

Earthquake-safe Buildings

Article 12. A Common Structural Weakness to Avoid: A Discontinuous Wall

For buildings that use walls to resist horizontal earthquake shaking, it is vitally important that the walls rise vertically from the foundations of the building and continue uninterrupted to roof level. This principle, that walls should be continuous, applies regardless of the material of construction, be it reinforced concrete or masonry. It also applies even if the walls are infill walls and are not primary structural elements. The strength and stiffness of infill walls mean that to a large extent they act as structural members even if not intended by the designers.

There are two main types of discontinuous wall layouts. The first is where a column and beam framework has all but one story infilled (Figure 1a). Usually the open story is at the ground floor. This arrangement most likely will lead to a soft story during a damaging earthquake. The danger of a soft story is discussed in the previous article, Article 11, of this series.

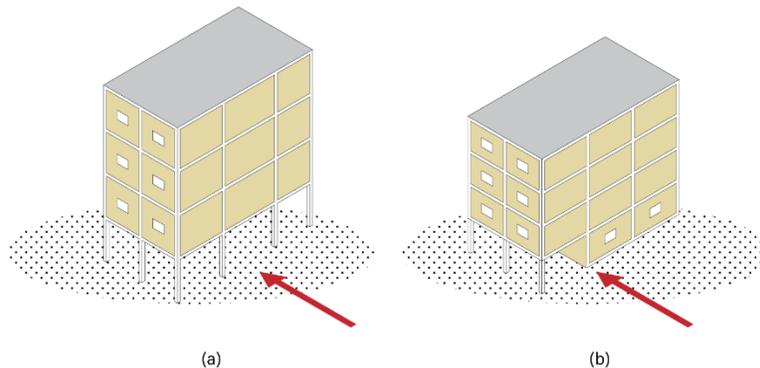


Figure 1. Two types of discontinuous walls. In (a) there are no infills at the ground floor, and in (b) the ground floor infill wall is off-set relative to the wall above.

The second type of discontinuous walls occurs where walls are off-set in plan (Figure 1b). There may be infill walls in every story, but at the ground level the wall is set back inside the building compared to the walls above. The upper walls therefore project out beyond the lowest wall (Figure 2). An off-set creates a serious local weakness in a wall, especially when it tries to resist horizontal earthquake forces. An off-set wall is like a tree with a kink in it (Figure 3). A strong wind will probably break the tree at the kink. Forces within any structure don't like changing direction abruptly. So, how to overcome this problem?



Figure 2. Buildings with off-set infill walls line this street.



Figure 3. A kink in a tree trunk introduces a local weakness.

The best approach is to ensure an off-set wall is not structural. Other structural elements within the building, like beam and column frames must be designed to resist earthquake forces in the direction parallel to the wall. At the design stage, the masonry of any proposed offset wall should be replaced by non-combustible light-weight material, like cement board or glazing. These are too weak to act as structural elements during an earthquake. Alternatively, separate any off-set masonry wall from its structural frame to prevent the wall functioning as structure (see Article 10).

About this article series:

This is a series of articles about earthquakes, their effects on buildings, and how to ensure that buildings are safe against earthquakes. They are intended for potential owners of new houses and larger buildings and others involved in the building industry. The articles are written by Andrew Charleson and colleagues from the World Housing Encyclopedia (<http://www.world-housing.net/>) which is sponsored by the Earthquake Engineering Research Institute (<https://www.eeri.org/>) and the International Association of Earthquake Engineering (<http://www.iaee.or.jp/>).

References:

Charleson, A. W., 2008. Seismic design for architects: outwitting the quake. Oxford, Elsevier, pp. 151-153.