THE ACTION OF SHORT COLUMNS AT REINFORCED CONCRETE BUILDING CONSTRUCTIONS

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Abstract: *This article presents the behavior of short columns at reinforced buildings to seismic forces, and these are classified in certain types of short columns, which can be appeared in building constructions such as: short columns at constructions placed on a sloping ground, short columns in buildings with intermediate floor, mezzanine (technical floor), short columns at walls which don't form continuity on height until to the next floor.*

Key words: *short columns, long columns, seismic forces.*

1. The Action of Short Columns

Why short columns bring more damaged during the earthquakes?

During earthquakes the buildings with reinforced concrete frames that have columns with different heights at the same level, short column, suffers a significant destructions comparative with usual taller columns. Two examples are shown in the Figure 1 with short columns:

a) civil building placed on sloping ground;

b) civil building with technical floor (mezzanine).

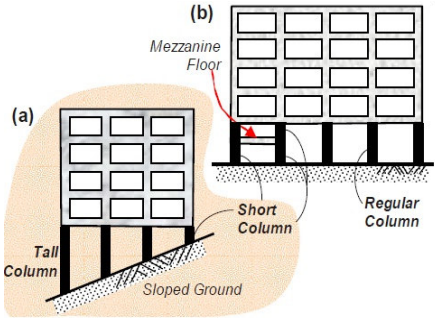

Fig. 1. *Building with short columns* [2]

Short column attracts larger earthquake forces more than tall column, stiffness of a column means resistance to deformation (Figure 3). If a short column is not adequately designed for such a large force. This behavior is called *Short Column Effect*. In the drawing, shown in the Figure 2, short column increase the shear force value 8 times, comparative with relative tall columns usually used in civil buildings.

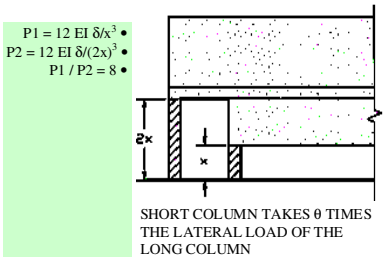

Fig. 2. *The ratio between the forces applied to the short columns and long columns*

In buildings, placed in seismic zones which are resistant to earthquake it is not admitted the damage at structural elements

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under the action of the shear forces, but except section deformation under the effect of the moments.

Fig. 3. *The civil building with cracked short columns*

The bending moment of plastic joint from the elastic-plastic behavior scatters the energy which is produced in the structure. During an earthquake, the transversal sections of the long columns and the short columns are displaced horizontally with same amount Δ (Figure 4).

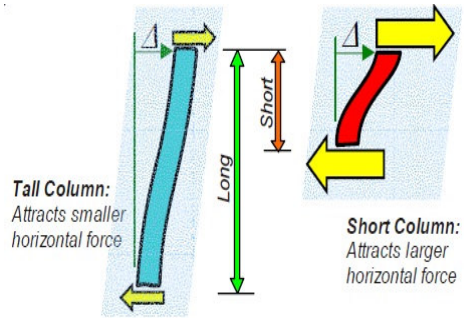

Fig. 4. *Short columns attracts shear forces more than the tall columns* [2]

The short columns attract a lot of shear force produced by the lateral seismical force. If the short columns are not designed to resist a large earthquake force, the column is damaged and cracks in X shape (Figures 5 and 6).

Fig. 5. *Short columns damaged, in the form of X-shaped cracking* [2]

Fig. 6. *Short columns damaged, in the form of X-shaped cracking*

2. The Behavior of Short Columns during Earthquakes

Many situations with short column effect arise in buildings. When a building is rested on sloped ground (Figure 1a), during earthquake shaking all columns move horizontally by the same amount along with the floor slab at a particular level (this is called *rigid floor diaphragm action*). If short and tall columns exist within the same storey level, then the short columns attract several times larger earthquake force and suffer more damage as compared to taller ones. The short column effect also occurs in columns that support mezzanine floors or loft slabs that are added in between two regular floors (Figures 1b). There is another special situation in buildings when short-column effect occurs. Consider a wall (*masonry* or *RC*) of partial height built to fit a window over the remaining height. The adjacent columns behave as short columns due to presence of these walls. In many cases, other columns in the same storey are of regular height, as there are no walls adjoining them. When the floor slab moves horizontally during an earthquake, the upper ends of these columns undergo the same displacement (Figure 7).

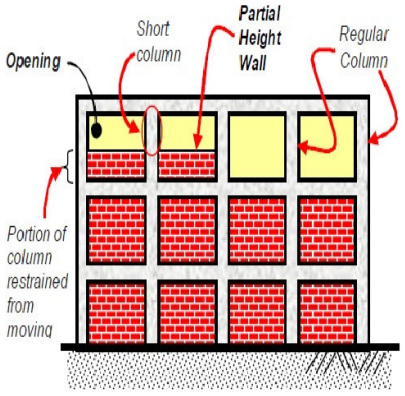

Fig. 7. *Walls with short columns and long columns at the same level* [2]

However, the stiff walls restrict horizontal movement of the lower portion of a short column, and it deforms by the full amount over *the short height* adjacent to the window opening. On the other hand, regular columns deform over the *full height*. Since the effective height over which a short column can freely bend is small, it offers more resistance to horizontal motion and thereby attracts a larger force as compared to the regular column. As a result, short column sustains more damage. Figure 4 shows X-cracking in a column adjacent to the walls of partial height.

3. What is the Solution?

In new building, short column effect should be avoided to the extent possible during architectural design stage itself. When it is not possible to avoid short column, this effect must be addressed in structural design. For ductile detailing of RC structures requires special confining reinforcement to be provided over the full height of columns that are likely to sustain short column effect. The special confining reinforcement (i.e, closely spaced closed ties) must extended beyond the short column into the columns vertically above and below by a certain distance as shown in Figure 8.

In existing building with short columns between two regular floors is willed to avoid the effect of short columns closing the openings by building a wall of full height. If that is not possible, short columns need to be strengthened using one of the well established retrofit techniques. The retrofit solution should be designed by a qualified structural engineer with requisite background.

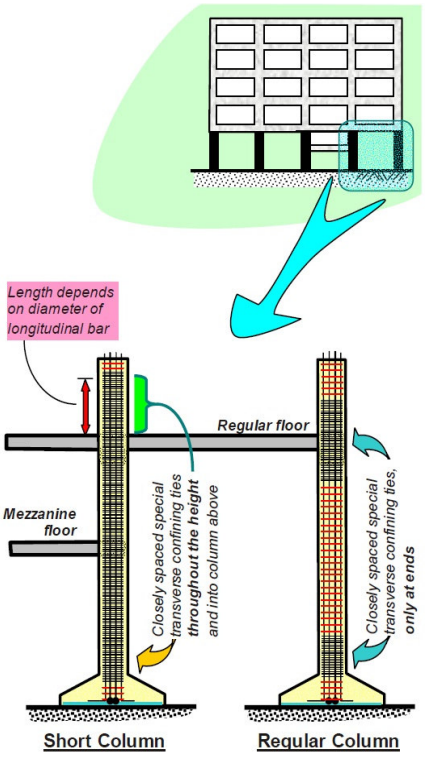

Fig. 8. *Reinforcement details* [1]

References

1. Alabadi, A.: *Training Centre of Jordan Engineering Association*. Amman, Jordan.
2. Murty, C.V.R.: *Indian Institute of Technology Kanpur*. Kanpur, India.