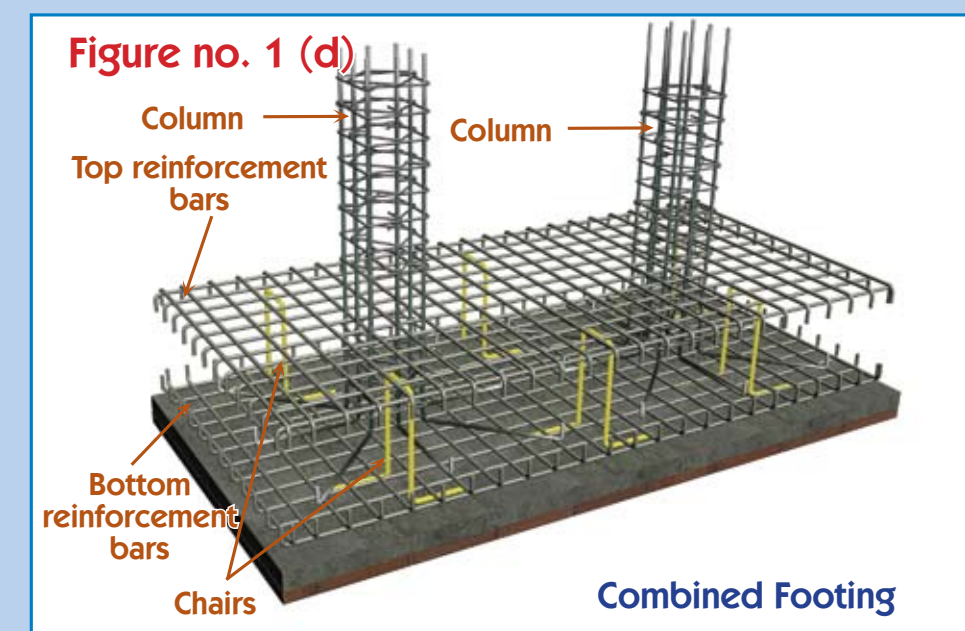
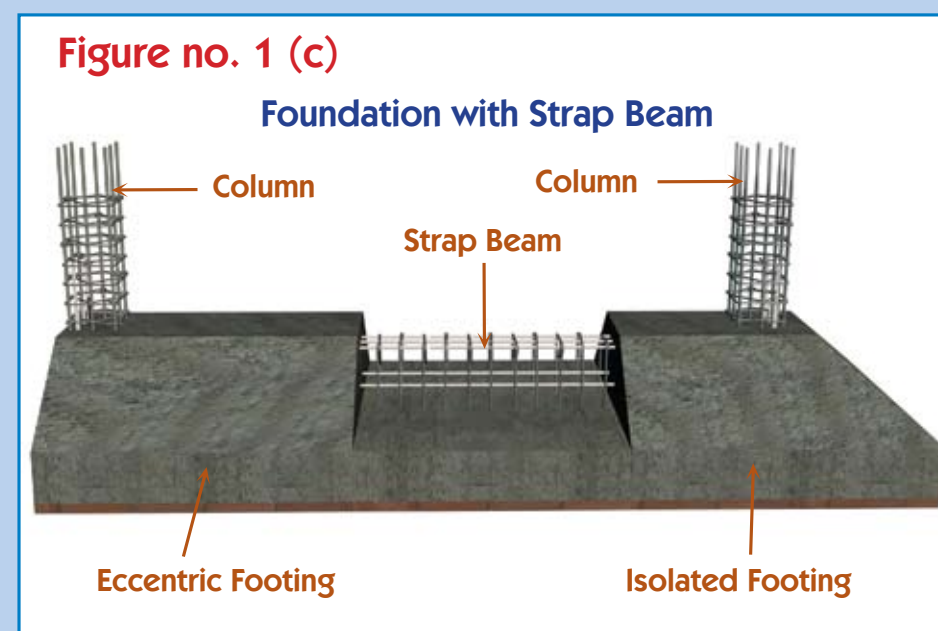
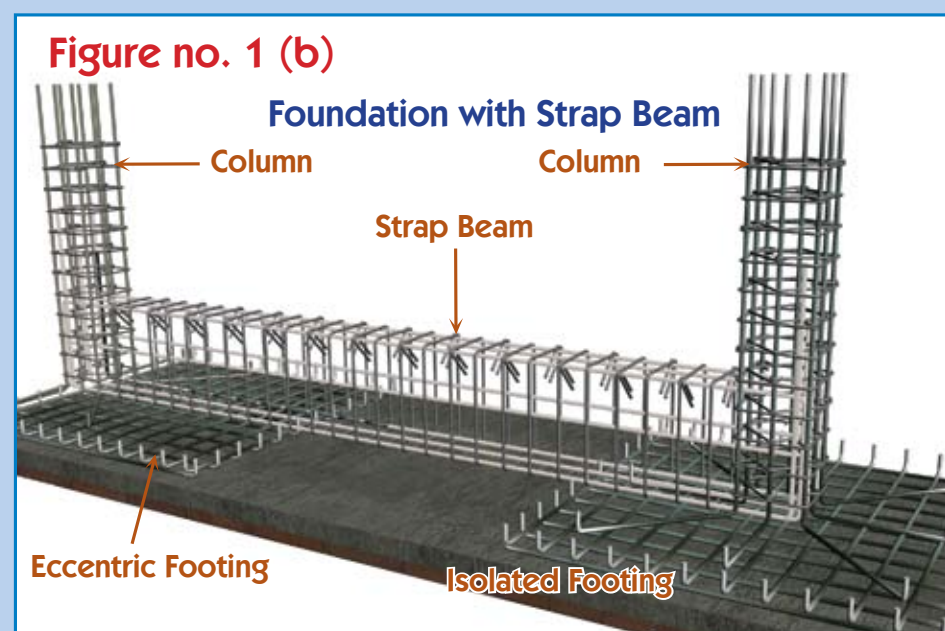
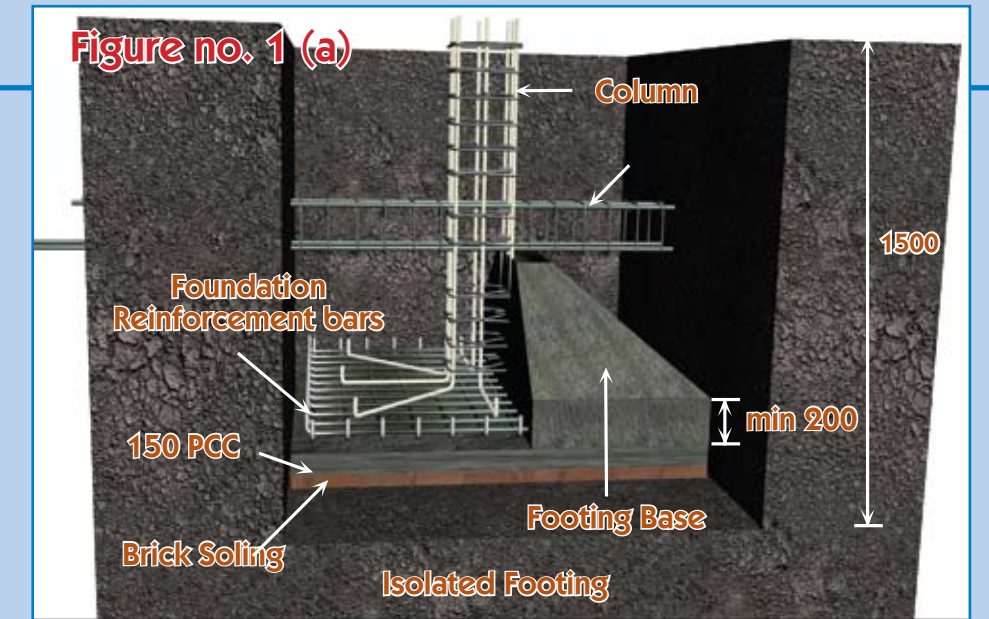


# Recommendations for construction of Earthquake Safer Buildings

## For RCC Frame Structure buildings up to three stories (For Buildings with room sizes up to 3.0 x 4.5m)

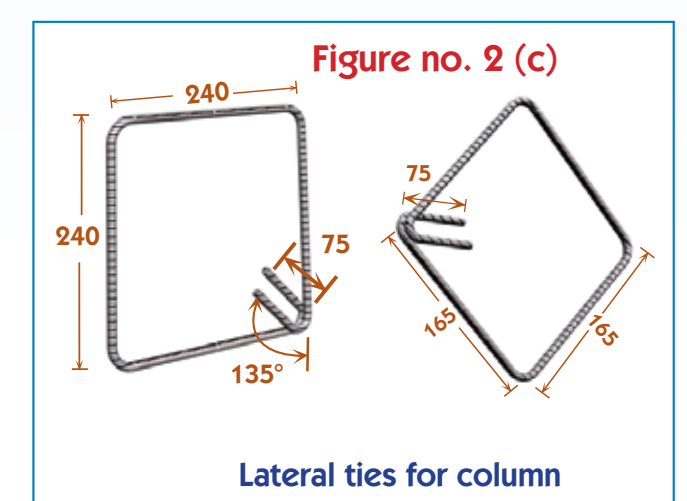
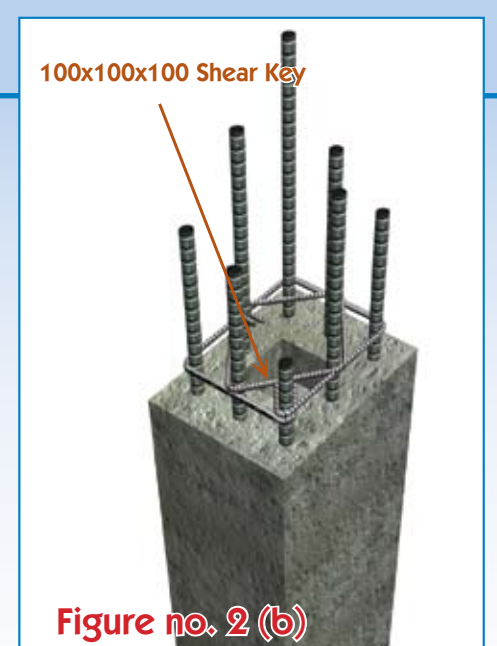
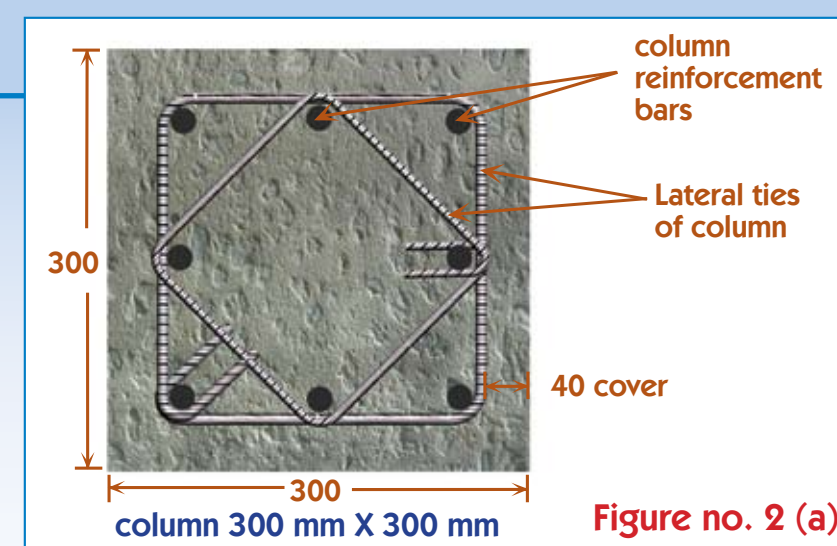
### 1. Construction of Foundations

- » The minimum depth of foundation should be up to 1500 mm.
- » Foundation should not be laid on filling soil and should go up to original firm soil.
- » The thickness at side of sloped footing should be minimum of 200 mm.
- » If columns are located at property line of neighboring plot either combined footing or strap beams should be constructed to avoid the eccentricity of foundation.
- » When the columns are located very close combined footings should be provided. The thickness of footing, numbers, size and layers of reinforcement bars (single or double layer) depend upon the load in foundations.
- » Vibrators must be used during concreting works in foundation.



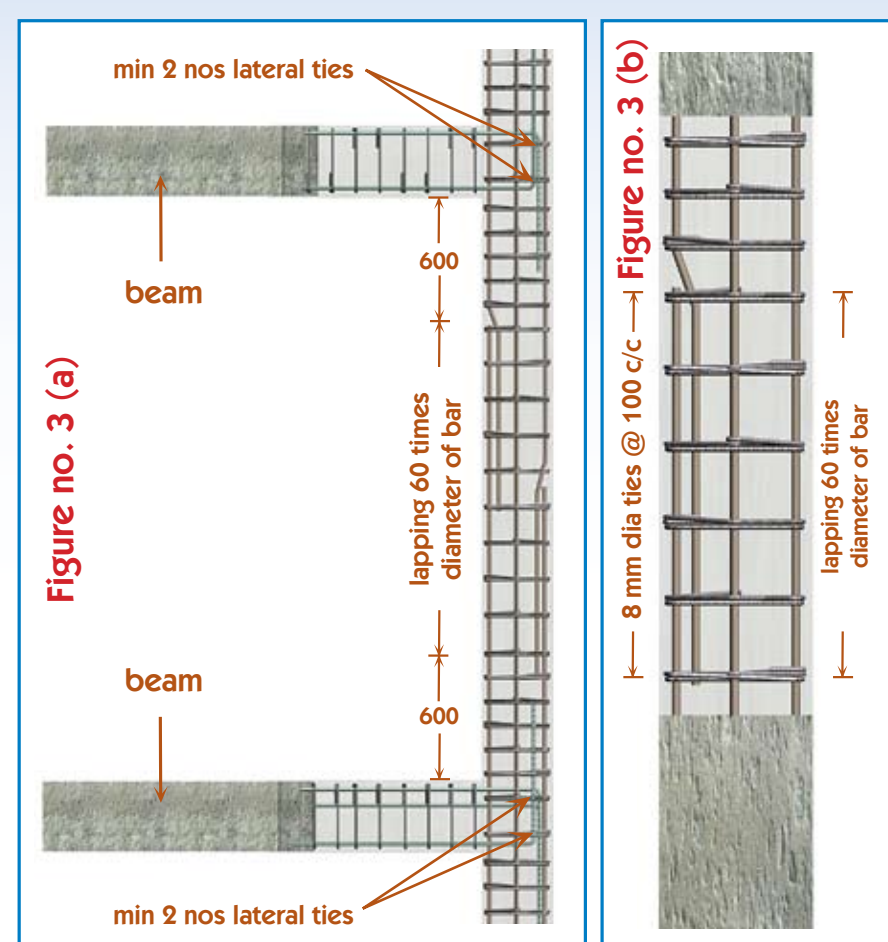
### 2. Construction of Columns

- » Columns should be comparatively stronger as all vertical loads of building transfer to the foundations through columns and as well as they withstand lateral seismic forces generated by earthquake.
- » All columns should be in grid in both direction in plan.
- » The minimum sizes of columns for building up to three stories with room sizes not more than 4.5 m. x 3.0 m. should be 300 mm x 300 mm or 75 mm more than width of beam.
- » There should be minimum 4 numbers of 16mm diameter reinforcement bars in columns located in outer faces of building and minimum 8 numbers of 12 mm diameter reinforcement bars in columns located at centers.
- » 8mm reinforcement bars should be used for lateral ties. The spacing of ties below the foundation should be 100 mm c/c up to tie beam. In the superstructure the spacing of ties should be 100 mm c/c up to 600 mm above and below the beam bottom/top and 150 mm spacing in mid height of columns. The length of hooks of ties should be 75 mm and should be bent in 135° inside the column as shown in figure no. 2 (d).
- » The ratio of concrete mix should be preferably M20 (1 cement : 1.5 sand : 3 aggregates) with concrete cover 40 mm (clear distance from face of column/formwork to the vertical reinforcement).
- » The formwork should be removed only after 24 hours of concreting. The curing of columns should be carried properly by putting water on the column surfaces for minimum 7 days. Jute bags can be used to cover the column surfaces during curing to keep the surfaces wet.
- » Shear key of size 100 x 100 x 100 mm should be provided at the top surface of the column to avoid cold joint between old and new concrete and to strengthen the column as shown in the figure 2 (b).



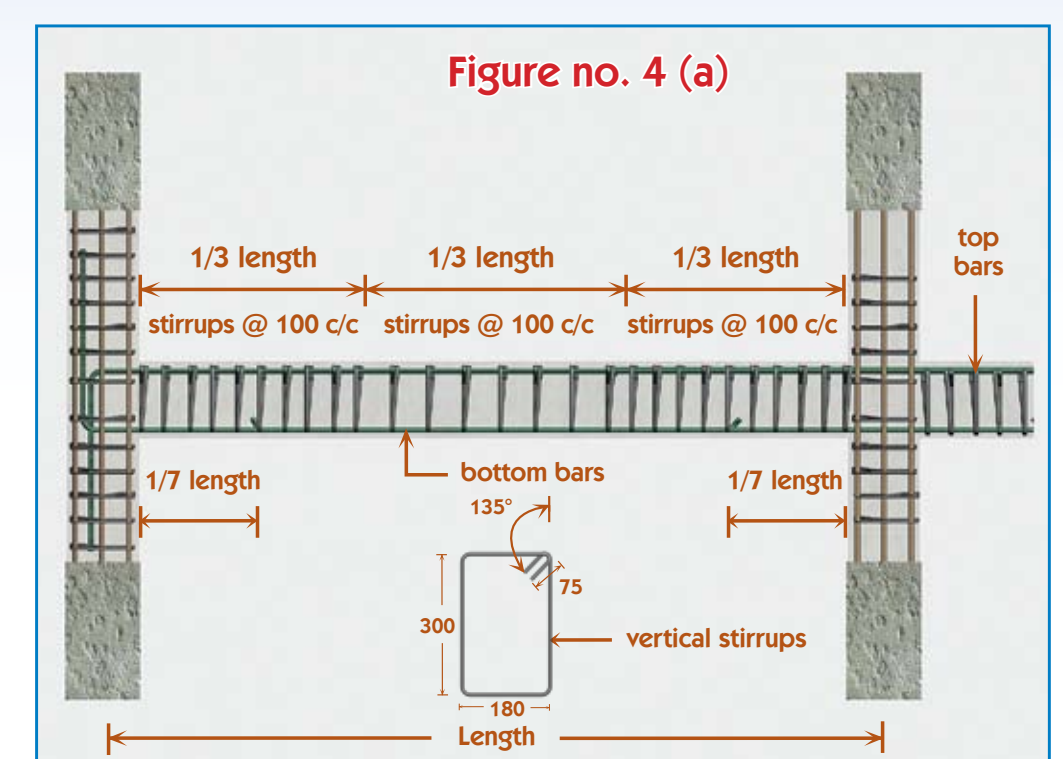
### 3. Lapping in Columns

- » The lapping in columns should be at the mid height of column starting from 600 mm from top of beam or ending up to 600 mm from bottom of beam as shown in figure no. 3 (a).
- » The reinforcement bars should not be lapped at one level i.e. should be lapped in staggered position aligned in a vertical line as shown in figure no. 3 (b).
- » The lapping length should be 60 times the diameter of reinforcement bars (for concrete mix 1:2:4). The spacing of lateral ties should be 100 mm c/c through out the length of lapping.



### 4. Construction of Beams

- » There should be minimum 2 nos of 16 mm diameter reinforcement bars at top and bottom of beams.
- » Extra bars should be provided at support and span as per the length of beams
- » Extra top bars should be provided up to 1/3 span of beam measured from the inside face of the columns and extra bottom bars should be provided at mid span leaving 1/7 length of beam measured from inside face of column in both sides.
- » The minimum size of vertical stirrups should be 8 mm diameter. The spacing should be 100 mm c/c at 1/3 span of beam at supports and 150 mm c/c at remaining mid span of beam.



Based on Nepal National Building Code



Government of Nepal  
Ministry of Physical Planning and Works  
**Earthquake Risk Reduction and Recovery Preparedness Programme for Nepal**  
(UNDP/ERRRP-Project: NEP/07/010)

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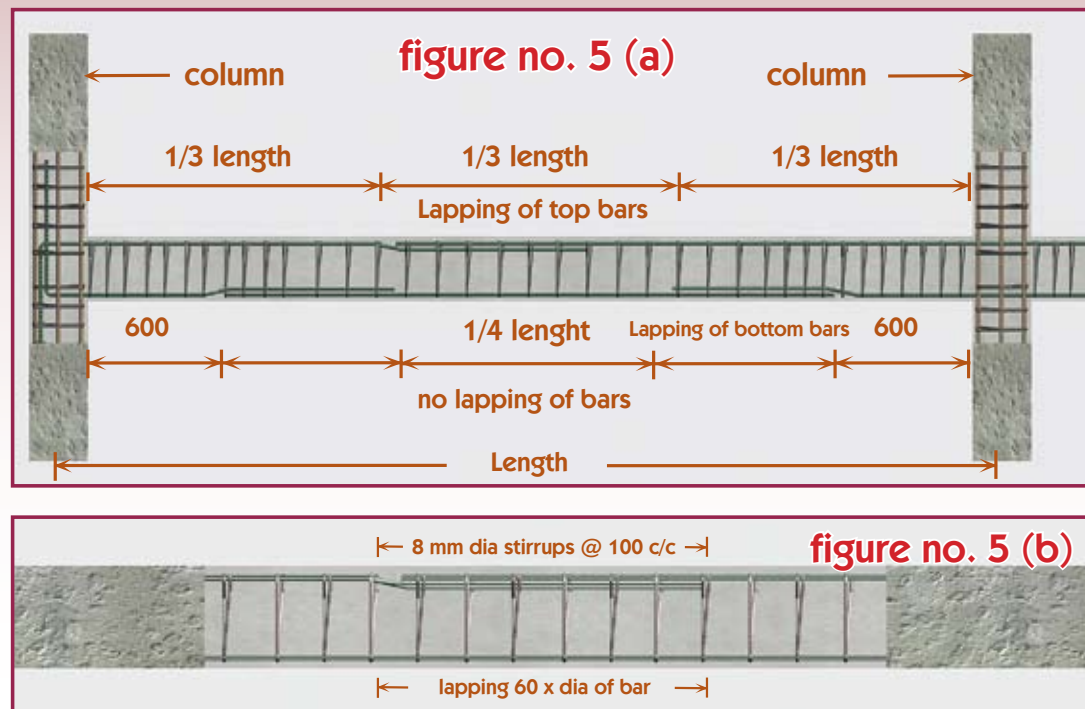


# Recommendations for construction of Earthquake Safer Buildings

## For RCC Frame Structure buildings up to three stories (For Buildings with room sizes up to 3.0 x 4.5m)

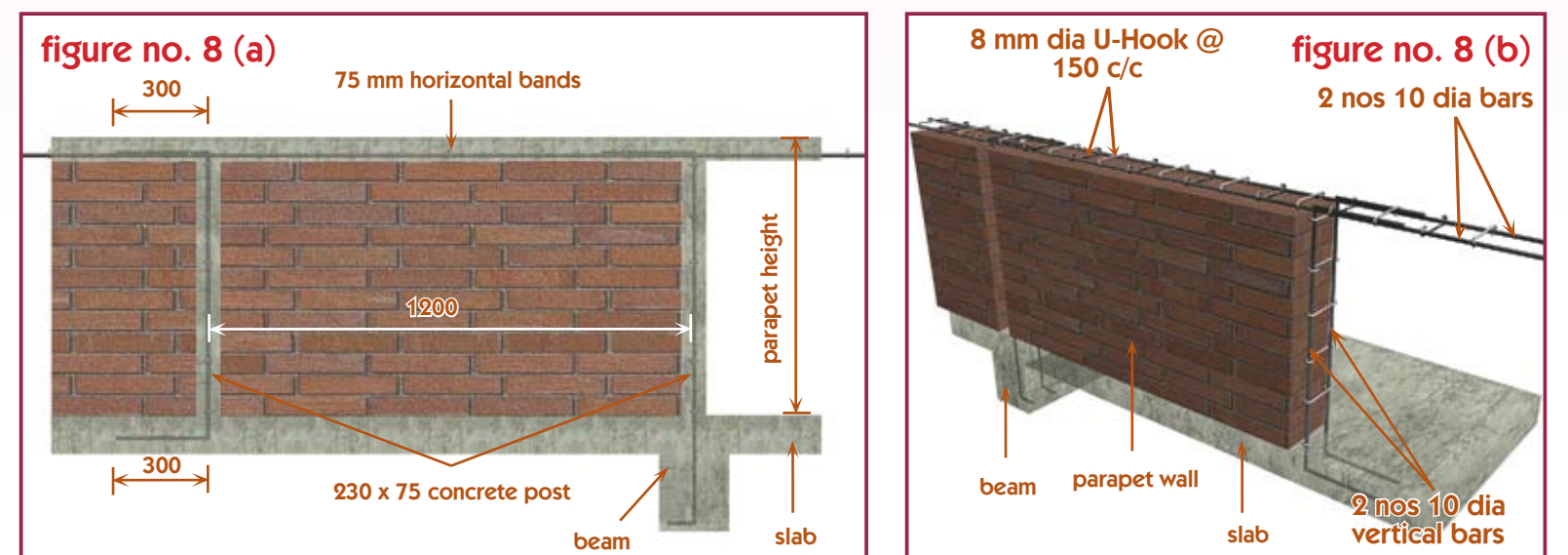
### 5. Lapping in Beams

- Reinforcement bars at bottom should not be lapped at mid  $\frac{1}{4}$  span of beam and should be lapped at edges 600 mm away from column faces.
- Reinforcement bars at top should be lapped at mid  $\frac{1}{3}$  of span of beam.
- The lapping length should be 60 times the diameter of reinforcement bars (for concrete mix 1:2:4). The spacing of vertical stirrups should be 100 mm c/c through out the length of lapping.
- The minimum size of stirrups should be 8 mm diameter.



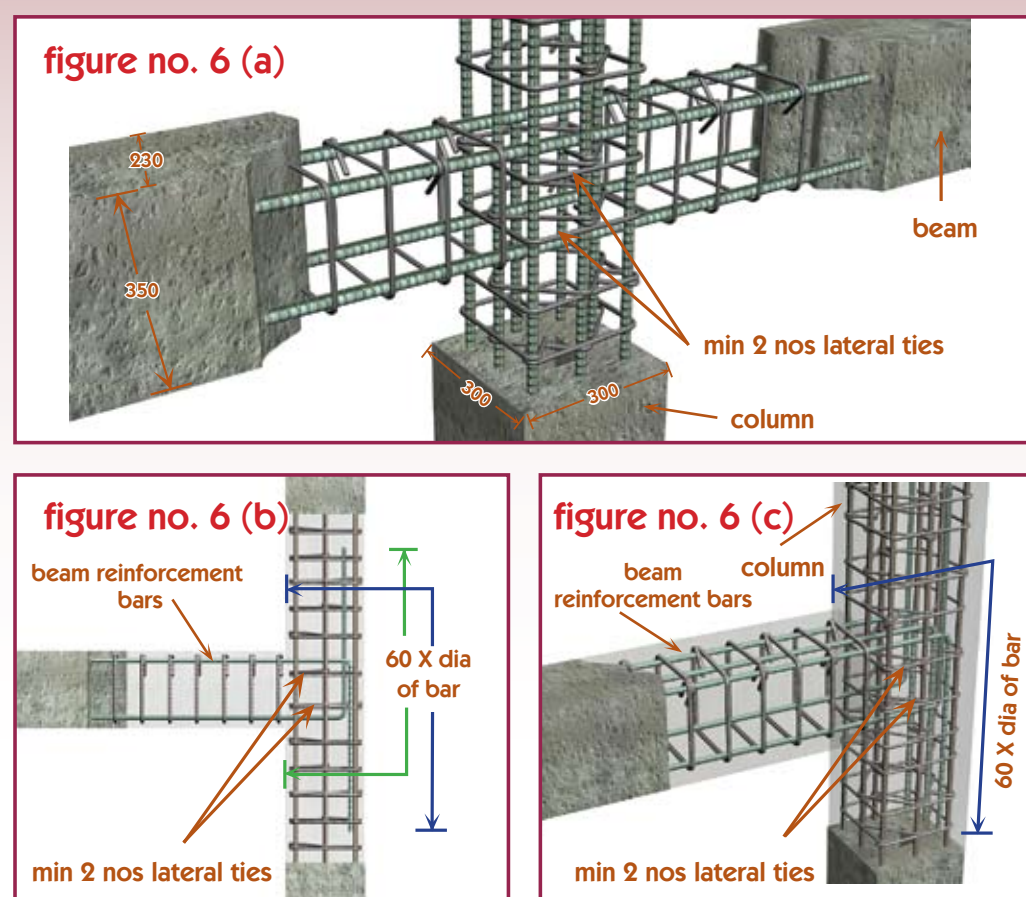
### 8. Construction of Parapet Bands

- Parapet bands should be provided to safeguard parapet walls at terrace and walls at verandahs.
- Concrete posts of size 230 x 75 mm with 2 nos 10mm diameter tied with 8 mm diameter U-hooks should be erected at 100 mm spacing from beams/slabs as shown in figure no. 8 (a, b).
- The concrete posts should be tied up at top with 75 mm thick horizontal concrete bands with 10 mm diameter bars tied with 8 mm diameter U-hooks.



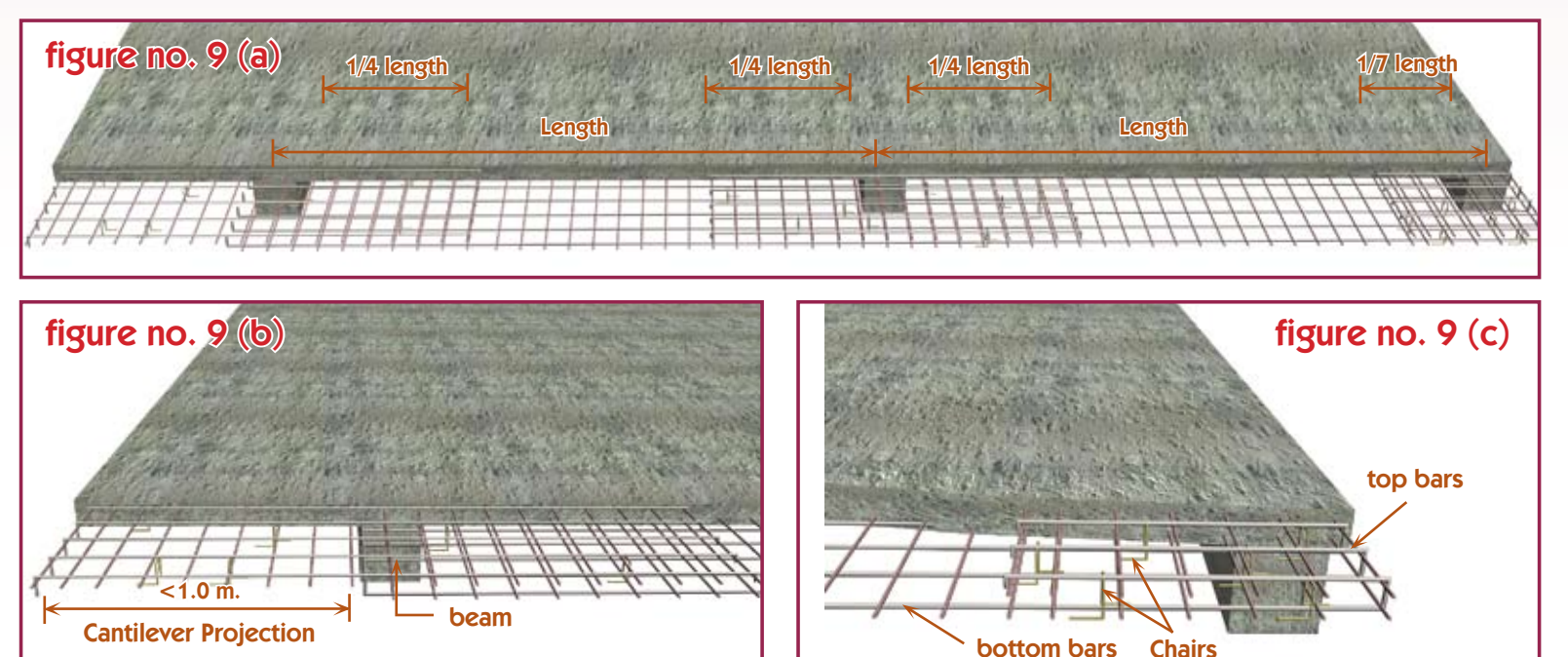
### 6. Beam and column joint

- All reinforcement bars of beams should pass inside the vertical bars of columns.
- Reinforcement of beams at the ending should be bent upwards/downwards inside the column up to 60 times diameter of development length. Bottom bars should be bent upwards and top bars should be bent downwards. The development length should be measured from the inside face of column as shown in figure no. 6 (b, c).
- Minimum two numbers lateral ties should be provided at beam & column joint as shown in figure.



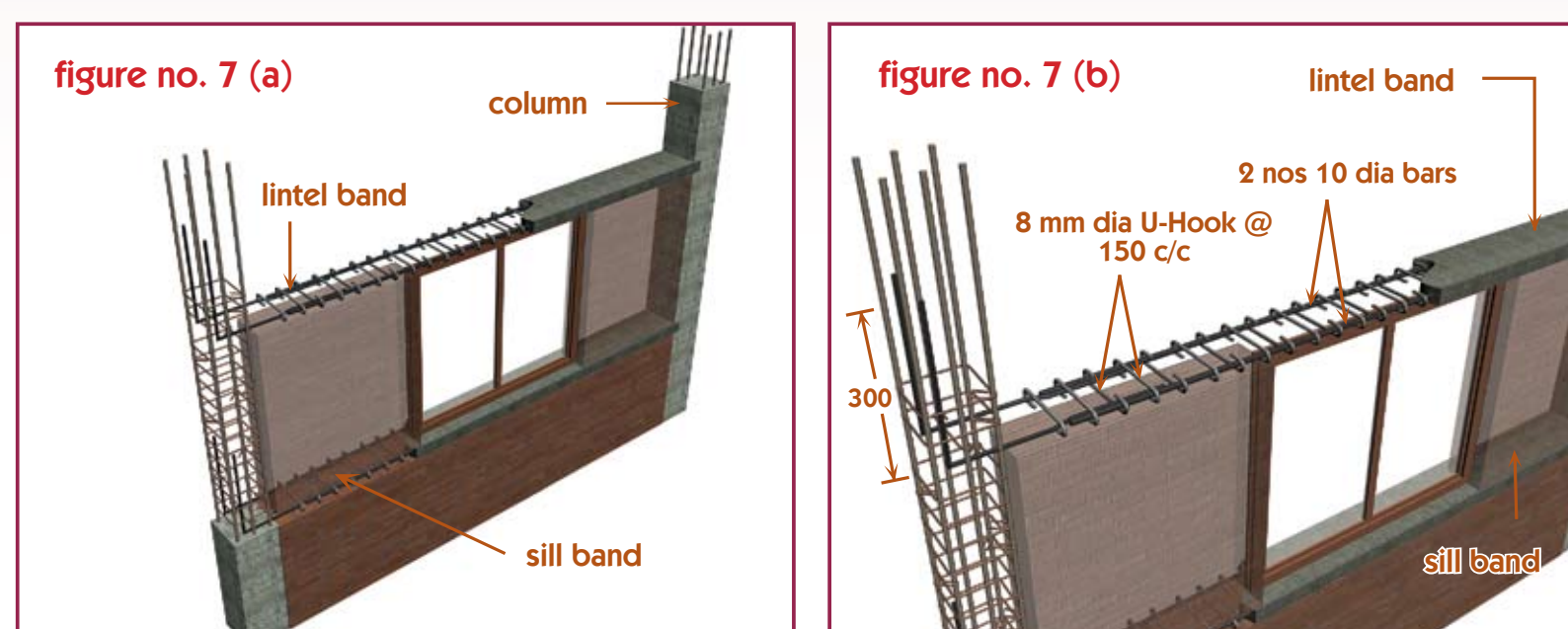
### 9. Construction of Slab

- For slab panel of size 4.5 m x 3.0 m reinforcement bars of 8 mm diameter can be provided at 150 mm spacing.
- For top projections up to 1.0 m, extra bars of 10 mm diameter should be provided.
- Chairs (10 mm diameter) should be provided for placing the top bars in position as shown in figure.
- Cover blocks (1 Cement :1 Sand) mortar of 15 mm thickness should be used for bottom bars.



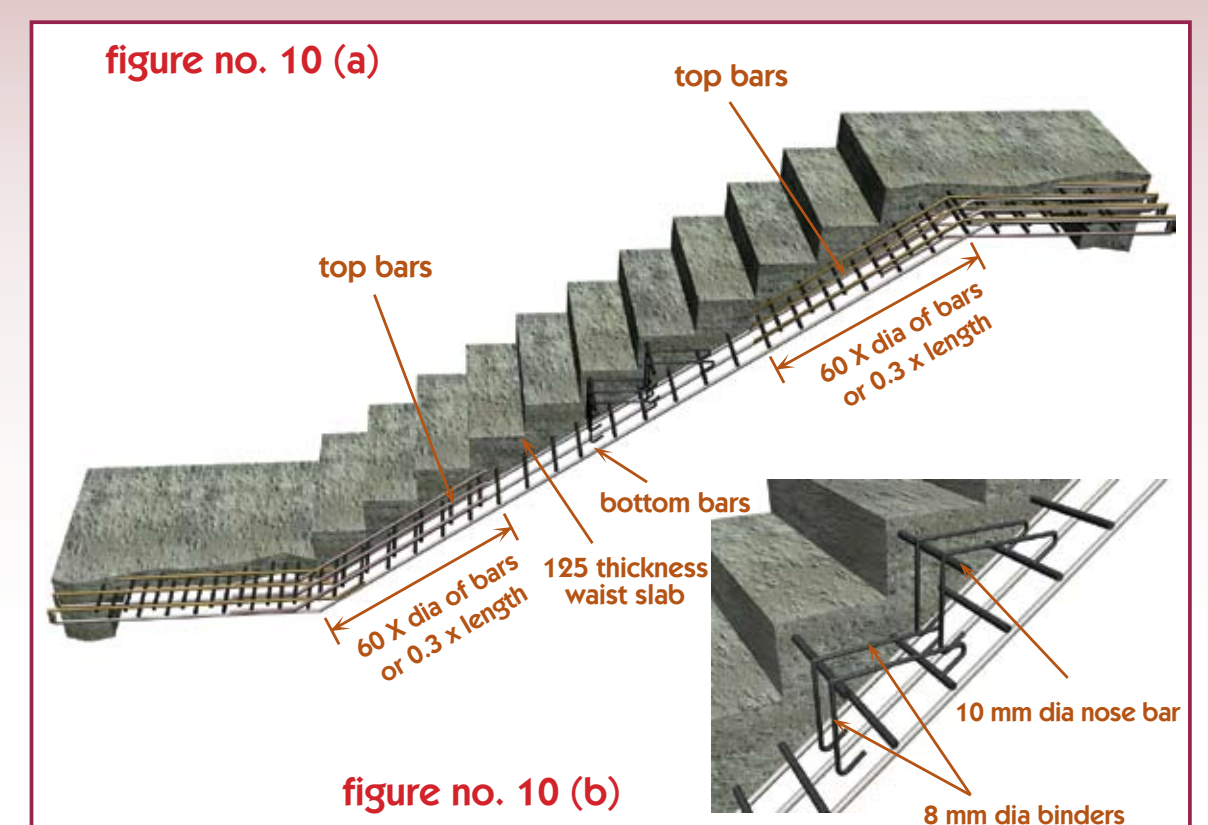
### 7. Sill and Lintel Bands

- To prevent the infill walls from falling out these shall be provided with horizontal reinforced concrete (RC) bands through the wall at about one-third and two-thirds of their height above the floor in each height (at sill and lintel level of openings)
- The RC bands should be tied up with columns abutting the wall by anchoring longitudinal bars fully with U-bars projected from columns
- The width of the band should be equal to the wall thickness and its thickness equal to that of the masonry unit or 75 mm, whichever is larger.



### 10. Construction of Staircase

- The minimum thickness of waist slab should be 125 mm.
- Top bars should be curtailed up to 60 times diameter length or  $\frac{1}{3}$  length of slope portion of waist slab which is greater that has to be measured from starting/ending of slope.
- Nose bars of 10 mm diameter should be provided at every step tied up by 8 mm diameter binders @ 300 mm c/c as shown in figure no. 10 (b).



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