NUMERICAL ANALYSIS OF A SANDWICH PANEL SUBJECTED TO MULTIPLE STATIC CONCENTRATED LOADS

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INTRODUCTION

Why sandwich panels?

- High load capacity at low weight
- Excellent thermal insulation
- Mass production character
- High installation speed

Fig.1. Sandwich panel
It is a well-know fact that solar collectors, photovoltaic panels and work platforms are installed directly to sandwich panels, causing multiple static concentrated loads.

Therefore, there is a need to determine forces, stresses and displacements from these actions.

**Fig.2.** Solar collector at sandwich panel
DESCRIPTION OF THE PROBLEM

We consider the simplest scheme of a single-span simply-supported sandwich panel.

Parameters of the panel:

**Dimensions:**

\[ L = 4 \text{ m}, \quad B = 1 \text{ m}, \quad D = 120 \text{ mm} \]

**Facings:**

\[ t = 0.5 \text{ mm}, \quad E_F = 205 \text{ GPa}, \quad \nu_F = 0.3 \]

**Core:**

\[ d_C = 119 \text{ mm}, \quad E_C = 8.16 \text{ MPa}, \quad \nu_C = 0.02 \]

- Concentrated loads: \( F_1 = 1 \text{ kN}, \quad F_2 = 1 \text{ kN} \)

Fig.3. Geometry of the sandwich panel
WORK GOAL

It is known in the literature that the method of analyzing plate system is to bring them into a one dimensional model - beam of the so-called effective width.

In this work an analysis of a sandwich panel subjected to multiple static concentrated load was conducted to:

- check if it is possible to use effective width method and superposition of the results.
- estimate how big is overestimation in effective width method.

Fig.4. Scheme, plate system changing into a beam model
DESCRIPTION OF THE MODELS

Plate model

• Numerical model was created as a 2D composite shell (three-layered shell), was discretized using four-node, conventional shell elements S4R, the mesh size was constant and equal to 0.10 m.

• The loads Load $F_1 = 1$ kN, $F_2 = 1$ kN were applied to single nodes

Beam model

• This approach was presented by the European Convention for Constructional Steelwork. The main aim of using this approach is to reduce the plate model to the beam model by introducing the effective width method.

• Example equation for effective width

$$b_w = b_e + 2x \left( 1 - \frac{x}{L} \right)$$
Case 1: Force $F_1$ next to Force $F_2$ in the middle of the spam

Maximum normal stress $\sigma_{xx}$ in $x$ direction in the lower facing of sandwich panel for:

a) numerical model

$$\sigma_{xx} = 33.85 \text{ MPa},$$

b) effective width method

$$\sigma_{xx} = 32.63 \text{ MPa}.$$
Case 2: Force $F_1$ in a single distance from Force $F_2$ in the middle of the spam

Maximum normal stress $\sigma_{xx}$ in $x$ direction in the lower facing of sandwich panel for:

a) numerical model 
   \[ \sigma_{xx} = 25.66 \text{ MPa}, \]

b) effective width method 
   \[ \sigma_{xx} = 25.09 \text{ MPa}. \]
Case 3: Force $F_1$ and force $F_2$ at the opposite side at non supported edge of the sandwich panel.

Maximum normal stress $\sigma_{xx}$ in $x$ direction in the lower facing of sandwich panel for:

a) numerical model

$$\sigma_{xx} = 24.36 \text{ MPa},$$

b) effective width method

$$\sigma_{xx} = 29.53 \text{ MPa}.$$
Case 4: Force $F_1$ and Force $F_2$ far from each other

Maximum normal stress $\sigma_{xx}$ in $x$ direction in the lower facing of sandwich panel for:

a) numerical model

$$\sigma_{xx} = 19.31 \text{ MPa},$$

b) effective width method

$$\sigma_{xx} = 17.25 \text{ MPa}.$$
CONCLUSIONS

• An analysis of the sandwich panel subjected to multiple concentrated static loads was presented.

• Two models (analytical beam model with the effective width, 2D numerical shell model) were considered.

• For the forces located in the middle of the spam the engineering method based on the so-called effective width was consisted with numerical solutions.

• The worst match was obtained for the forces at the opposite side at non supported edge of the sandwich panel.

• The obtained local stress level should be verified experimentally.

• It is necessary to further analyze the problem taking into account changes in design parameters.