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STRESS DISTRIBUTION IN THE ADHESIVE JOINT OF A "SANDWICH" SPECIMEN

Anna Jasińska, Bogdan LIGAJ

INTRODUCTION

The method of gluing is widely used: in the machine industry, in the construction of medical instruments and tools, in means of transport, etc. Examples are rail vehicles, buses, in which gluing allows: combining various materials, compensation of construction errors, reducing vehicle weight, shortening production time. Structural adhesives: epoxy, acrylic and polyurethane.

Glued joints experimental tests are carried out on samples of dimensions specified in relevant standards. The assessment of the glued joint strength carried out in laboratory conditions is to provide information necessary for the proper selection of the connection geometrical features. The glued joints strength tests can be carried out using samples of the shape shown in Figure 1. The specimen construction was submitted as an invention to the Patent Office of the Republic of Poland, in which it was registered under the number P.422884.

The aim of the work is to present the stress distribution in glued joints of the sandwich sample under four-point bending. The variable value in the calculations was the side surface shape of the glued joint.

SPECIMEN DIMENSIONS AND CALCULATION CONDITIONS

Calculations were carried out under four-point bending (Fig. 2). The places where the load is applied are located at the following distances: L1= 360 mm, L2 = 180 mm. The value of bending moment Mg = 16 Nm. The upper beam M1 was made of S235JR structural steel: S_y = 235 MPa, E = 210 000 MPa, ν = 0,30. The lower beam M2 was made of aluminum alloy AW-2017A: S_y = 317 MPa, E = 73 077 MPa, ν = 0,33. Glued joints AJ are made of MULTIBOND - 3670 glue (according to the manufacturer): S_u = 22 MPa, E = 2 780 MPa, ν = 0,40, A = ~15 %.

The calculations were carried out in ABAQUS 6.6-4. o discretize the 3D models presented above, three-dimensional finite elements of the C3D4H type were taken from the library of the ABAQUS 6.6-4 program.

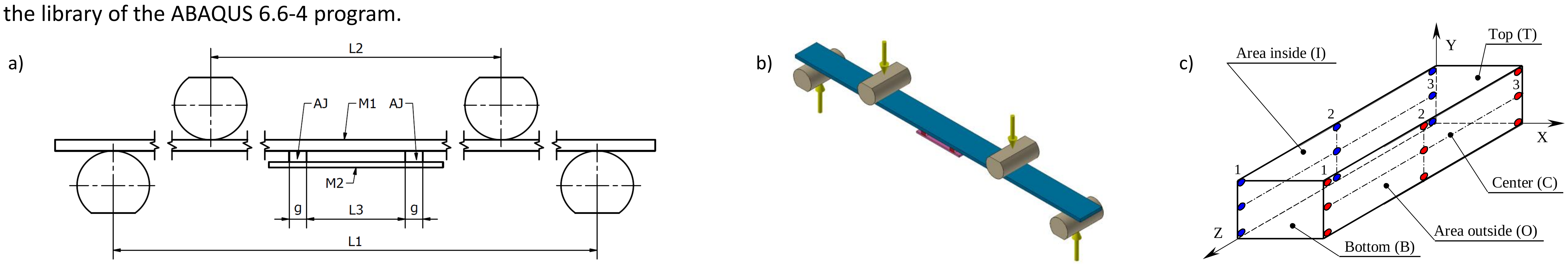

Fig. 1. General form of the sandwich specimen used in the calculations: a - specimen dimensions, b - bending moment loading method, c - determination of stress reading points

NUMERICAL CALCULATIONS RESULTS

Figure 2 show the stress distributions in the fragments of the sandwich specimen including glued joints.

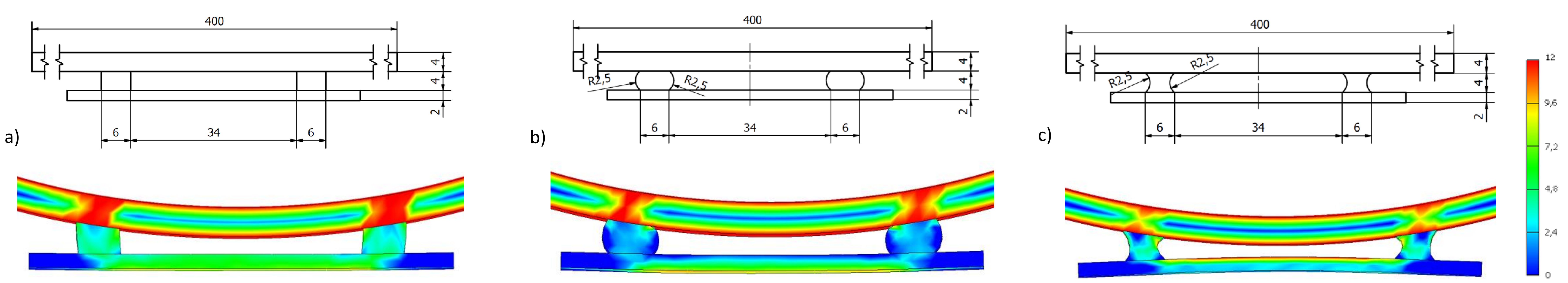

Fig. 2. Huber-Mises reduced stress in a glued joint with: a) flat side surfaces , b) convex lateral surfaces, c) concave side surfaces

ANALYSIS OF TESTS RESULTS AND CONCLUSIONS

Based on the stress distributions in the glued joints of the sandwich sample, it was observed that:

a) the highest stress values $\sigma_{H\text{-}M}$ occur in glued joint AJ with flat side surfaces at the contact with the upper beam M1 in its central part (point TO_2),
b) at the contact of the glued joint AJ with the bottom beam M2 the highest stress value $\sigma_{H\text{-}M}$ at the joint edges (points BO_1 i BO_3), and its value is about 50% of the stress value at points TO_1 and TO_3,
c) in the central part of the AJ joint on the outer surface, the highest stresses $\sigma_{H\text{-}M}$ were obtained at point CO_2,
d) on the internal surface of the glued joint AJ with flat side surfaces a different stress distribution was obtained than on the external surface of this joint; on the inner surface of the joint, the highest stresses $\sigma_{H\text{-}M}$ were on its edges,
e) stress distribution in glued joints AJ with convex side surfaces at the point of connection with the upper beam M1 is similar to the distribution in joint AJ with the flat side surfaces, in the joint AJ center part on the external and internal surfaces the value is similar low,
f) the highest stress values $\sigma_{H\text{-}M}$ in glued joint AJ with concave side surfaces occur in the middle of its part on external surface at point CO_2.

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