

Determination of Dead Loads, Soil Pressure, & Hydrostatic Pressure Loads as Per ASCE7-16

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Determination of Dead Loads, Soil Pressure, & Hydrostatic Pressure Loads as Per ASCE7-16

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Introduction

Structural design is a set of processes that assures a building is capable of resisting applied loads, fulfilling its functions, and sustaining its stability.

The processes of structural design can be summarized in the following steps, also shown in Figure 01:

1. Determination of applied loads
2. Selection of economic and proper structural system
3. Structural analysis of structural system to get internal actions
4. Design of structural members to resist internal actions

The determination of loads is critical because an incorrect calculation of applied loads can lead to an underestimation of loads, which may cause structural failures, or an overestimation of loads, which may cause uneconomic design.

To understand the behavior of any structural load, the structural designer should know the following properties:

1. Value of the load
2. Minimum value set by the code of loads
3. Direction of the load with respect to the building or structural elements
4. Classification of load in load combinations
5. Load cases pattern

The value of the load is calculated from actual load applied on the building, such as dead load, or is extracted from code of load ASCE7-16, such as live, roof live, snow, wind, and seismic load.

The minimum value of the load is the value that must be met by all loads, which is set by code of loads (ASCE7-16) for certain loads, such as live, roof live, snow, wind, and seismic loads.

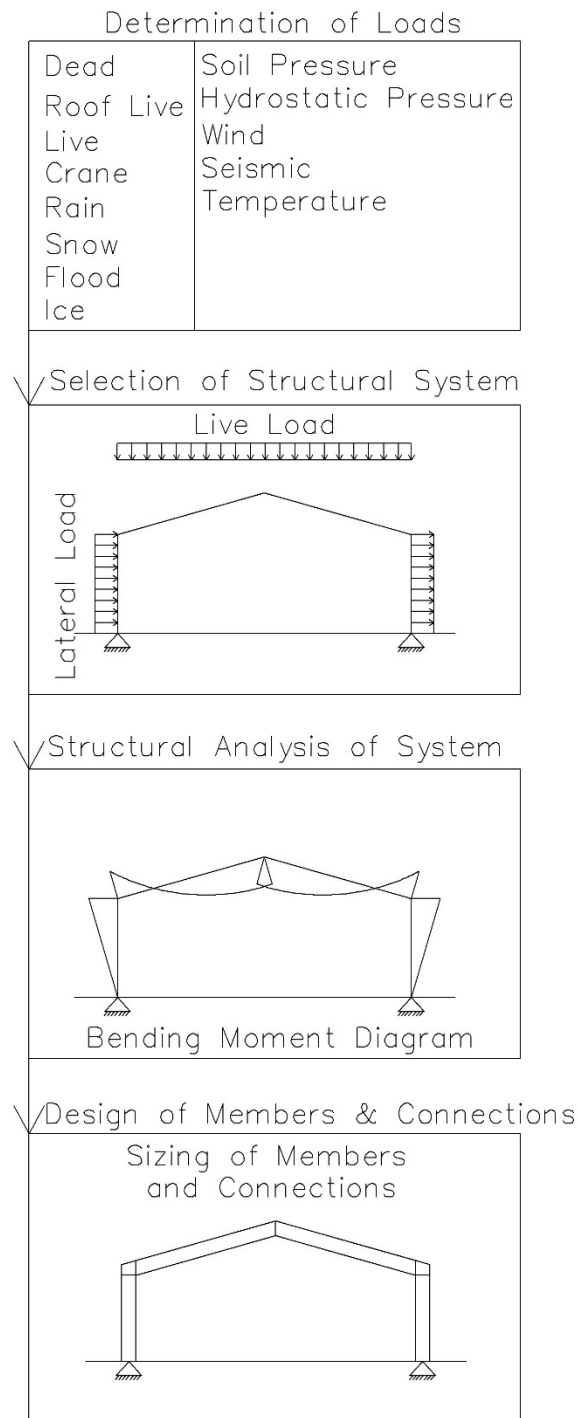


Figure 01: Steps of Structural Design

Sometimes, the code gives two values for the same load: a calculated value and a minimum value. The structural designer should check that the calculated value is larger than the minimum value.

The direction of load is quite important, as it determines the behavior of the load. For example, the direction of wind pressure acting on a frame rafter is perpendicular to the surface itself,

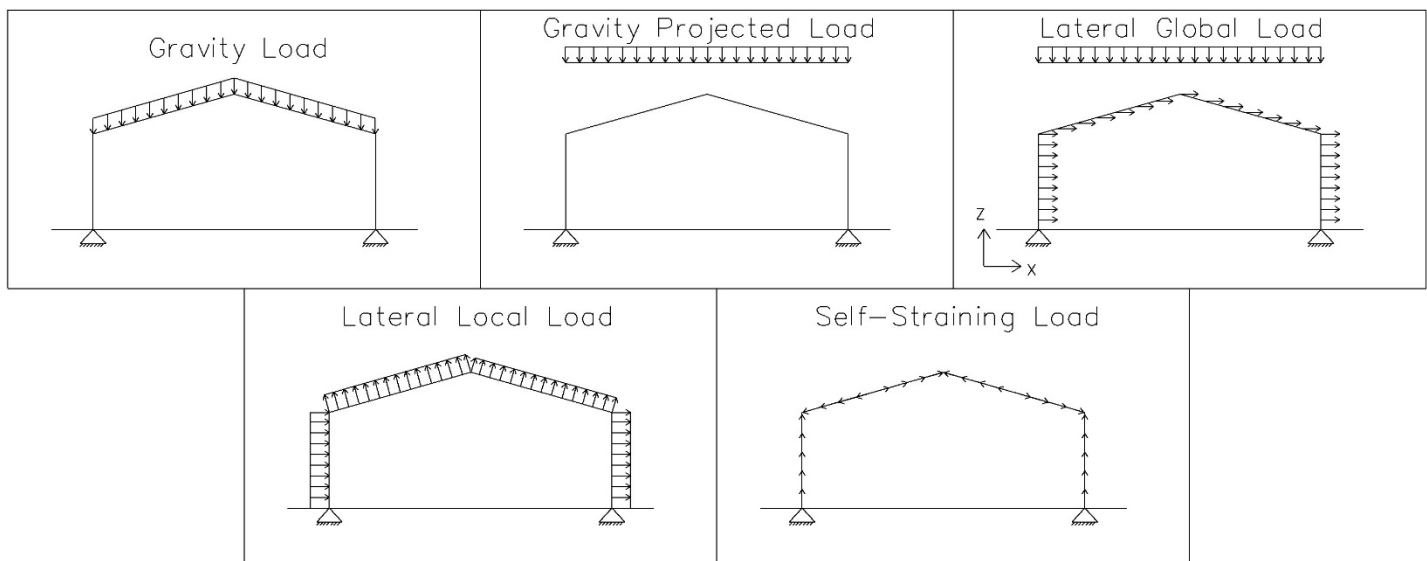
which is different from the direction of a seismic load, which is acting in X, Y, or Z global directions.

Types of load directions Figure 02:

1. Gravity loads: the load is distributed on the actual length of the structural member, e.g., inclined roof members, and its direction is parallel to gravity force, such as dead, collateral loads.
2. Gravity projected loads: the load is distributed on the horizontal projection of the structural member, and its direction is parallel to gravity force, such as roof live, snow, and live loads.
3. Lateral global X, Y, or Z loads: the load is acting laterally at each unit of area of the floors and vertical elements. These loads are commonly a ratio of vertical loads, and their direction is parallel to X, Y, and Z direction, such as seismic, structural integrity, and notional loads.
4. Lateral local loads: the load is distributed perpendicularly to the structural elements, even the member is inclined, such as wind loads.
5. Self-straining loads: such as temperature change, settlement, creep, and shrinkage loads.

Figure 02: Types of Directions of Loads

Classification of loads in load combinations is also important, as the improper determination of



load may negatively impact the effect of the load, especially when the structural designer deals with loads that are not listed specifically in the code of loads (ASCE7-16).

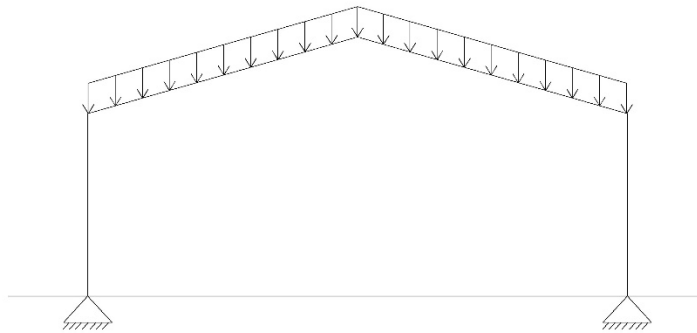
Classification of load combinations:

1. A_k : load of extraordinary event
2. D : such as dead, collateral load
3. D_i : Weight of ice
4. E : earthquake load
5. F : loads of fluids with well-defined pressures and maximum heights
6. F_a flood load
7. H : load due to lateral earth pressure, groundwater pressure, or pressure of bulk materials
8. L : live load; crane lifted capacity; machine loads
9. L_r : roof live load
10. R : rain load
11. S : Snow load
12. T : includes temperature change, settlement, creep, and shrinkage loads
13. W : Wind load
14. W_i : Wind on Ice

Load case pattern is the relationship between the cases of the load. The following types of pattern demonstrate the concept clearly:

1. Single pattern: the load has only one load case, such as dead load of weights of materials and construction, as shown in Figure 03.

Single Pattern

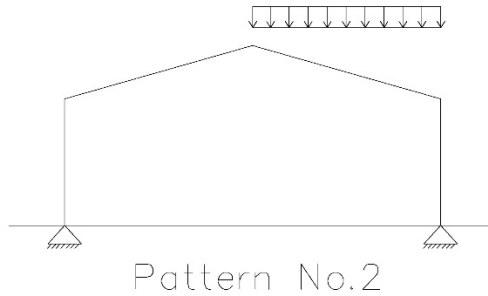
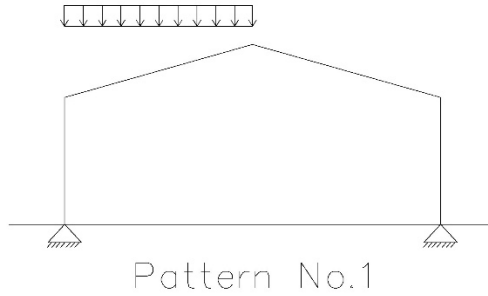


e.g. own weight of frame.

Figure 03: Single Pattern Loading

2. Separate patterns: each case of loading is added separately to the load combinations, such as varying dead load of fixed service equipment, vegetation and landscaped roofs, snow load, or temperature variance, as shown in Figure 04.

Separate Patterns

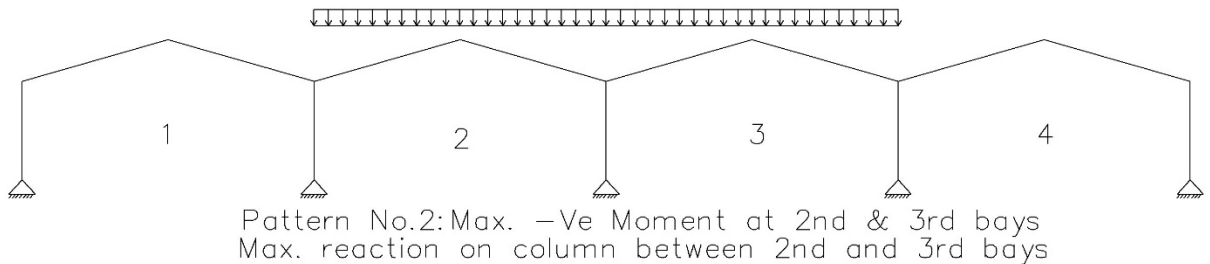
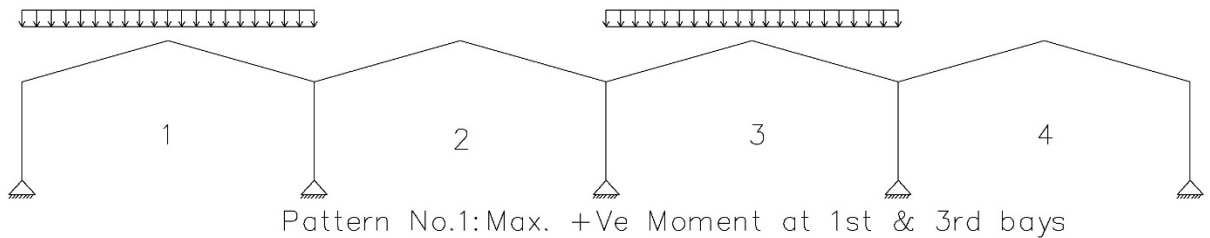


e.g: unbalanced snow load patterns.

Figure 04: Separate Patterns Loading

3. Alternative patterns: cases of loads are added to others to give a “maximum load effect” on the structural elements, such as live load and roof live loads on continuous beams or frames, then adding these load patterns to the load combinations, as shown in Figure 05.
- 4.

Alternative Patterns

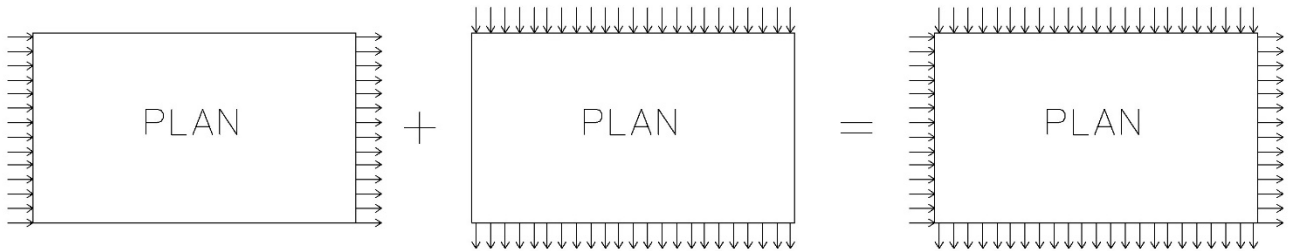


e.g: alternative roof live load patterns.

Figure 05: Alternative Patterns Loading

- Summed patterns: cases of loads are combined in an equation, such as summing wind load cases with different directions, or seismic load cases with different directions, as shown in Figure 06.

Summed Load Patterns



e.g: summed seismic load patterns.

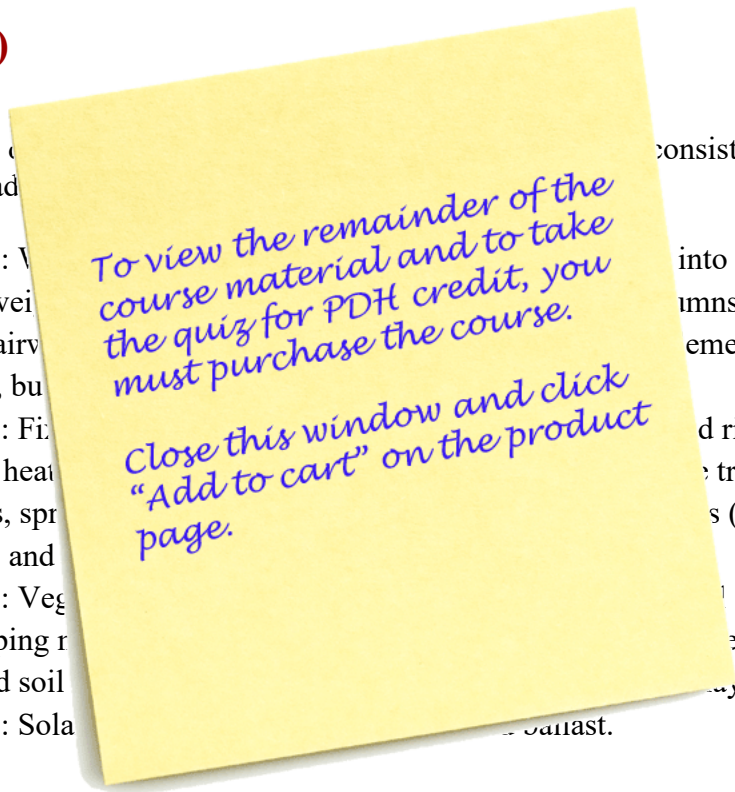
Figure 06: Summed Patterns Loading

In this course, we will study the determination of **Dead, Soil Pressure, & Hydrostatic Pressure Loads**, demonstrating the above information for each load.

Dead Load (D)

Based on the code, dead loads are divided into groups of loads.

- Group 1: Vertical loads due to the weight of building components such as self-weight of structural members, floors, roofs, decks, stairways, walls, partitions, ceilings, built-in cabinets, etc.
- Group 2: Fixed equipment and fixtures such as feeders, heat exchangers, piping supports, spring supports, etc. (including their own weight), and other non-structural components.
- Group 3: Vegetation, landscaping, and hardscaping materials, including saturated soil.
- Group 4: Solar radiation, wind, and snow loads.



consists of the following

into the building: such as columns, concrete on metal deck, and cladding, etc.

and risers, electrical conduits, trays, lighting fixtures, etc. (crane bridge, etc.)

landscaping & hardscaping materials, including cases such as fully saturated soil and layer materials.

of contrast.