Fracture mechanics Tutorials - Parallel 2D tensile cracking and calculate-ploting reaction-force

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Abstract

This document details some tutorials of 'fracture mechanics' module of PSD. These tutorials are not verbose, but does instead give a kick start to users/developers for using PSD's 'fracture mechanics' module.

Parallel 2D tensile cracking and calculate-ploting reaction-force

In solid mechanics often the quantities of interest includes plots such as reaction-force on a surface vs. the applied force. Often times these are experimental outputs and are used for validation.

PSD provides routines to calculate the reaction force on a surface and also provides means of live plotting (run-time) of these results. Imagine the test case of tensile cracking of plate (2D) as discussed above. Considering we are now interested in seeing the plot of reaction force at surface vs. the applied tensile displacement, we would need to use two extra flags in the PSD_PreProcess step. These flags are -getreactionforce and -reactionforce stress_based as read below:

```
PSD_PreProcess -dimension 2 -problem damage -model hybrid_phase_field \
-dirichletconditions 2 -getreactionforce -reactionforce stress_based
```

The flag -getreactionforce directs PSD to include the routines to get the reaction force and -reactionforce stress_based is the method by which we get reaction force, in this case reaction force is calculated using integral of stress in y direction $F_y = \int_{\partial\Omega_{top}} \sigma_y$. Other method -reactionforce variational_based also exists within PSD, which is more accurate but slower, this method calculates reaction force based on matrix vector multiplication $F_x, F_y = \mathbf{A}u_1, u_2$.

Run the problem in the usual way bu using PSD_Solve and appropriate number of processes and mesh. While the PSD solver runs it will create a file force.data that contains the reaction force and the applied traction.

```
PSD_Solve -np 4 Main.edp -mesh ./../Meshes/2D/tensile-crack.msh -v 0
```

You can then go ahead and plot force.data to see how F_y and F_x evolve with Δu_2. Within the file the first column is the loading Δu_2, the second and the third columns are the forces F_x and F_y.

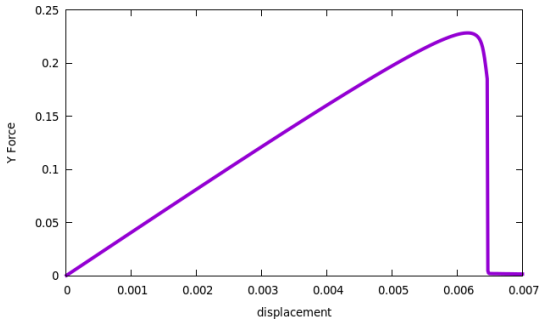

Figure 1: Applied traction vs. force in y direction.

Optionally if you have GnuPlot configured with PSD you can see live ploting of this curve if you use option -plotreactionforce during the PSD_PreProcess.

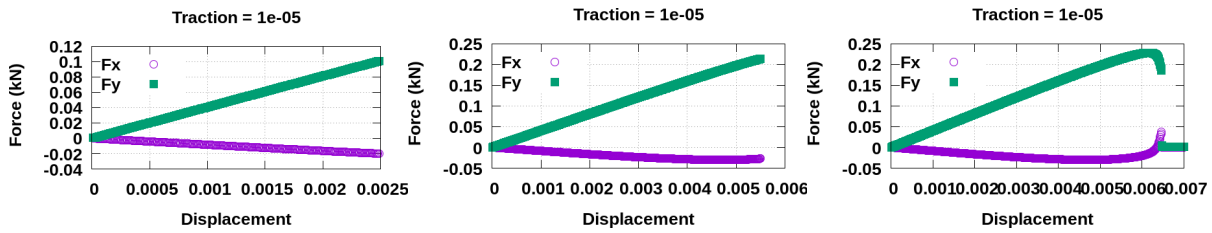

Figure 2: Applied traction vs. force in y direction plotted live using PSD.

Parallel 3D and calculate reactionforce

```
PSD_PreProcess -dimension 3 -problem damage -model hybrid_phase_field \
-dirichletconditions 2 -getreactionforce -reactionforce stress_based
```

```
PSD_Solve -np 3 Main.edp -mesh ./../Meshes/3D/tensile-crack.msh -v 0
```