

other beams &  
pinned frames



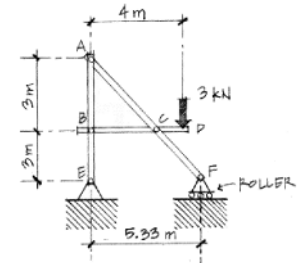
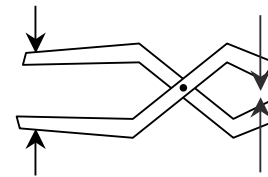
Continental train platform, Grimshaw 1993

Pinned Frames

- structures with at least one 3 force body
- connected with pins
- reactions are equal and opposite

– non-rigid

– rigid



Pinned Frames 2  
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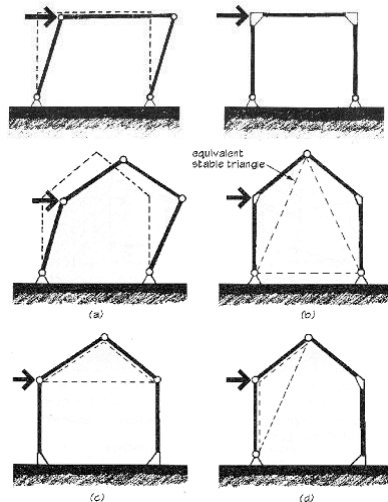
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Rigid Frames

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



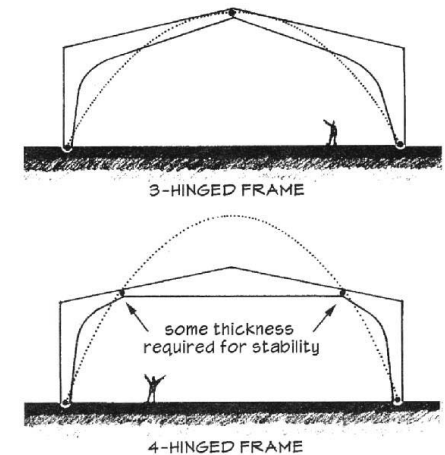
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Rigid Frames with PINS

- frame pieces with connecting pins
- not necessarily symmetrical



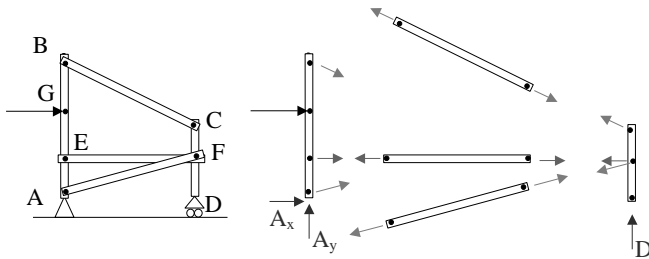
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## Internal Pin Connections

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



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## Arches

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



Packhorse Bridge, UK



Rainbow Bridge National Monument



Roman Aqueducts

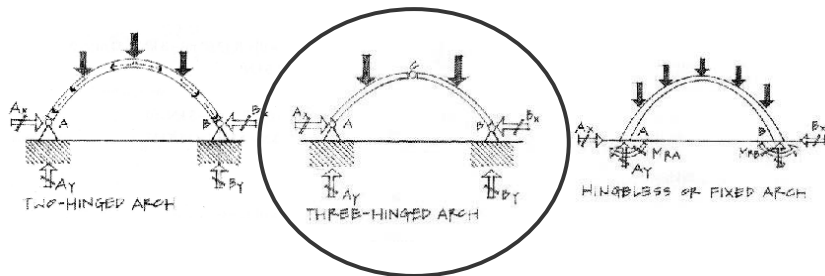
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## Arches

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



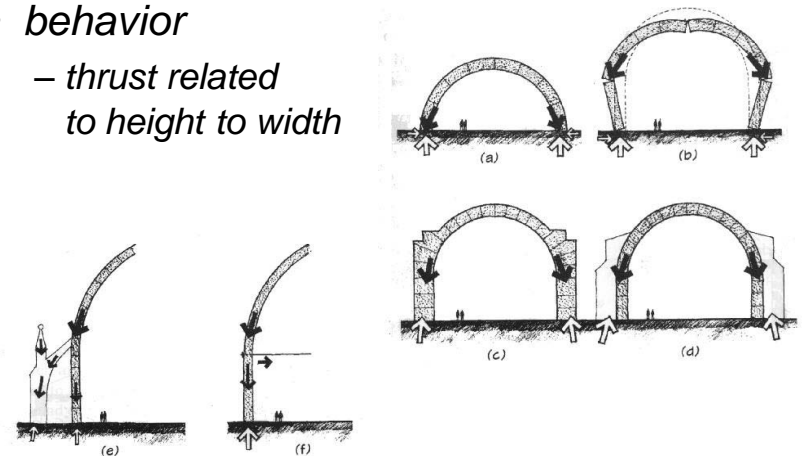
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## Arches

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



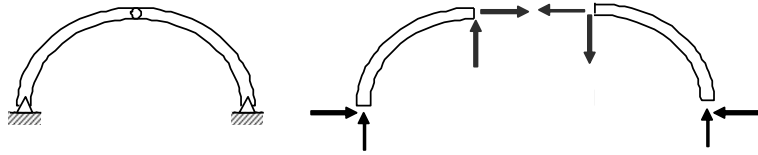
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## Three-Hinged Arch

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



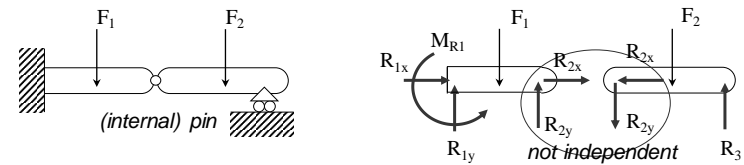
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## Compound Beams

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



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## 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

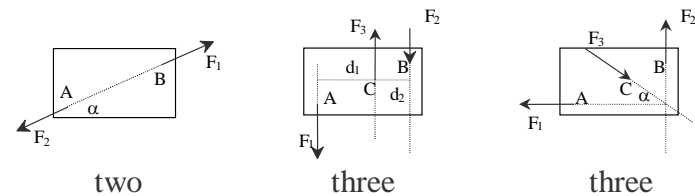
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## Rigid Body Types

- *two force bodies*
  - forces in line, equal and opposite
- *three force bodies*
  - concurrent or parallel forces



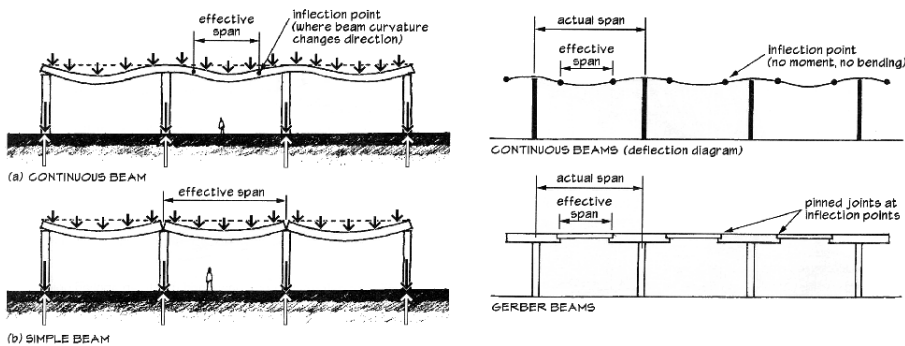
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## Continuous Beams

- statically indeterminate
- reduced moments than simple beam



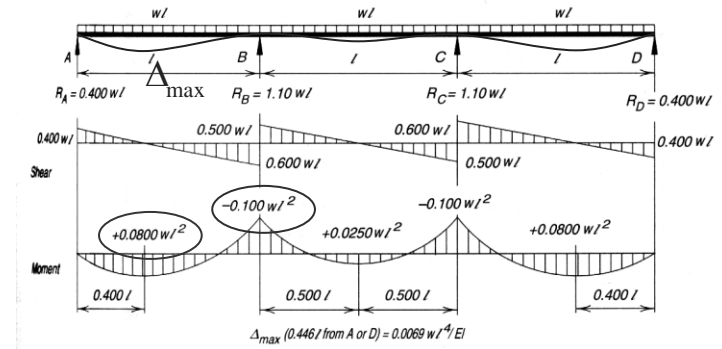
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## Continuous Beams

- loading pattern affects  
– moments & deflection



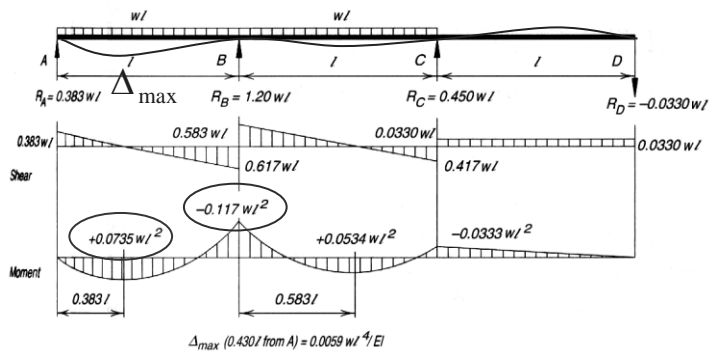
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## Continuous Beams

- unload end span



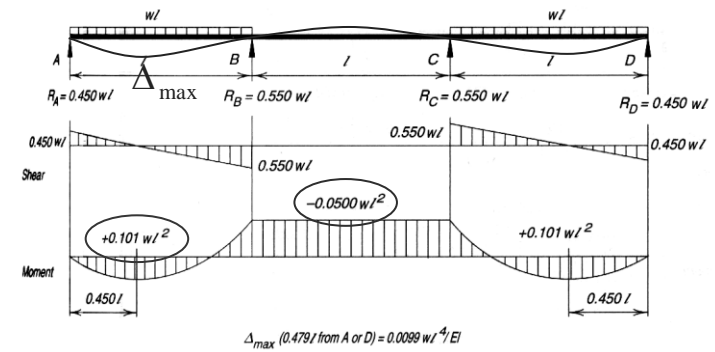
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## Continuous Beams

- unload middle span



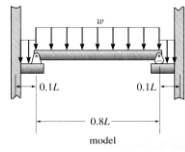
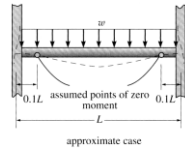
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# Analysis Methods

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



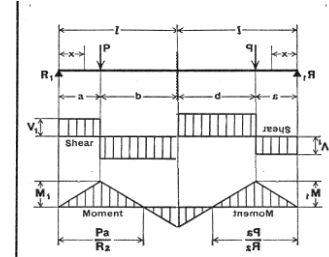
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# Two Span Beams & Charts

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



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14. BEAM FIXED AT ONE END, SUPPORTED AT OTHER—  
CONCENTRATED LOAD AT ANY POINT

$$R_1 = V_1 = \dots = \frac{Pb^2}{2l^2} (a + 2l)$$

$$R_2 = V_2 = \dots = \frac{Pa}{2l^2} (3l^2 - a^2)$$

$$M_1 \text{ (at point of load)} = R_1 a$$

$$M_2 \text{ (at fixed end)} = \frac{Pab}{2l^2} (a + l)$$

$$M_x \text{ (when } x < a) = R_1 x$$

$$M_x \text{ (when } x > a) = R_1 x - P(x - a)$$

$$\Delta \text{max. (when } a < .414l \text{ at } x = l \frac{l^2 - a^2}{3l^2 - a^2}) = \frac{Pa}{3EI} \frac{(l^2 - a^2)^2}{(3l^2 - a^2)^2}$$

$$\Delta \text{max. (when } a > .414l \text{ at } x = l \sqrt{\frac{a}{2l+a}}) = \frac{Pab^2}{6EI} \sqrt{\frac{a}{2l+a}}$$

$$\Delta a \text{ (at point of load)} = \frac{Pa^2 b^3}{12EI l^2} (3l + a)$$

$$\Delta x \text{ (when } x < a) = \frac{Pb^2 x}{12EI l^2} (3a l^2 - 2l x^2 - a x^2)$$

$$\Delta x \text{ (when } x > a) = \frac{Pa}{12EI l^2} (l - x)^2 (3l^2 - a^2 - 2a x)$$

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