V-121 VISUALIZATION OF SPATIAL PASSING MECHANISM OF FRESH CONCRETE BY 2D DEM

Hongwei CHU Saitama University
Atsuhiko MACHIDA Saitama University

1. INTRODUCTION

In this paper an attempt has been successfully given to demonstrate the spatial passing process of fresh concrete by its gravity through meshes by visualizing 2D DEM simulation with displacement, velocity and resultant force diagrams. The mechanism of spatial passing of fresh concrete can be summarized as following procedures: firstly, the packed assemblage is disturbed and driven downward through the spaces between positioned rebars which leads to downward particle velocity but vortex distribution of particle forces. Secondly, interactive forces influence particle movement in a way which attempts to prevent particle movement from falling orientation resulting in velocity vortex too. Thirdly, the particle assemblage can maybe completely fall down through the spaces between rebars or a certain amount of portion stagnates above the meshes due to explicit arch forming between particles.

2. PARAMETERS

Hereinafter a set of parameters used in 2D DEM simulation is listed in Table 1. A more detailed description of DEM method and physical sense of parameters can be found in literature [1].

Table 1 A set of parameters for DEM model

Spring constant Normal K_n	6×10^{-2} kgf/mm	Friction Coef. of particles μ_p	0.01
Spring constant Tangential K_s	1.5×10^{-2}kgf/mm	Friction Coef. of wall and particle μ_{wp}	0.01
Dashpot coef. normal η_n	5.7×10^{-4}kgf·s/mm	Allowance of spring tension λ	1.48%
Dashpot coef. Tangential η_s	7×10^{-4} kgf·s/mm	Time Step Δt	10^{-5}s
Particle no. Nel	330	Simulation Time T	1.4s

3. FLOWING MECHANISM

All the figures drawn hereinafter are combination of particle velocity and force diagrams simultaneously. The solid line represents velocity diagram while the dotted one is for force diagram. The magnitude of both force and velocity is proportional to the width of lines. Larger straight and curved arrow line is drawn to present the orientation of majority of force and velocity respectively.

1. Initial stage

Fig. 1 shows the initial stage of particulate assemblage when the support below mesh is removed. It is clearly seen that the particle assemblage is stationary at this stage but very small resultant particle force distributes randomly except gravitational forces of particles locating at the opening between rebars.

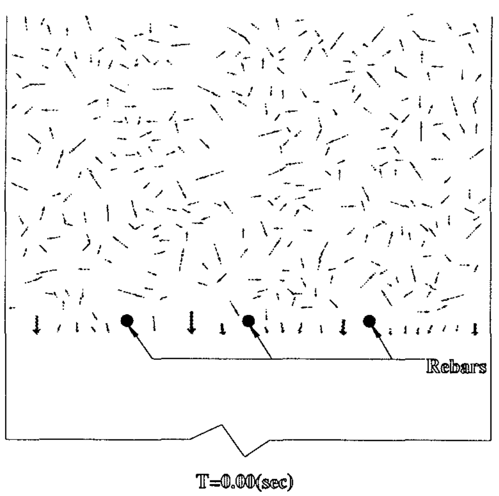

Fig. 1 Initial stage of particle assemblage(T=0.0s)

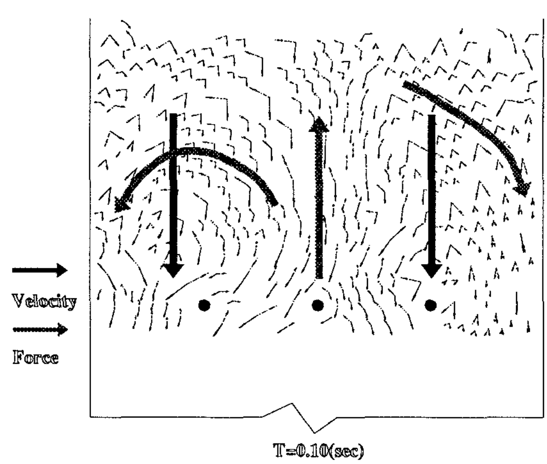

Fig. 2 Initial stage of particle assemblage(T=0.1s)

2. Starting stage

We can see that particle assemblage tries to flow downward at nearly vertical velocity directions as illustrated in Fig. 2, however particles interact among themselves to generate serious interference. By dimmed large force arrow resultant force forms three diversification, the middle branch going upward, the left branch going counterclockwise while the right branch coming clockwise. The left and right branches are quite similar to force vortex field.

3. Intermediate stage

There are a series of complicated situation before the particle assemblage can break its way out of the restriction of rebars and container edges. The velocity and force distribution can be visualized as arrow straight line while in most cases treated as curved arrow line which can be well called as vortex field. Interaction force tries to decrease the velocity in some portion as shown in A of Fig. 3 while accelerate the velocity in other area as shown in B of Fig. 3. During this stage it also can be seen that forces try to block

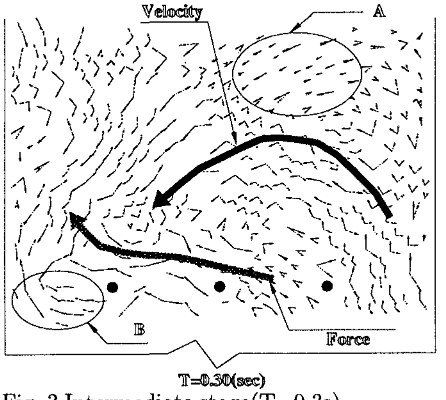

Fig. 3 Intermediate stage(T=0.3s)

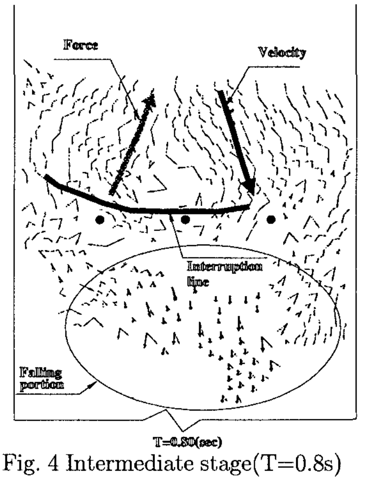

Fig. 4 Intermediate stage(T=0.8s)

the movement of particles by generating interruption line as shown in Fig. 4. Force and velocity vortex feature the common phenomenon of particle interactive interference which in most cases leads to portion of particulate assemblage falling down through the restraint of rebars as demonstrated in Fig. 4.

4. Ending stage

Usually the particulate assemblage finishes flowing through the rebars completely or a portion thereof is left on the top of rebars. The latter situation occurs only when the remained particulate assemblage generates arch explicitly. Fig. 5 shows two kinds of arches with Arch 2 being formed by interparticle compressive force while Arch 1 being formed by interparticle tensile force which is controlled by allowance of tension of particle. Rebars and container edges offer necessary boundary supports. Another interesting phenomenon is that usually particle velocity moves in a way against the arch force orientation and finally the remained particle assemblage becomes stable by interactively oscillating.

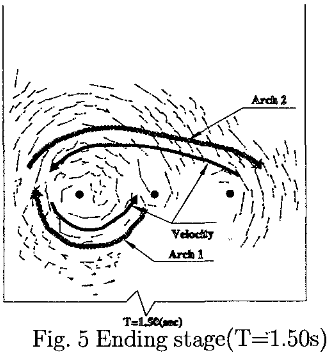

Fig. 5 Ending stage(T=1.50s)

4. CONCLUSION

The mechanism of fresh concrete flowing through meshes by its gravity can be concluded as:

1. Self gravity of the portion near the space of meshes triggers the interparticle interaction and commences the flowing procedure.
2. Particle assemblage interacts in a complicated manner that force tries to block the movement by forming force vortex and velocity vortex which usually results in some portion thereof falling down through the meshes.
3. Particle assemblage can thoroughly finish flowing or a portion is remained on the top of meshes by generating explicit arches which can be divided into compressive arch and tensile arch.

5. REFERENCE

1. Nabeta, K., Machida, A., Iwashita, K., Sasaki, T., : Numerical Simulation of Fresh Concrete Flow by Distinct Element Method, Proc. of Japan Concrete Institute, Vol. 16, No. 1, pp 479-484, 1994.