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METHODOLOGY OF MATERIAL PARAMETERS IDENTIFICATION IN SANDWICH PANELS VERSUS COMPUTER SIMULATION

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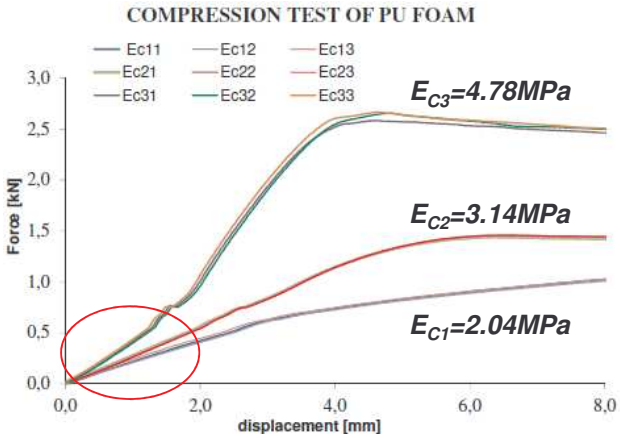
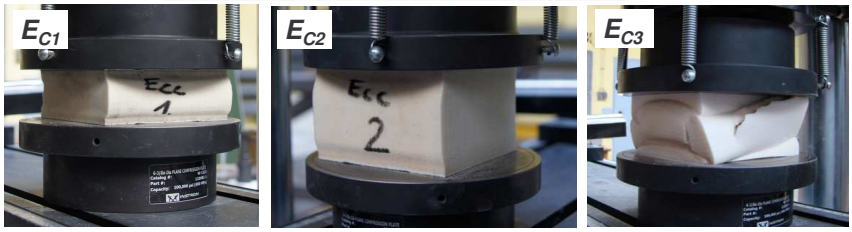
INTRODUCTION

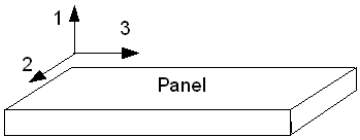
- Panels: thin, steel faces, soft PU core
- **Assumption of isotropy is not true!**

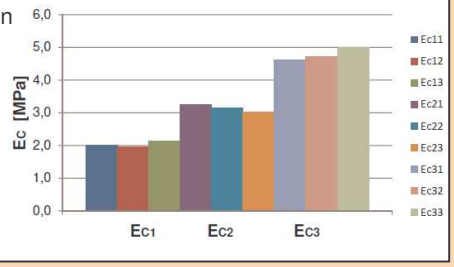


TESTING FOCUSED ON ANISOTROPY



E_{C1} – compression in the thickness (rise) direction
E_{C2} – compression in the width direction
E_{C3} – compression in the length direction





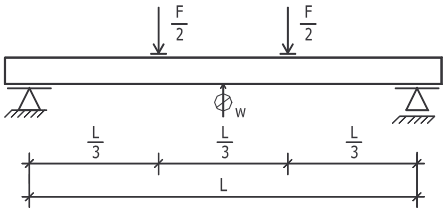
GOALS

Advanced numerical models require a number of properly identified parameters. Most important is Kirchhoff modulus G_C. Anisotropy must be accounted for.

	Behaviour of Sandwich	Computer model	Material	Testing method
1	Global response	Timoshenko beam theory (1D)	Linear, isotropic	Classical bending test
2	Orthotropic Sandwich	Modified Reissner theory (2D)	Linear, isotropic	**Advanced tests**
3	Local phenomena	FEM (3D)	Nonlinear, anisotropic	**Advanced tests**

DETERMINATION OF G_C

1a. Bending test - measurement of displacements (classical approach)



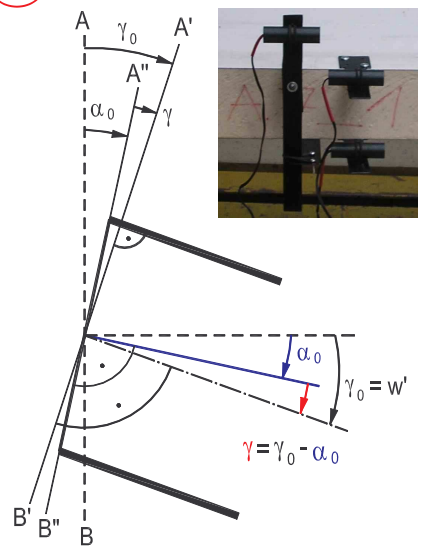
$$w = w_B + w_S$$

$$w_B = \frac{23 \cdot F \cdot L^3}{1296 \cdot B_S}$$

$$G_C = \frac{F \cdot L}{6 \cdot A_C \cdot w_S}$$

G_C = 3.81MPa

1b. Bending test - measurement of angles of rotation (proposal)



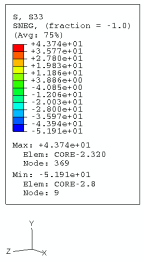
Two angles of rotation, which appear in Timoshenko beam theory are measured in the vicinity of a support. The α_0 is the angle of cross-section rotation, the γ_0 is the slope of the panel. The shear modulus is calculated directly from the difference between these angles.

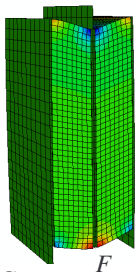
$$\gamma = \gamma_0 - \alpha_0$$

$$\tau = G_C \cdot \gamma \Longrightarrow G_C = \frac{V}{\gamma \cdot A_C}$$

G_C = 3.77MPa

2a (**3a**). Double lap shear test

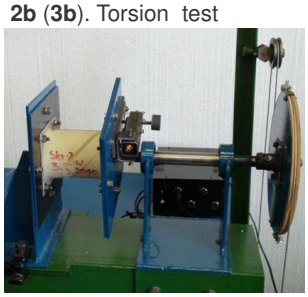


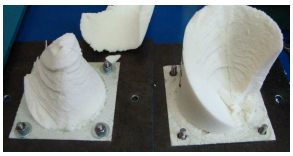


$$\gamma = \frac{w}{d_C}, \quad G_C = \frac{F}{2 \cdot \gamma \cdot B \cdot L}$$

G_C = 3.01MPa

2b (**3b**). Torsion test



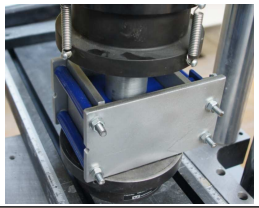


$$\varphi' = \frac{\varphi}{L}, \quad \varphi' = \frac{M_S}{G_C \cdot I_0}$$

G_C = 2.67MPa

2c (**3c**). Compression test with confinement of transverse displacements

Result: $\nu \approx 0$



CONCLUSIONS

- Evident anisotropy of PU core
- Bending test → valuable but insufficient
- Need for testing methods providing more material parameters
- Interesting that: different testing methods → different results
- Proper identification of material parameters → still challenging issue

References:
1. R. Juntikka, S. Hallstorm, Shear characterization of sandwich core materials using four-point bending, *Journal of Sandwich Structures & Materials*, **9** (1), 2007, pp. 67-94.
2. M. Chuda-Kowalska, Z. Pozorski, A. Garstecki, Experimental determination of shear rigidity of sandwich panels with soft core, *Proc.10th Int. Conf. Modern Buildings Materials, Structures and Techniques, Vol I,* Vilnius, Lithuania, VGTU 2010, pp. 56-63.
3. V. Tita, M. F. Caliri Junior, Numerical simulation of anisotropic polymeric foams, *Latin American Journal of Solids & Structures,* 9 (2012), pp. 259-279.