GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

MECHANICAL BEHAVIOUR OF HIGH STRENGTH CONCRETE USING IS10262-2009

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ABSTRACT

In the world of construction, concrete playing an important role in development. Concrete is a composite material which is a mixture of cement, fine aggregate, coarse aggregate and water. Due to the construction of larger structure demand for the high strength concrete has increased. In this paper main focus is to achieve High strength concrete as per IS10262-2009 where proper strength and workability is been made into optimum by conducting several trail mix, with which we concluded optimum w/c ratio , proper degree of workability and mix proportion by testing and with 7 days strength. This mix proportion has been tested for various experimental programs. Along with this replacement of silica fume was also done where 5% replacement of SF result in increase of strength while further increase resulted in reduction in compressive behavior. By using normal available material, quality materials, smaller water-cement ratio, larger ratio of coarse aggregate (CA)to fine aggregate (FA), smaller size of coarse aggregate, the targeted strengths of concretes were from 60 MPa to 70 MPa. While the variables considered were thewaterbinder ratio (from 0.35to as low as 0.25) and the superplasticizer-binder ratio (from 0.73% to 2.95%).

Keywords:- IS10262-2009, Concrete etc.

1. INTRODUCTION

Concrete, a composite consisting of aggregates enclosed in a matrix of cement paste including possible pozzolonas, has two major components –cement paste and aggregates. The strength of concrete depends upon the strength of these components, their deformation properties, and the adhesion between the paste and aggregate surface. With most natural aggregates, it is possible to make concretes up to 120 MPa compressive strength by improving the strength of the cement paste, which can be controlled through the choice of water-content ratio and type and dosage of admixtures. However, with the recent advancement in concrete technology and the availability of various types of mineral and chemical admixtures, and specialsuperplasticizer, concrete with a compressive strength of up to 100 MPa can now be produced commercially with an acceptable level of variability using ordinary aggregates. These developments have led to increased applications of high-strength concrete (HSC) all around the globe. The bottom range of the strength of HSC varies with time and geographical location depending primarily on the availability of raw materials and technical know-how, and the demand from the industry. Concretes that were considered to be high strength 50 years ago are now regarded as low strength. For instance, concrete produced with compressive strength of 30 MPa was regarded as high strength in the 1950's. Gradually, concretes with compressive strength of 40-50 MPa in the 1960's, 60 MPa in the 1970's, and 100 MPa and beyond in the 1980's have evolved and used in practical structures. In spite of the rapid development in concrete technologyin recent years, concrete with compressive strength higher than 40-60 MPa is still regarded as HSC. In the North American practice (ACI 318, 1999), high strength concretes are those that attain cylinder compressive strength of at least 41 MPa at 28 days .HSC offers many advantages over conventional concrete. The high compressive strength can be advantageously used in compression members like columns and piles. Higher compressive strength of concrete results in reduction in column size and increases available floor space. HSC can also be effectively used in structures such as domes, folded plates, shells and arches where large in-plane compressive stresses exist. The relatively higher compressive strength per unit volume, per unit weight will also reduce the overall dead load on foundation of a structure with HSC.Also, the inherent techniques of producing HSC generate a dense microstructure making ingress of deleterious chemicals from the environment into the concrete core difficult, thus enhancing the long-term durability and performance of the structure. Since the introduction of concrete with a compressive strength of 62 MPa in columns, shear walls and transfer girders of the Water Tower Place in Chicago in 1975, many applications of HSC in projects, ranging from transmission poles to the tallest building (Malaysia) on earth, with concrete strength reaching up to131 MPa in the Union Square building in Seattle, Washington have been reported. Production of HSC may or may not require special materials, but it definitely requires materials of highest quality and their optimum proportions. The production of HSC that consistently meets requirements for workability and strength development places more stringent requirements on material selection than that for lower strength concrete. However, many trial batches are often required to generate the data that enables the researchers and professionals to identify optimum mix proportions for HSC. Practical examples of mix proportions of HSC used in structures already built can also be the useful information in achieving HSC.Since concrete is everywhere and its history can be traced to ancient. Egypt and Rome, it is often falsely perceived as a "simple" material. Actually, the microstructure of concrete tends to be highly complex. Furthermore, the structure and the properties of this composite material can change over time. Most modern concrete structures are reinforced with steel, since concrete itself displace relatively low strength when loaded in tension. While steel reinforced concrete is obviously a widely used, cost-effectively construction material, degradation of such structures has become a major problem in many parts of the world. Just as background, concrete is usually assumed to be about 10% as strong in tension as it is in compression. That tensile strength is the basis for its ability to resist bending, or its flexural strength. Effect of Restraint, Volume Change, and Reinforcement on Cracking of Mass Concrete, concrete's tensile strength is often taken as 6.7 times the square root of its compressive strength. It also notes that where a conservative estimate is in order, we can use a minimum tensile strength of 4 times the square root of the compressive strength. Compressive strength. It also notes that where a conservative estimate is in order, we can use a minimum tensile strength of 4 times the square root of the compressive strength.

2. CONCRETE CONTENT

2.1Cement Powder

Strength development of concrete will depend on both cement characteristic and cement content. The choice of Portland cement for HSC is extremely important. For HSC containing no chemical admixture or fly ash, high cement content must be used. Here OPC 53 grade is used for producing High strength concrete.

2.2Fine Aggregate

Fine aggregates (FA) with a rounded particle shape and smooth texture have been found to require less mixing water in concrete and for this reason are preferable in HSC. HSC typically contain such high contents of fine cementitious materials that the grading of the FA used is relatively unimportant. However, it is sometimes helpful to increase the fineness modulus (FM) as the lower FM of FA can give the concrete a sticky consistency (i.e. making concrete difficult to compact) and less workable fresh concrete with a greater water demand. Therefore, sand with a FM of about 3.0 is usually preferred for HSC.

2.3 Coarse aggregates

In HSC the capacity of the aggregate can be the limiting factor. Thismay be either the result of the aggregate being weaker than the low water cement matrix, or alternatively it is not sufficiently strong and rigid to provide the strengthening effect. This is mainly related to the coarse aggregate (CA). For optimum compressive strength with high cement content and low water-cement ratios the maximum size of CA should be kept to a minimum, at ½ in. or 3/8 in. The strength increases were caused by the reduction in average bond stress due to the increased surface area of the individual aggregate. Smaller aggregate sizes are also considered to produce higher concrete strengths because of less severe concentrations of stress around the particles, which are caused by differences between the elastic modulus of the paste and the aggregate.

2.4 Water

Water is what turns dry concrete mix into usable concrete. The amount of water that you will add to your dry concrete mix depends on how much concrete you are making and what you are using it for. Standard pourable concrete has a uniform texture, and the consistency is similar to slightly loosened toothpaste or peanut butter.

2.5Water cement ratio

The single most important variable in achieving HSC is the water cement ratio.HSC produced by conventional mixing technologies are usually prepared with water-cement ratios in the range of 0.22 to 0.40, and their 28days compressive strength is about 60 to 130 MPa when normal density aggregates are used.

2.6 Air

Air is a key ingredient in concrete, and the mix must therefore be sufficiently aerated before use. If you are using a concrete mixer, you can allow the concrete to spin in the drum on low speed for 15 to 20 minutes in orders to incorporate enough air. If you are mixing the concrete by hand in a container, use a large shovel to fold the concrete repeatedly for 20 to 30minutes. Folding is a motion that is also used in making a cake, and requires picking up a portion of the mixture, turning it over, and dropping it over a bit from its initial position.

2.7**Chemical admixtures**

Chemical admixtures such as superplasticizers (high–range water reducer) increase concrete strength by reducing the mixing water requirement for a constant slump, and by dispersing cement particles, with or without a change in mixing water content, permitting more efficient Hydration. The main consideration when using superplasticizers in concrete are the high fines requirements for cohesiveness of the mix and rapid slump loss. Neither is harmful for the production of HSC. HSC mixes generally have more than sufficient fines due to high cement contents. The use of retarders, together with high doses of superplasticizers at the plant or at the job site can improve strength while restoring slump to its initial amount. Here Glenium B2233 is used to produce High strength concrete.

2.8**Mineral admixtures**

Finely divided mineral admixtures, consisting mainly of fly ash and silica fume (SF), and slag cement has been widely used in HSC. Fly ash for HSC is classified into two classes Silica fume (SF) is a by-product of the melting process used to produce silicon metal and ferrosilicon alloys. The main characteristics of SF are its high content of amorphous SiO_2 ranging from 85 to 98%, mean particle size of 0.1 – 0.2 micron (approximately 100 times smaller than the average cement particle) and its spherical shape. Because of its extreme fineness and high silica content, SF is a highly effective pozzolanic material. The SF reacts pozzolanically with the lime during the hydration of cement to form the stable cementitious compound calcium silicate hydrate (CSH). Normal SF content ranges from 5 to 15 percent of Portland cement (ACI). The use of SF as replacement of a part of the cement gives considerable strength gain. For most binder combinations, the use of SF is the only way of producing concrete of normal work ability with a strength level exceeding 80 MPa.

2.9 Mix Proportion for Producing High Strength Concrete:

Here for producing High Strength Concrete the following Concrete mix has been arrived from Trial and error processes by making Cubes and evaluating strength tests.

Cement	Fine Aggregate	Coarse Aggregate	W/C Ratio	Super Plasticizer
1	1.33	2.24	0.35	5ml/100 kg of cement

3. EXPERIMENTAL INVESTIGATION

The following were the experimental investigation made on the above mix ratio and their results were computed below.

3.1Compressive Test

The compressive test was used to find out the strength of the concrete. Here cubes were caste and their compressive strength values were plotted with respect to their ages. The replacement of cement with silica fume is giving a satisfactory performance. In addition to that the coarse aggregate of concrete was replaced by size of an aggregate as 100%20mm, 100%12.5mm, (60%20mm +40%12.5 mm).The combined percentage of (20mm+12.5mm) aggregates showing a satisfactory performance. The results variations are plotted below.

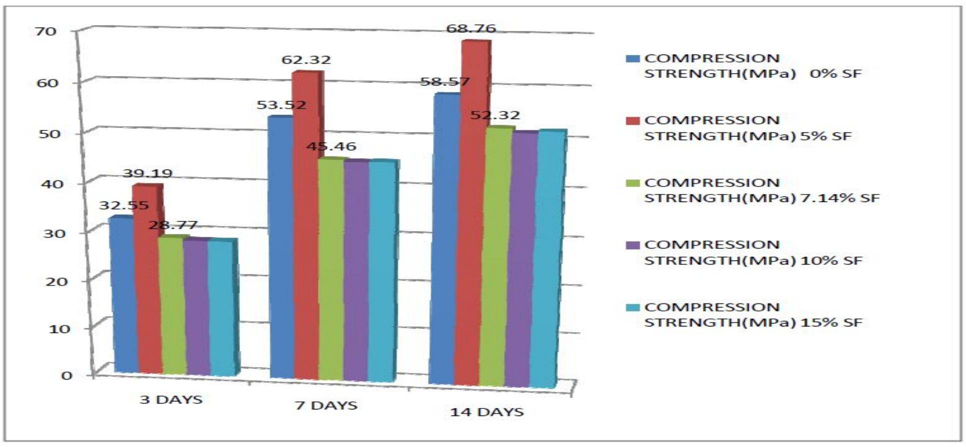

Fig 3.1 Compressive strength of concrete with Silica Fume.

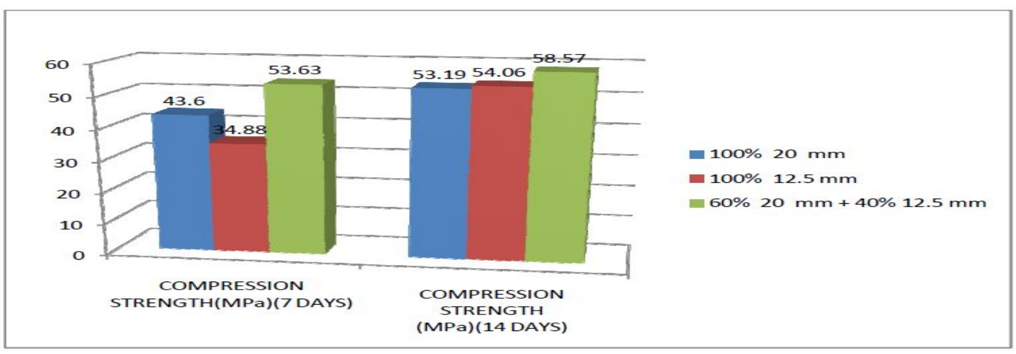

Fig 3.2 Compressive strength of concrete with replacement of aggregates.

3.2 Split Tensile Strength

The split tensile strength was carried out by making a cylindrical specimen of size 100mm diameter and 200mm height. The split tensile strength test results were plotted below.

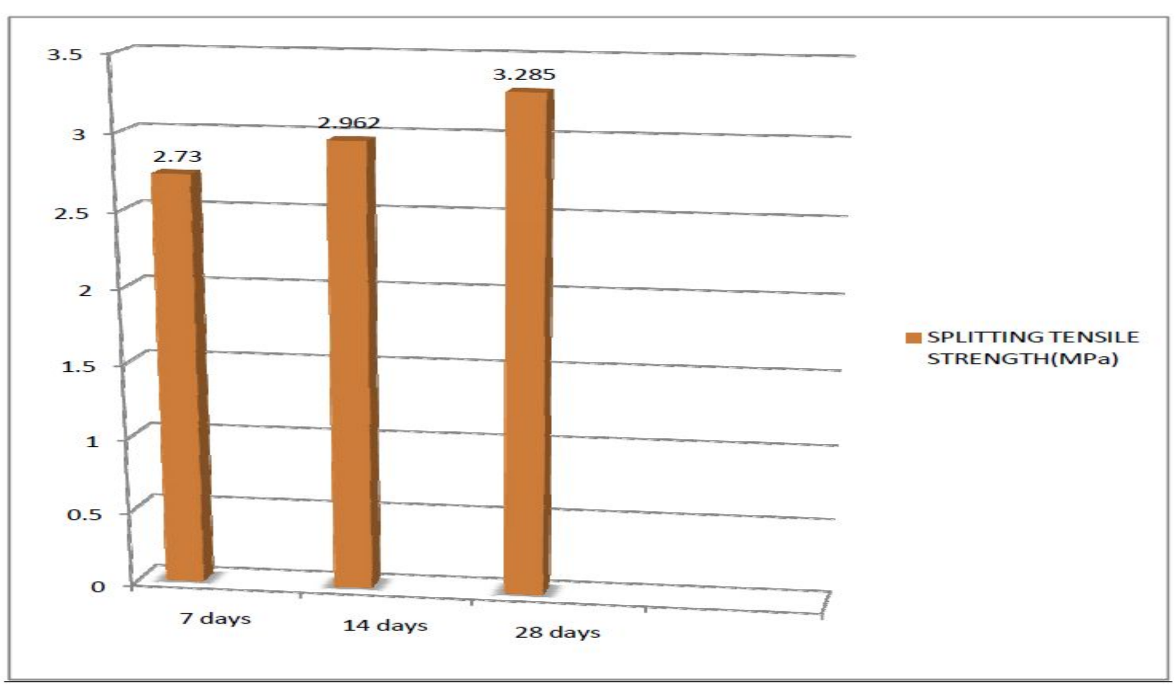

Fig 3.3Split Tensile strength of concrete

4.0 Conclusion

From the experiment conducted on high strength concrete, the following results are obtained. If 5% replacement of cement by silica fume gives the strength higherthan that of designed strength of M60 concrete. Lower the water cement ratio will give higher strength can be achieved. Mixing certain percentage of smaller size of aggregate result inincrease of strength of the concrete. The production of HSC may or may not require the special materials,but it definitely requires materials of highest quality and their optimum proportions. To achieve high strength and desired slump using superplasticisers inlow water cement ratio, mixture machine is must. Reducing the capillary pores in the matrix and improving the bondstrength between cement matrix and aggregate can be done by using low water-cement ratio and incorporating ultra-fine (such as silica fume) and by proper compaction of the concrete. Replacement of silica fume in cement more than 5% will leads to reduction in compressive strength of High strength concrete.

4. REFERENCES

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