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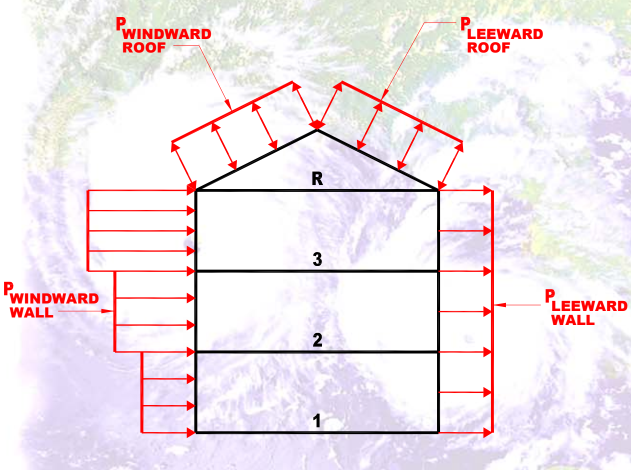
Lateral Loads

Introduction

To help insure the safety of its inhabitants, current building codes mandate structures to be designed to resist minimum sets of loads. These can be classified in two basic load groups, gravity loads and lateral loads. Gravity loads are loads induced vertically on a structure (downward toward the center of the earth). Typical design gravity loads are dead (weight of components), live (occupancy), rain, ice and snow loads. **Lateral loads primarily induce horizontal forces on structures. These loads are typically the result of some type of environmental event.** Lateral loads consist of wind, seismic (earthquake), blast, fluid (wave action) and earth pressure loads. This Technical Bulletin will concentrate on the basics of wind, seismic and blast loads.

Wind Loads

Wind loads are **applied from atmospheric events ranging from light breezes to hurricanes to larger extreme wind events such as tornadoes.** Current wind provisions are outlined in the *International Building Code* (IBC) and *Design Loads for Buildings and Other Structures* (ASCE 7). Code provisions contain maps which provide design wind speeds, depending on the building location. These wind speeds are converted to design wind pressures by squaring the wind speed and then multiplying it by various factors. These factors include the Wind Importance Factor, exposure factor, height factor and whether the building is located on a hill. Design wind pressures are then applied perpendicular to the building's surfaces, as shown in Figure 1. Wind pressures occur toward the building's surface, known as positive pressure, or away from the building's surface, known as negative pressure or **suction**. The side of the building where the wind is blowing is known as '**windward**' and the opposing side is known as '**leeward**.' However, all building surfaces must be designed as 'windward' and 'leeward' since it is typically unknown which direction the wind will blow. Wind loads can also induce vertical loads on a building. This is due to varying angles of building surfaces, such as a sloped roof (remember wind pressures are always applied **perpendicular** to the surface).

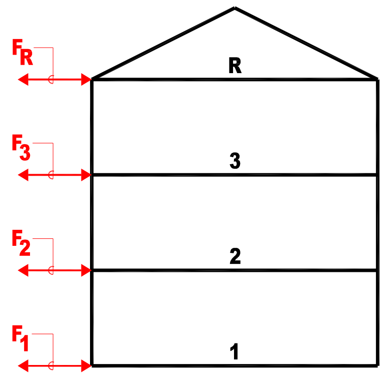


WIND PRESSURES

FIGURE 1

Seismic Loads

Seismic loads are applied vastly different from wind loads. They are applied via ground movements experienced during earthquakes. As the ground moves, the building's foundations are moved along with the ground, but the levels above need a moment to 'catch up' with the movement below (think of the 'bend' effect when waving a wand). Current seismic provisions are also outlined in the IBC and ASCE 7. Design seismic loads are largely dependent on the location of the building, the soil type, the lateral-force-resisting-system and the weight of the building. The heavier a building is, the higher the design seismic loads. Seismic loads are typically applied to a building at each level, as shown in Figure 2. The building's mass (self weight) is calculated then multiplied by a seismic factor and a horizontal force is applied to each level. Seismic provisions also require additional vertical loads applied on building to account for any vertical movement during an earthquake.



SEISMIC LOADS

FIGURE 2

Blast Loads

Blast loads are due to an explosion of some type. Blast design may be required for a variety of reasons, such as a nearby jet fuel plant or because of AT/FP Requirements (DoD Antiterrorism) outlined in the *United Facilities Criteria* (UFC) Code. Design blast loads are applied very similarly to wind loads; that is via pressure applied perpendicular to building surfaces. Blast loads are largely dependent on the proximity and magnitude of the presumed explosion. Design blast loads are applied towards and away from building surfaces since an explosion can cause positive or negative pressures.

Conclusion

Lateral load design is an integral part of the building's design. Recent Building Code revisions require consideration of both wind and seismic loads, even if in a negligible seismic zone. Basic understanding of lateral loads help explain why Structural Engineers design and layout certain elements the way we do. This knowledge also serves in associating how certain decisions can affect lateral load design – for example knowing that steeper roof pitches will experience larger horizontal wind loads, shallower roof pitches will incur larger uplift (suction) wind loads and heavier buildings will experience larger seismic loads.

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Subsequent Technical Bulletins will discuss Lateral Force Resisting Systems, which are the structural elements utilized to resist lateral loads. Future Technical Bulletins will further delve into the calculation and application of both wind and seismic loads.

SPEIGHT, MARSHALL & FRANCIS, P.C.
2125 McComas Way, Suite 103
Virginia Beach, Virginia 23456
www.smandf.com
(757) 427-1020
(757) 427-5919