A new torsion machine for adhesive joints

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ADVANCED JOINING PROCESSES UNIT

Introduction

Adhesive joints are used in structural applications due to their improved mechanical performance when compared to other classical mechanical joining methods. In order to predict the mechanical performance of adhesive joints, it is first necessary to determine the mechanical properties of the materials being used. These properties can be characterized under three basic loading modes: tensile, compression and shear. Tensile and shear tests are commonly used to determine the Young's modulus, tensile strength, and the strain to failure of materials. However, shear tests under torsion loading have been shown to provide higher accuracy in the measurement of the strain to failure since no stress concentrations occur in the specimen [1]. To explore the advantages associated with shear testing, a new torsional testing machine was developed [2]. It allows for accurate determination of the mechanical properties of structural adhesives by ensuring correct alignment of the specimens and avoiding any spurious bending moments during the tests. Two adhesives were characterised under shear loads using this novel machine and the results obtained were compared with those obtained with thick adherend shear tests (TAST) results. This work showed that by performing torsion tests in the newly developed testing machine, the adhesive is properly characterised, especially for the determination of the strain to failure.

A novel torsional testing machine

This invention consists in a machine specially designed to perform torsion tests on adhesive joints. This machine applies torsion loading to determine the shear stress-shear strain curve of these materials. The machine measures the torsion angle and torque applied, from which the shear stress-strain curve can be deduced. A major feature of the machine is the alignment procedure of the specimen, which is done vertically with a counter weight.

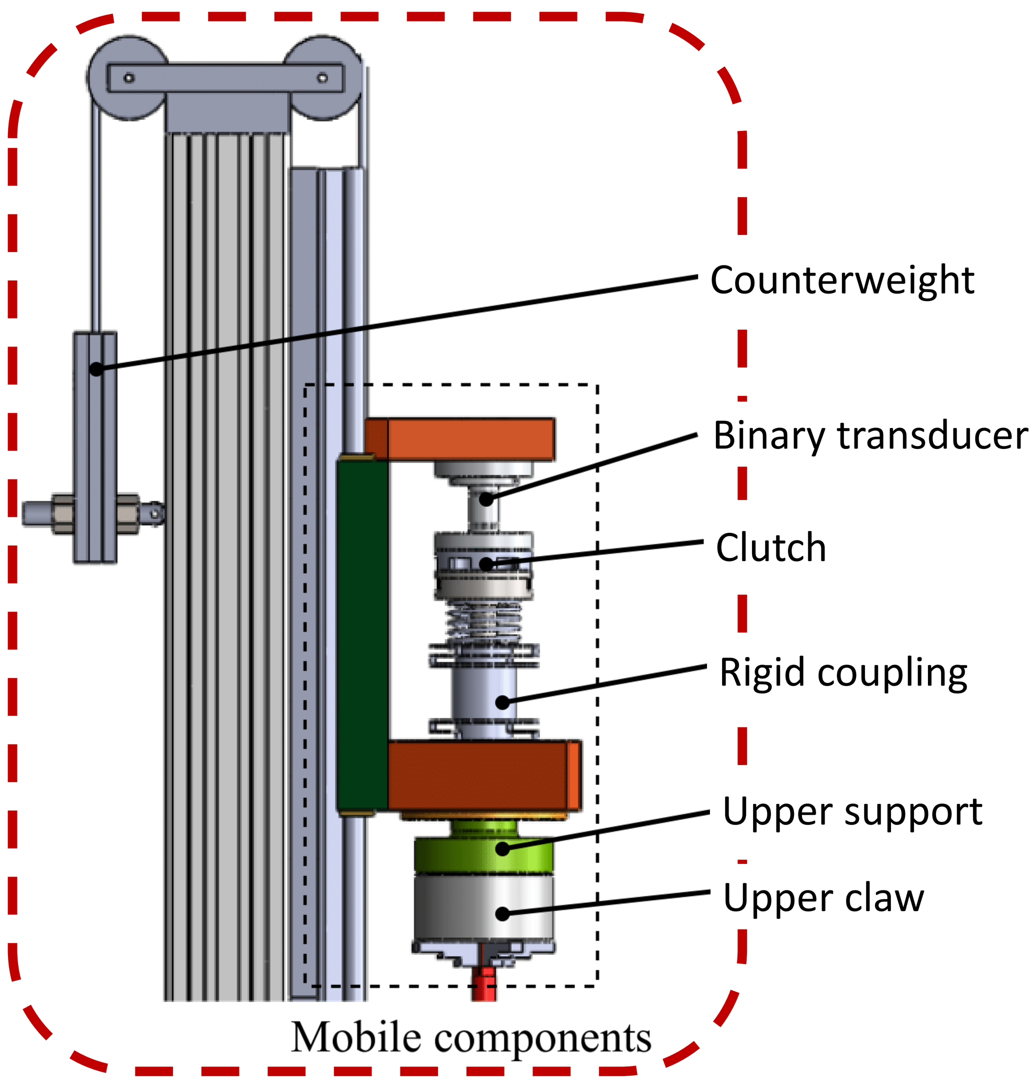


Figure 1 – Counterweight and mobile elements.

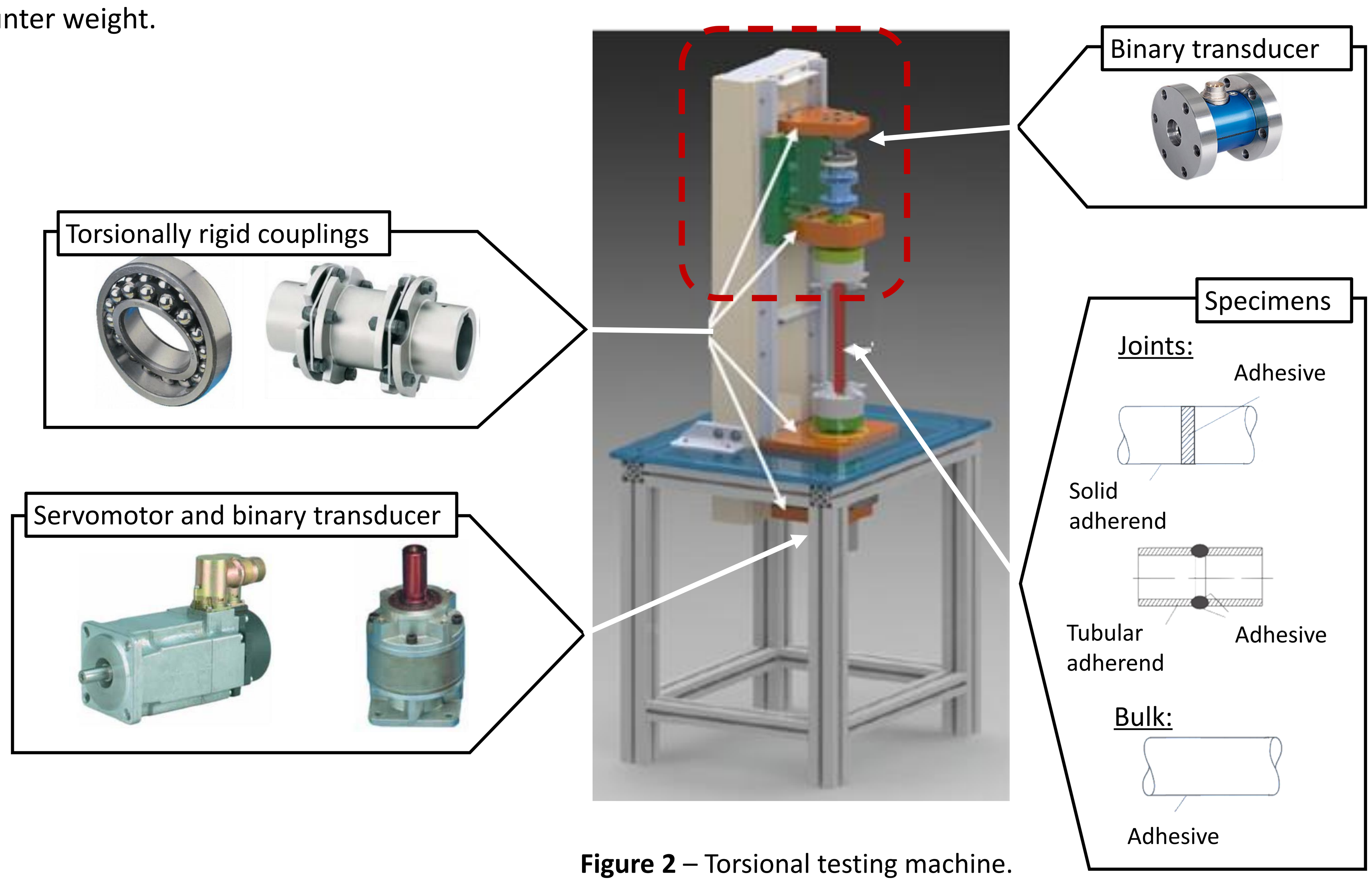


Figure 2 – Torsional testing machine.

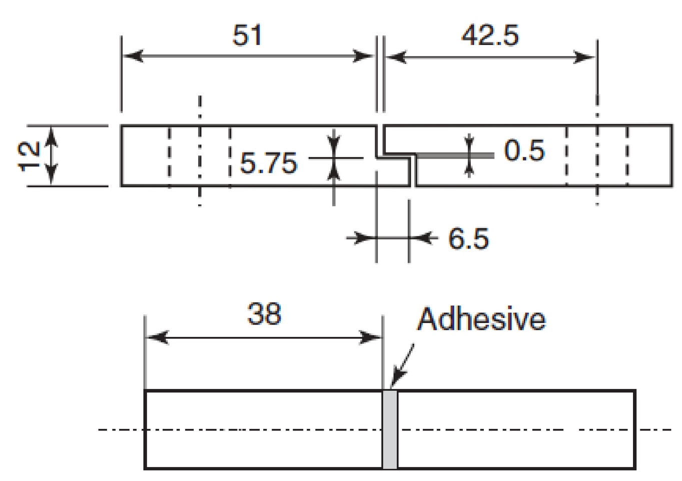
Validation

Structural adhesives:

- AF 163-2.K (3M) – one component modified epoxy structural adhesive;
- Araldite 420 A+B (Huntsman) – two component epoxy structural adhesive.

Joints tested [3]:

- Thick Aderend Shear Tests (TAST) according to ISO 11003-2 standard;
- Butt joints according to ASTM D 2095 standard.



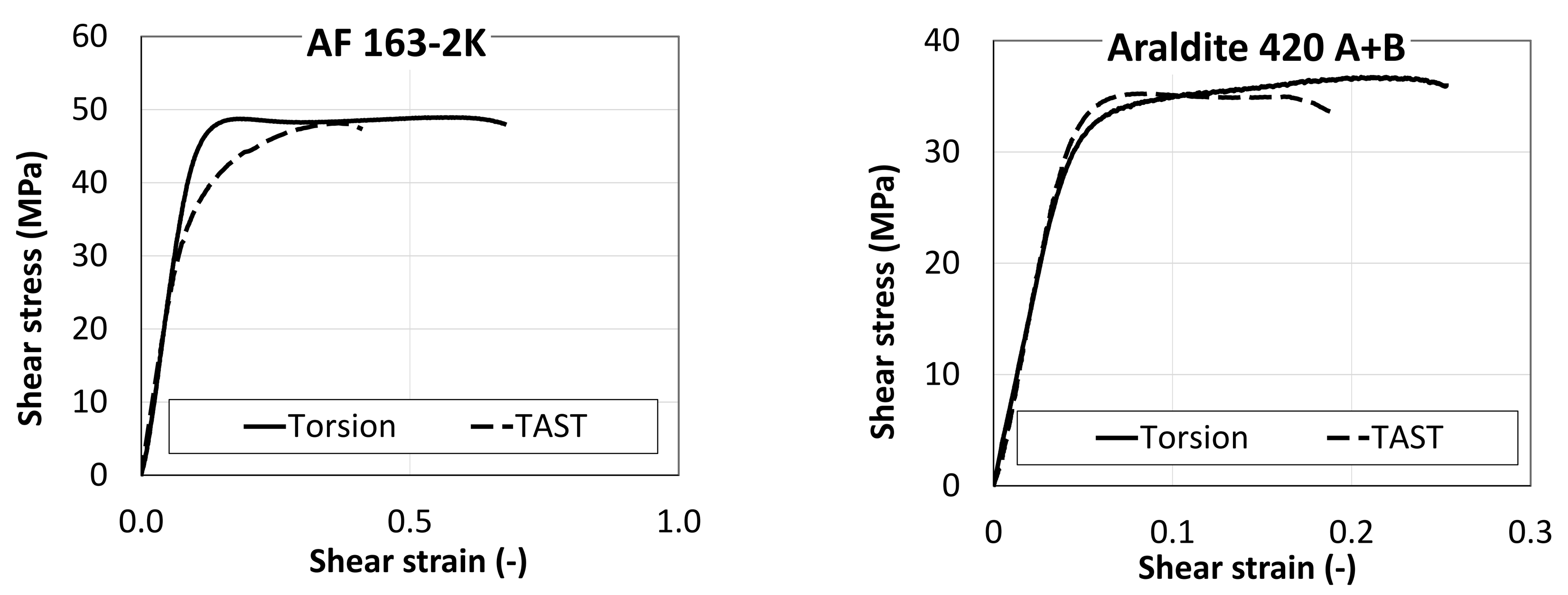


Figure 3 – Comparison of TAST and torsion tests at different rates [4].

Conclusions

- Torsion machines are uncommon because tensile loading is the preferred testing method. However, for polymeric materials, tensile loading is not sufficient for achieving the complete characterisation of the material, while torsion loadings provide a pure shear loading that are expected to provide more accurate results;
- The vertically aligned construction of the novel torsion machine avoids unwanted loads and spurious bending moments acting on the specimen during the torsion test procedure;
- The adjustment during the test allow to compensate any undesirable displacement, thus removing any no torsion load on the specimen.
- The determination of the strain to failure is properly characterized when used this novel torsion machine.

References

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Acknowledgements

The authors would like to thank the Portuguese Foundation for Science and Technology (FCT) for supporting the work presented here, through the individual grants CEECIND/03276/2018 and CEECIND/02752/2018.

MD2021 International Conference on Machine Design