ANTIPODAL FRAGMENT VELOCITIES FOR POROUS AND WEAK TARGETS AT CATASTROPHIC IMPACTS; M. Yanagisawa and T. Itoi, Univ. Electro-Communications, Chofu-shi, Tokyo 182, JAPAN.

Mortar, porous alumina and sand targets, which were spherical in shape, 11 to 15 cm in diameter, were impacted normally by plastic (polycarbonate) projectiles of nearly 1 g in mass at velocities about 6 km/s. Fragment velocity at the antipole of impact site (antipodal velocity, V_a), for each experiment, was obtained from two Flash X-ray images recorded prior to and at predetermined delayed time after impact event. It has been revealed that the velocities for the same E/M_t (impact energy divided by target mass) depend strongly on target material, and differ about an order of magnitude between the sand and basalt.

Target is hanged in the impact chamber of Electromagnetic Railgun Facility at Inst. Space Astronaut. Sci. [1] between Flash X-ray tube and 43 x 35 cm film cassette. Just before hitting the target projectile cuts thin wire placed in the path of its trajectory at $l = 52$ cm before impact point. At the predetermined delay (T = 1, 2 or 4 msec) after electric circuit detecting the wire broken, the X-ray tube irradiate a 35 nsec pulse. Thus, radiograph at $t_1 = T - l / v_0$ after the impact is obtained (Fig. 1), where v_0 is projectile velocity. Small sensors are glued on the targets for some experiments to monitor the initiation of antipodal movement and obtain the time between the initiation and the image acquisition, t_2. Target diameters, D, divided by $(t_1 - t_2)$ correspond to mean shock wave velocities in the targets, U_s. We calculate V_as by dividing the displacement of antipole between the two radiographs by t_2 or $(t_1 - D / U_s)$.

Results are summarized in Table 1. and V_as are plotted against E/M_t in Fig. 2 with the values reported by Fujiwara and Tsukamoto (1980) [2] for basalt targets. V_as are apparently smaller for porous or weak targets than dense and hard ones at the same E/M_t. V_as are also lower for the Porous alumina targets than solid ones in oblique impact experiments by Nakamura and Fujiwara (1991) [3].

V_a would represent relative velocities of large fragments at catastrophic impact. Then, it is inferred that porous or weak asteroids would easily re-accumulate gravitationally, so they could be shattered but hard to be dispersed. Such objects would lessen their size through cratering erosion rather than catastrophic disruption.

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REFERENCES: [1] Kawashima, N., Yamori, A., Yanagisawa, M., Kubo, H., Kono, M. and Teii, S. (January 1993) *IEEE Tran. Mag.* [2] Fujiwara, A. and Tsukamoto, A. (1980) *ICARUS, 44,* 142. [3] Nakanura, A. and Fujiwara, A. (1991) *ICARUS, 92,* 132.

Table 1. Experimental Results

Shot #	Material*	Target mass (kg)	Projectile mass (g)	Impact velocity (km/s)	E/M_t x 10^4 (J/kg)	V_a (m/s)
O-118	Mortar	1.5	1.1	6.7	1.6	16.9
O-119	Mortar	3.4	1.1	5.9	0.55	6.64
O-121	Sand	2.4	1.1	6.9	1.1	1.4
O-122	Sand	2.2	1.1	7.1	1.2	3.2
O-145'	Porous alumina	1.1	1.2	3.7	0.72	4.2
I-1	Porous alumina	0.94	1.1	5.0	1.5	8.1
I-2 **	Porous alumina	1.0	1.2	3.7	0.83	3.3

* Mortar targets are made of commercial mortar including some glue. They would have 20 or 30 % porosity judging from their low bulk density, 1.9 g/cm^3. Each porous alumina target consists of two hemispheres glued together. The glued boundary affected the fragmentation seriously and antipodal hemisphere was not shattered when projectile hit the center of the other hemisphere. Nominal density and porosity are 1.4 g/cm^3 and 60 %, and U_s was 2.8 km/s. Sand targets are thin spherical paper bags filled with non-cohesive sand (not quartz sand). We assume the effect of paper sheet on V_a being negligible. Their density is 1.4 g/cm^3, and the porosity would be about 50 %. U_s was 0.3 km/s.

** Oblique impact due to unexpected projectile trajectory. The projectile could lessen its mass and velocity before impact due to some problem of the gun.

Fig. 1. Radiograph at 0.9 msec after impact in Shot # O-118.

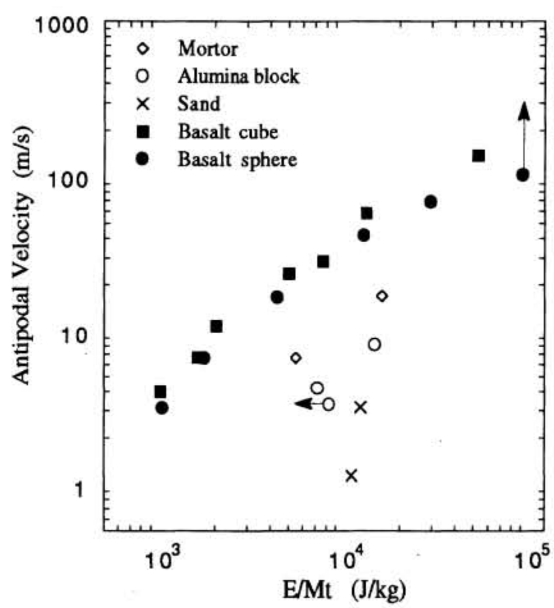

Fig. 2. V_as for porous and basalt[2] targets.