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The Study on Use of Demolished Concrete in Pavement Construction Consists Of Conducting Laboratory Investigations on Cement Concrete

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Abstract— **The purpose of this research was to study the behavior of recycled coarse aggregates when it was included in Plain Cement Concrete. Slump test was performed on freshly mixed concrete, and compression test was performed on hardened concrete. 135 samples of concrete were prepared with RCA and natural aggregate, changing their mixture design parameters, including coarse aggregate proportion.**

Key Words : Cement Concrete, Aggregates, Demolished Concrete,
Sub Area : Construction Technology & Management
Broad Area :Civil Engineering

I. INTRODUCTION

Concrete structures that are designed to have service lives of at least 50 years have to be demolished after 20 or 30 years because of deterioration caused by many agents. Old buildings require maintenance for better and higher economics gains. The rate of demolition has increased and there is a shortage in dumping space and also increase in cost of dumping. Instead of dumping this demolished concrete, use of demolished as recycled concrete would not only reduce the cost but also will conserve the non renewable energy sources. The use of demolished concrete will further result in reduction in use of natural aggregates. The usage of natural aggregates is causing damage to natural resources resulting in imbalance in environment. Recycled aggregates consist of crushed, graded inorganic particles obtained from the materials that have been used in constructions. Recycled aggregates are generally obtained from buildings, roads and bridges which are demolished due to completion of life, wars and earthquake.

II. OBJECTIVES OF THE STUDY

The study on use of demolished concrete in pavement construction consists of conducting laboratory investigations on cement concrete prepared by using demolished concrete to estimate its suitability for pavement construction. The main objectives of study are:

- To prepare mix design for M40 concrete with varying proportions of recycled aggregates.
- To determine the compressive strength of the samples at the end of 7, 28, 56 and 90 days.
- To determine the flexural strength of the samples at the end of 7,28, and 90 days
- To determine the sulphate resistance strength of samples at the end of 7, 28 and 56 days

III. METHODOLOGY

The methodology of the present study follows Indian Standard code IS: 516- 1959. Testing of strengths of concrete was carried out as per this code. Concrete mix design guidelines were as per IS: 10262-2009.All the materials should be taken at room temperature before going for batching and mixing. Materials are taken separately to ensure the avoiding the mixing of foreign material in them. Materials should be taken in such a way as to produce a mix of desired grading. Sieves should be used to separate the fine aggregates and coarse aggregates.

IV. TESTING FOR COMPRESSION STRENGTH

Testing Machine

Compressive strength testing machine was used to test the samples for compressive strength. The test samples were tested at the age of 7, 28, 56 and 90 days. The ages of samples were considered from the time water was added to dry materials. Three samples for each batch were prepared and their average value was taken for final compressive strength.

Procedure

Specimens submerged in water were tested immediately after removing from the water and while they were still in the wet condition. Surface water and grit was wiped off the specimens. Wiped off specimens were kept in open for 24 hours before testing so that they could get dry completely. The dimensions of the specimens to the nearest 0-2 mm and their weight were noted before testing.

Placing the Cubes in the Machine

The bearing surfaces of the testing machine were cleaned and any other material removed from the surfaces of the specimen. Cubes were placed in the machine in such a way that the load was applied to other side than the casting side. Nothing was placed between the faces of the test specimen and the steel platen of the testing machine. The load was applied without shock and increased continuously until the resistance of the specimen to the increasing load broke down

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and no greater load could sustain. The maximum load applied to the specimen was then recorded and the appearance of the concrete checked for any unusual features.

Preparation of Samples for Flexural Strength

Preparation of material, proportioning, weighing, mixing of material and workability for the flexural strength should be same as in section 3.2.

Size of Specimen

Cast iron mould of beams used to cast sample for flexural strength were of dimensions 100mm×100mm×500mm.

Casting of Beams

Moulds were cleaned and oiled same as the cubic mould. Fresh concrete was poured into beam moulds. Compacting, curing and opening of moulds should be done in same manner as done in case of cubic moulds.

Testing of Samples for Flexural Strength

Flexural testing machine was used to determine the flexural strength. The bed of the testing machine should be provided with two steel rollers, on which the specimens were to be placed or supported The load should be applied through two similar roller, mounted at the third points of the supporting span, the rollers were at the distance of $1/3^{rd}$ of the length of beam from either side. The load should be divided equally between the two loading roller, and all rollers should be mounted in such a manner that the load applied axially and without subjecting the specimen to any torsional stresses or restraints.

Procedure

Test specimens submerged in water should be taken out and wiped off to remove the water and any impurities on surface.

Placing the Beams in the Machine

The bearing surfaces of the supporting and loading rollers should be wiped, and any loose sand or other material removed from the surfaces of the specimen where they were to make contact with the rollers. The specimen should then be placed in the machine in such a manner that the load should be applied to the uppermost surface. The axis of the specimen should be carefully aligned with the axis of the loading device. Nothing should be used between the bearing surfaces of the specimen and the rollers, the load should be applied without shock and increasing continuously. The load should be increased until the specimen fails, and the maximum load applied to the specimen during the test should be recorded.

3.5.3 Calculation

The flexural strength of the specimen should be expressed as the modulus of rupture σ Calculated as below

$$\sigma = \frac{FL}{bd^2}$$

Where

F is the load (force) at the fracture point in MPa

L is the length of the support (outer) span in mm

b is width in mm

d is thickness in mm

Compressive Strength

The dried cubes were tested at the age of 7, 28, 56 and 90 days. The cubes were tested on compression testing machine (CTM) after drying at room temperature as per IS: 516-1959 as shown in Figure 4.3. The load was applied at rate of 350MPa/minute in a uniform and continuous manner. Impacts were prevented during the application of load. Application of load was kept continued until the sample failed and maximum load carried by the sample was recorded. Three samples for each test reading were tested. Final value of test is taken as an average of three samples.

Figure 4.3 Test for Compression Strength In CTM.

Flexural Strength

The dried beams were tested on flexural testing machine using two points loading. The transverse bending test was employed. Flexural strength was calculated as per equation 4.1 for a rectangular sample under a load in a two-point bending setup (as shown in Figure 4.4) where the loading span was one-third of the support span:

$$\sigma = \frac{FL}{bd^2} \quad (4.1)$$

F is the load (force) at the fracture point in MPa

L is the length of the support (outer) span in mm

b is width in mm

d is thickness in mm

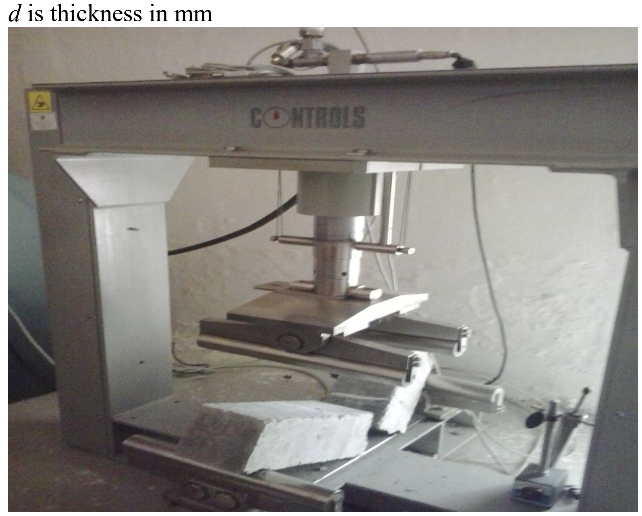

Figure 4.4 Test For Flexural Strength

The tests were conducted at the age of 7,28 and 90 days. Three test samples were tested for each final value. The average value of three samples was taken as the final flexural strength.

Workability

Workability varied with change in proportion of demolished aggregates. The slump values and compaction factor values did not show a uniform pattern as the percentage of demolished aggregates was uniformly varied. Super plasticizer was used to maintain the workability as water absorption increased due to presence of demolished concrete aggregates water cement ration (W/C) water kept constant (0.38). Figure 5.1 gives the variation of slump values versus type of mixes. Figure 5.2 gives the variation of compaction factor versus type of mixes.

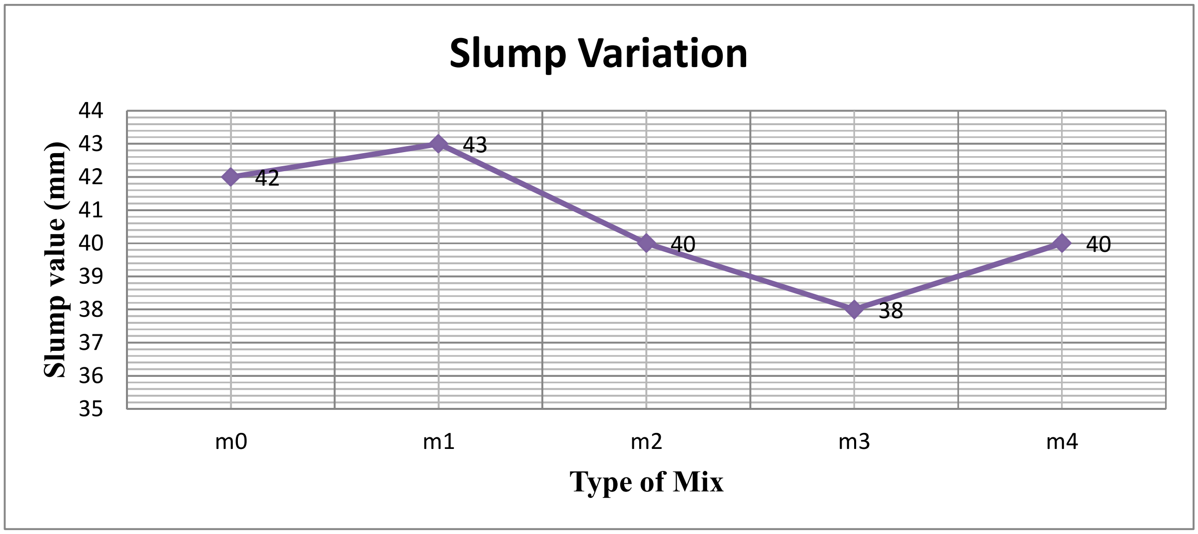

Figure 5.1 Variations of Slump Values with Type of Mix Used

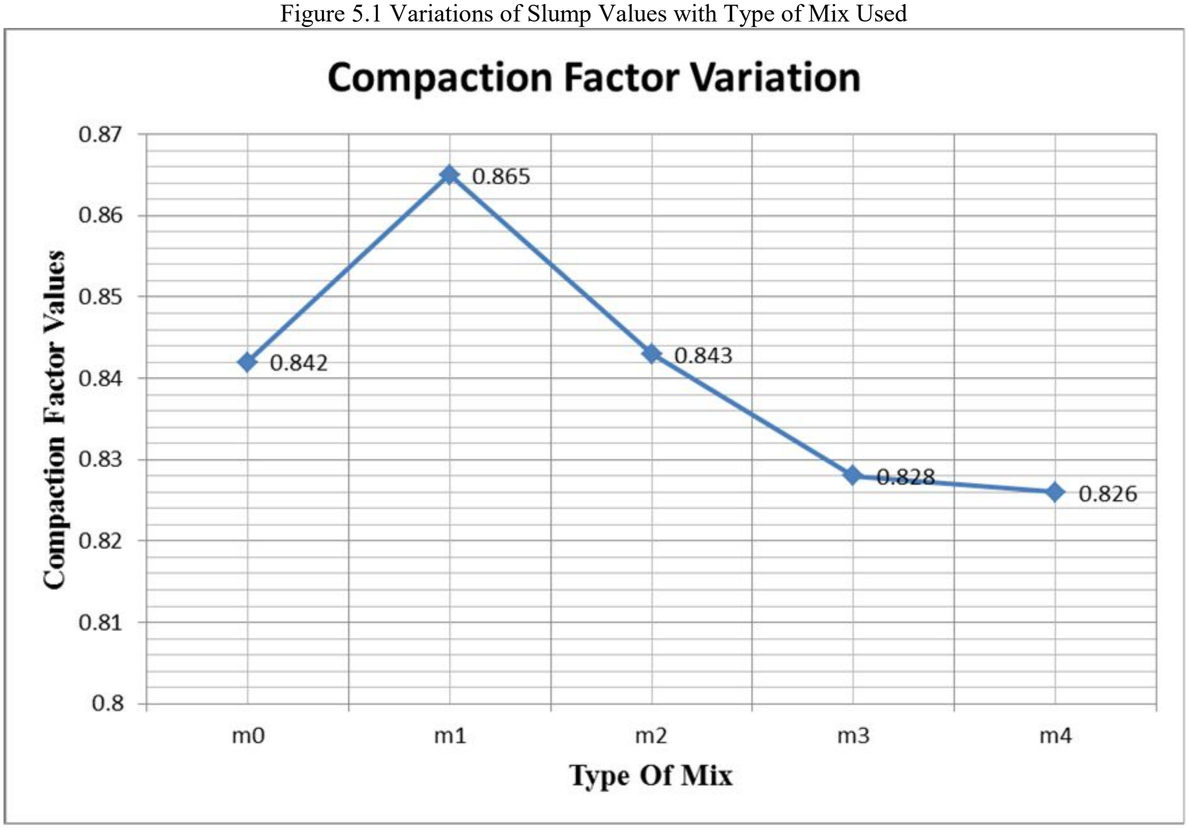

Figure 5.2 Variations of Compaction Factor Values with Type of Mix Used.

CONCLUSIONS

The research on usage of RCA in construction of pavement is very important because material waste is gradually increasing with the increase in urban development and increase in population. Recycled aggregates are easily available while natural aggregates need mining and their cost is much higher than the cost of natural aggregates. Recycled aggregates are cheaper than the virgin aggregates, so builders can easily afford these for construction purpose if their strength is equal or comparable to natural aggregates.

The study examines the properties of RCA when used with natural coarse aggregates. A lot of studies have been carried out on use of RCA concrete in construction. But in case of highway construction some more investigation is required. The main objective of the study was to investigate whether RCA can be used as material aggregates for concrete pavement construction. Compressive strength, flexural strength and sulfate resistance of RCA concrete is examined, where it was observed that mixing of RCA cause increased water absorption. To avoid this, super plasticizer is used to reduce the cement consumption. Concrete mix of M40 was designed as per properties of aggregates. The results of this study showed that RCA concrete gave comparable strength to conventional concrete. This indicated that RCA concrete can be viable source for construction of pavements. From the results, it is also found that workability of concrete is decreased due to higher water absorption. Whenever recycled aggregate is applied, water content is monitored carefully in concrete mix as water absorption is increased due to presence of porous mortar. In this study, super plasticizer (0.6% of cement) is used to overcome this problem.

Following conclusions can be drawn from results and discussion of results from the study:

The compressive strength of all mixes exceeded at the age of 28 days. Compressive strength of control mix i.e. of m0 is 50.05 MPa which is greater than the target strength of 48.25 for M40 concrete. Compressive strength of m1 is slightly increased to 50.36. So the compressive strength increases by 0.5%. For m2, compressive strength is increased to 50.20 MPa, it also showed an increase in compressive strength by 0.3%. Compressive strength of m3 is decreased to 49.11 MPa that showed a decrease in compressive strength by 1.9%. But in case of m4, there is sudden increase in compressive strength that raises the compressive strength to 52.36 MPa. Compressive strength is increased by 4.5%. So the results of test show that compressive strength does not follow a regular trend from m0 to m4. But from the results it is also concluded that compressive strength never went below the target strength for 28 days. This indicates that RCA can be used as replacement aggregates for compressive strength.

Flexural strength also followed the same pattern as of compressive strength. Flexural strength of control mix is 5.32MPa at age of 28 days. Flexural strength of mix m1 increased to 5.60 MPa. It shows that the increase in flexural strength is 5% for m1. For m2 flexural strength at age of 28 days is 5.40MPa, which shows an increase in flexural strength by 1.5%. Flexural strength of mix m3 is 5.38 and the flexural strength increased by 1 %. For the mix m4, flexural strength is 5.40 MPa. It shows that the flexural strength increased by 1.5 % at the age of 28 days. From the results and discussion of the results it is found that the flexural strength of RCA concrete is comparable to the natural aggregate concrete which is a positive point. So the RCA concrete can be used for flexural strength by adjusting W/C ratio.

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