Columns Detailing

Chapter 3
Section

3-3

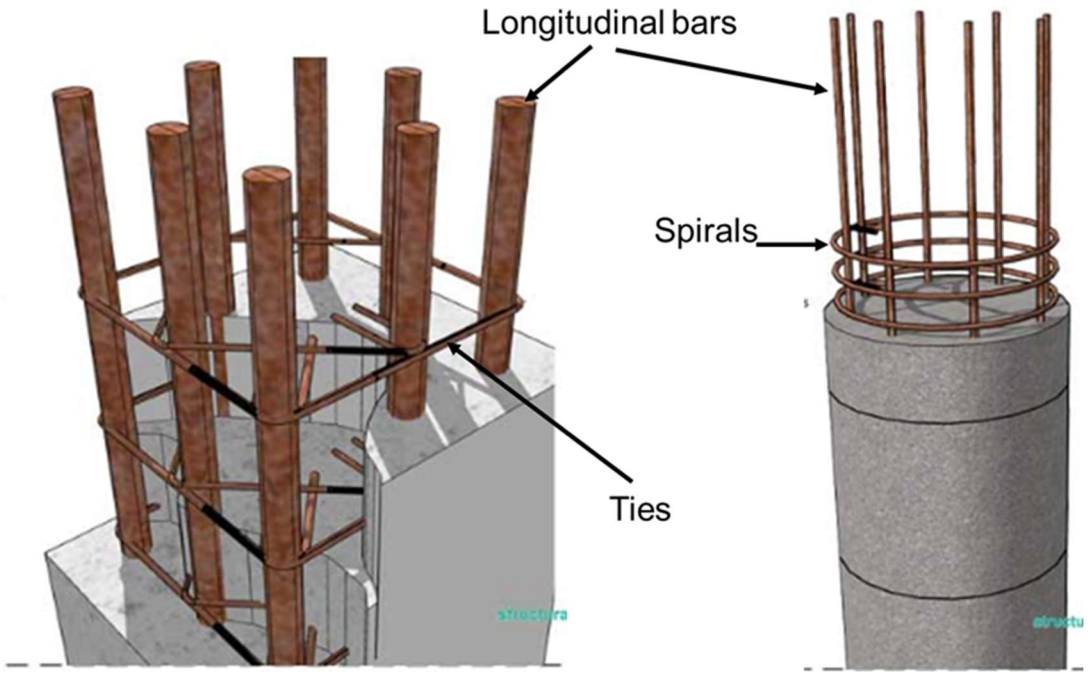
Introduction

- Columns are structural elements with a breadth/thickness ratio less than 3 to 4 that support loads from the floors and roof slabs and transfer these loads to the footings.
- Columns may be square, rectangular, circular or any of a variety of shapes in cross-section.

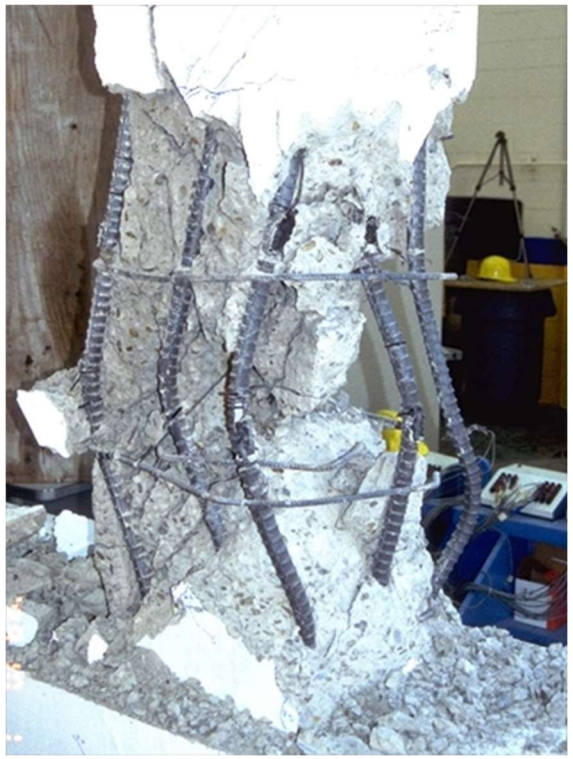
- Although columns are designed to carry vertical loads, stress in columns also includes uniaxial bending stress, biaxial bending stress and shear stress in addition to axial stress.

Types of reinforcement

1. Longitudinal bars - Main bars: to resist compression loads and mainly tension force due to bending
2. Transverse reinforcement: to resist shear forces if any and to support longitudinal bars and prevent bars buckling. This includes:
   - Ties (Tied Columns)
   - Spiral (Spirally-Reinforced Columns)
   - Links



Typical Columns Reinforcement



Buckling of main bars in columns

Design and detailing requirements

1. **Concrete grade**: it shall be noticed that Concrete grade is important in column, detailer have to check and verify the grade that has been used by the designer. Concrete grades less than 28/35 MPa (cylinder strength/ cube strength) are not normally used.
2. **Minimum number of bars** is 4 and 6 for rectangular and circular columns respectively. The recommended minimum bar diameter is 16mm. Total number of bars shall be even to ensure symmetrical distribution to two or four sides.
3. **Minimum Cross Sectional Dimensions**: although there is no limit to column size in the code for vertical load design, it is recommended that the least dimension of the column cross section shall be ≥ 250mm. For practical considerations, column dimensions are taken as multiples of 5 cm.
4. **Clear Distance between Reinforcing Bars:** ACI specify that for tied or spirally reinforced columns, clear distance between bars shall not to be less than the larger of 1.50 times bar diameter or 4 cm.

Design and detailing requirements

5. Lateral Reinforcement

- **Ties (stirrups) and links**

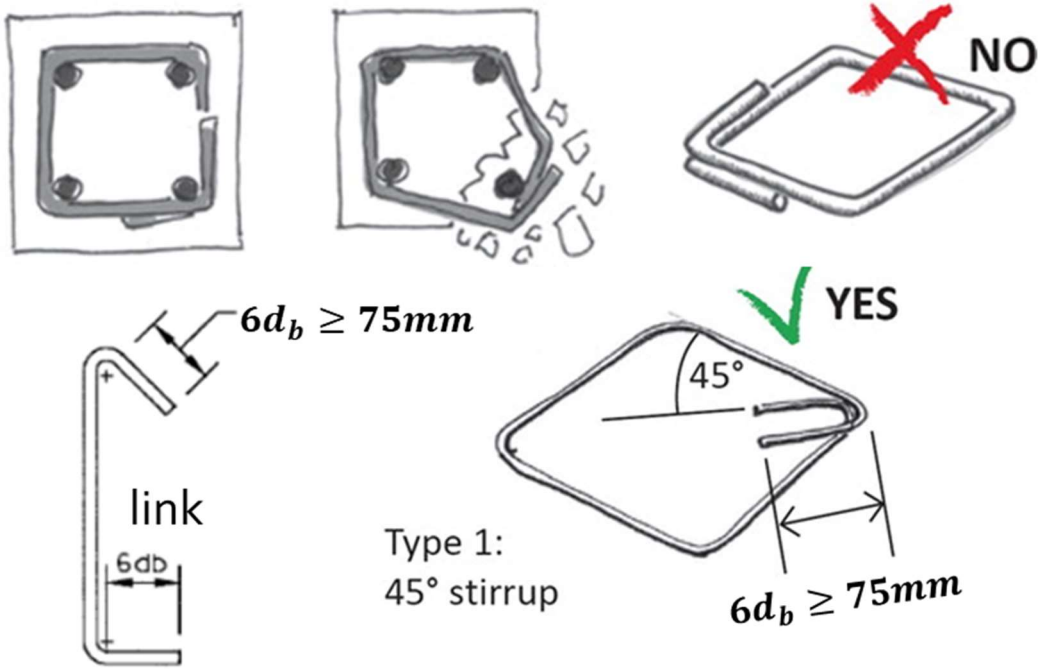
Size

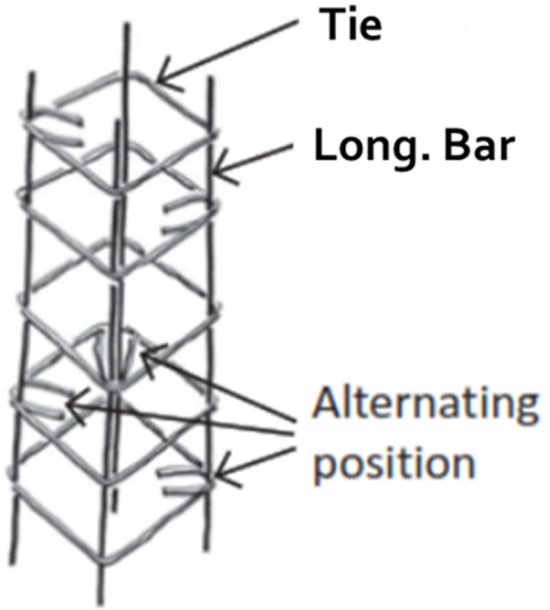
$\geq$ Φ10 mm bar if longitudinal bar $\leq$ Φ32 mm bar
$\geq$ Φ 12mm bar if longitudinal bar $\geq$ Φ36 mm bar
$\geq$ Φ 16mm bar if longitudinal bars are bundled

Vertical spacing

$s \leq 16\ d_b$ (d_b for longitudinal bars)
$s \leq 48\ d_t$ (d_t for tie bar)
$s \leq$ least lateral dimension of column

Arrangement



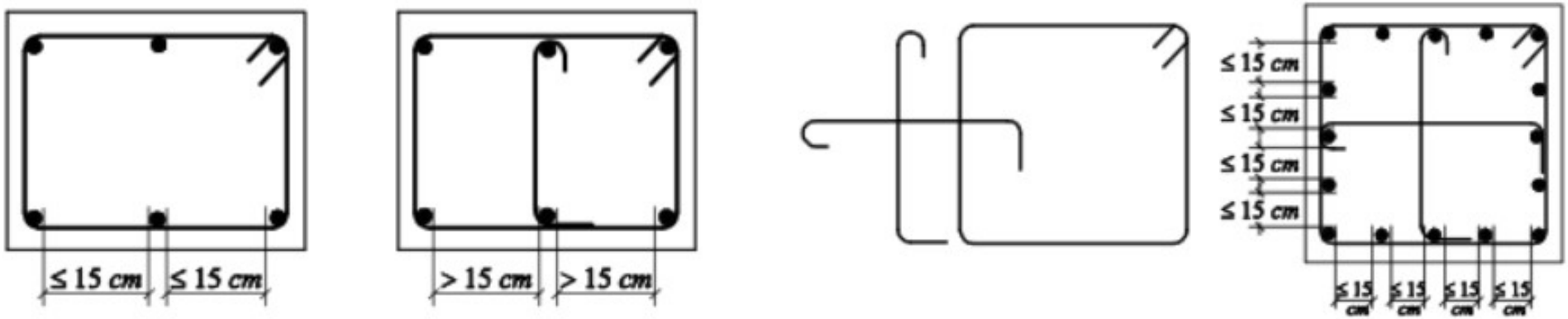


Design and detailing requirements

Minimum number of ties or links in the cross section:

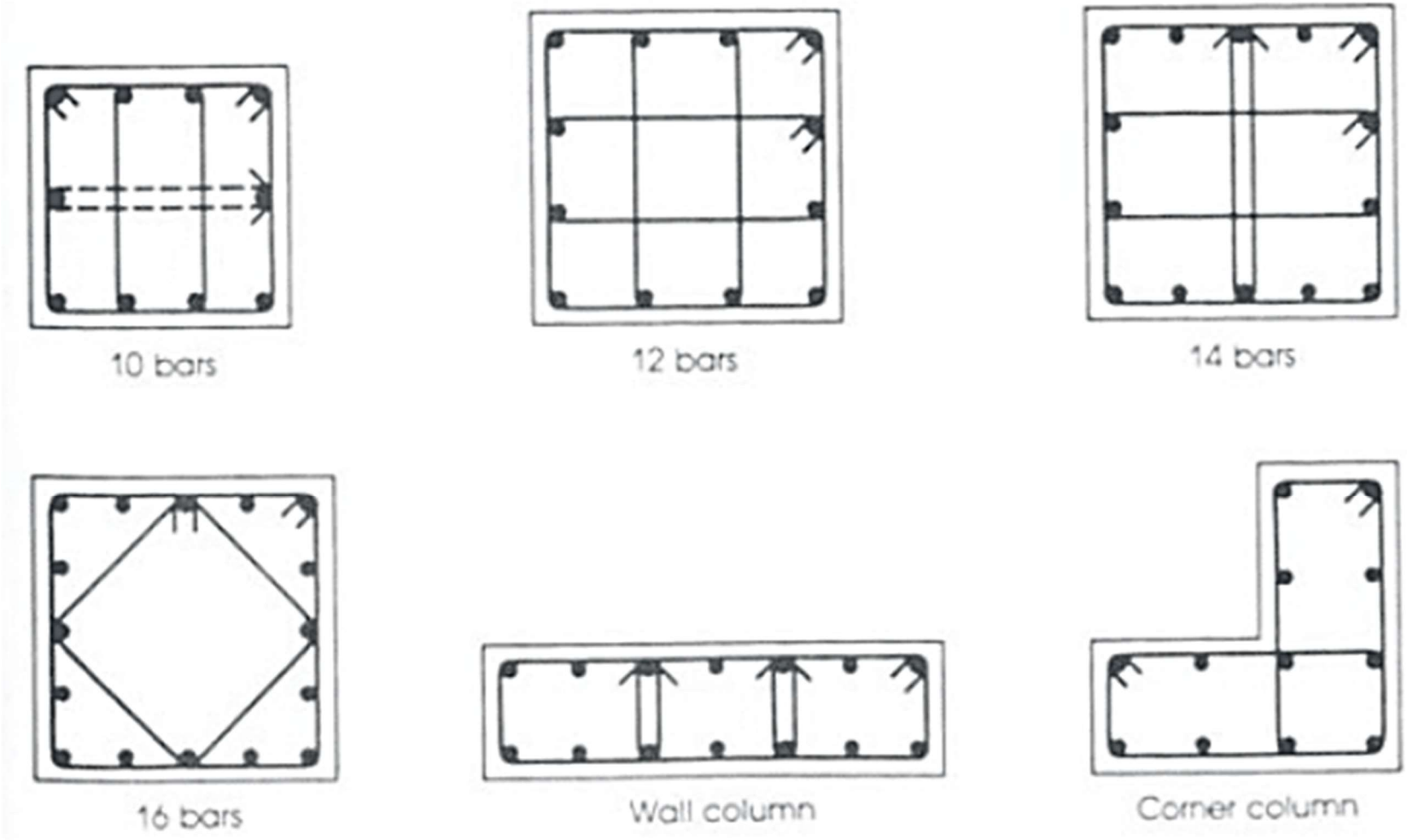
Although number of ties shall be calculated based on shear stress, ACI Code specifies that ties and links shall be arranged in such a way to restrain every single longitudinal bar, so:

- Every corner bar shall be restrained by the corner of a tie with an included angle of not more than 135 degrees as shown
- All bars shall be restrained by link/ tie where bars are spaced at centers > 150 mm;
- At least every alternate bar shall be restrained by link/ tie where bar centers < 150mm.



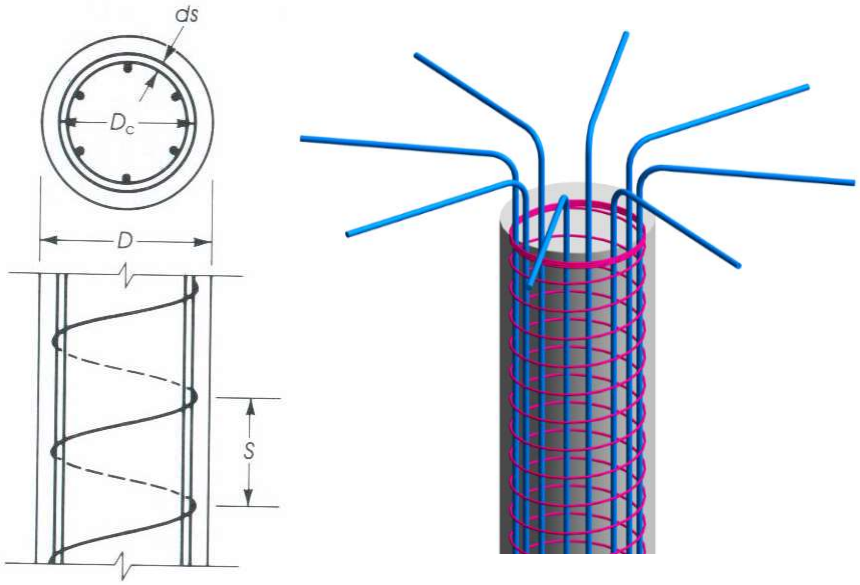
Design and detailing requirements

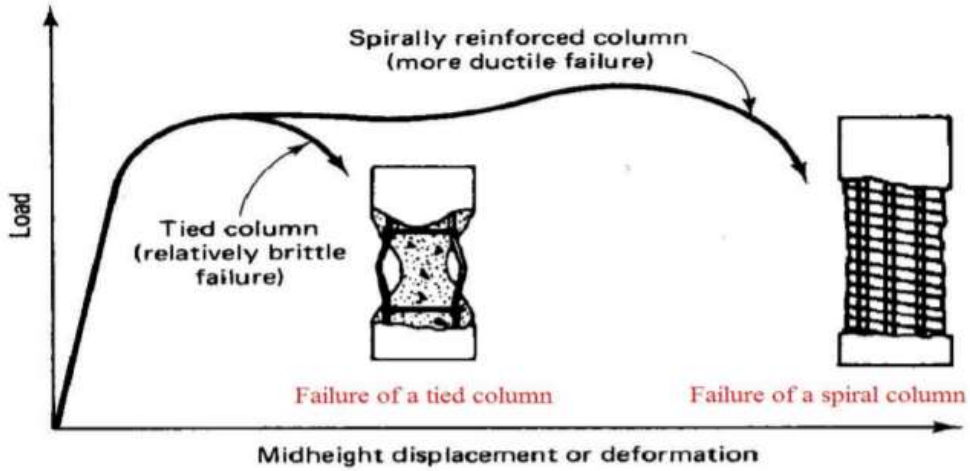
Sample of Lateral Ties arrangements for different column cross sections



Design and detailing requirements

Spirals Lateral Reinforcement





- Spirals advantages: comparison of load-deflection behavior between tide and spiral column

- According to ACI:
  - Spirals shall not be less than 10 mm (ds) in diameter.
  - The clear pitch of the spiral (S) is not to be less than 2.5 cm and not more than 7.5 cm.

Design and detailing requirements

6. Column splice and surface offset

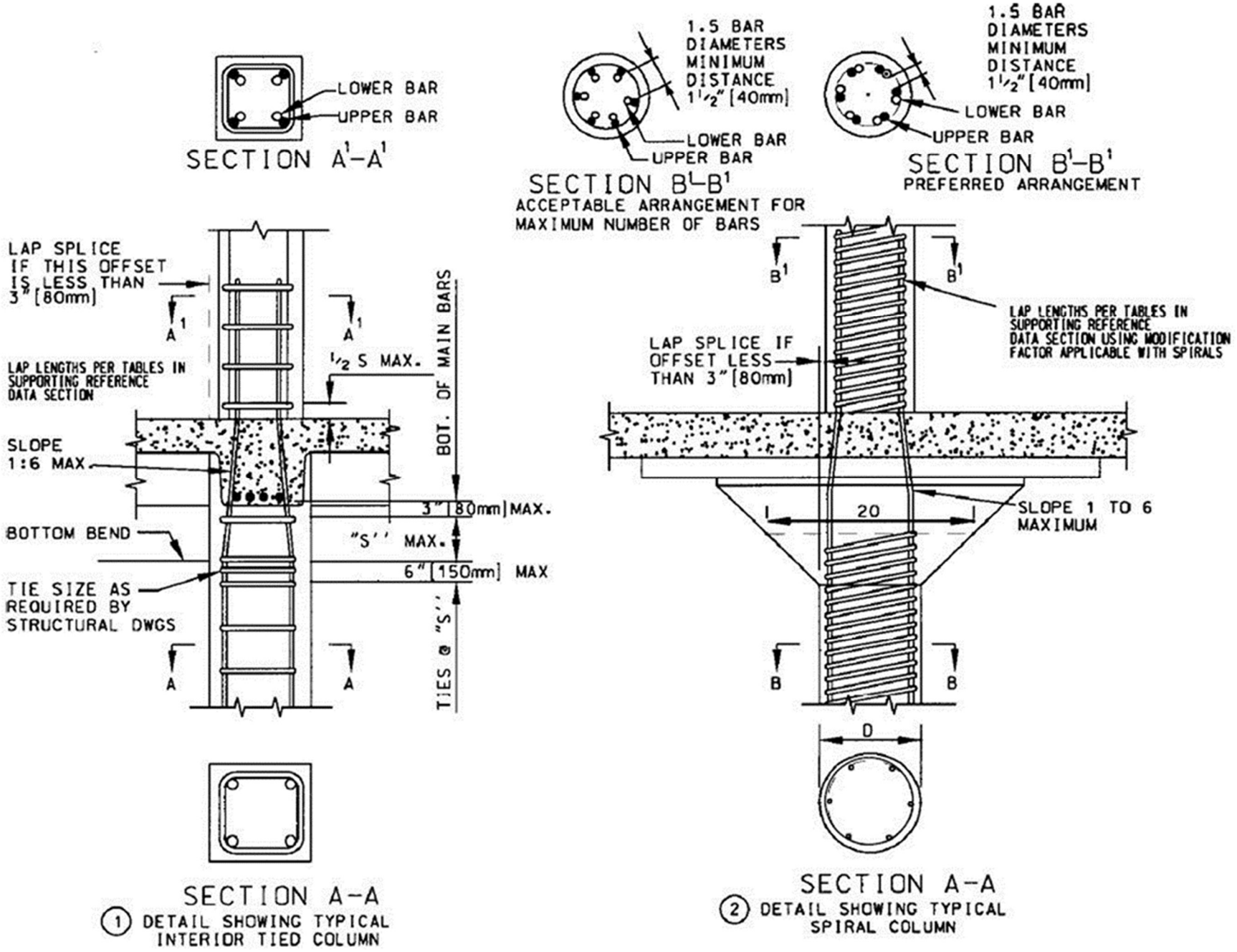
In most of the cases column reinforcement spliced every floor. The splice brings some problems during construction such as steel congestion at splice location. Therefore, in risky situations, engineers spliced reinforcement every other floor to reduce congestion or use the mechanical copular to connect rebars.

Design and detailing requirements

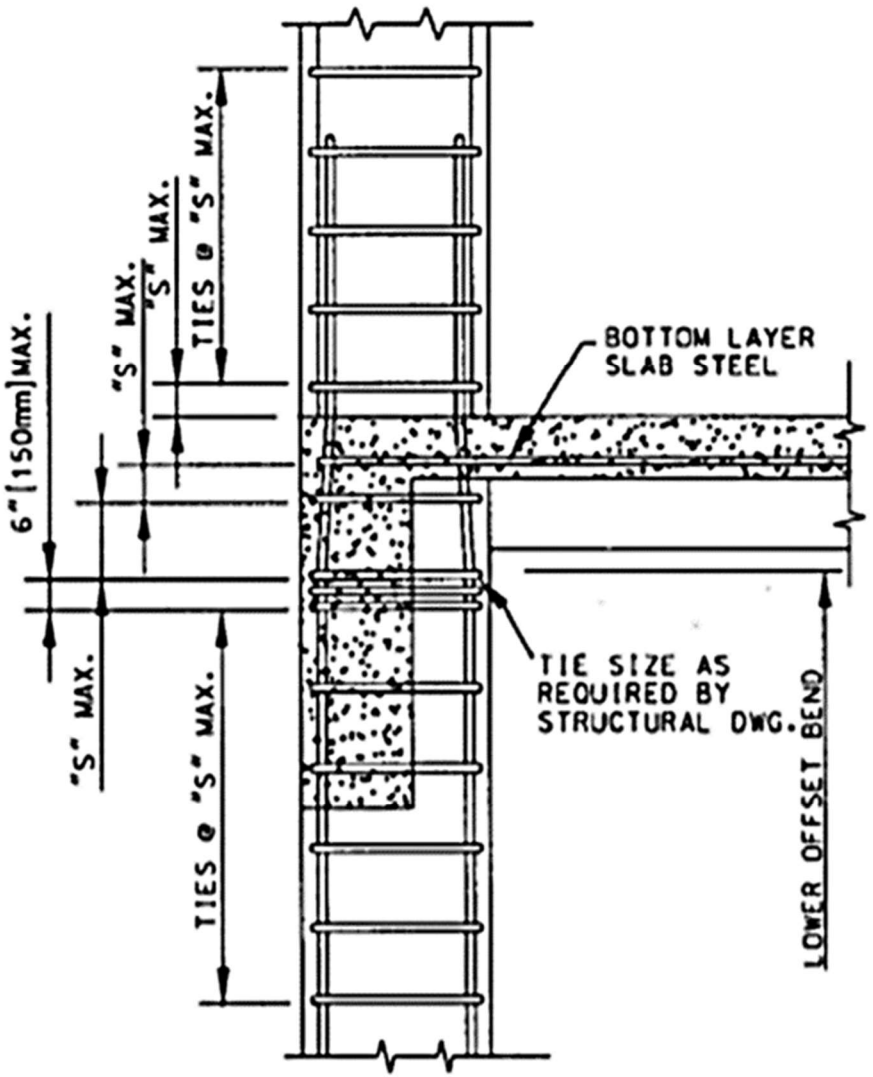
Splice and surface offset requirements

- Offset between column faces < 75 mm: vertical bars from below must be offset to come within the column above. The slope of the inclined portion shall not exceed 1 to 6. (see figure 1, 2, 3 and 4 next slides.
- When the offset is 80 mm or more, the vertical bars in the column below should be terminated at the floor slab and separate straight dowels provided as shown in figure 5.

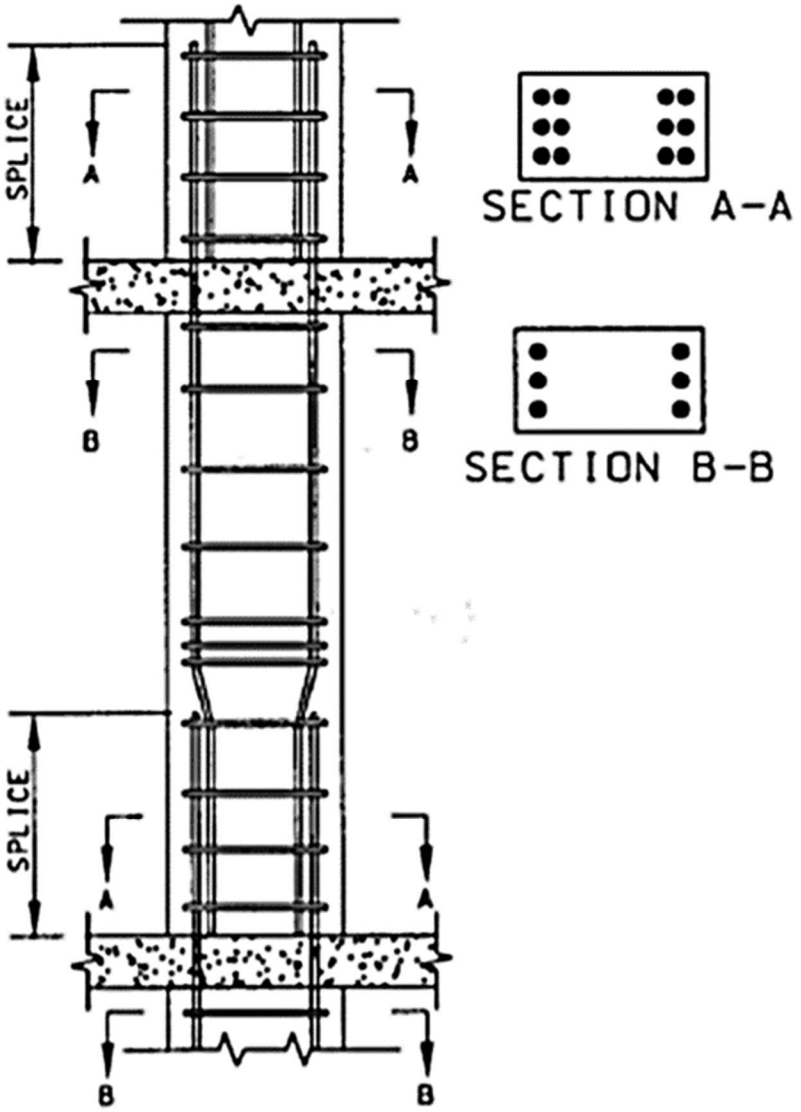
Design and detailing requirements



Design and detailing requirements



(3) DETAIL TYPICAL EDGE COLUMN WITH SPANDREL BEAM



FULL MOMENT LAP SPLICES WITH NO OFFSET

(4) DETAIL FULL MOMENT CAPACITY SPLICE

Design and detailing requirements

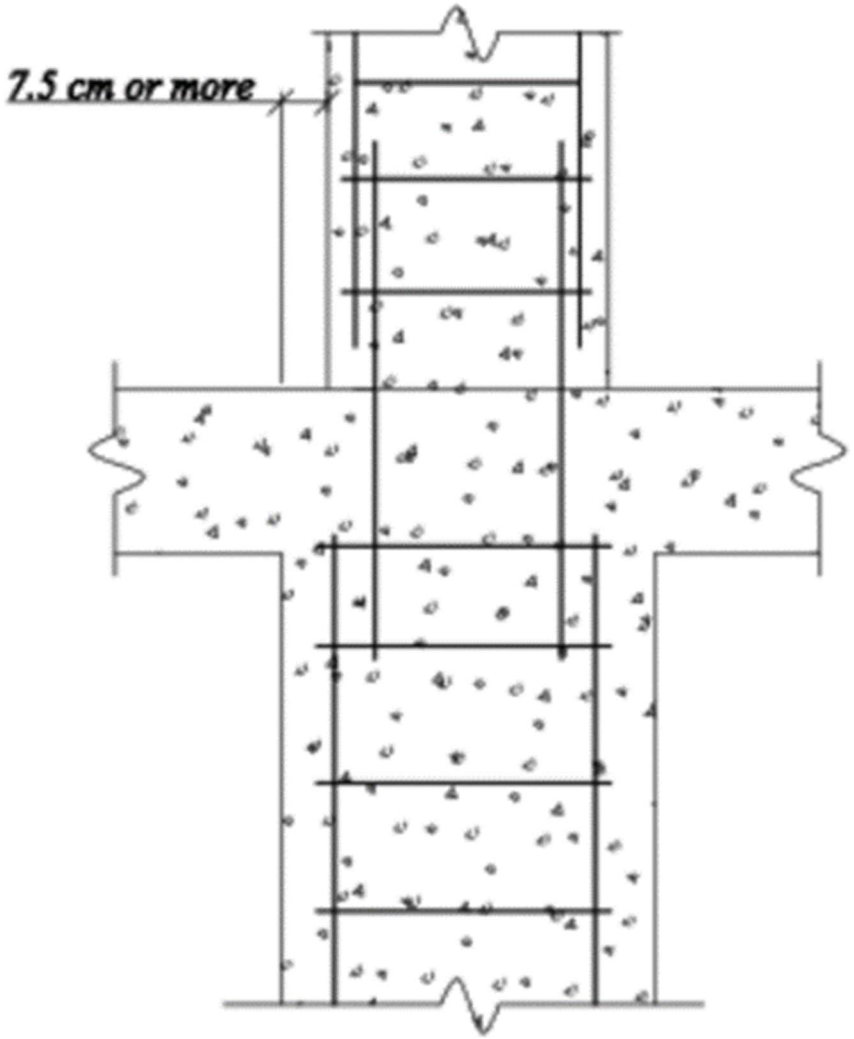
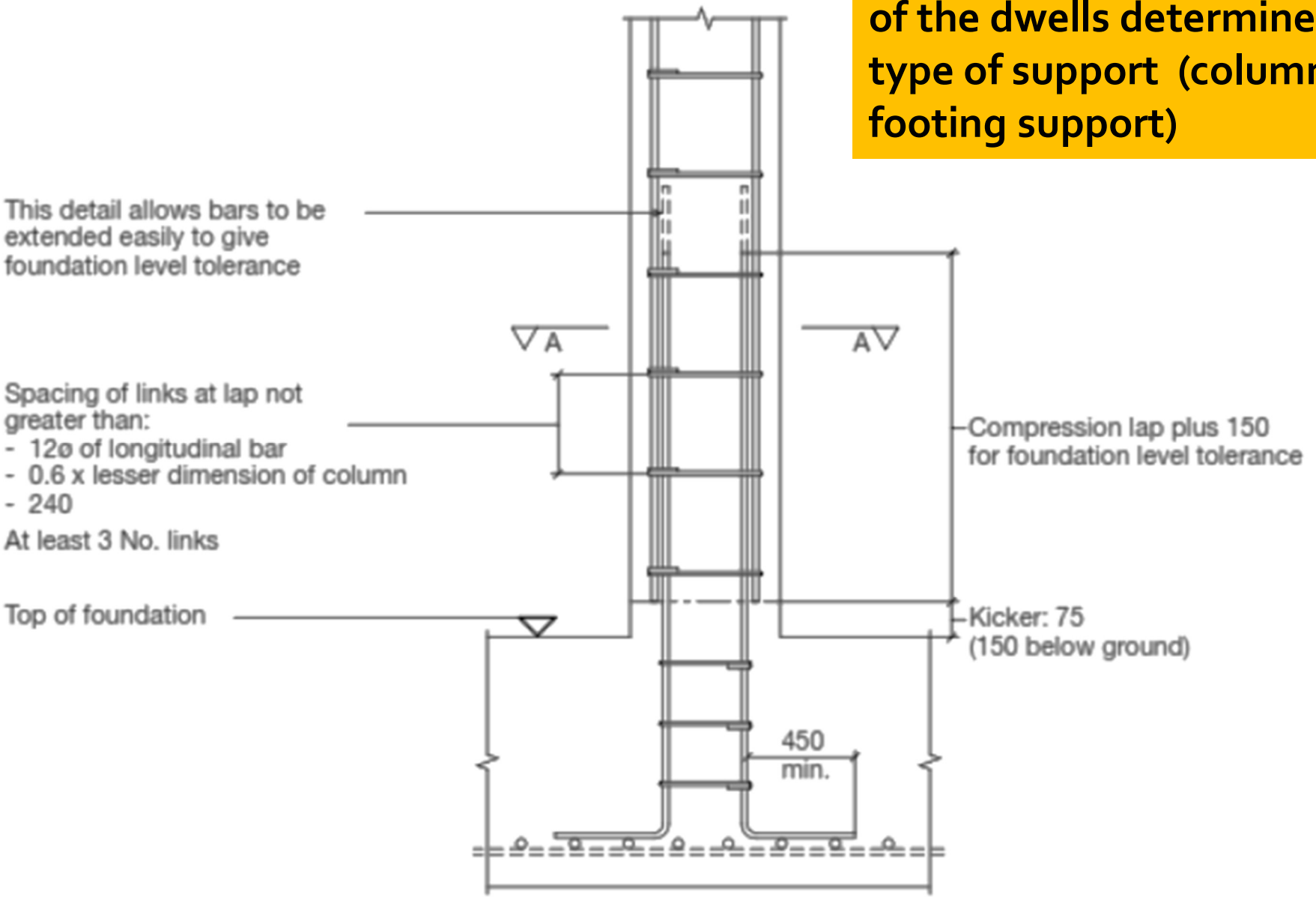


Figure 5. Colum Splice when surface offset > 75 mm

Design and detailing requirements

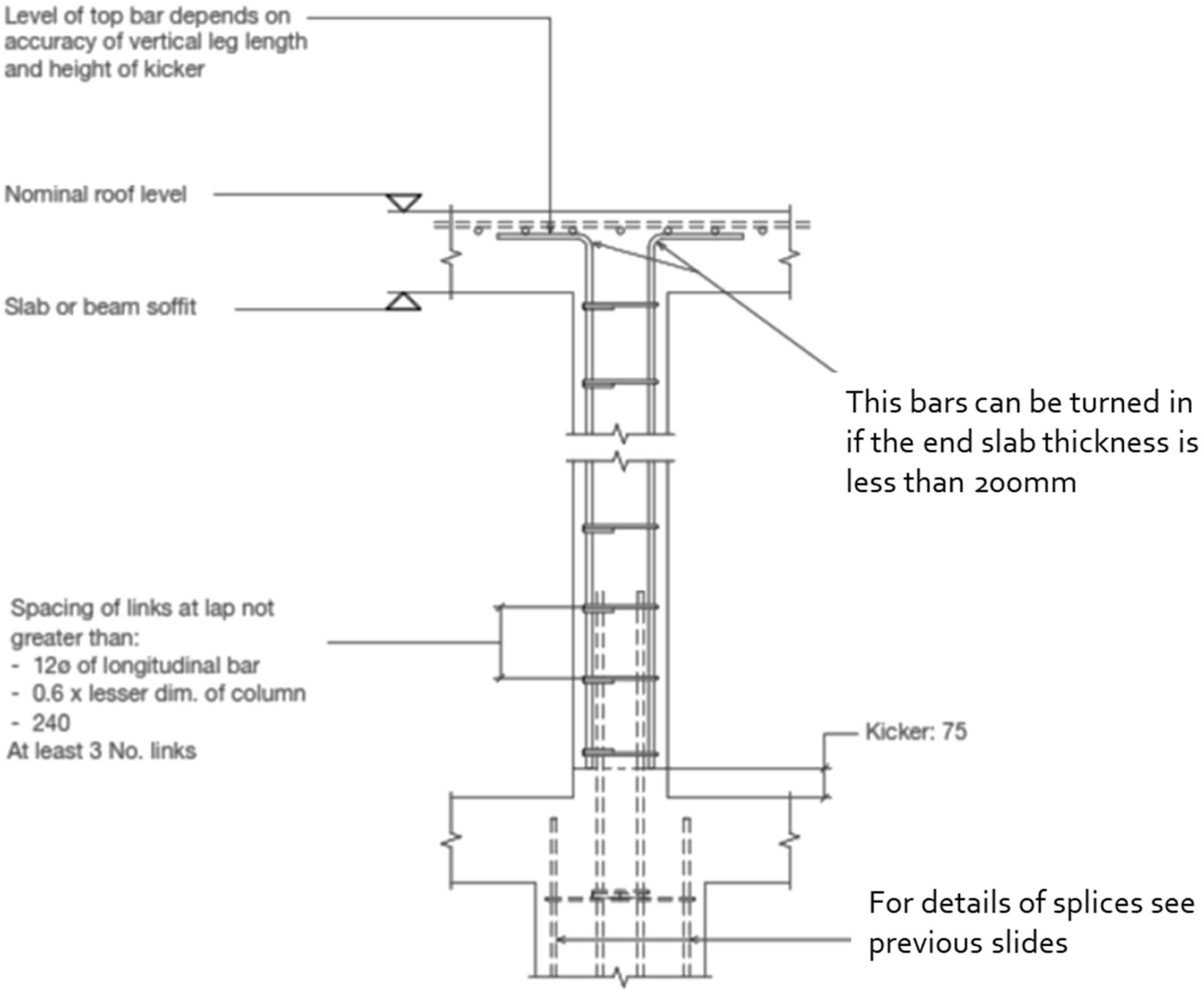
7. Starter bars (column dwells)

Note that the arrangement of the dwells determine the type of support (column – footing support)



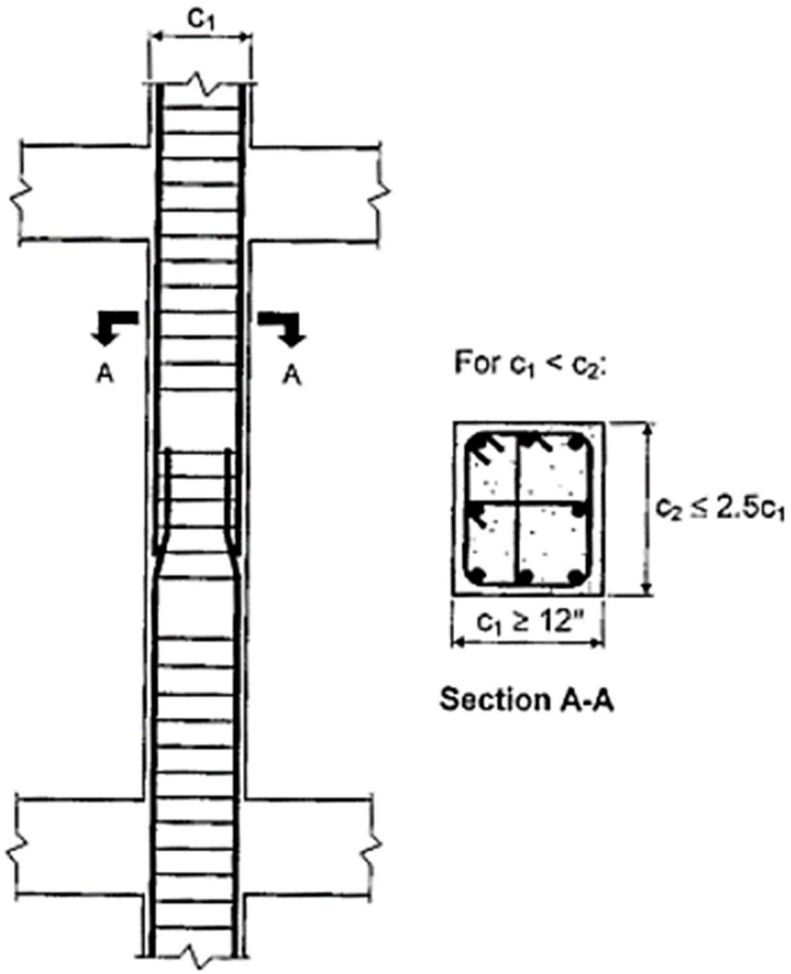
Design and detailing requirements

8. Column top detail

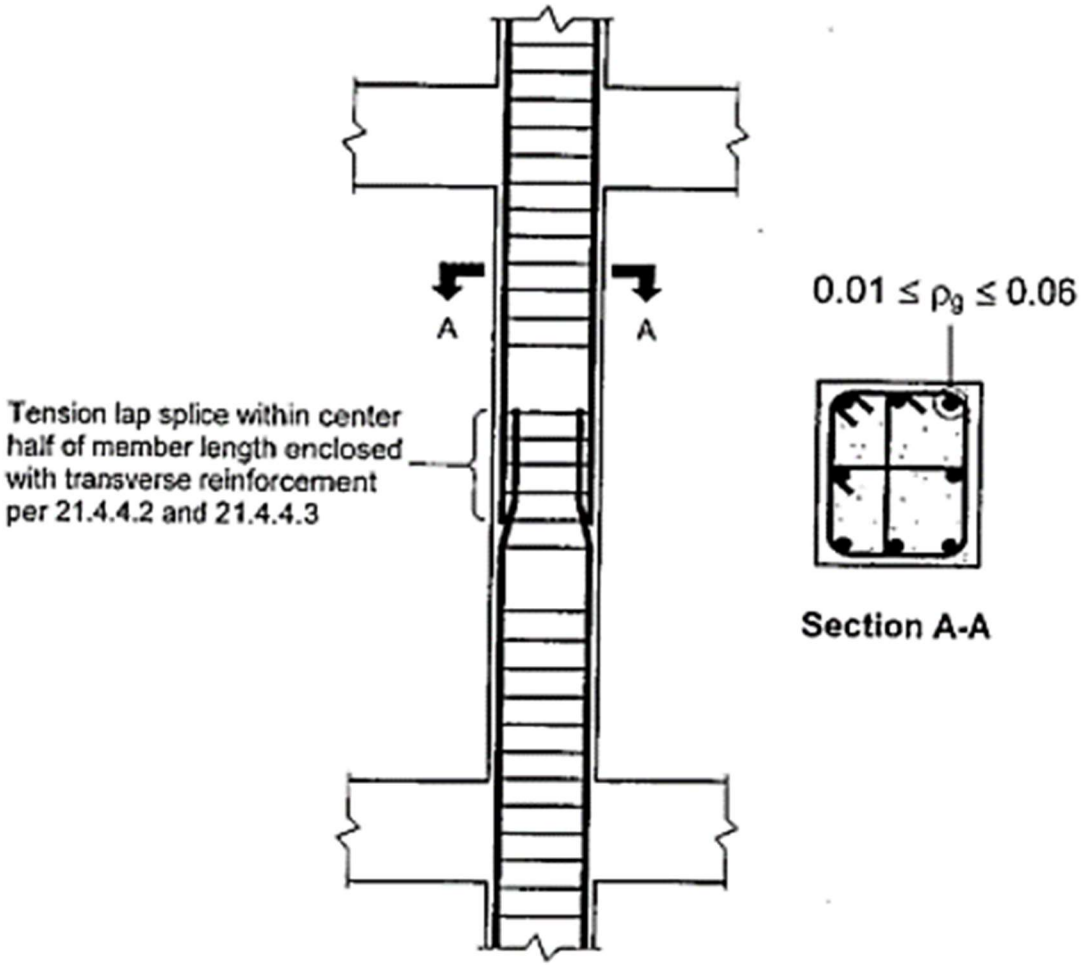


Design and detailing requirements

9. Column seismic details – ductile detailing



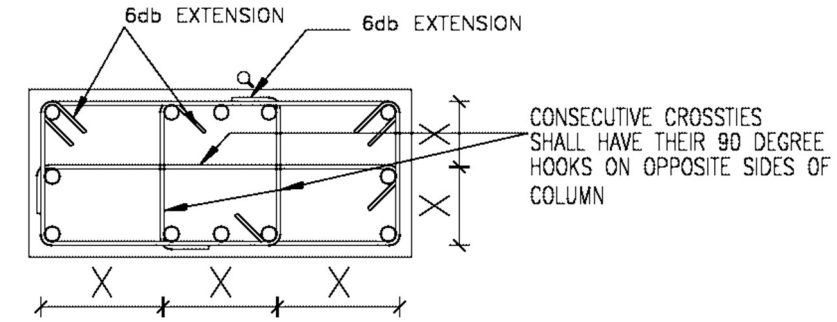
General Requirements

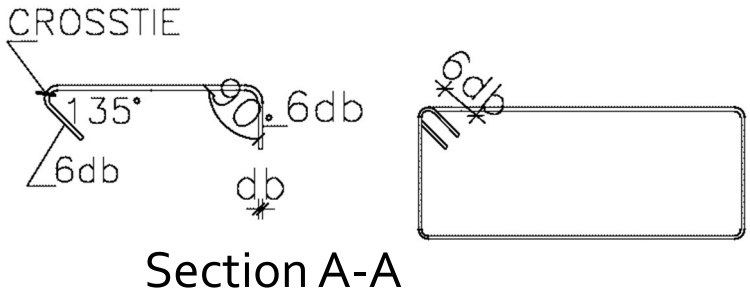


Longitudinal Reinforcement Requirements

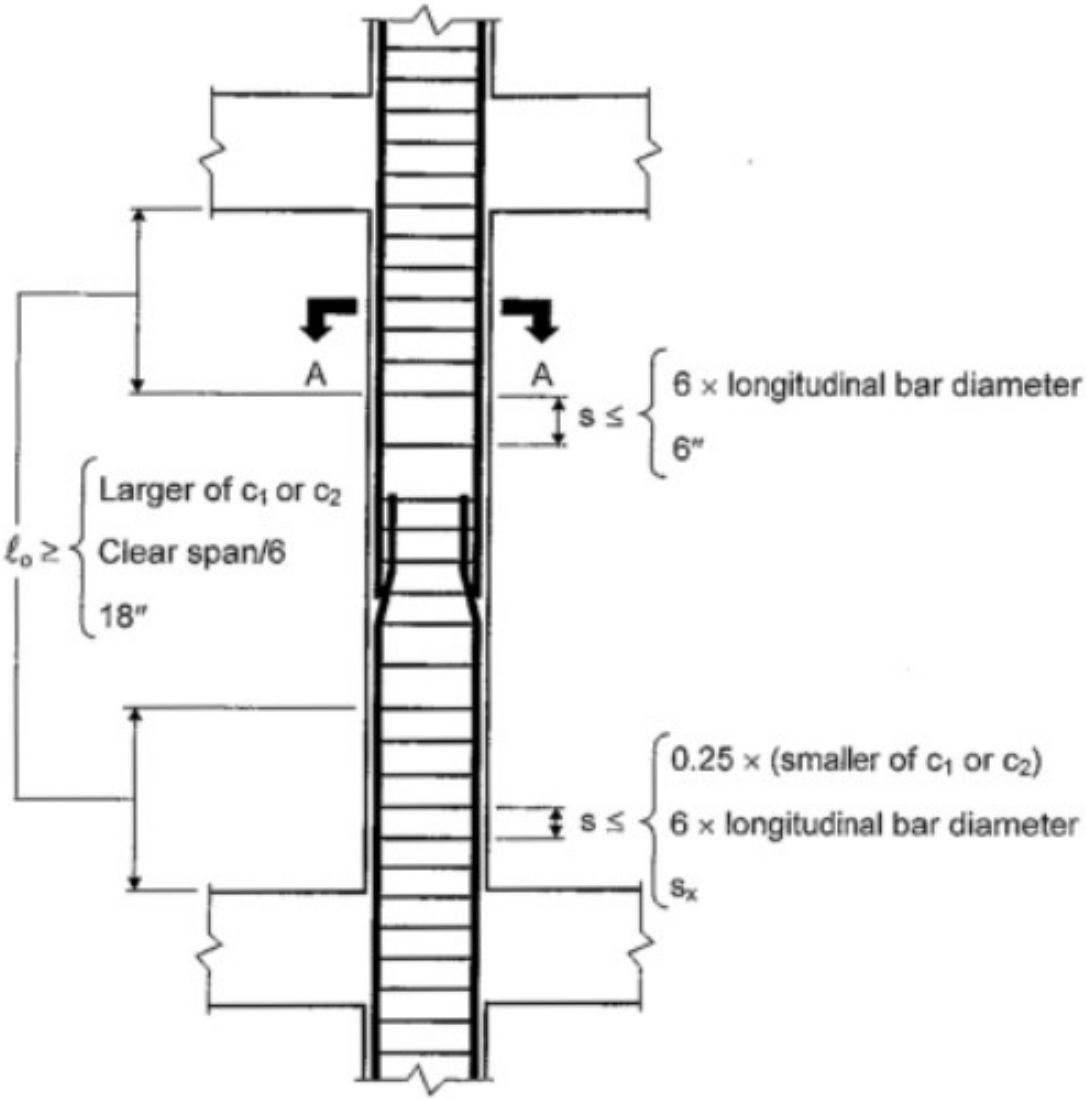
Design and detailing requirements

9. Column seismic details – ductile detailing





Section A-A



Transverse Reinforcement Requirements -Rectangular Hoop Reinforcement

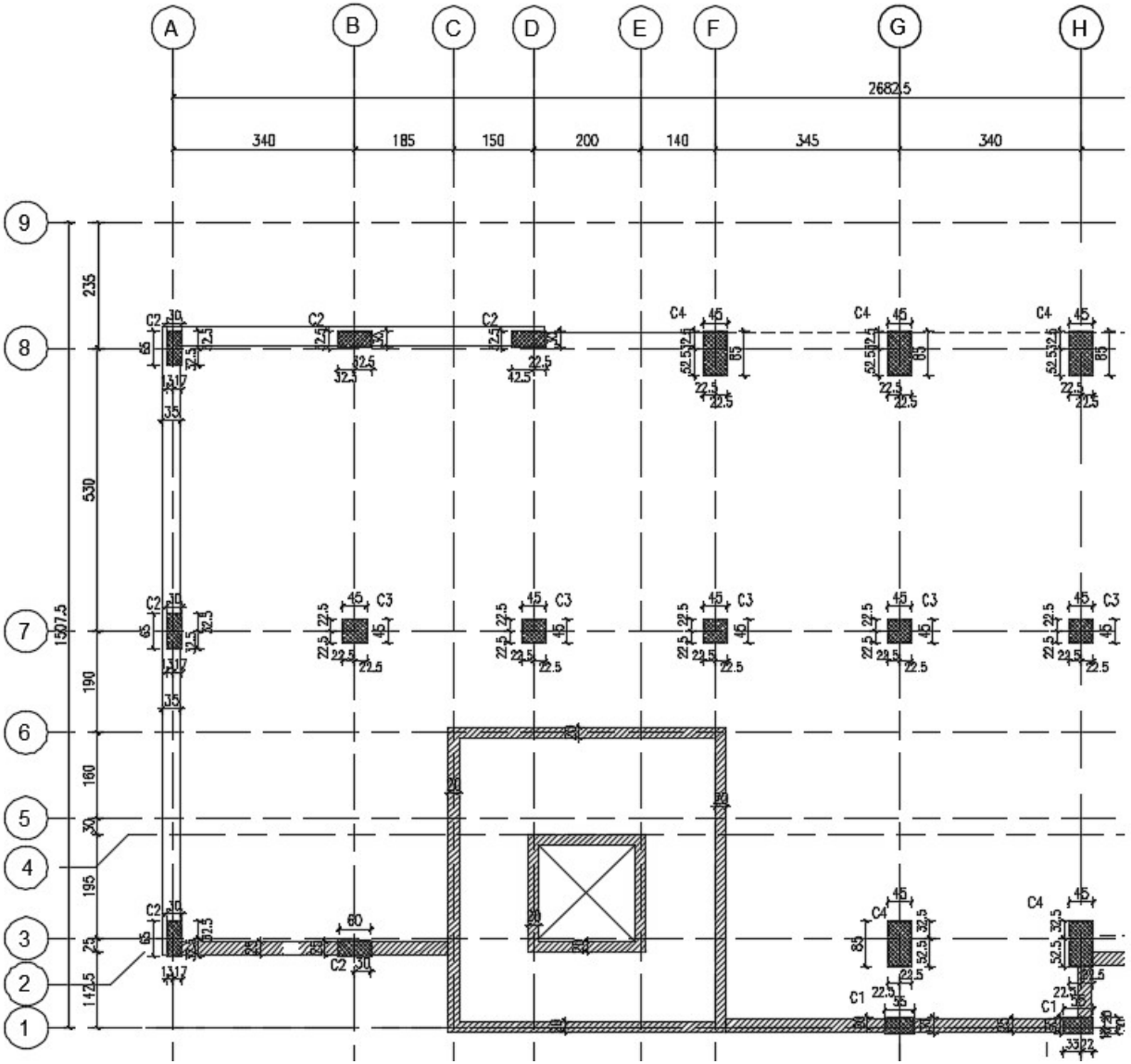
Columns working drawings

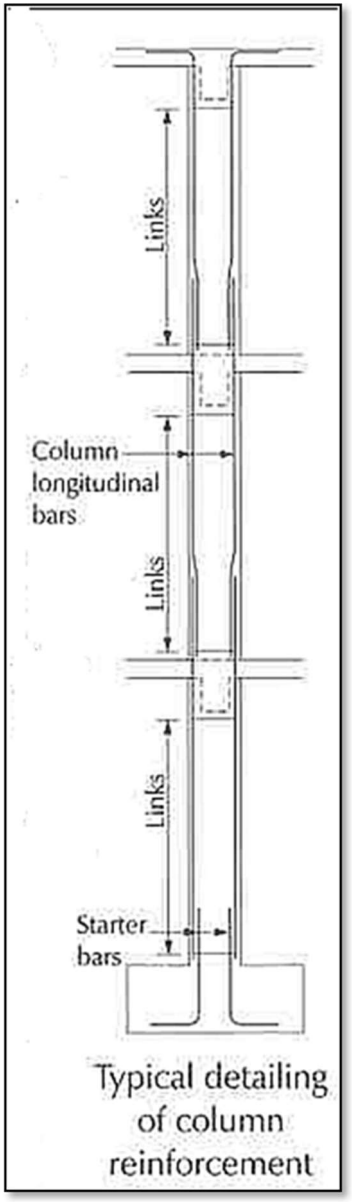
- **Required information**. Drawings must show:
  - Locations of columns relevant to grid lines.
  - Size of columns in plan.
  - Height of columns (vert. section, elevations)
  - Reinforcement: number, location, grade, and size of reinforcing steel.
  - Method of splicing.
  - All necessary details where column section or reinforcement changes.

- **Typically the column drawing usually consist of**
  1. Grid lines plan which show the dimension of the columns at the foundation level and relate column center lines to the grid lines.
  2. The general arrangement floor plans which are used as the grid line plan for each floor
  3. Atypical longitudinal section
  4. Columns Table that shows for each column its details in each story

Columns working drawings

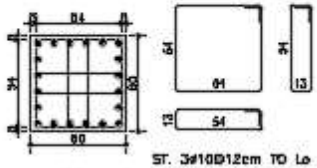
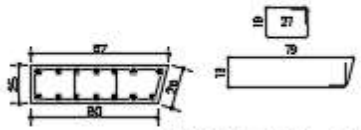
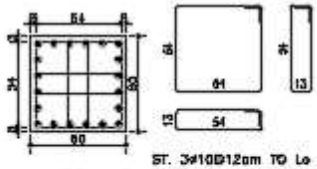
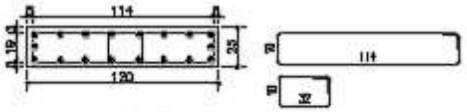
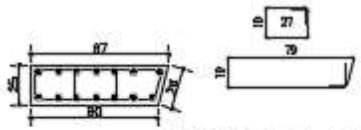
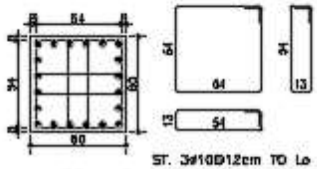
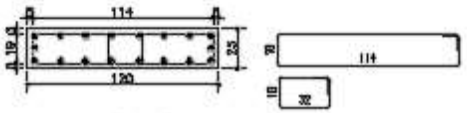
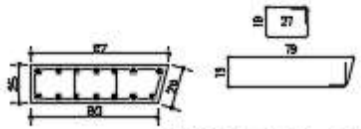
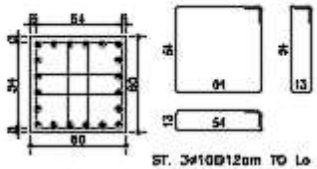
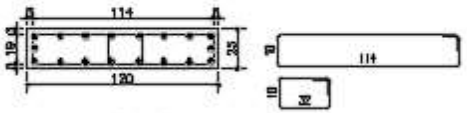
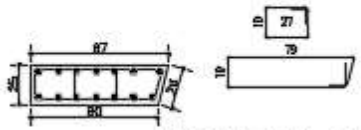
Sample grid line plan and typical longitudinal section





Columns working drawings

Columns Table: shows for each column its details in each story

COLUMN No. / FLOORS	C8	C10	C11	C12
STAIR	 V 20ø 16 ST. 3#10@12cm TO Lo = 78cm ST. 3#10@20cm OTHER		 V 14ø 16 ST. 2#10@12cm TO Lo = 75cm ST. 2#10@20cm OTHER	
THIRD	 V 20ø 16 ST. 3#10@12cm TO Lo = 78cm ST. 3#10@20cm OTHER	 V 18ø 16 ST. 2#10@10cm TO Lo = 75cm ST. 2#10@15cm OTHER	 V 14ø 16 ST. 2#10@12cm TO Lo = 75cm ST. 2#10@20cm OTHER	 V 14 ø 16 SPIRAL ST. #10@5cm
SECOND	 V 20ø 16 ST. 3#10@12cm TO Lo = 78cm ST. 3#10@20cm OTHER	 V 18ø 16 ST. 2#10@10cm TO Lo = 75cm ST. 2#10@15cm OTHER	 V 14ø 16 ST. 2#10@12cm TO Lo = 75cm ST. 2#10@20cm OTHER	 V 14 ø 16 SPIRAL ST. #10@5cm
FIRST	 V 20ø 16 ST. 3#10@12cm TO Lo = 78cm ST. 3#10@20cm OTHER	 V 18ø 16 ST. 2#10@10cm TO Lo = 75cm ST. 2#10@15cm OTHER	 V 14ø 16 ST. 2#10@12cm TO Lo = 75cm ST. 2#10@20cm OTHER	 V 14 ø 16 SPIRAL ST. #10@5cm

Columns working drawings

Sample Enlarged Sections