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Effects of Alccofine-1203 and Foundry Sand on Properties of Concrete Mix

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Abstract: The motive of the current study is to understand the effects of the addition of cementitious materials like Alccofine-1203, fly ash and foundry sand on the concrete. Cement is replaced by Alccofine-1203 in amount of 0, 5, 10, 15% and the fine aggregate is replaced by foundry sand in amount of 0, 5, 10, and 15% for preparing mix design of M30 grade. The overall performance of concrete mix is characterized by the test Flexural Strength (FS), Compressive Strength (CS), split tensile strength (STS), at the curing period of 7, 14 and 28 days. The entire test Results of concrete carrying Alccofine-1203 and foundry sand has greater compressive strength, enhanced durability and reduced dispersion property. It is observed that the maximum compressive, tensile and flexural strength scan be achieved by addition of 10% of Alccofine-1203 and 10% foundry sand in the mixture of concrete with fixed water cement ratio 0.45. The project results suggested that reasonable high performance concrete can be obtained by replacing fine aggregate with 0% to 10% of foundry sand along with partial replacement of cement with 10% of the A.F-1203.

Keywords: Alccofine-1203, Concrete, Foundry Sand, Flexural Strength, Compressive Strength, Split Tensile Strength.

I. INTRODUCTION

Concrete is one of the most widely used building materials in the world. Concrete consists of three main components: water, aggregates (rocks, sand or gravel) and Portland cement [1-2]. Cement, usually in the form of powder, acts as a binding material when mixed with water and aggregates. The mixture of cement, sand and aggregate with water results in solid block after getting set together. Concrete is very strong in resisting the compression while weak in tension [3-4]. For the purpose of enhancing the tensile properties, the steel bars are incorporated as reinforcing agent in the concrete structures. Alccofine-1203 is a supplementary cementitious material suitably replaces Silica fume used in high performance concrete [5].

Foundry sand is clean, uniformly sized, high quality silica sand, used in foundry casting processes. The sand is bonded to form molds or patterns used for ferrous (iron and steel) and non-ferrous (copper, aluminum, brass) metal castings. Shake-out sand from completed metal casting is often reclaimed back into the foundry sand process.

II. DESIGN SPECIFICATION

The principal objective of this work is to analyze the behavior of the specimen based on the concept of Strength Properties based Performance analysis of alccofine-1203 and foundry sand for strength and durability. The design method used is the Mix-Design Proportion- Guidelines IS 10262: 2009. In the thesis the mix proportioning for a concrete of M 30 grade adding alccofine-1203 and foundry sand on concrete as per the recommendation mentioned in the IS 10262: 2009. Even the entire Mix-Design was done under the control environment favorable for accomplishment of anticipated data and result. Some of the general data/details are mentioned below that are essential for the initial stage of Mix-Design.

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Mix Design

Table 1: Preliminary Data for Mix Design

W/C		0.45
Types of Cement		PPC
Maximum nominal size of aggregate		20mm
Type of aggregate		Crushed angular aggregate
Specific gravity of cement		3.09
Specific gravity	Fine aggregate	2.62
	Coarse aggregate	2.73
Sieve analysis	Fine aggregate	Conforming to grading Zone III Table 4 of IS 383
	Coarse aggregate	Conforming to Table 2 of IS 383
Specific gravity	Fly ash	2.19
Specific gravity	Alccofine-1203	2.70
Specific gravity	Foundry sand	2.1
Specific gravity	Marble dust	3.04

Data for Mix Proportioning

The following data is required for mix proportioning of a particular grade of concrete:

- Grade designation
- Type of cement
- Maximum nominal size of aggregate
- Minimum cement content
- Maximum water-cement ratio
- Workability
- Exposure conditions as per Table 4 and Table 5 of IS 456:2000
- Maximum temperature of concrete at the time of placing
- Method of transporting and placing
- Early age strength requirements, if required

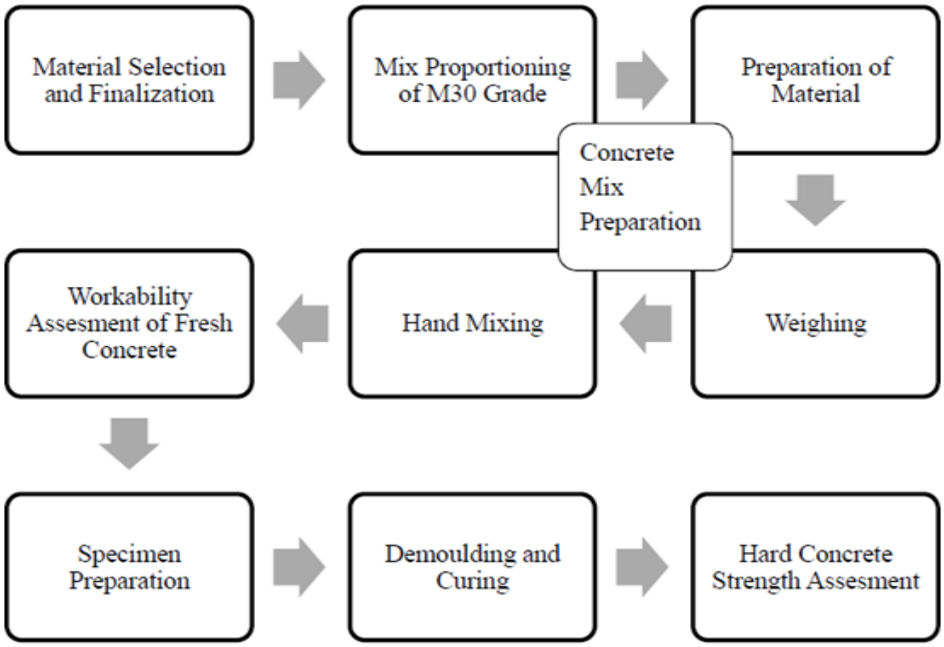

Fig 1: Experimental Methodology

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III. EFFECT OF FOUNDRY SAND, ALCCOFINE-1203 AND COMBINED ON COMPRESSIVE STRENGTH OF CONCRETE (MPA)

The below given table shows that the compressive strength increases as the percentage of foundry sand, Alccofine-1203 and combined increases but after the optimum percentage of foundry sand, Alccofine-1203 and combined the compressive strength reduces. It is due to the concrete microstructure gets negatively affected as the CSH layer breaks after the optimum dosage.

Table 2: Compressive Strength with Foundry Sand (F.S) Addition

Mixture No.	Compressive strength at 7 day (N/mm^2)	Compressive strength at 14 day (N/mm^2)	Compressive strength at 28 day (N/mm^2)
M-1	18.92	24.48	31.13
M-2	25.78	28.88	32.33
M-3	26.44	30.67	33.78
M-4	22.22	24.28	30.33

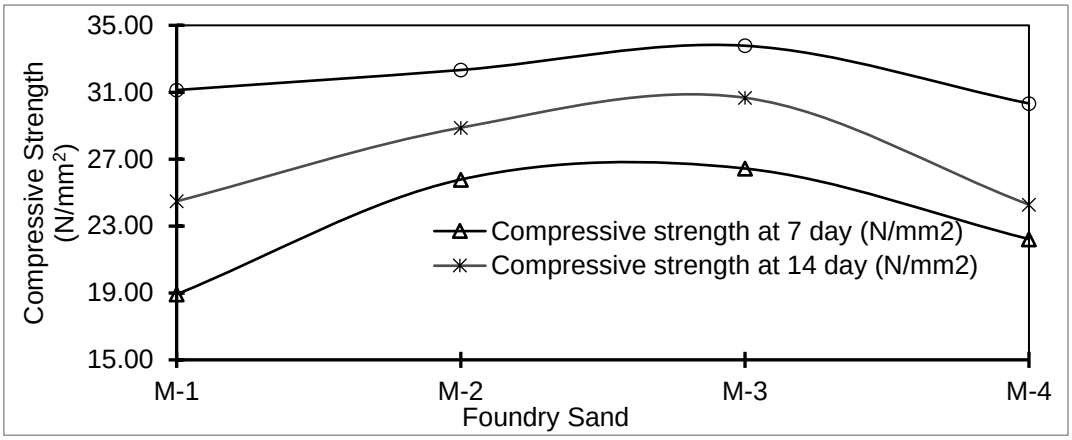

Fig 2: Graph Between Strength and Duration for F.A Replacement of F.S

Table 3: Compressive Strength with Alccofine-1203(A.F-1203) Addition

Mixture No.	Compressive strength at 7 day (N/mm^2)	Compressive strength at 14 day (N/mm^2)	Compressive strength at 28 day (N/mm^2)
M-1	18.92	24.48	31.13
M-2	23.55	26.22	31.67
M-3	26.33	30.22	33.55
M-4	22.45	25.90	31.45

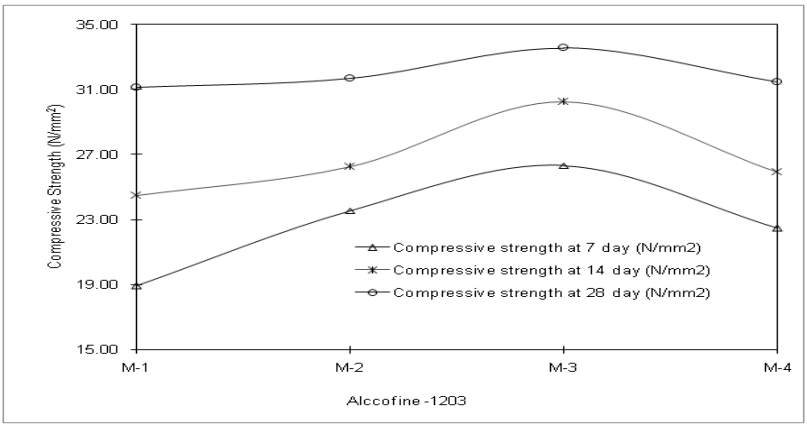

Fig 3: Graph between strength and duration for Cement Replacement of A.F

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Table 4: Compressive Strength with F.S &A.F-1203 Addition

Mixture No.	Compressive strength at 7 day (N/mm^2)	Compressive strength at 14 day (N/mm^2)	Compressive strength at 28 day (N/mm^2)
M-1	18.92	24.48	31.13
M-2	20.55	25.22	32.85
M-3	22.33	27.22	33.55
M-4	19.45	24.90	31.95

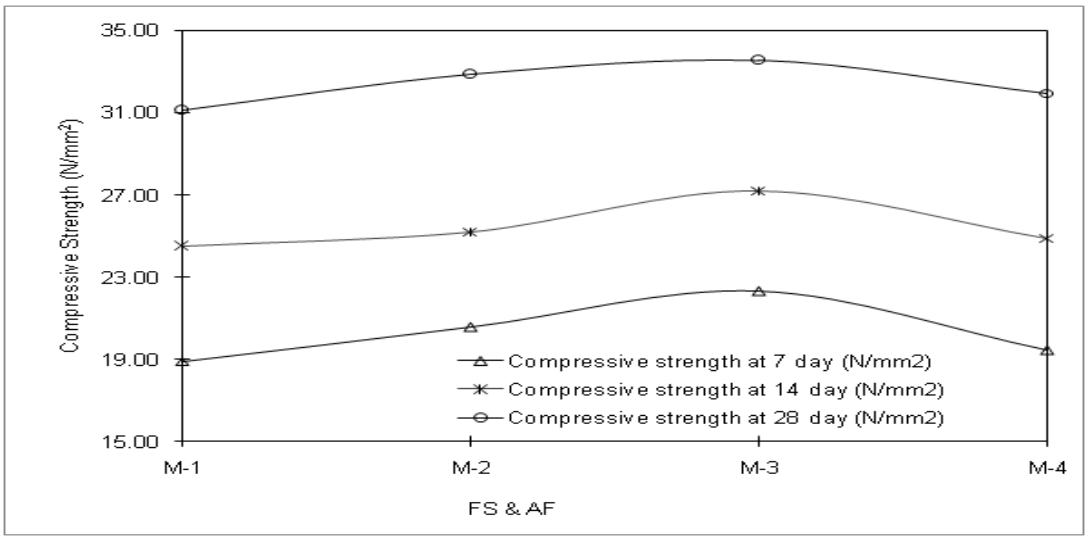

Fig 4: Graph between Strength and Duration for Cement/F.A Replacement of A.F/F.S

The Compressive strength is at its peak at around 10% so this is the optimum percentage at which the compressive strength becomes maximum further addition of foundry sand, Alccofine-1203 and combined (A.F-1203 & F.S) decreases the compressive strength. Foundry sand, Alccofine-1203 has got significant strength to resist compressive forces but is weak in resisting tensile forces.

Fig 5: Compressive Strength Test

Table 5: Standard Compressive Strength Gain by Concrete After 1, 3, 7, 14&28 Days

Age	Strength per cent
1 days	16%
3 days	40%
7 days	65%
14 days	90%
28 days	99%

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IV. EFFECT OF FOUNDRY SAND, ALCCOFINE-1203 AND COMBINED ON SPLIT TENSILE STRENGTH OF CONCRETE (MPA)

Table 6: Split Tensile Strength with Foundry Sand (F.S) Addition

Mixture No.	Split tensile strength at 7day (N/mm^2)	Split tensile strength at 14day (N/mm^2)	Split tensile strength at 28day (N/mm^2)
M-1	1.48	1.65	2.61
M-2	2.55	2.69	3.11
M-3	2.68	2.97	3.54
M-4	2.40	2.61	3.06

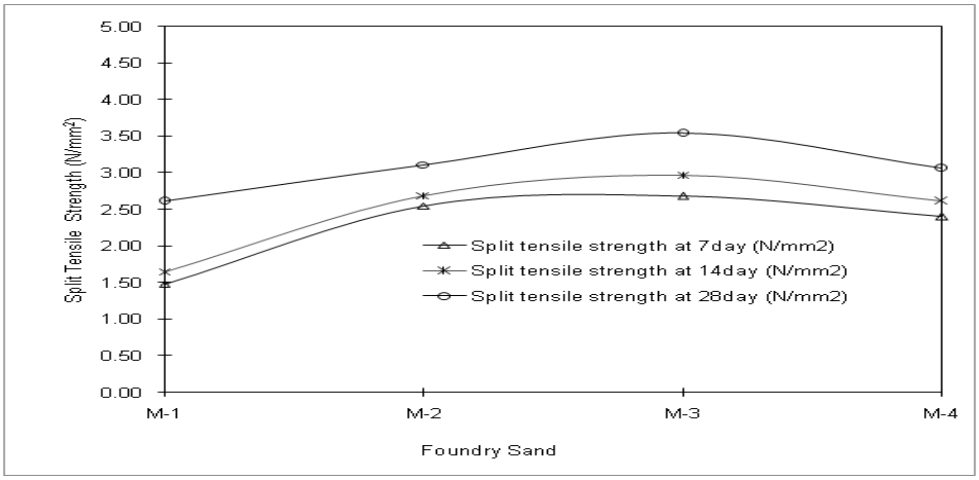

Fig 6: Graph Between Strength and Duration For F.A Replacement of F.S

Similar observation of compressive strength carried in split tensile strength of concrete addition with foundry sand shows the optimum percentage at 10% after 7,14 and 28 days.

Table 7: Split Tensile Strength with Alccofine-1203(A.F-1203) Addition

Mixture No.	Split tensile strength at 7day (N/mm2)	Split tensile strength at 14day (N/mm2)	Split tensile strength at 28day (N/mm2)
M-1	1.48	1.65	2.61
M-2	1.56	2.69	2.78
M-3	2.77	2.95	3.01
M-4	2.83	2.87	2.98

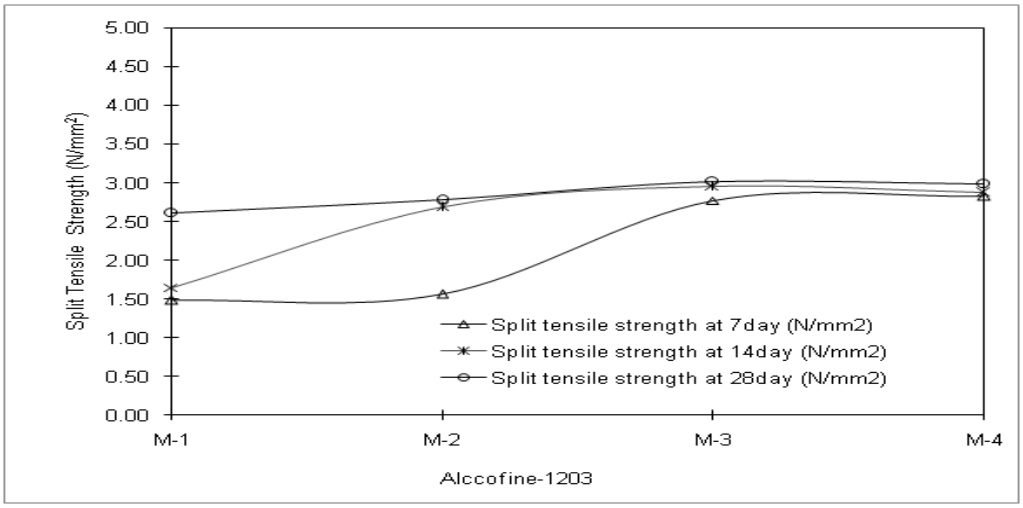

Fig 7: Graph Between Strength and Duration for Cement Replacement of A.F

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Similar observation of compressive strength carried in split tensile strength of concrete addition with Alccofine-1203 shows the optimum percentage at 10% after 7,14 and 28 days.

Table 8: Split Tensile Strength with F.S &A.F-1203 Addition

Mixture No.	Split tensile strength at 7day (N/mm2)	Split tensile strength at 14day (N/mm2)	Split tensile strength at 28day (N/mm2)
M-1	1.48	1.65	2.61
M-2	1.87	2.73	2.89
M-3	2.97	3.04	3.65
M-4	2.76	2.59	2.83

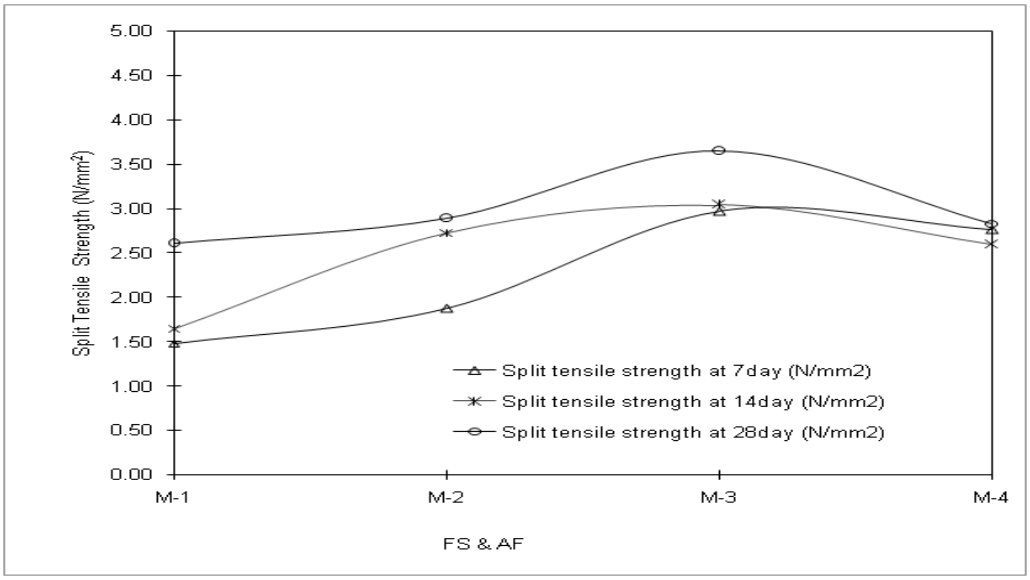

Fig 8: Graph between Strength and Duration for Cement/F.A Replacement of A.F/F.S

Similar observation of compressive strength carried in split tensile strength of concrete addition with Alccofine-1203 and foundry sand shows the optimum percentage at 10% after 7,14 and 28 days.

Fig 9: Split Tensile Strength

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V. EFFECT OF FOUNDRY SAND, ALCCOFINE-1203 AND COMBINED ON FLEXURAL STRENGTH OF CONCRETE (MPA)

The trend is followed when flexural strength test is that it increases as the percentage of foundry sand content increases. Flexural strength is the strength when the cylinder is cut into halves by applying lateral load.

Table 9: Flexural Strength with Foundry Sand (F.S) Addition

Mixture No.	Flexural strength at 7 day (N/mm^2)	Flexural strength at 14 day (N/mm^2)	Flexural strength at 28 day (N/mm^2)
M-1	1.36	2.45	3.34
M-2	1.87	2.80	3.88
M-3	1.97	2.96	4.01
M-4	1.76	2.77	2.98

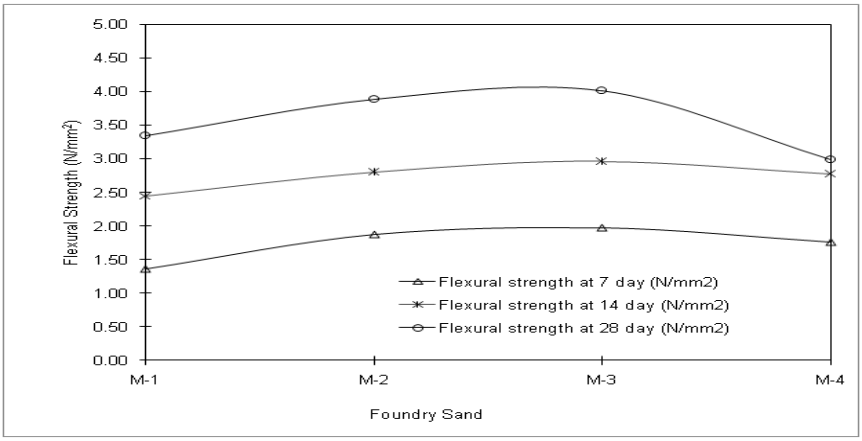

Fig 10: Graph between Strength and Duration for F.A Replacement of F.S

The trend is followed when flexural strength test is that it increases as the percentage of foundry sand content increases. But the optimum percentage of foundry sand is at 10% for the flexural strength.

Table 10: Flexural Strength with Alccofine-1203(A.F-1203) Addition

Mixture No.	Flexural strength at 7 day (N/mm^2)	Flexural strength at 14 day (N/mm^2)	Flexural strength at 28 day (N/mm^2)
M-1	1.36	2.45	3.34
M-2	2.17	2.59	3.69
M-3	2.59	2.77	3.98
M-4	2.28	2.67	3.19

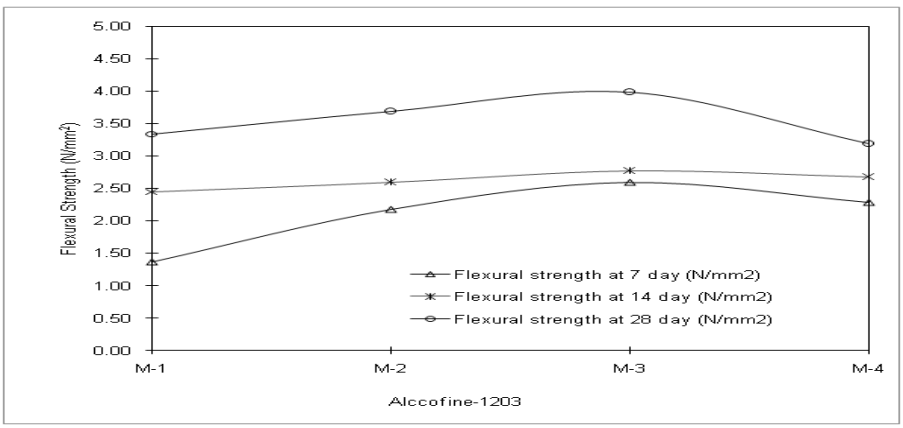

Fig 11: Graph between Strength and Duration for Cement Replacement of A.F

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The trend is followed when flexural strength test is that it increases as the percentage of Alccofine-1203 content increases. But the optimum percentage of Alccofine-1203 is at 10% for the flexural strength.

Table 11: Flexural Strength with F.S &A.F-1203 addition

Mixture No.	Flexural strength at 7 day (N/mm^2)	Flexural strength at 14 day (N/mm^2)	Flexural strength at 28 day (N/mm^2)
M-1	1.36	2.45	3.34
M-2	2.22	2.67	3.78
M-3	2.87	2.91	3.86
M-4	2.24	2.49	3.39

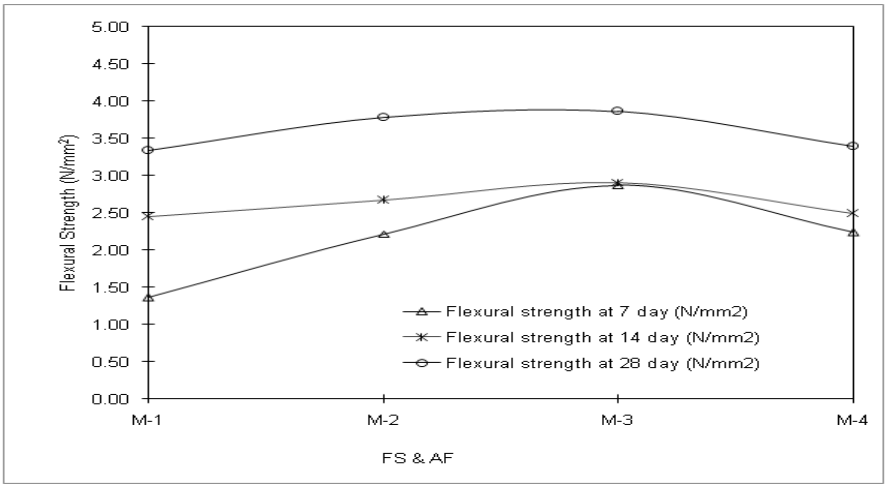

Fig 12: Graph between Strength and Duration for Cement/F.A Replacement of A.F/F.S

The trend is followed when flexural strength test is that it increases as the percentage of foundry sand and alccofine-1203 content increases. But the optimum percentage of foundry sand and alccofine-1203 is at 10% for the flexural strength.

Fig 13: Beam After Fail

VI. CONCLUSION

The aim of study is to increase the compressive strength, split tensile strength, and flexural strength of concrete mix and reducing the environmental pollution by using waste foundry sand and conserving natural resources (river sand). As the result produced in this project it is concluded that:

- As the study result in the graph (Fig 11 and fig 12) and above discussion it can be observed that with the increase in the percentage of Alccofine-1203 and Foundry sand the compressive strength, split tensile strength, flexural strength and the density of the concrete mix also increases.

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- It is observed from the result in the graph Fig 11 Shows that the optimum replacement of Fine aggregate by foundry sand is 10 %, after 10 % replacement no much significance to replacement of Fine aggregate by Foundry sand
- It is observed from the results shows that the optimum replacement of cement by Alccofine-1203 is 15 %, after 15 % replacement not much significance to replacement of cement by Alccofine-1203.
- Besides achieving economy in construction, by increasing the strength of the structure, using eco-friendly material to develop the standard concrete which may greatly increase the durability and strength of structures and provides a massive structures which does not effect by natural disaster and damages less to the structures.

At the W/C ratio of 0.45, slump flow test results were found to be satisfactory, i.e. passing Ability, filling ability and segregation resistance are well within the limits.

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