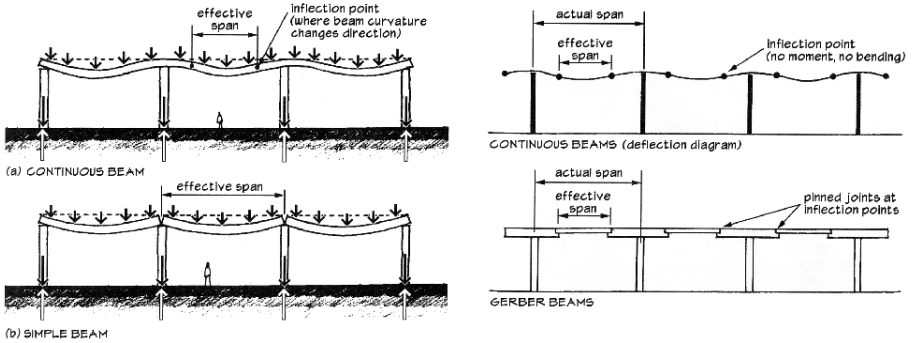
ELEMENTS OF ARCHITECTURAL STRUCTURES:
FORM, BEHAVIOR, AND DESIGN
ARCH 614
DR. ANNE NICHOLS
SPRING 2013

lecture
ten

other beams & pinned frames

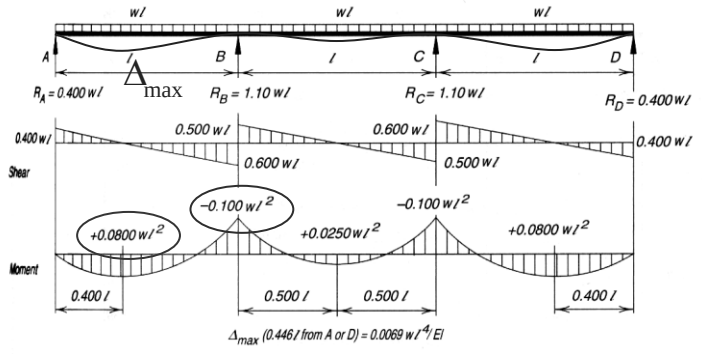
Continuous Beams

- statically indeterminate
- reduced moments than simple beam



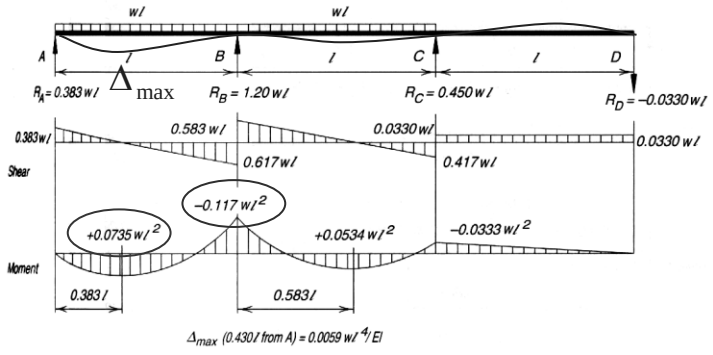
Continuous Beams

- loading pattern affects
  - moments & deflection



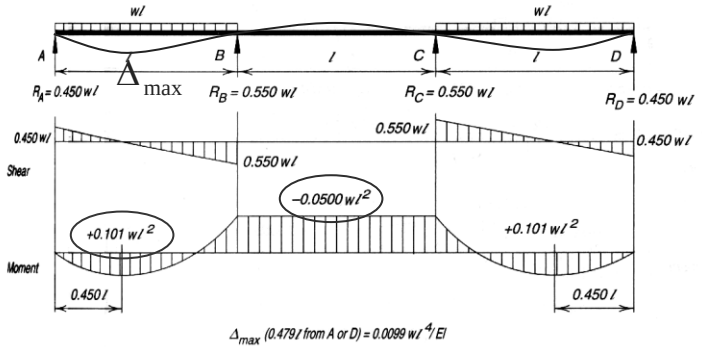
Continuous Beams

- unload end span



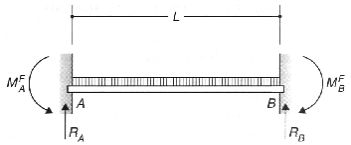
Continuous Beams

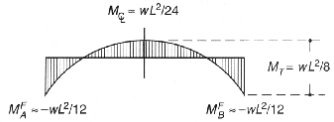
- *unload middle span*



Moment Redistribution

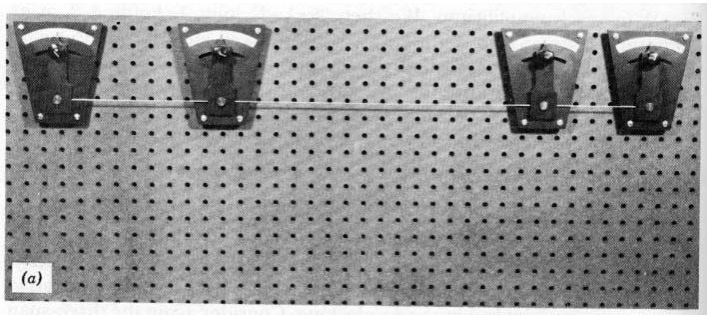
- *continuous slabs & beams with uniform loading*
  - *joints similar to fixed ends, but can rotate*
- *change in moment to center =* $\frac{wL^2}{8}$
  - *M_{max} for simply supported beam*





Moment Distribution (a)

- *no load*



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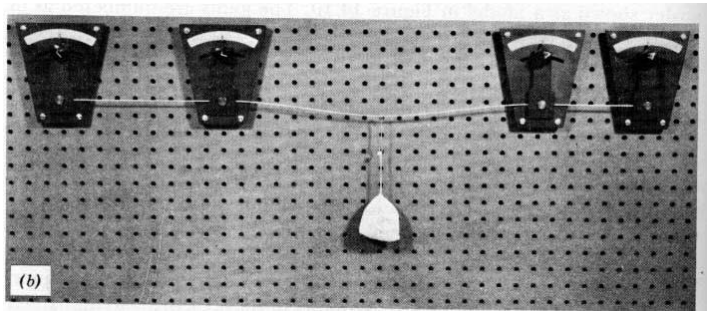
Moment Distribution (b)

- *add load*



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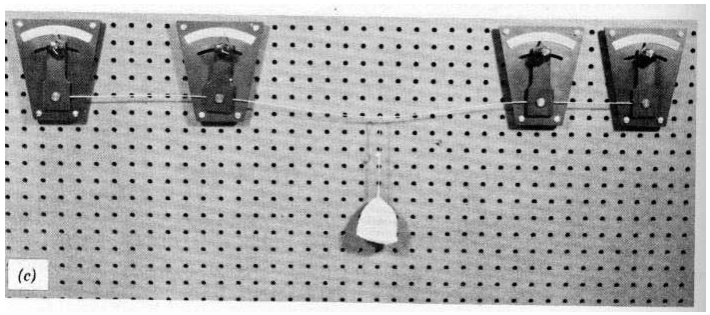
Moment Distribution Method (c)

- *release joint 2*



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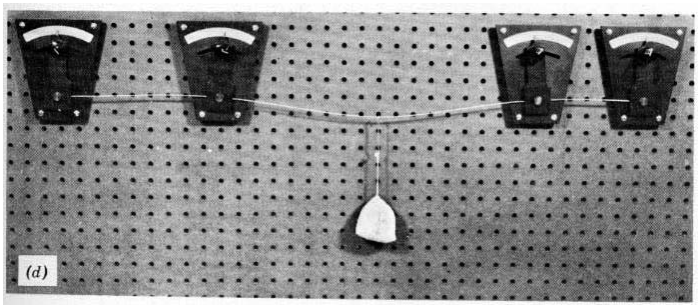
Moment Distribution Method (d)

- *release joint 3*



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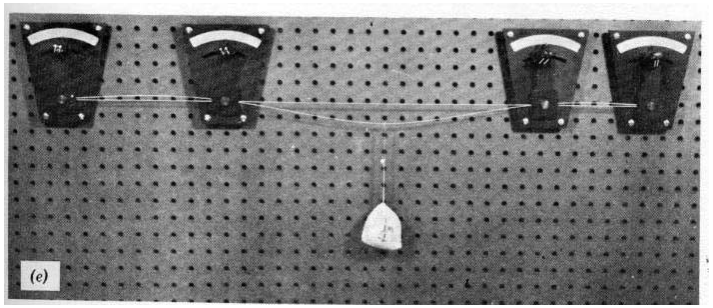
Moment Distribution Method (e)

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



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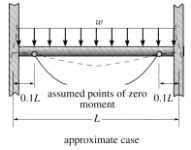
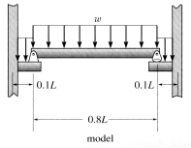
Analysis Methods

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





Theorem of Three Moments

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

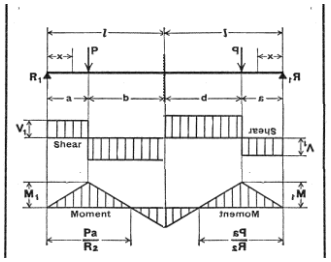
$$M_1L_1 + 2M_2\left(L_1 + L_2\right) + M_3L_2 = -\frac{w_1L_1^3}{4} - \frac{w_2L_2^3}{4}$$

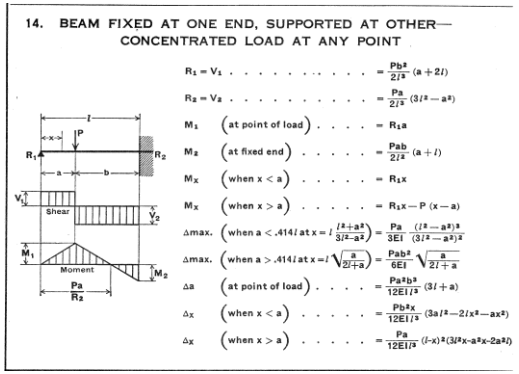
- *concentrated loads and same I:*

$$M_1L_1 + 2M_2\left(L_1 + L_2\right) + M_3L_2 = -\sum P_1L_1^2\left(n_1 - n_1^3\right) - \sum P_2L_2^2\left(n_2 - n_2^3\right)$$

Two Span Beams & Charts

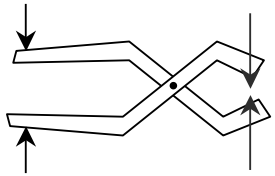
- *equal spans & symmetrical loading*
- *middle support as flat slope*

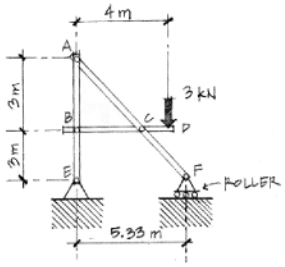




Pinned Frames

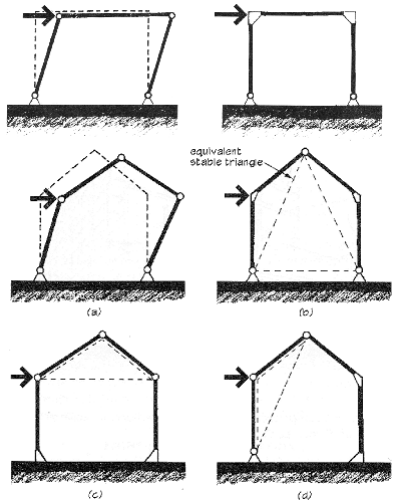
- *structures with at least one <u>3 force body</u>*
- *connected with pins*
- *reactions are <u>equal and opposite</u>*
  - *non-rigid*
  - *rigid*





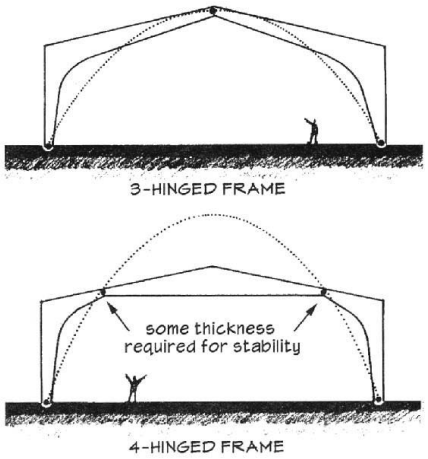
Rigid Frames

- *<u>rigid</u> frames have no pins*
- *frame is all one body*
- *typically statically indeterminate*
- *types*
  - *portal*
  - *gable*



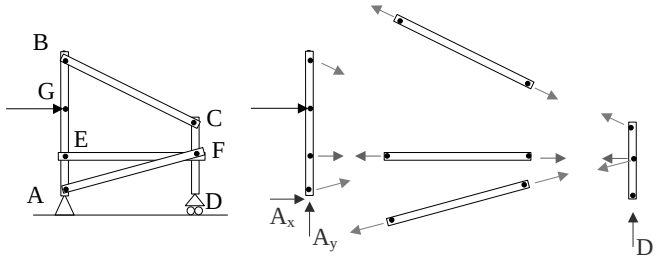
Rigid Frames with PINS

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



Internal Pin Connections

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



Arches

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

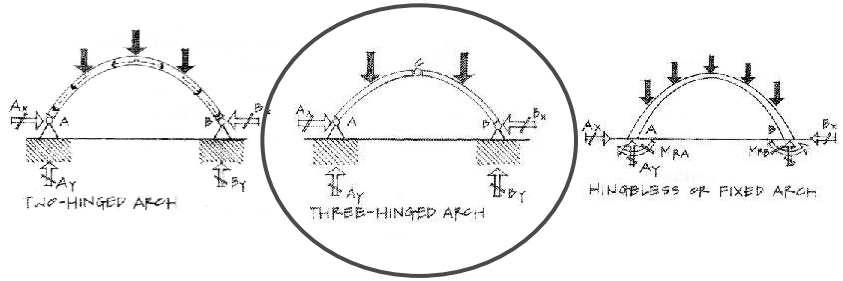
Packhorse Bridge, UK

Rainbow Bridge National Monument

Roman Aquaducts

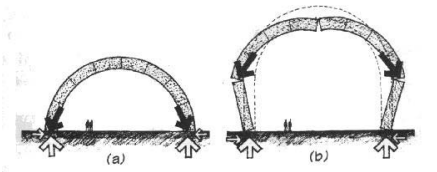
Arches

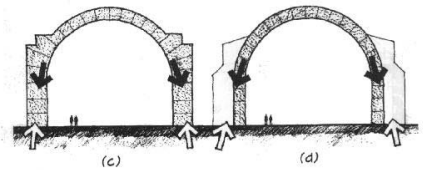
- *primarily sees compression*
- *a brick "likes an arch"*

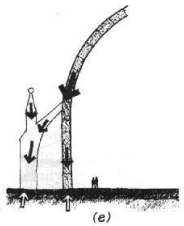


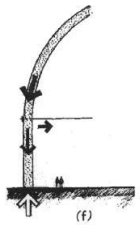
Arches

- *behavior*
  - *thrust related to height to width*



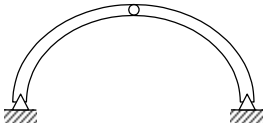


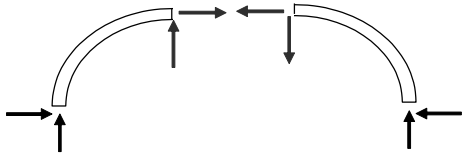




Three-Hinged Arch

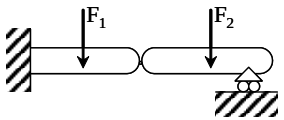
- *statically determinant*
  - *2 bodies, 6 equilibrium equations*
  - *4 support, 2 pin reactions (= 6)*

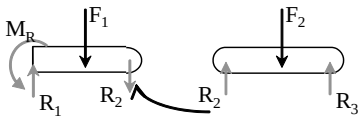




Beams with Internal Pins

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





not independent

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*