Telford, Brunel and British Metal Forms

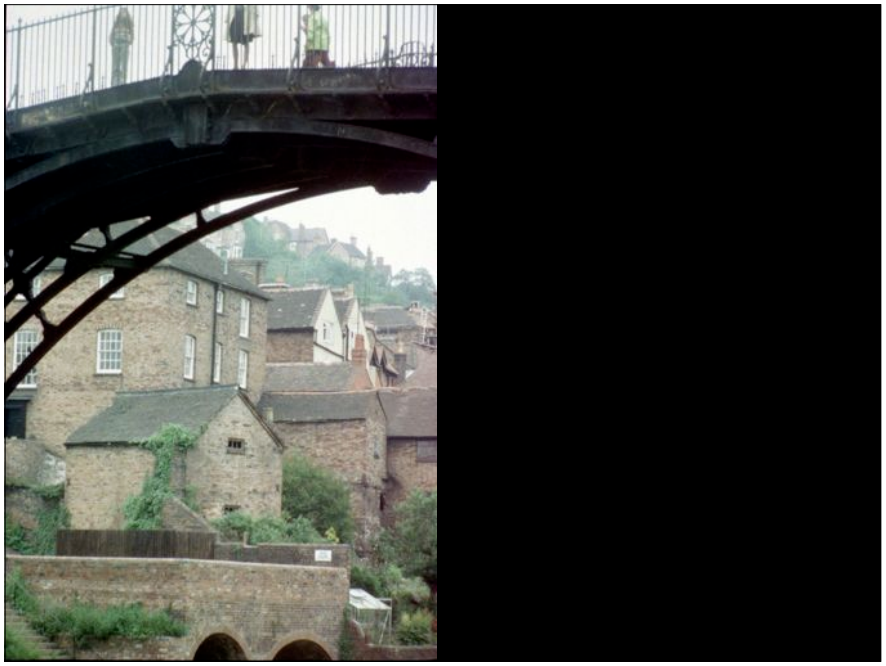
1780's to 1880's British Structural Engineering

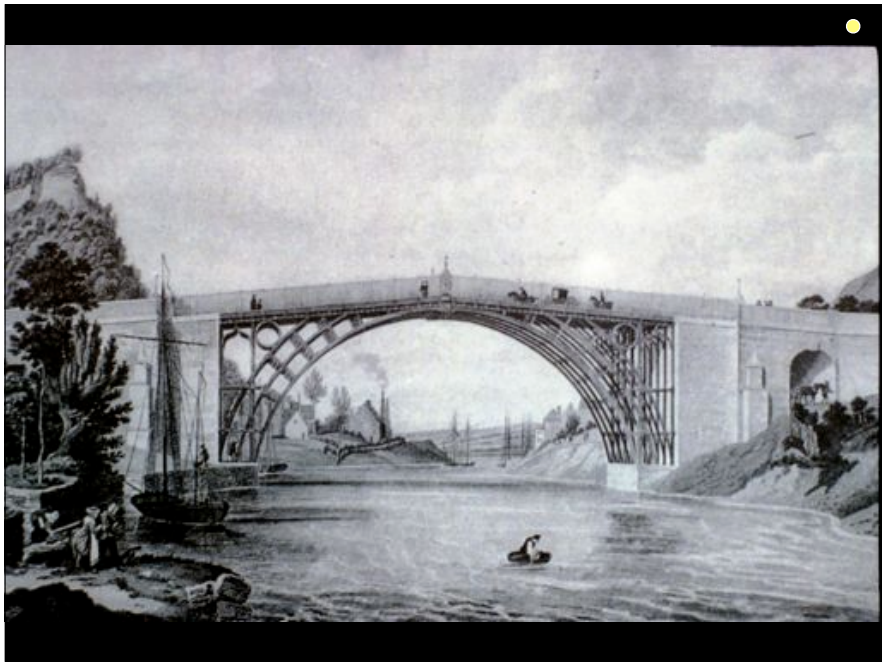
New materials and new forms

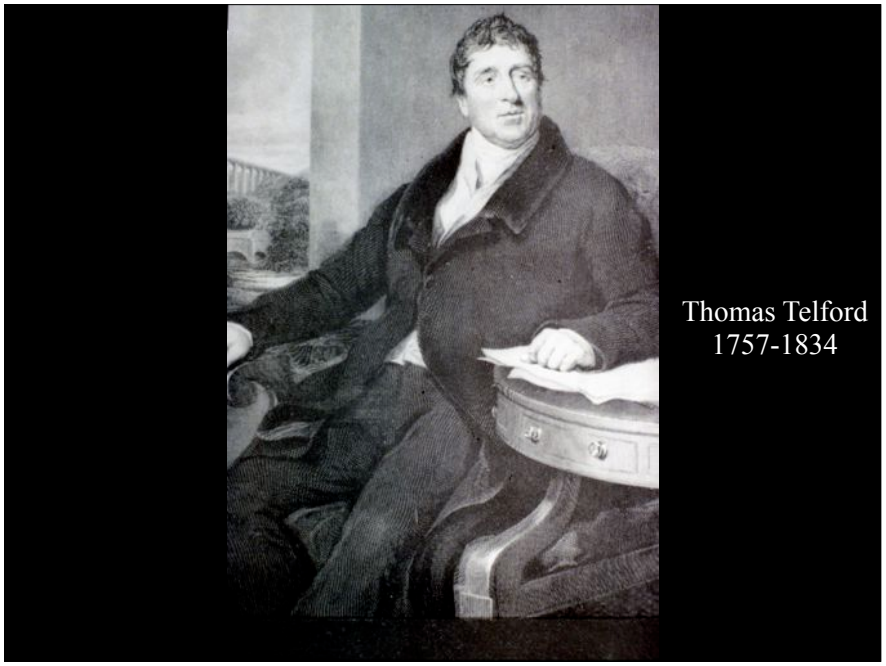
Form, forces, and efficiency in long span bridges

Saltash vs. Britannia bridges and struggles with the discipline of economy

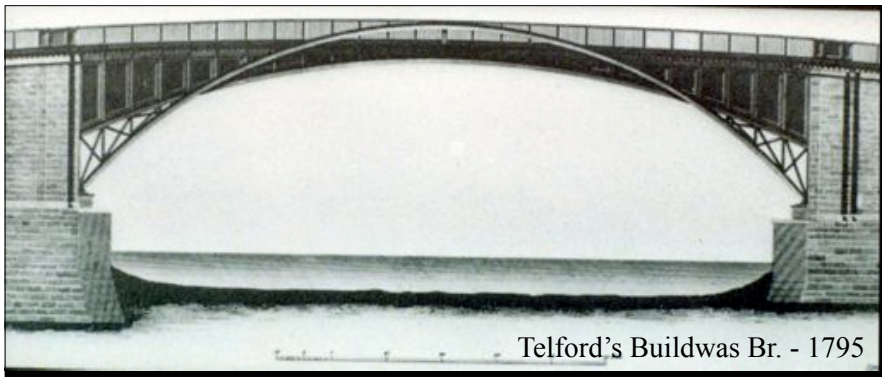
Iron Bridge - Abraham Darby - 1779



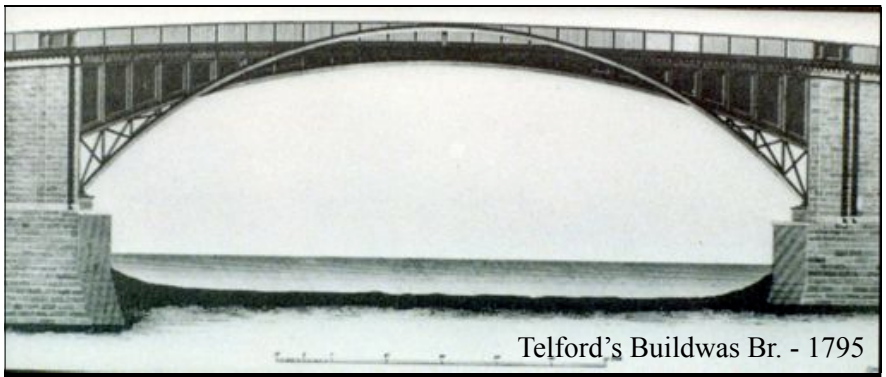




Thomas Telford
1757-1834

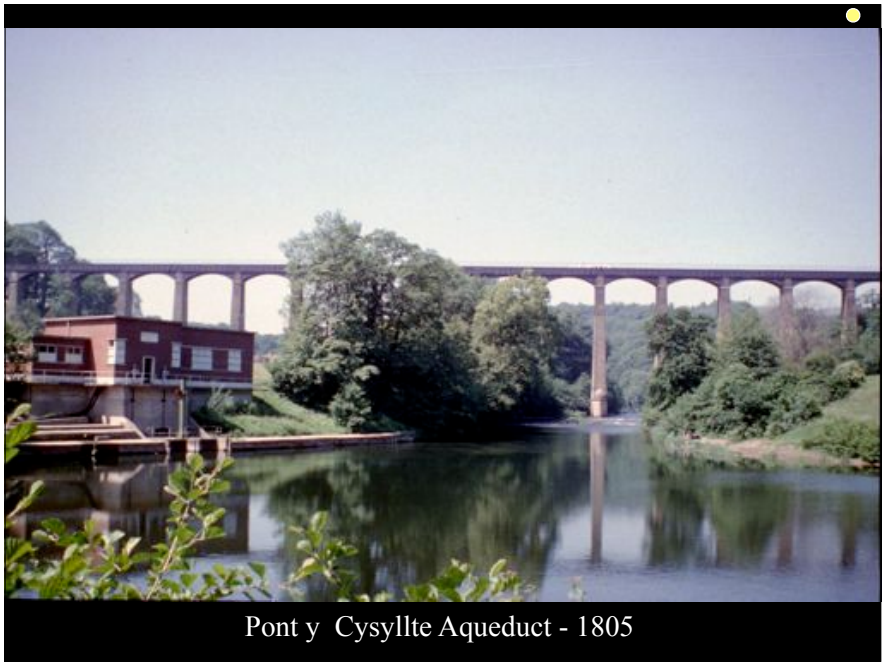


Telford's Buildwas Br. - 1795



Telford's Buildwas Br. - 1795

Darby's Iron Bridge - 1779

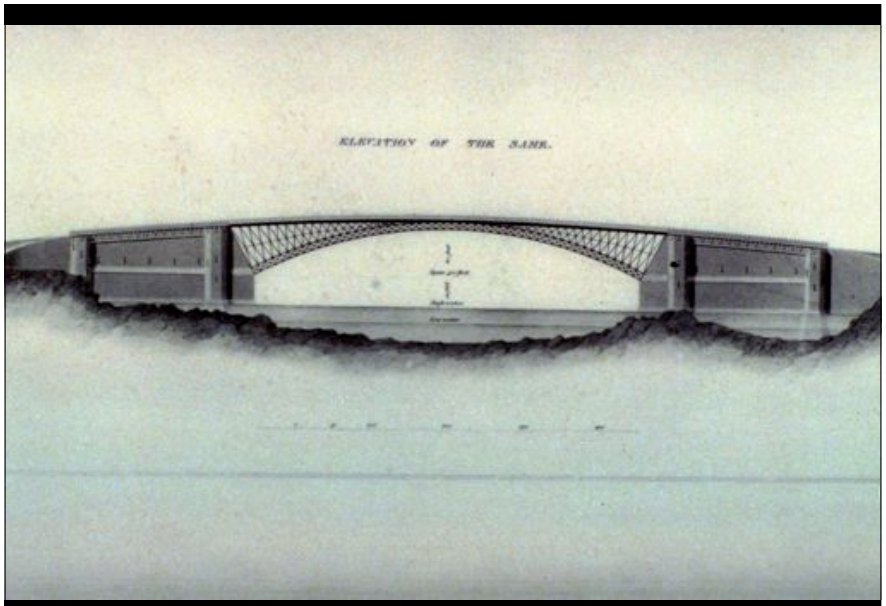


Pont y Cysyllte Aqueduct - 1805

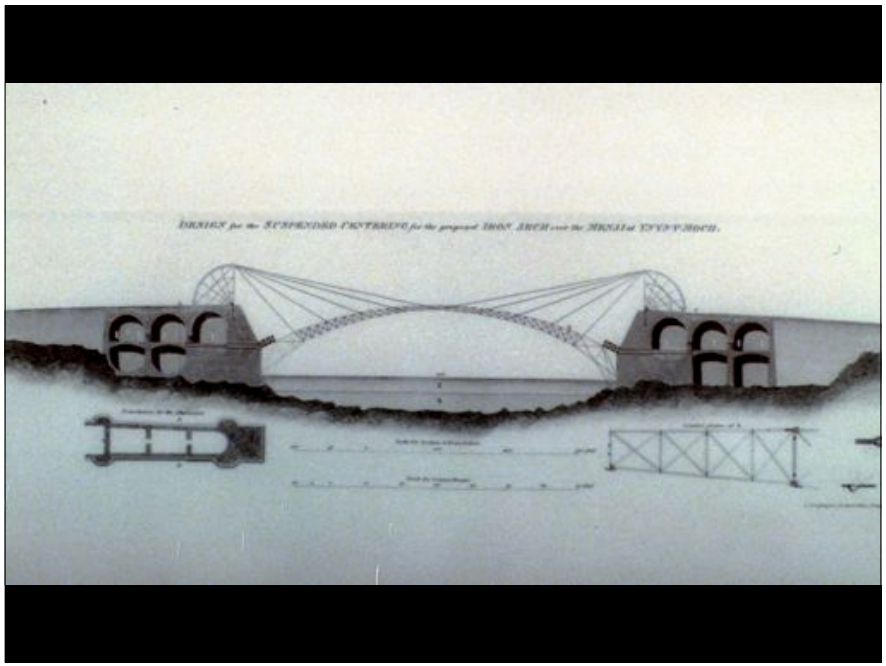
Pont y Cysyllte Aqueduct - 1805

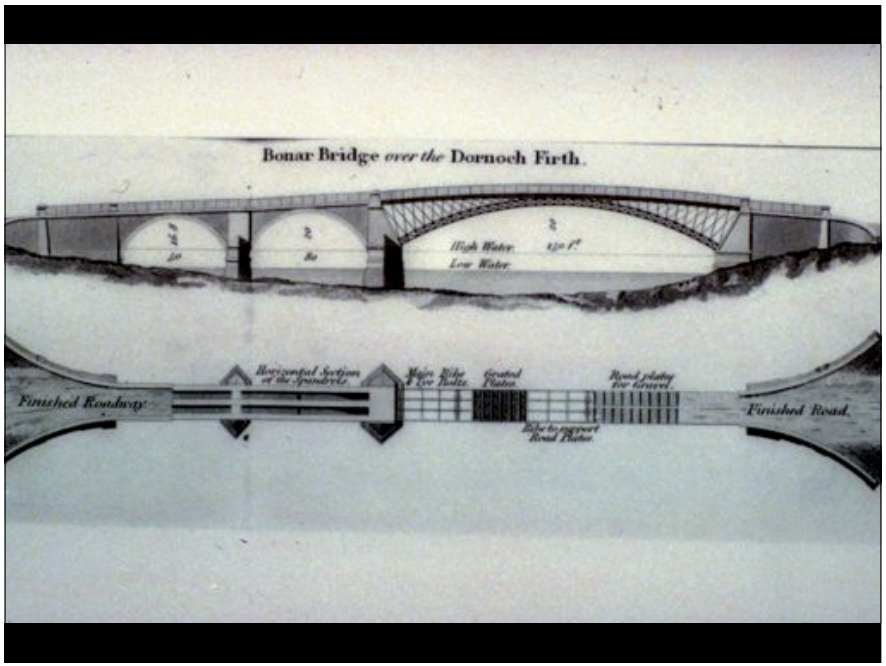
Exercise:
Write down at least one point under each ‘s’ for the Llangollen acqueduct

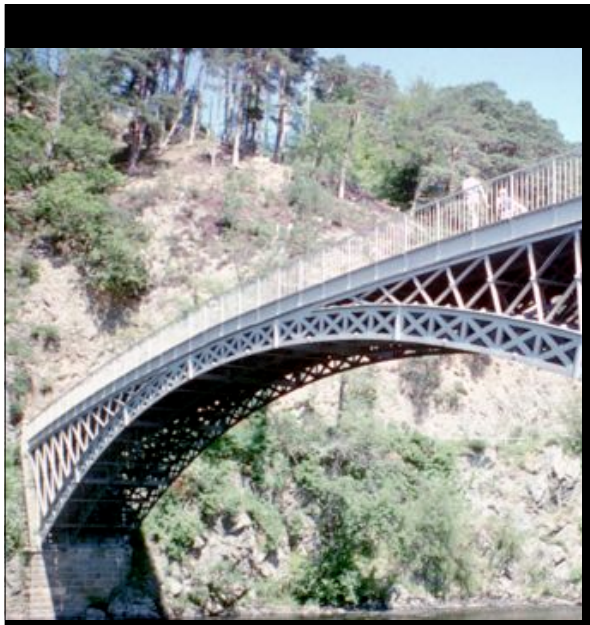
Tour de France
Telford/Eiffel video

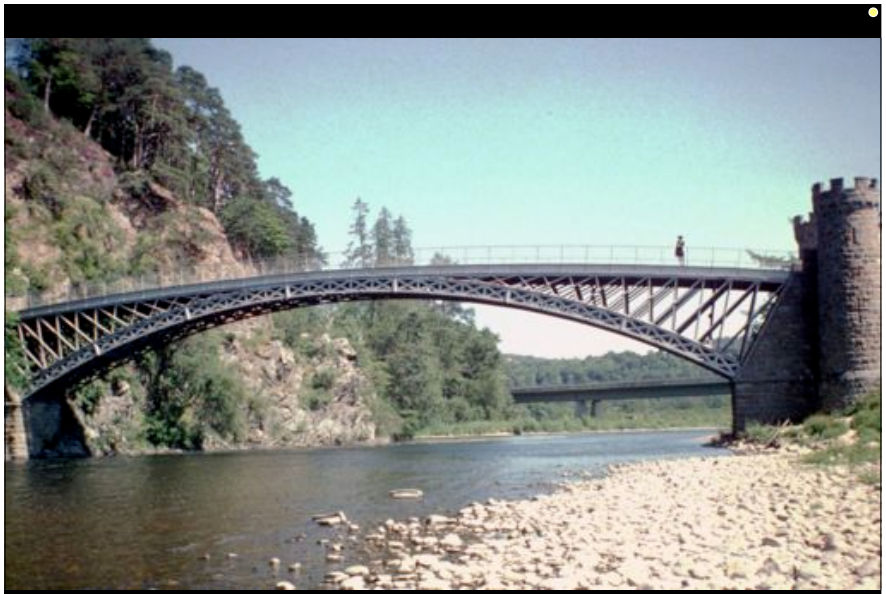


Telford proposal for Menai Straits

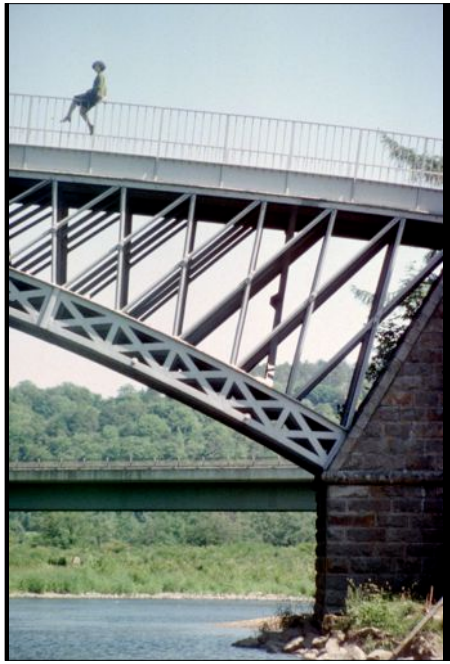


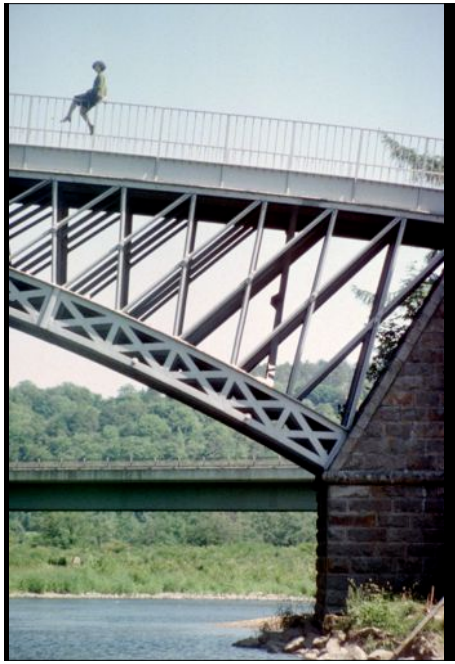






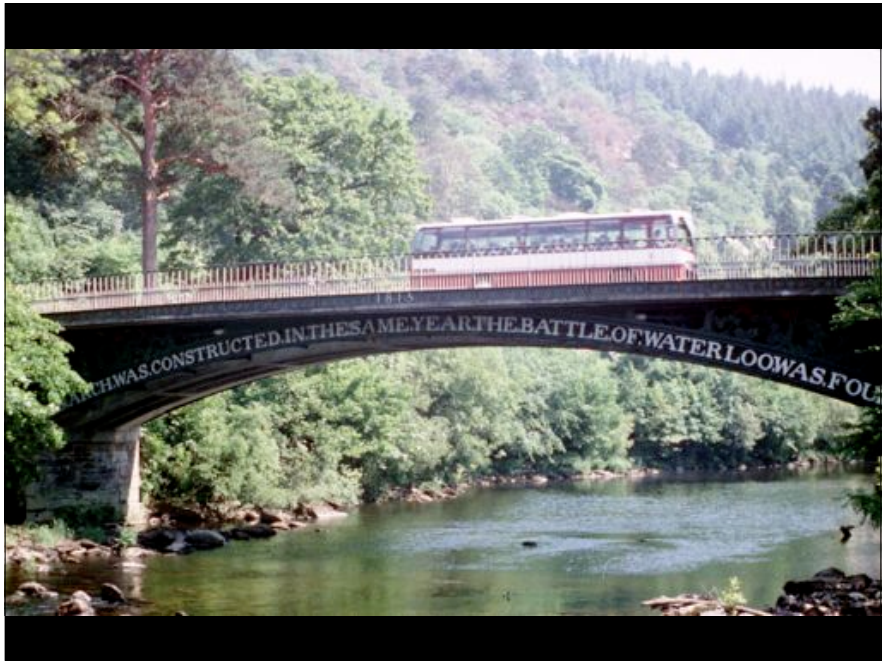
Craigellachie Bridge - 1814 - 150 feet

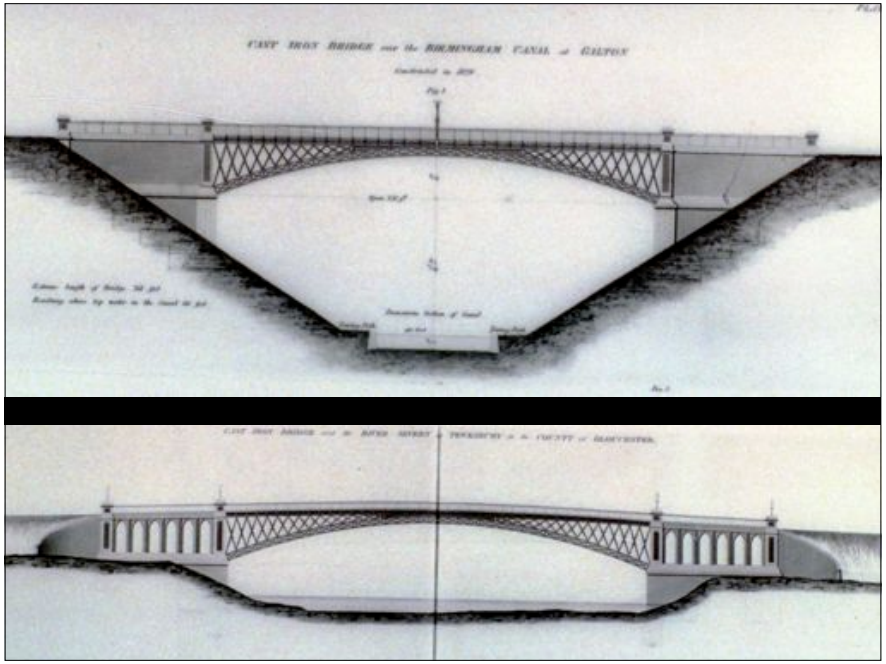


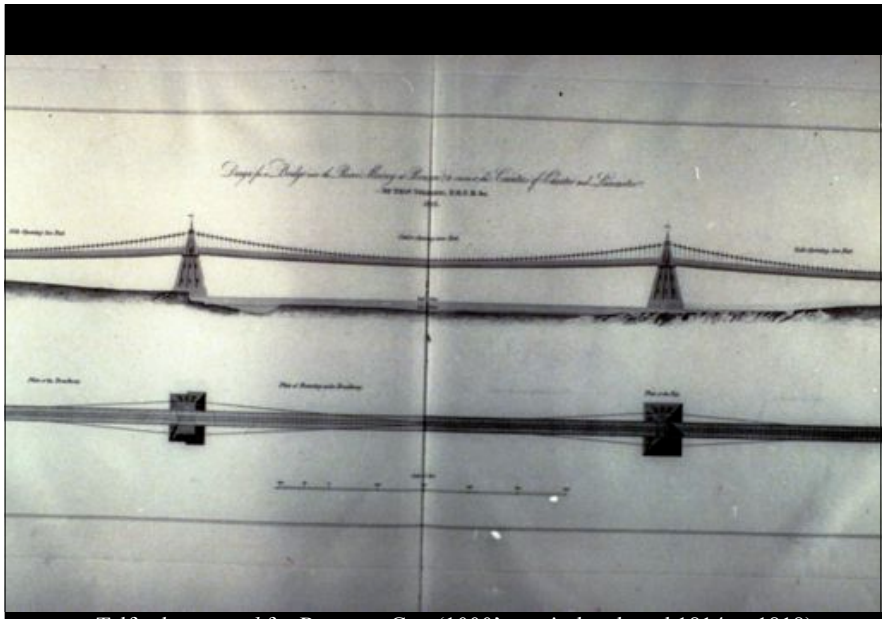


Minute “paper”:

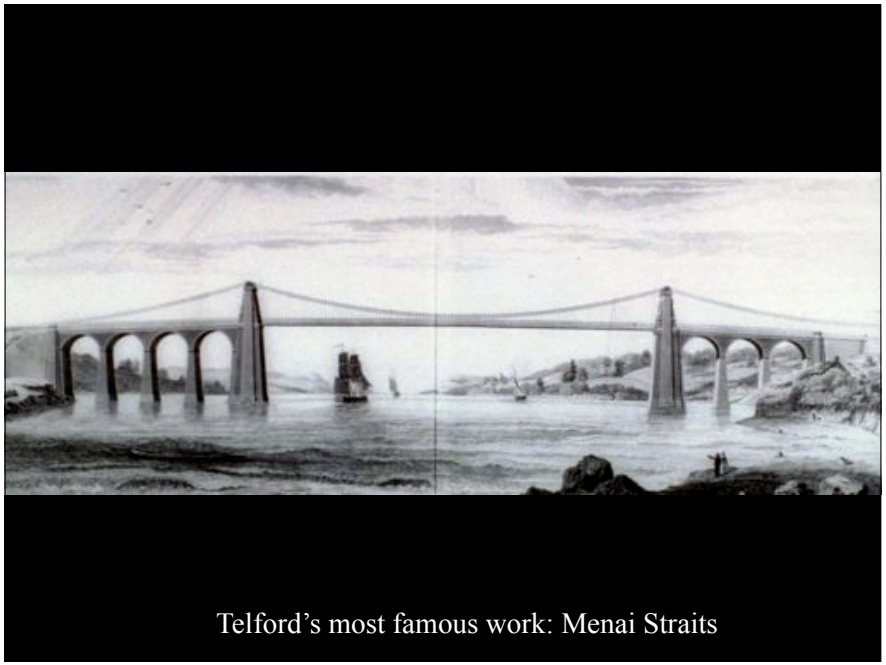
-Draw an alternative arrangement of members to connect the deck and arch of the Craigellachie bridge
-Compare your results with your neighbor. Explain why you chose your arrangement



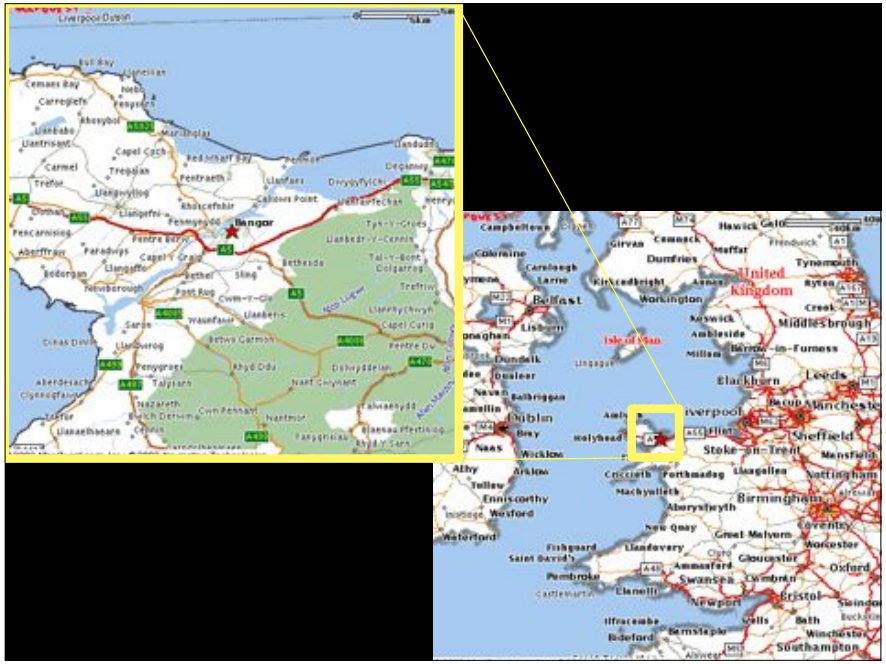




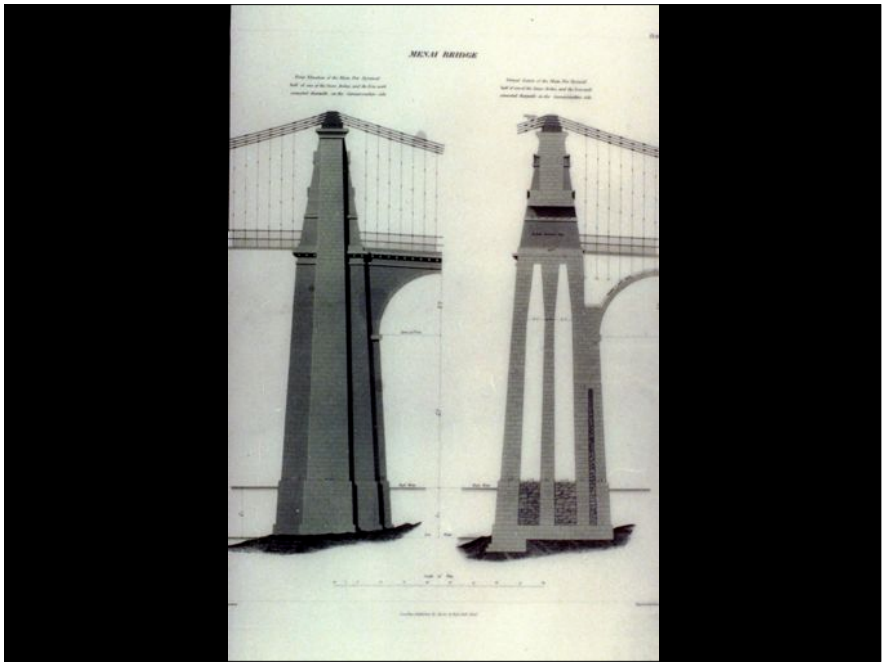
Telford *proposal* for Runcorn Gap (1000’ span!, developed 1814 to 1818)

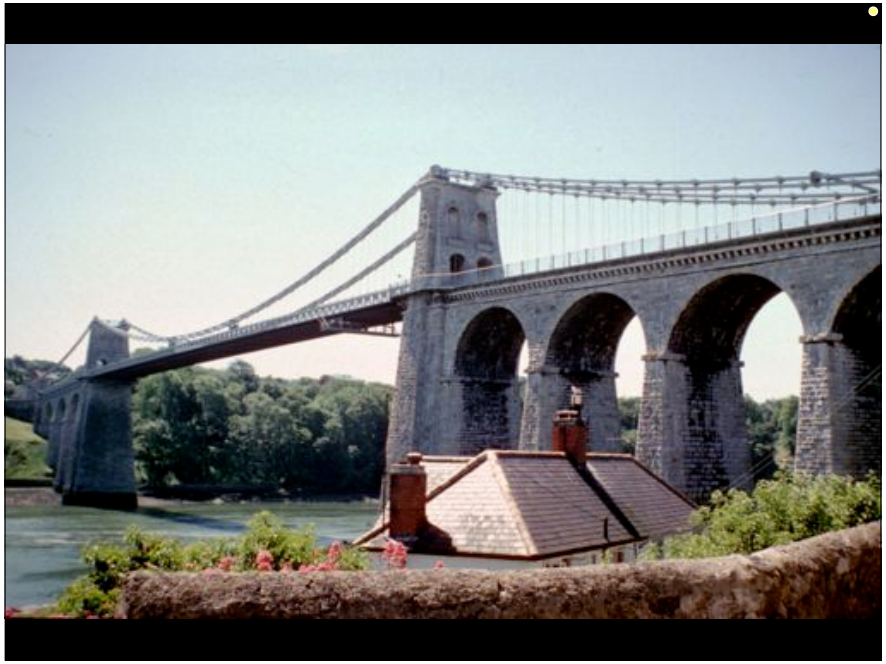


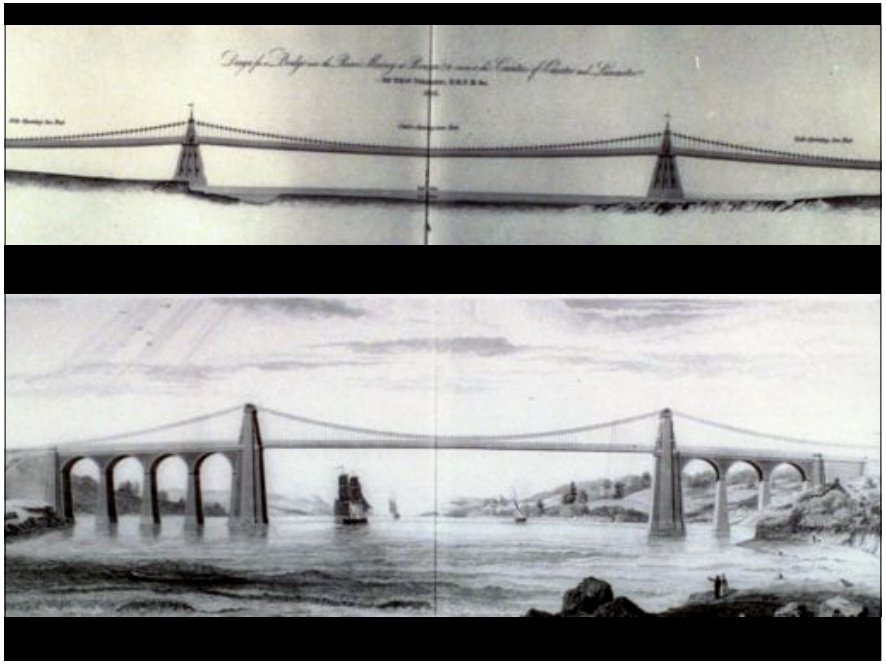
Telford’s most famous work: Menai Straits

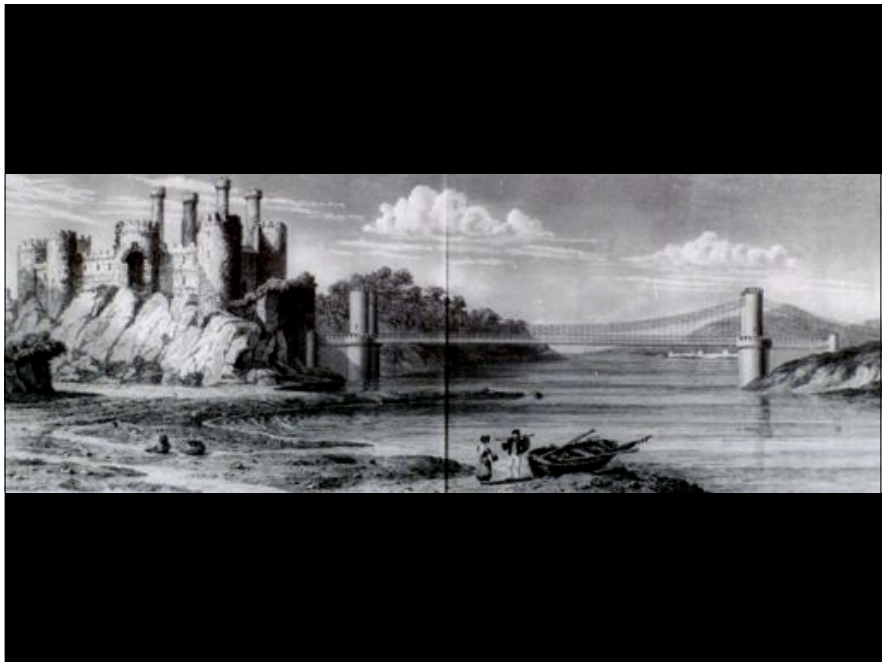


Menai Strait Bridge - 1826 - 580 feet

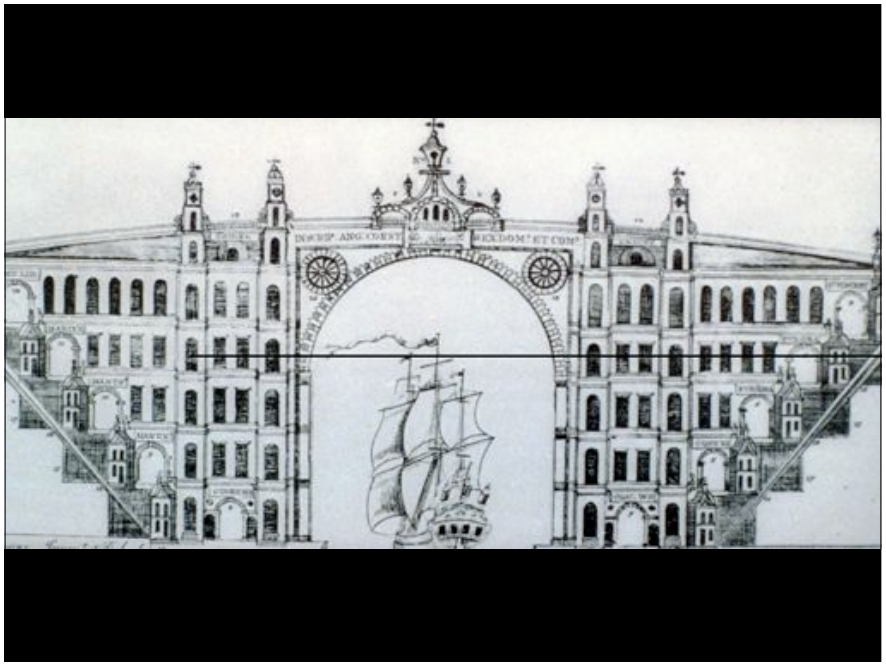


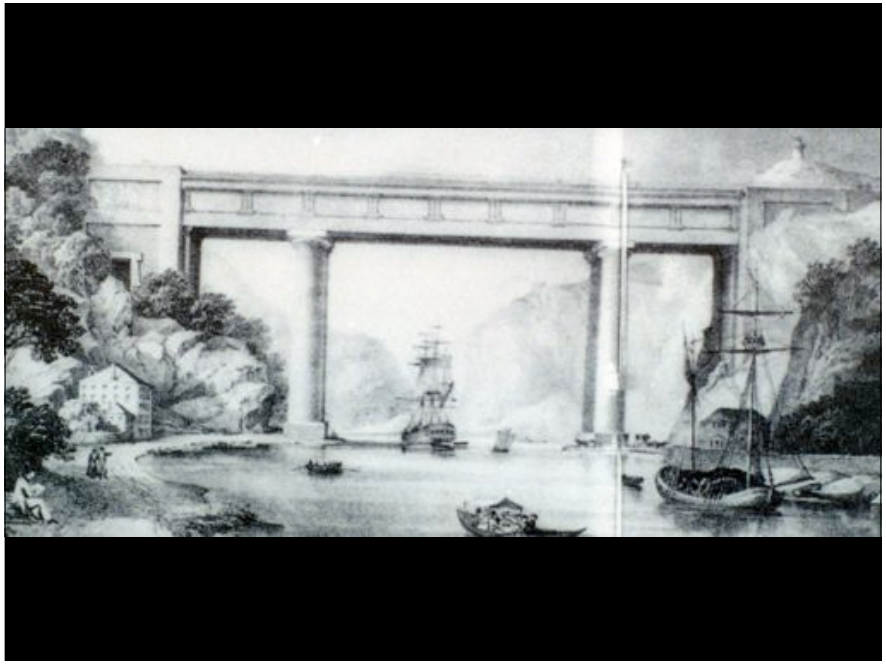


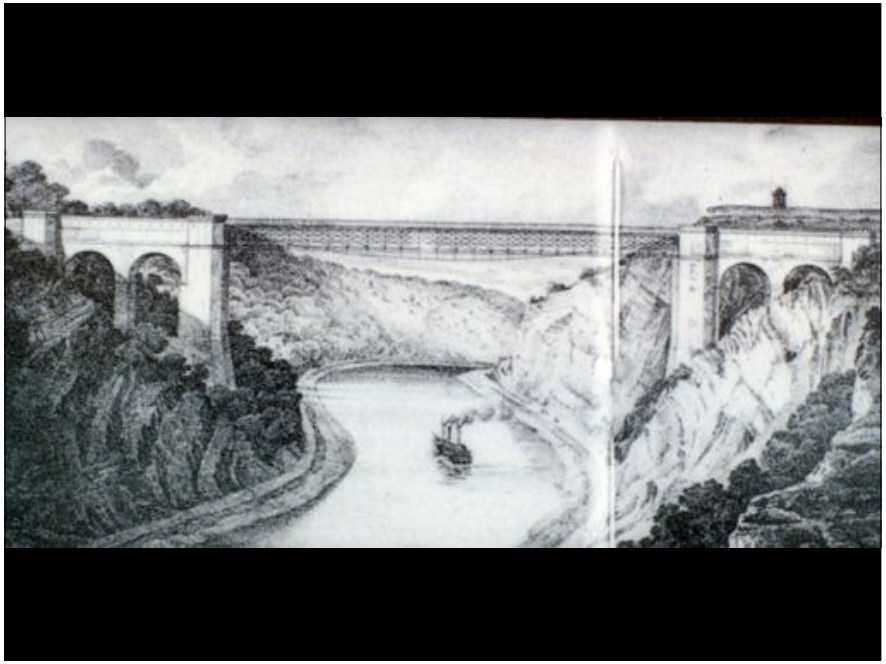


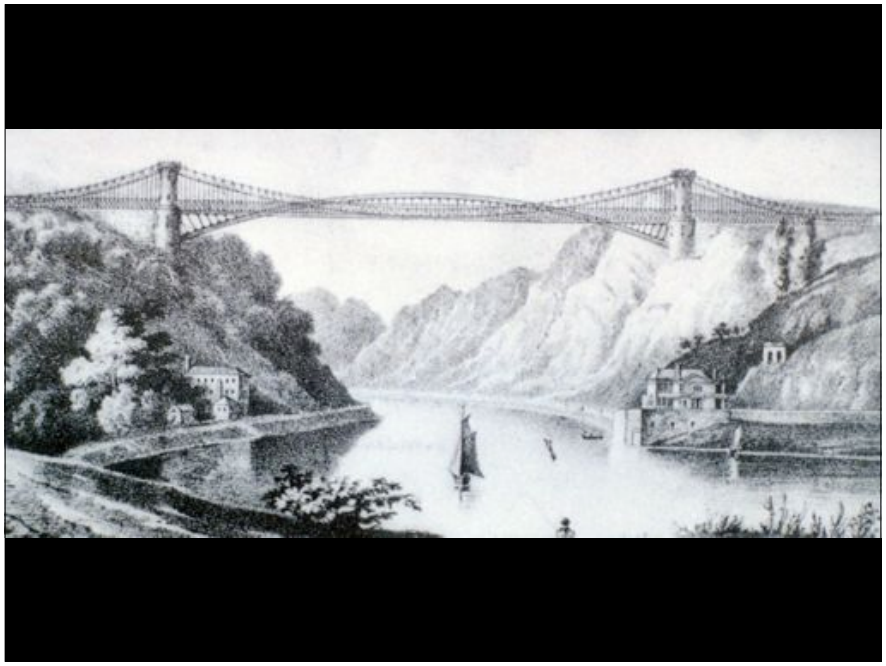


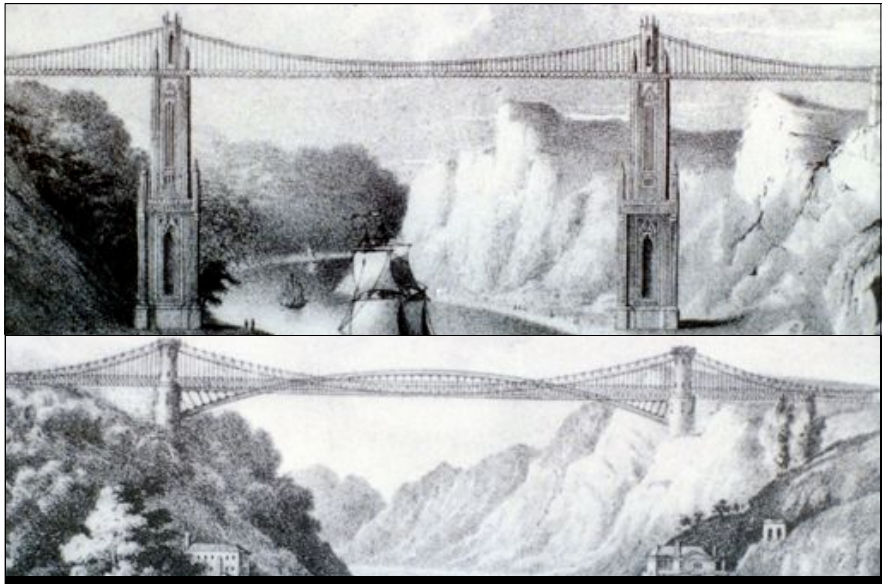
Clifton Bridge - I.K. Brunel - 1864 - 702 ft (vs 580 ft for Menai)











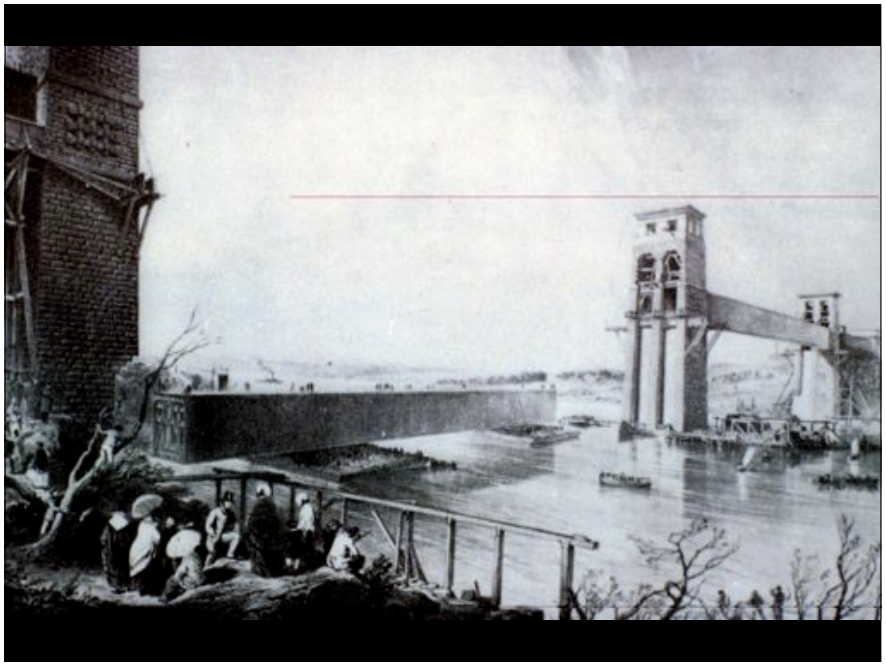
Without calculations or research, what issues in the design do you think would affect the economy of these alternative bridge designs?

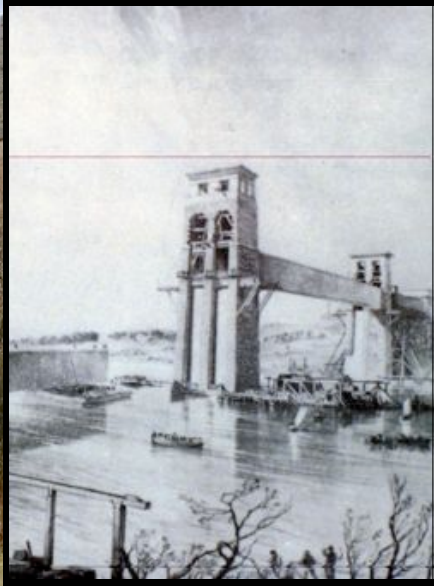
Isambard Kingdom Brunel
1806-1859

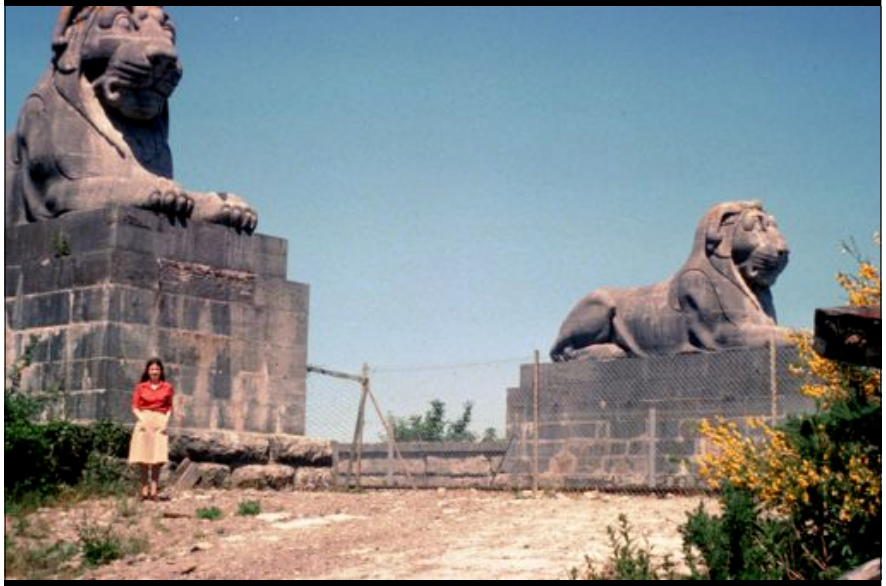
http://www.tate.org.uk/artist/turner-rain-steam.htm (visited 8 Sept 2003)

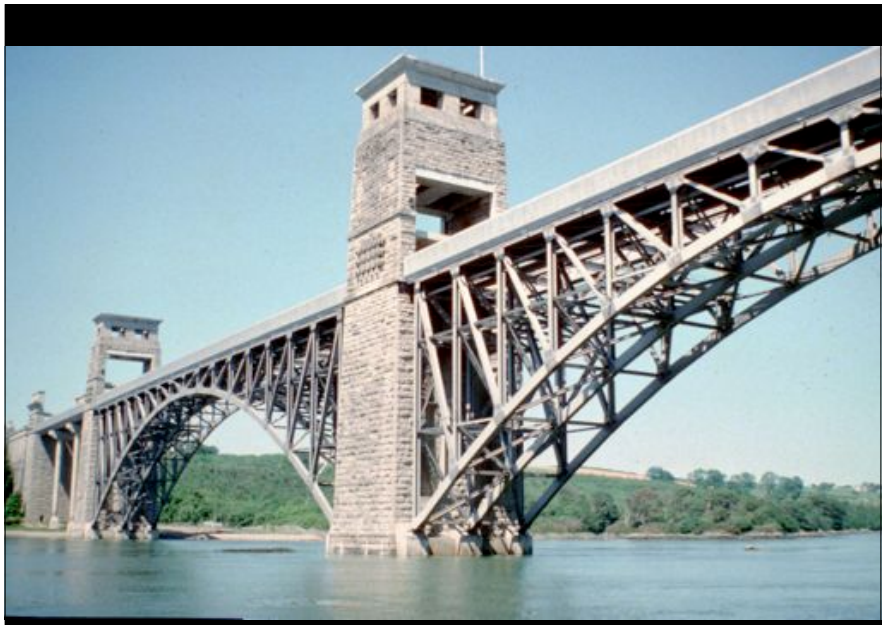
Brunel

Britannia Bridge - Stephenson - 1850





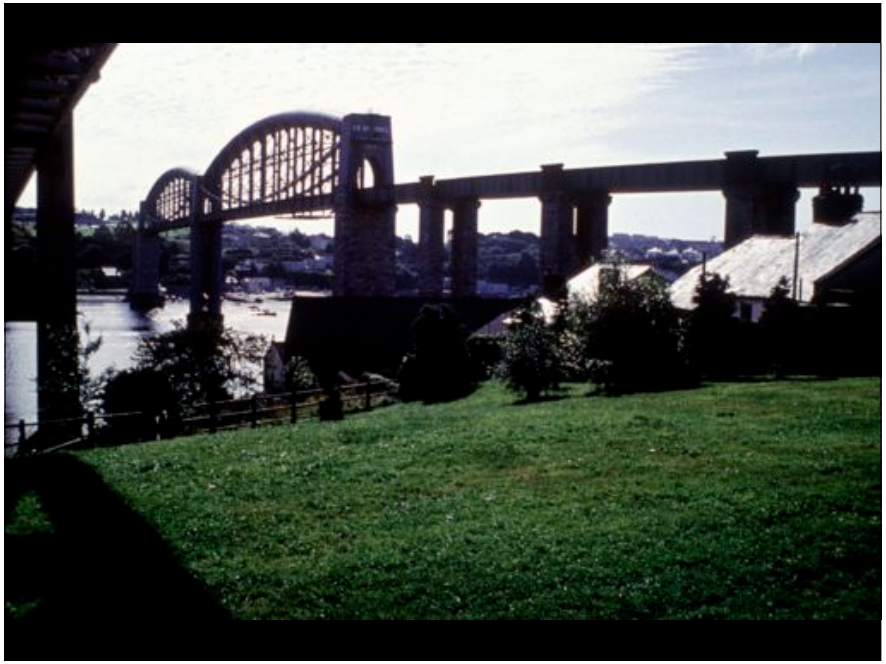


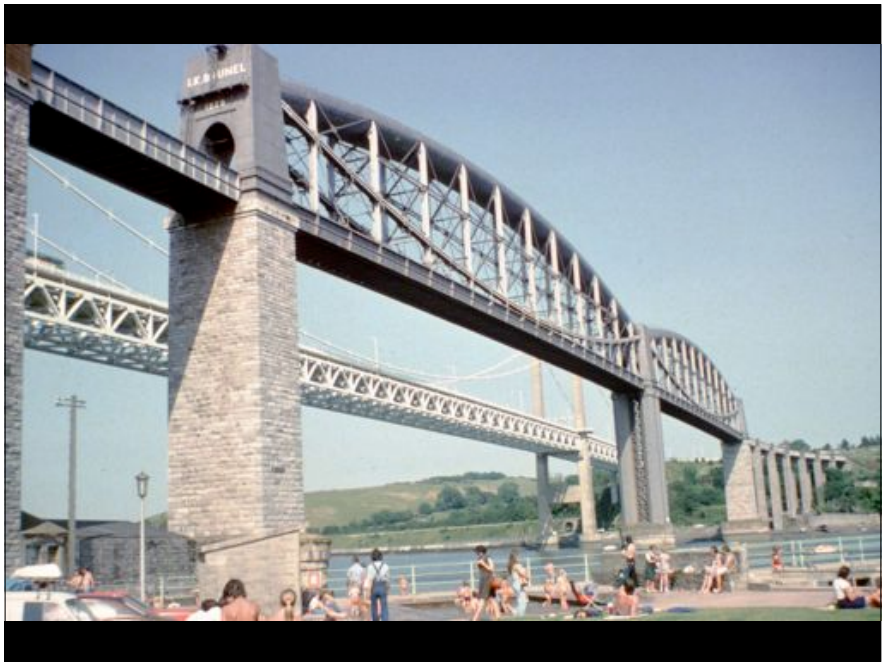


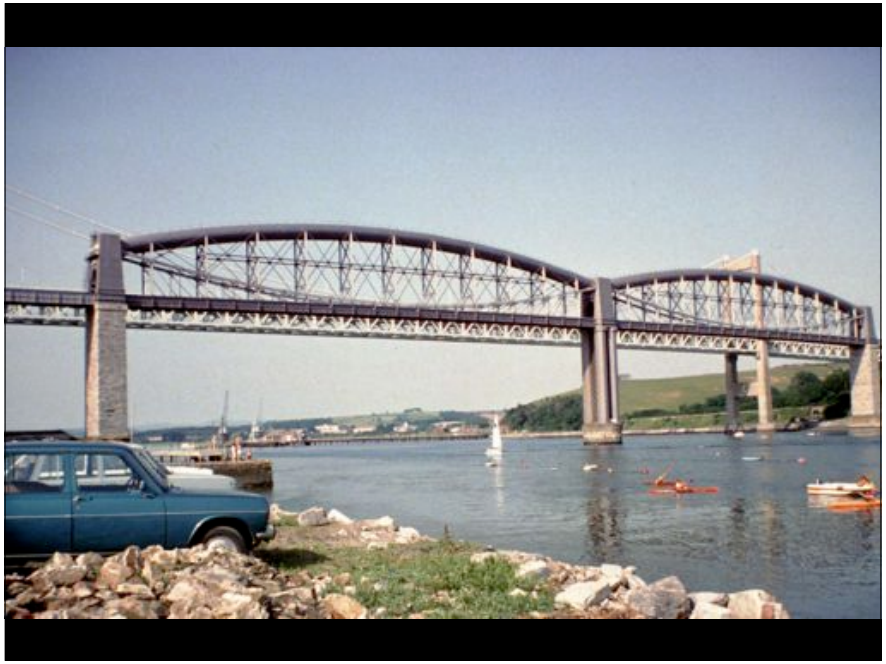
circa 1980's

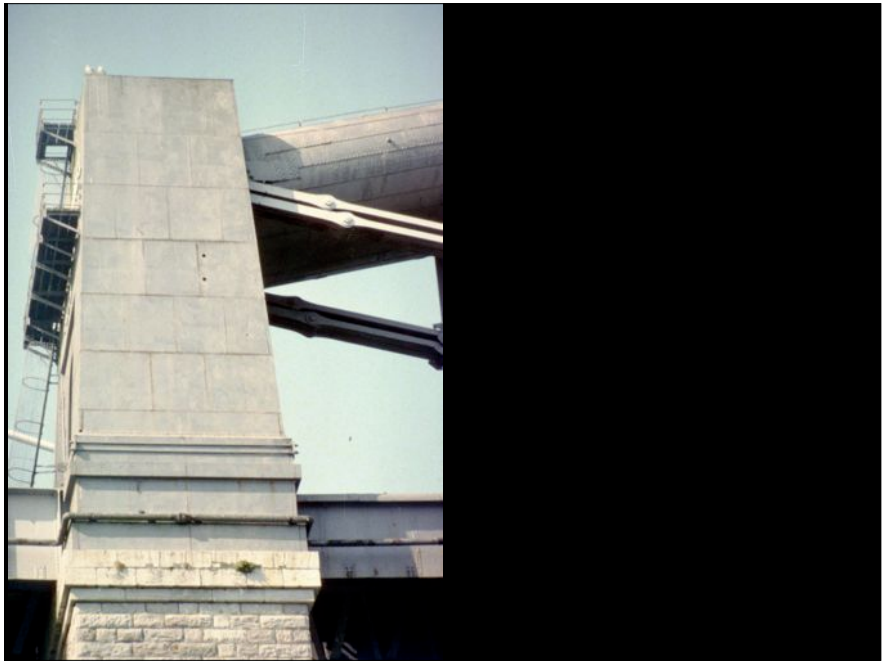
Brittania today

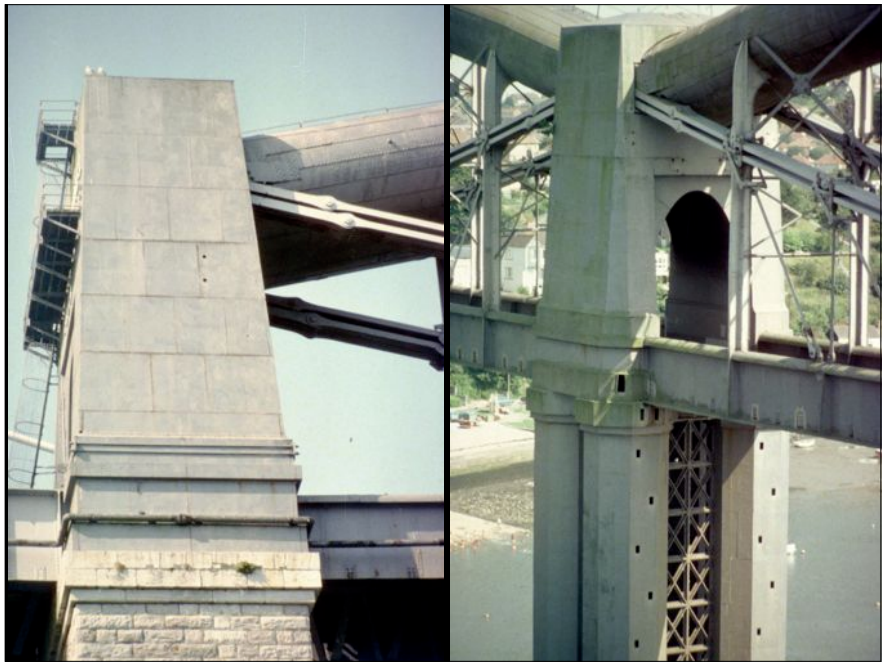
Saltash Bridge - Brunel - 1859 - 455 feet



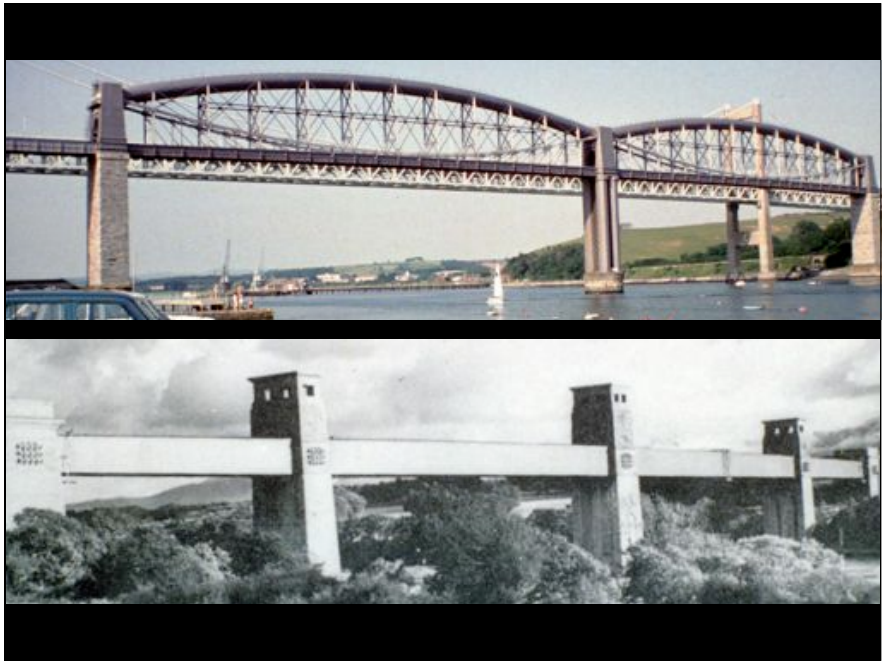




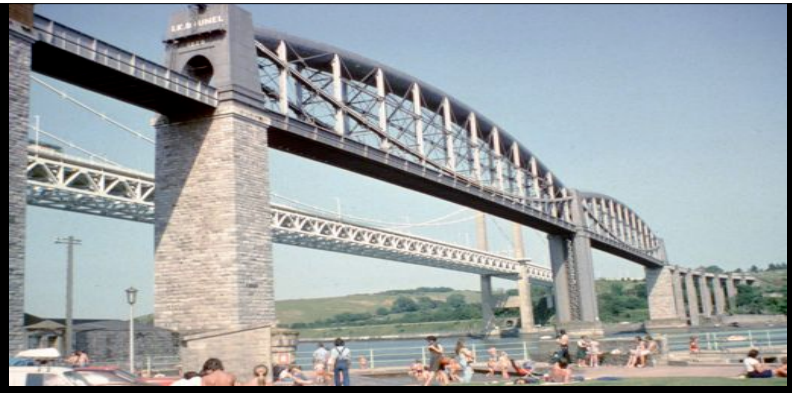





I.K.BRUNEL



	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


1980’s


2011

UMass announcements

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

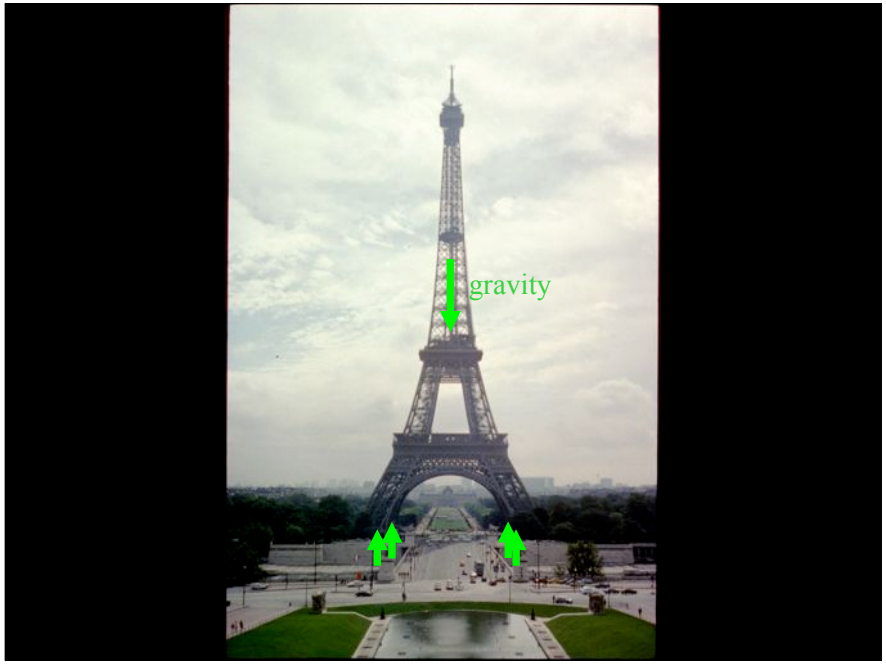
Eiffel Tower Structural Study

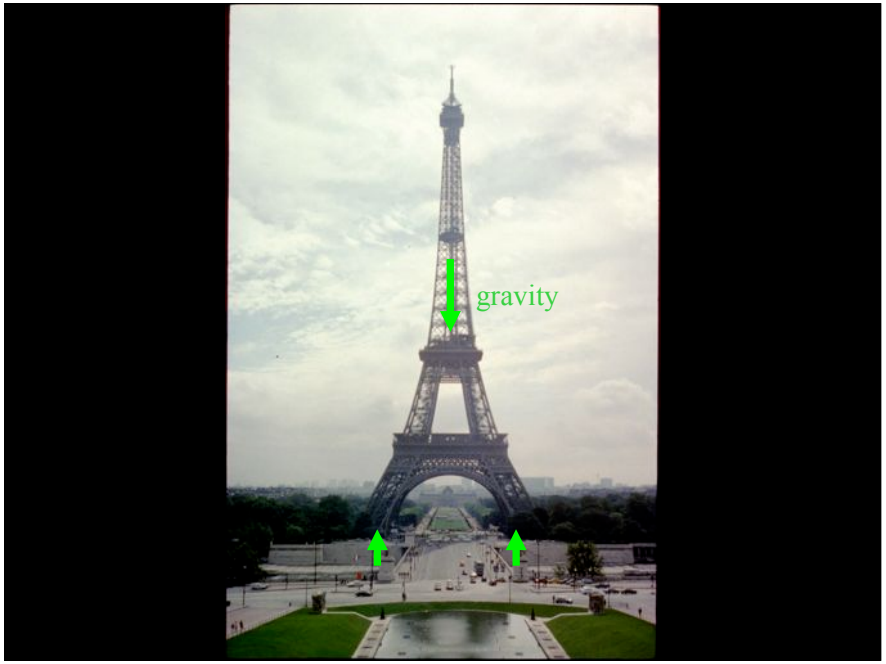
introduction to statics

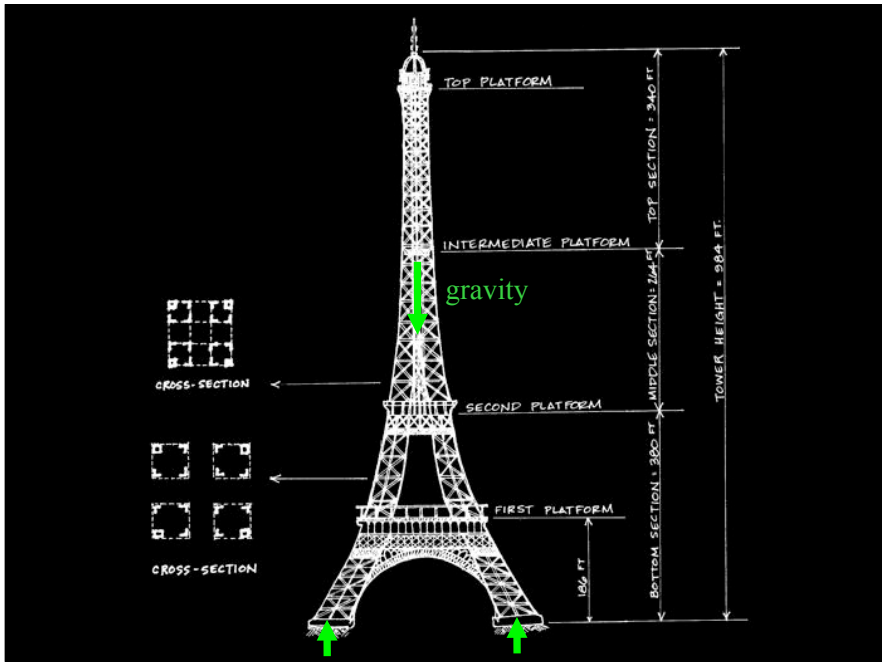
Tools and methods for structural analysis

Free body diagrams
Equilibrium
Load path

Free Body Diagrams



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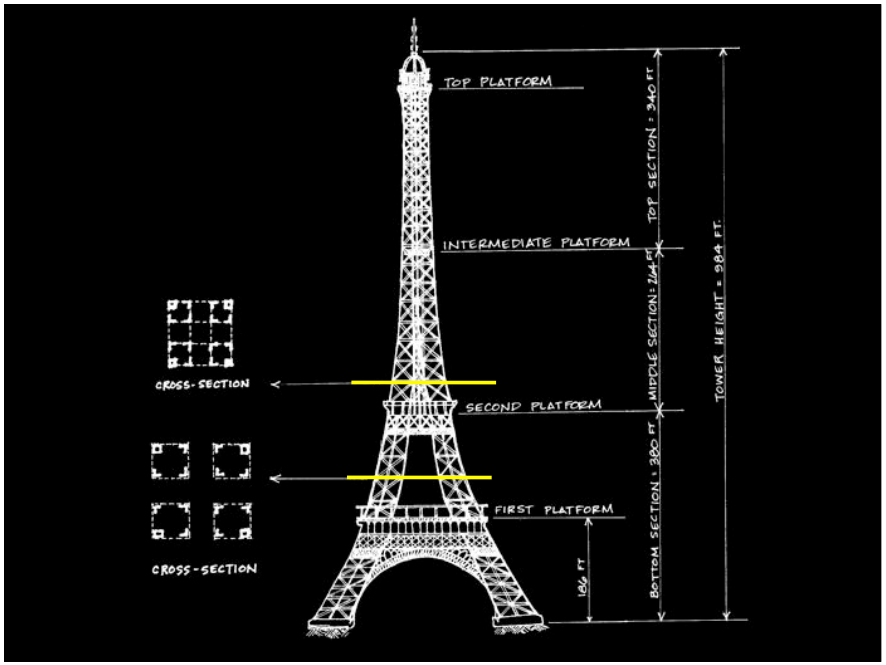
INTERMEDIATE PLATFORM
gravity
SECOND PLATFORM
FIRST PLATFORM
CROSS-SECTION
CROSS-SECTION
TOP SECTION = 340 FT.
MIDDLE SECTION = 104 FT.
BOTTOM SECTION = 380 FT.
TOWER HEIGHT = 984 FT.
186 FT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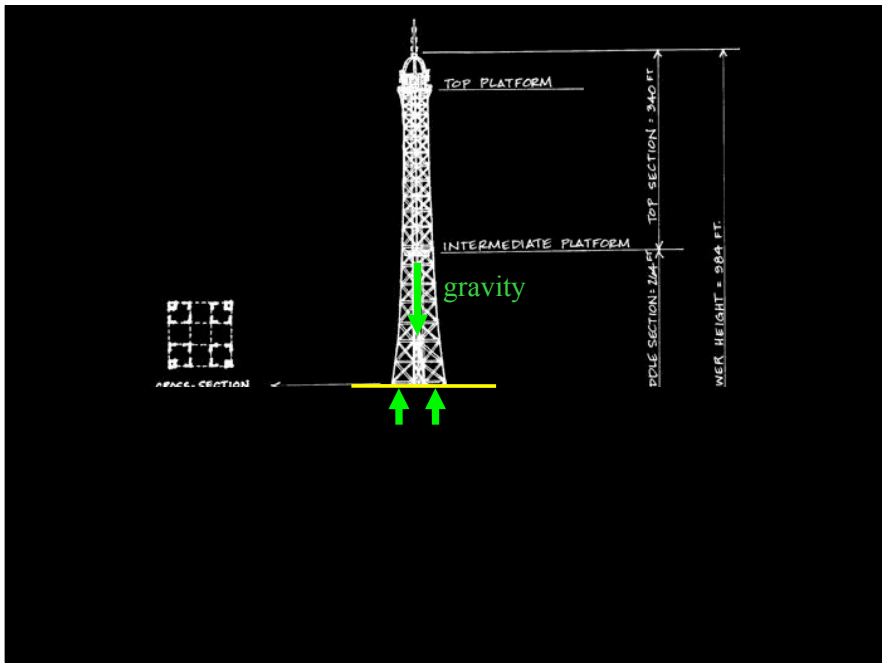
TOP PLATFORM
INTERMEDIATE PLATFORM
gravity
TOP SECTION = 340 FT.
MIDDLE SECTION = 104 FT.
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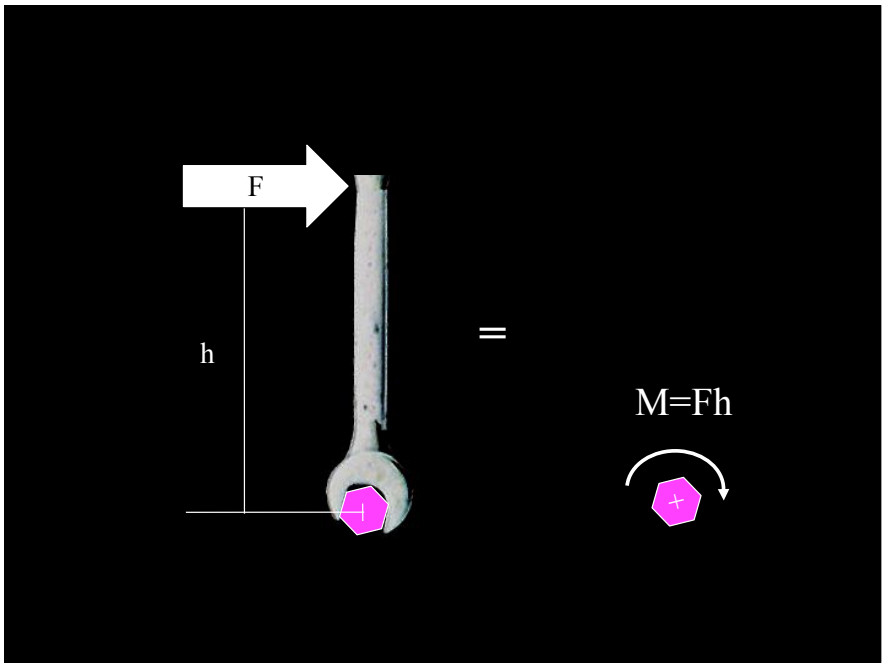
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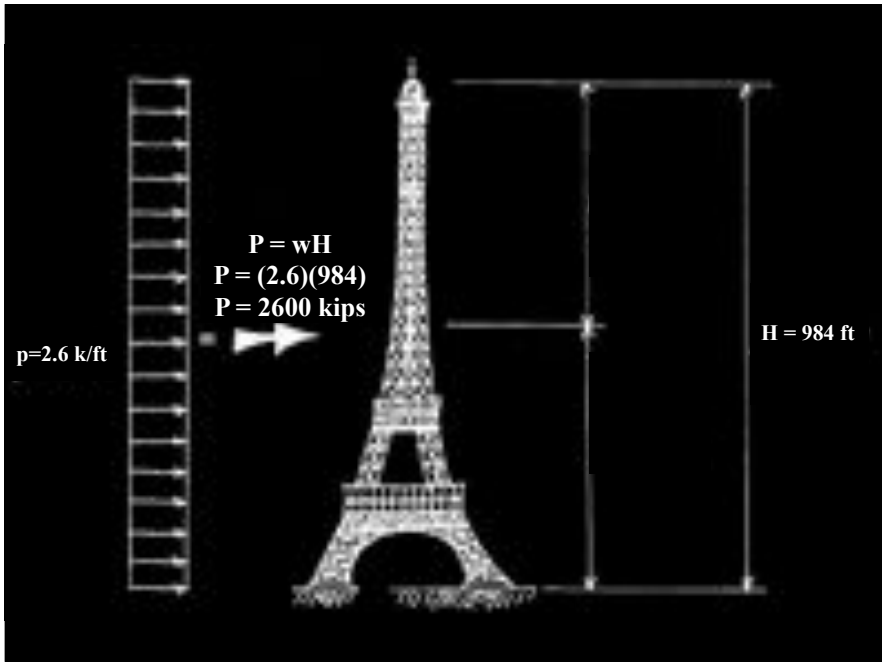
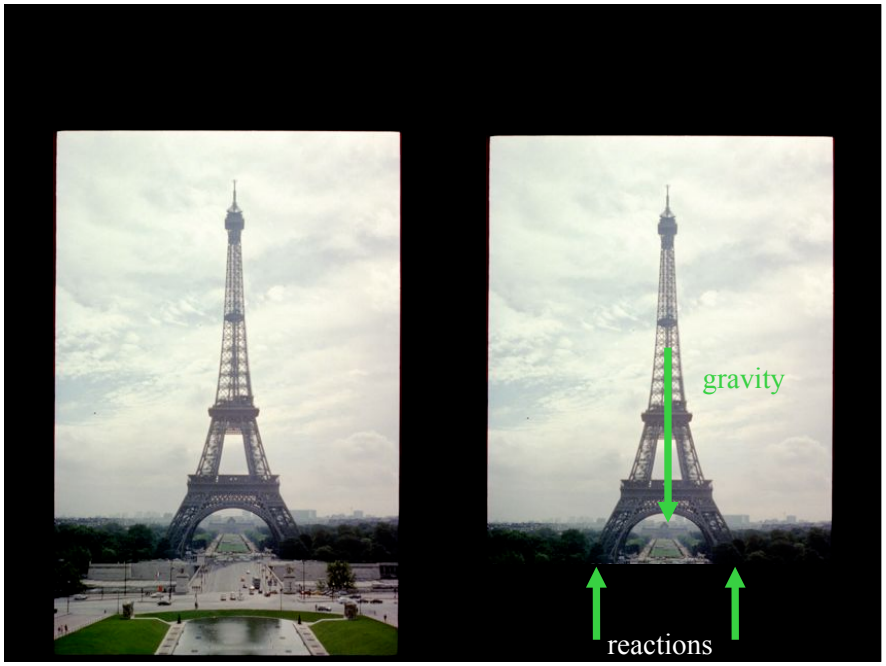

P = wH
P = (2.6)(984)
P = 2600 kips
p=2.6 k/ft
H = 984 ft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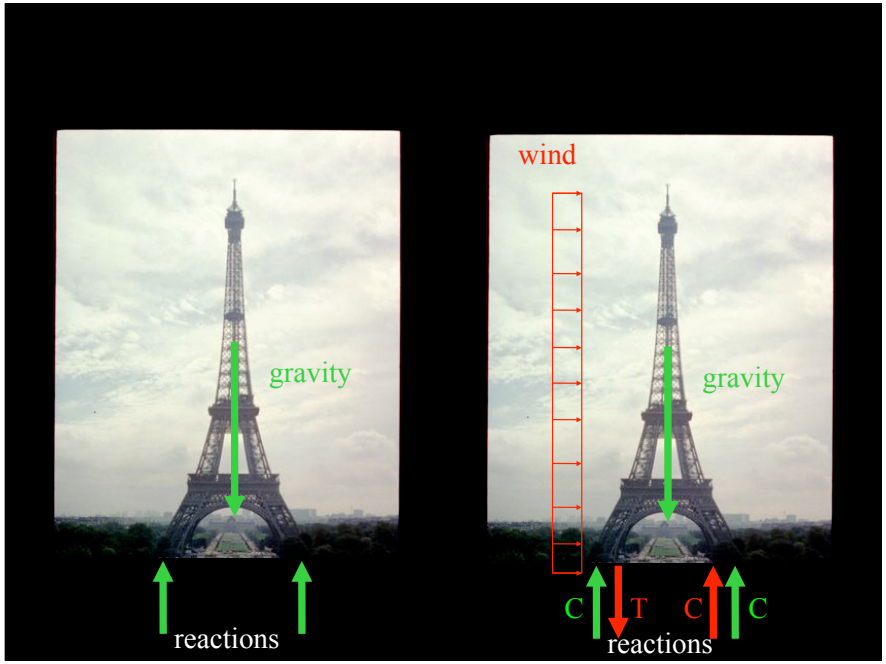
reactions


gravity
reactions
wind
gravity
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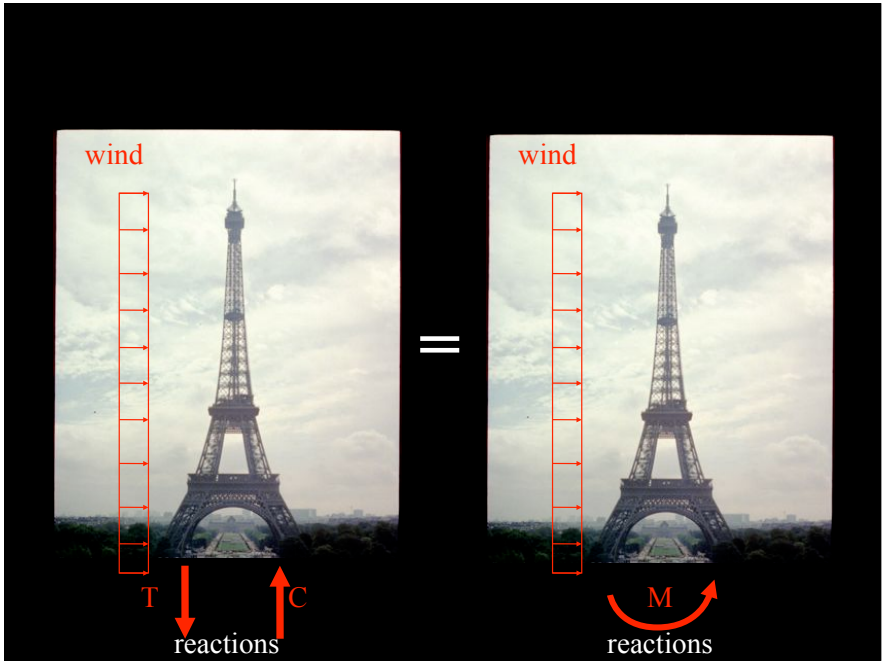
reactions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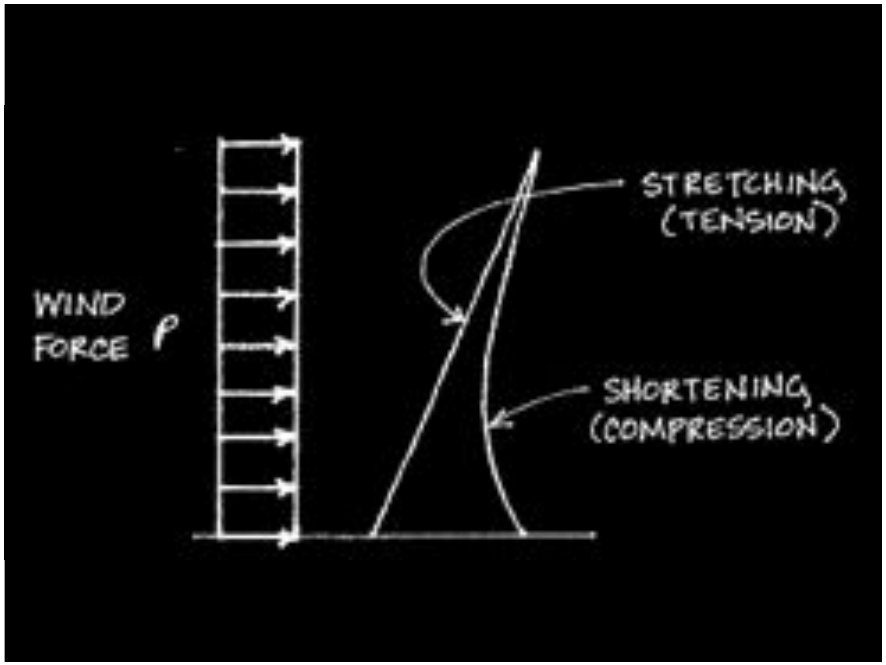
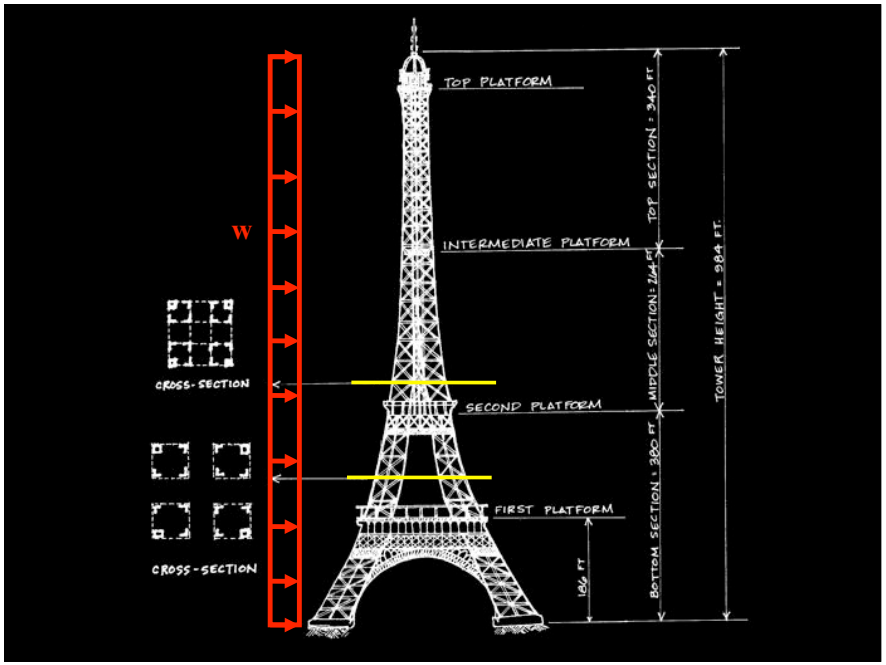

WIND
FORCE
p
STRETCHING
(TENSION)
SHORTENING
(COMPRESSION)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CROSS-SECTION
CROSS-SECTION
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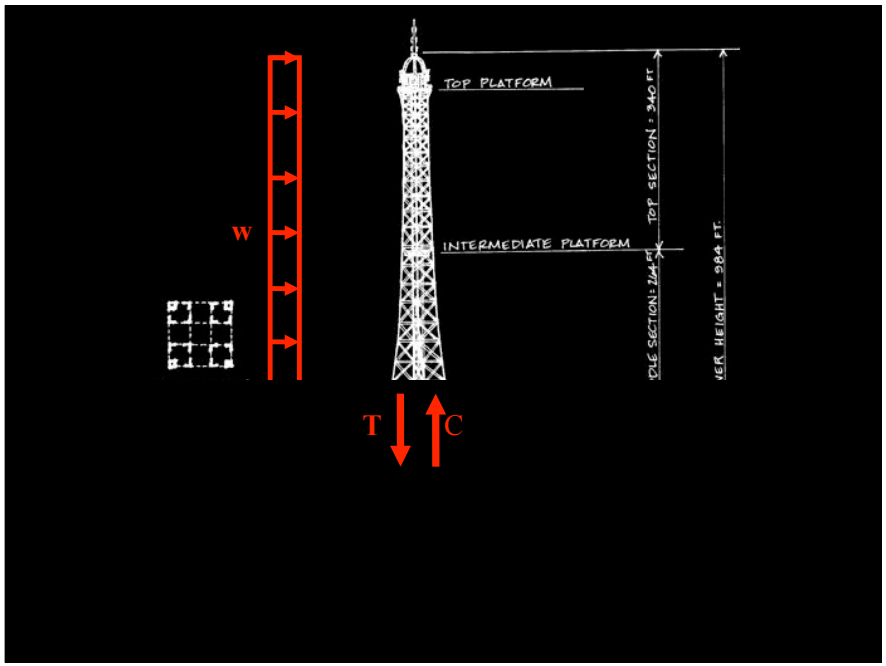
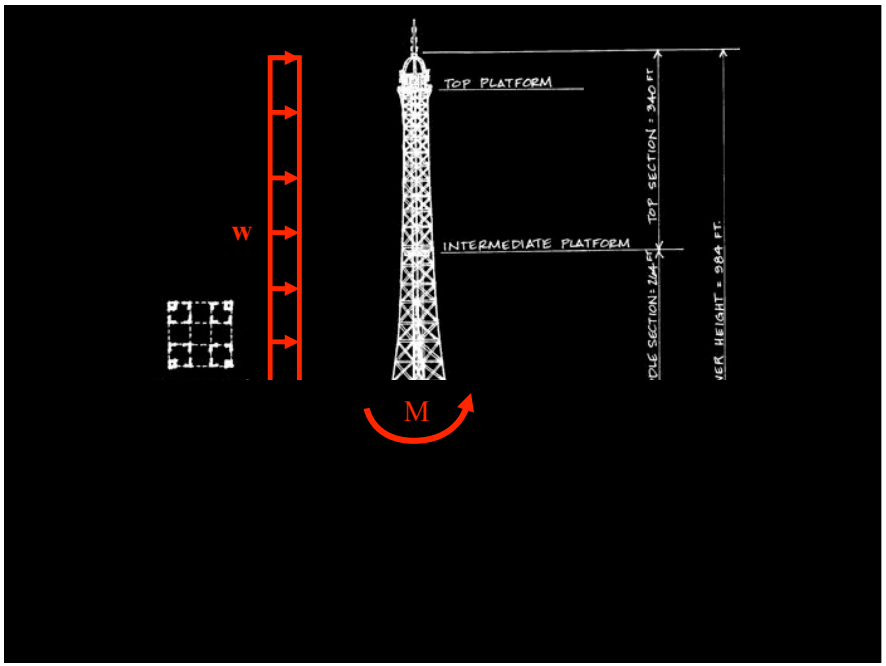
INTERMEDIATE PLATFORM
SECOND PLATFORM
FIRST PLATFORM
TOP SECTION = 340 FT.
MIDDLE SECTION: 194 FT.
BOTTOM SECTION: 380 FT
TOWER HEIGHT = 984 FT.
186 FT

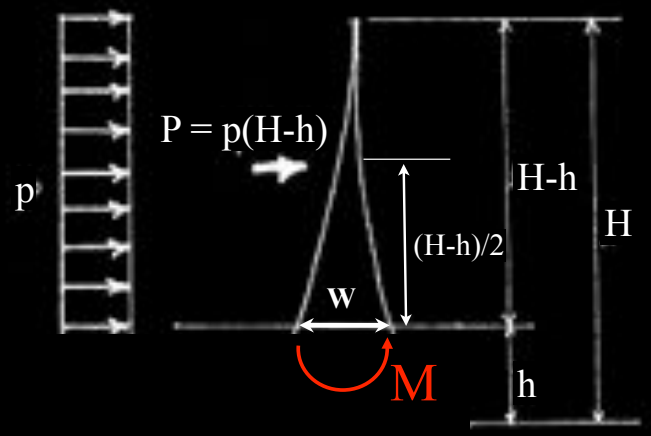

w
TOP PLATFORM
INTERMEDIATE PLATFORM
TOP SECTION = 340 FT.
DLE SECTION: 194 FT.
VER HEIGHT = 984 FT.
T
C


w
TOP PLATFORM
INTERMEDIATE PLATFORM
TOP SECTION = 340 FT.
DLE SECTION: 194 FT.
VER HEIGHT = 984 FT.
M

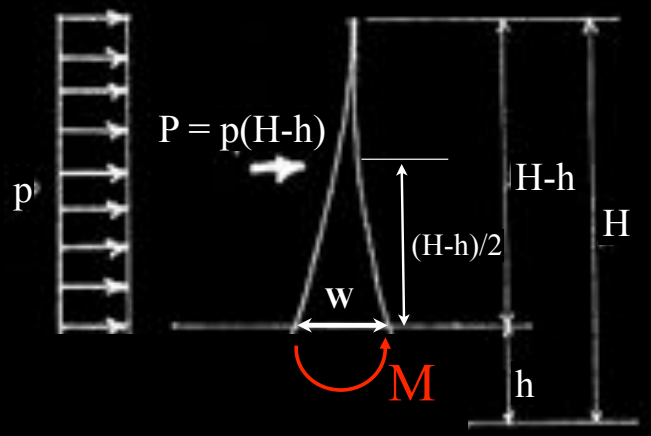
Civil Engineering Units

- 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

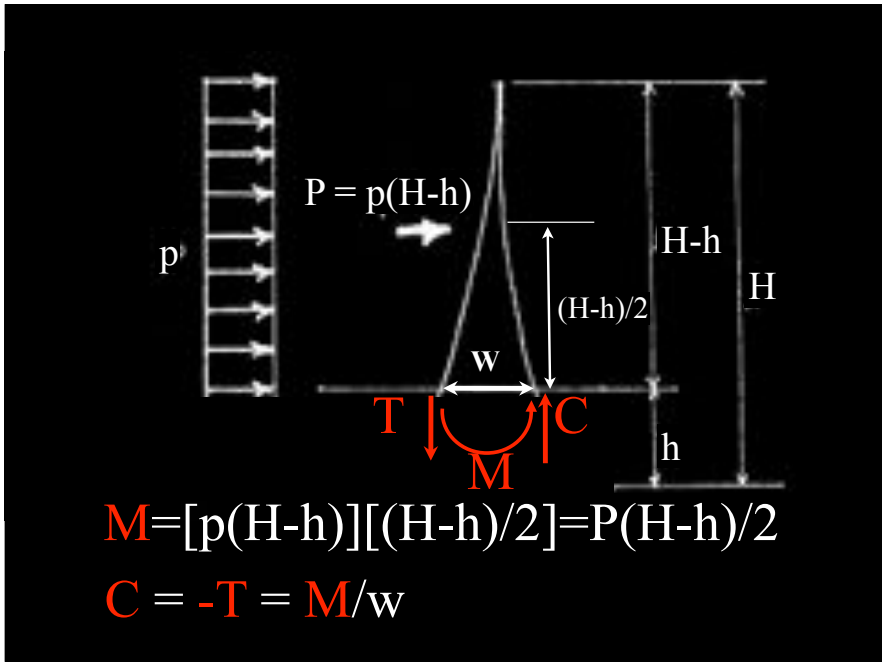


$\Sigma M_{section} = 0 \rightarrow M - p(H-h)(H-h)/2 = 0$



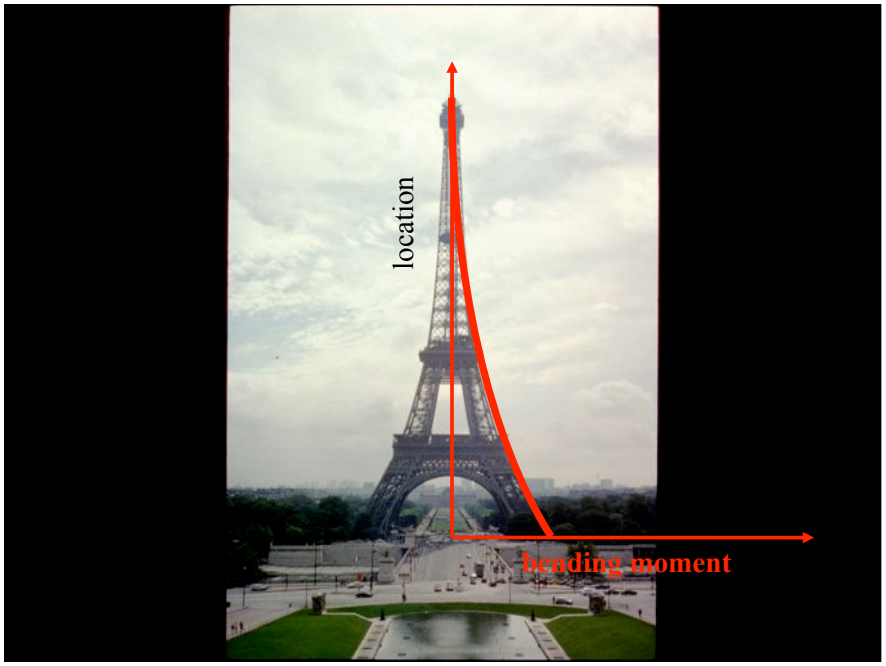
$\Sigma M_{section} = 0 \rightarrow M - p(H-h)(H-h)/2 = 0$

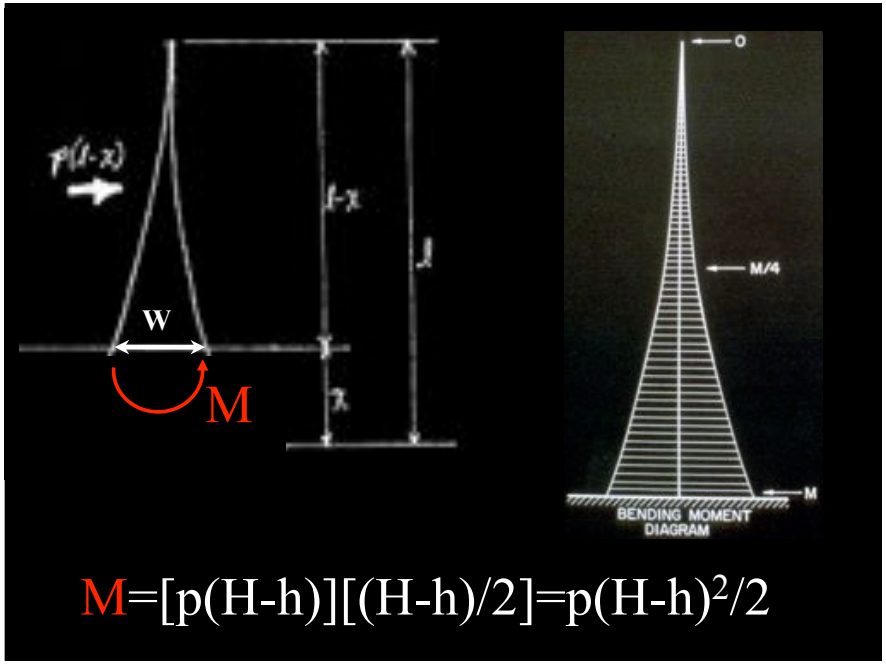
$M=[p(H-h)][(H-h)/2]=P(H-h)/2$



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

$C = -T = M/w$





$M=[p(H-h)][(H-h)/2]=p(H-h)^2/2$

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 of compression?

All forces or loads must eventually get to the ground.
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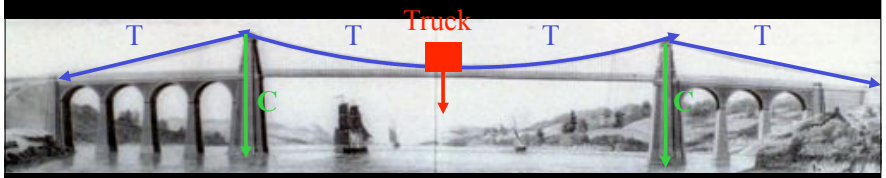

All forces or loads must eventually get to the ground.
Can we trace the path of tension of compression?