Non-linear Elastic Block

Computational Mechanics Tools

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Identify in the code (file, lines) the following items:

1. The definition of the example (loading, geometry):

The definition of the geometry can be chose in the *Main_Incremental* file *t (line 11)* and all the problems are defined in *preprocessing* file from line 8 to line 59.

2. The choice of solution method (Newton's method with line search or without it).

The choice of the solution method, which in this case it is Newton-*Rapshon with line search*, has to be activated at line 20 (*options.method = 1)* in the *Main_Incremental* file. At line 21 it is possible to activate the line-search (*option1*) or not (*option 0*). For the *main_buckling* file, the solution method has to be activated from line 18 to 20.

3. The implementation of the solutions.

The implementation of the solution can be identified in *equilibrate* file, from line 9 to 94.

4. The implementation of the incremental-iterative strategy, with smart initial guesses for imposed displacements.

The implementation of the incremental-strategy it can be found in the *main_buckling* file (from line 65 to line 97) and in the *main_incremental_iterative file (*from line 39 to line 71).

5. The introduction of random perturbations in the initial guesses of the solution method.

The random perturbation can be activated in the *main_buckling* file at line 76 and in the *main_incremental_iterative file at line 50.*

Results discussion

As we see form the obtained results, there is no proportionality of response with respect to the loads for a non-linear model. In order to emphasize this behavior, it can easily notice observing Figure 1 and Figure 2, where the deformation is not proportional as the load increase (Figure 2) or decrease (Figure 1). The linear model shows a typical proportionality response as the load decrease or increase characterized with a constant slope of the black line.

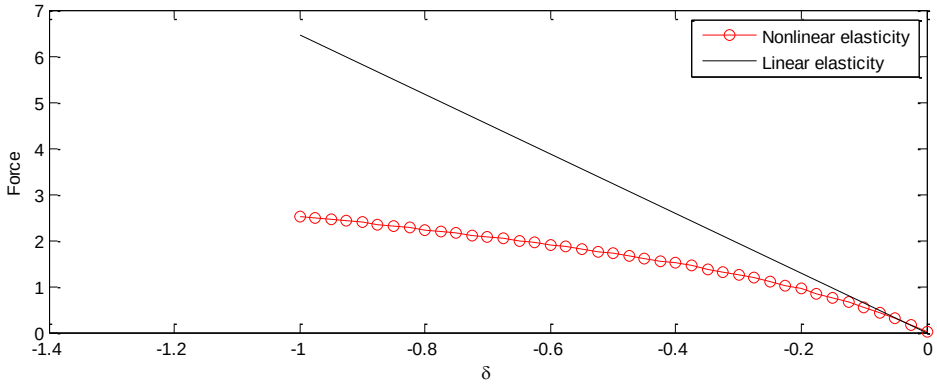

Figure 1: Deformation vs. force
Example 1 without line-search and for lambda = [1:.025:2]

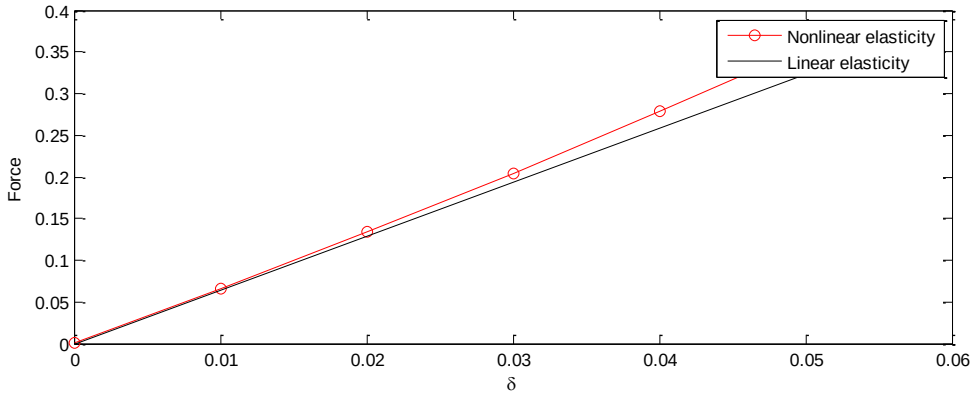

Figure 2: Deformation vs. force
Example 1 without line-search and for lambda = [1: -.01:0.5]

Another behavior we can see about a non-linear model is the no symmetry response with respect to the sign of the load. Figure 3 and Figure 4 show the comparison between a same load of 3e0 but with different sign. It can be noticed that, while for a linear model which is associated with a symmetric response (same absolute value of the slope for both loads), for a non-linear model, the response is asymmetric.

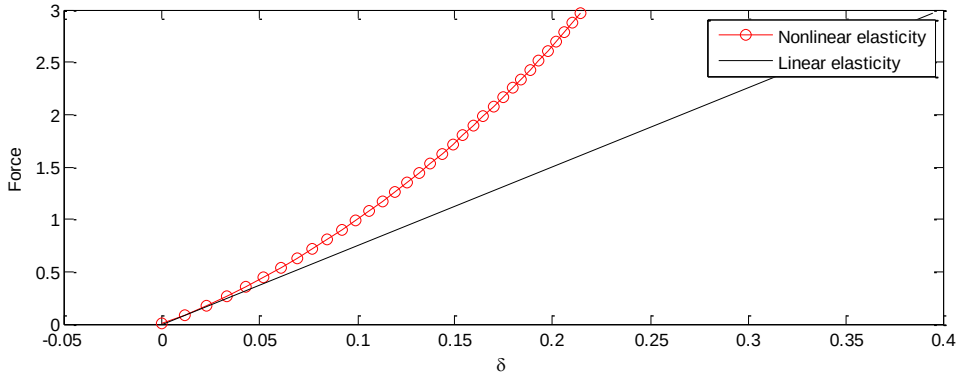

Figure 3: Example 0 without line-search and for mod1.force = 3e0.

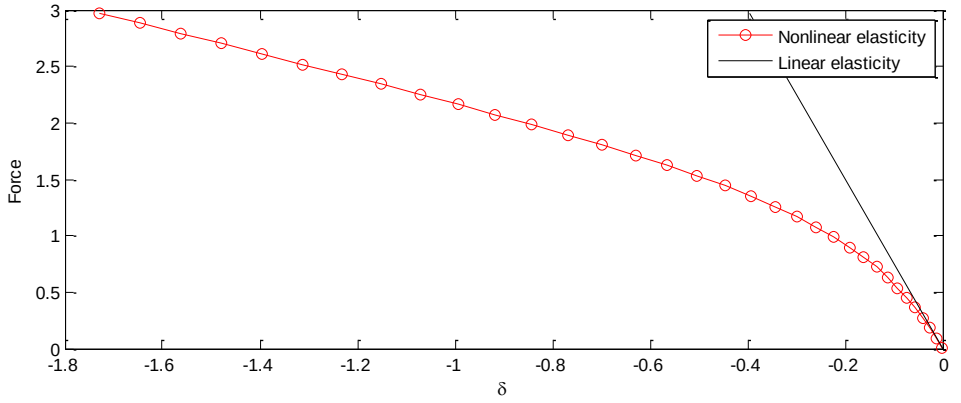

Figure 4: Example 0 without line-search and for mod1.force = -3e0.

Figure 5, which was obtained running the *main buckling file,* show different deformation for the same example so we can say that the solution is not unique

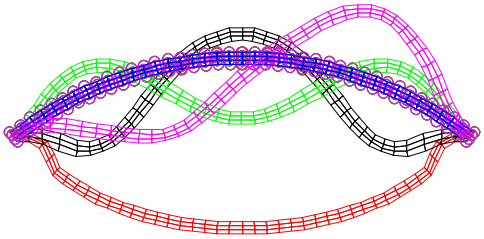

Figure 5: example 5 main buckling.

Comparing figure 9 with figure 10, which they show a solution without and with *a random perturbation*, we can observe clearly how a non-linear model can be unstable. Actually a system should be stable as we add a small perturbation and both solutions have to be similar.

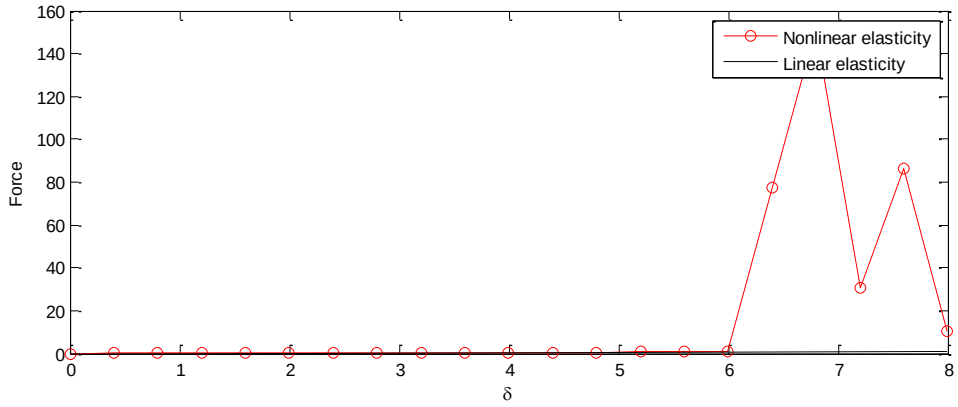

Figure 9: example 2 without line search with random perturbation.

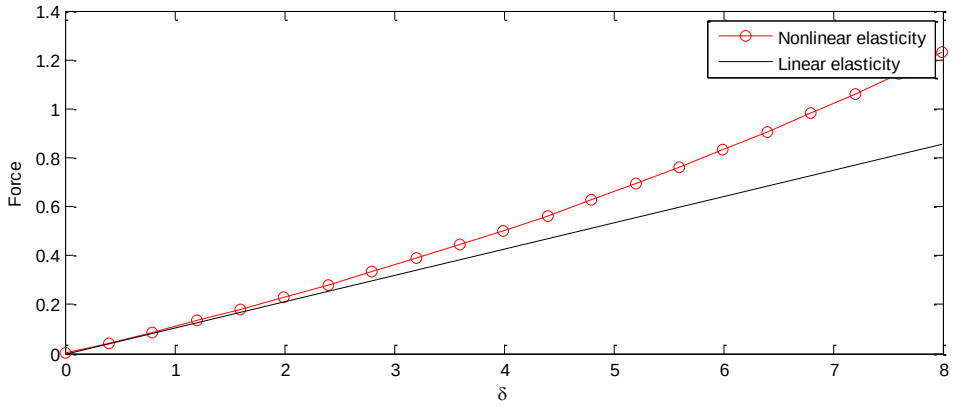

Figure 10: example 2 without line search without random perturbation.