"Study of Strength Properties of Concrete Containing Waste Foundry Sand"

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Abstract : In this study Waste foundry Sand, which is a waste product of foundry industry is used. Waste Foundry Sand is used as partial replacement of fine aggregate in concrete. As the natural sand is used as fine aggregate and it is a material which is adversely affecting our environment. Hence, therefore a focus has been made on the replacement of the natural sand in the concrete in this study.

In this study the Waste Foundry Sand has been used as the fine aggregate in the concrete. A number of samples are prepared with different percentages of Waste Foundry Sand in the Concrete. In total five samples were prepared as S-1, S-2, S-3, S-4 and S-5 having the percentage Waste Foundry Sand as 5%, 10%, 15%, 20% and 25% w.r.t to weight of fine aggregate. A number of tests have been performed on the concrete samples in order to examine the strength properties of the concrete which includes tests such as Compressive strength test, split tensile test etc.

After the test it was observed that both the strengths increase as we increase the percentage of Waste Foundry Sand in the concrete. But this increase was observed up to a certain limit after that the strength starts reducing. Thus, giving us the maximum value at certain percentage of waste foundry sand.

***IndexTerms* - Eco-friendly materials, Concrete, Waste minimization, Waste materials.**

I. INTRODUCTION

Concrete is one of the major materials used in construction industry in the present world. Concrete is the 2nd most consumed substance after water and is the most widely used man-made construction materials in the world. Every year more than a ton of Concrete is produced for every human being in the world.

If we will have a brief look on concrete then one may conclude that, concrete is economical, strong, and durable. But, besides these good qualities of concrete it has several disadvantages too. This includes negative impacts on environment from cement factories, Use of water for preparation of concrete. Therefore, the construction industry recognizes that considerable improvements are essential in productivity, product performance, energy efficiency and environmental performance.

The Engineers and researchers are facing a number of issues, institutional competitive and technical challenges in the present world. One of these issues is management of the solid waste. After the management of these solid waste, still some residue is left behind and that is disposed off in some water body or on land-fill sites. Scarcity of land for disposal is again a big challenge in front of the engineers. Hence, utilization of waste or by-products seems to be the best option as an alternative for landfilling. Throughout the industrial sector, including the concrete industry, the cost of environmental compliance is high. Use of industrial by-products such as foundry sand, fly ash, bottom ash and slag can result in significant improvements in overall industry energy efficiency and environmental performance.

In the past few years, the demand of different type of aggregates has been increasing all over the world. In most countries the rate of demand is much more than that of the growth rate of their economy or of their construction Industries. Man-made or Artificially manufactured aggregates are a lot expensive to produce, and it is not always possible that the natural source will lie near to the site or place of construction, it may be a considerable distance from the place of use but in such case the product will become uneconomical as the cost of transportation of aggregate will increase very rapidly. Apart from this, natural aggregate cause a number of other problems too, which includes the continued and expanding extraction of natural aggregates accompanied by serious environmental problems, such as flooding thus causing loss of property and sometime loss of life. Often it leads to irremediable deterioration of the country side. Moreover, quarrying of aggregates leads to disturbed surface area.

But the use of wastes generating from industry as an aggregate not only increase the overall production of the aggregate but also it eliminates the different problems which are occurring due to the extraction of aggregate from natural sources also it prevents the environmental pollution.

II. Theoretical framework

II.I Mix Design

Mix design is a process of selecting suitable ingredients for concrete and determining their proportions which would produce, as economically as possible, a concrete that satisfies the job requirements. The proportioning of the ingredients of concrete is an important phase of concrete technology as it ensures quality and economy. In pursuit of the goal of obtaining concrete with desired performance characteristics, the selection of component materials is the first step, the next step is a process called mix design by which one arrives at the right combination of the ingredients. There are many methods of designing concrete mixes.

Unit of Batch	Water (litres)	Cement (kg)	F.A (kg)	C.A (kg)
Cubic meter content	195	390	569	1165
Ratio of ingredients	0.5	1	1.45	2.98

Table 1 Mix proportion M20

II.II Mix Composition

At first, a series of control mixes were designed to have 28-day compressive strength of 30 MPa (M20 grade of concrete). The concrete mixes were designed with constant cement, fine aggregate and coarse aggregate. The fine aggregates were replaced with waste foundry sand varying from 0% to 20% at the equal interval of 5%, to study the effect of replacement of fine aggregates with waste foundry sand on the strength properties of concrete.

Control mix (0%WFS) having 30 MPa strength was designated as S-1 and mixes made with WFS were designated with S-2, S-3, S-4 and S-5. The detailed descriptions of all mixes are given in Table 2. The details of mix proportions of M20 grade of concrete mixes are given in Table 3.

M20 Grade of Concrete	
S-1	0 % WFS
S-2	5 % WFS
S-3	10% WFS
S-4	15% WFS
S-5	20 % WFS

Table 2 Detailing about different concrete mixes

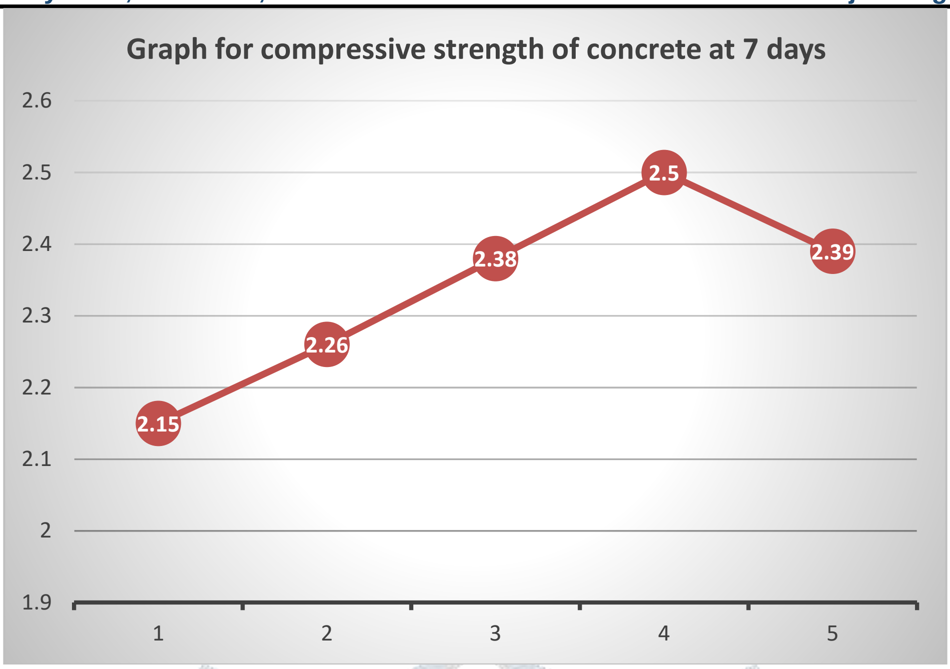
Sample No.	S-1	S-2	S-3	S-4	S-5
Cement (kg/m3)	390	390	390	390	390
Natural Sand	569	541	513	484	456
WFS(%)	0	5	10	15	20
WFS(kg/m3)	0	28	56	85	113
Coarse aggregate	1165	1165	1165	1165	1165
w/c ratio	0.5	0.5	0.5	0.5	0.5
water	195	195	195	195	195
slump	90	85	85	80	80

Table 3 M20 Grade Mixes

III. Results

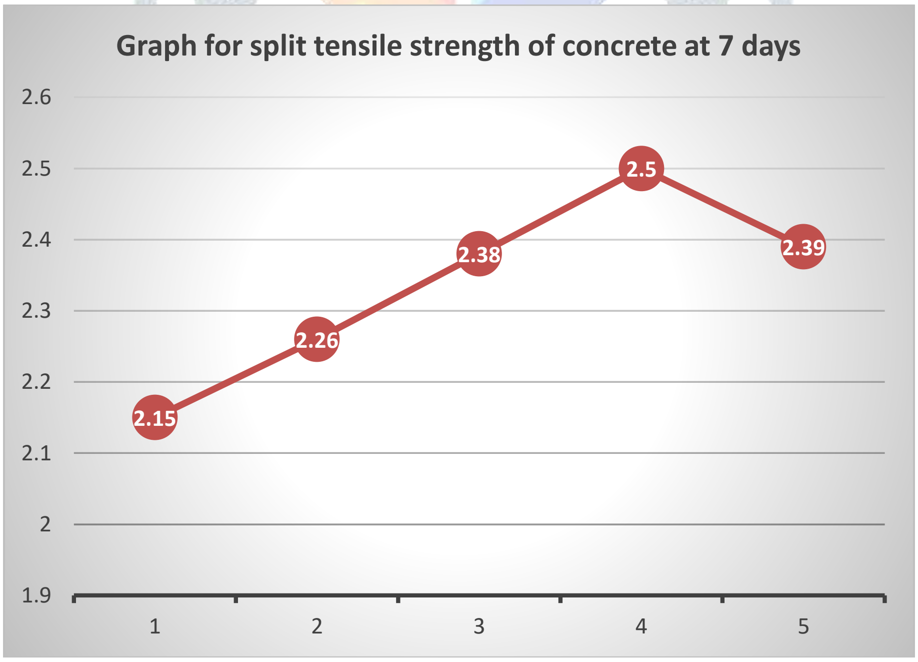
III.I Compressive Strength

Mix proportion of control concrete mix S-1 (0% WFS) was 390 kg cement, 569 kg fine aggregate and 1165 kg coarse aggregate per cubic meter of concrete with water-cement ratio 0.5. Compressive strength of control concrete mix was 30 MPa at the age of 28 days. It was found that, at the age of 7 days, compressive strength of mix S1 (0% WFS) was 19.7 MPa and mixes S-2 (5% WFS), S-3 (10%WFS), S-4 (15% WFS) and S-5 (20% WFS) were 22.4, 23.3, 25.3 and 24.8 MPa, respectively. Maximum compressive strength (25.3 MPa) was observed for S-4 (15% WFS) concrete mix; it was 28.42 % more than the control mix S-1(0% WFS). At the age of 28 days, percentage increase in compressive strength was 14.6, 22.6, 26 and 23.3% for mixes S-2, S-3, S-4 and S-5 than control mix S-1(30MPa). In investigation, it was observed that compressive strength of concrete increased with the increase in WFS content up to 15% as partial replacement of sand.



III.II Split Tensile Strength

The variations in splitting tensile strength with waste foundry sand content were similar to that observed in case of compressive strength. Splitting tensile strength of concrete mixes increased with the increase in WFS content. Splitting tensile strength of control mix S-1(0% WFS) was 2.15 MPa at 7 days. It increased by 5.1%, 10.7%, 16.3% and 11.6% for S-2 (5% WFS), S-3 (10% WFS), S-4 (15% WFS) and S-5 (20% WFS) respectively. Higher value of splitting tensile strength was observed at 15% WFS. At the age of 28 days, increase was 8.2%, 12.5%, 12.8% and 8.2% for M-2, M-3, M-4 and M-5 concrete mixes respectively than mix M-1 (4.23MPa). It was observed that up to 15% replacement of natural sand with WFS, concrete mixture M-4 (15% WFS) showed higher value of splitting tensile strength among all mixes.



IV. Conclusion

IV.I Compressive Strength

a) The capacity to bear the compressive stresses that is the Compressive strength of concrete mixes increased due to replacement of fine aggregate with waste foundry sand. However, compressive strength observed were appropriate for structural uses that means these can be used for construction purposes.

b) M20 (30 MPa) grade concrete mix obtained increase in 28-day compressive strength from 30MPa to 37.8MPa on 15% replacement of fine aggregate with WFS. Maximum strength was achieved with 15% replacement of fine aggregate with WFS. Beyond 15% replacement it goes to decrease, but was still higher than control concretes.

IV.II Splitting Tensile Strength

a) Concrete mixes obtained linear increase in 28-day splitting tensile strength from 3.42MPa to 3.86MPa for M20 grade of concrete mix (S-1) on replacement of fine aggregate with waste foundry sand at various percentages of 5% to 20%.

b) Splitting tensile strength of all concrete mixes was found to increase with increase in with varying percentage of waste foundry sand.

c) Maximum increase in splitting tensile strength was observed at 15% replacement of fine aggregate with waste foundry sand.

V. Cost Analysis

Cost analysis is a critical process in construction projects. It is comprehensive breakdown of all cost to be incurred in performing any activities per project requirement and specification. It maintains its importance not only from cost control and estimation point of views but also as a planning, administration, management and for people involved in business development marketing and sales.

The concrete prepared using 15 % waste foundry sand will be Rs. 166/m3 more expansive as compare to the concrete prepared by 0 % replacement of sand.

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