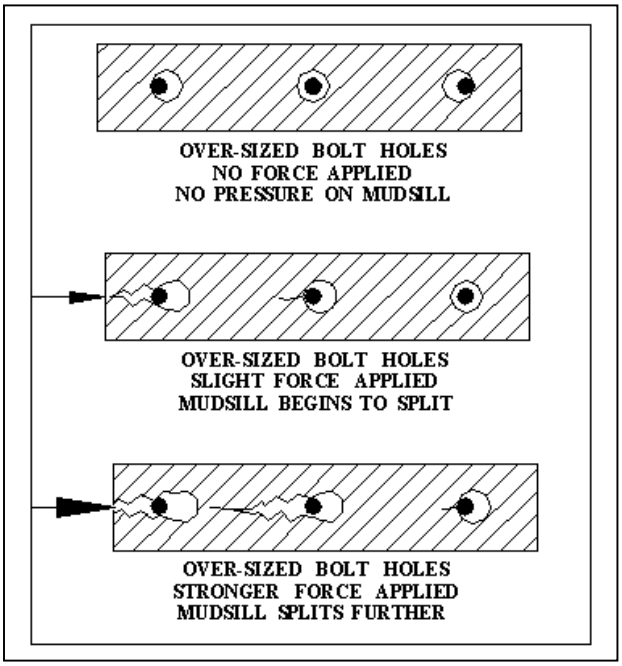
Understanding Your Retrofit

This is a typical newer house built on a level lot. It does not have cripple walls. Bolting was not required by the building code until 1958. If this house was built after this date, we know it was bolted with a ½ inch bolt placed every six feet on the perimeter foundation. However, even though it is bolted according to the code, it can still have structural weaknesses.

Oversized Holes

Usually bolts are installed in holes that are oversized. This is because oversized holes make it easier for a carpenter to build a house. The red arrow in the photo below represents earthquake forces pushing on the bolted mudsill. Your home has a 99% likelihood of having this problem.

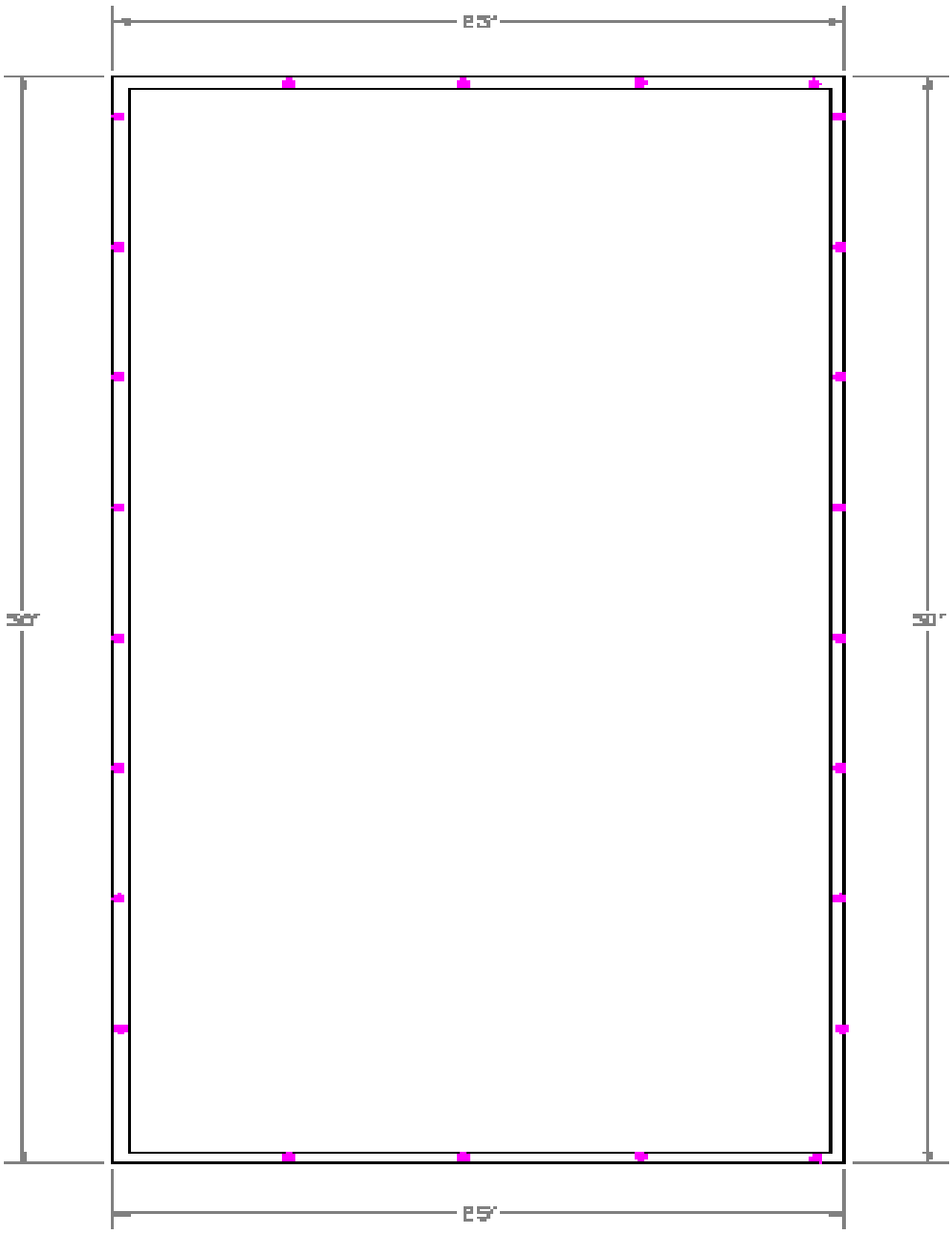


Oversized bolt holes will cause the house to slide on the foundation, at most a few inches, but will not cause a house to slide completely off the foundation.

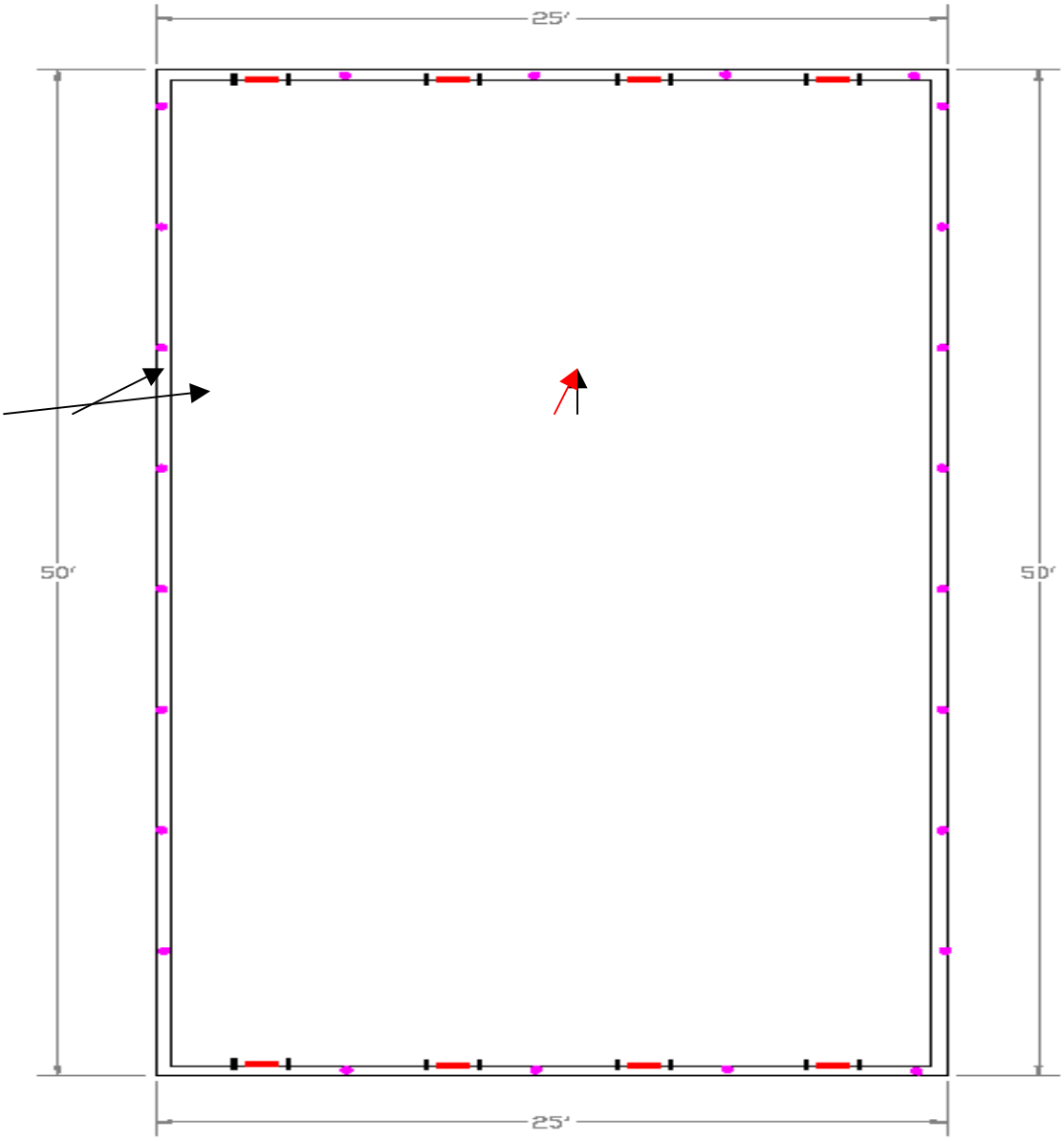
A good retrofit makes sure the house moves with the ground and foundation and does not slide so that pipes under the house do not break, cracks are much less likely in the plaster or sheet rock, windows are less likely to break, and doors are less likely to stick, etc.

The most cost-effective thing you can do to increase the earthquake resistance of your home is to add more bolts to the sides of the house that have the fewest number of bolts and therefore the greatest likelihood of slippage.

If you want to make sure you will not get slippage on any of the foundations, you can re-bolt all sides of the house. However, I think this is being over-cautious.

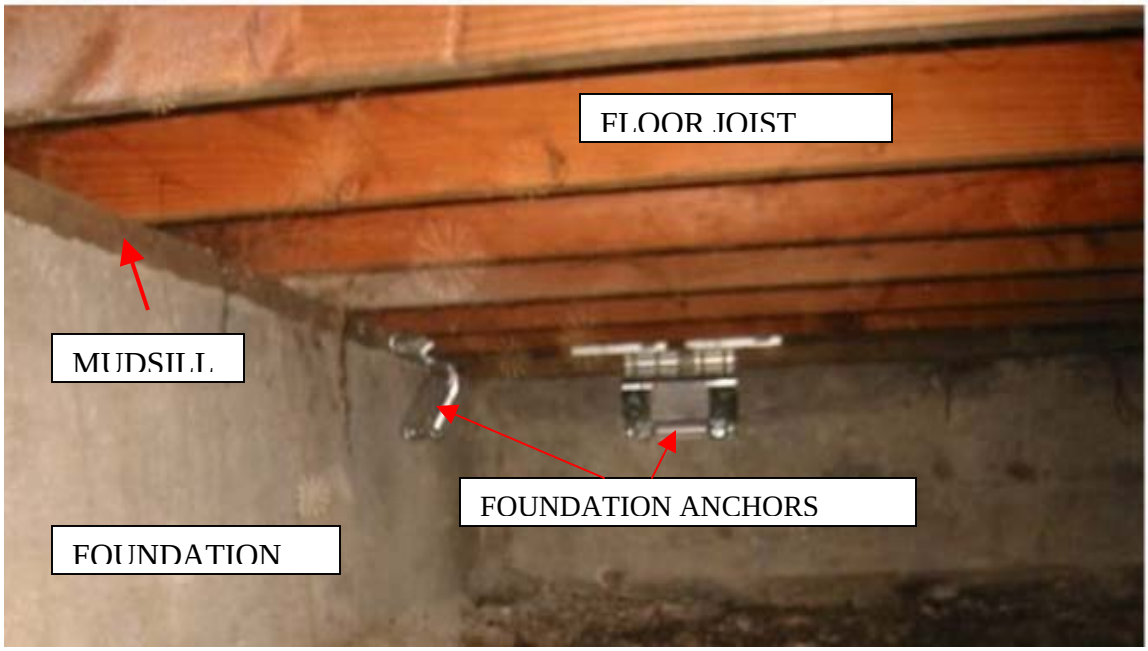


The pink dots represent bolts. If a rectangular house is bolted every six feet, there will be twice as many bolts on the long walls as on the short walls. This means this house is twice as earthquake resistant on the long walls as on the short walls and the failure point will be on the short walls.



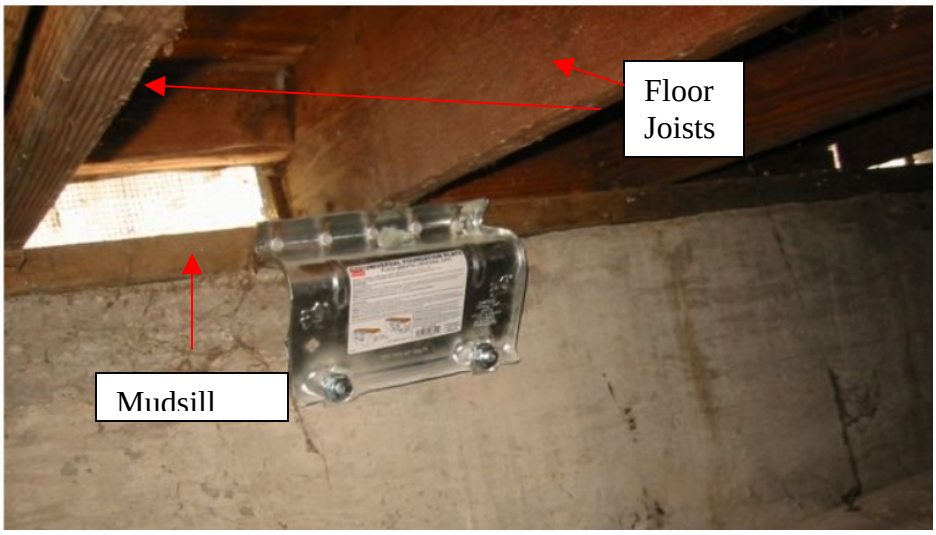
The red lines represent something called foundation anchors, which do the same thing as bolts. After adding these anchors, the bolting strength is now the same on each wall. The two short sides (top and bottom) of the house are now twice as strong as they had been and the earthquake resistance of this house has been doubled.

Foundation anchors also reduce slippage caused by oversized bolt holes. On the long walls the strength of the bolts should be sufficient to prevent slippage. If you want to make sure no slippage occurs on any of the foundations, a few people opt to re-bolt the entire house.

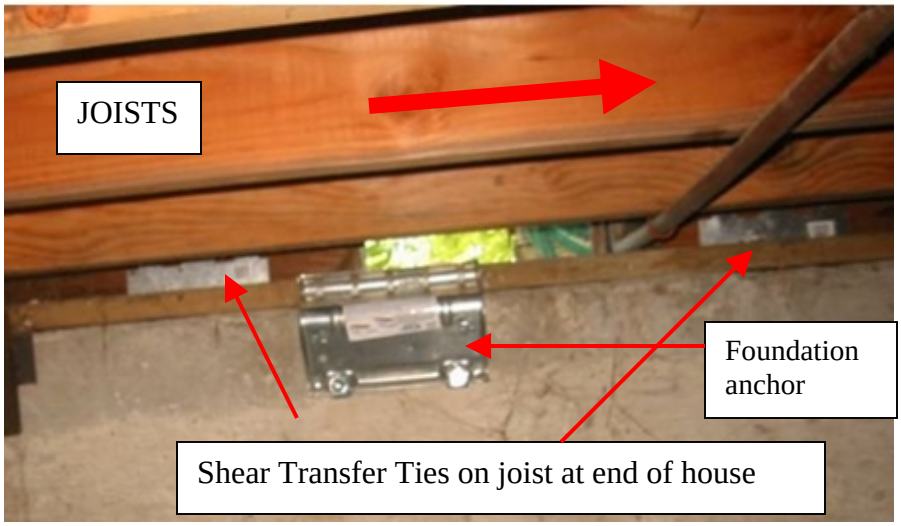


Foundation Anchors are bolted to the side of the foundation and mudsill. The mudsill is one part of the floor that can slide in an earthquake.

Here is an example of a failure when the floor slid off of the bolted mudsill. This is prevented with shear transfer ties. This failure occurred on the short side of the house.

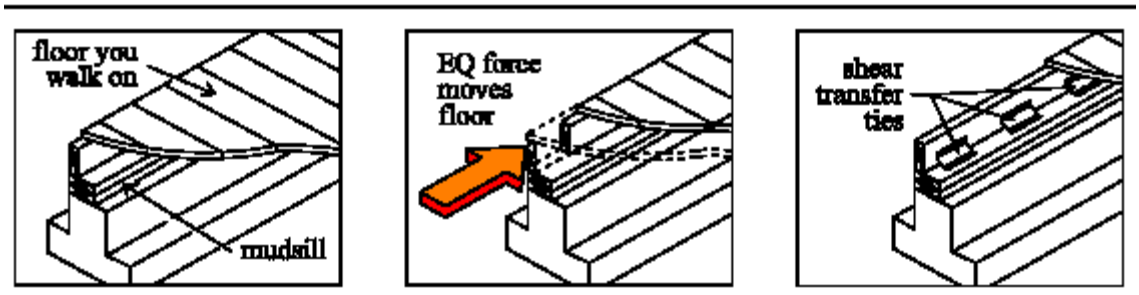


When the floor joists are perpendicular to the mudsill (usually the long sides of the house) they are almost always adequately nailed to the mudsill and no shear transfer ties are needed. This is because adequate nailing must be done as part of the construction process.



Here is a photo of floor joists that run parallel to the foundation. The joist sitting on the mudsill at the far end that has the foundation anchor attached to it is probably not adequately nailed and can slide off the mudsill and damage the house. This condition normally occurs on the front and back of the home and shear transfer ties are required.

Here is an example of another bolted house where the floor framing (floor joists) sitting on top of the foundation moved but did not slide off. The entire house shifted to the left and caused the front window break. The failure occurred on the short sides of the house.



Movement prevented by shear transfer ties.