

Existing Floor to Joist and Bottom Plate Connections

TRANSVERSE FIRST STORY BOTTOM PLATE TO END JOIST CONNECTION:

This point of potential failure will have to resist a wall load only. If the wall load is 80plf, then this wall will have to resist 1920 pounds on the average one story 24 foot long transverse wall. Most first story transverse walls have a door which breaks the bottom plate into two pieces. Approximately 4 feet of the bottom plate is missing because of the door opening, leaving a total of 20 feet of 2 x 4 bottom plate. It is safe to assume that the 20 linear feet of bottom plate has approximately eight 20d common nails attaching it to the end-joist with a capacity of approximately 1372 pounds ($129 \times 1.33 \times 8$).

Even though the transverse bottom plate to end-joist connection is weaker than the wall capacity, it is still not necessary to supplement this connection for the following reasons:

- 1) When we apply a high base shear factor of $V = 0.26W$ to the transverse walls, we discover that the load on the transverse wall bottom-plate will only be 499 pounds and that the existing connection of 1372 pounds is sufficient to meet this load. The other connections such as cripple wall plywood shear bracing, bolting, framing anchors, etc. should be strengthened to a capacity that is more than double $V = 0.26W$, before supplementing this connection makes any sense.
- 2) The transverse walls, because they often largely composed of doors and large windows, have low overall capacity above the bottom-plate. The capacity of these walls is often less than the 1372 pound capacity of the topplate to end joist connection. It does not really make sense to strengthen the bottom-plate to end-joist connection when it is already stronger than the wall itself. Given the fact that an earthquake attacks a house equally from all directions, the transverse walls themselves will fail in an actual earthquake before any of the bottom-plate to floor framing connections fail.

LONGITUDINAL FIRST STORY BOTTOM PLATE TO RIM-JOIST AND BLOCKING CONNECTIONS:

If the wall load is 120plf, (80plf of wall load, 1/4 of the floor load plus 1/4 of the ceiling load equals approximately 120plf), this wall will have to resist 4800 pounds on the average one story 40 foot long longitudinal wall. If the bottom plate is already attached to the rim-joist or joist blocking with 20d commons spaced 3 feet o.c., which would be fifteen 20d common nails in a 40-foot long wall, this connection should have a capacity of 2573 pounds ($15 \times 1.33 \times 129$).

Even though the bottom plate to rim-joist/blocking connection is weaker than the wall capacity, it is still not necessary to supplement this connection for the following reasons:

- 1) When we apply the base shear formula of $V = 0.26W$ to the 40 foot long longitudinal walls, we discover that the load on the longitudinal wall bottom-plate will be 1248 pounds and that the existing connection of 2573 pounds is sufficient to meet this load.
- 2) It does not make sense to spend money strengthening this connection unless the other connections have a greater or equal capacity. In other words, it is not cost-effective to strengthen the longitudinal bottom plate to floor framing connection when it is already much stronger than other critical connections in the house?

The other connections such as cripple wall plywood shear bracing, bolting, framing anchors, etc. should be strengthened to a capacity that is more than double $V=0.26W$, before it would be rational to supplement this connection.

Subfloor sheathing to Joist Connections

TRANSVERSE WALL FLOOR SHEATHING TO END JOIST CONNECTION:

It was a common construction practice to put at least two 8d nails at the end of each straight sheathed floor board. So this area should not be a point of failure. On the houses with straight sheathed floors, which we only see 5% of the time because sub-floors are usually diagonally sheathed, we can assume that the floor sheathing is well nailed to the top of the end joists on the transverse walls. There are probably two 8d commons in each floor sheathing board. THEREFORE, this connection should not be a point of failure because it is so well nailed.

LONGITUDINAL WALL FLOOR SHEATHING TO RIM JOIST OR JOIST BLOCKING CONNECTION:

On the longitudinal walls the edge straight sheathed sub-floor boards that have been installed perpendicular to the joists may or may not have very many nails attaching them to the rim joist or joist blocking, though there probably is one 8d common face-nail every 16" o.c. These edge straight sheathed sub-floor boards are important as they have to keep all the other floor boards in position and for this reason were probably well nailed. This connection probably has a capacity of 2410 pounds (62 x 1.33 x 30). Face nails rather than toe-nails would normally be used because the bottom plate of the first story wall would cover the nails.

Besides this edge nailing, at least one 8d nail would be field nailed into the other boards 16" o.c., either as toenails if the sub-floor is tongue and groove straight sheathing covered with oak overlay, or as face nails, if the sub-floor is diagonally sheathed. THEREFORE, I would not worry too much about the failure of the connection of the sub-floor to the joists along the longitudinal walls because they have sufficient nailing and overall lend the subfloor sheathing to joist connection a great deal of strength. Any redundancy in the bottom plate to floor framing nails that penetrate the sub-floor will also strengthen this connection. Please note that in appendix chapter 6 of the UCBC, related to URM retrofit, supplementing the shear capacity of sheathing-to-blocking or sheathing-to-rim-joist is not required, even though the mass restrained is likely to be higher than in a wood-framed residence. This is because the 2-8d nails per board to the joists, even those nails that are somewhat remote from the ends of the joists, are effective in transferring the shear to the joists and thence to the blocking – even though it is a somewhat indirect load path.

JOIST AND BLOCKING TO TOPPLATE CONNECTIONS

TRANSVERSE END-JOISTS TO TOPPLATE CONNECTION:

The end joists will only have a toenail every 6 to 8 feet attaching them to the topplates. This is because before nail guns were common a contractor would only put in enough toe-nails to hold the end-joist in place while he worked on it. These toe-nails are installed from the outside where they cannot be seen. It is thus quite possible that each end joist may have only 4 toe-nails attaching it to the upper topplate. THEREFORE: I disagree with Division 92 of the L.A. building code which does not require verification of this connection and believe that this

connection should be supplemented with L-70's or L-90's on single story as well as multi-story homes.

LONGITUDINAL RIM-JOIST TO TOPPLATE CONNECTION:

The connection of the rim-joists to the cripplewall topplate on the longitudinal walls is accomplished by two means: 1) The rim-joist is probably toe-nailed to the topplate with 20d commons every 6 to 8 feet. This is because a carpenter would have installed just enough toe-nails to hold the joist in place long enough for him to install the face nails into the joist ends. The average rim joist spanning 40 linear feet would therefore have a capacity of 1177 pounds (11nails x .83-toenail multiplier x 129). THEREFORE: This is a very weak connection and cannot be counted on.

LONGITUDINAL JOIST BLOCKING TO TOPPLATE CONNECTION:

Normally, this connection is made with two 20d common toe-nails in each block. Two toe-nails are installed in each block rather than one to prevent the blocks from rotating when the siding is installed. The average capacity per block would be 285 pounds (129 x 1.33 x .83 x 2). If a wall had 20 joist blocks the blocking would have a capacity of 5700 pounds.

LONGITUDINAL FLOOR JOISTS TO TOPPLATE CONNECTION:

This is normally accomplished with one 16d common toenail on the side of each floor joist. I believe we see just one toenail in each joist because the carpenter only wanted to keep the floor joist in place while he nailed up the rim joist or installed the blocking. These toenails do a lot to strengthen this connection. On a forty foot wall there are probably close to thirty nails which would have a capacity of 3212 pounds (30 nails x .83 x 129 equals 3212).

CONCLUSION: On homes with joist-blocking, the longitudinal floor framing to top-plate connection should have an existing capacity of 8912 (5700 + 3212)pounds. If the house has a rim-joist the longitudinal floor framing to top-plate connection should have an existing capacity of 4389 (1177 + 3212) pounds. In either case, the longitudinal floor framing to top-plate connection is much stronger than on the transverse cripplewall.

THEREFORE, if the joist to top-plate connections are to be strengthened, the strengthening on the longitudinal walls should be much less than on the transverse walls, or even omitted entirely on single story homes. Our policy is to add H-10R framing anchors at a capacity that is half the strength of the supplemental L70 or L90 anchors on the transverse walls. If the floor framing is blocked, or the homeowner has budget considerations, we omit the longitudinal framing anchors entirely.