講演番号 113

文献番号 20225113

A tailored solution for non-linear dynamic analysis of body structures

Fumio Numata[1] Noriyuki Muramatsu[1] Kazumasa Kato[1]
Markus Breitfuss[2] Oliver Grieshofer [2]

1) Magna International Japan Inc., Nihonbashi Plaza Building 6F, 2-3-4 Nihonbashi, Chuo-ku, Tokyo, 103-0027, Japan
2) MAGNA Powertrain, Engineering Center Steyr GmbH & Co KG, Steyrer Strasse 32, St.Valentin, Austria

KEY WORDS: Vehicle development, CAE, Design simulation, Fatigue, Reduced order model, Contact, Non-linear dynamics [B2]

The fatigue assessment based on numerical simulations is a well-established part of the development process within the automotive industry and an important tool for reaching durability and lightweight targets. A typical process for body structure durability assessment relies on the stress time histories obtained from the analyses of detailed but linear Finite Element (FE) models and the fatigue related data regarding material and deployed joining processes. This set of data represents the mandatory input for a fatigue solver from which the durability performance results, like damage distributions or safety factors, follow as output. The better the result accuracy of the utilized stress time histories, the better the accuracy of the obtained fatigue results. Examples showing the influence of contact stresses are available in the literature, and emphasize the need for efficient non-linear dynamic analysis of body structures. Therefore, a tailored solution for the non-linear dynamic analysis of body structures, which delivers stress time histories considering the body structure dynamics as well as local contact conditions, was developed and is presented in this contribution.

For improved fatigue assessment the stresses processed by the fatigue solver should consider the body structure dynamics as well as local contact conditions whilst keeping the advantages in terms of data handling and storage requirements. This requires a new process where the set of time independent stresses is capable to represent static, dynamic and contact states as well and respective scaling factors, which consider the contact influence. These scaling factors are not known in advance and need to be obtained from a dynamic contact analysis, see Fig. 1.

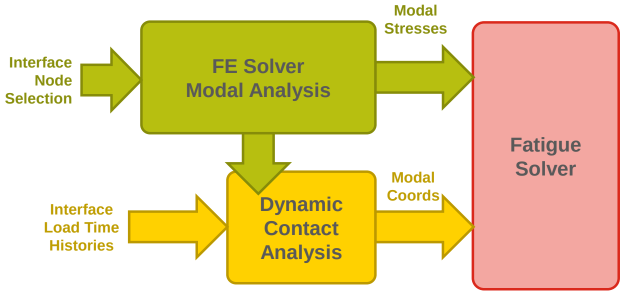

Fig. 1: Improved fatigue assessment based on a modal dynamic approach capable to consider contact

The approach based on Craig and Bampton utilizes a set of Constraint Modes (CM) and a set of Normal Modes (NM) for approximation of the structure displacements. To capture the contact stresses within joint contact interfaces of a body structure these modes are usually not sufficient as the account for global deformation rather than the local ones within the contact interface. Therefore, the extension with Joint Interface Modes (JIM) is suggested, see Fig. 2.

It is suggested that the dynamic contact simulation is run by the tailored solver. This means that a dynamic contact simulation of body structure is enabled by without generalized multi body simulation solver. Essentially one only has to match the interface nodes of the reduced order model with the interface load time history und start the simulation.

The damage values based on the linear analyses results were implausible high, see Fig. 3 (left). The damage values based on the suggested approach were uncritical, see Fig. 3 (right). This outcome matched the physical testing where no crack was observed.

The suggested method is a promising approach which works on the same input data as the inertia relief process, and even an engineer has no experienced using multi body simulation can run a dynamic contact simulation of body structure.

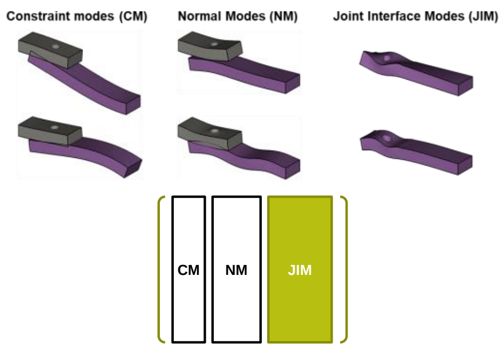

Fig. 2: Constraint, normal and joint interface modes collected as columns of the reduction basis

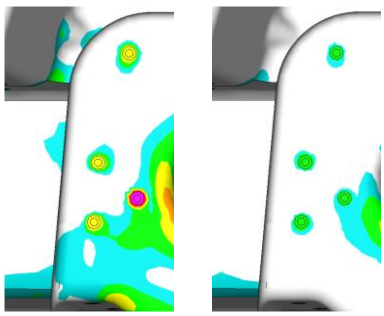

Fig. 3: Predicted damage at body rear axle spring seat for linear case (left) and non-linear case (right)