CRITICAL FACTORS AFFECTING THE USE OF FINITE ELEMENT ANALYSIS FOR ROTOMOULDED PARTS

SOCIETY OF PLASTICS ENGINEERS

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Presentation Overview

1. Introduction

2. Four Key Research Questions

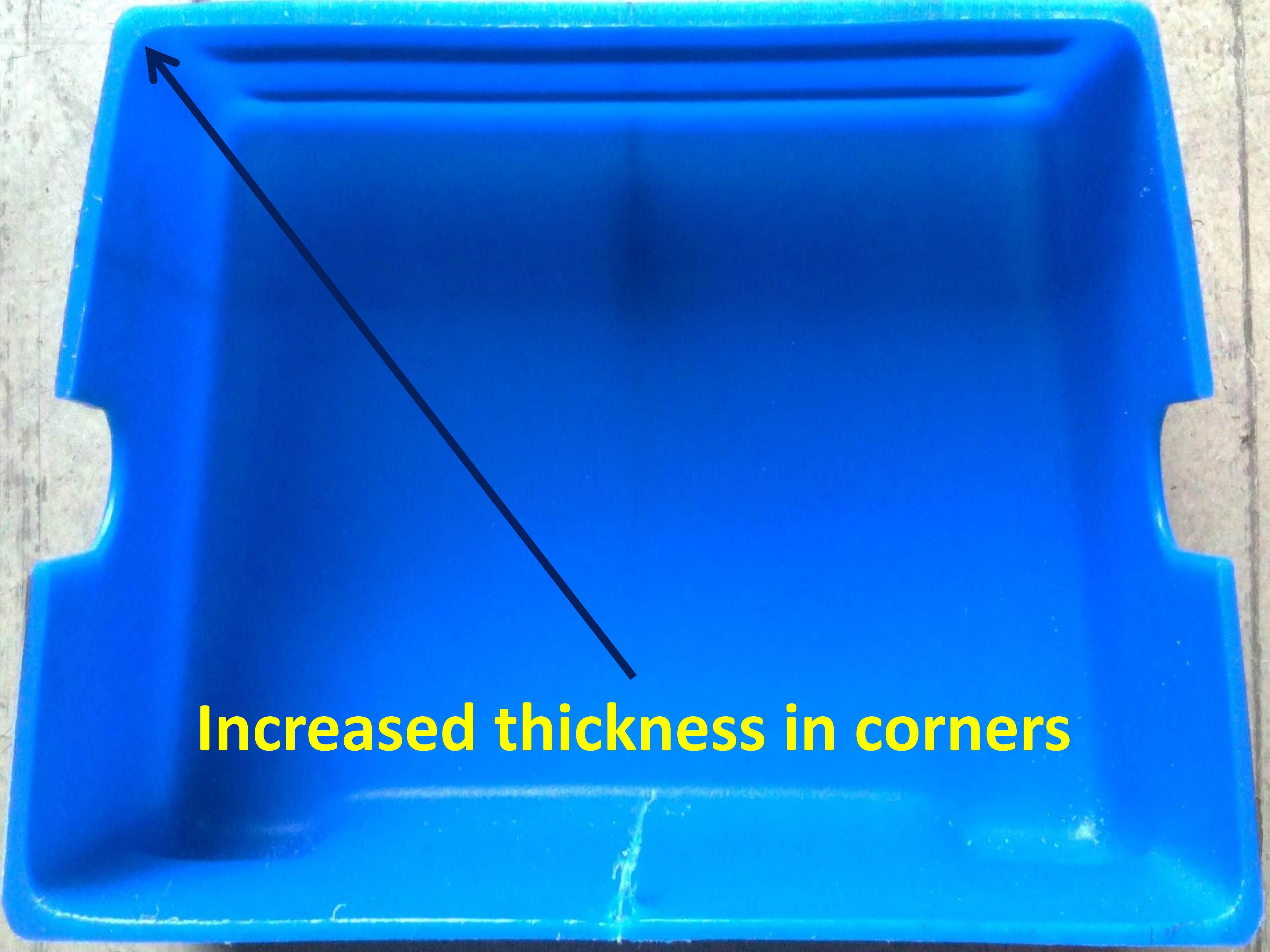
3. Results and Discussion

4. Conclusions

Introduction

Introduction

- Finite element analysis (FEA) is a numerical approximation of stresses for engineering designs.
- FEA is used in the rotomolding (RM) industry, however, it is not always perceived to be accurate or useful.
- Inaccuracies due to geometry variation, complex material characteristics, loading scenarios …
- Better correlation between FEA and physical rotomolded part performance is required.

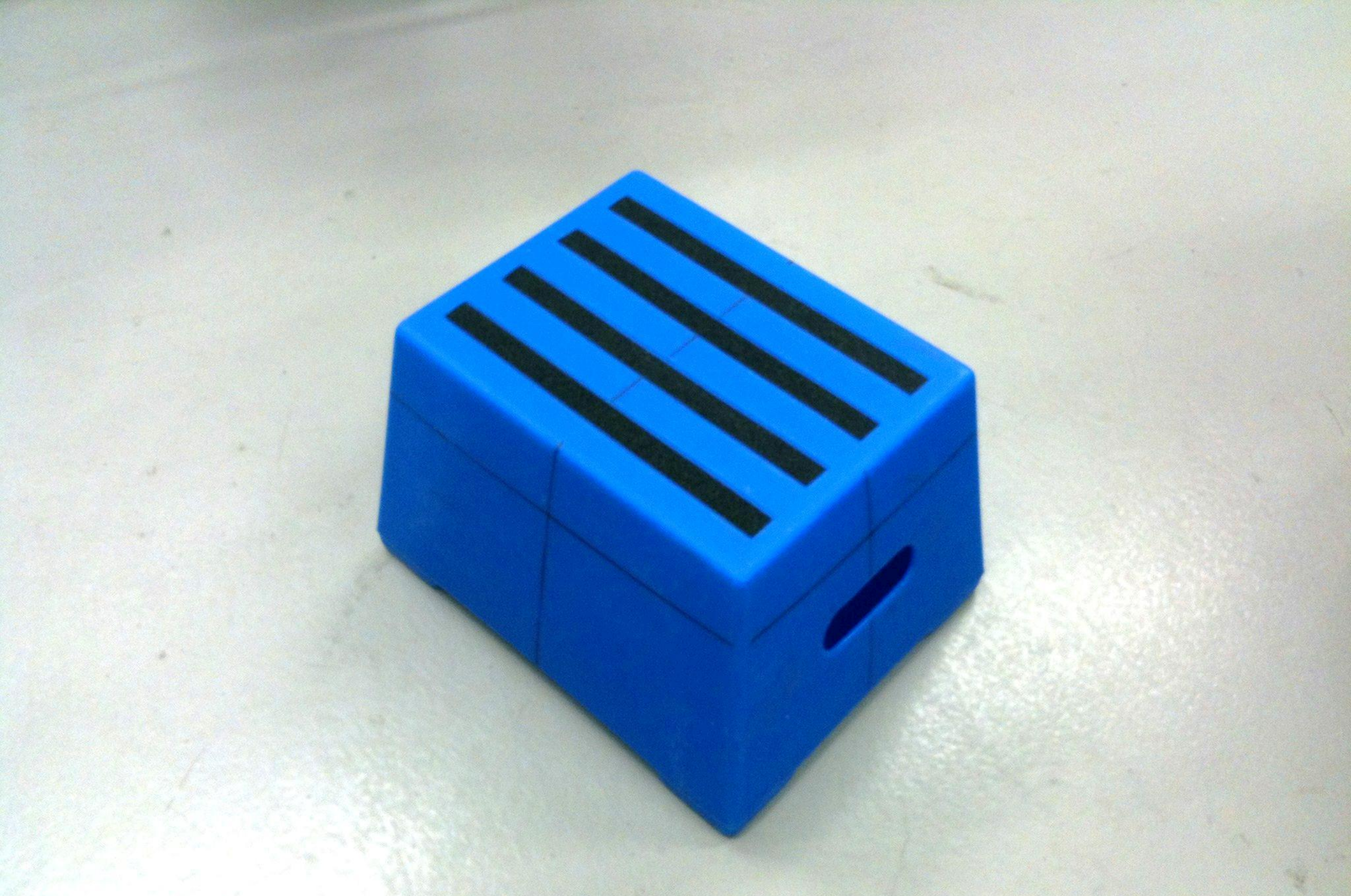

Increased thickness in corners

Key Research Questions

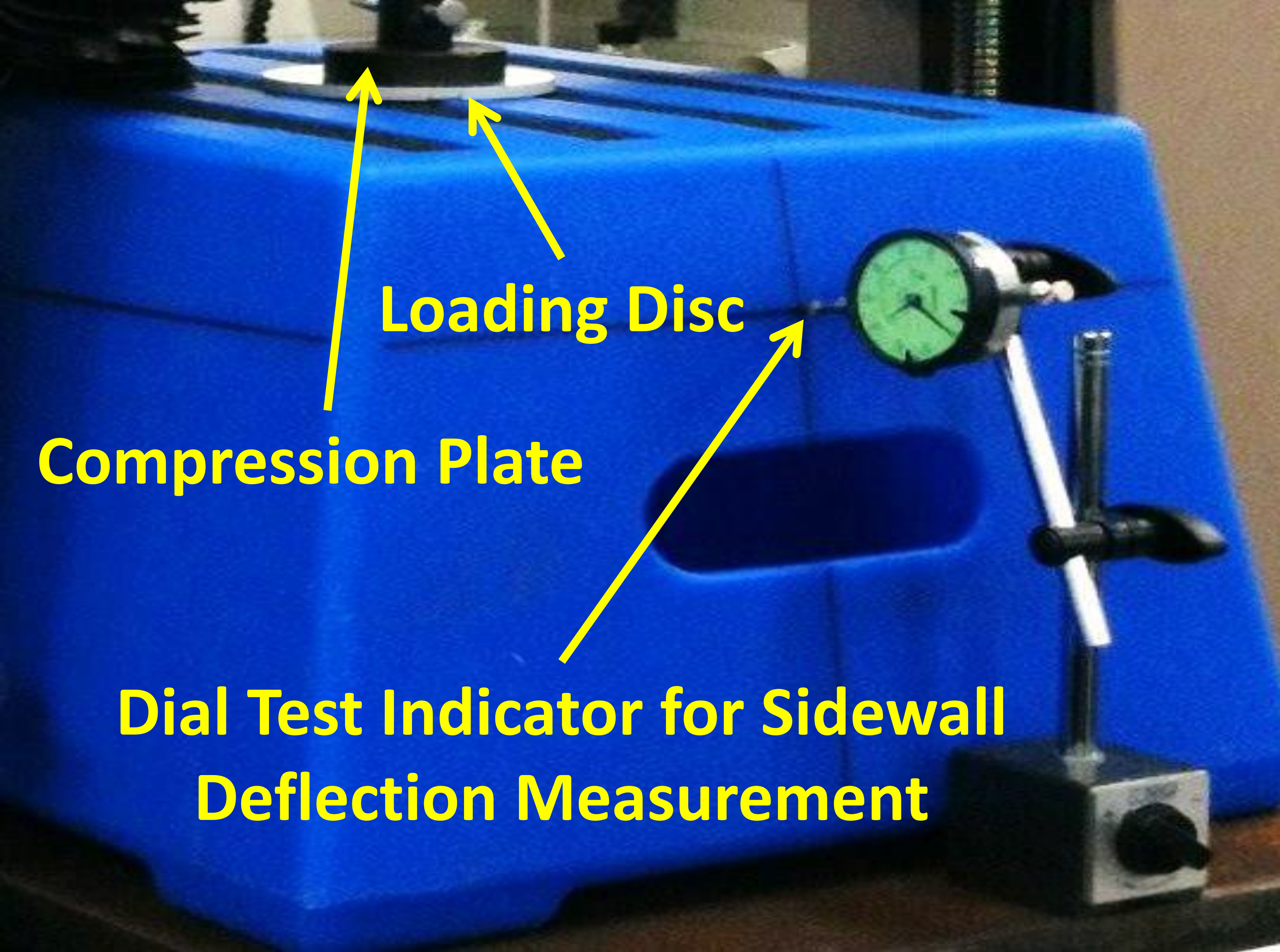
Key Research Questions

- Does FEA work?
- FEA information check list
- Are the material properties truly representative?
- How important is Poisson’s Ratio?

Does FEA Work?

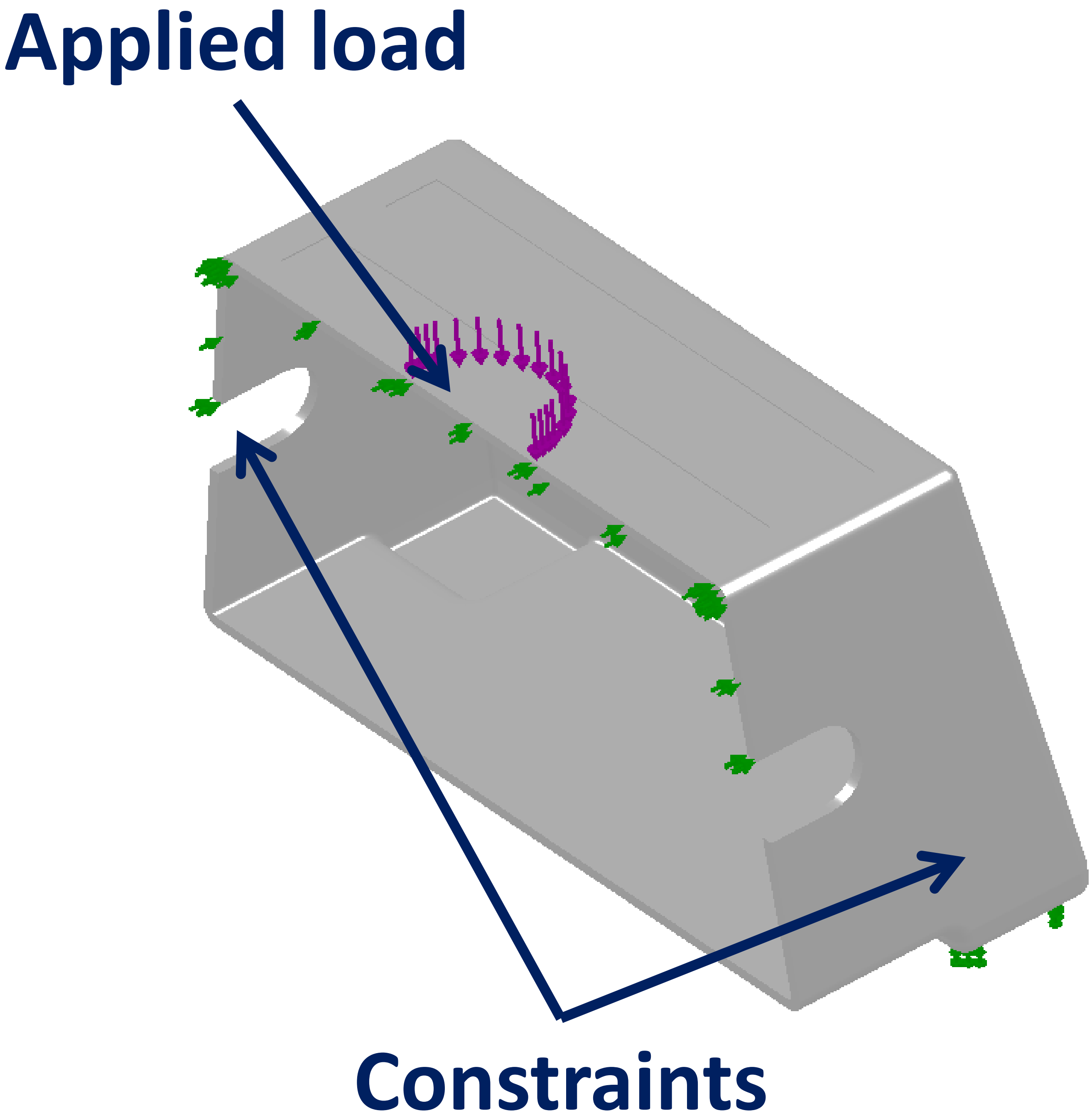


Linear Medium Density Polyethylene (LMDPE)

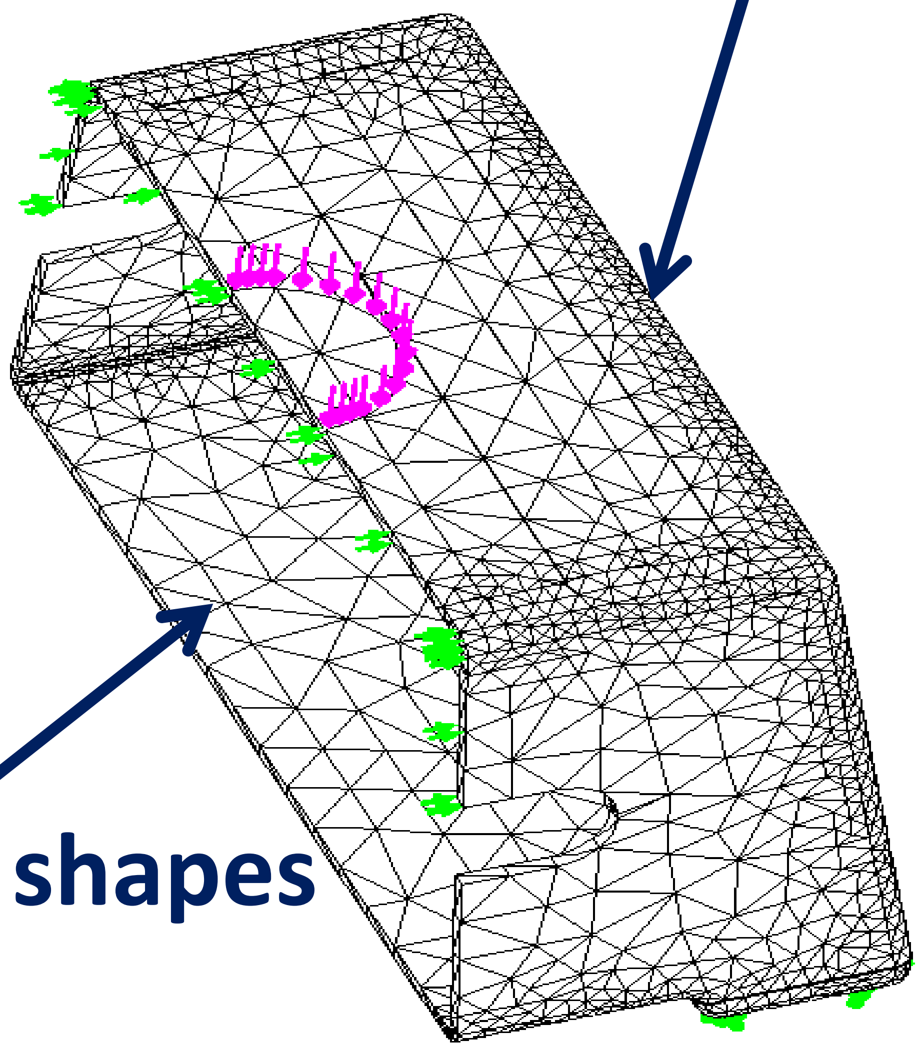

Loading Disc
Compression Plate
Dial Test Indicator for Sidewall
Deflection Measurement

FEA Test Scenario

- CAD file of safety step uploaded into FEA.
- Magnitude and direction of load specified; 600 N force applied through a 100 mm diameter disc on the top center surface.
- A displacement of 13 mm (replicating physical test) was also applied instead of a force.

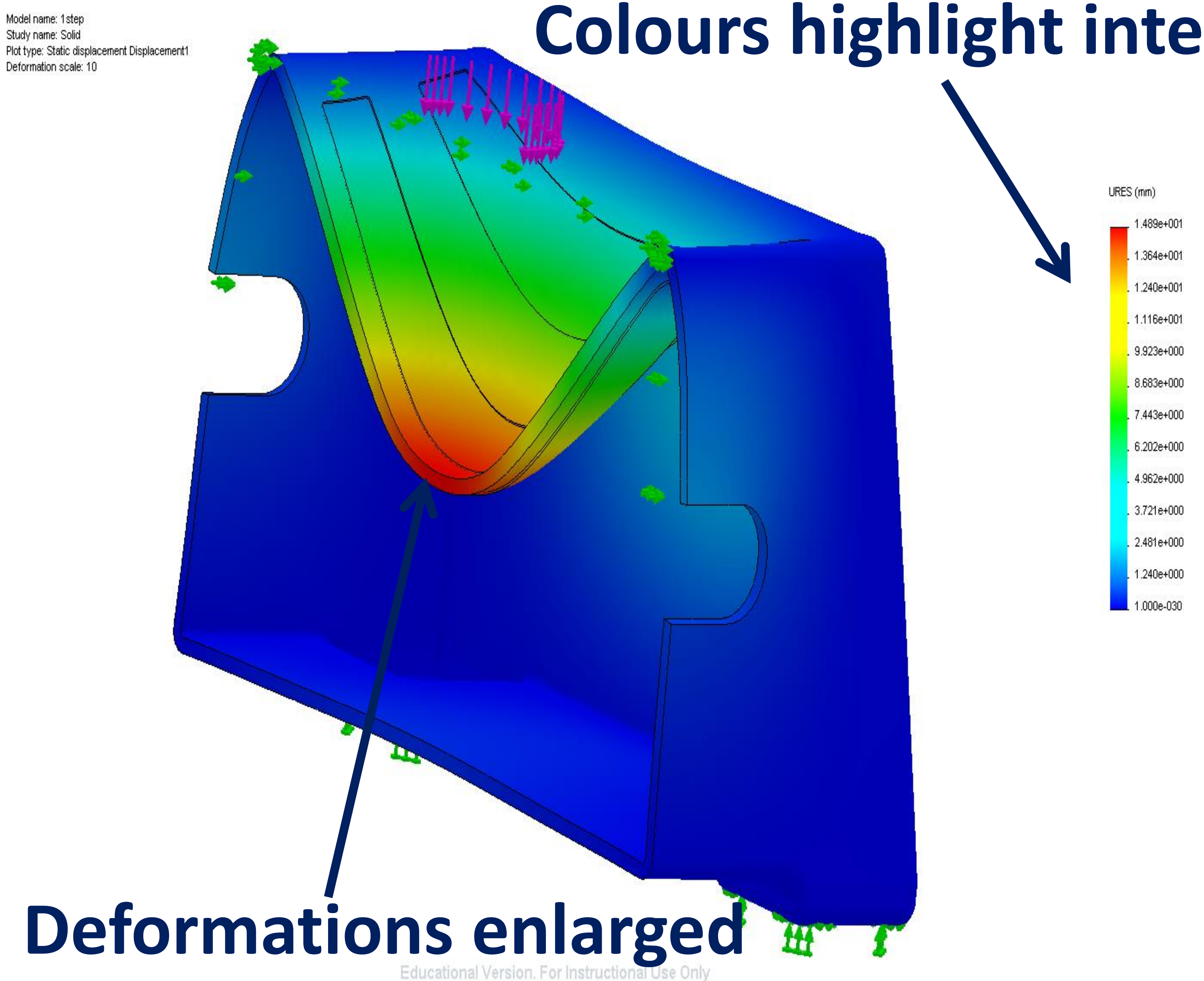

Applied load
Constraints

Finer mesh around edges

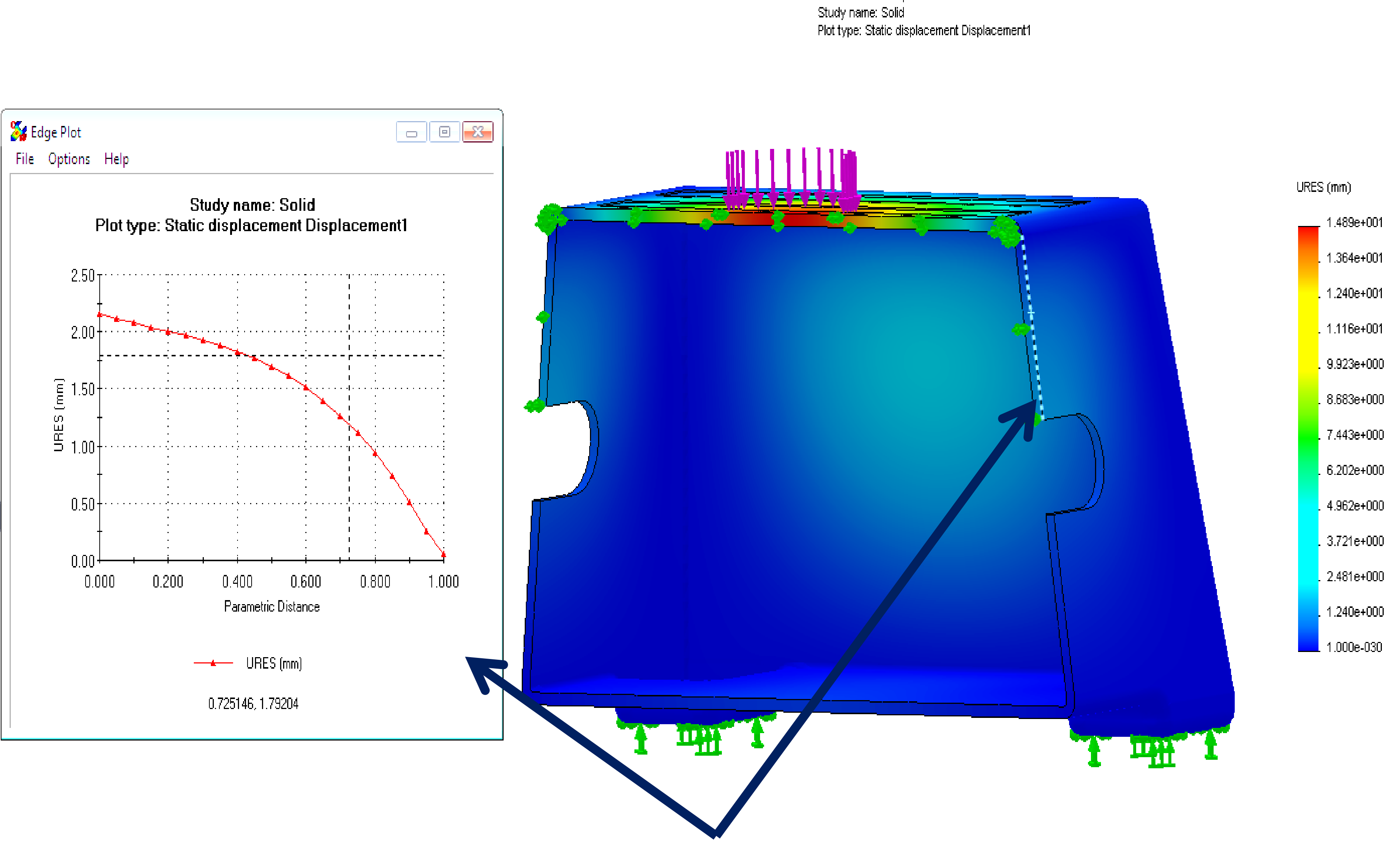


Idealised shapes

Colours highlight intensity

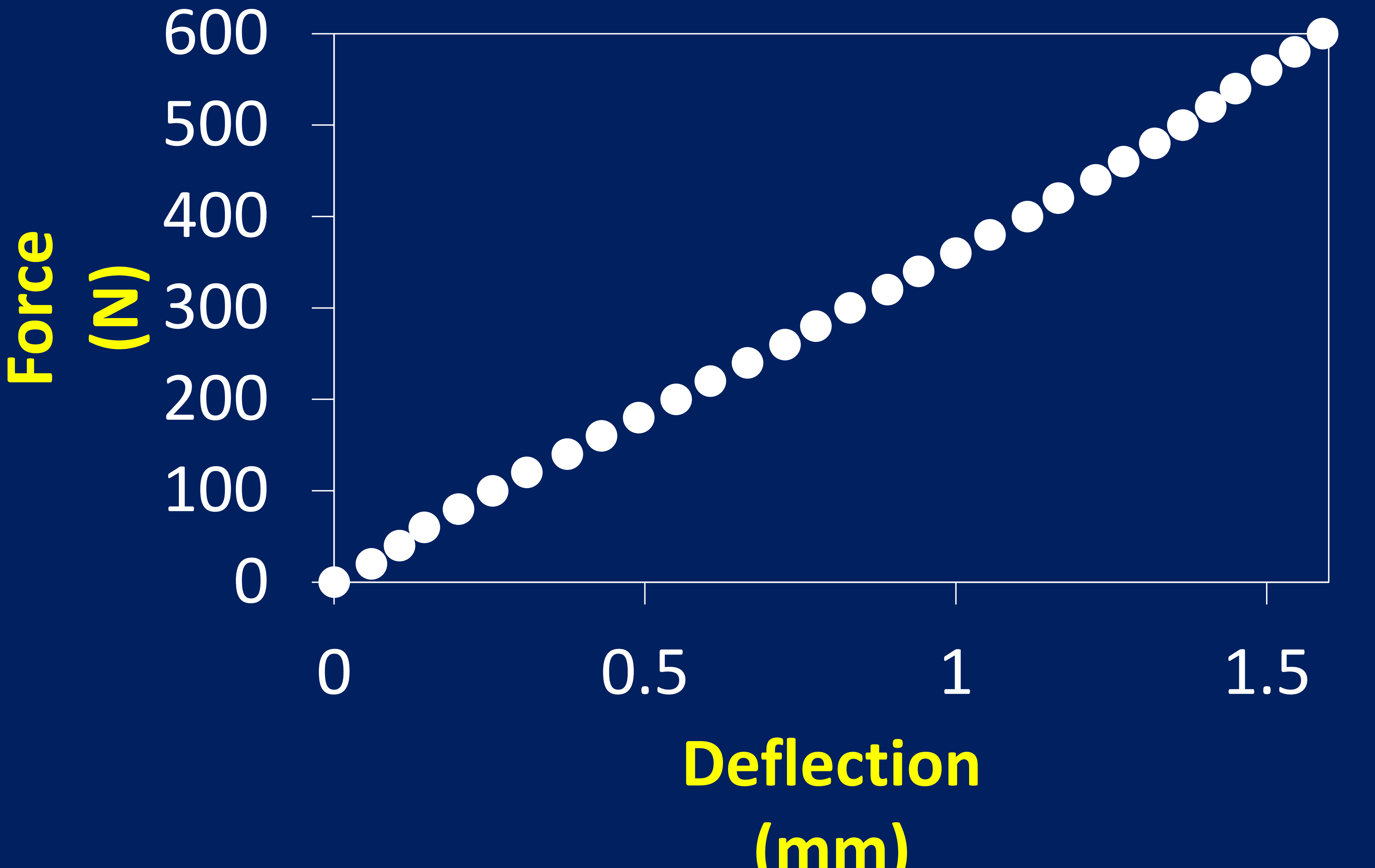


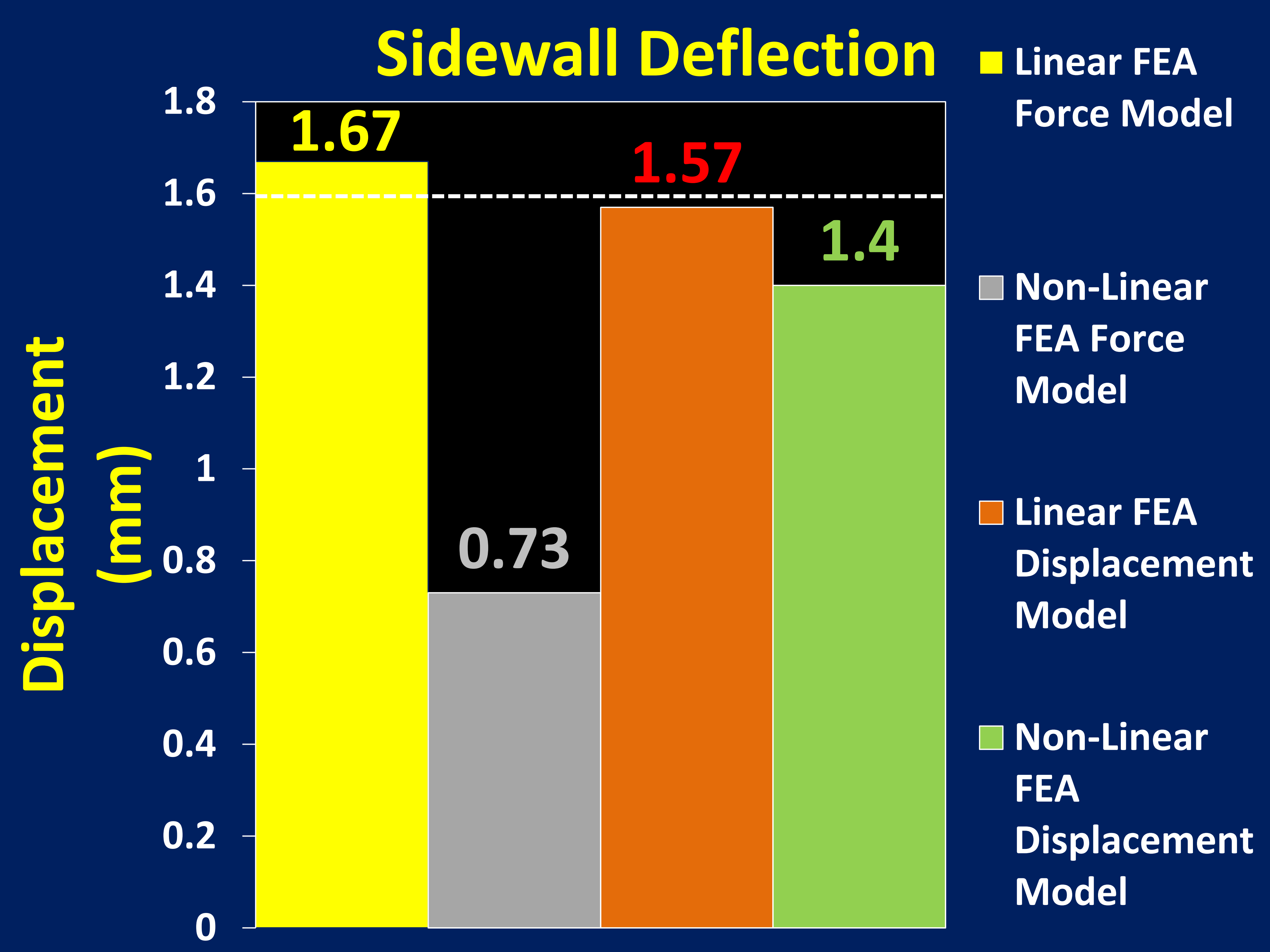
Deformations enlarged



Sidewall deflection highlighted and “probed”

Compression Response: Sidewall





Sidewall Deflection
Displacement (mm)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1.67
0.73
1.57
1.4
Linear FEA Force Model
Non-Linear FEA Force Model
Linear FEA Displacement Model
Non-Linear FEA Displacement Model

Analysis

- Measured values of maximum deflection at the sidewall coincide well with FEA predictions. Non-linear force model approximations were significantly less.

- Non-linear solutions took considerably longer with no real benefit in this instance.

- FEA variation from physical deflection may be due to material properties; PE behaves non-linear at low strains.

FEA Information Check List

FEA Information Check List - 1

- Measure wall thickness variation - **include realistic dimensions within the FEA model.**

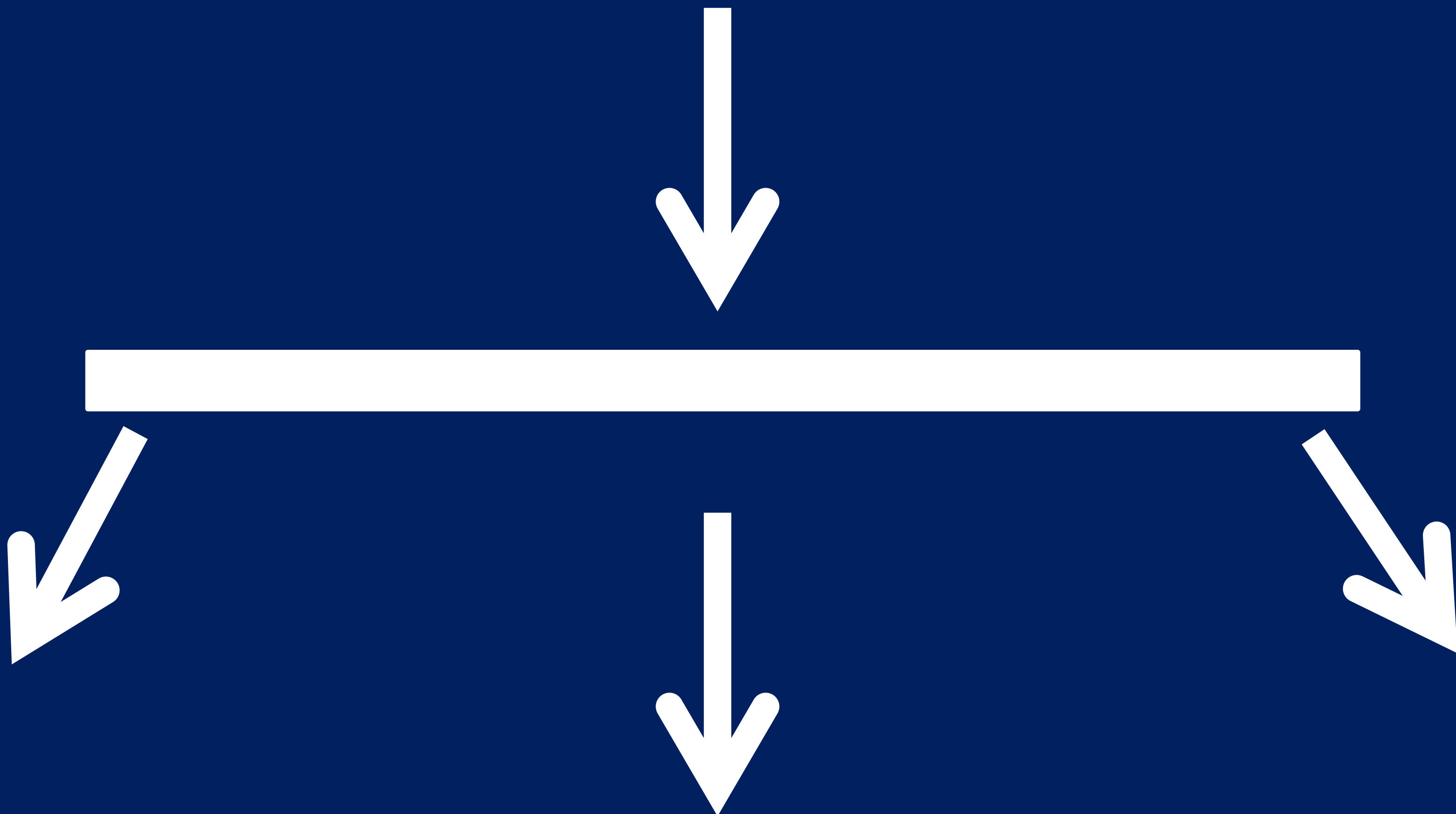
- Test setup and assumptions - **ensure representative loading scenario in FEA, simplify the model for speedy solutions, input realistic material properties, determine tensometer stiffness..**

FEA Information Check List - 2

- Product CAD file - **ensure dimensions and features are well defined.**
- Confirm FEA calculations - **familiarise with how the software calculates parameters.**
- Initial FEA to identify other areas of significant deflection - **for measurement during physical testing.**

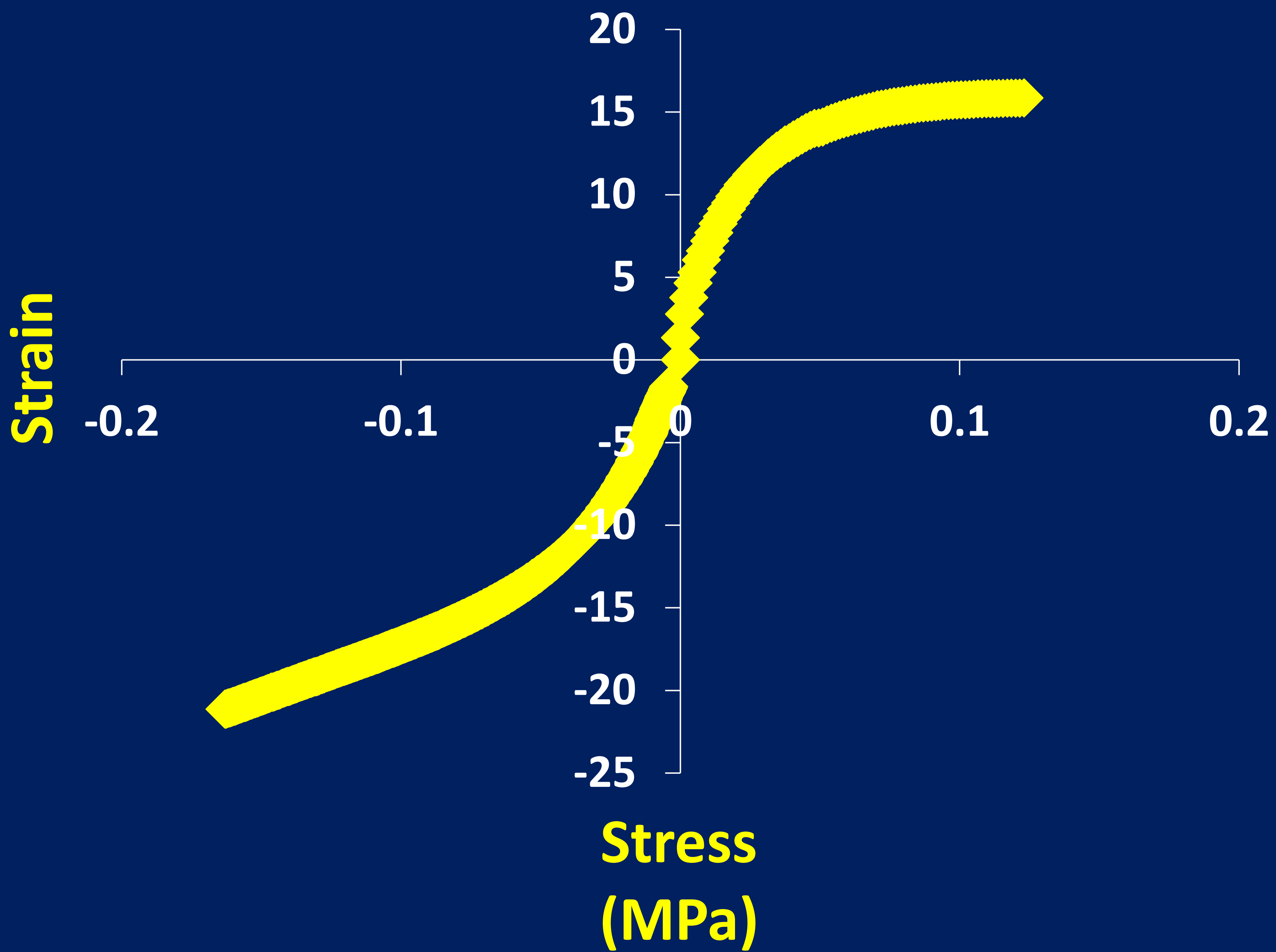
Are the material properties truly representative?

Compression of top surface



Tension in bottom surface

Tensile-Compression Curve

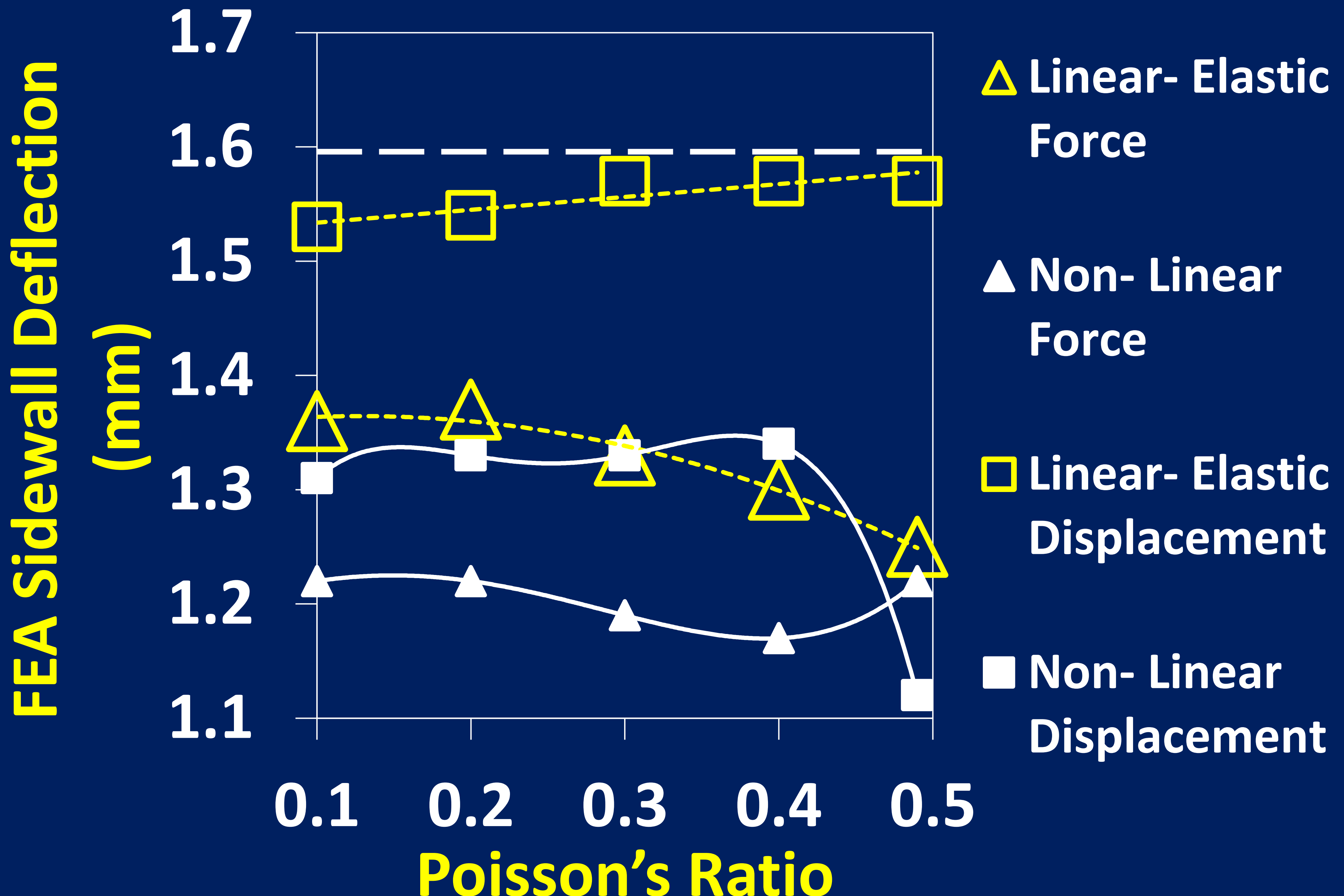


How important is Poisson’s Ratio?

Poisson’s Ratio

- Ratio of lateral to longitudinal strain within the linear-elastic region of the material.
- PE’s non-linearity at very low strains presents a challenge for measurement of Poisson’s ratio.
- Poisson’s ratio is important for FEA engineers.

Effect of Poisson's Ratio



Analysis

- Varying Poisson's ratio during FEA simulations has a relatively small effect on results of linear-elastic and non-linear force models.
- At Poisson's ratio of 0.3 and above the displacement models are less compliant.
- Poisson's ratio is more significant when considering larger deformations.

Conclusions

Conclusions

- FEA Solution type is important. Both linear and non-linear should be considered.

- FEA accuracy could be increased by modifying modulus, calculating a Poissons ratio and including compressive data.

- Loading scenario is more complex than initially considered; tension AND compression occuring. FEA assumes the compression behavior is mirror image of tensile behavior.

Conclusions

- Varying Poisson's ratio during FEA simulations has a mild effect on results, particularly between approaching the 0.3 and 0.49.
- Poisson's ratio is probably more significant when considering much larger deformations.
- Literature for Poisson's ratio is scarcely available.

THANK YOU FOR LISTENING