Efficient environment for gradient based shape optimization of structures

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The paper presents in a systematic way a general approach to symbolic description of direct and sensitivity analysis of the most important formulations that appear in description of mechanical problems by finite element method (steady state, transient, coupled and coupled transient problems [1]. It will be shown that the combination of a general symbolic description of problem combined with the use of the symbolic algebra system Mathematica, automatic differentiation, automatic code generation and theorem proving [2] represents an efficient combination of tools and techniques for the gradient based shape optimization of structures.A special emphasis will be given on symbolic-numeric approach to evaluation of design velocity field by direct differentiation of symbolically parameterized mesh. Efficiency of the approach will be presented on limit load optimization of a single-storey steel building subjected to cyclic loading.