UNIVERSITI TEKNOLOGI MARA

DYNAMIC CHARACTERISATION AND FINITE ELEMENT MODEL UPDATING OF A CAR DOOR IN WHITE STRUCTURE

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ABSTRACT

Nowadays, perceived quality of noise and vibration has become major attention for buying a car, and it is significantly reflected to the brand image for the car manufacturer. Most of the time, the door closing sound has been the first stage for customer to gauge the build-up quality of a car and also has the most interaction with the user. Understanding the importance of build-up quality of a car door structure, this study focused on analysing the dynamic characteristic of door in white (DIW) structure. DIW is categorised as complex engineering structure, where complexity items such as geometrical shape design and various joining methods bring many engineering challenges on the study field of structural dynamic characteristic. To address this challenge, finite element method is normally employed to predict the behaviour of structure since early development phase. However, despite the advancement on the computation method such as finite element method, predicted structural dynamic characteristic in terms of natural frequencies and mode shapes often produces conflicting result as compared to the experimental finding. Inaccurate predictions of the finite element model are believed to be arisen from invalid assumptions on input properties data and simplification of the geometry. This thesis objectively intends to study the spot weld joint behaviour and application of model updating method on DIW structure in order to develop a more reliable finite element model representation. In this research work, the potentials of joint elements such as ACM2, CWELD, and CFAST on representing spot weld joint on large complex structure are presented and discussed. Using the information that are gained from initial finite element results of studied joint elements and measured experimental data, iterative model updating method is then employed in order to minimise the discrepancies; thus, producing a more reliable finite element model. The objectives of this research work are accomplished by using MSC Nastran SOL 103 to predict the dynamic behaviour of finite element model, applying experimental modal analysis (EMA) to measure actual physical response of the structure, and finally adopting MSC Nastran SOL 200 as a model updating tool to minimise the discrepancies between finite element and actual measured data. Throughout the research works, CWELD joint element has been found to produce the least discrepancies as compared to EMA finding, subsequently followed by CFAST and ACM2. Application of finite element model updating has been validated to successfully improve the correlation level between finite element model and EMA. Total error has been significantly reduced from 13.47 percent to 9.30 percent.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Recently, perceived Noise, Vibration and Harshness (NVH) quality has become a major consideration on vehicle purchase option for the customer apart from safety and durability. NVH performance is often viewed as good quality car by the customer and represents the brand image of the car manufacturer. Producing acceptable level of perceived NVH quality required extensive study on dynamic analysis during vehicle development programme.

Fast introduction of the new car model with maintained good build up quality into the market has now become a requirement for each car manufacturer globally so as to ensure the market competitiveness. In order to ensure fast market introduction, development time needs to be shortened. To mitigate the issue, finite element (FE) method is used as a tool to predict the design quality as early as possible in the development stage. As an advantage, the use of FE also helps manufacturer to reduce the development cost by reducing quantity of prototype build.

Nevertheless, modelling of accurate representation of FE model is always a challenging task, and the need to reduce discrepancies between FE model and experimental model has resulted in a number of extensive research area. The research involves areas such as structural dynamic analysis, finite element method, experimental modal analysis, and model updating, as described in the following.

1.1.1 Structural Dynamic Analysis

Structural dynamic is a discipline focusing on behaviour of structures under dynamic loading. Vibration engineering is one of the focus subjects under structural dynamic analysis. Vibration phenomena can be unpleasant and harmful both to the structure and human. Vibration in general is a repeating motion in an interval of times, and it is called oscillation [1].