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RamSeries - Validation Case 4

Cantilever beam under punctual load

RamSeries

Version
15.1.0

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Table of Contents

1 Valid.Case 4 - Cantilever beam under punctual load

Model description

This validation example shows the analysis of a clamped thick cantilever beam under a point load at its free end.

Results for different density meshes of 3-noded triangles and 4-noded rectangle are compared against the exact analytical solution.

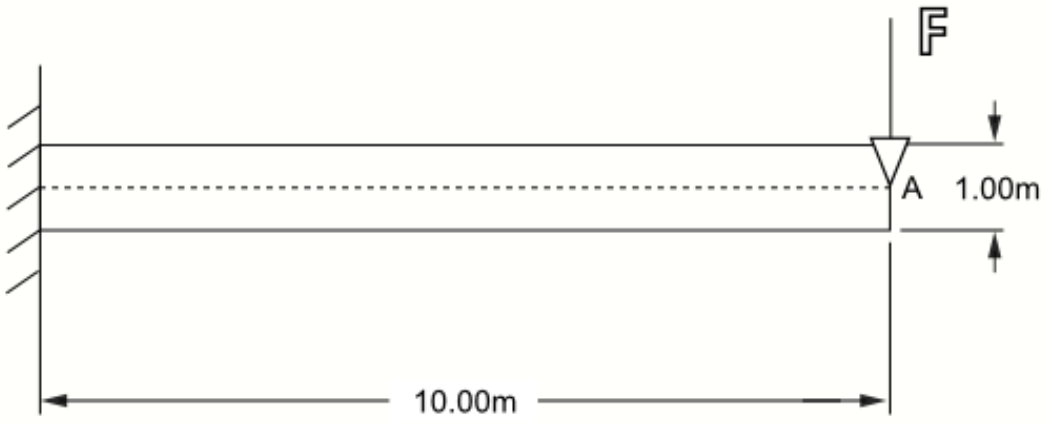
The values compared are:

- The vertical deflection of the center of the free end (point A).
- The σ_x stress at the lower fibre of the middle section (point B).

Geometrical model:

The rectangular cantilever beam geometry is defined as follows:

	Point 1	Point 2	Point 3	Point 4
x	0	10	10	0
y	0	0	1	1
z	0	0	0	0



FEM model setup:

- Boundary conditions:
  The left border of the cantilever beam is clamped, with all the degrees of freedom restrained.

- Loads:
  (F_x ,F_y ,F_z , M_x , M_y , M_z) = (0.0 , 900.0 , 0.0) (N)

  over point A (10.0 , 0.5 , 0.0)

- Material:
  Cantilever beam properties are the following:

  Thickness (t): 0.1 m

  E: 2.0e8 Pa

  v: 0.2

  η: 4000 N/m^3

Results

The exact analytical solution, given in Reference [1] (page 155), is:

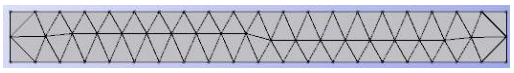
δ_{Ay} = 0.1800 m

σ_{Bx} = 2.7e5 Pa

Convergence of the vertical deflection at the free end (δ_{Ay}), and horizontal stress (σ_{Bx}) at the lower fiber of the middle section for unstructured meshes of 3-noded triangles and 4-noded rectangles, is shown:

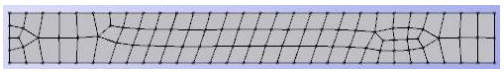
62 nodes, 78 elems

δ_{Ay} = 0.116 m; σ_{Bx} = 1.228e5 Pa



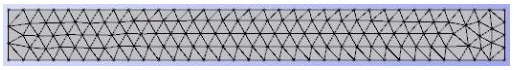
118 nodes, 85 elems

δ_{Ay} = 0.1667 m; σ_{Bx} = 2.523e5 Pa



168 nodes, 261 elems

δ_{Ay} = 0.1573 m; σ_{Bx} = 1.941e5 Pa

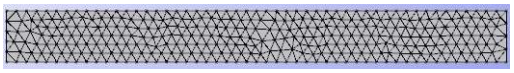


205 nodes, 160 elems

δ_{Ay} = 0.176 m; σ_{Bx} = 2.653e5 Pa

347 nodes, 583 elems

δ_{Ay} = 0.1698 m; σ_{Bx} = 2.303e5 Pa



293 nodes, 237 elems

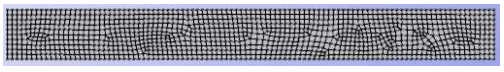
δ_{Ay} = 0.177 m; σ_{Bx} = 2.67e5 Pa

1203 nodes, 2184 elems

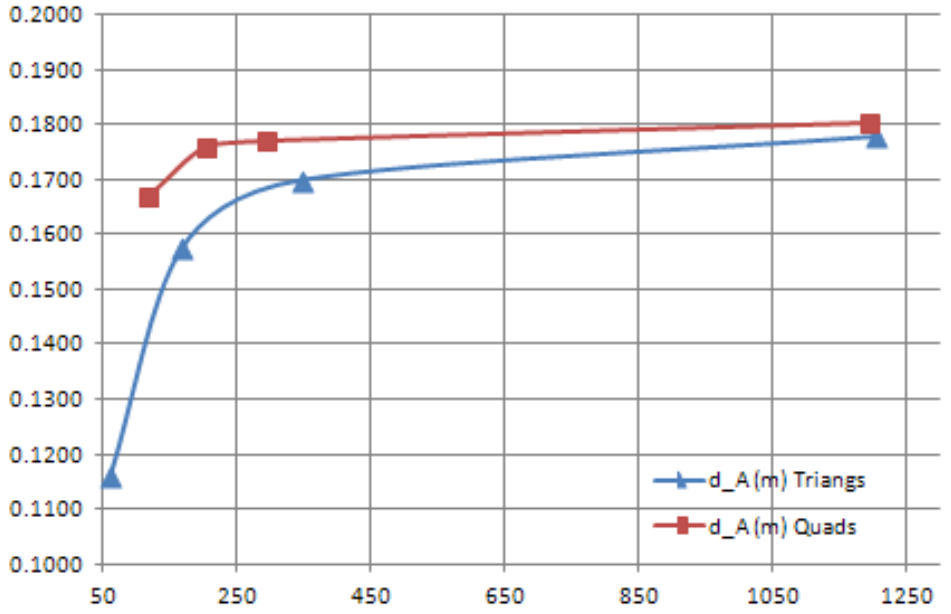
δ_{Ay} = 0.1777 m; σ_{Bx} = 2.494e5 Pa

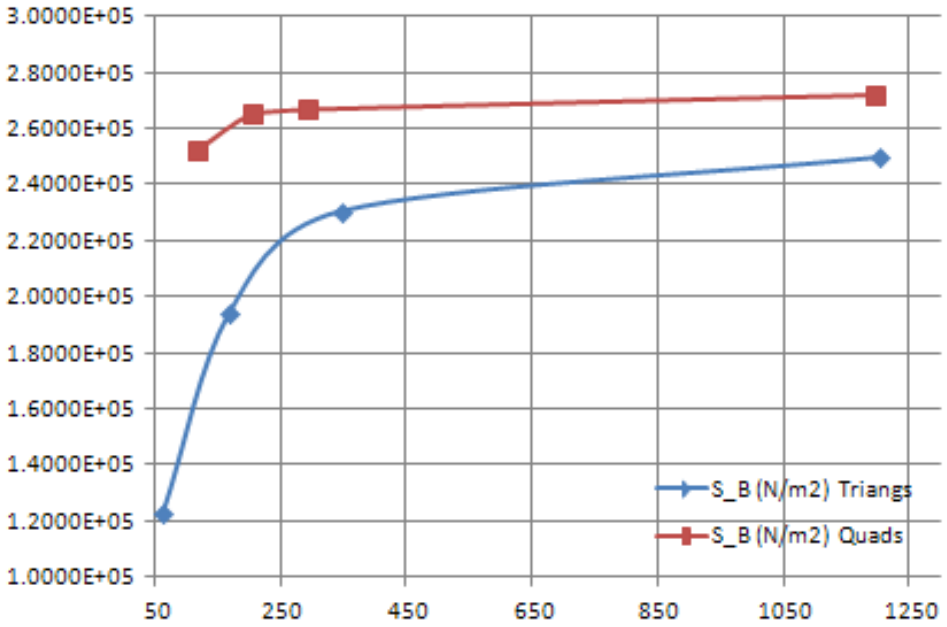
1195 nodes, 1084 elems

δ_{Ay} = 0.1803 m; σ_{Bx} = 2.723e5 Pa



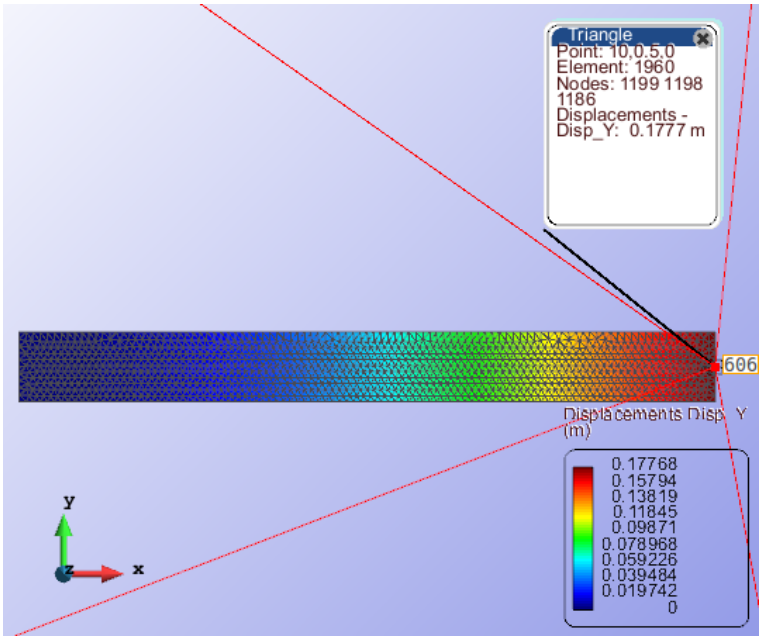
The following tales show the values presented above:



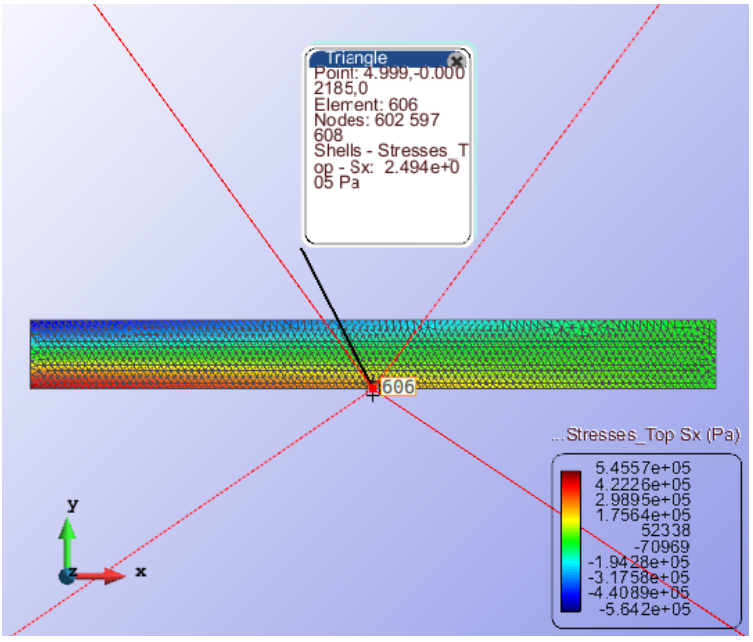


The convergence is similar to that shown in Reference [1].

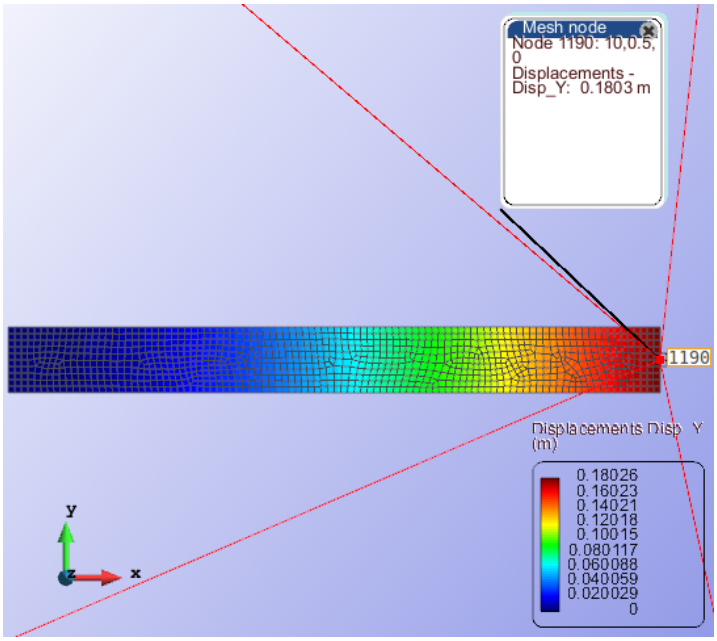
Results (deflections and stresses) for the refined meshes (triangles and rectangles), are shown:



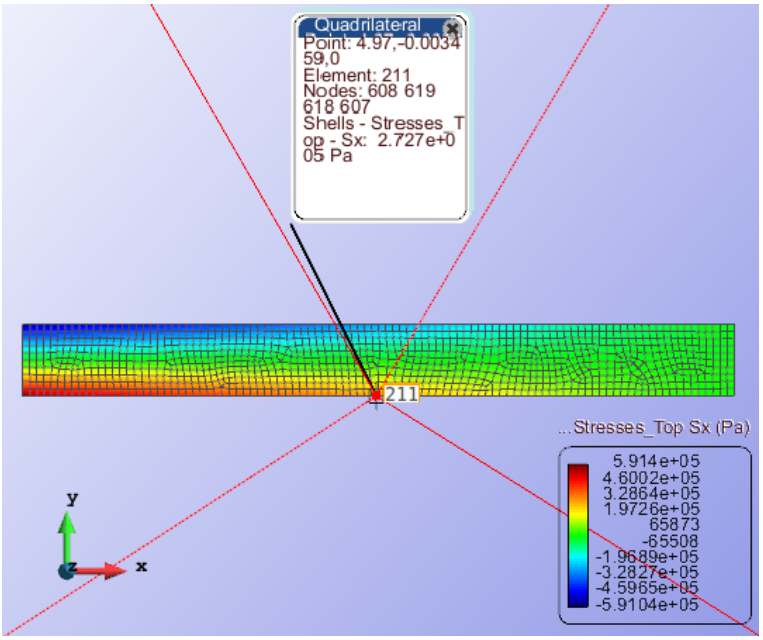
Vertical deflection at end point (triangles, 1203 nodes mesh)



Sx stress at middle point triangles, 1203 nodes mesh)



Vertical deflection at end point (rectangles, 1195 nodes mesh)



Sx stress at middle point (rectangles, 1195 nodes mesh)

Reference

[1] Eugenio Oñate. Structural Analysis with the Finite Element Method. Linear Statics. Volume 1. Basis and Solids. Springer, 2009.

Validation Summary

CompassFEM version	15.1.0
Tdyn solver version	15.1.0
RamSeries solver version	15.1.0
Benchmark status	Successfull
Last validation date	27/11/2018