بسم الله الرحمن الرحيم

* Analysis of two way slab

Dr. Ali H. Aziz

Note: $\frac{\ell}{s} < 2$

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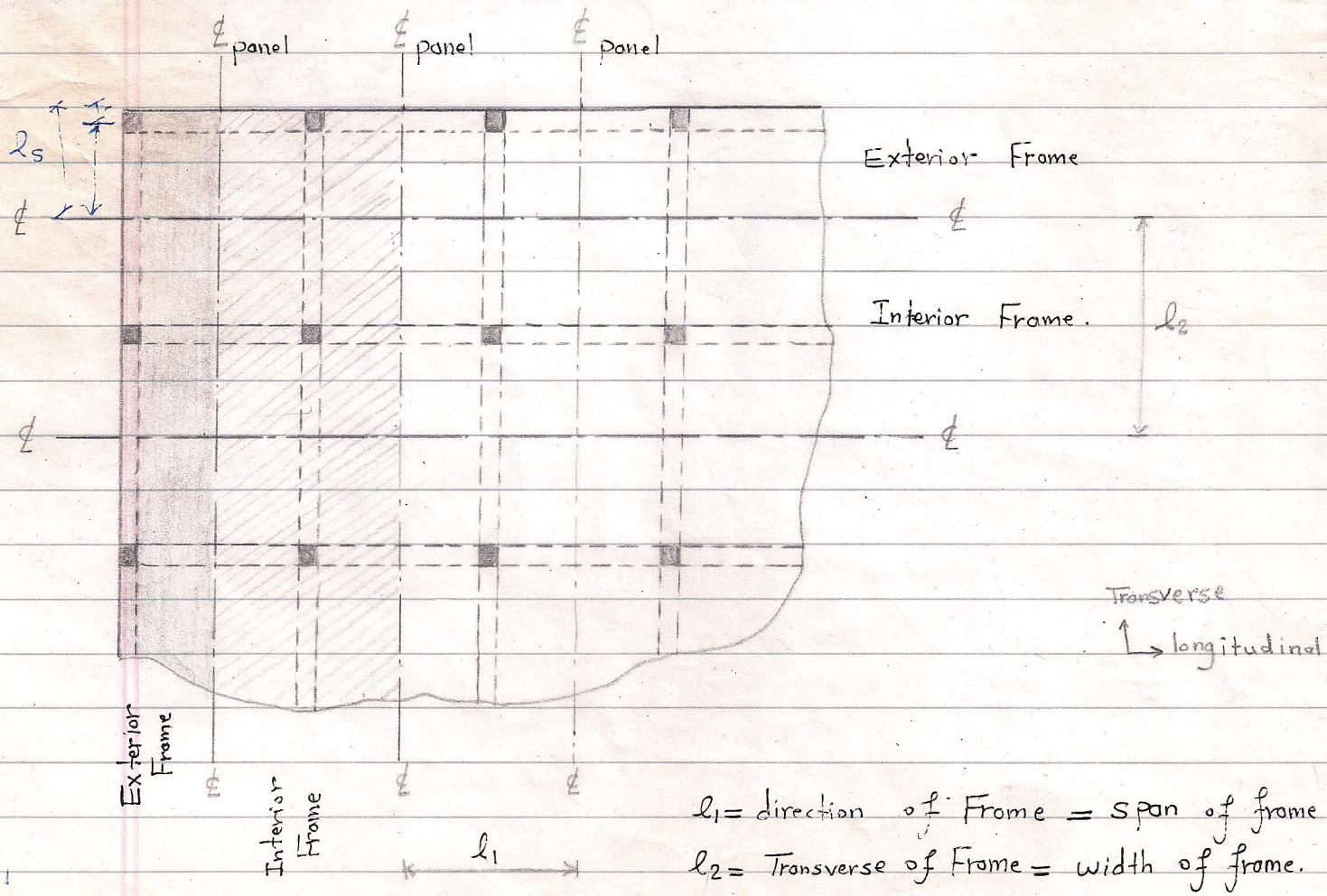
I- two-way slab with edge beams
II- Flat plate
II- Flat slab (with drop panel or Column Capital or both).

* Design of two-way slabs by the ACI-Code

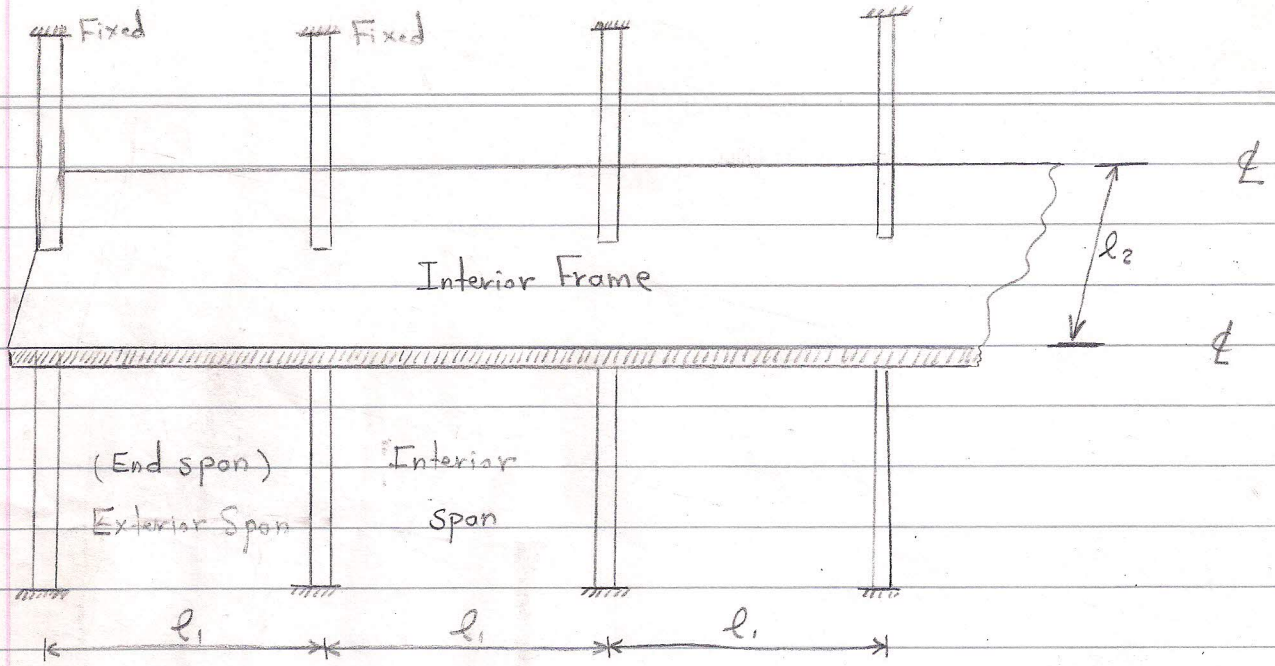
I- Direct Design method (D.D.M)
II- Equivalent Frame Method (EFM).

* General Design Concept of ACI-Code

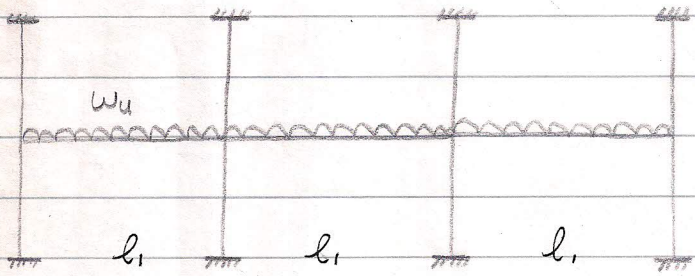
1- Divide the floor into lines midway between the columns. This creates a series of frames in two orthogonal directions.



ℓ_1 = direction of Frome = span of frame
ℓ_2 = Transverse of Frome = width of frame.



OR



Note/

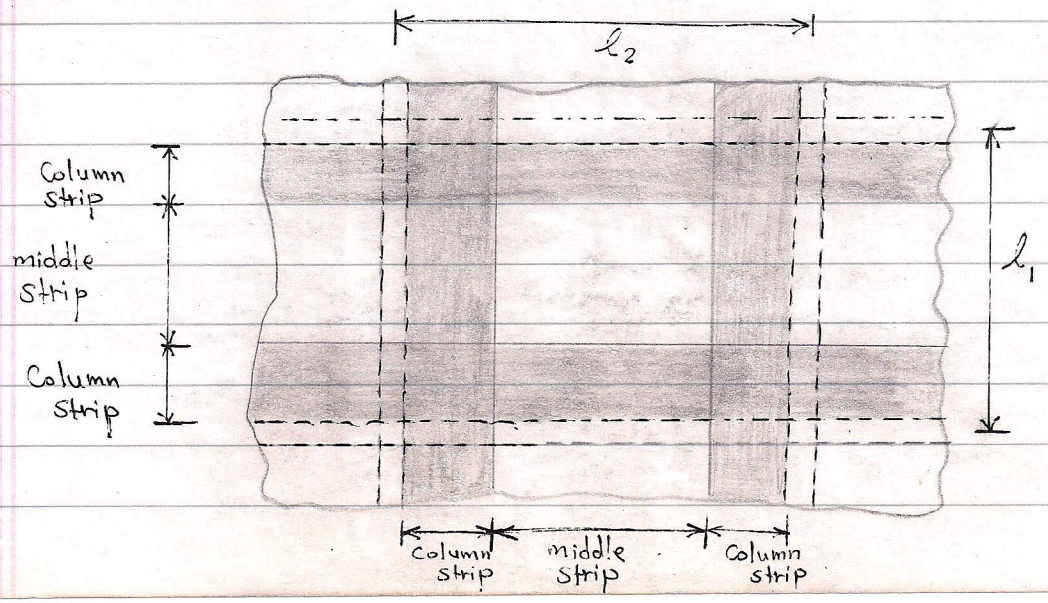
Zero shear ⊥ ... and ℄ ⊥ ...

L_1 = direction of the frame = span of frame

L_2 = Transverse of the frame = width of frame

2- Divide the panel into column strips and middle strips

* width of column strip = $\min\left(\frac{\ell_1}{4}, \frac{\ell_2}{4}\right)$



3- Design each frame separately using either:-
   i- Direct Design method (DDM).
   ii- Equivalent Frame method (EFM).

4- In either method, the design includes:-
   i- Determining the longitudonal moments in the direction of the frame (i.e M^- at supports & M^+ at mid span).

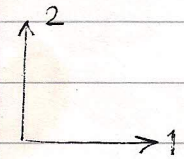
   ii- Transverse distribution of longitudonal moments (i.e distribute M^- & M^+ to column strips & middle strips, then to slab & beam).

$M^{\pm}$ < $M_{c.s}$ < Beam, slab
$M_{m.s}$ → slab

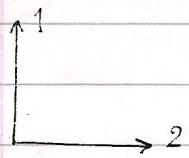
   iii- Preforming design procedure to find section dimensions & reinforcement.

5- The procedure of analysis discrabed above is actually based on assumed dimensions for beams and slabs; these assumed dimension have to Compared with the calculated dimensions, otherwise repate design procedure using the new found dimensions.

Note/



For Frames in x-direction



For frame in y-direction

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* Limitations of Direct Design Method

ACI- 13.6.1

1- * At least three continuous spans must exist in each direction.

2- ** The panels must be rectangular, with the length of the longer side of any panel not being more than (2) times the length of its shorter side length being measured c/c of supports.

3- *** Span lengths of successive spans in each direction may not differ in length by more than (1/3) of the longer span.

4- □ Columns must not be offset more than (10%) of the distance between centerlines of successive in each direction.

5- The live load must not be more than (2) times the dead load. All load must be due to gravity and must be (UDL) over an entire panel.

For Slab Beam system →

6- The relative stiffness of beams (if any) in two perpendicular directions shall be such that $0.2 \leq \frac{\alpha_1 l_2^2}{\alpha_2 l_1^2} \leq 5$ (which means that beams in the two direction should not differ too much in their stiffness).

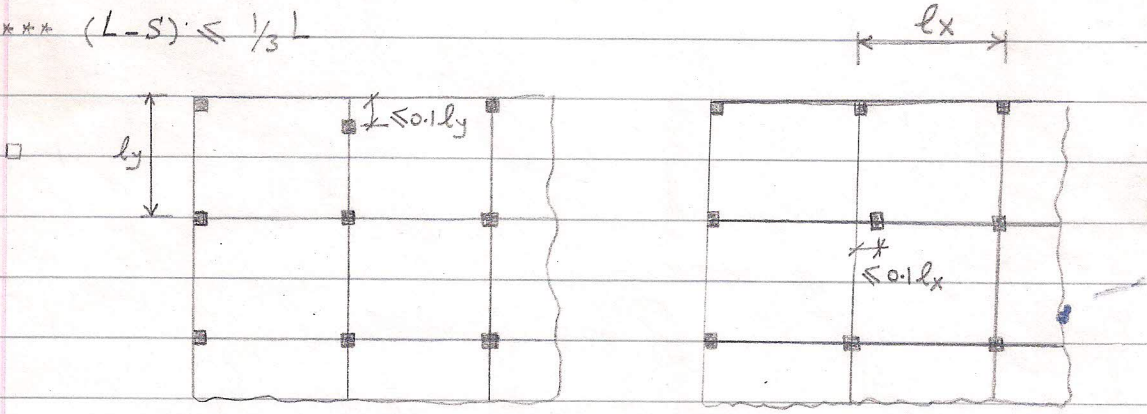
$$\alpha = \frac{E_{cb}}{E_{cs}} \frac{I_b}{I_s} \qquad E_c = 4700\sqrt{f'_c}$$

* Minimum (9) panels.

** two-way slabs.

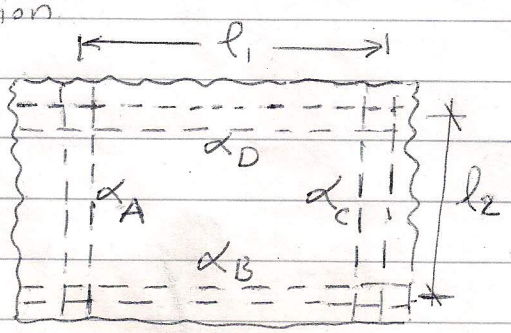
*** $(L-S) \leq \frac{1}{3} L$

□



Note / 6th Condition

$$\frac{\alpha_1 l_2^2}{\alpha_2 l_1^2}$$



$$\alpha_1 = \frac{\alpha_B + \alpha_D}{2}$$

$$\alpha_2 = \frac{\alpha_A + \alpha_C}{2}$$