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Keio University

Thesis Abstract

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Thesis Title

Load Transfer in Motor Vehicle Compartment Structures during Frontal Collision

Thesis Summary

To satisfy the requirements for high stiffness and lightweight vehicle bodies, it is necessary to imagine the figure of the entire structure from the viewpoint of load transfer and load paths. The parameters U* and U** have been introduced based on the internal stiffness and the internal compliance to express the load transfer.

In the present study, the load transfer and load paths in motor vehicle compartments are studied using indexes U* and U** at the initial stage of a collision. After obtaining the deformed body by a dynamic crash simulation, indexes U* and U** for the extracted deformed body are calculated statically. Since the main part of the compartment retains its linear elasticity to ensure the safety of the occupants, the author points out that linear U* and U** analyses can be applied during the initial crash stage, and develops a dynamic-static method.

For the study of a truck compartment, the author originally introduces a substitution modulus method to reproduce the material and geometrical nonlinearities. The index "m2-4msU**" is proposed as a standard condition for the truck cab. The distribution of U* is compared with that of U** and the characteristic difference between these indexes is revealed. It is shown that the main member of this cab transfers the loading effectively, and the corners of a member play an important role in the load transfer.

In the study of a passenger car compartment, a separation structure method is newly developed. The front end and suspension parts are not altered from the actual body, but the material of the compartment is assumed to have simple elastic property. The calculated U** distribution shows that the floor member plays a paramount role in the transfer of the impact loading and the shearing force in the floor panel distributes the loading to body sides. These results show the effectiveness of the new methods that use U* and U** in vehicle crash analysis.

In Chapter 1, the research background and the objective of the present study are introduced.

Chapter 2 of this thesis contains a review of conventional load path theories covering internal stiffness, indexes U* and U**, load paths, and histograms of U*sum and U**sum.

In Chapter 3, a dynamic-static method and substitution method are introduced and interpreted for the analysis of truck cabs. Nonlinear properties can be expressed by introducing the substitution modulus method. A separation structure method for a passenger compartment body is demonstrated. Using these methods, U* and U** analyses can be applied smoothly to crash problems.

In Chapter 4, the calculation models for a truck and a passenger car are described. Boundary conditions are also shown.

Chapter 5 focuses on the verification of the above approximate method in actual truck and passenger car models.

In Chapter 6, the results of U** analyses for truck cab structures are shown. It is shown numerically that the floor member and the floor panel play important roles.

In Chapter 7, from the comparison of U* and U**, the author shows that U*analysis is adequate for flat barrier impacts, and U** analysis is effective for deformable barrier tests.

In Chapter 8, the histograms of U*sum are discussed to examine the entire truck cab together with each path. The histogram of the main member has a sharp peak that shows a highly efficient load transfer.

In Chapter 9, the histogram of U**sum are discussed to examine the passenger car compartment.

Chapter 10 summarized the research findings and concluded the present study.