19th Century Iron Lenticular Truss Bridges from the Berlin Iron Bridge Company
(and Other Historic Bridges of Western Ma.)

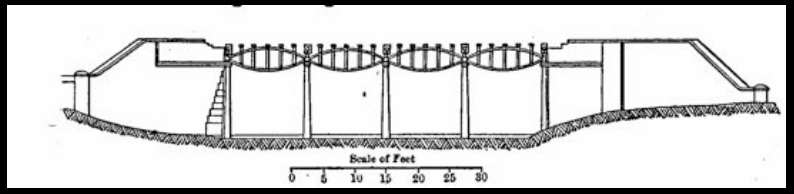
Dr. A. Lutenegger
Professor of Civil & Environmental Engineering
University of Massachusetts
Amherst, Ma

Form and forces in lenticular trusses
Marketing and mass production, The Berlin Company
Seeing the built environment

Pre-1878 Iron Lenticular Bridges

- R. Stephenson – 1824 Gaunless Bridge
- R. Stephenson – 1838 Kilsby Bridge
- Von Pauli – 1857 Isar Bridge
- Brunel – 1859 Saltash Bridge
- Gerber – 1860 Mainz Bridge
- Lohse – 1868 Hamburg Bridge

Gaunless Bridge

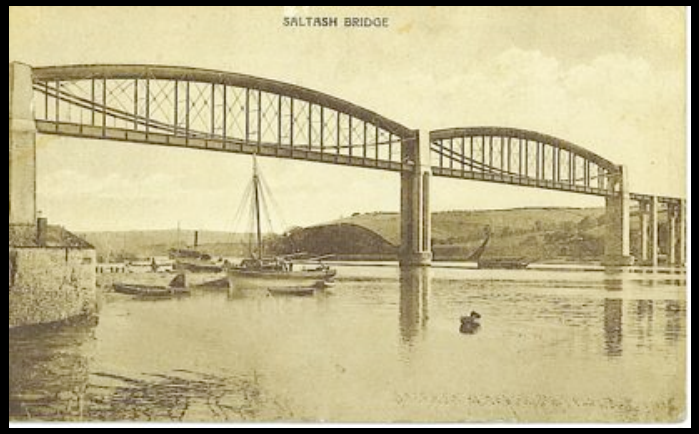


Gaunless Bridge

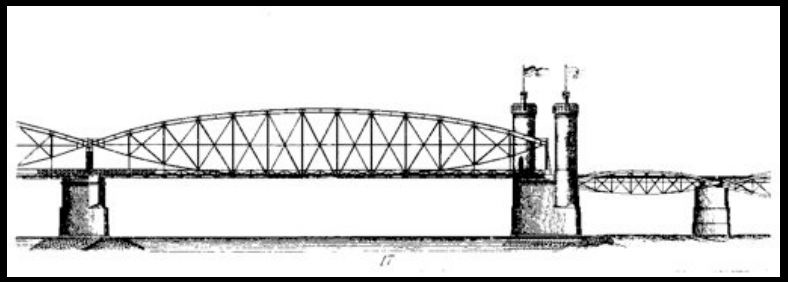
Gaunless Bridge

Brunel's Saltash Bridge

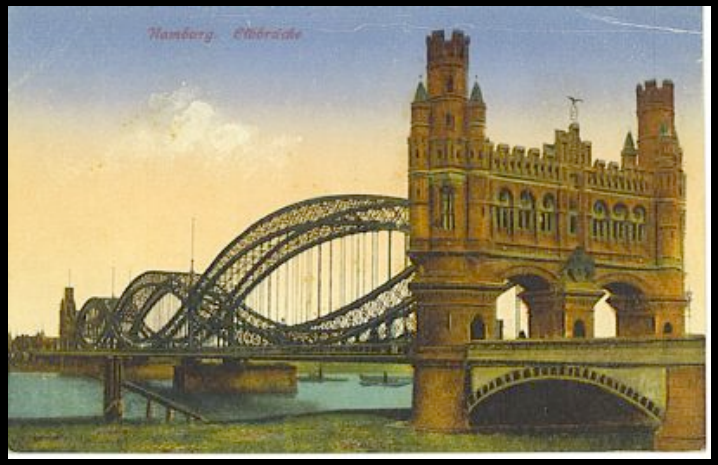
Brunel's Saltash Bridge



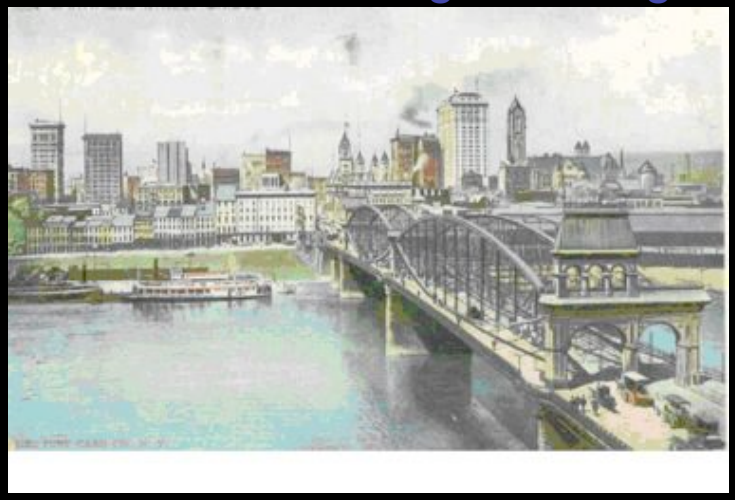
Mainz Bridge



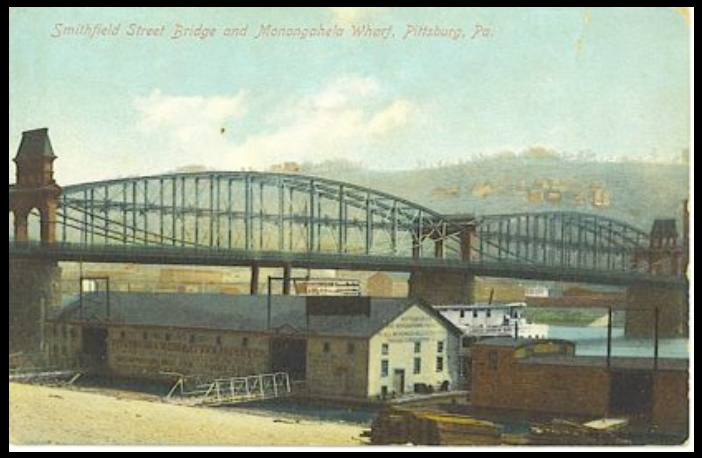
Hamburg Bridge



Lindenthal's Monongahela Bridge

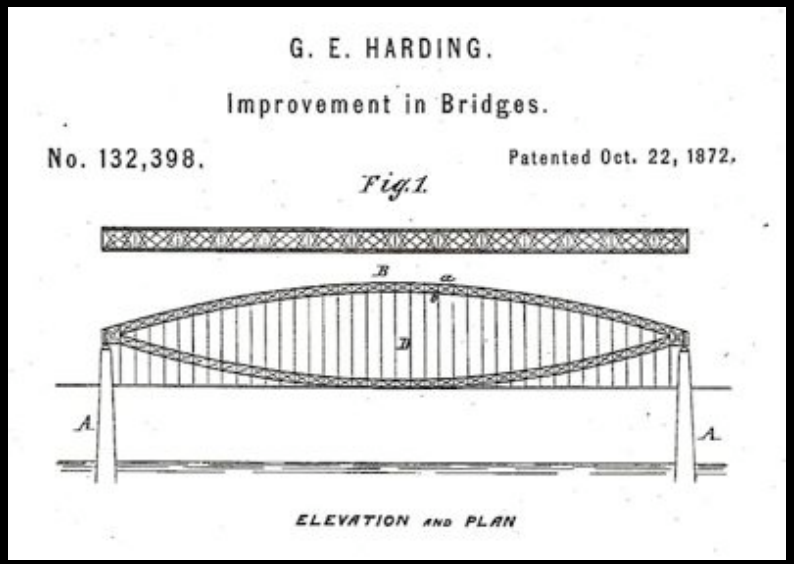


Monongahela Bridge



Patents Prior to 1878

- Barnes – 6,230 – 1849
- Stanley – 8,337 – 1851
- Hervey & Osborne – 13,461 – 1855
- Dieckmann – 113,030 – 1871
- Harding – 132,398 – 1972
- Eads – 142,381 – 1873


G. E. HARDING.

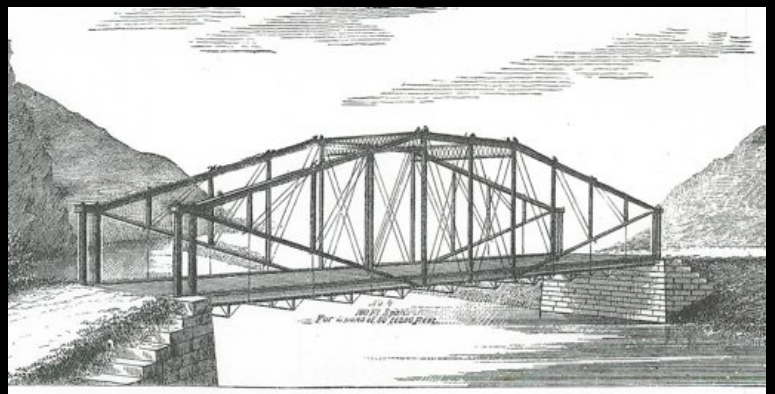
Improvement in Bridges.

No. 132,398. Patented Oct. 22, 1872.

Fig. 1.

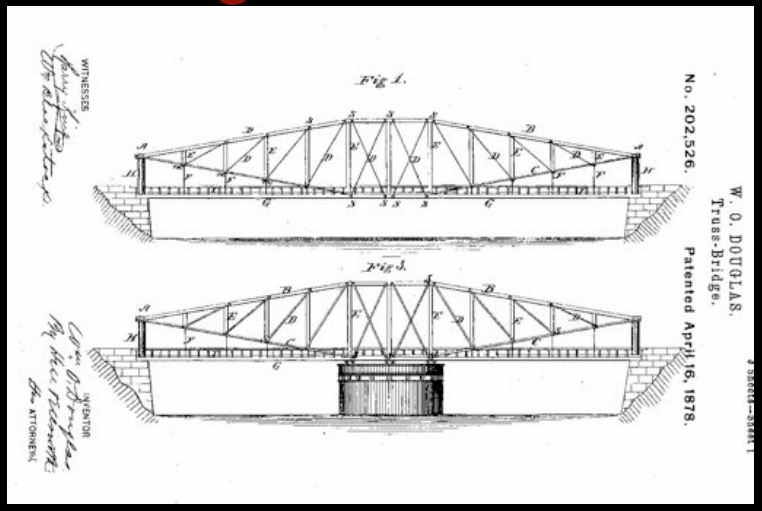
ELEVATION AND PLAN

Douglas 1877

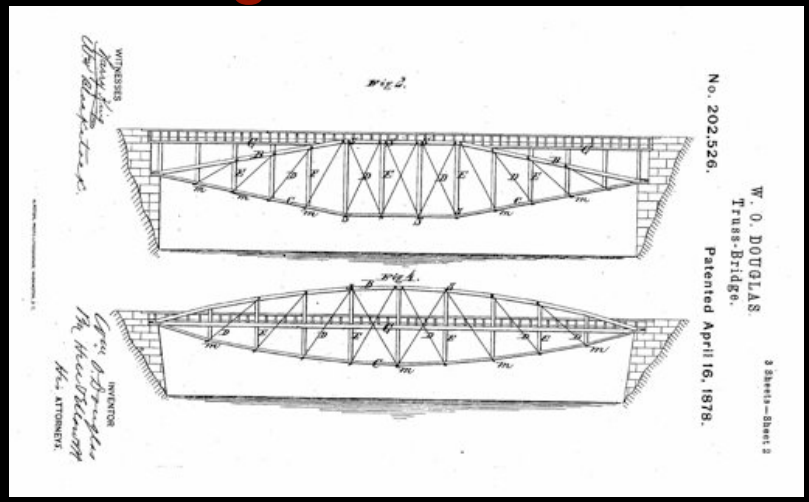


DESIGN FOR AN ELLIPTICAL TRUSS BRIDGE.

Douglas 1878 Patent



Douglas 1878 Patent



A TREATISE

ON THE

STRENGTH

OF

BRIDGES AND ROOFS,

WITH

PRACTICAL APPLICATIONS AND EXAMPLES,

FOR THE USE OF

ENGINEERS AND STUDENTS.

BY

SAMUEL H. SHREVE, A. M., Civ. Eng.

NEW YORK:
D. VAN NOSTRAND, PUBLISHER,
23 Murray St. and 27 Warren St.
1873.

CHAPTER X.

LENTICULAR TRUSSES.

214.—The form of this peculiar truss, known also as the Pauli System, is shown in the following figure:

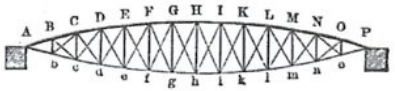
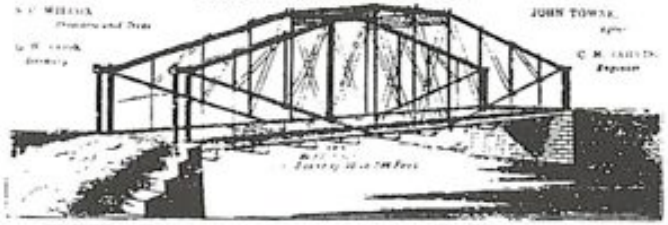


Fig. 81.

It is composed of two equal parabolic arcs for chords meeting at the ends, and braced with vertical and inclined braces. It is not capable of supporting any greater weight than a Bow String Truss of equal depth and length, and practically possesses many disadvantages.

THE CORRUGATED METAL CO.,

EAST BERLIN, CONN.



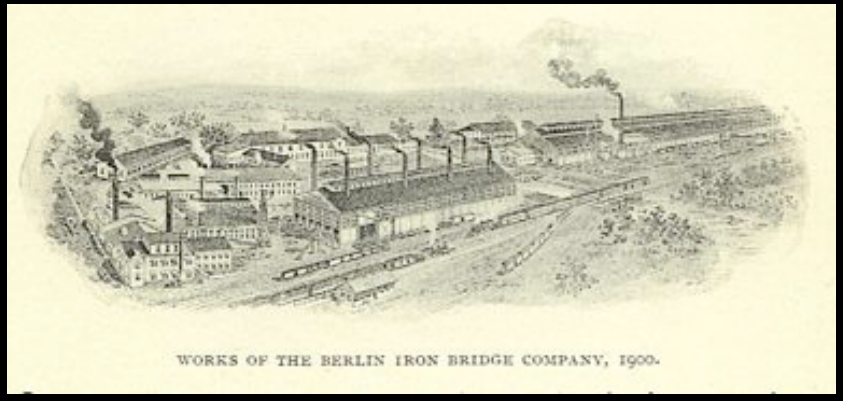
IRON BUILDERS.

Engineers and Contractors for Douglas Patent Wrought Iron Bridge.

ROOF TRUSSES, CORRUGATED IRON SHUTTERS, ROOFING, CEILING, SIDING,

And General Iron Construction.

WORKS OF THE BERLIN IRON BRIDGE COMPANY, 1878.



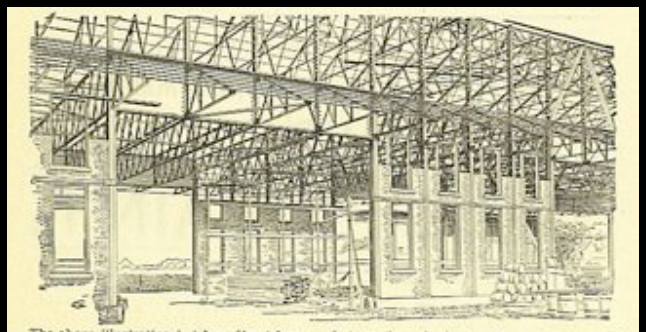
WORKS OF THE BERLIN IRON BRIDGE COMPANY, 1900.

The Driving Force

Send for Illustrated Catalogue.

CHAS. M. JARVIS,	BURR K. FIELD,	GEO. H. SAGE,	F. L. WILCOX,
Pres't and Chief Engineer.	Vice-Pres't.	Secretary.	Treasurer.

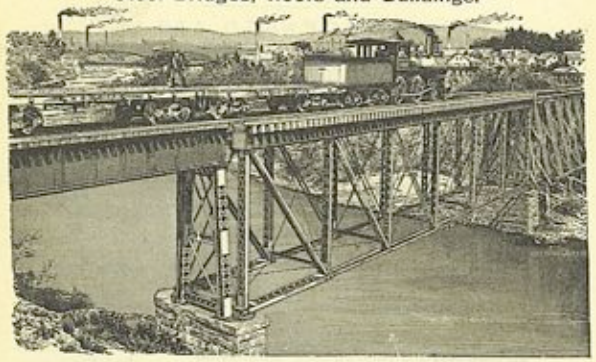
Office and Works: EAST BERLIN, CONN.



The above illustration is taken direct from a photograph made during the construction and shows the details of an Iron Building designed and built by us for the Newport News Ship-Building and Dry Dock Company, at Newport News, Va. The building is 60 ft. in width by 320 ft. in length, and is two stories high—the lower floor being used for a Ship Shed for punching, bending, riveting, etc., the upper floor being used as a Mold Loft. Outside of the building, extending entirely around it on all four sides, is an overhang 12 ft. wide, thus affording additional shop room outside of the building, where raw material may be stored and still protected from the weather. Wide openings are placed every 40 ft., so that raw material may be taken in, and finished product moved out, cheaply and quickly. The supporting frame is all iron throughout, and between the iron posts on the sides is a light brick wall.

THE BERLIN IRON BRIDGE CO.

Engineers, Architects and Builders of Iron and Steel Bridges, Roofs and Buildings.

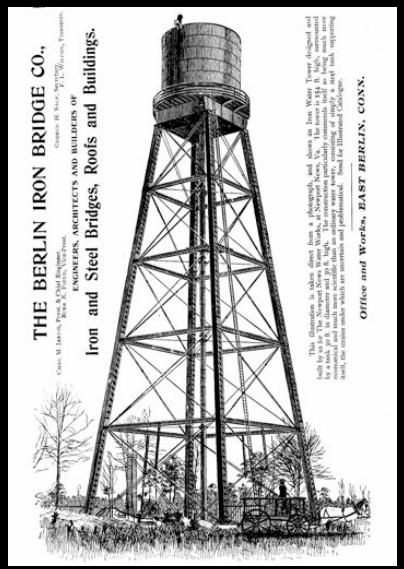


The above illustration is taken direct from a photograph of an Iron Truss and Plate Girder Bridge designed and built by us to carry the M. W. & C. R. R over the Naugatuck River at Waterbury, Conn.

THE BERLIN IRON BRIDGE CO.,

ENGINEERS, ARCHITECTS AND BUILDERS OF

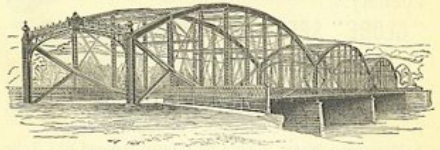
Iron and Steel Bridges, Roofs and Buildings.



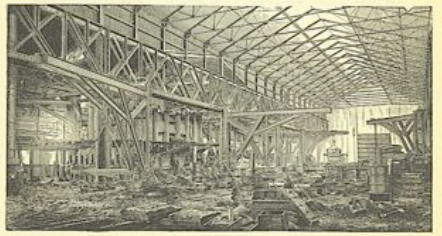
Office and Works, EAST BERLIN, CONN.

THE BERLIN IRON BRIDGE CO.

Engineers, Architects and Builders of Iron and Steel Bridges, Roofs and Buildings.

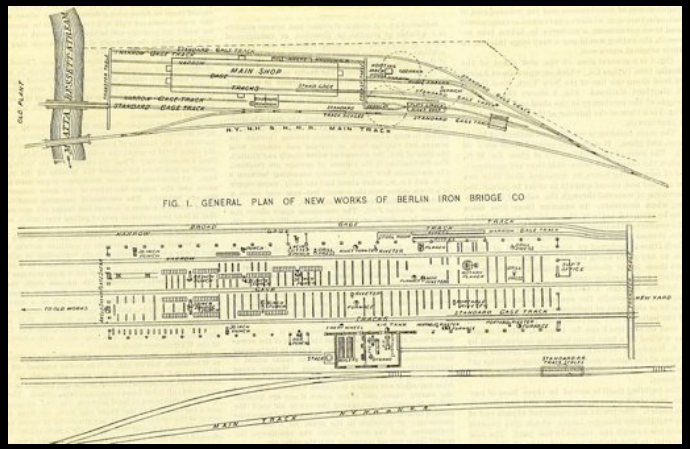


PARABOLIC TRUSS BRIDGE, AT BINGHAMTON, N. Y.



FOUNDRY BUILDING, FOR FARRELL FOUNDRY AND MACHINE CO., AT ANSONIA, CONN.

Layout of BIBCO Plant



Inside BIBCO Plant

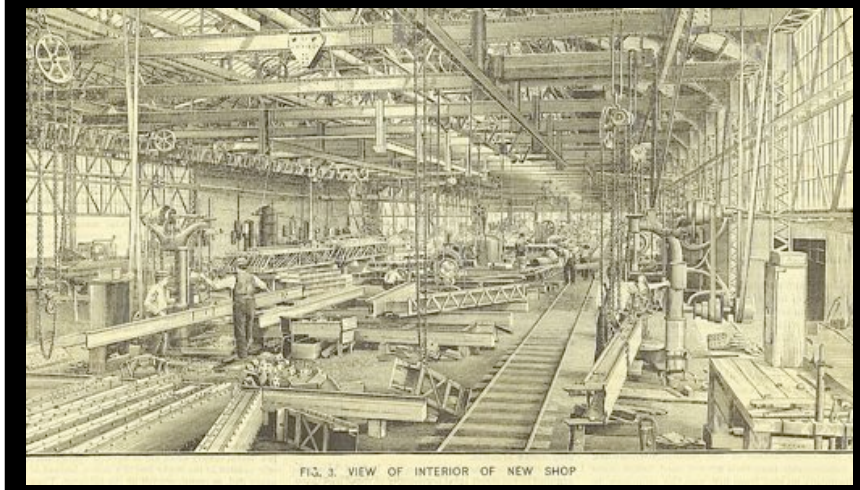
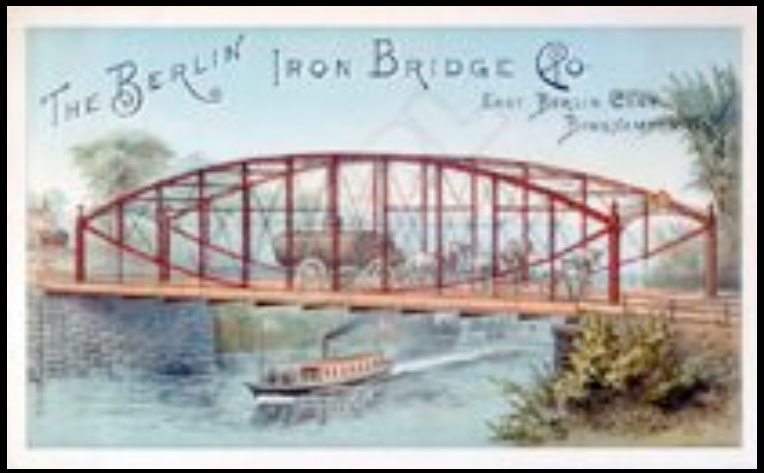
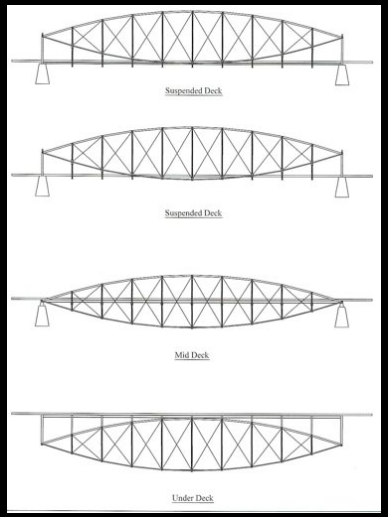


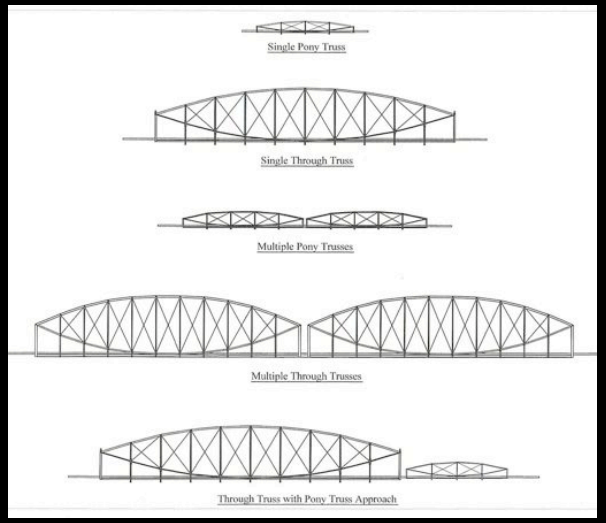
FIG. 3. VIEW OF INTERIOR OF NEW SHOP

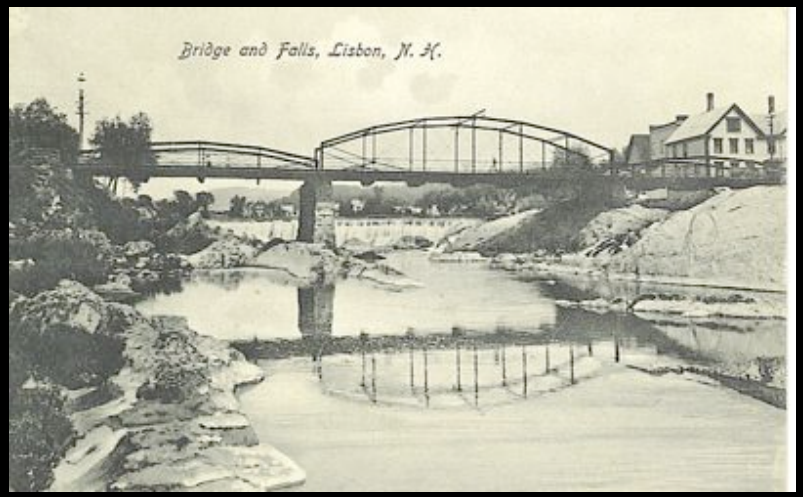


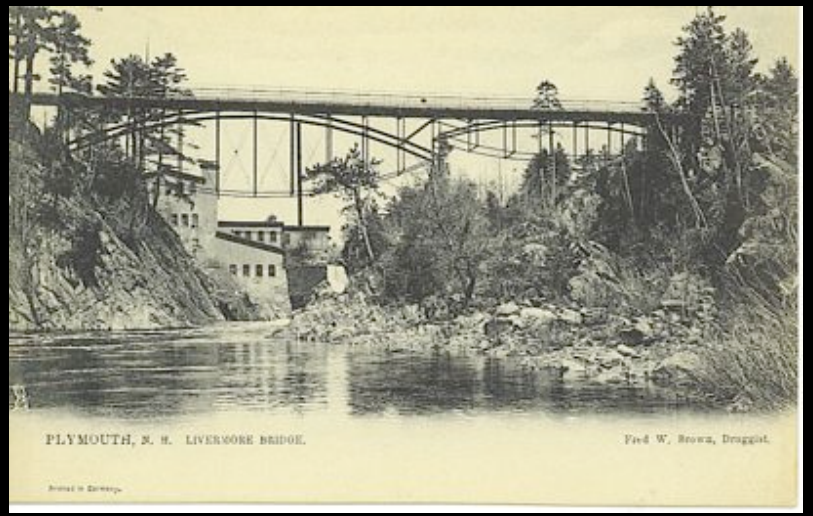
Styles of Lenticular Bridges



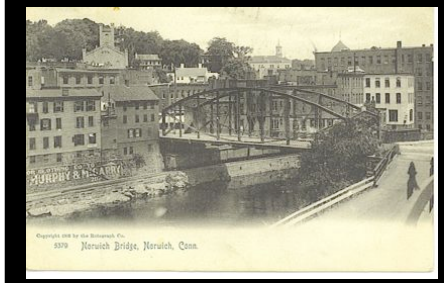
Configurations of Bridges

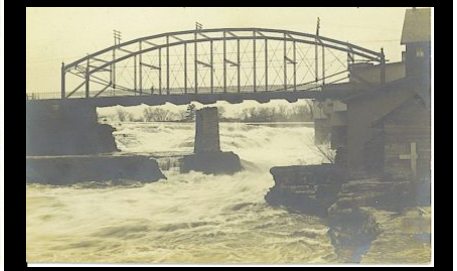


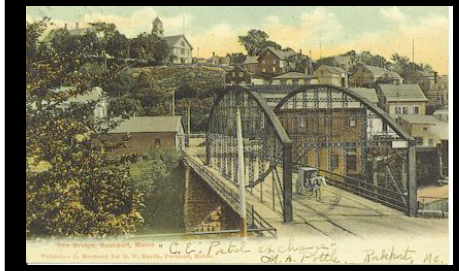


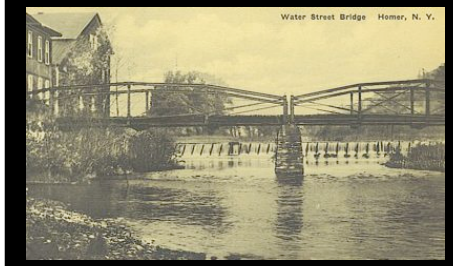


- Through Truss Bridges
- Pony Truss Bridges







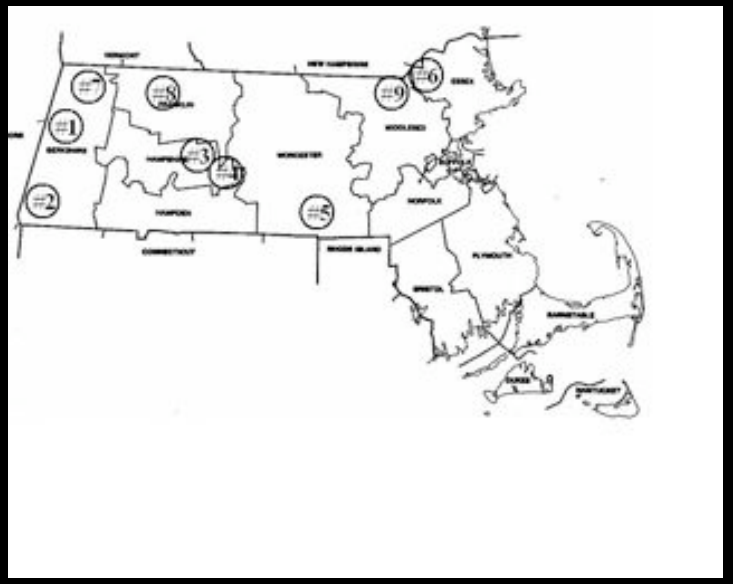


The Success of BIBCO Bridges

- From 1879 to 1900 over 600 Lenticular Bridge Structures Built
- Aggressive Marketing
- Modular Design & Construction
- Mass Production of Components
- Rapid Construction Schedule

About 55 Extant Bridges

- Massachusetts
- Connecticut
- New Hampshire
- Vermont
- Rhode Island
- New York
- Pennsylvania
- New Jersey
- Texas




5.4.2003


WEIGHT
LIMIT
5T
8T
13T

What's the Current Status of BIBCO Lenticular Brides?

1. Some bridges have been refurbished.
2. Some bridges are waiting for refurbishment.
3. Some bridges are waiting for discovery.

Bardwell's Ferry Bridge, Shelburne, Ma.

Rhule Road. Malta, N.Y.

Depot Rd. Bridge, Colchester, N.H.

Sheffield St. Waterbury, Ct.

Candor, N.Y.

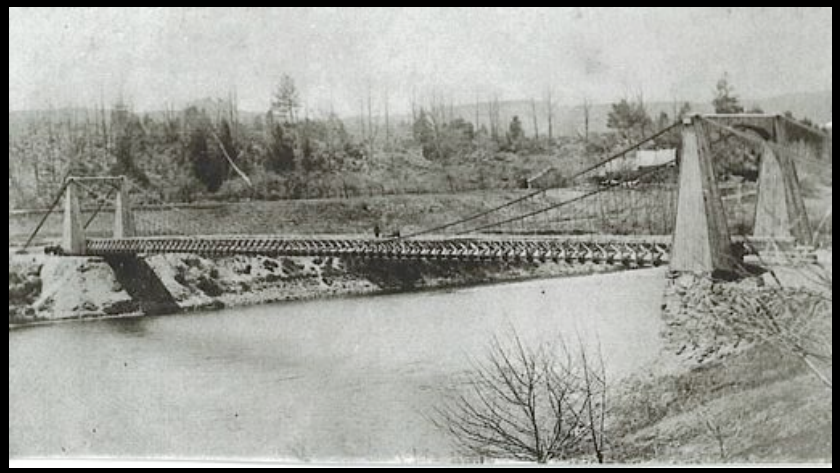
Melrose Rd. E. Windsor, Ct.

2007 Lenticular Truss Bridge

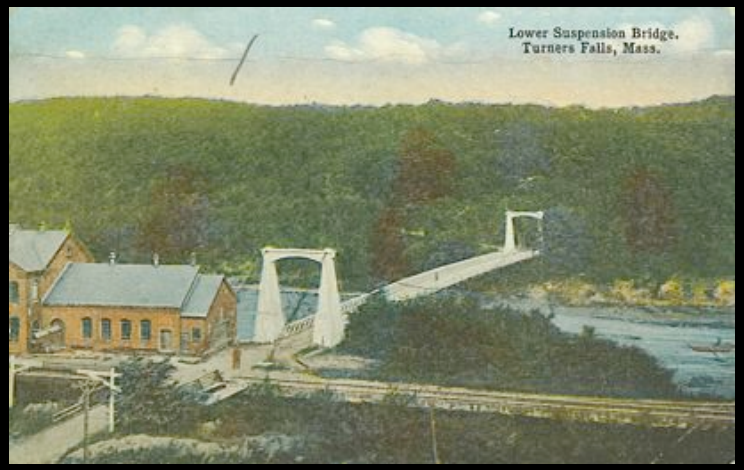
Other Historic Bridges of Western Ma.

- Suspension Bridges
- Iron Truss Bridges
- Steel Arch Bridges
- Concrete Arch Bridges

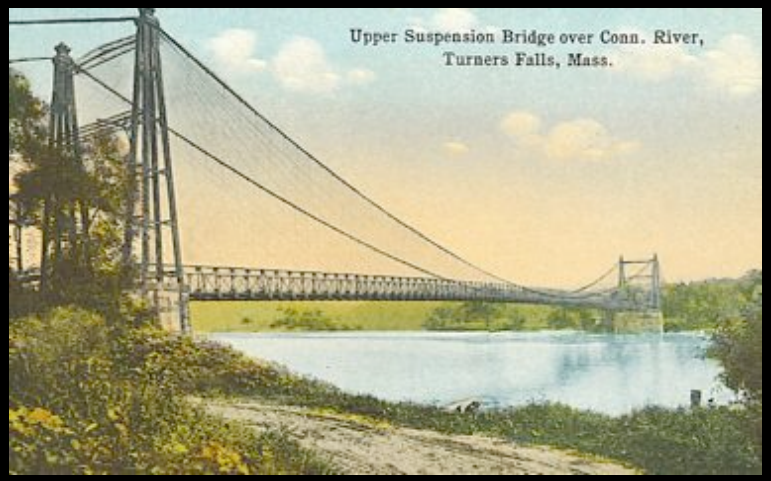
Stillwater Bridge – Deerfield 1870

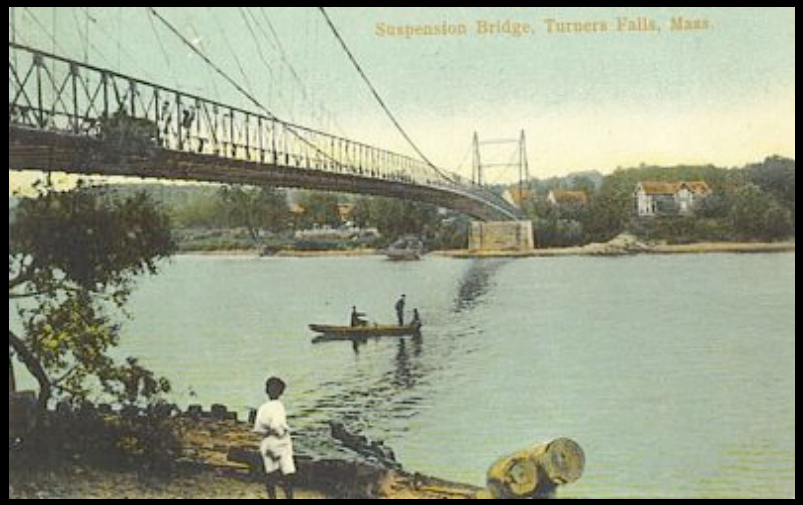


Lower Bridge – Turner's Falls 1872

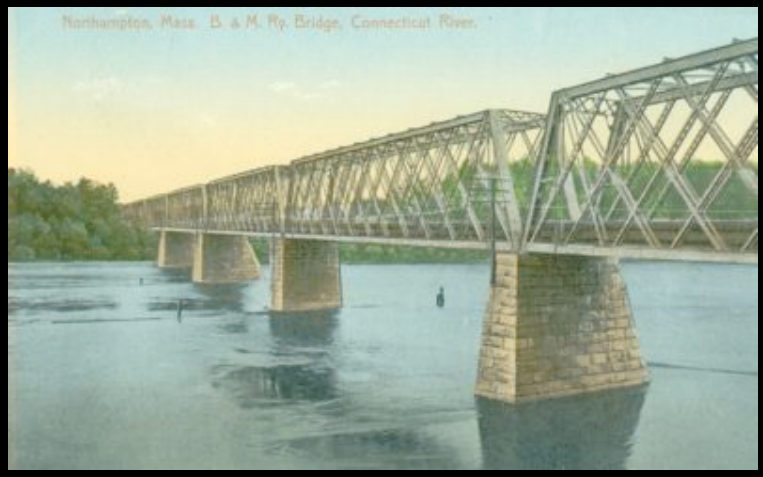


Upper Bridge – Turner's Falls - 1878





B & M Connecticut River Bridge - Hadley 1887



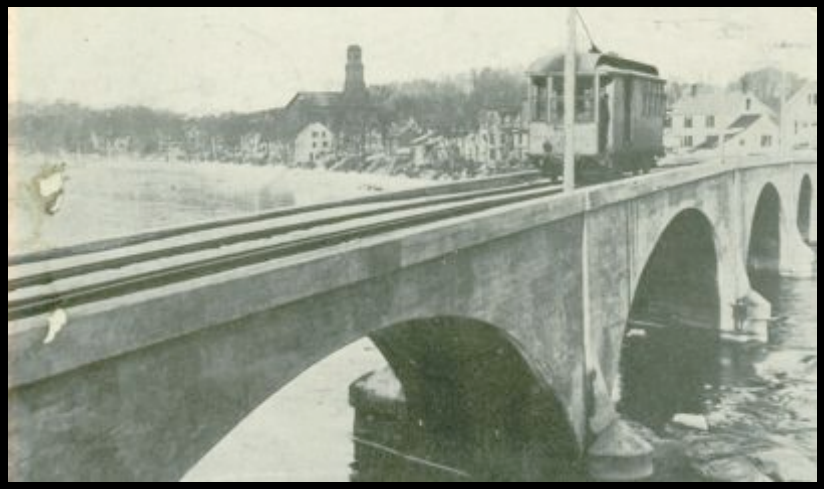
Clement Street Bridge – Northampton 1894

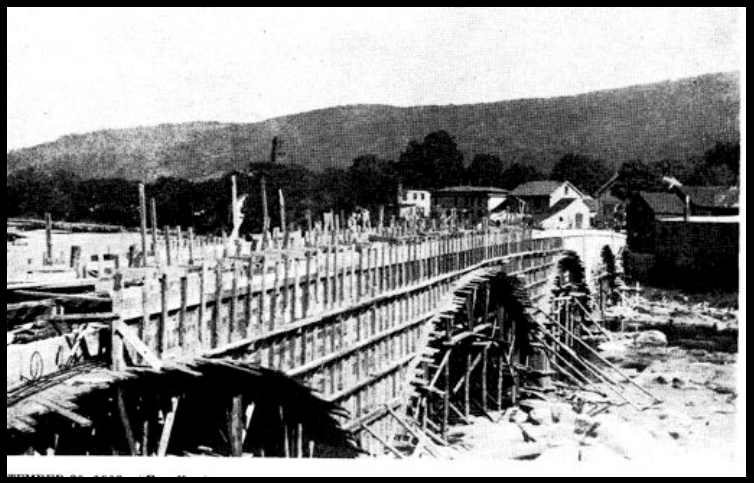
Hotel Street Bridge – Florence

Bridge of Flowers and Main Street Bridges - Shelburne

Main Street Bridge

Bridge of Flowers





French King Bridge – Irving Steel Deck Arch Bridge 1932

Farley Rd. Bridge – Erving
(Phoenix Bridge Co.)

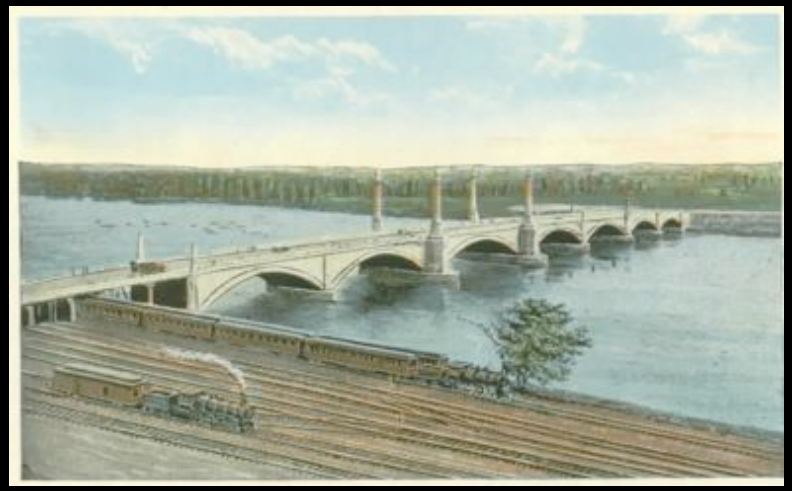
Shattuckville Rd. Bridge

East Mineral Road Bridge – Montague
1888

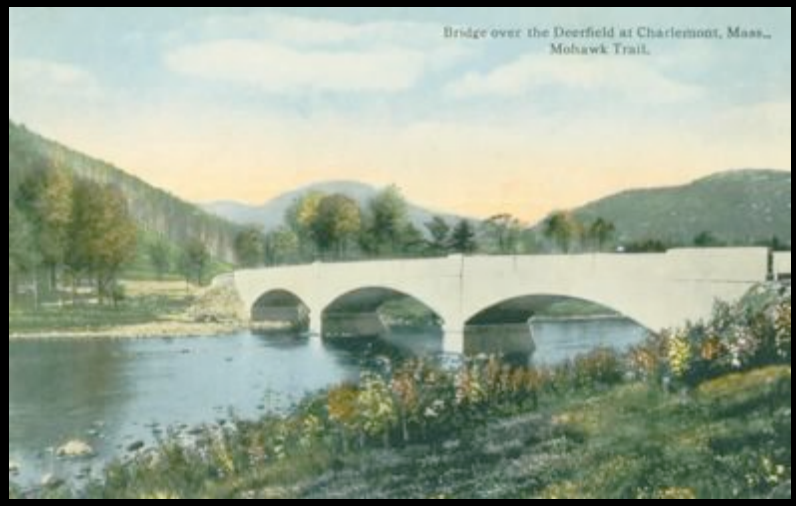
11th Street Bridge – Double Intersecting Warren Truss 1915

Adamsville Rd. Bridge - Colrain

Ct. River Bridge - Springfield

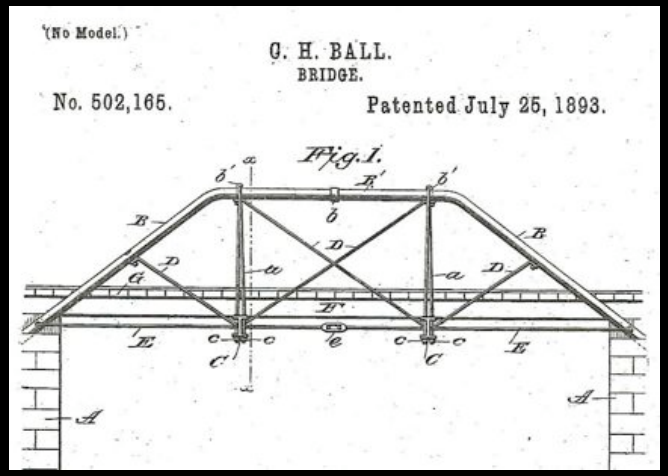


Rt. 2 Bridge - Zoar



1st Avenue Bridge – Turner's Falls

Ball Pipe Bridges



(No Model.)

C. H. BALL.

BRIDGE.

No. 502,165. Patented July 25, 1893.

Fig. 1.

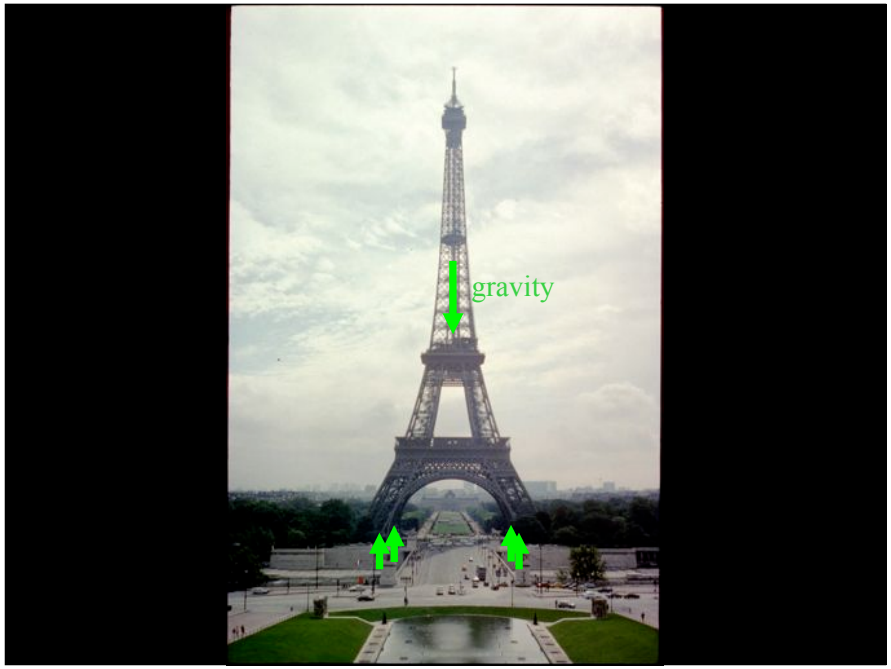
Eiffel Tower Structural Study

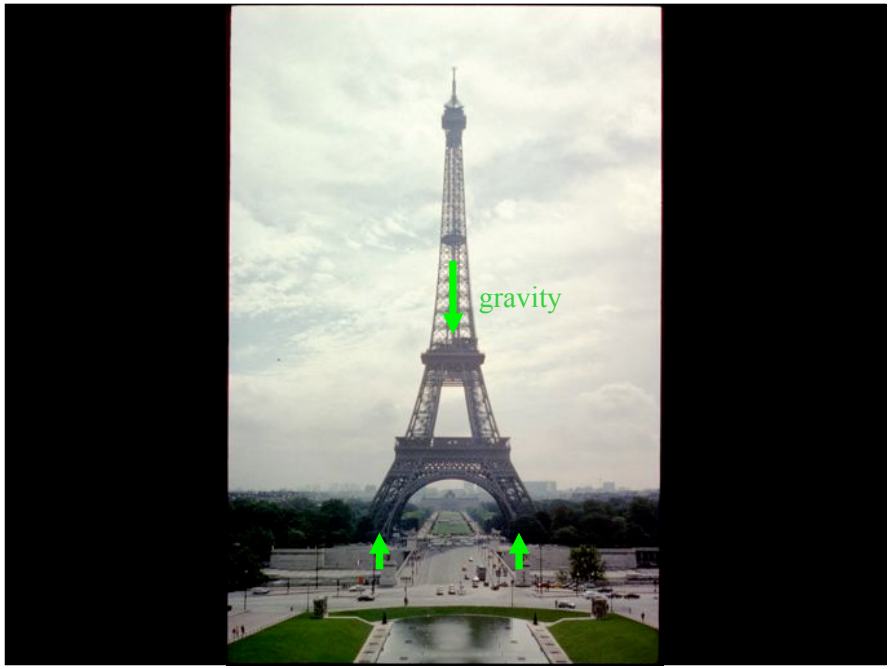
introduction to statics

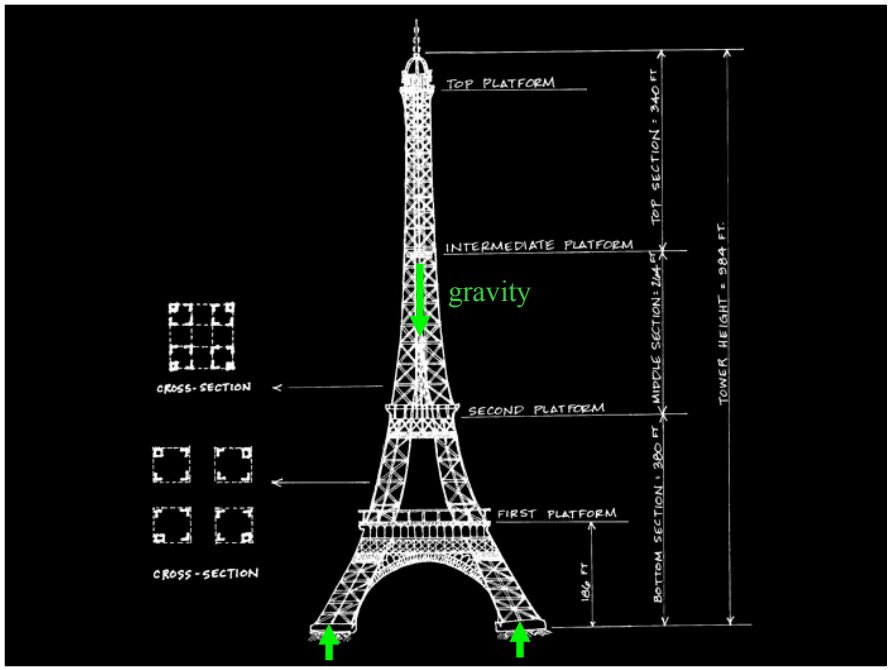
Tools and methods for structural analysis

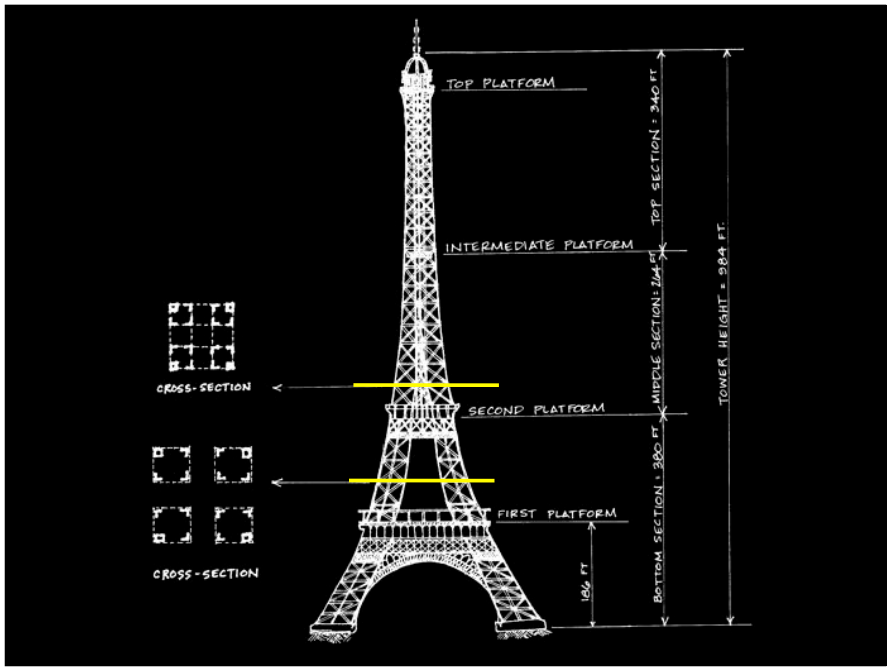
Free body diagrams
Equilibrium
Load path

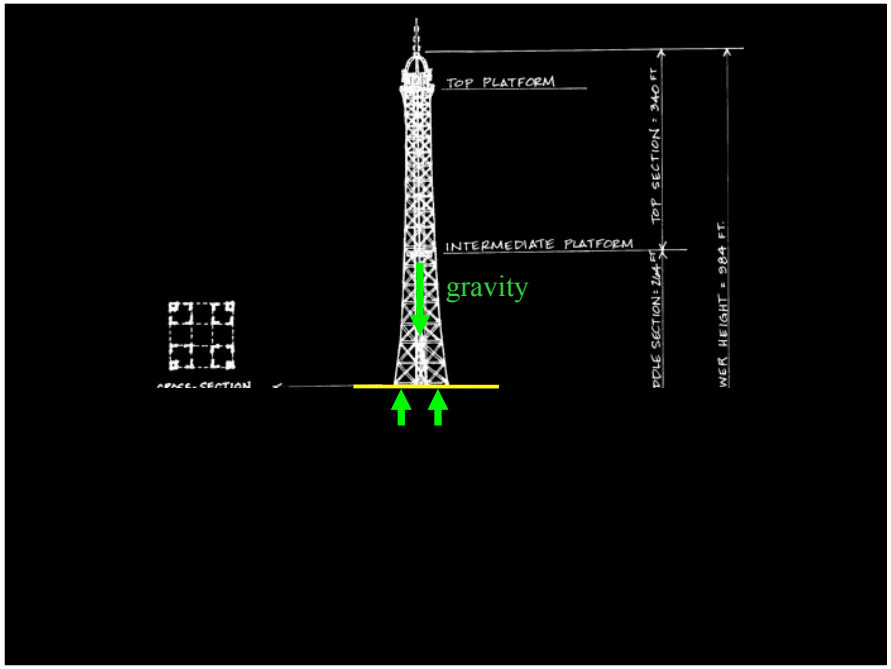
Free Body Diagrams

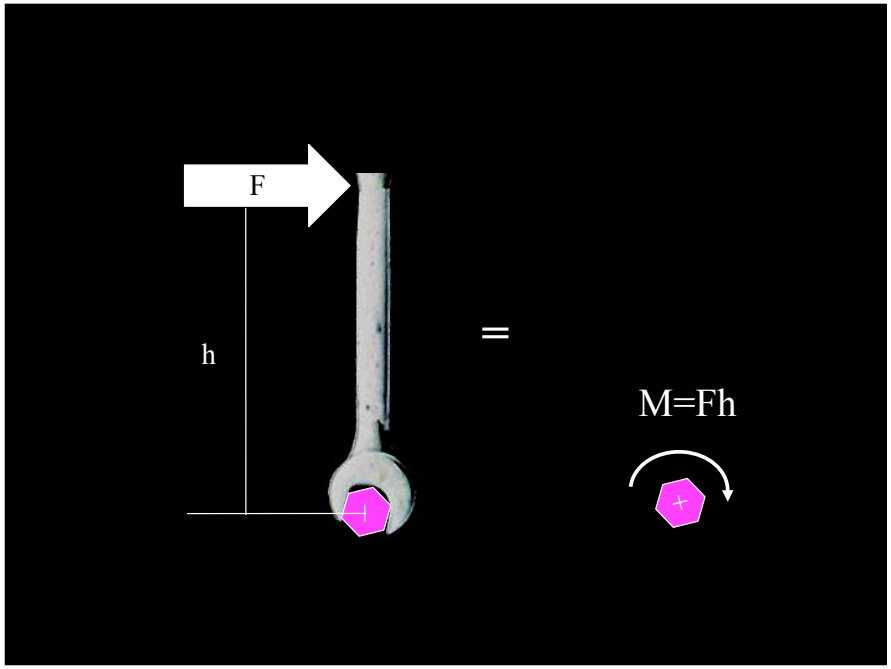


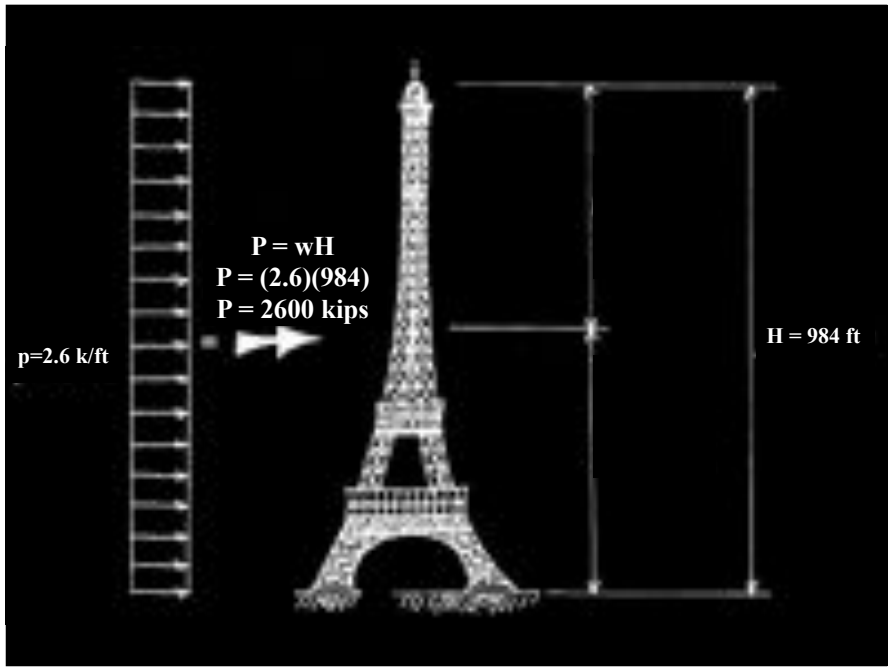


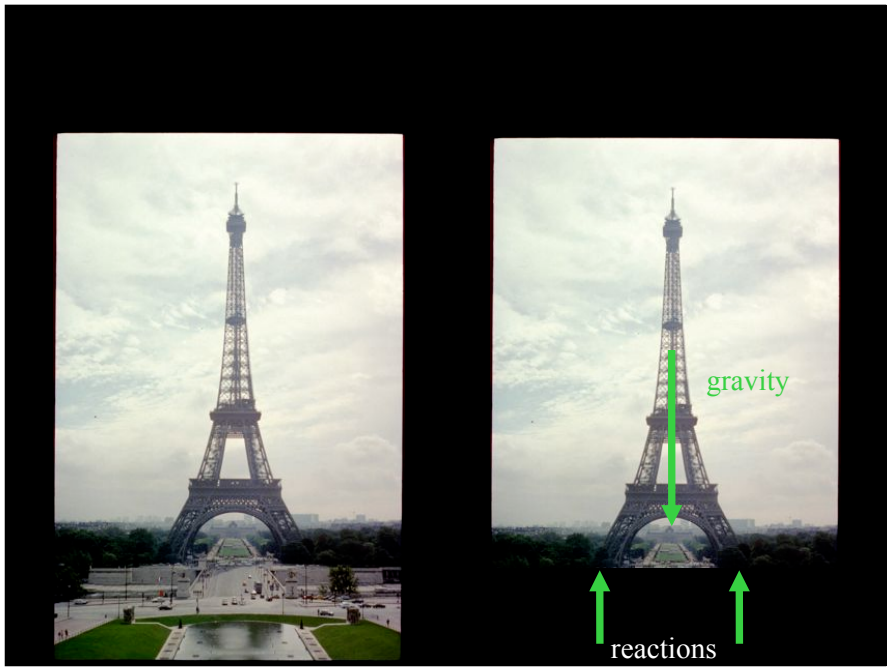

TOP PLATFORM
INTERMEDIATE PLATFORM
gravity
SECOND PLATFORM
FIRST PLATFORM
CROSS-SECTION
CROSS-SECTION
TOP SECTION = 340 FT.
MIDDLE SECTION = 380 FT.
BOTTOM SECTION = 186 FT.
TOWER HEIGHT = 984 FT.

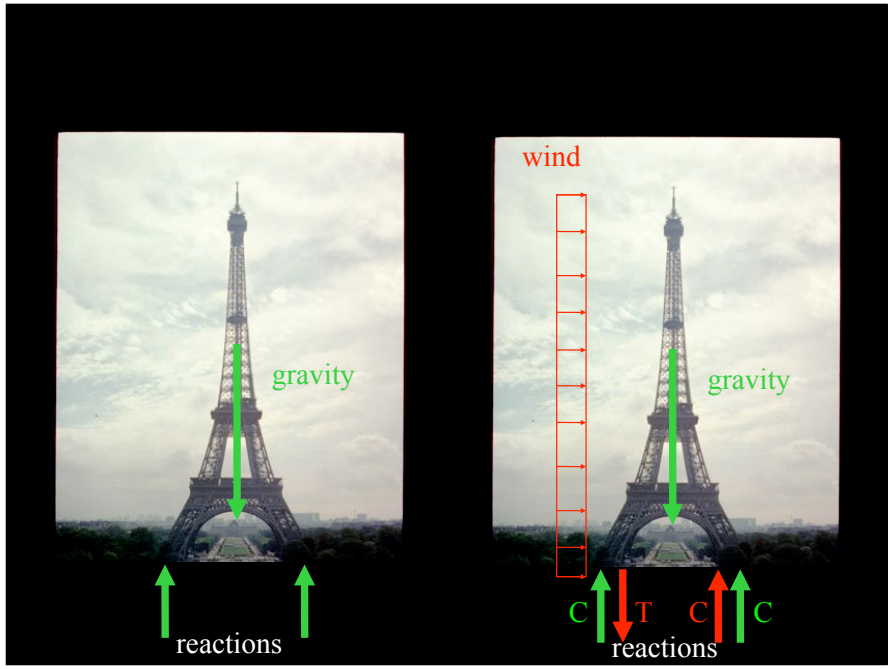

TOP PLATFORM
INTERMEDIATE PLATFORM
SECOND PLATFORM
FIRST PLATFORM
CROSS-SECTION
CROSS-SECTION
TOP SECTION = 340 FT.
MIDDLE SECTION = 380 FT.
BOTTOM SECTION = 186 FT.
TOWER HEIGHT = 984 FT.

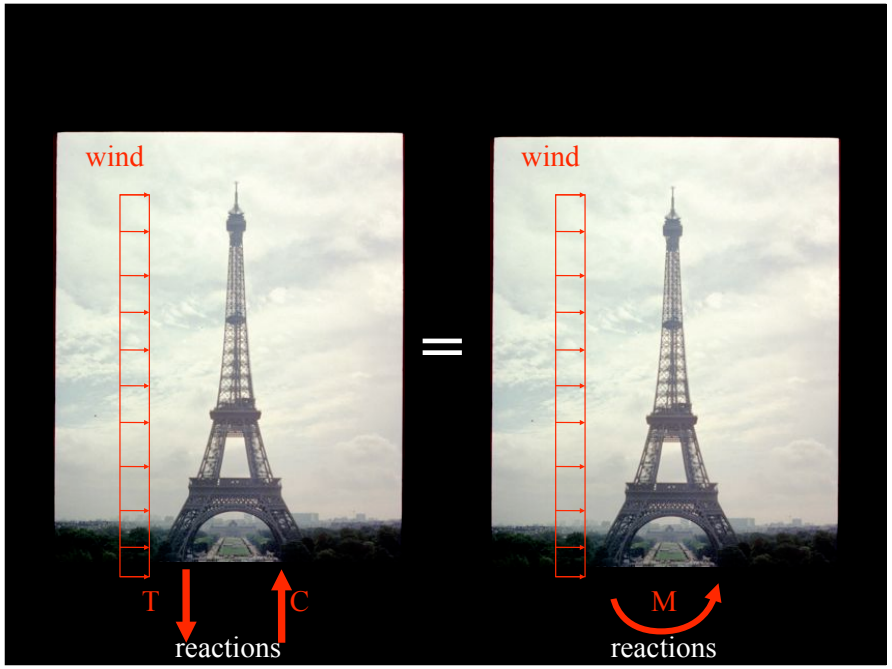

TOP PLATFORM
INTERMEDIATE PLATFORM
gravity
TOP SECTION = 340 FT.
WER HEIGHT = 984 FT.

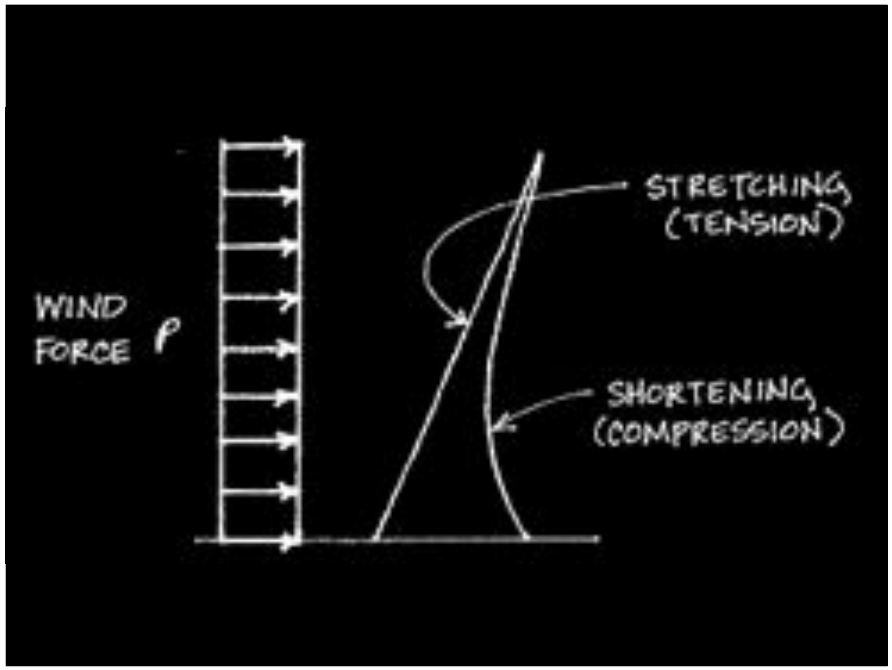

F
h
=
M=Fh

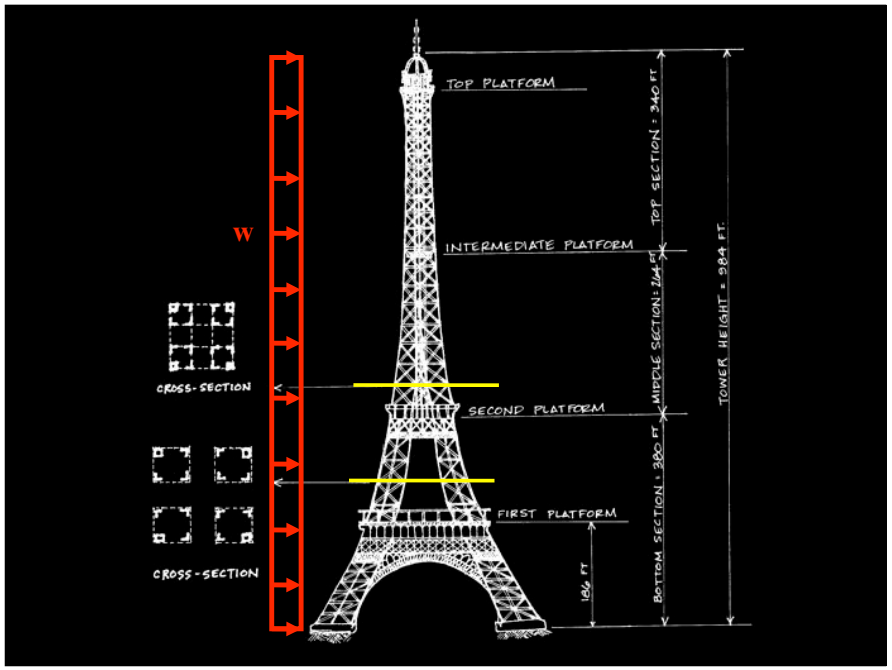

P = wH
P = (2.6)(984)
P = 2600 kips
p=2.6 k/ft
H = 984 ft

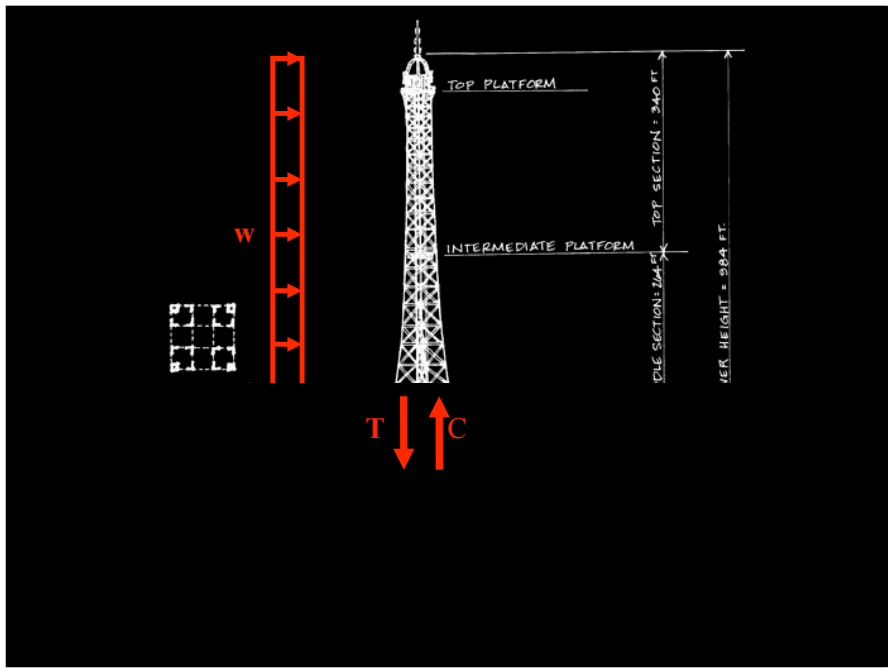

gravity
reactions

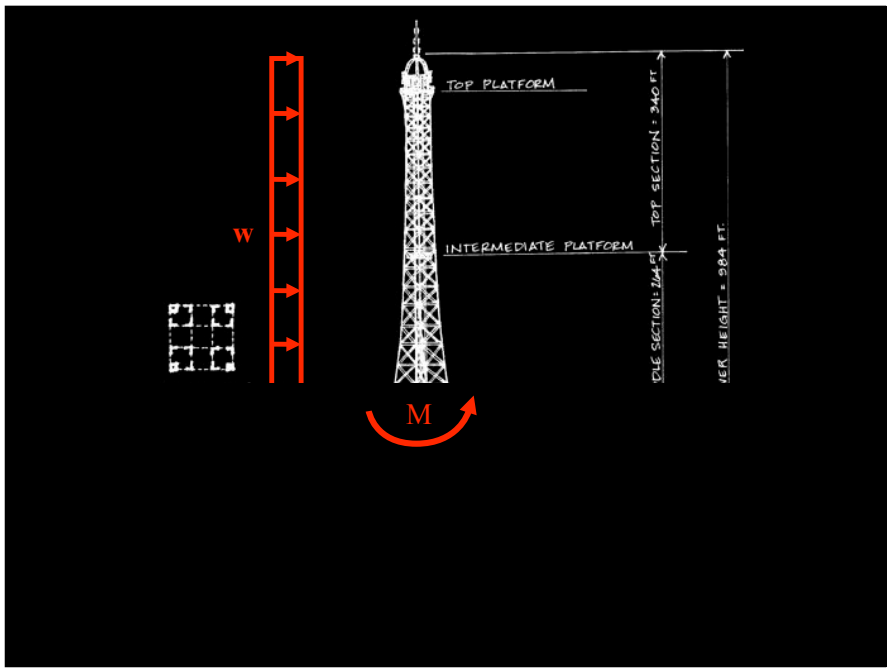

gravity
reactions
wind
gravity
C
T
C
C
reactions


wind
T
C
reactions
=
wind
M
reactions


WIND
FORCE p
STRETCHING
(TENSION)
SHORTENING
(COMPRESSION)


W
CROSS-SECTION
CROSS-SECTION
TOP PLATFORM
INTERMEDIATE PLATFORM
SECOND PLATFORM
FIRST PLATFORM
TOP SECTION = 340 FT.
MIDDLE SECTION = 214 FT.
BOTTOM SECTION = 380 FT.
TOWER HEIGHT = 984 FT.
186 FT

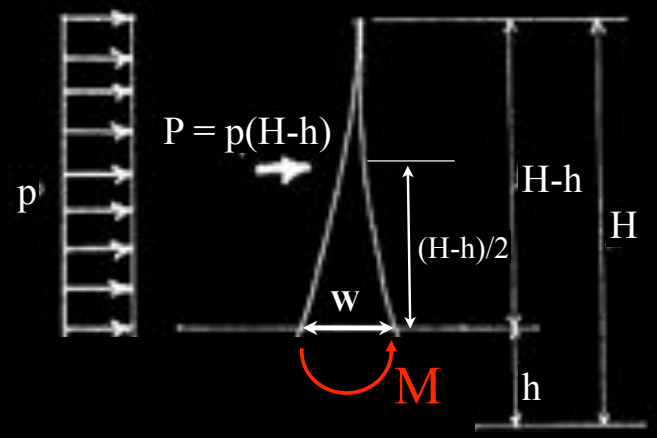

W
TOP PLATFORM
INTERMEDIATE PLATFORM
T
C


W
TOP PLATFORM
INTERMEDIATE PLATFORM
M

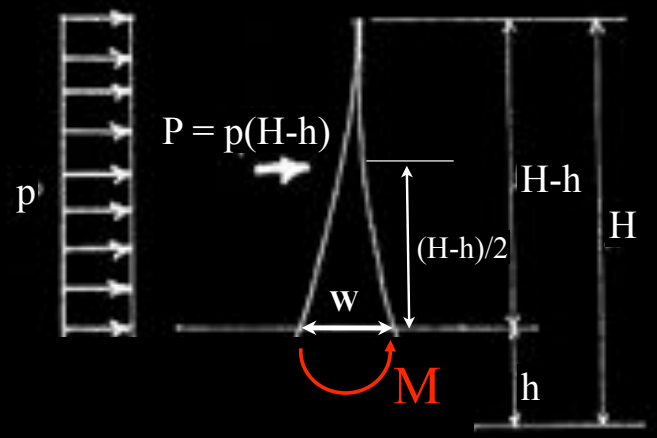
Civil Engineering Units

- 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

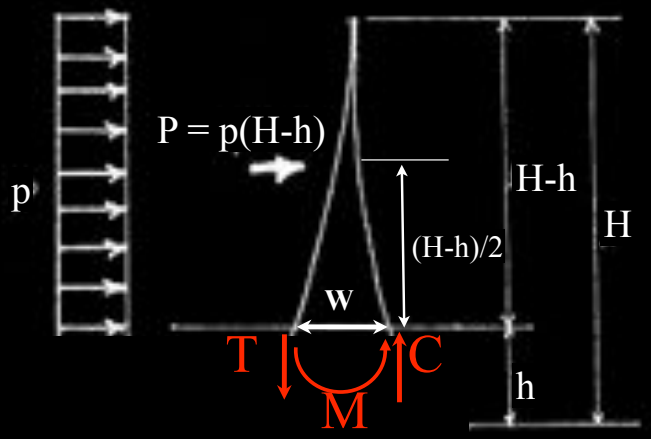


$\Sigma M_{section} = 0 \rightarrow M - p(H-h)(H-h)/2 = 0$



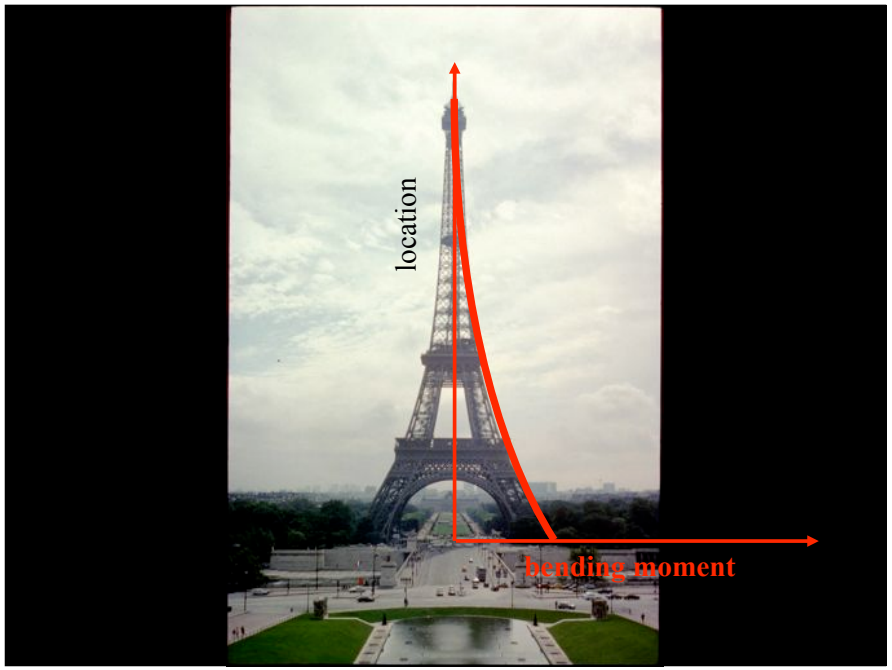
$\Sigma M_{section} = 0 \rightarrow M - p(H-h)(H-h)/2 = 0$

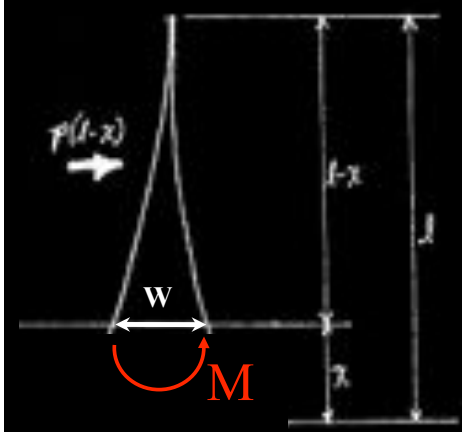
$M=[p(H-h)][(H-h)/2]=P(H-h)^2/2$

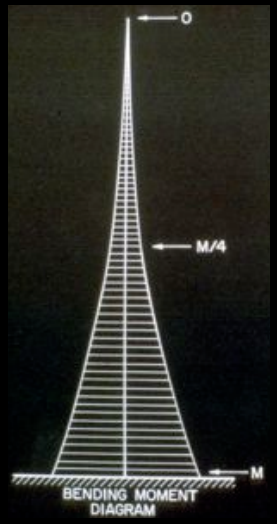


$M=[p(H-h)][(H-h)/2]=P(H-h)^2/2$

$C = -T = M/w$







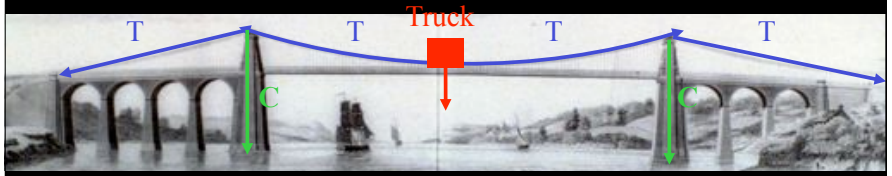
$M=[p(H-h)][(H-h)/2]=p(H-h)^2/2$

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.
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?