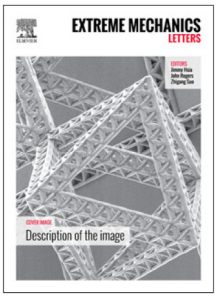
Accepted Manuscript



Penetration of confined ceramics targets

S. Das, W. Ronan, H.N.G. Wadley, V.S. Deshpande

PII: S2352-4316(17)30140-2
DOI: https://doi.org/10.1016/j.eml.2017.11.001
Reference: EML 323

To appear in: *Extreme Mechanics Letters*

Received date : 28 August 2017
Revised date : 31 October 2017
Accepted date : 1 November 2017

Please cite this article as: S. Das, W. Ronan, H.N.G. Wadley, V.S. Deshpande, Penetration of confined ceramics targets, *Extreme Mechanics Letters* (2017), https://doi.org/10.1016/j.eml.2017.11.001

Penetration of confined ceramics targets

S. Das[a], W. Ronan[a,b], H.N.G. Wadley[c] and V.S. Deshpande[a*]

[a] *Department of Engineering, University of Cambridge, Trumpington Street, Cambridge CB2 1PZ, UK.*

[b] *Biomedical Engineering, National University of Ireland Galway, Ireland.*

[c] *Department of Material Science & Engineering, School of Engineering and Applied Science, University of Virginia, Charlottesville, VA 22904, USA.*

Abstract

We have investigated the penetration response of confined ceramic targets impacted by Tungsten long-rod projectiles in the so-called Lundberg test setup with the ceramic modelled using a mechanism-based constitutive model. The calculations accurately predict the three observed penetration regimes, viz. interface defeat, dwell followed by penetration and penetration with no/short dwell. More importantly, the calculations suggest that these regimes occur in both a ceramic target and a reference target where microcracking of the ceramic is artificially switched off. This is because penetration occurs by a spherical cavity expansion mechanism with the onset of continued penetration set by the attainment of either a critical size of a plastic or damage zone. The dwell time then correlates with the time required to establish this inelastic zone. The main influence of damage is to reduce the pressure required to setup this critical inelastic zone and thereby reduce the interface defeat velocity as well as increase the penetration rate for a given velocity above the interface defeat velocity. We further show that an increase in the downward force due to the backflow of the deforming impactor is not essential for a dwell regime to exist. The mechanism-based ceramic model includes three material length scales and we demonstrate that the penetration size effect reported in experiments is primarily associated the length scale associated with rate dependent lattice plasticity and the critical size of the comminuted zone that is required to trigger granular flow. The material model is also used to probe the dependence of material properties such as strength and toughness on the penetration resistance. Two regimes of penetration, viz. a plasticity-dominated and a microcracking-dominated regime emerge from the calculations. These predictions suggest that increasing the strength rather than toughness of the Corbit-98 Alumina will have a greater beneficial influence on its penetration performance.

*Corresponding author. E-mail address: vsd@eng.cam.ac.uk.