

STRUCTURAL TESTING OF IMPACTED STIFFENED PANELS ON THE VERTEX TEST RIG

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ABSTRACT

The process of sizing and certification of aeronautical structures is organised according to the test pyramid, where numerous coupon tests form a basis for the design of larger-fewer tests, up to the full aircraft structure. Considering stiffened panel structure like the fuselage, it needs to withstand Ultimate Loads despite damaging incidents such as an impact generated by a tool dropped during maintenance. On composite materials, it notably leads to extensive tests of Compression After Impact to assess damage tolerance. These tests mostly take place either at small scale (coupon) or on large stiffened panels (structural details), which are either cheap and not representative of large structural effects, or costly and too complex and prohibitive for laboratory developments. Therefore, there is a need for structural testing at the intermediate scale, representatively of large structural issues, to notably study damage tolerance of composite stiffened panels at moderate cost. The VERTEX test rig allows to generate combinations of tension/compression-shear-pressure, representatively of large structural issues, on specimens with a 400 mm × 400 mm area of interest [1]. This study gets on with the opening of VERTEX tests towards compression after impact on stiffened panels, to study stiffeners debonding under post-buckling conditions [2].

Figure 1 illustrates the specimen geometry and a compression after impact configuration. Three identical samples were considered: Sample1 was impacted at 30 J on the stiffener flange (Figure 1), Sample2 impacted at the location but at 45 J, and Sample3 was impacted at 45 J on the skin. After impact, all three samples were subjected to compression up to complete debonding of the stiffener.

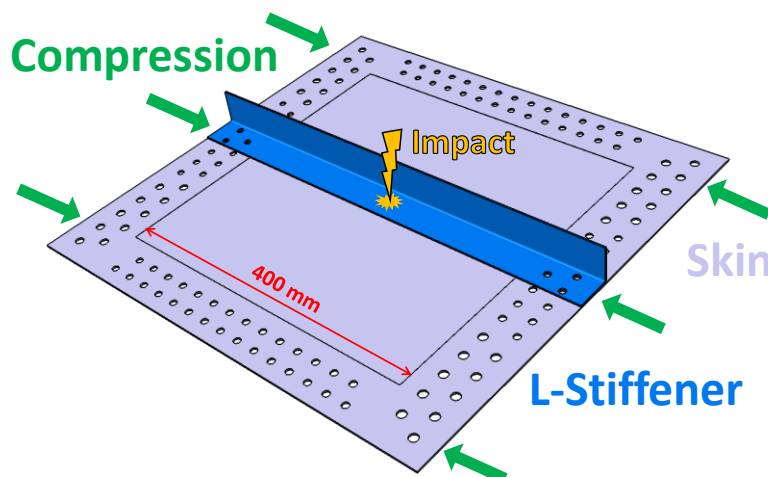


Figure 1: Stiffened sample considered under compression after impact.

A numerical model was developed to represent stiffener debonding of a specimen under compression: the composite was modelled with thick shell elastic elements, and cohesive elements at the skin/stringer interface allowed to represent the progressive debonding with an explicit solver (Figure 2). The model was used to perform virtual testing regarding the stiffener geometry (flange-web length and some technological solutions on the tips) in order to design the sample such as the desired phenomenology appeared during the tests.

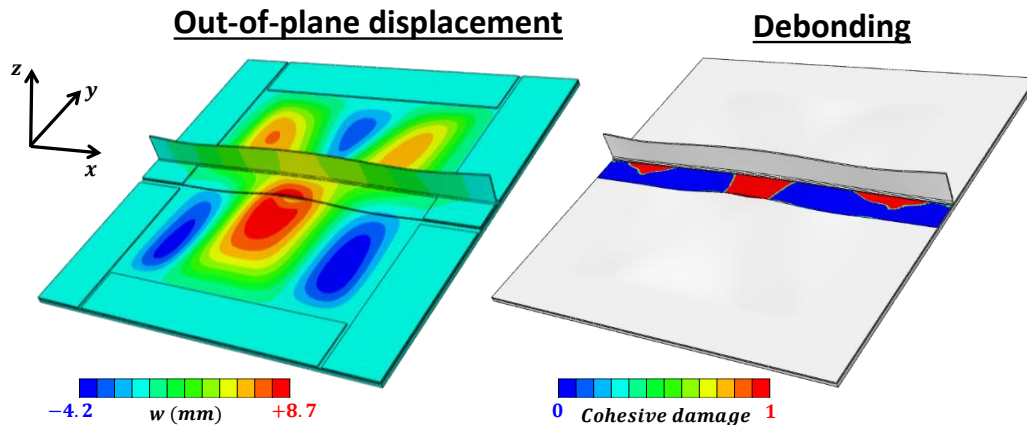


Figure 2: Model developed for virtual testing of some technological solutions, in order to ensure the intended phenomenology during the tests.

Compression after impact experiments were performed with the VERTEX test bench (Figure 3) and the observed debonding scenario were consistent with the numerical simulations. The effect of the impact (location and energy) on the debonding (strength and scenario) was not substantial.

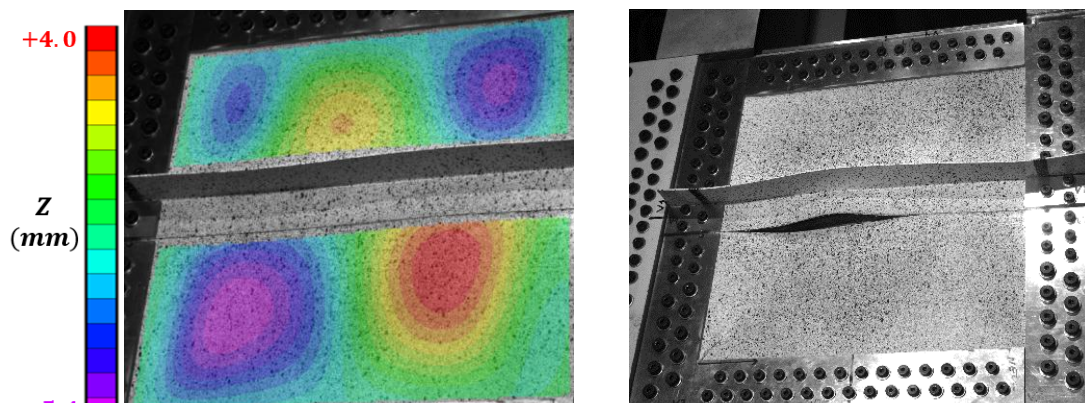


Figure 3: Experiment of compression after impact with the VERTEX test rig: (left) out-of-plane displacement field obtained with stereo-correlation before debonding, (right) picture of a sample after debonding.

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