Wood Framed Shear Walls With Openings

ASCE 7-02/05 reference section(s)	2001 CBC reference section(s)	Other standard reference section(s)
ASCE 7-02 ASCE 7-05 9.5.2.6.2.2 12.14.6.2 9.5.2.6.3.1 14.5.3	2315.1 Table 23-II-G	IBC 2006 2305.1; 2305.3 NEHRP 2000 12.4.2; 12.4.2.9; 12.4.3; C12.4.3 NEHRP 2003 AF&PA SDPWS2005: 4.3 Seismic Design Manual, vol. II 2000: (1997 UBC) Pp. 40-46, 69-76

Background

Wood framed shear walls with openings are commonly encountered in both commercial and residential projects. Consequently, design challenges arise where windows and shear walls compete for space along the building perimeter. This Blue Book article discusses applicable code requirements and provides guidance so that a sensible shear wall design with a clear rationale may be produced.

The critical nature of shear wall designs has increased in recent years as perimeter walls have trended toward larger and more numerous openings. Accordingly, engineers of commercial and especially residential projects of light wood frame construction are incorporating many narrow shear wall segments because architectural requirements emphasize higher dwelling densities and rooms with more daylight and better views. At the same time, the magnitude of design stresses increased in many regions with the introduction of the Near-Source Factor, *Na*, and other force-related features required since the 1997 UBC (ICBO 1997). Also, the use of new high-strength continuous tie-down devices has eliminated a holddown design limitation that often created a practical limit of allowable stresses. With the high-strength tiedowns common on wood framed buildings three to five stories in height, shear stresses at the first level are often pushed to the code limit. Collectively, these construction and seismic code trends have resulted in higher densities, taller buildings, shorter shear wall segments, and greater forces, all of which have intensified the demands on the structural system. This intensity spotlights the necessity of good engineering practice with regard to woodframe shear walls and the treatment of openings.

A prudent shear wall scheme is commonly considered essential for good seismic performance of light wood framed construction (Breyer et al 2006). It is recognized that shear wall placement will compete with nonstructural or architectural requirements, particularly at the perimeter of the building. Therefore it is useful for designers to appreciate the nonstructural requirements, such as for large or numerous windows, in order to improve early coordination and location of shear wall segments. Designers are encouraged to address these issues early in the design process when flexibility exists. The proper distribution of shear walls is considered by many practitioners to be more of an art-form than a science, but in practice a prudent engineer will tend to minimize long drag elements and will consider the load sharing of the elements. A good design is often described as elegant in that it is simple and not wasteful of resource materials. Most importantly, a prudent design acknowledges the essential issues, rather than ignoring them. It should be emphasized to those gaining experience that no amount of additional calculations or detailing of openings will make up for a poorly planned shear wall scheme.

Opportunity for Improvement

There are several practical opportunities for improving shear wall design and performance. One example is to consider the way contractors approach wood framed exterior wall construction. Prior to the 1997 UBC, engineers in the Western United States often made a simplifying assumption of only considering the full-height shear wall segments and did not include any contribution from spandrel sheathing. This assumption, which has come to be known as “segmented design," often differs with field conditions because:

1) Contractors may continue the sheathing above and below openings to provide a backing of even thickness for finish materials, and