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Strength and durability properties of high strength self compacting concrete

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Abstract

Self compacting concrete (SCC) is highly flowable, non-segregating concrete that fills uniformly and completely every corner of formwork by its own weight and encapsulate reinforfcement without any vibration, whilst maintaining homogeneity. In this current construction practices SCC plays a very vital innovation or alternative to normal concrete. SCC is produced by the same materials as that used for the production of normal concrete. But the properties of every material used for the production has a vital influence on the features of fresh and hardened state of SCC. Designing a lower grade with required properties may be easier, so in this paper SCC with higher strength will be designed as per Indian Standard codes. Flow test, V-Funnel test, L-Box test for fresh or plastic concrete and compressive strength on 7th, 28th and 180days were carried out to observe the strength of concrete. Chloride and Sulphate content were analyzed during 180days to know about its durability. The results show that this mix produces a very good quality M60 grade SCC.

Introduction

With the tremendous development of construction industry, nowadays the demand is increasing for self-compacting concrete (SCC). Most of the sites have the issues of congestion of reinforcement in structural members. The design issues are combined due to the high risk of seismic zone, defenselessness to cyclonic storms. SCC has become the only choice in such unavoidable site environments. Ideally SCC has a minimal dependence on workers since the compaction occurs by its own weight. So concrete durability found increased due to lesser amount of honeycomb and segregations [13], [14], [15], [16], [17]. Hence its durability. This was the most important driving force behind the development of self-compacting concrete (SCC).

Self-compacting concrete is vital innovation in concrete technology because of its enhanced performance in any working environment. SCC is found used in all the elements like thin to heavy structures and also for architecture purpose [18], [19], [20]. SCC is known to be a very excellent technical advancement and an absolute evolution in concrete technology for ages. SCC is a concrete of future, as it will be replacing normal concrete due to its distinct advantages. Key factor during the design is that SCC mix requires high powder content and lesser quantity of coarse aggregate.

Self-compacting concrete (SCC) also called as Self consolidating concrete or Rheodynamic concrete is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completing filling formwork and achieving full compaction, even in the presence of congested reinforcement [21], [22]. The hardened concrete is dense, homogeneous and has at least engineering properties at par with and durability as traditional vibrated concrete. The principle behind Self-compacting concrete (SCC) is that the settlement of aggregate is related to the viscosity of the fresh concrete. SCC has many benefits in terms of production and placement compared to traditional concrete, namely elimination of internal or external vibration for compaction, better flowablity, workability and pumpability as well as increasing bonding with congested reinforcement.

SCC can be produced using the same ingredients as that of the normal concrete. However, a close tolerance is needed to ensure strict control of workability characteristics. The proportioning of SCC mix is much more scientific than that of the conventional concrete mixes. SCC mix requires high powder content, lesser quantity of coarse aggregate, high range super plasticizer and Viscosity modifying agent to give stability and fluidity to concrete mix. The workability of SCC is equilibrium of fluidity, deformability, filling ability and resistance to segregation [1], [2], [3]. This equilibrium has to be maintained for a sufficient time period to allow for its transportation, placing and finishing. Combinations of tests are required to characterize the workability properties [4], [5], [6], [7]. SCC is a concrete of the future, as it well be replacing normal concrete due toits distinct advantages.

Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow round congested reinforcement. The fluidity and segregation resistance of SCC ensures high level of homogeneity, minimal concrete voids and uniform concrete strength, providing the potential for superior level of finish and durability to the structure. SCC is often produced with low water-cement ratio providing the potential for high early strength, earlier de-molding and faster use of elements and structures. The improved construction practice and performance, combined with the health and safety benefits, make SCC a very attractive solution for both precast concrete and on-site civil engineering [8], [9], [10], [11], [12]. The fluidity and segregation resistance of SCC ensures a high level of homogeneity, minimal concrete voids and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure. SCC is often produced with a low water cement ratio providing the potential for high early strength, earlier demolding and faster use of elements and structures.

Section snippets

Data for mix design

1. Grade of concrete: M60…
2. Characteristics compressive Strength: 60.0N/mm^2…
3. Maximum Size of Aggregates:12.5mm down…
4. Type of exposure: Moderate…
5. Degree of quality control: Good…
6. Target mean compressive strength: 68.25N/mm^2…

…

Test data of materials

1. **Cement:** Ordinary Portland 53 grade JSW cement was used for the study [23], [24], [25], [26]. All the Physical properties were satisfied as per IS 269–2015 requirements. The tests conducted and results are as follows;…

a. Consistency: 28.0%…

b. Initial setting time: 165minutes…

c. Final setting time:…

…

Properties of concrete in plastic state

From Table 5 it shows that;

- As per the design mix concrete flows and fills under its own weight without any segregation observed through visible eye. Concrete produced can be pumped and casted from top with free displacement from delivery point. Thus, satisfying SF1 requirements as per IS 10,262 2019.…
- Concrete with low viscosity will have a very quick initial flow and then stop. Concrete with a high viscosity may continue to creep forward over an external time. Viscosity is measured using a…

…

Conclusion

To conclude the mix is perfect, all the properties of fresh and hardened state were checked. To analyze the durability of concrete, Chloride and sulphate tests were conducted. Based on the above-mentioned results, the proposed concrete mix is found satisfactory. However, during the production of the mix following points are to be incorporated:

- The mix proportions recommended above should be tried in the field using the proposed materials and finalized by observing the actual performance of the…

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.…

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