UNIVERSITI TEKNOLOGI MARA

THE INVESTIGATION AND RECONCILIATION OF THE DYNAMIC CHARACTERISTICS OF A THIN PLATE LASER SPOT WELDED JOINT STRUCTURE

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ABSTRACT

In the structural dynamic analysis, having accurate information on the dynamic characteristics of a structure is vital to help engineers or modal analysts to understand the structure's characteristics. The dynamic characteristics can be identified by the use of the finite element method (FEM) and also by the experimental modal analysis (EMA). However, it is challenging for the modal analysts to reliably and accurately identify the dynamic characteristics of the structure merely using the finite element method, especially with the presence of mechanical joints such as spot welds, rivets, and bolted joints in the structure. The work presented in this thesis was primarily to investigate appropriate element connectors to be used for modelling and to reconcile the dynamic characteristics of a thin plate, laser spot welded structure via the finite element and model updating method. The initial finite element models of the welded structure were developed using three different element connectors (RBE, ACM and CWELD) and the models were then used to predict the dynamic characteristics of the structure. Meanwhile, the measured dynamic characteristics were obtained using an impact hammer and roving accelerometers under free-free boundary conditions. The measured results were then employed in the updating method for reconciling the initial finite element model with the test structure. The largest total error of the discrepancy between the predicted and measured natural frequencies was recorded in the RBE based initial finite element model (47.61%) followed by ACM2 based initial finite element model (23.28%). The CWELD based initial finite element model with the smallest total error (22.66%) was found to be the most appropriate model to represent the thin plate laser spot welded structure and to then be used for model updating. The CWELD based initial finite element model was successfully reconciled to the test structure within a satisfactory, acceptable level of error. The results suggest that CWELD element connectors have a better capability to represent the laser spot welds in the structure in comparison with other element connectors. The improvement in the CWELD based initial finite element model reveals that the finite element model updating can be used successfully to reconcile the initial finite element model with appropriate modelling of the test structure.

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INTRODUCTION

1.1 INTRODUCTION

Vibration is a mechanical oscillation movement in a particular time interval. Vibration can be desirable, but in many cases vibration is undesirable. In many engineering systems, vibration phenomenon can occur naturally. Any structure or component subjected to vibration can result in mechanical failure, system malfunction, poor performance, rapid wear or discomfort to a human being. Moreover, vibration can lead to more severe hazard and a threat to safety.

In recent time, many engineering structures become more complicated and are being used in more challenging condition and function. Demands for lighter structures, high durability, economical cost, user comfort and safety structures have always been areas of concern for engineer and designer to address the problem that occurs from the effect of vibration. Hence, structural dynamics analysis has become essential to understand the dynamic behaviour of structure, and this can be achieved through numerical approach or experimental approach.

1.1.1 Structural Dynamics Analysis

The traditional way of conducting structural dynamics analysis is by making a prototype followed by series of physical test to prototype to demonstrate its capacity to withstand certain conditions. Once the dynamic properties have been characterised, the behaviour of a structure in its operating environment can be predicted. Thus, the problem arising from structural dynamics can be controlled and enable design for optimal dynamic behaviour.

Changes by changes will be made to the prototype until it meets desirable criteria. This loop of redesigned and test consumed much effort, time and money. With the growing capabilities of computing techniques, number of prototype and testing can be reduced by simulating them using finite element model prediction. This