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Topology optimization of compliant mechanisms: Application to vehicle suspensions.

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By definition, a compliant mechanism is a mechanism that gains its mobility from the flexibility of some or all of its members, by deforming the structure elastically instead of relying on joint movements. A compliant mechanism consists of fewer parts than mechanisms with rigid joints and can even be monolithic. Sigmund [1] presented a method based on continuum-type topology optimization techniques to find the optimal compliant mechanism topology within a given design domain and a given position and direction of input and output forces. This design method, as demonstrated by Sigmund [1], has the ability to find mechanism with complex output behavior.

This work focuses on a compliant vehicle suspension. Since a common vehicle suspension consists of a mechanism with rigid joint motions, a compliant vehicle suspension can help to reduce weight and cost but also to improve its reliability and design flexibility. Furthermore, a compliant suspension can also play a role in the improvement of fuel efficiency of vehicles.

When designing a suspension, lots of requirements have to be satisfied, for example the suspension stroke, roll center height, lateral rigidity, etc. It is essential to respect these criteria to have good handling and comfort. In 2009, Kobayashi *et al.* [2] developed a method in two steps to design a compliant vehicle suspension. The first step concerns the topology optimization which generates an initial concept of the vehicle suspension. The formulation of the topology optimization problem takes into account the lateral rigidity and the vertical flexibility. In the second step, shape optimization is employed to impose others requirements on the design.

In this paper, we propose an efficient method to design a compliant vehicle suspension with only the topology optimization. The formulation of the topology optimization problem consists of five parts. The first one takes into account the basic requirement of a suspension: the vertical flexibility of the mechanism. The second one includes rigidity so that the structure can resist at different load cases and reaction forces. The next three steps concern requirements about lateral rigidity, bounce phenomenon and roll phenomenon. It is shown that this five steps method is an efficient way to develop a compliant vehicle suspension which satisfies the requirements of an actual suspension in the front plan of a vehicle. Numerical applications are realized under different requirements on the design.

References

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[2] Kobayashi M. and Higashi M. Design method for a compliant vehicle suspension based on a combination of topology and shape optimizations. In *8th World Congress on Structural and Multidisciplinary Optimization*, Lisbon, Portugal, 2009.