Sample Optimization Algorithm of a Rail Vehicle Chassis Frame

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Abstract. The paper is devoted to optimization of a rail vehicle, with special attention paid to its chassis frame. A simplified frame model composed of several cross members and three longitudinal members is assumed. The frame of predefined dimensions is subjected to symmetrical compression in the buffer centrelines and vertical load applied to a field corresponding to the passenger car floor. Eight decision variables are chosen that determine the size and shape of a frame variant. Quality of the variant is estimated based on three calculated data, i.e. its mass, maximum stress, and maximum deflection of the frame. Objective function that should tend to minimum is formulated by combination of these data. The optimization process is based on the genetic algorithm.

INTRODUCTION

The optimization problem of structures was considered by many authors. General description of optimization procedures is delivered by Ostwald [1]. The author in his monograph considered optimal design of shell structures and presented a review of the optimization methods. Goldberg [2] submitted detailed and extensive discourse on genetic algorithms and enclosed a source file of an example computer program solving the optimization tasks. Cho *et al*. [3] optimized the EMU carbody by selection of appropriate materials and sizes of particular parts of the structure. Kuczek *et al*. [4] used similar approach to the problem – they reduced the vehicle mass by application of innovative materials and varying cross-section geometry of the structural members. Harte *et al*. [5] optimized construction of the rail vehicle walls. Particular stages of the procedure included the finite element analysis of the structure. Randell *et al*. [6] delivered a report of the measures undertaken in Bombardier Transportation UK with a view to model the rail vehicle structures and to optimize them with regard to strength and stability.

Objective of the present paper is to present a proposal of an optimization procedure that might be used in designing the vehicles or their parts. A simplified model of the frame is considered, having two planes of symmetry. A quarter of the frame and the decision variables x_1 to x_8 are shown in Fig. 1.

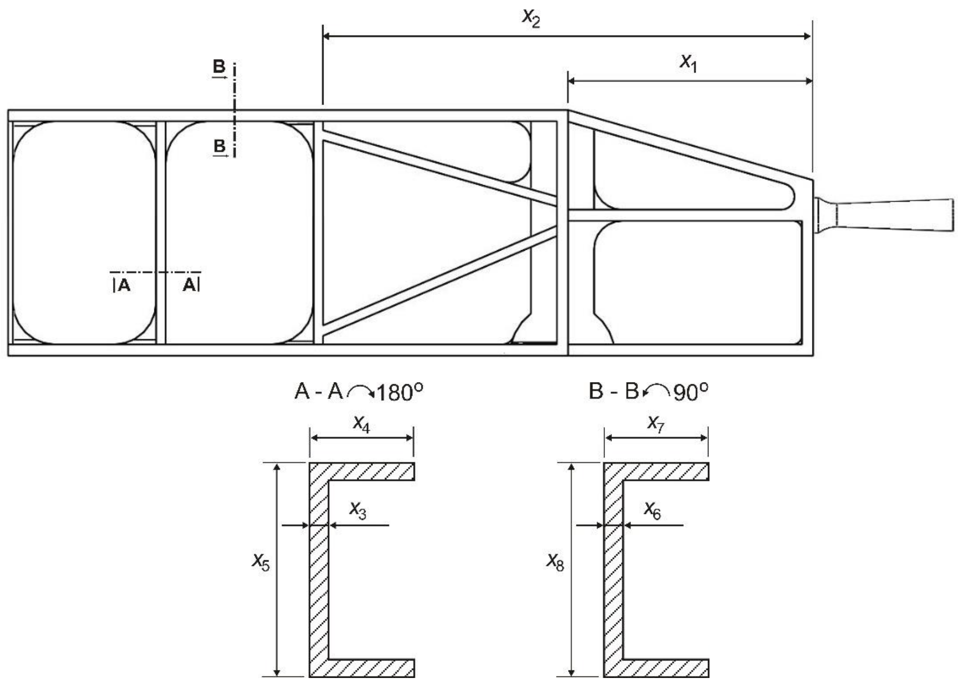

FIGURE 1. A quarter of the considered frame and the decision variables of the problem

The frame is composed of one I-beam located in lengthwise plane of symmetry and several C-beams. Their dimensions and location are determined by the above decision variables. Every variable may take discrete values of a predefined range. For particular frame variants (i.e. phenotypes) the mass, maximum stress, and maximum deflection of the frame are calculated. The best solution should be characterized by possibly small mass and deflection of the frame, keeping the maximum stress below its allowable level. Therefore, the product of these values is considered as the objective function. The elementary genetic procedure enables to find the variant distinguished by minimum value of the objective function.

CONCLUSIONS

The study has shown that the elementary genetic algorithm may be successfully applied to solve the optimization problem of the structure. The results obtained in case of the simplified model encourage to develop more efficient algorithms that should be effective for more complex structures.

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