COMPRESSIVE STRENGTH OF CONCRETE BY USING TERTIARY BLENDS SUBJECTED TO DEVIATIONAL CURING

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Abstract – *Concrete failures at site are associated to several reasons ; right from concrete mix design, properties of materials used, mixing, placing, compaction, curing procedures and many more. The main objective of this project is to study the effect of deviational curing on the strength properties of concrete produced by using market available fly ash based cement, slag based cement and metakaolin based cement. The different deviational curing sequences adopted are(W0+A28),(W3+A25),(W7+A21),(W14+A14),(W28+A0), (A0+W28), (A3+W25), (A7+W21), (A14+W14) and (A28+W0). In this discussion (W3+A25) means the concrete is cured in water for the first 3 days and cured in air for the next 25 days. Also (A7+W21) means the concrete is cured in air for the first seven days and cured in water for the next 21 days.*

***Key Words*: Deviational curing, Fly ash, Metakaolin, GGBS, Rice husk ash, Silica fume, Compressive strength**.

1.INTRODUCTION

From an environmental stand point cement has a negative impact, because manufacturing it emits about a ton of green house gas (CO2) into the atmosphere for every ton of cement manufactured. The cement industry demands high amount of energy, exploitation of raw materials and quarrying and high cost production, thus arising a need to find an effective way to reduce cement demand. In order to reduce the cement needed for making concrete, supplementary cementitious materials (SCMs) that have properties similar to cement can be used to partially replace it. Some commonly known SCMs are fly ash (FA),Silica fume (SF), Ground granulated blast- furnance slag (GGBS), Metakaolin (MK), Rice husk ash(RHA). The SCMs used in this research are waste materials, or may also be called as by products, obtained from different major industries like thermal power stations, and iron and steel industries. These materials are pazzolonic in nature and studies have found them to have similar microstructure as that of cement. This makes them effective replacement of ordinary portland cement (OPC).

Cement can be replaced with one, two or three SCMs their making binary, ternary and tertiary blended concretes, respectively. This research work focuses on studying the properties of quaternary blended concretes, and comparing their compressive strength results with of 100% OPC concrete. This was done in order to find optimum percentages out of various combinations of blends, such that the performance of concrete with a SCMs is not compromised with respect to the performance of 100% OPC concrete.

Supplementary cementitious materials, which in itself possesses little or no cementitious properties. but in the presence of moisture, it chemically reacts with calcium hydroxide to form compounds possessing cementitious properties. Keeping all these things in view, and attempt has been made in present paper to study property namely compressive strength of M30 grade cement concrete using quarternary mixes in corporating OPC fly ash, silica fume, GGBS, rice husk ash and metakaolin, along with conplast SP-430 super plasticizer.

1.1 DEVIATIONAL CURING

Curing of concrete place a major role in developing the microstructure pore structure of concrete. Curing of concrete means maintaining moisture inside the body of concrete during the early ages and beyond in order to develop the desired properties in terms of strength and durability.

Curing is the process of controlling the rate and extent of moisture loss from concrete to ensure an uninterrupted hydration of portland cement after concrete has been placed and finished in its final position. Curing also ensures to maintain an adequate temperature of concrete in its early ages, as this is directly effects the rate of hydration of cement and eventually the strength gain of concrete or mortors. Curing of concrete must begin as soon as possible after placement and finishing and must continue for a reasonable period of time as per the relevant standards, for the concrete to achieve its desired strength and durability. Inform temperature should also be maintained throughout the concrete depth to avoid thermal shrinkage cracks. Also protective measures to control moisture loss from concrete surface are essential to prevent plastic shrinkage cracks. In a nut shell, curing process is designed primarily to keep the concrete moist by controlling the loss of moisture from the body of concrete, during the given period in which it gains strength.

Following methods are the different types of curing:

1.Shading of concrete work
2.Covering concrete surfaces with Hessian or Gunny bags.
3.Sprinkling of water
4.Ponding method

5.Membrane curing
6.Steam curing and
7.Deviational curing

Here Deviational curing is nothing but the type of curing adopted in different curing sequences of both air and water. The different deviational curing sequences adopted are (W0+A28), (W7+A21), (W14+A14), (W28+A0), (A0+W28), (A3+W25), (A7+W21), (A14+W14) and (A28+W0).

1.2 SCOPE OF STUDY

Tertiary blend is a better option than binary blend, which has some limitations. And their is a substantial saving in quantity of cement so less production of cement is required so environmental degradation is reduced, thus it also helps in sustainable development.

Here in this topic we are going to study the strength of concrete by replacing the ordinary portland cement by cementitious material like fly ash, silica fume, metakaolin, rice husk ash and GGBS have excellent compressive strength and flexural strength and it is suitable for structural applications.

2. OBJECTIVE

The main objective of this project is to know the effect of tertiary blends on the strength properties of concrete and also to know the effect of deviational curing on the strength of concrete.

1. To know the effect of mineral admixtures (tertiary blends) cement will be replaced by mineral admixtures such as metakaolin, silica fume, fly ash, rice husk ash and GGBS by 20% weight of cement.

2. To know the effect of deviational curing on the strength of concrete.

3. To compare the compressive strength of conventional concrete with the concrete having replacement of mineral admixtures subjected to deviational curing.

3. LITERATURE REVIEW

Sayali A, Aishwarya P Patil, etal (2017), “High Strength Concrete with varying content of Micro Silica”

Naitik patel, Shubham Modi, etal (2016), “Effect of Binary and Quarternary Blends on Compressive Strength”

Pendhari Ankush R, Nandakumar Gopalakrishnan (2016), “Study of High Strength Tertiary Blend Concrete with varying content of Micro Silica”

Anitha M Pujar, Dr K B Prakash (2014), “Effect of Deviational Curing on the Strength Properties of Concrete”

4. MATERIALS AND METHODOLOGY

4.1 MATERIALS

MATERIALS	PROPERTIES
Cement	43 grade[OPC]
Fine aggregate	Less than 4.75mm size[M sand]
Coarse aggregate	<20mm down size [angular]
Water	Suitable for drinking, free from suspended solids

4.2 METHODOLOGY

4.1.1 Metakaolin

Fig:4.1

It is obtained by heating the kaolin to the temperature 600 to 850°c

4.1.2 Rice husk ash

Fig:4.2

It is obtained by burning the rice husk at the temperature of 500 to 700°c

4.1.3 Silica fume

Fig:4.3

It is obtained after reducing high purity quartz with a coal in an electric arc furnace by heating up to 2000°c.

4.1.4 GGBS

Fig:4.4

It is obtained by Iron manufactured in blast furnace.

4.1.5 Fly Ash

Fig:4.5

It is obtained from thermal power station, after the drying process.

TESTS:

1. Cement: Initial & final setting time, Standard & normal consistency, Fineness test, Specific gravity.
2. Fine & coarse aggregate: Specific gravity, Moisture content, Particle size distribution.
3. Concrete:
   a)Fresh concrete: Slump test, Compaction factor, Vee- bee consistometer, Flow table.
   b)Harden concrete: Compression test.

Compression Test:

Compression Testing Machine

Compression strength (s)= P/A
Where, P is the maximum load applied to the specimen in Newton
A is the area of the specimen in mm.

DIFFERENT DEVIATIONAL CURING SEQUENCES

AX+WX	WX+AX
A0+W28	W0+A28
A3+W25	W3+A25
A7+W21	W7+A21
A14+W14	W14+A14
A28+W0	W28+A0

Where,
A is the Air, W is the water and X is the number of days.

5. RESULTS AND DISCUSSION

Table NO.1 Compressive strength test results

Description of deviational curing	Compressive Strength (MPa)		
	Metakaolin (series 1)	GGBS (series 2)	RHS (series 3)
A0+W28	38.41	43.20	29.12
A3+W25	37.15	39.45	28.82
A7+W21	36.63	38.25	28.23
A14+W14	32.74	32.60	27.80
A28+W0	28.29	29.20	24.36
W0+A28	29.10	28.17	22.42
W3+A25	35.94	38.32	25.83
W7+A21	36.83	44.12	26.20
W14+A14	39.16	42.78	28.15
W28+A0	38.10	43.63	30.25

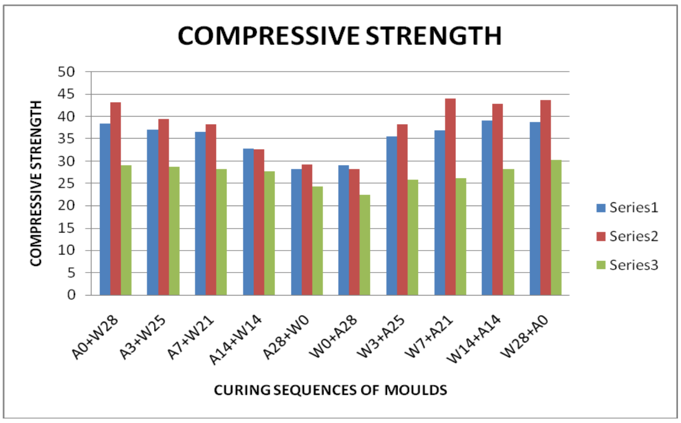

Fig-1: Variation of compressive strength subjected to deviational curing

It is observed that the compressive strength of concrete goes on increasing with deviational curing of (W0+A28) to (W28+A0). When the concrete is cured for (W0+A28), the strength obtained 29.10 MPa is where as that of the concrete when cured for (W28+A0) the strength obtained is 38.10 MPa. Intermediate values of strength were obtained for other deviational curing sequences such as (W3+A25), (W7+A21), and (W14+A14). Around 40 % of strength is affected for concrete which is cured under (W0+A28), as compared to the reference mix which is cured for 28 days in water. This discussion holds good for concrete produced with Metakaolin and GGBS based cement. Similar trends have been observed for concrete produced with the GGBS based cement and Rice husk ash based cement.

Thus it can be concluded that as the initial water curing period increases the concrete gains the compressive strength.

6. CONCLUSIONS

The following conclusion can be drawn based on the studies made.

1. As the initial water curing period increases the concrete gains the compressive strength and (W28+A0) gives higher compressive strength. This is true for concrete produced from fly ash based cement, slag based cement and metakaolin based cement.

2. As the initial air curing period increased, the concrete looses the compressive strength and is severely affected at (A28+W0). This is true for concrete produced from fly ash based cement, slag based cement and Metakaolin based cement.

3. Concrete produced from metakaolin and GGBS based cement can exhibit higher compressive strength when subjected to deviational curing.

4. As the initial water curing period increases up to the certain limit of days the concrete gains compressive strength i.e., (W7+A21) and (W14+A14) gives higher compressive strength . This is true for metakaolin based cement, slag based cement, rice husk ash based cement.

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