Effectiveness on mechanical properties of M60 grade SCC with partial replacement of cement by different mineral admixture like GGBS, lime powder and Metakaolin at various percentages

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Abstract Production of cement brings about the discharge of greenhouse gases which at last prompts an unnatural weather change on one hand. On other hand consumption of crude materials like limestone. So by utilizing elective materials we can lessen the creation of cement. Presently a day's the majority of the analysts are centered around replacement of cement with other mineral admixtures like Ground granulated blast furnace slag (GGBS), Metakaolin and lime powder and so forth without bargaining its mechanical properties and durability. Self compacting concrete doesn't need vibration for setting and compaction. This paper presents the outcomes on various mechanical properties of self compacting concrete utilizing the standard Portland cement, GGBS, lime powder and Metakaolin as binding material in making concrete. The hardened concrete properties like compressive strength, split tensile strength and flexural strength are found in trial work and comparison made with normal concrete.

Key words: M60 grade, SCC, GGBS, Lime powder and Metakaolin.

1. Introduction

Day by day development in human advancement keeps an eye on fast development in development movement with the end goal that elevated structures, honor shafts, express highways and gigantic developments. Self-compacting concrete (SCC) become first brought in Japan at some point of 1980's, given that then it has been the trouble to a few examinations in order to achieve the favored homes of concrete structures. Simultaneously the makers of parts have created more noteworthy and more prominent advanced plasticizers and stabilizers custom-made for the precast and the equipped mix industry. Self compacting concrete (SCC) has created as a progressive time, equipped for achieving the notoriety of being a spectacular advancement inside the field of concrete time. No vibration is crucial for SCC which could stream around obstacles, exemplify the reinforcement and top off the system totally under its own one of a kind self weight. Making concrete system without vibration were executed inside the past. For example, placement of concrete submerged is performed by means of the utilization of termite without vibration.

Self compacting concrete requires high slump esteems which can be created by utilizing super plasticizer expansion to the solid combination. In this current examination an exploratory ingestion was led to decide the functionality, compressive strength, split rigidity and flexural strength of M60 grade SCC by utilizing various rates of GGBS, Lime powder and Metakaolin, the blend extents utilized are 75%C+25%GGBS (M1), 75%C+15%GGBS+10%LP(M2), 75%C+15%GGBS+10%MK(M3), 75%C+10%GGBS+15%LP, and 75%C+10%GGBS+15%MK.
2. Materials used for the study

For this experimental study initially collect the necessary materials to make self compacting concrete the details of materials collection and specification are discussed in the below

Cement

Ordinary Portland cement of 53 grade was used in this experimentation changing in accordance with I.S. – 12269-1987. For the current assessment I was assembled ultra tech concrete of 53 evaluation from neighborhood. The model concrete pack used in this examination is showed up in the underneath figure 1. The particular gravity 3.14 and consistency 28%.

![Figure 1: OPC 53 grade Cement](image)

Sand (FA)

Locally accessible zone II with specific gravity 2.53, water absorption 2.5% and fineness modulus 2.92, changing according to I.S. – 383-1970. It is the aggregates which passes through 4.75 mm IS sieve and contains fundamentally quite a phenomenal extent of coarser as is permitted by detail which are appeared in the figure 2.

![Figure 2: Fine aggregates (Sand)](image)

Gravel(CA)

Coarse aggregates are those stones which are retained on IS 4.75mm IS sieve number the coarse
aggregates which are used in this experimental work is shown in below figure 3 the specific gravity is 2.6 and bulk density is 1523 Kg/m³ with water absorption is 2%.

![ aggregates](image)

**Figure 3:** 10mm size coarse aggregates

Mineral admixtures

**GGBS**

The Ground granulated blast furnace slag (GGBS) which is collected from JSW Allahabad is used in this experimental work.

**Metakolin**

Metakolin is the fine powder material which is utilized to improve the concrete strength and durability. The metakolin is appeared which is accessible at Adhipathi minerals kothapally.

**Lime powder**

Lime is fine powder which is collected from local areas used in this study.

**Super plasticizer**

Super plasticizer of master ease 3709 is used in this current study which is 1% of weight of the cement content.

3. Experimental investigation

For determine the mechanical properties of M60 grade self compacting mix cube, cylinders and beams are casted. The cubes of 150mmX150mmX150mm, cylinders of 150mm dia and 300mm length and beams of 150mmX150mmX500mm are utilized. All the specimens are permitted to curing for 7 days, 28 days at ambient temperature. Different mechanical properties of M60 SCC is determined. The compressive strength and split tensile of concrete is find by using compression testing machine (CTM).
The flexural strength is controlled by utilizing two point load test.

The different mix proportions used for this study is shown in the below table. Different proportions of GGBS, metakolin and lime powder is used as replacement for cement.

| Mix  | Cement (%) | GGBS (%) | Metakolin (MK) | Lime powder (LP) |
|------|------------|----------|----------------|------------------|
| M1   | 75         | 25       | 0              | 0                |
| M2   | 75         | 15       | 0              | 10               |
| M3   | 75         | 15       | 10             | 0                |
| M4   | 75         | 10       | 0              | 15               |
| M5   | 75         | 10       | 15             | 0                |

### 4. Testing procedure

**Fresh concrete tests**

Workability of concrete is determined by using EFNARC guidance for M60 SCC for different mix proportions. The workability tests like slump cone, L box, V funnel and U box test is determined the test results are shown in the below table.

| Property       | M1    | M2    | M3    | M4    | M5    |
|----------------|-------|-------|-------|-------|-------|
| Slump (mm)     | 650   | 630   | 615   | 590   | 570   |
| L-box (ratio)  | 0.9   | 0.86  | 0.81  | 0.75  | 0.7   |
| V-funnel (sec) | 10    | 11    | 12.5  | 14    | 16    |
| U-box (ratio)  | 0.8   | 0.75  | 0.77  | 0.8   | 0.79  |
**Harden concrete tests**

The hardened tests like compressive, split ductile and flexural strength of M60 grade Self compacting concrete is determined for 7 days and 28 days restoring by utilizing different extents of GGBS, metakolin and lime powder as a substitution for concrete.

**Compressive strength**

The compressive strength is resolved for 7 days and 28 days examples age by utilizing compression testing machine (CTM). The outcomes are appeared in the below table and chart.

**Table 3:** Compressive strength test results

| Mix  | Compressive strength(N/mm²) |
|------|-----------------------------|
|      | 7days | 28days |
| Mix1 | 48.2  | 71.33  |
| Mix2 | 46.3  | 69.66  |
| Mix3 | 39.23 | 59     |
| Mix4 | 45.27 | 67.33  |
| Mix5 | 20    | 29     |

**Graph 1:** Comparison of compressive strength of concrete

**Split tensile strength**

The split tensile is resolved for 7days and 28 days restoring. The split tensile is controlled by utilizing compression testing machine (CTM) the test outcomes are appeared in below table and chart
Table 4: Split tensile strength test results

| Mix   | Split tensile strength (N/mm²) |
|-------|--------------------------------|
|       | 7days                         |
|       | 28days                        |
| Mix1  | 4.02                          |
|       | 4.29                          |
| Mix2  | 3.98                          |
|       | 4.01                          |
| Mix3  | 3.03                          |
|       | 5.091                         |
| Mix4  | 3.18                          |
|       | 3.34                          |
| Mix5  | 3.32                          |
|       | 4.45                          |

Graph 2: Comparison of compressive strength of concrete

Flexural strength

The flexural strength of SCC is resolved for 7 days and 28 days restoring days to radiates example. The flexural strength is dictated by two point load test machine. The test outcomes are appeared in the below table and chart.

Table 5: Flexural strength test results

| Mix   | Flexural strength (N/mm²) |
|-------|----------------------------|
|       | 7days                     |
|       | 28days                    |
| Mix1  | 6.2                        |
|       | 9.2                        |
| Mix2  | 5.6                        |
|       | 6                          |
| Mix3  | 6                          |
|       | 6.2                        |
| Mix4  | 5.7                        |
|       | 6.5                        |
| Mix5  | 4.6                        |
|       | 5.6                        |
5. Conclusions of the study

1. Mix 1 obtained maximum compressive strength when cement is partially replace with 25% of GGBS compressive strength of M60 grade SCC Concrete.
2. For Mix 2 also at par with conventional concrete when cement was partially replace with GGBS.
3. For Mix 3 Split tensile strength is highest when compared.
4. The maximum flexural strength occurred for mix1 i.e addition of ggbs to 70% of cement without adding lime powder and metakaolin.

References

[1]. N.Ravi teja and K.V .Ramana "Investigation of solidarity properties of self Compacting Concrete with Rise Husk Ash and Lime-stone Powder as Admixture”. vol. 5, Issue 12, December 2016.
[2]. N.Bouzoubaa and M.Lachemi " Self Compacting Concrete Incorporating High-Volumes of Class F Fly Ash". Cement And Concrete Research, Vol. 31, No. 3, Mar 2001,pp. 413-420.
[3]. Gainster R. furthermore, Gibbs J., (2001) "Self-compacting solid section 1. The material an its property" Journal concrete, July/August 2001.
[4]. Kodama Y; "Current state of self-compacting concrete", cement shimbun, No.2304,Dec1997.
[5]. Koing G; Holschemacher K; Dehn F;Weibe D."Self-compacting solid Time of material properties and bond behavior".Proceedings of the second International Symposium on self-compacting concrete,Tokyo,(2001),pp507-516.
[6]. Nagataki S and Fujiwara H. "Self-compacting cement of high-flow able concrete", ACI Special Publications SP-154,June 1995, pp 301-314.
[7]. Okamura Hajime,"self-compacting superior concrete",(1997) solid global.
[8]. Ozawa K,"Development of high performance concrete dependent on the strength plan of solid structures".
[9]. Ozawa K, Sakara N, and Okamura H,"Evaluation of self-compatibility of new solid utilizing the Funnel test".
[10]. Seto K, Okada K, Yanai S, and Nobuta Y, "Development and uses of self-compacting concrete".
[11]. Bilodeau, A. furthermore, Malhotra, V. M. (2000). "High-volume fly debris framework:
Concrete answer for practical turn of events." ACI Materials Journal, Vol. 97, No. 1, pp. 41-48.
[12]. Dinakar, P., Babu, K. G., and Santhanam, M. (2008). "Sturdiness properties of high volume fly debris self compacting cements." Cement Concrete Composites, Vol. 30, No. 10, pp. 880-886.
[13]. Gesoglu, M., Güneyisi, E., and Özbay, E. (2009). "Properties of self compacting cements made with parallel, ternary, and quaternary cementitious mixes of fly debris, impact heater slag, and silica rage." Construction and Building Materials, Vol. 23, No. 5, pp. 1847-1854.
[14]. Gesoglu, M. furthermore, Ozbay, E. (2007). "Impacts of mineral admixtures on new and solidified properties of self-compacting cements: Binary, ternary and quaternary frameworks." Materials and Structures, Vol. 40, No. 9, pp. 923-937.