APA Research Report 138 and its use in Wood Frame Retrofit Work

On page 4 at the beginning of this report the objective is clearly defined as follows: "The tests reported here were undertaken to develop design and construction recommendations for high diaphragm shears using two layers of plywood, thicker plywood, or a greater number of fasteners than are common in current practice." In other words, this document researches plywood diaphragm construction methods that are not normally used or even described in modern building codes. Wood frame seismic retrofit work often requires the use of atypical shear wall designs, which makes familiarity with APA Research Report 138 invaluable.

The beginning of the report Table 1 gives allowable design shears for the horizontal diaphragms that would normally be found in roofs and floors. The tests that relate to wood frame seismic retrofit work are as follows:

"A large number of diaphragms were tested to determine if a large number of staples would result in a corresponding increase in shear wall performance and if the use of staples would reduce the tendency for framing members to split. The tests showed that an increase in the number of staples did have a significant increase in shearwall performance and that "During these tests it was discovered that a large number of either 10d or 16d nails, spaced less than 3" o.c. as required to develop high shears, often caused the framing member to split. On the other hand, the use of pneumatically driven staples showed that staples with a 7/16 inch crown could be driven as close as 1" o.c. without causing splitting, either at the time of driving or when the specimen was loaded in shear" (p.14)

Another test checked to see how staples with a minimum penetration of 2 inches would effect shear wall performance. This test was performed because in the test mentioned above "In all cases, the failure was staple withdrawal from the framing." (p14) This test was to see if an increase in penetration reduced this tendency. Increasing the staple penetration had the positive effect wherein these tests now "revealed only very slight staple withdrawal." Increasing staple penetration did therefore significantly increase shear wall performance. Unfortunately, no tests were conducted using 15/32 structural one plywood, the most commonly found plywood used in wood frame seismic retrofit work. The load values in Table 1 were therefore extrapolated.

Another test checked to see how multiple rows of power driven nails versus a single row of nails would affect the performance of a shear wall. In this test three rows of perimeter nails were fastened to 3by framing 3" o.c. and 2 rows were nailed 3" o.c. in the field. The additional rows of nails resulted in a very significant increase in shear wall performance as shown in Table 1 in APA Research Report 138. The information gleaned from this test is very important for the field of wood frame seismic retrofit work. In older homes that need retrofit work the most, old growth lumber that is full dimenion 2" lumber is the standard. Installing two rows of 10d shorts 3" o.c. on the shear wall perimeter will does not split the framing. Unfortunately, this nailing pattern does not correspond directly with the APA test but a shearwall capacity has

can be interpolated using this formula: V=94(lateral load of a 10d nail) x 1.30 (increase for nails used in diaphragm construction) x 1.6 (increase for wind and seismic) x 8 (fasteners per foot) =.1564plf “

Extrapolating from this information, construction of high capacity nailed shear walls is quite feasible in wood frame seismic retrofit work so long as all boundary framing can be made to take the necessary fasteners without splitting. The biggest potential problem is the mudsill connection where blocking is often used. A nominal 2 by 4 block 14 inches long simply cannot take a double row of 10d nails or closely spaced nails without splitting. Use of nailed blocks on the mudsill as recommended by Chapter A3 of the IEBC, Chapter 92 of the City of Los Angeles Building Code, and Plan Set A retrofit guidelines, makes building of high capacity shear walls impossible. Fortunately, other methods, especially the flush-cut method make it both practical and easy.