☒ **Deflection / Disruption Models & Testing**

MOMENTUM ENHANCEMENT OF RUBBLE PILE SIMULANTS AT 5 KM/S

James D. Walker [(1)], Sidney Chocron [(1)] , Donald J. Grosch[(1)], Daniel D. Durda[(2)], Simone Marchi[(2)]

[(1)] *Southwest Research Institute, 6220 Culebra Rd., San Antonio, TX 78238, USA*

[(2)] *Southwest Research Institute, 1050 Walnut Street, Boulder, CO 80302, USA*

james.walker@swri.org, sidney.chocron@swri.org, donald.grosch@swri.org, durda@boulder.swri.edu, marchi@boulder.swri.edu

Abstract

Prior to the DART spacecraft impact into Dimorphos, our group performed impact tests into rock structures measuring momentum enhancement [1,2]. One of these targets was a collection of rocks held in place by cement. A binder was required since our targets are hung in a vertical pendulum inside an evacuated target chamber to measure momentum enhancement β. In particular, the measured β in that test was 3.4 for an impact of a 3-cm-diameter aluminum sphere at 5.44 km/s.

After the DART spacecraft impact, and upon examination of the photographs of the Dimorphos surface, our group worked to produce simulants so that we could measure the momentum enhancement due to hypervelocity impact on these surfaces. Within the DART community, nearly all computations are being performed with basalt as a surrogate for the Dimorphos surface material. Because of this, it is very relevant to pursue building targets of basalt since 1) basalt is viewed by many as an appropriate analog to the asteroid material and 2) basalt is being used by DART Investigation Team members and others in their computations. Thus, basalt-based targets will be directly comparable to the DART Impact Modeling Working Group computations (of which we are a part).

We constructed targets whose primary constituent is basalt. Crushed basalt was obtained in a variety of sizes. Initial measurements of density of these pieces was performed. We explored a number of approaches to holding the material in place for our vertical pendulum, and we will report on the different mixtures of grout and sand that were used and the resulting target strength. We mix sand with the grout to reduce the cohesive strength. The DART Impact Modeling Working Group is exploring a wide range of cohesive strengths from the matrix, ranging from lows of 1 to 10 Pa, to midrange of 10s of kPa, to some even larger values on the high end. The various modeling groups state that reasonably good β values can be obtained with each of these scales of numbers.

Using our large two-stage light gas gun, we impacted 3-cm-diameter aluminum spheres into five large targets made of crushed basalt held together with grout and sand (Figure 1). The size of the targets is on the order of 60 x 60 x 30 cm. The impact speeds exceeded 5 km/s. Different crushed basalt rock size distributions were used in the target assemblies, with the largest characteristic size being smaller, comparable, or larger than the impactor. The paper will report the resulting measured momentum enhancement βs and any dependences observed based on the distribution of characteristic rubble size vs. impactor size.

These experiments will hopefully play an important role in the DART analysis by pinning down some specific β data points with a well characterized experiment at impact speeds of interest for the DART program with targets made of distributed rocks. We will present some of our related computations.

Figure 1. Left: A target hanging in the pendulum before impact showing the crushed basalt held in place by a mixture of grout and sand. Right: roughly 20 microseconds after impact (projectile came from right to left). (LGG 407)

1. "Momentum Enhancement from a 3 cm Diameter Aluminum Sphere Striking a Small Boulder Assembly at 5.4 km s^{-1}," J. D. Walker, S. Chocron, D. J. Grosch, S. Marchi, A. M. Alexander, *Planetary Science Journal* **3** 215, 2022. https://doi.org/10.3847/PSJ/ac854f.

2. "Momentum Enhancement from 3-cm-diameter Sphere Impacts at over 5 km/s into Iron and Rock," J. D. Walker, S. Chocron, D. J. Grosch, S. Marchi, A. Alexander, Hypervelocity Impact Symposium, Alexandria, VA, Sept. 19 – 22, 2022.

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Comments:

Alternative session: Impact Effects and Consequences
Preference for Oral Presentation