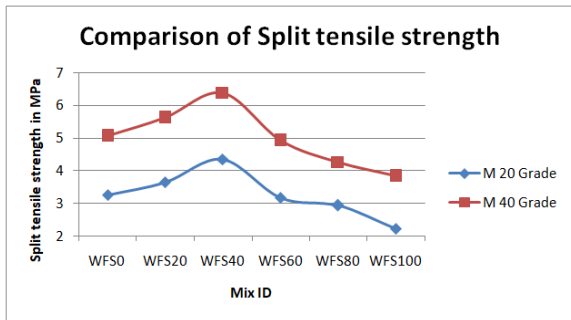
Split tensile strength



Split tensile strength of M20 Grade



Split tensile strength of M40 Grade



Comparison of Split tensile strength

VI CONCLUSIONS

From the above study the following conclusions were made

1. Increase in compressive strength of the concrete with increases in waste foundry sand up to 40% and the maximum compressive strength is achieved at 40% replacement of natural fine aggregate with waste foundry sand which comes to be 33.86 MPa for (M20 grade) and 54.65 MPa for (M40 grade) respectively and then there was a considerable decrease in the strength.
2. Replacement of fine aggregate with waste foundry sand showed increase in the split tensile strength of plain concrete of grade M20 and M40 up to 40% and then there was a considerable decrease in the strength. Maximum strength was achieved at 40% i.e. 4.34 MPa and 6.37MPa respectively.
3. Replacement of fine aggregate with waste foundry sand showed increase in the Flexural strength of plain concrete of grade

M20 and M40 up to 40% and then there was a considerable decrease in the strength. Maximum strength was achieved at 40% i.e. of 6.02 MPa and 11.64 MPa respectively.

4. When percentage of waste foundry sand was increased beyond 40% the mix started losing its workability.
5. Use of foundry sand in concrete can save the ferrous and non-ferrous metal industries disposal, cost and produce a 'greener' concrete for construction.
6. Environmental effects from wastes and disposal problems of waste can be reduced through this research.
7. A better measure by an innovative Construction Material is formed through this research.
8. The used foundry sand can be innovative Construction Material but judicious decisions are to be taken by engineers.

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