Introduction to Structural Design and Structural Mechanics

Structural engineering

Structural engineers are involved in planning, design, construction, refurbishment of buildings, bridges, ports, towers, etc. The degree of responsibility is high because collapse of a structure often has serious consequences.

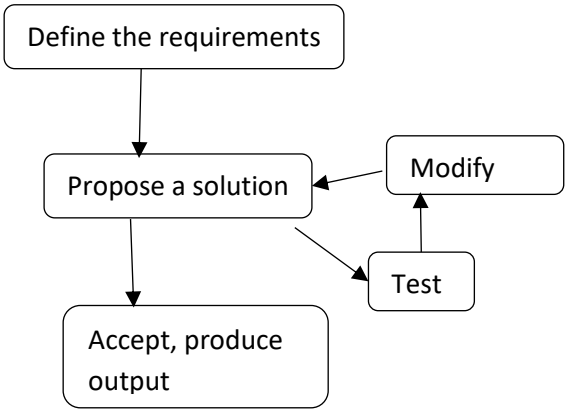
Structural design

In design a range of ways representing a structure i.e. models, are used -such as graphics, text, mathematical models, etc. These models define, as far as is practical, what is to be created.

Models used in professional engineering include:

- Those for specifying the system e.g. graphical models for the geometry and text for, for example, material specifications.
- Mathematical models that are used to predict the behaviour of the system.

See, for example the example on nodal analysis that explains the difference between a graphical/engineering model and a mathematical/analysis model.



The main strategy in design is to propose a solution by making a specification of what the object may be and to test that against the requirements. If it does not meet the requirements, changes have to be made until the design is adequate.
For example, one chooses the initial dimensions of a column in a building, tests these against code of practice requirements and, if necessary, resizes the column until the requirements are met
More on design process

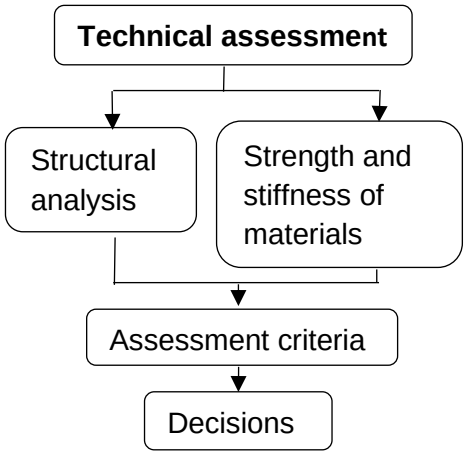
Design requirements

The design requirements for a structure are:

- *Technical requirements*: Ensuring that the structure will perform in use and in extreme conditions e.g. under loading or fire.
- *Other requirements* include: cost, sustainability, aesthetics, buildability, maintainability, etc.

The technical requirements are of special importance because failing to meet them can be catastrophic.

Structural mechanics



Structural mechanics is the mathematical logic and procedures used in making technical assessments of structures. A main requirement for a structure is to satisfy strength criteria, normally expressed as:

$$F \leq R$$

That is, any force that a structure is required to support - *F* - must be less than the resistance of the structure - *R.* The forces are predicted by the use of *structural analysis*. This involves making a mathematical *analysis model* of the structure that represents its behaviour under load. Traditional structural analysis involves the modelling of frameworks made up of members such as beams, columns, struts and ties. With the use of computers, more complex types of structure can now be modelled.

The resistance of a structure to load depends on material properties and other factors. The theory behind this is sometimes called *strength of materials.* It is referred to in this resource as *strength and stiffness of materials.*

To apply strength criteria, one sets up an analysis model to find the forces, calculates the resistances and compares the results so as to make decisions about the adequacy of the structure. This, and the use of other criteria, is described here as *technical assessment.* Examples of technical assessment are given in the Applications Sheets.

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