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The Use of Basalt Aggregate as Coarse Aggregate in High Strength Concrete Mixes

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ABSTRACT:

Concrete technology has been changing rapidly and constantly since its discovery. The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. The scope of this work is limited to the development of a suitable mix design to satisfy the requirements of workability and strength of the concrete mix using basalt aggregate as a coarse aggregate. To evaluate the workability of concrete mixes using basalt aggregate as coarse aggregate.To evaluate the strength of hardened concrete using basalt aggregate as coarse aggregate The results of the compressive strength tests will be conducted on the trial mixes containing 0%,25%, 50%,75% and 100% basalt, respectively. The compressive strength will be tested as the percentage of basalt content in the mix is increased. Five mixes were prepared; namely 0% basalt (as a control mix), 25% basalt, 50% basalt, 75% basalt and 100% basalt for each set of design mix. The composition of each mix was 60% coarse aggregate of 20 mm size and 40% coarse aggregate of 10mm size. Fine aggregate confines to zone-I.

Key Words:
Basalt, Workability, Compaction, Compressive Strength.

1.0 INTRODUCTION:

Cement is the most secure, most sturdy and practical building material. It gives unrivaled imperviousness to fire, picks up quality after some time and has a to a great degree long administration life. Cement is the most broadly utilized development material as a part of the world with yearly utilization assessed at somewhere around 21 and 31 billion tons. Solid development minimizes the long haul expenses of building or base undertaking.

1.1 SCOPE AND OBJECTIVES:

The scope of this work is limited to the development of a suitable mix design to satisfy the requirements of workability and strength of the concrete mix using basalt aggregate as a coarse aggregate.

Objectives:
1.To evaluate the workability of concrete mixes using basalt aggregate as coarse aggregate.
2. To evaluate the strength of hardened concrete using basalt aggregate as coarse aggregate.

1.2 DEFINITIONS
Admixture:

Material added during the mixing process of concrete in small quantities related to the mass of cementations binder to modify the properties of fresh or hardened concrete.

Super plasticizer:

Super plasticizers are also known as high range water reducers, are chemical admixtures used where well-dispersed particle suspension is required.

Mix design:

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.

Workability:

The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product.

1.3 CONSTITUENT MATERIALS:

The various ingredients used in the study were based on extensive preliminary experimental work.

1.3.1 CEMENT:

Ordinary Portland cement of 53 grades conforming to IS: 12269-1987 has been used throughout the experimentation. it is having a specific gravity of 3.15.

1.3.2 FINE AGGREGATE:

The locally available natural sand passing through 4.75mm IS sieve having specific gravity of 2.59 and conforming to grading zone-I of IS:383-1970 was used. The sand was dried in the sunlight before its use.

1.3.3 COURSE AGGREGATE:

Coarse aggregates lime stone and basalt of two fractions with specific gravities 2.7 and 2.83 respectively were used. Fraction-I was obtained by passing through 25mm and retained on 20 mm IS sieve and was taken at 60% of the total coarse aggregates content. Fraction II was obtained by passing through 12.5m IS sieve and retained on 10mm IS sieve and was taken at 40% of the total coarse aggregates content.

1.3.4 FLY ASH:

Fly ash having specific gravity of 2.2 obtained from was used as a mineral admixture for developing HPC mixes.

1.3.5 SUPER PLASTICIZER:

Most admixture manufacturers will have a range of super plasticizing admixtures tailored to specific user requirements and the effect of other mix constituents. The admixtures should bring about required water reduction and fluidity but should also maintain its dispersing effect during the time required for transport and application.

2.0 TEST METHODS FOR KEY PROPERTIES OF AGGREGATES:

- Specific Gravity Test
- Absorption Test
- Los Angeles Test

2.1 DESCRIPTION OF THE WORKABILITY TEST METHOD:

- Concrete Slump Test
- Types Of Droop
- Applications

2.2 Factors Affecting the Choice of Mix Proportions
The various factors affecting the mix design are:

2.2.1. Compressive strength:

It is a standout amongst the most imperative properties of cement and impacts numerous other describable properties of the solidified cement. The mean compressive quality required at a particular age, as a rule 28 days, decides the ostensible water-concrete proportion of the blend. The other element influencing the quality of cement at a given age and cured at a recommended temperature is the level of compaction.

2.2.2. Workability:

The level of workability required relies on upon three variables. These are the extent of the segment to be cemented, the measure of support, and the strategy for compaction to be utilized. For the slender and entangled area with various corners or out of reach parts, the solid must have a high workability so that full compaction can be accomplished with a sensible measure of exertion. This likewise applies to the inserted steel areas. The coveted workability relies on upon the compacting gear accessible at the site.

2.2.3 Durability:

The sturdiness of cement is its imperviousness to the forceful natural conditions. High quality cement is for the most part more solid than low quality cement. In the circumstances when the high quality is redundant but rather the states of presentation are such that high strength is essential, the sturdiness necessity will decide the water-concrete proportion to be utilized.

2.2.4 Maximum nominal size of aggregate:

When all is said in done, bigger the most extreme size of total, littler is the bond necessity for a specific

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water-concrete proportion, in light of the fact that the workability of solid increments with expansion in greatest size of the total.

2.2.5 Grading and type of aggregate:

IS 456:2000 and IS 1343:1980 suggest that the ostensible size of the total ought to be as huge as could reasonably be expected. The reviewing of total impacts the blend extents for a predetermined workability and water-concrete proportion. Coarser the reviewing leaner will be blend which can be utilized. Extremely incline blend is not attractive since it doesn't contain enough better material to make the solid durable. The sort of total impacts firmly the total bond proportion for the coveted workability and stipulated water concrete proportion. An imperative component of an agreeable total is the consistency of the mixing so as to review which can be accomplished distinctive size divisions.

2.2.6 Quality Control:

The level of control can be evaluated measurably by the varieties in test outcomes. The variety in quality results from the varieties in the properties of the blend fixings and absence of control of exactness in grouping, blending, putting, curing and testing. The lower the distinction between the mean and least qualities of the blend lower will be the bond substance required. The variable controlling this distinction is termed as quality control.

3. EXPERIMENTAL PROCEDURE:

Five mixes were prepared; namely 0% basalt (as a control mix), 25% basalt, 50% basalt, 75% basalt and 100% basalt for each set of design mix. The composition of each mix was 60% coarse aggregate of 20 mm size and 40% coarse aggregate of 10mm size. Fine aggregate confines to zone-I.

3.1 LABORATORY TESTS:

The laboratory tests investigated in this project included:
1. Key properties of an aggregate such as specific gravity, absorption and abrasion are determined for both lime stone and basalt aggregates.

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The laboratory tests investigated in this project included:
1. Key properties of an aggregate such as specific gravity, absorption and abrasion are determined for both lime stone and basalt aggregates.

2. Workability is determined by performing slump cone test for every mix.

3. Compressive strength is determined by breaking cube samples (15x15x15) cm. Three cubes for each mix were tested.

3.2TABLES AND GRAPHS: GENERAL:

Results that are obtained for various laboratory tests are tabulated as shown below. Also graphs are drawn for the results to compare various set of values in order to compare the values and draw a conclusion for the work done.

Table 1: Key Properties of Coarse Aggregate

Properties	Lime stone	Basalt
Specific gravity	2.7	2.83
Absorption (%)	2.5	1.6
Abrasion (%)	29	18

Table 2: Proportions of M50 Design Mix

Water (kg/m^3)	171
Cement(kg/m^3)	427
Fly ash(kg/m^3)	33
Fine aggregate (kg/m^3)	634
Lime stone (kg/m^3)/ Basalt (kg/m^3)	1197 1231
Super plasticizer(kg/m^3)	2.3

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Table 3: Slump height for the design mixes

Basalt content	M50 design mix
0 %	96mm
25 %	102mm
50%	115mm
75%	124mm
100%	136mm

Table 4: 7 Days Compressive Strength Test Results for M50 Grade Concrete Mix In N/mm2.

sample	0% basalt	25% basalt	50% basalt	75% basalt	100% basalt
1	39.11	40.88	41.77	45.33	46.22
2	41.33	39.55	43.55	44.88	45.77
3	40.44	41.33	42.66	44.44	44.88

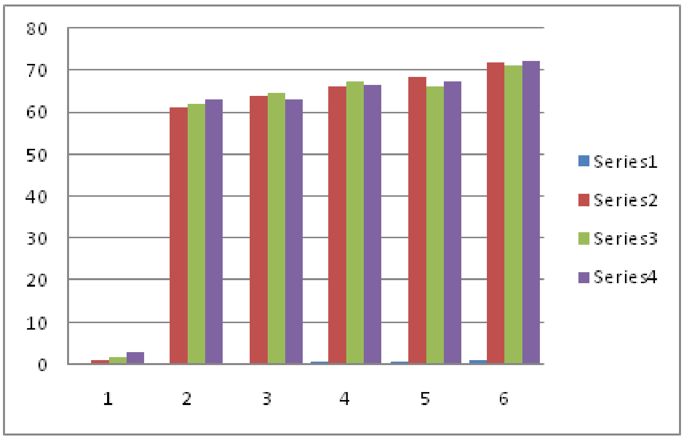
Table 4: 7 Days Compressive Strength Test Results for M50 Grade Concrete Mix In N/mm2.

sample	0% basalt	25% basalt	50% basalt	75% basalt	100% basalt
1	61.33	64	66.22	68.44	72
2	62.22	64.88	67.55	66.22	71.11
3	63.11	63.11	66.66	67.55	72.44

Table 5: 28 Days Compressive Strength Test Results for M50 Grade Concrete Mix In N/Mm2.

3.4 Compressive Strength Test Results:

The results of the compressive strength tests that were conducted on the trial mixes containing 0%,25%, 50%,75% and 100% basalt, respectively. In general, the compressive strength increased as the percentage of basalt content in the mix is increased. There is an increase in compressive strength of around 18 % for M 50 mix.



Graph: Compressive Strength Test Results for M50 Grade Concrete

4. CONCLUSIONS:

The laboratory test results in compressive strength, seems to indicate that the increase in basalt content enhances the mix strength over the conventional limestone mix. This is due to the fact that basalt is denser and more durable and less water absorbing than limestone. Also higher workability is obtained for more basalt aggregate content mix which reduces the cost of labor. As basalt aggregate is a natural aggregate also available in plenty at low cost, an economical and relatively high strength concrete is obtained by using basalt aggregate as coarse aggregate in concrete mixes.

5. FUTURE SCOPE:

More important is that the concept of Green Building and sustainable development principles, which will modify the whole picture in favor of the environment. Advances in concrete research have demonstrated that it is possible to coordinate these two develop¬ments, thereby minimizing the need for vast additional cement production capacity and creating that balanc¬ing act of sustainable development on a global scale.

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