Experimental Investigations on the Hole Drilling Method for the Residual Stress Measurement on Different Materials According to the new ASTM E837-20

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The life expectancy of a mechanical component is mainly determined by the interaction between defects in the part and the stresses to which it is subjected. These stresses are the result of stresses applied in service, compounded with stresses that develop in the object during all the machining and manufacturing processes. Applied stresses are generally taken into account in design engineering, but residual stresses are often overlooked, being closely correlated with the material, the manufacturing processes and its heat treatment. The hole drilling method is the most effective approach to evaluate residual stress in a wide range of materials: it is not only able to be applied on metals but also on polymeric, composite, and ceramic materials. This method has the advantage that the measurements can be made over a small area; a special strain gage rosette is bonded to the surface of the specimen and a hole is drilled through the centre of the rosette. The strains measured at the surface correspond to the stresses relaxed during the drilling process; using the measured strains and appropriate models (e.g. the new release of the ASTM E837-20 [1]) it is possible to calculate the stresses that exist in the material. MTS3000-Restan, developed by SINT Technology [2], is the automatic system for the measurement of these stresses, by means of the hole drilling strain gauge method, according to the new standard. This poster presents some different cases of residual stresses: a classic reference test on aluminium, a test on a glass specimen, a polymeric component and a sample in additive manufacturing. For example, the application of the hole drilling method to polymers and glass is very complex due to the higher coefficients of expansion and the viscoelastic behaviour of polymeric materials [3], and to the brittleness of the glass. When applying the hole drilling technique to these materials, it is essential to minimize the thermal and mechanical effects due to both temperature variations and hole drilling procedures, also avoiding the rise in temperature near the strain gauges because of the electrical resistance heating. The hole drilling method can be also applied to innovative materials, like additive manufacturing components: a case study of residual stresses into these materials will be presented in this poster as well.

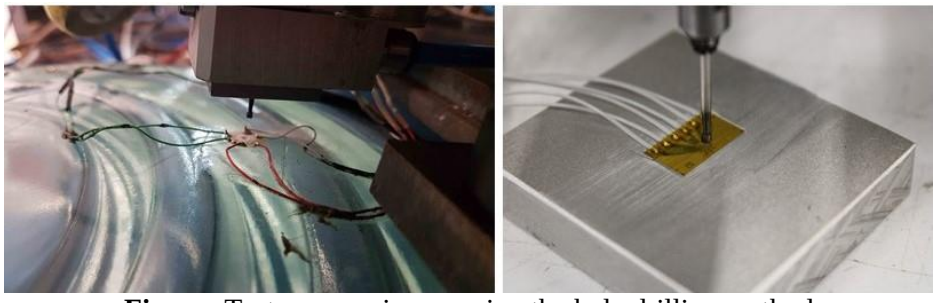

Figure: Tests on specimens using the hole drilling method

References

[1] ASTM, ASTM E837-20 Standard Test Method for Determining Residual Stresses by the Hole-Drilling Strain-Gage Method, 2020.
[2] A. Benincasa, E. Valentini, E. Boccini, S. Gulisano, An Automatic System for Residual Stress Measurements by Hole Drilling, 4th International Conference on Structural Integrity, 2021.
[3] E. Valentini, A. Benincasa, L. Bertelli, Improvements in the Hole-Drilling Test Method for Determining Residual Stresses in Polymeric Materials, Materials Performance and Characterization, doi:10.1520/MPC20170123, www.astm.org, 2017.