Volume : 2 | Issue : 1 | Jan 2013 • ISSN No 2277 - 8160

Research Paper | Engineering

Performance of Concrete with Recycled Coarse Aggregate

Chetna M Vyas — Assistant Professor, Civil Engineering Department, A.D.Patel Institute of Technology, New Vallabh vidhyanagar-Gujarat-India

Darshana R Bhatt — Associate Professor, Structural Engineering Department, B.V.M.Enggineering College, Vallabh vidhyanagar-Gujarat-India

ABSTRACT

Initially for a long period concrete was considered as a durable material which requires a little or no maintenance and it was true except a test subjected to very hostile or aggressive environments. Concrete is the premier construction material across the world. It is most widely used in all types of civil engineering infrastructure and environment protection, local/domestic developments. Concrete is a manufactured product, consisting of cement, aggregates and water. Among these, aggregates, i.e. sand, crushed stone or gravel form the major part. Now a day's the use of aggregates from natural resources has been questioned at an international level. This is mainly because of the greater awareness of environmental protection. A large proportion of potentially useful material i.e. recycled coarse aggregate disposed of as landfill. The results of this experimental programme aimed at examining the performance of cement concrete produced with natural and recycled coarse aggregates. The effects of up to 100% recycled coarse aggregate concrete on a range of durability properties have been established and assessed its suitability for use in a series of various applications. The environmental and economic implications of this are no longer considered sustainable and, as a result, the construction industry is experiencing more pressure than ever before to overcome this practice.

KEYWORDS: durability, recycled coarse aggregate, concrete

I.INTRODUCTION

A durable concrete is one that performs well and satisfactorily under different aggressive and hostile environment during its long life service span. Concrete is a well-known building material obtained by mixing cement paste with aggregates and water.

Sometimes material other than traditional like admixture is added to concrete before or during mixing, to provide a more economical solution and enhanced concrete properties. It is difficult to imagine the modern infrastructure development without concrete. It finds wide application in buildings, roads, bridges and dams, among others.

The most important properties of hardened concrete are its compressive strength and durability. The factors that favour concrete strength usually benefit its durability except the thickness of concrete cover. Factors that affect the strength and durability of concrete include quality and quantity of cement used in a mix, grading of aggregates, maximum nominal size, shape and surface texture of aggregate, water/cement ratios, curing method, presence or otherwise of clayey particles and organic matter in the mix, as well as aggressive agent that attack concrete externally or internally.

Other factors affecting concrete durability include the use of admixtures, employment of cement, concrete compaction, bacteria, chloride ions, carbon dioxide, alkali reactive particles and abrasives action attack etc. by reacting chemically with various components.

II. MATERIALS

a) Cement

The most common cement used is an Ordinary Portland Cement (OPC). The Ordinary Portland Cement of 53 grade (Sanghi OPC) conforming to IS:8112-1989 is be use.

b) Aggregate

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is good gradation of aggregates. Good grading implies that a sample fractions of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste means less quantity of cement and less water, which is further mean increased economy, lower shrinkage and greater durability.

c) Coarse Aggregate

The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 are used. The Flakiness and Elongation Index were maintained well below 15%.

d) Fine aggregate

Those fractions from 4.75 mm to 150 micron are termed as fine aggregate. The river sand and crushed sand is used in combination as fine aggregate conforming to the requirements of IS: 383. The river sand is wash and screen, to eliminate deleterious materials and over size particles.

e) Recycled coarse aggregate

The recycled coarse aggregate is procured from demolished concrete structures. This demolished concrete structure is located in Anand District in Gujarat State.

TABLE 1.
PROPERTIES OF RECYCLED COARSE AGGREGATES

Property	Recycled Coarse Aggregate
Fineness modulus	7.476
Specific Gravity	2.74
Impact value (%)	12.92
Density (Kg/m^3)	1660.44

f) Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. Water cement ratio used is 0.55 for M20, 0.50 for M25 and 0.45 for M30 concretes.

III DESIGN MIX

A mix M20, M25 and M30 grade was designed as per IS 10262:2009 and the same was used to prepare the test samples. The design mix proportion is shown in Table 2

TABLE -2
CONCRETE MIX PROPORTIONS

w/c ratio	Proportion	Cement (kg/m3)	Sand (kg/m3)	Coarse Agg. (kg/m3)	Water (kg/m3)
0.55	1:2.06:3.87	327	679.25	1265.5	180
0.5	1:2.12:3.46	360	763.51	1245.73	180
0.45	1:1.87:3.06	400	751.6	1226.3	180

TABLE -3
NO. OF SPECIMENS PER MIX

Type of Concrete Mix	No. of Mix
M20 Grade	6 mix
M25Grade	6 mix
M30 Grade	6 mix
Total No. of Mixes	18 mix

TABLE -4
DETAILS OF ALL MIX BATCHES

Sr. No.	Mix	Recycled coarse aggregate
M20 (18 Cylinder of size 100mm dia and 200mm Ht)	Mx1	0 %
	Mx2	20%
	Mx3	40 %
	Mx4	60 %
	Mx5	80 %
	Mx6	100%
M25 (18 cubes of size of 150mm x 150mm x 150mm)	My1	0 %
	My2	20%
	My3	40 %
	My4	60 %
	My5	80 %
	My6	100%
M30 (18 cubes of size of 150mm x 150mm x 150mm)	Mz1	0 %
	Mz2	20%
	Mz3	40 %
	Mz4	60 %
	Mz5	80 %
	Mz6	100%

III EXPERIMENTAL WORK

Testing for Durability of Concrete: (Acid Attack Test): A total number of 36 cubes of size of 150mm x 150mm x 150mm & 18 Cylinder of size 100mm dia and 200mm Ht were water cured for 28 days. After 28 days curing the specimens were taken out and allowed to dry for one day. Weights of the specimens were taken. For acid attack 5% of dilute hydrochloric acid with pH value about 2 was used. After that specimens were immersed in the above said acid water for a period of 28 days.

Figure 1: Durability Test

IV RESULTS

The results of Change in Mass of the Cylinders & cubs Soaked in 5% dilute HCL Solution for 28 Days after water curing of 28 days for M20, M25, M30 Grade Concrete the measurement are shown in Table 5.

Table 5
Change in Mass of the Cylinders Soaked in 5% dilute HCL Solution for 28 Days for M20, M25, M30 Grade Concrete

Mix Type	Avg. Initial Weight (kg) Before soaked in HCL	Avg. Final Weight (kg) After soaked in HCL	% Loss in Weight
Mx1	4.026	3.998	0.69
Mx2	4.11	4.075	0.84
Mx3	3.944	3.891	1.34
Mx4	3.867	3.819	1.24
Mx5	3.709	3.666	1.15
Mx6	3.691	3.624	1.81
My1	8.722	8.629	1.07
My2	8.601	8.515	0.99
My3	8.823	8.733	1.01
My4	8.461	8.365	1.13
My5	8.598	8.507	1.06
My6	8.492	8.392	1.16
Mz1	9.252	9.134	1.28
Mz2	9.16	8.907	2.75
Mz3	8.677	8.509	1.93
Mz4	8.665	8.348	3.67
Mz5	8.611	8.526	0.98
Mz6	8.727	8.614	1.28

Fig 2: Change in Mass of the Cylinders Soaked in HCL for M20 Grade Concrete

Fig 3: Change in Mass of the Cubes Soaked in HCL for M25 Grade Concrete

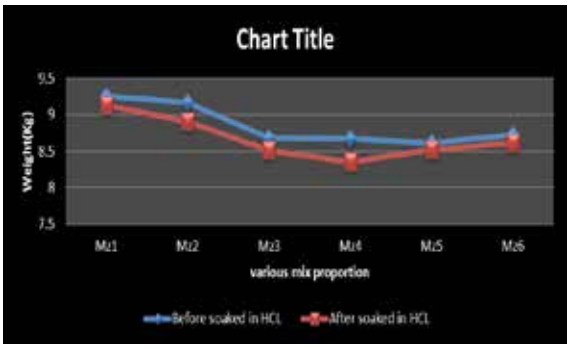

Fig 4: Change in Mass of the Cubes Soaked in HCL for M30 Grade Concrete

V CONCLUSIONS

Based on limited experimental investigation concerning the modulus of elasticity of concrete, the following conclusions are drawn:

In durability test the strength of specimens (28days in water & 28days in water with 5% HCI) are:

(a) In M 20 grade 100% replacement of natural coarse aggregates maximum loss in weight is 1.81%.
(b) In M 25 grade the results are similar.
(c) In M 30 grade 60% replacement of natural coarse aggregates maximum loss in weight is 3.67%.

REFERENCES

[1] Amnon Katz (2004), "Treatments for the Improvement of Recycled Aggregate" Journal of materials in civil engineering November - December 2004. | [2] Nobuaki Otsuki, M.ASCE, Shin-ichi Miyazato and Wanchai Yodsudjai (2003), "Influence of Recycled Aggregate on Interfacial Transition Zone, Strength, Chloride Penetration and Carbonation of Concrete." Journal of materials in civil engineering September - October 2003. | [3] V. Ramasamy and Dr, s, Biswas (2009), "Durability properties of Rice Husk Ash Concrete" ICI journal October, – December 2009; p -41-50. | [4] Olorunsogo, F.T. AND Padayachee. N., 'Performance of recycled aggregate concrete monitored by durability indexes', Cement and Concrete Research, 32 (2002)179-185. | [5] Dhir, R. K. Limbachiya, M. Leelawat, C. T., 'Suitability of recycled concrete aggregate for use BS 5328 designated mixes', Proc. Inst. Civ. Engrs & Bldgs, 1999, 134, Aug., 257-274. |