

Structural Optimization Using Natural Shapes

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Abstract : This paper reviews some fundamental concepts of structural optimization, which is based on the type of materials used in construction and the shape of the structure. The first step in structural optimization is to break down all internal forces in a structure into fundamental stresses, which are tensions and compressions. Knowing the stress patterns directs our selection of structural shapes, and the most appropriate type of construction material. In our selection of materials, it is essential to understand all construction materials have flaws, or micro-cracks, which reduce the capacity of the material, especially when subjected to tensions. Because of material defects, many construction materials perform significantly better when subjected to compressive forces. Structures are also more efficient if bending moments are eliminated. Bending stresses produce high peak stresses at each face of the member, and therefore substantially more material is required to resist bending. The shape of the structure also has a profound effect on stress levels. Stress may be reduced dramatically by simply changing the shape. Catenary, triangular and linear shapes are the fundamental structural forms to achieve optimal stress flow. If the natural flow of stress matches the shape of the structures, the most optimal shape is determined.

Keywords : Shell structures, structural optimization, Stress flow, Construction materials, catenary shapes

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