A Review Paper on Self-Compacting Concrete

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Abstract

Historically, concrete structures were created without the use of compression, including applications like underwater concrete placement via a tremie, which also operates without compression. These techniques are often used in inaccessible areas. The production of such mixtures frequently involved costly additives and large amounts of cement. However, the strength of these concrete mixtures was typically low, making them impractical for many uses. This led to the development of Self-Compacting Concrete (SCC). The key properties of SCC, including its filling capacity, ability to flow, and resistance to segregation, are evaluated through workability tests such as the slump flow, V-funnel, and L-box tests.

Keywords

Self-Compacting Concrete, Flow-ability, Passing Ability, Resistance to Segregation, Fly Ash, Superplasticizer.

I. INTRODUCTION

Self-Compacting Concrete (SCC) is a ground breaking material that eliminates the need for mechanical vibration during placement and compaction. It is able to flow and fill forms under its own weight, ensuring a dense, uniform, and durable hardened state similar to conventionally vibrated concrete. Techniques for creating concrete without compression have been in use for some time, such as underwater placement using a tremie. These methods have been applied in areas that are difficult to access.

Traditionally, these concrete mixtures required costly additives and large quantities of cement but often resulted in low strength, which was a significant limitation. This led to the development of SCC in Japan during the 1980s. SCC's unique property is its ability to fill voids fully without segregation, excessive bleeding, or other material separation without the need for mechanical consolidation. The key performance indicators of SCC include its ability to flow and pass through narrow spaces without clogging, as well as its resistance to segregation. These properties help ensure that the concrete fills all spaces in the form and maintains a uniform composition.

The primary applications of SCC aim to produce concrete with improved performance, reliability, durability, and high strength, making it ideal for rapid construction. To achieve the required fluidity, SCC typically uses high-performance superplasticizers and may include materials like silica fume, fly ash, glass powder, or stone dust. SCC has been successfully used in countries such as Japan, Denmark, France, and the UK, where it has contributed to reduced noise pollution, as well as savings in time, labor, and energy.

II. LITERATURE REVIEW

Ozawa et al. (1989) investigated the fluidity and segregation resistance of SCC, focusing on the impact of mineral additives like fly ash and blast furnace slag. They concluded that replacing a portion of Ordinary Portland Cement (OPC) with fly ash (10-20%) and slag (25-45%) improved fluidity without compromising strength.

Domone and His-Wen (1997) conducted slump tests on highly workable concrete, finding a beneficial relationship between slump values and flow rates. Their tests showed that higher flow rates were achieved with higher slump values.

Bui et al. (2002) introduced a rapid method for assessing the segregation resistance of SCC, utilizing an extensive testing program on SCC mixtures with varying moisture-to-binder ratios and aggregate combinations. Their results highlighted the importance of assessing both vertical and horizontal separation resistance.

Xie et al. (2002) developed a high-strength SCC incorporating superabsorbent fly ash and a hot plasticizer, optimizing processability, mechanical properties, and durability. They found that this mix maintained consistent slump flow (600-750 mm) and L-box flow rates (35-80 mm/sec).

Lachemi and Hossain (2004) studied four types of viscosity-modifying agents (VMAs) in SCC production. They assessed the fresh and cured properties, and found that satisfactory flow was achieved in the V-funnel test, where flow time under 6 seconds indicated good deformation resistance.

Cengiz (2005) explored the use of fly ash in SCC, replacing up to 70% of OPC with fly ash. His research confirmed that high volumes of fly ash could produce flexible, high-strength SCC, showing strong compressive and flexural tensile strength correlations.

Ferrara et al. (2006) evaluated key properties of High-Performance Self-Compacting Concrete (HPSCC), including fluidity, segregation resistance, and filling capacity. Their tests found that SCC achieved the desired performance when these properties were optimized.

Kumar (2006) examined SCC development history and testing methods, concluding that mixing characteristics significantly influence SCC performance. His findings suggested that the Orimet test better simulates actual placement conditions compared to slump flow tests.

Sahmaran et al. (2007) investigated fiber-reinforced SCC with high fly ash content. Their results showed that the inclusion of 50% fly ash as a replacement for cement resulted in well-performing mixtures, with slump flow diameters within the acceptable range.

Khatib (2008) studied the effects of fly ash (FA) on SCC, replacing up to 80% of Portland cement. The research found that FA improved strength, workability, shrinkage, and ultrasonic pulse velocity, with an optimal 40% FA replacement resulting in concrete with compressive strengths exceeding 65 N/mm² at 56 days.

Grdić et al. (2008) evaluated SCC mixed with various additives like silica fume and fly ash, using the L-box test to assess the material's ability to pass through narrow enclosures without clogging. They found that the mix exhibited good flowability and consistency.

Miao (2010) developed SCC with up to 80% cement replacement, noting that fly ash acted as a lubricant and reduced the need for superplasticizers. This resulted in SCC mixes with better flow properties.

Heba (2011) conducted an experimental study on SCC with varying amounts of fly ash and silica fume. Her results indicated that incorporating up to 30% fly ash increased compressive strength, with 15% fly ash yielding the highest strength.

III. CONCLUSION

Increasing the amount of fine material in the mix enhances the stability (cohesion) of fresh concrete and reduces segregation potential. Experimental results have shown that partial replacement of fine aggregates with mineral additives can produce SCC with low segregation potential when evaluated by the V-funnel test. Key factors influencing SCC properties include the type and amount of coagulant, binder, mixed water, and superplasticizers. Tests such as slump flow, V-funnel, L-box, U-box, and compressive strength have been used to evaluate SCC performance. Incorporating mineral admixtures, such as fly ash, can enhance the flowability and consistency of SCC, ensuring it meets the necessary standards for construction.

REFERENCES

[1] Bui, V.K.; Montgomery, D.; Hinczak, I. and Turner, K. (2002).Rapid testing method for segregation resistance of self- compacting concrete.Cement and Concrete Research. 32: 1489-1496.

[2] Cengiz, Duran Aity (2005). Strength properties of high- volume fly ash roller compacted and workable concrete and influence of curing condition. Cement and Concrete Research. 35: 1112-1121.

[3] Domone, P. and His- Wen, C (1997).Testing of binders for high performance concrete research. Cement and Concrete Research.27: 1141- 1147.

[4] Domone, P. (2007). A review of the hardened mechanical properties of self- compacting concrete. Cement and Concrete Composites. 29: 1-12..

[5] Ferrara, Liberato; Park, Yong- Dong and Shah, Surendra P. (2006).A method for mix design of fibre reinforced self-compacting concrete. Cement and Concrete Research. 37: 957-971.

[6] Grdić, Zoran; Despotović, Iva and TopličićĆurčić, Gordana (2008).Properties of self- compacting concrete with different types of additives. Architecture and Civil Engineering (Volume 6, No. 2: 173-174)

[7] Heba, A. Mohamed (2011).Effect of fly ash and silica fume on compressive strength of self- compacting concrete under different curing conditions.Ain Shams Engineering Journal. 2: 79-86.

[8] Khatib, J.M. (2008). Performance of self- compacting concrete containing fly ash.Construction and Building Materials. 22: 1963-1971

[9] S. Kumar, P.(2006).Methods of testing and design. IE (I) Journal- CV, Volume 86: 145-150.

[10] Lachemi, M and Hossain, K.M.A. (2004). Self- consolidating concrete incorpating new viscosity modifying admixtures. Cement and Concrete Research. 34: 917-926.

[11] Miao, Liu (2010).Self- compacting concrete with different levels of pulverized fuel ash. Construction and Building Materials. 24: 1245- 1252.