11th World Congress on Structural and Multidisciplinary Optimisation
07th -12th, June 2015, Sydney Australia

Topology optimization of 3D suspension linkage system of an automobile by using work transmittance efficiency based mechanism synthesis formulation

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Abstract

The goal of our research is to perform a topology optimization based synthesis of a three-dimensional suspension linkage of an automobile. To the authors' knowledge, this is the first attempt to use the topology optimization method for three-dimensional suspension mechanisms. The underlying formulation is based on the transmittance efficiency function and issues appearing in the topology optimization-based design of three-dimensional automobile suspensions are presented.

While automobile suspension systems are quite complicated as they are usually made of multiple-link mechanisms, they perform quite well. However, there is still a strong demand for new suspensions that are compact and/or exhibit much enhanced ride and handling performances. However, it is difficult to come up with an improved suspension system without using a systematic design method when the design cycle is very tight and the required performance is high.

Motivated by this need, we have considered to expand for the three-dimensional suspension design a recently-formulated mechanism synthesis method by our group. It is based on a topology optimization method using the transmittance efficiency function. The formulation was given and tested for two-dimensional problems. Therefore, its expansion to design realistic three-dimensional suspension linkage must be pursued and we report recent advances made in this direction. For the suspension design, we employ a ground-structure approach in which spatial truss elements and zero-length springs. The design requirements such as toe/camber angle, a roll center height, etc., are considered and the transmittance efficiency function is maximized to assure the correct degree of the suspension mechanism. The design problem is solved by using a gradient method in which truss thicknesses, spring stiffness, and coordinates of the ground nodes are used as design variables. Through this study, we were able to successfully recover the conventional suspension systems, the double wishbone type and MacPherson strut suspensions, possibly with new linkage connectivity.