1.3 Type Of Loads On Structures And Load Combinations

A structural load is a force, deformation, or acceleration applied to structural elements. A load causes stress, deformation, and displacement in a structure. Structural analysis, a discipline in engineering, analyzes the effects of loads on structures and structural elements. An excess load may cause structural failure, so this should be considered and controlled during the design of a structure. Different types of loads can cause stress, displacement, deformation on a structure; which results in structural problems and even structural failure. Determining the total load acting on a structure is very important and complex.

Different types of loads

The loads in buildings and structures can be classified as vertical loads, horizontal loads and longitudinal loads. The vertical loads consist of dead load, live load and impact load. The horizontal loads consist of wind load and earthquake load. The longitudinal loads i.e. tractive and braking forces are considered in special cases of design. The estimation of various loads acting is to be calculated precisely. Indian standard code IS: 875–1987 and American Standard Code ASCE 7: Minimum Design Loads for Buildings and Other Structures specifies various design loads for buildings and structures.

1. **Dead load**

   Dead loads, also known as permanent or static loads, are those that remain relatively constant over time and comprise, for example, the weight of a building's structural elements, such as beams, walls, roof and structural flooring components. Dead loads may also include permanent non-structural partitions, immovable fixtures and even built-in cupboards. Dead loads comprise the weight of the structure or other fixed elements before any live loads are taken into consideration.

   Live loads are added to the dead load to give the total loading exerted on the structure. The calculation of dead loads of each structure is calculated by the volume of each section and multiplied by the unit material weight.

2. Live load

Live load is a civil engineering term that refers to a load that can change over time. The weight of the load is variable or shifts locations, such as when people are walking around in a building. Anything in a building that is not fixed to the structure can result in a live load since it can be moved around.

Live loads are factored into the calculation of the gravity load of a structure. They are measured in pounds per square foot. The minimum live-load requirements are based on the expected maximum load. A live load can be expressed either as a uniformly distributed load (UDL) or as one acting on a concentrated area (point load). It may eventually be factored into the calculation of gravity loads.

3. Wind load

The movement of air relative to a structure can apply wind loads, and analysis draws upon an understanding of meteorology and aerodynamics as well as structures. Wind load may not be a significant concern for small, massive, low-level buildings, but it gains importance with height, the use of lighter materials and the use of shapes that may affect the flow of air, typically roof forms.

Where the dead weight of a structure is insufficient to resist wind loads, additional structure and fixings may be required. Wind load is required to be considered in structural design especially when the heath of the building exceeds two times the dimensions transverse to the exposed wind surface.

The design wind loads for buildings and other structures shall be determined according to one of the following procedures:

Method 1 – Simplified procedure for low-rise simple diaphragm buildings

Method 2 – Analytical procedure for regular shaped building and structures

Method 3 – Wind tunnel procedure for geometrically complex buildings and structures

4. Snow load

This load can be imposed by the accumulation of snow and is more of a concern in geographic regions where snowfalls can be heavy and frequent. Significant quantities of snow can accumulate, adding a sizable load to a structure. The shape of a roof is a particularly important factor in the magnitude of the snow load. The code IS 875 (Part-

4):1987 deals with snow loads on roofs of the building. There are many variables involved in determining snow's weight:

5. Earthquake load

Earthquake load takes place due to the inertia force produced in the building because of seismic excitations. Inertia force varies with the mass. The higher mass of the structure will imply that the earthquake loading will also be high. When the earthquake load exceeds the moment of resistance offered by the element, then the structure will break or damage.

The magnitude of earthquake loading depends upon the weight or mass of the building, dynamic properties of the building and difference in stiffness of adjacent floors along with the intensity and duration of the earthquake. Earthquake load acts over the surface of a structure placed on the ground or with an adjacent building. Buildings in areas of seismic activity need to be carefully analysed and designed to ensure they do not fail if an earthquake should occur.

Earthquake load depends on the following factors;

- Seismic hazard
- Parameter of the structure
- Gravity load.

6. Load combination

A load combination results when more than one load type acts on the structure. Building codes usually specify a variety of load combinations together with load factors (weightings) for each load type to ensure the safety of the structure under different maximum expected loading scenarios.

7. Special loads

Thermal load – The loads occur when the materials expand or contract with temperature change and this can exert significant loads on a structure.

Settlement load – When one part of a building settles more than other parts this type of load occurs.

Flood load – These are caused by flood and water ingress in the foundation which results in corrosion.

Soil and fluid load – It is caused due to excessive flow of water in the soil which impacts the soil density.