Computational Structural Mechanics and Dynamics, Assignment 6

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Assignment 6
On "Beam Theory":

The problem definition is the following:

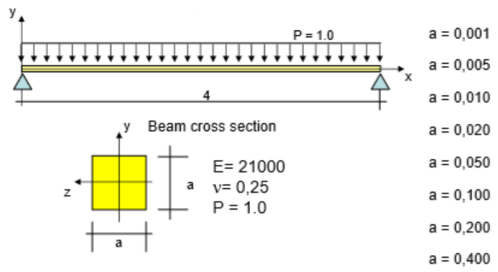


Figure 1: Problem Description

The problem was modelled using GiD and a problem data file was obtained. The P=1 was implemented using the "denss" value as in the examples of the class, the specific weight. Both ends are simply supported. The moment of inertia is $I = \frac{a^4}{12}$.

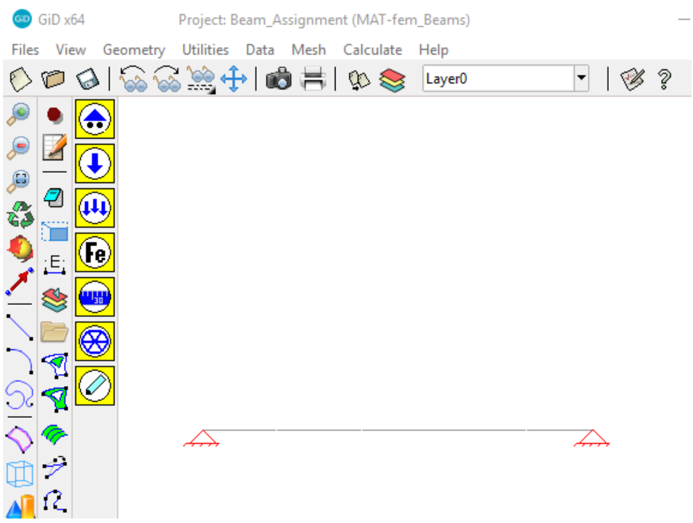


Figure 2: GiD Modelling

GiD produces a file that can be read by the MATLAB program both, for Euler-Bernoulli and Timoshenko. The only change that needs to be implemented is in the case of the reduced integration Timoshenko Beam element. The changes were implemented as an option at the beginning of the file that asks the user whether or not using the reduced integration.

The second change, using only one Gauss point, was not needed since the latest version of the code only uses one Gauss point already.

```
Reduced_Int=input('Which matrix to use, Full Integration (0) or Reduced Integration?(1)');
```

```
if Reduced_Int==1
    K_s = [   1    ,    len/2 ,    -1    ,    len/2 ;
        len/2 , len^2/4 , -len/2 , len^2/4 ;
         -1    ,  -len/2 ,     1    ,  -len/2 ;
        len/2 , len^2/4 , -len/2 , len^2/4 ];

else

K_s = [   1    ,    len/2 ,    -1    ,    len/2 ;
        len/2 , len^2/3 , -len/2 , len^2/6 ;
         -1    ,  -len/2 ,     1    ,  -len/2 ;
        len/2 , len^2/6 , -len/2 , len^2/3 ];
end
```

Figure 3: Modifications in the code for Reduced Integration

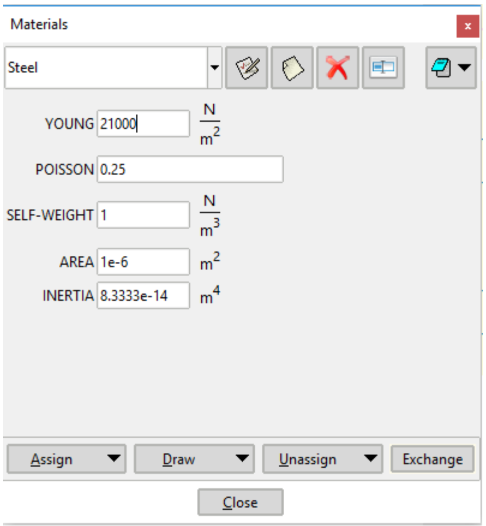
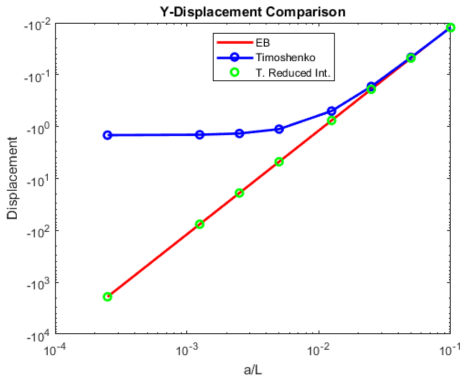
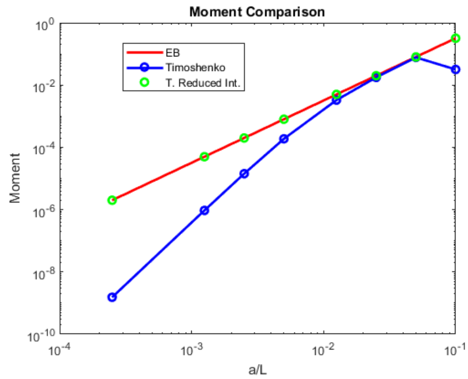


Figure 4: Modifications in the code for Reduced Integration

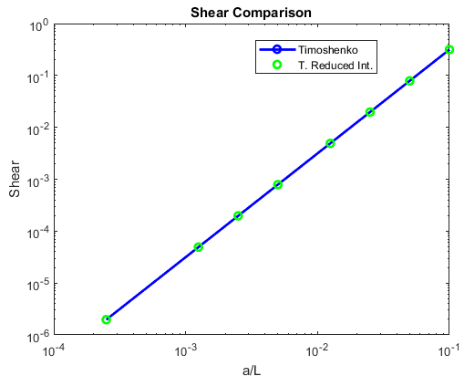
After running the simulations for all the cases and all the 3 versions of the codes, the maximum displacements, moments and shear were obtained.



(a) Maximum Displacement



(b) Maximum Moment



(c) Maximum Moment

Figure 5: Results of the simulation

Conclusions:

The Timoshenko element using reduced integration is able to give precise results for both thin and thick beams (using a sufficiently fine mesh). In Figure 5(a), one can observe that the Timoshenko element using full integration is over stiffening the results. Notice also how the results for shear are the same for reduced integration and for full integration, Euler-Bernoulli is not able to provide this information. finally, it should be noted that the results using a thicker beam are expected to be more accurate using the thick beams theory of Timoshenko with full integration, but the robustness and relative cheap cost of this simulations allow to use the Timoshenko element with reduced integration for both thick and thin beams; therefore it should be preferred in the general case.