DM Berg Consultants, P.C.

Fall 2001

Our deepest sympathy goes out to the victims and families of the September 11th tragedy.

DM BERG CONSULTANTS, P.C. is a structural engineering firm providing services for both public and private-sector clientele. Our business focus is:

- Building designs for new construction
- Analyses, forensics, and report writing
- Rehabilitation and restoration for existing buildings and parking structures
- Envelope and weatherproofing designs for new and existing building roofing and cladding systems

Project Types

Assembly
Civic
Commercial
Educational
Healthcare
Hospitality
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Institutional
Parking Garages
Residential
Retail
Specialty

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Why are there Hold-downs in Wood Framed Buildings?

by William H. Barry, P.E., Project Manager

Winds (breezes, wind storms, hurricanes, tornadoes, etc.) and earthquakes generate horizontal loads on buildings. These forces must be transferred from each level of a building to its base. In wood frame buildings, shear walls typically accomplish this transfer. Shear walls are the walls of a building that are sheathed with a rigid material such as plywood, oriented strand board (OSB), and in some cases gypsum wall board (GWB). Horizontal forces transferred to the top of these walls cause the walls to attempt to rotate. When a wall is supporting the ends of floor and roof framing, the potential wall overturning is partially restrained by the weight of the floors and roof. When a wall is parallel with the floor and/or the roof framing, there is little weight on the wall to resist overturning. Hold-downs are used to prevent the lifting of the base of the walls where the uplift minus the downward weight exceeds the capacity of a typical nailed connection.

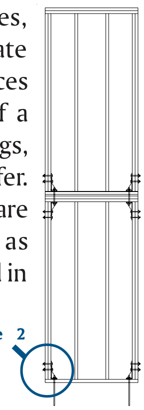


Figure 1

Many owners, architects and contractors have asked why there are hold-downs or why there are more hold-downs in current buildings. There are more hold-downs in buildings for a number of reasons:

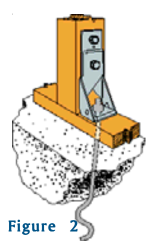


Figure 2

- The national building codes now require engineers to consider wind and seismic loads for nearly all types of buildings in all locations.
- Engineered wood products like trusses and I joists allow the use of longer spans. Long span framing can result in fewer structurally useable shear wall panels, and results in a significant differential in vertical loads between the walls supporting framing (bearing walls) and the walls parallel to the framing (non-bearing walls).
- Open floor plans and large window openings generally result in fewer structurally useable shear wall panels.
- Higher floor-to-floor heights result in higher hold-down forces due to the taller wall panels and increased wind loads.

Most hold-downs utilized in wood framed buildings connect to a group of studs at the end of a wall panel and to a vertical rod that is either connected to the foundation or extends to another hold-down below (see Figures 1 and 2). The connection to the wall studs is accomplished with bolts, lag screws, or nails depending on the type of hold-down selected for the design forces. A typical hold-down configuration is shown in Figure 2. Hold-downs are available for a range of uplift loads and framing configurations.

The disadvantage of the typical type of hold-down is its reliance on the wood members to transfer the uplift forces from the wall to the hold-down. An alternate system that is gaining acceptance involves threaded rods that extend from the base of a wall all the way to the topmost plate at the roof. This "tie-down" system eliminates the extensive horizontal drilling that is required with conventional hold-downs. Additionally, this system is more efficient because it eliminates the unavoidable eccentricity of the typical wood stud to hold-down connection. A diagram of this system is shown in Figure 3.

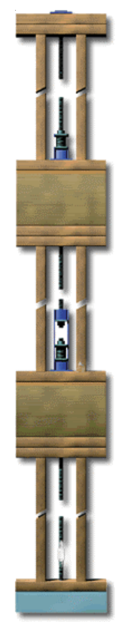


Figure 3

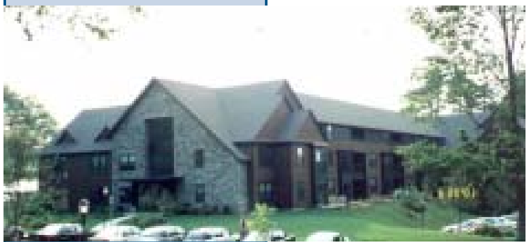
This office has found it reasonable to allow contractors to anchor the hold-downs to the foundation using drilled-in anchor because the location of these anchors is critical and the required level of accuracy cannot easily be achieved with cast-in-place anchors.

When considering construction type and cost, owners, developers, and architects need to consider hold-downs as a necessary structural element. A coordination meeting with the structural engineer at the schematic design stage may allow a significant reduction in the number of hold-downs a building may require by strategically locating walls, both vertically and horizontally.

For additional information on this topic, The Engineered Wood Association has a brochure "Introduction to Lateral Design" which can be obtained in Adobe Acrobat format at www.apawood.org. Additionally, a companion article "Understanding Shear Wall Design" is available on our website in the *News* subcategory of the *Company* heading.

Figures 2 and 3 courtesy of Simpson Strong-Tie Co., Inc.

FULLER VILLAGE
MILTON, MASSACHUSETTS
by Scott Webber, Principal



Fuller Village
Milton, Massachusetts

Architect:
DiMella Shaffer Associates
General Contractor:
CorJen Construction
Total Cost: *$13,700,000*
New: *223,000 sq.ft.*
Units: *156*

Fuller Village is a residential community for seniors and is located on a sloping, corner lot bordered by Blue Hill and Brush Hill Avenues in Milton, Massachusetts.

The housing consists of townhouses, apartment-style units, and modern rental apartments. Renovations were also done to the existing Kennedy Mansion.

The Villas are individual one story cottages with attached garages, with each unit averaging 1,000 sf. These are wood framed with conventional concrete foundations.

The Foster Residences are wood framed with a conventional concrete foundation. This is a 3-story, elevator-equipped independent living facility, with units averaging 975 sf.

The Depoyan House is wood framed with a conventional concrete foundation. This is a 3 story, elevator-equipped senior living apartment building, with units averaging 525 sf.

Both the Foster Residences and Depoyan House have accessible subgrade space.

The rehab of the *Kennedy Mansion*, an existing home built in 1880, acts as the site's community building. It is approximately 8,000 sf. An existing elevator was replaced and all systems were upgraded.

SCOTT WEBBER
PRINCIPAL

Scott Webber received an Associate of Science Degree in Civil/Structural Engineering from Blue Hills Technical Institute and has over 20 years of experience in the structural field.

Through his advancement with the firm and exposure to numerous types of building structures, Mr. Webber has developed a unique ability to visualize and understand the components required to prepare documents that are well detailed and coordinated with the other design disciplines involved in the construction process.

A key element in the success of the firm is Mr. Webber's ability to continually direct and achieve the best efforts of our staff, along with the respect he has earned from the firm's clients.

In his spare time (hah, hah) Scott enjoys spending time with his family and friends. He is an active member of the Norwood Elks and is a soccer coach/ Clinic Coordinator for the Norwood Soccer League.

In addition to the Fuller Village project featured to the left, Mr. Webber is managing the following projects:

64 Sewall St. Luxury Apts. - Brookline, Massachusetts
Architect: CYMA2, Inc.
Court Square Residences - S. Boston, Massachusetts
Client: Pappas Industrial Parks, Inc.
St. John of God - Brighton, Massachusetts
Architect: The Architectural Team, Inc.

Technical Note

The American Institute of Steel Construction (AISC) has replaced the previous version of "Code of Standard Practice for Steel Building and Bridges" dated June 10, 1992 with a new version dated March 7, 2000. This Code provides a useful framework for a common understanding of the acceptable standards when contracting for structural steel. Unless specific provisions to the contrary are contained in the Contract Documents, the existing trade practices that are contained in this Code are considered to be the standard custom and usage of the industry.

Some major changes have been made in the 2000 revision. A few important ones are mentioned here:

- Requirements for existing structures have been added in Section 1.7 to cover demolition, shoring, protection of existing work, surveying, field dimensions, and removal of hazardous materials.
- The Definition of "Structural Steel" as defined in Section 2.1 and "Other Steel, Iron or Metal Items" as defined in Section 2.2 are very important in the bidding process. These Sections have been revised to more accurately reflect current practice.
- Section 3.3 states that "When discrepancies exist between the Design Drawings and Specifications, the Design Drawings shall govern. This is different from the 1992 version which stated, "In case of discrepancies between plans and specifications for buildings, the specifications govern."

We recently had our **Summer Party.** We enjoyed a barbecue, swimming and lounging by the pool, and listening to the sounds of a DJ (Karaoke was very entertaining!)

Follow along in our future newsletters as we break down seismic design in Massachusetts, explaining why today's buildings continue to change. Articles include the necessity for wood hold-downs in shear walls (feature article); seismic load paths (Winter 2002); seismic upgrades and hazard mitigation as required by Chapter 34 of the Massachusetts State Building Code (Spring 2002); and seismic bracing of cmu walls (Summer 2002).

Past articles include: "Why We Design for a Seismic Event in Massachusetts" featured in Summer 2001.
To read past articles, visit www.dmberg.com and click on **Company** subcategory **News**.

DMBC, P.C. strives to create a working atmosphere where, through mutual cooperation and respect amongst staff and clients, the process of designing structures can be carried out with efficiency for all concerned including owners, developers, other clients, and end users.

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Companion Article to "Why are there Hold-downs in Wood-Framed Buildings?

Understanding Shear Wall Design

by William H. Barry, P.E., Project Manager

In traditional wood design, only the full height wall panels between window and door openings are considered to -resist the lateral loads from wind and seismic forces. This design method is known as the "Segmented Shear Wall Methodology." An example of this is shown in Figure 1 where only the shaded portions of the wall are considered shear wall panels and each end of each panel is anchored with hold-downs. Additionally, building codes typically limit the minimum length of wall panels that can be considered as shear walls to half the wall height (and 4'-0" minimum). For example, in a 10'-0" tall wall only the portions of the wall between openings that are 5'-0" or longer are considered in the structural design as narrower panels are considered too flexible. An example of a narrow wall panel is Wall Panel 2 of Figure 1. The type and quantity of hold-downs required for a particular wall panel is related to the amount of lateral load the wall panel must resist from wind or seismic forces, the length and height of the wall panel, and the amount of gravity load available to counteract the uplift. Short length walls with heavy lateral loads may result in large forces that the hold-downs must resist. When long length shear wall panels are utilized, hold-downs may be minimized because the uplift forces may be such that they can be resisted by other connections in the framing (e.g., typical foundation anchor rods). For shorter length shear wall panels, the uplift forces can require large hold-downs or groups of hold-downs at each end of the wall. When the wall height is increased from the typical 8'-0" to a higher 10'-0", the hold-down force is 25 percent higher, and this is without considering the increased wind loads and seismic mass due to the taller walls. In addition, the hold-downs must be connected to the foundation and as the force in the hold-downs increases, the connections to the foundation become more expensive to construct.

The latest building codes (SBCCI 1995, UBC 1997, and IBC 2000) offer a new approach to shear wall design called the "Perforated Shear Wall Design Methodology." This methodology is intended to reduce the number of hold-downs by requiring them only at the extreme ends of the entire wall. An example of this is shown in Figure 2, where the entire wall area minus the openings is considered the shear wall and only the extreme ends of the wall are anchored with hold-downs. The methodology works by reducing the shear capacity of the entire wall based on the sizes of the wall openings. The reductions result in shear wall capacities that are less than traditional shear walls because consideration is given to the potential uplift at the sides of the openings. To minimize the potential for uplift at the sides of openings, the method has specific requirements regarding the quantity and spacing of the anchor rods and floor-to-floor ties along the length of the wall.

Several issues should be considered when laying out a shear wall building. The walls and openings should align from floor to floor as shown in Figures 1 and 2. When the walls and/or openings are not aligned over one another, the hold-downs from above must be anchored to beams which must then be anchored to other members. The lateral forces must be transferred through the floor sheathing (known as the floor diaphragm) and this can result in the need to provide blocking at the diaphragm panel edges and increasing the panel nailing. At times, the shear walls from above may have to be ignored in the design because they cannot be properly anchored. Secondly, shear walls need to be reasonably distributed throughout the building and oriented in both primary directions. The reason the shear walls need to be reasonably distributed throughout the building is because the typical wood floor diaphragms that transfers the lateral forces to the shear walls have limited capacity. If all the shear walls are concentrated in one portion of the building, the remaining portion of the building will rotate about the rigid part and the shear walls and diaphragms may become overstressed. The shear walls need to be oriented in both primary directions so that the building can resist lateral forces originating in any direction. ■

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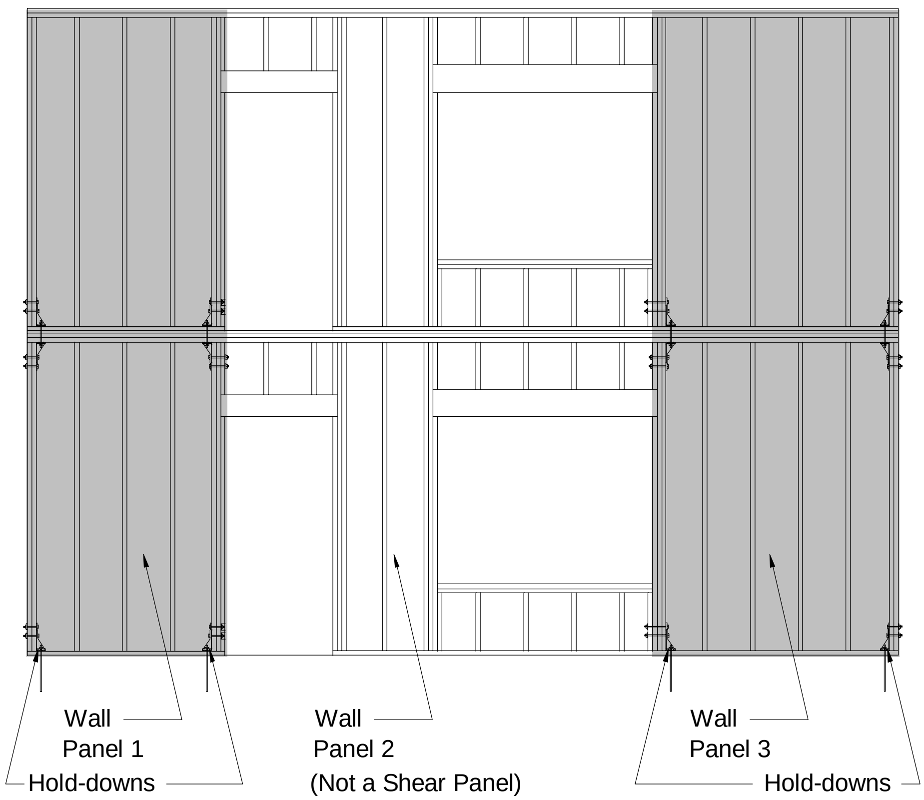

FIGURE 1 - SEGMENTED SHEAR WALL

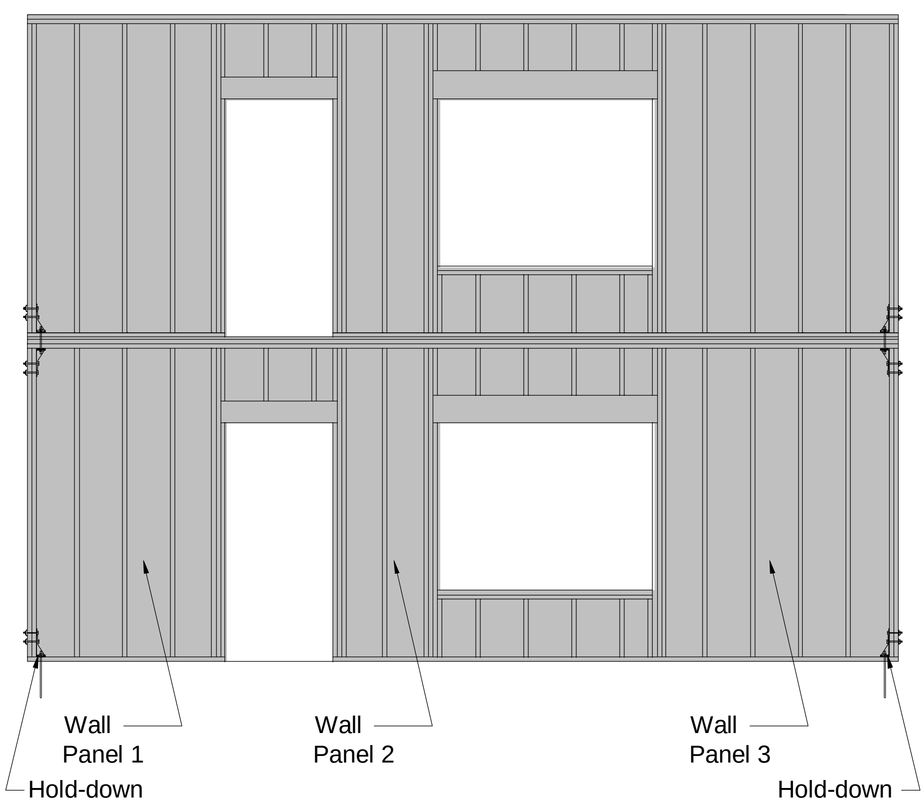

FIGURE 2 - PUNCHED SHEAR WALL