A Review of Design of High Performance Concrete (HPC) upto 120 MPa

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Abstract: This papers cover the study of high performance concrete upto 120 MPA .High performance concrete now a days widely used for construction of high rise building, bridges, tunnels, under water constructions for increasingits durability and strength. In this project we will first design concrete mix of M60,M80,M100,M120 by using special type of super plasticizer and admixture like metakaonin and allcofine.. After completion of design of concrete mixture we will cast of M60, M80,M100,M120 cubes ,beams and cylinder. After 3,7, 28 days of casting we will take the compressive strength , flexural strength and split tensile strength .After analysis of results we will study weather M60,M80,M100,M120 will achieve strength as per design of concrete mix.

Index Terms- **High performance concrete , HPC , M60,M80,M100,M120 Metakaolin , Allcofine , High rise building.**

I.INTRODUCTION

Concrete is the most widely used construction material in India with annual consumption exceeding 100 million cubic meters. It is well known that conventional concrete designed on the basis of compressive strength does not meet many functional requirements such as impermeability, resistance to frost, thermal cracking adequately. Conventional Portland cement concrete is found deficient in respect of:

Durability in severe environs (Shorter service life and require maintenance)

Time of construction (longer release time of forms and slower gain of strength)

Energy absorption capacity (for earthquake-resistant structures)

Repair and retrofitting jobs.

High performance concrete (HPC) successfully meets the above requirement.

High performance concrete is a concrete mixture, which possess high durability & high strength when compared to conventional concrete. This concrete contains one or more of cementious materials such as fly ash, silica fume or ground granulated blast furnace slag & usually a super plasticizer. High performance concrete (HPC) is a specialized series of concrete designed to provide several benefits in the construction of concrete structures that cannot always be achieved routinely using conventional ingredients , normal mixing & curing practices. High performance concrete should have at least one property like high strength, high durability, acid resistance, self-compaction, low permeability to water as compared to normal concrete, to qualify as high performance concrete. Material technology has evolved concrete today into an engineered material with several new constituents.

II. LITERATURE REVIEW

J. Chena et. al.[1] (2017).

The author studied on Production of high-performance concrete by addition of fly ash microsphere and condensed silica fume. With reference to the packing model of concrete materials, addition of fly ash microspheres (FAM) to fill the voids between cement grains, followed by addition of condensed silica fume (CSF) to further fill the voids between FAM would reduce the water content to achieve the desired flowability. This could allow the adoption of lower water/cementitious materials (W/CM) ratio to produce High-Performance Concrete (HPC). This study was aimed to evaluate the effects of FAM and CSF on the packing density of cementitious materials and the flowability and strength of cement paste. The results showed that the addition of FAM and CSF can significantly increase the packing density, thereby enhancing flowability and strength performance concurrently. From the experimental investigations presented in this paper, the following conclusions can be drawn the addition of FAM and/or CSF can more substantially increase the flow spread at low W/CM ratio than at high W/CM ratio. Correlations of the flow spread to the WFT yielded very high R2 values of well above 0.9, indicating that the WFT principally governs the flow ability of cement paste. On the other hand, at the same WFT, the flow spread is higher at higher FAM content and marginally lower at higher CSF content.

Wojciech Kubissaa et. al.[2] (2017).

The author studied on Ecological high performance concrete. In this paper the authors present the possibility to utilize two waste materials to produce high performance concrete (HPC). To prepare the mixes, Recycled Concrete Aggregate (RCA) of 4-16 mm fraction and Class F fly= ash (from coal burning power plant) were used. Concretes with RCA were mixed with 300 kg/m3 of different types of cements and Supplementary Cementing Materials (SCM). The concrete sample specimens were tested for mechanical properties and for some properties which are related to durability. After 28 days compressive strength values up to 59.5 MPa and after 90 days 71.8 MPa were achieved. Besides we obtained good values regarding those properties, which significantly influence the durability of reinforced concrete structures. The conclusion are in the paper it has been shown that it is possible to produce a high quality concrete with a targeted 55 MPa mean compressive strength at the age of 28 days and of more than 60 MPa after 90 days. Good durability influencing properties could be measured at the same time by the usage of coarse RCA of an average quality and by simultaneous addition of Class F fly ash as SCM.

Swati Choudhary et. al.[3] (2014).

Author studied on the High Performance concrete (HPC) has immensely increased due to utilization of large quantity of concrete, thereby leading to the development of infrastructure Viz., Buildings, Industrial Structures, Hydraulic Structures, Bridges and Highways etc. This paper includes the detailed study on the recent developments in High Performance Concrete, stressing more on the earthquake prone areas. It highlights the advantages and importance of High Performance concrete over conventional concrete and also includes effect of Mineral and Chemical Admixtures used to improve performance of concrete. The behavior of SIFCON is also discussed briefly. The alternative for the HPC is also recommended.

Viatceslav Konkov et. al.[4] (2013).

The author studied on Principle Approaches to High Performance Concrete Application in Construction. Designing high performance concrete compositions, optimal application of this material as in the field of erecting unique buildings and constructions, so in large-scale construction, are discussed in the article. Requirements to high performance concrete are set; the existing practice of its application in modern construction is described. Constantly growing standards as for physical and mechanical properties of buildings and constructions erected so for their maintenance, including issues of safety and ecological matters, determine increasing requirements to functional characteristics of construction materials. At the same time, concrete has the leading position among these materials taking into account its variety and usage scale. The world annual production of concrete exceeds 4 billiards cubic meters of ready mix and precast concrete of different application area. The conclusion are High Performance and Ultra High Performance Concrete is a very promising building material which seriously changes philosophy of approaches to vision of what we want and what we can expect from core building material. It has become to be treated as material which can simultaneously achieve various goals set by high standards of modern customers to unique buildings and constructions and to objects of large-scale construction not only in terms of strength, but also in terms of safety, life quality, decreasing all types of resources (energetic, labor, material, financial) as at the stage of building, so, especially, at the stage of maintenance.

Yves F. Houst et.al.[5] (2008).

The author studied on Design and function of novel superplasticizers for more durable high performance concrete. In this article we shall describe our quest and ultimate success in furthering our understanding of the action of superplasticizers on the rheology of cement and concrete. By specifically producing superplasticizers with varied architectures, we have been able to show the important structural features of the macromolecules that lead to a successful superplasticizer or water reducing agent. Using both non-reactive model MgO powders, three different types of cement blends, the adsorption behaviour and the effect on the rheological properties of these two important superplasticizer families have been used to further develop a conceptual model for superplasticizer-cement behaviour. We shall briefly describe the adsorption of the polymers onto the different surfaces and their influence on surface charge and rheology and the influence of the various ionic species found in cement pore solutions that may influence polymer-cement affinity. The key factors are shown to be the effective adsorbed polymer thickness and the induced surface charge which can be influenced by the polymer architecture, the pore solution composition and the initial particle surface charge.

Ping-Kun Chang et .al.[6](2004).

The author studied on An approach to optimizing mix design for properties of high-performance concrete Laboratory and in situ test results reveal that the densified mixture design algorithm (DMDA) can be used to produce high-performance concrete (HPC) of good durability and high workability. The water-to-solid (W/S) weight ratio is known to have significant influence on the volume stability of concrete. This paper discusses strength of f Vc>56 MPa, slumps of 230–270 mm, effect of the W/S ratio on the development of strength and durability of HPC at both fresh and hardened states. In addition to the water-to-cement (W/C) ratio and water-tobinder (W/B) ratio, the W/S ratio also has a significant effect on the performance of concrete. The utilization of fly ash and slag has been proven beneficial to the rheology of HPC in enhancing its strength development and durability. The conclusion are the DMDA has proved to be capable of producing HPC with slumps of 230–270 mm and strength of f Vc > 56 MPa while avoiding water bleeding and segregation of aggregate. The use of domestic pozzolanic materials and strong water reducing agent also contributes to the high strength and workability of concrete.

Y.N. Chana et . al .[7] (2000).

The author studied on the Compressive strength and pore structure of high-performance concrete after exposure to high temperature up to 80˚C. The experimental program was carried out to study the mechanical properties and pore structure of high-performance concrete (HPC) and normal-strength concrete after exposure to high temperature. After the concrete specimens were subjected to a temperature of 80̊C, their residual compressive strength was measured. The porosity and pore size distribution of the concrete were investigated by using mercury intrusion porosimetry. Test results show that HPC had higher residual strength, although the strength of HPC degenerated more sharply than the normal-strength concrete after exposure to high temperature. The changes in pore structure could be used to indicate the degradation of mechanical property of HPC subjected to high temperature. The results and conclusions are summarized as although the strength of HPC degenerated more sharply than the conventional concrete with the increase of exposed temperature, the HPC had higher residual strength. The variation of pore structure, including porosity and pore size distribution, could be used to indicate the degradation of mechanical properties of HPC subjected to high temperature.

Kevin J. Folliard et. al .[8] (1997).

The author studied on properties of high performance concrete containing shrinkage-reducing admixture. The effects of a recently developed shrinkage-reducing admixture on high performance concrete properties are described. High-performance concrete mixtures containing silica fume were cast with and without shrinkage-reducing admixture. The mechanical properties, drying shrinkage, and resistance to restrained shrinkage cracking were investigated. The results show that the shrinkage-reducing admixture effectively reduced the shrinkage of high-performance concrete. This paper has summarized the results of a study on the effects of a recently developed shrinkage-reduced admixture on high-performance concrete. The conclusion are The use of SRA in high performance concrete was found to significantly reduce drying hrinkage and restrained shrinkage cracking in laboratory ring specimens. The effectiveness of SRA in reducing shrinkage was observed despite a very short (24-hours) moist-curing period. However, proper curing should remain an essential component in concrete field applications, and this improved curing would also increase the efficacy of SRAs in reducing shrinkage and subsequent cracking.

Chong Hu et .al.[9] (1996).

The author studied on the rheological properties of fresh high-performance concrete were investigated with a new rheometer for concrete. It was found that, in a steady state, this category of concrete, without or under vibration, behaves as a Bingham material, and can be characterized by the shear yield stress (in Pa) and the plastic viscosity (in Pa.s). For the tested concretes, vibration reduced the yield stress to about half that without vibration, but little influenced the plastic viscosity. A new method for characterizing the evolution of workability is presented, which emphasizes an increase of the shear yield stress versus time. The thixotropy of concrete was confirmed, and it was noted in particular that the yield stress of a concrete after a resting period, called resting yield stress, can be several times that of the concrete in a steady state. The dilatancy of concrete was observed in some tests. Several factors influencing this phenomenon are discussed. Finally, a model is proposed for estimating the plastic viscosity of high performance concrete from the mixture proportions. The high-performance concrete (HPC) has been widely used for the last decade. With super plasticizer, this concrete has a better compactness, owing to the reduction of water The silica fume used in certain cases increases even more the concrete compactness by filling of some inter grain voids. Some rheological properties of fresh high-performance concrete are discussed in this paper. The following conclusions have been drawn from the experimental results measured with the BTRHEOM rheo meter: Common fresh HPC (slump value over 10 cm) without heavy segregation and in a steady state, either without or under vibration, seems to be a Bingham material. The evolution of the workability of concrete can be described by the evolutions of the yield stress and of the plastic viscosity, and determined by their combined effect according to the particular application. In the first hour, the viscosity of HPC is nearly constant.

F.P. Zhou et. Al.[10] (1995).

The author studied on the effect of coarse aggregate on elastic modulus and compressive strength of high performance concrete. A set of high performance concrete mixes, of low water/cement ratio and fixed mortar composition, containing six different types of aggregates of constant volume fraction, has been used to check moduli of elasticity at 7, 28 and 91 days, The results have shown that, apart from the aggregates of very low and very high modulus, concrete modulus at 28 days can be predicted quite well by well-known models. Increase in modulus thereafter is slight. For the wide range of coarse aggregate stiffness used, combined with a single, high strength, low water/cement ratio mortar. The conclusion may be drawn Cube strength (about 90 N/mm2 at 28 days with normal aggregates) is drastically reduced, as expected, by the weaker aggregates and is also reduced (by about 9%) by the stiffer (steel) aggregates.

III. PROBLEM STATEMENT

Present study focused on Design of High Performance Concrete (HPC) upto 120 MPa. The investigation aims at determining mechanical properties of high performance concrete & compare with the results in the code & literature.

IV OBJECTIVES OF STUDY

The main objectives of the present work are ,

1. To understand the basic guidelines for designing HPC mix proposed by Different Codes and papers published in the literature.
2. To investigate the properties of materials used for making HPC.
3. To arrive the concrete mix proportioning for concrete of strength in the range of 60 MPa to 120 MPa.
4. To investigate mechanical properties of HPC and compare with the results in the code and literature.

V. METHODOLOGY

The methodology of the present work are,

1. Literature survey is carried out for designing concrete mix.
2. Collect the materials to prepare the concrete of strength 60 MPa to 120 MPa.
3. Trials are made for achieving the proposed strength by casting Cubes and Cylinders. The
4. Strength test may be made at the age of 3, 7, and 28 days.
5. Once the proportioning of concrete ingredients is decided for the strength, the cubes, cylinders and beams are cast to assess the compressive and tensile strength of concrete.
6. The results obtained may be compared with the results in the literature and new equations may be proposed for tensile strength, in terms of its compressive strength.

VI. SCOPE OF THE STUDY

Currently conventional concrete is used widely for residential, commercial & public buildings. But if we consider the important structures such as bridges, high rise commercial complex or under water constructions, strength of concrete plays an vital role in overall life of structure, overall stability of structure & durability of structure as well. It is therefore very essential to design the concrete having high strength by adding different admixtures and by adopting suitable IS mix design procedure.

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