Telford, Brunel and British Metal Forms

1780’s to 1880’s British Structural Engineering

New materials and new forms
Form, forces, and efficiency in long span bridges
Saltash vs. Britannia bridges and struggles with the discipline of economy

Iron Bridge - Abraham Darby - 1779
Exercise:
Write down at least one point under each ‘s’ for the Llangollen aqueduct.
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
Menai Strait Bridge - 1826 - 580 feet
Without calculations or research, what issues in the design do you think would affect the economy of these alternative bridge designs?
circa 1980's

Brittania today

Saltash Bridge - Brunel - 1859 - 455 feet
Britannia  Saltash
Efficiency  Hollow box  Lenticular
          460 ft span  455 ft span
          7000 lb/ft  4700 lb/ft
Economy  £ 198 /ft  £ 102 /ft
Elegance  Form not expressive  Form ambiguous

What considerations may have led to the very different (lenticular vs. suspension) bridges built at the same location?

List as many as you can.

Circling back to Brunel’s Clifton Suspension Br.
702’ main span, vs. 580’ at Menai
UMass announcements

Homework 2 (Eiffel) now due Feb 12 5PM
Help session after class Feb 11
Journal assignment due tonight midnight

Eiffel Tower Structural Study
introduction to statics

Tools and methods for structural analysis
Free body diagrams
Equilibrium
Load path
Free Body Diagrams
Fh = M = Fh
\[ P = wH \]
\[ P = (2.6)(984) \]
\[ P = 2600 \text{ kips} \]

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

\[ p = 2.6 \text{ k/ft} \]
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 1 ft x 1 ft, you are = 150 psf
  - other way – say a constant wind of 40 psf is blowing on a building which is 100 ft x 100 ft across – the force is 40 psf X 100 ft X 100 ft = 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

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

\[ M = [p(H-h)][(H-h)/2] = P(H-h)/2 \]
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
All forces or loads must eventually get to the ground. Can we trace the path of tension of compression?