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PPS21-P13 Room:Poster Time:April 29 18:15-19:30

Experimental study of compaction process of powder bed by centrifuge experiment

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Dust aggregates in protoplanetary disk are compacted by dust-dust collisions, ram pressure of the disk gas and self-gravity (Kataoka et al., 2013). At reaccumulation phase of asteroids, porosity of rubble pile and regolith would be determined by collisional pressure and self-gravity.

Relationship of porosity of powder layer and particle's radius is given by (Yu et al., 2003; Kiuchi and Nakamura, 2014)

$p=p_0+(1-p_0)\exp\{-mR_F^{-n}\}$ (1)

where R_F is the ratio between the magnitudes of the van der Waals force between two particles and gravity force on particles, therefore a function of particle radius. p_0, m, and n are constants. p_0 should be understood as the porosity without any interparticle force.

It is not clear if Eq.1 can be applied for powder layer under different gravity from 1 G. Eq.1 was originally derived for particles at surface, and we don't know to what extent this equation is able to be applied for the interior of planetary bodies, i.e., it has not examined for the porosity evolution of bodies due to the accumulation of new grains and blocks onto the surface. If Eq.1 is applicable to such case, porosity given by Eq.1 should be consistent with the result of the case in which R_F is reduced by increasing the gravity. In this study we perform experiments, under different gravitational accelerations, and we compare the results with Eq.1.

We use silica sand, 60 wt% of grains have sizes ranging from 7.5 μm and 80 μm and fly ash, 60 wt% of grains have sizes ranging from 1 μm and 8 μm. They were sieved into a cylindrical container of diameter 5.8 cm and depth 3 cm. After that, the top part of the bed over the height of the container was leveled off. Porosity of each granular bed is approximately 60 % and 70 %. The experiments were performed at elevated acceleration on a centrifuge to provide 1-18 G and observed with a video camera. In contrast with unidirectional compressive compaction using a piston, centrifugal compaction is capable of applying uniform compressive force at any place of the container without causing any local disturbance (Mizuno et al., 1991). After the materials were compressed, bed height was measured with a laser displacement meter and the difference between the initial bed height and the average bed height after acceleration was calculated.

As a result, it is shown that Eq.1 is consistent with experimental result within 6 % (silica sand) and 5% (fly ash) in porosity when assuming the grain diameter=24 μm and 4.5 μm, respectively. This diameter corresponds to the median of cumulative weight distribution of the grains. Also, the diameter of the small silica sand grains sticked with large grains is close to 24 μm.

Keywords: planetesimal, asteroid, porosity, high gravity, powder and granular material