Methodology for the nonlinear kinematic design of vehicle structures subjected to the Small Overlap Crash Test

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ABSTRACT

Crashworthiness design focuses on the development of energy absorbing structures with the aim of reducing occupant injuries during a crash event. We propose a methodology for the design and validation of vehicle structures subjected to the Insurance Institute for Highway Safety Small Overlap Frontal Test (SOFT). The objectives of this methodology are: (i) to find a solution space, see [2], of the functional properties of the structure in the early phase of automotive design; and (ii), to present a practical solution for the assurance of the performance once the design has matured into physical prototypes.

Test requirements are specified at the full vehicle level. Therefore, functional properties can be defined using a kinematic model in the early design phase. A kinematic model for the SOFT that describes and quantifies the highly nonlinear kinematic modes of the test [1] is developed and validated here using finite element simulations. The identified functional properties for the SOFT are the resistances to deformation of the front structure in transversal and longitudinal directions and are represented as force-displacement curves and adopted in the model as elastoplastic collapse elements. A stochastic sampling tool is used to calculate the solution spaces, which are special sets of feasible solutions, for these functional properties [2]. Once physical prototypes are available, it becomes important to verify if the design strategy was correctly executed. With that objective, a video analysis of the crash test is implemented in combination with a signal analysis of the acceleration and rotational velocity sensors as stated in [3]. As a result, the forces acting on the prototype at each level of deformation in the crash test are identified and compared to those from the previously calculated solution space. If the functional parameters lie in the solution space, the correctness of the early design-to-prototype process is assured.

REFERENCES

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