Tensile strength of particle layers of irregularly shaped particles: Dependence on particle size and filling factor

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Understanding the tensile strength of particle layers is important for studying the physical evolution of regolith layers and rubble pile bodies. The tensile strength of a layer consisting of monodisperse particles is expected to be expressed by Rumpf's equation or an equation of similar form (Kimura+, 2020). According to Rump's equation, the tensile strength is proportional to the product of the filling factor of the particle layer, the coordination number between the particles, and the interparticle force, and inversely proportional to the square of the diameter of the particles constituting the particle layer. The coordination number is considered to be positively dependent on the filling factor and ranges from several to about 10. A numerical simulation and a semi-analytical model of aggregate of monodisperse spheres have shown that tensile strength is proportional to about the square of the filling factor and inversely proportional to the particle size (Tatsuuma+, 2019).

However, the results of Brazilian disk tests on agglomerates of irregularly shaped particles show that the tensile strength depends more strongly on the filling factor than on the square of the filling factor. In the case of irregularly shaped particles, the size dependence of interparticle forces is expected to be different from that of perfect spheres, and thus the size dependence of tensile strength is not simple.

In this study, we investigated the tensile strength of agglomerates consisting of graphite particles of several microns in size. The agglomerates were prepared by pressing the particles in a mold. By varying the maximum applied force, agglomerates with different filling factors between 0.27 and 0.55 were obtained. The tensile strength was found to depend on the filling factor to the power of about 4.5. The tensile strength was found to be dependent on the particle size to the power of -2.5±1.0 by comparison with the results of a previous study (Bischoff+, 2020). The results of the graphite particle adhesion measurement and the tensile strength including the results of the measurement will also be discussed.

Keywords: tensile strength, particle size, filling factor

