Modelling Of Windshield Mechanical Behaviour With RADIOSS

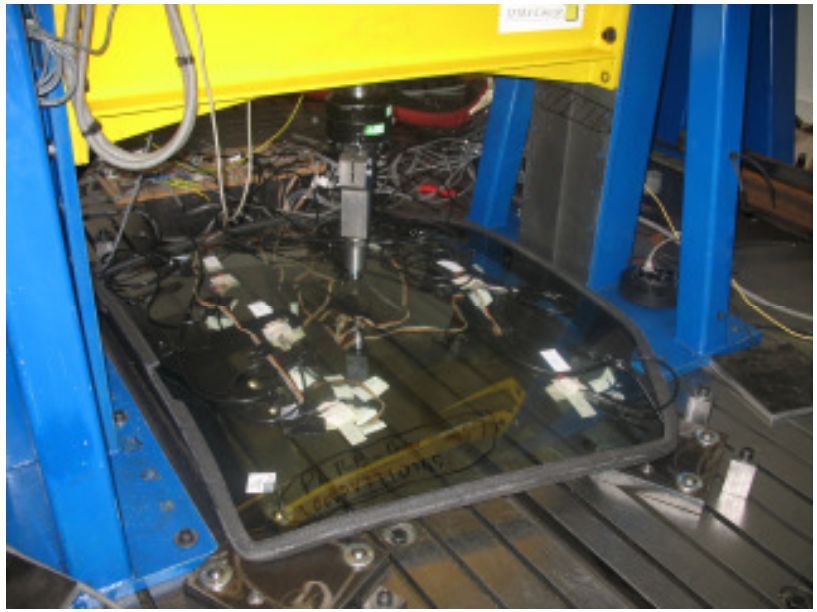
- Salim BOUABDALLAH
- Malek ZARROUG

INTRODUCTION

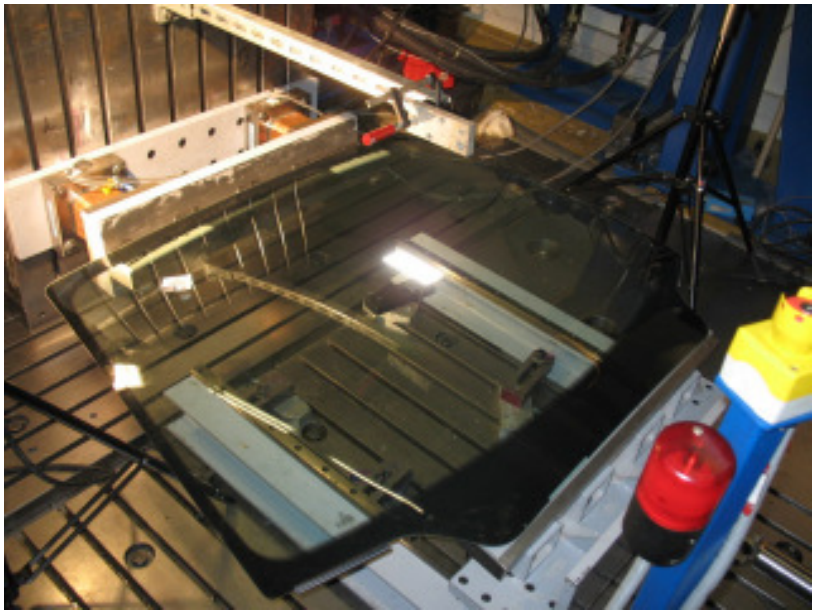
- Windshields have become structural parts in its own
- Before studying its behaviour under dynamic loads (impact, roof crush,...), we have to understand its quasi-static behaviour
- Experimental investigations have been done by PSA

EXPERIMENTAL TRIALS

- Flexural Trial

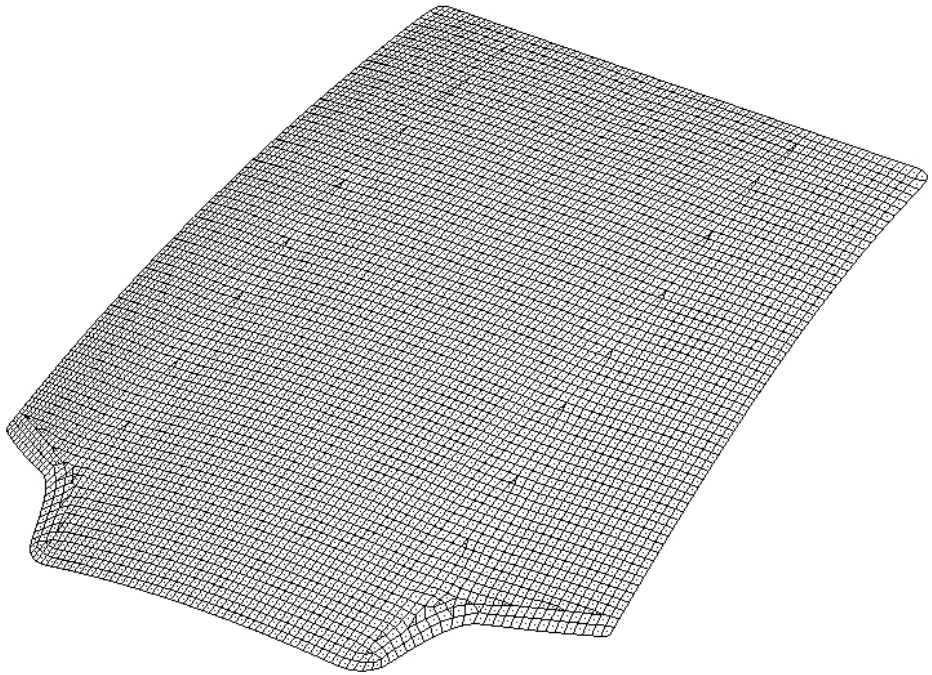


- Compression Trial



PROBLEM DEFINITION

- 3 Layers glass/PVB/glass
- Elasto-Plastic
  (Johnson-Cook)
- Eg/Epvb = 750



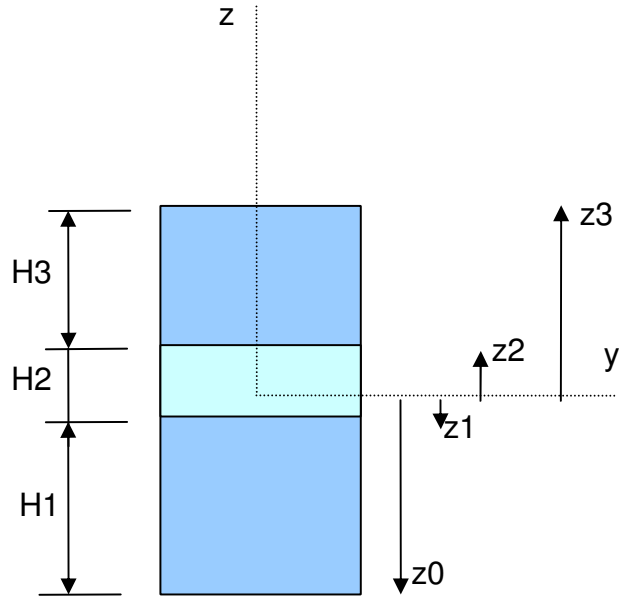
Importance of Transverse Shear Energy

PROBLEM DEFINITION

H1 = 2.1 mm

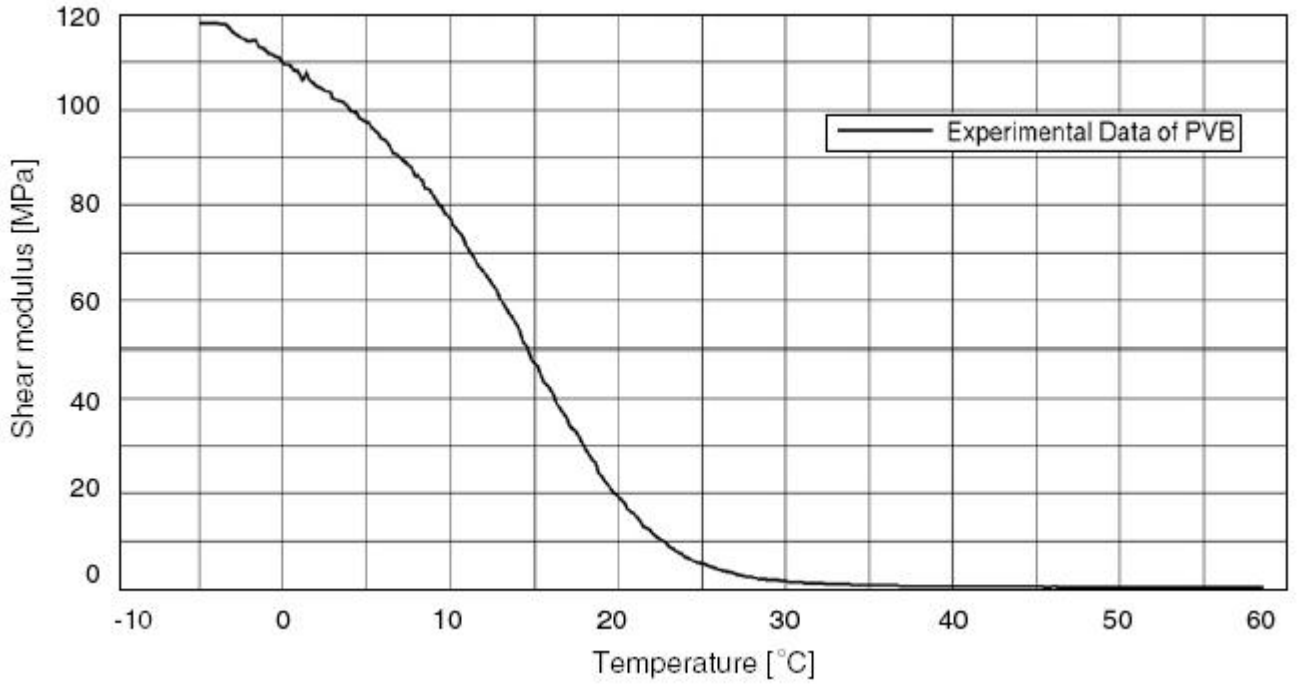
H2 = 0.76 mm

H3 = 1.6



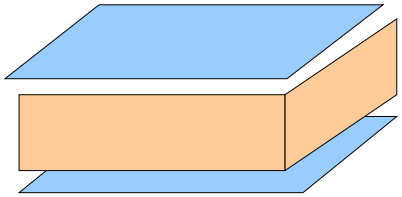
PROBLEM DEFINITION

Strong Thermal Dependency of PVB Eastic Contants (Timmel et al., 2007)



USED MODELS

Simulate the load carrying capacity of the PVB after the glass fails



Shell + Solid + Shell

2 Coïncident Shells

Sandwich Shell

SANDWICH SHELL

- In RADIOSS (Ashear) k = 0.8333 by default

  ➡ Over stiff structure

- Need To Pre-Process prior to RADIOSS Run

SANDWICH SHELL

- Transverse Shear Stress must satisfy 3D equilibrium

$$\sigma_{xx,x} + \sigma_{xz,z} = 0$$

$$\sigma_{xz} n_z = 0$$

- « True » distribution

$$\sigma_{xz} = \frac{T}{H_m H_f - H_{mf}^2} \int_{Z_0}^{z} E(z)(zH_m - H_{mf})\, dz$$

SANDWICH SHELL

- Hm : Membrane stiffness

$$H_m = E_V b (H_1 + H_3) + E_{PVB} b H_2$$

- Hf : Bending stiffness

$$H_f = E_V b \left[\frac{H_1^3}{12} + H_1 \frac{(Z_0 + Z_1)^2}{4} + \frac{H_3^3}{12} + H_3 \frac{(Z_2 + Z_3)^2}{4} \right] + E_{PVB} b \left[\frac{H_2^3}{12} + H_2 \frac{(Z_1 + Z_2)^2}{4} \right]$$

- Hmf : Coupling stiffness

$$H_{mf} = E_V b \left[H_1 \frac{(Z_0 + Z_1)}{2} + H_3 \frac{(Z_2 + Z_3)}{2} \right] + E_{PVB} b \left[H_2 \frac{(Z_1 + Z_2)}{2} \right]$$

SANDWICH SHELL

- Correction (Ashear)

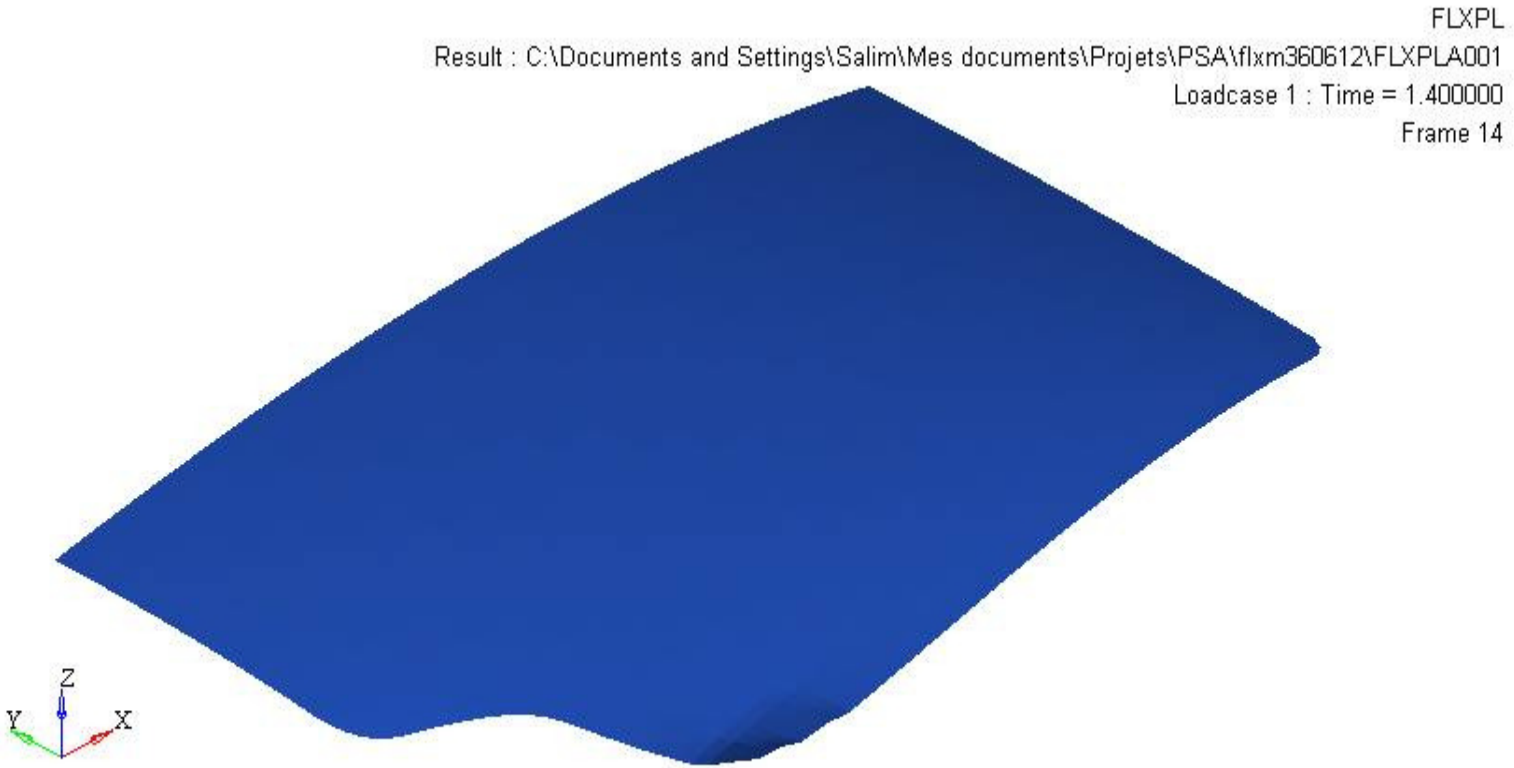
$$k = \frac{T^2}{\int_A G(z)\,dA \cdot \int_A \frac{\sigma_{xz}^2}{G(z)}\,dA}$$

- Here : k = 0.00146

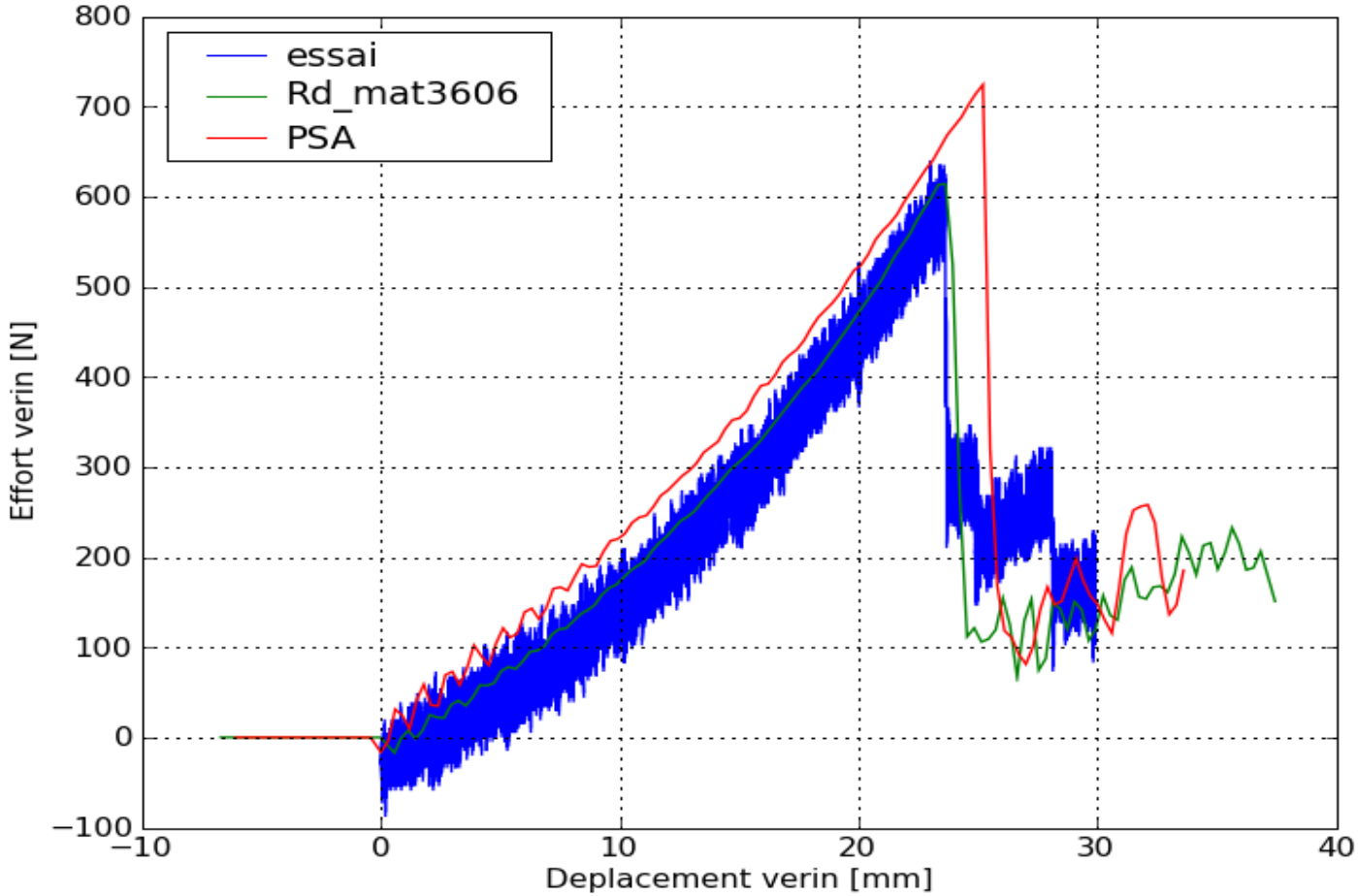
SANDWICH SHELL

- Benefits
  - Easy to use (simple data deck)
  - CPU time
- Drawbacks
  - Need to compute transverse shear correction
  - Is it possible to simulate layer-wise failure ?

BENDING SIMULATION

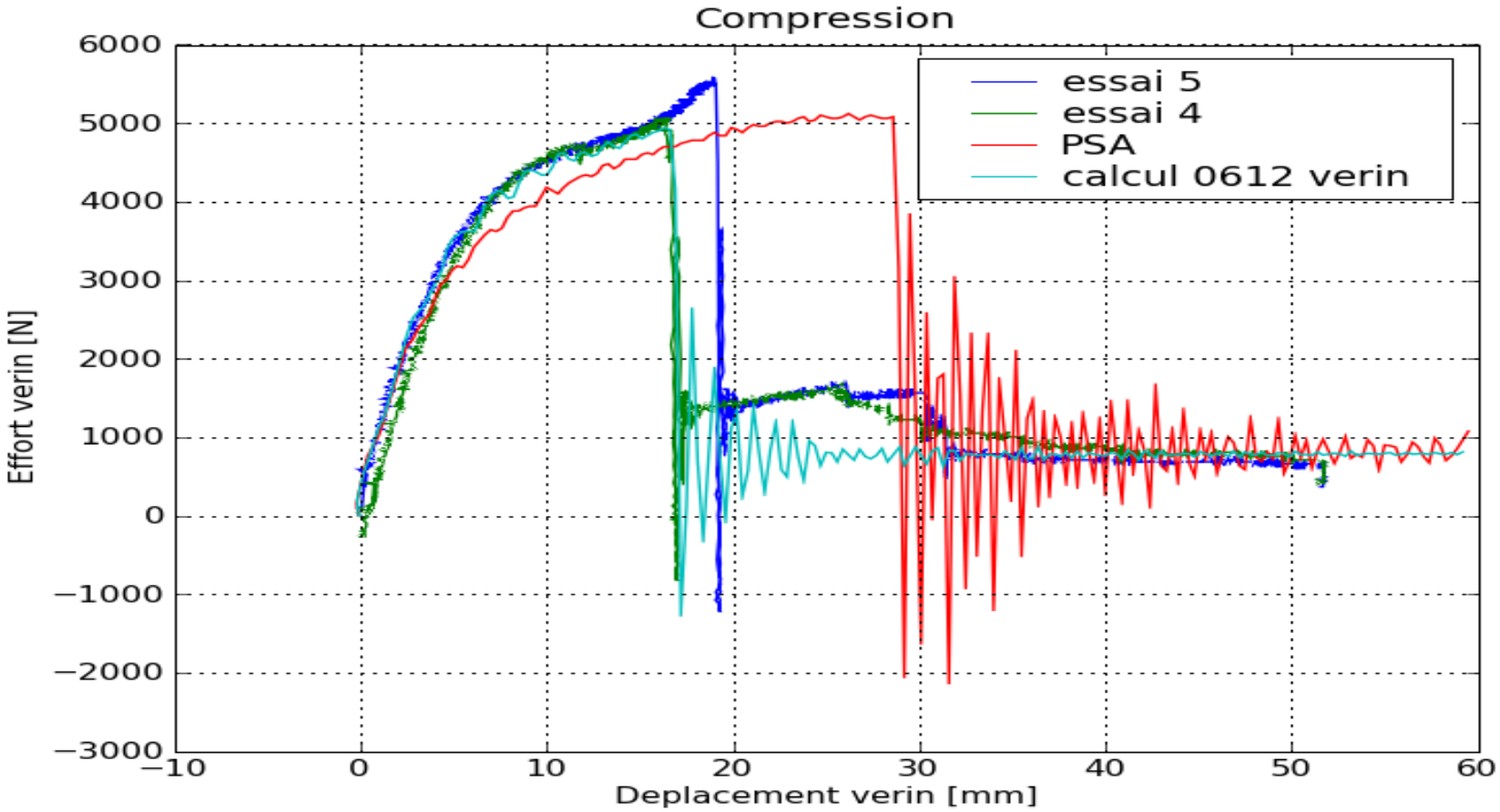


BENDING SIMULATION



COMPRESSION SIMULATION

COMPRESSION SIMULATION



CONCLUSION

- Use of Sandwich Shell (Property 11)
- Take care of Temperature (Epvb)
- For Progressive Failure Use Linear Piece-wise Elasto_Plastic Material (Material 36)

PERSPECTIVE

- Extend This Simulation To Impact Study and other Dynamic Applications