V − 5　A Study on Vibration Susceptibility of High Fluidity Concrete

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1.0 Introduction

High fluidity concrete is characterized by its ability to flow under its own weight. If the viscosity of mix is optimum and it has sufficient flowability, the mix will not require vibration for placement as the case for Self-Compacting concrete or SCC. However, in a construction site, there is a possibility of missing the SCC criteria. Some of the practical problems published by Ouchi and Nakajima[1] include shutting down of mixer due to the high viscosity of SCC, insufficient flowability achieved from not enough mixing, varying flowability between batches as a result of pre-cooling of aggregates especially in summer casting, drastic change in flowability when the HRWR was affected by the high ambient temperature, and poor flowability after pumping of concrete. In this study, a broad range of high fluidity concrete as categorized in Table 1 was vibrated to assess the ability of such concrete to undertake vibration.

Table 1 Types of mix vibrated with respect to SCC

Mix	Mix category	Slump (mm)	V-time (s)
	SCC target	600-700	8-12
1	Low flow high V-time	400-500	12-20
2	Moderate flow, SCC V-time	500-600	8-12
3	SCC flow, low V-time	600-700	6-8
4	VEA treated mix	Above 700	6

2.0 Experimental Steps

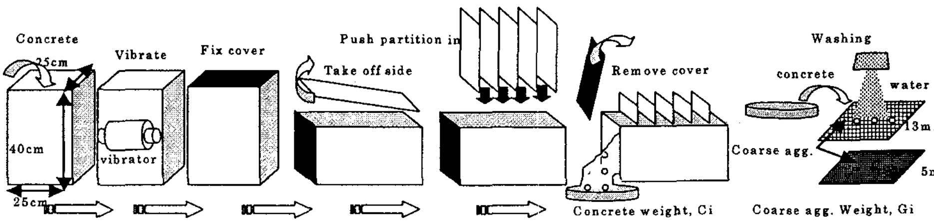

Fig.1 Schematic diagram of experimental steps

(mm)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. 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]. 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 three levels of amplitude (viz 0.03, 0.05 & 0.10 mm) were selected. In Mix 4, very high fluid and low viscous mix, a VEA was added to enhance its viscosity before applying vibration.

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

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

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

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

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

3.0 Experimental results

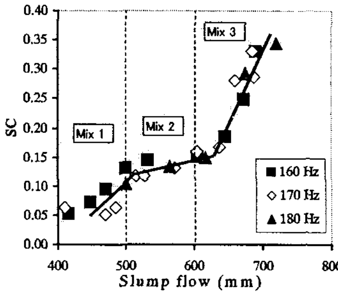

Fig.2 Vibration results of Mix 1, 2 & 3

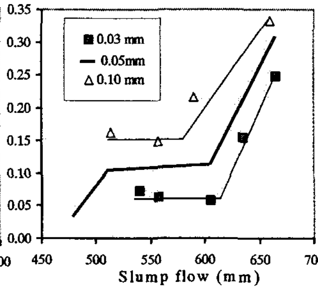

Fig.3 Results of different amplitude

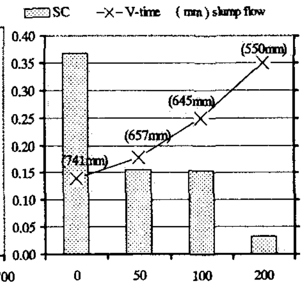

Fig.4 SC for Mix 3 using VEA

Fig.2 shows the vibration results for Mix 1, 2 & 3 vibrated for 160, 170 and 180 Hz with amplitude 0.05mm. The SC values for Mix 1was comparatively small and indicate little or no segregation. The threshold value of SC to show segregation has been established as 0.10 from earlier investigations[2]. It was found that low flowability mix can take up vibration easily. In the case of Mix 2, all mixes seemed to have same SC value, probably due to similarity in viscosity. This indicated that at mixes with optimum viscosity could accept vibration despite insufficient flowability. Last but not least, Mix 3 proved that highly flowable mix with low viscosity could not accept any form of vibration as shown by the abrupt change in SC values. In the following experiments, the amplitude of vibration was changed from 0.05mm to 0.03 and 0.10 mm. Higher amplitude of vibration gave a greater degree of segregation. The trend in SC was similar to the previous one except in magnitude. Finally, very highly flowable mix was treated by VEA as a form of *treatment* before applying vibration. For different dosages of VEA from 50-200g/m^3, the slump flow and V-time of mix also changed accordingly. The results of vibrating such mixes indicated that at an optimum dosage of VEA, such mix could be vibrated without incurring much problem. Based on the vibration done on high fluidity concrete, a vibration susceptibility graph was proposed in Fig. 5. This graph shows the range of slump flow and V-time that could easily accept vibration or needed optimum vibration or prior treatment with VEA.

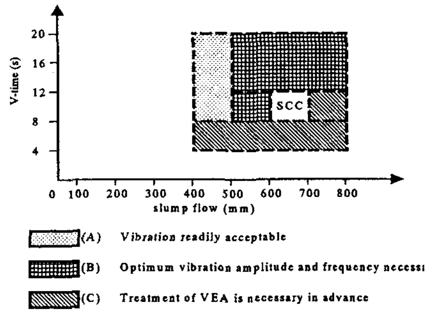

Fig.5 Vibration susceptibility graph

4.0 Conclusion

It was concluded that high fluidity mix could still accept some form of vibration. The degree of vibration depends much on the viscosity of mix. The vibration susceptibility depends on the range of slump flow and V-time of different mixes. At least, three vibration conditions prevailed; viz mix that could accept vibration easily, mix that needed an optimum vibration level and mix that require treatment with VEA before applying vibration.

【References】

1. Ouchi, M. and Nakajima, Y., "A Guide for Manufacturing & Construction of Self-Compacting Concrete – Learning from Real Troubles", COMS Engineering Corporation, 2001
2. Safawi, M.I., Iwaki, I., & Miura, T, "A Study on the V-Funnel Time with Respect to Flowability, Reliability and Segregation Tendency," - Cement Science and Concrete Technology, 2003, No.57