BUS PILLAR TEST MONITORING, SIMULATION AND VALIDATION

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SUMMARY

The present paper describes the test results obtained of an instrumented pillar and the validation of the numerical models of the tests. The main objective was to develop the structural health monitoring system based on Fiber Bragg Grating technology to use in the prototype bus section tested according to UNECE Regulation no. 66 (www.litebus.com).

Keywords: Structural Heath Monitoring, FBG, Numerical Model Validation, Mechanical Test, Bus Roll Over.

INSTRUMENTED PILLAR DESCRIPTION

The tested pillar sample was instrumented with 8 Fiber Bragg Grating (FBG) strain sensors, 4 on each of two optical fibers. The optical fibers were embedded in the laminate during lay-up. Above the optical fibers there is only a thin ply reinforced with veil. Thus, the sensors can be considered as being placed at the outer surface. The optical fibers are placed so to arrange four pairs of sensors, one on each optical fiber. Two pairs are placed after the transition of the cross sections of the pillar and one pair is placed close to the central loading roller, as shown in Figure 1. The other pair is placed in a non-critical position.

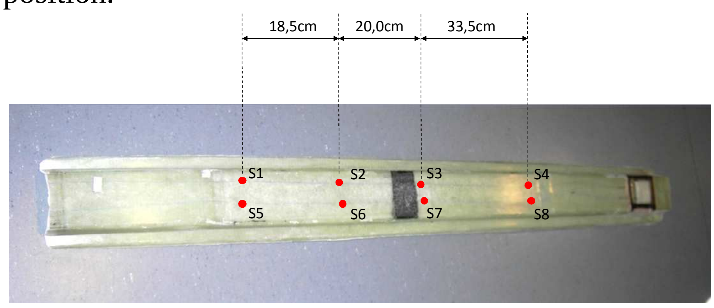

Figure 1- Sensor location within the pillar sample

After sensor embedment, FBG sensor spectral response was unaltered. As shown in the spectral figures, similar position sensors in each of two optical fibers also have similar assigned wavelengths.

STATIC TESTING

First mechanical testing was provided by three point static bending, imposing a load and an unload ramp on the sample. Sensors with similar locations on the pillar exhibit similar strain values which assess the good measurement repeatability. Maximum difference between initial and final strain values is 0.6% of the maximum measured strain, which indicates no fiber slipping during the testing. Regarding resolution, $1\mu\varepsilon$ resolution is demonstrated on the tests. From this first static test, viable sensors and embedment processes for providing accurate strain measurements is demonstrated.

DYNAMIC TESTING

Test setup is shown in the next figure and strain vs. displacement and load as measured by the FBG sensors shown in figure 2.

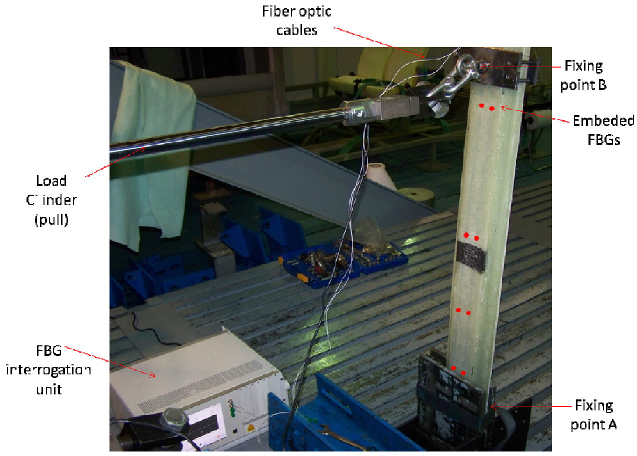

Figure 2- Dynamic test

Measurements from the two sensors closer to damage are quite different, probably due to slight dissimilar locations within the pillar sample, which translate into quite different strain points in this setup. This assessment is reinforced by previous results on the static testing, which showed different strain measurement results even for much lower strain values. The rest of the sensor pairs provided similar results for equivalent pillar locations. The most critical (the one closer to the clamping fixation) broke at $11m\varepsilon$ compression, at the same time as the overall pillar sample failed. Information from one pair of sensors became unavailable during part of the test due to sensor spectrum overlap, and thus the individual response was irresolvable. Nevertheless, the sensors were not damaged, since their response could still be recorded on the latter part of the test. Overlapping issues can be solved by correct allocation of the sensors in wavelength bands, which can be performed with clearer knowledge of the sample expected strain values at each sensing location. Final strain values suggest that no relevant fiber slipping has occurred during testing.

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