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Comparison Of ACI, DOE, USBR, And BIS Techniques Of Mix Design Using Rounded Aggregate For M 35 And M 40 Grades Of Concrete

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Abstract:- The need for concrete is growing daily, and it is currently the most consumed material. The concrete's ingredients are chosen based on the work's viability, affordability, and availability. However, the requirements of the material (i.e., aggregate) can change for a variety of reasons, therefore in order to maintain the specific standards, it is necessary to know the optimum way in terms of economy and strength. The Bureau of Indian Standard Method, the British Mix Method, and the United States Bureau of Reclamation are only a few of the concrete design techniques that are being used by many nations. Therefore, it is important to examine the similarities and differences between the design mixtures, as this will aid in determining the optimal approach for various conditions. The majority of these techniques are based on actual relationships, tables, graphs, and charts that were created by in-depth research and trials with locally accessible resources. The primary goal of this work is to examine various concrete mix design techniques for cost-effectiveness, locally accessible materials, and the characteristics of concrete with various aggregates.
Key words: *feasibility, aggregate types, and mix design techniques.*

1. INTRODUCTION

Concrete is essentially a paste and aggregate mixture. The fine and coarse aggregates' surfaces are covered with the paste, which is made of Portland cement and water. The mixture solidifies and becomes stronger through a chemical process known as hydration, creating the mass that resembles rock and is called concrete. The secret of concrete's amazing properties—that it is strong and long-lasting when hardened yet pliable and malleable when freshly mixed—lies in this process. The careful selection and proportioning of the concrete's component materials is crucial to producing a robust, long-lasting product. The physical and chemical qualities are largely determined by the characteristics and ratios of these components. The optimum approach is promoted by design mix procedures, which aid in determining the proportions. The four approaches (ACI, DOE, USBR, and BIS) are all proportionate ingredients based on empirical relations, charts, graphs, and tables created through extensive trials, as well as standard process. These approaches can be thoroughly compared in terms of strength and deviation by creating identical design mixtures. The optimum approach will be projected from this process, and since the variation in the aggregate is incorporated, some methodology must be used to carry out this procedure. Therefore, it is necessary to examine the interpretation of these samples for different parameters, such as economy and strength. The quality and quantity of cement, water, and aggregates; batching and mixing; placement, compaction, and curing are only a few of the variables that affect the compressive strength of hardened concrete, which is typically seen as an indicator of its other qualities. The cost of labor, plant, and materials make up the price of concrete. The goal is to create a mix that is as lean as feasible because the cost of resources varies because cement is several times more expensive than aggregate. The amount and quality of ingredient materials are sometimes limited by site limitations. There is a great deal of versatility in the types of aggregates that may be utilized in concrete mix design. If the materials meet the fundamental IS standards, mix design can provide a cost-effective solution. Longer distances may result in lower transportation costs. The cost of materials needed to produce a minimal mean strength known as characteristic strength—which is determined by the structure's designer—relates to the actual cost of concrete.

2. LITERATUREREVIEW

Baskaran, K. et al. (2013) [1] In order to determine the initial mix proportion for the paving blocks, a comparison of the ACI and DOE mix design methodologies was conducted. For characteristic compressive strengths (cylinder strength for the ACI technique and cube strength for the DOE method), quantities of constituents were estimated between 15 and 50 N/mm2. Trial mixtures were cast and tested for compression at 7 and 28 days based on the estimated proportions.The resulting compressive strengths are more than the Sri Lankan Standard's requirements for paving blocks when the mix is proportioned according to the ACI mix design procedure. On the other hand, a correlation has been shown between the grade design and the paving blocks' achieved compressive strength.Likewise, when paving blocks are mixed
The obtained compressive strengths met the Sri Lankan Standard's compressive strength standards for Classes 2, 3, and 4 roads because they were constructed using the DOE mix design approach.

Rishi, G. (2003) [2] The ACI design method was used in his research to create the concrete mix. Sands with fineness moduli of 2.4 and 2.6 that are readily available locally are utilized. 10 mm and 20 mm coarse aggregates are utilized in 50:50 and 67:33 ratios of total volume. Nine 150 mm cubes were cast for each mix proportion in the lab and evaluated for seven, fourteen, and twenty-eight days using an Automatic Compression Testing Machine (ACTM). He found that regardless of the amount of cement, fineness modulus, or aggregate ratio employed, compressive strength diminishes as the water cement ratio rises. When 20 mm and 10 mm size aggregate are used in a ratio of 67:33, the strength of the concrete is greater than when the ratio is 50:50. At lower w/cratio, the effect is more noticeable.

M.c. Nataraja et.al. (2010) [3] The ACI and BIS concrete mix designs are compared and contrasted in this essay. According to the investigations, these methodologies differ in the design calculations for the water cement (w/c) ratio, cement content, and aggregate content.In contrast to the previous BIS technique, the ACI method computes sand content after determining coarse aggregate content. Nonetheless, the ACI method is followed in the coarse aggregate computation sequence in the new BIS. The findings demonstrate that using a generalized w/c curve increases the amount of cement used in the old BIS code.It is a result of both the lack of research data and the very low grade of cement that was available in India at the time. The w/c ratio is greater when using the ACI mix design method. The old BIS approach differs from the ACI mix design method in that it has a lower sand content, even though the sand content falls in both systems as the strength requirement increases. The ACI approach is adopted in IS 10262:2009. Instead of using any existing curves, a designer must create the w/c curve for the kind of materials that will be utilized as the foundation for the mix design. In the event that such data is not available, the w/c ratio should be assumed based on the relationship that has previously been established to begin the procedure.The w/c ratio can also be chosen using Table 5 of IS456:2000. Because it determines the computed cement content, one should exercise caution when choosing the initial w/c ratio. For instance, the cement content of an M20 concrete mix will differ if the initial w/c is assumed to be 0.5 or 0.55. This study compares the suggested mix design principles from ACI and BIS. The design steps are used to summarize the computation procedures of the two codes. These techniques are used to depict a typical M20 mix design.

Dr S.A. Deepa, (2014) [4] Comparative research on various design mix techniques
1. The compressive strength is determined using the following methods in decreasing order: IS10262-1982, IS 10262-2009, ACI method, and DOE method.
2. It is evident that while the IS 10262-1982 mix design approach produces greater strength, it also uses more cement and has a significantly higher safety factor.
3. The DOE method is the most cost-effective design approach because it provides the desired compressive strength of concrete in an economical manner.
4. The ACI method has a higher fine aggregate content than the new BIS method.

5. The BIS approach significantly increases the amount of coarse aggregate. Higher workability will result from the ACI mix. As the fine aggregate fills in the voids, it should also contribute to enhanced strength.
6. When the design strength requirement increases in the case of BIS, the fine aggregate content decreases. Consequently, voids in high-strength concrete are likely to be larger, which could result in a reduction in strength.
7. We conclude that the minimum cement concentration utilized in DOE approaches in the aforementioned four methods provides the desired compressive strength of concrete in an inexpensive manner for both tests.

Prof. Dr. B. Ahmed Memon et.al. (2014) [5] has researched the recycled concrete aggregates used to prepare concrete for new construction. They claim that demolished concrete is gathered from the city of Nawabshah and treated to a maximum size of one inch. To gain a good understanding of these aggregates, their basic characteristics (specific gravity and water absorption) are assessed and contrasted with those of natural aggregates.

Using 0%, 50%, 60%, 70%, and 80% replacement of the natural coarse aggregates, 30 RC beams are constructed in five batches using #4 bars as main bars and #2 bars as stirrups. All beams are 36" x 6" x 6" in size, with a concrete mix of 1:2:4 and a water-to-cement ratio of 0.45 to 0.55. Beams are tested for flexural strength and cracking behavior utilizing central point load following a 28-day curing period. In compared to beams constructed with 100% natural aggregates, the test results of this study demonstrate a minimum and maximum drop in flexural strength of 12% and 26.6%, respectively. The behavior and location of the crack are the same in both situations, despite the first crack appearing at a lower load than reference concrete. The study's findings indicate that 88% strength can be attained by substituting 50% of natural aggregates with waste concrete aggregates that have been demolished. As a result, we can be utilized in locations with low or moderate load.

A.M. kannak et.al. (2013) [6] investigated the design of concrete mixtures with normal strength that substitute recycled concrete aggregates for virgin natural aggregates.Three-mix design techniques that make use of Concrete workability, compressive strength, and elastic modulus are used to compare direct weight replacement, equivalent mortar replacement, and direct volume replacement. With varying levels of aggregate replacement, 42 mixtures were created. It was found that the concrete's workability varies greatly based on the replacement technique employed, with the comparable mortar and direct volume approaches producing the best and worst workability, respectively. The mixtures using recycled concrete aggregates exhibited little differences from concrete containing natural aggregates in terms of compressive strength and elastic modulus.

R. Tugrul Erdem et.al. (2012) [7] investigated the characteristics of concrete utilizing the crushed and rounded aggregate. These have an impact on fresh concrete's workability, pumpability, placing, bleeding, and segregation. Strength, density, permeability, pore quantity, shrinkage, and creep are all significantly impacted by hardened concrete. While rounded aggregate is created by erosion brought on by natural forces, crushed aggregate is created when rocks crack in crushers. Because of their uneven surfaces and friction impact, crushed particles make fresh concrete less workable. For a given workability and strength in regular strength concrete, round-shaped aggregates need less water and cement. However, because they provide better internal friction and bonding, angular and rough-shaped particles must be included in high-strength concrete.

Turan Özturan et.al. (1997) [8] examined how the type of coarse aggregate affected the concrete's compressive, flexural, and splitting tensile strength at various strength levels. Basalt, limestone, and gravel coarse materials were used to create concrete with 28-day target compressive strengths of 30, 60, and 90 MPa. Using a cement with a higher strength while maintaining the same other parameters, the gravel aggregate concrete with a goal strength of 90 MPa was likewise recreated. According to the results of a 28-day test, basalt produced the highest compressive strengths in high strength concrete, whereas gravel produced the lowest. When utilized in high strength concrete, crushed limestone and basalt produced higher tensile strengths than gravel aggregate.

Suryakanta (2014) [9] According to his research, angular aggregates are better than rounded aggregates from the following two perspectives. When it comes to concrete used for roads and pavements, angular aggregate is preferred because of its superior interlocking effect. For a given volume, the rough textured angular aggregate's total surface area is greater than that of the smooth rounded aggregate. The angular aggregate may exhibit a stronger binding than the spherical aggregate due to its larger surface area. For a given workability, angular aggregate with a rough texture needs more water due to its larger surface area than spherical aggregate. This indicates that rounded aggregate provides greater strength under specific conditions in terms of the water-to-cement ratio and resulting strength.

3. CONCLUSION

Upon reviewing the literature, it has been noted that the majority of the studies concentrate on comparing two design mix approaches, such as ACI and BIS. Strength and economy characteristics have not been examined simultaneously for all four approaches. Very little research has been done using rounded aggregate; instead, the majority of researchers have employed crushed and recycled aggregates. The comparison based on strength metrics has been done, but the deviation of the design mix proportions other than strength characteristics and overall economy has not been compared.

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