

How to find the optimal design?

How should the optimal design look like? With topology optimization you can design structures that are highly optimized for a given task. Today the optimization is often based on simple models when it would be more realistic to base the design on an more advanced model.

Topology optimization is a tool to design structures that can be very specialised for a specific task, e.g. how a crash beam in a car should look like to maximize the energy loss during a collision. Today the optimization is often based on the structure behaving elastic, i.e. if the load on the structure is removed then it returns to its original form. However if the structure gets permanent deformations - plasticity - then the optimization should also be based on this, to get a more reliable design. To perform a topology optimization there must be an objective with the structure e.g. maximize the energy loss while only using a certain amount of material to keep the cost low. How the value of the objective changes, when a small change in the design is made, is called sensitivity and is needed to perform the optimization. Because of the history dependency in plasticity the sensitivities become very complex to calculate if permanent deformations are involved. Once the sensitivities are known, highly specialized structures can be created.

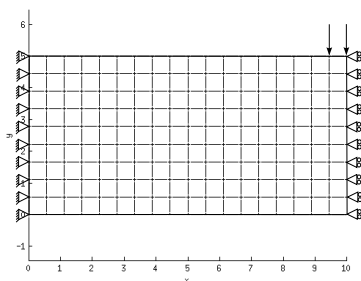


Figure 1: How the load is applied

A structure is locked from movement in the left side and an load is applied to the right at the top, see figure 1. The area where material is allowed are in the rectangles where white represents no material and black is filled with material. The objective is to maximize the energy loss during loading while only using one fourth of the total volume. The result of an optimized structure can be seen in figure 2.

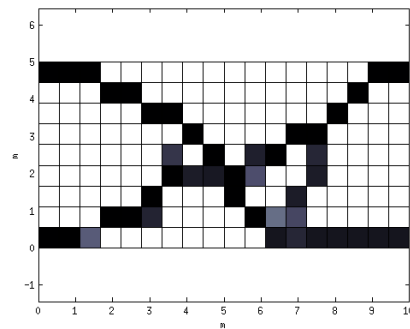


Figure 2: A highly optimized structure for absorbing energy

The optimized structure increased the loss of energy almost 400 times compared to the non optimized structure which was a guess of evenly distributed material.

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