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Effect of muffler mounting bracket designs on durability

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ABSTRACT

Automotive industries perform durability tests on vehicles in the end-user environment to reduce failures and warranty costs in the end-user hands. In this paper we present the failure analysis of muffler mounting brackets of three-wheeler vehicles observed during the durability test. Cracks at the weld location between the engine cradle and brackets were observed in all the vehicles at an average distance of 10,000 km. Many possible causes of the failures are identified using fishbone diagram. The fishbone diagram is a graphical analysis tool that provides a systematic way of looking at effects and the causes that contribute to those effects. Statistical analysis of the failure data was conducted using Weibull distribution for durability life prediction. Further investigations were carried out on the design using finite element method (FEM). A FEM model was developed for the engine cradle assembly in which engine and muffler were modeled as point mass. Vertical forces were applied on the assembly using '4g' criterion, where g is the acceleration due to gravity. The applied force accounts for the high impact forces that act on the structure during durability testing. Results show high magnitude of stresses and strain energy at the weld location. Analysis of the design suggests that bracket was acting as a cantilever beam with one-plane welding mounted on the engine cradle. Modified design, though eliminated the above failure, shifted the failure mode to the bush-bracket region. Various design modifications were carried out and its effect on durability has been discussed. FEM analysis on the final design shows significant reduction in stresses at the critical locations. The new design of the bush-bracket system passed the durability target of 1,00,000 km.

1. Introduction

Durability and reliability of a product are equally important from a customer point of view. Reliability is the measure of unanticipated interruptions or unexpected failures during customer use [1]. During a reliability test, one important goal is to maximize the opportunities for observing unexpected failures, so that they can be fixed. Automotive industries are still riddled with significant warranty costs that incur due to premature failure of their products in the customer hands. The key to reducing the design & development expenses and warranty expenses is to subject the product for reliability and/or durability tests for failure modes investigation. The failure investigations of the muffler mounting brackets reported in this paper are observed during the durability tests under actual environment. The target durability of the component was 1,00,000 km whereas the average failures were observed at 10,000 km. One interesting part of this failure investigation is that solution of one failure mode resulted in the shift of failure mode to other part of the same component. The subsequent failure investigations are also presented in the paper.

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