Durability Properties of Concrete Using Manufactured Sand as Fine Aggregate

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***Abstract*:-Common river sand is expensive due to excessive cost of transportation from natural sources. Also large –scale depletion of these sources creates environmental problems. In such a situation the manufactured sand can be an economical alternative to river sand. Manufactured sand can be defined as residue, tailing or other non-valuable material after the extraction and the processing of rocks to form fine particles less than 4.75 mm. Use of manufactured sand as a fine aggregate in concrete and mortar draws serious attention of researchers and investigators. In this paper the various durability tests are discussed for M20 grade concrete with natural sand and manufactured sand as fine aggregate. The various tests performed are chemical attack, drying shrinkage, water permeability and rapid chloride ion penetration test. From the test results it is observed that the concrete blended with manufactured sand having good durability properties.**

Keywords: **Manufactured sand, chemical attack, Drying Shrinkage, Permeability, Rapid chloride penetration**

I. INTRODUCTION

The durability of cement concrete is defined as its ability to resist weathering action, chemical attack, or any other process of deterioration. Durable concrete will retain its original from, quality and serviceability when exposed to its environment. We build concrete structures in highly polluted urban and industrial areas, aggressive marine environments, harmful sub-soil water in coastal area and many other hostile conditions where other materials of constructions are found to be non-durable. When designing a concrete mix or designing a concrete structure, the exposure condition at which the concrete is supposed to withstand is to be assessed in the beginning with good judgment. In case of foundation, the soil characteristics are also required to be investigated. The environmental pollution is increasing day by day at particularly in urban areas due to industrial atmosphere. It is reported that in industrially developed countries, over 40 percent of total resources of the building industries are spent on repairs and maintenance. In India the money that is spent on repair of buildings is also considerable. Every Government department and municipal bodies have their own "Repair boards" to deal with the repairs of buildings. It is a sad state of affairs that we do not give enough attention to the durability aspects even when we carry out repairs. In order to put modern construction technology into practice, it is required to be well aware of characteristics of local constructive materials and their abilities, making use of scientific potential of this country and other states.

I.A Significance of the Research

Due to the above reasons, the durability studies such as acid, chloride, sulphate attacks, drying shrinkage, permeability and rapid chloride penetration tests on concrete with the natural river sand and manufactured sand are conducted and compared.

II. LITERATURE REVIEW

Sawich.Z. and Heng S.S. (1995) studied the influence of powdered limestone and W/C ratio on the durability of concrete in 5% Na_2SO_4. The results shows that a beneficial influence of a powdered lime stone on concrete durability was observed when w/c < 0.6. Above this value the powdered lime stone has almost no essential effect on sulphate resistance. R. Ilangovan, N. Mahendran and K. Nagamani (2000) made a study on concrete by 100% replacement of natural sand by quarry dust. They concluded that the compressive strength, flexural strength and durability properties of concrete made of quarry dust are nearly 10% more than the conventional concrete. K.Perumal and R.Sundarajan (2003) reported that the quarry rock dust could be used as alternative replacement of natural sand in concrete. They observed that using quarry rock dust reduces the cost without affecting the strength. They concluded that the weight loss and strength of concrete with quarry rock dust is considerably less. Nisnevich.M., et al (2003) studied when Crushed sand is blended with natural sand, which reduces the volume of voids as 41 – 46% and also reduces the required water content. They found that the optimum percentage of crushed sand to natural sand is 1:1.5 (or) 1.5:1. Stella L.Marusin (2003) have investigated the

reversible reaction of sodium sulphate solution on concrete. Salvador Villalobos.,et al (2005) studied the evaluation, testing and comparison between the crushed manufactured sand and natural sand. They concluded that the blended manufactured sand can be utilized in concrete. Karthik Obla, Colin lobo, Lionel lemay (2005) have made a study on durability properties of concrete. They informed that the compressive strength loss considerably low in concrete with quarry rock waste compared to conventional concrete. Leslie Struble (2005) has made a study on durability of concrete and he has suggested many methods for improving concrete durability properties. Md Saffiuddin,S.N.Raman, M.F.M.Zain (2007) investigated the utilization of quarry waste fine aggregate in concrete mixtures. They concluded that the use of rockdust enhancing the durability of concrete. Ilangovan.R et al., (2008) studied the "Strength and Durability Properties of Concrete containing Quarry Rock Dust as Fine Aggregate" It was found that the compressive, flexural strength and durability studies of concrete made of quarry rock dust are nearly10% more than the conventional concrete.

III. EXPERIMENTAL INVESTIGATION

The materials used are Portland pozzolana cement, Natural River sand, Manufactured sand, 20mm down size Coarse aggregate. The properties of materials are shown in Tables 1 to 3.

Table 1 Properties of Cement

S. No	Description	Values
1	Specific gravity	3.15
2	Fineness (by sieve analysis)	4.6%
3	Consistency	29%
4	Initial setting time	110 minutes

Table 2 Properties of Coarse Aggregate

S.NO	Description	Values
1	Specific gravity	2.73
2	Bulk density	1653.06 kg/m^3
3	Surface moisture	0.086%
4	Water absorption	1.00%
5	Fineness modulus	6.98

Table 3 Properties of Fine Aggregate

S. No	Proportions	Specific gravity	Fineness Modulus	Surface Moisture in%	Water Absorption in %	Zone
1	A	2.59	2.21	0.11	0.09	III
2	B	2.60	2.50	1.80	NIL	I
3	C	2.56	2.51	4.44	NIL	I

A –100% Natural Sand, B –100% Manufactured sand, C –70% Manufactured sand & 30% Natural sand

IV. TESTING DETAILS

IV.A Chemical Attack

For performing the chemical attack, the tests namely acid attack, chloride attack and sulphate attack are conducted. For each test 9 cubes of size 150 mm x 150 mm x 150 mm are cast. The weight and the compressive strength at the end of 28 days are calculated and they are placed in the sulphuric acid, sodium chloride and sodium sulphate solutions of 0.1Normality. The weight loss and the loss in compressive strength of the concrete cubes are calculated.

IV.B Drying Shrinkage Test

Mortar bars of size 25 mm x 25 mm x 250 mm are used to measure the drying shrinkage. The mortar mixes with the required proportions (CM1:3) are mixed and compacted by hand operation. Gauge studs are inserted in the bar moulds coaxial with the bar before the mortar is poured into the moulds. After 24 hours, the mortar bar specimen are demoulded and subsequently submerged in water for curing for 7 days. Length of each specimen is measured using a length comparator immediately after curing. Soon after measuring the initial length, the specimens are kept in the laboratory conditions. The average temperature in the laboratory is 35 ± 2^0C and the relative humidity is 65 ± 5 percent. The lengths of the specimens are measured for their change in length to calculate drying shrinkage at different ages. The drying shrinkage of mortar is the contraction in the length of mortar bar.

IV.C Permeability Test

The test is conducted as per IS: 3085 (Part 7) – 1963. The standard cubes of size 150 mm x 150 mm x 150 mm are cast and cured for 28 days. After curing period, it is taken out and allowed to dry for 2 days and the four faces of the cubes are painted to prevent the penetration of water from sides. Then the top surface is effectively sealed to achieve water tightness. Glass bottles are kept in position to collect the water percolating through the specimen. Compressor is started and the pressure is applied at the rate of 0.5 MPa to the water column. The quantity of water passing through the cube is collected at the bottom, in the glass bottle through the funnel, being maintained in humid atmosphere to prevent losses due to evaporation. The operating pressure, quantity of water collected, time of observation etc., at intervals is recorded. The test is continued till the uniform rate of flow is obtained. The co-efficient of permeability is calculated using the formula

$$K=QL/ATH$$

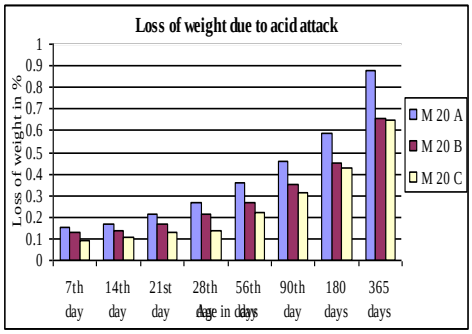
IV.D Rapid Chloride Penetration Test

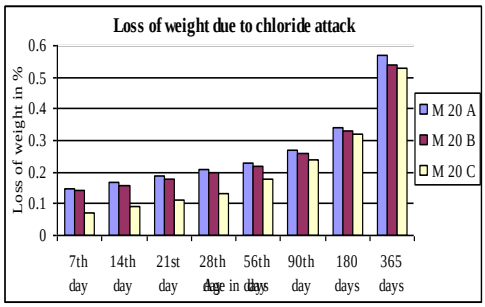
In the AASHTO T277 (ASTM C1202) test, a water-saturated, 50 mm thick, 100 mm diameter concrete specimen is placed in one reservoir contains 3.0 % NaCl solution and another

reservoir contains 0.3 M NaOH solution and subjected to a 60 V applied DC voltage for 6 hours. The total charge passed is determined and this is used to rate the concrete.

V. RESULTS AND DISCUSSION

Table 1 shows that the properties of cement are within the allowable limits. From Table 2, it was observed that the properties of coarse aggregate values satisfy the standards. Table 3.3 gives the properties of natural river sand and manufactured sand. Figure 1 shows the losses in weight of the concrete cubes in acid, chloride and sulphate attack at various periods. From the Figure, it is observed that the weight losses are lesser in manufactured sand and it is least for the optimum proportion of 70 % of manufactured sand when compared to the concrete with natural river sand. This may be due to the less entry of the solution in to the pores of concrete. Figure 2 shows the strength losses of the concrete cubes in acid, chloride and sulphate attack at various periods. It is noticed that the strength losses are lesser in manufactured sand and it is least for the optimum proportion of 70 % of manufactured sand when compared to the concrete with natural river sand. Due to the better interlocking of manufactured sand, the loss of strength is less in manufactured sand. Figure 3 shows the drying shrinkage values of natural sand and manufactured sand. It is found that the drying shrinkage value of manufactured sand is high at initial period and it is reduced at later period. This may be due to the minimum amount of clay content present in the manufactured sand. Figure 4 shows the water permeability test. From the Figure, it is noted that the permeability values are reduced while using the manufactured sand. This may be due to the less voids of better interlocking bond between the aggregate and cement paste. Figure 5 shows the rapid chloride penetration test results. From the Figure, it is found that the chloride ion penetrability is high for concrete with natural sand and it is reduced while using manufactured sand. This may be due to the grain size of the manufactured sand is coarser and the better packing is developed. Due to the better packing the permeability of the concrete is reduced. From the above results, it is observed that the optimum proportion of 70 % manufactured sand gives better results.





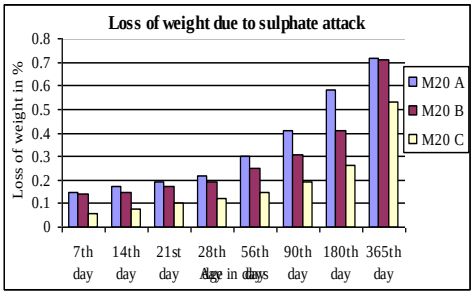
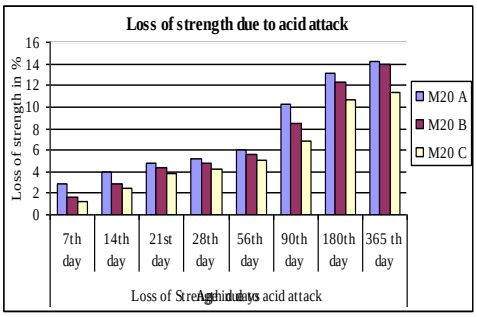
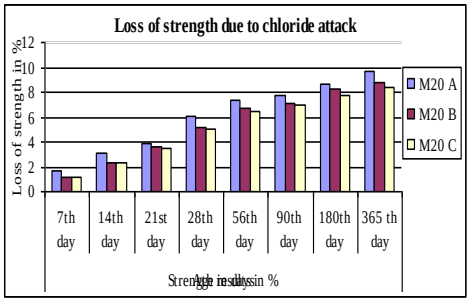


Fig 1 Loss of Weights due to Chemical Attack





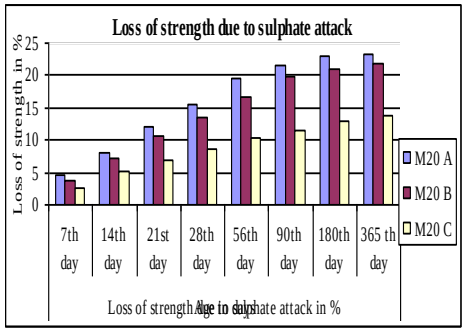


Fig 2 Loss of Strength due to Chemical Attack

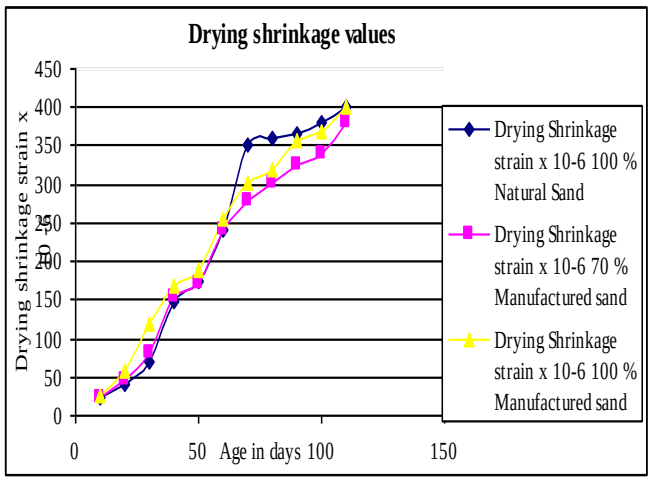


Fig 3 Drying Shrinkage Test Results

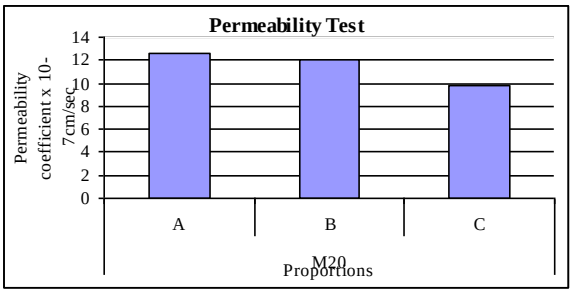


Fig 4 Water Permeability Test

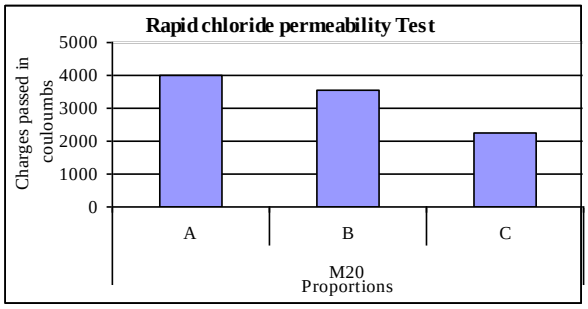


Fig 5 Rapid Chloride Permeability Test

V. CONCLUSION

The weight loss due to acid attack, chloride attack and sulphate attack is reduced as 25 – 40 % while using 70 percentages of manufactured sand.

The loss in compressive strength due to acid attack, chloride attack and sulphate attack is reduced as 2 - 8 % for the optimum proportion of manufactured sand.

The drying shrinkage strain is less while using the manufactured sand.

The permeability of the concrete with manufactured sand is 20 % less when compared to the natural river sand. The chloride ion penetration is less for the concrete with manufactured sand and it is also reduced for high grades of concrete.

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