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A Study on Characteristics of High Performance Concrete of M80 & M90 By Using Robo Sand and Fly Ash Partial Replacement of Sand and Cement

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Abstract- River sand is the one of the basic material in the manufacture of concrete. High Performance Concrete (HPC) is a concrete meeting special combinations of performance and uniformity requirements that cannot be always achieved routinely by using conventional constituents and normal mixing. Recently natural sand is becoming very costly because of its demand in the construction industry and BAN of sand mining in rivers. So research for the alternatives of natural sand is going to find in economical way to meet the high performance characteristics. In this path the manufactured sand called ROBOSAND is the new material i.e., arrived in the world of concrete to fulfill the requirements of Natural sand. The other material FLYASH comes from the industries as a by-product which is freely available. Many researches suggesting that the Fly ash is a good replacement for cement. Codes such as ACI are also suggesting that flyash will be useful material to replace cement up to 35%. This present paper mainly focuses on achieving high performance characteristics of concrete by comparing M80 and M90 grades. The strength, workability and Durability properties for both grades are compared by varying the percentages of ROBOSAND with natural sand by 0%, 25%, 50%, 75% and 100% together with flyash of 20% replacement in cement. The compressive strength, split tensile strength and flexural strength are compared for both grades and results are tabulated and the optimum percentages are concluded.

Keywords- High performance concrete, High strength concrete, Robosand, Manufactured sand, Fly ash, Silica fume.

1. Introduction

Concretes of strengths above 40 Mpa are generally confirmed to produce high strengths. HPC is nothing but high strength concrete not only gives high ultimate strength but performs better in many aspects like durability, abrasion resistance and sulphate attack etc. According to ACI High performance concrete is defined as a material meeting special combinations and uniformity requirements and performance that cannot be always be achieved by Normal mixing, placing and using conventional materials.

High Performance concrete plays an important role in present constructional activities. High rise buildings and off shore structures and long span bridges, structures at marine environment are requires high strength concrete for its more stability and durability for lifetime. There is a possibility of obtaining required high performance characteristics for concrete with low water cement ratios and super plasticizers'. Mineral admixtures such as silica fume and flyash are used to fill microscopic voids to get required strengths.

The developing country like India facing shortage of good quality natural sand and particularly in India, natural sand deposits are being used up and creating serious problem to environment and society. The sand mining from riverbeds is causing a serious threat to environment such as erosion of riverbed and banks, degrading landslides, loss of vegetation on the river banks, lowering the underground water table etc. Hence, sand mining from riverbeds is being restricted or banned by the authorities. Hence Robosand has become a viable alternative to the natural sand. Robosand or Manufactured sand is crushed fine aggregate produced from crusher units and designed for use in normal strength and high strength concretes and other specific products. Use of Manufactured Sand as an alternative to river sand will giving same results as of the natural sand and it will gives high strength with some of the additives in it. Many construction authorities and Ready Mix plants are using Robosand because of its good constructional properties as natural sand.

1.1Robosand

Robosand is also called as manufactured sand obtained by crushing natural granite stone. Robosand is defined as a crushed granite aggregate produced by crushing natural granite stone.

Fig 1. Robosand

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1.2 Preparation

The preparation of Robosand involves rock-hit-rock crushing technique using the state of the art plant. Granite, Basalt and Charkonite are the natural rocks that are used to manufacture Robosand. It is prepared in three stage configuration in VSI crusher to obtain perfect shape and gradation.

1.3 Properties

- Robosand is a perfect substitute for Natural sand and it is a environmental friendly product.
- It cannot contain Harmful ingredients and organic materials.
- Based on the sieve analysis reports by NCCBM and JNTU, Robosand is confirming to Zone – II of IS 383 specifications.
- It is compatible with any type of Cement.
- The shape and gradation is also good for Robosand and it can be controlled.
- Setting time of robosand is normal as natural sand.
- The Workability of manufactured sand (Robosand) is pretty good in all cases.
- The grain size of Robosand is in between 0 – 4.5mm is suitable for all concrete preparations.
- Robosand will show high compressive strength in concrete due to its better bonding properties.

1.4Importance of Robosand

Robosand is important in many aspects because of the following issues

- The river sand which is available today is very deficient in many aspects because it containing high amount of silt and fine particles.
- Natural sand contains other impurities such as shells, coal, bones, silt and mica. When this sand is used in construction, Decay of these materials occurs due to the weathering effect. This will shorten the service life of a structure.
- Recently the Government if India put a BAN on lifting river sand from river beds. So the availability and cost of natural sand are increased.
- Removing sand from river beds shows some adverse effects on environment such as
    - Reduction in water head results in less percolation of rain water into the ground.
    - The roots of the trees cannot able to get water.
    - The river water containing excess impurities when it is flowing.
    - Due to the sand lifting, erosion of sand will occurs at nearby land.
- By considering these issues Robosand is playing an important role in constructions.

1.5 Advantages Of Robosand

- Robosand particles has cubical shape, this will helps in making concrete more cohesive.
- It contains perfect gradation, so it involves less voids in concrete and the compressive strength will increases.
- Due to its well balanced physical and chemical properties the robosand will gives more durability in structures.
- Robosand has very consistent quality and no seasonal fluctuations because it is produced under conditions and with Raw material from single source.
- Robosand will worked out to be very economical because the complete absence of waste materials and silt.

1.6 Fly Ash

Fly ash is a by–product obtained by burning coal from the thermal power plants. Form the power plants, for every year around 85 million tons of flyash is producing as a waste product. There is only 10 – 15 % is using for constructions. Some of the brick manufacturing industries are using flyash. In present days its usage is increased upto some extent.

Fly ash is mostly available in two types. They are Class – C fly ash and Class – F flyash. The Class – C fly ash is produced from lignite or sub-bituminous coal and Class – F is produced from anthracite coal. The Class – C fly ash and slag will contain 35% of silica and low calcium oxide content than ordinary Portland cement. Because of its low calcium oxide content it gives better durability.

1.7 Properties Of Fly Ash

Fly ash is a pozzolanic material means it is a silicious or silicious - aluminous material that reacts with calcium oxide to form cement. When Portland cement reacts with water and produces calcium silicate and lime. In this calcium silicate (CSH) useful for the development of strength and lime is helpful in filling voids. Fly ash reacts with lime and produces CSH, the same product in Portland cement. This reaction of fly ash will improves strength in concrete.

Some of the important properties of Fly ash are

- The spherical shape and particle size distribution of fly ash will increases the flowability and fluidity. So the amount of water can be reduced, this will helps in producing high strengths. So fly ash can be used as a water reducer.
- The drying shrinkage of concrete is directly proportional to the cement paste to aggregate ratio and water content. Due to the increase in drying shrinkage cracks are observed in concrete. So the water reducing property of fly ash reduces the drying shrinkage.
- Fly ash has excellent water tightness of the concrete will increases the durability.
- Fly ash reduces the alkali aggregate reaction, which reduces the harmful expansion in concrete.

1.8 Advantages of Fly Ash

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Volume 05 Issue 22
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- High ultimate strength
- Improved workability
- Reduced bleeding
- Reduced heat of hydration
- Reduced permeability
- Increased resistance to sulphate attack
- Lowered costs

Fig 1.2 Fly ash

2. Material Details

In this experimental program, the primary stage includes the preliminary re-search on selecting the raw materials. Number of conventional trails is prepared and the mix proportions for both M80 and M90 grades are selected by changing different water cement ratios. By replacing the fly ash in 10%, 15%, 20%, 25% and 30% optimum percentage is selected for main trails. The main experimental work involves the replacement of Robosand in 25%, 50%, 75% and 100% along with 20% fly ash, 5% silica fume in cement for M80 and M90 grades. The strength and durability properties are studied in this work by comparing both grades.

2.1Materials

Concrete is a composition of three raw materials. They are Cement, Fine aggregate and Coarse aggregate. These three raw materials play an important role in manufacturing of concrete. By varying the properties and amount of these materials, the properties of concrete will changes. The main raw materials used in this experimental work are cement, fine aggregate, coarse aggregate, mineral and chemical admixtures.

2.2 Cementitious Materials

2.2.1Cement

Cement is the main ingredient in manufacturing of concrete. The characteristics of concrete will b greatly affected by changing the cement content. The cement used in this project is Ordinary Portland cement of 53 grade confirming to IS 12269 – 1987.

2.2.2 Fly Ash

The other cementitious material Fly ash was used as replacement material to cement. Fly ash is obtained from VTPS, Vijayawada and the fly ash is of Class – C type. The specific gravity is 2.15

2.2.3 Silica Fume

Silica fume generally used as mineral admixture. In this work silica fume is used as a replacement material. Silica fume is obtained from ELKEM Industries, Mumbai and it is Black in colour. The specific gravity of silica fume is 2.20

2.2.4 Fine Aggregate

Aggregates of size ranges between 0.075mm – 4.75mm are generally considered as fine aggregates. In this experimental work two types of fine aggregate were used. They are River sand and manufactured sand (Robosand). The manufactured sand was used to replace the natural sand. The fine aggregates are selected as per IS-383 specifications.

2.2.5 River sand

It is also called as natural sand. In this work a good quality of natural sand was used. The sand is medium sand and is confirming to Zone-II as per standard specifications.

2.2.6 Robosand

Manufactured sand used in this process is obtained from nearest crusher unit. The Robosand is of superior quality and well graded material. It is also confirming to Zone-II.

2.2.7 Coarse Aggregate

Aggregates of size more than 4.75mm are generally considered as coarse aggregate. The maximum size of coarse aggregate used in this experimental are 12.5mm. A good quality of coarse aggregates is obtained from nearest crusher unit. The coarse aggregates are selected as per IS-383 specifications.

2.2.8 Chemical Admixture

Chemical admixtures in concrete are confirms to ASTM C 494 Specifications. Chemical admixtures will gives required workability with low water contents. They improves they improves the workability and concrete quality. Hence less cement content is used with reduced water content to achieve same strength.

They are also called as superplastisizers. In this Experimental work GLENIUM B233 is used as a super plasticizer.

3. Mix Propotion Details

3.1 For M80 Grade

Cementitious = 620 Kg/m^3

- Cement = 465 Kg/m^3
- Fly ash = 124 Kg/m^3
- Silica fume = 31 Kg/m^3

Fine aggregate = 543 Kg/m^3

Coarse aggregates = 1088 Kg/m^3

Mix ratio:

Cement: Fine Aggregate: Coarse Aggregates: water

1 : 0.87 : 1.75 : 0.32

3.2 For M90 Grade

Cementitious = 650 Kg/m^3

- Cement = 487.5 Kg/m^3
- Fly ash = 130 Kg/m^3
- Silica fume = 32.5 Kg/m^3

Fine aggregate = 513 Kg/m^3

Coarse aggregates = 1088 Kg/m^3

Mix ratio:

Cement: Fine Aggregate: Coarse Aggregates: water

1 : 0.78 : 1.67 : 0.30

The final mix ratios for both grades are tabulated here

Tab 3.1 Mix proportion ratios for M80 and M90

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Volume 05 Issue 22
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Grade	Mix Ratio	W/C ratio
M80	1: 0.87: 1.75	0.32
M90	1: 0.78: 1.67	0.30

Tab 3.2 Percentages of Material replacements

Material replacing	Percentage of replacement
River sand with Robosand	25%, 50%, 75%, 100%
Cement with fly a	20%
Cement with silica fume	5%

3.3 Detailing of Trail Mixes

The trail mixes are prepared for both M80 and M90 grades. For each grade the replacement of materials are stipulated as follows

The details of trail mixes for M80 and M90 grades are tabulated as follows

Tab 3.3 Trail mix details for M80 and M90 grades

Mix	Fine aggregate (%)		Cementitious material (%)		
	Natural sand	Robosand	Cement	Flyash	SF
Control	100%	0%	100%	0%	0%
Trail 1	100%	0%	75%	20%	5%
Trail 2	75%	25%	75%	20%	5%
Trail 3	50%	50%	75%	20%	5%
Trail 4	25%	75%	75%	20%	5%
Trail 5	0%	100%	75%	20%	5%

3.4 Mix Proportion Quantites

Material quantities of mix proportions according to the trail mixes are described as follows

Tab 3.4 Mix proportion quantities of M80 grade W/C Ratio=0.32

Mix	Cementitious materials (Kg/m^3)			Fine aggregate (Kg/m^3)		Coarse aggregate (Kg/m^3)	Water (Lit/m^3)	Superplastisizer (Lit/m^3)
	Cement	Fly ash	Silica fume	Natural sand	Robosand			
Control	620	0	0	543	0	1088	198.4	1.86
Trail 1	465	124	31	543	0	1088	198.4	1.86
Trail 2	465	124	31	407.25	135.75	1088	198.4	1.86
Trail 3	465	124	31	271.5	271.5	1088	198.4	1.86
Trail 4	465	124	31	135.75	407.25	1088	198.4	1.86
Trail 5	465	124	31	0	543	1088	198.4	1.86

Tab 3.5 Mix proportion quantities of M90 grade W/C Ratio=0.30

Mix	Cementitious materials (Kg/m^3)			Fine aggregate (Kg/m^3)		Coarse aggregate (Kg/m^3)	Water (Lit/m^3)	Superplastisizer (Lit/m^3)
	Cement	Fly ash	Silica fume	Natural sand	Robosand			
Control	650	0	0	513	0	1088	195	1.95

Trail 1	487.5	130	32.5	513	0	1088	195	1.95
Trail 2	487.5	130	32.5	384.75	128.25	1088	195	1.95
Trail 3	487.5	130	32.5	256.5	256.5	1088	195	1.95
Trail 4	487.5	130	32.5	128.25	384.75	1088	195	1.95
Trail 5	487.5	130	32.5	0	513	1088	195	1.95

4. Results and Discussions

4.1 Workability of Concrete

The workability of concrete is observed by the Slump Cone method. The range of slump was selected from the Table A1.5.3.1 of ACI 211.1-91. The slump range was 25-100mm. The value of slump for both grades are shown below

Tab 4.1 Slump obtained for M80 and M90 grades

Mix	Slump (mm)	
	M80	M90
Control	85	82
Trail 1(0% RS)	84	80
Trail 2(25% RS)	80	75
Trail 3(50% RS)	76	72
Trail 4(75% RS)	72	68
Trail 5(100% RS)	65	60

4.2 Compressive Strength (Is 516-1959)

Compressive strength is obtained by applying crushing load on the cube surface. So it is also called as Crushing strength. Compressive strength of concrete is calculated by casting 150mm x 150mm x 150mm cubes. The test results are presented here for the compressive strength of 7 days and 28 days of testing.

The water cured specimens are eliminated from moisture content by surface drying before testing in CTM. The detailed test results are summarized as follows

The compressive strength results for both M80 and M90 grades are shown below

Tab 4.2 Compressive strengths for M80 and M90 grades

Mix	Compressive strength M80 (N/mm^2)		Compressive strength M90 (N/mm^2)	
	7 days	28 days	7 days	28 days
Control	56.1	85.5	68.8	95.5
Trail 1	57.5	89.6	70.5	96.2
Trail 2	58.1	90.5	71.8	98.2
Trail 3	**60.2**	**91.1**	**72.0**	**105.5**
Trail 4	58.5	89.2	71.2	99.5
Trail 5	56.4	88.9	69.9	98.6

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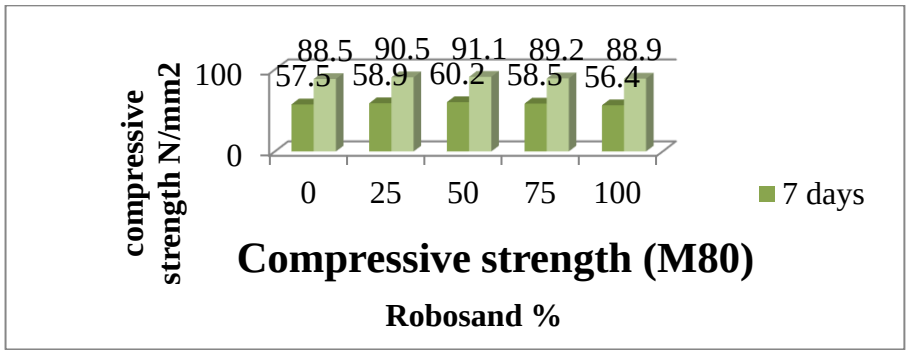

Fig 4.1 Compressive strength variation for M80 grade at 7 & 28 days

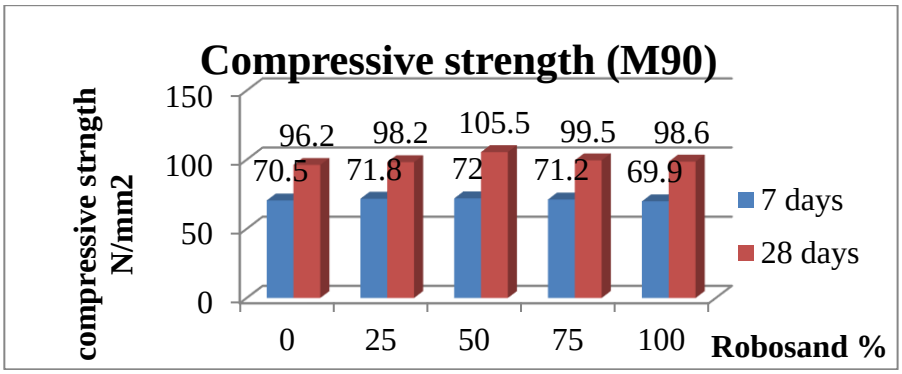

Fig 4.2 Compressive strength variation for M90 grade at 7 & 28 days

4.3 Split Tensile Strength: (Is 516-1959)

Out of all the properties of concrete, tensile strength is very important one. The tensile strength is calculated by testing cylindrical specimens of size 300mm height and 150mm diameter. Here each set of specimens are tested for 7 days and 28 days of curing. The details of test results are summarized below

Here the detailed tabulations are made for split tensile strengths and are shown below

Tab 4.3 Split tensile strengths for M80 and M90 grades

Mix	Split tensile strength M80 (N/mm^2)		Split tensile strength M80 (N/mm^2)	
	7 days	28 days	7 days	28 days
Control	4.28	5.55	5.65	6.25
Trail 1	4.24	5.58	5.62	6.26
Trail 2	4.30	5.60	5.75	6.30
Trail 3	4.38	5.65	5.80	6.65
Trail 4	4.32	5.62	5.65	6.50
Trail 5	4.22	5.56	5.60	6.45

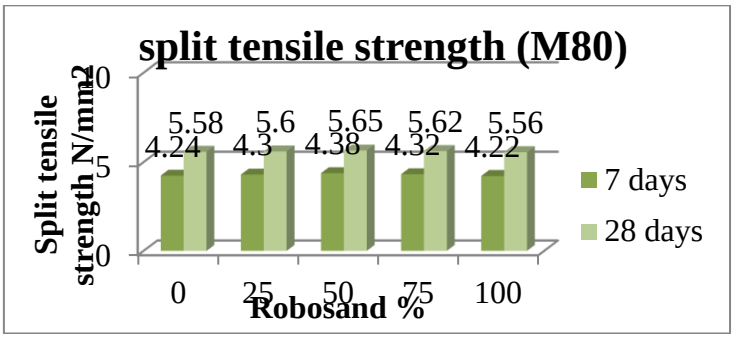

Fig 4.3 Split tensile strength variation for M80 grade at 7 & 28days

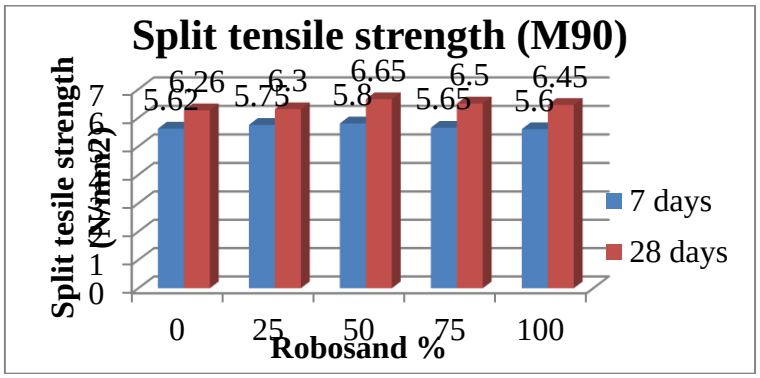

Fig 4.4 Split tensile strength variation for M90 grade at 7 & 28days

5. Conclusions

These following conclusions are given based on the above experimental results

- In the present investigation possibility of high strengths are observed for M80 and M90 grades that are successfully achieved.
- The material Robosand is a good alternative to replace River sand that it satisfied all the requirements as well as natural sand and it can be used for all constructional purposes in place of natural sand for sustainable constructions.
- The coarse aggregates of maximum size of 12.5mm are used to reduce the amount of area occupied by 20mm aggregates, thereby reducing amount of voids and gives better bonding.
- By using Glenium B233 as superplastisizer at a dosage of 0.3% shows better workability and uniformity in mixing of concrete. It is a good water reducing agent.
- For M80 grade, maximum compressive strength of 91.1 Mpa, Split tensile strength of 5.65 Mpa and Flexural strength of 10.5 Mpa had occurred for Trail 3 i.e., 50% RS, 20% FA and 5% SF.
- For M90 grade, maximum compressive strength of 105.5 Mpa, Split tensile strength of 6.65 Mpa, flexural strength of 11.12 Mpa had occurred for Trail 3.
- At the replacement of 50% Robosand in Trail 3 for M80grade, from 7days to 28days the rate of increase in compressive strength is of 34.3% and flexural strength is of 3.5% and split tensile strength is of 3%. For M90 grade, the rate of increase in compressive strength is of 35% and flexural and split tensile strengths are of 4% and 2%.

6. References

[1] ACI 211.1-91, Standard practice for selecting proportions for Normal, Heavy weight and Mass concrete.
[2] ACI Committee 226, Use of Flyash in concrete.
[3] ACI Committee 211, Guide for selecting proportions for High strength concrete with Portland cement and Flyash.
[4] Ravindra Gettu, Zdenek P, Bazant (1990)-"Fracture properties and Brittleness of High strength Concrete"-ACI materials journal, Title no. 87-M66
[5] C.S. Poon, L. Lam, Y.L. Wong (2000) – "A Study on High strength concrete prepared with large volumes of low calcium fly ash" – Journal of Cement concrete and research 30 (2000) 447 – 455.
[6] Rachna M N, E. Ramesh Babu (2014) – "Experimental investigation on Robosand as replacement material of Fine aggregate in Normal concrete" – Journal of IJATES, Vol 2 (2014), Issue 7, July 2014.

[7] Chai Jaturapitakkul, Kraiwood Kiattikomol, Vanchai Sata, Theerarach Leekeeratikul (2004) – "Use of ground coarse fly ash as a replacement of condensed silica fume in producing high-strength concrete" – Journal of Cement and Concrete Research, Vol 34 (2004), 549-555

[8] Venu Malagavelli, P.N. Rao (2010) – "High performance concrete with GGBS and Robosand" – Journal of IJEST, Vol 2 (2010), 5017-2113