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ijirset@gmail.com

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A Review Paper on the Effect of Different Types of Coarse Aggregate on Concrete

Abhinandan Ghai¹, Abhishek Bansal², Mukesh Saini³

B.Tech. Scholar, Department of Civil Engineering, Arya College of Engineering and Research Centre, Jaipur, India¹

B.Tech. Scholar, Department of Civil Engineering, Arya College of Engineering and Research Centre, Jaipur, India²

Assistant Professor, Department of Civil Engineering, Arya College of Engineering and Research Centre, Jaipur, India³

ABSTRACT: The strength of a concrete mix is determined by the type of cement used, the coarse aggregate used, and the interaction between aggregate and mortar. Coarse aggregate, on the other hand, is frequently treated as an inert material, with only its physical properties such as shape, size, water absorption, and specific gravity being studied. As the quality of the mortar mix improves, the strength of the coarse aggregate becomes more important. The type of coarse aggregate used in high-performance concrete has a significant impact on the strength and elasticity modulus of the concrete. Mortar strength and interfacial bond strength could be comparable to aggregate strength in high-strength concrete having compressive strengths more than 40 MPa and a water-cement ratio of less than or equal to 0.4 is commonly used. This paper examines past research on the effects of various types of coarse aggregate on several processes in depth. Concrete mix parameters include compressive strength, tensile strength, and elasticity modulus.

I. INTRODUCTION

The construction industry is booming, and demand for building materials has surged, thanks to the country's rapid infrastructure expansion. The need for high-rise buildings has risen dramatically as a result of space constraints, rapid urbanization, and population increase. Performance/strength concrete and composite materials. As a result of this renewed interest, several academics have begun to investigate the efficiency of concrete's constituent materials. The attributes of the mortar, aggregate, and mortar-aggregate bond, which are determined the strength and durability of structural concrete are determined by the characteristics of the mortar, aggregate, and mortar-aggregate bond. The kind, texture, and mineralogy of coarse aggregate affect the varied properties of concrete in its hardened and fresh phases for the same grade of mortar mix. When the water/cement ratio is less than 0.4, the binding strength between mortar and aggregate is equal to the aggregate's own strength. As a result, before using coarse aggregate since a raw material, its full potential should be investigated, as it will affect both the strength and modulus of elasticity of concrete. A detailed investigation of coarse aggregate is required to improve the mechanical properties of concrete. Because coarse aggregate accounts for roughly 70% of the volume of the concrete mix, it is crucial in determining the concrete's strength and durability. The features and behavior of the interfacial transition zone are influenced by aggregate qualities such as size, shape, texture, petrography, and mineralogy. The bond strength of aggregate has been studied extensively due to its shape and surface texture, but the type of aggregate also influences the bond that aggregate forms with mortar. The aggregate's mineral elements might cause a chemical reaction between cement and aggregate, strengthening or weakening the bond. The difference in modulus of elasticity between the aggregate and the cement mix is the primary source of micro fractures. Low tensile strength is caused by differential shrinkage in the two zones due to differences in modulus of elasticity, strength of concrete. As a result, the quality of ITZ has a significant impact on the tensile strength of concrete, particularly high-strength concrete. The quality of the mortar and the bond qualities of the aggregate are the most important factors in determining the compressive strength of concrete.

However, when the quality of mortar improves in high-strength concrete, the impact of aggregate type becomes more important. Aside from the qualities mentioned above, the modulus of elasticity of concrete is also a factor to consider in terms of design and strength. The strength of concrete has improved dramatically, while the modulus of elasticity has received far less attention. High-strength concrete has helped to lessen the dead load of the structure by allowing for thinner sections to carry load, needing a higher modulus of elasticity. The type of aggregate has a direct relationship with the modulus of elasticity of concrete. As a result, aggregate type and mineralogy have an impact on a wide range of concrete qualities, and the material should not be thought of as inert. Before using the aggregate in high-performance concrete, a thorough petrographic analysis should be performed. The impacts of various types of coarse aggregate on

the various characteristics of concrete are discussed in this work. An attempt was made to determine the type of effect based on several articles on the issue.

Compressive strength, modulus of elasticity, tensile strength, flexural strength, and the mortar-aggregate bond are all mechanical properties of aggregate.

II. STUDY OF PARAMETERS

Based on a review of past research on the issue, the following properties have been studied.

2.1 Compressive strength

A M90 mix was cast with a water/cement ratio of 0.29 and a 10% silica fume cement replacement. To preserve workability, a super plasticizer was utilized as an admixture, and the coarse aggregate volume was kept constant at 0.425 for all six types (Table 1). The sample's compressive strength was tested at 7, 28, and 91 days. The 28-day strength of concrete containing expanded clay aggregates was found to be roughly 30% of that of mortar, while the corresponding figure for sintered fly ash the overall percentage is 80%. When limestone was utilized, the results were comparable to mortar, but the cube strength for glass beads was higher. The steel bead aggregate has a lower tensile strength than the mortar. It was found that as aggregate porosity increased, cube strength decreased. The stiffest aggregates were also used to achieve the lowest cube strength

Table 1: Properties of coarse aggregate used

Aggregate	Shape	Maximum size (mm)	24 hour water absorption
Expanded clay	spherical	10	17.5
Sintered fly ash	spherical	6	13.6
Limestone	angular	10	2
Gravel	rounded	10	2
Glass beads	spherical	10	0
Steel	spherical	3	0

Zhou F P, Lydon FD [1] studied the effect of three different types of coarse aggregate namely basalt, limestone and gravel on 28 day compressive strength. Three different mixes M30, M60 and M90 were casted with water/cement ratio as 0.58, 0.40 and 0.30 respectively. On all specimens, water curing was employed for the first seven days, followed by air curing for the remaining 28 days. In high-strength concrete, basalt and limestone were shown to be stronger than gravel (target strength of 60 MPa). When concrete with gravel as the coarse aggregate was compared to concrete with limestone and basalt as the coarse aggregate, the results were striking. The 28-day compressive strength was 10 to 20% lower. Gravel and basalt, on the other hand, demonstrated equivalent strength in a combination with goal strength of 30 MPa. The influence of coarse aggregate type is more common in high strength concrete than in regular strength concrete, according to the findings.

The 28-day strength of a mix cast with crushed quartzite, crushed granite, limestone, and marble coarse aggregate was investigated by Ke-Ru Wu et al. [2]. To test the effect of aggregate type on concrete strength, the mix was casted with target strengths of 30, 60, and 90 MPa. For the purpose of assessing its strength, a 100mm x 100mm x 100mm cube was cast and hardened for 28 days. The mix was cast for three different water/cement ratios of 0.26, 0.44, and 0.55, and When the water cement ratio was reduced and the coarse aggregate strength was increased, the concrete's strength improved, especially for high strength concrete. The influence of coarse aggregate type on the compressive strength of standard concrete, on the other hand, was negligible. Aggregates are especially significant in high-strength concrete because when coarse aggregate is employed to its full potential, the cement aggregate bond is greatly increased.

H Beshretal. [3] investigated the effects of calcareous, dolomitic, quarzitic limestone, and steel slag as coarse aggregates. For the whole mix, the water/cement ratio was fixed at 0.35. The steel slag combination had the highest compressive strength, while the calcareous limestone mix had the lowest, according to tests. The compressive strength of a high-strength mix with a low water/cement ratio and a high cement concentration is shown to be substantially impacted by the coarse aggregate quality. The aggregate strength, rather than the cement paste, determines the strength

parameter, and failure in such a mix occurs due to aggregate cracking. The compressive strength result backed up the previous assertion, which was further validated by an abrasion test on aggregate to determine its strength.

The influence of alkali-aggregate reactivity on the compressive strength of high and normal strength concrete was investigated by H. Marzouk et al. [4]. Highly reactive aggregates and moderately reactive aggregates were used to make high and standard strength concrete. After a 28-day curing period, the samples were divided evenly and placed in a curing tank with sodium hydroxide or de-ionized water at 80°C for 12 weeks. The reduction of 24 percent for samples placed in sodium hydroxide and an increase of 14 percent for samples kept in de-ionized water was found in normal strength concrete mixes prepared with highly reactive aggregate elevated temperature which led to accelerated hydration. For samples containing moderately reactive aggregate the compressive strength remained same in sodium hydroxide and a slight increase with time was seen in de-ionized water. Whereas, due to improvement of 4
1234567890“””” 14th International Conference on Concrete Engineering and Technology IOP Publishing IOP The compressive strength of all the samples rose with sample maturity, according to the Conf. Series: Materials Science and Engineering 431 (2018) 082001 doi:10.1088/1757-899X/431/8/082001 microstructure in high strength concrete.

A.A. Jimoh et al. [5] studied the effect of aggregate type and size on compressive strength. Sand, quarry dust, granite, and gravel as coarse material of 20- and 28-mm size were used to cast a 1:2:4 proportion sample. The best results were achieved with a mix of quarry dust and 20 mm granite. It was discovered that when coarse aggregate size increased, its strength decreased. The mechanical properties of concrete cast with phyllite and granite as coarse aggregate were reported by Mohammed Seddik Meddah et al. [6]. At different stages of curing, five distinct mixes with goal strengths of 20, 25, 30, 35, and 40 MPa were cast and tested. The result showed that though the strength development pattern was same for both the aggregates but phyllite concrete mix achieved 15-20% low strength compared to granite concrete. This can be attributed to lower class of phyllite as compared to granite in terms of aggregate properties and characteristics.

Abdullahi. M [7] looked on the impacts of coarse particles in normal strength concrete, such as quartzite, granite, and gravel. The quartzite sample has the highest compressive strength, followed by gravel and granite. To accommodate for variations in compressive strength with curing age, a linear polynomial numerical model was devised.

Theophilus Yisa Tsado [8] studied the effect of using igneous, sedimentary and metamorphic rock as aggregate in normal strength concrete. Granite, limestone, and marble were the aggregates used in each category. During the testing, it was discovered that granite concrete performed best, while marble aggregate concrete performed worst due to the metamorphic rock's inherent qualities being weaker than the igneous and sedimentary rocks employed in the study.

2.2. Modulus of Elasticity

The modulus of elasticity as studied by Ke-Ru Wu et al. [2] The elastic properties of its constituent material, as well as the interfacial zone between aggregate and paste, have an impact. Due to the large volume occupied by coarse aggregate and its stiff characteristics it influences the most. Not only the physical characteristics but also its type and chemical properties also effect the modulus of elasticity. With increasing concrete strength, the impact of aggregate type on the elastic modulus grows. High strength aggregate with low brittleness can be used to make low brittleness concrete.

H Beshr et al. [9] claim that softer aggregates are better result in lower modulus of elasticity and thus more ductile collapse of concrete. In high strength concrete made with various types of aggregates, significant differences in elastic modulus and hysteresis loop were detected. Concrete built with steel and quarzitic aggregate has a greater static modulus than calcareous and dolomitic limestone aggregate. It was seen that the effect of coarse aggregate type is more significant on elastic modulus than compressive strength.

F.P. Zhou et al. [10] employed several theoretical models to predict the modulus of elasticity, including Voigt, Reuss, Hirsch, counto, Pcounto, and BNC, and compared the experimental results. Except for shale and steel beads, all of the models produced findings that were within 10% of the experimental results. It was found that strong aggregates produce concrete with higher modulus of elasticity.

2.3. Splitting tensile strength

T. Ozturan et al. [11] observed that the tensile strength measured using flexure and splitting tests showed that the tensile strength was higher for basalt and limestone as compared to gravel aggregate. The difference in tensile strength between the two types of coarse aggregate became minor when the target mean strength of concrete was reduced. The tensile strength of the concrete was mainly dependent on the strength of mortar and interfacial bond strength between mortar and aggregate.

The splitting tensile strength of aggregates has little effect on the split tensile strength of concrete, according to Ke-Ru Wu et al. [12]. According to T. Akçaoğlu et al., tensile strength is also reliant on aggregate size, and the drop in tensile strength with increasing aggregate size becomes greater in high strength concrete. [12]

III. CONCLUSION

From the extensive literature review done on the topic following conclusions can be drawn about the parameters studied:

- 1) In high strength concrete the compressive strength is affected by the type of aggregate used whereas in normal strength concrete, compressive strength is independent of aggregate type.
- 2) Stiffer aggregates will produce stiffer concrete mix.
- 3) Modulus of elasticity is mainly dependent on the mortar aggregate interface which is further dependent of the strength of aggregate for high strength concrete
- 4) Tensile strength of aggregate is independent of the type of aggregate used and is significantly affected by the surface characteristic of the aggregates.

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