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Optimum Quantity of Mineral Admixture in High Performance Concrete

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***Abstract*- A high performance concrete is something which demand much higher performance from concrete compared to performance expected from routine concrete. High performance concrete is achieved in practice by using selection of raw material (mineral admixture/ chemical admixture) & appropriate mix design the desire performance objective.**

Our aim of the project is find the optimum value of mineral admixture for M-50 grade concrete by using and comparison of different admixture silica fume. The project is to find out the dosage of these minerals in M-50 grade concrete which gives the high strength & high workability in high performance concrete in minimum and maximum time duration

Most high-performance concrete have a high cementation content and a water cementations material ratio of 0.40 or less. A supplementary cementation material such as silica fume is often used in high performance concrete. all these materials increase the modulus of elasticity as well as the compressive strength of the concrete.

Index Terms- High performance concrete, silica fume, High workability, High Strength

I. INTRODUCTION

Concrete is the most widely used construction material. It is difficult to point out another material of construction which is as versatile as concrete. There are various types of concretes are used in field. One of them is High performance concrete. High performance concrete has been defined as concrete that possesses high workability, high strength and high durability. High Performance Concrete is a concrete made with appropriate materials combined according to selected mix design, properly mixed, transported, placed, consolidated and cured so that the resulting concrete will give excellent performance in the structure.

In high performance concrete admixtures are the ingredients other than water, aggregates, cement, and fibers that are added to the concrete batch immediately before or during mixing. A proper use of admixtures offers certain beneficial effects to concrete, including improved quality, acceleration or retardation of setting time, enhanced frost and sulfate resistance, control of strength development, improved workability, and enhanced finish ability. Mineral admixtures (silica fume, Metakaolin and GGBS) are usually added to concrete in larger amounts to make mixtures more economical, reduce permeability, increase strength, and influence other concrete properties.

II. OBJECTIVE

B. OBJECTIVES

1. Objective of the project was to determine the optimum value of mineral admixtures in HPC (High performance concrete).
2. We were using M-50 grade of concrete. With using different dosage of Silica fumes in M-50 grade concrete as part replacement of Cementitious materials to achieve above mentioned benefits in concrete.

III LITRETURE REVIEW

Various departments of Civil engineering Colleges and University were worked and researched for Mineral admixtures proportion in HPC. Following tables shows the research work related to our team project work.

In the 1950s:

In the 1950s, ready-mixed concrete with design strength of 35 MPa was considered high strength. The history of true, commercially available high-strength concrete in the US can be traced back to the early 1960s. In 1960, the Washington State Highway Department specified 41 MPa concrete for pre-stressed girders, allowing the Highway Department's girders to be among the thinnest in the country. In 1961, Seattle's monorail track girder was specified with 48 MPa, while at the same time 55 MPa concrete was being specified by the Port of Seattle for use in precast concrete piles (Howard and Leatham, 1989). The increased use of chemical and mineral admixtures in the decade of the 1960s quickly led to significant increases in attainable compressive strength. Place Victoria in Montreal, constructed in 1964, reached a height of 190 m (624 ft) using 40 MPa concrete in the columns (Shaeffer, 1992).

Three high-strength concrete bridges, representing the first generation use of high-strength concrete bridges were built for Japan National Railway in 1973. The reasons for selecting high strength concrete included reductions in dead load, deflections, vibration, and noise, along with an anticipated reduction in long-term maintenance costs. After over 20 years of service, the bridges have performed in accordance with all expectations (CEB-FIP, 1994).

The results of experimental work on short- and long-term mechanical properties of high-strength concrete containing different levels of silica fume. The aim of the study was to investigate the effects of binder systems containing different levels of silica fume on fresh and mechanical properties of concrete. The work focused on concrete mixes having a fixed water/binder ratio of 0.35 and a constant total binder content of 500 kg/m". The percentages of silica fume that replaced cement in this research were: 0%, 6%, 10% and 15%. Apart from measuring the workability of fresh concrete, the mechanical properties evaluated were: development of compressive strength; secant modulus of elasticity: strain due to creep, shrinkage, swelling and moisture movement. The results of this research indicate that as the proportion of silica fume increased, the workability of concrete decreased but its short-term mechanical properties such as 28-day compressive strength and secant modulus improved. Also the percentages of silica fume replacement did not have a significant influence on total shrinkage; however, the autogenous shrinkage of concrete increased as the amount of silica fume increased. Moreover, the basic creep of concrete decreased at higher silica fume replacement levels. Drying creep (total creep basic-creep) of specimens was negligible in this investigation. The results of swelling tests after shrinkage and creep indicate that increasing the proportion of silica fume lowered the amount of expansion. Because the existing model for predicting creep and shrinkage were inaccurate for high-strength concrete containing silica fume.

IV. DATA COLLECTION

Material Properties

Silica fumes, Ground granulated blast furnace slag (GGBS), metakaolin, fly ash etc. Mineral admixtures are used in HPC. Some details of them is given below.

Silica Fumes:

Silica fume is a by-product from manufacturing silicon metal or ferrosilicon alloys. The smoke that results from furnace operation is collected and sold as silica fume, rather than being landfilled. Silica fume is widely used in concrete and refractory application. One of the most beneficial uses for silica fume is in concrete. Silica fume consists primarily of amorphous (non-crystalline) silicon dioxide (SiO_2). The individual particles are extremely small, approximately 1/100th the size of an average cement particle. Because of chemical & physical properties, like high silica content & extreme fineness, silica fume is a very effective pozzolanic material.

Properties of Silica Fumes

State Amorphous- Sub-micron powder

Color Gray to medium gray powder

Specific Gravity: 2.10 to 2.40

Solubility Insoluble

Bulk Density: Densified 500 to 600 kg/m3

Bulk Density: Undensified "as produced" 300 to 450 kg/m3

Table -1: Properties of Silica Fume

Analysis/Properties	Typical	Limits
Silica	97.5	Min 96%
Carbon	0.5	Max 1.3%
Iron	0.1	Max 0.3%
Alumina	0.4	Max 0.7%
Calcium	0.2	Max 0.3%
Magnesium	0.1	Max 0.5%
Potassium	0.3	Max 0.6%
Sodium	0.1	Max 0.3%
Phosphor	0.1	Max 0.2%

Sulphar	0.1	Max 0.4%
Chloride	0.1	Max 0.1%
Water	0.4	Max 0.8%
Loss on ignition@750ºC	0.6	Max 1.5%
Coarse particles,>45 micron(325 mesh)	0.2	Max 0.6%
Specific surface area (B.E.T)	20m²/g	-
PH value (fresh)	6.0	4.5-6.5

Ground Granulated Blast furnace Slag (GGBFS or GGBS):
Ground granulated blast furnace slag (GGBS) is a by-product from the blast-furnaces used to make iron. These operate at a temperature of about 1,500 degrees centigrade and are fed with carefully controlled mixture of iron-ore, coke and limestone. The iron ore is reduced to iron and the remaining materials form a slag that floats on top of the iron. This slag is periodically tapped off as a molten liquid and if it is to be used for the manufacture of GGBS it has to be rapidly quenched in large volumes of water. The quenching optimizes the Cementitious properties and produces granules similar to coarse sand. This 'granulated' slag is then dried and ground to a fine powder

Metakaolin:
Metakaolin differs from other supplementary Cementitious materials, like fly ash, silica fume and slag, in that it is not a by-product of an industrial process. It is manufactured for a specific purpose under carefully controlled conditions. Metakaolin is produced by heating kaolin, one of the most abundant natural clay minerals, up to temperatures of 650-900 °C. This heat treatment, or calcinations, serves to break down the structure of kaolin. Bound hydroxyl ions are removed and resulting disorder among alumina and silica layers yields a highly reactive, amorphous material with pozzolanic and latent hydraulic reactivity, suitable for use in cementing applications. The advantage of replacing some of the cement with metakaolin, rather than simply adding metakaolin to the mix, is that any existing color formulas or mix designs won't change, or will only very slightly change. This is because the dosage of pigments and super plasticizers are based on the cement content in the concrete. Concrete made with metakaolin can be cast, finished and cured in almost the same fashion as ordinary concrete made without metakaolin. Calcium hydroxide accounts for up to 25% of the hydrated Portland cement, and calcium hydroxide does not contribute to the concrete's strength or durability. Metakaolin combines with the calcium hydroxide to produce additional cementing compounds, the material responsible for holding concrete together. Less calcium hydroxide and more cementing compounds means stronger concrete Metakaolin, because it is very fine and highly reactive, gives fresh concrete a creamy, non-sticky texture that makes finishing easier. Efflorescence, which appears as a whitish haze on concrete, is caused when calcium hydroxide reacts with carbon dioxide in the atmosphere. Because metakaolin consumes calcium hydroxide, it reduces efflorescence Alkali-silica reaction is a reaction between calcium hydroxide (the alkali) Because metakaolin consumes calcium hydroxide, it takes away the alkali and the reaction does and glass (the silica) which can cause decorative glass embedment in concrete to pop out. not occur.

V. CONCLUSION

In order to prove in high strength we, achieve a high strength based on the admixture adding as silica fume and GGBHs.
To Study of what is importance of strength in strcture design.
To achieve a economy for laying of concrete due to reduction of Water and aggregate in up to 10%

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