V-259 STUDY ON FACTORS AFFECTING BLOCKING OF MODELED MORTAR FLOWING THROUGH OPENING OF OBSTRUCTION

Somnuk TANGTERMSIRIKUL*
Kazumasa OZAWA***
Kouji YAMADA**
Koichi MAEKAWA***

1. INTRODUCTION

This paper deals with segregation, caused by the aggregate blocking, of modeled mortar flowing through opening of obstruction. The test in which flowing speed was controlled to be independent on paste consistency was carried out. Some of the factors considered affecting blocking were, consequently, investigated experimentally and statistical analysis was performed to decide the important factors.

2. EXPERIMENT

The set of testing apparatus, shown in Fig.1, consists of hollow steel cylinder with inside diameter of 10 cm, piston with steel shaft at the center, speed-controlled motor and load cell. The sample used was mortar using blast-furnace slag, having specific gravity and blaine finess values of 2.9 and 7860 cm /g, respectively, instead of cement, and river sand with maximum size of 5 mm, specific gravity of 2.62, finess modulus of 2.59, absorption and solid volume percentage of 1.58 % and 70.2 %, respectively. The cylinder was filled with mortar and flow was induced through 3 10-mm-diameter holes, punched at the piston, by lowering the piston with force applied from the motor. Flowing speed was considered proportional to the piston speed since mass balance law held true. The piston was enclosed with rubber ring to prevent leakage of mortar at the vicinity of inside cylinder wall. The applied load was recorded with dynamic data recorder which was able to store measured data at every time interval of 0.05 sec. The investigated factors were sand volume, flowing speed and w/c (w/c : water/slag ratio).

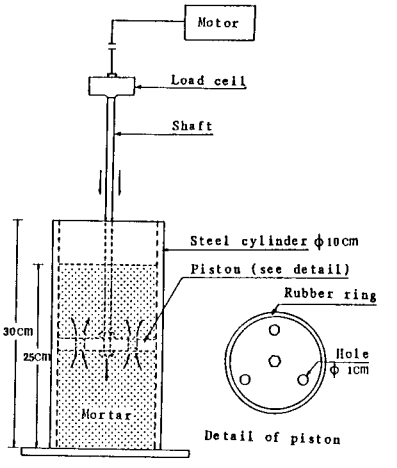

Fig.1 Apparatus

3. RESULTS AND DISCUSSION

Examples of load data in the time domain is given in Fig.2. By varying the factors, data were obtained and analysed by statistical procedure to determine variances. Variance was determined by dividing summation of the square of deviation from mean value with n-1 (n : number of data to be analysed).

The analytical results are given in Fig.3. It was regarded that fluctuation of load in the time domain was caused, to a significant degree, by collision of the sand particles at the holes. Larger variance was considered corresponding to either larger numbers of collision expressing higher frequency with amplitude unchanged or more rigorous collision manifesting greater amplitude with unvaried frequency or both. Fig 2 shows the case of violent collision causing large amplitude and that of large number of collision resulting in high frequency in the upper and lower curves, respectively. Blocking was anticipated when numbers of collision was larger and/or the collision was less rigorous.

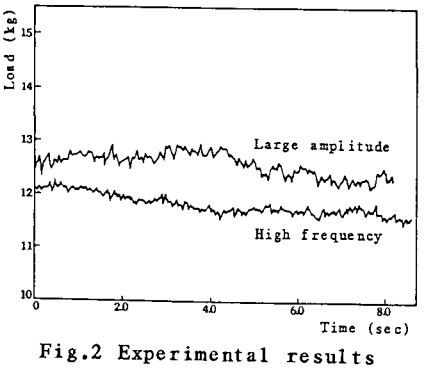

Fig.2 Experimental results

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* Member of JSCE, Graduate student, University of Tokyo
** Sumitomo Cement Company
*** Member of JSCE, Department of Civil Engineering, University of Tokyo

Therefore, blocking was more likely to take place when sand content was larger and flowing speed was lower. This is because larger sand content gives rise to greater numbers of collision, on the other hand, higher flowing speed produces harsher collision. According to this, the occurrence of blocking can not be decided by the value of variance itself but frequency and amplitude, influencing the value of variance, are to be involved into the consideration of blocking.

For the values of mean, which correspond to the average applied load, test results show that the higher the sand content, the flowing speed and the lower the w/c value are, the larger the mean values are obtained.

For the effect of w/c, experiment to determine the relationship between blocking probability and sand volume was carried out. The number of trial was ten times per each data point. The experimental results shown in Fig.4 revealed that blocking took place when sand content approached a critical value, blocking can be considered free from probabilistic influence. Therefore, the blocking volume was utilized to check the independency of blocking on w/c. Blocking volume was defined as sand volume at the time when blocking occurred. Another test was performed by adding further 1% of sand, starting from sand volume = 40%, until blocking occurred. Piston speed was controlled at 0.2 cm/sec. The test result illustrated in Fig.5 shows that blocking volume is independent on w/c. The range of blocking sand volume verified to be independent on w/c in this study was from w/c = 50% to 75% corresponding to flow table value of 203 mm and p-funnel value of 13 sec, respectively. However, the occurrence of segregation without being forced to flow when paste consistency is too high or the incapability to be forced to flow of a very stiff mixture when paste consistency is too low is not pertinent to what being considered in this paper since they do not involve blocking.

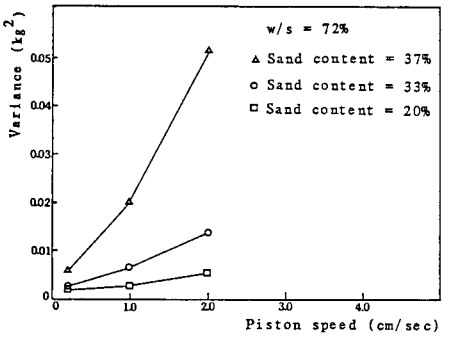

Fig.3 Analytical results

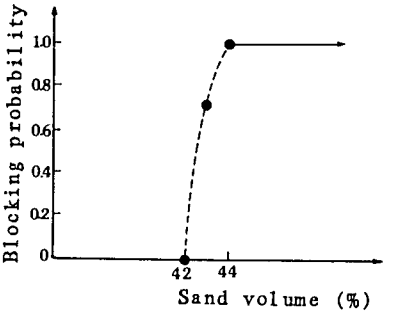

Fig.4 Blocking probability vs sand volume

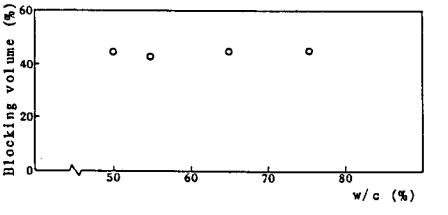

Fig.5 Blocking volume vs paste consistency

4. CONCLUSION

Results from the speed-controlled tests emphasized that blocking of the modeled mortar flowing through opening of obstruction is influenced by the sand content and flowing speed. On the contrary, w/c has a negligible effect on blocking sand volume when constant piston speed of 0.2 cm/sec is maintained. There are still other factors namely, aggregate size, grading, size of opening, flow pattern, etc, which are to be studied further.

REFERENCE

1) MAEKAWA,K., YAMADA,K., KISHIMOTO,T., OZAWA,K., Segregration resistance of flowing mortar with blast-furnace slag , The symposium on application of blast-furnace slag to concrete, JSCE, March 24th, 1987