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Effects of medium filling pores on impact disruption of rubble-pile bodies

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Introduction

Rubble-pile bodies could be constructed from collisional fragments and these fragments were re-accumulated by mutual gravitational force. It is expected that rubble pile bodies have large macro porosity with the size of the same order of the constituent fragments because the fragments were accumulated randomly. According to our previous impact experiments on rubble pile bodies, we found that these macro pores caused the attenuation of the impact pressure drastically and, therefore, the rubble-pile structure was quite efficient to prevent impact disruption of the constituent fragments. Furthermore, these macro pores might be filled with solid medium, such as regolith and dusts, actually. The medium filling the pores among the fragments would surely affect the impact disruption. Thus, we performed high-velocity impact experiments on rubble pile targets to investigate the effect of medium filling the pores on impact disruption.

Experimental methods

We used 1/4-inch Nylon spheres for the projectile and it was launched by a two-stage light gas gun. These projectiles were impacted on cylindrical targets at the velocity ranging from 2~7km/s. These targets are made of 7mm glass beads and the pore spaces were filled with gypsum or ice. Impact fragmentation was observed by a high-speed video camera with the framing rate of 10000~125000 frames $sec^{-1}$and the fragment velocities were analyzed for each shot. Additionally, we recovered these fragments after the shot and estimated the impact damage of the target

Experimental results and discussions

We proposed M_{fsum} as a new parameter to describe the impact damage of rubble-pile targets, quantitatively. M_{fsum} is defined to be the total mass of fragments whose mass is less than a half mass of the original bead. We compared the impact damage of the targets whose pore spaces filled with gypsum or ice with that of the target without medium. As a results, M_{fsum} obtained from the targets with medium was found to be about two times larger than that without medium. Antipodal velocity observed for the target with medium also was found to be two to four times higher than that of the target without medium Therefore, we expect that the impact disruption of rubble-pile targets could be enhanced by the medium filling the pore spaces among constituent fragments. Furthermore, the degree of disruption of rubble pile targets might be controlled by the physical properties of the medium.

Keywords: rubble-pile bodies, impact disruption, minor body, planetesimals, re-accumulation, attenuation of impact pressure