SANDWICH PANELS WITH HOLES

André Jorissen¹, Luc Castelijns² and Johnny van Rie³

ABSTRACT: In the paper called “sandwich structures with wood-based faces” [1] presented at the WCTE 2012 in Auckland the structural performance of sandwich panels with wood based faces, applied in inclined roofs, is analysed. Additionally this paper gives special attention to the bi-axial compression stresses at supports.

The paper presented now can be seen as a report of the efforts carried out at Eindhoven University of Technology (TU/e), in cooperation with Industry, to provide scientific and experimental background to a building component which is widely used for mainly roof structures. Sandwich panels with holes, created for roof windows (skylights) are analysed analytically, numerically and experimentally.

KEYWORDS: Sandwich, panel, wood

1 INTRODUCTION

Sandwich panels as shown in Figure 1 are studied.

The core consists out of rigid foam thermal insulation material. The rigid foam may contain up to 98% of gas (i.e. air, CO₂, Pentane). Consequently, the core shows rather poor structural behaviour. The material has some compression strength. The modulus of elasticity and shear modulus are low. When these panels are loaded in bending, the bending moment is taken by the wood based faces. The shear load is taken by the core (the insulation material) resulting in shear deformation. For rectangular (wood based) beams the shear deformation can be neglected (it generally counts for less than 3% of the total deformation). The shear deformation can definitely not be neglected for sandwich panels where it may count for more than 30% of the total deformation.

When a hole is present in the sandwich panel, as shown in figure 1, the load carrying capacity consequently reduces. Furthermore, the failure mode is completely different from panels without a hole. Cracks develop at the sky light corners in the wood based faces subjected to tension. This phenomenon is analysed analytically, numerically and experimentally in order to obtain a reliable design for sandwich elements with holes. Furthermore, it is investigated how efficient different methods to reduce the negative effect of the sky light hole on mainly the strength are: firstly rounding at the sky hole corners and secondly reinforcements like locally increasing of the face thickness. And at last it is investigated how the load scheme, from uniform loaded panel (panel without a hole; q₁ in figure 2) to a panel loaded uniformly and point loads simultaneously (panel with a hole; q₁ and q₂ and F in figure 2), affects the stress distribution and the panel strength evaluation.

Figure 1: Sandwich panel studied

1 André Jorissen, Eindhoven University of Technology (TU/e), Den Dolech 2, 5612 AZ Eindhoven and SHR Timber Research, Nieuwe Kanaal 9b, 6709 PA, Wageningen, The Netherlands. Email: a.j.m.jorissen@tue.nl
2 Luc Castelijns, Eindhoven University of Technology (TU/e), Den Dolech 2, 5612 AZ Eindhoven. Email: l.j.j.casteleijns@student.tue.nl
3 Johnny van Rie, Kingspan Unidek, Scheiweg 26, Gemert, The Netherlands. Email: Johnny.vanRie@kingspanunidek.com
2 ANALYTICAL ANALYSES

For the analytical analyses the sandwich element is modelled as a beam as shown in figure 2.

![Beam model of the sandwich element with a hole](image)

Figure 2: Beam model of the sandwich element with a hole

The tensile capacity of the face subjected to tension is determined by introducing a stress intensity factor (for transformation of the model tension stress into a peak tension stress).

3 NUMERICAL ANALYSES

The numerical analyses are primarily carried out for panels regarded as two dimensional structures. This means that variation over the panel thickness is not considered.

4 EXPERIMENTS

Two types of experiments are carried out to determine the peak stress behaviour of the face material: a bending test based on a test known as the ‘Nordic test’[2], for which the test set up is shown in figure 3, and a tensile test, for which the test set up is shown in figure 4.

![“Nordic test”](image)

Figure 3: “Nordic test”

![Tension test](image)

Figure 4: Tension test

The test samples are also modified so, that stress levels are reduced, either by shape of edge (rounding of the hole corners), or by a local increase of the face thickness.

5 RESULTS

The results, including a design rule based on the beam model, will be published in the full paper.

The design rules include modification from uniformly distributed loads ($q_1$ in figure 2) to adapted universal distributed (but reduced) load ($q_1$ and $q_2$ in figure 2) combined with point loads ($F$ in figure 2).

6 CONCLUSIONS

The conclusions will be published in the full paper.

REFERENCES
