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Utilization of Different Size Aggregate in Concrete: A Review

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ABSTRACT
Over 60-65% of concrete is made up of aggregates, which also play a big role in its strength. In this work, elongation and thickness gauge are used to calculate shape properties such flakiness and elongation. Granite was employed as the study's aggregate. Concrete structures deflect, crack, and loose stiffness when subjected to external load. Loss of flexural strength of concrete is largely responsible for cracks in structure. In reinforced concrete structures, the mix proportions of the materials of the concrete and aggregate type determine the compressive strength while the composite action of concrete and steel reinforcement supplies the flexural strength. In occasion of loss of stiffness, steel reinforcement no longer supports flexural stresses; concrete in turn is subjected to flexure.
In this paper presenting review of literature related to utilization of concrete material with aggregates.
Keywords: Concrete, aggregate, flaky, flexural and compressive strengths.

I. INTRODUCTION:

Only water is used more frequently around the world than concrete, which is thought to be the most widely used man-made material. One of the most important building components, it is also very inexpensive, easy to make, offers continuity and solidity, and readily bonds to other materials. Cement, fine aggregate (sand), coarse aggregate (crushed or uncrushed stones), and water are all present in the proper proportions. The key to producing high-quality concrete lies in the raw ingredients required. Concrete's strength has been discovered to be significantly influenced by the water-cement ratio, slump, cement-to-aggregate ratio, cement quality, aggregate gradation, and curing procedure efficiency. The specific gravity, particle size analysis, shape, and surface texture of the aggregates have a considerable impact on the characteristics of wet and hardened concrete, whereas the elastic modulus, toughness, and mineralogical composition have a substantial impact on the hardened state of concrete.

In an effort to comprehend how differences in mixing water requirements effect aggregate, the particle form of fine and coarse aggregate was investigated in relation to the water demand for adequate hydration of concrete. It has been demonstrated that the form of the fine aggregate has a bigger influence on the amount of water used than the coarse aggregate.

The particle size distribution of fine aggregates had a greater influence on the characteristics of concrete than did coarse aggregates, according to the aforementioned and taking into account the allowed limits. The choice of the appropriate type of fine aggregate for concrete production is of utmost importance since river sand, the most common fine aggregate used in the manufacturing of concrete, has become extremely expensive and relatively scarce. As a result, there is a critical need for replacement materials made from industrial wastes, such as grit, also known as quarry dust, which is locally available at different quarry sites.

The vital component of concrete that gives it structure and minimises shrinkage is called aggregates. 70 to 80 percent of the entire volume of concrete is made up of aggregates. So, it can be conclude that in order to learn more about concrete, one must unquestionably have a thorough understanding of aggregates.

The research papers from different authors are summarized in this section who were constantly working towards different innovation and improve the properties of concrete and study the behaviour of different aggregate.

II. REVIEW OF LITERATURE SURVEY

Aves and A Jr (2022) examined the compressive strengths of concrete built with fine and coarse particles from five different regions. Several physical tests, including those for specific

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gravity and absorption, sieve analysis, abrasion testing, workability testing, and compressive strength testing, were used to assess the application of these aggregates on the compressive strength of concrete.

The results showed that the average compressive strength of concrete formed from fine and coarse aggregates from natural river quarry sites was 23.465 MPa, and that provided crushed fine and coarse particles had an average compressive strength of 19.555 MPa. The aggregates from rivers that occasionally experienced saline water intrusion had a lower average compressive strength (18.54 MPa). For 7, 14, and 28 days, compression strength observations were made.

A.Ndon and A. Ikpe (2021) analysed the compressive strength of concrete made with various crushed stone sizes (e.g., 3.35mm–10mm, 13.2mm–19mm, and 20mm–28mm) in order to identify the variations in strength between the various sizes of crushed stones that were tested after 7days, 14days, and 28days of crushing.

According to the findings, compressive strength increased with increasing coarse aggregate size. It also demonstrated that the strength of concrete increased with the number of curing days and, finally, that concrete cubes created with larger coarse aggregate sizes were found to weigh more than those generated with smaller coarse aggregate sizes. Larger aggregate should be utilised for foundation construction because it has a higher compressive strength.

Pertiwi et.al (2021) the effect of coarse particles on the compressive strength of concrete was examined. Using natural river sand as the fine aggregate, ordinary Portland cement as the coarse aggregate, and polymer admixture to ensure workability, two concrete samples (CS1 and CS2) were created. 5 mm–10 mm and 10–20 mm coarse aggregate combinations were used. Additionally, specimen controls were made for each circumstance. The water-cement ratio of 1: 2: 4 and 0.55 was kept, and the planned concrete slump flow was 60-5 mm.

A 300 x 300 mm concrete cylinder was tested for compressive strength after 28 days of curing. CS1 had the highest compressive strength, measuring 33.28 MPa, while CS2 came in second with 36.10 MPa. These different compressive strength traits were obtained when the coarse aggregate was resized, demonstrating the influence of coarse aggregate size on concrete. Additionally, the size of the coarse aggregate has little effect on how well the concrete performs.

Lee et.al (2021) looked at the compressive strengths of concrete for various ages based on water content and aggregate volume fractions, such as dune sand (DS), crushed sand (CS), and coarse aggregate (CA). Using experimental data, the effects of changes in aggregate volume fraction on compressive strength were investigated. Compressive strength of concrete increases until the volumetric DS to fine aggregate (FA) ratio (DS/FA ratio) reaches 20%, beyond which it tends to decrease. The relationship between compressive strength variations and aggregate volume fractions was investigated under two different circumstances, taking into account the effects of each aggregate on compressive strength: (2) 0 CA CS DS and (1) 0 DS CS CA When condition (1)'s effect factor of CA = 1, the ranges for DS and CS for all mixtures were, respectively, 0.04-0.83 and 0.72-0.92. The CS and CA values fell between the ranges of 0.68-0.80 and 0.02-0.79, respectively, when the DS effect factor for condition (2) was 1.

The slump/AD ratio increased, whereas the DS/FA ratio increased by up to 40%, according to the results. For concrete workability, for example, a DS/FA ratio of 40% was ideal. Compressive strength of concrete increased till the DS/FA ratio reached 20%. After then, the compressive strength decreased as the DS/FA ratio rose. For the same DS/FA ratio, the compressive strength typically increases dramatically as water content decreases. Changes in the DS/FA ratio had a greater impact on differences in compressive strength than did changes in the unit water content. Therefore, when assessing the strength of concrete built with DS and CS, the DS/FA ratio should take precedence over the unit water content.

Bian et.al (2021) identified peak stress and elastic modulus of recycled concrete using the response surface methodology to develop regression equations. Design considerations include coarse aggregate content, aggregate form, and maximum aggregate size. Experiments, theoretical research, and numerical modelling were used to evaluate how aggregate quality affected the mechanical characteristics of recycled concrete.

The peak stress and elastic modulus of recycled concrete were found to be at their best when the coarse aggregate content was 45 percent, the maximum coarse aggregate size was 16 mm, and the regular round coarse aggregates made up 75 percent of the mixture. The maximum aggregate size and aggregate shape remain constant while the peak stress and elastic modulus of recycled concrete first climb and then fall with an increase in the amount of coarse aggregate. While the maximum aggregate size increases, the peak stress and elastic modulus of recycled concrete fall while the coarse aggregate concentration and aggregate shape remain unchanged. While the fraction of coarse aggregate and maximum aggregate size remain constant, the peak stress and elastic modulus of recycled concrete increase as the amount of regular round aggregates increases.

Nisa and Kumar (2021) The shape of coarse aggregate particles has been linked in the research paper to the workability and compressive strength of cement concrete for stiff pavements. We identified the shape characteristics, such as sphericity, flatness, form factor, and elongation. The slump and compressive strength of cement concrete were also tested for several types of coarse aggregate.

A significant correlation between several aggregate shape parameters, workability, and compressive strength was demonstrated by the experimental data. The concrete constructed using different kinds of coarse particles exhibited the maximum compressive strength over time. The results indicate that the shape of the coarse aggregate influences the strength of concrete, which leads to the conclusion that when deciding whether or not to use coarse aggregate to prepare cement concrete for rigid pavements, the shape of the aggregate should be taken into consideration as a crucial factor.

Chhetri et.al (2021) investigated the effect of coarse aggregate size on compressive strength of concrete. For this, four sources were selected from the Seti River's whole length. The coarse aggregate from these sources was collected and sieved to produce aggregate samples of the required size. The coarse aggregate obtained from these sources was put through physical tests like specific gravity and water absorption. There were mechanical tests performed, including the Los Angles test, impact value test, and aggregate crushing strength test.

The outcomes of the mechanical test showed that all of the aggregates are top-notch building materials, with just small variations in their mechanical properties. Concrete cubes of M20 grade nominal mix by volume were cast using a consistent cement, sand, and water cement ratio for each source while altering the coarse aggregate size. Five distinct batches of aggregate were cast, with the size ranges being 20mm-25mm, 16mm-20mm, 10mm-16mm, 10mm-25mm, and 4.75mm-25mm. In comparison to other cubes, the one made from properly graded aggregate (4.75mm–25mm) had greater strength. Bond failure for every source was the main cause of failure for concrete cubes, which caused the process to begin.

Oluwasola et.al (2020) testing on the aggregate crushing value and aggregate impact value were done on the aggregate, while tests on the concrete's slump, water absorption, compressive strength, and flexural strength were done on the concrete. Forty-eight reinforced concrete beams were created for the flexural strength test, and a total of one hundred and thirty-two concrete cubes were created for the compressive strength test using the 1:2:4 and 1:3:6 mixes, respectively.

The findings of the slump test showed that a higher proportion of flaky and elongated aggregates impairs workability. If the outcome of water absorption is taken into account, flaky aggregates absorb more water than elongated aggregate. The shape of the aggregate used had a significant impact on the compressive strength of the concrete cube, and it was discovered that when the percentage of flaky and elongated material was low as opposed to high, the compressive strength was somewhat high. The highest compressive strength, 15 N/mm2, is consistent with the compressive strength of a typical 1:2:4 mix of concrete. In comparison to the presence of a higher percentage of flaky and elongated aggregate, which results in reduced flexural strength, it was observed that the flexural strength was strong with 30% of elongated aggregate and 30% of flaky.

Ansari et.al (2020) examined aggregates before being graded by passing through an IS sieve of retained material and a 20mm filter. The mix design ratio was chosen from the excel sheet we created in accordance with IS 10262 - 2009; the mix ratio of 1:1.9:2.3 was adopted and maintained throughout the trial. Throughout the course of the investigation, a constant cement to sand and water ratio of 0.45 was used. The amount of aggregate used in the study was 820.22kg, while 438.13kg of cement was used. Due to the size and shape of aggregates, the aggregate grading process has a significant impact on the overall performance of aggregates.

The marble, sand stone, and normal aggregate, sand stone aggregates, according to the results, had delivered the highest strength in comparison to both of them. Sandstone aggregate yields the highest value of compressive strength, 33.33 N/mm2. The highest compressive strength was found in sandstone that had a gradation of 60–40%. The sand stone aggregate gradation provided the best strength out of all the aggregate gradations. Sandstone should only be utilised in large-scale projects or when a strong structure is required because it is slightly more expensive to employ in every structure. The highest strength of aggregates can be achieved by keeping the w/c ratio, cement content, and sand content constant at 0.45, 438.13, and 820.22, respectively.

Strzałkowski and Garbalinska (2020) investigated the effects of crushed basalt and natural round gravel as aggregate forms on the compressive strength and thermal properties of concretes with silica fume were investigated. The compressive strength and thermal properties of several concretes were determined throughout the first year of specimen curing. Additionally, optical and mercury intrusion porosimetry were used to measure the porosity.

Experiments using mercury porosimetry showed that the introduction of silica fume led to a decrease in the concentration of pores smaller than 0.15 m when compared to reference concretes without the inclusion of silica fume. Testing on basalt-crushed concrete found several additional pores with widths ranging from 0.05 to 300 m. The compressive strength of concrete built using natural round gravel aggregate was improved by the addition of silica fume. The compressive strength of basalt-based concrete, on the other hand, was markedly reduced due to much higher porosity in the range of more than 70 m. When compared to concrete constructed with normal gravel aggregate, the values achieved in basalt concrete are much lower. The distinctive porosity structure of the basalt-based concrete also had an impact on the rate of specimen drying for each group. This led to the discovery that the use of crushed basalt aggregate greatly aerates concrete, despite the use of silica fume. Concrete based on crushed aggregate hence has much lower compressive strength but better thermal insulating properties when compared to equivalent concrete built on natural round gravel aggregate.

Chegbeleh et.al (2020) identified the effects of aggregate size, content, and type on concrete's compressive strength was the goal of this research paper. The examination was carried out using petrographic and physico-mechanical analyses of the samples. The coarse aggregate itself was employed for the physico-mechanical property tests, and the ten (n=10) rock samples from each quarry site were used for petrographic studies. However, compressive strength tests were performed on cast concretes that were created using aggregates of varied sorts and sizes that were collected from the two quarry sites.

The petrographic study reveals two rock types: quartzo-feldspathic gneiss and granodiorites from the Amasaman quarry and gneiss and meta-granite from the Shai Hills quarry. The physical and mechanical test findings are consistent with the requirements of accepted construction standards. The results of tests on compressive strength show that while the compressive strength of concretes in classes A, B, and C diminishes as the aggregate nominal size increases, this is not the case for class D concretes. It can be inferred that the size and make-up of the aggregate significantly affect the compressive strength of concrete. The fact that concretes constructed from quartzofeldspathic gneiss and granodiorites have higher compressive strengths than those created from gneiss and meta-granit further supports the idea that aggregate type impacts concrete's compressive strength.

Prajapati and Karanjit (2019) looked at the effects of coarse aggregate types on the compressive strength of various nominal mix concrete grades. The five sources of coarse aggregates that were selected after completing field research and questionnaire surveys with suppliers and contractors were A-Panauti, B-Melamchi, C-Chaukidada, D-Khopasi, and E-Kaaldhunga. While certain forms of coarse aggregates were sub-angular and flaky, the majority of them had an angular shape. A total of 90 concrete cubes, each measuring 15 cm, were produced using three different grades of nominal mix, M1 (1:2:4), M2 (1:2:3), and M3 (1:1.5:3) by weight. Only the sources of coarse aggregate were made changeable for each mix ratio, with the amounts of water, sand, and cement remaining constant.

According to the observations, the source of the coarse aggregate considerably affects the compressive strength of various grades of nominal mix concrete. Lean mix concrete (1:2:4 & 1:2:3) has a comparatively wide range of compressive strength when compared to rich mix concrete (1:1.5:3). In terms of the reasons why concrete cubes fail, samples A and B's cubes collapsed owing to crushing of the coarse aggregate, but samples C, D, and E's cubes primarily failed due to bond failure.

George and Asha K (2018) examined the strength properties of M30 grade concrete using synthetic flyash coarse aggregate in place of some of the natural granite coarse aggregate. Instead of utilising large amounts of cement, flyash was used to make the aggregates. Before a workable mixture was selected for large-scale production, several experimental mixtures were conducted. In amounts of 25%, 30%, 35%, 40%, 45, and 50%, manufactured fly ash aggregate was substituted for natural coarse aggregate in the casting of cubes, beams, and cylinders. The compressive strength, flexural strength, and split tensile strength of the cast cubes, beams, and cylinders were all assessed independently.

Fly-ash aggregates, as opposed to angular-shaped natural aggregates, are more manageable, according the results. The aggregate crushing and impact value of fly-ash aggregates is below what is allowed. Fly-ash aggregates are thought of as lightweight aggregates since their specific gravity is lower than that of natural aggregates. Concrete made from fly ash aggregates has a density of 2160 kg/m3, which is lower than the 2400 kg/m3 of a typical concrete mix. The FAA concrete's compressive strength is around 80% that of a regular concrete mix for a 30-35 percent substitution, and it gradually decreases as the replacement percentage rises. Even for flexural and split tensile strength, after fly ash aggregates have taken the place of aggregates to the level of 35 percent, there is a loss in strength. Fly ash aggregate's main flaw is that it absorbs 10% more water than natural gravel, although this can be fixed by utilising one of the several available treatment methods, like treating with water glass.

I.Majeed et.al (2018) utilizeddifferent sizes (coarse: 3/4 inch, fine: 1/2 inch, and crushed) and shapes (rounded, longitudinal, and irregular) of gravel in concrete in the research work to examine their effects on compressive strength. Following the completion of the process, the samples were maintained in the maturation basin for a duration of 7, 14, and 28 days before a compression test was performed. The samples were prepared for each size and shape of the gravel.

When compared to samples of diverse shapes, it was discovered that samples of different sizes had a stronger resistance to compression. Depending on the size and form of the gravel's grains as well as the curing time, the gain from using both crushed and irregular gravel ranges from 30 to 36%.

Ogundipe et.al (2018)analyzed the effect of aggregate size on the compressive strength of concrete. After 7, 21, and 56 days of curing, concrete cubes formed with 6, 10, 12, 5, 20, and 25 mm aggregates for the two nominal mixes were built and tested for compressive strength. In the investigation, two nominal mixes (1:3:6 and 1:2:4) were used. Following the same pattern for both nominal combinations, the analysis found, was the strength development.

The findings show that compressive strength increases as aggregate size increases up to 12.5 mm, with 20 mm concrete having a better compressive strength than 25 mm concrete. With increasing aggregate size utilised in the mix, concrete gains compressive strength. But it was found that there is a particular aggregate size that will give the best performance, and using an aggregate size larger than it will not give the intended result.

Nwofor and Eme (2016) used three cubes with the measurements 150 mm x 150 mm x 150 mm to produce high-quality concrete. As a result, taking the design into consideration is necessary in order to calculate the appropriate mix in line with BS 1881 part 125:198. Concrete was prepared in three batches: batch 1 with 100% river sand as fine aggregate, batch 2 with 100% grit (quarry dust), and batch 3 with 50% river sand and 50% grit. Using conventional moulds and w/c values of 0.35, 0.45, and 0.60 together with a 1:2:4 mix design ratio, concrete cubes were created. The droop of wet concrete was measured in accordance with BS 1881: Part 102 specifications (1983). In compliance with BS 1881: Part 108, three cubes (150x150mm) for each type of fine aggregate were also cast (1983).

After the longest curing age of 28 days, the three concrete samples reached their highest compressive strength. To get the best compressive strength, cement, grit, and gravel were mixed together in the concrete sample mix. The results demonstrate that the packing density of the mixture determines the properties of concrete such as compressive strength, which can be seen as a secondary and dependent quality, rather than the grading and particle form of the fine aggregate used in concrete manufacturing. Because grit is abundantly available yet still considered an industrial waste, employing it in construction is considered to be more cost-effective because it allows for maximum utilisation.

Ajamu and Ige (2015) looked at how varying coarse aggregate sizes affected concrete beams' compressive and flexural strengths. Concrete cubes and beams with varying aggregate sizes of 9.0mm, 13.2mm, 19mm, 25.0mm, and

37.5mm were made using standard moulds with internal dimensions of 150x150x150mm for the concrete cubes and 150x150x750mm for the reinforced concrete beam in accordance with BS 1881-108 (1983) and ASTM C293 standards. A water cement ratio of 0.65 was maintained by using a 1:2:4 mix ratio. The generated specimens were each subjected to a compressive and flexural strength test on a universal testing apparatus after a 28-day water cure.

According to the findings, cube compressive strengths for coarse aggregate sizes of 13.2mm, 19.0mm, 25.0mm, and 37.5mm were 21.26N/mm2, 23.41N/mm2, and 24.31N/mm2, respectively. Flexural strengths for test beams range from 4.93N/mm2 to 4.78N/mm2, 4.53N/mm2, 4.49N/mm2, and 4.40N/mm2. The findings supported the hypothesis that concrete, if used primarily to withstand flexural loads, should be made of finer coarse particles.

Aginam et.al (2013) Three distinct kinds of coarse materials, with a maximum size of 20 mm, were utilised in the experiment: crushed granite, washed gravel, and unwashed gravel. Investigated were the relative densities and grading of the aggregates. A mix ratio of 1:3:6 and a water/cement ratio of 0.6 were utilised, respectively, for the experiment. The target mean strength at 28 days was 15N/mm2. Four of the twelve (150 mm x 150 mm x 150 mm) concrete cubes that were cast were crushed 7, 14, 21, and 28 days following maturation for each type of coarse aggregate.

Every cube had the necessary mean strength after seven days of curing. The 28-day strengths of the concretes made using crushed granite, washed gravel, and unwashed gravel were 25.1 N/mm2, 20.0 N/mm2, and 16.9 N/mm2, respectively. It was shown that concrete's strength is significantly influenced by the internal organisation, surface properties, and particle form.

Polat et.al (2013) examined the impact of different aggregate types on the compressive strength of concrete using aggregate shape indices such aspect ratio, elongation, flatness, form factor, roundness, shape factor, and sphericity. Four different types of coarse aggregate and natural aggregate were used to make the concrete for testing. Four alternative morphologies of these aggregates were selected: flat, long, spherical, and mixed. The shape features were identified utilising two separate aggregate views in digital image processing. It was shown how to use an image analyzer to quantify the morphological characteristics of coarse aggregate.According to test results, there is a significant correlation between compressive strength and a number of aggregate shape factors. It was shown that the particle shape factors are capable of measuring the combined effect of many particle shape characteristics, including as flatness, elongation, and sphericity, on the compressive strength of an aggregate. Spherical particles were favoured for concrete's improved compressive strength, UPV, unit weight, and slump values. The aggregate becomes more spherical the higher the values supplied.

Jain and Dr. Chouhan (2011) conducted laboratory experiments to examine the effect of aggregate determined on prior concrete mixtures built with particles of different sizes and diverse water-cement ratios. The shape of the aggregate was measured using the angularity number, a laboratory technique created to compare the features of various aggregates for mix design reasons.

The findings demonstrate that shape of the aggregate, along with size of the aggregate and water cement ratio in the mix, should be taken into account as an important parameter in establishing the acceptability of course aggregate to make pervious concrete. This is because the strength and permeability of pervious concrete vary as a function of shape of the aggregate.

III. CONCLUSION:

Here authors examined various samples in different proportions with different materials, aggregate shape and size. Examined their effects on compressive strength. Following the completion of the process, for a duration of 7, 14, and 28 days

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