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LUMPED PARAMETERS UPDATING FOR MODEL REDUCTION IN RAILWAY COACHES CRASHWORTHINESS

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Summary: The development of a new railway coach design demands a series of requirements, including crashworthiness analysis, in compliance with European regulations. Explicit transient simulations using the full-scale numerical models for crashworthiness analyses would incur excessively high computational cost, becoming technically unfeasible even for huge server clusters. A common approach to circumvent this situation is to remove less affected zones of the original structure and substitute it for a set of discrete flexible elements and a pointwise mass. Typically, some portion of the mid-span of the coach is chosen, provided that it lies sufficiently far away from the directly impacted parts. Then, these new elements are adjusted to correctly reproduce the total mass of the removed elements and their equivalent stiffness. Though simple and efficient, this method tends to accurately approximate only low-frequency behaviour, since equivalent stiffness is based solely on the static response. This research proposes the application of a large enough set of mass and stiffness elements so that the frequency response of the original structure can be approximated, spanning a sufficiently representative frequency range. A minimum set of parameters shall be used, although large enough to reproduce the frequency response of the removed components with the desired accuracy, while increasing only marginally the computational cost of the simplified structure. In a first step, the modal analysis of the removed portion shall be used to obtain its frequency response function. Then, an optimization routine will be used to fit the set of discrete parameters to reproduce as best as possible this frequency response. This preliminary result shall be used as the initial estimate to rerun the procedure, this time employing the modal data of the full original model. Finally, a modal analysis of the obtained simplified model is computed, and the results are used for comparison with the original structure. Moreover, the results of explicit transient simulation shall be presented to assess the quality of the resultant simplified model.