ALMUSTAQBAL UNIVERSITY COLLEGE

DEPARTMENT OF BUILDING & CONSTRUCTION ENGINEERING TECHNOLOGY

ANALYSIS AND DESIGN OF REINFORCED CONCRETE STRUCTURES II

SHEAR IN SLABS

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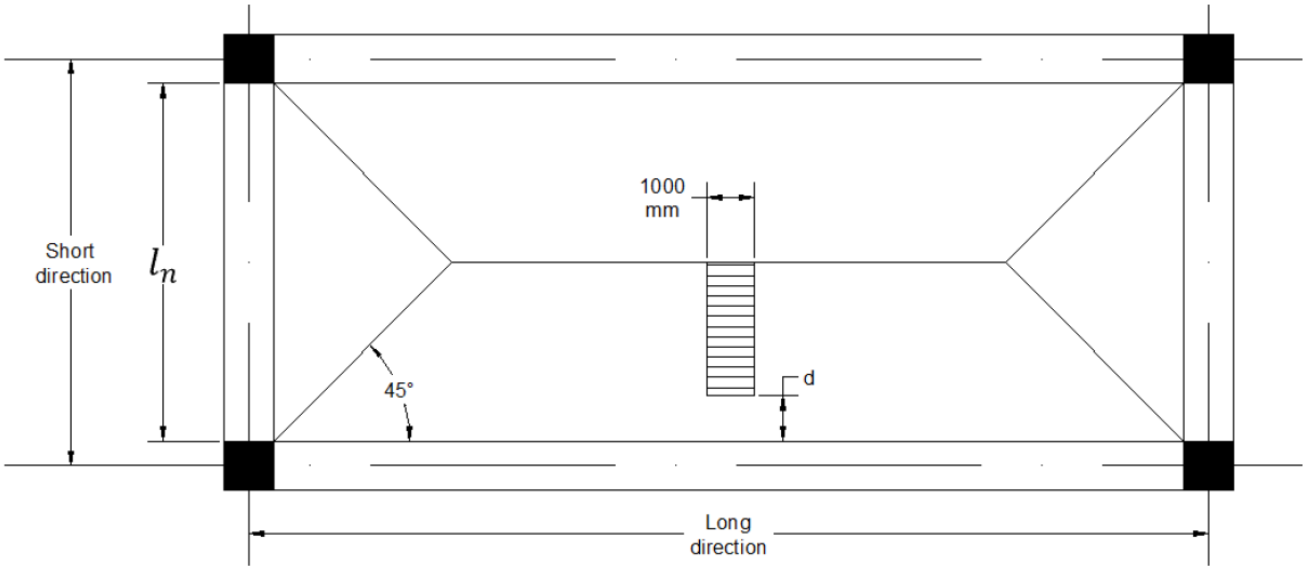
SHEAR IN SLABS

1. ONE WAY SHEAR:

A. SHEAR IN SLABS WITH BEAMS:



Shear Force (Vu) is the shear force caused be the load affecting the slab at a distance equal to the effective depth (d) from the face of the beam.

$$Vu = Wu\left(\frac{l_n}{2} - d\right)$$

Where:

Vu: ultimate shear force caused by the load.

Wu: ultimate load.

ln: length of clear span from face to face of the columns.

d: effective depth.

The ultimate shear force Vu should be equal or less than the factored concrete shear strength Vc.

$$Vu \leq \emptyset Vc$$

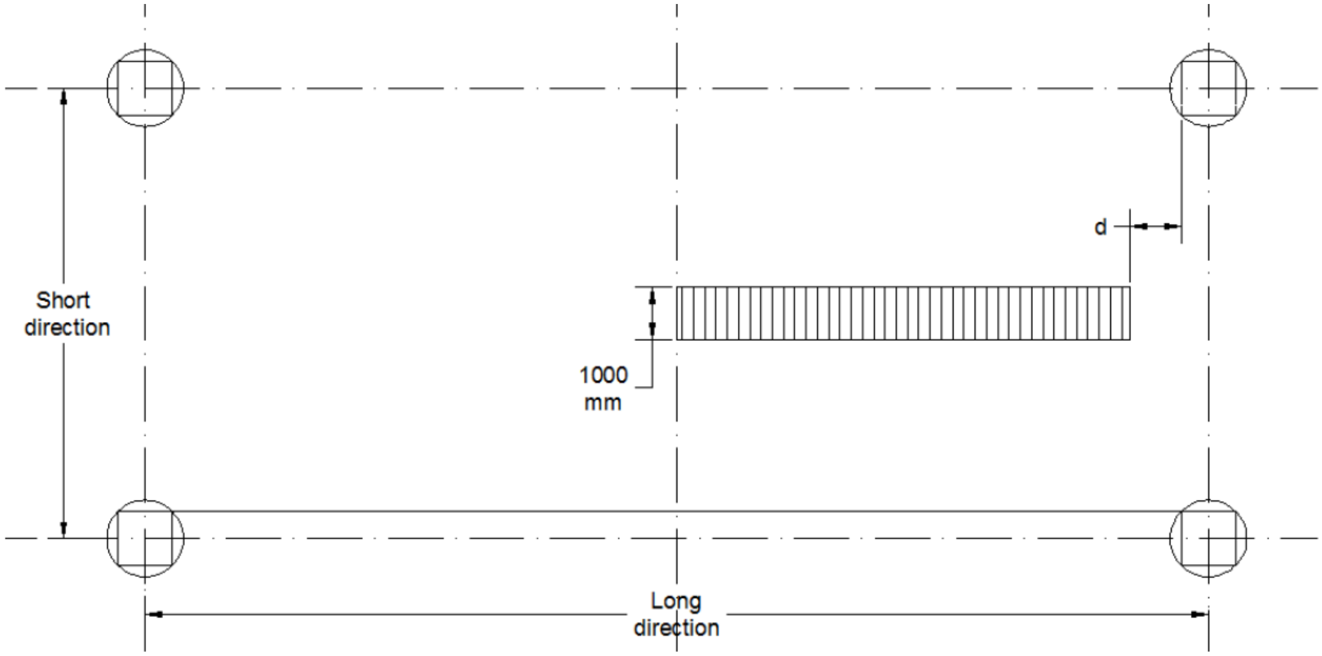
Where:

$Vc = \frac{\sqrt{f_c'}}{6}\, bd$

$\emptyset = 0.75$

$b = 1000mm$

B. SHEAR IN SLABS WITHOUT BEAMS:



$$d_s = t - 20 - 1.5\ D_{bar}$$

$$Vu \leq\ \emptyset Vc$$

$$Vc = \frac{\sqrt{f_c'}}{6}\ bd$$

B=1000mm, $\emptyset = 0.75$

STEPS TO FOLLOW WHEN DETERMINING ONE WAY SHEAR SLAB

1. To find the shear force **Vu** we must determine **ln** and **d**. determine ln by taking the short span or long span which is required then subtract the dimension of the column.
2. The effective depth d, either **d** **short** or **d** **long** according to the required direction.

$$d_{short} = t - c - 0.5\ D_{bar}$$

$$d_{long} = t - c - 1.5 D_{bar}$$

3. We determine the shear force **Vu** using the formula $V_u = \ W_u\ (\frac{l_n}{2} - d)$.
4. We determine the factored concrete shear $\emptyset Vc$

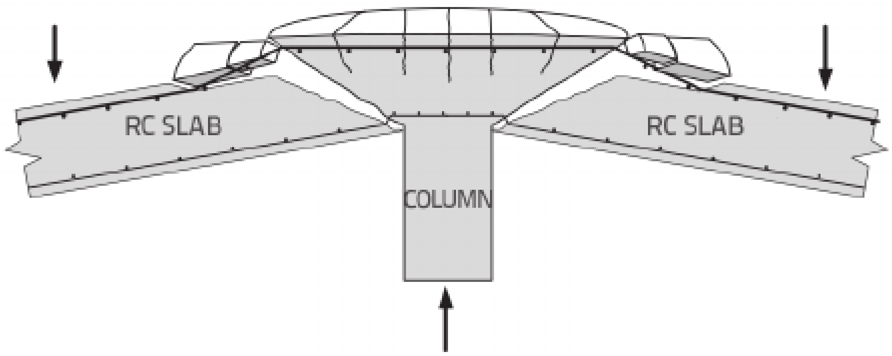
$$Vc = \frac{\sqrt{f_c'}}{6}\ bd,\ \ \emptyset = 0.75\ \&\ b{=}1000mm$$

5. Compare **Vu** to $\emptyset Vc$.

$$Vu \leq\ \emptyset Vc$$

2. TWO WAY SHEAR (PUNCHING SHEAR)

- **Punching shear** is a type of failure of reinforced concrete slabs subjected to high localized forces.
- In flat slab structures this occurs at column support points.
- This type of failure is catastrophic because no visible signs are shown prior to failure.
- Punching shear failure disasters have occurred several times in this past decade.



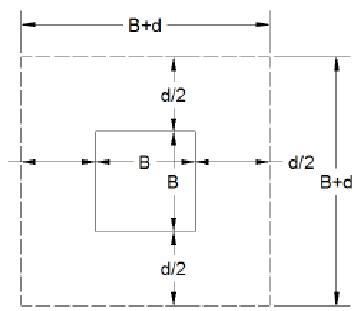
METHODS USED TO PREVENT PUNCHING SHEAR FROM OCCURING

1. Increasing the thickness of slab or increasing the column dimensions (uneconomical).
2. Using drop panels.
3. Using column capital
4. Using shear reinforcement.

Check the examples below.

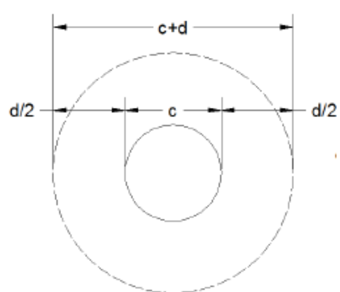
HOW TO CALCULATE PUNCHING SHEAR

- Critical section for the punching shear is taken perpendicular to the plane of the slab at a distance $\frac{d}{2}$ from the support.
- Area defined by the critical shear perimeter is b_o.
- For a rectangular column:



$$b_o = (B + d) \times 4$$

- For a circular column:



$$b_o = \pi\,(c + d)$$

- Determine the shear force V_u.

$$V_u = W_u (l_1 \times l_2 - A_{ps})$$

- Determine the shear stress v_u

$$v_u = \frac{V_u}{b_o d}$$

- Determine concrete shear v_c

	$0.33\ \lambda\sqrt{f_c'}$
v_c is the **least** of	$0.17\ (1 + \frac{2}{\beta})\lambda\sqrt{f_c'}$
	$0.083\ (2 + \frac{\alpha_s d}{b_o})\lambda\sqrt{f_c'}$

Where:

λ = 1 for normal concrete.

β = is the ration between the long side to the short side of the column.

α_s= position of column, interior column α_s**= 40**, edge column α_s**= 30**, corner column α_s **= 20**.

- If $\emptyset v_c \geq v_u$, then no shear reinforcement is required.
- If otherwise $\emptyset v_c < v_u$, then shear reinforcement is required.
- Check if $v_u \leq \emptyset \times 0.5 \times \sqrt{f_c'}$
- We must determine v_s

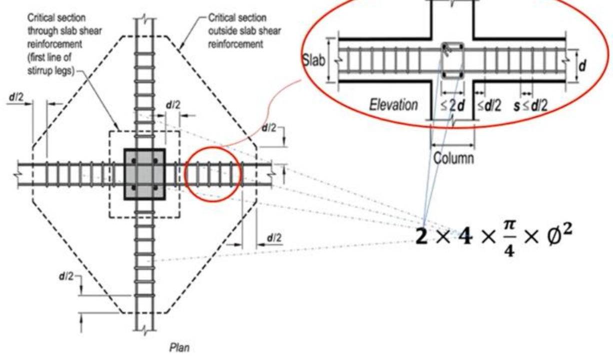
$$v_s = \frac{v_u}{\emptyset} - v_c, \text{ where } v_c = 0.17\ \lambda\sqrt{f_c'}$$

- Determine the shear reinforcement area (A_v) or spacing between stirrups (s) from the following formula:

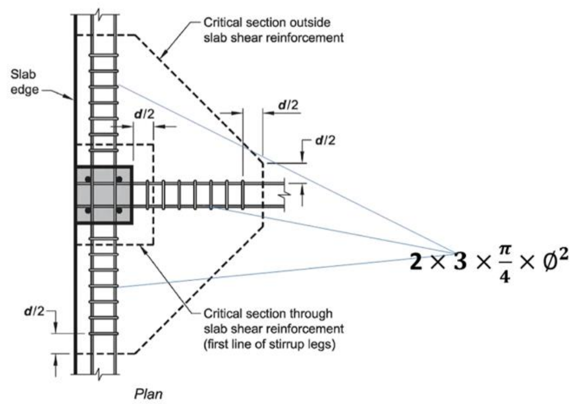
$$v_s = \frac{A_v f_y}{b_o s}$$

- If A_v is required, we use $s = \frac{d}{2}$.
- If **s** is required, then A_v is determined according to the position of the column.

- Calculating of Av
- For interior column



Edge Column



Corner Column