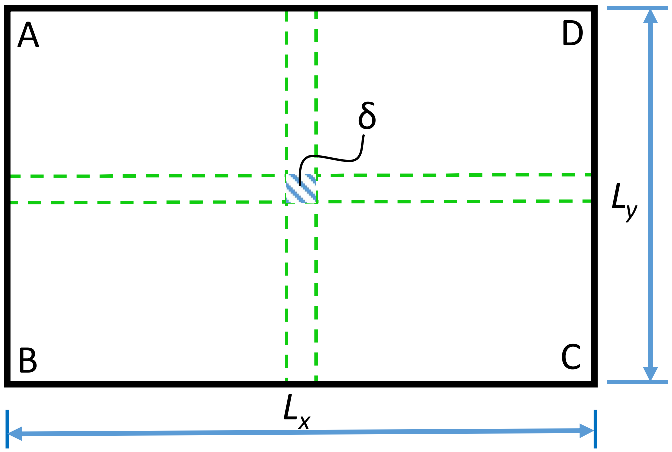
Slab Design:

Slabs:



Let, ω_L and ω_S are the load carried along the longer and shorter spans L_x and L_y respectively. Now, apply deflection compatibility –

$$\frac{5}{384}\frac{\omega_L L_x^4}{EI} = \delta = \frac{5}{384}\frac{\omega_S L_y^4}{EI} \rightarrow \omega_S = \omega_L \left({}^{L_x}/_{L_y}\right)^4 \qquad \left({}^{L_x}/_{L_y}\right) = r > 1.0$$

$$\rightarrow \omega = \omega_S + \omega_L$$

$$\rightarrow \omega_L = \frac{1}{1+r^4}\omega = r_L\omega \qquad \rightarrow M_{L_x} = \omega_L\frac{L_x^2}{8} = r_L\omega\frac{L_x^2}{8}$$

$$\rightarrow \omega_S = \frac{r^4}{1+r^4}\omega = r_S\omega \qquad \rightarrow M_{L_y} = \omega_S\frac{L_x^2}{8} = r_S\omega\frac{L_y^2}{8}$$

Grashoff-Rankine Theory

Annex-D of IS-456:2000 (D-1.1) recommends:

$$M_{L_x} = \alpha_x \omega L_y^2$$

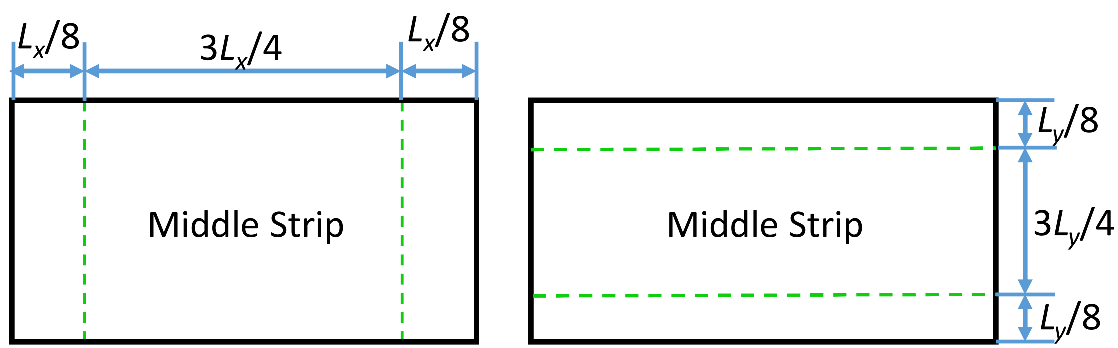
$$M_{L_y} = \alpha_y \omega L_y^2$$

For coefficients, refer Table 26 & 27.

NB: Shorter span carries more load and BM. Hence, main steel in shorter span will be at the bottom.

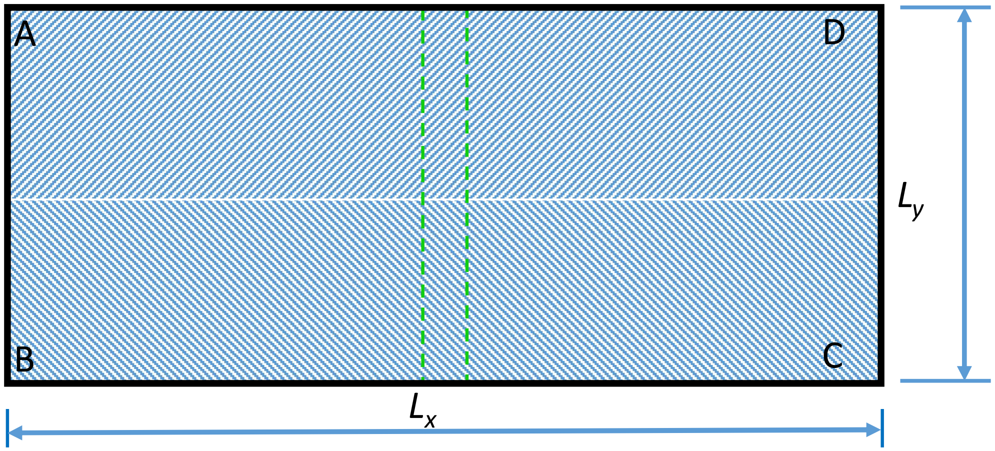
r	r_S	r_L	r	r_S	r_L
1.00	0.50	0.50	2.00	0.94	0.06
1.50	0.84	0.16	2.50	0.97	0.03
1.75	0.90	0.10	3.00	0.98	0.02
Two-way Slab			One-way Slab		

D-1.2: Slabs are considered as divided in each direction into middle and edge strips, as shown below –



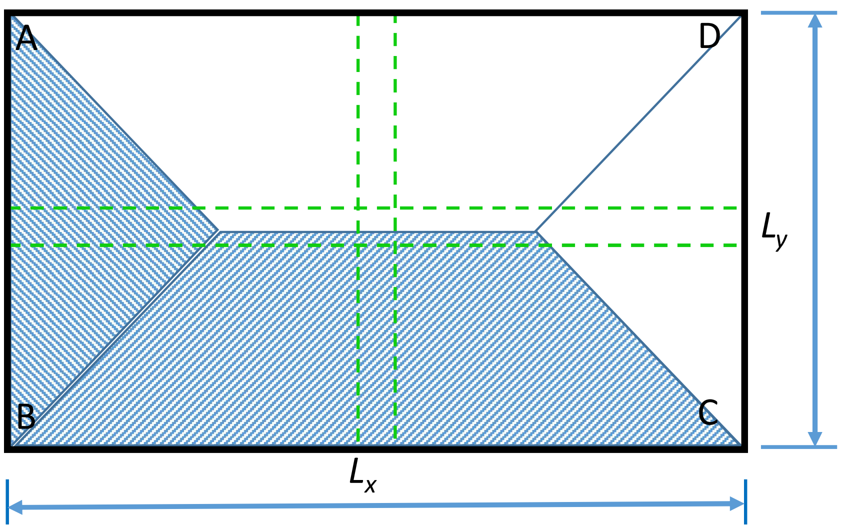
Slabs:

One-way Slab



r	r_S	r_L	r	r_S	r_L
1.00	0.50	0.50	2.00	0.94	0.06
1.50	0.84	0.16	2.50	0.97	0.03
1.75	0.90	0.10	3.00	0.98	0.02
Two-way Slab			One-way Slab		

Two-way Slab



Note:

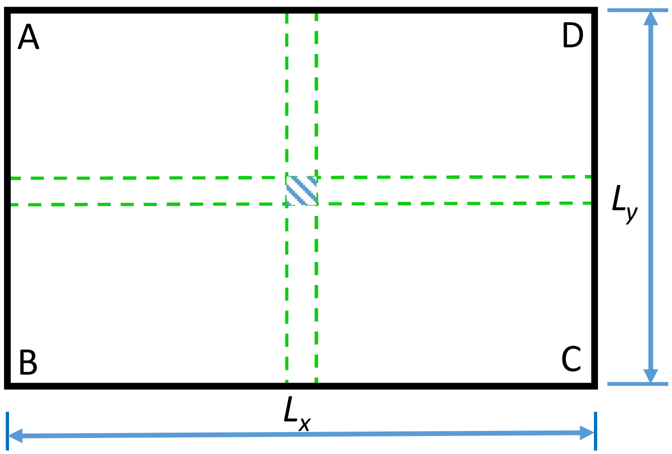
1. For slabs spanning in two directions, the shorter of the two spans should be used for calculating the span to effective depth ratio.
2. For two-way slab of shorter span up to 3.5m with mild steel reinf. The span to overall depth ratio given below generally satisfy deflection limits for loading up to 3kN/m^2

   SS Slab 35

   Cont. Slab 40

For high strength deformed bars of grade Fe415, the values above should be multiplied by 0.8.

Slabs:



D-2 Simply Supported:

D-2.1: When the slabs do not have adequate provision to resists torsion at corners and to prevent corners from lifting, the maximum moments per unit width must be calculated using coefficients in Table 27.
D-2.1.1: At least 50% of the tension reinforcements at mid span should extend to support. Remaining 50% should extend within $0.1L_x$ or $0.1L_y$

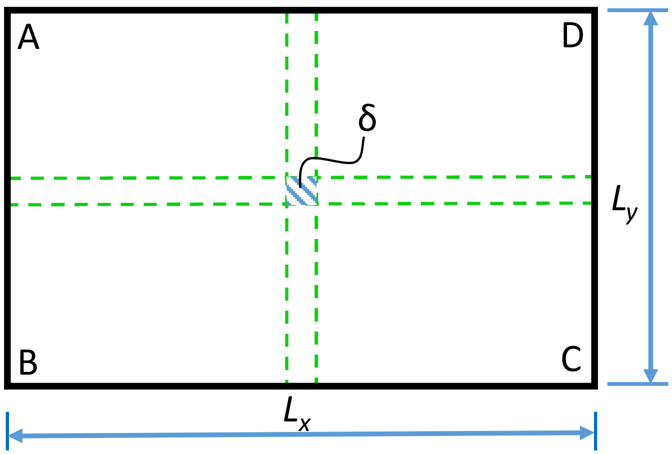
NB: Mostly encountered in masonry structures.

D-1 Restrained Slabs:

D-1.3: The maximum moments as in D-1.1 apply only to the middle strips and no distribution shall be made.
D-1.4: Tension reinforcement provided at mid-span in the middle strip shall extend in the lower part of the slab to within 0.25L of a continuous edge or 0.15L of a discontinuous edge.
D-1.5: Over the continuous edge of a middle strip, the tension reinforcement shall extend in the upper part of the slab a distance of 0.15L from the support and at least 50% shall extend a distance of 0.3L

NB: Evaluate mid-span reinforcement in both directions and estimate other reinforcements accordingly

Slabs:



D-1 Restrained Slabs:

D-1.6: At a discontinuous edge, negative moments may arise. They depend on the degree of fixity at the edge of the slab but, in general, tension reinforcement equal to 50% of that provided at mid span extending 0.1L into the span will be sufficient

D-1.7: Reinforcement in edge strip, parallel to that edge, shall comply with the minimum given in Section 3 and the torsion given in D-1.8 to D-1.10.

Caution: Code does not recommend over reinforced section.

Annex G: Moment of Resistance

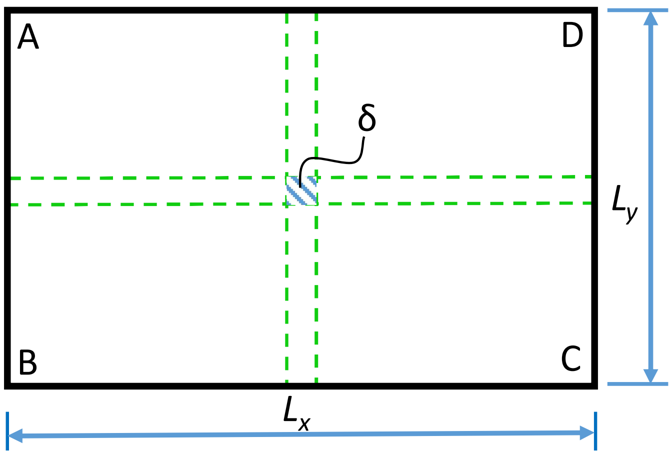
Section without compression reinforcements

G-1.1a) Determine the depth of neutral axis $\frac{x_u}{d} = \frac{0.87}{0.36}\frac{f_y}{f_{ck}}\frac{A_{st}}{bd}$

G-1.1b) Capacity for under reinforced section (refer Note below Cl38.1) $M_u = 0.87 f_y A_{st} d \left(1 - \frac{f_y}{f_{ck}}\frac{A_{st}}{bd}\right)$

G-1.1c) Capacity for balanced section (refer Note below Cl38.1) $M_{u,lim} = 0.36\frac{x_{u,max}}{d}\left(1 - 0.42\frac{x_{u,max}}{d}\right) bd^2 f_{ck}$

Slabs:



Control of Deflection Cl 23.2

a) The final deflection due to all loads including the effects of temperature, creep and shrinkage and measured from the as-cast level of the support of floors, roof and all other horizontal members, should not normally exceed span/250

b) The deflection including the secondary effects mentioned above occurring after erection of partition and application of finishes should not normally exceed span/350 or 20mm whichever is less.

Design against shear

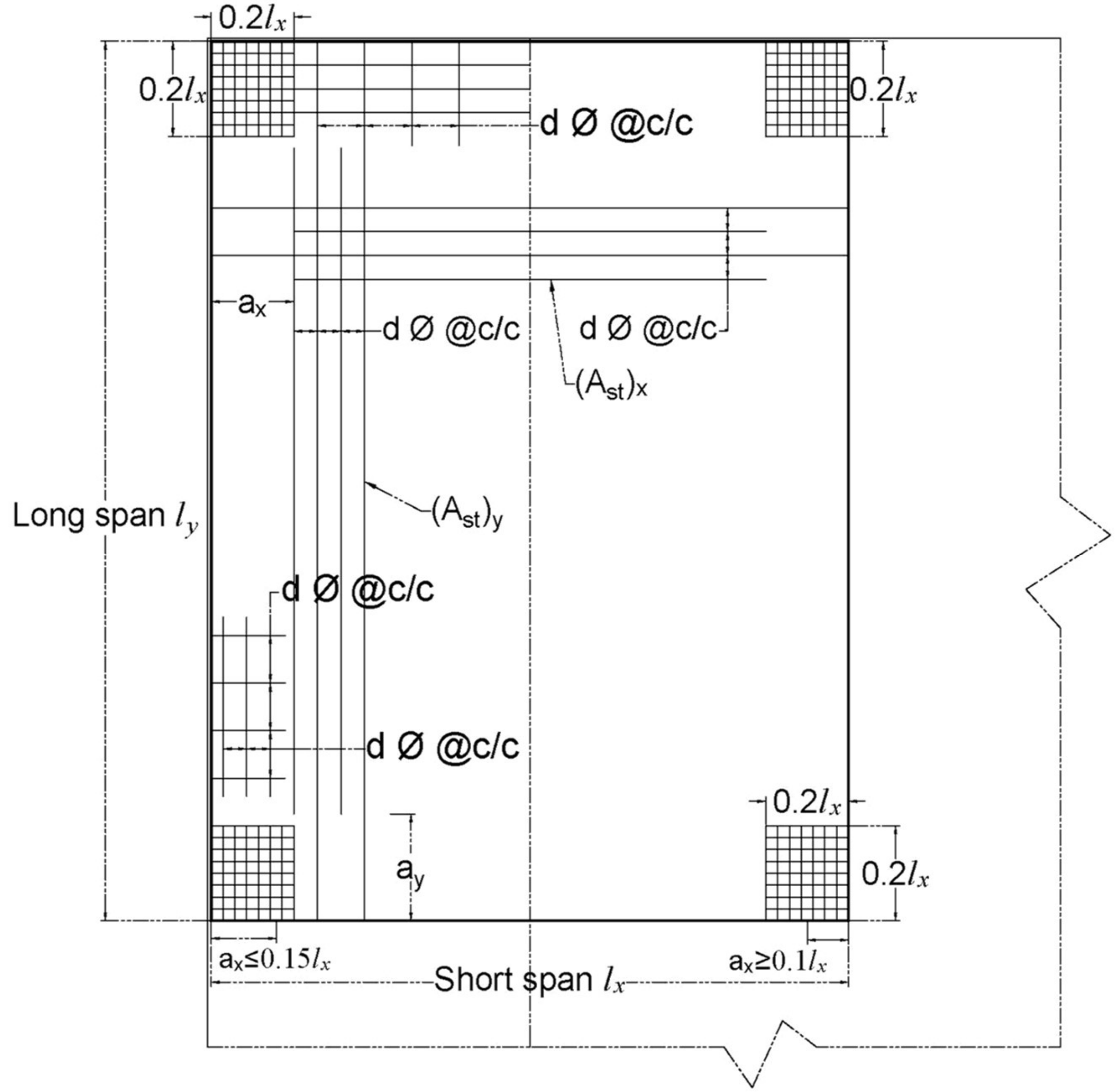
Cl 40.1 Nominal Shear Stress $\tau_v = \frac{V_u}{bd} < \tau_c$ Refer Table 19 for allowable limits

Design against development length

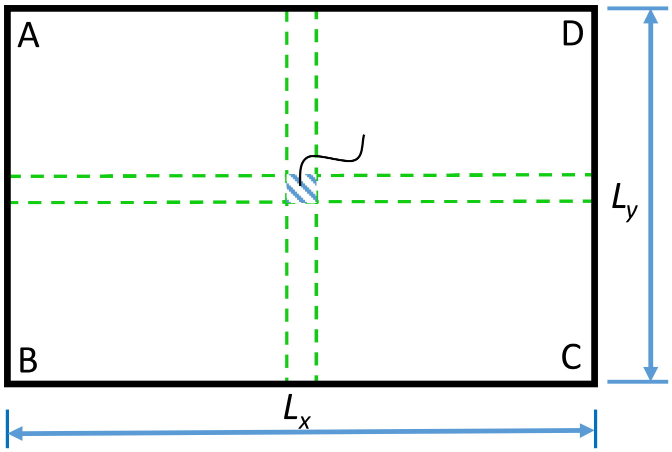
Cl 26.2.1 Development length of bars $L_d = \frac{\emptyset}{4}\frac{\sigma_s}{\tau_{bd}}$ Design bond stress for M20 concrete is 1.2N/mm^2

Reinforcement Details:

Draw general arrangement and reinforcement details in AUTOCAD/Hand-Sketch



Slabs:



List of checks:

1. Check against bending (Annex D & G)
2. Check against shear (although not so important in slab. But show the calcs.) (Cl 40)
3. Check against development length (Cl 26.2.1)
4. Check against deflection (Cl23.2)
5. Any other clause relevant for slab design

Attention:

1. Use schematic diagram and mark all slabs clearly
2. Show detailed calculation for once sample of a one-way slab and a two-way slab.
3. ~~For all remaining slabs in every floor use a table to show all key parameters~~

Note: Hard copy of the report must be submitted to the respective TA at the end of the sessional class. Use a cover page with the details.