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The development of new empirical apparatuses for evaluation fresh properties of self-consolidating mortar: Theoretical and experimental study

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HIGHLIGHTS

- Based on the theory of volume-to-surface ratio, mini L-box, mini U-box and new mini V-Funnel apparatuses were suggested.
- The relationships between recommendation ranges of SCMO empirical apparatuses were considered.
- Fluid flow velocity in mini V-Funnel, new mini V-funnel and mini Orimet tests was investigated.
- Based on the flow velocity, new time interval for mini V-funnel was proposed.

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ABSTRACT

Self-Consolidating Concrete (SCC) and Self-Consolidating Mortar (SCMO) contain unique properties such as filling ability, passing ability, and segregation resistance, differentiating them from ordinary concretes. Little changes in SCMO and SCC ingredients bring about major changes in their workability and segregation. The behavior of fresh SCMO depends on variable factors such as water to cement ratio, gradation and moisture content of aggregates, type of mineral additives, dosage and type of superplasticizer and other chemical admixtures. In addition, evaluation of fresh properties of the SCMO requires simple and fast methods.

In this study, based on the flow velocity and volume to surface ratio method, new apparatuses were developed to evaluate the fresh properties of SCMO. Mini J-ring, mini U-box, and mini L-box were used to measure passing ability parameters. Mini slump, mini Orimet, new mini V-funnel and mini V-funnel were used to measure filling ability and mini column segregation was used to measure segregation of self-consolidating mortars. The relationships between critical areas of mentioned methods are considered. The Experimental set-up method was used to record the fresh properties. In addition, 27 different mortar mixtures were prepared to verify the test methods. Results show that flow velocity and volume to surface ratio were appropriate criteria to design new apparatuses to measure fresh properties of self-consolidating mortar.

1. Introduction

Self-Consolidating Concrete (SCC) was first developed in Japan in the 1980s to reduce or eliminate vibration and improve quality, workability, and homogeneity of concrete [1]. SCC is a special type of concrete which is compacted under its own weight with no signs of segregation or bleeding [2,3]. Many studies have been conducted on SCC; for instance, Daszko et al. [4] Studied about passing ability of SCC, Sonebi et al. [5] considered passing ability and filling ability of SCC and Bui et al. [6] and Libre et al. [7] continued the investigation on the stability and segregation resistance of SCC. Placement of fresh concrete through congested reinforcement structures and be compacted under self-weight are important subjects in construction industry [8–11]. Mechanical vibrators are used for compaction and placement of ordinary concrete that make much noise and

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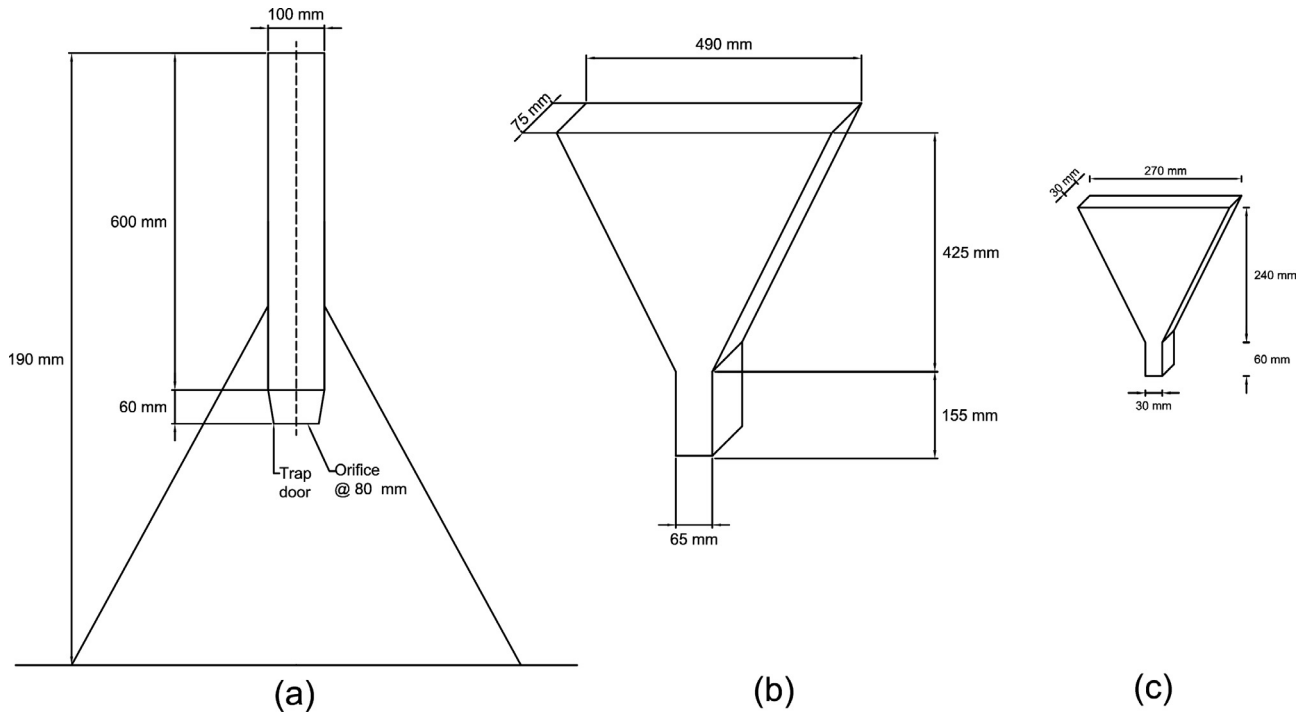

Fig. 1. Configuration of (a) Orimet, (b) V-Funnel and (c) mini V-funnel [18].

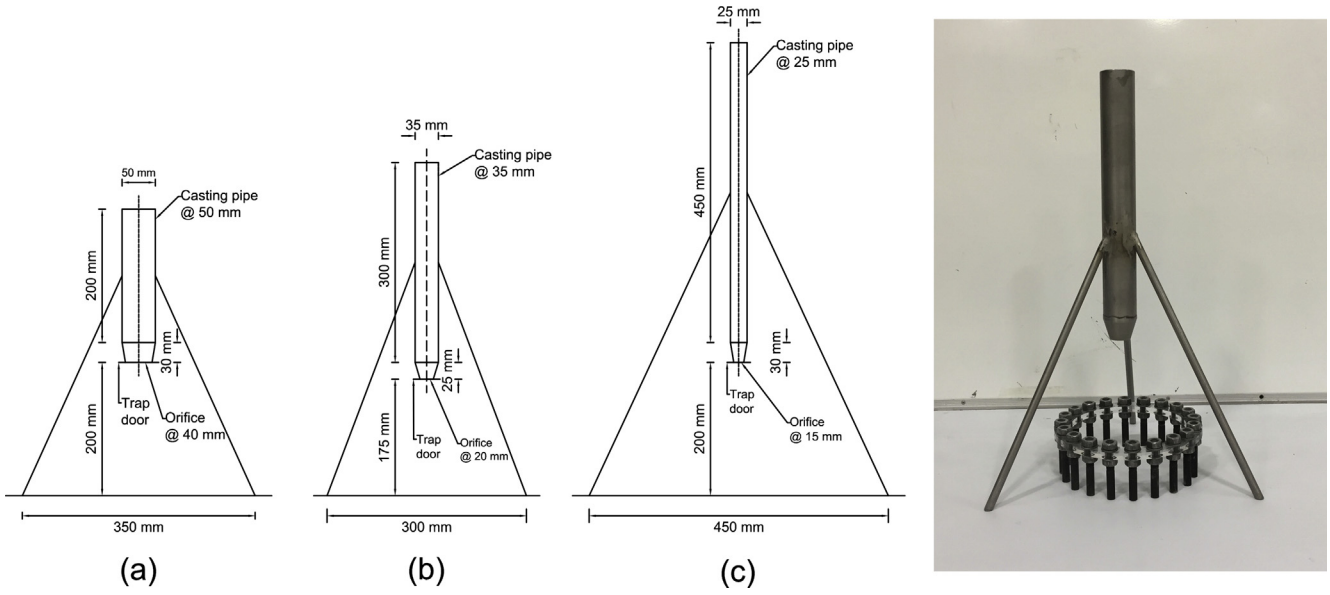

Fig. 2. Configuration of (a) mini Orimet-a, (b) mini Orimet-b and (c) mini Orimet-c [22].

Table 1
Volume to surface ratio ($\frac{\forall}{A}$) of Orimet and mini Orimet apparatuses.

	Orimet (Fig. 1a)	mini Orimet _a (Fig. 2a)	mini Orimet_b (Fig. 2b)	mini Orimet_c (Fig. 2c)
$\forall$(lit)	5.1	0.44	0.305	0.23
A (cm^2)	50.26	12.57	3.14	1.77
$\frac{\forall}{A}$ (m)	1.01	0.35	0.97	1.3

require labors [12–14]. By increasing passing ability and filling ability, the risk of segregation increases; increasing the segregation reduces the stability of the concrete and causes bleeding and reduce

Table 2
Comparison between flow velocities of Orimet with mini Orimet_a, b and c.

Δt (s)	V (m/s)			
	Orimet (Fig. 1 a)	mini Orimet_a (Fig. 2a)	mini Orimet_b (Fig. 2b)	mini Orimet_c (Fig. 2c)
1	1.01	0.35	0.97	1.3
2	0.51	0.175	0.48	0.65
3	0.34	0.12	0.32	0.42
4	0.25	0.09	0.24	0.32
5	0.2	0.07	0.19	0.26