

OPTUM GX

Verification of plate element with elastic properties



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1 Introduction

1.1 Plate element

OPTUM GX uses a triangular plate element with a quadratic displacement field. The stress and moment fields are linear and described by a total of 18 variables. The in-plane part of the plate element contributes to 7 nodes, whereas one is a center node and the remaining 6 are corner nodes and edge (midpoint) nodes. The bending part of the plate element uses the same corner and edge nodes as well as two nodes along each edge for moment continuity.

1.2 Upper, lower and mixed

Currently in OPTUM GX the plate element is based on a so-called mixed formulation which in essence is a hybrid, or mixed, formulation of an upper and lower bound formulation. The output results when using the plate element with a mixed formulation is guaranteed to be within the brackets of the upper (unsafe) and lower (safe) bounds. The hybrid formulation ensures an superb precision.

Currently in OPTUM GX the mixed formulation is the only element available.

1.3 Material models and yield conditions

In the present document verification of the **elastic material** model is considered

2 Square plate with simple supports – elastic material

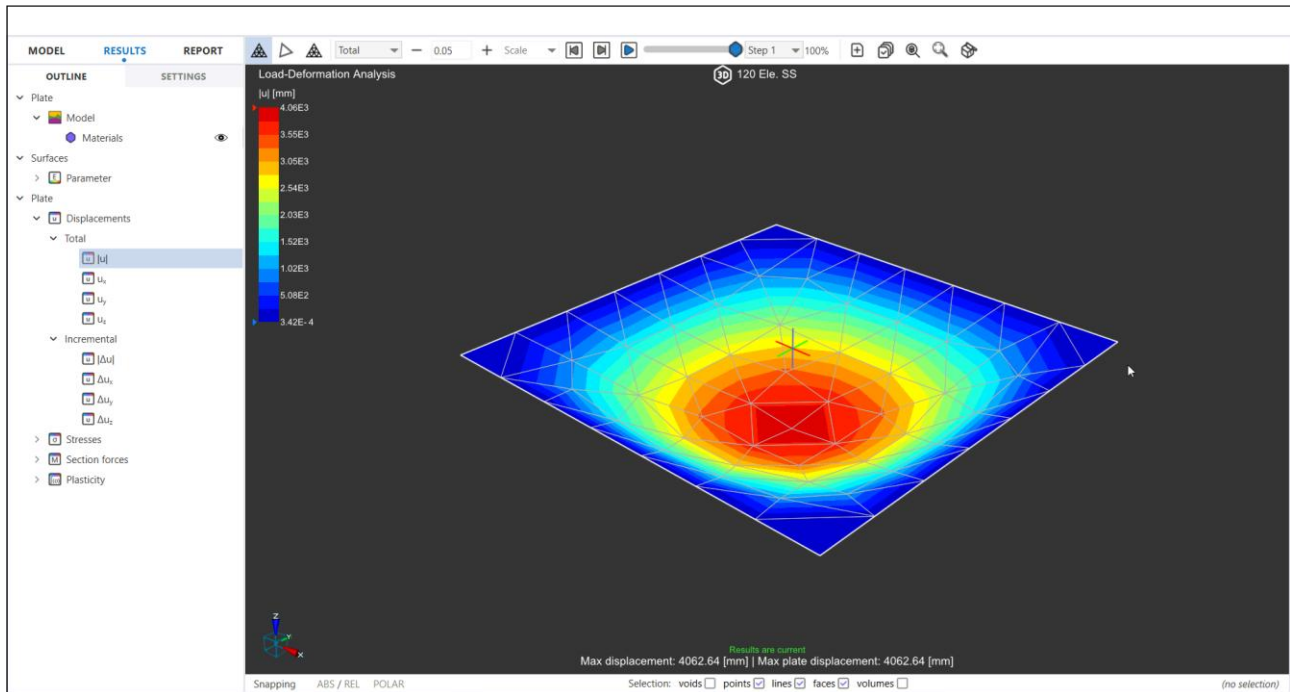


Figure 1: Square plate with simple supports – 120 elements

Benchmark Results

4.0624 (infinite series)
4.05938 – 30 elements
4.05990 – 60 elements
4.06264 – 120 elements

Discrepancy

0.05% for 120 elements

General description:

Square 1x1m elastic plate. All edges with simple supports Loaded with unit area load of 1.0 kPa.
E = 0.01125 MPa, Poisson ratio 0.25, plate thickness 0.1 m. Density 0.0 kg/m³.

Material properties:

Material	
Name	Flat plate (steel)
Material Model	Von Mises plate
Color	Change...
Reducible Strength	Yes
Cross Section	
Thickness, t (m)	0.1
Stiffness	
E (MPa)	0.01125
ν	0.25
Strength	
Yield condition	None (elastic)
Unit Weights	
Weight (kN/m ³)	0

Partial factors:

Unity

Reference:

S. Timoshenko, Theory of Plates and Plates, McGraw-Hill (1987)

3 Square plate with fixed supports – elastic material

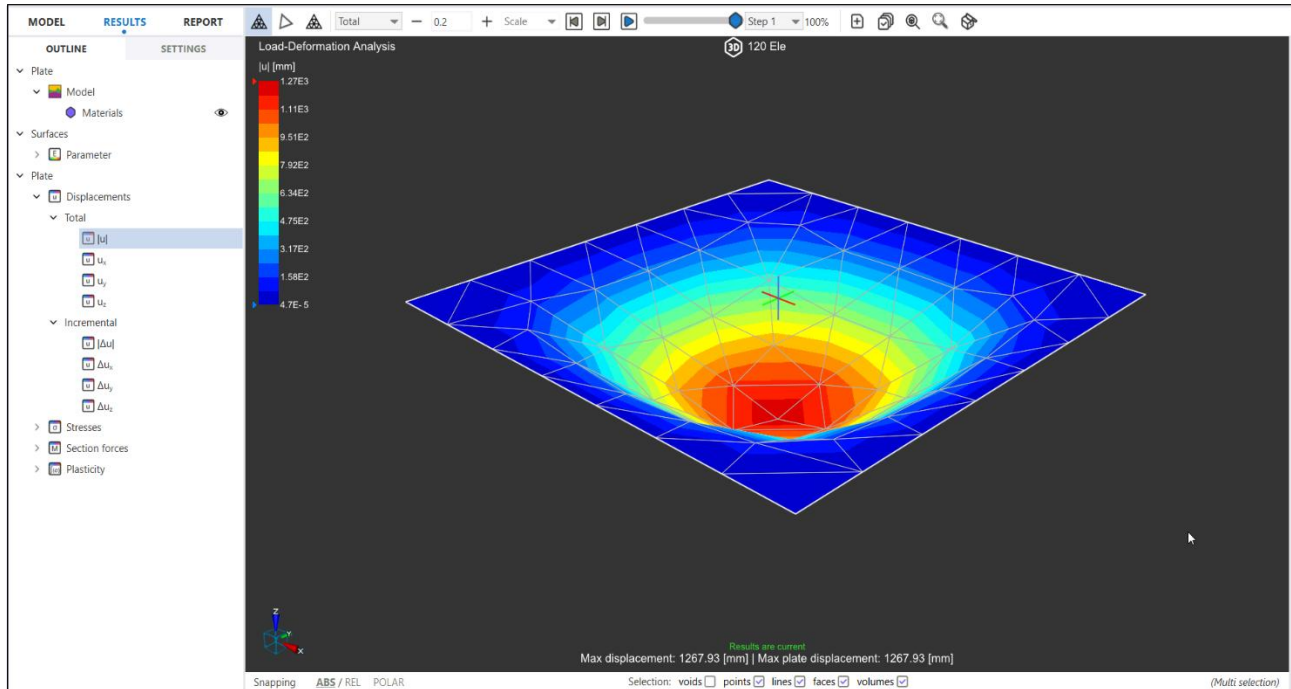


Figure 2: Square plate with fixed supports

Benchmark Results

1.2653 (infinite series)
1.29380 – 30 elements
1.27438 – 60 elements
1.26793 – 120 elements
0.20% for 120 elements

Discrepancy

General description:

Square 1x1m elastic plate. All edges with simple supports Loaded with unit area load of 1.0 kPa.
E = 0.01125 MPa, Poisson ratio 0.25, plate thickness 0.1 m. Density 0.0 kg/m³.

Material properties:

Material	
Name	Flat plate (steel)
Material Model	Von Mises plate
Color	Change...
Reducible Strength	Yes
Cross Section	
Thickness, t (m)	0.1
Stiffness	
E (MPa)	0.01125
ν	0.25
Strength	
Yield condition	None (elastic)
Unit Weights	
Weight (kN/m ³)	0

Partial factors:

Unity

Reference:

S. Timoshenko, Theory of Plates and Plates, McGraw-Hill (1987)

