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Evaluation of Basalt Fibre with Partial Replacement of Fine Aggregate by Foundry Sand in Concrete

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Abstract : In developing countries where concrete is widely used, the high and steadily increasing cost of concrete has made construction is very expensive. This project is experimented to reduce the cost construction and increase strength & durability. The environment has led to studies on various materials which could be used as partially replacement for fine aggregate. In this project, fine aggregate is partially replaced with foundry sand (20,30, 40%), and basalt fiber used to improve the both compression and tensile strength of concrete (2,2.5,3%).Decided to did all the preliminary tests for concrete materials including foundry sand.

Keywords : Foundry sand, Basalt fiber, Compression strength test, tensile strength test.

1.Introduction:

1.1 General

Concrete is a composite material which composed of Cement, sand and aggregates are essential needs for any construction industry. Sand is a major material used for preparation of mortar and concrete and plays a most important role in mix design. In general consumption of natural sand is high, due to the large use of concrete and mortar. Hence the demand of natural sand is very high in developing countries to satisfy the rapid infrastructure growth.

Some alternatives materials have already been used as a replacement of natural sand such as fly-ash, quarry dust or limestone and siliceous stone powder, filtered sand, copper slag are used in concrete and mortar mixtures as a partial or full replacement of natural sand (Chandana Sukesh et al 2013). Even though offshore sand is actually used in many countries such as the UK, Sri Lanka, Continental Europe, India and Singapore, most of the records regarding use of this alternative found mainly as a lesser extent of practice in the construction field.

Since waste materials can be obtained at little or no cost, while making significant contribution to the conservation of natural resources and maintenance of ecological balance. Foundry sand is an industrial waste. It is categorized as light weight aggregate. Cost reduction of 48% can be achieved if the waste utilization can be used in the concrete mixtures. The foundry sand is the byproduct of quartz rock.

In this modern age, civil engineering constructions have their own structural and durability requirements, every structure has its own intended purpose and hence to meet this purpose, modification in traditional cement concrete has become mandatory. It has been found that different type of fibers added in

specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure.

Basalt rock is a volcanic rock and can be divided into small particles then formed into continues or chopped fibers. Basalt fiber has a higher working temperature and has a good resistance to chemical attack, impact load, and fire with less poisonous fumes. Some of the potential applications of these basalt composites are plastic polymer reinforcement, soil strengthening, bridges and highways, industrial floors, heat and sound insulation for residential and industrial buildings, bullet proof vests and retrofitting and rehabilitation of structures.

1.2 Foundry sand

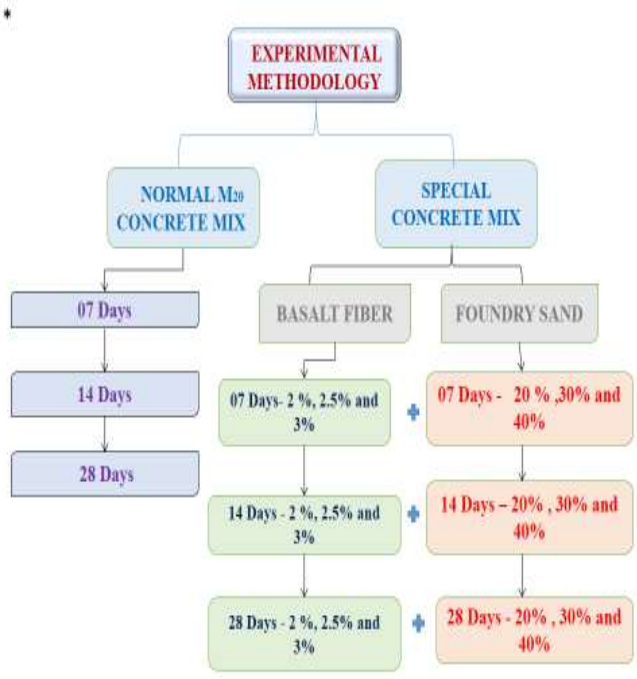
Foundry sand is clean, uniformly sized, high-quality silica sand that is bounded to form moulds for ferrous (iron and steel) and non-ferrous (copper, aluminum, brass) metals. Type of foundry sand depends on the casting process in foundries.

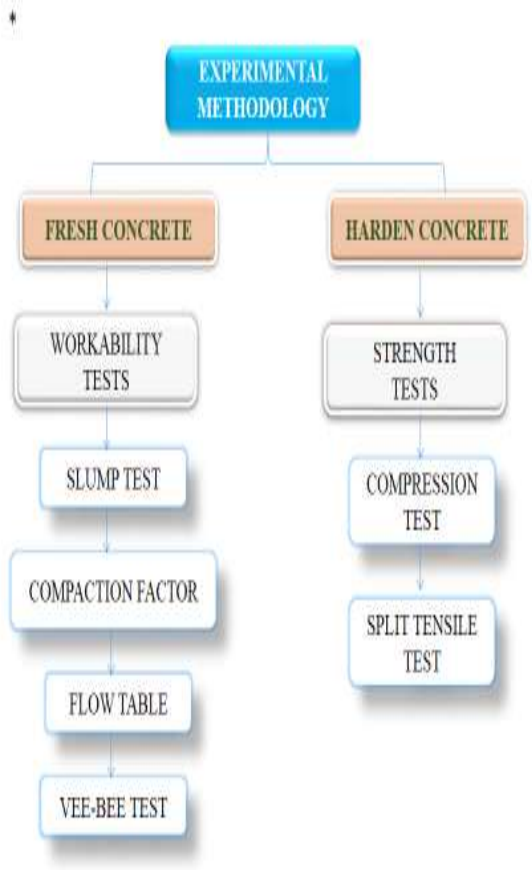
Use of waste foundry sandas full or partial replacement by fine aggregate helps to achieve different properties or behavior of concrete.

2. Experimental Investigations:

The experimental study includes research work for the workability test and hardened concrete specimen test the whole test program is as follows.

- Workability test on concrete.
- Compression strength on concrete
- Tensile strength on concrete





3. Design Mix Methodology

Mix design is done according to the IS design method and numerous trial mixes were conducted to optimum mix .once the optimum mix is determined, it is used to produce concrete with 20%,30%& 40% replaced of foundry sand . The concrete is prepared to find out the compressive strength and the tensile splitting strength. The constituents of this optimum mix preparation showing in table.

Table 1:Optimum Mix Preparation

W/C Ratio	Proportion	Cement (kg)	Fine aggregate (kg)	Coarse Aggregate (kg)	Water (lit.)
0.5	1:1.5:3	75	125	250	40

Table 2: Concrete Design Mix Proportion

Mix	OPC 53 Grade (%)	Fine Aggregate (%)		Coarse Aggregate (%)	Basalt Fiber(%)
		Natural	Replacement	Natural	
I	100	100	0	100	0
II	100	80	20	100	2.0
III	100	70	30	100	2.5
IV	100	60	40	100	3.0

4. Tests Conducted

The various tests had been done on fresh and hardened concrete.

4.1 Fresh Concrete Test

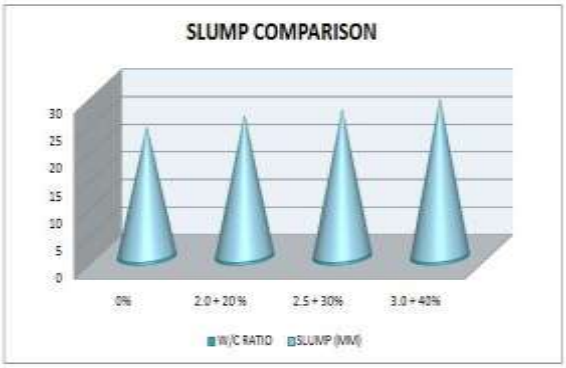
4.1.1 Slump Test

It is the most commonly used method of measuring consistency of concrete.

Table 3: Slump Test

Mix	Slump(mm)	Type
0%	23	TRUE SLUMP
2.0 + 20%	25	TRUE SLUMP
2.5 + 30%	26	TRUE SLUMP
3.0 + 40	28	TRUE SLUMP

Graph 1: Slump comparison



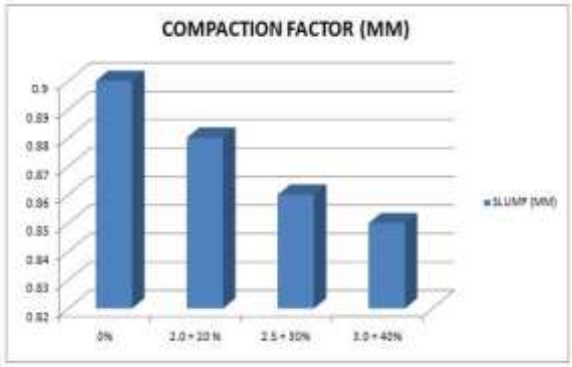
4.1.2 Compaction Factor Test

This is a more refined test then the slump test and this property is measure of workability.

Table 4:**Compaction Factor**

Mix	Compaction factor
0%	0.9
2.0 + 20%	0.88
2.5 + 30%	0.86
3.0 + 40	0.85

Graph 2:Compaction Factor Comparison

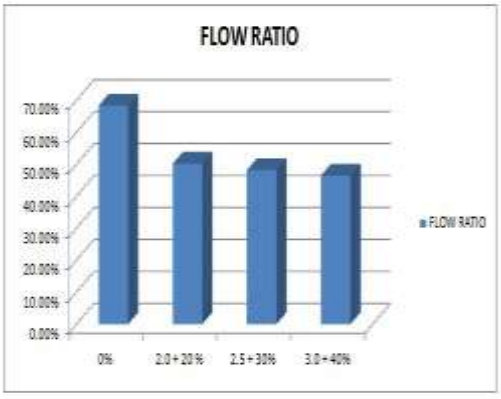


4.1.3 Flow Table Test

This test gives an indication of the quality of concrete with respect to consistency, cohesiveness and non-segregation.

$$\text{Flow}=\frac{\text{Average spread in diameter in cm}-25}{25}\text{X } 100$$

Graph 3:Flow ratio



S.NO	MIX	W/C RATIO	TIME	FLOW RATIO
1	0%	0.5	15	68.40%
2	2.0 + 20 %	0.5	15	50.20%
3	2.5 + 30%	0.5	15	53.18%
4	3.0 + 40%	0.5	15	46.50%

4.2. Result and Discussions

Thus the compressive and tensile strength graph shows that strength increased than its original strength.

4.2.1Compressive Strength

The compressive loading tests on concretes were conducted on a compression testing machine of capacity 2000kN. The readings on dial gauge were recorded and compressive strength was calculated. The test was conducted on 150mm cube specimens at 7, 14 and 28 days.

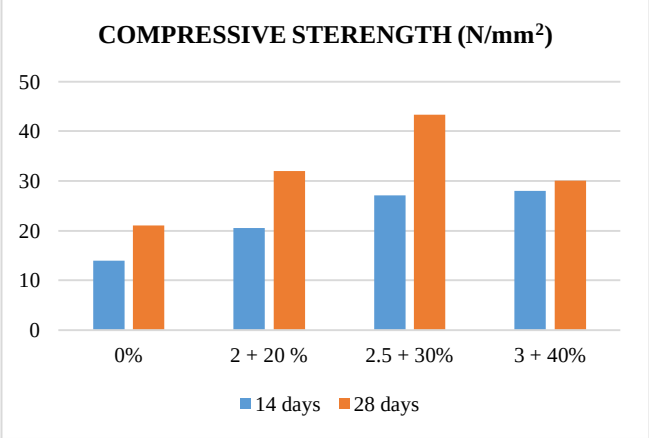
Calculations:

Compressive Strength = $\frac{\text{Maximum load}}{\text{Area}}$ = P/A

Table 5: Compressive Strength

S. No	Mix	Compressive Strength (N/mm^2)	
		14 Days	28 Days
1	0%	13.88	21.02
2	2 + 20%	20.58	32.01
3	2.5 + 30%	27.14	43.33
4	3 + 40%	28.03	30.12

Graph 4:Compressive Strength Comparison



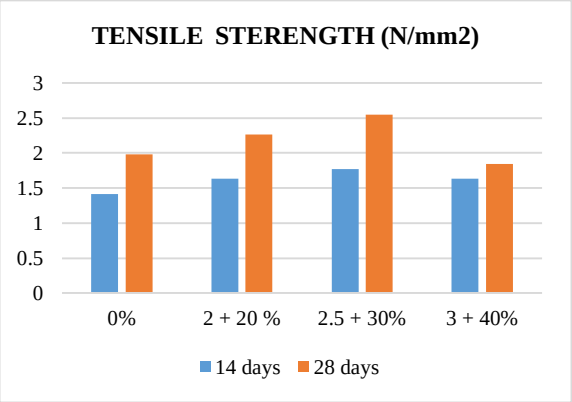
4.2.2 Split Tensile Strength

Splitting tensile strengthtest on concrete cylinder is a method to determine thetensile strength of concrete.

Table 6:

S. No	Mix	CompressiveStrength (N/mm^2)	
		14 Days	28 Days
1	0%	1.41	1.98
2	2 + 20%	1.63	2.26
3	2.5 + 30%	1.77	2.55
4	3 + 40%	1.63	1.84

Graph 5: Tensile Strength Comparison



5. Conclusion

In this study the density and strength characteristics of concrete produced by volume replacement of 20%,30% and 40%, replacement of foundry with Basalt fiber were investigated. We found the compression strength of the concrete has increased than its original strength. The split tensile strength is increased than its original strength. When the fiber is increased more than the 2.5% of weight of cement both compression and tensile strength is decreased. Durability studies on foundry sand and basalt fiber in concrete should be carried out to assess its behaviour in aggressive environments. At the same time the workability of concrete has reduced while using foundry sand and basalt fiber.

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