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Effect of Manufacturing Sand on Durability of Concrete

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Abstract – *Concrete is widely used material in the world. Concrete is versatile material and it is composition of cement, sand, aggregate and water. Aggregate occupy 70 to 80% of total volume of concrete and it affect fresh and hardened properties of concrete, out of this fine aggregate consumes 20 to 30% of the volume. Sand is most widely used as fine aggregate in concrete. The river bed is main source as sand, hence natural resources are getting depleted due to over exploitation. The manufacturing sand which is available in various queries and it alternative material to natural sand in concrete. The scope of present work to investigate the effect of durability properties of manufacturing sand with grade of M20 and M40 grade of concrete with replacement natural sand to manufacturing sand from 0%,50%,70% and 100% on concrete properties. Here various hardened and durability test conducted for concrete.*

Key Words: Durability, Natural sand, manufacturing sand.

1. INTRODUCTION

Concrete is the world's most commonly used construction material.

Aggregates are the concrete's main element. Sand mining in waterways has grown to such a degree that sand mining is prohibited in many nations. Even where there is no ban, excellent sand is not easily accessible nowadays; it is transferred from a long range. Alternative sources are being examined with the latest ban on river sand mining in India. Attention has been given to how produced sands can be used as an alternative to natural sands. It went into practice to make produced sands by crushing rock blocks into sand granules. A better replacement for river sand can be the artificial sand generated by appropriate machines. Day after day, demand for produced fine aggregates for concrete production is growing. So, in many instances, rock mining has also turned out to be an environmental issue. If an appropriate industrial or agricultural product by waste material can partly replace sand, owing to the scarcity of sand, the issues will be reduced. It will also be an environmentally friendly technique of disposing big amounts of materials otherwise contaminating soil, water and air. It will be a precious resource if this waste can be used in concrete as a partial sand substitute material.

2. Previous Work Done on M-Sand

Ahmed and EI kourd (1989) stated that adding microfines called "dust" enhanced concrete's shrinkage characteristics. Seven concrete mixtures were produced over a year and measured. In this respect, the drying shrinkage increased by an increase in the amount of microfines.

With the addition of calcareous powder, Sawich and Heng (1995) noted the durability of concrete. The outcome showed that when w/c < 0.6 was observed a positive impact of a powdered calcareous stone on concrete durability. There is almost no vital impact above this value of powdered calcareous.

On the 28th day of the initial surface absorption of concrete, Raman et al (2004) explored the impact of quarry dust and mineral admixture. During the use of quarry powder in concrete mixes, they discovered that durability characteristics are lowered.

Li Beixing (2009) has been a significant research for many years evaluating the impact of including calcareous fines in MS on fresh and hardened concrete. It has been founded that in MS 10 to 15 % of calcareous penalties can be permitted without damaging impact on concrete's physical and mechanical characteristics. This document reports the findings of an experimental investigation into the effect of calcareous fines on concrete compressive strength and durability as a substitute of fines aggregate. For low strength concrete with a steady water / cement ratio of 0.55 and high strength concrete with a steady w / c ratio of 0.32, two series of mixture ratios were produced.

S Karthik (2017) used bamboo as a reinforcing material for beam samples comprising 25% of admixture such as fly ash and GGBS as a partial substitute for cement and produced sand as a good aggregate in this current research. The properties inquiry in the sample includes compressive and divided tensile strength, flexural strength and load characteristics–deflection features, pattern and propagation established by crack, and bamboo micro-scale analysis. In this, 75% cement and 12.5% of fly ash and GGBS as binder MS as fine aggregate and granite are included. A total of 27 cubes with a diameter of 150 mm were casted and tested in triplicate by 300 mm height. All 36 beams of 100 x 100 x 500 mm were generated and used by water immersion for the period mix ratio of 1:2:4 of cement, sand and granite for approximately 28 days. In all samples, a 20 mm spacing of the cover was maintained and a water cement ratio of 0.50 was adopted. Partial replacement of cement desires fly ash and GGBS in entirely M-sand concrete as a good aggregate resulting in a promising compressive force. Although their value is low relative to the reference concrete, for some structure implementation it can form a fine material, yet in terms of divided tensile strength the material is better than the reference concrete. Under BRC's flexural loading efficiency produced with alternative materials was considerably small compared to BRC with reference material, a bad bonding of a bamboo with concrete on its alternative material may be a consideration

3. MATERIALS AND METHODS

3.1. Materials

3.1.1 Cement: OPC 43- grade confirming to Indian Standards is used in the present study and the test is conducted to determine specific gravity. The specific gravity of cement was found to be 3.12 by proper experimentation.

3.1.2 Fine aggregates: Manufactured sand and river sand passing through 4.75 mm sieve was used. The specific gravity of manufacturing sand was found as 2.83 and river sand 2.69.

2.1.3 Coarse aggregate: Coarse aggregate used of is well graded and normally weight gravel. The size aggregate used is 20mm (70 %of total weight of aggregate) and 10mm (30 %of total weight of aggregate)

2.1.4 Water: Fresh water available in the local sources was used for the mixing.

2.1.5 Admixture: MasterRhuebuilt 1100(2.0) super plasticizer is used.

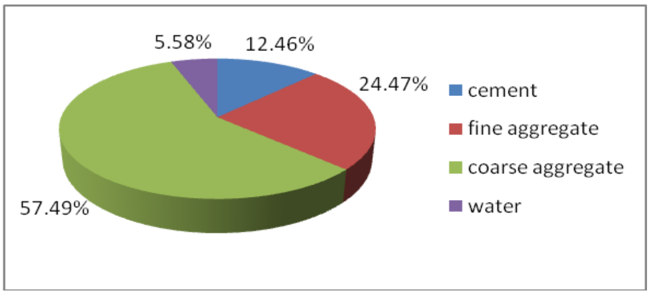
Table 2.1: Significant properties of materials used

Materials	Specific gravity
Cement	3.12
River sand	2.69
Manufacturing sand	2.83
Coarse aggregate	3.03

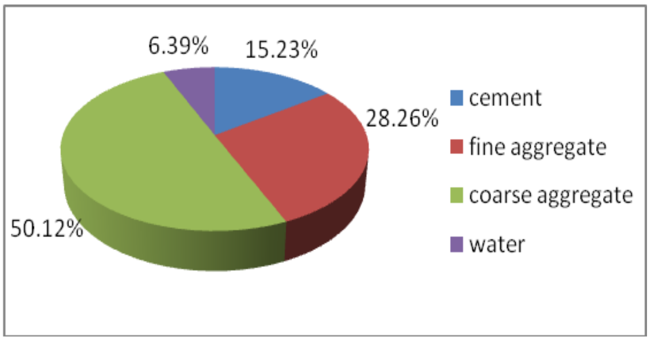
2.2 Mix Design:

Mix design was carried out using IS 10262-2009 for M20 and M40 grades of concrete. In the design mix, natural river sand was partially replaced by 100%, 50% and 70% with M-sand. Crushed angular aggregate with sizes of 10mm and 20mm confirming to IS: 383-1970 was used and having bulk density of 1728 kg/m^3 & loose density of 1527 kg/m^3. The coarse aggregate was tested with reference to IS: 2386 -1963.The specific gravity was found to be 3.03 for 20mm aggregate and 2.68 for 10 mm aggregate and fineness modulus is 2.75. Water absorption of coarse aggregates with reference to IS: 2386 (Part III)-1963 was determined as 20.6%. The impact test was performed to determine the toughness of the aggregate sample and the impact value obtained was 46.5%. The crushing test was carried out to find the compressive strength of the aggregate and found to be 30.3%. Locally available river sand having bulk density of 1860 kg/m^3 and specific gravity of 2.56 was used. The Fineness modulus of river sand is 2.69. Ordinary Portland cement of 43 grade confirming to IS 12269-2013 was used in the experimental investigation.

Mix proportion for M20:-



Mix proportion for M40:-



Replacement of manufacturing sand:-

Mix	A	B	C	D
Cement (kg/m^3)	300	300	300	300
Natural sand (kg/m^3)	648	-	369.68	517.55
Manufactured sand(kg/m^3)	-	739.36	375	225
Coarse aggregate(kg/m^3)	1522.52	1522.52	1522.52	1522.52
water(kg/m^3)	148	148	148	148
Admixture(ml/kg per cement)	6	6	6	6

Table shows replacement of manufacturing sand in that A is shows replacement of 100% natural sand, B is 100% manufacturing sand C is 50% natural sand and 50% of manufacturing sand and D is the 70% of manufacturing sand and 30% natural sand.

3. Experimental Program

3.1 Specimen

The experimental program consisted of casting and testing of specimen's size of cubes 150 X 150 X 150 mm, cylinder 150 X 300 m and beam of 100 X 100 X 500 mm.

3.2 Compressive strength:-

The test procedure were used as given in IS 516:1979 steel moulds of size 150x150x150 mm were used for casting the specimen concrete mix was prepared and specimen were prepared for curing tank for period of 3,7 and 28 days. The compressive strength of

concrete with 100% natural sand, optimum replacement level of 50% and 70% and 100% manufacturing sand for M20 and M40 grade concrete was measured at different periods of 3,7 and 28 days.

Table 3.1: Compressive Strength (M20 and M40 Grade Concrete)

Grade of Concrete	Replacement of M-sand	3 days	7 days	28 days
		N/mm²	N/mm²	N/mm²
M 20	MS 00	25.03	27.01	32.99
	MS 50	26.06	28.46	35.91
	MS 70	24.76	28.46	35.91
	MS 100	24.1	29.94	44.98
M 40	MS 00	30.2	37.34	45.09
	MS 50	42.07	49.56	57.57
	MS 70	27.47	32.39	47.18
	MS 100	32.73	43.31	53.58

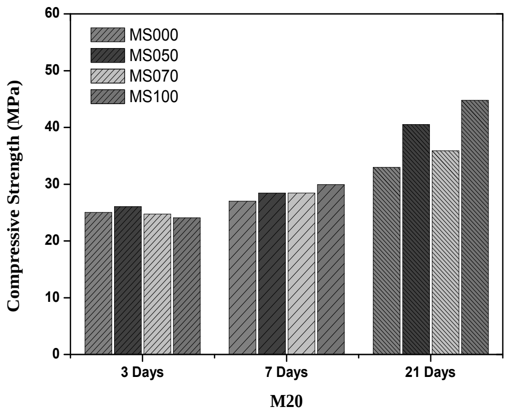


Figure 3.1: Compressive strength of cube M20

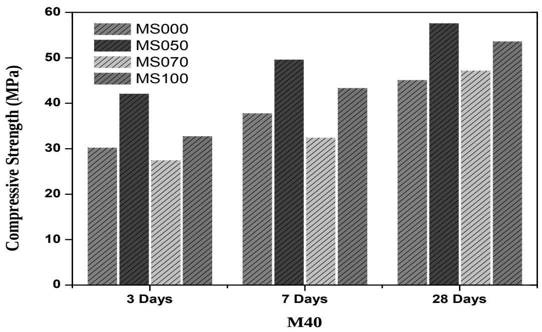


Figure 3.2: Compressive strength of cube M40

3.3 Split Tensile strength:-

The split tension test is a method of determining the tensile strength of concrete. In the most common form, a cylinder is compressed along two opposite generators until it splits across the diametrical plane connecting the loading strips. The test procedure were used as given in IS 516:1979. Steel moulds of diameter 150mm and height

300mm were used for casting the specimen's concrete mix and specimen were allowed for curing in a curing tank for period of 7 and 28 days.

Table 3.2: Split Tensile Strength (M20 and M40 Grade Concrete)

Grade of Concrete	Replacement of M-sand	7 days	28 days
		N/mm²	N/mm²
M 20	MS 00	2.08	2.88
	MS 50	2.24	3.09
	MS 70	1.94	2.77
	MS 100	2.6	3.92
M 40	MS 00	3.59	3.92
	MS 50	3.16	4.21
	MS 70	3.13	4.23
	MS 100	3.33	4.56

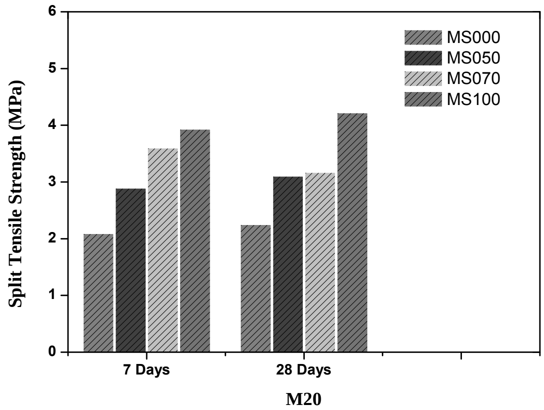


Figure 3.3: Split Tensile Strength of cylinder M20

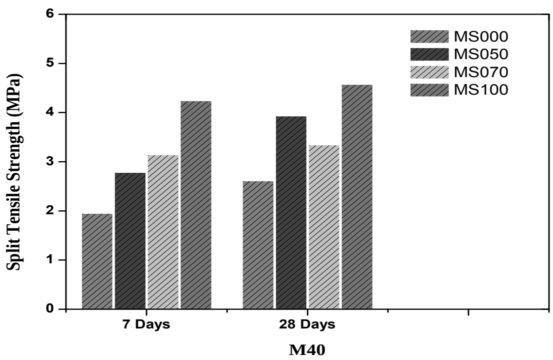


Figure 3.4: Split Tensile strength of cylinder M40

3.4 Flexural strength:-

The test procedure were used as given in IS 516:1979. Steel moulds of size 500x100x100 mm were used for casting the specimens. Concrte mix and specimens were prepared as per 3.4.1. specimens were allwed to cure in curing tank for a period of 7 and 28 days.

Table 3.3: Flexural Strength (M20 and M40 Grade Concrete)

Grade of Concrete	Replacement of M-sand	7 days	28 days
		N/mm²	N/mm²
M 20	MS 00	2.40	2.88
	MS 50	2.59	3.72
	MS 70	2.56	3.86
	MS 100	2.51	3.47
M 40	MS 00	3.98	5.73
	MS 50	4.24	6.16
	MS 70	4.18	5.73
	MS 100	3.90	5.62

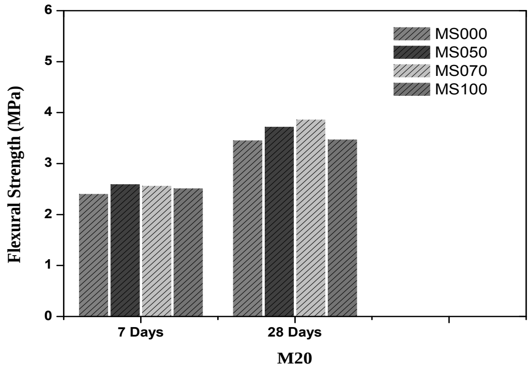


Figure 3.5: Flexural strength of cube M20

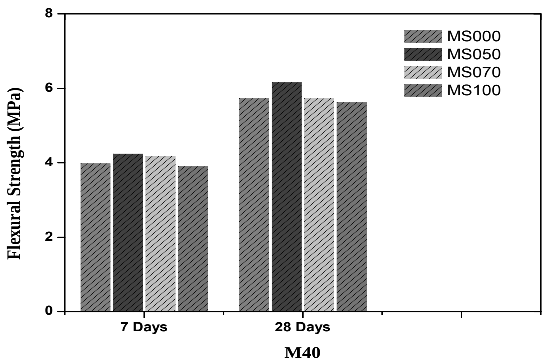


Figure 3.6: Flexural strength of cube M40

3.5 Drying shrinkage:-

The loss of capillary water, drying shrinkage is described as contracting a hard concrete combination. This shrinkage leads tensile stress to increase, which can lead to cracking, inner warping, and external deflection before the concrete is subjected to any type of loading. Several factors rely on the shrinkage of drying. These factors include component features, component ratios, manner of blending, healing humidity content, dry atmosphere, and member size. Under normal conditions, concrete cured will undergo some volumetric change. A specific concrete's shrinking potential is affected by the quantity of mixing, the time elapsed after adding water, fluctuating temperature, slumping, placing, and healing.

Table 3.4: Drying Shrinkage (M20 and M40 Grade Concrete)

Grade of Concrete	Replacement of M-sand	28 days	56 days
		Strainx10-3	Strainx10-3
M 20	MS 00	0.61	1.18
	MS 50	0.72	1.24
	MS 70	0.7	1.24
	MS 100	0.85	1.66
M 40	MS 00	0.6	1.35
	MS 50	0.64	1.06
	MS 70	0.75	1.27
	MS 100	1.04	1.83

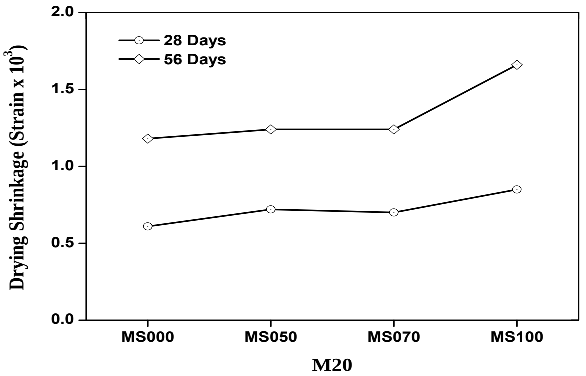


Figure 3.7: Drying Shrinkage of cube M20

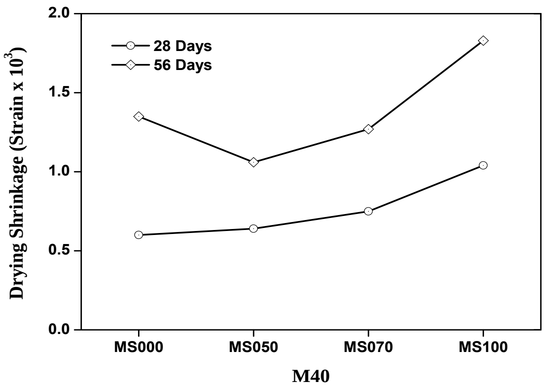


Figure 3.7: Drying Shrinkage of cube M40

4. Conclusions

4.1 General

The report on this thesis includes the following studies:

(a) Characterization of manufactured sand
(b) Effect of manufactured sand on fresh and hardened properties of concrete
(c) Effect of manufactured sand on durability properties of concrete

4.2 Characterization of manufactured sand

The primary to evaluate the effect of physical and chemical characteristics of various proportions of manufactured sand in concrete. The following conclusion is made from the above experimental investigations:

- The presence of alumina content in the manufactured sand sets rapidly, when it reacts with the cement. Thus it reduces the workability of the concrete.
- Blending of manufactured sand with natural sand reduces the amount of micro fines, which improves the workability, strength, durability and structural properties of the concrete.

4.3 Effect of manufactured sand on fresh and hardened properties of concrete

The fresh and hardened properties of concrete with manufactured sand varying from 0 to 100% as increment have been studied and the following conclusions are drawn.

- The slump value is decreased by about 60% for 100% replacement manufactured sand, while in case of optimum replacement value is decreased by about 23 to 38% when compared to the natural sand.
- The strength achievements are increased up to the replacement level of 50% manufactured sand. Beyond that proportion, there is no improvement in the strength achievement due to the large amount of fines particle in it.
- The strength achievements are higher at early periods, for higher grade concrete due to the high cement content and less water content.
- The compressive strength, splitting tensile strength and flexural strength of concrete with manufactured sand are increased by about 20%, 15% and 20% respectively when compared to natural sand.

4.4 Effect of manufactured sand on durability properties of concrete

The durability properties of the concrete were studied for 100% manufactured sand and the optimum replacement of 50%and 70% manufactured sand and then properties were compared with 100% natural sand. From the experimental investigation the following conclusions are arrived.

- The draying shrinkage strains 6%, 4% and 2%less than for 100% natural sand, 50% and 70% manufactured sand respectively, when compared to the 100% manufactured sand.

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