SPEIGHT MARSHALL & FRANCIS
A Professional Corporation

Technical Bulletin

FROM SPEIGHT, MARSHALL & FRANCIS, P.C.

Structural Engineering - Special Inspections
December 2009
Bulletin No. XXXVII

Vertical Force Resisting Elements

Introduction

Our previous "Horizontal Force Resisting Elements" (HFRE) Technical Bulletin discussed diaphragm types and functions within a Lateral Force Resisting System (LFRS). Another critical aspect of the LFRS is the collection of Vertical Force Resisting Elements (VFRE). VFRE are essential for the proper performance of a structure during a wind or seismic event. This technical bulletin will introduce VFRE, their function, various types and the vital role they play in a structure.

Vertical Force Resisting Elements

The primary function of VFRE is to transfer horizontal load from the diaphragm to the foundation and underlying soils. As discussed in previous Technical Bulletins, these horizontal loads are caused by wind, seismic or blast events. A secondary, but equally important, function of the VFRE is controlling horizontal deflection, or 'drift', of a structure. Excessive drift can cause various problems including brick and interior finish cracking, window and door leaking, and structural damage. Figure 1 and the list below show common types of VFRE along with their relative drifts:

Common VFRE:

- Moment Frames (Steel, Concrete) – Most Drift
- Braced Frames (Steel, Light-Gage) – Less Drift
- Shearwalls (Wood, Masonry, Light-Gage) – Least Drift

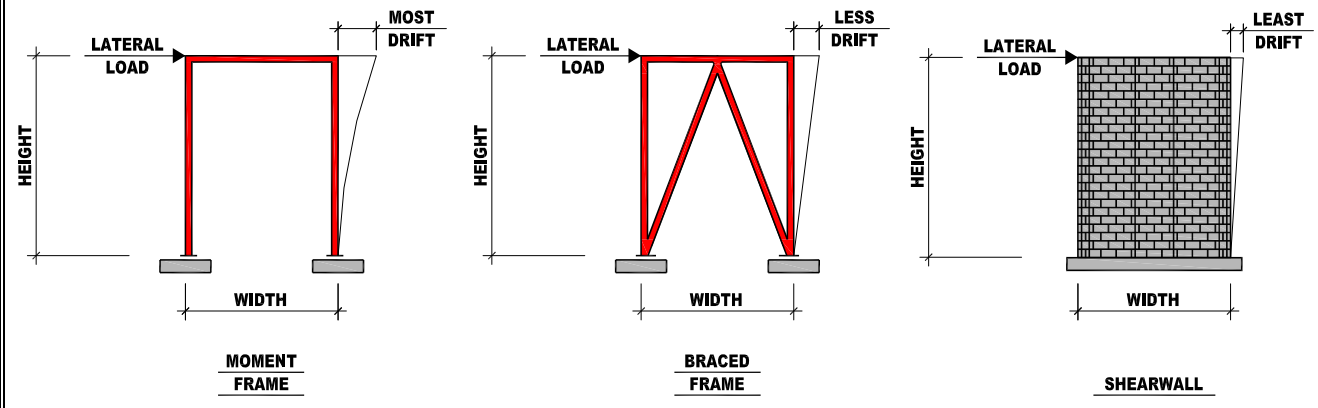

FIG. 1

(Various VFRE and their corresponding drifts)

When lateral loads are applied to a building, its natural tendency is to overturn and lift off of its foundation. The tension and compression forces that develop from overturning are also resolved by the VFRE. Another important factor is the height to width ratio of the VFRE. VFRE with narrow bay widths will be less efficient because of the larger forces and drifts. Figure 2 illustrates the increased frame drift and overturning forces associated with the increased height to width ratio of a braced frame.

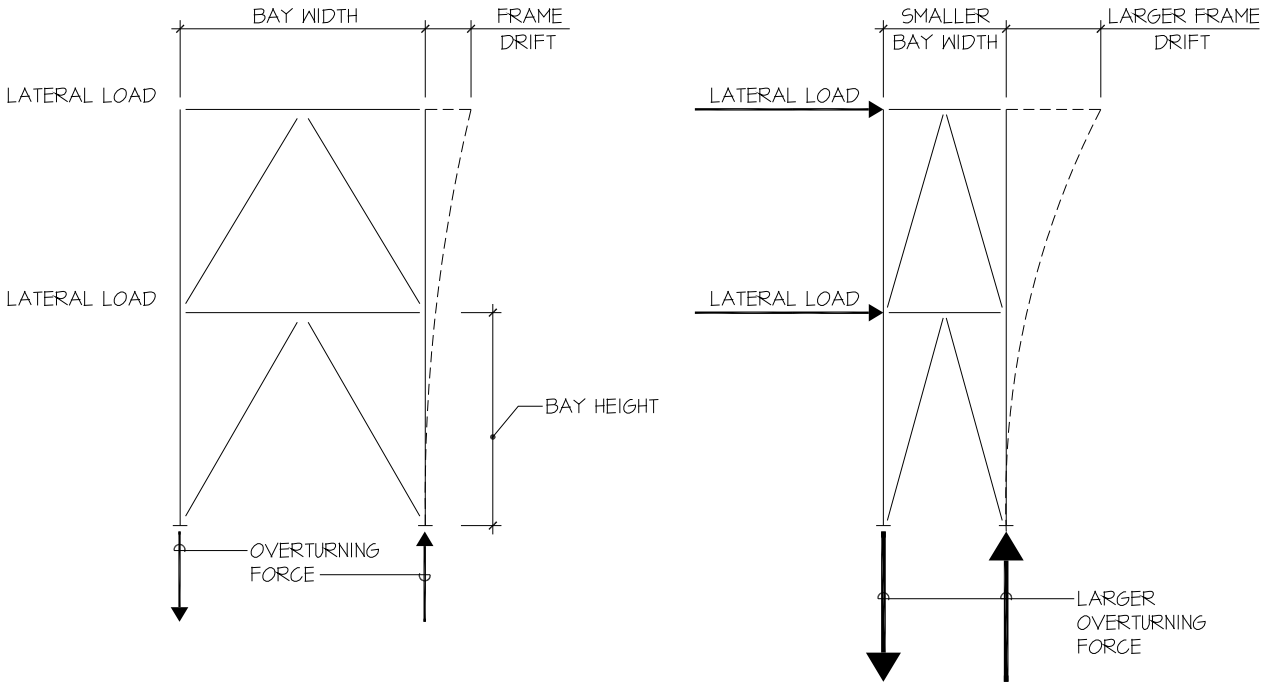

FIG. 2

(As the bay width to height ratio increases, the lateral deflection and overturning forces also increase)

The selection of VFRE is impacted by many factors including architectural constraints, diaphragm type, materials used, building geometry, code provisions and the magnitude of lateral loads on the structure. The different VFRE provide various pros and cons. For example, while brace frame and shearwall systems are more economical and efficient, they can create restrictions in wall opening locations and other aesthetic issues. Conversely, moment frame systems typically require heavier (more expensive) members and connections but they allow more freedom to use open floor space.

Conclusion

VFRE are a critical component in completing the LFRS load path and the integrity of the structure. If proper consideration is given to the VFRE early in the project, a more economical design can be achieved.

Our next Technical Bulletin will discuss various types of VFRE, including their advantages, disadvantages and common application.

Download past issues of our Technical Bulletins here

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