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Crashworthiness Optimization of an Automotive Front Bumper in Composite Material

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Abstract : In the last years, the crashworthiness of an automotive body structure can be improved, since the beginning of the design stage, thanks to the development of specific optimization tools. It is well known how the finite element codes can help the designer to investigate the crashing performance of structures under dynamic impact. Therefore, by coupling nonlinear mathematical programming procedure and statistical techniques with FE simulations, it is possible to optimize the design with reduced number of analytical evaluations. In engineering applications, many optimization methods which are based on statistical techniques and utilize estimated models, called meta-models, are quickly spreading. A meta-model is an approximation of a detailed simulation model based on a dataset of input, identified by the design of experiments (DOE); the number of simulations needed to build it depends on the number of variables. Among the various types of meta-modeling techniques, Kriging method seems to be excellent in accuracy, robustness and efficiency compared to other ones when applied to crashworthiness optimization. Therefore the application of such meta-model was used in this work, in order to improve the structural optimization of a bumper for a racing car in composite material subjected to frontal impact. The specific energy absorption represents the objective function to maximize and the geometrical parameters subjected to some design constraints are the design variables. LS-DYNA codes were interfaced with LS-OPT tool in order to find the optimized solution, through the use of a domain reduction strategy. With the use of the Kriging meta-model the crashworthiness characteristic of the composite bumper was improved.

Keywords : composite material, crashworthiness, finite element analysis, optimization
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