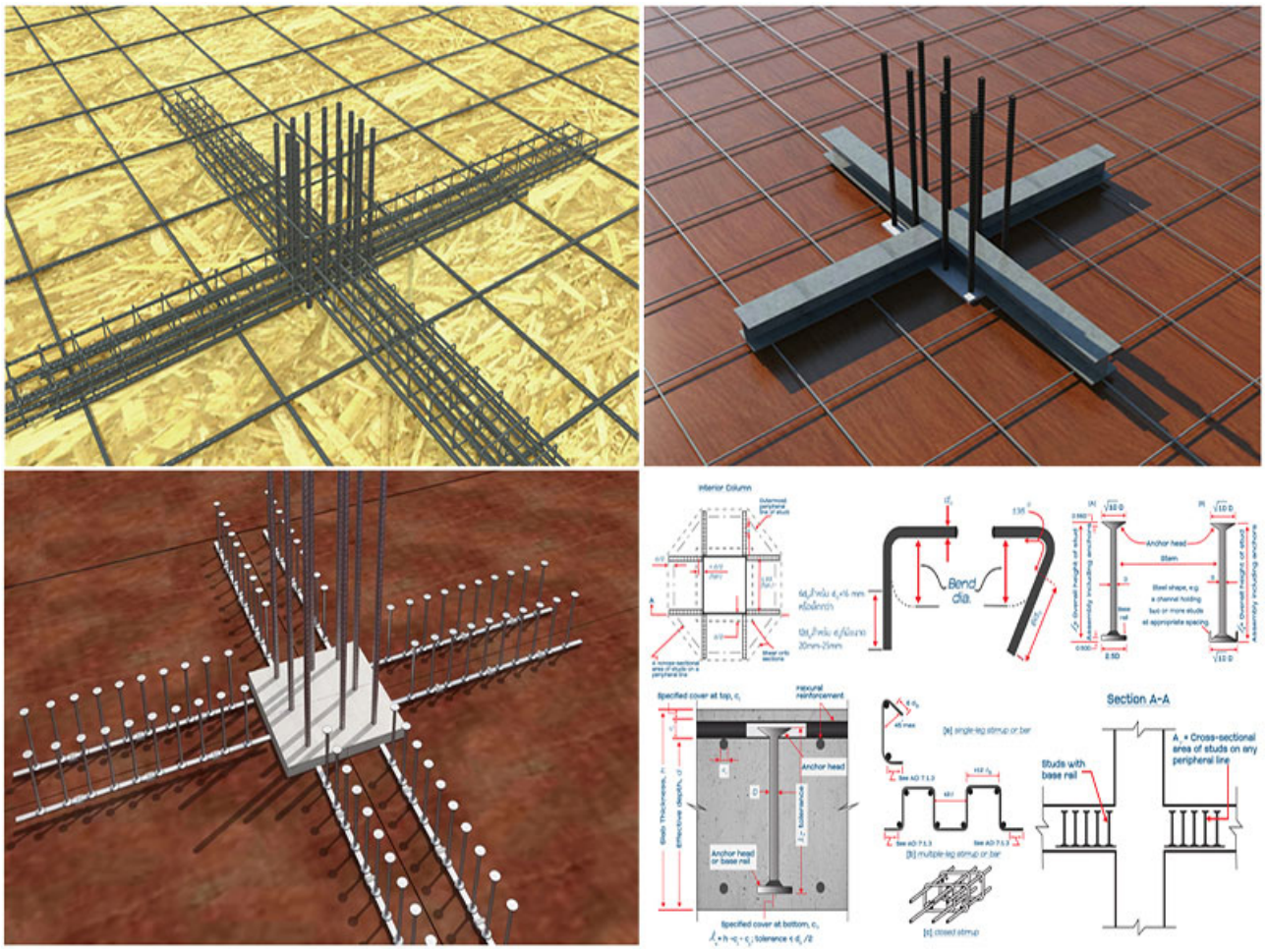
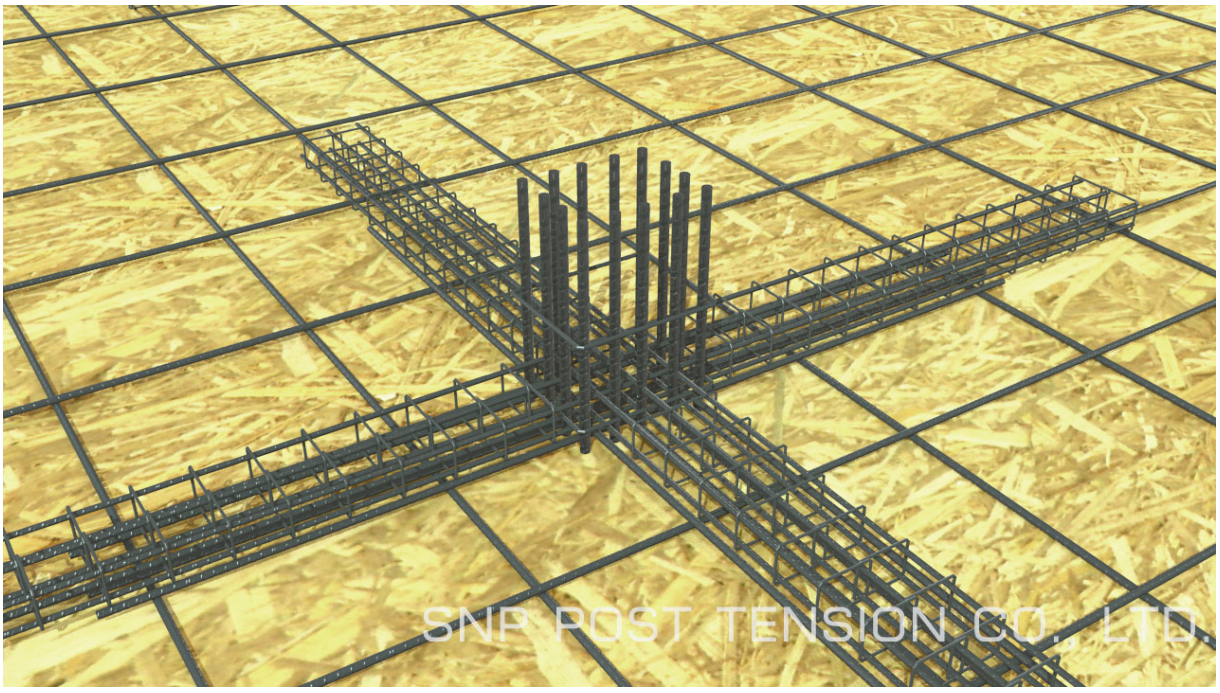
Shear Force in Post-Tension Floor Part 2



From the article, Shear Force in Post-Tension Floor, Part 1, we have learned about the correct calculation of shear force and if it is inspected that the counter shear strength is insufficient, the solution is th add more column capital. If shear force and negative moment at column head are insufficient, we can add drop panel to solve the issue. In case it is undesirable to add floor thickness at column head area, it is also possible to add more counter shear strength through three following ways:

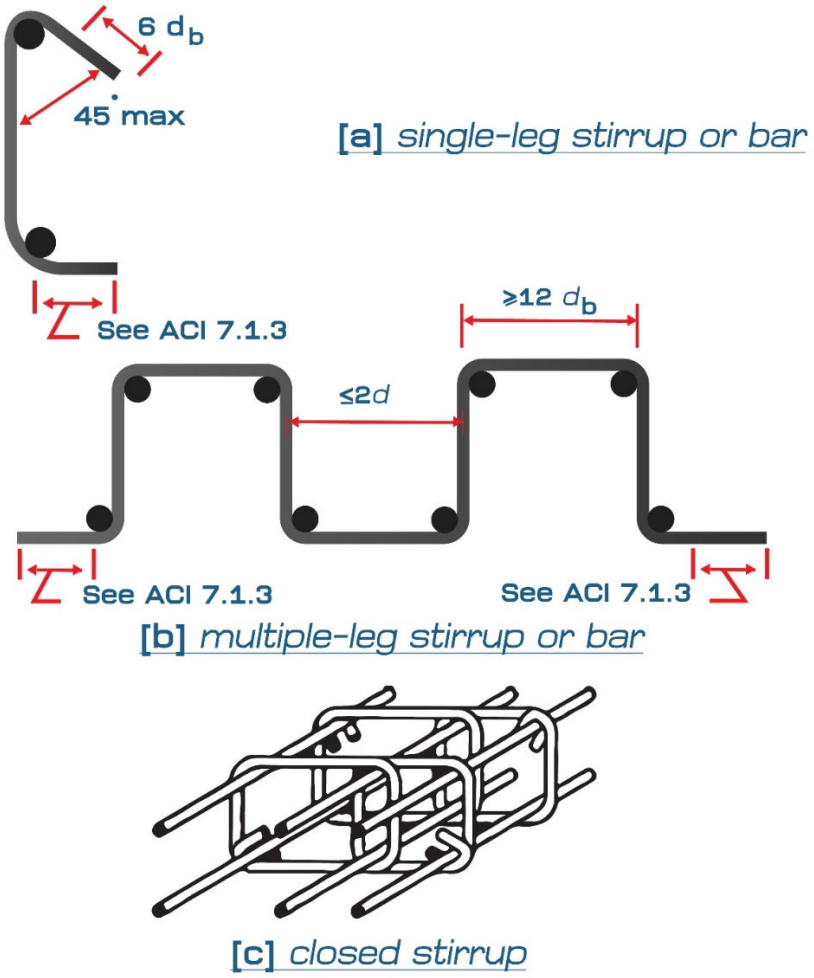
1. Shear reinforcement consisting of bars
2. Shear reinforcement consisting of steel I or C shaped sections, shearhead
3. Headed shear stud reinforcement, shear studs All three methods can be explained in details, sizes, locations, and installation as follows:

1. Shear Reinforcement Consisting of Bars



Floor Thickness Requirements of Shear Reinforcement Consisting pf Bars

ACI 11.11.3 states that “steel shear reinforcement comprises steel, tie bar or single or multiple strand steel wires that are permitted to use in floor or foundations with an effective depth of greater than or equal to 15 cm, but not to be less than 16 times the diameter of the tie bar. The appearance of the tie bar is as shown below. According to above requirements, therefore, we can find the minimum thickness of the area that shear reinforcement tie bar can be placed from an effective depth that must not be less than 15 cm and concrete



covering of the floor must be equal to 2 cm. As a result, the minimum floor thickness must be 17 cm. However, take into account the requirements on diameter of tie bars.

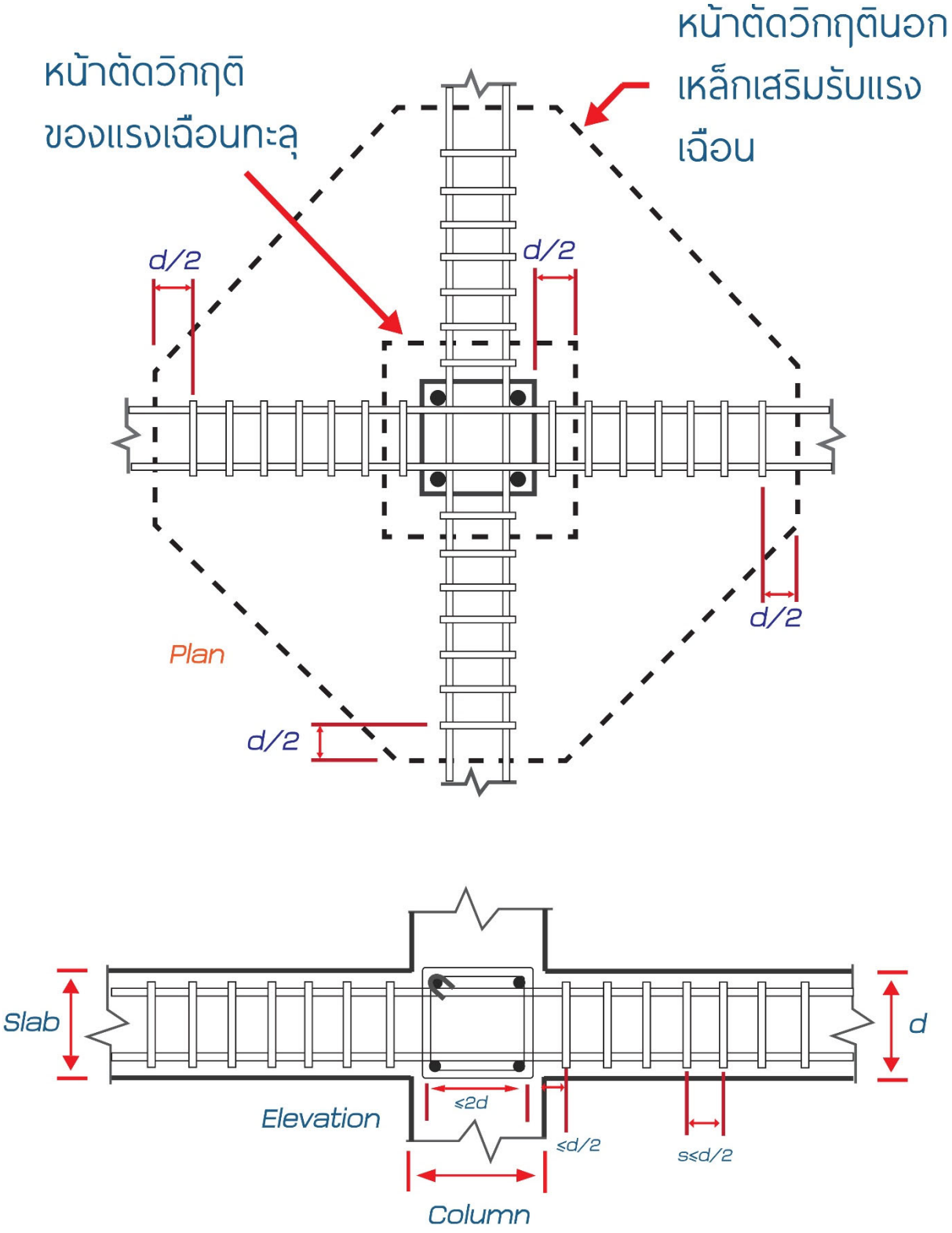
- For RB9MM ⟶ 16DIA. = 14.4CM tie bars, minimum floor thickness must be 15 + 2 = 17CM.

- For DB10MM ⟶ 16DIA. = 16.0CM tie bars, minimum floor thickness must be 16 + 2 = 18CM.

- For DB12MM ⟶ 16DIA. = 19.2CM tie bars, minimum floor thickness must be 19.2 + 2 = 21.2CM

Distance Requirements

- The distance between column edge to the first tie bar must not exceed D/2.
- The distance between tie bar's leg must not exceed 2D, measured in the direction parallel to the column.
- The distance between tie bars must not exceed D/2.

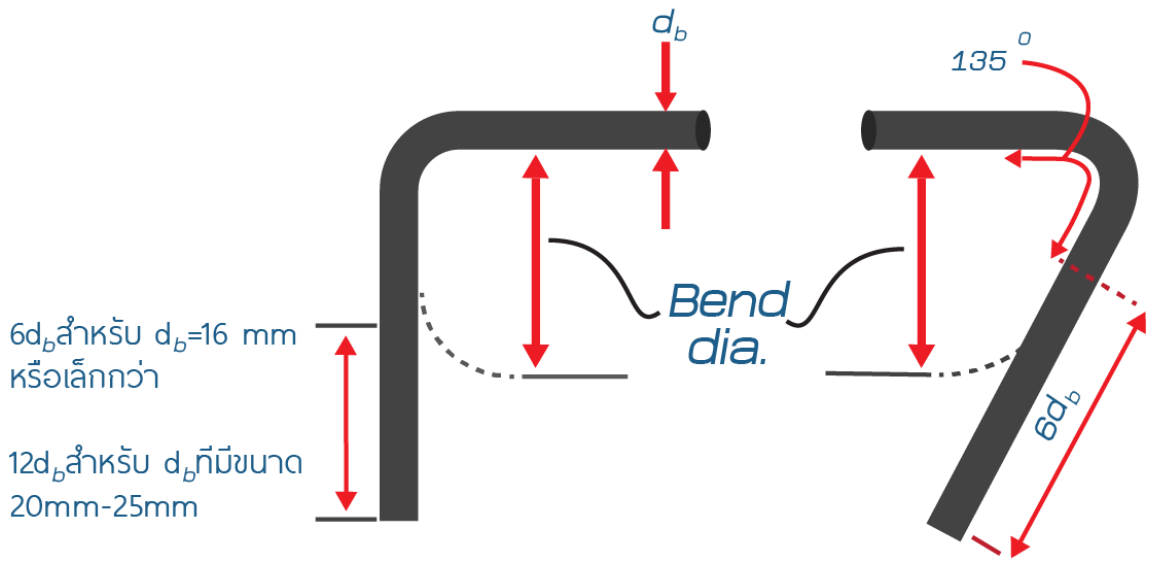


Bending Requirements of Tie Bars - DB is set to be the diameter of tie bars

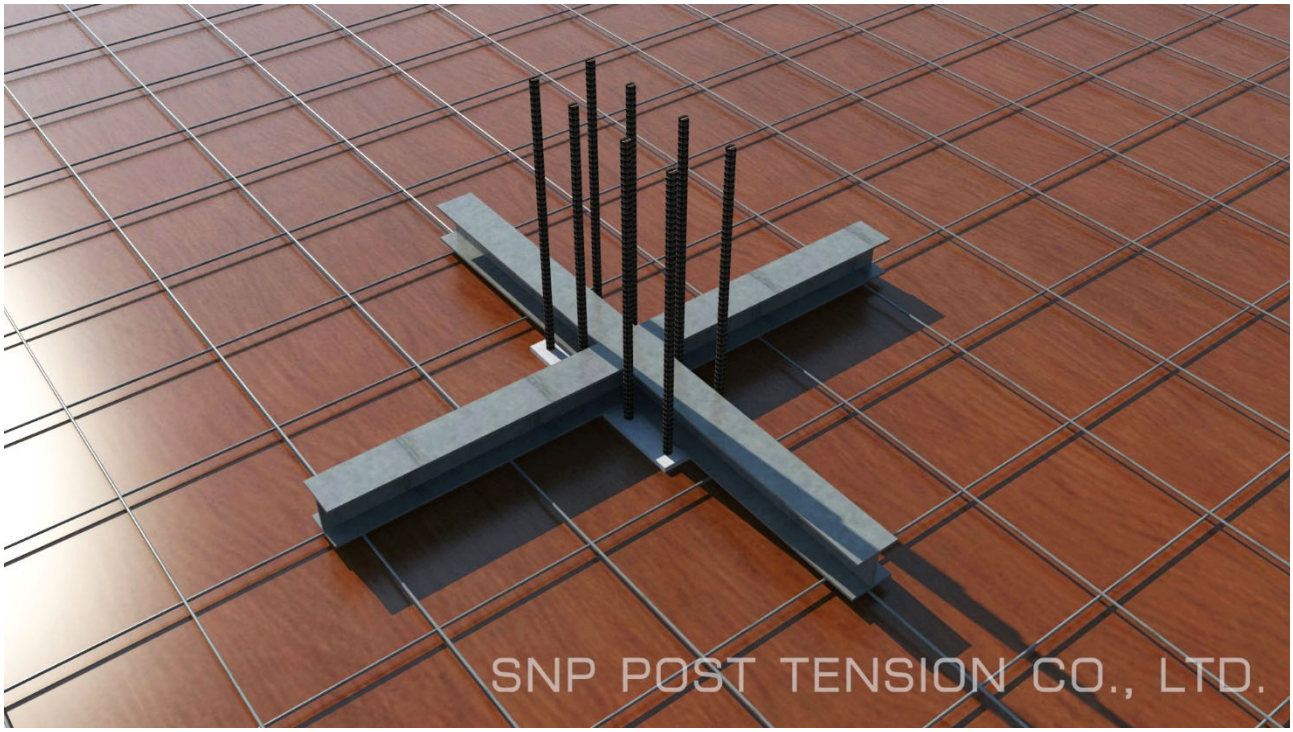
- If DB is 16MM or smaller, bending 90 degrees will add stressing range to another 6 DB
- If DB is 20MM to 25MM, bending 90 degrees will add stressing range to another 12 DB
- If DB is 6MM to 25MM, bending 135 degrees will add stressing range to another 12 DB

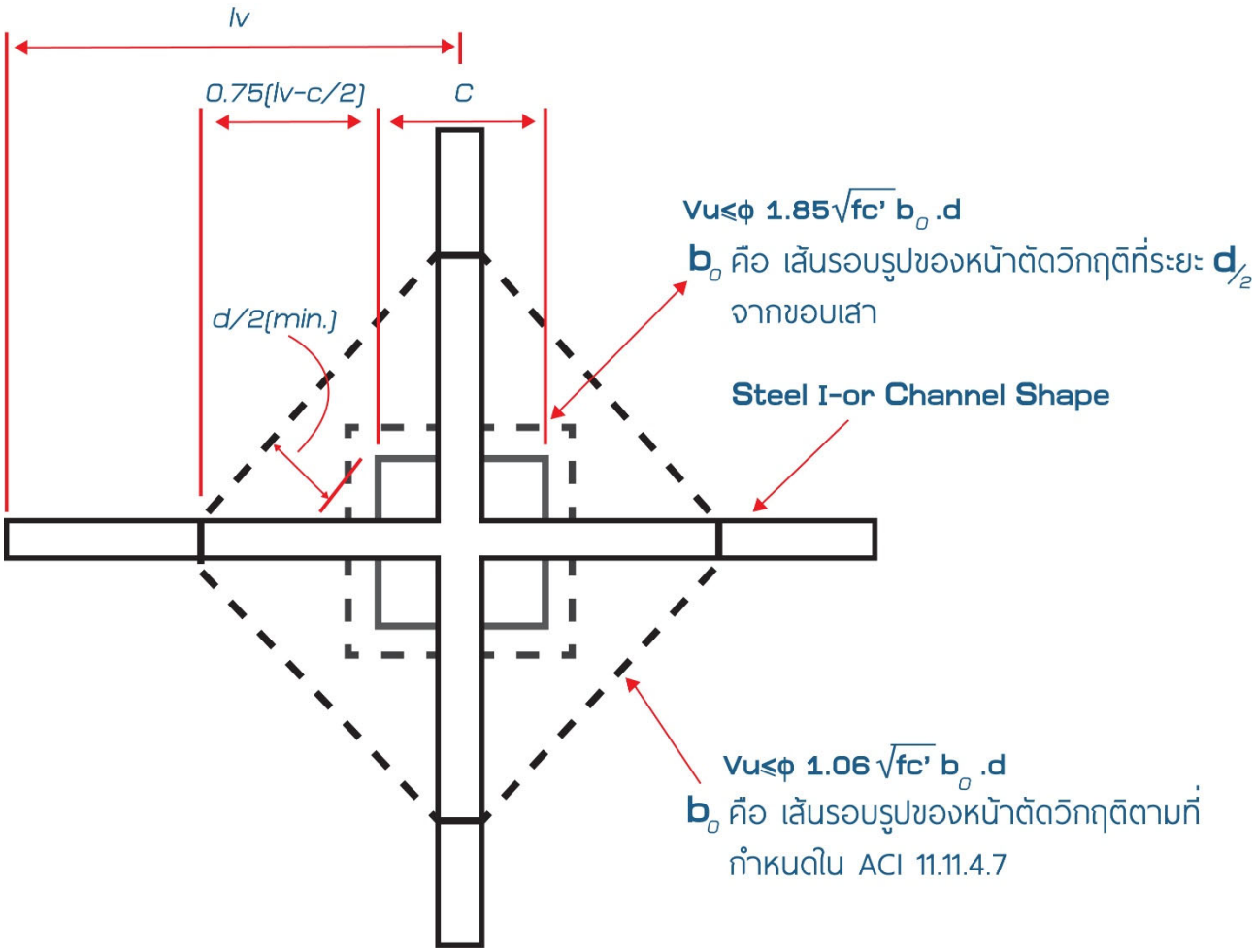
Bend Diameters are as follows:

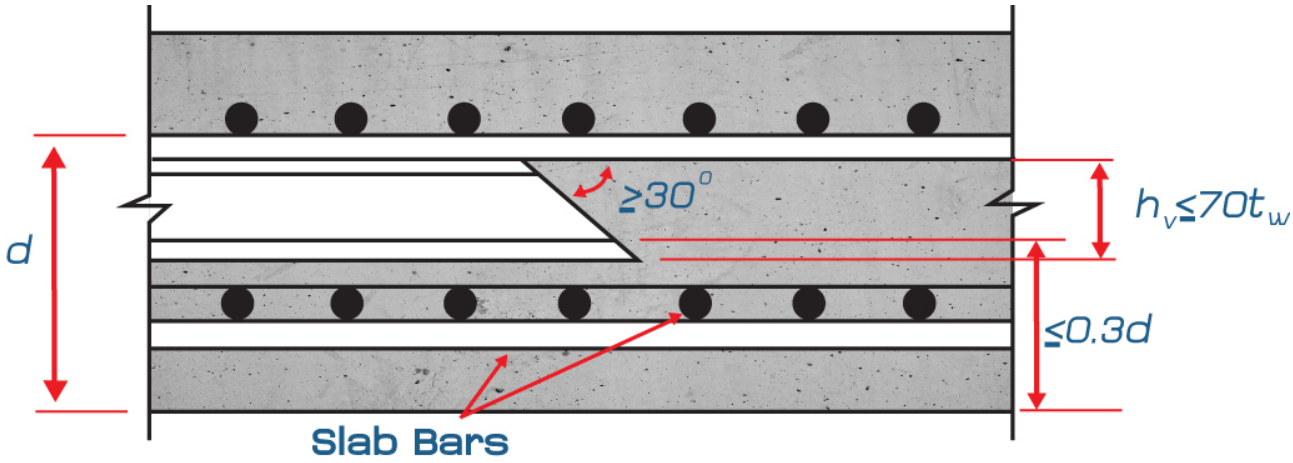
- If DB is 6MM to 25MM, bend diameter of the tie bar must not be less than 6 DB.
- If DB is 28MM to 36MM, bend diameter of the tie bar must not be less than 8 DB.
- If DB is 43MM to 57MM, bend diameter of the tie bar must not be less than 10 DB unless if primary steel reinforcement is smaller than 16MM, bend diameter of the tie bar must not be less than 4DB. According to bending requirements, when DB is greater than 16 mm, it can be difficult to bend following the standards for floor with lower thickness than 25 cm.



2. Shear Reinforcement Consisting of Steel I or C Shaped Sections, Shearhead

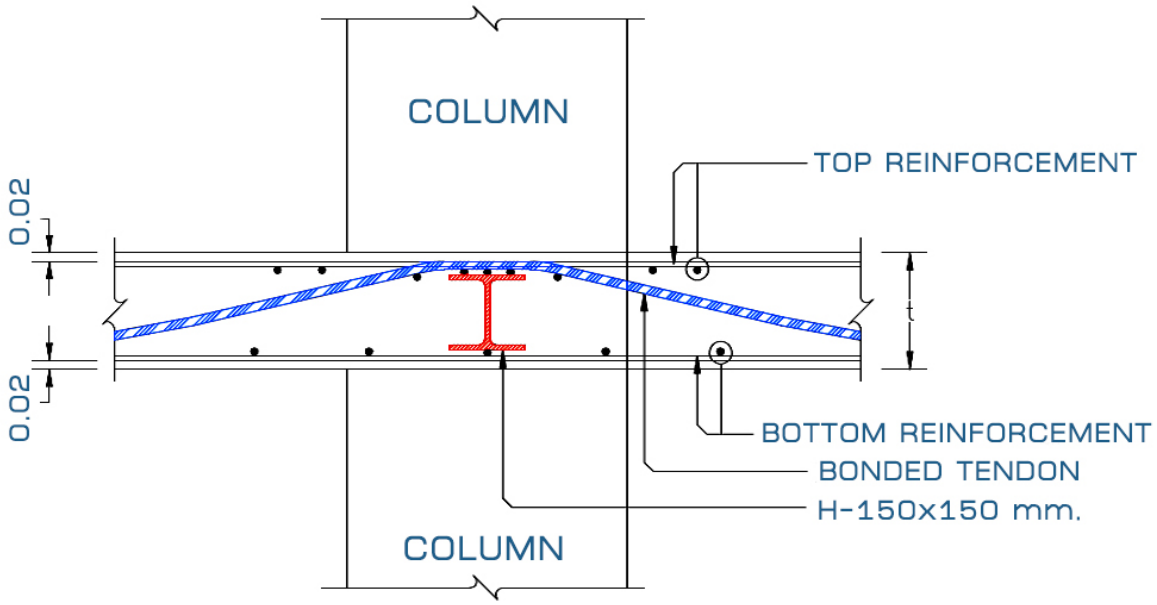




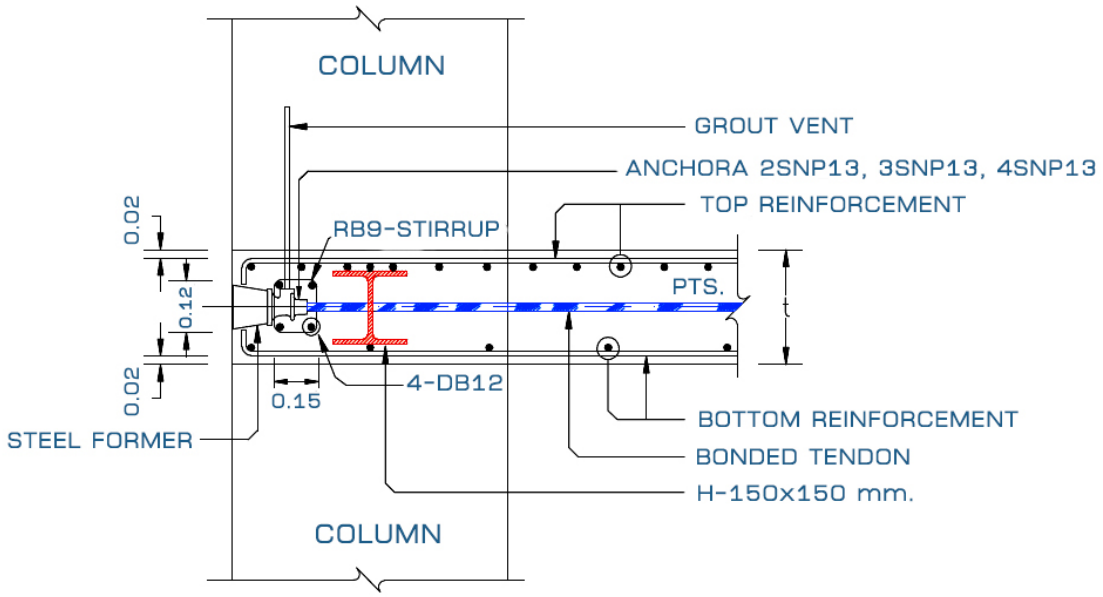


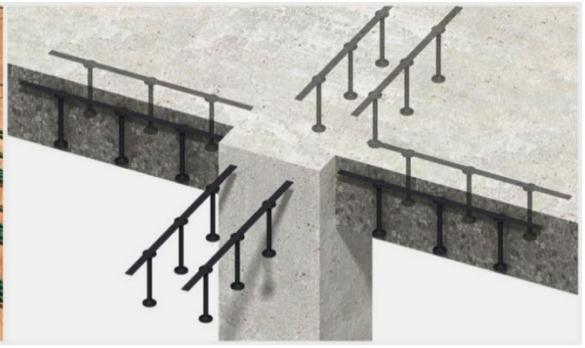
Tips on choosing a shearhead

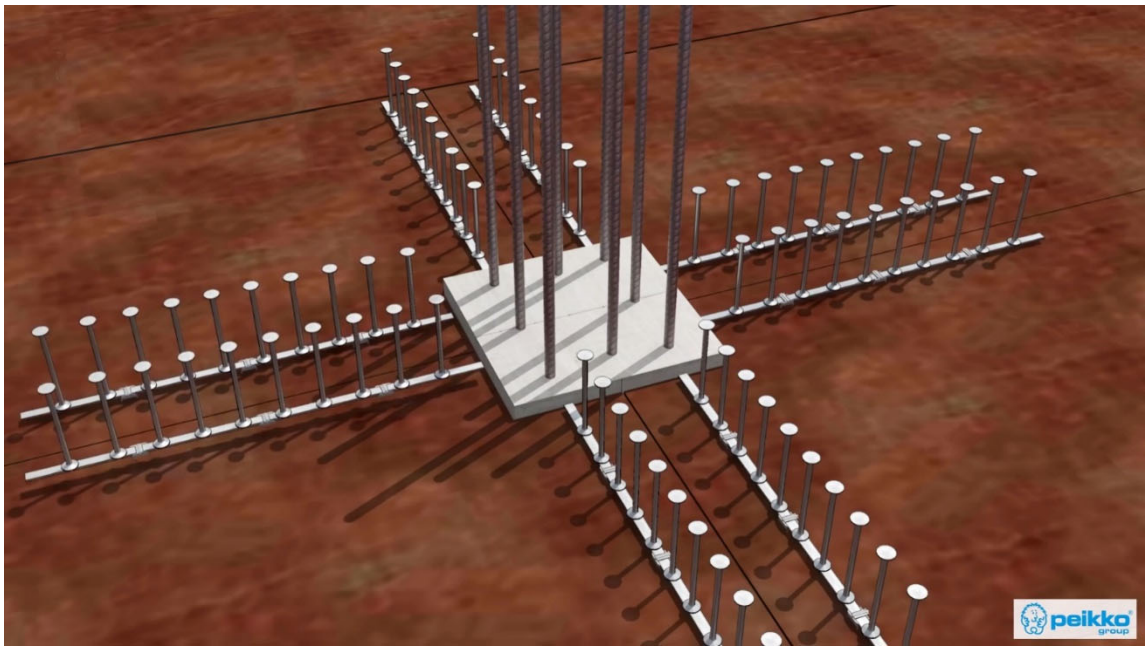
1. From the picture below, it can be seen that the strands must cross the H-beam. This makes the floor in the column head area relatively thick. In addition, there is a specified spacing of H-beam placement where both upper and lower steel reinforcements must also be able to be placed. Therefore in general, the floor should be as thick as 30 cm which makes it possible to form a shear head out of an H-beam.



2. For columns at the edge or corner of the building, strands may need to go out at the center of floor thickness, which, when shearhead is chosen to be used in this area, H-beams are drilled so that the strands can pass through.



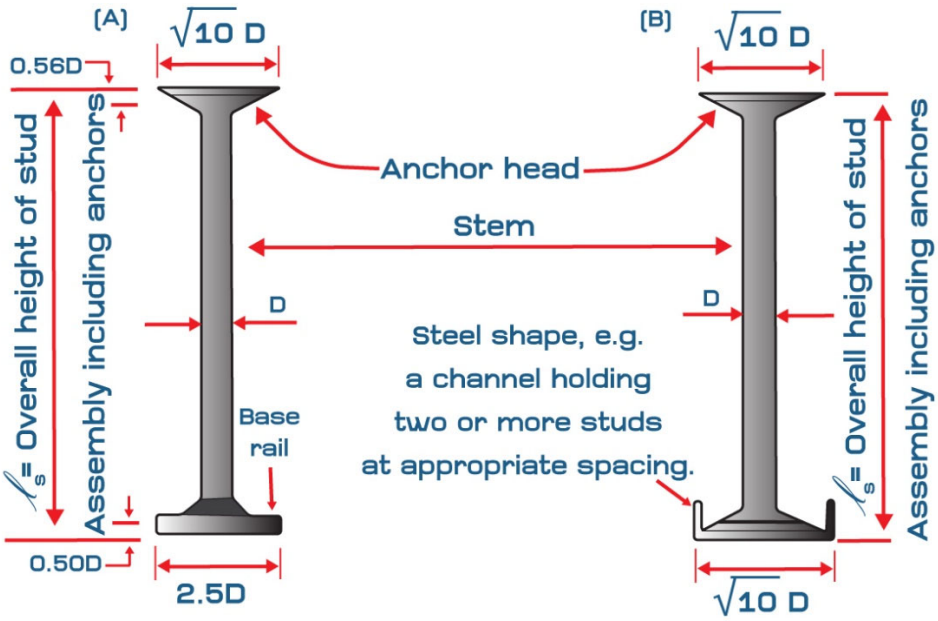


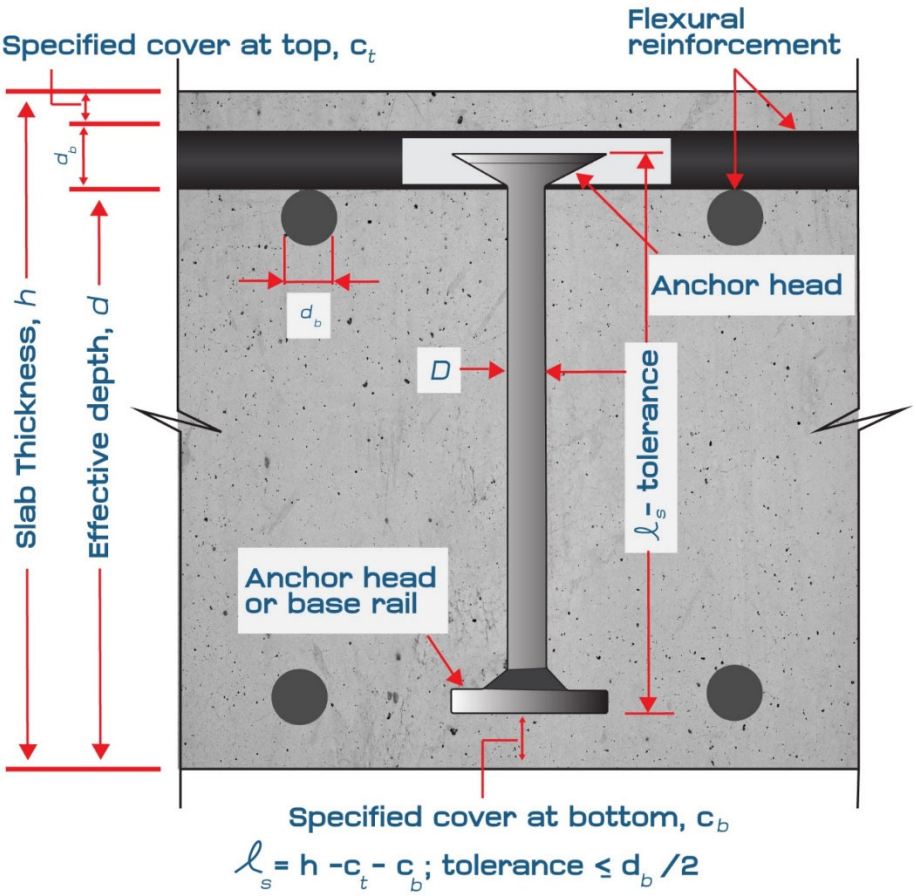


Stud and base rail to be used must meet ASTM A1044 standards which specifies that D is the diameter of the stud.

-The size of stud head must not be less than √10 D

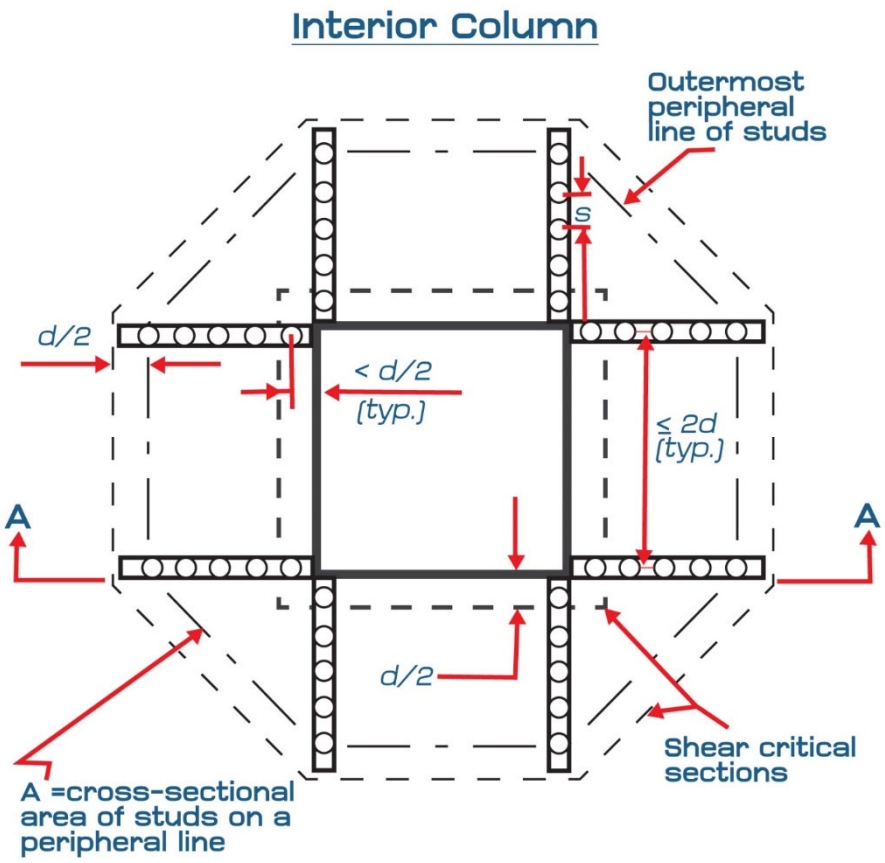
-The size of base rail head must not be less than 0.5D in thickness and 2.5D in width.

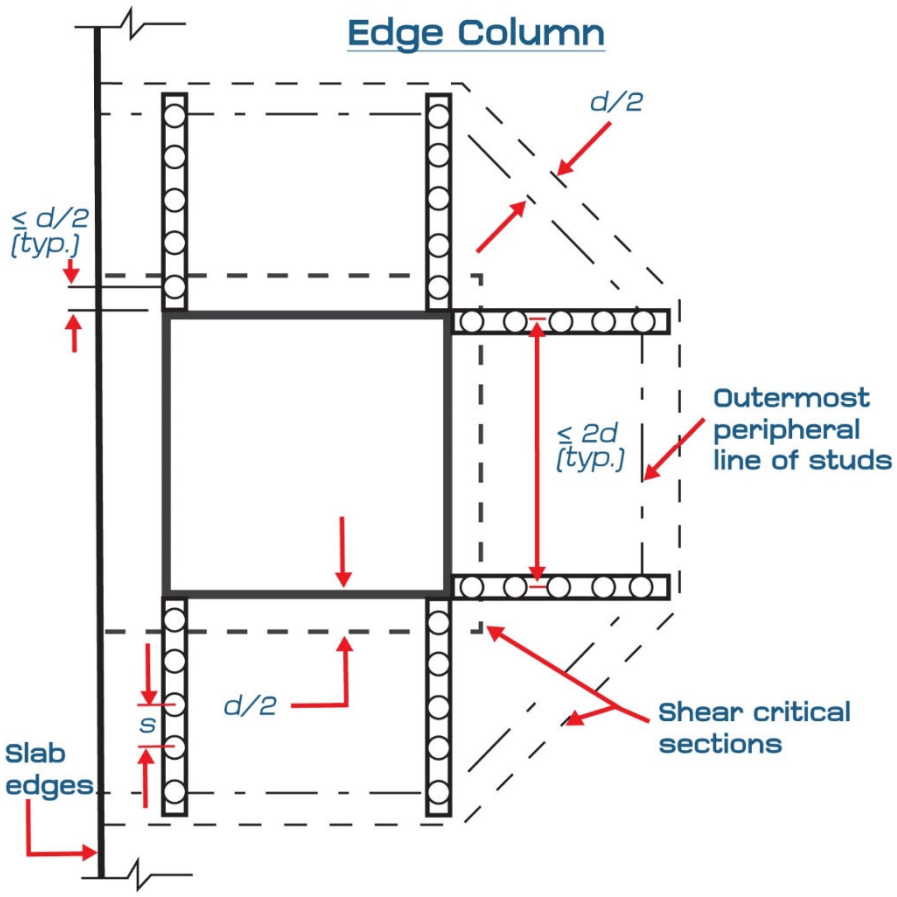


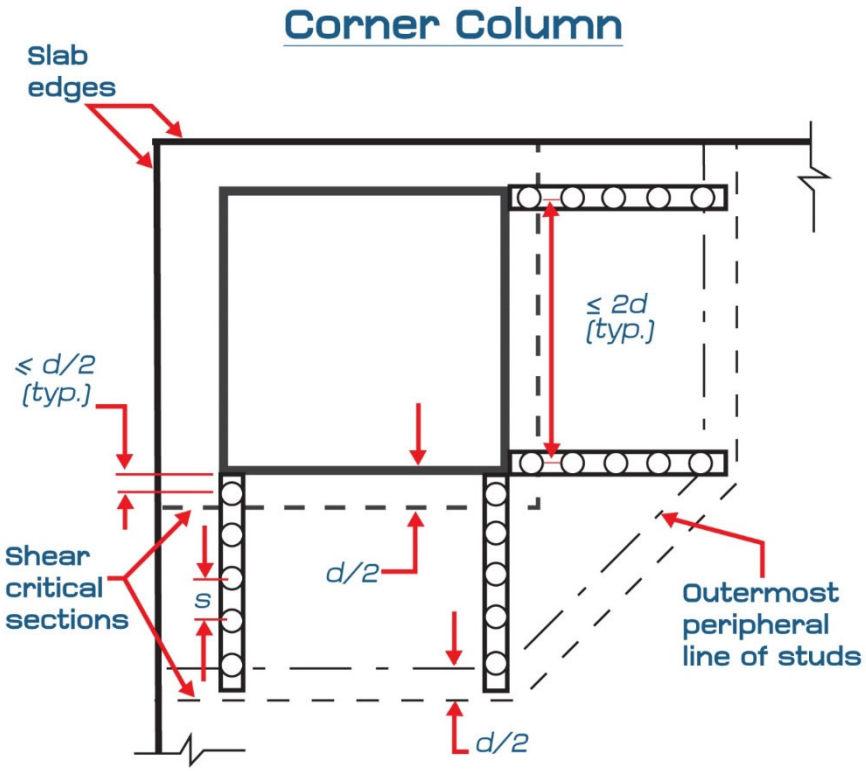


Calculation of stud height must meet the requirements which are all the heights must not be less than the thickness of the floor minuses the following data:

1. Range of concrete cover of upper reinforcing steel.
2. Rang of concrete cover of base plate.
3. Half of the diameter of the reinforcing steel bars that takes tensile stress from bending.




Edge Column
d/2
≤ d/2
(typ.)
≤ 2d
(typ.)
Outermost
peripheral
line of studs
d/2
s
Slab
edges
Shear critical
sections


Corner Column
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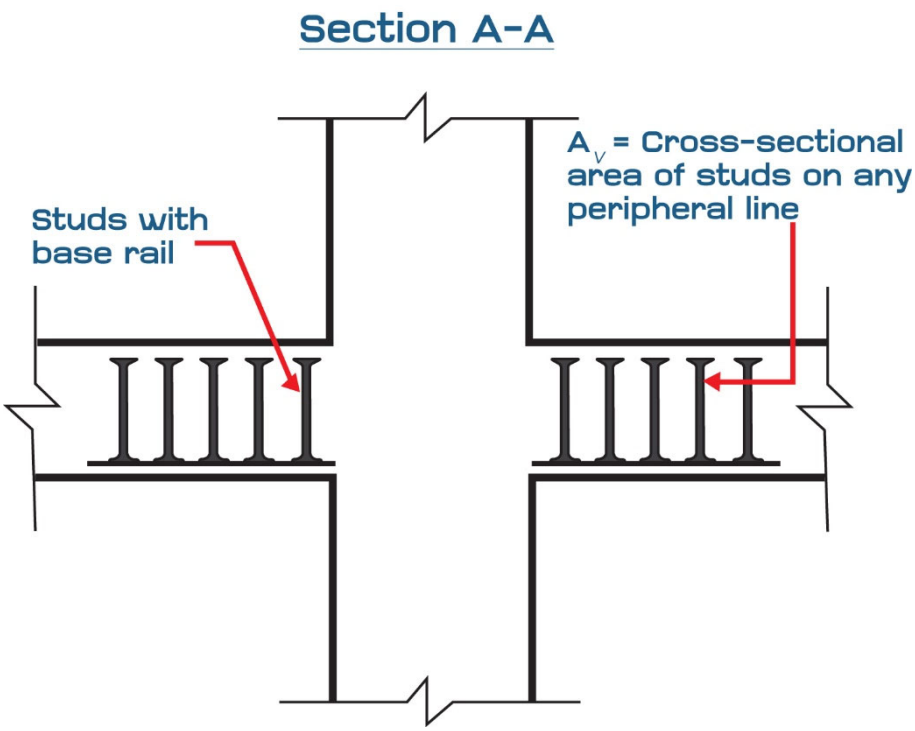
d/2



Assume that D is the effective depth:

- The distance between the first row of shear stud from the edge of the column to the center of the first row of stud must not exceed D/2.
- The distance between rows of shear stud measured perpendicularly to the edge of the column must be constant for the prestressed concrete floor. The distance must not exceed 0.75D.
- For other types of floor, the distance depends on the total shear stress that occurs.

    A) 0.75D when the total shear stress is less than or equal to $\Phi 1.59\sqrt{}$ ("FC'")

    B) 0.50D when the total shear stress is greater than $\Phi 1.59\sqrt{}$ ("FC'")

- The distance between edges of base rail must not exceed 2D.

Compiled by

Mr.Parkpoome Vanitkamonnunt (Senior Professional Engineer 1924)

Reference document

1. ACI Committee 318; “Building Code Requirements for Structural Concrete (ACI 318-11) and Commentary”

2. M.E. Kamara, L.C. Novak; Notes on ACI 318-11 Building Code Requirements for Structural Concrete with Design Application

3. ACI-ASCE Committee 421; “ Guide to Shear Reinforcements for Slabs” (ACI 421.1R-08)

4. มาตรฐานสำหรับอาคารคอนกรีตเสริมเหล็ก โดยวิธีกำลัง ; สมาคมวิศวกรรมสถานแห่งประเทศไทย