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Analysis of a Dynamic Response of a Car Door Impact into the Lock

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Abstract. Innovative approaches to new design conceptions require at the same time application of simulation numerical methods and some physical experiments. The present paper describes preparation and implementation of both virtual and physical experiments focused on the dynamic response of a new design conception of a so-called car tailgate.

Introduction

Development of new products of advanced technical level is today realised at several stages. First and foremost it is design of new conceptions in larger sense (design, material concept, production and technological concepts, concept of placing on the market etc.). In case of products of high technical and use value, creation of their virtual (computer) models, verified and optimized by means of a number of computer simulations, is standard. It is usually followed by the stage of realization of physical prototypes and their complete testing. If the required criteria are satisfied, the new product is released into the batch production.

The present paper is an example of application of the computer simulation for a configuration design of a dynamical experiment and consequently it presents a subsequent realization of the physical experiment with an already produced tailgate prototype. Thus it is obvious that the aim of both applied procedures is identification of dynamic response of both virtual and physical prototypes of a new concept to the loading defined by a normative, respecting comfort and security of the vehicle crew.

Applied numerical procedures and methods of solution

The numerical study and prediction of a dynamic response of the tailgate at the defined impact into the lock in a car body were realized by means of sw ANSYS and MSC.ADAMS. For numerical analyses the Finite Element Method combined with the method of a modal synthesis was applied. Thus the basic dynamic properties of the elastic group of bodies of the tailgate could be taken into account and the tailgate response during the forced impact into the lock could be predicted. Both virtual models respected the essential rigidity properties of the applied constructional materials as well as the boundary conditions of the afterwards realized physical experiment.

CAE simulation model of the flexible tailgate was at first created by means of the sw ANSYS from the original CAD data, where a so-called „modal neutral file“ had been generated via special algorithms, necessary for simulations of the dynamic response of the tailgate by means of the sw MSC.ADAMS (application of the so-called modified Craig Bampton’s method). The aim of virtual simulations was to show whether the prescribed impact velocity on the lower tailgate edge can be reached with a sufficient precision when the real physical experiment is suitably laid-out. An illustration of the numerical experiment lay-out and the results of simulations are in the Fig.1.

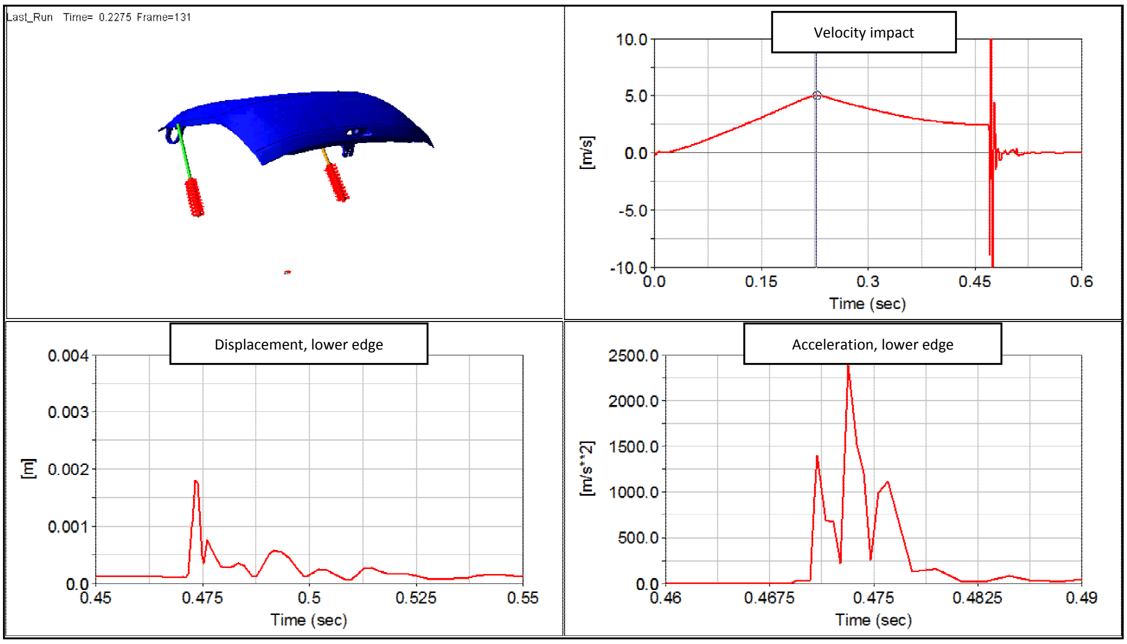

Fig. 1 – Multi-body model of the tailgate modulus with kinematic quantities outputs

Applied experimental procedures and methods of solution

The dynamic response of the tailgate modulus was realized by means of physical experiments, specially designed and prepared for this purpose according to the results of previous numerical simulations. For the experimental purposes, suitable fixtures had been made. Kinematic and dynamic physical quantities were scanned by accelerometers and by measuring the tailgate velocity at closing or impact into the lock, respectively. The scanned physical quantities were being recorded by the logger DEWETRON. The whole process of experiment was monitored by a high speed camera OLYMPUS. Examples of the physical experiment lay-out are in the Fig. 2a and 2b.

Fig. 2a – Physical experiment lay-out

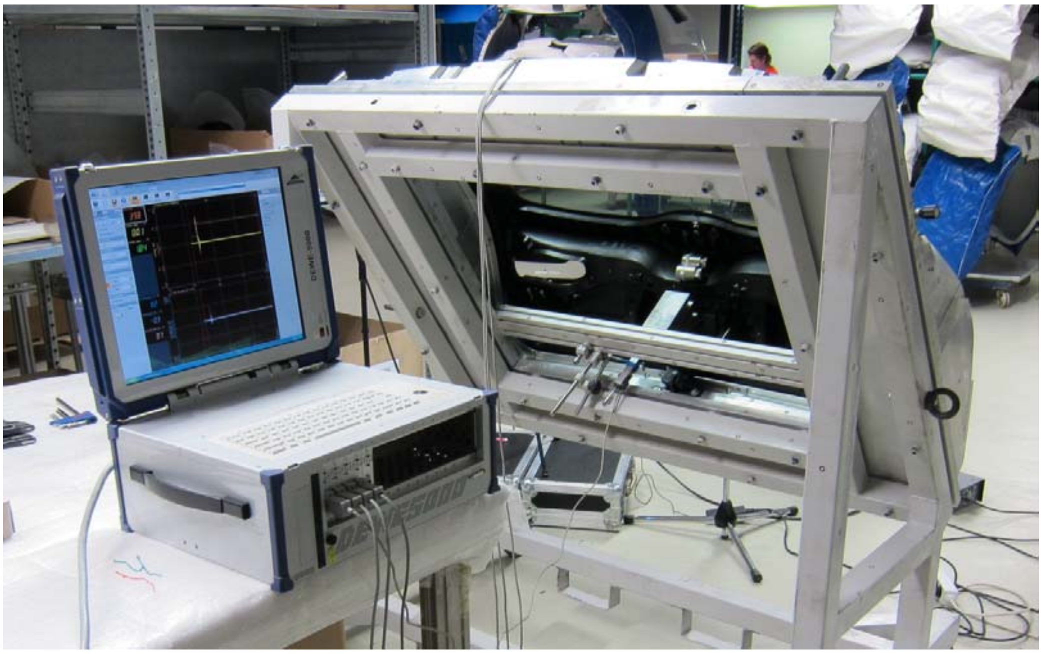

Fig. 2b – Physical experiment lay-out

Results and typical records of the time behaviour of kinematic quantities

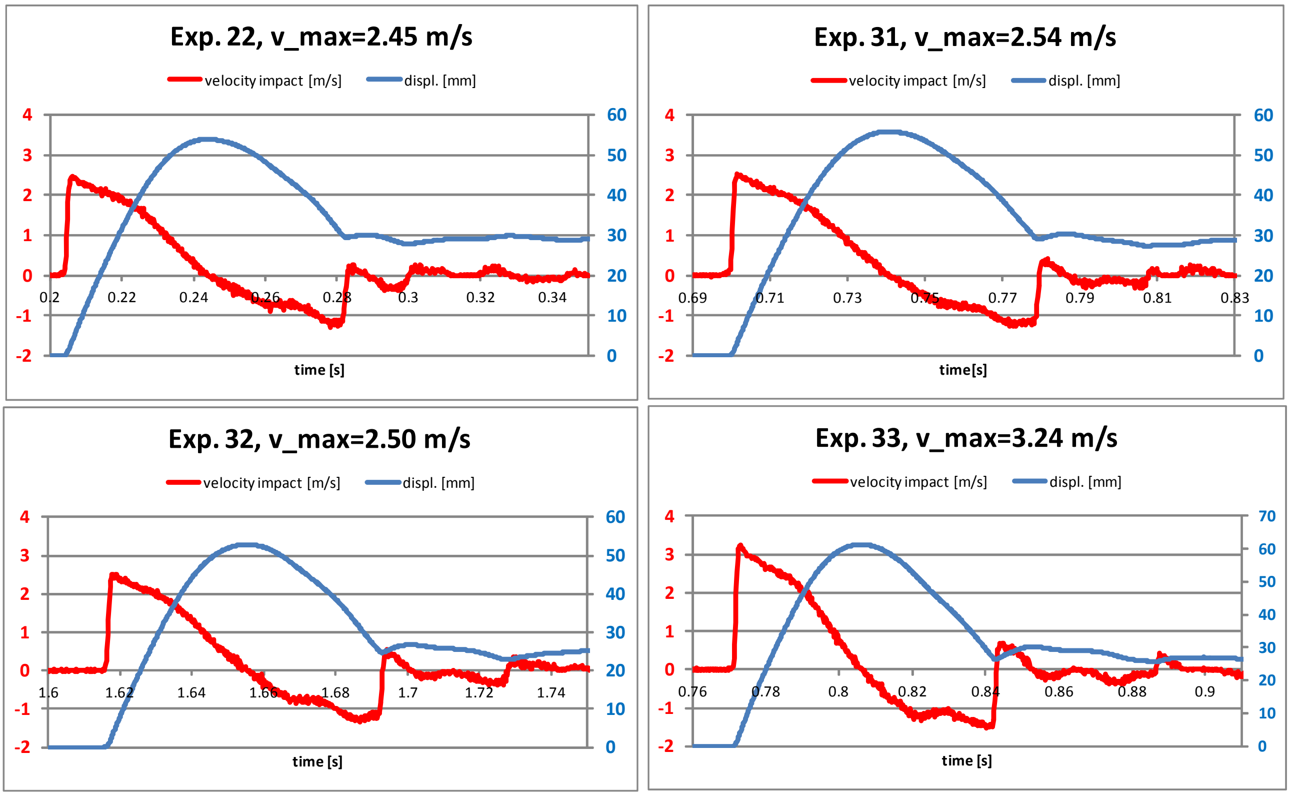

Fig. 3 – Records of time behaviour of displacements and velocities of the tailgate impact into the lock

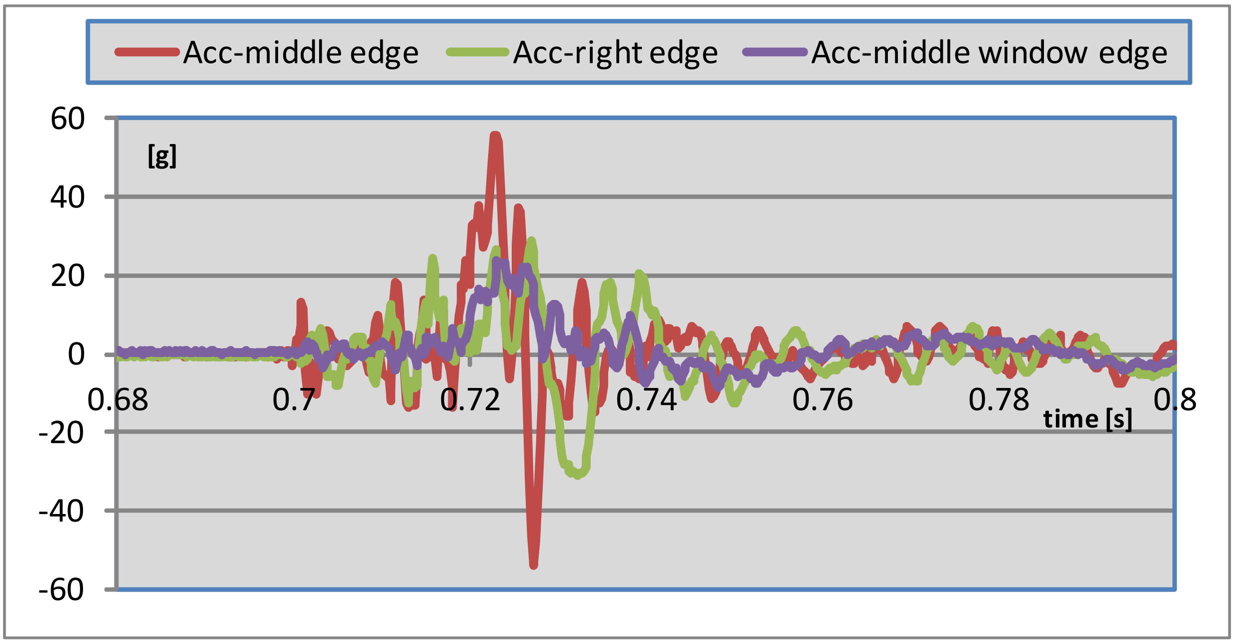

Fig. 4 – Records of time behaviour of acceleration at selected points of the tailgate

Summary

It is obvious from the presented results, that the conditions of experiment (velocity of the tailgate impact into the lock), prescribed by the normative regulation and predicted by the numerical study were satisfied. The accelerometers placed in the area of the lower edge of the tailgate modulus and under the wiper hole in the windscreen, provided realistic values of accelerations, i.e. power effects of the tailgate mass of inertia on the vehicle body.

Important information on the oscillations of the tailgate at the moment of its impact into the lock is offered by the records of the high-speed camera. Their analysis shows the fact, that if the tailgate modulus was not centred to the vehicle body, adjustment of gaps can occur, i.e. collisions between the body and the tailgate modulus edges. Some oscillations were recorded at the velocities both lower and higher than required by the regulation.

References

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