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INVESTIGATION OF DURABILITY PROPERTIES OF MANUFACTURED SAND IN CONCRETE

C. Anand[1]

[1]Assistant Professor Thanthai Periyar Government Institute Of Technology

ABSTRACT

The huge quantity of concrete is consumed by construction industry all over the world. In India, the conventional concrete is produced using natural sand from river beds as fine aggregate. Decreasing natural resources poses the environment problem and hence government restriction on sand quarrying resulted in scarcity and significant increase in its cost. This paper presents the optimization of partial replacement of manufactured sand by natural sand in High Performance Concrete. Concrete mixes were evaluated for durability properties of manufactured sand in concrete by partially replaced with natural sand with by three proportions (ie 25%,50%,75%). In this study, Chloride ion penetration and Water absorption calculated for M60 grade concrete with manufactured sand.

Keywords : Natural sand ,Manufactured sand, High Performance Concrete, Water absorption test, RCPT test.

1. INTRODUCTION

Sand is the one of main constituents of concrete making which is about 35% of volume of concrete used in construction industry. Natural sand is mainly excavated from river beds and always contain high percentage of in organic materials, chlorides, sulphates, silt and clay that adversely affect the strength, durability of concrete and reinforcing steel there by reducing the life of structure, When concrete is used for buildings in aggressive environments, marine structures, nuclear structures, tunnels precast units, etc.

Fine particles below 600 microns must be at least 30% to 50% for making concrete will give good results. Normally particles are not present in river sand up to required quantity. Digging sand, from river bed in excess quantity is hazardous to environment. The deep pits dug in the river bed, affects the ground water level. Erosion of nearby land is also due to excessive sand lifting. In order to fulfill the requirement of fine aggregate,some alternative material must be found.

The cheapest and the easiest 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 is known as Manufactured sand.

2. AIM AND SCOPE OF PRESENT INVESTIGATION

Concrete is a widely used construction material for various types of structures due to its structural stability and strength. .The artificial sand produced by proper machines can be a better substitute the must be of proper. When fine particles are in proper proportion, the sand will have fewer voids required will be less .Such sand will be more economical. It contributes high strength and high impermeability of concrete. Using these properties, durability properties of M 60 grade concrete with and without manufactured sand. The employment of M-Sand in cement and concrete has gained considerable importance because of the requirements of environmental safety and more durable construction in the future. The use of M-Sand as partial replacement of cement in mortar and concrete has been extensively investigated in recent years. This literature review clearly demonstrates that M-Sand is an effective pozzolana which can contribute to mechanical properties of concrete and Durability properties of concrete can decrease the temperature effect that occurs during the cement hydration. M-Sand blended concrete can improve the workability of concrete compared to OPC. It can also increase the initial and also final setting time of cement pastes. Additionally, M-Sand blended concrete can decrease the total porosity of concrete and modifies the pore structure of the cement, mortar, and concrete, and significantly reduce the permeability which allows the influence of harmful ions leading to the deterioration of the concrete matrix.. M-Sand helps in enhancing the early age mechanical properties as well as long-term strength properties of cement concrete.In this study we did different types of tests. Test results reveal using M-Sand gives excellent concrete strength and durability.In future using of M-Sand by the replacement of fine aggregates should be increased for various works.

Material Properties Manufactured sand IS Code Provisions

BIS Guidelines IS: 383-1970 for selection and testing of Coarse and Fine aggregates available. Generally, Sand is classified as Zone I, Zone II, Zone III and Zone IV (i.e. Coarser to Finer). There is sieve designation for each zone. Gradation is made in accord with the usage of the sand. There are testing sieves, consists of 4.75mm, 2.36mm, 1.183mm, 600microns, 300 microns, 150 microns and a pan

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Typical Sieve analysis: Comparison of River & Manufactured Sand			
IS Sieve	**% of passing(River Sand)**	**% of passing (Manufactured Sand)**	**Zone II (As per IS:383)**
4.75mm	100	99.2	90-100
2.36mm	99.7	91.4	75-100
1.18mm	89	58.3	55-90
600micron	60.9	43.6	35-59
300micron	17.7	24.6	8-30
150micron	3.1	10.6	0-20
75micron	Max 3	Max 15	Max 15
	Zone II	Zone II	
Zone II Zone II Note : The gradation of manufactured sand can be controlled at crushing plant			

Technical specification – comparison between Manufactured and River sand				
Sl No	**Property**	**River sand**	**Manufactured sand**	**Remarks**
1	Shape	Spherical particle	Cubical particle	Good
2	Gradation	Cannot be controlled	Can be controlled	
3	Particle passing 75micron	Presence of silt shall be less than 3%(IS:383-1970)reaffirmed 2007	Presence of dust particle shall be less than 15%	Limit 3% for uncrushed & limit 15% for crushed sand
4	Silt and Organic impurities	Present (Retard the setting & Compressive Strength)	Absent	Limit of 5% for Uncrushed & 2% for Crushed sand
5	Specific gravity	2.60	2.67	May vary

Cost comparison of Manufactured and River sand:				
Sl No	**Location- Bangalore City**	**River sand**	**Artificial sand**	**Remarks**
1	Market rate	Rs 1100 per MT	Rs 600 per MT	50% Cheaper
2	In Concrete - Rs per Cum	Rs 770 – 880	Rs 420 – 480	Saving of Rs 350-400 per cum
3	In Mortar(1:5) for 100kgs	Rs 198	Rs 156	20% less

3. METHODOLOGY

Super Plasticizer

Chemical admixtures are used to enhance the properties of concrete and mortar in the plastic and hardened state. These properties may be modified to increase compressive and split strength at all ages, decrease permeability and improve durability, inhibit corrosion, reduce shrinkage, accelerate or retard initial set, increase slump and workability, improve pump ability and finish ability, increase cement efficiency, and improve the economy of the mixture. An admixture or combination of admixtures may be the only feasible means of achieving the desired results, In certain instances, the desired objectives may be best achieved by mixture changes in addition to proper admixture usage.

Water absorption test

One of the main sources of contamination of concrete in structures is water absorption which influences durability of the concrete and also has the risk of alkali aggregate reactions (Ithuralde 1992). The more impermeable the concrete, the greater will be its resistance to deterioration. The incorporation of pozzolan such as flyash reduces the average pore size and results in a lesspermeable paste (Poon et al., 1997; Chindaprasirt et al., 2005). Literature studies have identified that commonly permeability of blended cement concrete is less than plain cement paste. It was observed that

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the incorporation of M - Sand in the composites could cause an extensive pore refinement in the matrix and in the interface layer, thereby decreasing water permeability (Rodrigues et al., 2006). The radial expansion of Portland cement hydration products in pozzolanic particles would have a pore modification effect studied, the effect of partial replacement of cement with M - Sand at different replacement levels on the porosity and water absorption of concrete and reported that the coefficient of water absorption for M - Sand replaced concrete at all levels was less than control concrete.

Rapid chloride Permeability test

Chloride permeability characteristics of concrete in bridges and other structures can now be evaluated electronically using a six hour laboratory procedure. The simple test is performed on concrete specimens taken from cores or test cylinders. The method is also suitable for evaluation of materials and admixtures for HPC and other concretes. Current flow with time is measured when a 4in (102mm) diameter, 2in (51mm) thick specimen is subjected to a 60V DC potential across ends. The negative end is exposed to 3% sodium chloride solution, and the positive end to 0.3N sodium hydroxide solution. The Instrument controller automates the current relative to time and determines coulombs as a measure of chloride permeability.

Models are available to test up to four or eight specimens simultaneously. Voltage, time, current and coulombs for each specimen are continuously displayed. Printouts of the data are automatically activated every thirty minutes or at a user selectable rate. The printout can also be manually activated at any time and directed to the internal printer. Tests are automatically terminated at 360 minutes. Current range is 0-1 amp DC per core. The Rapid Chloride Permeability Units have a wide range voltage supply capability of 30-60V DC. Instrument cabinets measure l9xl7x7in (432x483x178mm), W x H x D.

HMA-280 Test Cells are ordered separately. Each cell consists of two Plexiglas chambers with embedded conductive mesh and required electrical connections; HMA281 Vacuum Apparatus is required for either system, and includes vacuum pump, electronic vacuum gauge, water trap, desiccators, stand, clamps, filter paper, and vacuum hose.

WATER ABSORPTION PERMEABILITY TEST

One of the most important properties of a good quality concrete is low permeability, especially one resistant to freezing and thawing. A concrete with low permeability resists ingress of water and is not as susceptible to freezing and thawing. Water enters pores in the cement paste and even in the aggregate.

Absorption

For concrete payers, the test procedure involves drying a specimen to a constant weight, weighing it, immersing it in water for specified amount of time, and weighing it again. The increase in weight as a percentage of the original weight is expressed as its absorption (in percent). The average absorption of the test samples shall not be greater than 5% with no individual unit greater than 7%.

Permeability

Permeability of concrete differs from absorption. Permeability relates to the size of the pores, their distribution and most importantly their continuity. As a result, permeability is not necessarily directly related to absorption. It has been related to water cement (wlc) ratio of concrete. Water cement ratio is the measure of the amount of water divided by the cement in a mix. For concrete payers to meet the freeze-thaw requirements they need to be high quality. This is reflected through low absorption, low permeability, and high density. In addition, these properties arise from high performance concrete mixes that incorporate low w/c ratios

Determination of water absorption

The method of determination aggregates or concrete water absorption is based on the principle of vacuum saturation. The test to determine water absorption comprise two stages, the first consists on submitting the test specimens to vacuum (about 0.7 mbar) for 3 hours being, after this period and in a second stage, saturated in distilled water and submitted again to vacuum during another period of 3 hours. The detailed experimental procedure is explained elsewhere [2]. The water absorption, also designated as open porosity, is determined as follows:

A(%) = (Wsat — Wdry)/(Wsat — Wwat) x 100

being, A - water absorption, in percentage, Wsat - weigh of the saturated sample, Wdry - weigh of the dry sample and Wwat - weigh of the saturated sample immersed in water.

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4. RESULTS AND DISCUSSION

RCPT Results

S. No	Grade of concrete	% of M SAND	charges passed(coulombs)	chloride ion penetrability as per ASTM ci 202
1	M60	0	2700	2000-4000 (Moderate)
2	M60	25	1832	2000-4000 (Moderate)
3	M60	50	2799	2000-4000 (Moderate)
4	M60	75	2464	2000-4000 (Moderate)

Note :-

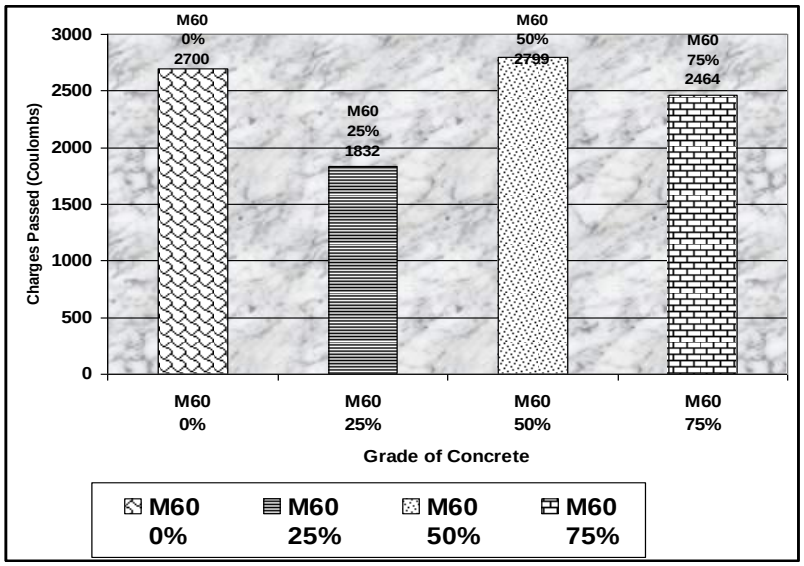
BC - CONTROL CONCRETE : BR 1-25% M-Sand

BR2-50% M-Sand : BR2-75% M-Sand

The effects of adding M-Sand on the RCPT after 7 and 28 days of curing are shown in table 8&9. A general pattern is observed in which the Durability develops rapidly with addition of M-Sand until an optimum condition is reached, beyond which the increase in Durability is either nominal or there is marginal decrease in strength. .

Further it is also observed that curing period has marked influence on the durability properties increases with increasing curing period.

From this we get chloride ion penetration is low in the case of 25 % replacement of sand next 75 % of replacement



WATER ABSORPTION TEST

Water Absorption RESULTS OF M60 GRADE CONCRETE MIXTURES (N/mm^2)

MIX DESIGNATION M-Sand (%)	**BRI**	**BR2**	**BR3**
	25	**50**	**75**
Days of curing	Average Absorption of water in %	Average Absorption of water in %	Average Absorption of water in %
28days	3.62	3.90	3.23

Note

BC - CONTROL CONCRETE BR1-25% M-Sand

BR2-50% M-Sand BR2-75% M-Sand

Fine Aggregate - replacement material

The show that water absorption results M60 grade concretes

- It shows 28 days results in 75% of replacement of Manufactured Sand we get low absorption of water. It increases the life of concrete.

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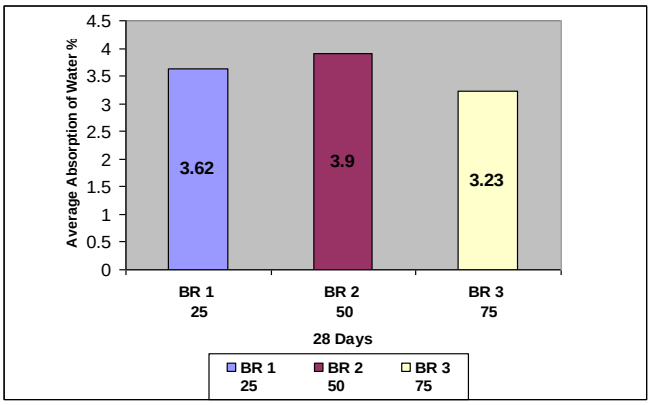
Water Absorption Test



5. CONCLUSIONS

- It is observed that the durability properties of concrete can be improved by partial replacement of M-sand for fine aggregate.
- From the above experimental results it is proved that, M-sand can be used as partial replacement for the natural sand. Chloride ion penetration and water absorption are decreased as the percentage of M- sand is increased up to optimum level. The optimum percentage of replacement of natural sand by M-sand 75%.
- in 25% of replacement we get least chloride ion penetration .comparing to M sand we get low chloride ion penetration. hence using the M-sand will increase the life of the structure.
- In 75% of replacement we get less water absorption.
- The dwindling sources of natural sand and its high cost could encourage the adoption of M-sand by 75% replacement of natural sand.

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