Telford, Brunel and British Metal Forms

1780’s to 1880’s British Structural Engineering
Iron Bridge - Abraham Darby - 1779
Thomas Telford
1757-1834
Telford’s Buildwas Br. - 1795
Telford’s Buildwas Br. - 1795

Darby’s Iron Bridge - 1779
Pont y Cysyllte Aqueduct - 1805
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Tour de France
Telford/Eiffel video
Telford proposal for Menai Straits
DESIGN for the SUSPENDED CENTERING for the proposed IRON ARCH over the MENDI of YNYSYMOCH.
Craighellachie Bridge - 1814 - 150 feet
Minute “paper”:

- Draw an alternative arrangement of members to connect the deck and arch of the Craigellachie bridge
- Compare your results with your neighbor. Explain why you chose your arrangement
Telford proposal for Runcorn Gap (1000’ span!, developed 1814 to 1818)
Telford’s most famous work: Menai Straits
CROESO I BORTHAETHNY
WELCOME TO MENAI BRIDGE
Menai Strait Bridge - 1826 - 580 feet
Clifton Bridge - I.K. Brunel - 1864 - 702 ft (vs 580 ft for Menai)
Without calculations or research, what issues in the design do you think would affect the economy of these alternative bridge designs?
Isambard Kingdom Brunel
1806-1859
Brunel
Britannia Bridge - Stephenson - 1850
Brittania today
<table>
<thead>
<tr>
<th></th>
<th>Britannia</th>
<th>Saltash</th>
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</thead>
<tbody>
<tr>
<td><strong>Efficiency</strong></td>
<td>Hollow box</td>
<td>Lenticular</td>
</tr>
<tr>
<td></td>
<td>460 ft span</td>
<td>455 ft span</td>
</tr>
<tr>
<td></td>
<td>7000 lb/ft</td>
<td>4700 lb/ft</td>
</tr>
<tr>
<td><strong>Economy</strong></td>
<td>£ 198 /ft</td>
<td>£ 102 /ft</td>
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<tr>
<td><strong>Elegance</strong></td>
<td>Form not expressive</td>
<td>Form ambiguous</td>
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Eiffel Tower Structural Study

introduction to statics
Tools and methods for structural analysis

Free body diagrams
Equilibrium
Load path
Free Body Diagrams
gravity
gravity
M = Fh
\[ P = wH \]
\[ P = (2.6)(984) \]
\[ P = 2600 \text{ kips} \]

\[ p = 2.6 \text{ k/ft} \]

\[ H = 984 \text{ ft} \]
gravity

reactions
\[ \text{wind reactions} = \text{CM} \]
TOP PLATFORM
INTERMEDIATE PLATFORM
SECOND PLATFORM
FIRST PLATFORM
BOTTOM SECTION: 2,066 FT
MIDDLE SECTION: 2,464 FT
TOP SECTION: 340 FT
TOWER HEIGHT: 984 FT
Civil Engineering Units

- Lots of imperial units..
- The kip? kip = kilopound = 1000 lb
- The psf? a pound per square foot
  - say you weigh 150 lb and are standing on a part of the floor which is 1ft x 1ft, you are = 150psf
  - other way – say a constant wind of 40 psf is blowing on a building which is 100ft x 100ft across – the force is 40psf X 100ft X 100ft = 40,000 lb
  - 40,000 lb = 40 kips
- Also… psi and ksi, pound/sq. in, and kip/sq. in
  - Materials may be described as having limit stresses in psi or ksi, e.g., typical yield stress of steel = 50 ksi
Equilibrium
\[ \Sigma M_{\text{section}} = 0 \Rightarrow M - p(H-h)(H-h)/2 = 0 \]
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\[ M = [p(H-h)][(H-h)/2] = P(H-h)/2 \]
M = \left[ p(H-h) \right] \left[ \frac{(H-h)}{2} \right] = P(H-h)/2

C = -T = M/w
\[ M = [p(H-h)][(H-h)/2] = p(H-h)^2/2 \]
Load path

or, how the load travels to the ground
All forces or loads must eventually get to the ground. Can we trace the path of tension or compression?
All forces or loads must eventually get to the ground. Can we trace the path of tension or compression?
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Secondary load path