Analysis on Behaviour of Effect of Flakiness Aggregate on The Compressive Strength of The Concrete

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Abstract- *In this Review Paper effect of flakiness on the compressive strength of concrete cube will be studied and analysis using experiments. Total 30 cubes will be casted using normal 5% of 10 mm, 12 mm & 20mm size respectively of flaky aggregates and 10% of 12mm size of flaky aggregate. NDT(Non Destructive Test) of the casting cube using rebound hammer and ultrasonic pulse velocity will be also carried out. All the cubes will be tested for compressive strength. Based on these data, comparative studies will be carried out to quantify the effect of flakiness aggregate on the concrete.*

Keywords- Flakiness Aggregate, Concrete, Compressive Strength, NDT (Non Destructive Test)

I. INTRODUCTION

1.1.CONCRETE:

Concrete is used as a binding material in present condition in entire world. Concrete is a very heterogeneous composite material. It is a composite material, where coarse and fine aggregates are filler material and cement paste is binding material. The maximum properties of concrete and workability of concrete depends upon the aggregate. The characteristic of concrete should be measured on the relative basis and degree of quality must be maintained for any construction purpose. Concrete should be durable to work satisfactorily under different condition, which shall give it protection from disintegration in severe exposure condition. Water tightness is essential for a hydraulic structure, but strength and rigidity are obviously the primary structural requisite for the building.

Concrete is made up of fine aggregate (sand), coarse aggregate (gravel or crushed stones etc.), cement and water to make a hardened paste. These material are mixed in proper proportion to make a plastic mass which can be moulded into any pre- defined shape as per IS standard. After hydration of cement by water, the concrete shows hardness as that of stone and provide greater strength of the member. Due to this concrete plays a key role in the construction of building elements.

The mechanical properties of concrete depend on properties of aggregate like shape of aggregate, size of aggregate, source of aggregate, crushing type of aggregate, normal or light or heavy weight aggregate, angularity index, modulus of elasticity, surface texture, specific gravity, bulk density, absorption and moisture content, cleanliness, soundness of aggregate, bulking of aggregate, thermal properties and grading of aggregate etc.

1.2.AGGREGATE:

Aggregate are formed by the disintegration of existing rocks by weathering action either by wind, water or glaciers. These broken pieces may be rounded, angular or circular in shape. Aggregate are the important constituents in concrete

1.2.1.Classification Of Aggregate:-

1.2.1.1 Classification Based On Unit Weight

Aggregate can be classified on the basis of its unit weight which are

- Normal Weight Aggregate
- Light Weight Aggregate And
- Heavy Weight Aggregate.

1.2.1.2.Classification according to geological origin:

The aggregate are usually derived from natural source and may have been naturally reduced to size or may have to be reduced by crushing. The suitability of the locally available aggregate depends upon the geological history of the region.

Such an aggregate may further be divided into two categories:

- Natural Aggregate
- Artificial Aggregate

1.2.1.3.Classification according to size

The size of aggregate used in concrete ranges from few centimetres or more, down to a few microns. The maximum size of aggregate may vary, but in each case it is so graded that the particles of different size fractions are incorporated in the mix in appropriate proportions. The particles size distribution is called the grading of aggregate.

According to size, aggregate is categorized as:-

- Fine Aggregate
- Coarse Aggregate

1.2.1.4.Classification according to shape

- Rounded Shape
- Irregular Shape
- Flaky And Elongated Shape
- Angular Shape

1.2.2.Introduction Of Flaky Aggregate

The flaky and elongated particle of coarse aggregate are generally present in normal aggregate is excess of 10% to 15% of the weight of coarse aggregate. The thickness of flaky particle is less than 0.6 times sieve size and the length of elongated particle is more than 1.8 times than the sieve size. Flaky and elongated grains are determined by the relation between the length, width and thickness of the grain.

Criteria for describing particle shape according to ASTM D 2488-00.

A grain is classified as flaky if : Thickness /Width > 2
A grain is classified as elongated if: Thickness/length > 2.5

II. LITERATURE REVIEW

The literature review presents the current state of knowledge and examples of successful uses of alternative materials in concrete technology, and in particular the use of flaky aggregate. Flaky Aggregate is a coarse aggregate fraction in non-structural concrete. It also presents a review of available literature on Flaky Aggregate properties including particle size distribution, density and water absorption, and identifies the need to investigate porosity and possible chemical contamination of the aggregate.

Ponnada (2014) research :This work aims at starting the same quantitatively. M25 grade of concrete for various ratios of weights of elongated aggregate to flaky aggregate and angular aggregate to overall aggregate were checked for compressive strength, density and workability. The results expose that the effect of elongated aggregates is more than flaky aggregates, on the characteristic compressive strength of concrete. Concrete with 1:1 ratio of flaky to elongated aggregates has minimum weight. For a constant EA: FA ratio, density growths but characteristic compressive strength and compaction factor reduction with decrease in AA: TA ratio. For a constant AA: TA ratio, specific compressive strength and compaction factor are maximum density of concrete is minimum for an EA: FA ratio of 1:1. Still the outcomes or results and explanations cannot be generalised within the scope of this work, they can absolutely impress on the structural engineers and editors of standard codes of preparation of various countries that the flakiness and elongation indices have to be calculated for course aggregate being used in concrete and essential strength reduction factors have to be adopted.

Manjunath et al. (2014) investigating the Workability and Strength of Concrete Mixes with Variation of Flaky Aggregates. In this experimental investigation, the effect of flaky aggregates on fresh and hardened properties of concrete with different water cement ratios 0.5, 0.45 with super plasticizer of 0.6% was investigated. 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 were tested for compressive strength and split tensile strength. The test results are compared with different water cement ratios and the concrete made using water cement ratio of 0.45 with super plasticizer of 0.6% has the good workability & compressive strength. 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 the result of this investigation the workability of all concrete.

Patel et al. (2013) reported on the effect of coarse aggregate physical characteristics on strength properties of high efficiency concrete by using mineral and chemical admixture. This paper shows that by properly selecting aggregate and improving mixture proportions, the amount of cementations materials providing for workability can be minimized while achieving suitable workability and hard-bitten properties. The results of this research conform that the aggregate can play an important role in cement concrete mixture. The aggregate type has effect on the compressive strength of normal concrete. The compressive strength of concrete cube by using compression testing machine of capacity 2000 kN vary from 28.62 N/mm^2 to 62.50 N/mm^2 at

56 days. The maximum compressive strength is detected in type a coarse aggregate.

Polat et al. (2013) reported that the correlation between aggregate shape and compressive strength of concrete by digital image processing approach. In this study the shape characteristic such as aspect ratio, elongated, flatness, form factor, roundness, shape factor, and spherically were determined with digital image processing. Also determined the unit weight, slump, ultrasonic pulse velocity and compressive strength of concrete. The test result indicated that there is a good correlation between some shape properties of aggregate and compressive strength. The test result indicated that a strong correlation between the some shape indexes of aggregate and compressive strength of concrete. The particle shape factors were shown to be adequate measure of the combined contribution of some particle shape factor such as flatness, elongation and spherically to the compressive strength of an aggregate. Spherical particles were desirable for increase compressive strength, UPV, unit weight and slump values of concrete, the more nearly spherical the aggregate, the higher mentioned values.

Abdullahi (2012) reported the effect of aggregate category on compressive strength of concrete. Purpose of this work, three types of coarse aggregates used i.e., quartzite, granite, and river gravel, were used. The fine aggregate is normal type sand found from a borrow pit. Preliminary laboratory analysis was conducted to establish the suitability via the aggregates for construction related works. Tests conducted contain sieve analysis, bulk density, and specific gravity. Concrete nominal mix (1:2:4) was accepted for this work and mix compositions were calculated by absolute or accurate volume method. For all type of coarse aggregate 75 cubes (150 x 150 mm) were cast to permit the compressive strength to be observed at 3, 7, 14, 21, and 28 days. The results obtained from tests show that concrete made by river gravel has the maximum workability followed by crushed quartzite and crushed granite aggregates.

Rogers and Gorman (2008)reported a flakiness test for fine aggregate. This paper describes the development of a test for measuring the amount of flaky particles in fine aggregate. Commercially available slotted sieves for testing grain or seeds are used. Material in the pass 4.75 mm to 2.36 mm fraction is tested on a 1.8 mm slotted sieve and material in the pass 2.36 mm to 1.18 mm portion is tested on a 1.0 mm slotted sieve. The equipment is inexpensive and the test is not excessively time consuming. The measurement of flaky particles may also be used to compare the effect of different crushers and crusher systems on creation of flaky particles in fine aggregate. The results show the high amounts of flaky particles in a fine aggregate may warn of difficulty in compacting asphalt mixtures in which the material is used by itself as the fine aggregate.

Jain and Chouhan (2011) reported on the influence of shape of aggregate on compressive strength and permeability properties of permeable concrete. In this paper the magnitude of this effect is determine by conducting laboratory trials on mixes of permeable concrete prepared by using proper aggregate of differ in shape with different water cement ratio. The shape of aggregate is measure in terms of angularity number. Result Indicate that strength and permeability of concrete vary as function of shape of aggregate alongside with aggregate size and water cement ratio in this mix. This research paper analyses the all type of aggregate. It gives the compressive strength of pervious concrete which vary inversely with angular number of aggregate. The higher compressive strength is given when pervious concrete mix prepared using small size of all aggregate. It was also concluded that the permeability of pervious concrete varies which is depend on shape and size of aggregate and water cement ratio. The small value of angularity number aggregate mixed with pervious concrete gives less permeability but higher compressive strength.

Zaki (2010) reported a study on presentation of flat or flaky and elongated aggregates use in low traffic road. The study is showed to evaluate workability of the pavement concrete using flat and elongated aggregate as the core material and to compare the strength of using flat or flaky and elongated aggregate in concrete mixes for low traffic road with the normal mixes. Throughout the primary stage, the aggregates were tested for expressive the characteristic. The test that had been done was AIV Test, ACV Test, L. A. Abrasion Test, index of flakiness and index of elongation. The bitumen also had been tested for both penetration test and softening point test. After that, the mixtures were designed and ready. The secondary phase of the study was to evaluate the acts of the mixture having of flat and elongated aggregates. The results are observed that flat and elongated aggregate might have a significant effect on the performance of the mixtures. Thus, the conclusion of flat and elongated aggregate can be used in pavement mixtures but the percentage of aggregate must be limited to certain level to make sure the strength characteristics of the mixes can be reserved.

Vyawahare and Modani (2009)reported the improvement of its strength and workability of concrete with flaky and elongated aggregates. The objective of this study is to improve the workability of concrete of concrete with flaky and elongated aggregates using super plasticizer and mineral mixture to determine the permissible percentages of these aggregates in the concrete mixes without adversely affecting the characteristics of the mix. The result of this paper can be concluded that elongated aggregate can also produce quality concrete which can be used for PCC works like Pavements, Factory floors, Foundation. With the W/C ratio of 0.4, dose of super plasticizers 0.80 and optimum powder content (Fly ash) 0.25, the concrete with any proportion of flaky and elongated aggregate replacing normal aggregate can produce workable concrete with acceptable strength. The 20% replacement of normal aggregate with flaky and elongated aggregate has proved to be equally good as concrete made up with normal aggregate.

Murat (2007)reported the investigation of relationship between aggregate shapes in this study, relationships between aggregate shape parameters and compressive strength of concrete were studied using digital image processing and investigation methods. The study was conducted based on three mix design parameters, gradation category, aggregate types and maximum aggregate size, at two stages. A total of 40 cubic concrete samples were ready at a constant water-cement ratio. Once the compressive strength tests were performed, each specimen was cut into 4 equal pieces in order to obtain the digital images of cross sections using a digital flatbed scanner. A number of aggregate shape parameters were then determined from the digital image of the cross sections to investigate their relationships with the compressive strength. The results indicated that even though the aggregate type was found to give strong correlation with the compressive strength, weak correlations, however, exist between the compressive strength and the aggregate shape parameters. The study suggested that the analyses of relationships should be further investigated by including the effects of aggregate distribution within the specimen.

KariantoniGinting et al. (2005) reported that workability and resilient modulus of asphalt concrete mixtures containing flaky aggregates shape. The objective of this paper perform the flaky aggregates is normally avoided in bituminous mixtures, they influence the aggregate gradation, reduce interlocking characteristics, and it should be therefore limited. Indonesian National Standards (SNI) specified a tolerance of flaky aggregate content for a maximum of 25% in Asphalt Concrete mixture for surface course. Gradation was modified into 5 variations of flaky aggregate content, i.e. 5%, 15%, 25%, 35% and 45%. The Marshall test were done with 5 variations of asphalt content such as 5.0%, 5.5%, 6.0%, 6.5% and7.0%, respectively. Each variation of flaky aggregate content resulted on different optimum asphalt content of 5.85%, 5.90%, 6.0%, 6.05% and 6.15%. Workability Index (WI) measure during gyropac (350 gyrations) at their optimum asphalt content show that the WI decreases with decreasing the flaky aggregate content. The results show the flaky aggregate content influence the Marshall properties of asphalt mixture including the optimum asphalt content. The stability decrease, the flow increase, the VMA increase, the VIM increase and the asphalt content increase with increasing the flaky aggregate content. The values of Workability Index are influenced by the flaky aggregate content, the values of workability decrease with increasing the flaky aggregate content. The values of resilient modulus are also influenced by the flaky aggregate content, the values of resilient modulus decrease with increasing the flaky aggregate content. In general, 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

Chang and Lin (2005) reported an experimental study on effect of coarse aggregate shape on the strength mixtures of asphalt concrete. The objectives of this paper are to evaluate aggregate characteristics including elongation, flatness, and other shape indices. The following particle shapes were selected for this study: cubical, rod, disk, and blade. The change in rotation angle of coarse aggregate was found to correlate well with the internal resistance of a HMA mix. Cubical particles were desirable for increased aggregate internal friction and improved rutting resistance. Flaky and elongated aggregate was shown to have less compatibility and higher breakage. The results show that there exist separate morphological properties for different particle shapes. For cubic particles, the flatness percentage is 0.80 and elongation 0.81, and values of both are more than two third. Note that, in cubic-shape limestone, particles in the size range 25 mm to 19 mm are the maximum spherical, and those in the size range 9.5 to 4.75 mm are relatively flat and elongated. Cubic particles possess a advanced sphericity value than do the others. The typical sphericity values are between 0.5 and 0.9, which relates well with the explanation of each aggregate shape.

Quiroga and Fowler (2004) reported the effect of aggregate characteristic on the performance of Portland cement concrete. Aggregate shape, grading and texture have a significant outcome on the performance of fresh concrete. Aggregate mixtures with well-shaped, rounded, and smooth particles require less paste for a given slump than blends with flat, elongated, angular, and rough particles. At the same time, uniform grading with proper amounts of each size result in aggregate blends with high packing and in concrete with low water demand. The effect of shape, texture and grading of aggregates on fresh concrete was evaluated experimentally, measured by means a proportion method based on fulfill density concepts, the Compressible Packing Model (CPM), and observed by an empirical tool suggested by siltstone. The effect of different categories and amounts of micro-fines was estimated at the same time as well as the impact of chemical admixtures and additional cementing materials on concrete with high micro-fines were also evaluated experimentally.

Mansur and Islam (2002) reported an experimental study on the effects of different concrete specimen types on the compressive strength and established the inter-relationships between their strengths. Each of a total eleven test data sets generated in this study consists of five strength values for the five different types of test specimens. Each strength value was calculated by averaging the strength of at least three identical specimens. A total of 210 specimens were tested in this program. In the analysis, 150 mm cube compressive strength was taken as the reference, and strength values determined for each type of specimen were converted to the corresponding standard cube strength by using suitable expressions obtained from linear regression analyses. From the result of experimental study, it has been found that the ratio of cube to cylinder compressive strengths decreases with an increase in the degree of concrete strength. Also, a decrease in size or the aspect ratio of samples leads to a decrease in the cube/cylinder strength ratio. In this experimental study, two different high-strength concrete mixtures were used. The expected cube compressive strength of concrete mixes is M15 and M20. The cement used in all mixes is Portland-pozolana cement, when river sand are used as fine aggregate and coarse aggregate respectively.

Kwan et al. (2002) reported the particle shape study of coarse aggregate through digital image processing. The particle shape features of the coarse aggregate used can considerably affect the workability, strength, and durability of the manufactured concrete. Though usually, particle shape and size dimensions have to be done in a manual way that is together bulky and time consuming. Here, in digital image processing (DIP) methods are used to analyses the particle shape characteristics of coarse aggregate. The main element shape characteristics measured are flakiness and elongation. 25 aggregate models of different rock type and size have been analyses and the results are compared to results found by the traditional manual method. Strong correlation between the digital image processing and manual dimension results is achieved and thus the digital image processing method, which is much faster, may be a better substitute for particle shape measurement. In fact, the digital image processing method yields more information about the particle shape than the manual method. With the digital image processing method used, it is possible to measure the mean thickness/breadth and length/breadth ratios of the aggregate directly, slightly than just the amount of flaky elements or elongated elements according to random definitions.

Ozturan*et al.* (1997) reported the influence of coarse aggregate variety taking place mechanical properties of concretes by different strengths. This paper is on the influence of the category of coarse aggregate on compressive, flexural and tensile strength going on concrete produced at various strength levels. Concretes with 28 days aim compressive strengths of 30, 60 and 90 MPa were made by basalt, limestone and gravel coarse aggregates. The gravel aggregate concrete with 90 MPa object strong point was also simulated by using a cement of higher strength, keeping the additional parameters same. 28th day test results have specified that, in higher strength concrete, basalt shapedthe maximum, whereas gravel provided the lowest compressive strengths. Standard strength concretes made with basalt and gravel gave similar compressive strengths even though the concrete having limestone achieved fairly higher strength. Higher tensile strengths were found with crushed basalt and limestone both compared to the gravel aggregate when used in higher strength concrete. In the reproduce mixture, almost 30 percent rises in flexural and splitting tensile strengths were found as a result of using stronger cement, whereas compressive strength was not precious at all.

Kaplon (1958) reported the effects of the properties of coarse aggregates on the workability of concrete. Thirteen coarse aggregates were investigated to determine the effects of their shape, surface texture and water absorptive capacity on the workability of concrete. An attempt has also been made to assess these effects quantitatively. The result of this research is changes in the angularity of coarse aggregates have a greater effect on the workability of concrete than changes in the flakiness of the aggregates. Increased angularity and/or flakiness leads to a reduction in the workability of concrete. Although there was a wide variation in the surface textures of the aggregates, no correlation was found between this property and the workability of concrete. The differences in the capacities of the aggregates to absorb water were insufficient to produce significant changes in the compacting factor. No correlation was, therefore, found between this property and concrete workability. This does not rule out the possibility that highly porous aggregates when used in a dry condition will affect the workability of concrete

2.1 PROBLEM IDENTIFICATION

From the literature review, it is observed that researches have attempted on various aspects of flakiness of the aggregates. But it is observed that very few literatures are available on the effect of flakiness on the flexural strength.

Hence, in this study effect will be made to measure the effect of flakiness on the flexural strengths of the concrete through an experimental program.

III. CONCLUSION

Based on the limited study carried the following conclusions can be drawn :

From the results of slump and compression tests, many salient conclusions can be drawn. It is observed that slump value increases when flaky aggregates are up to 10% with 10 mm aperture size and reduces beyond that. Same pattern is observed in M20 and M25 concrete. In case of compressive strength test, it is observed that there is drop in compressive strength of M20 concrete as amount of flaky aggregate and aperture size is increased. However in M25 concrete there is a significant rise after drop in compressive strength.

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