**Structural system analysis and Structural analysis**

Structures subject to this type of analysis include all that must withstand loads, such as buildings, bridges, vehicles, machinery, furniture, attire, soil strata, prostheses and biological tissue. Structural analysis employs the fields of [applied mechanics](https://en.wikipedia.org/wiki/Applied_mechanics), [materials science](https://en.wikipedia.org/wiki/Materials_science) and [applied mathematics](https://en.wikipedia.org/wiki/Applied_mathematics) to compute a structure's [deformations](https://en.wikipedia.org/wiki/Deformation_%28engineering%29), internal [forces](https://en.wikipedia.org/wiki/Force), [stresses](https://en.wikipedia.org/wiki/Stress_analysis), support reactions, accelerations, and [stability](https://en.wikipedia.org/wiki/Structural_stability). The results of the analysis are used to verify a structure's fitness for use, often precluding [physical tests](https://en.wikipedia.org/wiki/Physical_test). Structural analysis is thus a key part of the [engineering design of structures](https://en.wikipedia.org/wiki/Structural_engineering).

**Structures and loads**

A [structure](https://en.wikipedia.org/wiki/Structure) refers to a body or system of connected parts used to support a load. Important examples related to [Civil Engineering](https://en.wikipedia.org/wiki/Civil_Engineering) include buildings, bridges, and towers; and in other branches of engineering, ship and aircraft frames, tanks, pressure vessels, mechanical systems, and electrical supporting structures are important. In order to design a structure, one must serve a specified function for public use, the engineer must account for its safety, aesthetics, and serviceability, while taking into consideration economic and environmental constraints. Other branches of [engineering](https://en.wikipedia.org/wiki/Engineering) work on a wide variety of [non-building structures](https://en.wikipedia.org/wiki/Non-building_structure).

**Classification of structures**

A *structural system* is the combination of structural elements and their materials. It is important for a structural engineer to be able to classify a structure by either its form or its function, by recognizing the various [elements](https://en.wikipedia.org/wiki/Structural_engineering#Structural_elements) composing that structure. The structural elements guiding the systemic forces through the materials are not only such as a connecting rod, a truss, a beam, or a column, but also a cable, an arch, a cavity or channel, and even an angle, a surface structure, or a frame.

**Loads**

Once the dimensional requirement for a structure have been defined, it becomes necessary to determine the loads the structure must support. In order to design a structure, it is therefore necessary to first specify the loads that act on it. The design loading for a structure is often specified in [building codes](https://en.wikipedia.org/wiki/Building_code). There are two types of codes: general building codes and design codes, engineer must satisfy all the codes requirements for a reliable structure.

There are two types of loads that structure engineering must encounter in the design. First type of load is called Dead loads that consist of the weights of the various structural members and the weights of any objects that are permanently attached to the structure. For example, columns, beams, girders, the floor slab, roofing, walls, windows, plumbing, electrical fixtures, and other miscellaneous attachments. Second type of load is Live Loads which vary in their magnitude and location. There are many different types of live loads like building loads, highway bridge Loads, railroad bridge Loads, impact loads, wind loads, snow loads, earthquake loads, and other natural loads.

**Analytical methods**

To perform an accurate analysis a structural engineer must determine such information as [structural loads](https://en.wikipedia.org/wiki/Structural_load), [geometry](https://en.wikipedia.org/wiki/List_of_structural_elements), support conditions, and materials properties. The results of such an analysis typically include support reactions, [stresses](https://en.wikipedia.org/wiki/Stress_%28physics%29) and [displacements](https://en.wikipedia.org/wiki/Displacement_%28vector%29). This information is then compared to criteria that indicate the conditions of failure. Advanced structural analysis may examine [dynamic response](https://en.wikipedia.org/wiki/Dynamic_response), [stability](https://en.wikipedia.org/wiki/Buckling) and [non-linear](https://en.wikipedia.org/wiki/Non-linear) behavior. There are three approaches to the analysis: the [mechanics of materials](https://en.wikipedia.org/wiki/Strength_of_materials) approach (also known as strength of materials), the [elasticity theory](https://en.wikipedia.org/wiki/3-D_elasticity) approach (which is actually a special case of the more general field of [continuum mechanics](https://en.wikipedia.org/wiki/Continuum_mechanics)), and the [finite element](https://en.wikipedia.org/wiki/Finite_element) approach. The first two make use of analytical formulations which apply mostly to simple linear elastic models, lead to closed-form solutions, and can often be solved by hand. The by and finite element approach is actually a numerical method for solving differential equations generated by theories of mechanics such as elasticity theory and strength of materials. However, the finite-element method depends heavily on the processing power of computers and is more applicable to structures of arbitrary size and complexity.

Regardless of approach, the formulation is based on the same three fundamental relations: [equilibrium](https://en.wikipedia.org/wiki/Mechanical_equilibrium), [constitutive](https://en.wikipedia.org/wiki/Constitutive_equation), and [compatibility](https://en.wikipedia.org/wiki/Compatibility_%28mechanics%29). The solutions are approximate when any of these relations are only approximately satisfied, or only an approximation of reality.

**Limitations**

Each method has noteworthy limitations. The method of mechanics of materials is limited to very simple structural elements under relatively simple loading conditions. The structural elements and loading conditions allowed, however, are sufficient to solve many useful engineering problems. The theory of elasticity allows the solution of structural elements of general geometry under general loading conditions, in principle. Analytical solution, however, is limited to relatively simple cases. The solution of elasticity problems also requires the solution of a system of partial differential equations, which is considerably more mathematically demanding than the solution of mechanics of materials problems, which require at most the solution of an ordinary differential equation. The finite element method is perhaps the most restrictive and most useful at the same time. This method itself relies upon other structural theories (such as the other two discussed here) for equations to solve. It does, however, make it generally possible to solve these equations, even with highly complex geometry and loading conditions, with the restriction that there is always some numerical error. Effective and reliable use of this method requires a solid understanding of its limitations.