REVIEWING THE IMPACT OF USING DIFFERENT AGGREGATES ON THE CONCRETE CHARACTERISTICS

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Abstract:

Concrete that has been prepared will function differently depending on the characteristics of the materials used for construction. Researchers have noted that the qualities of the material used as aggregate have a considerable impact on the strength and workability of concrete. One of the key elements of concrete is aggregate. The word "aggregate" describes a combination of mineral components, like sand, crushed stone, and gravel, and a binder, likelime, water, Portland cement, bitumen, etc., used to produce composite materials, such as bituminous concrete and Portland cement concrete. Both Portland cement and bituminous concrete commonly contain between 92 and 96 percent by volume of aggregate. The impact of aggregate type on the characteristics of concrete has been examined in this paper.

Keywords-: Materials, Crushed Stone, Concrete, Portland Cement, Water.

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1. Introduction

Concrete is used extensively and in significant quantities in the construction of buildings and other structures to fulfill the demands of globalization (Kandekar et al. 2012). Between 70 and 80 percent of Portland cement concrete by volume is typically made up of aggregate. Aggregate is additionally utilized for the base and sub-base courses of both flexible and rigid pavements. Aggregates may be produced artificially or naturally. Concrete's primary ingredient is aggregate. The majority of aggregate is made from broken rocks, sand, and gravel that are found in nature. Aggregate is a granular material. Since aggregate typically makes up between 70% and 80% of the volume of concrete, its properties can be anticipated to be significantly influenced by it.

Fig. 1 Coarse aggregates

Aggregates are divided into six kinds by the British Standard Institution (BSI-812, 1975): irregular, flaky, rounded, angular, selongated. For specific reasons, the rounded, angular, and irregular, are all categorized as equi-dimensional or cuboidal. Whether an aggregate is flaky, elongated, flaky and elongated, or equal in size is determined by the connection between the particle's shortest, longest, and average diameter.

Aggregates are essential elements of concrete, and the properties of aggregates have a direct impact on the features of concrete (Jain and Chouhan, 2011). A while back, aggregates were thought to be inert throughout the initial stages of cement and concrete development. The edge of the aggregate and the paste, however, shows a chemical link, according to current findings.

The shape and properties of the material used in place of coarse and fine particles have an impact on concrete's key characteristics, such as strength and workability (Ponnada, 2014). According to Vyawahare and Modani (2009), the flakiness index and elongation index, two essential physical features of mineral aggregates, have an impact on the quality of concrete mixtures. According to Siswosoebrotho et al. (2005), flaky aggregates have an impact on aggregate gradation by lowering the interlocking characteristic. For higher aggregate internal friction and improved rutting resistance, cubical particles were preferred (Chen et al., 2005).

The dimensions of the particles and the material utilised in place of the coarse and fine aggregates are important qualities, and these have an impact on the fundamental properties of concrete, such as strength and workability. Along with the shape of the aggregates, the texture of the coarse aggregate are also associated. Several researchers disagree with round aggregates due to bonding between aggregates and cement. Moreover, the angular aggregates are better to rounded aggregates in the two circumstances –

1. Angular aggregates are superior to round aggregates in terms of concrete's ability to interlock, which makes them ideal for usage in roads and pavements.
2. For the specified quantity, rough angular aggregate has a greater total surface area than smooth rounded aggregate. As a result of having a larger surface area, angular aggregates showed higher binding strength than rounded aggregates.

The adhesion or bonding between cement paste and the aggregate has been subjected to several complex factors besides the physical and mechanical properties; this fact has been revealed by several researches and experiment. With the increase in smoothness of surface there is a decrease in contact area, hence a greatly refined and smooth particle will have low bonding in terms of area in comparison with a rough particle of the same quantity.

2. Significance of Aggregates Shape and Type

Aggregate type and form have a significant impact on workability. Compared to spherical aggregates or aggregates with a cubical shape, concrete made with an angular, elongated, or flaky aggregate is highly harsh. When compared to angular or flaky aggregate, round aggregate will be easier to work with since it has less surface area and voids per unit of volume or weight. Additionally, the frictional resistance is greatly reduced due to its round shape. This explains why crushed sand and aggregate don't give concrete the same level of workability as river sand and gravel.

In the case of the high strength and high performance concrete used today, the shape of the aggregate will be particularly crucial when utilizing very low w/c, of the order of around 0.25. We've already discussed how natural sand will run out or become expensive in the future. One must choose manmade sand. The shape of crushed sand that is now accessible is unsatisfactory, but contemporary crushers are built to produce well-shaped and well-graded aggregates. As the molten steel is separated from the impurities in the steel-making furnaces, steel slag is produced as a byproduct of the process. Concrete may use this as aggregate.

3. Literature review

Utilizing new shape aggregates is necessary given the rising use of conventional normal aggregates. The mechanical properties of plain concrete or the bending/shear strengths of beams constructed from aggregates with non-traditional forms have both been the focus of research by a number of scientists as a result. In 2013, Muhit et al. looked into how different types of crushed aggregates alone affected concrete's physical characteristics. All other factors, including the water cement ratio for each kind, were maintained constant, and two types of crushed aggregates were employed in order to clearly see the effects of these materials.

According to Ponnada in 2014, the combined impact of flaky and elongated particles on the strength and workability of concrete has been discussed. Compressive strength, density, and workability tests were performed on concrete made with M 25 grade using various weight ratios of elongated to flaky aggregate and angular to total aggregate. The findings show that flaky aggregates do not have the same impact on distinctive compressive strength of concrete as elongated aggregates. Concrete with a flaky to elongated particles ratio of 1:1 has the least weight.

The impacts of flaky aggregates in asphaltic concrete, AC14, are examined in a study by Jakarsi (2013) that was conducted in a laboratory. In this investigation, three different proportions of flaky aggregates—8%, 16%, and 24%—were taken into consideration. It is discovered that as the amount of flaky aggregates in the mixture is increased, the bitumen concentration would rise. Additionally, the value of the Marshall Properties for AC14, such as stability, VTM, and stiffness, decreases when the flaky aggregate content increases while the value of flow and VFA increases.

For a decent concrete mix, Agarwal et al. (2007) looked into the effects of grading river sand particles. Three types of sand—fine, medium, and coarse—have been established. To keep the overall Fineness Modulus (all-in-aggregate) roughly the same, these were blended with coarse aggregate in a variety of ratios.

Pervious concrete's compressive strength and permeability are significantly influenced by the shape of the aggregate used in its production. By conducting laboratory tests on pervious concrete mixtures made with aggregates of various shapes and variable water cement ratios, Jain and Chouhan in 2011 were able to quantify the size of this effect.

Elongation, flatness, and other shape indices were assessed as aggregate characteristics by Chen et al. in 2005. For this investigation, cubical, rod, disk, and blade particle forms were chosen. It was discovered that the internal resistance of an HMA mix and the change in rotation angle of coarse aggregate correlated effectively. The combined effect of particle shape, angularity, and surface roughness on an aggregate's stability has been adequately measured by the particle index (PI), it has been demonstrated. Aggregate gradation is impacted by flaky aggregates because they have less interlocking characteristics. By SISWOSOEBROTHO et al. (2005), gradation was changed into 5 variations of flaky aggregate content, namely 5%, 15%, 25%, 35%, and 45%. Five different asphalt composition levels—5.0%, 5.5%, 6.0%, 6.5%, and 7.0%—were used in the Marshall test.

Vyawahare and Modani (2009) carried out research on the usage of superplasticizer and mineral additive to improve the workability and strength of concrete containing flaky and elongated aggregates. The purpose of the study was to establish the maximum amounts of these aggregates that could be used in concrete mixtures without impairing the mixture's qualities.

The outcomes of a laboratory investigation conducted by Hamzah et al. (2010) to investigate the effects of asphalt mixes including geometrically cubical aggregate to enhance the design of HMA mix. Stability and flow tests were performed on a total of 75 high-cubicity specimens. The results of the Marshall Test on five different coarse cubical aggregate

percentages demonstrate the substantial impact of aggregate form on mix mechanical properties.

Adom-Asamoah and Afrifa evaluated the flexural behavior of twelve reinforced concrete (RC) beams comprising of coarse phyllite aggregates, a by-product of underground gold mining activities. The beams were tested to their absolute limits using four point tests.

According to Singh and Biswas (2013), flaky aggregates have a bigger surface area that raises the demand for bitumen in bituminous mix. Additionally breaking when rolling, flaky particles lessen the tensile strength of the pavement layer. Due to practical considerations, the grade and size of the aggregates differ from those specified in the job mix formula during the actual execution of the task. According to Naidu and Adiseshu (2013), the physical characteristics of the aggregate have a substantial impact on the strong serviceability of hot mixes in terms of stability, flow, voids in mineral aggregate, voids filled with bitumen, and air voids. Dense bituminous macadam mixtures had been studied with various ratios (10%,20%,30%,40%,50%) of various forms of aggregates.

According to Ryza et al. (2013), the influence of aggregate particle form on mechanical behavior is well known. The durability, workability, shear resistance, tensile strength, stiffness, and fatigue behavior of concrete are all connected to the form of the aggregate particles.

According to research done by Othman et al. (2010), the marshal test results of five different coarse cubical aggregate percentages demonstrate the substantial impact of aggregate forms on mix mechanical qualities. It was looked into if geometric cubical aggregate may partially replace regular aggregate in hot mix asphalt.

Thirteen coarse aggregates were examined by Kaplan (1958) to ascertain the impact of their form, surface roughness, and water absorption on the workability of concrete. In addition, a quantitative evaluation of these impacts has been attempted. Additionally, it was shown that variations in the flakiness of the coarse particles have less of an impact on the workability of concrete than variations in their angularity.

4. Conclusions and Discussions

A study has been performed to review the effect of utilising different shape aggregates over the basic characteristics of concrete. From the fact that only flaky aggregates were used in the concrete mix, it has been found to be comparable to concrete made with standard aggregate. Compressive strength and workability parameters decrease with a rise in the proportion of flaky and elongated aggregate.

The link between aggregate voids and texture, shape, and grading of aggregates has been demonstrated by studies. Less void content is seen in rounded, cubical, and properly graded particles than in flaky or elongated aggregates. Shapes such as circular or angular are recognized as significant characteristic.

The convexity and angularity pointed at the sharpness of the edges and corners can be used to determine the roundness of an object. The workability of a mixture can be greatly affected by flaky and elongated particles, which can produce harsh mixtures.

In addition to increasing the water requirement, extra, irregularly shaped particles could weaken concrete. The concrete's strength and durability may also be harmed by flat particles when they are positioned in certain ways.

When compared to spherical aggregates or cubical sized aggregates, concrete with angular, elongated, or flaky aggregate is highly harsh. Round aggregate will be less difficult to work with than angular or flaky aggregate since it will have less surface area and voids overall for a given volume or weight.

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