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# A FEM-DEM Coupled and Evolved Formulation for Analysis of Multi-fracture in Solids

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Multi-fracture simulation is one of the hot issues in solid mechanics. There are lots of numerical methods to simulate these problems, some methods are FEM-based, and others are DEM-based. Due to the advantage and disadvantage of FEM and particle DEM respectively, a FEM-DEM (block-particle) coupled and evolved approach is suggested.

To construct the FEM-DEM coupled and evolved model, the numerical domain is discretized by random and compact particles, which are all deactivated at first. Then Delaunay method is used to create FEM elements based on particles. Macro constitutive law (such as damage model or plastic model) is introduced to obtain the macro stress and strain, and then damage and plastic criteria is used to form the potential tensile or shear failure band. The particles will be activated if attached elements reach critical state (the damage factor or plastic strain arrive at certain value), and the FEM will be deleted simultaneously; then the multi-fracture propagation will be simulated by the evolvement of particle clusters.

the FEM-DEM formulation is implemented on Kratos (a multi-physics numerical simulation open source platform in Linux, mainly developed by CIMNE). GiD is used to generate high quality particles; mesh application in Kratos is adopted to create FEM elements based on particles; FEM elements in structural application is used to obtain the stress, strain and damage factor; DEM application is used to simulate the evolvement of fracture. An interface application named FEM-DEM application is realized to define the changing point and transform the information from FEM to DEM.

Finally, various numerical cases, such as uniaxial compression, cutting and impacting, are used to test and verify the DEM-FEM coupled and evolved method. The nemerical results show the accuracy and rationality of the method.

## REFERENCES

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