Continental train platform, Grimshaw 1993
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 = \( \frac{wL^2}{8} \)
  - \( M_{\text{max}} \) for simply supported beam
Moment Distribution (a)

- no load
Moment Distribution (b)

- add load

http://nisee.berkeley.edu/godden
Moment Distribution Method (c)

- release joint 2

http://nisee.berkeley.edu/godden
Moment Distribution Method (d)

- release joint 3

http://nisee.berkeley.edu/godden
Moment Distribution Method (e)

- exposure of final shape after cycles over initial shape

http://nisee.berkeley.edu/godden
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:

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

- 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
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
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**

```
F1  F2
(internal) pin
```

```
R1x  R1y  M_{R1}  F1

R2x  R2y
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