

An Experimental Study On High Performance Concrete By Using Admixture**Metakaolin, Slag, Silica Fume, Fly Ash On M80 Grade Concrete***¹P. SATISH REDDY, #²D. RAJITHA ,¹PG Scholar Department of civil Engineering, CMR College Of Engineering & Technology, UGC AUTONOMOUS

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Abstract— High performance Concrete is the concrete meets the unique performance and requirements of uniformity that are not to be received through conventional fabric, ordinary blending, putting and curing practices. In this, look at, a quick evaluation on power and sturdiness on M80 grade of concrete consequences, a brand new composite cloth has been advanced and stepped forward Binders are developed.

Important governing factors for HPC (High Performance Concrete) are power, long term durability and serviceability. As consistent with Indian general code IS: 456-2000 concrete of compressive strength = 60Mpa. Concrete of grades M80 and M90 etc. Are taken into consideration as High Performance Concrete (HPC).

In this project mineral admixtures specifically Fly Ash, Silica Fume, Slag & Metakaolin contributed through diverse reputed industries are using. In this challenge paintings, a brief evaluate offered on “A STUDY OF HIGH PERFORMANCE CONCRETE BY USING ADMIXTURE LIKE METAKAOLIN, SLAG, SILICA FUME ON M80 GRADE CONCRETE “I actually have extensively utilized brilliant plasticizer namely VARAPLAST SP125 manufactured by “AKARSH SPECILATIES IN CHENNAI”.

I used these super plasticizers in order to achieve lower water-cement ratio and to achieve good workability when we go for High Strength Concrete such as M80. I have compared the combinations of various percentages of admixtures in M80. I presented the combination represented these results in the form of BAR CHARTS and GRAPHS.

The strength tests include compressive, split tube tensile and flexural tests for cubes, cylinders and beams. And durability tests include Acid-Alkali attack tests and Rapid permeability chloride tests were conducted and the test results were presented in graphs and bar charts.

Keywords— High Performance Concrete, M80 grade, Metakaolin, Cooper Slag, Silica Fume, Fly Ash, Superplasticizer Varaplast SP125, Slump test, Compressive Strength Test, Split Tube Tensile Test ,Flexural Test, Alkaline attack test and Acid Attack Test.

I. Introduction

Concrete is a strong & durable material. The most popular material Reinforced concrete is used though out the world for construction. After all experiments and researches appreciate to workability, energy and durability of concrete is elevated very tons and gives a unique overall performance is called as “High Performance Concrete”. It is quite a number substances combining of merchandise beyond the traditional mix concrete and creation strategies.

High Performance Concrete (HPC) is to give performance characteristics for set of materials used and exposure conditions depending on the requirement of cost, life period and durability. The factor for durability of concrete is greater than 80Mpa. As Henry G. Russell, who is Consulting engineer and previous chairman of the American Concrete Institute’s high overall performance concrete committee, “All excessive- strength concrete is high overall performance concrete, however now not all excessive performance concrete is high-strength concrete” High Performance Concrete (HPC) is a product which includes materials with distinctive special residences compared to the traditional concrete and production methods.

NEED OF HIGH PERFORMANCE CONCRETE

To reduce the column sizes and increasing available space by constructing of high-rise buildings and also to construct long-term bridges and to increases the durability of bridge decks for satisfying the needs of applications like durability, modules of elasticity, flexural strength.

Target of the examination

The goals of the investigation are according to the accompanying,

- To study the new and solidified properties of cement.
- To find the saving response for significant expense of concrete.
- To decide the ideal level of fly ash, silica seethe, metakaolin, and copper slag dependent on quality models.
- To study mechanical properties, for example, compressive strength test, droop test, split pliable

test, flexural quality test, basic analysis and antacid test toward the finish of 7 and 28 days of restoring by halfway supplanting concrete by fly debris, silica smolder, metakoalin and by copper slag under typical relieving with compound admixture.

- To decrease ecological contamination by using such material in concrete.
- To decrease the weight on normally accessible material by incompletely supplanting with metakoalin, copper slag, fly Ash and silica smolder.

Requirement for the investigation

- For necessity of substitute for concrete.
- To defeat the material lack of cement.
- To diminish the segment estimates and expanding accessible space by developing of elevated structures
- To build long haul spans and to expands the solidness of extension decks.
- To diminish the cost by making use of locally available materials.
- To check various properties of cement with different rates of silica fume, fly ash, metakoalin, copper slag.

II. MATERIALS AND METHODS

A. Metakaolin: -

Significant research has been done on actuated normal mud and kaolinitic mud. These unrefined substances have much of the time been called as "metakaolin".

Such an item white or cream in shading, sanitized, thermally initiated is known as "unreasonable receptive metakaolin". High responsive metakaolin by exchange name "METACEM" is being fabricated in India by method of "Forte MINERALS DIVISION" in Baroda. Metakaolin that we've utilized on this assignment work was contributed by methods for "AKARSHA SPECIALITIES IN CHENNAI" CALCINED Mud – HIMACEM is a High Reactivity Metakaolin (HRM), that is produced by means of the unnecessary temperature cure of especially chosen kaolin under oversight circumstances. It is a white mineral admixture, having brilliant pozzolanic properties. It responds with free lime delivered during the hydration of concrete to shape extra cementations items.

High Responsive Metakaolin as A Worth Included Solid Admixture

- High Responsive Metakaolin (HRM) is a worth included solid admixture and is as a rule progressively utilized in the created nations instead of silica seethe.
- HRM can be utilized as an exceptionally viable pozzolanic admixture to
- Provide high compressive qualities.
- Reduce porousness and infiltration of particles

Zones OF Use

Despite the fact that, HRM can be utilized in a wide assortment of blend plans where improved compressive qualities impermeability is required.

It is utilized in the accompanying zones of use.

- In superior cement.
- In marine and compound safe structures.

- Industrial floors and different structures that require high compressive strength.
- Bridge deck applications.

Advantages OF HRM

Coming up next are the advantages of utilizing HRM in concrete.

- Reduces porousness, since extra cementitious items framed increment the thickness of concrete glue.
- Increase compound obstruction because of the nearness of free lime.
- Reduces drying shrinkage by permitting the utilization of less concrete while creating improved properties.

B. Fly Ash

Fly ash is a derivative from burning crushed coal in electric power generating plants. Throughout burning, mineral impurities in the coal (feldspar, clay, quartz, and shale) fuse in suspension and drift out of the combustion chamber with the exhaust gases. As the melted material rises, it cools and sets into spherical glassy particles called fly ash. Fly ash is gathered from the exhaust gases by electrostatic precipitators or bag filters. The fine powder resembles Portland concrete however it is artificially unique. Fly ash chemically reacts with the result calcium hydroxide formed by the chemical reaction between cement and water to form extra cementitious products that develop many desirable properties of concrete. All fly ashes shows cementitious properties to varying degrees depending on the chemical and physical properties of both the fly ash and cement. Differentiated with concrete and water, the synthetic response between fly ash and calcium hydroxide regularly is more slow bringing about suspended hardening of the concrete.

Arrangement of fly ash :

The differentiation of fly ash is done in a different way as per IS codes used.

1.Type of Fly Ash as per IS Codes (IS 3812-1981)

Grade I

The grade of Fly ash is derived from bituminous coal having fractions $\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3$ greater than 70 %.

Grade II

This grade of Fly ash derived from lignite coal having fractions $\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3$ greater than 50 %.

2. Type of Fly Ash as per American Society for Testing and Materials (ASTM C618)

Dependent on the type of coal and the resultant chemical analysis, ASTM has categorized fly ash into

C Type

C Type fly ash is created from the burning of lignite or sub bituminous coals, contains CaO higher than 10 % and holds cementitious properties not withstanding pozzolanic properties..

F Type

F Type fly ash is formed from the burning of bituminous or an anthracite coal contains CaO below 10 % and holds pozzolanic properties.

Two kinds of fly ash are normally utilized in solid: Class C and Class F. Class C are regularly high-calcium fly ash remains with carbon content under 2%; though, Class F are commonly low-calcium fly ashes with carbon substance under 5% however now and then as high as 10%. As a rule, Class C remains are delivered from burning sub-bituminous or lignite coals and Class F ashes bituminous or anthracite coals. Execution properties between Class C and F ashes shift contingent upon the compound and physical properties of the debris and how the ash collaborates with concrete in the solid. Many Class C remains when presented to water will respond and turn out to be hard simply like concrete, however not Class F ashes. Most, if not all, Class F ashes will only react with the results shaped when concrete responds with water. Class C and F fly ashes were utilized in this exploration venture.

C. Silica Fume

Micro silica, is also identified as Silica fume is an amorphous (non-crystalline) polymorph of SiO₂, silica. It is a ultra fine powder made as a subsidiary out of the silicon and ferrosilicon composite creation and comprises of round particles with a normal molecule measurement of 150 nm. The fundamental field of utilization is as pozzolanic material for superior cement.

Silica fume is utilized for flyovers at-Mumbai where, without precedent for India 75 Mpa concrete was utilized in 1999. In India silica Fume of global quality is promoted by "Buffalo Asylum Framework PVT LTD IN COCHIN" and furthermore at "ELKEM METALLUGY PVT LTD IN MUMBAI".

The superior cement created utilizing Small scale silica is accomplished through three guideline systems:

- The quality particles of smaller scale silica have the likelihood to fill the minuscule voids between particles, building up a less penetrable solid structure. The creation strategy guarantees the streamlining of molecule size and circulation.
- The pozzolanic reaction happening when the free calcium hydroxide freed inside the concrete hydration technique responds with smaller scale silica to give additional calcium silicate hydrate (crystalline developments).
- The appropriate size of a molecule decreases solid draining additionally helps improves bond at the blend interface with concrete glue.

Silica fume is added to Portland concrete cement to improve its properties, specifically its compressive quality, bond quality, and abrasion spot obstruction. The benefits of utilizing miniaturized scale silica can be significant as it decreases thermal cracking brought about by the heat of cement hydration and can improve toughness to assault by sulfate and acidic waters. Micro silica or silica fume is an

excellent admixture for concrete as it leads to better manufacturing properties.

D. Copper Slag

Copper slag is totally embed material and its physical properties square measure sort of like characteristic sand. A research facility study was administrated inside the Foundation to break down the capability of exploitation copper dross as a halfway substitution of sand in concrete. the use of copper slag once grounded fine is utilized as a trade for sand and cement gives potential natural moreover as financial edges for every single associated industry, outstandingly in regions any place a generous amount of copper dross is made. In a few nations, there's a deficiency of characteristic blend that is fitting for development, while in alternative nations the utilization of blend has expanded as of late, on account of will increment inside the lodging business.

Advantages Of Copper Slag

- Copper slag has conjointly increased quality in building business to be utilized all fill material.
- Copper slag can even be utilized as antique, designed into squares.
- Copper slag is wide utilized as partner degree rough media to dispose of rust, late covering and option in dry grating impacting in view of high hardness (6-7Mohs), high thickness (2.8-3.8 gr/cm³) and low free silicon oxide content.
- Copper slag is wide used in the sand impacting business and it's been used in the production of grating instruments.

Works of Copper Slag

- Diminishes the improvement esteem in view of sparing in material worth
- Lessening the interest for essential normal assets
- Diminishes the glow of affiliation, and permeability
- Diminishes the climate sway on account of creation and blend mining
- Refinement of pore pressure

D. Superplasticizer Varaplast SP125

Superplasticizers, are improved chemical admixtures over plasticizers with highly effective plasticizing effects on wet concrete also known as high range water reducers, super plasticizers results in substantial enhancement in workability at a given water cement ratio. For constant workability, reduction of water content up to 29% may achieved by the use of super plasticizers. Super plasticizers can be used at the higher dosage than conventional plasticizers in the range of 0.5% to 3% by weight of cement. So the use of varaplast SP 125 superplasticizer is used in this project for the reduction of water and to improve workability .Their addition to concrete or mortar allows the decrease of the water to solidify proportion without adversely influencing the functionality of the blend, and empowers the creation of self-consolidating concrete and elite cement. This the functionality of the blend, and empowers the creation of self-consolidating concrete and elite cement. This impact drastically improves the presentation of the hardening fresh glue.

III. Preparation of specimen

Preparation of cubes, cylinders, beams by Metakoalin, silica fume, Cooper slag, Fly ash, as factorial replacement to

the cement by using superplasticizer with different percentage of replacement to cement.

A. Casting of specimen

The casting of specimen is done in sequence of conventional concrete and fly ash by 15%, Metakoalin 5%, Cooper Slag by 5%, Silica fume by 5% to cement

MIXS	Grade of concrete
1.	M80
2.	M80+FLYASH 20%
3.	M80+FLYASH,15%+SILICAFUME 5%
4.	M80+FLYASH15%+METAKAOLIN 5%
5.	M80+FLY ASH 15%+SLAG 5%

The specimen were tested for 7 days and 28 days for slump test compressive strength test, acid attack test, flexural test, split tensile test, alkaline test.

III. RESULTS AND DISCUSSION

A. Compressive Strength

Pressure is the test normally led for concrete, with the goal that we can get the quality properties. The size of the 3D shape example 15cm X 15cm X 15cm was cast to test different solid blends for compressive strength. In the wake of trim, saved for relieving for 7 days and 28 days the compressive strength was led. The water and coarseness on the 3D shapes was expelled before testing the solid shapes. The test was conveyed according to Seems to be: 516-1959.

At 7days of curing the compressive strength of M80 grade of concrete has increased from 39 N/mm² to 42 N/mm² for partially replacing cement by coconut shell ash, silica fume & fly ash.

At 28days of curing the compressive strength of M80 grade of concrete has increased from 74 N/mm² to 89.3 N/mm² and then decreased to 79.6 N/mm² for partially replacing cement by fly ash15% and cooper slag 5%

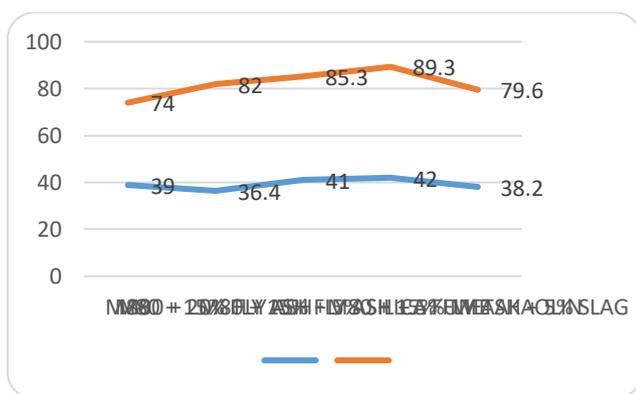


Fig 1: Compressive strength of High Performance Concrete of M80 grade in N/mm²

B. Cylinder Splitting Tension Test:

This is additionally now and again alluded as "Brazilian test". This test is done by setting a tube shaped example on a level plane between the stacking surfaces of a pressure testing machine and burden is applied until disappointment of the chamber along the vertical distance

across. At the point when burden is applied along the generatrix, a component on the vertical measurement of the chamber is exposed to a vertical compressive pressure

$$F_t = 2P / (d l)$$

where P = most extreme pliable burden

l = length of the chamber

d = distance across of the chamber

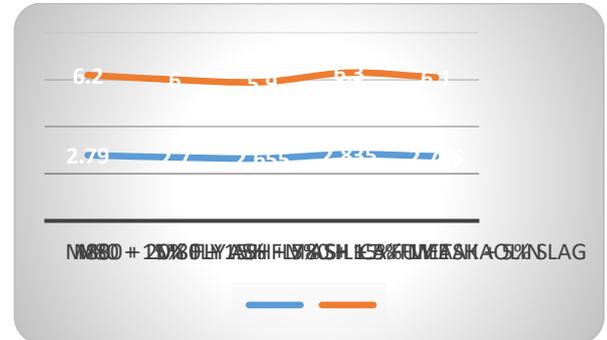


Fig 2 : Tensile Tests results For 7 Days And 28 Days

C. Flexural Quality Test:

Kaleidoscopic examples 100×100×500 mm were tried by IS: 516(1959). The outcomes for flexural quality of crystals for 7days and 28days are given in table. An essential issue in structuring concrete for use in thruway programs is the flexural quality of cement.

Its skill is helpful inside the format of asphalt pieces and landing strip runway as flexural strain is critical in these cases. The flexural power or the modulus of break of cement is an in direct level of the ductile vitality. The estimation of modulus of break relies on the size of the pillar and astoundingly at the relationship of stacking.

The flexural vitality of the example is communicated on the grounds that the modulus of break, which if 'a' rises to the hole among line of crack and the close to help, estimated on the middle line of the pliable part of the example, in cm, is determined to the nearest 0.0005 MPa as follows:

$$f_b = p \times l / b \times d^2$$

at the point when 'an' is more prominent than 20.0 cm for 15.0 cm example, or

$$f_b = 3p \times a / b \times d^2$$



Fig 3: Flexural quality test For 7 Days And 28 Days

D. Durability:

I. Acid Attack Test

The corrosive assault test can be led on solid shape submerged into the corrosive water for relieving for 28 days. The corrosive assault opposition was get by the % loss of

weight of example and the % loss of compressive strength of drenched blocks in corrosive water. The response of four different concrete mixes to sulfuric acid attack has drawn by conducting sulfuric acid test. The change in weights of the cubes of different mixes have shown.

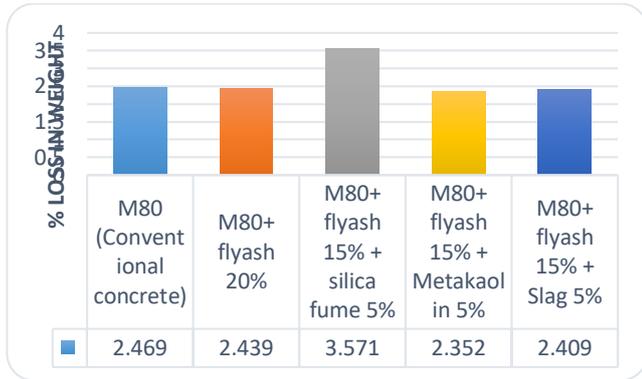


Fig 5: %Loss Of Weight Reduction Of Cubes After 28days Of Acid Curing:

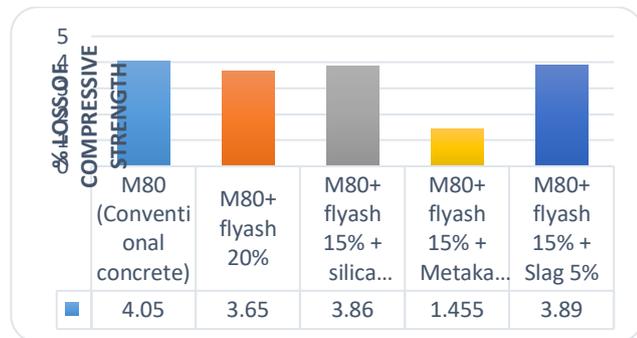


Fig 6: Compression Strength Of Cubes After 28days Of Acid Curing

From the above results of Acid attack test, the mix 4 has shown the good resistance to sulfate attack it is because of the less permeability, less surface porosity and chemical resistance of cement. The above parameters are responsible for performance of concrete in durability against sulfate attack on specimens. The other key reason for the resistance of sulfate attack is due to metakaolin and fly ash in concrete which decreases the voids and pores of the concrete so the acid present in the water cannot affect the concrete.

II. Alkaline Test:

The opposition of solid blends in basic assault test will be controlled by the solid shapes drenched in soluble water having 5% of sodium hydroxide (NaOH) by weight of water. The solid 3D shapes which were relieved for 28 days in water and expelled from the restoring tank permitted drying for 1day.

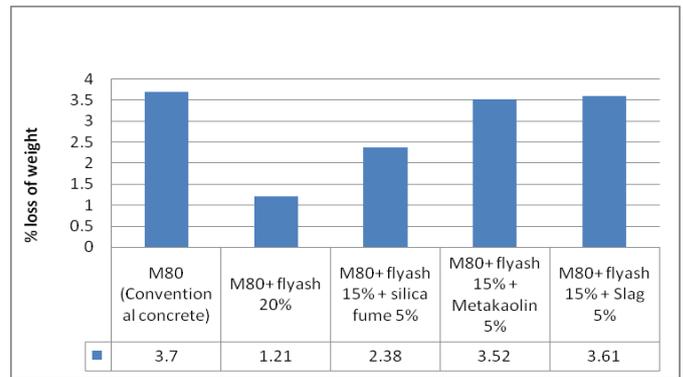


Fig 7: % Loss Of Weight Decrease Of 3D squares After 28days soluble restoring

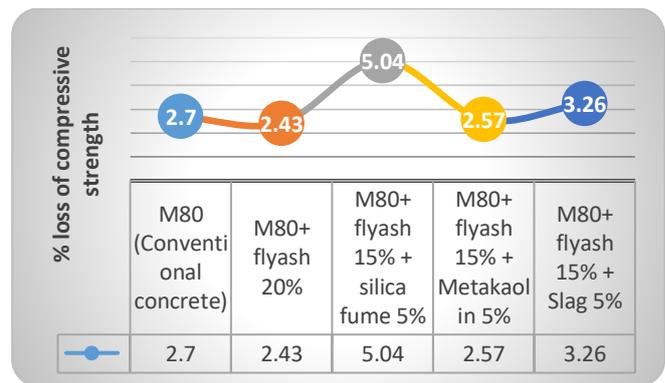


Fig 8: %Loss Of Compressive strength After 28days Basic curing of specimens

IV. CONCLUSIONS

- In elite solid blend plan, the water concrete proportion is embraced low. It is important to keep up super plasticizers for required usefulness. At the point when the level of mineral admixtures in the blend builds super plasticizer rate additionally increments for getting of required quality.
- In instance of various blends Of percent substitute of mineral admixtures gives the most extreme compressive power for M80 grade concrete in 89.3 Mpa with substitution of concrete by methods for 15% fly Ash and 5% Metakaolin Mineral admixtures comprising of Fly debris, miniaturized scale silica, metakaolin and Slag likewise make commitments viably for achieving high force.
- The extent of utilizing high generally speaking execution concrete in our constructional exercises lies huge, viz., precast, prestressed spans, multi-celebrated structures, scaffolds and structures on seaside regions and like.
- To influence this change, we can ought to resuscitate the structuring to frameworks through empowering utilization of high quality cement. When miniaturized scale split appears, astounding disappointment is found in over the top vitality solid 3D shapes.

Recommendations For The Future Work

- This examination is additionally conveyed for various W/C proportions for various mineral and compound admixtures, likewise for various solid evaluations.
- Fly Ash and Metakaolin blends are end up being the best among all the mineral admixtures as it adds to accomplish exceptionally high compressive strength.
- Silica Fume and fly Ash blend ends up being the best among all the mineral admixtures as it adds to accomplish high solidness even in extreme presentation condition It is recommending that the investigation of porousness of cement for the estimation of solid strength might be broadened.

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