



Continental train platform, Grimshaw 1993

other beams & pinned frames

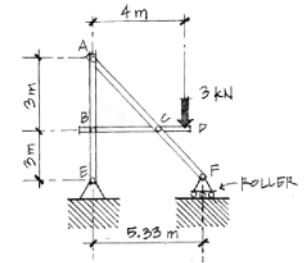
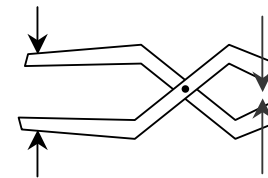
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Pinned Frames

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



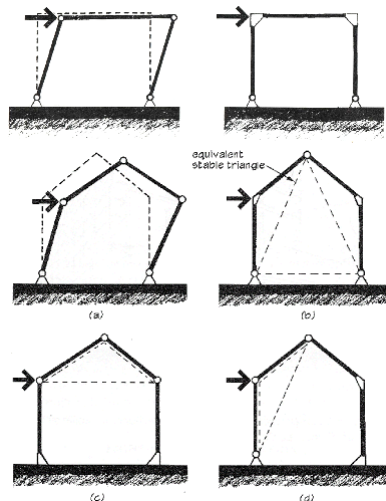
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Rigid Frames

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



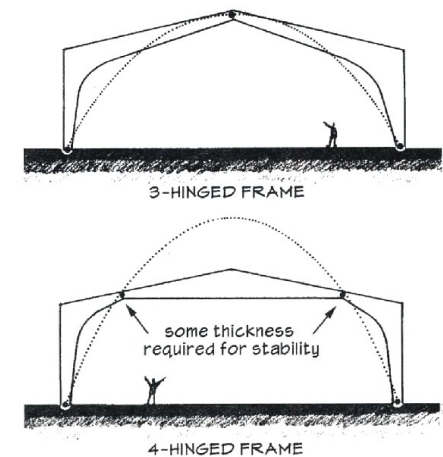
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Rigid Frames with PINS

- frame pieces with connecting pins
- not necessarily symmetrical



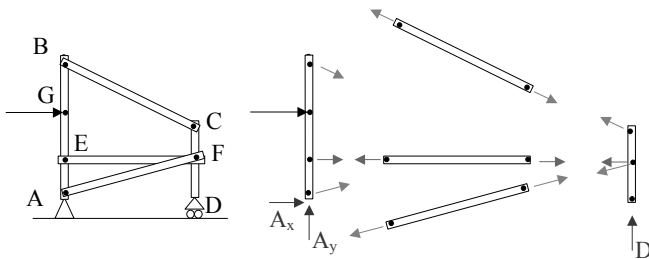
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Internal Pin Connections

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



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Arches

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



Rainbow Bridge National Monument

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Packhorse Bridge, UK

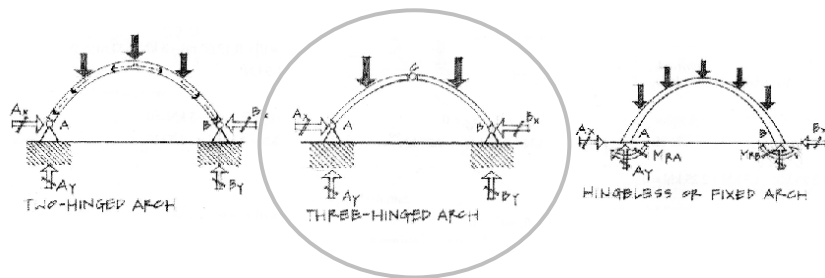


Roman Aquaducts

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Arches

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



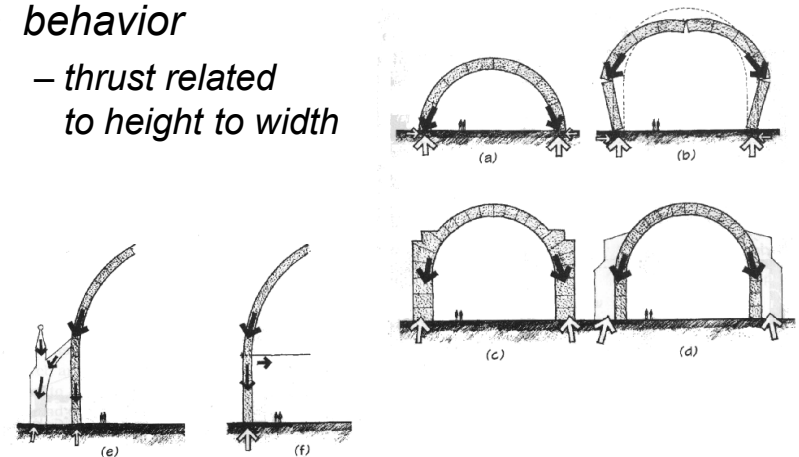
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Arches

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



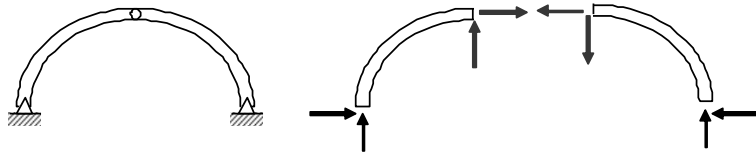
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Three-Hinged Arch

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



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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

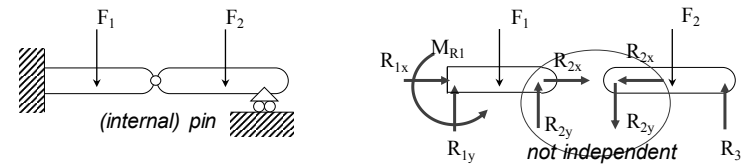
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Compound Beams

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



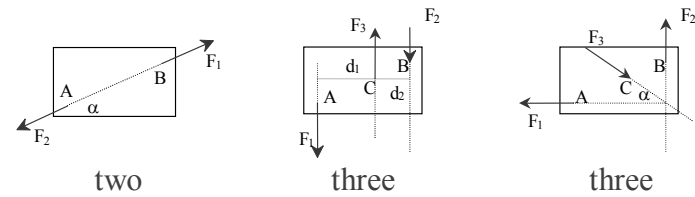
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Rigid Body Types

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



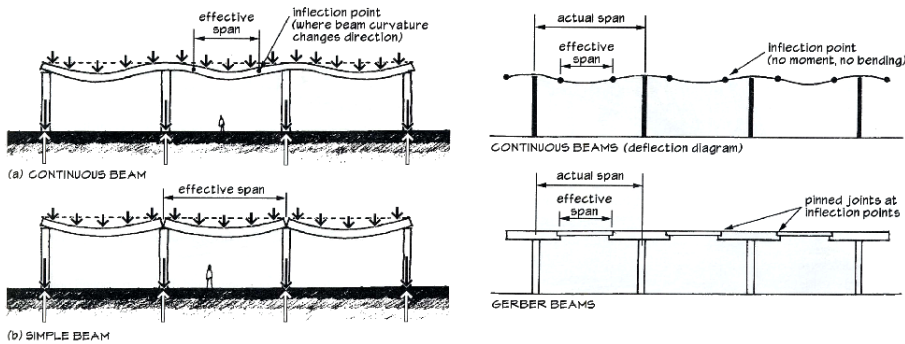
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Continuous Beams

- statically indeterminate
- reduced moments than simple beam



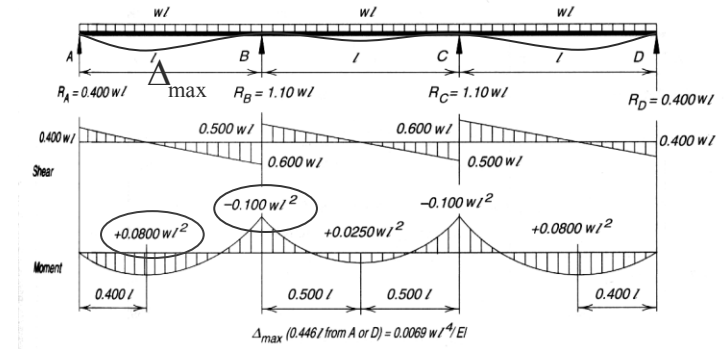
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Continuous Beams

- loading pattern affects – moments & deflection



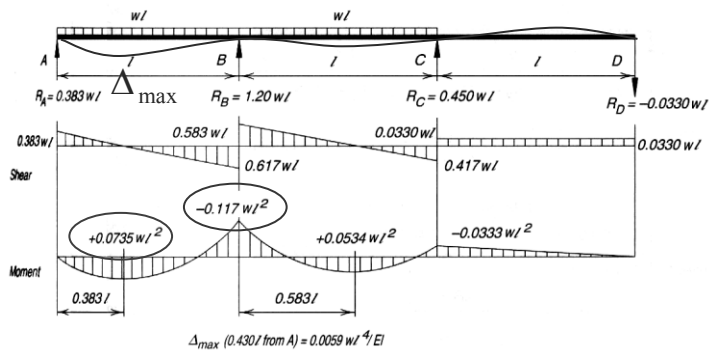
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Continuous Beams

- unload end span



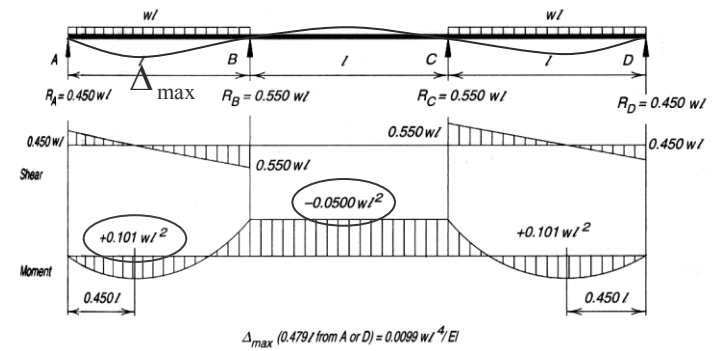
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Continuous Beams

- unload middle span



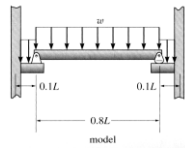
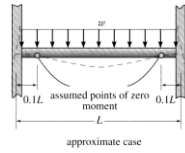
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Analysis Methods

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



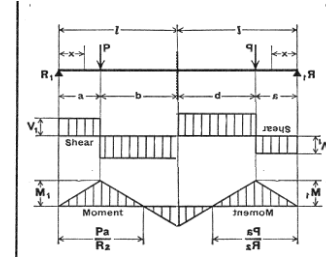
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Two Span Beams & Charts

- 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

$$R_1 = V_1 \dots \dots \dots = \frac{Pb^3}{2l^3}(a+2l)$$

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

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

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

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

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

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

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

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

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

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

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