MODELLING, DESIGN AND ANALYSIS
OF A TESTING RIG FOR COMPOSITE MATERIALS

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ABSTRACT

This paper deals with the modelling, designing, meshing and analyses of a composite material testing apparatus. 3D-modeller Solid Edge [1-3] has been utilized to perform geometric modelling (Fig. 1) and to derive 2D-drawings for the definitive version of the fixture (Fig. 2).

A non-obvious design results, because large flexibility in the utilization of the testing rig is required. In fact, a wide range of specimen thicknesses and lengths, both tension and compression loadings, both static and dynamic tests must be allowed by means of the same fixture. Several alternatives have been proposed in literature [4-7]. Previous research has been focused on assessing the right way to transfer loading to a composite material specimen, but none of the papers in literature seems to account properly for the loading train alignment during push-pull testing.

In this work a novel, unconventional apparatus for testing composite material samples is described. Particular care has been devoted to achieve a reliable alignment of the loading train to avoid unpredictable bending stress to be imposed on the cross section of the specimen. The apparatus is composed of four geometrically similar grips (roughly in the form of rectangular parallelepipeds), two in the upper part and two in the lower part of the fixture. The two lower grips are aligned horizontally by sliding on a guide obtained directly on the lower crosshead which is fixed to the jack of an INSTRON hydraulic press. Two guide columns are provided in the inferior grips and two guide bearings (with bushing) are in the upper ones to allow sliding of the upper grips vertically by reducing friction to an acceptable low value. As a result, specimen can be gripped through a very stiff (in bending) substructure which is assembled in series with the hydraulic testing machine (Fig. 1 and Fig. 4). The substructure can be aligned through the loading train by means of precision gages. In any case, theoretical and experimental verification seem to confirm that the apparatus is so stiff, compared to specimen, that, even if this sub-loading-frame is out of alignment with respects of the hydraulic press, almost the whole additional bending stresses discharge on the guide columns leaving specimen in a pure testing loading.

Testing rig has been modelled through Solid Edge 3D-modelling package (Fig. 1). Functional requirements of couplings have been studied directly by Solid Edge assembly module. The potential of the parametric modeller reveals its appeal already during the first design steps. This apparatus has been utilized to verify a meshing module developed in Department [8]. Design has been carried on by standard methods, while a finite element analysis (Fig. 3) has been performed through Nastran and Ansys to verify the soundness of the model, by accounting for fatigue strength requirements.

A prototype of the apparatus has been made (Fig. 4). Production of an optimized lighter version, starting from 3D solid model, through a CAM procedure and a numerical control machine, is on plan. A CAD-CAE-CAM (CAX) chain will be utilized during this optimization phase.
REFERENCES


