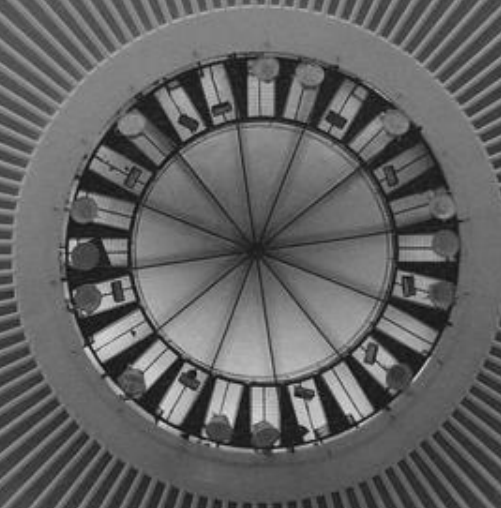


# *Reinforced Concrete Structures*

*MIM 232E*




## *Principles of Load Bearing System Design*


**LBSD-2**

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I.T.U. Faculty of Architecture

Structural and Earthquake Engineering WG

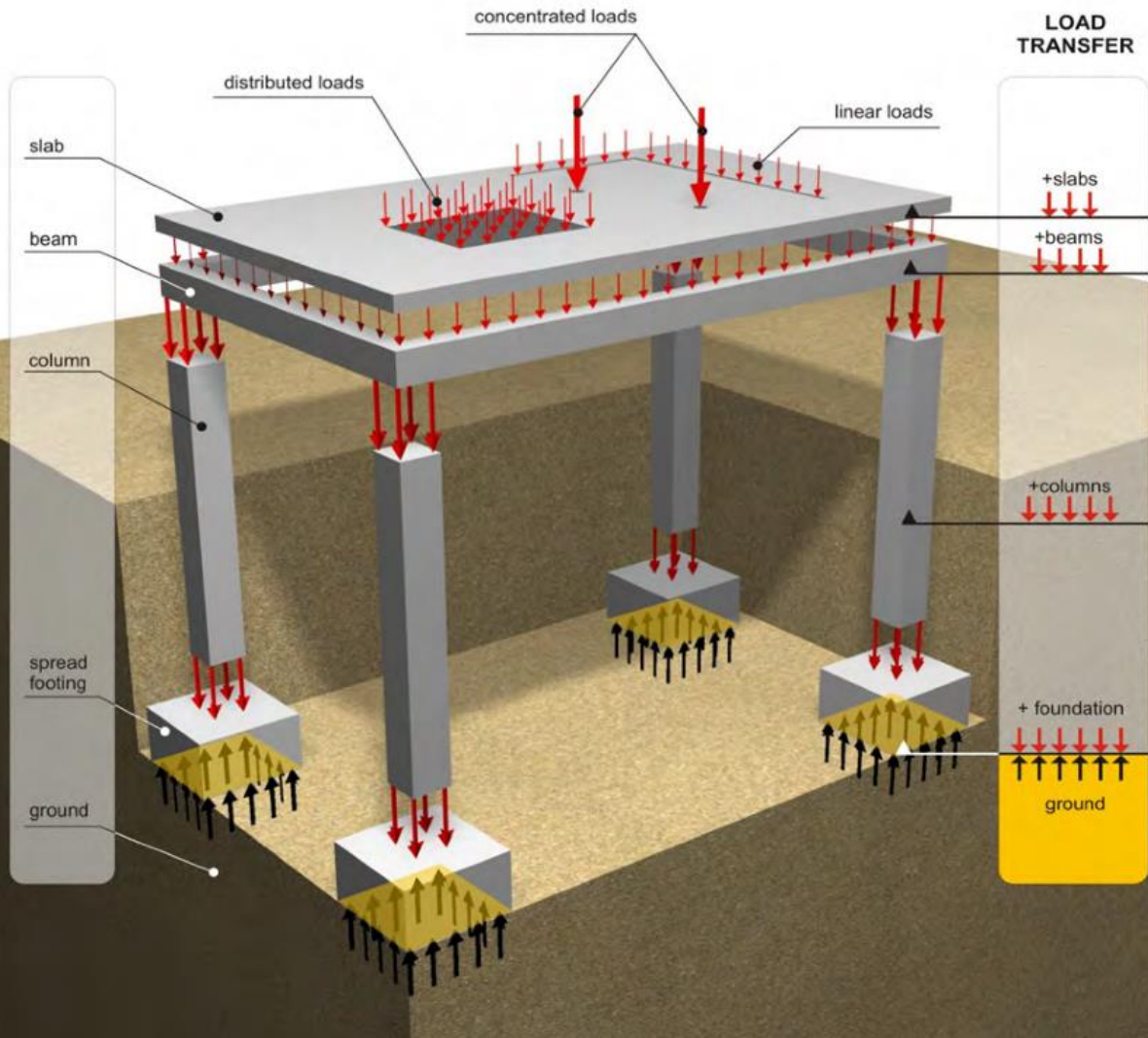
- LBS  Compatible with Arch.
- Functional conditions for LBS
  - Supplying independence in plan  
less cross-section usage as possible
  - Compatible with installation  
supplying easy maintenance for inst.

- Fire-proofing
  - Sound, water, humidity isolation
  - Prevent cracking/excessive deformations
- 
- Civil/Structural Eng.  Structural Safety

# Load Bearing System

## General

### Forming LBS;



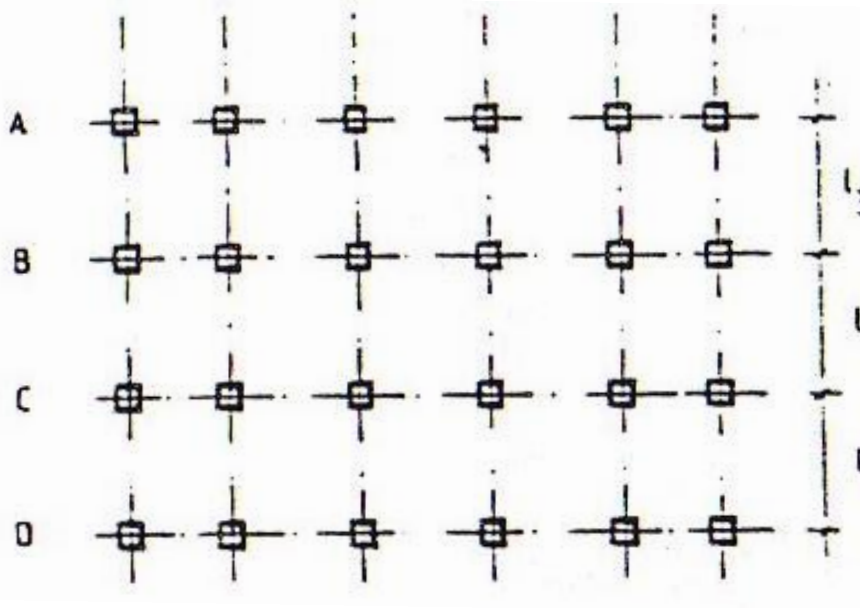
### RC buildings;

- Slabs
- Beams
- Columns
- Shear Walls
- Foundations

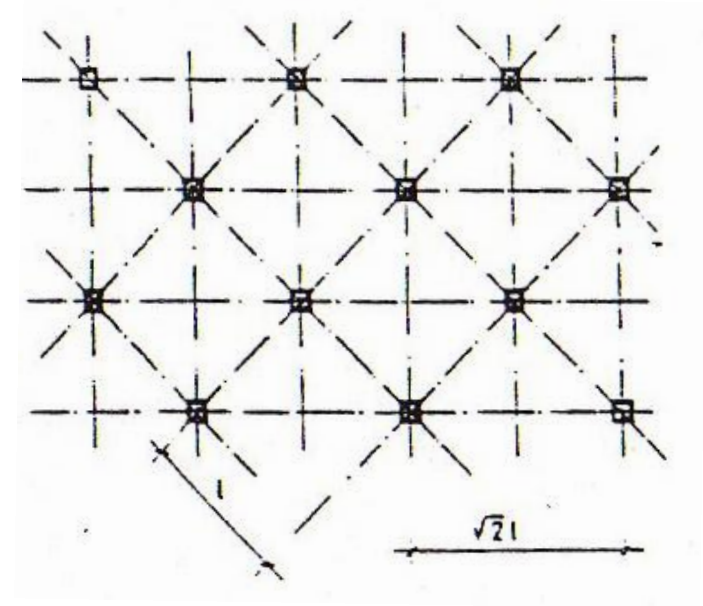
Integrated Design

- RC skeleton LBS;  
constituted by 1D and 2D members (as modeling)
- 1D members; column, beam etc.
- 2D members,  
Wall, carry in-plane loads;  
Plate; carry perpendicular to plate loads;
- In a LBS, loads should be transferred to soil in the shortest way.

- In a LBS, Firstly;  
Vertical LB members are arranged (considering slab type)
- Determine axes at least in two direction
- Orthogonal axis formation should be arranged as possible.



- Good configuration (regular-orthogonal)



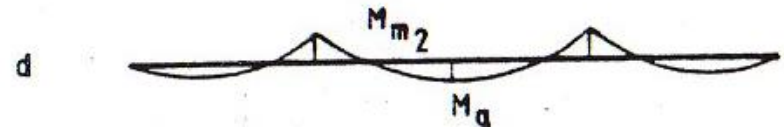
- Good config. ! (regular-but non orthogonal)

- Columns at axes intersections



- Regular LBS
- Regular slab-beam system

- Continuous columns; from top to bottom/soil
- Columns should be tied by beams in two directions
- Span of adjacent axes should be close each other
- Due to choose of side span properly, balanced moment distribution is obtained between the spans





- Beams with large loadings should be supported by columns directly, rather than to support by another beams (indirect loading)
- Columns & Shear Wall (SW) are arranged considering closeness of Center of Rigidity and Center of Gravity
- In general;  
6~8m axis interval is proper

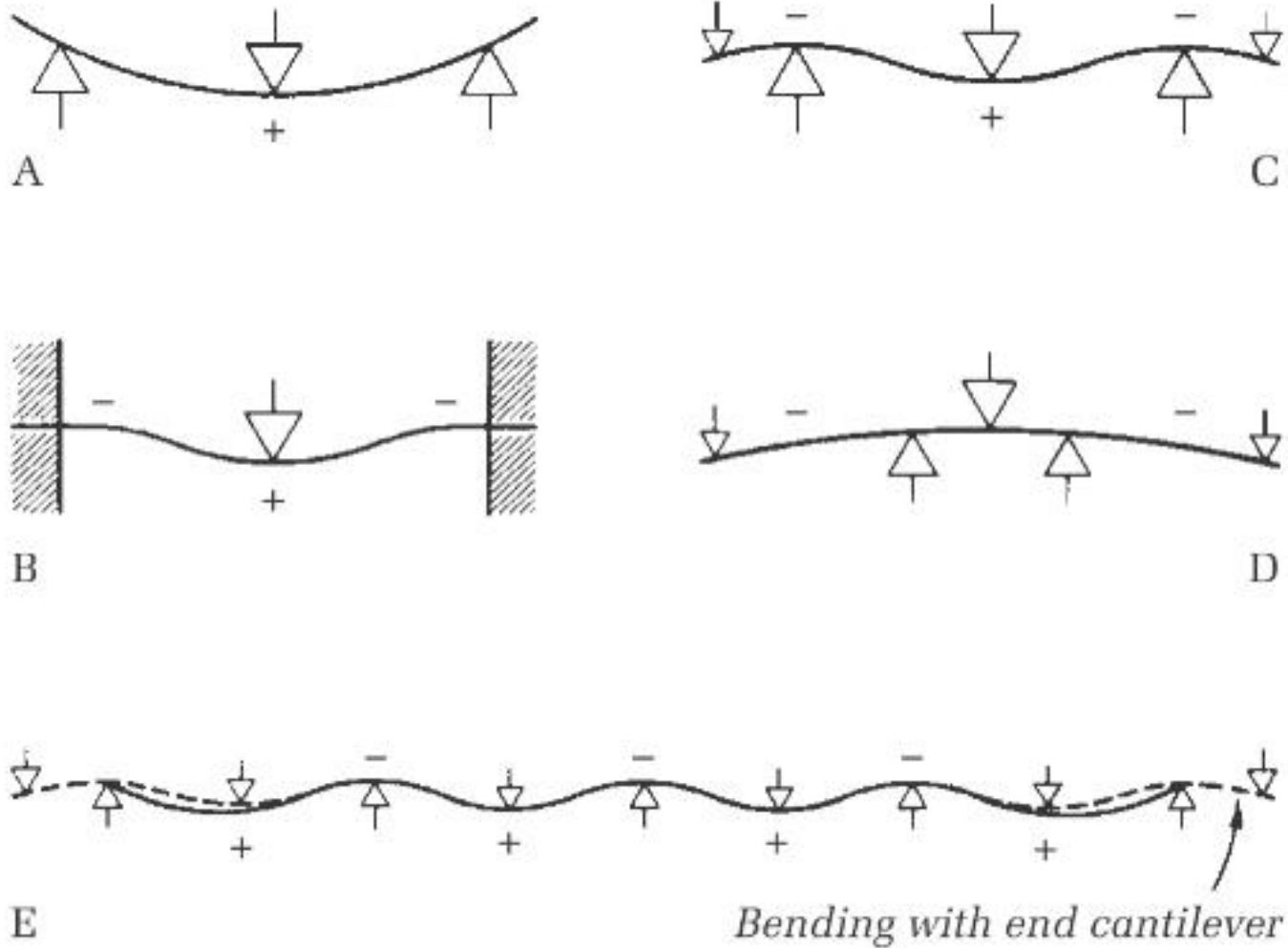
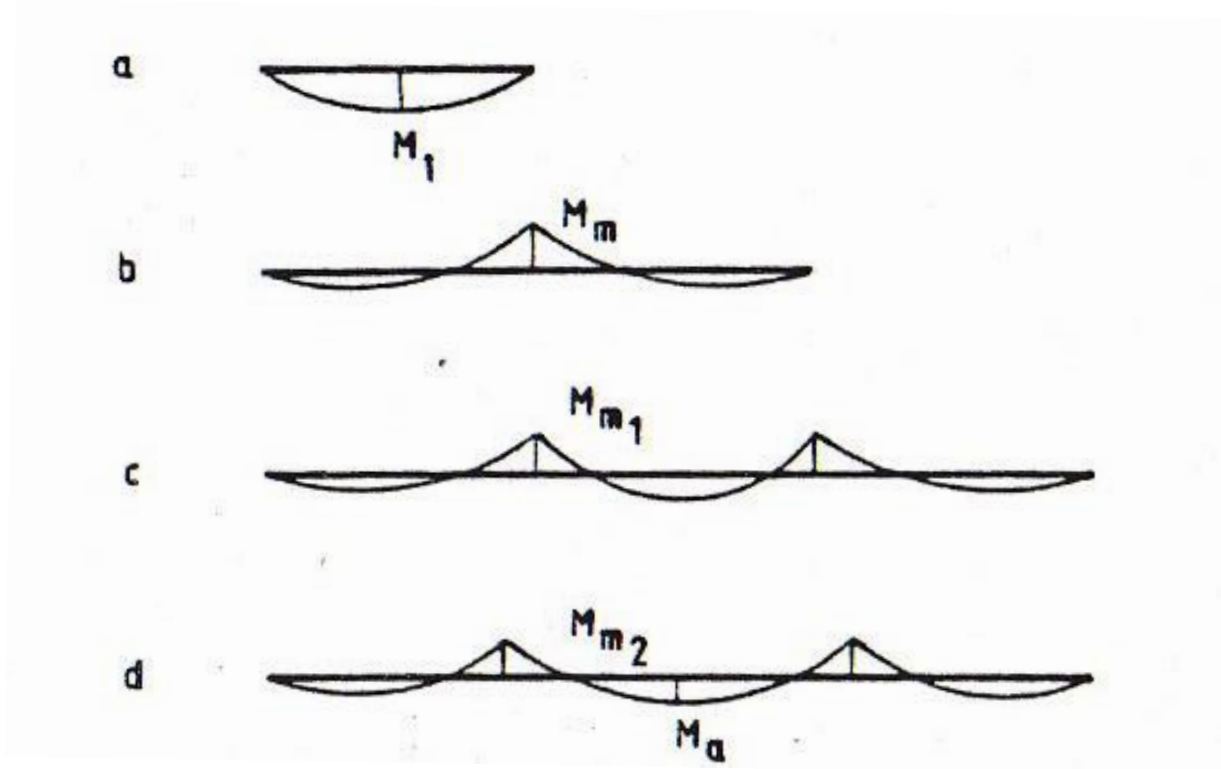


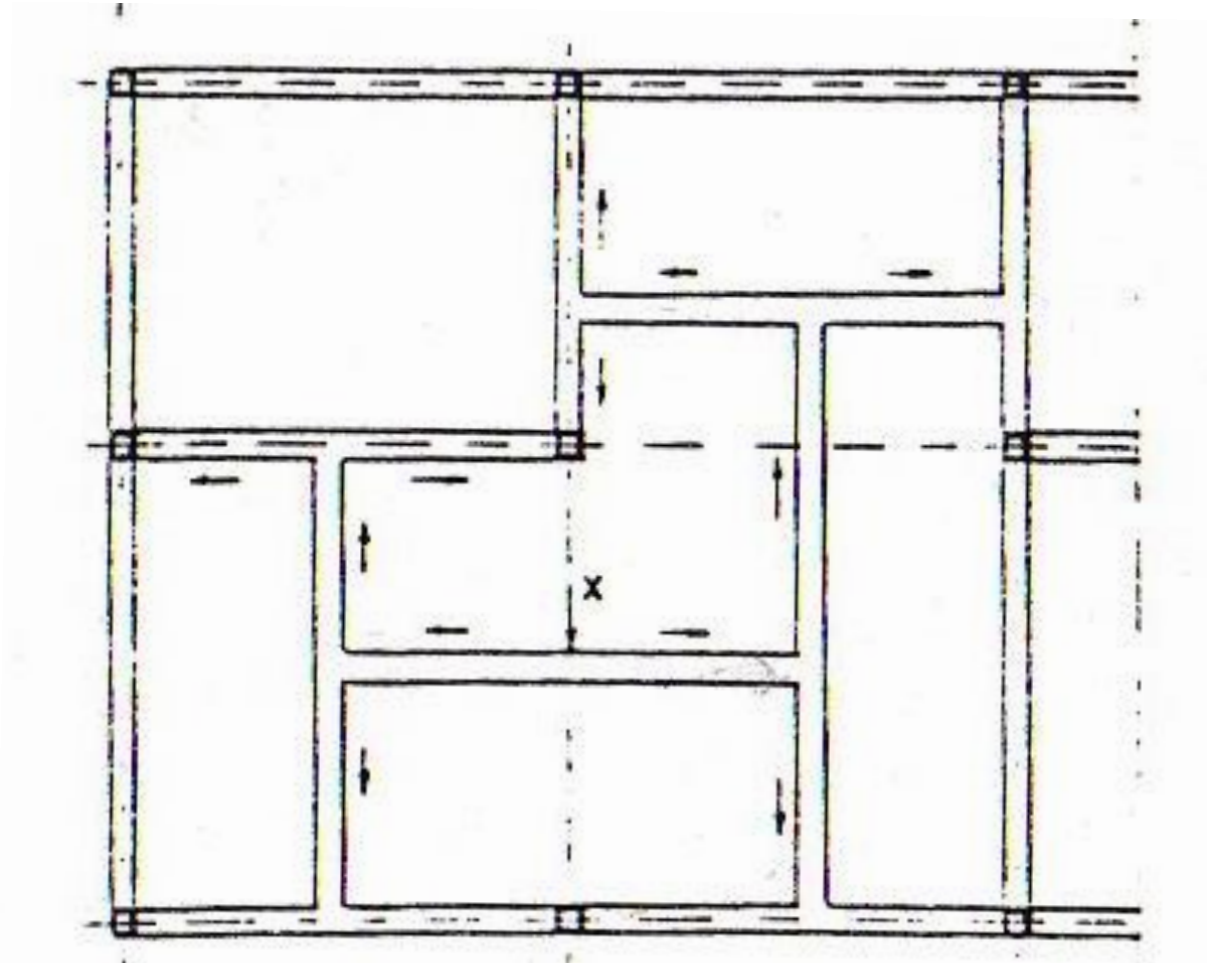
Figure 3.30 Beam action

- At least 3 span in one direction is better



- Beams tie the columns;
- Compatible with installation
- Beam arrangement;

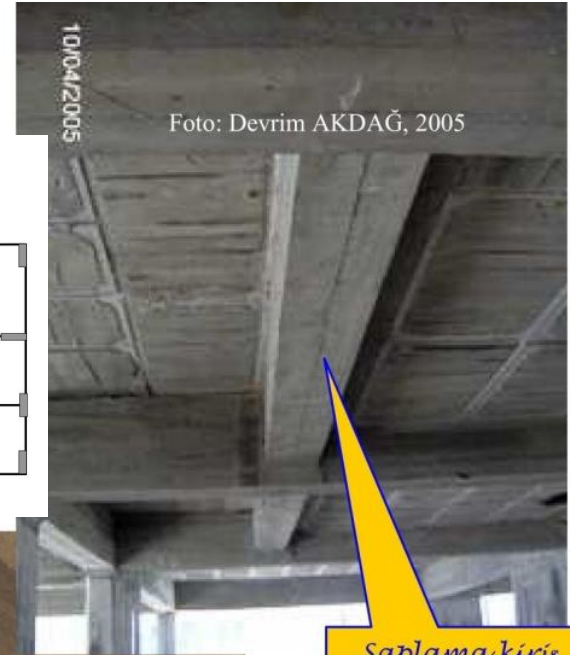
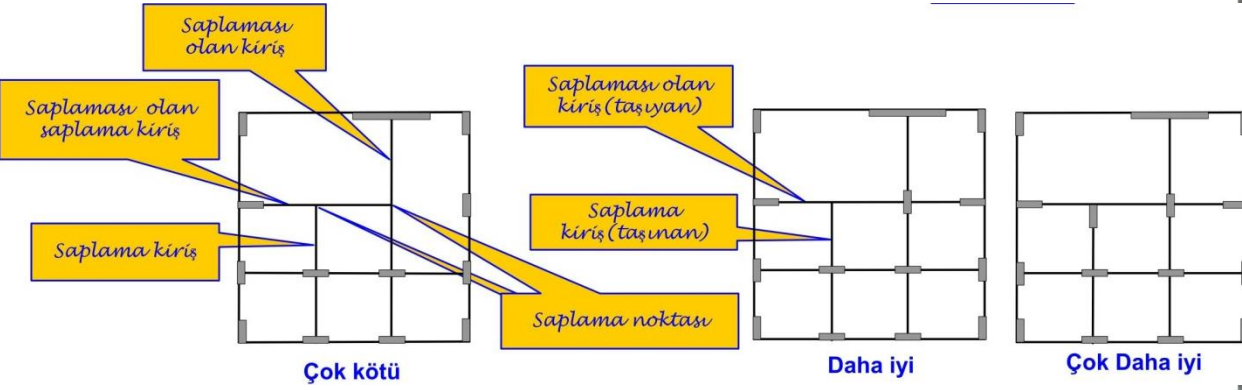
Transferring loads to columns in the shortest way



Beam arrangement causing irregular load transfer

# Load Bearing System

## Beams



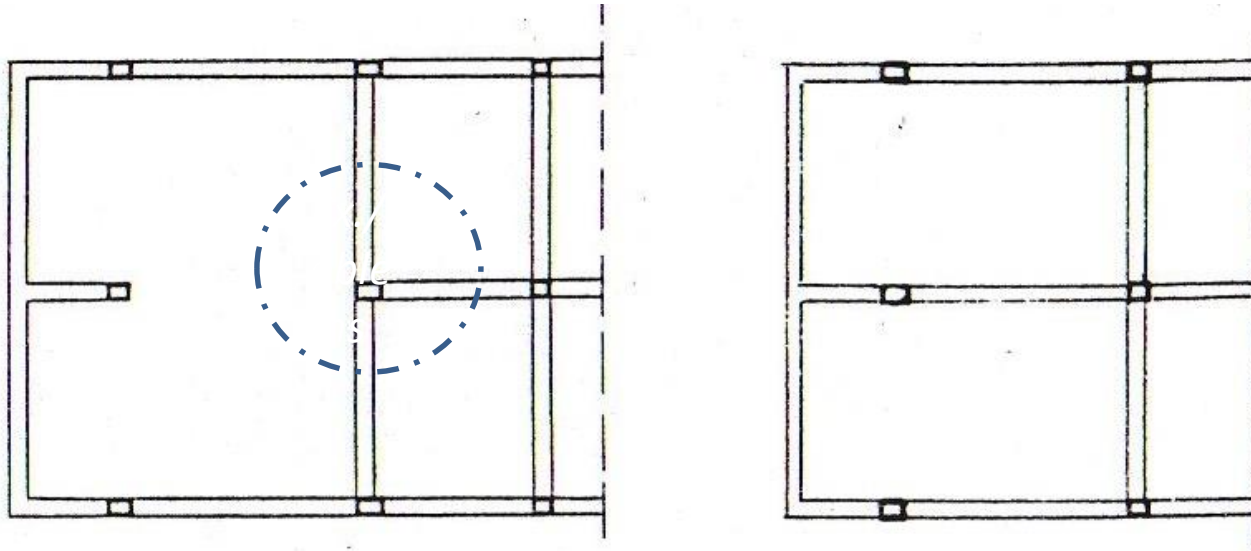
ın kirişe aktarılır.



(askı çubukları).

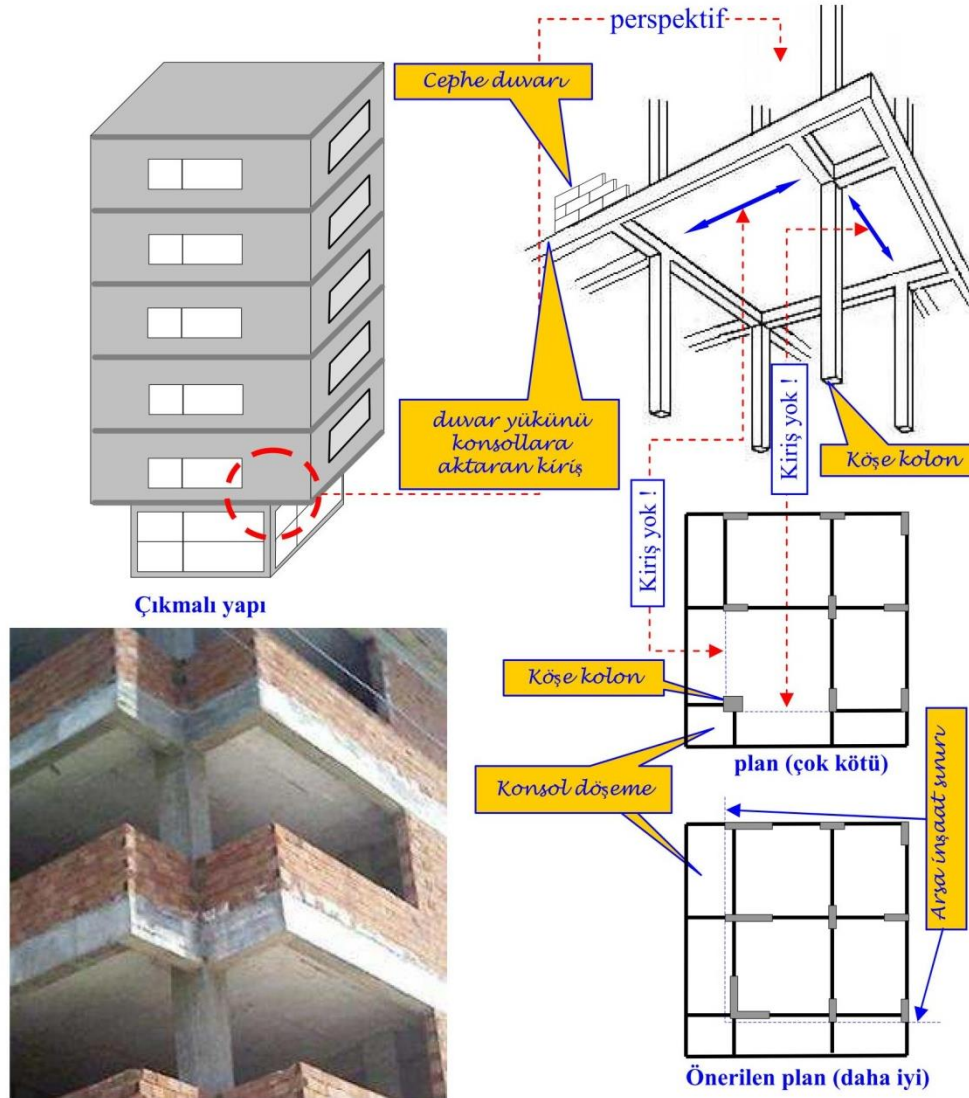
Beam arrangement causing irregular load transfer

Ex./problems



# Load Bearing System

## Beams

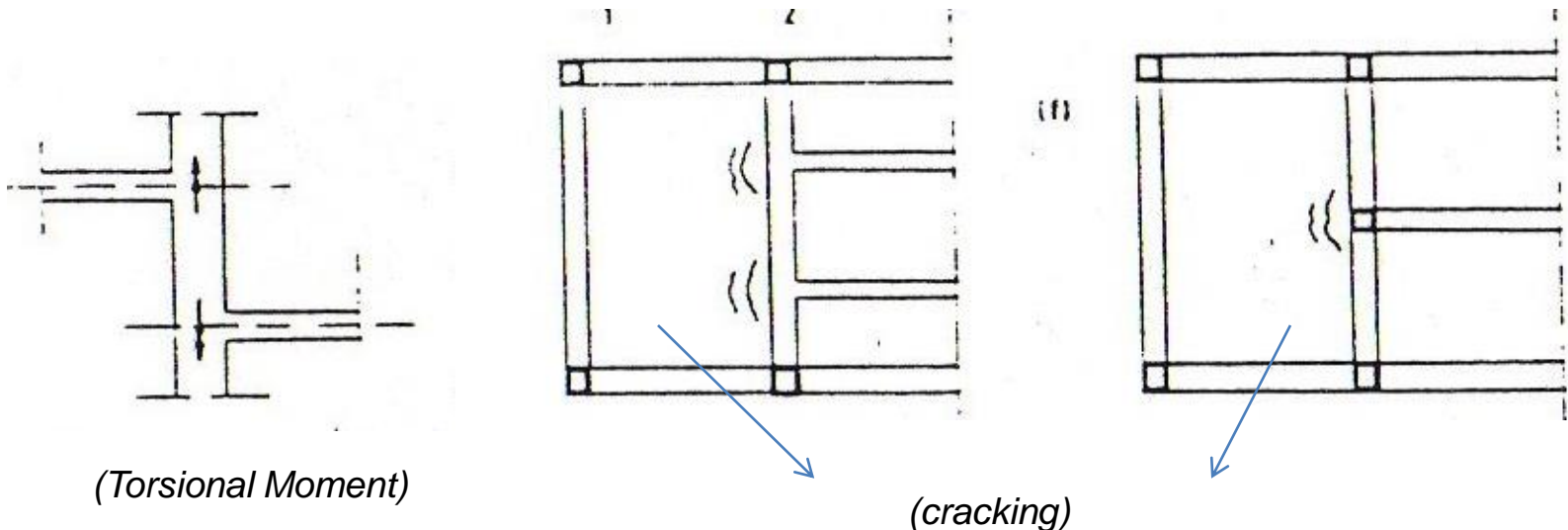


Beam arrangement causing irregular load transfer



- $h/\ell \approx 1/6 \sim 1/16$
- Avoid the arrangements that produced additional/secondary effects

Ex./problems



# Load Bearing System

## Beams

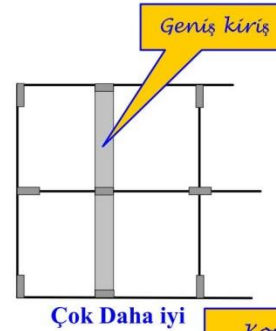
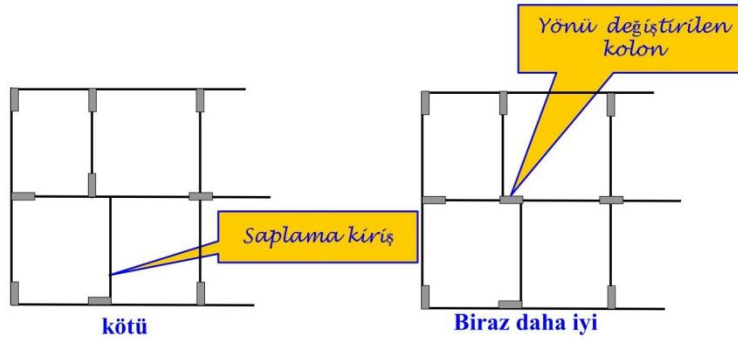
ndur.

Kolon civarında  
saplama

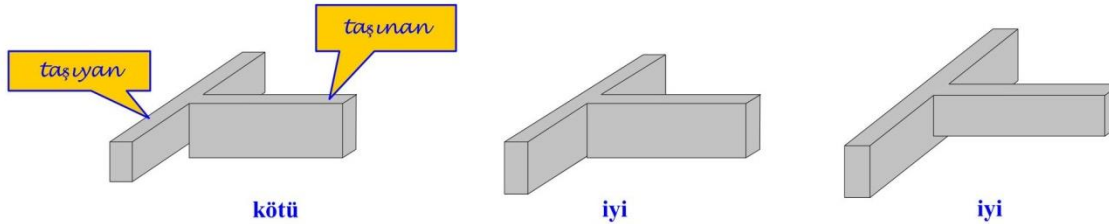


uvvetli

Konsol sadece kolona bağlı,  
sürekli olmalıydı!



Taşıyan kirişin yüksekliği taşıyan kirişin yüksekliğinden daha fazla olmamalıdır:

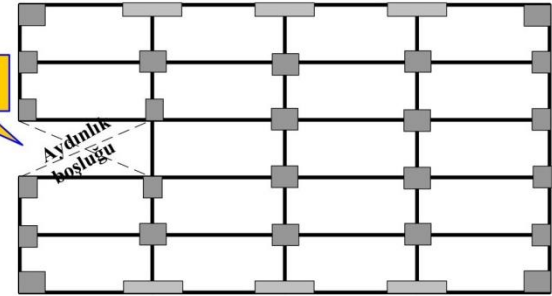


Beam arrangement causing irregular load transfer

Aydınlık boşluğu  
(kiriş yok)



Kiriş yok!



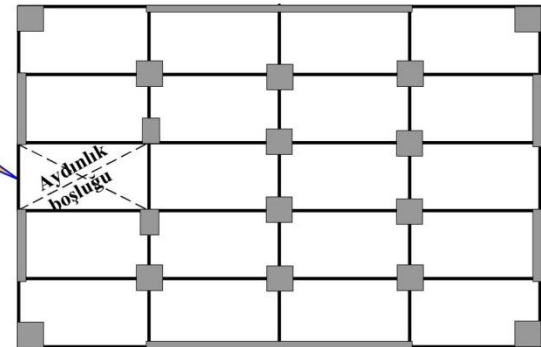
kötü

Aydınlık boşluğu  
(kiriş var)

1 mutlaka



Kiriş var

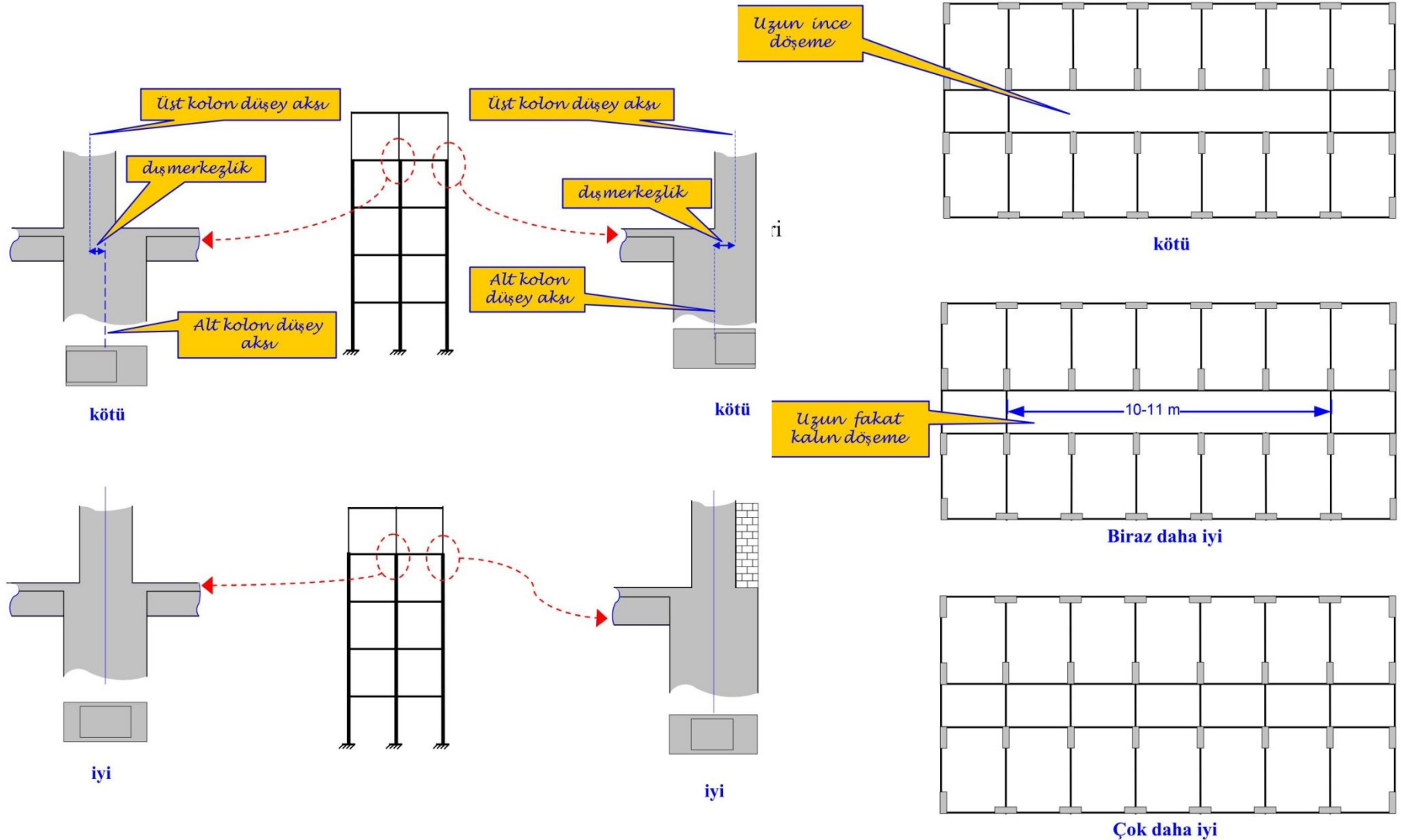


iyi

Beam arrangement causing irregular load transfer

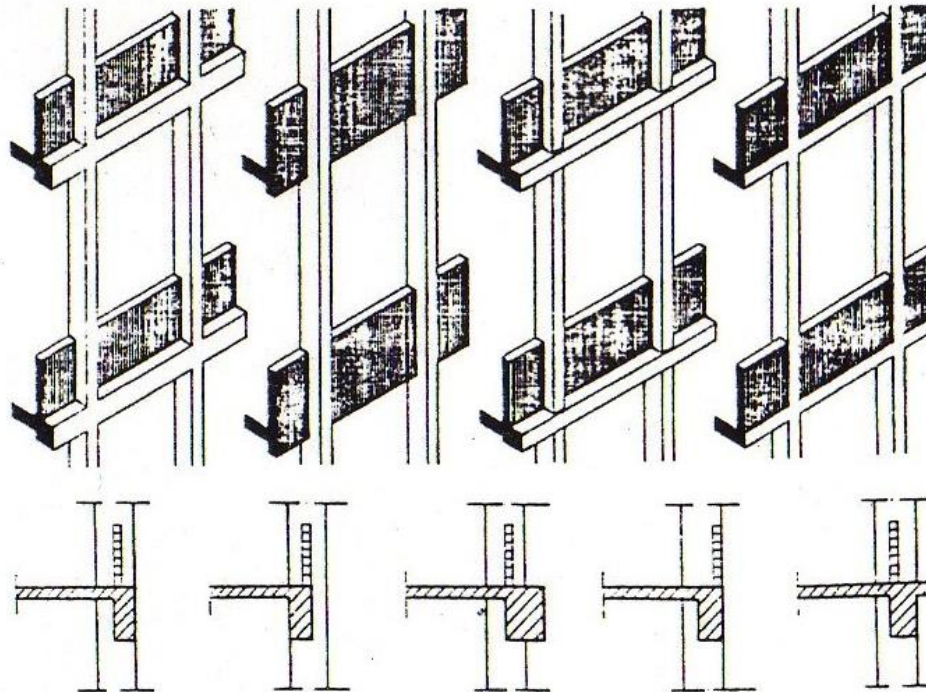
# Load Bearing System

## Beams



Beam arrangement causing irregular load transfer

- Façade effects the form of columns & beams



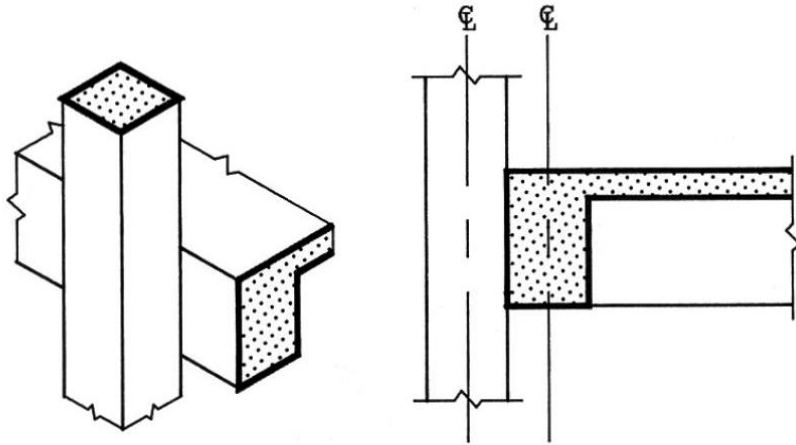


Figure 6-39. Eccentric load paths created by architectural detailing of structural connection

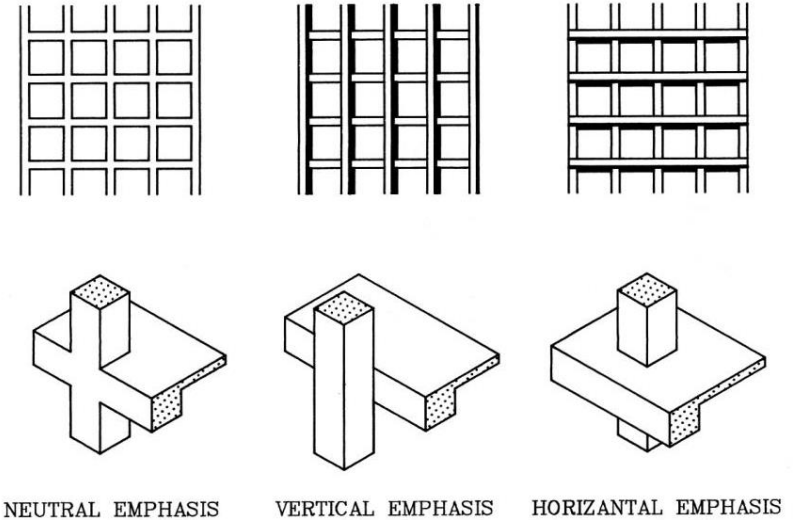
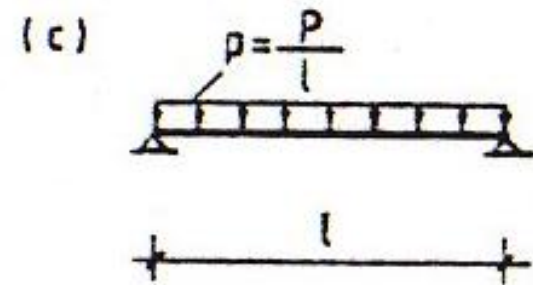
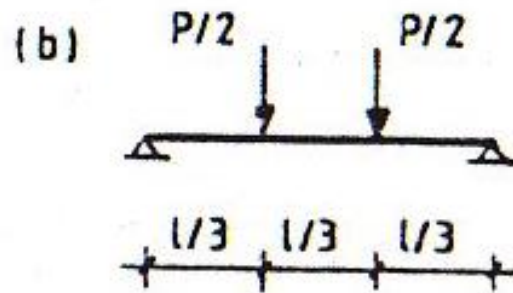
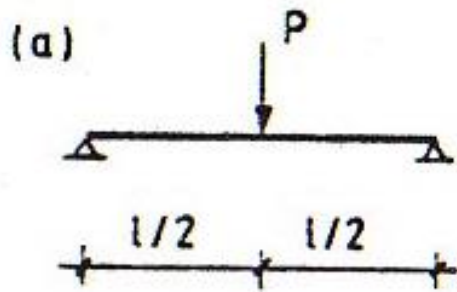
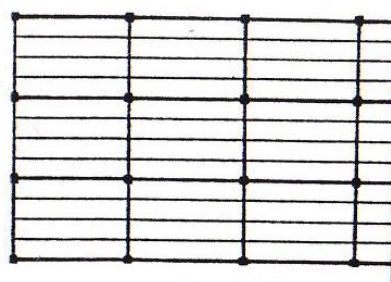


Figure 6-40. Facades: differences in architectural emphasis

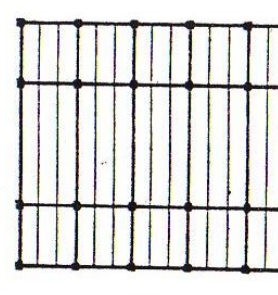
- By proper loading; Moment values can be reduced (if possible)



- For long spans, usage of secondary or ribbed slab (may be in two way)



(a)

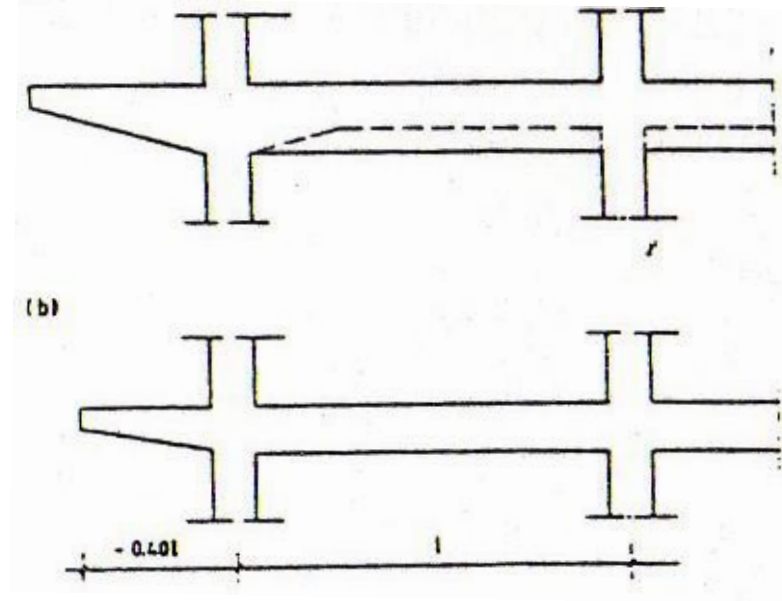


(b)

- Beams with large height should be parallel to installation members
- Arrangement of secondary beams along long span; Primary beams along short span is proper



- Cantilevers are statically profitable in terms of effect on moment dist. on side column.
- However, it is an isostatic member (-)
- deflection is important
- cracks may occur at below walls
- Cantilever span should be in proportional with the next span.



- Cantilever may be arranged to equalize span moments



- For distributed loading;  
( $a \sim 0.4 * \ell$ )

$a$ : cantilever length

- In the case of concentrated load at the end of cantilever,

$$a = (25 \sim 30) * \ell \quad (\text{max.})$$

## Deflection:

$$a \rightarrow d$$

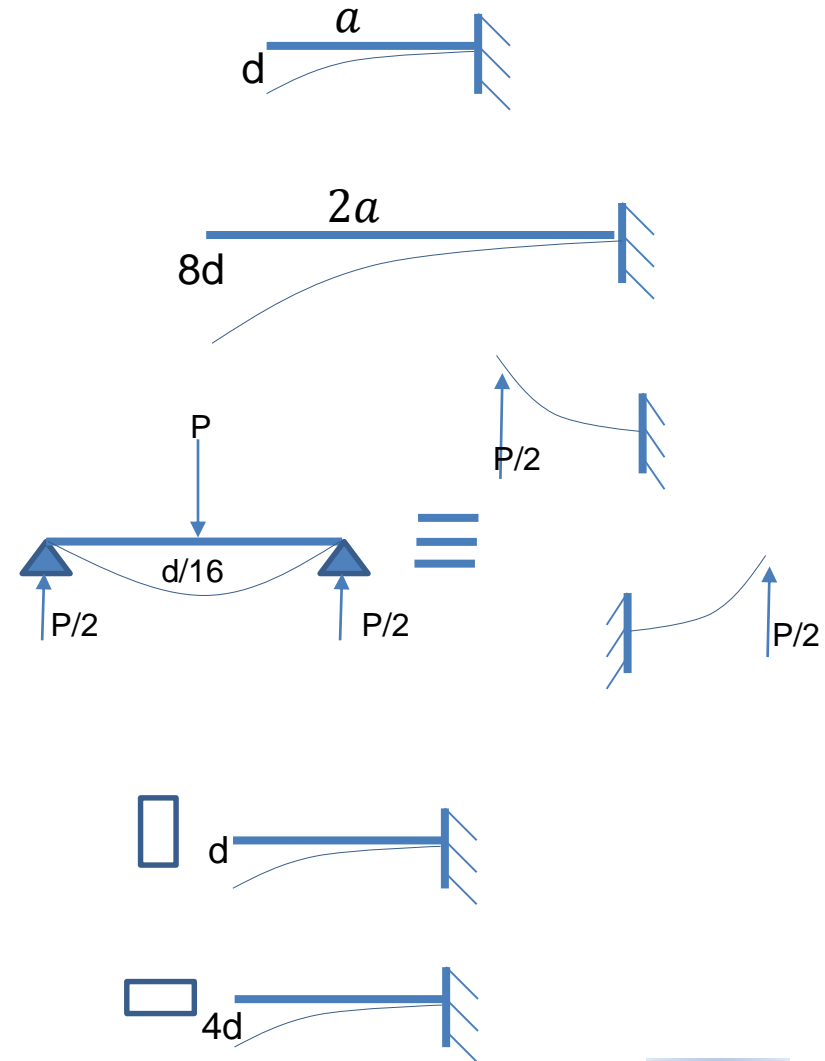
$$2a \rightarrow 8d$$

- With the same span/loading/CS; deflection;  
 simple beam  $\rightarrow d/16$   
 cantilever  $\rightarrow d$

- With the same span/loading;  
 Deflection of cantilever;

$$\text{CS } b/h=1/2 \rightarrow d$$

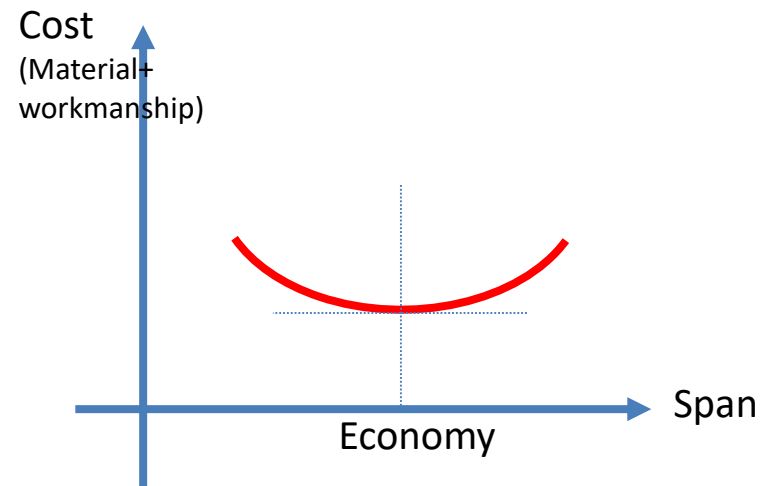
$$\text{CS } b/h=2/1 \rightarrow 4d$$

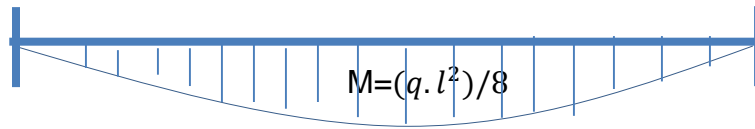


- Depends on function

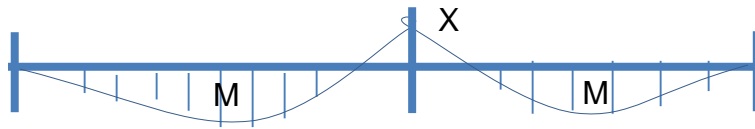


- Optimization is required among Span-number of column-storey height

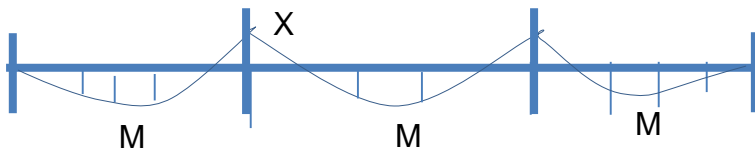




$$M = \frac{q \cdot l^2}{8}$$



$$X = \frac{q \cdot l^2}{32} \quad M = \frac{q \cdot l^2}{57} \quad (1/4)$$



$$X = \frac{q \cdot l^2}{90} \quad M = \frac{q \cdot l^2}{108} \quad (1/11)$$

# Load Bearing System

## Spans

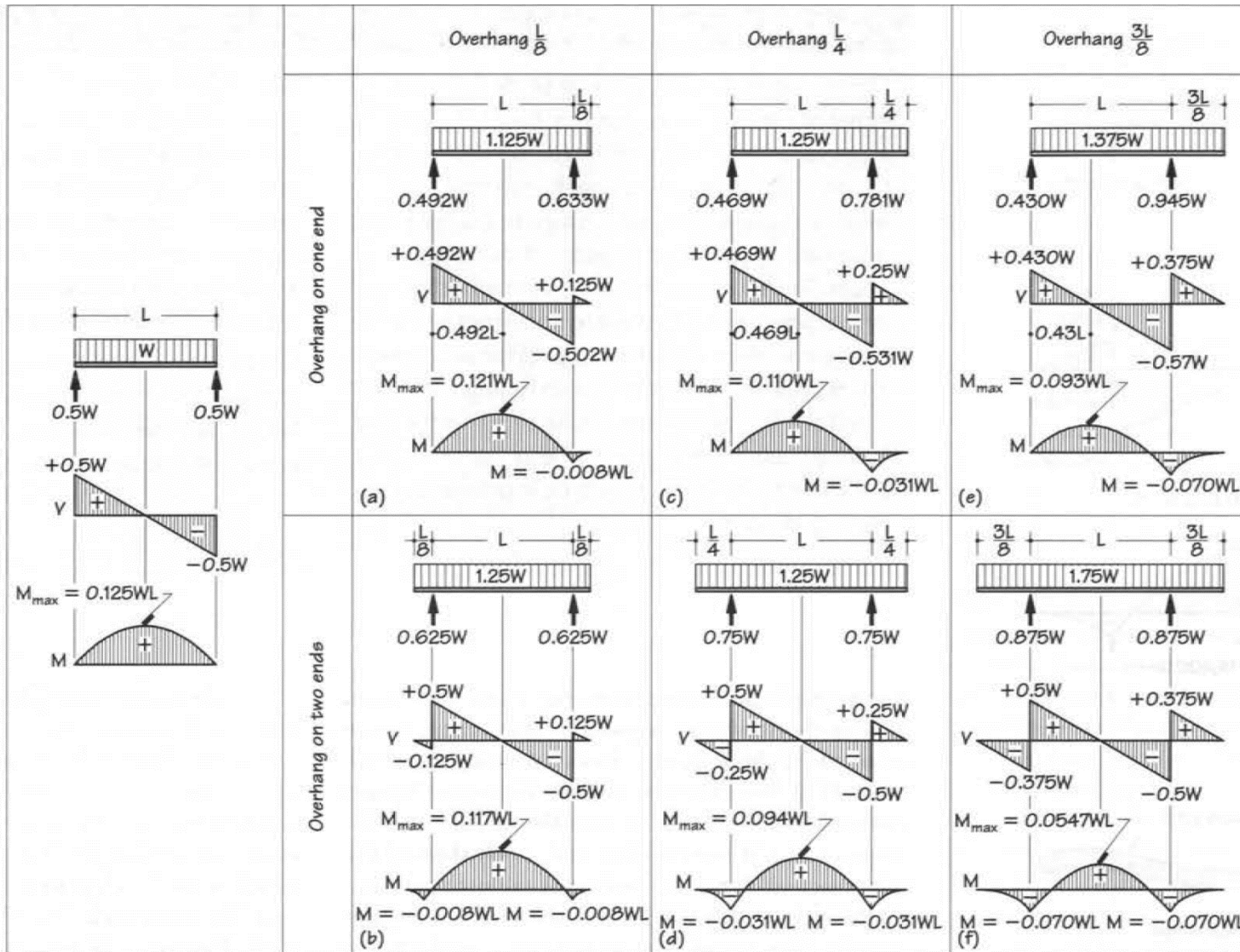
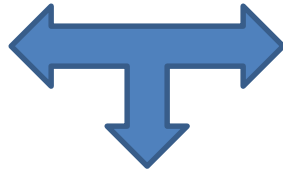


Figure 16.21 Effects on maximum  $V$  and  $M$  values of different lengths of overhangs on beams.

- Storey slabs



plane areas required

RC plaque is an essential slab member

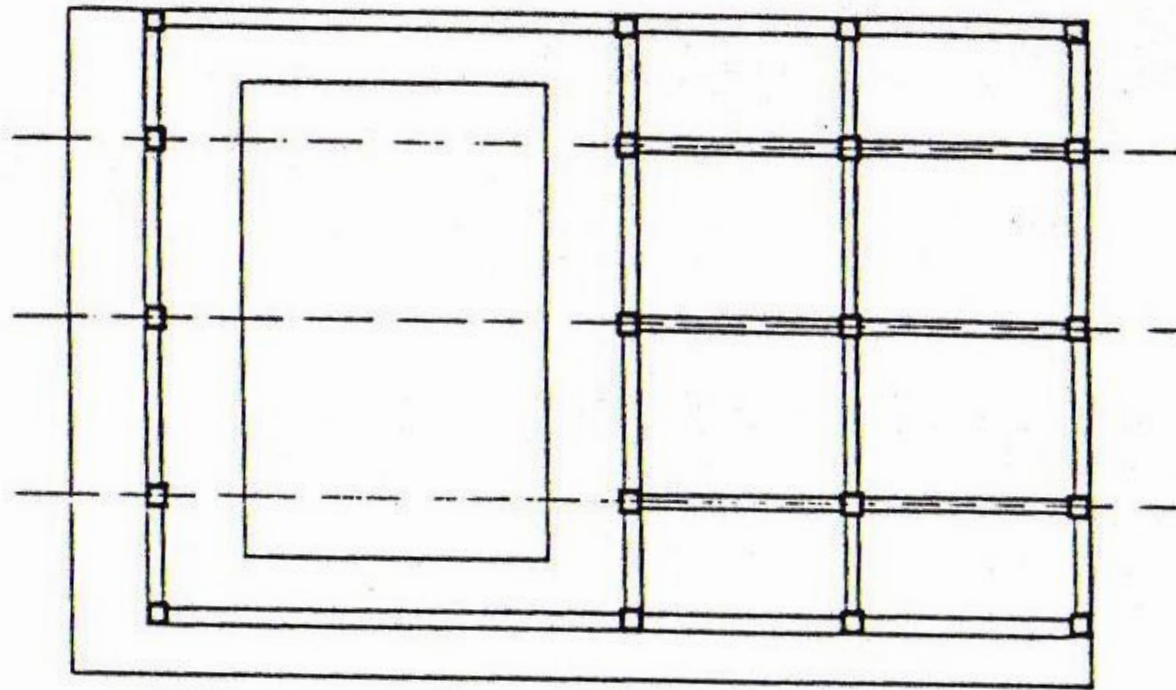
- Generally, a rectangular 2-way plaque is a convenient member for slabs (in terms of areal load carrying and reinforcement arrangement)
- Plaque;  
erection is rapid & economic

- Generally,  $A \leq 50\text{m}^2$  for economic reasons
- Large plaques can be divided by secondary beams
- Deflection check is required



- In a LBS; continuity, integrity and smoothness should be provided
  - LBS; Compatible with Architecture,  
Optimization between Arch. and LBS
  - Slabs; diaphragm effect under lateral loads;  
slab spaces should be limited.
- For  
Safe, long-life and  
aesthetics structures

- Ex. of insufficient diaphragm effect



- Staircase/Staircase spaces should be well-prepared
- Surrounding of staircase should be well-prepared  
(center of gravity effect etc.)