UNIVERSITI TEKNOLOGI MARA

FINITE ELEMENT ANALYSIS FOR THE DYNAMIC BEHAVIOUR INVESTIGATION OF A SPOT-WELDED STRUCTURE UNDER INITIAL STRESS INFLUENCE

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ABSTRACT

The development of accurate analytical modelling of the representation of laser spot welds in assembled structures has become an interesting topic of challenge in the structural dynamics community. This is because laser spot welds contribute significantly to the integrity of the structure and the overall dynamic behaviour of an assembled structure. However, accurately determining the dynamic behaviour of a laser spot welded structure using the finite element method is challenging due to the difficulties in representing laser spot welds, which are usually associated with initial stresses. These problems are the main motivation for achieving the goal of this research, which is to investigate the influence of initial stresses on the dynamic behaviour of a laser spot welded structure. The structure under investigation is a hat-plate structure, a simplified structure taken from a car Body in White (BiW) joined by laser spot welding. For the experimental modal analysis, the dynamic behaviour of the hat-plate structure was measured with an impact hammer and a roving accelerometer under free-free boundary conditions. Meanwhile, the CWELD element connector for the laser spot welds of the FE model was developed to predict the dynamic behaviour of the structure. A new scheme was developed to include the initial stresses in the FE model. The predicted results were validated with measured data. NASTRAN SOL 200 was used to update the FE model considering the experimental results. In addition, the comparison of the results showed that the total error without initial stress was 26.45%. The FE model was then used in the model updating method with the measured data as benchmark data for matching with the sensitivity analysis to identify the most sensitive parameters. The total error dropped to 8.06 % after the first attempt of model updating. The initial stresses that may result from the laser spot welding of the test structure was used as potential updating parameters in the second attempt to update the FE model. The predicted results of the updated CWELD-based FE model of the laser spot-welded structure with the new scheme incorporating the initial stress have shown great success, as the total error was significantly reduced from 26.45 % to 2.36 %. The proposed updating scheme has been successfully used to reduce the total error of the initial FE model of the welded structure. The reduction means that the dynamic behaviour of the initial FE model has been perfectly matched to the tested welded structure. Furthermore, the initial stresses were identified as the largest contributor to the errors and the proposed modal updating scheme has enormous potential to be used in the development of a robust FE model of a car BiW for the automotive industry.

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