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VIII ВСЕРОССИЙСКАЯ НАУЧНО-ПРАКТИЧЕСКАЯ КОНФЕРЕНЦИЯ С МЕЖДУНАРОДНЫМ УЧАСТИЕМ, ПОСВЯЩЕННАЯ 50-ЛЕТИЮ ОСНОВАНИЯ ИНСТИТУТА ХИМИИ НЕФТИ

«Добыча, подготовка, транспорт нефти и газа»

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SIMULATION AND EXPERIMENTAL VERIFICATION OF THE PROCESS OF DAMAGE DETECTION OF CFRP SUBJECTED TO DROP-WEIGHT IMPACT LOADING

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Carbon fiber reinforced polymers (CFRP) are widely applied in different industries. The benefits provided by these materials determine their wide usage in newly designed aircrafts: Boeing 787 and Airbus 350XWB have about 50% wt. of CFRPs in the structure. However there are drawbacks: e.g. susceptibility to impact damaging and lack fracture toughness of due to viscoelastic deformation behavior. Thus impacts during aircraft operation lead to the formation of large amount of barely visible impact damages (BVID) which can evolve producing large delamination. Any formed damages should be detected and repaired timely but the areas of aircraft skins are quite large demanding fast and productive non-destructive testing (NDT) to reduce maintenance time.

Conventional ultrasonic NDT method is applicable to testing of CFRP, but time consuming due to small scanning area and manual operation. Due to non-contact and full-field application shearing speckle pattern interferometry (or shearography) is a robust NDT method which measures the strain of the testing object directly. Analysis of the strain fields for non-homogeneities allow revealing damages and flaws in different structures.

The paper deals with application of newly designed shearographic device and developed software for detection on damages of different CFRP specimens subjected to impact loading. Based on the previous studies the robust algorithm for digital processing of speckle images was established. It is based on the sin/cos filtering with iterative approach providing smooth high contrast phase map without loss of phase information. The device utilizes 5 Mpx CCD image sensor and five step phase shifting technique using piezodriven mirror in order to retrieve relative phase change.

The tests were carried out on laminate and honeycomb panels with the sizes of 300x300 mm. The experimental testing of the technique consists in detection of BVID of honeycomb panel obtained using drop-weight technique. The obtained shearograms easily revealed the BVIDs as non-uniformities in the strain fields. The honeycomb specimens show the regular texture associated to the core while stacking of plies in the laminate is easily seen in the shape of straight lines coincidental to the direction of reinforcement. The results are analyzed and discussed in view of sensitivity of shearography to BVID and delamination.

The same process was simulated using ABAQUS FEM software. The obtained data was compared with experimental results and discussed in terms of the sensitivity of digital shearography to the depth of damage location and possibility of its stable detection.

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