V－23 振動締固めを行った高流動コンクリートの材料分離に関する研究

A Study on Segregation of High Fluidity Concrete Induced by Vibration

東北大学　学生会員　○Safawi Mohammad Ibrahim
東北大学　三浦一浩
東北大学　フェロー　三浦　尚

1.0 Introduction

The properties of fresh concrete have changed tremendously since the introduction of powdered materials and the high reduction of water-binder ratio. Addition of powdered materials caused the fresh concrete to increase in viscosity while usage of High Range Water Reducing (HRWR) agent enhances workability. The fresh concrete is said to have both yield stress and viscosity. Slump flow test is representative of the former while V-funnel test shows the viscosity[1]. For such high fluidity concrete, it will be self-compactable if the slump flow, V-funnel time and U-box height fulfilled the Self-Compacting concrete (SCC) criteria. However, concrete production is affected by many factors like moisture content of aggregates, ambient temperature, mixing efficiency and so on. In the case of concrete missing these criteria, placing will require the use of vibration. The purpose of this study will be to investigate the degree of aggregate segregation in high fluidity concrete with respect to applying vibration. This paper reports the preliminary result of an ongoing experimental study on vibration of normal and flowable mortar.

2.0 Experiment on Mortar Vibration

The mix proportion is shown in the Table 1. Mortar with prefix N represents a normal mix while that with prefix F represents flowable mix. The following number shows the ratio of sand over mortar (S/M) calculated from the mix proportion. Slump flow and V-funnel time were taken at the end of mixing. The slump spread for the flowable mortar was due to its self-weight whereas the normal mortar was given a dynamic induction. The mixed mortar was then poured into 6 cylindrical moulds 300 x 150 mm diameter. 3 cylinders were vibrated using a poker vibrator with diameter 27mm having frequency 12,000VPM. The mortar are left to settle for one hour. Then each cylinder was scooped into three division; top, middle and bottom portion. After taking the weight of the top and bottom mortar, it was sieved using 0.09mm and 1.2mm sieves. Sand is assumed as particles greater than 0.09mm[2]. Sieving proceeded using flowing water from the pipe until all powder were washed. The retained sand were kept in 110^{0}C chamber for 24 hours before the weights were taken again. The moisture content of sand in each experiment was measured to compensate for the weight of sand after drying. Figure 1 summarizes the whole process. Segregation of sand is calculated as:

Label	W/C	W	C	S	Sp	%vinsol
N-63	0.55	283	514	1360	-	0.025
F-60	0.32	160	500	1000	3.0	-
F-51	0.32	160	500	680	1.3	-

Table 1 Mix proportion of mortar used in the experiments

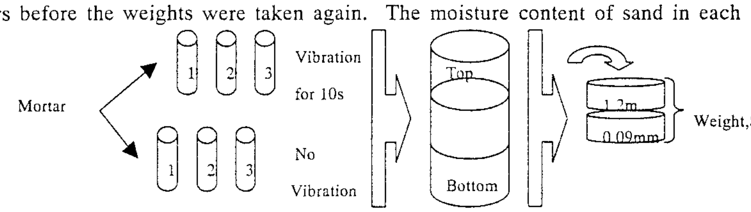

Figure 1 Flow diagram of experimental steps

$$S = \frac{S/M_{Bottom} - S/M_{Top}}{2xS/M_{calculated}}$$

S/M_{Top}, S/M_{Bottom}- ratio of sand over mortar by weight for top and bottom portion

$S/M_{calculated}$ - ratio of sand over mortar calculated from mix proportion

3.0 Results and discussion

Figure 2 shows the S/M ratio for all types of mortar with and without vibration.

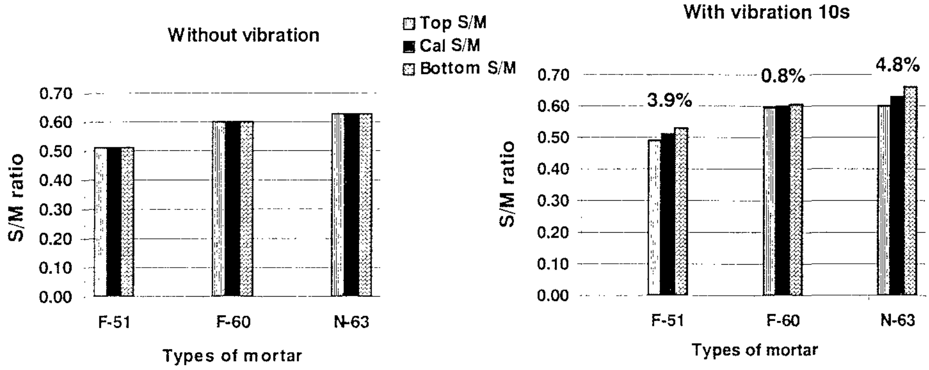

Figure 2 The ratio of S/M for mortars with and without vibration

An average value of S/M was taken from all three samples in each group. The mortar without vibration did not show any change in the ratio of S/M for top and bottom portion. This showed that the test method is reliable. The mixing was homogeneous and thus sand particles were evenly distributed in the mix. In the case of mortars experiencing vibration, a segregation pattern was obvious. Under the experimental condition, the vibration was categorically rigorous. As such, significant segregation would be expected. However, flowable mortars showed less amount of segregation than normal mortar. The normal mortar N-63 exhibited 4.8% segregation while flowable mortar F-60 and F-51 showed only 0.8% and 3.9% segregation respectively. N-63 and F-60 results can be compared together because the S/M ratio are close to one another. The force exerted by the vibrator is far greater than the respective yield stress of both mortars. The main difference between them is the plastic viscosity. F-60 being more viscous was able to maintain homogeneity better than N-63. Table 2 shows the slump flow and V-funnel time for the respective mortar. Comparing F-51 and F-60 would reveal further that viscosity difference is responsible for the different degree of segregation. All conditions the same, F-51 is less viscous than F-60. It would be possible that viscosity of the mix is a significant factor in vibration of concrete or mortar.

Label	Slump flow	V-fun. Time
N-63	216	7.32
F-60	220	10.82
F-51	222	5.84

Table 2 Results of Slump flow and V-funnel time

4. Conclusion

The preliminary results showed that flowable mortar could maintain homogeneity better than normal mortar when exposed to vibration. The level of segregation is lesser in the former than the latter. The main difference between the two is that flowable mortar flows easily at the same time become highly viscous. The viscosity of the mix may be responsible for the different level of segregation. A further experimentation is underway to investigate this hypothesis.

【References】

1) Domone, P.L.J & Jin, J, "Properties of Mortar for Self-Compacting Concrete", Proceedings of the First International RILEM Symposium, Stockholm, Sept. 1999.

2) Nagamoto, N and Ozawa, K. "Influence of Properties of Fine Aggregates on Self-Compactability of fresh Concrete", pp 105-110, Proceedings of Japan Concrete Institute, Vol.18, No.1 Jul 1996 (in Japanese)