

lecture  
 ten

load tracing  
 and types



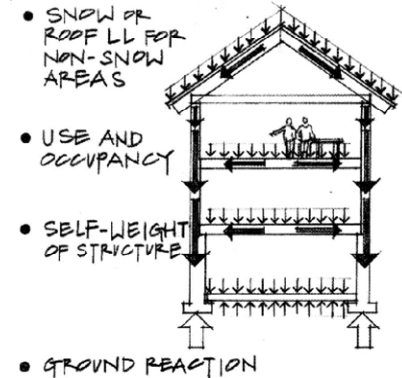
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Structural Loads

- gravity acts on mass ( $F=m \cdot g$ )
- 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



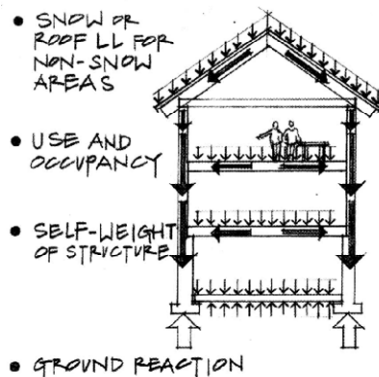
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Load Tracing

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

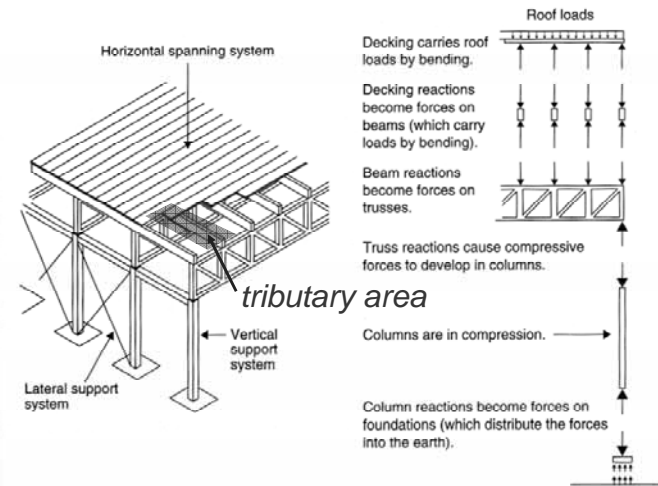


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Load Tracing



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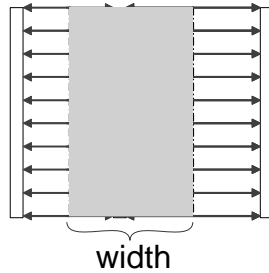
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# Load Tracing

- tributary load
  - think of water flow
  - “concentrates” load of area into center

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



# Load Tracing



## Alamillo Bridge Calatrava 1992

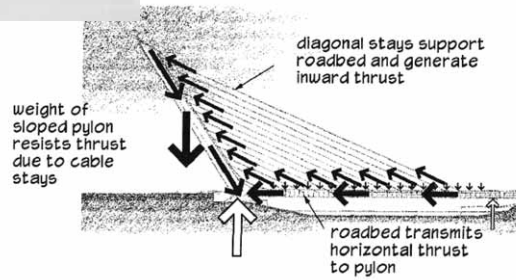


Figure 3.12: Alamillo bridge, load path diagram.

# Load Tracing



## Patcenter Rogers 1986

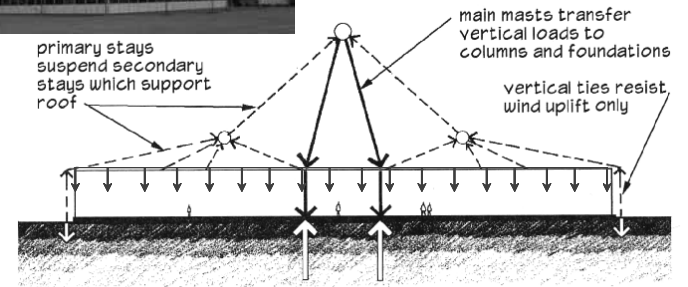
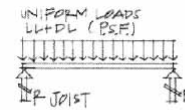
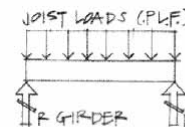


Figure 3.5: Patcenter, load path diagram.

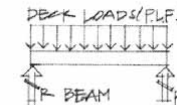
# Load Paths



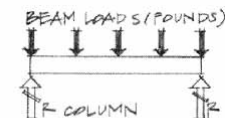
(a) FBD—decking.



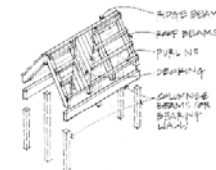
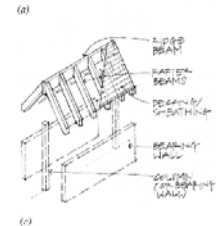
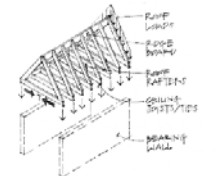
(c) FBD—beams.



(b) FBD—joists.



(d) FBD—girder.



# Load Paths

- wall systems

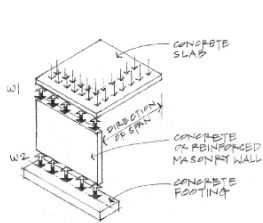


Figure 4.12 Uniform wall load from a slab.

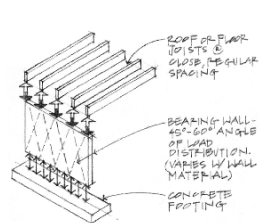


Figure 4.13 Uniform wall load from rafters and joists.

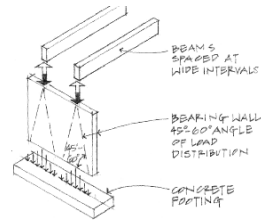


Figure 4.14 Concentrated loads from widely spaced beams.

# Load Paths

- openings & pilasters

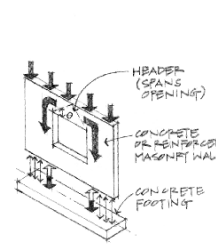


Figure 4.15 Arching over wall openings.

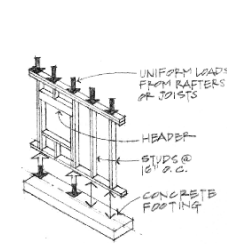


Figure 4.16 Stud wall with a window opening.

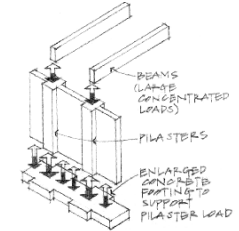


Figure 4.17 Pilasters supporting concentrated beam loads.

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# Load Paths

- foundations

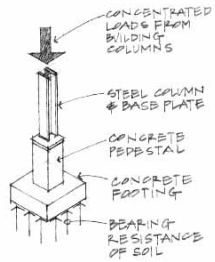


Figure 4.24 Spread footing.

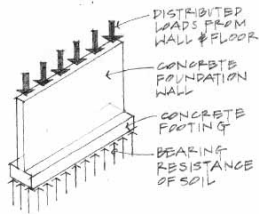


Figure 4.25 Wall footing.

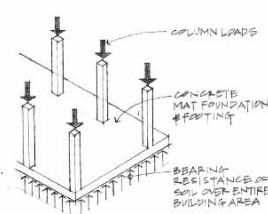


Figure 4.26 Mat or raft foundation.

# Load Paths

- deep foundations

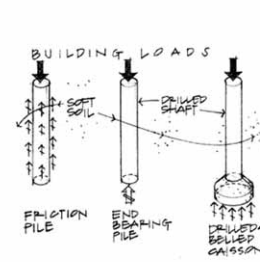


Figure 4.27 Pile foundations.

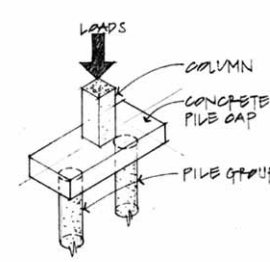


Figure 4.28 Pile cap on one pile group.

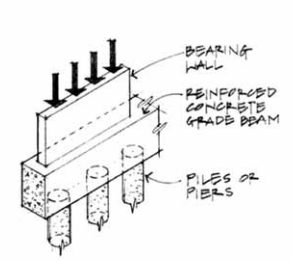


Figure 4.29 Grade beam supporting a bearing wall.

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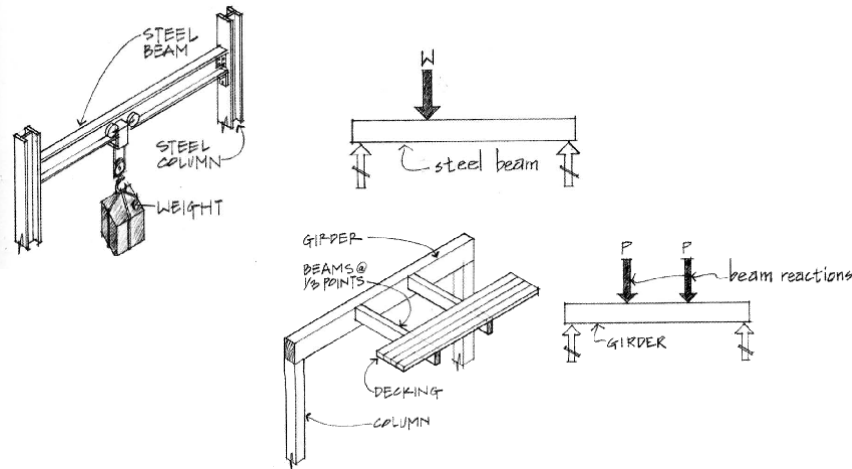
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# Concentrated Loads

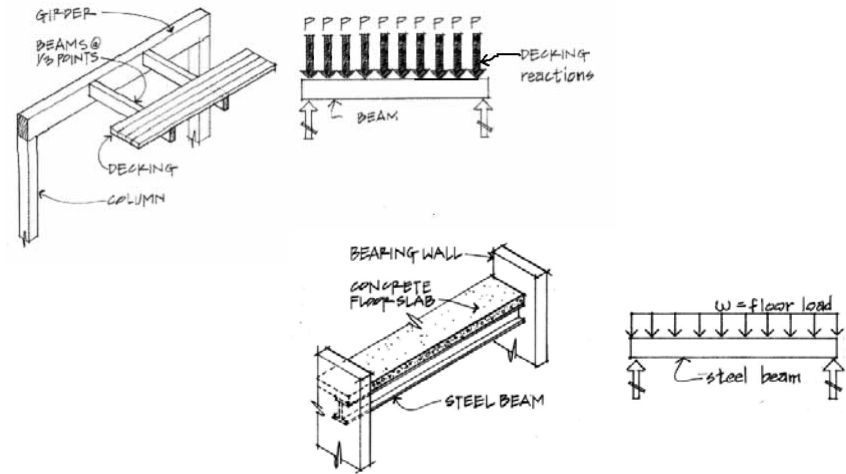


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# Distributed Loads



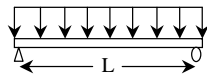
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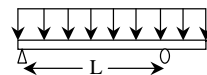
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# Distributed Loads

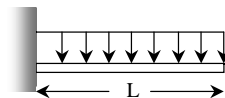
- statically determinate beam supports
  - simple



- overhang



- cantilever



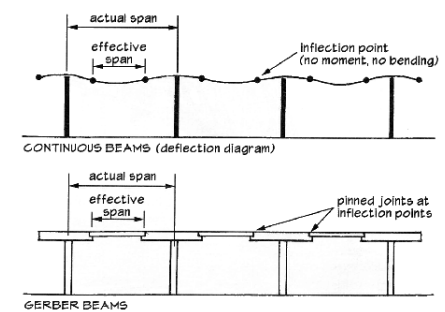
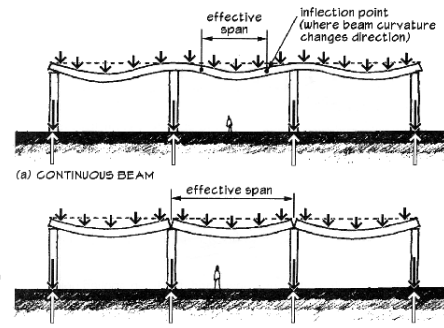
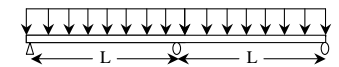
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# Distributed Loads

- continuous beams
  - statically indeterminate
  - floors



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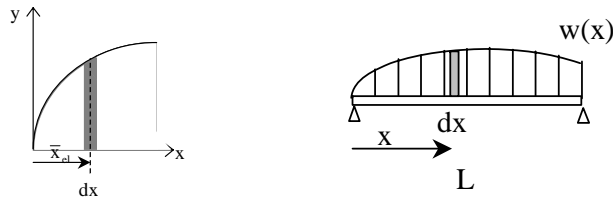
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## Equivalent Force Systems

- replace forces by resultant
- place resultant where  $M = 0$
- using calculus and area centroids

$$W = \int_0^L w dx = \int dA_{\text{loading}} = A_{\text{loading}}$$



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## Area Centroids

- Table 7.1 – pg. 242

Centroids of Common Shapes of Areas and Lines

Shape		x	y
Triangular area		$\frac{b}{3}$	$\frac{h}{3}$
Quarter-circular area		$\frac{4r}{3\pi}$	$\frac{4r}{3\pi}$
Semicircular area		0	$\frac{4r}{3\pi}$
Semiparabolic area		$\frac{3a}{8}$	$\frac{3h}{5}$
Parabolic area		0	$\frac{3h}{5}$

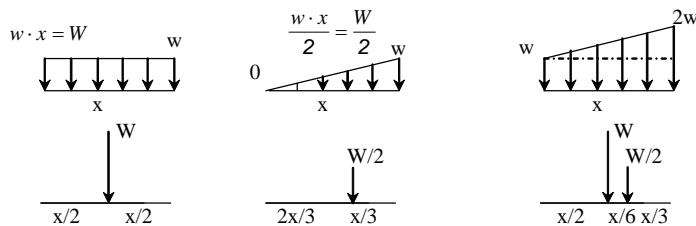
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## Load Areas

- area is width  $\times$  "height" of load
- $w$  is load per unit length
- $W$  is total load



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