TESTING DEVICE FOR EVALUATION OF THE ADHESIVES MECHANICAL CHARACTERISTICS

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1. GENERAL CONSIDERATIONS

The authors intend to offer an improved method, using better efficiency specimens for testing the wood-joint's adhesives, subjected to various cases of loading.

Their goal consists in eliminating the undesired bending effect from the main solicitation as much as possible, which is the shearing of the adhesive layer.

It is a well-known fact that the single-lap adhesive bonding produces a strong bending effect (see Fig.1), elaborated by Goland and Reissner in [3] and analyzed meticulously in [1].

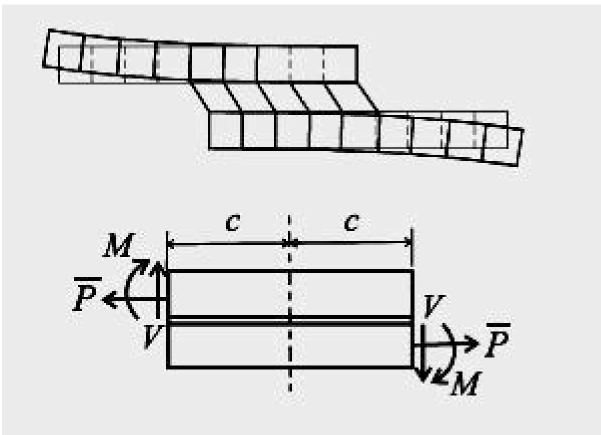

Fig.1
The Goland and Reissner's model [3]

Goland and Reissner [3], calculated the shear and peel stresses in the adhesive layer, based on the determination of the loads at the ends of the overlap (Fig.2).

The peel stress is defined as the induced transverse direction normal stress through the thickness direction of the adhesive layer, due to the bonded parts'

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bending (mainly as a cylindrical bended plate's one, applicable especially in the metal bonded parts) [1; 2; 3].

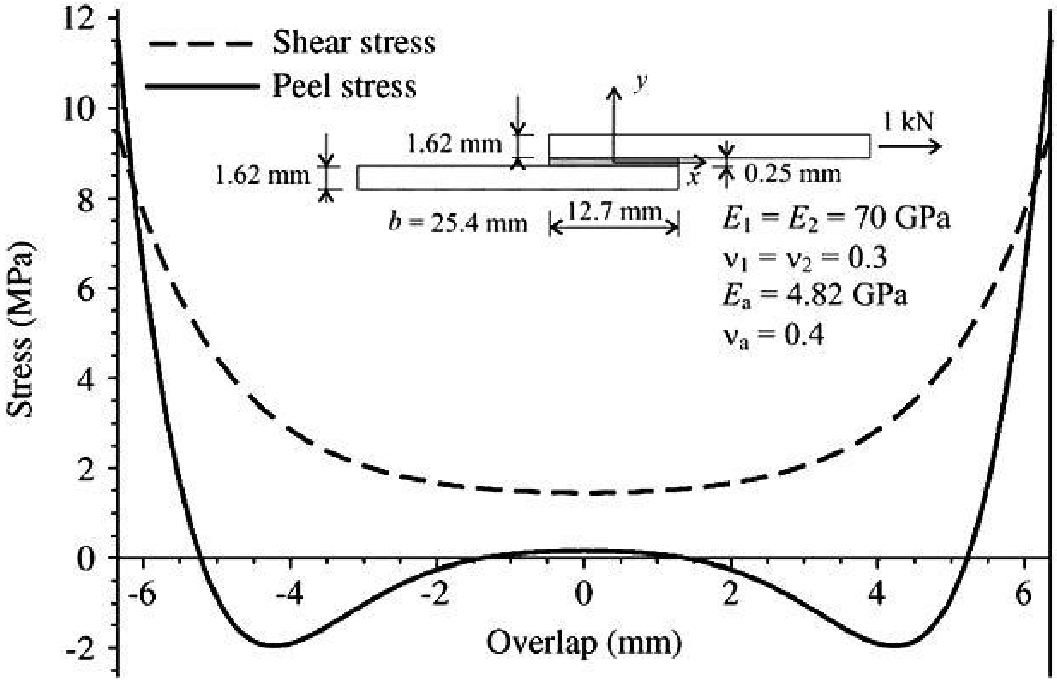


Fig. 2
The adhesive shear and peel stress distributions, based on Goland and Reissner's researches for Aluminium alloy adherends and an epoxy adhesive [3]

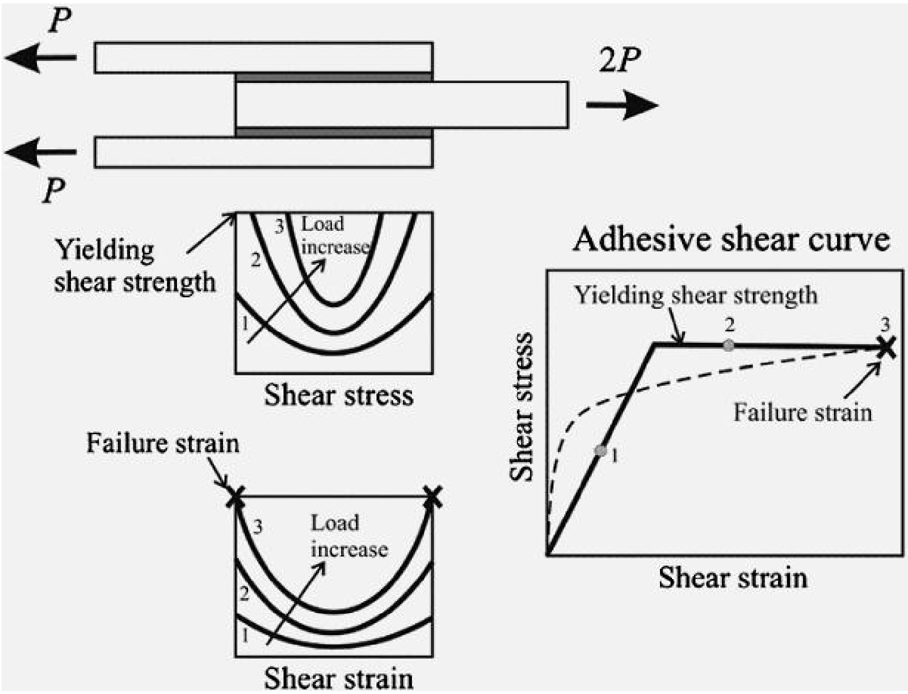


Fig. 3
Schematic explanation of shear plastic deformation of the adhesive according to Hart-Smith [5].

In this case, the test results will not be able to separate the shear effect from the above mentioned bending one.

Consequently, in order to put the pure shear effect (how is the adhesive response to the shear effort) in evidence, one has to look for other kinds of testing specimens.

A significant improvement concerning on the specimens' type, consists of the double-lap adhesive bonding, analyzed meticulously by Hart-Smith [4; 5] and illustrated in figure 3.

Based on the previous experimental investigations of this contribution's authors [6], although the peel stress isn't eliminated 100%, its magnitude is significantly reduced.

This is the reason of the present proposal, regarding the improvement of the specimen's type, described below.

In this sense, they performed meticulous prepared investigations by means of Holographic Interferometry, described briefly in the next paragraph.

2. EXPERIMENTAL INVESTIGATIONS USING HOLOGRAPHIC INTERFEROMETRY

The authors conceived and achieved an original Holographic stand for the evaluation of the glue's time-dependent behaviours [6].

This original stand (Fig. 4) allows testing different kind of glues for shearing, bending, tensile and torsion solicitations (loads). In this paper, only the shearing test-device is presented.

The main parts of the stand are presented briefly below. In a very rigid support ***1*** the tested wood specimen's subassembly ***2*** (see figure 5) is fixed, by means of a rigid cross piece ***3***.

The loading process is realised by means of a transverse ***4***, which transmits the acting force ***F*** to the wood specimen using some very flexible nylon thread.

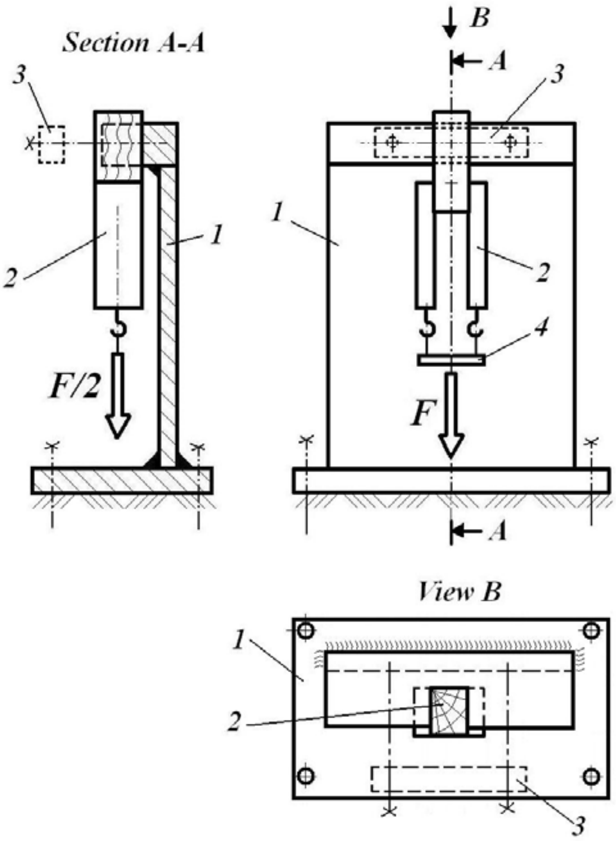
So, one can assure that the acting force will be divided exactly into two equal parts. One can observe that there are two symmetrical placed wood specimens (the lower parts) and the glued surfaces are practically subjected only to shear.

In figures 6 and 7 two holograms are presented, as illustration of the investigations, where the wood members were fixed using Urelite, respectively Polyvinyl-acetate glues.

At the first attempt, only the time-dependent behaviours of the tested glues were investigated.

Supplementary, by performing a calculus, regarding on the in-plane rotation of the lower members considering their initial positions, angular displacements were obtained roughly about $2...2.4'$.

These results underline the fact that also this kind of specimens are subjected to some small rotations and in order to find out the accurate shear behaviour (stress or/strain) one has to look for other solution.



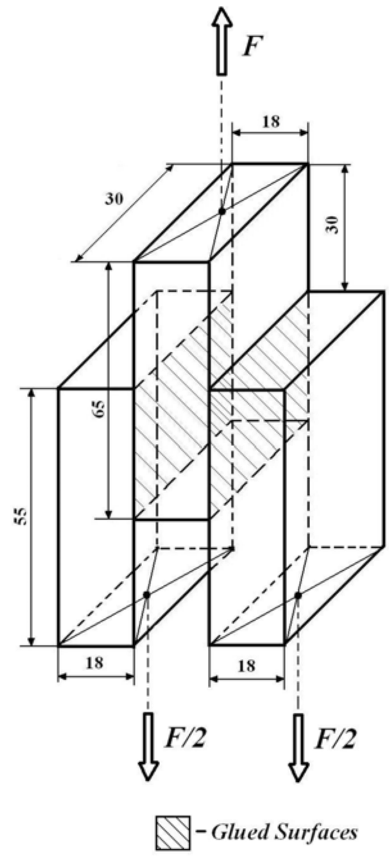
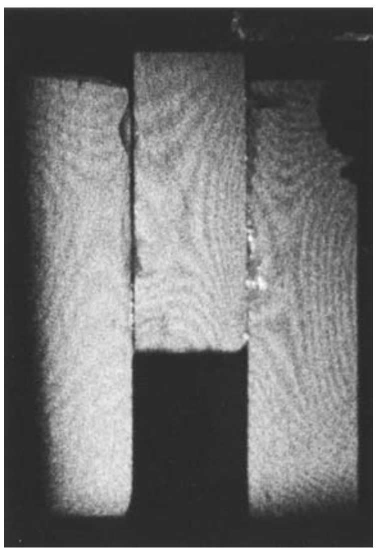


Fig. 4
The scheme of the Holographic stand [6]

Fig. 5
Wood-specimens subassembly



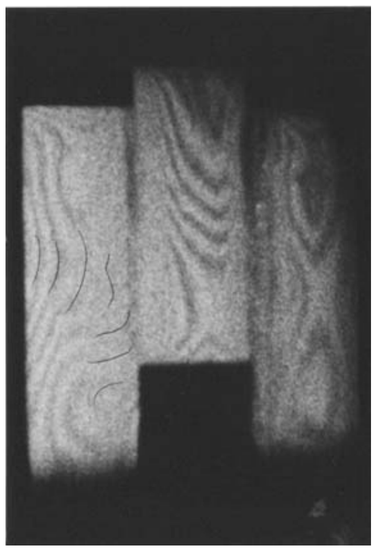


Fig. 6
Hologram for Urelite glue [6]

Fig. 7
Hologram for Polyvinyl-acetate glue [6]

3. THE FEM SIMULATION OF THE ANALYZED SPECIMENS

The authors performed some comparative FEM simulations in ANSYS 14.0, of the briefly analyzed specimen types, in order to verify the predicted behaviours.

In this sense, the glue thickness was divided in 5 layers in order to take into consideration the adhesive stress modification through the thickness direction, mainly of the interface stresses.

In figure 8 and figure 9 the displacement fields through the thickness of the glue (in *z*-axis direction) for the single-lap joint and the double-lap joint's respectively are presented.

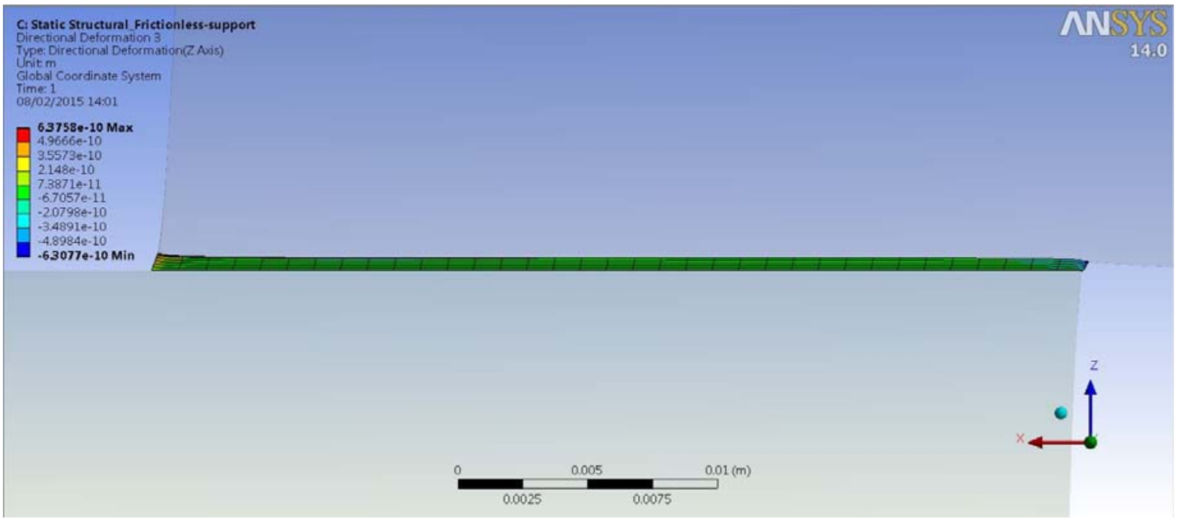


Fig. 8

The single-lap joint's transversal displacement field

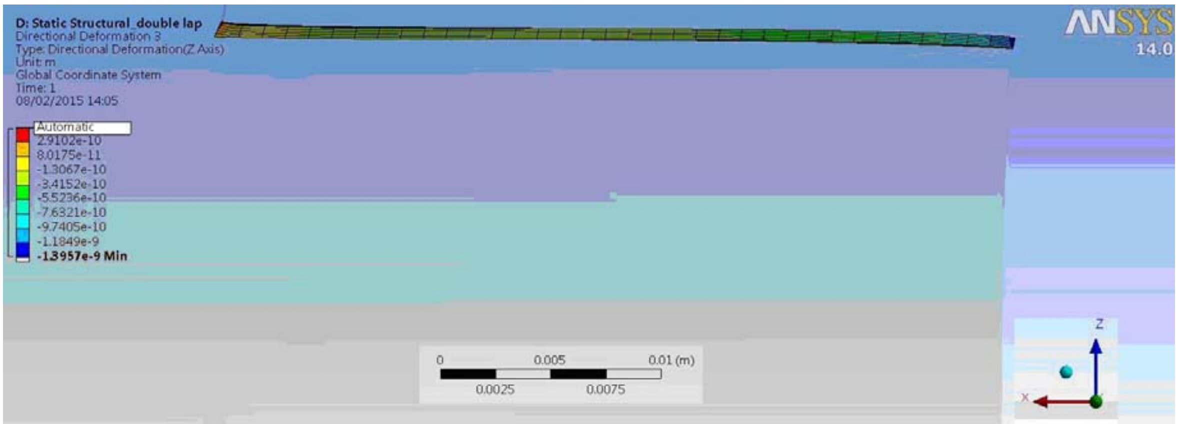


Fig. 9

The double-lap joint's transversal displacement field for a half of the joint

One can observe that the predicted transversal displacements by the above-mentioned references are correctly estimated.

Also, using Holographic Interferometry the authors' previous experimental investigations results were confirmed.

4. THE PROPOSED NEW SPECIMEN

Mainly, the idea of the new testing specimen consists of superposing (by vertical rotation) two sets of above-described specimens, finally obtaining the set presented in figure 10.

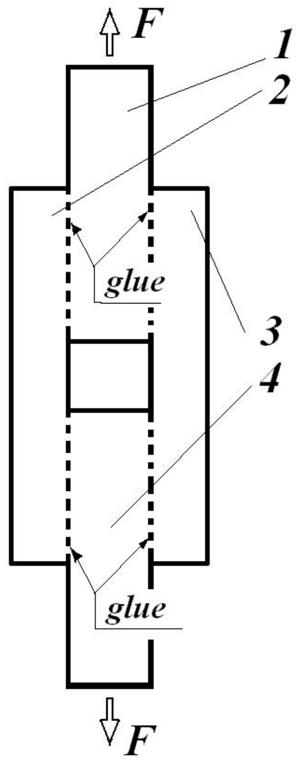


Fig. 10
The proposed new testing specimen's subassembly

In this case, the bending effect can be eliminated 100% and the shear effect will be easier to monitor.

By numerical simulation in ANSYS 14.0, the authors obtained similar results, shown in figure 11 (the mesh of the specimen's subassembly) and figure 12 (the transversal direction displacement field).

The fact, that in this case of numerical simulation the glue was also divided in five equal thickness layers has to be mentioned.

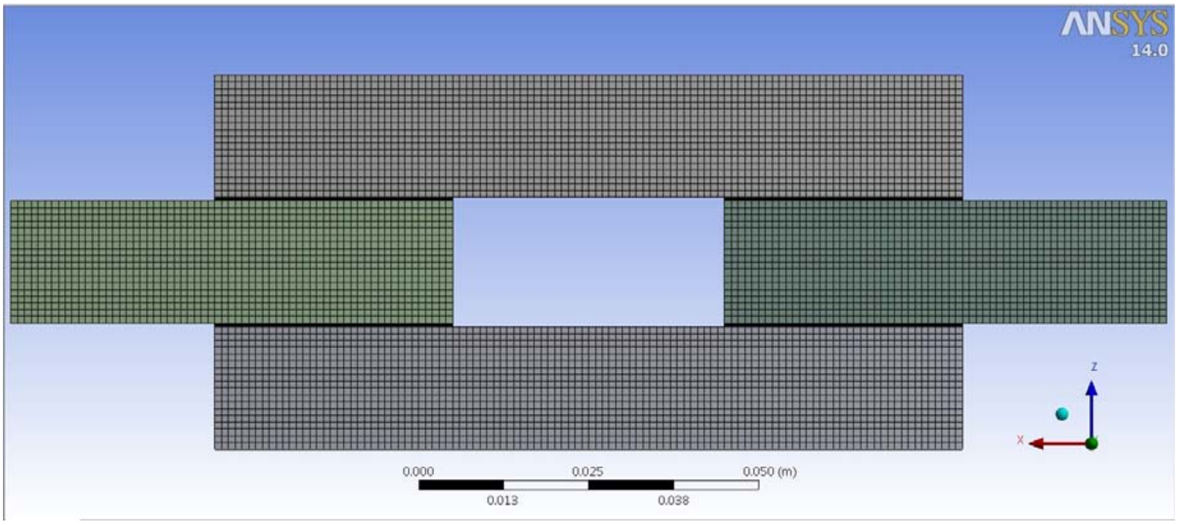


Fig. 11
The applied mesh for the new double-lap joint

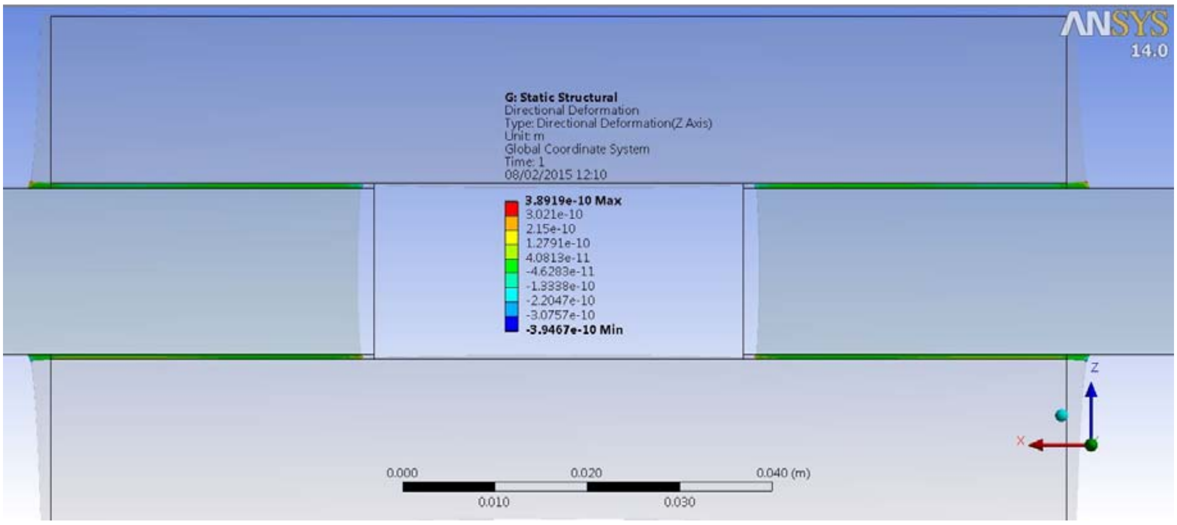


Fig. 12
The proposed new double-lap joint's transversal displacement field for a half of the joint

5. CONCLUSIONS

The proposed new specimens' set can be easily introduced both in Holographic and Video Image Correlation testing stands, which were conceived by the authors in the last years.

Also, one has to mention the fact that using this new specimens' set a better statistical evaluation of the obtained values became possible, due to the fact that in this case each set will represent in fact two of the older ones.

Having four glued surfaces, the strain distribution (respectively the displacements ones) can be more easily evaluated by averaging the obtained values.

The further goal of the authors will be to perform several, statistical acceptable tests for different kind of glues, widely applied in Romanian furniture industry.

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