HIGH STRENGTH CONCRETE: A REVIEW

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Abstract: *Concrete is a construction material composed of cement, fine aggregates, coarse aggregates mixed with water. Concrete is a 2nd most used material in the world behind water. High strength concrete (HSC) farther than high compressive strength, possesses uniform high density and very low impermeability. The cement industry is the largest producers of carbon dioxide (CO_2), so that we will replace the cement by using mineral admixtures such as fly ash, metakaolin, silica fume. High strength concrete is made by replace mineral admixtures to cement. The development of High Strength Concrete has been a great breakthrough in concrete technology. The supplementary cementitious material (SCM) is need of civil industry, because supplementary cementitious material becomes essential part of high performance and high strength concrete mix design.*

Key Words: *High Strength, Super plasticizer, Metakaolin, Fly ash, Silica fume.*

1. INTRODUCTION

Concrete technology changing rapidly and constantly since its discovery. More and more concrete is used for infrastructure projects. Conventional concrete is not very suitable against severe aggressive conditions, chemical conditions and thermal stresses. High strength concrete is made carefully by selecting the high-quality materials and mixture design. High strength concrete can be produced with a wide range of aggregates, but smooth and/or rounded aggregates may tend to exhibit aggregate bond failure at a relatively low strength. Crushed rock aggregates of 10 to 20 mm size, which are not too angular and elongated, should preferably be used. However, it has been found that bond strength between smaller size aggregates is greater than between larger size aggregates and for that reason smaller size aggregates tend to give better results.

The development of high strength concrete is based on the water-cement (water-binder) ratio. For the high strength concrete the w/c ratio should be kept low. Use of low water-cement ratio and other cementitious materials make the use of polycarboxylate-ether based superplasticizers mandatory. Superplasticizers should be used to achieve maximum water reduction, although plasticizers may be adequate for lower strength. Increasing the cement content may not always produce higher strength. Above certain levels it may have little effect. An optimum amount of total cementitious materials usually appears to be between 450 to 550 Kg/m^3. The basic proportioning of an HSC mix follows the same method as for normal strength concrete, with the objectives of producing a cohesive mix with minimum voids. This can be done by theoretical calculations or subjective laboratory trails

1.1 History

High strength concrete often considered as new material. Its development has been many years ago In USA in the 1950 concrete with a compressive strength of 34 MPa was considered high strength, in 1960 Concrete with 41 to 52 MPa compressive strength were used commercially. In the early 1970s 62 MPa concrete was produced In the last 30 years concrete of very high strength come in construction field in high rise buildings and long span bridges.

According to IS 456-2000 compressive strength over 110 MPa has been considered for the application in cast in place building and prestressed concrete members, but recently reactive concrete is a one which having nearly compressive strength of 250MPa. It is based on pozzolanic materials.

2. LITRATURE REWIEW

2.1 P. Dinakar and other three are studied that Using MK as a partial replacement for cement decreased the plastic density of the mixtures By utilizing local MK and cement designed for a low water/binder ratio of 0.3,high strength and high performance concretes can be developed and compressive strengths of more than 100 MPa can be realized. The optimum replacement level of OPC by MK was 10 %, which gave the highest compressive strength in comparison to that of other replacement levels; this was due to the dilution effect of partial cement replacement. These concretes also exhibited a 28-day splitting tensile strength of the order of 5.15 % of their compressive strength and showed relatively high values of modulus of elasticity. Splitting tensile strengths and elastic modulus results have also followed the same trend to that of compressive strength results showing the highest values at 10 % replacement.[1]

2.2 Arka Saha and other two are studied that, Replacement of fly ash by equal weights of fly ash results in reduction in compressive strength at 28 and 90 days. Fly ash used in the investigation had a low reactive silica content and lower fineness compared to the cement and hence neither the filler effect nor the pozzolanic actions could yield higher strength with respect to control. Up to 30% fly ash replacements, all the concrete mixes exhibited strengths exceeding or equal to 40 MPa at both the ages. Hence the proper use of fly ash has a tremendous potential in producing high strength high performance concrete. Higher proportion of fly ash like 40% can also be adopted if specified age for designing mixes is considered as 90 days. Century old Abrams w/c ratio law which was originally formulated for concrete with cement as the only cementitious material is also valid for HSC containing fly ash. The results also suggest that high strength high performance concrete with fly ash as a partial replacement of cement can have a w/cm lower than 0.34.[2]

2.3 Nicola Longarini and other studied the use of waste ashes made by thermal power stations turns out to be not only in an improvement of intrinsic properties of concrete as mechanical strength, workability, durability and resistance to chemicals attacks and freeze cycles, but also an interesting solution in the perspective of a sustainable design which uses waste materials of a production process hardly reusable. Finally, it is important to say that when fly ash are used in concrete, the potential for leaching of trace elements is very low. This is due to the constituents of fly ash being encapsulated in the matrix of the concret[3]

2.4 D. Vishwandha Varma and other studied that among the various replacements, the concrete with 15% Metakaolin replaced cement shows good compressive strength than other percentages. The strength of concrete decreased with increase in time duration of sample kept in furnace. The benefit of using metakaolin is to increase the pozzolanic action so as to prevent the corrosion activity of concrete in coastal area.[4]

2.5 Dr. Vijayshekharreddy and other four are studied that In high strength concrete mix design as water cement ratio adopted is low, super plasticizers are necessary to maintain required workability as the percentage of mineral admixtures is increased in the mix, the percentage of super plasticizer should also be increased, for thorough mixing and for obtaining the desired strength. In M80 grade of concrete as the water-cement ratio of 0.25 is insufficient to provide the good workability, hence super plasticizer is necessary. In case of individual percentage replacement of mineral admixtures, the maximum compressive strength achieved in M80 grade concrete is 78 Mpa with 10% replacement of Metakaolin. In case of two combinations percentage replacement of mineral admixtures the maximum compressive strength achieved in M80 grade concrete is 78 Mpa with 7.5% replacement of Fly ash and 7.5% replacement of Slag. In case of three combinations percentage replacement of mineral admixtures the maximum compressive strength achieved in M80 grade concrete is 79 Mpa with 5% replacement of Fly ash, 5% replacement of Slag and 5% replacement of Silica [5]

2.6 Amritpal Kaur and other studied that,replacement of cement with 9% metakaolin and 10% marble powder give better strength.When amount of metakaolin increases permability decreases.If percentage of metakaolin increased more than 9% then strength is decreased.[6]

2.7 Vijay Agarwal and two others studied that the by-product silica fume used as partial replacement of cement, has a positive influence on the compressive as well as tensile strength of concrete. The 28 day compressive strength obtained by partially replacing cement with silicafume shows a noticeable increase when compared to the target mean strength. The tensile strength also has increased marginally. The results for test against acid attack show that silica fume contained concrete possesses greater acid resistance as compared to the normal concrete. This reinforces the earlier observations that silica fume helps in increasing the durability of reinforced concrete. In the present scenario silica fume is present in excess and it cannot be disposed of because it requires more area for disposal. It contains chemicals that can contaminate underground water table if disposed in the open without proper treatment. So this study can be used to encourage industries to use silica fume as replacement for cementitious materials by 10%-30% of their weight. It has also been found that at the same w/c ratio the strength of silica fume concrete is more than the normal concrete. The cost of concrete also decreases by 20%-30% by using silica fume. Good quality control and high early strength can be achieved in silica fume concrete which may be useful in various structural constructions such as high-rise buildings, bridges, chimneys, machine foundations, run ways etc., wherein, the timeframe of completion vis-à-vis the economy is an important driving factor for the targeted purpose as well as for the contractors and owners alike as this concrete will provide faster stage by stage or floor to floor construction.[7]

2.8MalvikaChakravarthy and other studied that the water cement ratio is adopted low in high performance concrete mix hence super plasticizers are required for workability. The maximum compressive strength achieved for M80 grade concrete is 88.8MPa with the mineral admixtures' replacement combinations of 15% Flyash and 10% of Metakaolin. The percentage replacement of mineral admixtures such as Fly ash, Silica fume and Metakaolin contribute for achieving high strength along with the steel fibers. It is also observed that the high strength concrete cubes tend to fail suddenly with the appearance of micro cracks. They also observed that the workability decreases with increased percentage addition of Silica Fume and Metakaolin and workability increases with addition of Fly ash [8]

2.9 Sunny Jagtap and two others observed that Metakaolin concrete increases the compressive and flexural strength effectively as compared with conventional concrete. Workability decreases as percentage of metakaolin in concrete increases. The strength of concrete increases with increase in metakaolin content up to 15% replacement of cement. As the Percentage of metakaolin powder in concrete increases, workability of concrete decreases.[9]

2.10 M Mohammed Ashik and other studied that 10% Metakaolin can be taken as the optimum dosage, which can be utilized by using super plasticizer. Mixed as a partial replacement to cement for giving maximum possible compressive strength at any stage. The optimum percentage of Metakaolin is again 10% in the case of Split Tensile Strength, Flexural Strength and Modulus of Elasticity. Metakaolin addition to concrete leads to decrease in workability which has to be compensated by adding Super plasticizers.[10]

3. MATERIAL

Cement: Cement is the primary constituent for manufacturing concrete. Here Pozzolana Portland Cement (53grade) confirming to IS12269-1987 was used. Specific gravity of cement is 3.15

Fine aggregate: Locally available river sand free of silt confirming to IS 383-1970 with specific gravity 2.65 is used

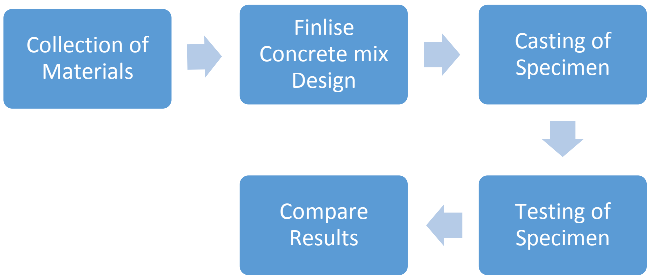
Coarse aggregate: Crushed stone aggregate of 10-12 mm size is added from nearby quarry with specific gravity 2.74 confirming to IS 383-1970

Superplasticising Admixture: The hyperplasticiser shall be ADDMIX 389, high range water reducing, Superplasticizer based on polycarboxylic ether formulation. The product shall have specific gravity of 1.1 & solid contents not less than 40% by weight.

Mineral Admixtures: Metakaolin, Silica fume, Fly ash

4. METHODOLOGY

- Collection of Material like Pozzolana Portland Cement, Coarse aggregate, Fine aggregate, Metakaolin, Fly ash, silica fume, Admixture.
- Laboratory test on basic ingredients of concrete like Cement, Coarse aggregate, Fine aggregate.
- Finalize Mix design for concrete.
- Partial replacement of cement with Metakaolin, Fly ash, Silica fume in carious percentages.
- Check workability of concrete.
- Casting of cube specimen
- Determine Compressive strength of concrete.



5. CONCLUSIONS

1) The water cement ratio is adopted low in high strength concrete mix hence superplasticizer is required for workability.

2) The concrete with crushed granite aggregate of 12mm developed higher compressive strength

3) The strength of concrete is increases with decrease in water cement ration & decreases with increase in water cement ratio.

4) Using Metakaolin as a partial replacement for cement decreased the plastic density of mixture.

5) It is also observed that the workability decreases with increased percentage addition of silica fume and metakaolin and workability increases with addition of fly ash.

6) The optimum percentage of replacement of cement with Cementous material is 10 - 20 %

7) The cost of steel is decreased with increase in grade of concrete. For high strength concrete the water-cement ration should be kept low

8) Use of Fly ash, Metakaolin, gives Green concrete.

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