Telford, Brunel and British Metal Forms

1780’s to 1880’s British Structural Engineering

Iron Bridge - Abraham Darby - 1779
Thomas Telford
1757-1834

Darby's Iron Bridge - 1779

Telford's Buildwas Br. - 1795

Telford's Buildwas Br. - 1795
Pont y Cysyllte Aqueduct - 1805
Exercise:
Write down at least one point under each ‘s’ for the Llangollen aqueduct
Telford proposal for Menai Straits

Bonar Bridge over the Dornoch Firth

Bridge over the River Spey at Craigellachie
Craigellachie 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
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?
Brittania today

Saltash Bridge - Brunel - 1859 - 455 feet
<table>
<thead>
<tr>
<th>Britannia</th>
<th>Saltash</th>
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<tbody>
<tr>
<td>Efficiency</td>
<td></td>
</tr>
<tr>
<td>Hollow box</td>
<td>Lenticular</td>
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<tr>
<td>460 ft span</td>
<td>455 ft span</td>
</tr>
<tr>
<td>7000 lb/ft</td>
<td>4700 lb/ft</td>
</tr>
<tr>
<td>Economy</td>
<td></td>
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<tr>
<td>£ 198 /ft</td>
<td>£ 102 /ft</td>
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<tr>
<td>Elegance</td>
<td></td>
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<tr>
<td>Form not expressive</td>
<td>Form ambiguous</td>
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</table>
What considerations may have led to the very different (lenticular vs. suspension) bridges built at the same location?

List as many as you can.
Eiffel Tower Structural Study

introduction to statics

Tools and methods for structural analysis

Free body diagrams
Equilibrium
Load path

Free Body Diagrams
\[ F \cdot h = M \]

\[ P = 2.6 \text{ kips/ft} \]

\[ P = (2.6)(984) \]

\[ P = 2600 \text{ kips} \]

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

Gravity reactions
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
\[ \Sigma M_{\text{section}} = 0 \rightarrow M - p(H-h)(H-h)/2 = 0 \]

\[ M = [p(H-h)][(H-h)/2] = P(H-h)/2 \]

\[ C = -T = M/w \]
Load path

or, how the load travels to the ground

\[ M = \left[ p(H-h) \right] \frac{(H-h)}{2} = p(H-h)^2/2 \]

All forces or loads must eventually get to the ground. Can we trace the path of tension of compression?
All forces or loads must eventually get to the ground. Can we trace the path of tension of compression?