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Research Paper

INVESTIGATION OF NO-FINES CONCRETE IN BUILDING BLOCKS

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More than 40 million residential units are needed to house millions of homeless people in India. Blocks are important components in residential buildings. Even though bricks made of soil have been widely used so far, there is very good scope for using blocks made of cement, sand and coarse aggregates because bricks are not available at all places to the desired requirements. A concrete block is primarily used as a building material in the construction of walls. A concrete block is one of several precast concrete products used in construction. Major advantage of concrete blocks is that their strength can be engineered as per requirement, thus making them relatively stronger than masonry with bricks walls by around 15-20%. The market for building block is growing at a rapid rate, especially in the areas where burnt bricks are not easily available or of poor quality. Unfortunately, rigorous scientific studies have not been made on the strength, durability and economy of concrete building blocks. Lightweight concretes can either be lightweight aggregate concrete, foamed concrete or Autoclaved Aerated Concrete (AAC). Such lightweight concrete blocks are often used in mason’s house construction, because of their less density and self-weight, it helps for faster construction.

Keywords: No-fines concrete, Building blocks, Investigation

INTRODUCTION

No-Fines Concrete is a method of producing light concrete by omitting the fines from conventional concrete. No-fines concrete as the term implies, is a kind of concrete from which the fine aggregate fraction has been omitted. This concrete is made up of only coarse aggregate, cement and water. Very often only single sized coarse aggregate, of size passing through 20 mm retained on 10 mm is used. No-fines concrete is becoming popular because of some of the advantages it possesses over the conventional concrete. The single sized aggregates make a good no-fines concrete, which in addition to having large voids and hence light in weight, also offers architecturally attractive look. No-fines concrete is generally made with the aggregate/ cement ratio from 6:1 to 10:1 Aggregates used are normally of size passing through 20 mm

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and retained on 10 mm. Unlike the conventional concrete, in which strength is primarily controlled by the water/cement ratio, the strength of no-fines concrete is dependent on the water/cement ratio, aggregate cement ratio and unit weight of concrete. The water/cement ratio for satisfactory consistency will be used. Water/cement ratio must be chosen with care. If too low a water/cement ratio is adopted, the paste will be so dry that aggregates do not get properly smeared with paste which results insufficient adhesion between the particles. On the other hand, if the water/cement ratio is too high, the paste flows to the bottom of the concrete, particularly when vibrated and fills up the voids between the aggregates at the bottom and makes that portion dense. This condition also reduces the adhesion between aggregate and aggregate owing to the paste becoming very thin. No standard method is available, like slump test or compacting factor test for measuring the consistency of no-fines concrete. Perhaps a good, experienced visual examination and trial and error method may be the best guide for deciding optimum water/cement ratio. No-fines concrete, when conventional aggregates are used, may show a density of about 1600 to 1900 kg/m^3, but when no-fines concrete is made by using light weight aggregate, the density may come to about 360 kg/m^3. No-fines concrete does not pose any serious problem for compaction. Use of mechanical compaction or vibratory methods is not required. Simple roding is sufficient for full compaction.

AIM and Scope of Investigation

AIM

The main objectives of the project are as follow:

1. To identify the strength of no-fines concrete specimen.
2. To identify the most economical mix for blocks.
3. To study the durability of these concrete blocks.

Scope of Investigation

1. Reduction in dead loads making savings in foundations and reinforcement.
2. Improved thermal properties.
3. Improved fire resistance.
4. Savings in transporting and handling precast units on site.
5. Reduction in formwork and propping.

MATERIALS

General

Material investigation is done to test the various materials that are used in making concrete cubes. According to these test results obtained we designed the mix ratios for the materials and prepared the concrete cubes, beams and cylinders. The information are given below,

Cement

OPC of 43 grades in one lot was procured and stored in air tight container. The cement used was fresh, i.e., used within three months of manufacture. It should satisfy the requirement of IS12262. The properties of cement are determined as per IS4031:1968 and results are tabulated.

TEST ON CEMENT

Cement is the most important ingredient of concrete. One of the important criteria for the selection of cement is its ability to produce improved microstructure in concrete. Some of the important factors which play a vital role in the selection of the type of cement are compressive strength at various ages, fineness, heat of hydration, alkali content, tricalcium silicate (C3S) content, tricalcium aluminates (C3A) content, dicalcium silicate (C2S) content and compatibility with admixtures, etc. Nowadays, practically in site, most of the constructions are being done by Ordinary Portland Cement (OPC).

Fineness Test

The fineness of cement has an important bearing on the rate of hydration and hence on the rate of gain of strength and also the rate of evolution of heat. Finer cement offers a greater surface area for hydration and hence faster the development of strength. Maximum number of particles in a sample of cement should have a size less than about 100 microns. The smallest particle may have a size of about 1.5 microns. By and large average size of the cement particles can be taken as about 10 micron. The particle size fraction below 3 microns has been found to have the predominant effect on the strength at one day while 3-25 micron fraction has a major influence on 28 days. Increase in fineness of cement is also found to increase the drying shrinkage of concrete. It is suggested that there should be about 25-30% of particles less than 7 micron in size.

Procedure

100 gram of cement is correctly weighed and is taken on a standard IS sieve No. 9 (90 microns). Air-set lumps in the sample, if present, are broken down with fingers. The sample is continuously sieved giving circular and vertical motion for a period of 15 minutes. Mechanical sieving devices may also be used. The residue left on the sieve is weighed. The weight shall not exceed 10% for ordinary test.

Standard Consistency of Cement

The standard consistency is defined as that consistency which will permit a vicat plunger having 10 mm diameter 50 mm length to penetrate to a depth of 33-35 mm form top (or 5-8 mm from bottom) of the mould in vicat apparatus. Standard consistency has to be used in determining the initial settling time and final settling time.

Coarse Aggregate

The coarse aggregate is strongest and porous component of concrete. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of movement of moisture. The coarse aggregate used passes in 19 mm and retained in 11.4 mm sieve. It is well graded (should of different particle size and maximum dry packing density and minimum voids) and cubical in shape.

BULK DENSITY

The bulk density of the sample is found in rod state and in loose state, since the weight varies with respect to the percentage of voids. The test shall be carried out in dry material why determining the voids, but during the bulking test a small amount of water may be imparted. The weight of empty weight container is found and is then filled with water to obtain the volume of container.

In Rod State

The metal container shall be filled about with one third with thoroughly mixed aggregate and tamped 25 times with tamping rod. Further, a similar quantity is added and again it is subjected to 25 times of tamping. The remaining one third also filled in the same way. The net weight of the aggregate is measured and bulk density in rod state is calculated.

In Loose State

The metal container is filled up to overflowing by discharging the aggregates from a height of not more than 50 cm from the top of measure. Care should be taken to prevent segregation. The surface is leveled and net weight is calculated.

Table 1: Bulk Density Value

S. No.	Size of Aggregate (mm)	Bulk Density at Rodv State (kg/m^3)	Bulk Density at Loose State (kg/m^3)
1.	6	1453	1365
2.	12	1484	1360
3.	20	1443	1345

Water

Ordinary drinking water available in the construction laboratory was used for casting all specimens of this investigation. Water helps in dispersing the cement even, so that every particle of the aggregate is coated with it and brought into ultimate contact with the ingredients.

It reacts chemically with cement and brings about setting and hardening of cement. It lubricates the mix and compact property. Potable water, free from impurities such as oil, alkalis, acids, salts, sugar and organic materials were used. The quality of water was found to satisfy the requirement if IS 456-2000.

MIX DESIGN

General

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. The main objective is to stipulate the minimum strength and durability. The mix design proportions adopted in our project for the grade of M40 are.

Figure 1: Mixing, Casting and Curing

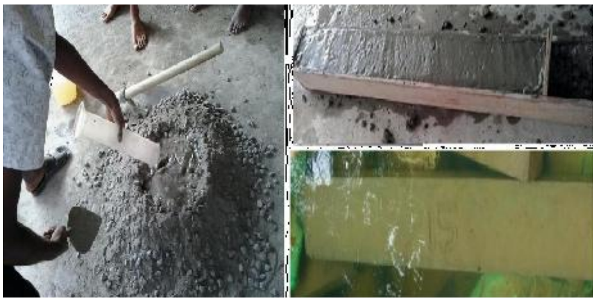


Table 2: Mix Proportion

S. No.	Mix Proportions
1.	1:6
2.	1:8
3.	1:10

Casting

Mould Preparation

The cube mould was placed in position on an even surface. All the interior faces and sides were coated with mud oil to prevent the sticking of concrete to the mould.

Mixing

The concrete with grade M30 (1:1.02:2.26) with water cement ratio 0.38 is used. Concrete is mixed in roller type of mixing machine.

Placing Concrete

Concrete is properly placed beneath and along the sides of the mould with help of trowel.

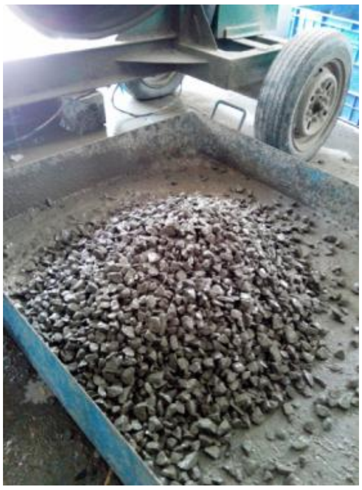
Compaction

Hand compaction was done for all the cubes used in the test. The damping mild steel rods having point ends were used to poke the concrete and it is placed in vibrating table to make compaction complete.

Curing

The mould is striped after 24 hours. The test cubes were cured for duration of 7 and 28 days in a curing tank. After the wet curing the specimens were air cured for minimum period 2 Hours under laboratory conditions.

Figure 2: Mixing of Coarse Aggregate



TEST RESULTS

Testing of concrete plays an important role in controlling and confirming the quality of cement concrete. Cube, beam and cylinder are tested for its strength characteristics.

Compression Test

The cubes of size 150 x 150 x 150 mm are placed in the machine such that load is applied on the opposite side of the cubes as casted. Align carefully and load is applied, till the specimen breaks. The formula used for calculation

Compressive Strength = Total Failure Load/ Area of the Cube

Compressive Strength Results

Table 3: Compressive Strength for 7 Days

S. No	Normal Concrete (N/mm^2)	No Fines Concrete (N/mm^2)
1.	23	27

Table 4: Compressive Strength for 14 Days

S. No	Normal Concrete (N/mm^2)	No Fines Concrete (N/mm^2)
1.	32	37

Table 5: Compressive Strength for 28 Days

S. No	Normal Concrete (N/mm^2)	No Fines Concrete (N/mm^2)
1.	28	42

Split Tensile Test

The test is carried out by placing cylinder specimen of dimension 150mm diameter and 300mm length, horizontally between the loading surface of compression testing machine and the load is applied until failure of the cylinder along the vertical diameter. The failure load of the specimen is noted.

The failure load of tensile strength of cylinder is calculated by using the formula

Tensile strength = 2P/3.14 DL6.2.2

where,

P – Failure of the specimen

D – Diameter of the specimen

L – Length of the specimen

Figure 3: Split Tensile Test

Split Tensile Strength Results

Table 6: Split Tensile Strength for 7 Days

S. No	Normal Concrete (N/mm^2)	No Fines Concrete (N/mm^2)
1.	0.989	1.257

Table 7: Split Tensile Strength for 14 Days

S. No	Normal Concrete (N/mm^2)	No Fines Concrete (N/mm^2)
1.	2.26	2.857

Table 8: Split Tensile Strength for 28 Days

S. No	Normal Concrete (N/mm^2)	No Fines Concrete (N/mm^2)
1.	3.68	4.24

Flexural Test

The test is carried out to find the flexural strength of the prism of dimension 100 x 100 x 500 mm. The prism is then placed in the machine in such manner that the load is applied to the uppermost surface as cast in the mould. Two points loading adopted on an effective span of 400 mm while testing the prism .The load is applied until the failure of the prism. By using the failure load of prism.

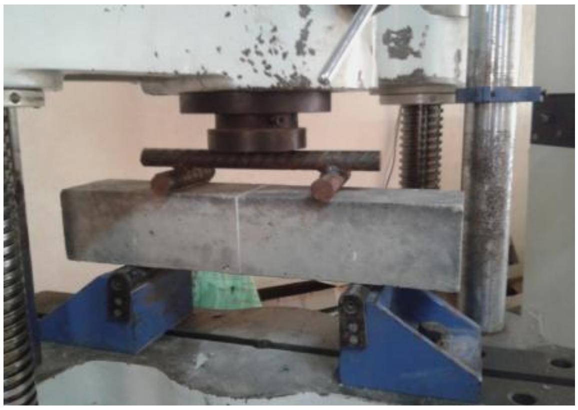
Flexural Strength = Pl / bd^2

P – Failure load of the prism

b – Breadth of the prism

d – Depth of the prism

Figure 4: Flextural Test on Prism



Flexural Test Results

Table 9: Flexural Strength for 7 Days

S. No	Normal Concrete (N/mm^2)	No Fines Concrete (N/mm^2)
1.	5.24	6.4

Table 10: Flexural Strength for 14 Days

S. No	Normal Concrete (N/mm^2)	No Fines Concrete (N/mm^2)
1.	7.24	8.2

Table 11: Flexural Strength for 28 Days

S. No	Normal Concrete (N/mm^2)	No Fines Concrete (N/mm^2)
1.	8.64	9.48

RESULTS AND CONCLUSION

- 1:6 mix proportions gives more compressive strength than the other two mix proportions.
- The effect of water/cement ratio have greater impact on ultimate strength as

0.45% water content gives more strength than other water content used in this investigation.

- The use of water content more than 0.45% causes the flow of cement to the bottom of the specimen.
- The use of different size aggregates also have greater impact on the ultimate strength as 12 mm size aggregate gives more strength than other sizes namely 6 mm and 20 mm.
- The use of 6 mm aggregate causes increase in dry density.
- The use of 20 mm aggregate causes more voids inside the concrete thereby reduction in strength.
- The ultimate strength of no-fines concrete is of the range between 5 N/mm^2-12 N/mm^2.
- From the investigation, the most economical mix with high strength identified was 1:6 mix ratios with 12 mm aggregate and 0.45% water content.

SUGGESTION FOR FUTURE WORK

- The ultimate strength of conventional concrete blocks is of the range between 1.3 N/mm^2-9.5 N/mm^2.
- The ultimate strength of no-fines concrete blocks were higher compared with nominal concrete blocks.
- The water absorption percentage is of the range 5.5-8.5 for no-fines concrete blocks and 8.5-17 for nominal concrete blocks.
- The durability of no-fines concrete blocks were higher compared with nominal concrete blocks.
- The cost of manufacturing of no-fines concrete blocks were 3.5-5 rupees but for nominal concrete blocks it was 4.5-6.5 rupees.
- Hence, the no-fines concrete blocks were more economical than nominal concrete blocks.

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