The Narrow Shear Panel Dilemma

This is what can happen if you don't read my blog! (Photo courtesy APA – The Engineered Wood Association, *Narrow Walls That Work*, 2005)

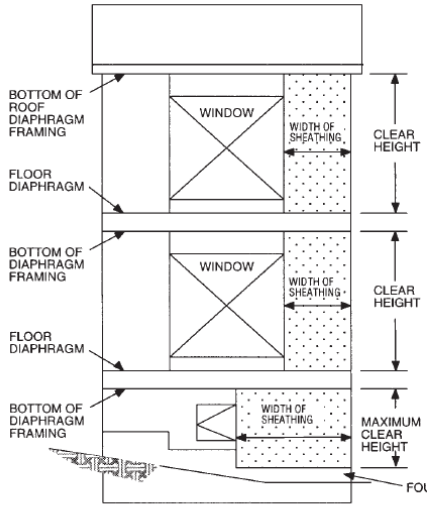
I'm doing the structural design of a new waterfront house in Seattle (not the one in the above photo). The architect has designed the front garage wall with very little shear panel—it's mostly door. As I've said in previous columns, doors and windows provide no useable resistance to wind and earthquake loads. That resistance must come from either shear walls or moment frames. No one much cares for moment frames because they're expensive and hard to build, which means engineers, if they want to maintain any semblance of popularity, not to mention income, will try their darndest to figure out how to make shear walls work.

Between calculations, I happened to be browsing through December's BUILDERnews Magazine and noticed an ad on page 16 by the APA (American Plywood Association) showing a picture of a guy with a ripped down, narrow sheet of plywood walking up to the exact garage wall situation I'm currently wrangling with. He looked puzzled because he could see the ad's text just below his feet that says regular old plywood shear walls can now "be used as approved braced walls as narrow as 16-inches". He also undoubtedly noticed that there were no holdowns at the corners of his slender shear wall panels, further exacerbating his stupefaction (stupefaction—I love that word).

A little background. Building codes do not allow tall, skinny

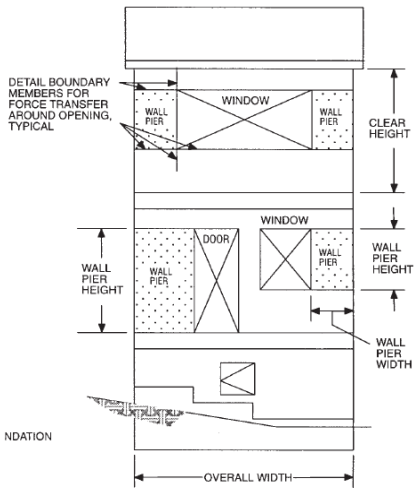
shear walls. Well, actually, they are allowed, but they may not be used to resist lateral loads if said wall's aspect ratio (height to width) exceeds approximately 3-1/2:1 (2003 IBC Table 2305.3.3). I say approximately because this ratio depends on the type of sheathing, which code you use, and whether the load is from wind or earthquake. In the case of my garage project: using OSB or plywood sheathing; the International Building Code (IBC); wind forces being worse than seismic; and with a sole plate to top plate height of 10-feet, I need shear wall panels at least 10/3.5 = 2.85-feet wide. The architect gave me exactly 2.0-feet. No good.

What about trying the IRC – the International Residential Code? I can use it in this case because I'm designing a single-family residence. It allows alternate braced wall panels for this type of application. But checking the fine print in section R602.10.6, I find that, rats, said panels must be at least 2'-8" wide. Again, no good. Actually, I can't use the IRC's prescriptive shear wall sections in my case anyway because the house is in seismic design category "E", which triggers engineering.



(a) HEIGHT-TO-WIDTH RATIO

Back to the 2003 IBC. Check out the following two sketches (courtesy International Code Council, 2003 International Building Code). This whole business of aspect ratio has everything to do with how you measure the particular shear wall's height—and there is more than one way. Sketch "A" shows the conservative method: as measured from floor to ceiling. But sketch "B" shows a more favorable way: shear wall height equals the actual opening's height. Of course there has to be a catch, which is if you use method "B", you must, and I quote the IBC, section 2305.3.7.1: "design for force transfer [around the opening] by a rational method". And further, you must: "Detail the boundary openings around the elements." Unfortunately, there is no guidance or illustration as to how either of these "musts" are accomplished.

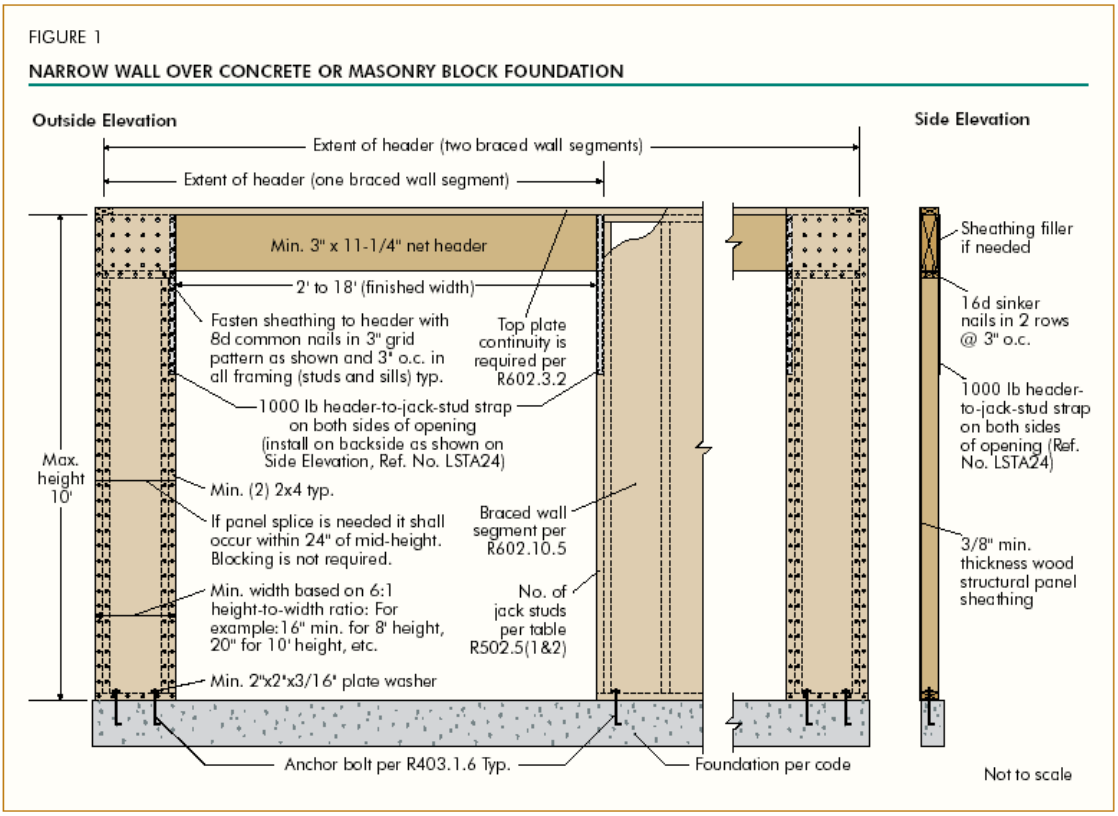


(b) HEIGHT-TO-WIDTH RATIO WITH DESIGN FOR FORCE TRANSFER AROUND OPENINGS

In the case of my project, the overall wall height is 10-feet, but the garage door is only 7-feet high. So, using method "B", my shear panels must be at least 7/3.5 = 2 feet wide. Well, what do you know—that's exactly what I've got to work with. Now all I have to do is figure out how to determine and detail the force transfer around the opening. To avoid a moment frame, I'm sure I can come up with something. Won't my architect love me!

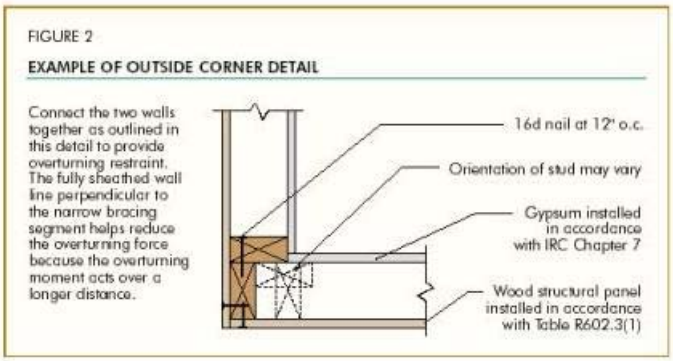
Now, what about the APA claim of code-approved 16-inch wide shear panels? I visited www.apawood.org/bn to get the scoop and here it is:

The APA devised what they call the APA Narrow Wall Bracing Method. Here is what it looks like (courtesy APA, *Narrow Walls That Work*, 2005).



A few important things to note:

- No holdowns are required.
- Can be constructed on-site.
- Has been approved in the 2004 IRC Supplement, so is code-compliant with the IRC.
- Is approved only when connected directly to concrete. It is *not* IRC-approved for 2nd floor or subfloor installations.
- The return-wall-to-adjacent-wall-corner must be constructed per IRC, which includes drywall, like so:



- The header must be continuous over the shear panel(s).
- The aspect ratio can be 6:1, as measured from the

bottom of sole plate to the top of header. So a 16-inch wide panel is good for 8-feet in height. A 10-foot height requires, (10*12)/6 = 20-inch wide panels. There can be cripple wall bracing over the header which does not affect this height.

- The entire structure's exterior walls and interior braced walls (where required per IRC) must be sheathed with plywood or OSB.
- Particular attention must be paid to nailing and strapping as shown in the figures above.
- I could find no published actual shear strength values. In other words, if I need this wall to resist 3,000 pounds of lateral force, I have no idea whether two, 2-foot wide APA narrow walls will cut the mustard. As far as I can tell, these APA narrow walls are intended only as prescriptive shear walls in accordance with the IRC.

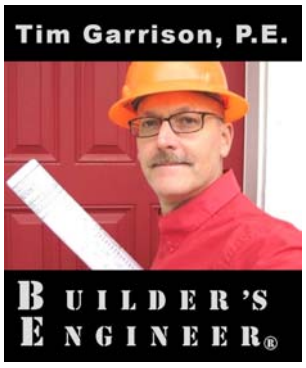
I'm left wondering, could I use this on my project? The answer is no because mine is in seismic design category "E", which means engineering is required and prescriptive design is not allowed.

Just for grins, say I was in seismic design category "D1". Now could I use APA narrow walls? To find out, I go to IRC Table R602.10.1, which tells me that for a single story building I need:

- A panel on each corner. Check.
- A panel at least every 25-feet on center. My garage's total width is 15'-2", so check.
- The height to the top of header is 10-feet, so I need at least 20-inch wide APA narrow wall panels. I've got 24-inch wide panels, so check.
- For method 3 shear walls (plywood or OSB sheathed), at least 20% of the braced wall line must be legal shear wall. In my case, I've got 2+2 = 4-feet of legal shear wall out of 15.1 total feet, which equates to 26.5%, so check.

The answer is yes: if this building was in seismic design category D1, I could have used APA narrow walls on the front garage wall.

Unfortunately, since I'm in seismic design category "E", instead, I'll use a two-sided plywood shear wall with holdowns—a more expensive and troublesome solution. Not as troublesome, however, as a steel or PSL moment frame. Mission accomplished.



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