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Experimental Investigation on Strength and Durability Characteristics of Multi Blended Cement Concrete

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Abstract - **The main aim of the present study is to determine the strength of concrete mix of M30 grade, with partial replacement of cement with Silica fume, Rice husk ash and FLY-ASH. Portland cement is the most important ingredient of concrete and is a versatile and relatively high cost material. Large scale production of cement is causing environmental problems on one hand and depletion of natural resources on other hand. Hence, the researchers are currently focused on use of waste material having cementing properties (such as fly ash, GGBS, metakaloin, silica fume, rice husk ash) which can be added in concrete as partial replacement of cement, without compromising on its strength and durability, which will result in decrease of cement production thus reduction in emission in greenhouse gases, in addition to sustainable management of the waste. This paper presents a study on mechanical and durability properties of ternary blend is a mixture of three products (i.e. portland cement and two SCMs) and quaternary blend is a mixture of four products (i.e. portland cement and three SCMs). The pozzolanic material such as fly ash, silica fume, rice husk ash were used as a cement replacing materials in conjuction with ordinary Portland cement. This paper presents a study on mechanical and durability properties of concrete made with multi component cement. Study includes concept of multi blended cement exploits the beneficial characteristics of all pozzolanic materials in producing better concrete.**
Keywords: **Strength, Durability, Multi Blended Cement Concrete**

I. INTRODUCTION

Concrete is the key material used in various types of construction from the flooring of a hut to a multi-storied high rise structures. Concrete is one of the versatile heterogeneous materials. With the advent of concrete civil engineering has touched highest peak of technology. It is the material of choice where strength, durability, impermeability, fire resistance and abrasion resistance are required. The properties of concrete mainly depend on the constituents used in concrete making.

Concrete is composed of cement (pozzolona Portland cement) and other cementitious materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of gravel or crushed rocks such as limestone or granite plus a fine aggregate such as sand), water and chemical admixtures.

Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a robust stone-like material.

The urgent need to strengthen concrete structures is on the rise. Various motivations lead to increase demand for strengthening. Deterioration and ageing of concrete structures are not the only reasons for strengthening beams. Other reasons include upgrading design standards, committing mistakes in design or construction exposure to unpredicted loads due to changing the usage of the structure. Strengthening of concrete members is usually accomplished by construction of external reinforcement concrete or shotcrete jackets, by epoxy bonding steel plates to the tension face of the members or by external post tensioning.

II. OBJECTIVES

1. To study the properties of chemical and mineral admixtures.
2. To select the ingredient which are used as a supplemental cementitious materials (SCM).
3. To design a concrete mix for M30 grade concrete.
4. To replace the cement by admixtures in specified proportion for ternary (i.e. PC and two SCMs) and quaternary (i.e. PC and three SCMs) mix.
5. To find the optimum mix for ternary blended concrete from the following proportion (TC 1= PC-70% + FA-20% + SF-10%, TC2= PC-70% + FA-20% + RHA-10%, TC 3=PC-80% + SF-10% + RHA-10%) by conducting compression strength test and the proportion for quaternary mix is kept as constant(QC= PC-60% + FA-20% + SF-10% + RHA-10%).
6. To cast the concrete cube, prism, cylinder for the adopted ternary and quaternary concrete mix.
7. To study the compressive strength, split tensile strength and flexural strength for ternary and quaternary concrete mix and compare the strength with conventional mix.
8. To study the durability properties of ternary and quaternary concrete mix and compare the strength with conventional mix.
9. To select the appropriate dimension and reinforcement details for beam.
10. To cast the beam for ternary blend, quaternary blend

and conventional concrete mix.

11. To determine the load carrying capacity and deflection of beam for ternary bended beam and quaternary blended beam and compare with conventional concrete beam.

III. METHODOLOGY

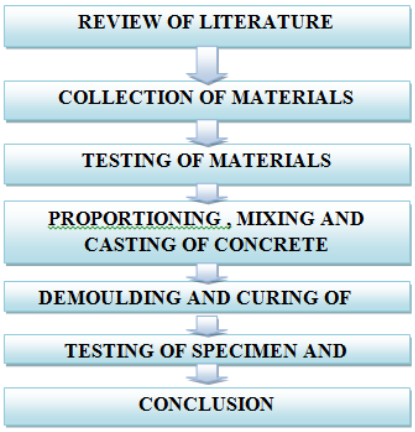

Fig. 1 Flowchart

IV. RESULTS

The concrete mix M30 grade is set as apiece the method given in the IS: 10262:2009 and proposition of mix were 1:1.87:3.37. The replacement of OPC with devastate materials are made on the equal weight basis. The w/c ratio is occupied 0.42 % for all the mixes. The % proportion of ternary mix is given below,

TABLE I PERCENTAGE OF REPLACING CEMENT IN TERNARY MIX (TC)

TC	Cement %	Fly Ash %	Silica Fume%	Rice Husk Ash %
TC 1	70	20	10	-
TC 2	70	20	-	10
TC 3	80	-	10	10

The optimum mix for ternary mix is calculated by the above proportion by conducting the compressive strength test and the investigation is going to proceed by that optimum mix. The % replacement proportion for quaternary mix is given below,

TABLE II PERCENTAGE OF REPLACING CEMENT IN QUATERNARY MIX

	Cement %	Fly Ash %	Silica Fume%	Rice Husk Ash %
QC	60	20	10	10

TABLE III MIX PROPORTION

MIX	Cementious material(kg/m^3)				Fine	Coarse Aggregate (kg/m^3)	Water (lit/m^3)	Super Plasticizer (lit/m^3)
	Cement	Silica fume	Fly ash	Rice husk ash	(kg/m^3)			
CC	380	-	-	-	711	1283	160	1.9
TC 1	266	38	76	-	711	1283	160	1.9
TC 2	304	38	-	38	711	1283	160	1.9
TC 3	266	-	76	38	711	1283	160	1.9
QC	228	38	76	38	711	1283	160	1.9

A. Compression strength test result for optimum mix for quandary mix

The results of compression strength were presented in table 4.8. The tests were carried out to obtain compressive strength of concrete at the age of 28 days.

TABLE IV COMPRESSIVE STRENGTH FOR FINDING OPTIMUM MIX IN TERNARY BLENDED CONCRETE (N/MM2)

MIX	Compressive Strength(N/mm^2)
TC 1	36.4
TC 2	26.2
TC 3	30.2

Ash(20%)+Silica Fume (10%)) provide higher compressive strength when compared with other ternary blended mix and selected it as a optimum mix and gives a notation as TC and proceed the experiment by comparing the strength of ternary and quandary mix with conventional M30 mix.

B. Compression strength test result of blended mix with conventional mix

The cube with dimension of 150*150*150mm is prepared for each mix and the 28th day compressive strength is measured for each mix.

Fig. 2 Failure pattern of Cub

TABLE V COMPRESSIVE STRENGTH

MIX	Compressive Strength (N/mm^2)
Conventional Mix	35.11
TC	36.4
QC	31.1

C. Split Tensile Strength Test Result

Test has been conducted after 28 days of curing is conducted on 150mm diameter and 300mm length cylinders as per IS 5816-1999 and compare the strength of mix 1 and conventional concrete.

TABLE VI SPLIT TENSILE STRENGTH

MIX	Split Tensile Strength (N/mm^2)
CC	3.57
TC	4.24
QC	3.25

D. Flexural Strength Test Result

Test has been conducted after 28 days of curing is conducted on 100mm*100mm*500mm prism and compare the strength of mix 1 and conventional concrete.

TABLE VII FLEXURE STRENGTH

MIX	Flexure Strength
CC	3.29
TC	4.12
QC	3.18

V. DISCUSSION

1. On analyzing the above result, the compressive, Split Tensile Strength, Flexure Strength of Mix 1 (i.e. Ternary Mix) is high when compared to Conventional Mix and Mix 2 (i.e. Quaternary Mix).
2. The mechanical property of Quaternary Mix is little less than Conventional mix.
3. But the blended concrete has a possibility of gaining more strength at a period of 56^{th} day due to the addition of Fly Ash, because Fly Ash attain high strength after long time.

VI. CONCLUSION

1. The addition of SCM's in concrete results to enhance the properties of conventional concrete and decreasing the cement content so that it can reduce the harm to environment.
2. The ternary mix of Cement (70%)+Silica Fume (10%)+Fly Ash(20%) gives high compressive strength (17% higher) when compared to other ternary mix.
3. In durability property both ternary blended concrete and quaternary blended concrete gives high resistance than of conventional concrete.
4. The ultimate load carrying capacity of the Ternary Blended concrete beam shows 7.14% increase in strength than that of conventional concrete beam was as increase of the first crack load is about 10% than that of the conventional concrete.
5. The Energy absorption of Ternary Blended concrete shows increases of 59% than that of the conventional concrete
6. The partial replacement of OPC in concrete by waste material facilitates environmental friendly disposal of waste which is generated in huge quantities in industries
7. The cost of silica fume is bit costly but the overall cost of concrete is reduced due to the replacement of fly ash and rice husk ash

   The ductility factor of Ternary Blended concrete shows increases of 35% than that of the conventional concrete.

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