ARCHITECTURAL STRUCTURES I:
STATICS AND STRENGTH OF MATERIALS

ENDS 231

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FALL 2007

lecture

ten

load tracing and types

Structural Loads

- *gravity acts on mass (F=m·g)*
- *forces*
  - *acts at a point*
    - *ie. joist on beam*
  - *acts along a "line"*
    - *ie. floor on a beam*
  - *acts over an area*
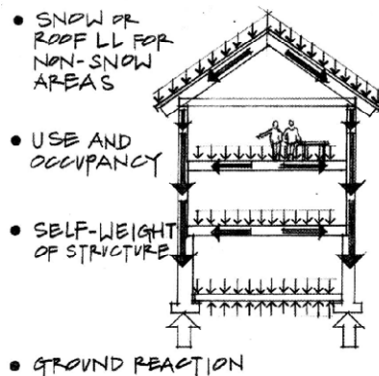   - *ie. people, books, snow on roof or floor*

Load Tracing

- *how loads are transferred*
  - *usually starts at top*
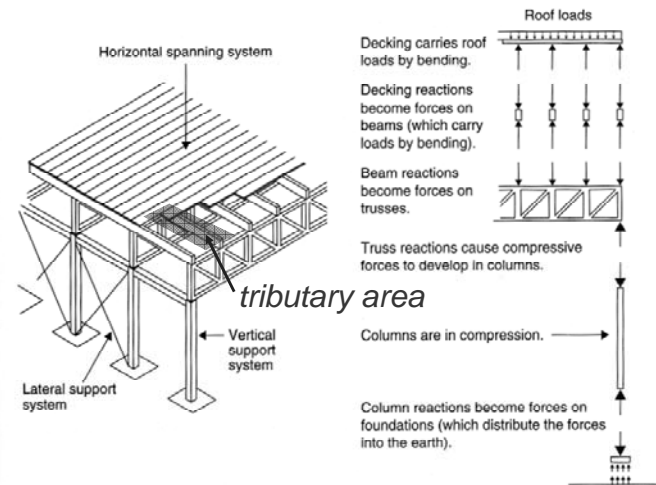 - *distributed by supports as actions*
  - *distributed by tributary areas*

Load Tracing

Horizontal spanning system

tributary area

Vertical support system

Lateral support system

Roof loads

Decking carries roof loads by bending.

Decking reactions become forces on beams (which carry loads by bending).

Beam reactions become forces on trusses.

Truss reactions cause compressive forces to develop in columns.

Columns are in compression.

Column reactions become forces on foundations (which distribute the forces into the earth).

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Load Tracing

- *tributary load*
  - *think of water flow*
  - *"concentrates" load of area into center*

$$w = \left(\frac{load}{area}\right) \times (tributary\ width)$$

width

Load Tracing

Patcenter
Rogers 1986

main masts transfer vertical loads to columns and foundations

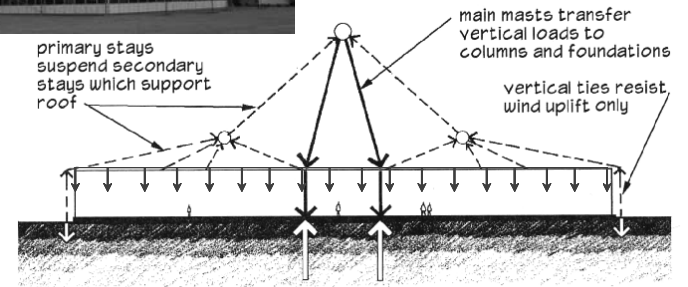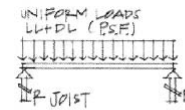primary stays suspend secondary stays which support roof

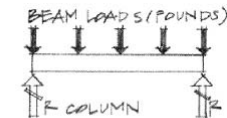vertical ties resist wind uplift only

Figure 3.5: Patcenter, load path diagram.
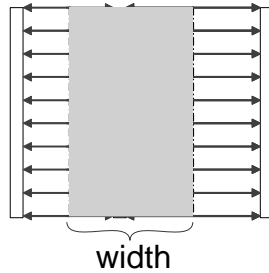
Load Tracing

Alamillo Bridge
Calatrava 1992

diagonal stays support roadbed and generate inward thrust

weight of sloped pylon resists thrust due to cable stays

roadbed transmits horizontal thrust to pylon
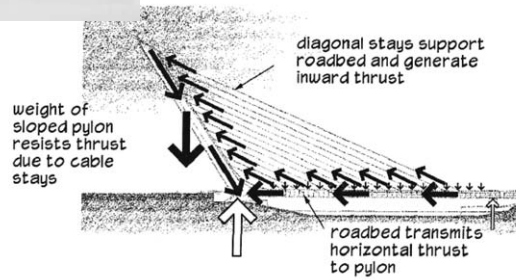
Figure 3.12: Alamillo bridge, load path diagram.

Load Paths

UNIFORM LOADS LL+DL (P.S.F.)

R JOIST

(a) FBD—decking.

DECK LOADS(PLF.)

R BEAM

(b) FBD—joists.

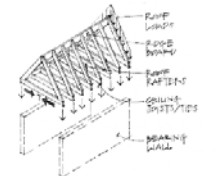JOIST LOADS (PLF.)

R GIRDER

(c) FBD—beams.

BEAM LOADS(POUNDS)

R COLUMN

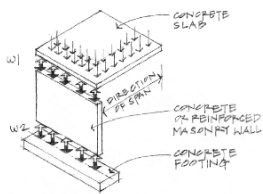*(d) FBD—girder.*

2
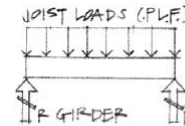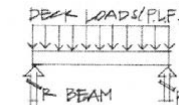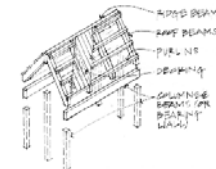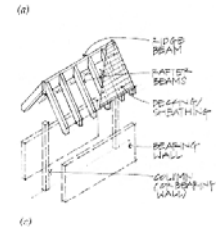
Load Paths

- ## wall systems

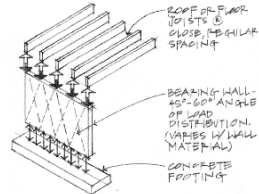Figure 4.12   Uniform wall load from a slab.

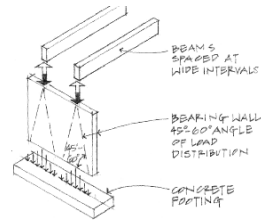Figure 4.13   Uniform wall load from rafters and joists.

Figure 4.14   Concentrated loads from widely spaced beams.
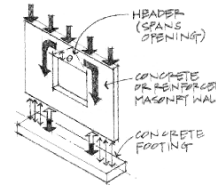
Load Paths

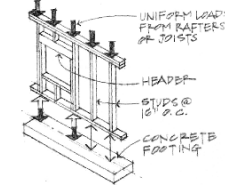- ## openings & pilasters

Figure 4.15   Arching over wall openings.

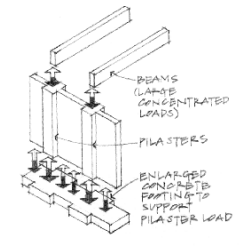Figure 4.16   Stud wall with a window opening.

Figure 4.17   Pilasters supporting concentrated beam loads.

Load Paths
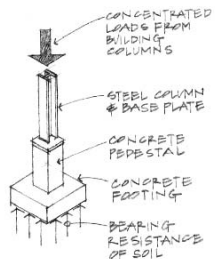
- ## foundations

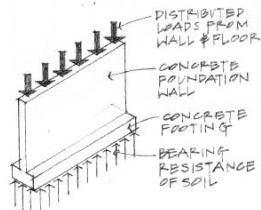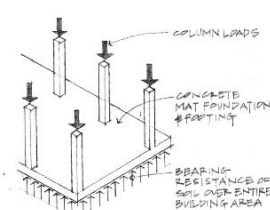Figure 4.24   Spread footing.

Figure 4.25   Wall footing.

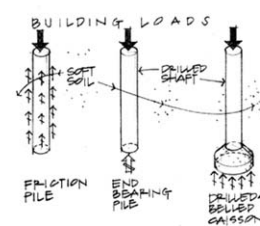Figure 4.26   Mat or raft foundation.

Load Paths
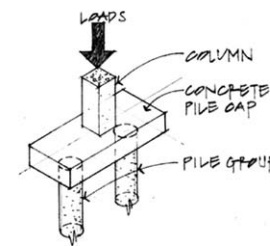
- ## deep foundations

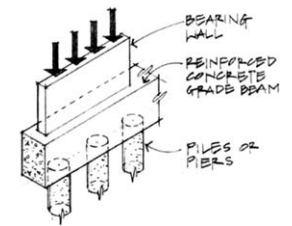Figure 4.27   Pile foundations.

Figure 4.28   Pile cap on one pile group.

Figure 4.29   Grade beam supporting a bearing wall.
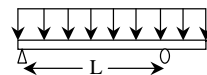
Concentrated Loads
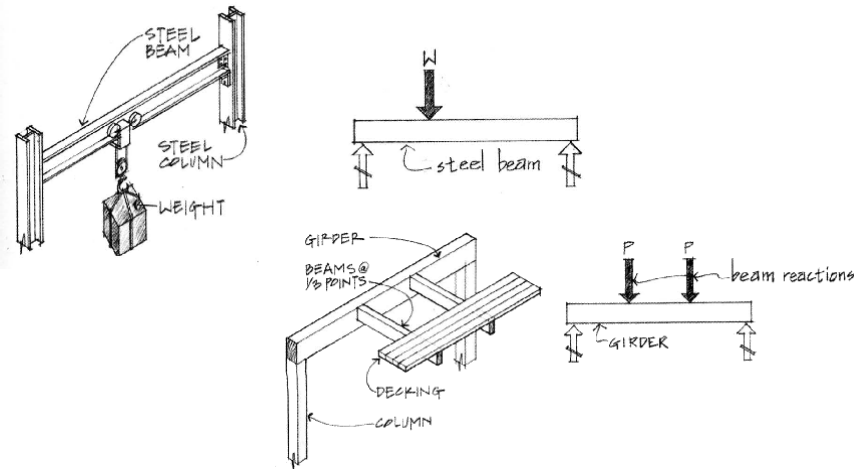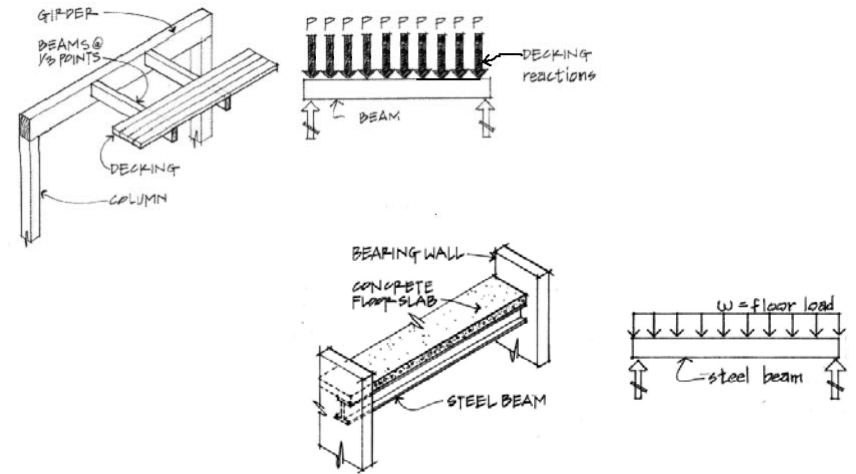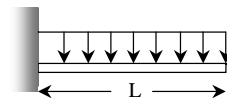
Distributed Loads

Distributed Loads

- *statically determinate beam supports*
  - *simple*
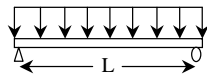
  - *overhang*

  - *cantilever*

Distributed Loads

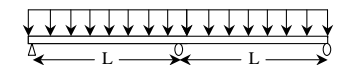- *continuous beams*
  - *statically indeterminate*
  - *floors*
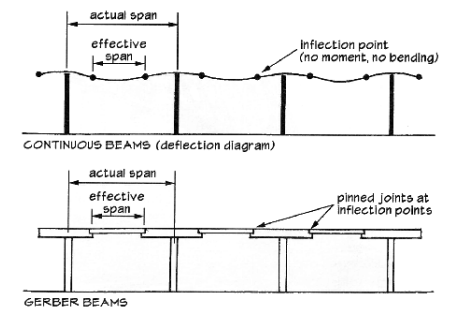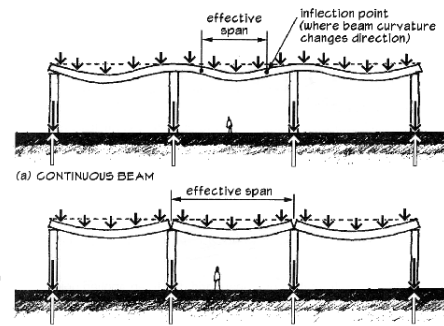
Equivalent Force Systems

- *replace forces by resultant*
- *place resultant where M = 0*
- *using <u>calculus</u> and area centroids*
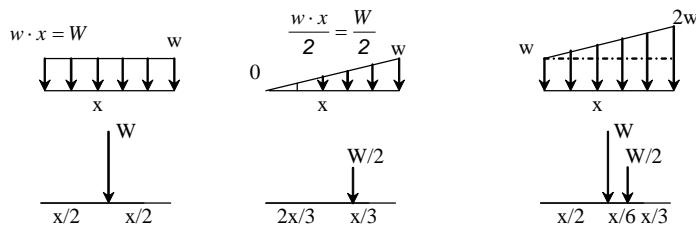
$$W = \int_0^L w\,dx = \int dA_{loading} = A_{loading}$$
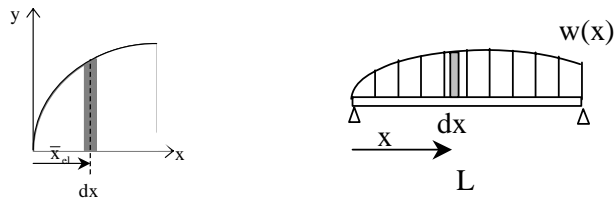
Area Centroids

- *Table 7.1 – pg. 242*

Centroids of Common Shapes of Areas and Lines

Shape			$\bar{x}$	$\bar{y}$
Triangular area			$\dfrac{b}{3}$ *right triangle only*	$\dfrac{h}{3}$
Quarter-circular area			$\dfrac{4r}{3\pi}$	$\dfrac{4r}{3\pi}$
Semicircular area			0	$\dfrac{4r}{3\pi}$
Semiparabolic area			$\dfrac{3a}{8}$	$\dfrac{3h}{5}$
Parabolic area			0	$\dfrac{3h}{5}$

Load Areas

- *area is width x "height" of load*
- *<u>w</u> is load per unit length*
- *<u>W</u> is total load*

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