

Effects of Ground Composition on Crater Formation

(Depth of Penetration, Crater Diameter)

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Introduction

Knowledge of crater formation may be useful in understanding the constituents of the terrestrial planets^[1-3] as well as gathering information from battlefield damage assessments, such as locating underground bunkers. This research presents the results of a novel experiment to understand the influence of ground composition on crater formation, in particular, its penetration depth and crater diameter.

Experimental Set-up

A single stage vertical gas gun was employed to accelerate hemispherical Polyoxymethylene (POM) projectiles into granular targets (Figure 1). A test fixture was designed and fabricated in house to contain the granular material (sand, clay-loam soil and gravel). 8 target sets were built using the granular medium, as shown in Figure 2. Mild steel was used as the base plate for the fixture to replicate a metallic structure beneath the targeted granular material. Preparation of the target is shown in Figure 3. Cratering was observed through high speed video recording (Figure 4) and parameters (depth of penetration, crater diameter etc) were measured, recorded and analyzed.

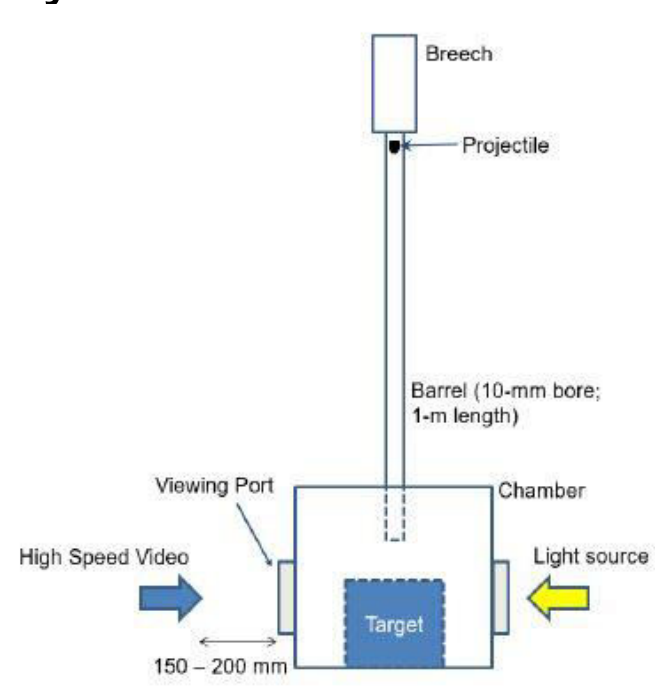


Figure 1: Schematic diagram of experiment

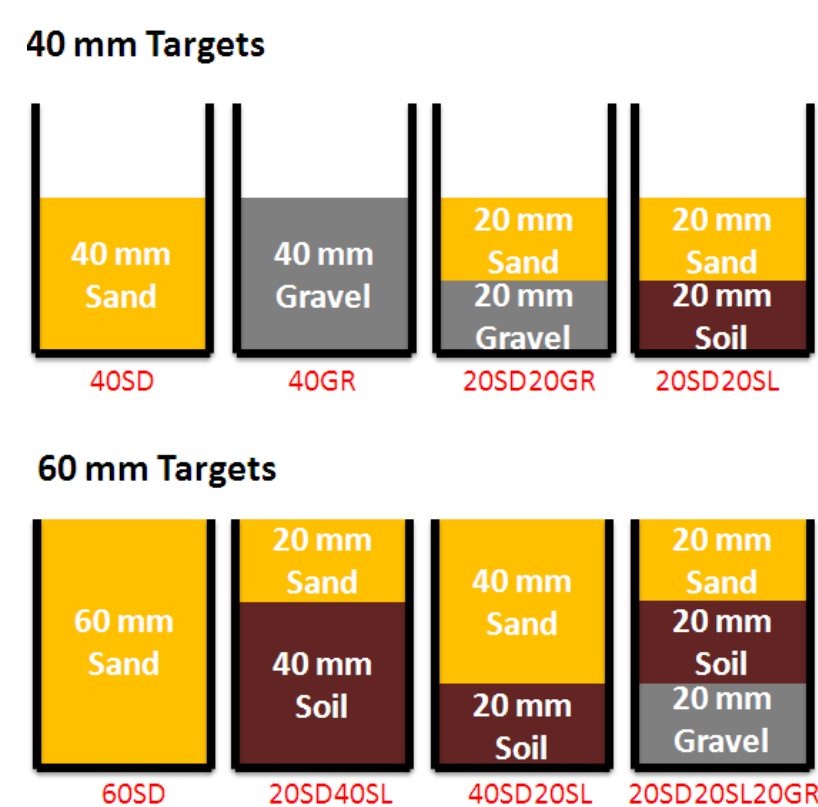


Figure 2: 8 different types of target

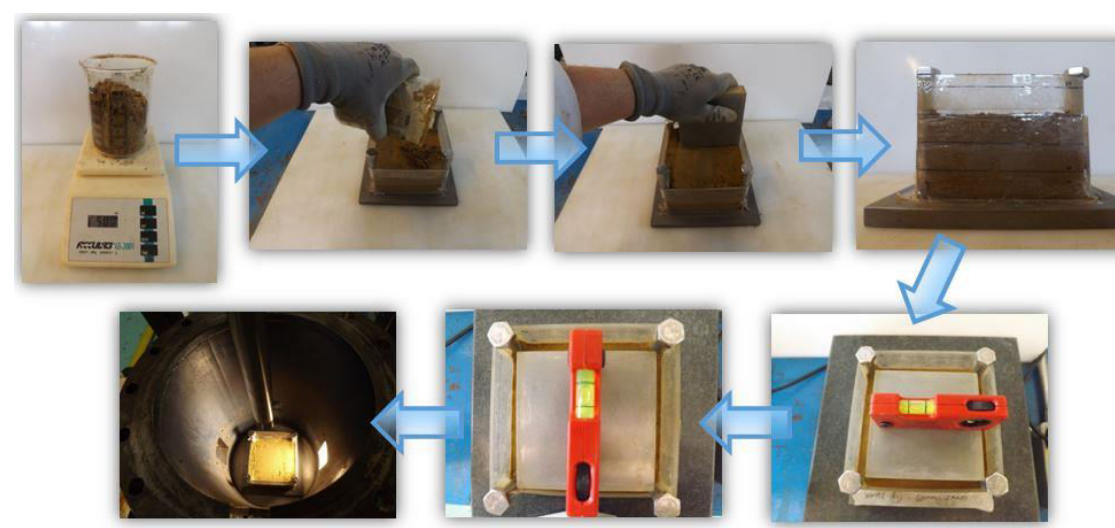


Figure 3: Preparation of the target

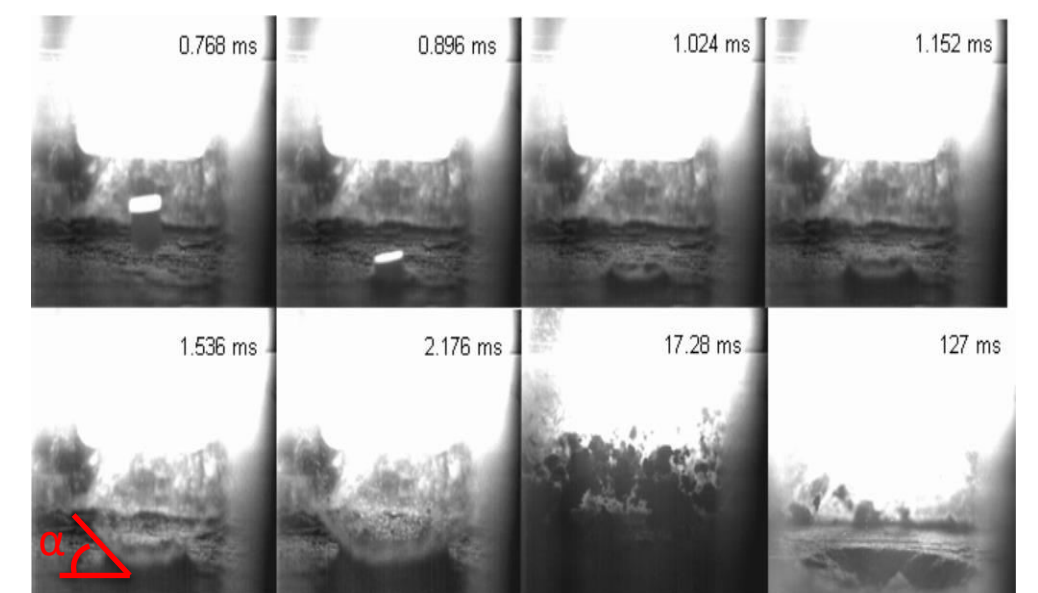


Figure 4: High speed video footage

Results and Discussions

40 mm Targets

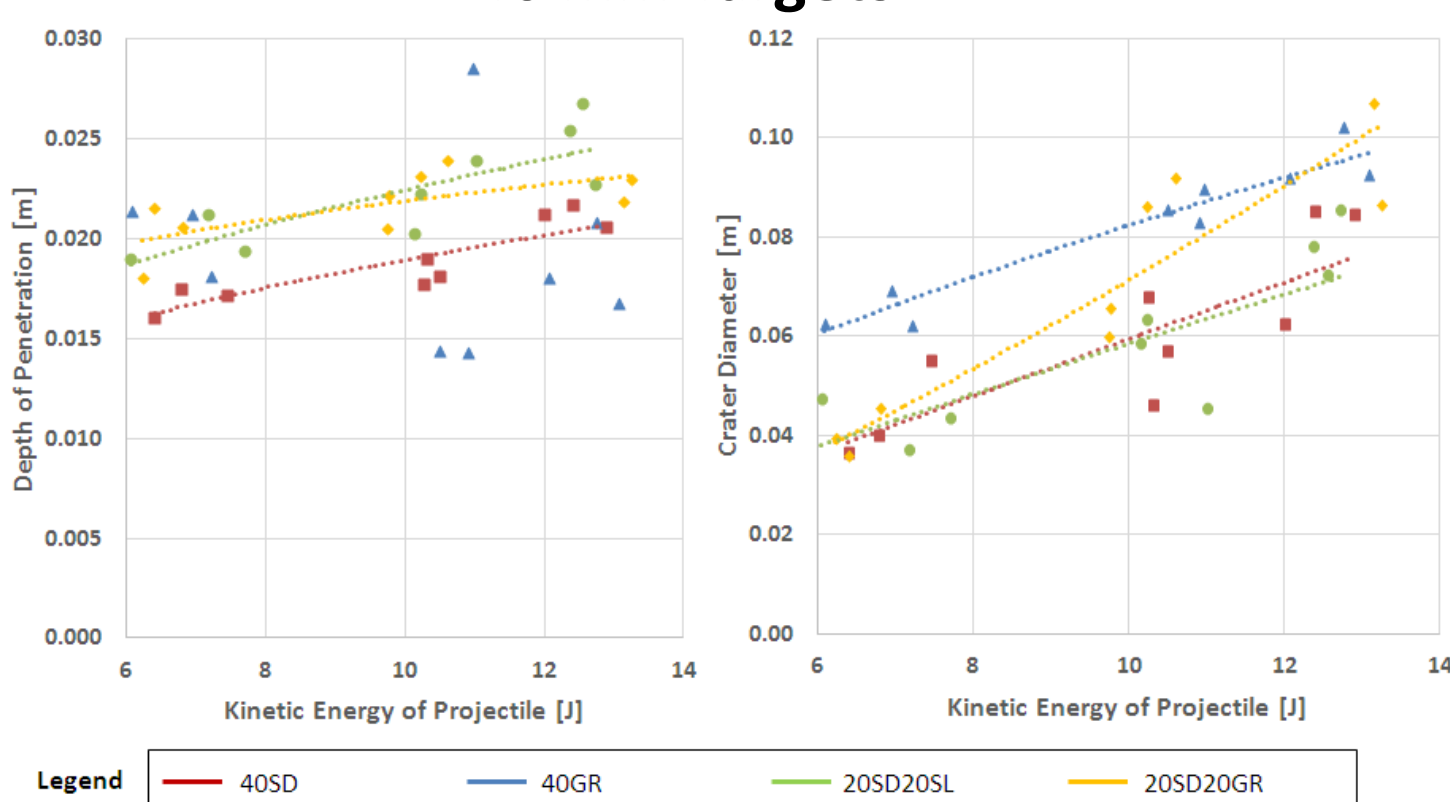


Figure 5: Depth of penetration and crater diameter (40 mm targets)

60 mm Targets

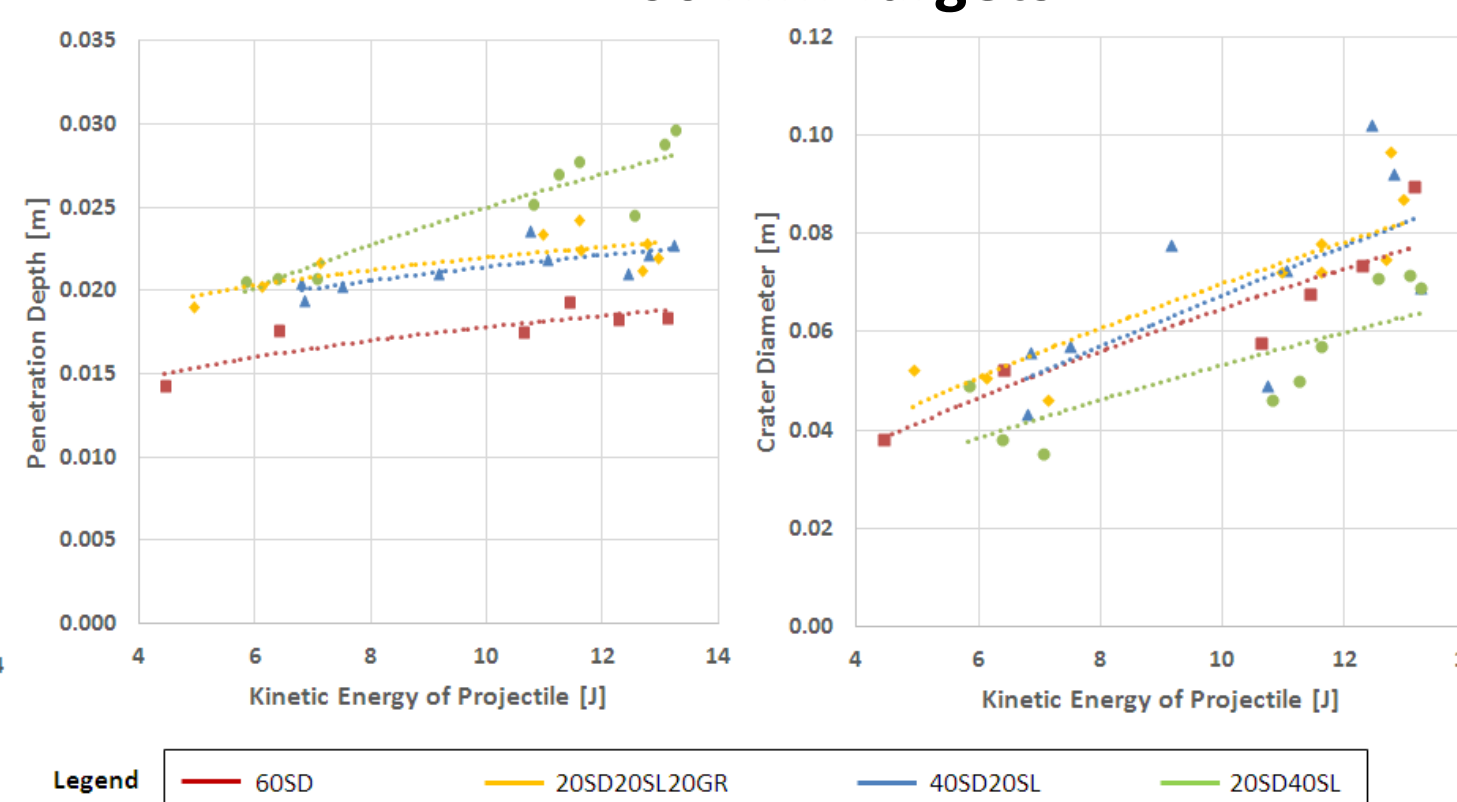


Figure 6: Depth of penetration and crater diameter (60 mm targets)

40 mm vs 60 mm Targets

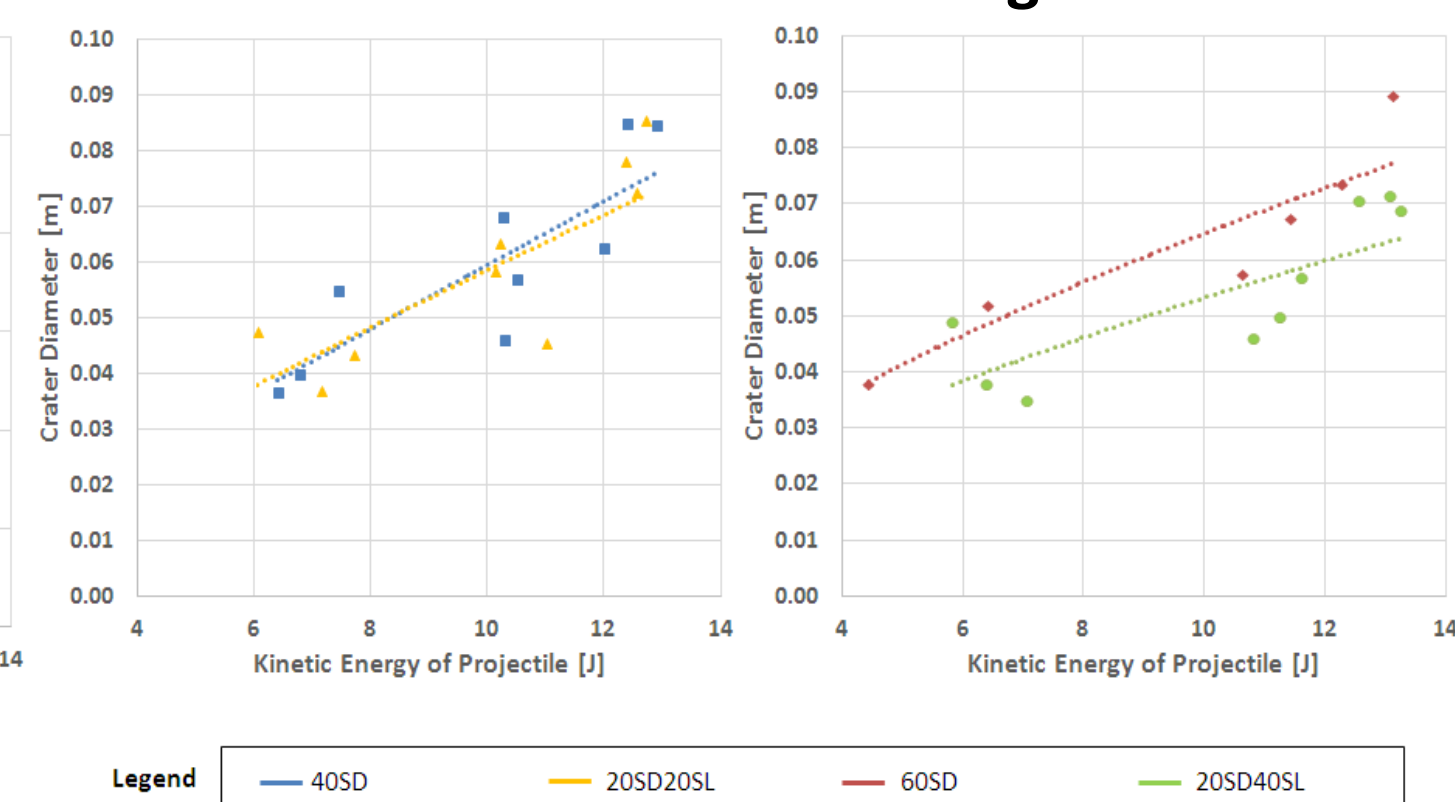


Figure 7: Comparison of crater diameters 40 mm targets (left) & 60 mm targets (right)

- Penetration depth was deeper in layers of granular target as compared to homogeneous target.
- Composition that comprises of gravel tends to create larger craters.
- Different compositions exhibited distinct behaviours in depth of penetration and crater diameter.
- Resistance to cratering was perhaps increased by altering the acoustic impedance of the composition (e.g. packing an equal or taller height of soil beneath the sand, as shown in Figure 7).

Based on the behaviours outlined above, it is postulated from this research that in an area which has been subjected to an impact of known properties, there is a possibility to identify underground structures. By looking at the depth of penetration and crater diameters, information of the ground composition can also be gathered.

References

- [1] Osinski GR, Pierazzo E. Impact cratering : processes and products 2013:1–20. doi:10.1002/9781118447307.
- [2] Bland MT, Raymond CA, Schenk PM, Fu RR, Kneissl T, Pasckert JH, et al. Composition and structure of the shallow subsurface of Ceres revealed by crater morphology. Nat Geosci 2016;9:538–42. doi:10.1038/NGEO2743.
- [3] Barlow NG. Constraining geologic properties and processes through the use of impact craters. Geomorphology 2015;240:18–33. doi:10.1016/j.geomorph.2014.08.027.