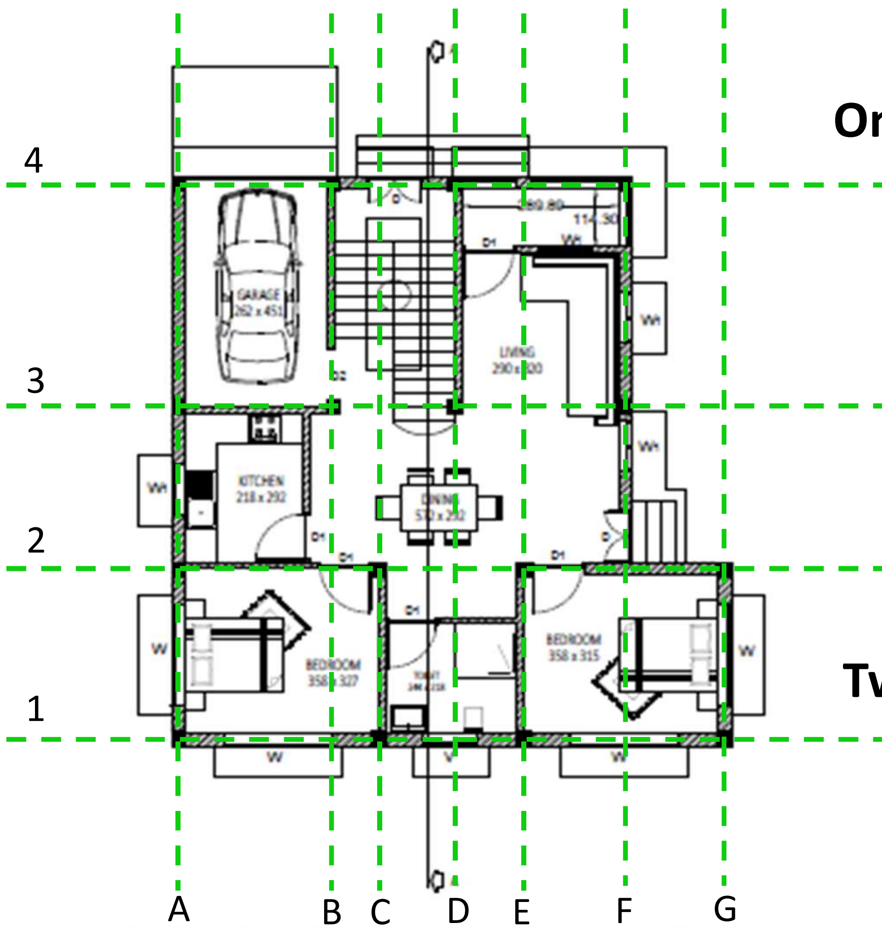
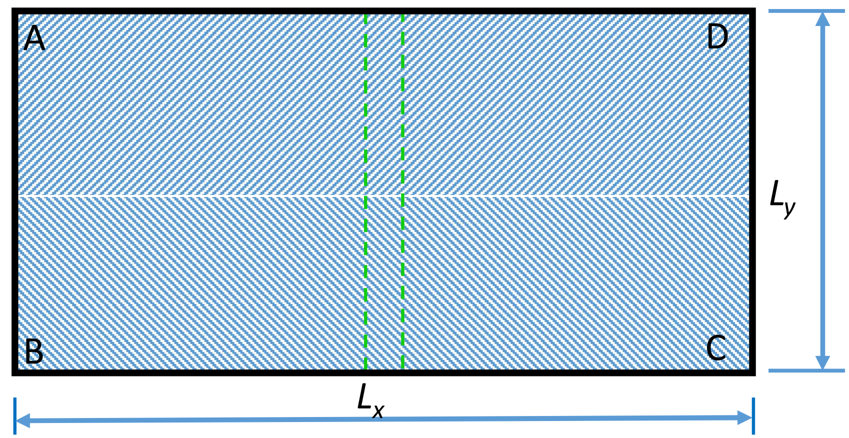
Beam Design:

Load Estimation:

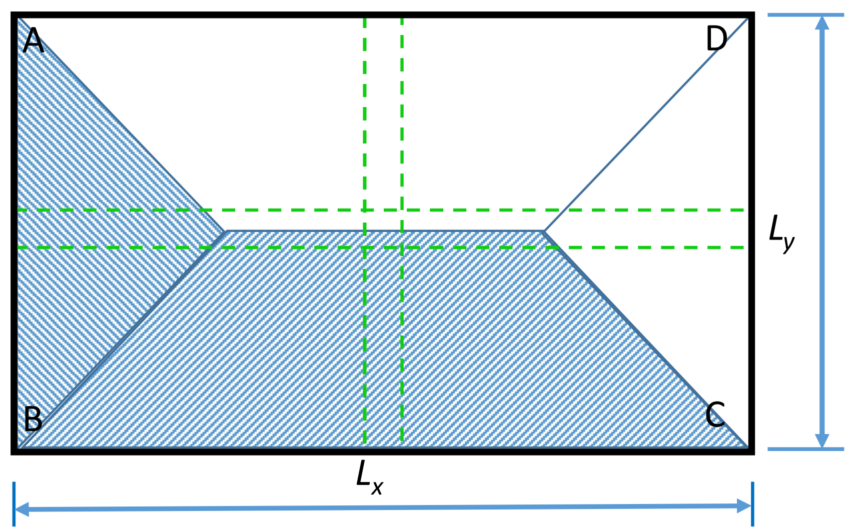


GROUND FLOOR PLAN

One-way Slab



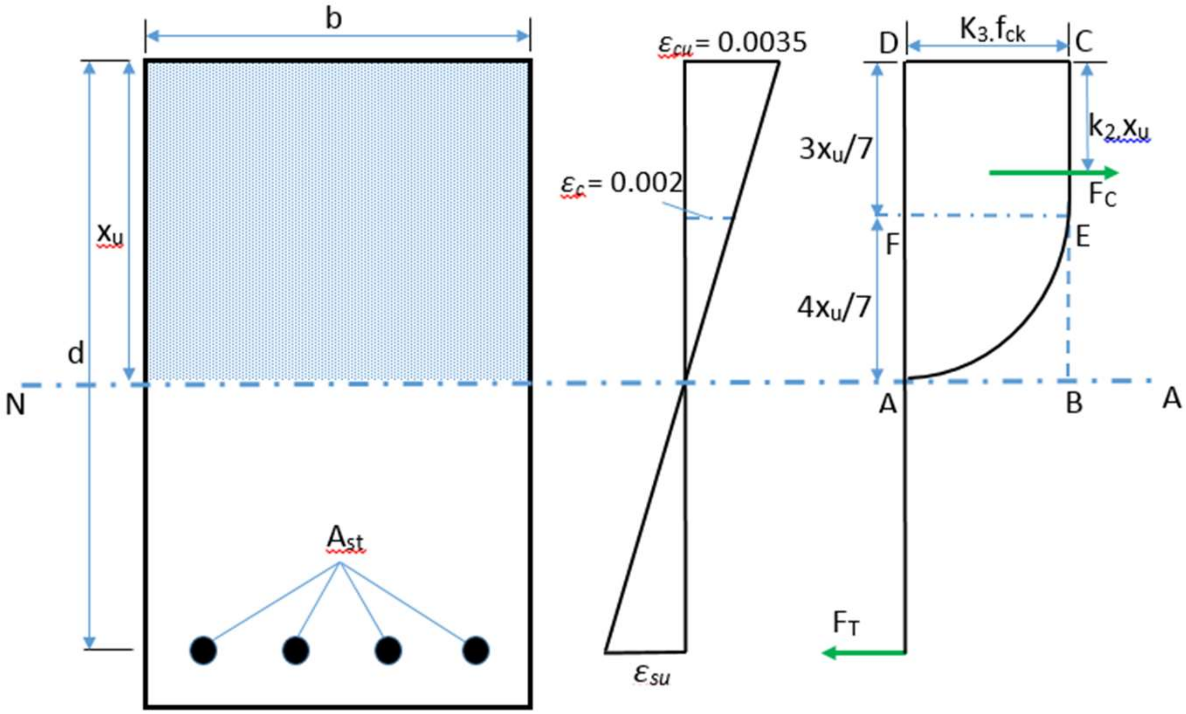
Two-way Slab



Important Points for Beam Design:

- (Cl22.2) Effective Span of a continuous beam – if the width of the support is less than 1/12 of the clear span, the effective span shall be clear span plus effective depth of the beam or center to center distance between supports, whichever is less. If the supports are wider than 1/12 of the clear span or 600mm whichever is less, effective span shall be as per three options in Cl22.2b
- (Cl22.3) Stiffness – may be based on the moment of inertia of the section determined on the basis of any of the three options i.e. **Gross section**, Transformed section and Cracked section
- (Cl22.5) Moment and Shear Coefficients – Unless more exact estimates are made, coefficients given in Table 12 and Table 13 are used for BM and SF without redistribution referred to in Cl22.7. Attention: end support dictates the correction for shear coefficients in Table 13
- (Cl23.0) Effective depth – Distance between the centroid of tension reinforcements and the maximum compression fiber.
- (Cl23.2) Control of Deflection – (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. (Attention: check span to depth ratio following Cl23.2.1)
- (Cl23.3) Slenderness Limits for Lateral Stability – Clear distance between the lateral restraints does not exceed 60b or $250b^2/d$ whichever is less.
- (Cl26.2.1 & Cl26.2.3.3) – Development Length $L_d \leq \frac{M_1}{V} + L_0$

Design Against Bending:



Determine the depth of neutral axis –

$$\frac{x_u}{d} = \frac{0.87}{0.36}\frac{f_y}{f_{ck}}\frac{A_{st}}{bd}$$

Capacity for under reinforced section –

$$M_u = 0.87 f_y A_{st} d \left(1 - \frac{f_y}{f_{ck}}\frac{A_{st}}{bd}\right)$$

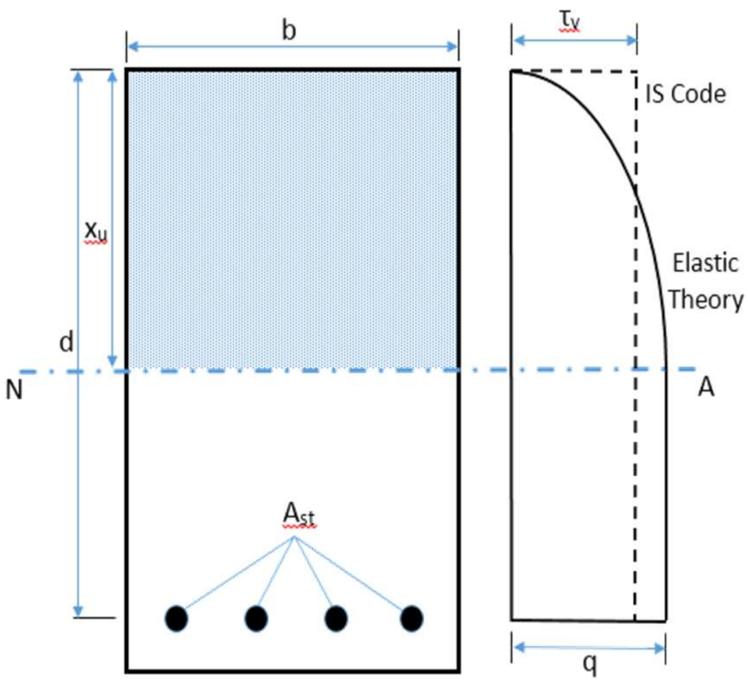
Capacity for balanced section –

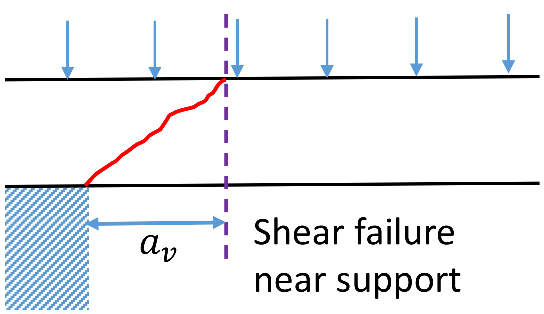
$$M_{u,lim} = 0.36\frac{x_{u,max}}{d}\left(1 - 0.42\frac{x_{u,max}}{d}\right) bd^2 f_{ck}$$

Caution: Avoid over-reinforced section

Important: (Cl26.2.3.4) Negative moment reinforcement – At least one-third of the reinforcement provided for negative moment at the support shall extent beyond the point of inflection for a distance not less than the effective depth of the member of 12ϕ or one-sixteenth of the clear span whichever is greater.

Design Against Shear:





Shear failure near support

(Cl40) Limit State of Collapse in Shear for uniform cross section

$$\tau_v = \frac{V_u}{bd}$$

Note: Design shear strength of concrete is given in Table 19

(Cl40) Limit State of Collapse in Shear for non-uniform cross section

$$\tau_v = \frac{V_u + \frac{M_u}{d}\tan(\beta)}{bd}$$

Prefer to avoid in G+2 residential type

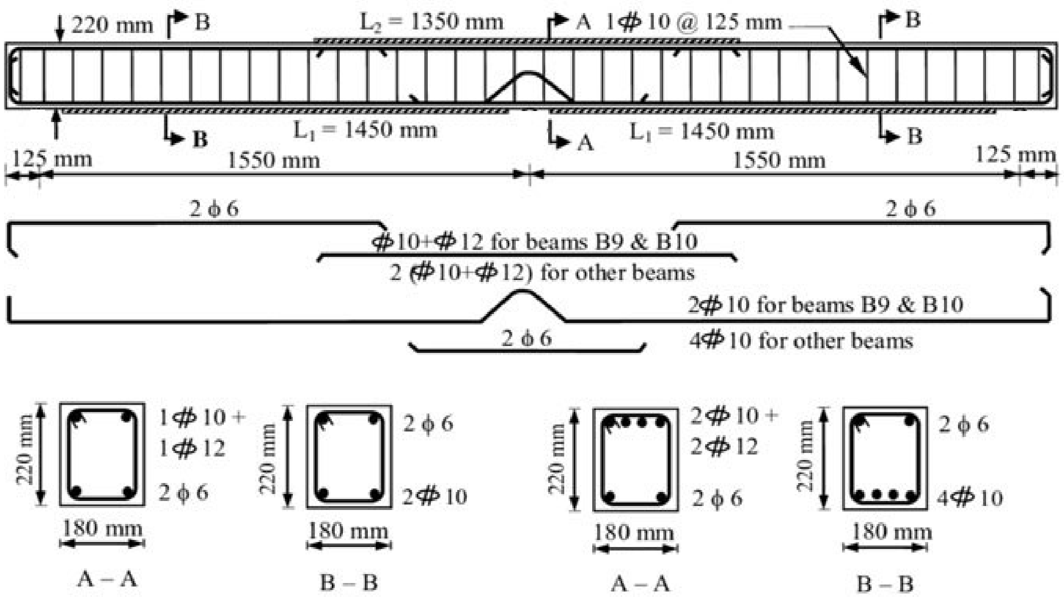
(Cl26.5.1.5) Minimum Shear reinforcement

$$\frac{A_{sv}}{bs_v} \geq \frac{0.4}{0.87f_y}$$

(Cl26.5.1.5) Maximum spacing of shear reinforcement – The maximum spacing along the axis of the member shall not exceed 0.75d for vertical stirrups and d for inclined stirrup at 45 degree

(Cl40.2.3) Nominal shear stress – Under no circumstances, even with shear reinforcement, shall the nominal shear stress in beams τ_v exceed τ_{cmax} given in Table 20

Typical Beam Details:



Typical sections for beams B9 & B10

Typical sections for other beams

List of checks:

1. Check against bending (for critical beam at mid span and at support)
2. Check against shear (for critical beam at mid span and at support)
3. Check against development length (Cl 26.2.1)
4. Check against deflection (Cl23.2)
5. Any other clause relevant for slab design

Attention: One complete set of calculations and table for all other sections. Use grid to mark the beams