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ASSESSMENT OF COMPRESSIVE STRENGTH OF M40 CONCRETE WITH MANUFACTURED SAND- AN APPLICATION BASED CONCRETE MIX

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ABSTRACT

This paper presents the performance of compressive strength of M40 Grade artificial sand concrete with partial replacement of river sand to manufactured/Artificial sand. This necessitates huge demand of concrete for infrastructure development worldwide and extreme scarcity of natural sand availability. Investigation carried out by varying 0 to 100% replacement of natural sand with manufactured sand in M40 mix.The concrete specimens were cured on normal moist curing under normal atmospheric temperature. The compressive strength was determined at 7, 14 and 28 days. M 40 Grade concrete using complete manufactured sand yielded an excesses strength of 7.65%, 7.76% and 2.71% compared to conventional concrete for 7 days, 14 days and 28 days respectively, with a reduction of -25.37% in slump. To improve the workability 0.5% of Cera-Chem plasticizer as admixture is recommended.Hence M40 Grade concrete with manufactured sand was found to increase the compressive strength of concrete on all ages when compared to conventional concrete with river sand.

Keywords: admixture, compressive strength, cement, manufactured sand, m40 grade concrete, river sand.

INTRODUCTION

The rapid urbanization and industrialization all over the world made natural sand as scarce material, which is one prime constituted of cement concrete. The alternative way of getting substitute for natural sand is by crushing natural stone to get artificial sand of desired size and grade which would be free from all impurities. Manufactured sand used in the current investigation is made of crushing rock boulders in vertical shaft impact crushers. For the purpose of experimentation concrete mix is designed for M40 grade artificial sand concrete (ASC) by 0% to 100% replacement of natural sand to artificial sand with a replacement increment of 10%. The Cera-Chem plasticizer (CCP) is usedas admixture of dosage 0.5% volume fraction in all mixes. The compressive strength of M40 concrete with slump for various replacements of natural sand to manufactured sand presented in the paper.

LITERATUREREVIEW

The availability of natural sand becomes very scarce day by day due to rapid urbanization and industrialization of every part of the world. Hence availability of natural sand for concrete preparation also limited. Many authors done investigation on concrete by replacing sand by alternative materials such as, local materials, used sand, ceramic fines, bottom ash etc. [1, 2, 3, 5]. Availability of above materials in large quantity is restricted to few areas and not in all places. But, manufactured sand/artificial sand can be made available everywhere due to availability of plenty of crushed stones. Few authors carried out studies on the compressive strength studies of concrete made of manufactured sand(M-sand)/artificial sand in varying proportions were higher than those of conventional concrete by using natural sand as fine aggregate [6, 7, 8, 10, 11, 12, 13, 14, 15, 16]. However, it was found that workability of the concrete mixes decreased with an increase in percentage of M-sand as fine aggregate. It reveals that higher water requirement in such concrete to maintain desired workability.But, higher percentage of water reduces the strength of concrete; alternatively plasticizer can be substituted to main workability without effecting strength of concrete.

In the current investigation M40 concrete mix tested for its compressive strength by replacing varying quantity of fine aggregate with M-sand (0% , 40%, 50%, 60%, 70% ,80%, 90%, 100%), which is most common concrete mix used in highway bridge construction. An attempt has been made to find optimal percentage replacement of fine aggregate with M-sand to get maximum strength.

METHODOLOGY

The research methodology that has been followed during the study includes, collection of materials, testing of materials for its physicalproperties, casting and testing of concrete for 7, 14 and 28 days strength.

Materials

Cement

Ordinary Portland cement of 53grade confirming to IS12269-1989, (Locally available brand Penna super) is used for this present study. The specific gravity of cement is, and the other properties of cement are given in Table-1.

Table-1. Physical properties of cement.

Property	**Value**	**Requirement**(IS12269-1989)
Specific gravity	3.15	ISH99-1959
Initial setting time	33 min.	Minimum 30 min.
Final setting time	385 min.	Maximum 600 min.
Fineness modulus	1.68%	<10%
Sound ness	5.50	Maximum 10mm
Standard consistency	28.20%	-

Coarse Aggregates

Crushed granite aggregates of (maximum size) 20mm is used. Sieveanalysis has been carried out, and the results are given in Table-2. The coarse aggregate having specific gravity 2.70, bulk density 2700 Kg/m³ and fineness modulus 6.67 and Impact value of 12.50% was used.The physical properties of coarse are presented in Table-3.

Table-2. Sieve Analysis for coarse aggregate (20mm).

Sieve Size mm	**Weight retained in gm.**	**% byweight retained**	**Cumulative % byweight retained**	**Cumulative % byweight passing**	**Limit**
40 mm	0.00	0.00	0.00	100.00	100
20 mm	55.00	2.75	2.75	97.25	95-100
10 mm	1240.00	62.00	64.75	35.25	25-55
4.75 mm	700.00	35.00	99.75	0.25	0-10
2.36 mm	5.00	0.25	100	0.00	0
1.18 mm	-	-	100	0.00	-
600µ	-	-	100	0.00	-
300µ	-	-	100	0.00	-
150µ	-	-	100	0.00	-
	Fineness modulus		6.67		

Fine Aggregates

River Sand

Sand available in river Cauvery is used for current work, having the bulk density of 1460kg/m^3, specific gravity 2.60, andfineness modulus as 3.44was used. The physical properties are presented in Table-3.

Manufactured Sand (M-sand)

Manufactured/Artificial sand is manufactured in vertical shaft impactcrusher (VSI crusher at Salem) was collected from nearby Quarry at Panamarathupatty,Salem. It is used as an alternate for river sand in replacement of fine aggregates. The bulk density of M-sand is 1556kg/m^3, specific gravity andfineness modulus is found to be 2.45 and 3.54 respectively. The physical properties are presented in Table-3.Sieve analysis for river sand and M-sand are presented in Tables 4and5 respectively.

Table-3. Physical properties of coarse aggregate and fineaggregates.

Property	Coarseaggregate	Fine aggregate	
		River sand	Msand
Specific gravity	2.70	2.60	2.45
Bulk density(kg/m3)	1510	1460	1556
Water absorption (%)	0.45	1.00	0.85
Moisture content (%)	0.65	1.55	1.10
Aggregate impact value (%)	12.50	-	-
Fineness modules	6.67	3.44	3.54
Fineness particles Less than 150mm (%)	-	4.14	7.60
Sieve analysis		Zone II	Zone II

Table-4. Sieve analysis for natural sand.

Sieve Size mm	Weight retained in gm.	% byweight retained	Cumulative % byweight retained	Cumulative % byweight passing	Limit
4.75	60	2.00	2.00	98.00	90-100
2.36	60	2.00	4.00	96.00	75-100
1.18	471	13.9	17.90	82.10	55-90
600m	673	22.43	40.33	59.67	35-59
300m	1315	43.83	84.16	15.84	8-30
150m	351	11.70	95.86	4.14	0-10
Pan	125	4.16	100	0.00	
	Fineness modulus		3.44		

Table-5. Sieve analysis for artificial sand/Msand.

Sieve Size mm	Weight Retained In gm	% By Weight retained	Cumulative % byWeight retained	Cumulative % byWeight passing	Limit
4.75	99	2.75	2.75	97.24	90-100
2.36	130	3.62	0.37	93.62	75-100
1.18	996	27.76	34.13	65.86	55-90
600µ	441	12.29	46.42	53.51	35-59
300 µ	1147	31.98	78.40	21.60	8-30
150 µ	502	14.00	92.40	7.60	0-10
Pan	270	7.53	99.53	0.07	
	Fineness modulus		3.54		

Water

Fresh potable water having p^H value 7 is used for making concrete and for curing the concrete cubes.

RESULTS AND DISCUSSIONS

The main objective of current experimental investigation is to find out the effective percentage of replacement of river sand by M- sand with 0%,40%,50%,60%,70%,80%,90% and 100% to achieve

maximum compressive strength. Concrete mix was designed as per IS 10262-2009. M40 grade concrete having mxi proportions of 1:1.3:2.6 used by weight and the w/c ratio was fixed as 0.40 as per the designed curve. Concrete mix with different proportions of M-sand is added for replacement of river sand from 40% to 100%. The mixes are designated as M, M2, M3, M4, M5, M6, M7 and M8 respectively.The concrete mix proportions are presented in Table-6.The specimens of cubes of size 150mm×150mm×150mm wascasted, as per IS specifications and specimens were removed after 24 hours of casting and cured for 7, 14 and 28 days respectively. After curing, cubes were taken for compression test.

Consistency of concrete is tested by slump test for W/C ratio of 0.40 (as per IS1199-1959) and for different mix proportions of river sand and M-sand. The results are tabulated in Table-7 and Figure-1. The values present in Table-7 and Figure-1 reveals that, increase of percentage of M-sand in concrete causes reduction in the slump values (lesser workability).Concrete after properly curried for 7 days, 14 days and 28 days are taken from the water tank and exposed for few hours for natural conditions and then tested in concrete compressive testing machine (CTM). The compressive strength of various mixes of M40 grade are given in Table-8 and shown in Figure-2.

Table-6. Mix proportions for M40 grade concrete for varying replacement of fine aggregate with M-sand.

S. No	Mix details	Cement (kg/m^3)	Natural sand (kg/m^3)	Msand (kg/m^3)	Coarse aggregates (kg/m^3)	Water (l/m^3)
1.	M1(AS0)	430	572	-	1144	176
2.	M2(AS40)	430	343	229	1144	176
3.	M3(AS50)	430	286	286	1144	176
4.	M4(AS60)	430	229	343	1144	176
5.	M5(AS70)	430	172	400	1144	176
6.	M6(AS80)	430	114	458	1144	176
7.	M7(AS90)	430	57	515	1144	176
8.	M8(AS90)	430	0	572	1144	176

Table-7. Workability of concrete for different mixes (Slump).

S.No.	Mix	Slump(mm)
1	M1(AS0)	55
2	M2(AS40)	44
3	M3(AS50)	43
4	M4(AS60)	40
5	M5(AS70)	38
6	M6(AS80)	36
7	M7(AS90)	35
8	M8(AS90)	35

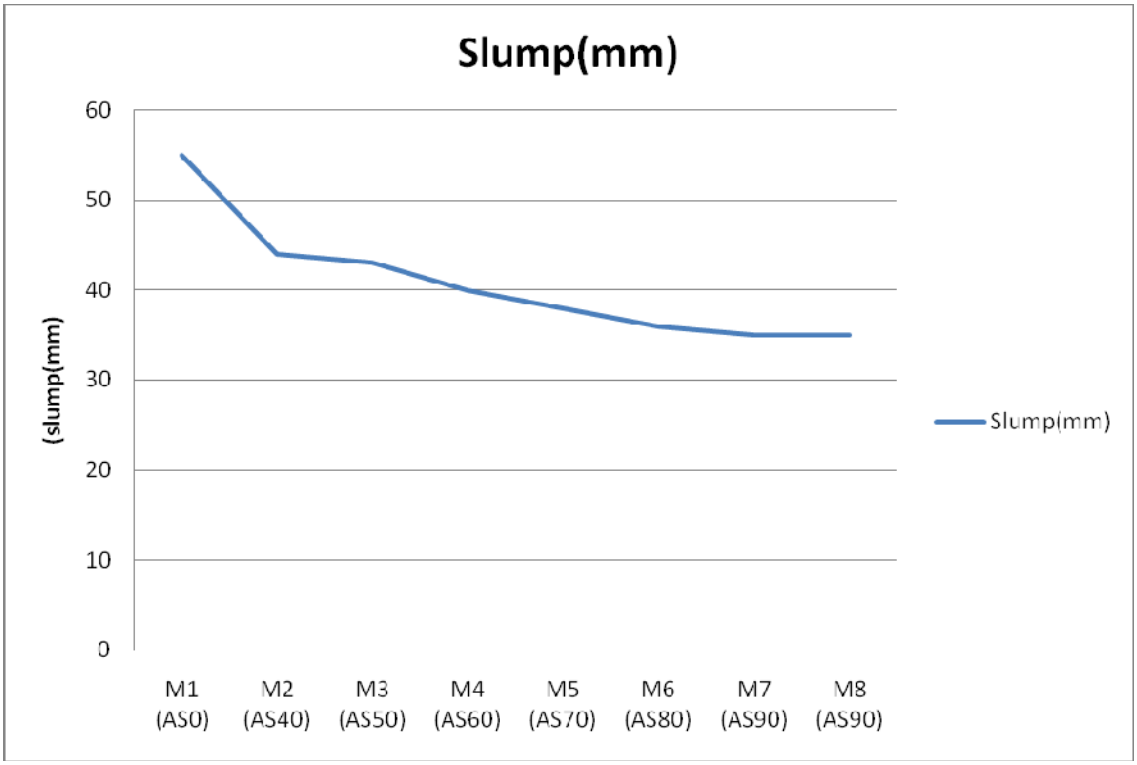

Figure-1. Workability of M40 concrete mix with varying % of artificial sand.

Table-8. Compressive strength of various mixes of M40 concrete.

S.No	**Mix** Proportion (River Sand : Artificial Sand)	**Compressive Strength** N/mm²		
		7 Days	**14 Days**	**28 Days**
1	M1(AS0)	37.91	56.14	62.44
2	M2(AS40)	39.81	56.59	66.82
3	M3(AS50)	37.78	54.66	67.34
4	M4(AS60)	41.78	56.14	62.22
5	M5(AS70)	40.15	52.87	61.93
6	M6(AS80)	39.33	53.03	57.33
7	M7(AS90)	42.22	50.96	58.67
8	M8(AS90)	40.51	49.92	60.66

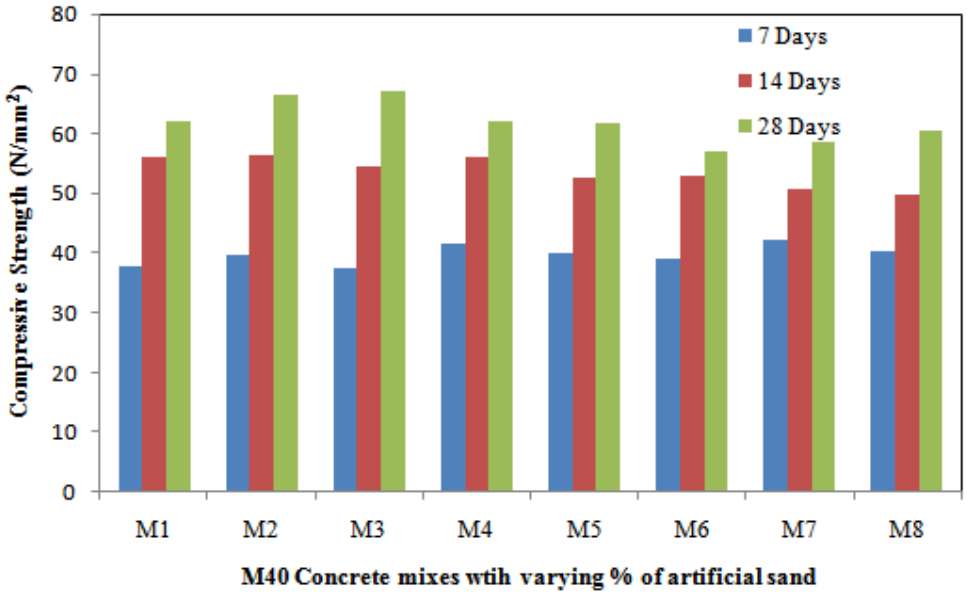

Figure-2. Variation of compressive strength of M40 concrete with different % of artificial sand.

CONCLUSIONS

The Concrete cubes were cast at various percentage of M Sand content. The water cement ratio for this work was taken as 0.40 and slump of the fresh concrete varied between 8 mm and 12 mm. Cubes were tested for 7, 14 and 28 days to determine compressive strength of M40 concrete mixes.The following are the conclusions drawn from the current investigation.

- The 28 days compressive strength of M40 concrete mix with100% natural river sand is 62.44 N/mm². However, M40 concrete with 50% replacement of natural sand by M-sand yield compressive strength of 67.34 N/mm², which is 7.85% higher.
- The compressive strength of all mixes increased with age from 7 days to 28 days. Current investigation revealed that 60%, 70%, 80%, 90% and 100% of natural sand replacement with M-sand decreases the strength at 28 days. Hence for achieving maximum strength of M40 concrete, the optimum replacement of natural sand by M-sand is upto 50%.
- Concrete mix becomes harsh with increase in percentage of manufactured sand. Hence to increase thee workability, use of 0.5% volume fraction admixtures is recommended.
- The M40 concrete prepared using the M-sand yielded the satisfactory results in terms of strength and workability.Hence use M-sand for concrete is recommended.

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