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Characteristics and Performance of Flowing Concrete {Review Study}

Eethar Thanon Dawood and Mahyuddin Ramli
School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 Penang, Malaysia

Corresponding Author: Eethar Thanon Dawood, School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 Penang, Malaysia

ABSTRACT
The use of flowing concrete is significantly increased in the last decades. The development of flowing concrete or Self Compacted Concrete (SCC) enables the construction Engineers to use this material as one of the best solution for different types of field applications. Therefore, this study is a trial to highlight the importance and the performance of the flowing concrete and show the enhancement obtained in the properties of concrete by using this material.

Key words: Flowing concrete, high performance concrete, self compacted concrete, superplasticizer

INTRODUCTION
The production of flowing concrete was regarded very difficult in the past due to the ignorance of superplasticizers. The basic advantages of superplasticizers include (Kosmatka *et al.*, 2002; Dawood and Ramli, 2010a, 2011a):

- High workability of concrete resulting in easy placement without an increase in cement-content or reduction of strength
- High strength concrete with normal workability but lower water content
- A concrete which requires less cement but has a normal strength and workability

The effect of a superplasticizer on the properties of concrete has been investigated by many researchers. These admixtures can be added to concrete with a low-to-normal slump and water-cement ratio to attain high-slump flowing concrete. Mortar testing serves as the basis for the workability properties of Self-Compacting Concrete (SCC). In fact, assessing the properties of Self-Compacted Mortar (SCM) is an integral part of the SCC design (Sahmaran *et al.*, 2006). Flowing concrete is a high fluidity concrete that can be used with little or no vibration or compaction without excessive bleeding or segregation. Flowing concrete is used for the following applications (Dawood and Ramli, 2010b, 2011b):(1) thin-section placements, (2) areas of closely spaced and congested reinforcing steel, (3) tremie pipe (underwater) placements, (4) pumped concrete to reduce pump pressure, thereby increasing lift and distance capacity, (5) areas where conventional consolidation methods are impractical or cannot be used and (6) to reduce handling costs. Adding superplasticizer to a 75 mm slump concrete can easily produce a concrete with a 230 mm slump. Flowing concrete is defined by ASTM C 1017 as concrete with a slump greater than 190 mm which still maintaining cohesive properties.

The performance of flowing concrete: The setting time may be accelerated or retarded based on the admixture's chemistry, dosage and interaction with other admixtures and cementitious materials in the concrete mixture. Superplasticized concretes often bleed significantly less than control concretes of equally high slump and higher water content. The drying shrinkage of high-slump, low-water-content, superplasticized concrete is usually less compared to a high-slump, high-water content conventional concrete; however this concrete may result in a higher shrinkage upon drying than conventional low-slump, low-water-content concrete (Kosmatka *et al.*, 2002).

The effectiveness of the superplasticizer is increased with a higher amount of cement and fines in the concrete (Ramli and Dawood, 2008; Dawood and Ramli, 2011c; Kosmatka *et al.*, 2002).

Self Compacting Concrete (SCC) represents one of the most significant development in concrete technology for decades. Inadequate homogeneity of cast concrete due to poor compaction or segregation may drastically lower the performance of concrete *in-situ*. Self-compacting concrete was developed to ensure adequate compaction and facilitate placement of concrete in structures with congested steel reinforcement and in restricted areas. Self-compacting concrete was first developed in the late 1980s, mainly for use in highly congested reinforced structures in seismic regions (Bouzoubaa and Lachemi, 2001; Dawood and Ramli, 2011a). Since the durability of concrete structures became an important issue, adequate compaction by skilled labours was required to obtain durable concrete structures. This requirement led to the development of SCC and its development was first reported in 1989 (Okamura and Ouchi, 2003).

Self-compacting concrete can be described as a high performance material which flows under its own weight without requiring vibration to achieve consolidation by complete filling of form works even when access is hindered by narrow gaps between the reinforcement bars (Zhu *et al.*, 2001). It can also be used in situations where it is difficult to use mechanical compaction for fresh concrete, such as underwater concreting, cast in-situ pile foundations, columns or walls with congested reinforcement and basis machine. The high flowability of SCC makes it possible to fill the formwork without vibration (Khayat and Morin, 2002). Since its inception, SCC has been widely used in large constructions (Okamura and Ouchi, 2003) and more recently, its' use has become widespread for different applications and structural configurations (Bouzoubaa and Lachemi, 2001).

Self-compacting concrete can also be regarded as "the most revolutionary advances in concrete construction for several decades". Originally developed to offset a growing shortage of skilled labour, it is now taken up with enthusiasm for both site and precast concrete work (EFNARC 2002).

Su and Miao (2003) reported a new method for the mix design of medium strength flowing concrete with a low content of cement. The proposed method determines the packing factor (aggregate content) first and then fills binding paste containing fly ash and granulated blast-furnace slag into the voids between aggregates to make concrete with the desired workability and strength. Tests on slump, slump flow and compressive strength were carried out and the results indicate that medium strength flowing concrete can be successfully produced using this method. Concrete mixtures designed by using this proposed method require a small quantity of binder and are therefore very economical.

High-Performance Concrete (HPC) technology has been one of the most important subjects in concrete research since HPC has unique properties and numerous advantages in practical applications. Among them, the fine workability (i.e., easy placing and consolidation) is one of the most representative characteristics. For this reason, the use of such concrete is quickly spreading worldwide. Nowadays, the workability of HPC is mainly evaluated by the slump test or the flow test (Yen *et al*., 1999; Dawood and Ramli, 2009). An alternative test method adopted in Japan and Taiwan is the slump-flow test (JSCE-F503, 1990; Ramli and Dawood, 2008) which is simply a measurement of the diameter of the concrete after it has collapsed in a standard slump test.

CONCLUSIONS

The use of flowing concrete or SCC is so important especially due to its applications in the different types of structures field. The mix design and the experimental tests are so important to understand the performance of this material in this regards. The flowability, compressive strength and durability performance among others, should be tested and thus the overall performance of the flowing concrete can be evaluated depending on the experimental test results.

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