Euler and elasticity

What is elasticity?

A material is said to be elastic if it deforms under stress and can return to its original shape

Under small stresses, many solids' strains are roughly proportional to the stresses they are undergoing. Linear elasticity, however, is an approximation; real materials exhibit some degree of non-linear behavior

A beam is a structural element that carries load. Euler and Daniel Bernoulli were the first to launch a useful theory in circa 1750, when science and industrial art were generally unlinked. In fact, the Eiffel Tower and Ferris wheel have been the first proof of validity of the equation. Its simplicity makes it since then and until today a primary tool for sizing all engineered structures, bridges, buildings, balconies etc. The equation arose from four distinct subsets of beam theory.

Euler-Bernoulli beam equation

The out-of-plane displacement w of a beam is governed by the Euler-Bernoulli Beam Equation,

$$\frac{d^2}{dx^2} \left[E I \frac{d^2 w}{dx^2} \right] = p$$

where p is the distributed loading (force per unit length) acting in the same direction as y (and w), E is the Young's modulus of the beam, and I is the area moment of inertia of the beam's cross section.

The Euler-Bernoulli equation applies to various boundary conditions and loading models.



Elasticity applied to civil engineering

The Euler-Bernoulli beam equation as well as the Euler equations of fluids are widely involved in civil engineering, for example for dams, bridges and architecture. Great dams, turbines and generators show the well-know competence of our engineers and entrepreneurs.

Switzerland is also strongly involved in complex architecture, where elasticity is applied, such as the Beijing National Stadium, designed by Swiss architects Herzog and de Meuron.

> NAME OF TAXABLE

Different kinds of bridges surrounding the old town of the capital city of Switzerland Bern.

Swiss rail network has a very large number of bridges, over the rivers and in the mountains.

The Grande Dixence Dam in Valais, Switzerland, is the tallest gravity dam in the world.











A spring is a flexible elastic object used to store mechanical energy. There are many different kinds of springs, e.g. helical springs or watch springs



The Euler-Bernoulli beam equation was first enunciated circa 1750, but was not applied on a large scale until the development of the Eiffel tower in Paris -first designed by ETH Zurich's Alsatian engineer Maurice Koechlin- and the Big Wheel in the late 19th century. Following these successful demonstrations, it quickly became a cornerstone of engineering and an enabler of the Second Industrial Revolution.



A cantilever is a beam anchored at one end and projecting into space. The cantilever model is typically applied to balconies, aircraft wings or diving boards.







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