The micromechanics of fault gouge and dynamic earthquake triggering: investigation by Discrete Element Method numerical simulations

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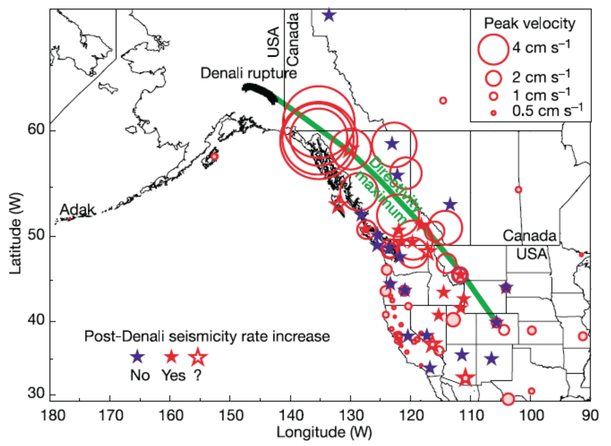
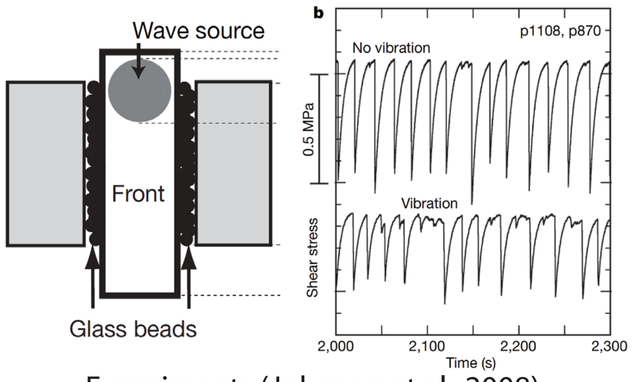
DYNAMIC EARTHQUAKE TRIGGERING



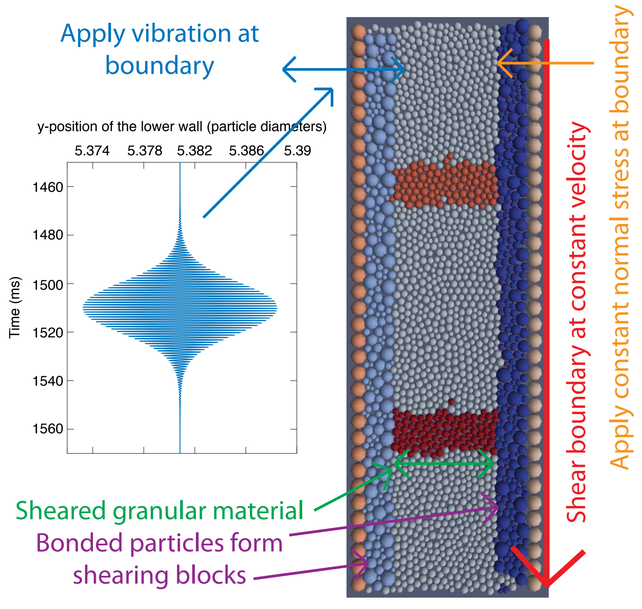
Observations (Gomberg et al., 2004)



Experiments (Johnson et al., 2008)

Seismic waves can trigger unstable fault slip. Goal: explore mechanics of a sheared granular material subjected to external vibration to simulate passing seismic waves

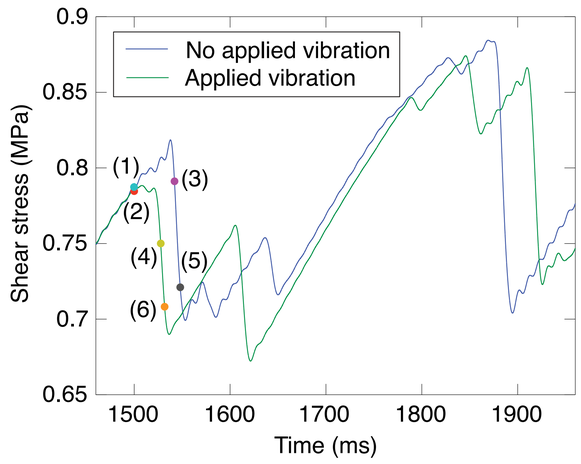
DISCRETE ELEMENT MODEL



MODEL DYNAMICS

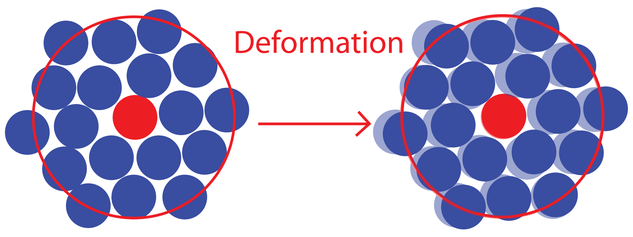
When vibration is applied, stick-slip event occurs earlier = dynamic triggering.

Look at microscopic deformation to better understand effect of vibration

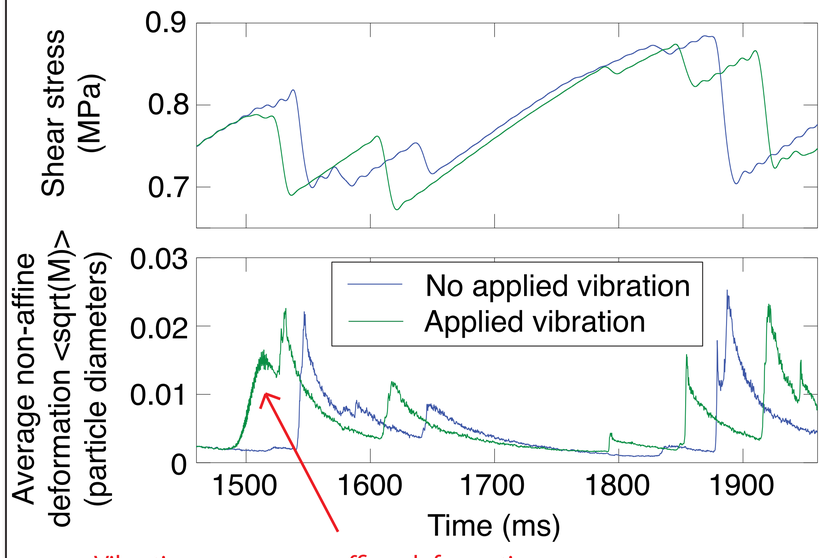


NON-AFFINE DEFORMATION

How does vibration affect particle scale deformation?
Need a metric to quantify inelastic deformation



For each particle, find best fitting strain tensor to map neighboring particles to their new positions = "affine" or elastic deformation. Deviations from this are inelastic = "non-affine," quantified by metric M (sum of residuals over all particles in neighborhood) (Falk and Langer, 1998)



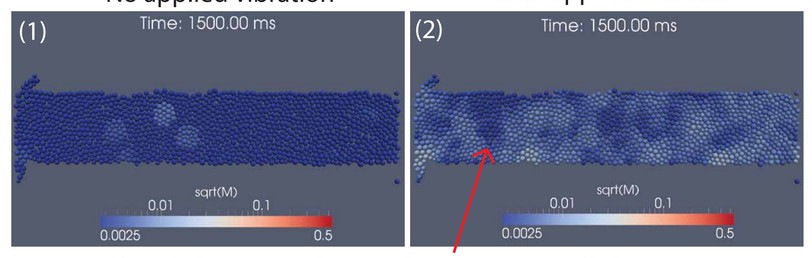
Vibration causes non-affine deformation

Averaged non-affine metric good indicator of slip and plastic deformation in the granular layer.

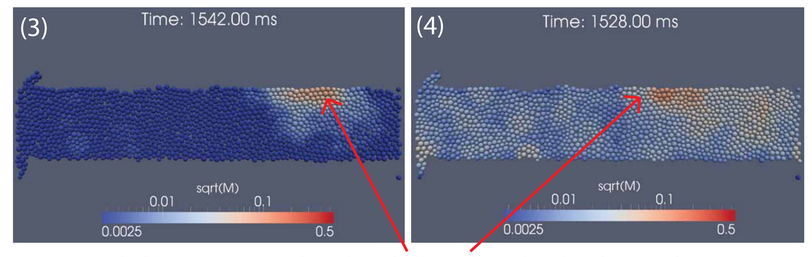
VIBRATION AND NON-AFFINE DEFORMATION

Non-affiine metric M shows spatial distribution of plastic deformation

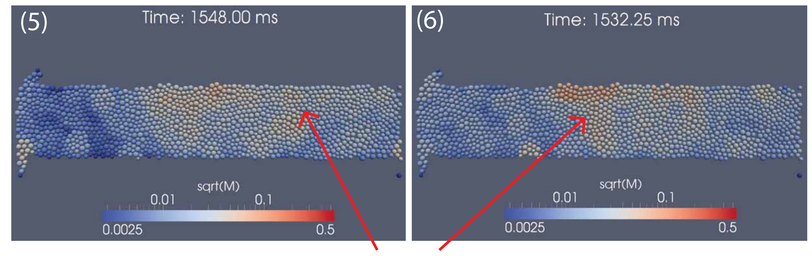
No applied vibration | With applied vibration



Non-affine deformation due to vibration is spatially homogeneous



Rapid slip occurs in a localized shear band in both simulations

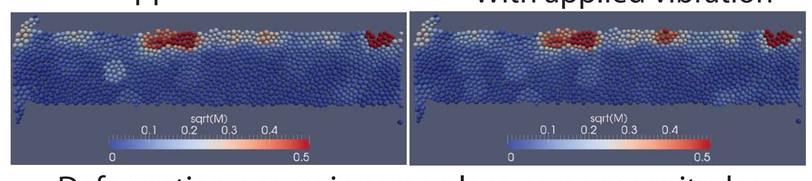


Slip later in the event is more distributed spatially

ARE TRIGGERED EVENTS DIFFERENT?

Non-affine deformation during entire slip event

No applied vibration | With applied vibration



Deformation occurs in same place, same magnitudes

Evolution of shear stress with non-affine deformation. Similar behavior with and without vibration