IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684, p-ISSN: 2320-334X
PP 19-25
www.iosrjournals.org

Experimental Study on Mechanical Properties of M-Sand Concrete by Different Curing Methods

Sagura R[1], Jagadeesan R[2]

[1] *PG Student, Department of Civil Engineering, K.S.Rangasamy College of Technology Tiruchengode, Tamilnadu, India, 637215*

[2]*Assistant Professor, Department of Civil Engineering, K.S.Rangasamy College of Technology Tiruchengode, Tamilnadu, India, 637215*

ABSTRACT: Concrete is widely used composite construction material consist of cement, fine aggregate and coarse aggregate. One of the constituent materials of concrete especially, the fine aggregate plays an important role for imparting better performance of concrete in its fresh and hardened state. The shortage of the resources of natural sand(NS), have the possibility for the use of M-Sand (MS).Proper curing of concrete structures is important to ensure their intended performance and durability requirements. Curing plays a major role in developing the concrete microstructure and pore structure. The self curing concrete means that no external curing required for concrete. The scope of this study is to investigate the effect of replacement of NS by MS for different curing methods. In self and membrane curing methods the Super Absorbent Polymer (SAP) and wax based membrane curing compounds were used. Using M20 grade of concrete cubes, cylinder and prism were casted for NS and MS. The specimens were allowed for air curing, standard moist curing, membrane curing and with Super-Absorbent Polymer (SAP) at different proportions of 0.2%, 0.3% and 0.4% by weight of cement and the various mechanical properties were studied.

Key words: M-Sand, Membrane Curing, Self curing, Super absorbent polymer.

I. INTRODUCTION

Aggregates occupy 65 to 80% of the total volume of concrete and affect the fresh and hardened properties of concrete. Out of the total composition of aggregate, the fine aggregate consumes around 20 to 30% percent of the volume. The limiting resources of natural sand avail the possibility for the use of manufactured sands.

To attain desirable strength and other properties, curing is necessary. Curing is the process of maintaining the proper moisture content to promote optimum cement hydration immediately after placement. As a result, adequate curing is essential for concrete to obtain advanced structural and durability properties and therefore is one of the most important requirements for optimum concrete performance in any environment or application.

1.1 Self-curing

The ACI-308 code states that "Internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing water." 'Internal curing' is often also referred as 'Self–curing.' It is a very promising technique that can provide additional moisture in concrete for a more effective hydration of the cement and reduced self-desiccation. Self curing implies the introduction of a curing agent in to concrete that will provide this additional moisture. The additional internal water is typically supplied by using relatively small amounts of saturated, light weight, fine aggregates or super absorbent polymer particles in the concrete.

1.2 Wax Based Membrane Curing Compound

It is a low viscosity wax emulsion incorporating alkali reactive emulsion breaking System ensuring that the emulsion breaks down to form a non penetrating continuous film immediately upon contact with a cementitious surface preventing excessive water evaporation and in turn permits more efficient cement hydration. This reduces shrinkage increasing durability.

1.3 Super Absorbent Polymer

A superabsorbent polymer (SAP) is a polymeric material which is able to absorb a significant amount of liquid from the surroundings and to retain the liquid within its structure without dissolving[1]. Super Absorbent Polymers are prepared from acrylic acid and a crosslinker by solution or suspension polymerization. The type and quantity of crosslinker control both the swelling capacity and gel modulus. It is one kind of functionality macromolecule polymer which is non-toxic, non-irritating and non-corrosive. It cannot conflagrate and blast. SAP can be used as a dry concrete admixture since it takes up water during the mixing process, and the use of SAP permits free design of the shape and the size of the formed inclusions. Most SAPs are cross-linked polyelectrolytes. Because of their ionic nature and interconnected structure, they absorb large quantities of water and other aqueous solutions without dissolving. With the present polymer types the theoretical maximum water absorption is approximately 5,000 times their weight[2].

II. EXPERIMENTAL INVESTIGATION

2.1 Materials

Cement: Portland pozzolona cement of 53 grades was used in this entire investigation.
Fine Aggregate: Natural and M- Sand conforming to Indian standard zone II
Coarse Aggregate: Locally available quarry stone in good strength passing through 20 mm and retain in 10mm sieve.
Water: Ordinary potable water without acidity and alkaniety available in the laboratory was used.
Wax Based Membrane Curing Compound: Colour - Bulk liquid White and Minimum application temperature at 10°C
Super Absorbent Polymer: The common SAPs are added at rate of 0 – 0.6 wt % of cement. The SAPs are covalently cross-linked. They are Acryl amide/acrylic acid copolymers. One type of SAPs are suspension polymerized, spherical particles with an average particle size of approximately 200 mm; another type of SAP is solution polymerized and then crushed and sieved to particle sizes in the range of 125–250 mm. The size of the swollen SAP particles in the cement pastes and mortars is about three times larger due to pore fluid absorption. The swelling time depends especially on the particle size distribution of the SAP. It is seen that more than 50% swelling occurs within the first 5 min after water addition.

TABLE 1
PROPERTIES OF SUPER ABSORBENT POLYMER

FORM – dry	Crystalline white powder / granules
Particle size	0 – 1 mm
Water absorption with distilled water	800 g for 1 g
pH of absorbed water	Neutral
Density	1.08
Bulk density	0.85
Hydration / Dehydration	Reversible
Decomposition in sun light	6 months
Available water	95% approx.

2.2 Mix proportions

The control mix was proportioned by IS 10262: 2009[3] to obtain compressive strength of 20 MPa. The mix proportion and quantity of material taken for one meter cube of self curing concrete mixes are given in Table 2.The mixes M1 (Standard moist curing), M2 (Air curing), M3 (Membrane curing), M4, M5 and M6 were obtained by adding SAP content of 0.2%, 0.3%, and 0.4% of weight of cement .Additional water added to the mix depend upon the amount of SAP added (for 1 kg SAP add 45 liter water).

TABLE 2

MIX PROPORTIONS PER M^3

MIX	CEMENT (Kg)	F.A (Kg)	C.A (Kg)	WATER (Lit)	SAP (Kg)
MIX 1, 2&3	440.84	754.81	1031.52	198	-----
MIX 4	440.84	754.81	1031.52	201.80	0.88
MIX 5	440.84	754.81	1031.52	203.70	1.32
MIX 6	440.84	754.81	1031.52	205.5	1.76

2.3 Properties of Harden Concrete

2.3.1 Compressive Strength Test

The test is carried out on 150 x 150 x 150 mm size cubes, as per IS: 516-1959[4]. The test specimens are marked and removed from the moulds and unless required for test within 24 hrs, immediately submerged in clean fresh water and kept there until taken out just prior to test. A 1000 kN capacity Compression Testing Machine (CTM) is used to conduct the test. The specimen is placed between the steel plates of the CTM and load is applied at the rate of 140 $kg/Cm^2/min$ and the failure load in kN is observed from the load indicator of the CTM.

Compressive strength = Load / Area (MPa)

2.3.2 Splitting Tensile Strength Test:

The Splitting tensile strength of concrete cylinder was determined based on 516-1959[4]. The load shall be applied nominal rate within the range 1.2 N/(mm2/min) to 2.4 N/(mm2/min). The test was carried out on diameter of 150 mm and length of 300mm size cylinder

Split Tensile Strength = $2P/\pi DL$ (MPa)

2.3.3 Flexural Strength Test:

The Flexural strength of concrete prism was determined based on IS: 516 – 1959[4]. Place the specimen in the machine in such a manner that the load is applied to the upper most surface as cast in the mould along two lines spaced 13.3 cm a part. Apply load without shock and increase continuously at a rate of 180 kg/min and it is increased until the sample fails. Measure the distance between the line of fracture and nearest support.

If a > 13.3 cm then,

Modulus of rupture $f_b = Pl/bd^2$

If a < 13.3 cm, $f_b = 3Pa/bd^2$

III. RESULTS AND DISCUSSIONS

Mechanical properties studies conducted on self curing concrete namely compressive strength, split tensile strength and flexural strength and their results are discussed below.

3.1 Compressive strength

The results of compressive strength on the various mixes M 1, M 2, M 3, M 4, M 5 and M 6 at 7 and 28 days are presented in table 3 and figure 1& 2.

TABLE 3
TEST RESULTS FOR COMPRESSIVE STRENGTH

S. No	Type of Curing	MPa (7 days)		MPa (28 days)	
		NS	MS	NS	MS
Mix 1	Standard moist curing	12.44	12.82	23.54	24.32
Mix 2	Air curing	11.02	11.21	17.32	19.21
Mix 3	Membrane curing	15.52	15.98	25.36	26.13
Mix 4	Self curing concrete SAP-0.2% of cement	14.62	15.65	24.23	25.03
Mix 5	Self curing concrete SAP-0.3% of cement	16.35	17.13	27.47	28.21
Mix 6	Self curing concrete SAP-0.4% of cement	15.72	16.03	26.30	27.41

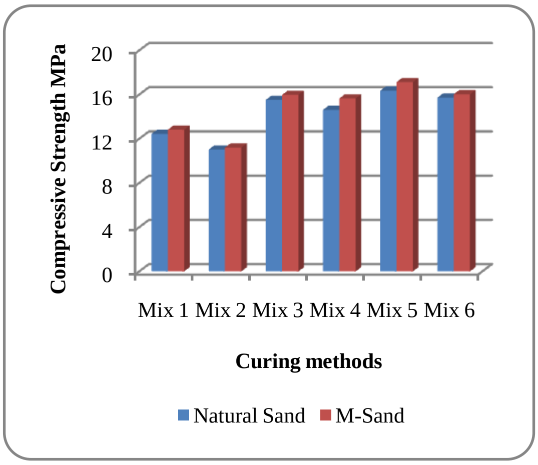

Fig. 1 Compressive strength for 7 days

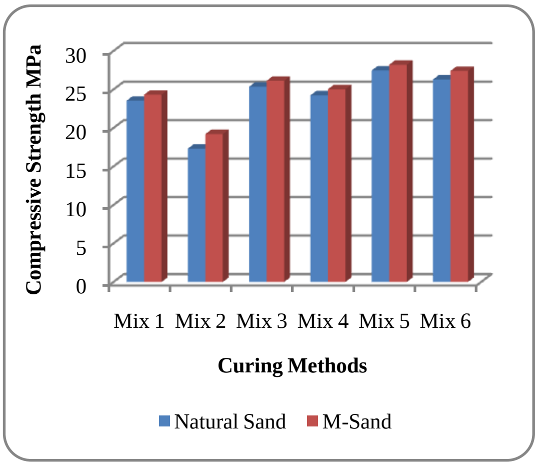

Fig. 2 Compressive strength for 28 days

From the table 3 it was noted that the compressive strength increased for 7 days and 28 days for the Mix 3, Mix 4, Mix 5 and Mix 6 for both NS and MS when compared to control mix. It shows that by adding SAP content at 0.3% of cement maximum compressive strength is obtained.

S.NO	TYPE	MPa (7 days)		MPa (28 days)	
		NS	MS	NS	MS
Mix 1	Standard moist curing	1.96	2.01	2.05	2.21
Mix 2	Air curing	1.17	1.32	1.76	1.97
Mix 3	Membrane curing	2.18	2.24	2.35	2.49
Mix 4	Self curing concrete SAP-0.2% of cement	2.15	2.19	2.55	2.60
Mix 5	Self curing concrete SAP-0.3% of cement	2.35	2.49	2.71	2.83
Mix 6	Self curing concrete SAP-0.4% of cement	2.20	2.24	2.68	2.75

3.2 Split Tensile Strength

The results of Split Tensile Strength on the various mixes M 1, M 2, M 3, M 4, M 5 and M 6 at 7 and 28 days are presented in table 4 and figure 3&4.

TABLE 4
TEST RESULTS FOR SPLIT TENSILE STRENGTH

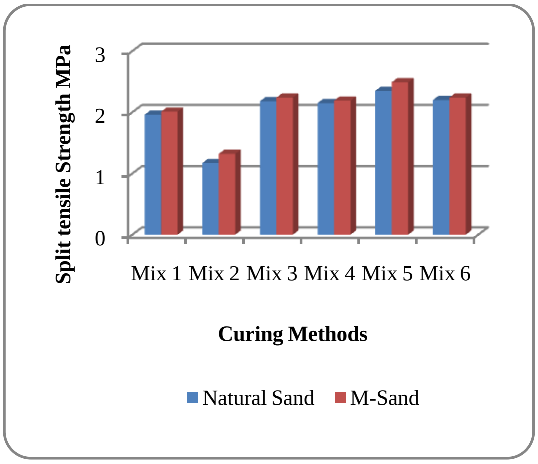

Fig. 3 Split tensile strength for 7 days

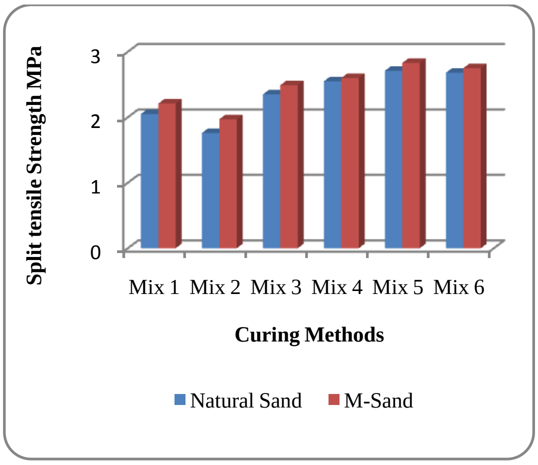

Fig. 4 Split tensile strength for 28 days

From the table 4 it was noted that the split tensile strength increased for 7 days and 28 days for the Mix 3, Mix 4, Mix 5 and Mix 6 for both NS and MS when compared to control mix. It shows that by adding SAP content at 0.3% of cement get maximum flexural strength.

3.3 Flexural strength

The results of Flexural Strength on the various mixes M 1, M 2, M 3, M 4, M 5 and M 6 at 7 and 28 days are presented in table 5 and figure 5&6.

TABLE 5
TEST RESULTS FOR FLEXURAL STRENGTH

S. No	TYPE	MPa (7 days)		MPa (28days)	
		NS	MS	NS	MS
Mix 1	Standard moist curing	2.51	2.58	3.29	3.37
Mix 2	Air curing	2.02	2.12	2.72	2.89
Mix 3	Membrane curing	3.51	3.75	3.85	3.92
Mix 4	Self curing concrete SAP-0.2% of cement	3.29	3.67	3.98	4.16
Mix 5	Self curing concrete SAP-0.3% of cement	3.98	4.28	4.34	4.51
Mix 6	Self curing concrete SAP-0.4% of cement	4.02	4.12	4.21	4.30

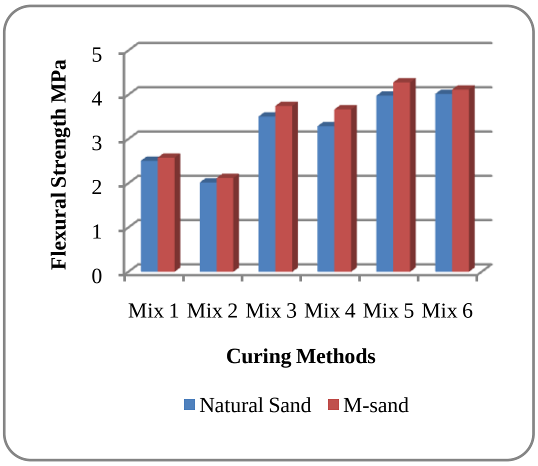

Fig. 5 Flexural strength for 7 days

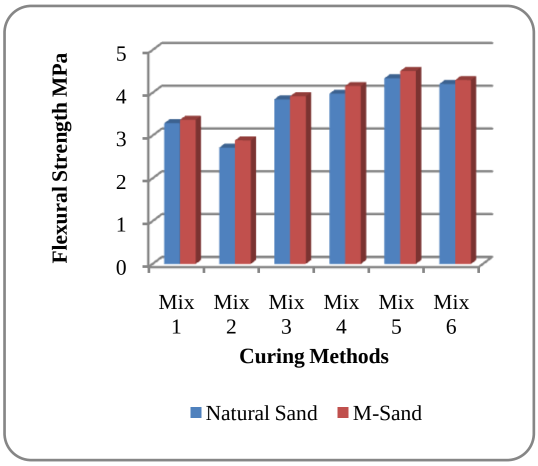

Fig. 6 Flexural strength for 28 days

From the table 5 it was noted that the flexural strength increased for 7 days and 28 days for the Mix 3, Mix 4, Mix 5 and Mix 6 for both NS and MS when compared to control mix. It shows that by adding SAP content at 0.3% of cement get maximum flexural strength.

IV. CONCLUSION

The workability of the concrete gets reduced for MS as compared to the NS. The mechanical properties (compressive, split-tensile, flexural strength) of the concrete specimen made by MS were more as compared to the conventional concrete. The membrane curing results in greater strength in both NS and MS as compared to the air curing and standard moist curing. Accumulation of SAP leads to a significant increase of mechanical properties of the concrete. Addition of 0.3 % of SAP by the weight of cement increases the strength in terms of compression, split tensile and flexural strength of concrete over 0.2% and 0.4 % of addition. Membrane and self curing gives better results as compare to the air and standard moist curing.

REFERENCES

[1] El-Dieb.A.S.(2007), Self-Curing Concrete: water retention, hydration and moisture transport*", Construction and Building Materials* vol. 21, pp. 1282–1287.
[2] PietroLura, Ole Mejlhede Jensen and Shin-Ichi Igarashi, Experimental observation of internal water curing of concrete, *Materials and Structures* 40 pp.211-220,2007.
[3] IS 10262: 2009, Concrete mix proportioning-guidelines, Bureau of Indian Standards, New Delhi, India.
[4] IS: 516-1959, Methods of tests for strength of concrete, Bureau of Indian Standards, New Delhi, India.
[5] Salvador Villalobos, Lange D.A. and Roesler J.R., Evaluation, testing and comparison between crushed manufactured sand and natural sand*"*, Technical Note pp. 1-6.
[6] Francis k , Jino John(2013), Experimental investigation on mechanical properties of self curing concrete, *International Journal of Emerging Trends in Engineering and Development* vol.2, pp. 641-647.
[7] Priyanka A. Jadhava and Dilip K. Kulkarni(2012), An experimental investigation on the properties of concrete containing manufactured sand, *International Journal of Advanced Engineering Technology* vol.3, pp.101-104.
[8] Ilangovan.R, Mahendran.N and K. Nagamani.K (2008*)*, Strength and durability properties of concrete containing quarry rock dust as fine aggregate, *Journal of Engineering and Applied Sciences* vol. 3, pp.20-26.
[9] Elavenil.S. and Vijaya.B.(2013), Manufactured Sand, A Solution and an alternative to river sand and in concrete manufacturing, *Journal of Engineering, Computers & Applied Sciences* Vol. 2, pp. 20-24.
[10] Nirav R Kholia, Binita A Vyas, T. G. Tank (2013*)*, Effect on concrete by different curing method and efficiency of curing compounds – A Review, *International Journal of Advanced Engineering Technology* vol. 4, pp. 57-60.
[11] Ambily.P.S and Rajamane N.P, (2009), Self curing concrete – An Introduction, Concrete Composites Lab, Structural Engineering Research Centre, Chennai.
[12] Manoj Kumar.M and Maruthachalam. D(2013), Experimental investigation on self-curing concrete, International Journal of Advanced Scientific and Technical Research vol. 2, pp. 300-306.
[13] Bart Craeye, Matthew Geirnaert , Geert De Schutter(2011), Super absorbing polymers as an internal curing agent for mitigation of early-age cracking of high-performance concrete bridge decks, *Construction and Building Materials* vol.25, pp. 1–13.
[14] Gaston Espinoza-Hijazin, Mauricio Lopez(2011*)*, Extending internal curing to concrete mixtures with w/c higher than 0.42, *Construction and Building Materials* vol. 25 pp. 1236–1242.
[15] Geetha.M and Malathy.R(2011), Comparative study of strength and durability properties of polymeric materials as self curing agents, *International Journal of Engineering Science and Technology* vol. 3, pp. 771-776.
[16] George c. Hoff(2002*)*, The use of lightweight fines for the internal curing of concrete, *Northeast Solite Corporation* pp.1-44.