Effect of Flaky Aggregates on the Strength and Workability of Concrete

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Abstract:- In these paper effects of flaky aggregates on the compressive strength, tensile strength and Workability of concrete have been studied using experiments respectively. Concrete cubes and cylinders have been cast using variation of flaky aggregates (20%, 30%, 40%, 50%, 60%, 70%) with water cement ratios 0.5. Concrete mix design of M25 grade was done according to IS: 10262-2009. Workability was measured in terms of slump test. Concrete cubes and cylinders was tested for compressive strength and splitting tensile strenght.The test results are compared and It was concluded that flaky aggregates beyond certain limit decreases strength and workability and hence the strength of concrete greatly depends on internal structure and shape of aggregates.

Key word: *Flaky aggregates, workability, compressive strength, Concrete cube, splitting tensile strength.*

1. INTODUCTION

Concrete is a composite material produced by the homogenous mixing of selected proportions of water, cement, and aggregates (fine and coarse). In absolute volume terms the aggregate amounts to 60-80% of the volume of concrete and is, therefore, the major constituent of the concrete. To know more about the concrete it is essential that one should know more about the aggregates. Since the aggregate characteristics are critical to the performance of the concrete mixes. It is well known that shape of aggregate plays very important role in 'Shaping' the properties of concrete.

The flaky aggregate are avoided for making quality concrete. The presence of flaky aggregates beyond certain limits increases the degradation of the concrete mixes. The presence of high percentage of flaky aggregates makes the mix harsh and difficult to work with. Here the flaky aggregate is stated as that the aggregate with a ratio of the shortest diameter and the average diameter is less than 0.60. Flaky particles tend to orient in one plane and cause laminations which adversely affect the durability of the concrete.

Flaky aggregate was shown to have lower compatibility and higher breakage . Highly flaky aggregates have more voids and reduce the workability. Workability of the fresh concrete be such that the concrete can be properly compacted, transported, placed and finished concrete should not segregate i.e. it has to be cohesive. A workable concrete should not shown ant segregation or bleeding. This results in large voids, less durability and strength.

2. OBJECTIVES OF STUDY

The objectives of the study are:

- To investigate the effect of flaky aggregate on the compressive strength, splitting tensile strength and workability of concrete.
- To determine the compressive strength of M25 Concrete with different flakiness of aggregates.
- To determine the splitting tensile strength of M25 Concrete with different flakiness of aggregates.
- To obtain graphically comparison of compressive strength for M25 Concrete mix with different flakiness of aggregates.
- To obtain graphically comparison of splitting tensile strength for M25 Concrete mix with different flakiness of aggregates.
- To obtain graphically representation of Workability of M25 concrete with different flakiness of aggregates.
- To draw conclusions about improvement in the workability and strength of concrete.
- . To determine the most suitable percentage of flaky aggregates in the concrete mixes.
- To determine the effect of workability on compressive strength of concrete

3. BASIC ASPECTS

3.1 Materials:

- **Portland pozzolana cement**

  Portland pozzolana cement confirming to IS: 1489-1991 (Part 1) for Portland Pozzolana Cement (Fly Ash based) was used.

Table 1: Physical properties of PPC

Property	Test Results obtained
Standard Consistency	30%
Initial setting time	45 min
Final setting time	285 min
Fineness	2%
Specific gravity	3.15

- **Fine aggregate**

The sand used in the investigation was ordinary river sand. The sand passing through 4.75 mm sieve was used in the preparation of specimens. The physical properties of sand were determined as per IS: 2386-1963.

Table 2: Physical properties of Fine aggregate

Sr. No.	Property	Test Results obtained
1	Specific gravity	2.65
2	Bulk density	1452 Kg/m^3
3	Moisture content	1%

- **Coarse aggregate**

The coarse aggregate used in the investigation was 20 mm size crushed granite stone obtained from quarries. The physical properties were determined as per IS: 3286-1963.

Table 3: Physical properties of Coarse aggregate

Sr No.	Property	Test Results obtained
1	Specific gravity	2.62
2	Bulk density	1356 Kg/m^3
3	Flakiness index	30%
4	Moisture content	0.5%

- **Water**

The water used in the mix design was potable water from the water supply and is free from suspended solids and organic materials, which might have affected the properties of the fresh and hardened concrete. The presence of tannic acid or iron compounds is objectionable. The general required of water for mixing and curing concrete shall be as per IS: 456-2000.

4. REVIEW OF RELATED LITERATURE:

A large number of researchers have extensively studied the effect of flakiness on the compressive strength & workability of concrete.

M R Vyawahare, P O Modani , have studied on Improvement in Workability and Strength of Concrete with Flaky and Elongated Aggregates, it was concluded that extremely flaky and elongated aggregate can also produce quality concrete which can be used for PCC works .

Jian-Shiuh Chend, M.K. Chang & K.Y. Lin , have studied on Influence of coarse aggregate shape on the strength of asphalt concrete Mixtures, it was concluded that flaky aggregate in a mixture resulted in lower resistance to shear deformation and it was shown to have lower compactibility and higher breakage.

Bambang Ismanto siswosoebrotho & Kariantoni ginting , have studied on Workability and resilient modulus of asphalt concrete mixtures containing flaky aggregates shape, it was concluded that the values of Workability Index are influenced by the flaky aggregate content the values of workability decrease with increasing the flaky aggregate content and flaky aggregate does influence the properties of asphalt mixture and its use should therefore be limited to avoid the unexpected mixture properties that might be occurred during construction.

D. Sakthibalan , have studied on Influence of Aggregate Flakiness on Dense Bituminous Macadam & Semi Dense Bituminous Concrete Mixes, it was concluded that the parameters such as stability, flow, voids filled with bitumen and tensile strength ratio decreases with increase in proportion of flaky aggregates for both DBM and SDBC mixes. The parameters such as air voids and voids in mineral aggregate increases with increase in proportion of flaky aggregates for both DBM and SDBC mixes.

Ganapati Naidu .P and S. Adiseshu , have studied on Influence of Coarse Aggregate Shape Factors on Bituminous Mixtures, it was concluded that the Particle shape parameter, higher sphericity value obtained for cubical shape aggregates and lower value for blade shape aggregate, because the sphericity value higher indicates the roundness of the aggregate.

Sander Popovics and Janos Ujhelyi , have studied on contribution to the concrete strength versus water-cement ratio relationship.

Animesh Das , have studied on A revisit to aggregate shape parameters found that Aggregates constitute major part of the pavement structure. The engineering properties of the aggregates, as well as its shape (*i.e.* form and angularity) and texture, substantially affect the overall performance of the pavement

5. METHODOLOGY

Methodology is the process of performing any work in proper manner i.e. step by step procedure of work.

This procedure of methodology is shown in following steps;

a) Procurement of material.

b) Material testing.

c) Arriving mix proportion.

d) Workability by Slump cone test.

e) Cube and cylinder Casting.

f) Curing of specimens.

g) Compressive Strength test of cubes for 7 days, 14 days and 28 days.

h) Splitting tensile strength test of cylinders for 7 days and 28 days.

i) Result and Discussion

The specimen of standard cube of size (150 mm x 150 mm x 150 mm) and cylinder was used to determine the compressive strength of concrete and tensile strength of concrete. For compressive strength, three specimens were tested for 7, 14 and 28 days with varying percentage of flakiness index of aggregate. And for tensile strength, three specimens were tested for 7 and 28 days. The constituents were weighted and the materials were mixed in a mixer. The mixes were compacted with the help of tamping rod. The specimens were de molded after 24 hours, cured in water for 7days, 14days and 28 days for compressive testing and 7 days ,14 days for tensile strength testing. Then tested for its compressive strength and tensile strength as per Indian Standards.

6. RESULT AND DISCUSSION

In this investigation, the M25 concrete is used and prepare cubes of concrete having different flakiness of aggregate to determine the compressive strength of concrete by compressive strength testing machine for 7, 14 and 28 days and also concrete cubes are prepared to determine the splitting tensile strength using universal testing machine for 7 and 28 days. Workability of concrete is determine using slump cone test for different flakiness of aggregate. Results have been compared on the basis of compressive strength testing machine and universal testing machine

- **Workability**

In laboratory , workability of M25(1:1:2) concrete is determine . Concrete is prepared with water cement ratio 0.5 and the flakiness of coarse aggregate taken is various from 20%,30%,40%,50%,60% and 70%. Concrete is made with this different percentage of flakiness index and determine workability with the help of slump cone test. Table shows the slump value of concrete for various flakiness index of aggregate. The graph showing variation of slump with initial time is shown in Fig1 .

TABLE 4: SLUMP VALUE OF CONCRETE FOR DIIFFERENT FLAKINNESS INDEX OF AGGREGATE

S.NO.	% FLAKINESS INDEX OF AGGREGATE IN CONCRETE	SLUMP VALUE (in mm)
01	70%	50
02	60%	58
03	50%	61
04	40%	67
05	30%	71
06	20%	76

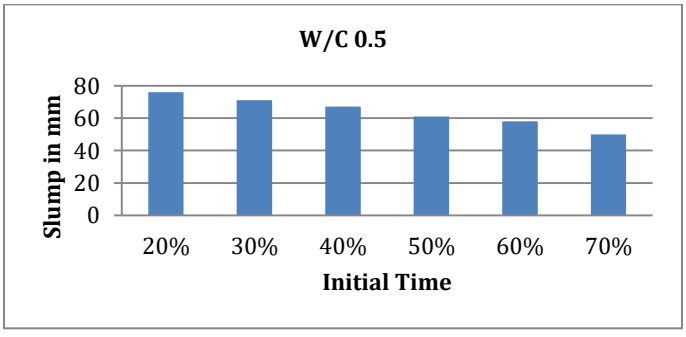

Fig 1: Variation of slump with initial Time

- **Compressive strength**

The compressive strength of concrete for 30% .Flaky aggregate was as good as concrete made up with normal aggregates but for 70% Flaky aggregate the strength is very much decreased not reaching the estimated target strength of 31.6Mpa. The graph showing variation of compressive strength with flaky aggregate percentage is shown in Fig 2

Mix proportions	Flaky aggregates (%)	W/C ratio	Compressive strength in Mpa		
			7 days	14 days	28 days
M25(1:1:2)	20 %	0.5	20.26	25.96	31.94
	30%		19.65	24.55	30.39
	40%		18.84	23.24	28.86
	50%		17.72	21.84	26.54
	60%		16.26	20.29	25.29
	70%		14.86	18.84	24.13

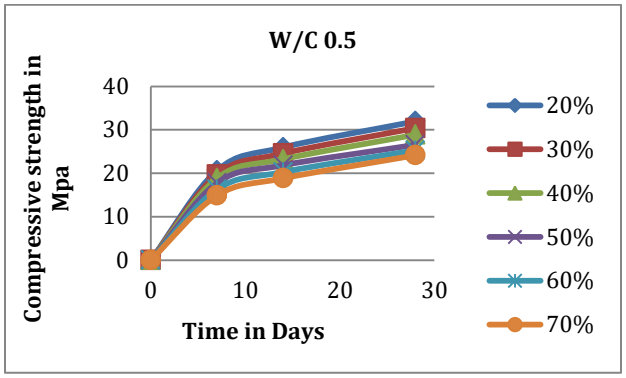

Fig 2: Variation of Compressive strength with flaky aggregate percentage

- **Splitting tensile strength**

The determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. As increase in Flaky aggregate percentage the concrete members cracked for the smaller load. The graph showing variation of splitting tensile strength with flaky aggregate percentage is shown in Fig 3.

Mix proportions	Flaky aggregates (%)	W/C ratio	Splitting tensile strength in Mpa	
			7 days	28 days
M 25 (1:1:2)	20 %	0.5	2.27	3.18
	30%		2.16	2.94
	40%		2.04	2.75
	50%		1.96	2.54
	60%		1.83	2.43
	70%		1.74	2.31

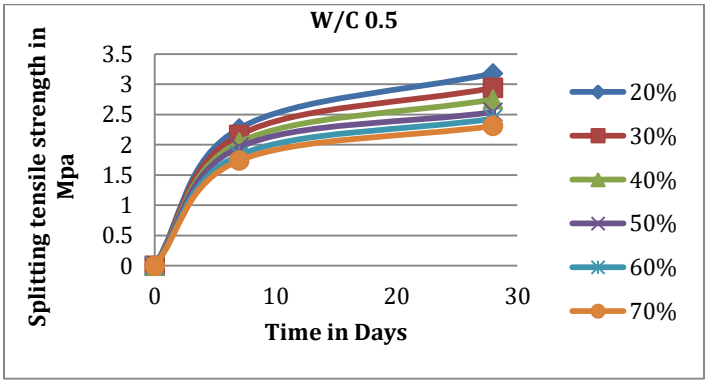

Fig 3: Variation of splitting tensile strength with flaky aggregate percentage

7. CONCLUSIONS

- The workability of M25 concrete mix used in this investigation significantly decreased with increase in the percentage of flaky aggregate content.
- Compressive strength of M25 concrete has decreased with increase in the percentage of flaky aggregate content.
- Splitting tensile strength of M25 concrete has decreased with increase in the percentage of flaky aggregate content.
- The 30% replacement of flaky aggregate with normal aggregate proved to be equally good as concrete made up with normal aggregates.

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