The Segregation of High Fluidity Concrete Subjected to Different Frequency and Amplitude of Vibration

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1. Introduction

Vibration has been one of the most important methods of placing fresh concrete. In the advent of High Range Water Reducing agent, the workability of fresh concrete has advanced such that it is able to flow under its own weight and at different viscosity. This has cast doubt on the use of vibrator to place such concrete particularly the problem of segregation. Recognizing high fluidity concrete as having both yields stress and plastic viscosity, a study was undertaken to examine the segregation of concrete of different flow range and viscosity. The main objective was to investigate the effect of different frequency and amplitude on the tendency to segregate.

2. Experimental Steps

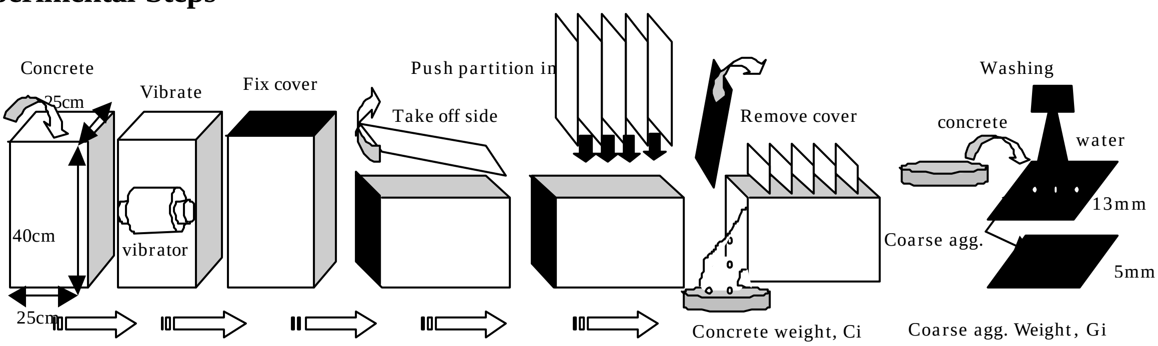

Fig. 1 Experimental steps for getting weight of concrete and coarse aggregates

The experimental steps are schematically shown in Fig. 1. The dimension of the formwork is 25 x 25 x 40 cm. A form vibrator, attached on its side, was chosen due to ease in changing frequency and amplitude. The concrete was vibrated for 10s before let to set. To obtain the coarse aggregate profile, it was divided into equal parts by means of metal slides. This approach relied on the knowledge that aggregate settlement stops immediately after vibration is terminated [1]. The sides of the formwork have guides to ensure vertical insertion. The weight ratio of coarse aggregates to concrete was measured and the segregation coefficient, SC is given as [1]. Table 1 shows the mix proportion to obtain high fluidity concrete of different flow and viscosity. A standard cone and V-funnel test (JSCE-F 512-1999) were used to measure flow and viscosity respectively. Three levels of frequency (viz 160, 170 & 180 Hz) and two levels of amplitude (viz 0.05 & 0.10 mm) were selected.

Table 1 High fluidity concrete mix (Kg/m^3)

W/C	W	C	S	G	Sp (%) (C x %)
0.27	165	600	800	850	1.7-2.5
0.29	175				1.8-3.3
0.31	185				2.8-3.0

$$\mathrm{SC} = \sqrt{\frac{s\sum(1-x_i)^2}{H}} \qquad [1]$$

$$x_i = \frac{(G/C)_i}{(G/C)_{average}}$$

$$\left(\frac{G}{C}\right)_i = \frac{\text{weight of coarse agg. in each tray}}{\text{weight of concrete in each tray}}$$

$$\left(\frac{G}{C}\right)_{ave.} = \frac{\text{total weight of coarse agg.}}{\text{total weight of concrete}}$$

Height of formwork, H = 40cm
Distance between partitions , s = 8 cm

キーワード：High fluidity concrete, Vibration, Segregation, Frequency, Amplitude

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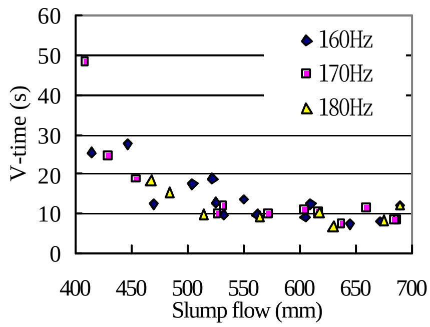

Fig.2 Graph of slump flow Vs V-time

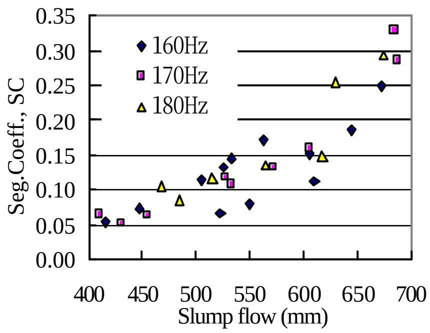

Fig.3 Graph of Slump flow Vs SC

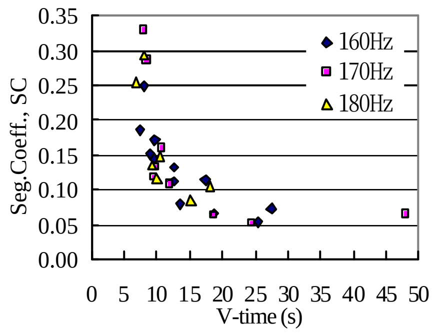

Fig.4 Graph of V-time Vs SC

3. Experimental results

The results of slump flow and V-funnel time for the mixed concrete are graphically shown in Fig. 2. The high fluidity concrete covered the range of slump flow between 400–750 mm and V-time range of 7-50s. The results of SC with respect to slump flow and V-time are shown in Fig. 3 and 4. A vibration of 160, 170 & 180Hz (displacement 0.05mm) showed little variation in SC values. Despite its high workability, a 10–20Hz difference was not significant to cause any major segregation results. The slump flow curve is best described by a power law with a point of inflexion close to a slump value of 500mm. On the other hand, the V-time curves indicated that any concrete having V-time less than 10s are liable to segregate easily. Combining both the effects of flowability and viscosity, a slump/V-time ratio is plotted against SC in Fig. 5. The slump/V-time ratio had been introduced as a factor to describe the fresh property of high fluidity concrete[2]. It became apparent that high fluidity concrete with slump/V-time ratio less than 0.04 have high resistance to segregation while that above 0.08 were easily segregated. Fig.6 compared the SC result of concrete vibrated with 0.10mm amplitude. At the region of slump/V-time ratio above 0.08 vibrations at 0.10mm amplitude showed greater SC values than that of 0.05mm.

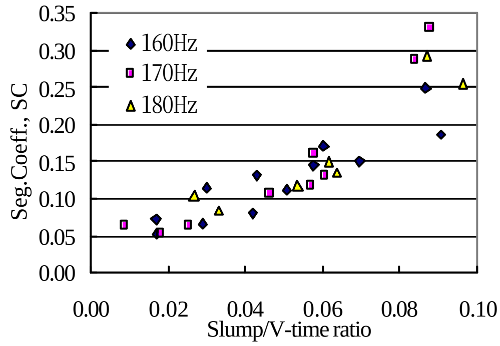

Fig.5 Graph of Slump/V-time ratio Vs SC

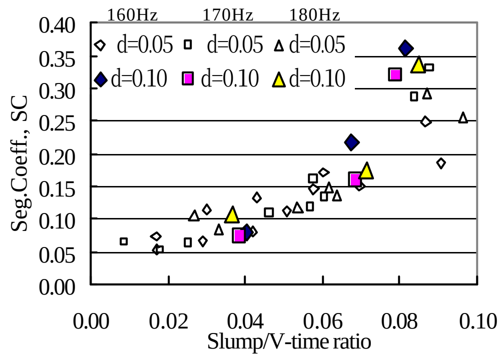

Fig.6 Comparing vibration displacement of 0.05 & 0.10mm

4. Conclusion

Vibration should not be applied to high fluidity concrete with slump flow less than 500mm or V-time less than 10s or else segregation problem would be expected. In terms of slump/V-time ratio, for value above 0.08 no vibration should be applied while less than 0.04 application of vibration is deemed possible. In between these two values, calculated input of vibration is possible while keeping the level of segregation to the minimum. Higher amplitude of vibration gives greater degree of segregation for high fluidity concrete with slump/V-time ratio above 0.08.

References

1) Petrou, M.F., et al, “Influence of Mortar Rheology on Aggregate Settlement”, ACI Mat. Journal, July/Aug. 2000
2) Safawi, M.I., et al, “Introducing the Slump/V-time ratio to Describe the Workability of High Fluidity Conc.” Tohoku JSCE Conf., 2003