lecture

ten

other beams & pinned frames

Continuous Beams

- *statically indeterminate*
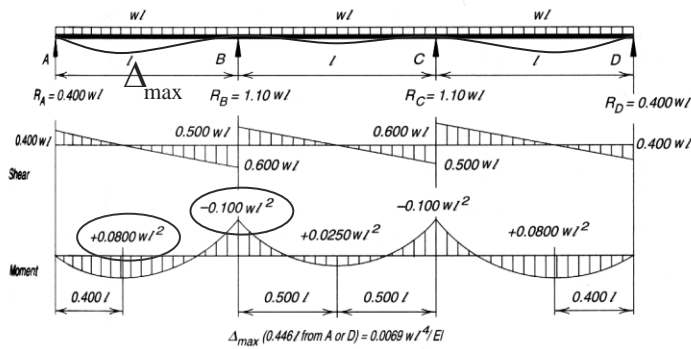- *reduced moments than simple beam*
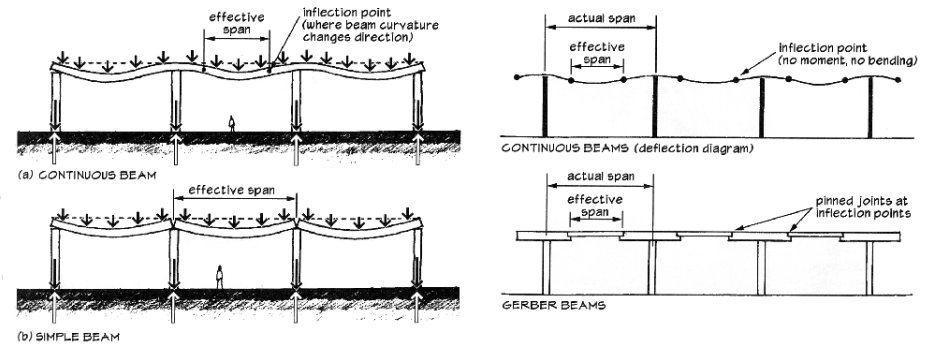
Continuous Beams

- *loading pattern affects*
  - *moments & deflection*

Continuous Beams

- *unload end span*
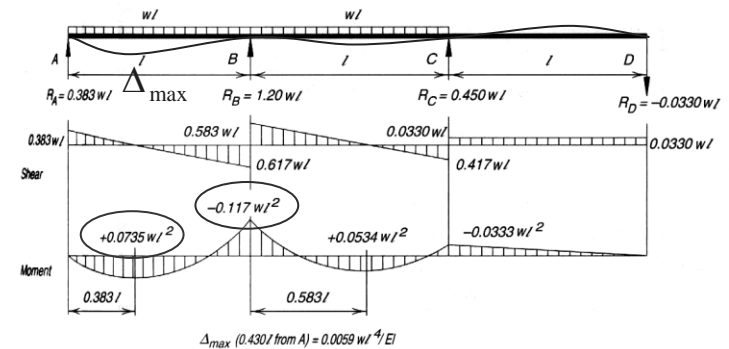
1

Continuous Beams
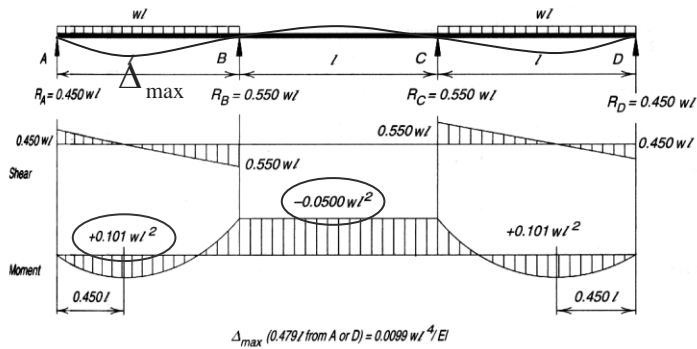
- *unload middle span*

Moment Redistribution

- *continuous slabs & beams with uniform loading*
  - *joints similar to fixed ends, but can rotate*
- *change in moment to center =* $\dfrac{wL^2}{8}$
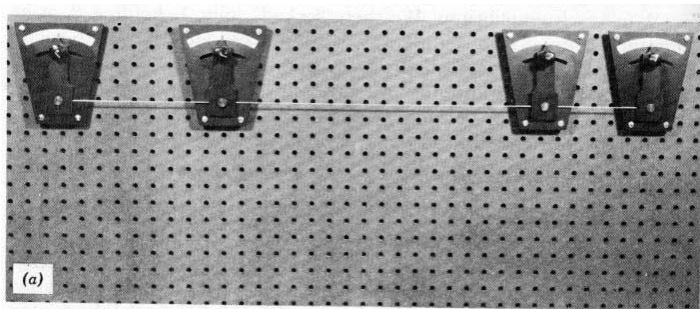 - M_{max} *for simply supported beam*
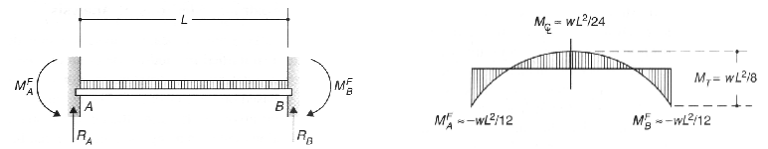
Moment Distribution (a)

- *no load*

http:// nisee.berkeley.edu/godden

Moment Distribution (b)

- *add load*
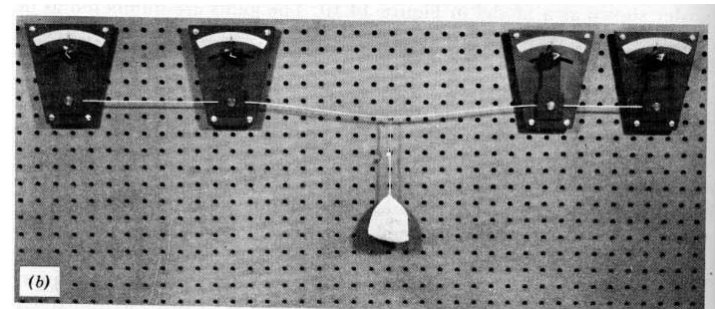
http:// nisee.berkeley.edu/godden

Moment Distribution Method (c)

- *release joint 2*
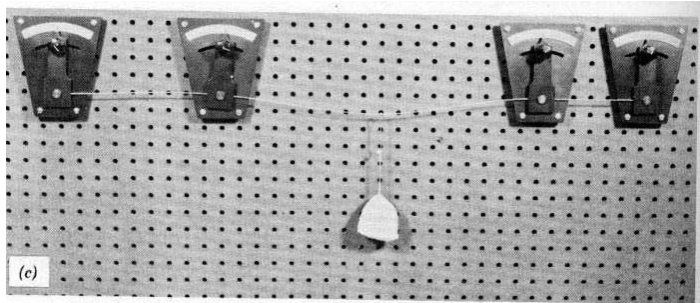
Moment Distribution Method (d)

- *release joint 3*

Moment Distribution Method (e)

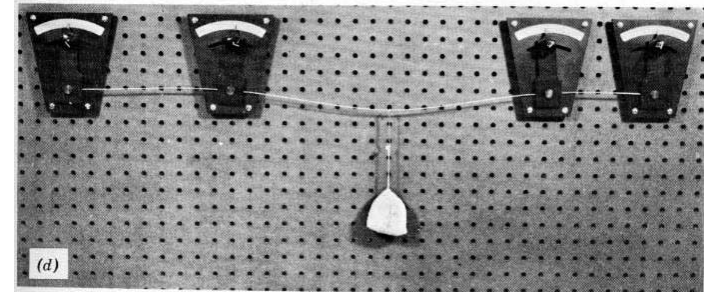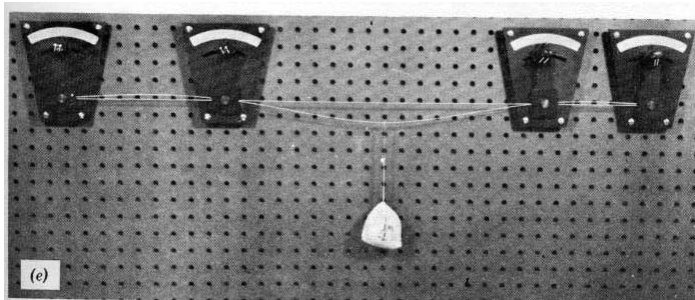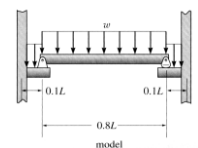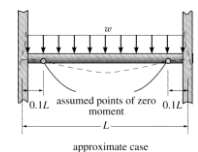- *exposure of final shape after cycles over initial shape*

Analysis Methods

- *Approximate Methods*
  - *location of inflection points*
- *Force Method*
  - *forces are unknowns*
- *Displacement Method*
  - *displacements are unknowns*

3

Theorem of Three Moments

- *moments at three adjacent supports (2 spans)*
- *distributed load and same I:*

$$M_1 L_1 + 2M_2(L_1 + L_2) + M_3 L_2 = -\frac{w_1 L_1^3}{4} - \frac{w_2 L_2^3}{4}$$

- *concentrated loads and same I:*

$$M_1 L_1 + 2M_2(L_1 + L_2) + M_3 L_2 =$$
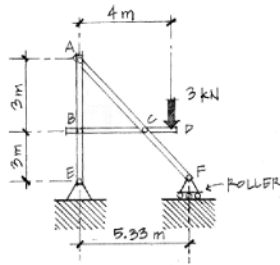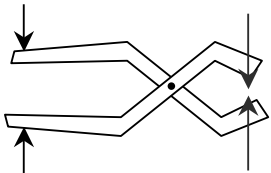$$- \sum P_1 L_1^2 (n_1 - n_1^3) - \sum P_2 L_2^2 (n_2 - n_2^3)$$

Two Span Beams & Charts

- *equal spans & symmetrical loading*
- *middle support as flat slope*

Pinned Frames

- *structures with at least one 3 force body*
- *connected with pins*
- *reactions are equal and opposite*
  - *non-rigid*   - *rigid*
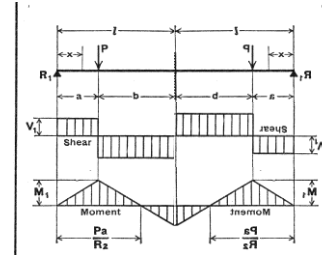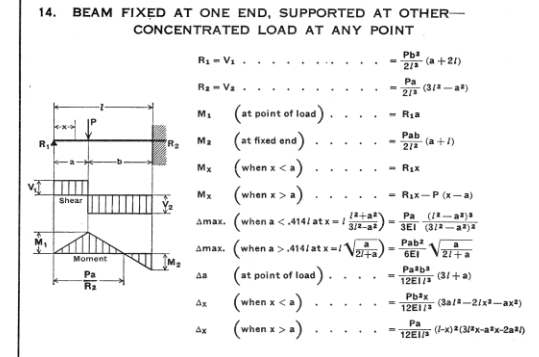
Rigid Frames

- *rigid frames have no pins*
- *frame is all one body*
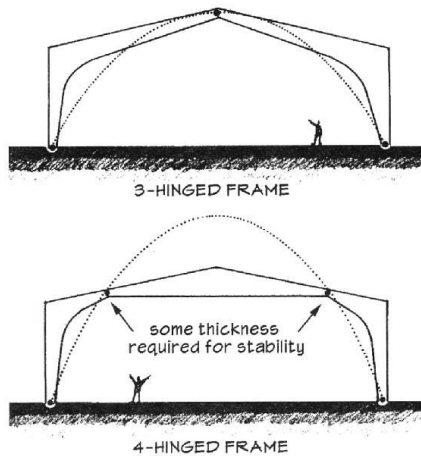- *typically statically indeterminate*
- *types*
  - *portal*
  - *gable*
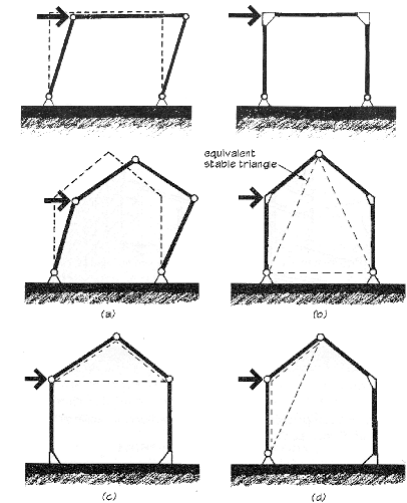
4

Rigid Frames with PINS

- *frame pieces with connecting pins*
- *not necessarily symmetrical*

3-HINGED FRAME

some thickness required for stability

4-HINGED FRAME

Internal Pin Connections

- *statically determinant*
  - *3 equations per body*
  - *2 reactions per pin + support forces*
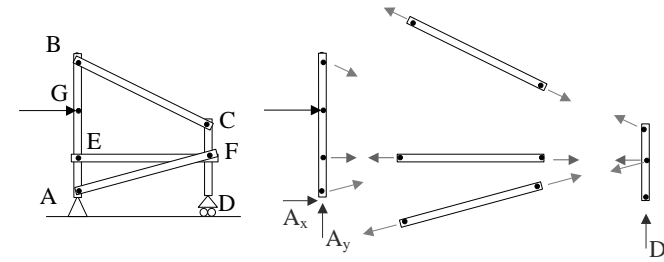
Arches

- *ancient*
- *traditional shape to span long distances*

Packhorse Bridge, UK

Rainbow Bridge National Monument
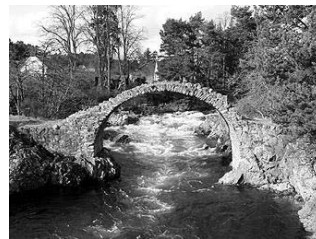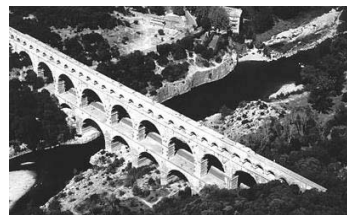
Roman Aquaducts

Arches

- *primarily sees compression*
- *a brick "likes an arch"*
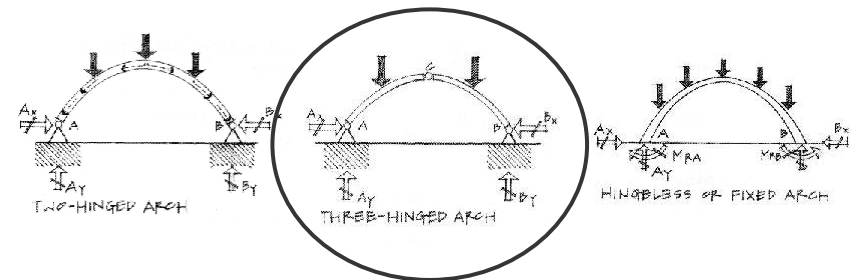
TWO-HINGED ARCH

THREE-HINGED ARCH

HINGELESS OR FIXED ARCH

Arches

- *behavior*
  - *thrust related to height to width*
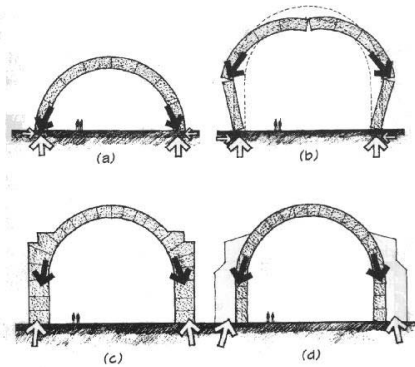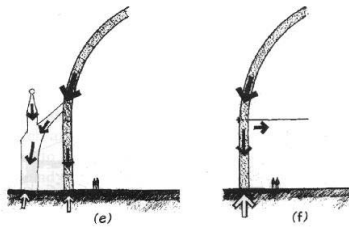
Three-Hinged Arch

- *statically determinant*
  - *2 bodies, 6 equilibrium equations*
  - *4 support, 2 pin reactions (= 6)*
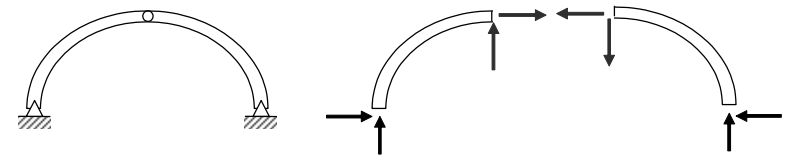
Beams with Internal Pins

- *statically determinant when*
  - *3 equilibrium equations per link =>*
  - *total of support & pin reactions (properly constrained)*
- *zero moment at pins*

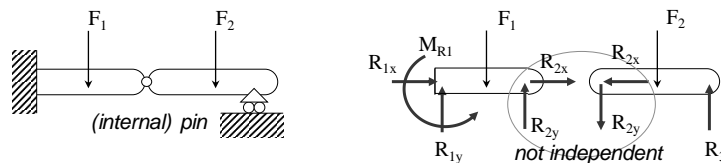F_1 F_2

(internal) pin

R_{1x} M_{R1} F_1 R_{2x} R_{2x} F_2

R_{1y} *not independent* R_{2y} R_{2y} R_3

Procedure

- *solve for all support forces you can*
- *draw a FBD of each member*
  - *pins are integral with member*
  - *pins with loads should belong to 3+ force bodies*
  - *pin forces are equal and opposite on connecting bodies*
  - *identify 2 force bodies vs. 3+ force bodies*
  - *use all equilibrium equations*