

## Reduction of frictional force depending on slip gradient

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We discuss a reduction of frictional shear forces depending on slip gradients based on numerical small scale tests. Distinct element method (DEM) is applied for the tests in order to capture both the micro scale mechanisms and the macro scale frictions. The slip gradients are the same as the micro scale shear strains parallel to the shear plane, perpendicular to the slip direction. The characteristics of the macro scale frictional coefficient are stable for the particle layouts in micro scale and the normal stress in macro scale. The reductions are qualitatively explained by considering the inclined shear plane depending on the three dimensional shear strains.