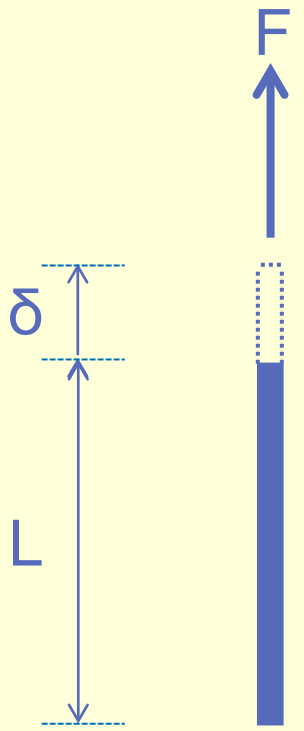
ASSOCIATION OF ROTATIONAL MOLDERS
2013 ANNUAL MEETING

USING STIFFER MATERIALS TO DOWN-GAUGE ROTOMOLDED PARTS

Dr Nick Henwood, Rotomotive Limited

TYPICAL FILM DOWN-GAUGE



Deflection (stretch):

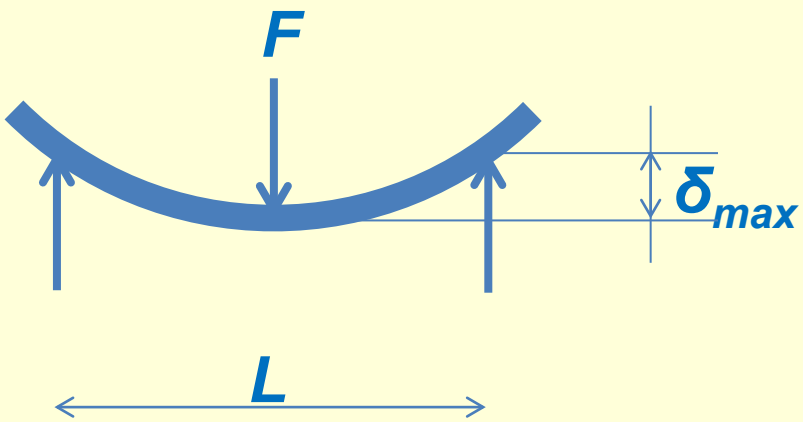
$$\delta = \frac{F\,L}{E\,B\,t}$$

E = Young's Modulus for material

B = Width of strip

t = Thickness of strip

TYPICAL ROTO DOWN-GAUGE



Deflection (bend):

$$\delta = \frac{F L^3}{4 E B t^3}$$

E = Young's Modulus for material

B = Width of beam

t = Thickness of beam

FILM versus ROTO

effect of reducing thickness

FILM:

- Mainly depends on STRETCHING
- $\delta \propto 1 / t$
- Half thickness → deflection x 2
- Half thickness, same deflection requires E x 2

ROTO:

- Mainly depends on BENDING
- $\delta \propto 1 / t^3$
- Half thickness → deflection x 8
- Half thickness, same deflection requires E x 8

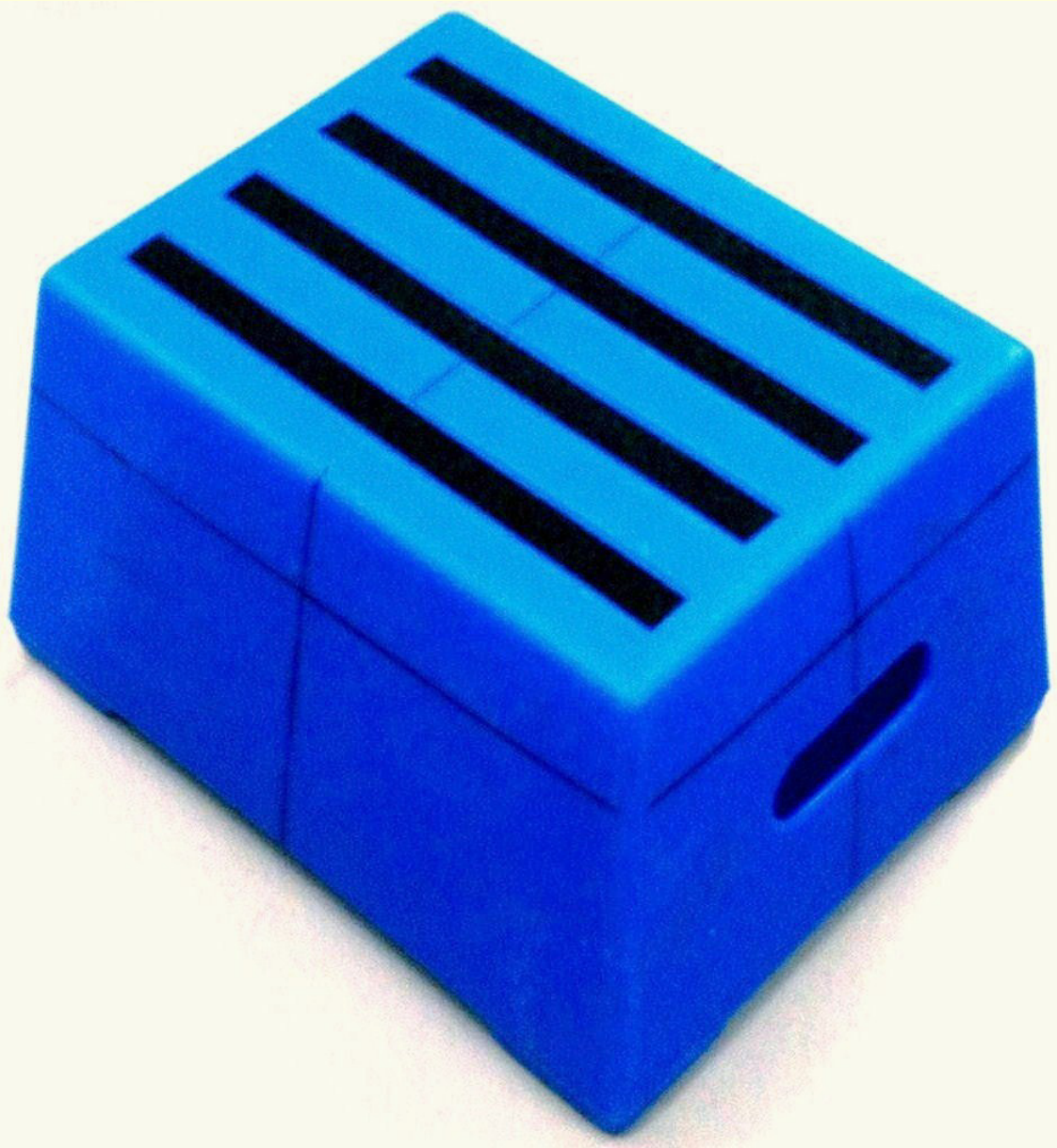
E-MODULUS VALUES FOR TYPICAL ROTO MATERIALS

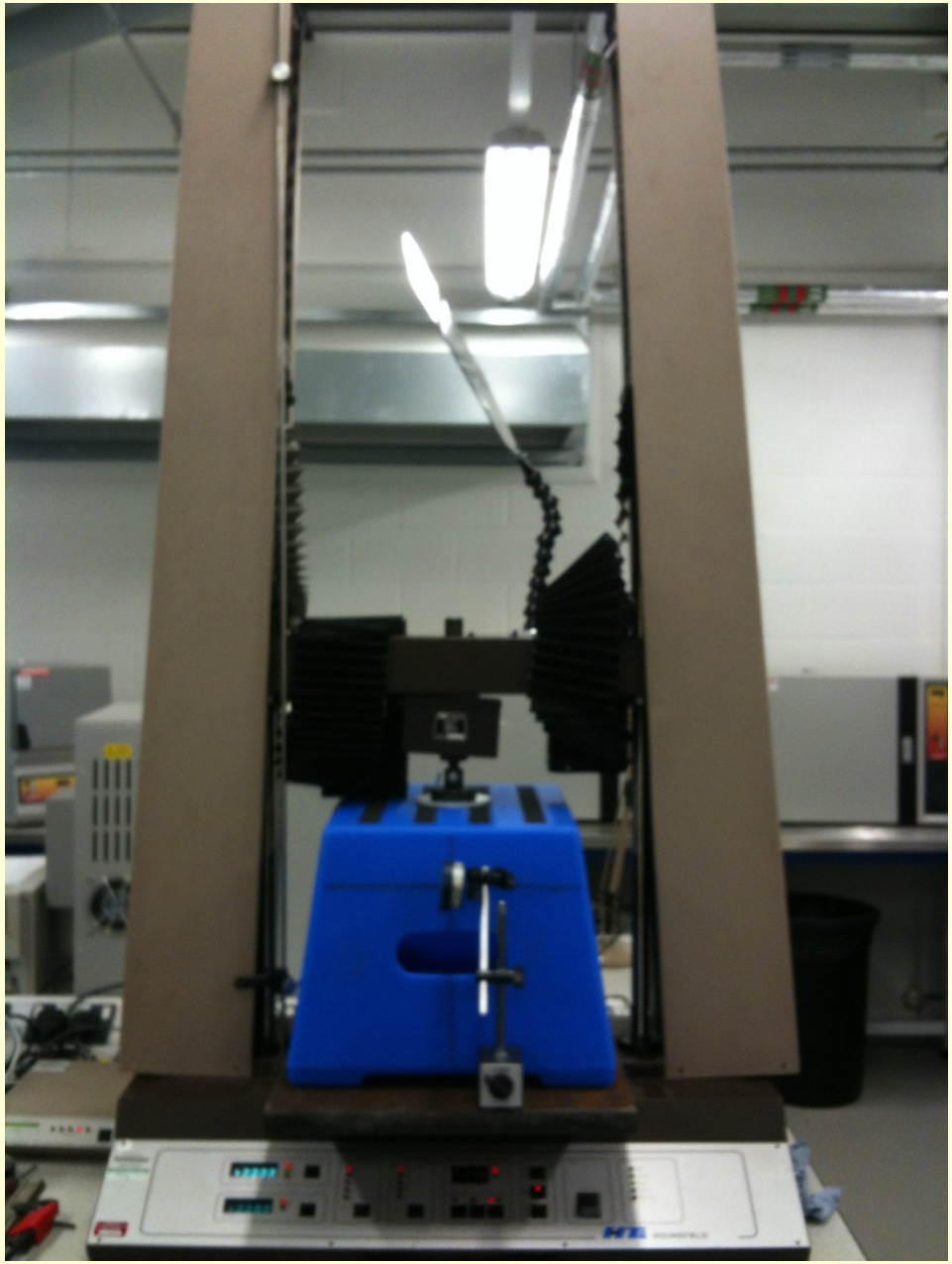
MATERIAL	E-MODULUS	$E_{material} / E_{LMDPE1}$	DOWN-GAUGE POTENTIAL
LMDPE 1	645	1.00	0%
LMDPE 2	790	1.22	6.8%
S - L	935	1.45	12.2%
XLPE	850	1.32	9.2%
“PKT 2”	1290	2.00	20.6%
PP	1500	2.33	25.6%
PA12	1250	1.94	20.7%
PA11	1300	2.02	21.7%
“PKT 3”	1935	3.00	30.7%
PC	2375	3.68	36.6%

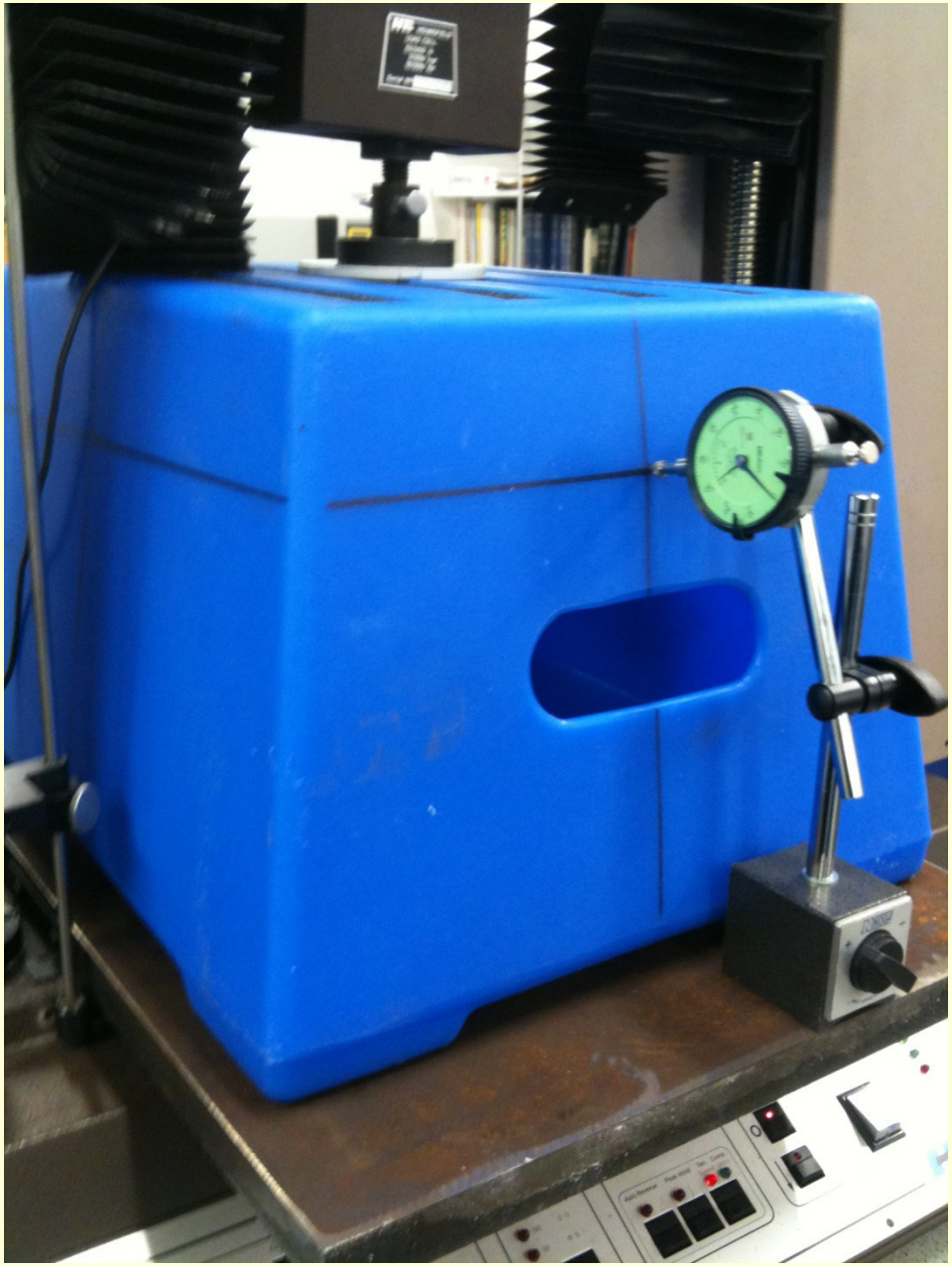
how well does simple beam theory reflect the reality of a complex 3D shape?

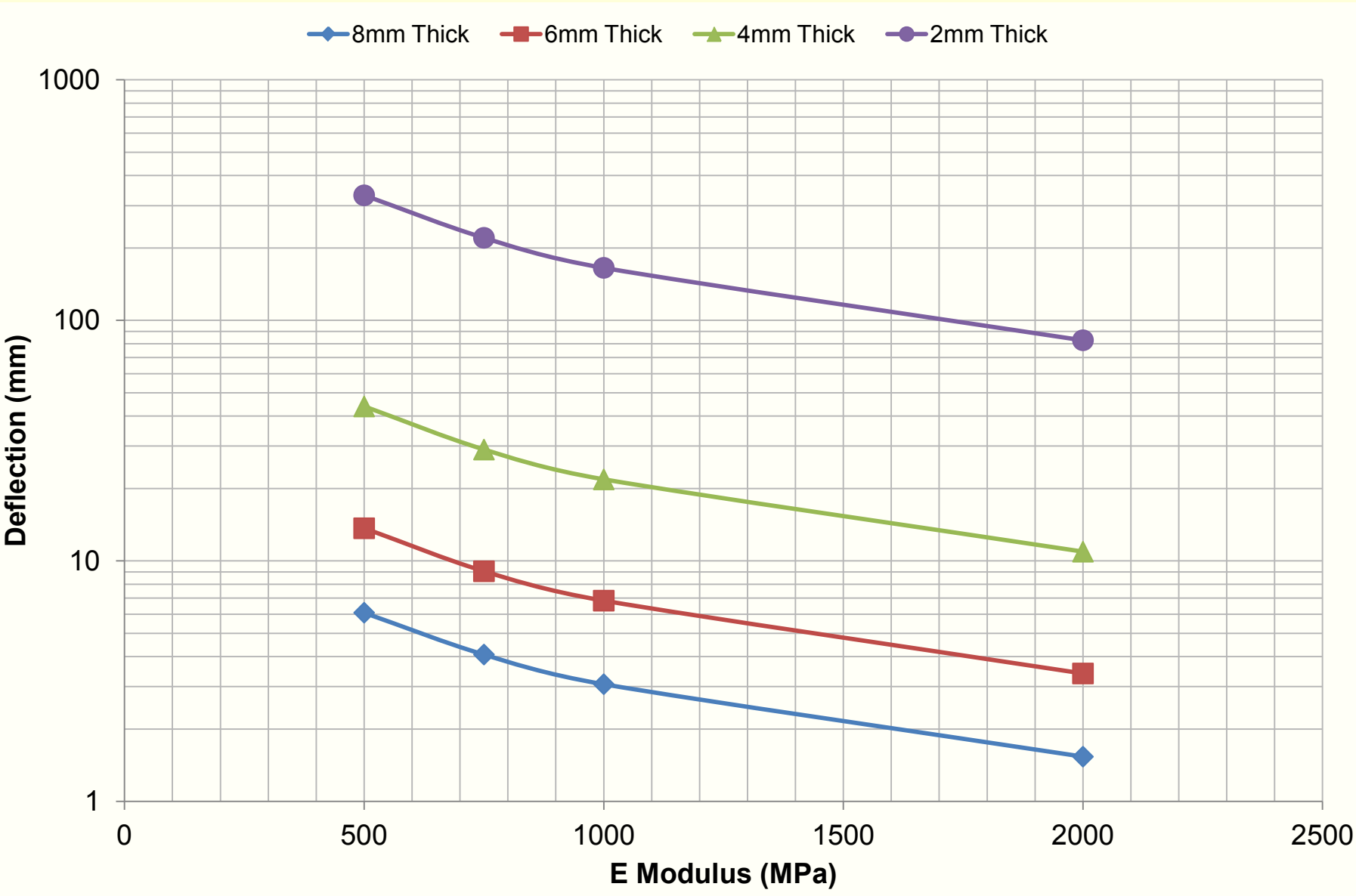
FEA vs. SIMPLE BEAM EXCERCISE

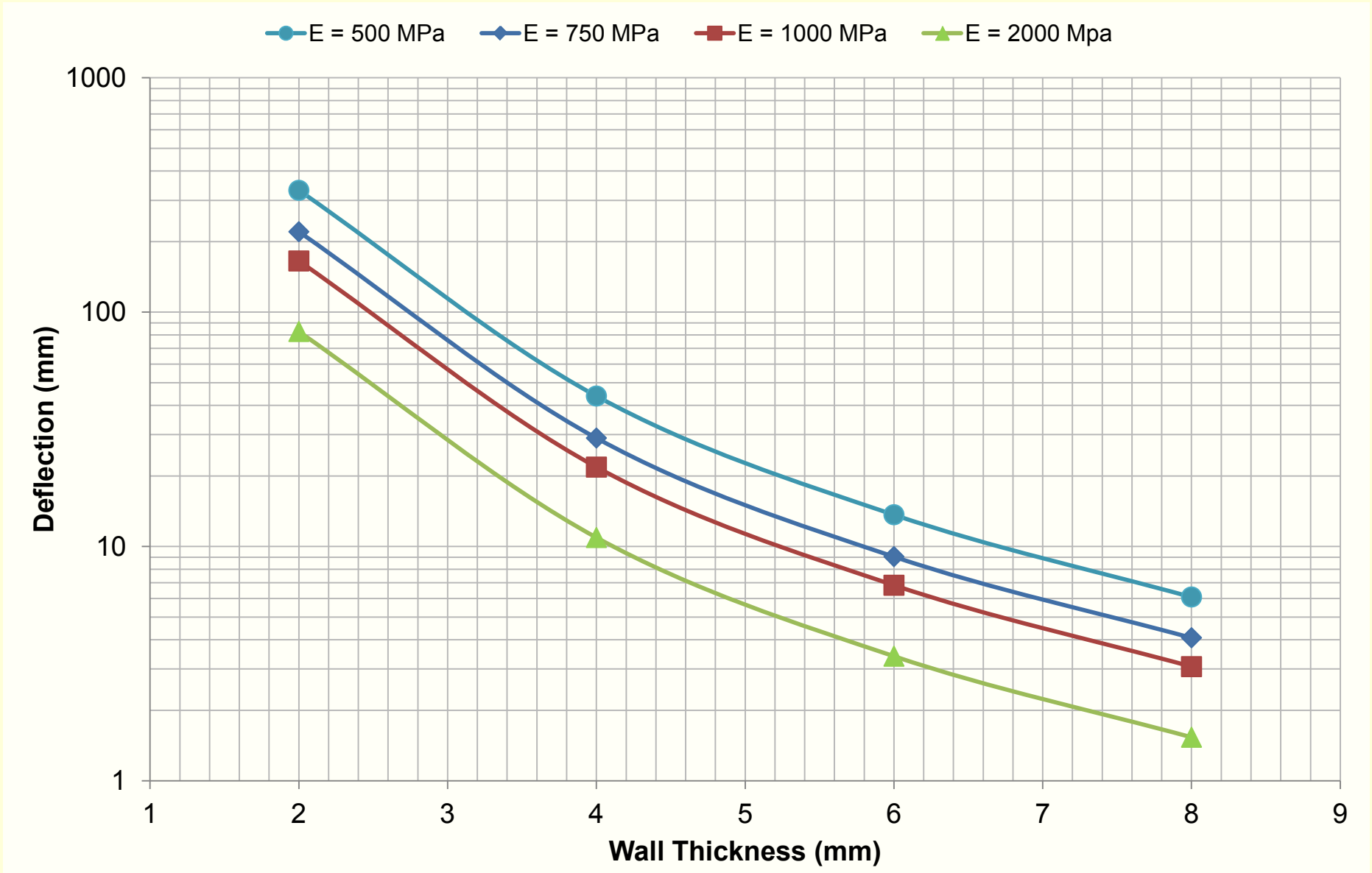
- Conducted by PhD student at MMU
- Used “Builder’s Step” for evaluation
- Employed a shell model, using linear-elastic simulation
- Applied force 300N
- E varied 500, 750, 1000 & 2000 MPa
- Thickness varied 8, 6, 4 & 2 mm
- Poisson’s Ratio assumed 0.3








8mm Thick
6mm Thick
4mm Thick
2mm Thick
1000
100
10
1
Deflection (mm)
0
500
1000
1500
2000
2500
E Modulus (MPa)


E = 500 MPa
E = 750 MPa
E = 1000 MPa
E = 2000 Mpa
1000
100
10
1
Deflection (mm)
1
2
3
4
5
6
7
8
9
Wall Thickness (mm)

CONCLUSIONS: FEA

- Empirical relationship $\delta \propto E^{-1.005}$ conforms closely with theoretical relationship $\delta \propto E^{-1}$
- Empirical relationship $\delta \propto t^{-2.883}$ conforms approximately with theoretical relationship $\delta \propto t^{-3}$
- Overall, FEA analysis for complex shapes correlates closely to simple beam theory

CONCLUSIONS: DOWN-GAUGING

- **Effect of thickness changes in rotomolded parts are primarily due to bending effects**
- **Bending relationship $\delta \propto t^{-3}$ for roto creates a higher barrier to down-gauging than stretch relationship does for film**
- **Maximum weight reduction, even for very stiff materials, currently available, is ≈ 30%**
- **The search for stiffer materials continues…**