ME – MTech(Res) Thesis Defense

Energy Loss In Elastic-Plastic Low Velocity Impact In Presence Of Electric Field

Mr. Vineethkumar kasula, M.Tech.(Research), Department of Mechanical Engineering, IISc,Bengaluru

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ABSTRACT

Impact phenomena are prevalent in various fields, including the impact between celestial bodies, particle dampers, sports mechanics, and granular media. Impacts between bodies often exhibit inelastic behaviour due to different energy dissipation mechanisms like plastic deformation, fracture. Low-velocity impacts are those in which the relative velocity of the bodies during impact is small compared to the speed of sound in the same bodies. Many engineering low velocity impact problems involve metals in which the predominant dissipation mechanism is plastic deformation. The presence of an electric field in applications such as pantograph-catenary systems in electric trains and contacts in electric switches further complicates the analysis. The present study addresses this issue experimentally by carrying out the elastic-plastic impact of spheres on metallic sample in the presence of an electric field.

Steel and zirconia spheres were impacted onto an Al6061 flat sample at impact velocities ranging between 1 and 4 m/s. The impact event was captured using a high-speed camera at 40,000 fps. The effect of friction in the contact is studied systematically by varying the incident angle of the sphere with respect to the normal of the sample's surface. The effect of the electric field is studied by applying a DC voltage ranging between 1 V to 80 V in normal impact between the steel sphere and the sample. The current flow during the contact is measured with a high-speed data acquisition system at 1 GS/s. The electric field causes the dielectric breakdown of the air between the sphere and the sample, resulting in a visible discharge. This arcing is found only during the rebound phase of the impact and was captured at 300,000 fps.

The coefficient of restitution was found to decrease with an increase in impact velocity, and the energy loss during the impact was found to increase with impact velocity. In the presence of an electric field, the duration of arcing was found to increase with supply voltage. The contact time increased with electric field for a given impact velocity. It was found that the electric field did not affect impact kinematics but influenced contact time. The electric pitting due to arcing on the sample is found to increase with supply voltage. In summary, the presence of an electric field alters the contact time during impacts but does not significantly affect the kinematics of the impact.

ABOUT THE SPEAKER

Vineethkumar kasula is pursuing his MTech (Research) at the department of mechanical engineering at the Indian Institute of Science, Bengaluru, under the guidance of prof.M.S.Bobji. Vineeth obtained his bachelor's degree in mechanical engineering from Sri Venkateswara University College of Engineering, Tirupati, Andhra Pradesh in 2021. To pursue his research and academic interests, he joined IISc as MTech (Research) student in Force Microscopy lab in 2022.