UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Assignment 6

Computational Structural Mechanics and Dynamics

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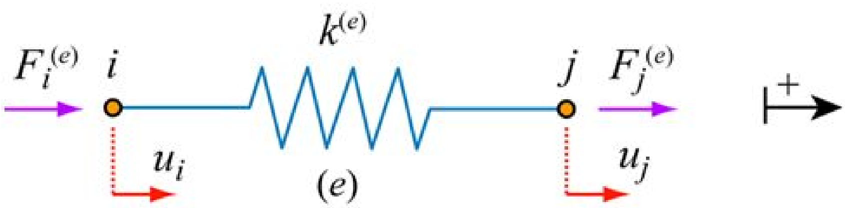


Contents

1 Assignment 6.1

Program In Mat Lab the Timoshenko 2 Nodes Beam element with reduce integration for the shear stiffness matrix
To implement this, only a minor change in the shear stiffness matrix was made:

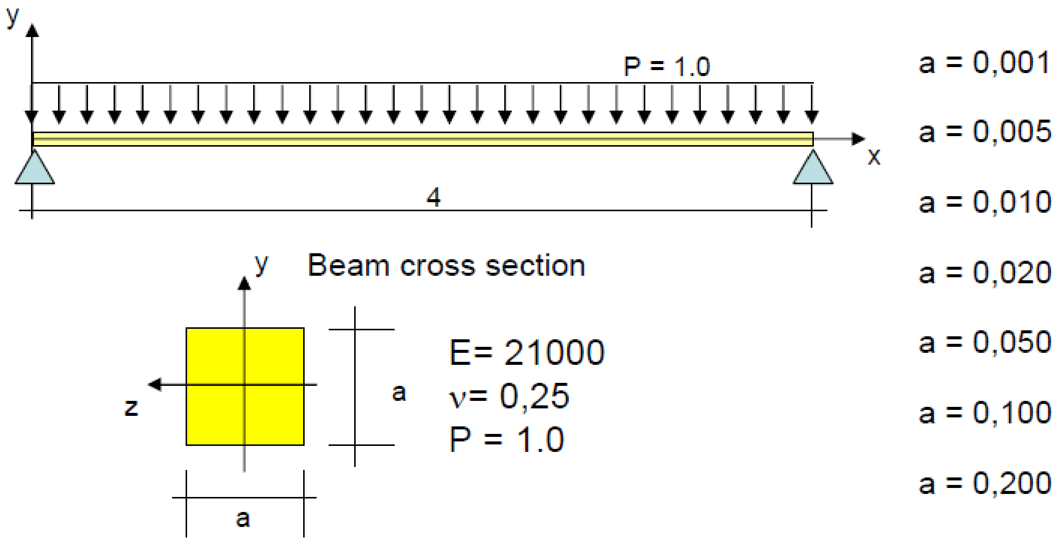
```
K_s = [   1    ,   len/2  ,  -1     ,   len/2  ;
        len/2  , len^2/4  , -len/2  , len^2/4  ;
         -1    , -len/2   ,   1     , -len/2   ;
        len/2  , len^2/4  , -len/2  , len^2/4  ];
```

2 Assignment 6.2

Solve the following problem with a 64 element mesh with the

- 2 nodes Euler Bernoulli element
- 2 nodes Timoshenko Full Integrate element
- 2 nodes Timoshenko Reduce Integration element

Compare maximum displacements, moments and shear for the 3 elements against the a/L relationship



Once the programs were properly structured, the Mat-Fem problem type was downloaded and installed to pre-process with GiD. In the GiD interface, the geometric and physical data were entered, as well as the generation of the 64-element mesh. Once the input file for Matlab with the ".m" extension was generated, it was loaded with the Euler-Bernoulli, Timoshenko Full Integration and Timoshenko Reduce Integration Matlab programs. These programs generate a ".res" file containing the results, these results can be used to perform a more interactive GiD post-process, however, the scope of this project is to compare the different results obtained for different ratios of to a/L. To speed up the calculations, only the GiD interface was used for the first example, and then the data was modified directly in the file extension ".m" and in turn, the desired results were obtained from the ".res" file generated each time the process was performed. Below are the different simulations carried out in the following table:

L	a	Area	Inertia
4	0.001	1.00E-06	8.33E-14
4	0.005	2.50E-05	5.21E-11
4	0.01	1.00E-04	8.33E-10
4	0.02	4.00E-04	1.33E-08
4	0.05	0.0025	5.21E-07
4	0.1	0.01	8.33E-06
4	0.2	0.04	1.33E-04
4	0.4	0.16	2.13E-03

Note: All the values were inserted as dimensionless.

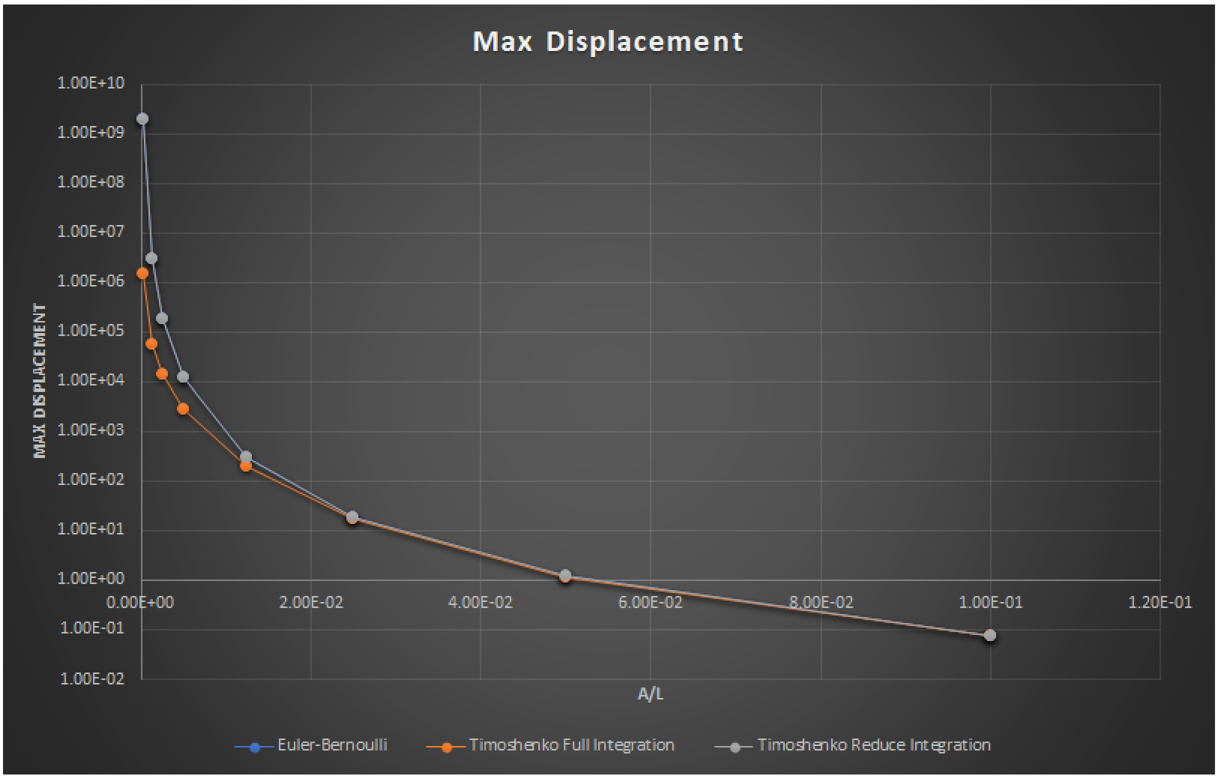
The results to compare will be the maximum displacements, Mz and shear forces present in all the simulations. To facilitate this comparison, the results are summarized in the following tables:

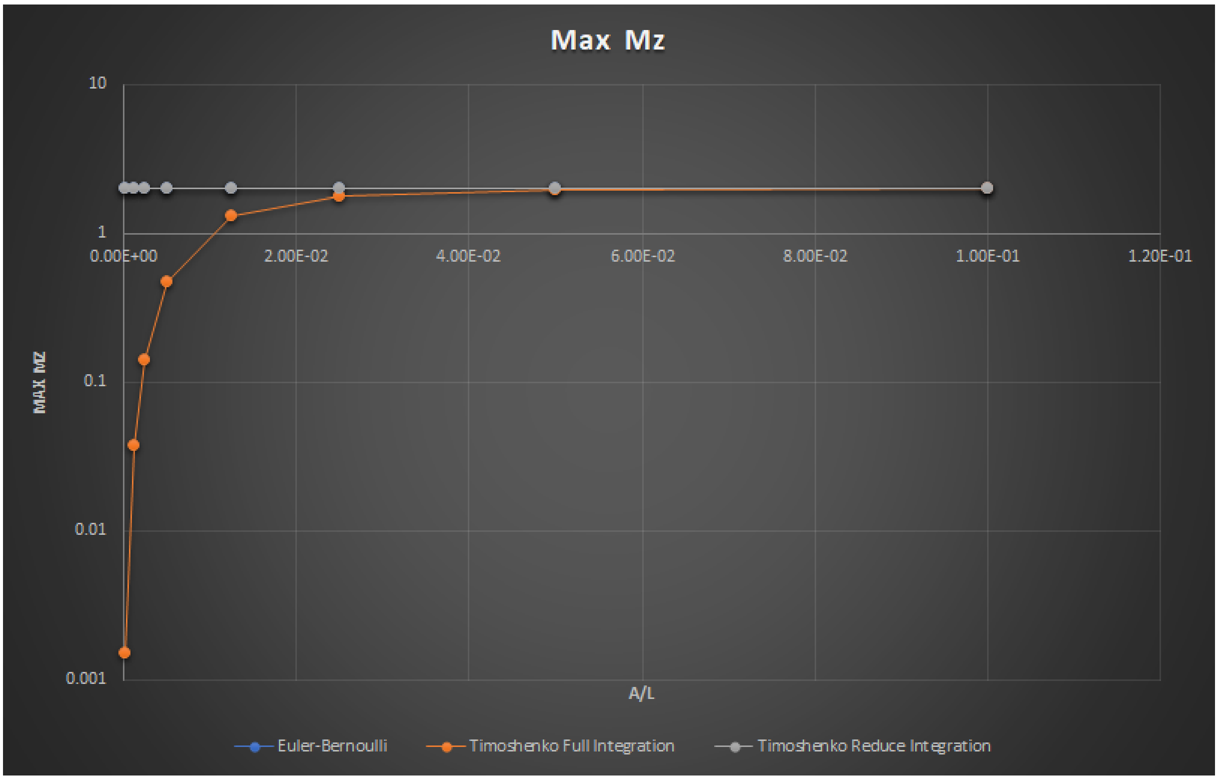
Euler-Bernoulli				
a	a/L	Displacement	Mz	Shear force
0.001	2.50E-04	1.90E+09	1.9999	2
0.005	1.25E-03	3.05E+06	1.9999	2
0.01	2.50E-03	1.90E+05	1.9999	2
0.02	5.00E-03	1.19E+04	1.9999	2
0.05	1.25E-02	3.05E+02	1.9999	2
0.1	2.50E-02	1.90E+01	1.9999	2
0.2	5.00E-02	1.1905	1.9999	2
0.4	1.00E-01	7.44E-02	1.9999	2

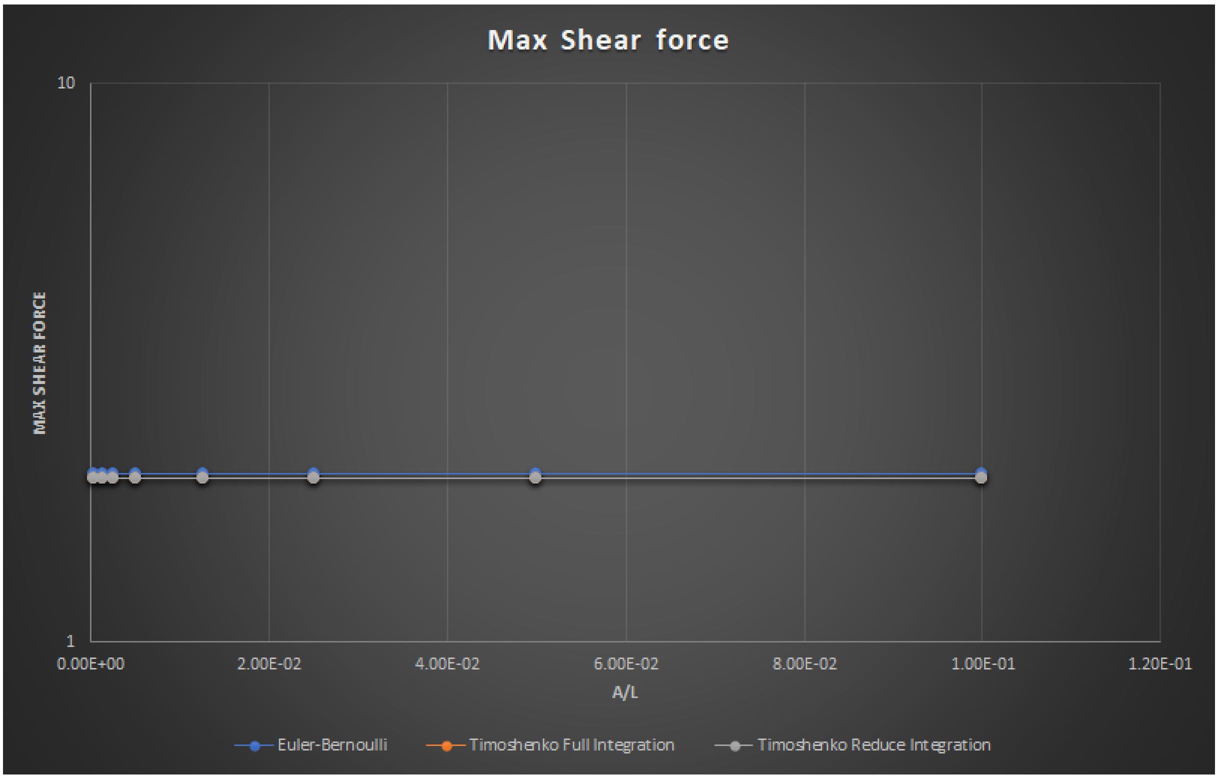
Timoshenko Full Integrate				
a	a/L	Displacement	Mz	Shear force
0.001	2.50E-04	1.46E+06	1.53E-03	1.9688
0.005	1.25E-03	5.74E+04	3.77E-02	1.9688
0.01	2.50E-03	1.36E+04	1.43E-01	1.9688
0.02	5.00E-03	2.80E+03	4.70E-01	1.9688
0.05	1.25E-02	2.00E+02	1.3144	1.9688
0.1	2.50E-02	1.69E+01	1.7687	1.9688
0.2	5.00E-02	1.1596	1.936	1.9688
0.4	1.00E-01	7.56E-02	1.9829	1.9688

Timoshenko Reduce Integration				
a	a/L	Displacement	Mz	Shear force
0.001	2.50E-04	1.90E+09	1.999	1.9688
0.005	1.25E-03	3.05E+06	1.999	1.9688
0.01	2.50E-03	1.90E+05	1.999	1.9688
0.02	5.00E-03	1.19E+04	1.999	1.9688
0.05	1.25E-02	3.05E+02	1.999	1.9688
0.1	2.50E-02	1.91E+01	1.999	1.9688
0.2	5.00E-02	1.1971	1.999	1.9688
0.4	1.00E-01	7.62E-02	1.999	1.9688

A better way to interpret these results is offered graphically below:




Max Mz
MAX MZ
10
1
0.1
0.01
0.001
0.00E+00
2.00E-02
4.00E-02
6.00E-02
8.00E-02
1.00E-01
1.20E-01
A/L
Euler-Bernoulli
Timoshenko Full Integration
Timoshenko Reduce Integration


Max Shear force
MAX SHEAR FORCE
10
1
0.00E+00
2.00E-02
4.00E-02
6.00E-02
8.00E-02
1.00E-01
1.20E-01
A/L
Euler-Bernoulli
Timoshenko Full Integration
Timoshenko Reduce Integration

3 Discussion

- Displacements: It can be noticed that as a/L increases, the three models converge to similar displacements, while the big difference appears in the Timoshenko Full Integration model in which a great change in magnitudes can be seen when a/L is very small. These figures are more precise since when shear locking occurs, the element becomes more rigid and therefore suffers less displacement.
- Bending Moment: Considering the analytical value of the maximum bending moment, it can be noticed that the Euler-Bernoulli and Timoshenko Reduce Integration models give very accurate results, while the Timoshenko Full Integration presents very different results when the a/L ratio is very small, this again due to shear locking, although in this case it is unfavorable for this model, the previously mentioned ones being more precise.
- Shear Force: In the case of the shear force, there are no significant changes between the three models.

376/5000 Therefore we can conclude that as the element has a higher a/L ratio, the three models will behave in a similar way. While as a/L decreases, Euler-Bernoulli and Timoshenko Reduce Integration will be better predictors of bending moments, while the Timoshenko Full Integration model will be more accurate in terms of displacements.