Impact of adding admixture on the compressive strength of high-performance concrete

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Abstract-This paper is focused on variation in strength parameter mainly on compressive strength of high-performance concrete on adding admixture like utilizing green and pozzolanic material as supplementary cementitious material. Various types of specimens with different mix proportions were analysed in the study. The compressive strength of the different specimens was analysed on different days with constant w/c ratio. The supplementary Cementous materials available nearby Delhi-NCR were used in samples as replacement of cement and laboratory investigations were performed. The use of alternative material of Portland cement leads to reduction of emission gasses and impact on production capacity of cement plant and provides a strategy to reducing the cost of construction and remedies of Solid waste disposals.

Keywords: High Performance Concrete (HPC), Compressive Strength, Supplementary Cementous Material (SCM)

Introduction:-

The primary objective of this research work is to develop common unified in-situ approach by developing simple and multivariate linear parametric regression models for estimating the strength parameters of concrete to accelerate the decision process of mix design and to simplify the Quality assurance assessment of any concrete structure. Following sub objectives are defined to achieve above main objective of research:

• To determine the effect of mechanical characteristics of HPC by including supplementary cementitious material.

• To identify the optimum proportion of green materials like Fly Ash, Silica Fume and Rice Husk Ash and micro material like Alccofine in order to accelerate the mechanical property of the concrete mix along with cement.

• To develop multi-variate parametric regression models for estimating the compressive strength with different proportions and combinations of Fly ash, Slag, Alccofine, Rice Husk Ash, Cement and Water/Cement ratio.

As stated earlier that the prime objectives of this research was to produce data from a organised investigation so as to contribute to the development of performance based specifications for HPCs. The main focused measures of the research were both the physical properties and durability characteristics of HPCs containing both binary and ternary blends of Portland cement and supplementary cementitious materials. The principle for evaluating the quality of hardened HPCs are dependent on their considerded purposes. For example, a HPC designed for a sulphate exposure condition needs to be evaluate differently from that designed to resist a marine exposure condition. This means that a general research on HPC with the aim of the data contributing to the development of performance based specifications should not be confined to one transport property or durability mechanism. This performance-based specification will be beneficial for developing countries like India as industries are switching from oil to coal due to energy crisis.

Materials and Mix Methodology: - In the preparation of High Performance Concrete in addition to normal mixing materials like Cement(OPC), Aggregate, sand, the waste materials like, Silica Fumes, Fly Ash, Rice Husk Ash, Allcofine were used to accelerate the strength properties of the specimen. In this study the Ordinary Portland Cement of 43 grade (Ambhuja Cement) was used, Physical Properties Property Average Value for OPC Used in Present Investigation Standard Value for OPC Specific gravity 3.15 _ Consistency (%) 31% _ Initial setting time (min) 42 > 30 Final setting time (min) 450. The aggregate used for concrete consists of coarse aggregate and fine aggregate. The fine aggregate of F.M.=2.67 River yamuna sand has a grading of size between 150 µm to 4.75 mm as per IS 383-1970 ,whereas coarse aggregate of 20mm size were used. The fresh potable water free from injuries were used at normal temperature28*c +or- 2*c.

Fly Ash used in this research work was obtained from Pragati Thermal Power Plant, New Delhi. The properties of fly ash were as in table

S.No.	Test	Obtained Result	Required as per IS 3812:Part 1 : 2003
1.	SiO2 +Al2O3 +Fe2O3 percent by mass, minimum	89	70
2.	SiO2 present by mass, minimum	58	35
3.	MgO present by mass Maxm	3	5
4.	Total sulphur as sulphur trioxide SO_3 present by mass maxm	1.5	2.75
5.	Loss on Ignition(LOI), percent by mass, maximum	2	12
6.	Specific gravity	2.52	
7.	Fineness – specific surface area in m2 /kg, minimum	300	320
8.	Lime reactivity, average compressive strength in N/mm2 , minimum	4.8	4

Testing:-

As per recommendation of code of practices IS 516–1959, compressive strength of the specimens was carried out. The samples were cured in potable water at temperature 28 degree for 7 days, 14 days and 28 days and were tested in dry condition after removal from water and grit present on the surface. The load was applied without shock and increased continuously until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The value of maximum load applied to the specimens was then recorded and the appearance of the concrete for any unusual features in the type of failure was noted. Average of the three values was taken as the substitutes of the compressive strength of the specimen as noted.

The predominant quality of High-Performance Concrete, differentiate it from traditional cement concrete is its far higher level of strength. The high performance of concrete is due to the refinement of pore structure of the cement concrete to acquire a very dense material with super low permeability to admittance of water, air, oxygen, chlorides, sulphates and other very bad representatives. Therefore, the steel reinforcement submerged in High Performance Concrete requires high level of protection. Various aspects of High-performance concrete contemplate for the resistance to freezing and thawing. Primarily, very few chilled waters are present in the structure of hydrated cement paste. Secondary, the strength of the high-performance concrete decreases by entrained air reduces because the enhancement in workability due to the air bubbles cannot be fully recompense by a reduction in the water content in the presence of a superplasticizer. Furthermore, air amusement at very low water/cement ratio is tough aspect Thus, it is advantageous to establish the maximum value of the water/cement ratio under which alternating cycles of freezing and thawing do not result in destruction of cement concrete. The High-Performance Concrete possess remarkable abrasion resisting value, not only of high strength of the concrete but also because of the good bond connecting the coarse aggregate and the matrix which counteracts different wear of the surface. On the other side, High Performance Concrete consists low value of resistance to fire because the very low permeability of High-Performance Concrete does not allow the emergence of steam formed from water in the hydrated cement paste. Due to the absence of open pores in the structure zone of High-Performance Concrete the growth of bacteria can be prevented. Therefore, we conclude that High Performance Concrete have superior durability aspects in comparison to conventional cement concrete.

Detailed laboratory investigations were carried out covering almost all available additional cementitious materials (SCMs) nearby area of Delhi NCR of India. Attempts has been made to produce high performance concrete with commonly used ingredients such as cement, sand and coarse aggregates in this research, which are easily available in local areas along with Supplementary Cementitious Materials. • Workability • Compressive strength of cubes ϖ Laboratory investigations were carried out covering the almost all aspects of High performance concrete. The major experimental outcomes of this paper is that the results of Compressive strength testing of various mix proportions by considering all local available supplementary cementitious materials, it was reproduced that for binary mix incorporating Slag has given good results as compare to others. The outcome was that the value of compressive strength of concrete is increases with the increase in Alccofine content up to 10 % & Silica content up to 10%. It was also determined that there is possibility of production of concrete having compressive strength more than 70 N/mm^2 from ternary mix including Alccofine or Silica Fume as SCM. It was observed that there is significant improvement in durability measure for high performance concrete. The maintenance cost of the structure can be minimised by using high durable concrete achieved through the use of supplementary cementitious materials. Therefore, the cost of life cycle get decreased . In the research the conventional high performance concrete was modified by incorporating Fly Ash, Alccofine, Silica Fume, Rice Husk Ash and as SCM. The modifications minimizes the CO2 emission and makes concrete environment-friendly. In the compressive strength testing of various mix proportions by deliberating all available supplementary cementitious materials, it was illustrate that for binary mix including rice husk ash produces better results as compare to others. It was also observed that there is significant improvement in durability measure for high performance concrete. The concrete achieved by the process was high value in terms of durability through the use of supplementary cementitious materials and also minimised the maintenance cost of the structure. Hence life cycle cost will decrease.

The uses of High Performance Concrete in severe exposure conditions were restricted due to danger of concrete by chlorides or sulphates or other aggressive agents as they ensure very low permeability. High Performance Concrete is normally used to increase the durability under extreme conditions of exposure and under normal circumstances both, because carbon di-oxide is always present in the air. This results in carbonation of concrete destroys the reinforcement and leads to corrosion. Aggressive salts are sometimes also present in the soil, which may cause abrasion. High performance concrete can be used to prevent detoriation of concrete. The most appropriate reason for the deterioration of concrete is alternate periods of rapid wetting and prolonged drying with a frequently alternating temperatures. The low permeability of High performance concrete ensures long life of a structure exposed to such conditions.

This research paper is evident that the various countries using High strength concrete for achieving High strength and superior durability in their structural constructions. The few examples of applications for High Performance Concrete are: Bridges – Joigny (France), Greatbelt (Denmark), Akkegawa (Japan), Willows (Canada) High rise buildings -- Water tower plaza (US), Nova Scotia (Canada) Tunnels -- La Bauma and Villejust (France), Manche (UK) Pavements-Valerenga (Norway), Highway 86,Paris airport (France) Nuclear structures-Civeaux (France).

Conclusions

It has been found that compressive strength of concrete increases with increase in Alccofine content up to 10%. The optimum replacement level of OPC by Alccofine (A) was 10 %, which gave the highest compressive strength at the age of 28 days . It has been observed that the maximum compressive strength was obtained for mixes containing 10% Alccofine with 1% super plasticizer average value for 28 days was found to be 32.8 N/mm^2 with W/c Ratio of 0.35 . As the percentage replacement increases beyond 10%, the 28 days compressive strength of HPC started decreasing.

The High-Performance concrete provides many advantages in the sustainable and economical design of structures and give a direct savings in the concrete volume, savings in real estate costs in congested areas, reduction in form-work area. The High-Performance Concrete due to its greater durability is likely to result in low maintenance cost and longer life. The introduction of low life-cycle costing of high-performance concrete, the long-term economic benefits are likely to more than offset the premium costs for initial construction. The designing of structures with high performance concrete from Conventional concrete will have to revive. The use of waste materials like Rice Husk Ash in high performance concrete not only reduces the cost of construction but also helps in reducing the pollution in environment. The use of rice husk ash as an alternative for cement & as additive to reduce corrosion and increase durability of concrete strength. RHA is also use for manufacturing load bearing blocks bricks tiles in low cost.

The high recommendation for the development of co-relation with other mineral admixtures like Red mud, Plastic waste, Burnt brick, Marble Dust, Granite Powder or any other material available in other parts of India. The Use of High Density poly-ethylene which is polyethylene thermoplastic made from petroleum should be used to make High Strength Concrete. Future study should investigate the other durability properties by including these SMSgts study recommends that use laboratory tests to determine the suitability of these mineral admixtures in self-compacting concrete also. The research also recommends that conduct a comprehensive laboratory testing of concrete mixes with of these mineral admixtures includes light weight aggregates

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