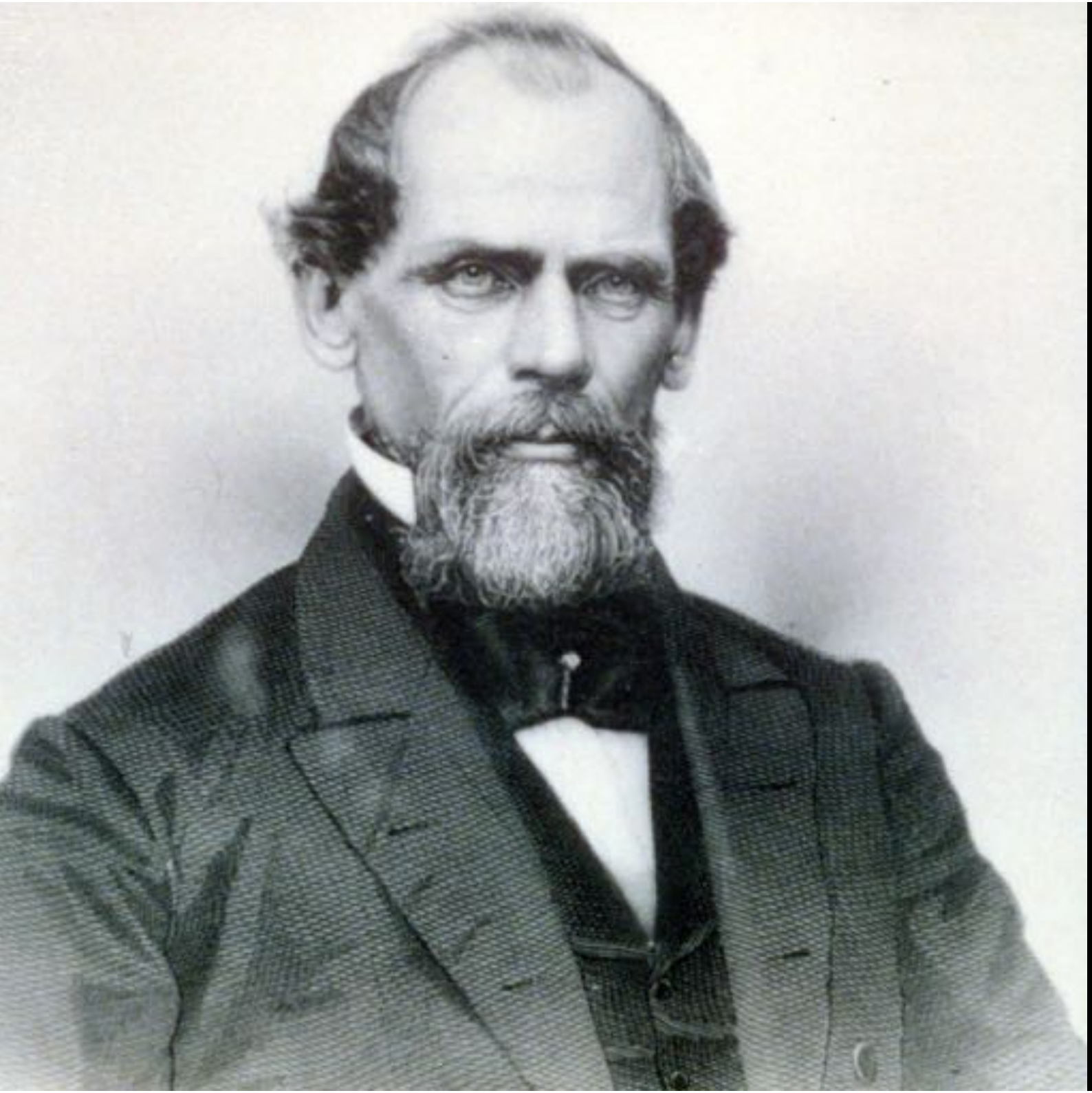
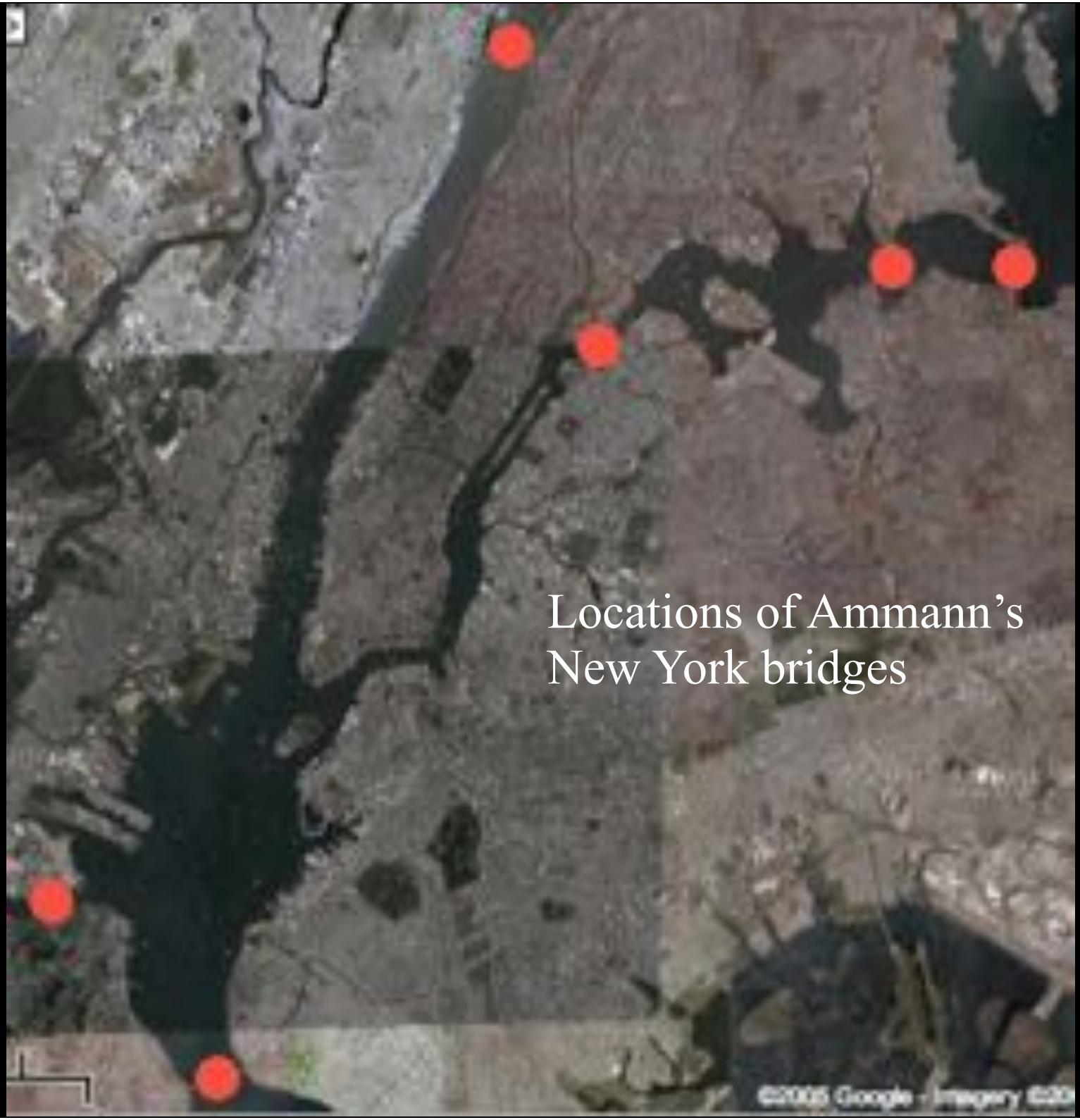
Amman and Long Span Bridges in 20th Century New York

Social role of Ammann's bridges in New York
The Hellgate Arch: form and forces
Stiffness in suspension bridges (cont.)
Lindenthal and the RR vs. Amman and the automobile
Form, function, and aesthetics in suspension bridge towers



Othmar H. Ammann


Locations of Ammann's
New York bridges

Gustav Lindenthal (1850-1935)

Hellgate Bridge - Gustav Lindenthal - 1916 - 977 feet

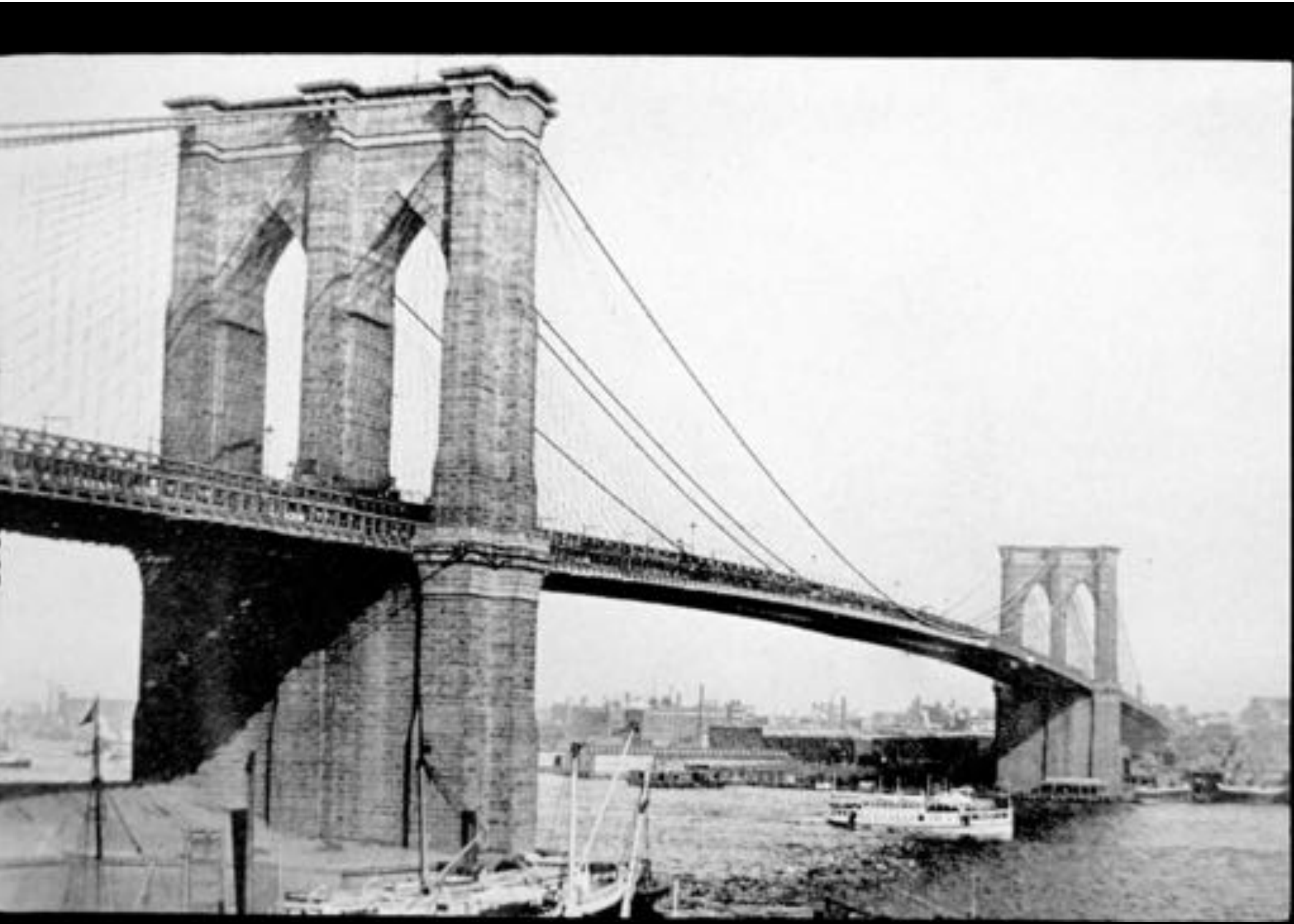
contrast with Sydney Harbor Bridge...

http://en.structurae.de/photos/index.cfm?JS=3089
Katrin Janberg

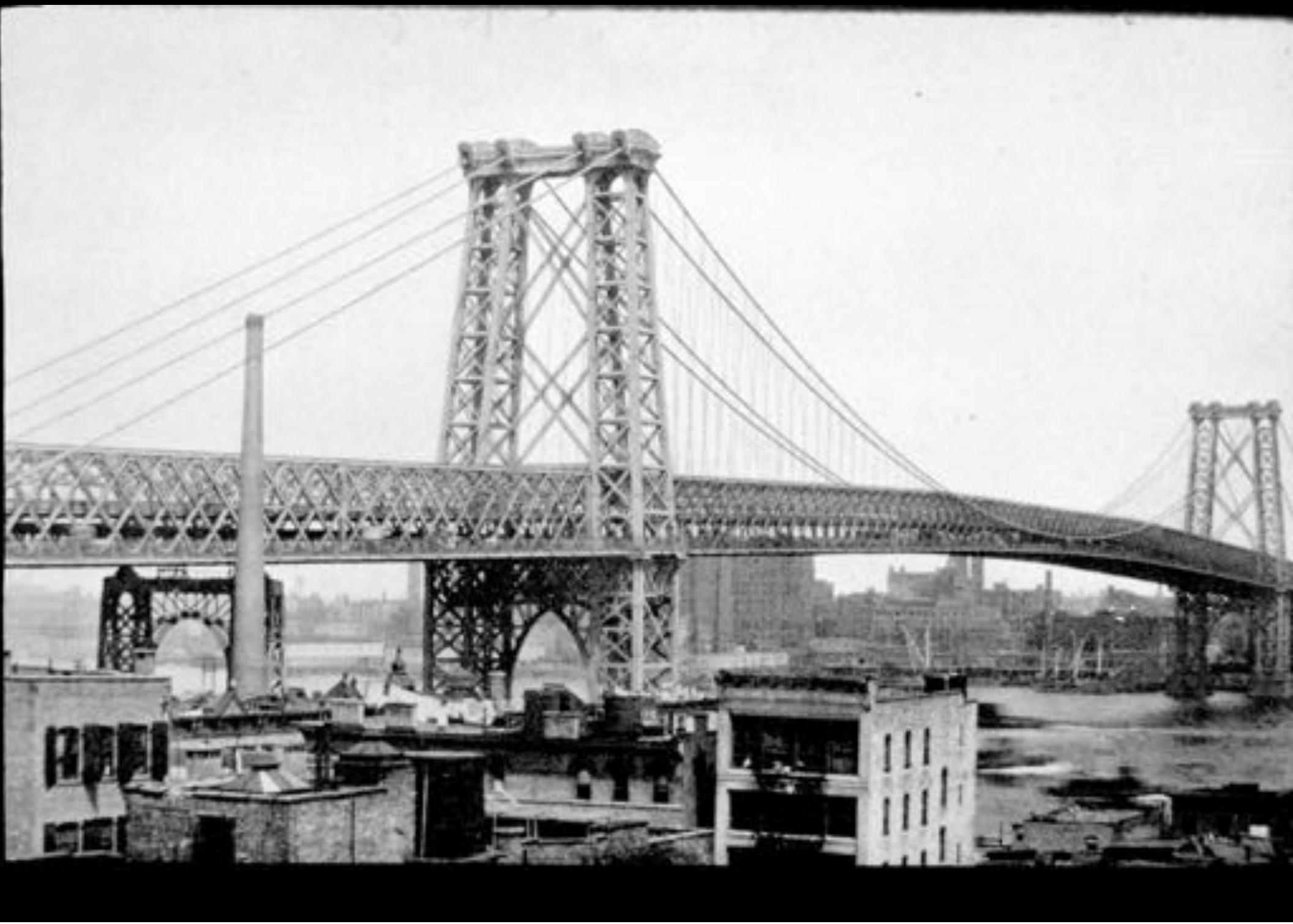
Amman - Bayonne Bridge - 1675 ft [510 m] (proposal)

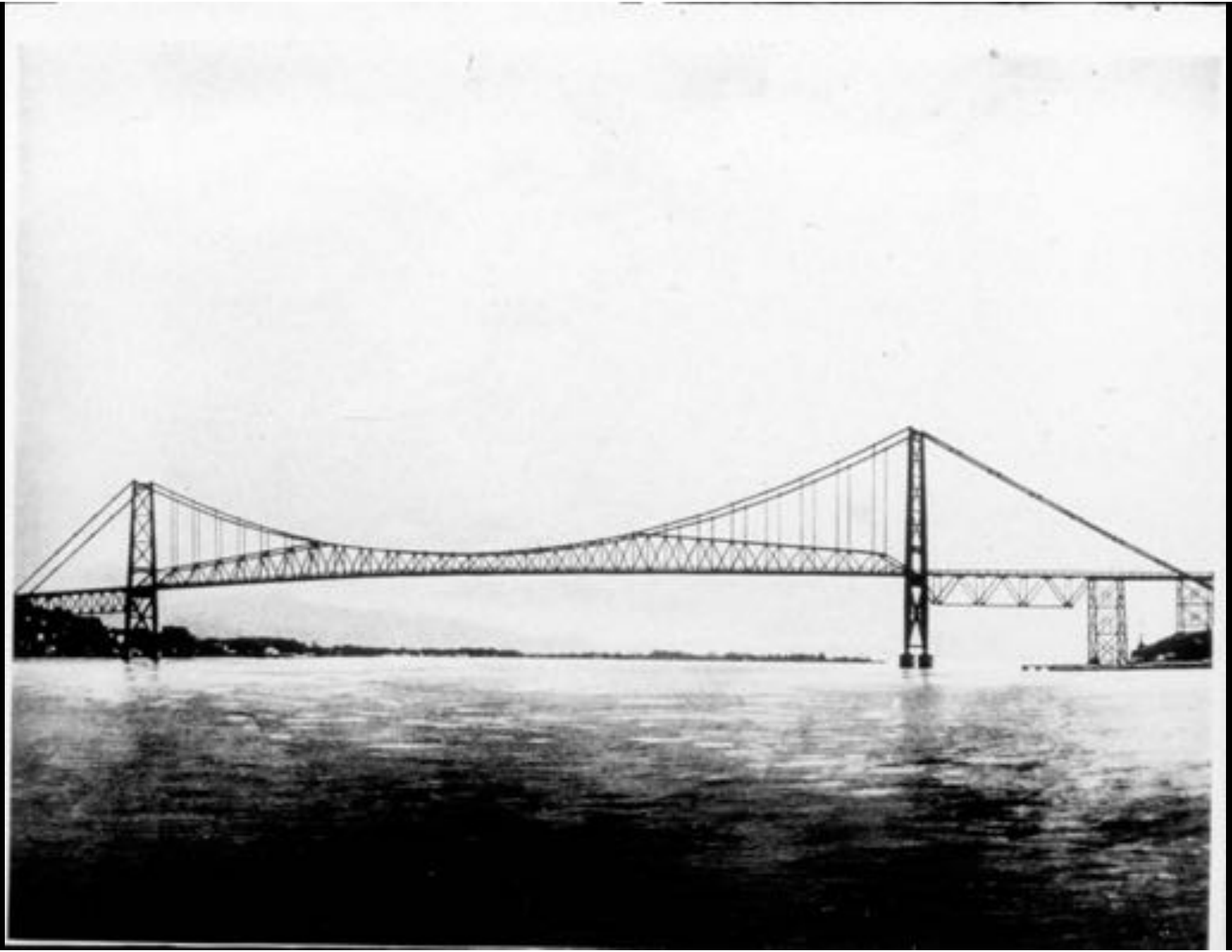
Amman - Bayonne Bridge - 1675 ft [510 m] (as built)

considering the aesthetics/elegance of the landscape of long span suspension bridges after the Brooklyn Bridge, but before Amman's George Washington Bridge, i.e. roughly the furst three decades of the twentieth century

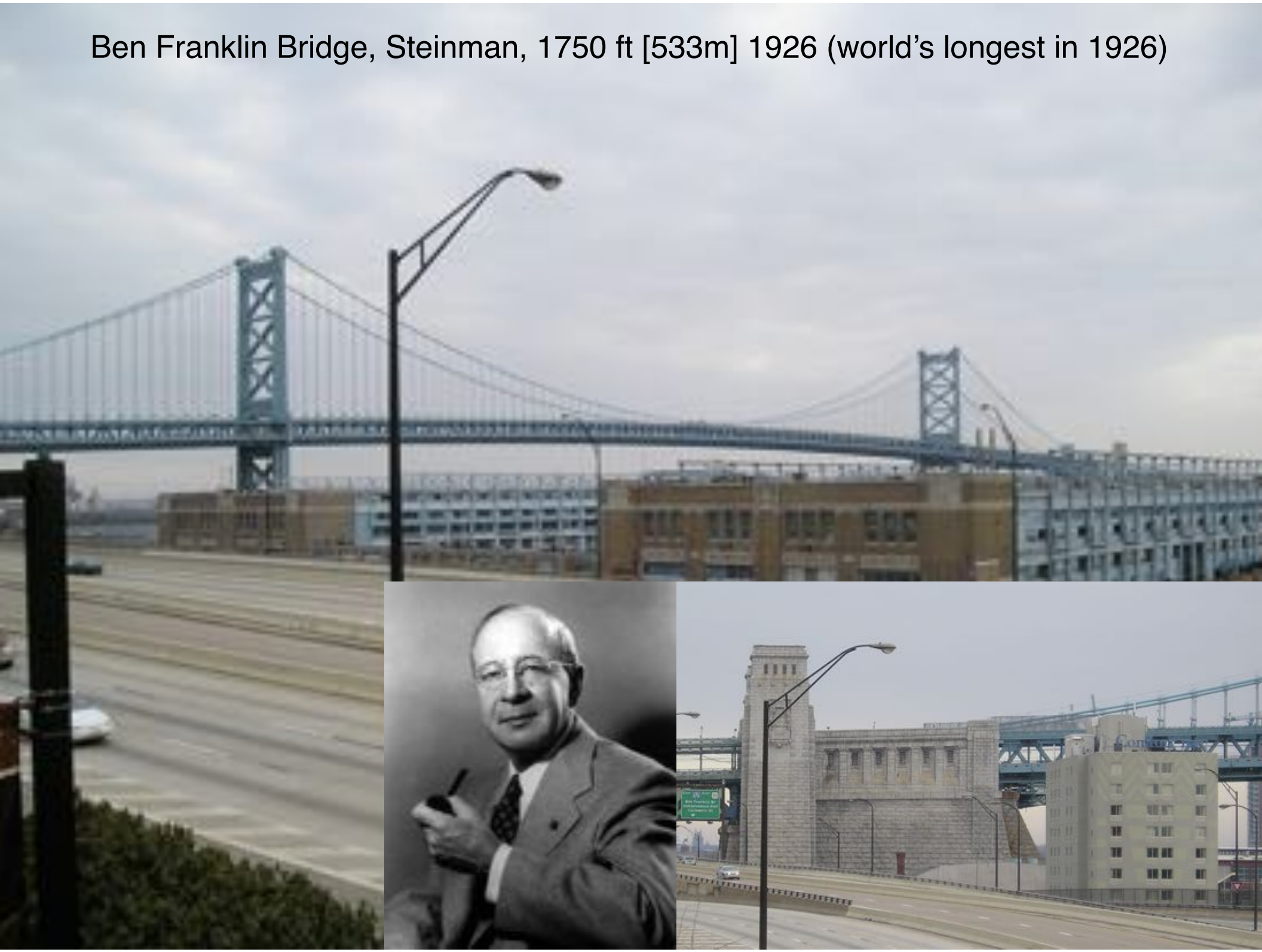


a brief tour of suspension bridge aesthetics (or lack of)...





Ben Franklin Bridge, Steinman, 1750 ft [533m] 1926 (world's longest in 1926)



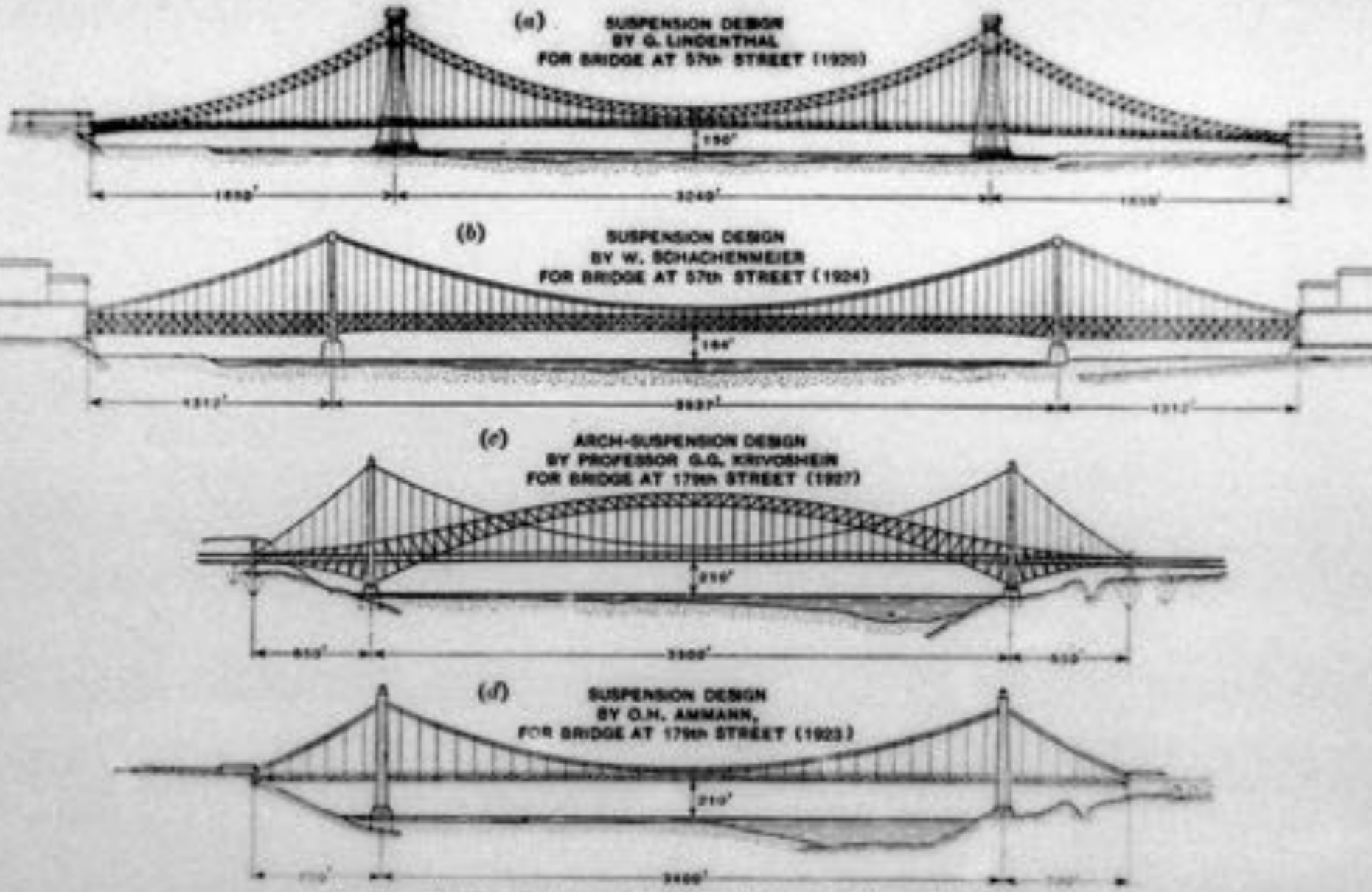
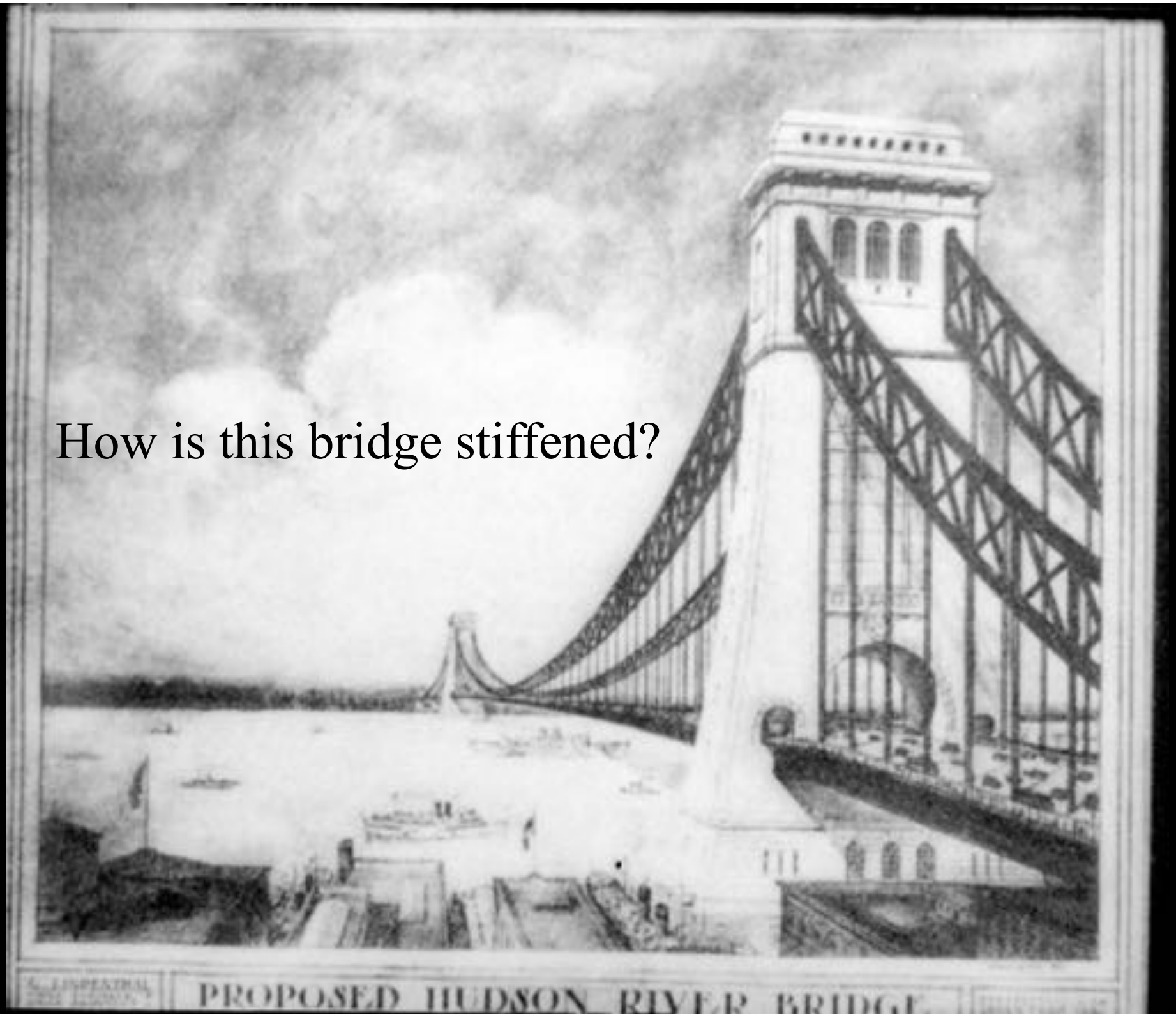
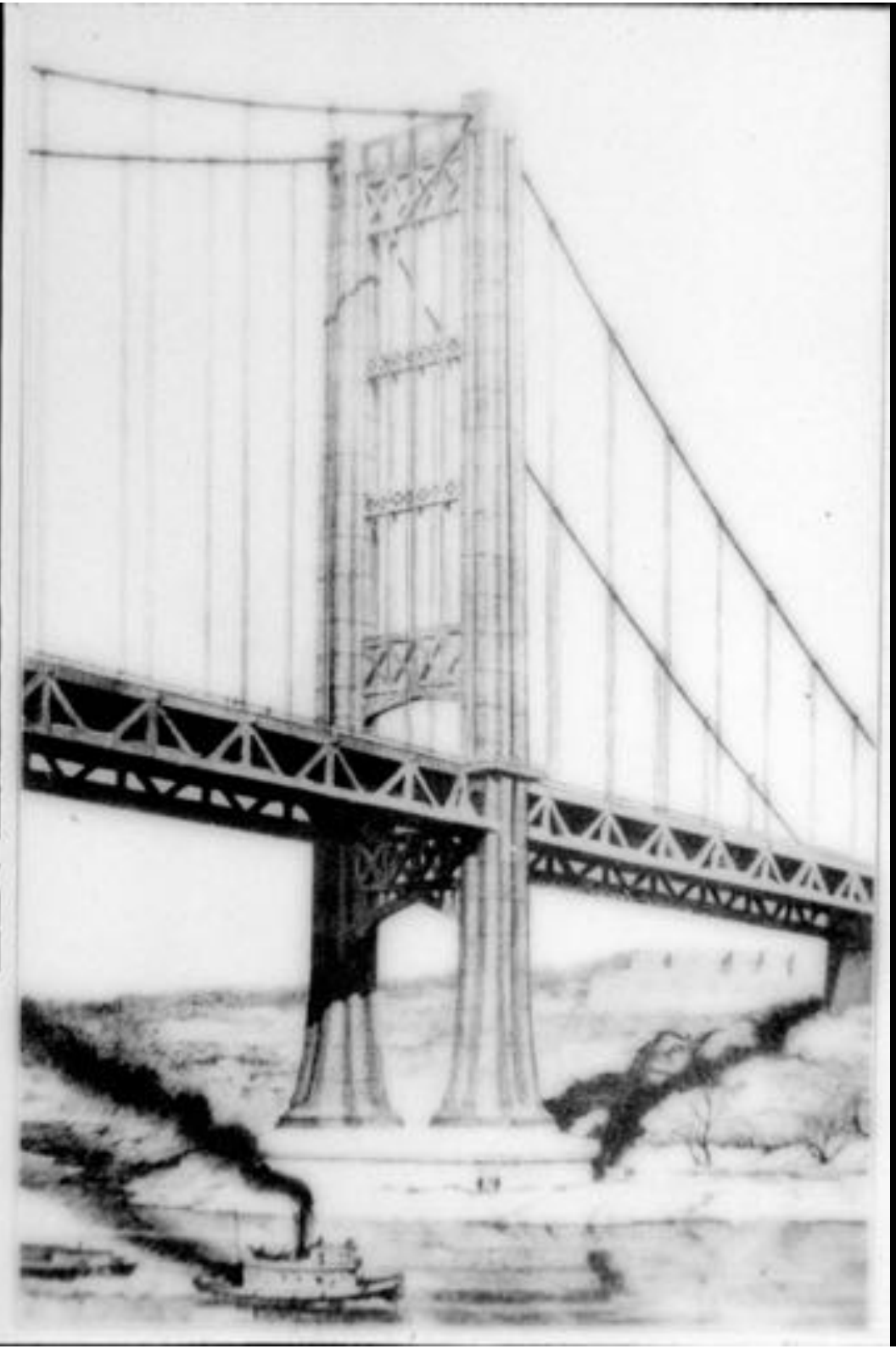


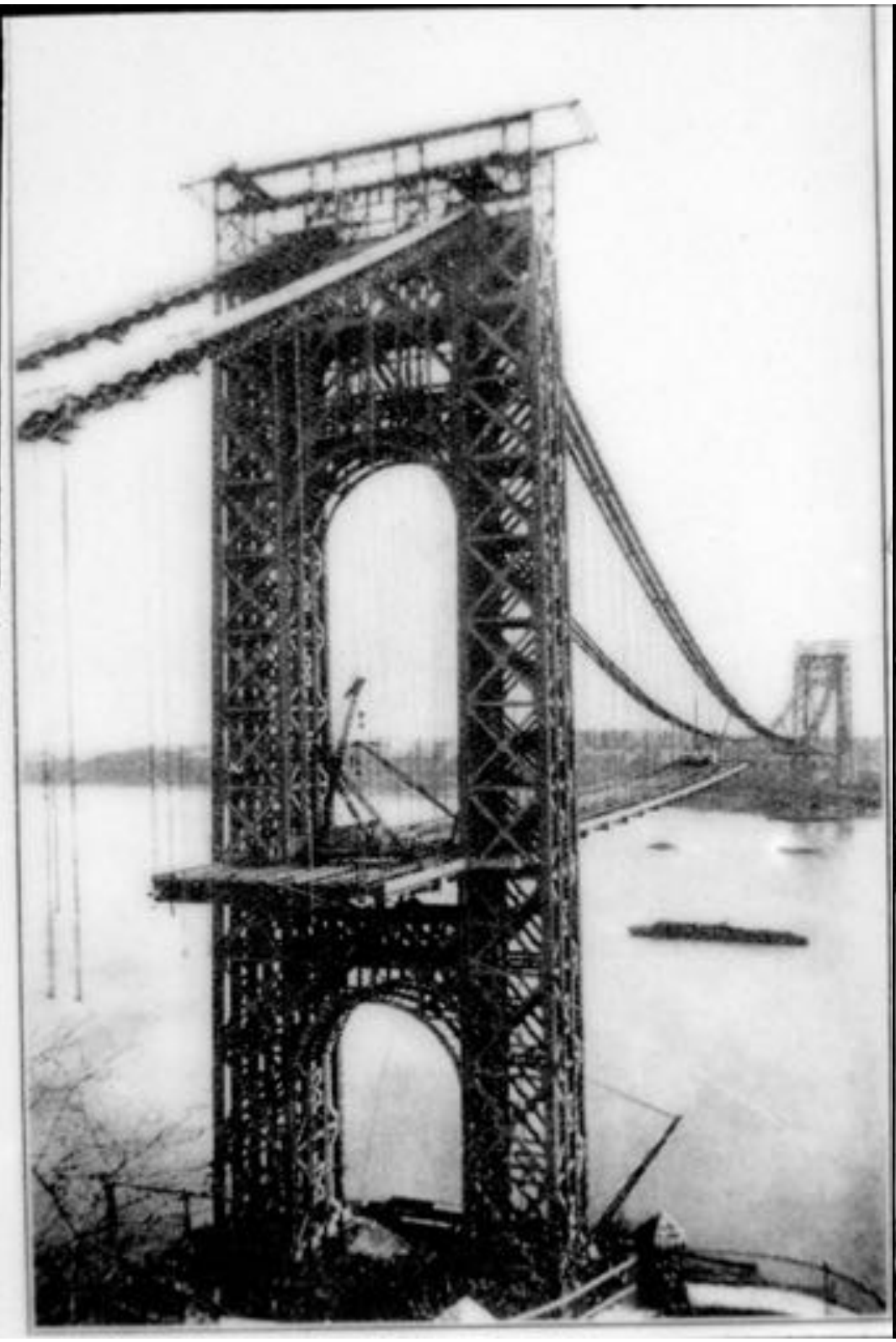
FIG. 19 — RECENT STUDIES FOR A BRIDGE ACROSS THE HUDSON RIVER

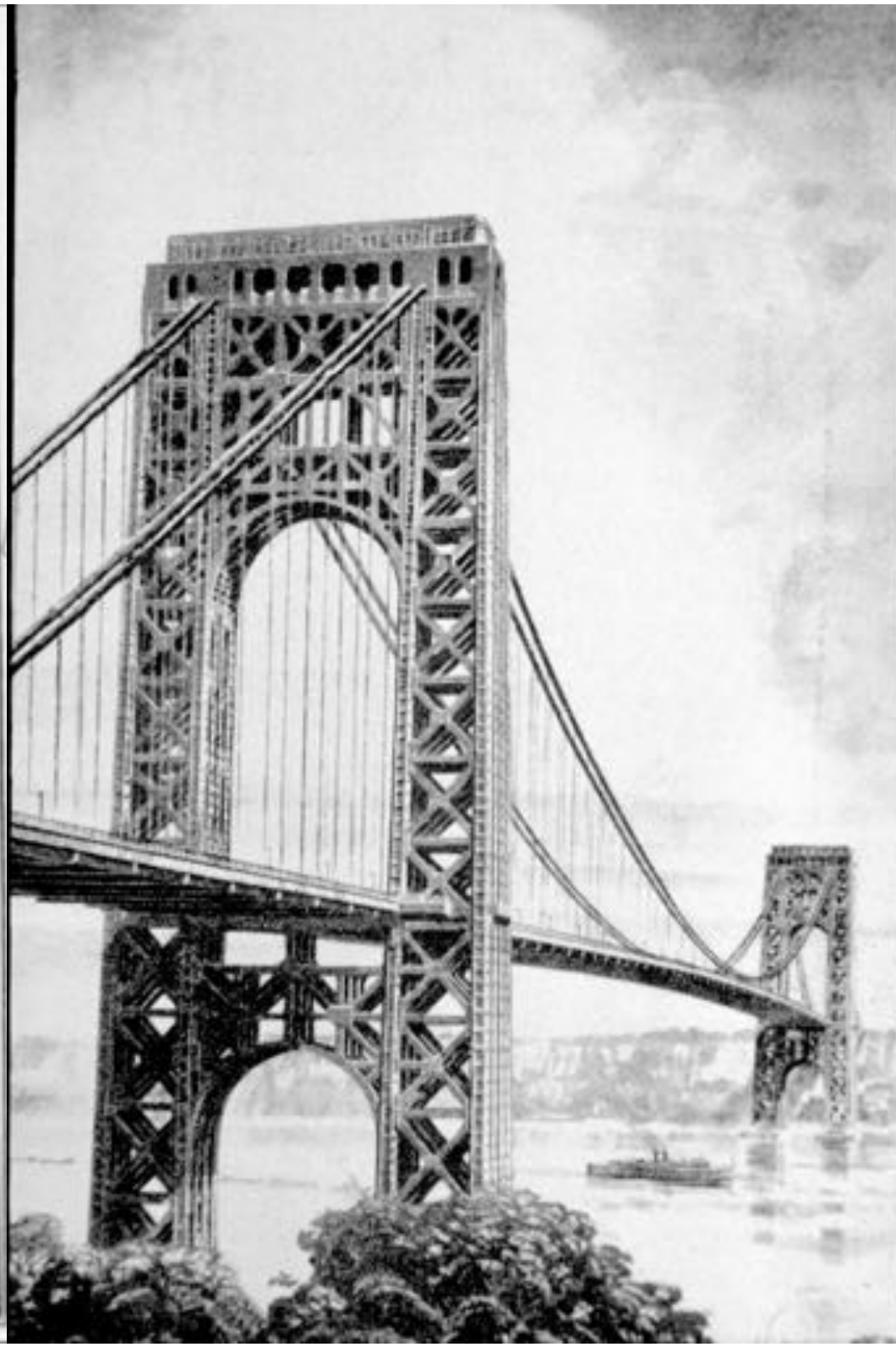
PROPOSED HUDSON RIVER BRIDGE


How is this bridge stiffened?
PROPOSED HUDSON RIVER BRIDGE

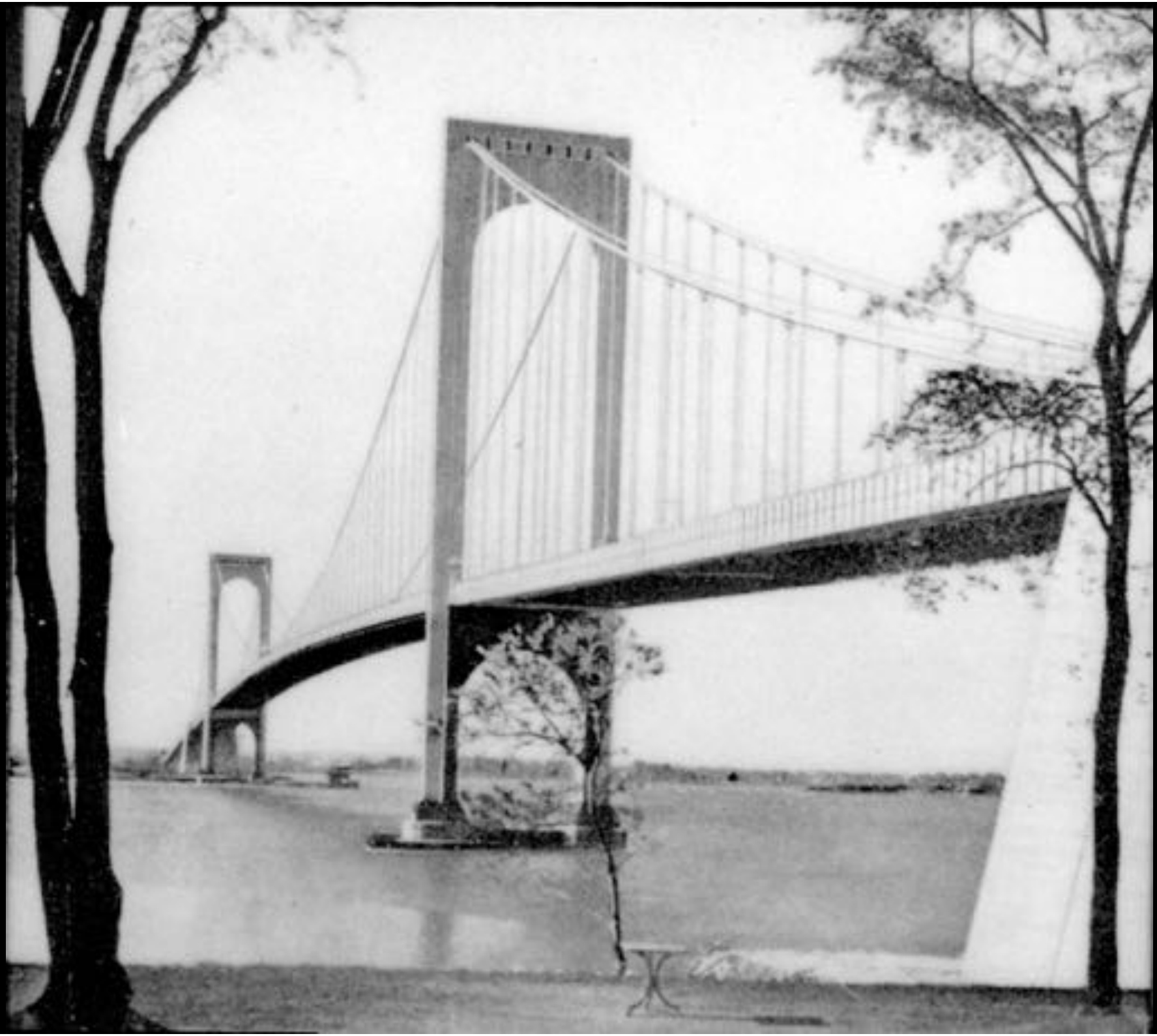


George Washington Bridge - Othmar Ammann - 3500 ft [1067 m] - 1931

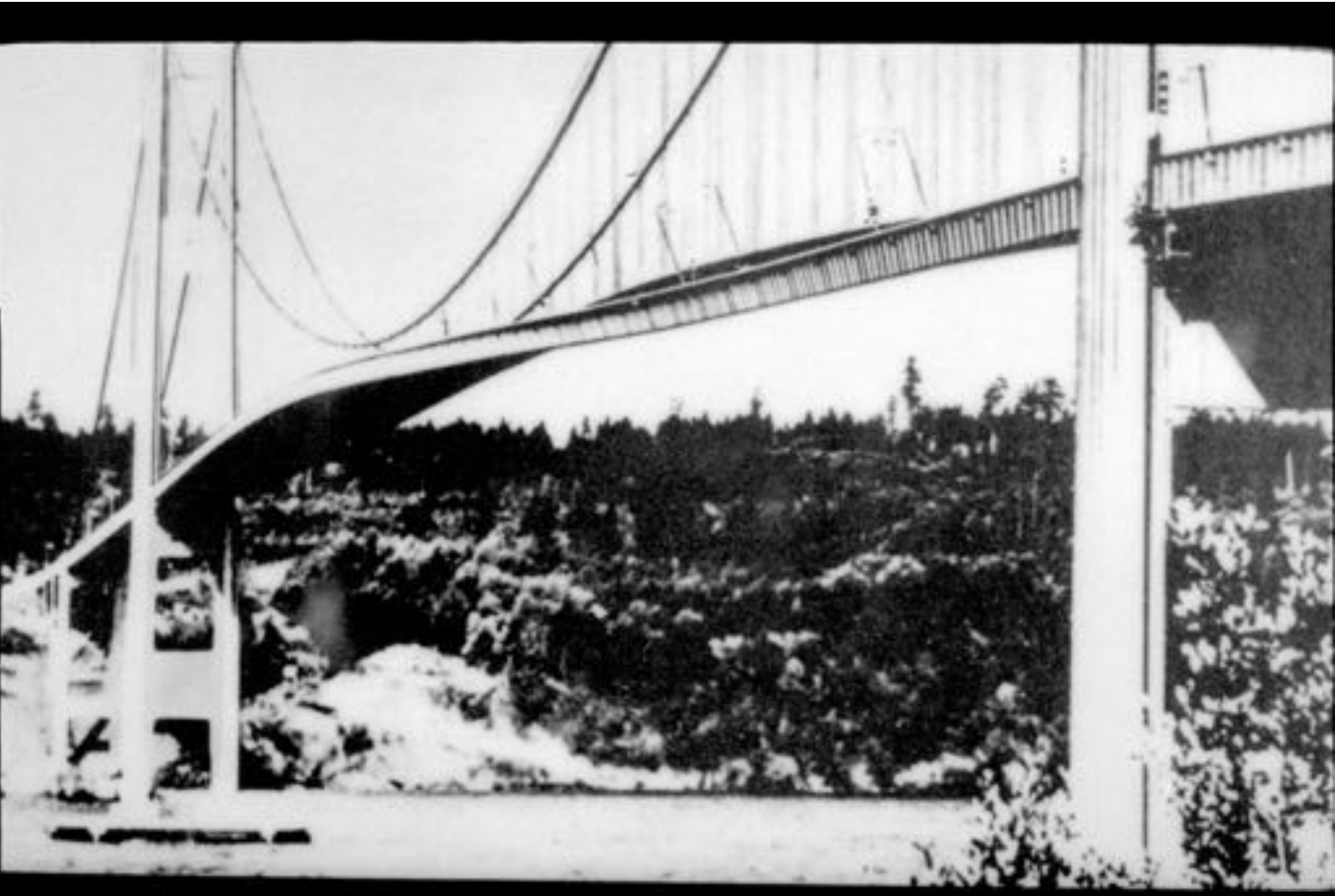




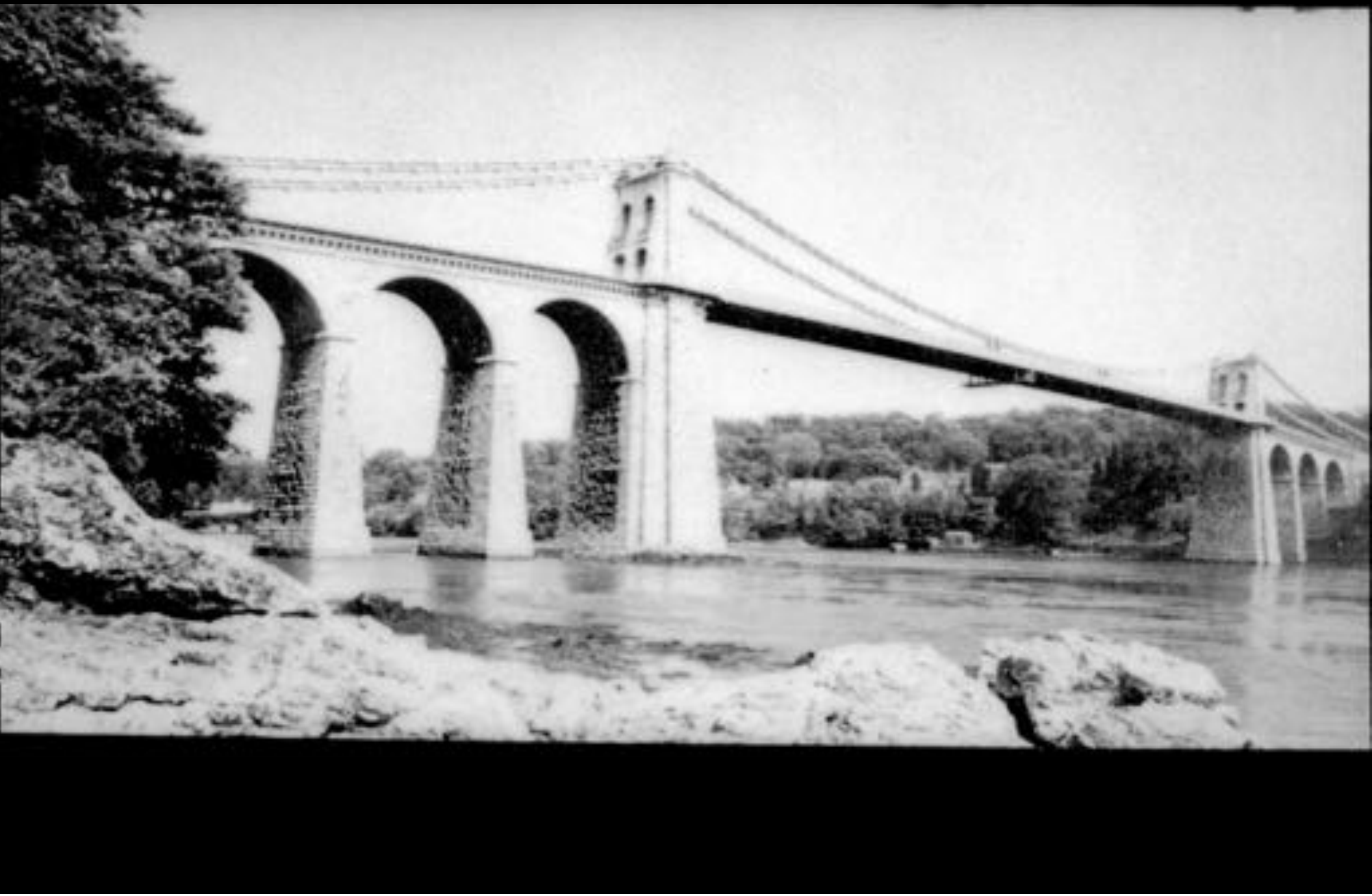
Deer Isle Bridge - David Steinman

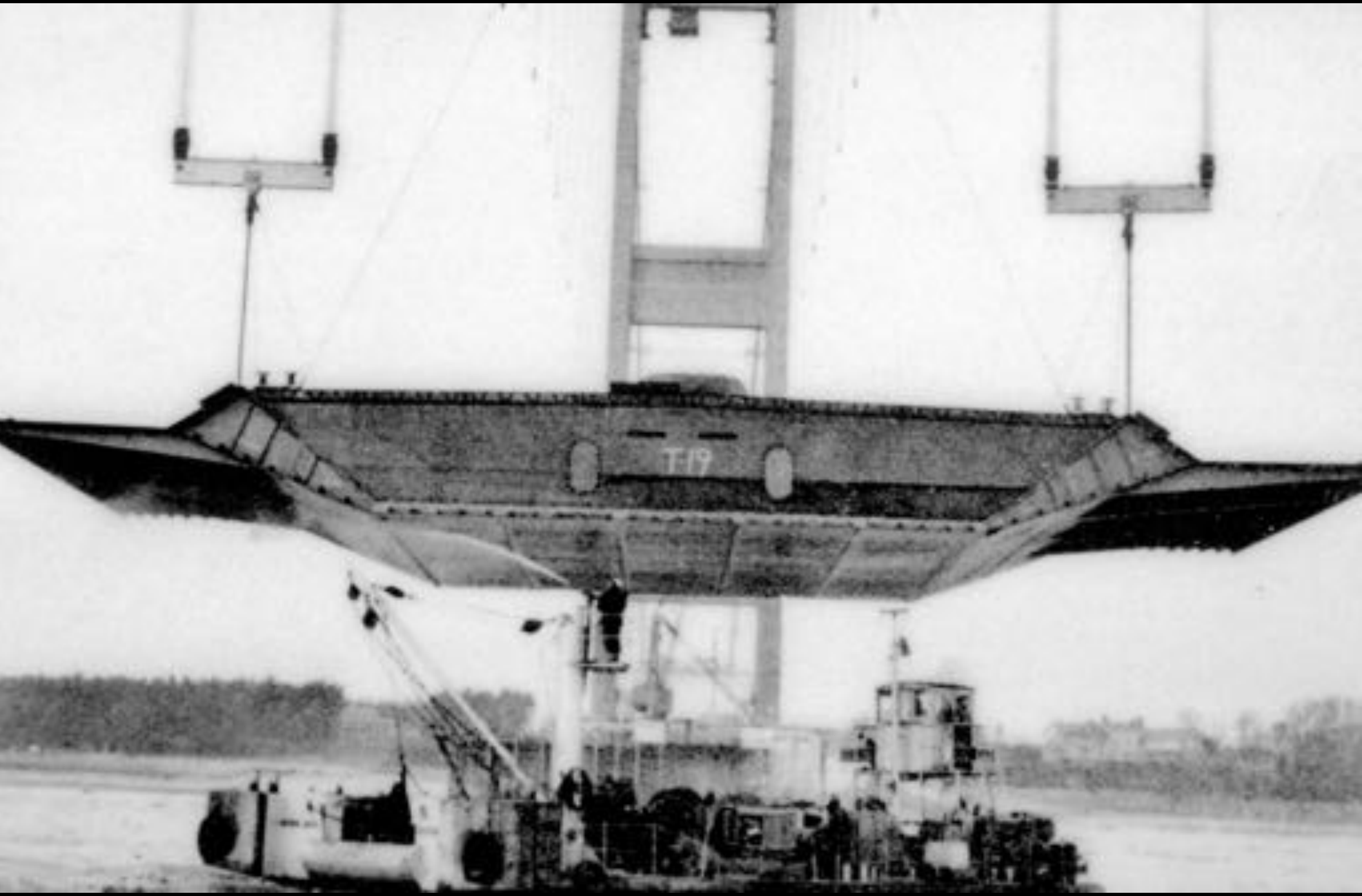


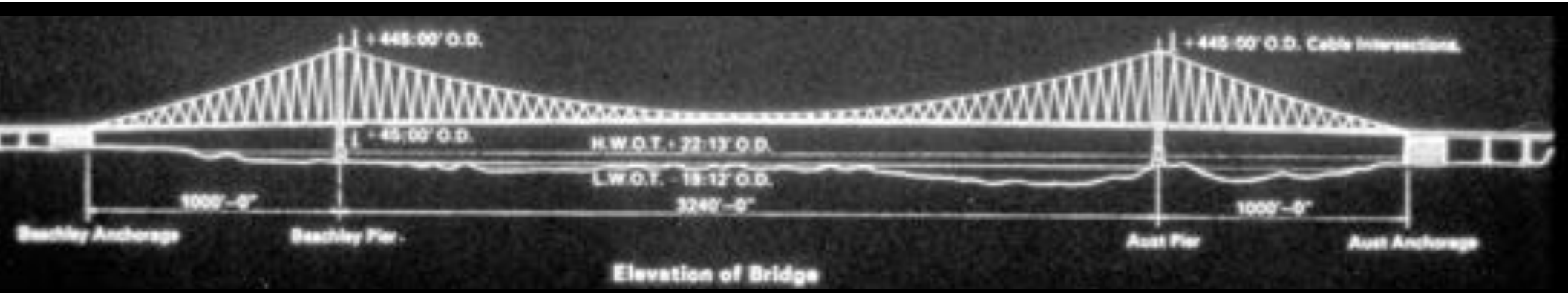
Tacoma Video



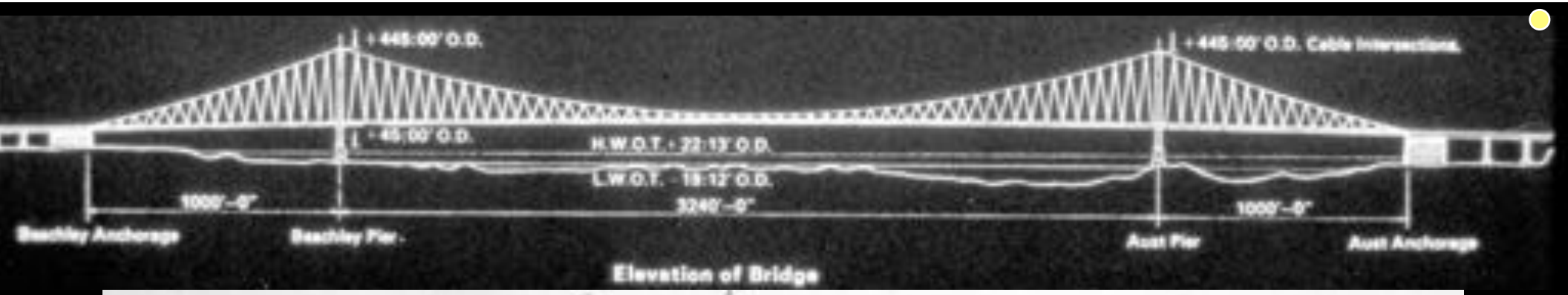
First Tacoma Narrows Bridge



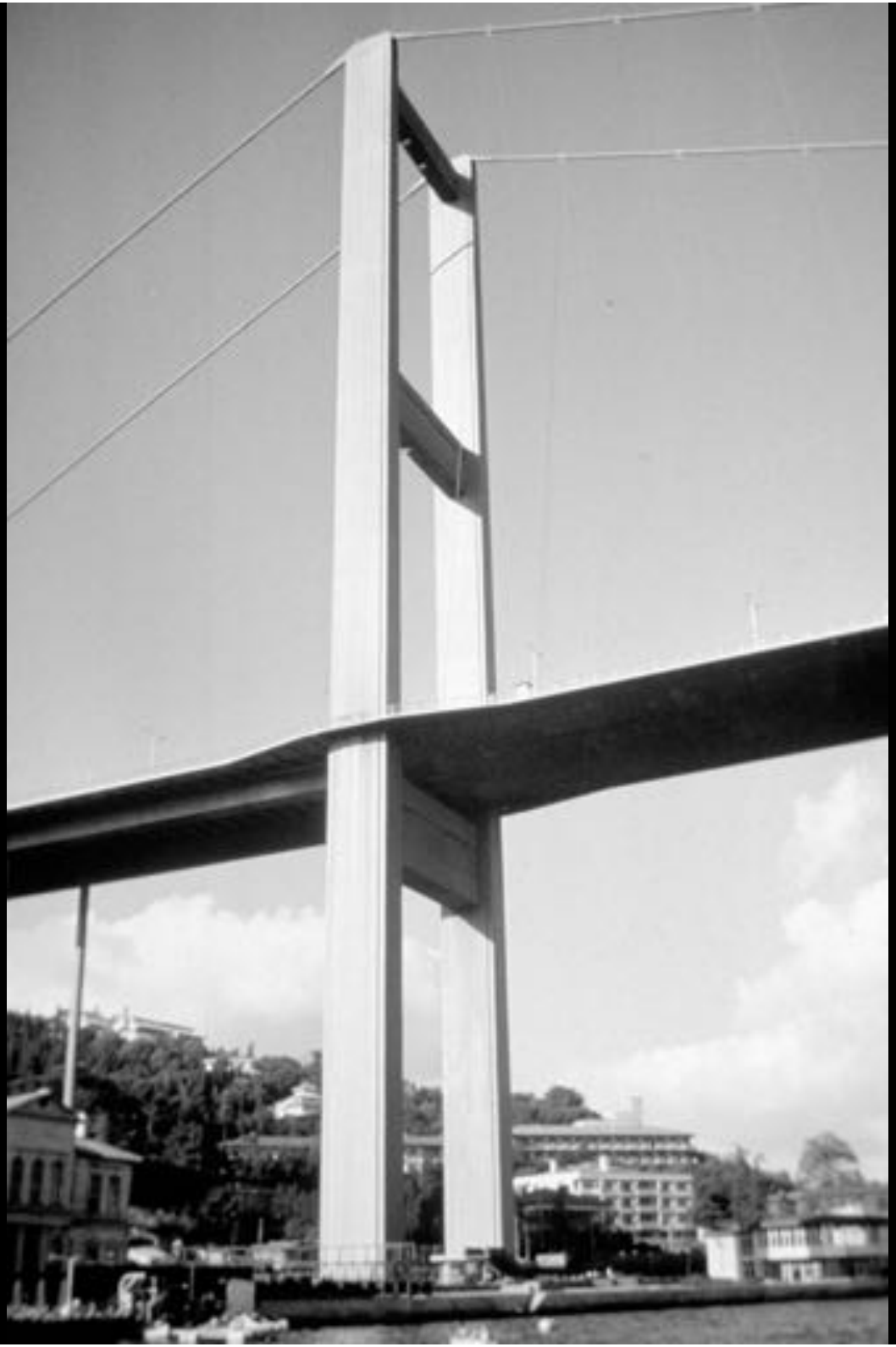

T/9



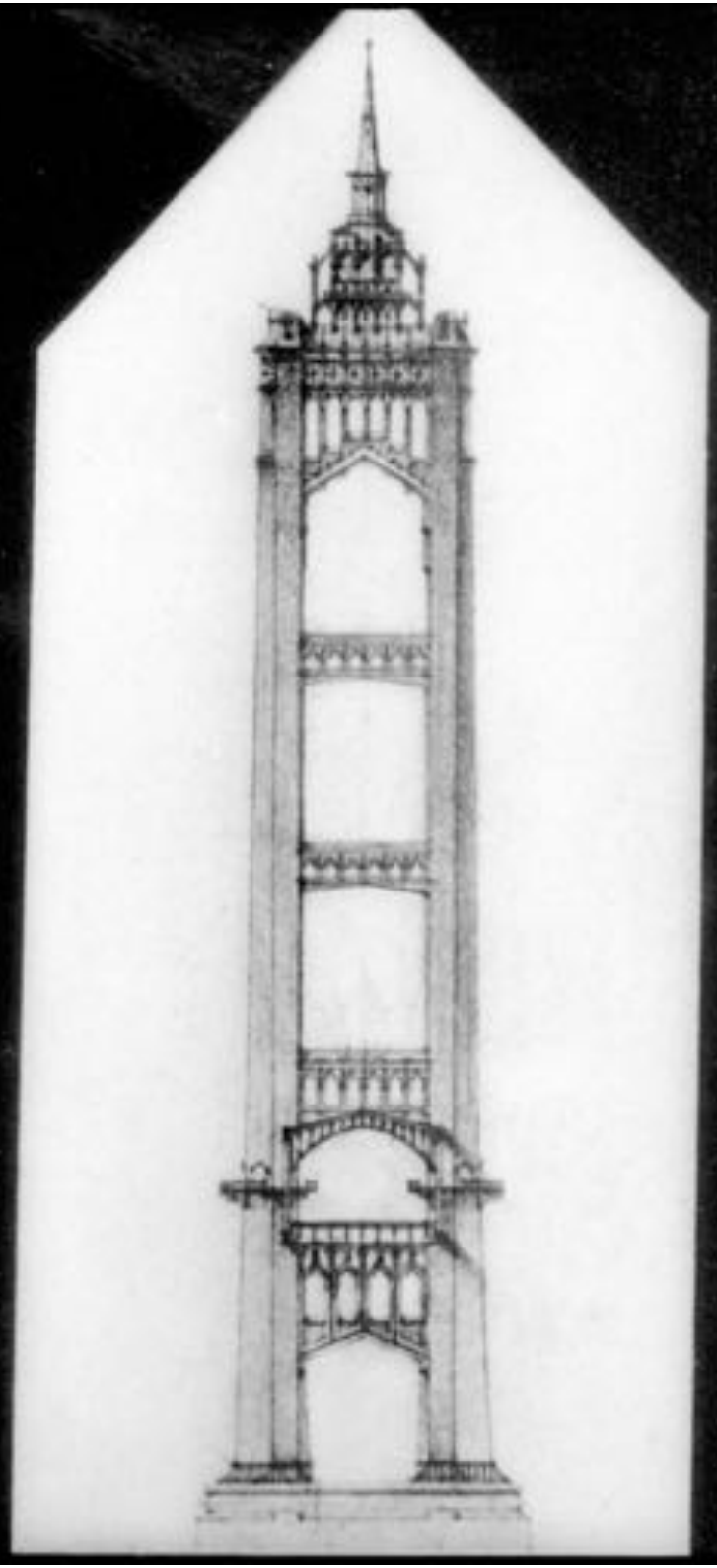
Elevation of Bridge

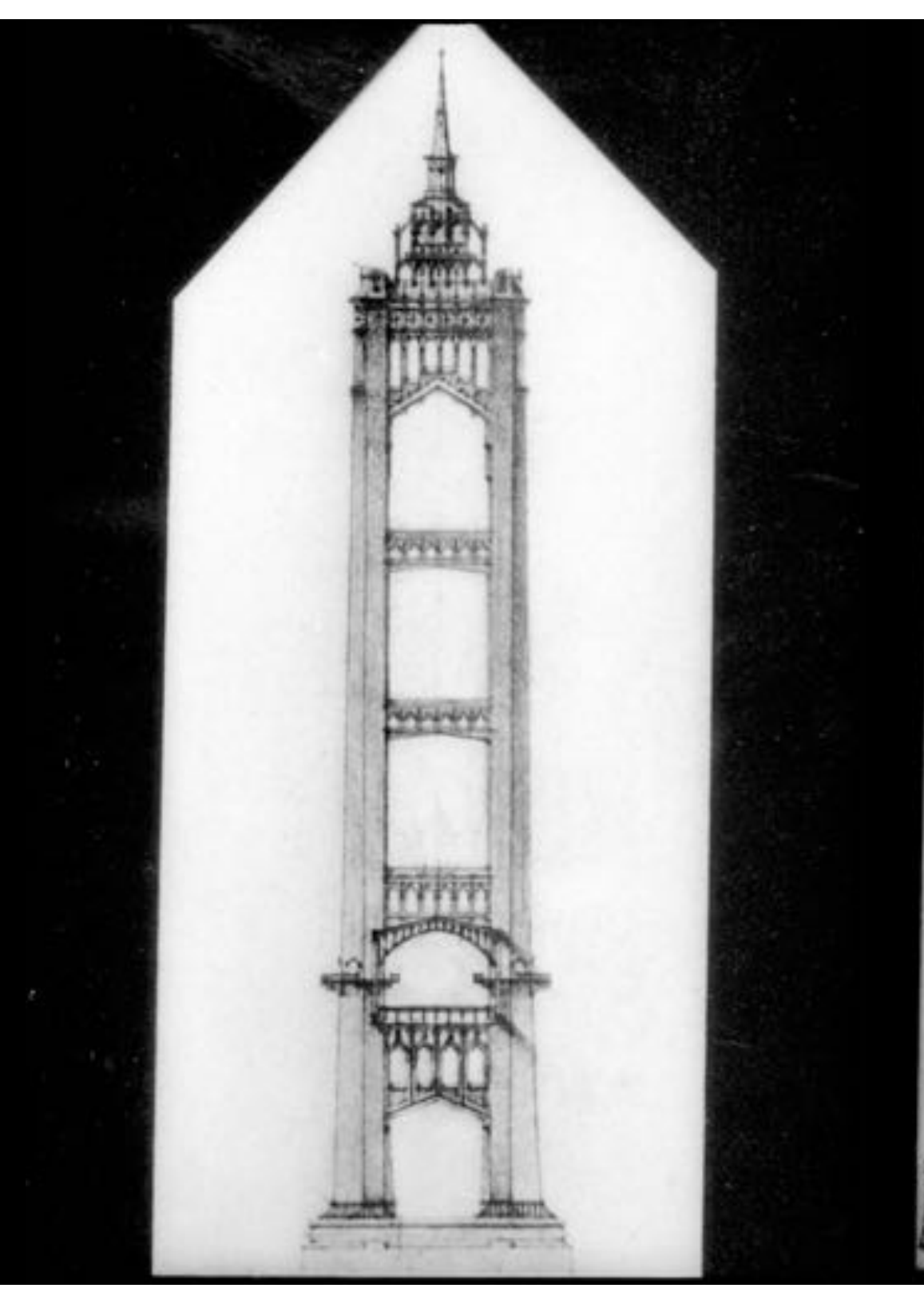


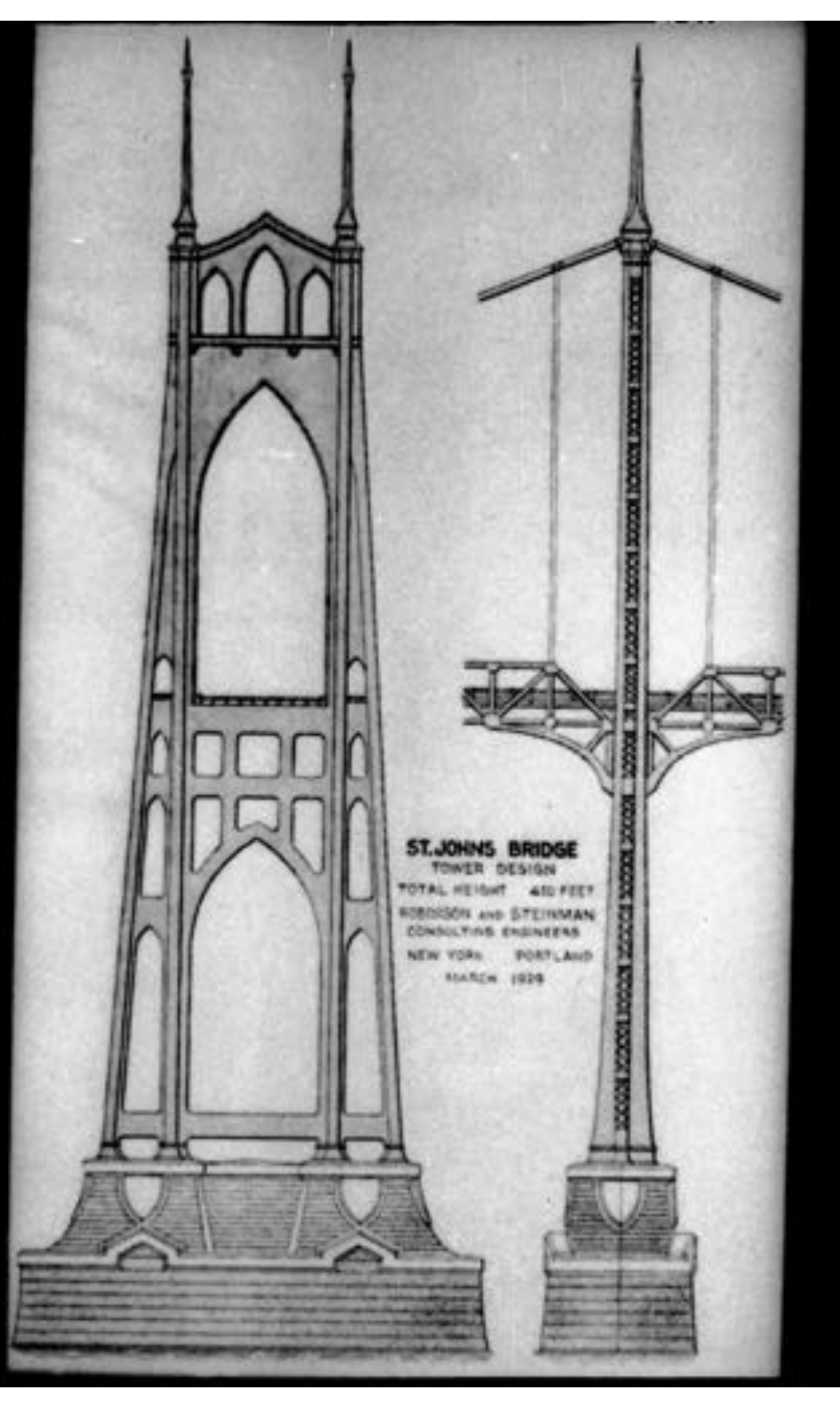
Elevation of Bridge

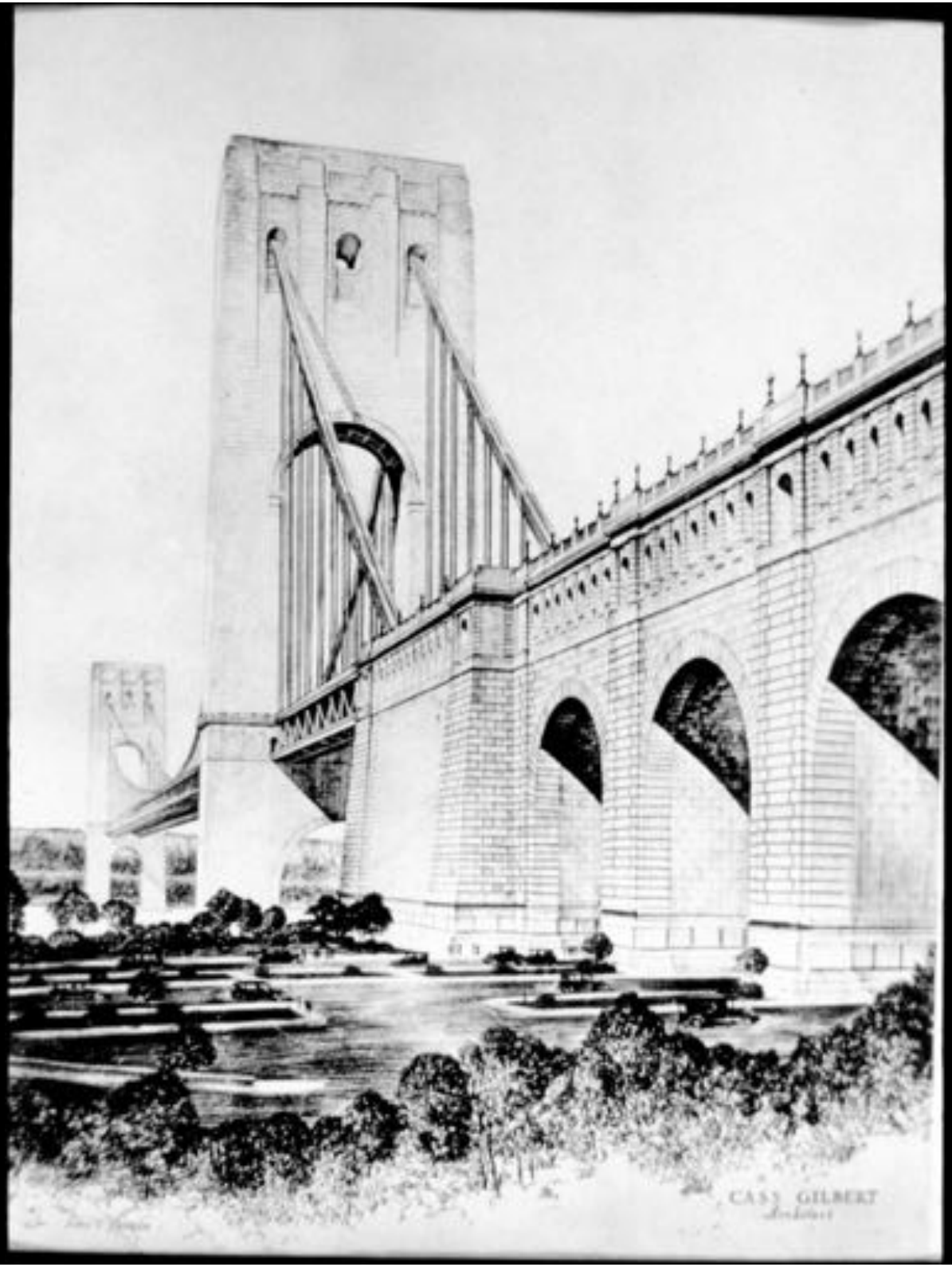


Consider the aesthetics and scientific function of towers particularly Ammann's vs. Steinman's towers



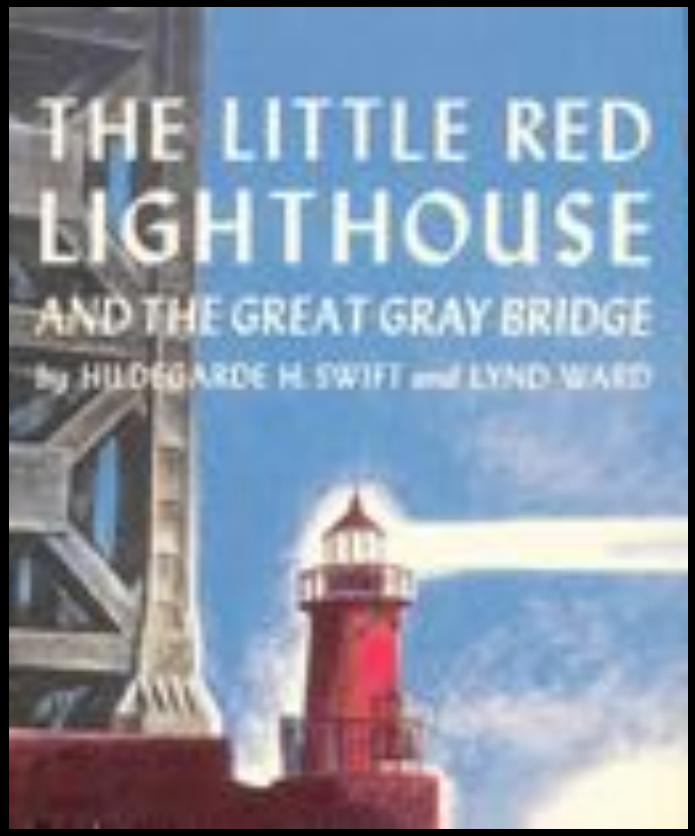


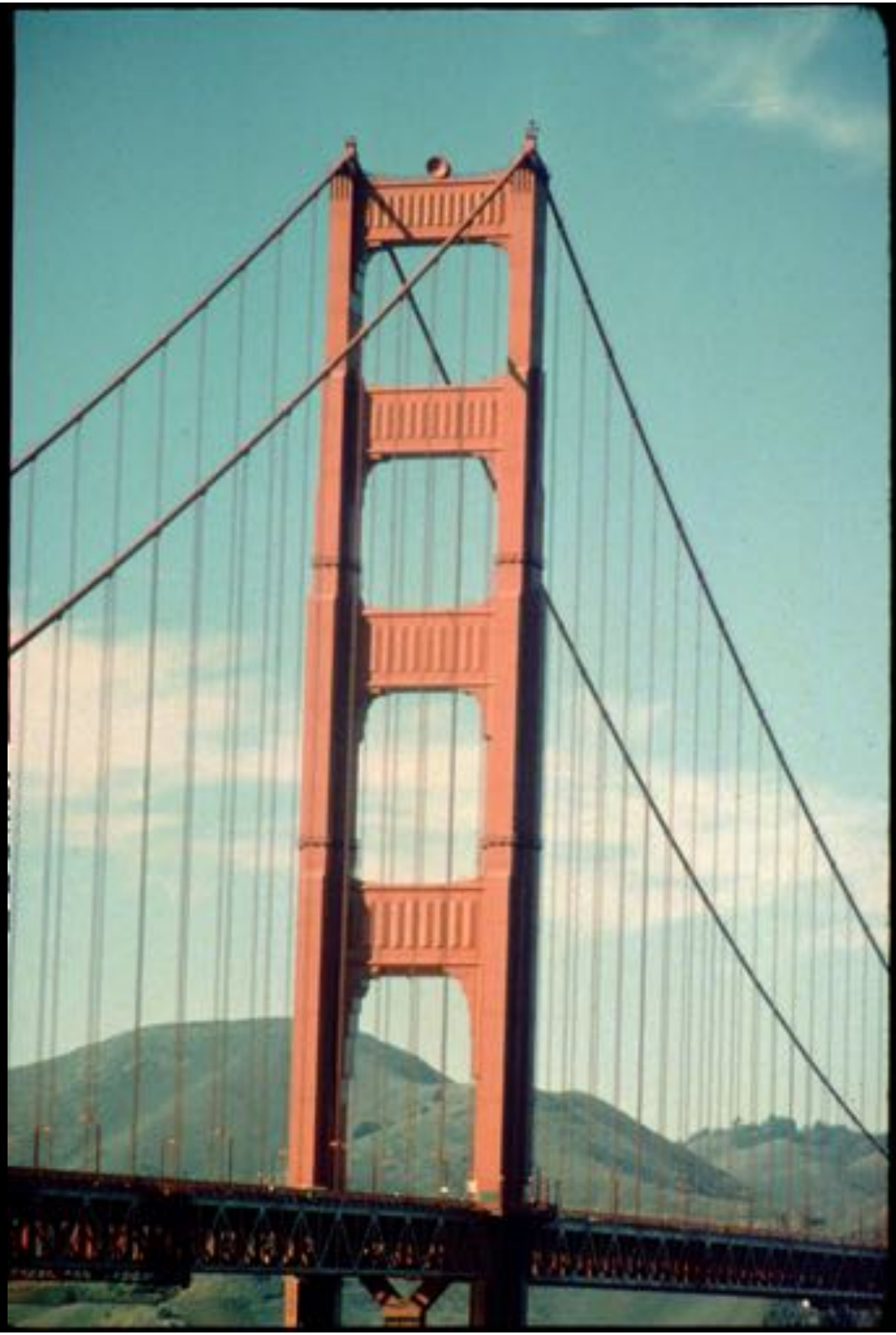

ST. JOHNS BRIDGE
TOWER DESIGN
TOTAL HEIGHT 400 FEET
ROBINSON and STEINMAN
CONSULTING ENGINEERS
NEW YORK PORTLAND
MARCH 1928


CASS GILBERT

GWB Today

(NY Port Authority Site)


THE LITTLE RED
LIGHTHOUSE
AND THE GREAT GRAY BRIDGE
by HILDEGARDE H. SWIFT and LYND WARD

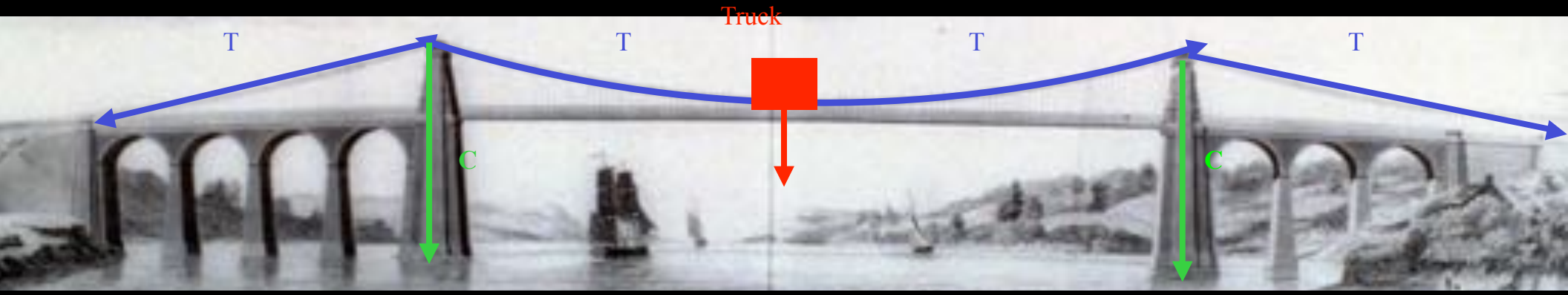


Golden Gate Bridge
1937
4200 feet [1280 m]

Suspension Bridge Statics and understanding tall towers

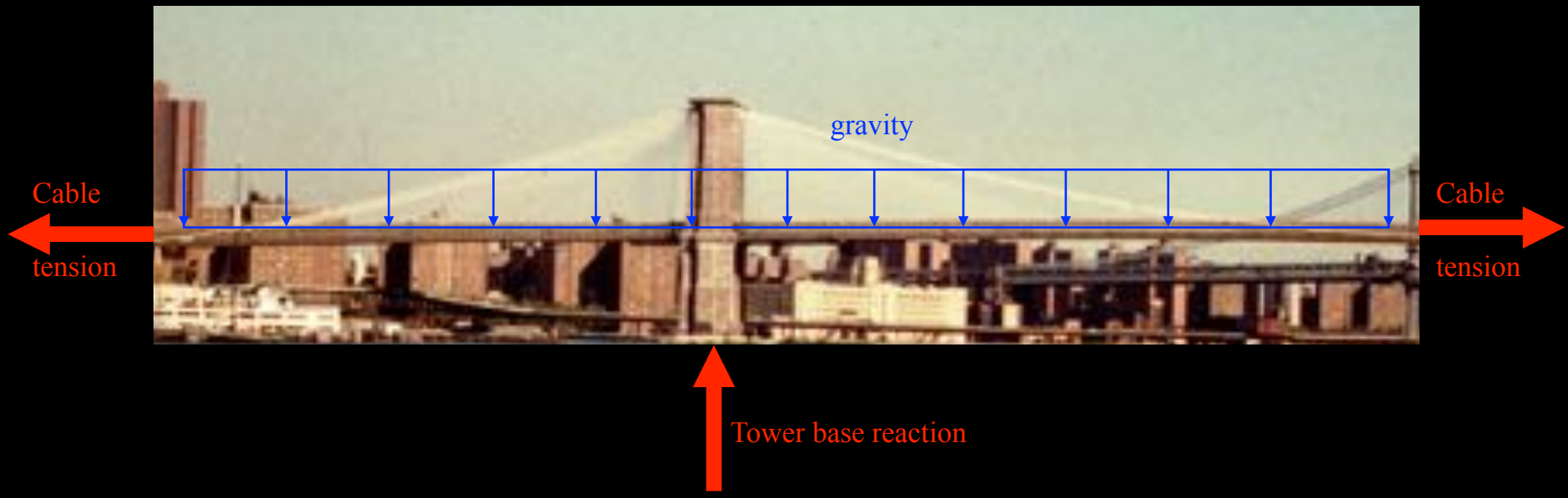
Load Path

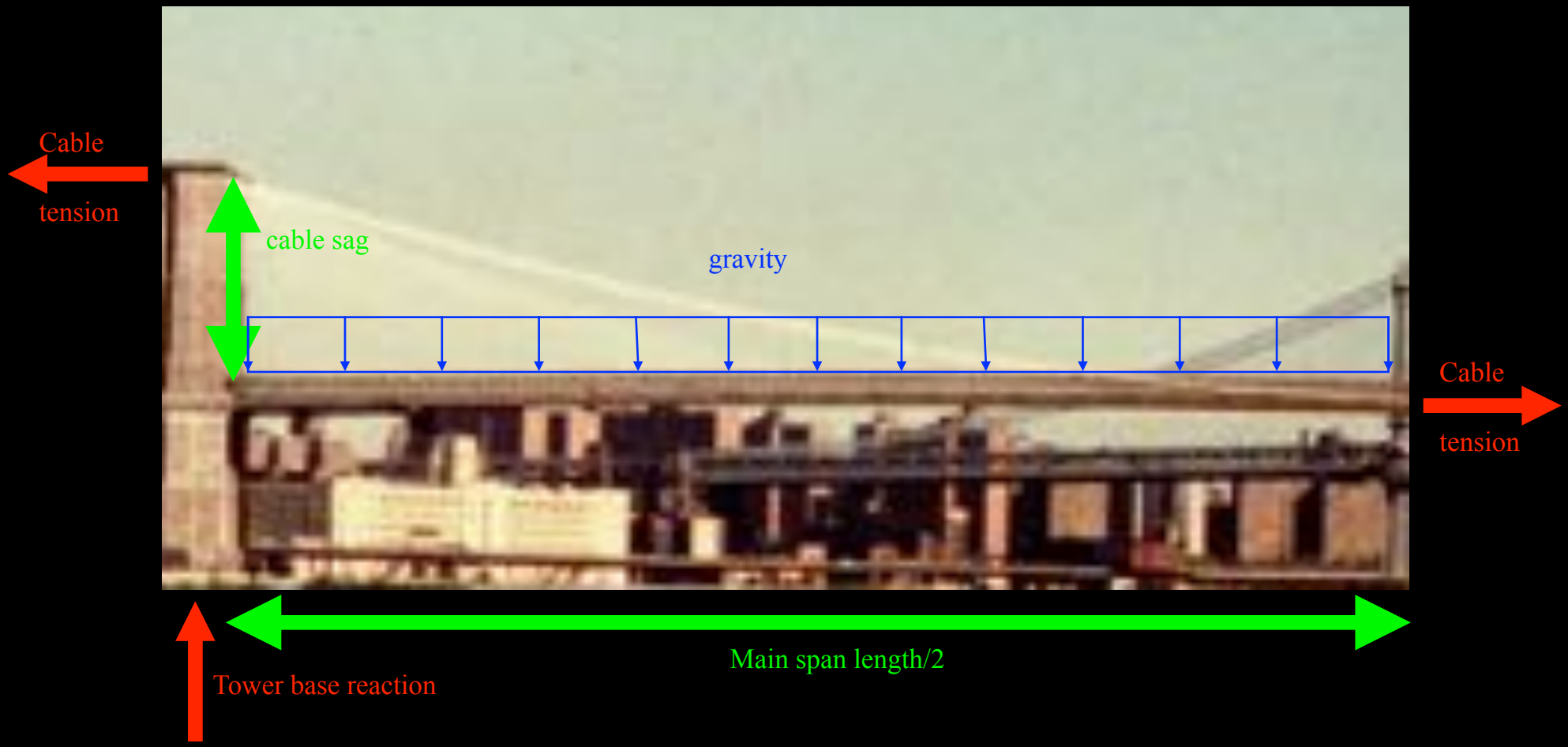
All forces or loads must eventually get to the ground.
Can we trace the path of tension of compression?



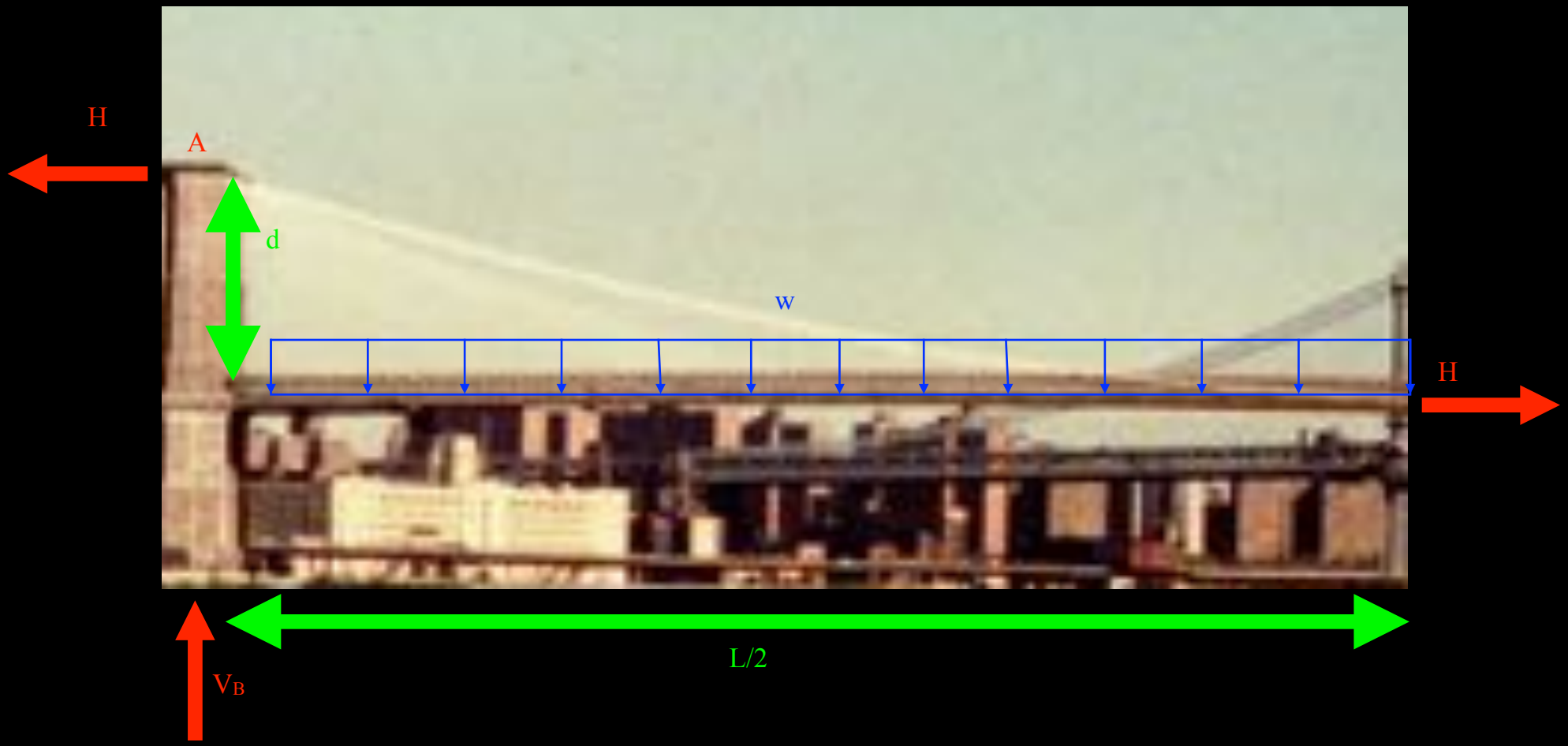
Free Body Diagrams

A sketch of all or part of a structure, detached from its support

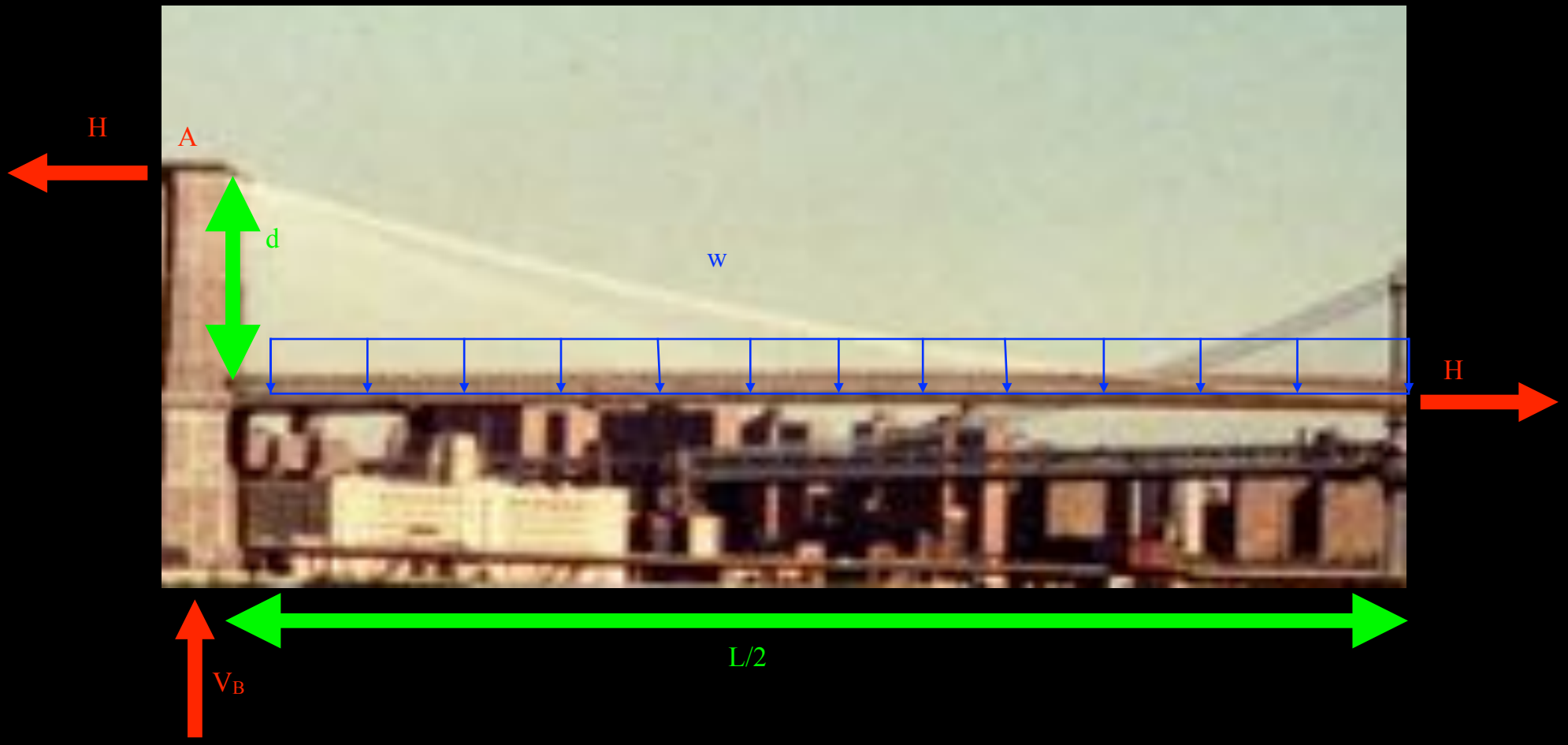



Cable
tension
cable sag
gravity
Cable
tension
Tower base reaction
Main span length/2

Notation

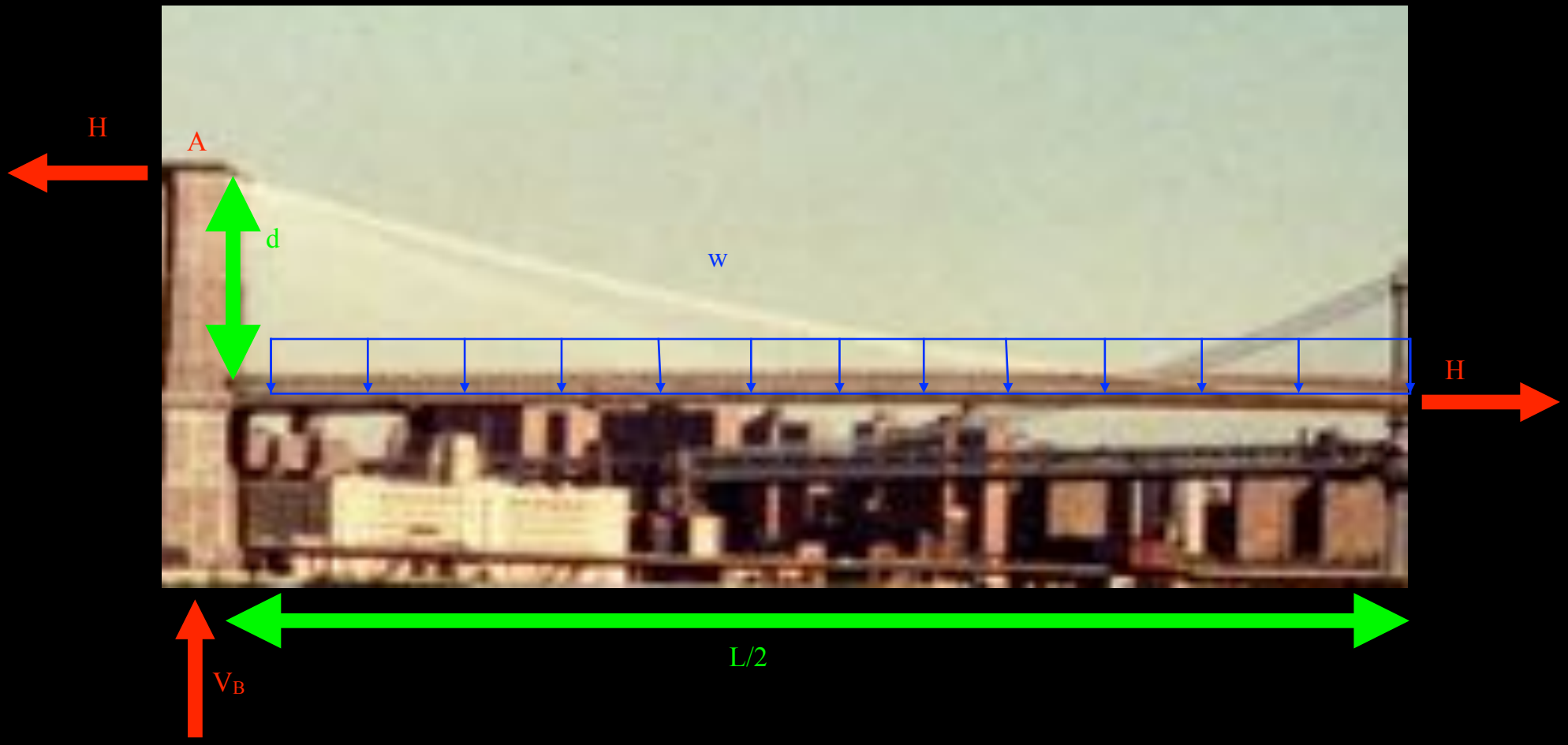


Equilibrium



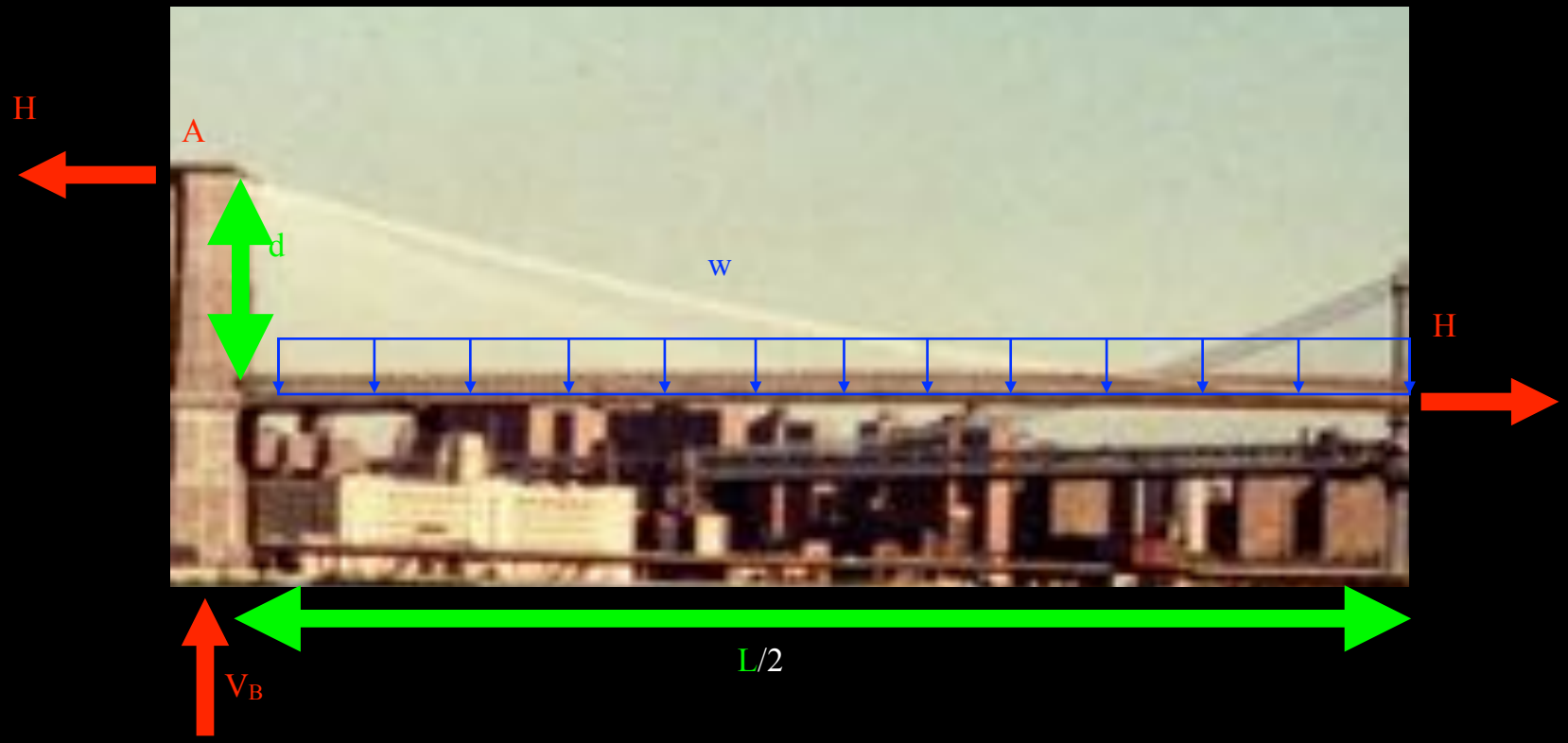
$$\Sigma M_A = 0$$

Equilibrium



$\Sigma M_A = 0, \quad Hd - wL^2/8 = 0, \quad H = wL^2/8d$

Cable tension



$H = wL^2/8d$

$R = L/d$

$H = wLR/8$

w = load

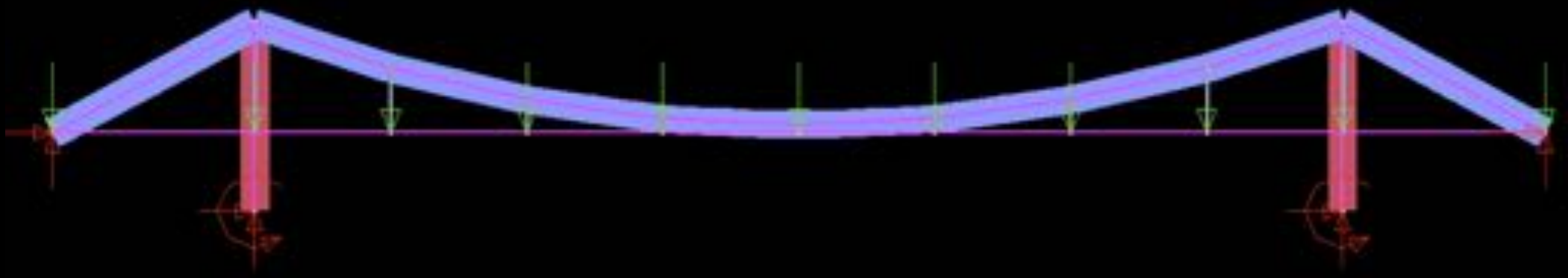
L = size

R = form

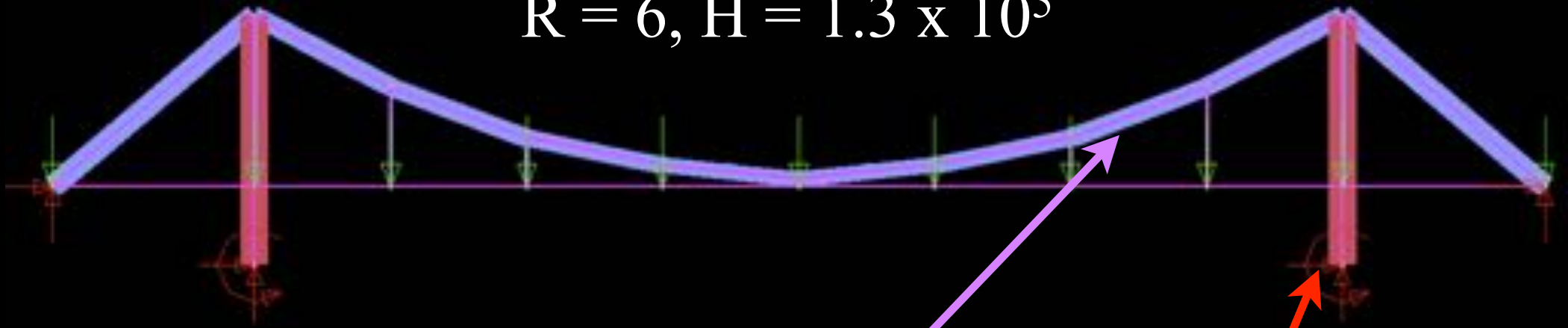
H = function

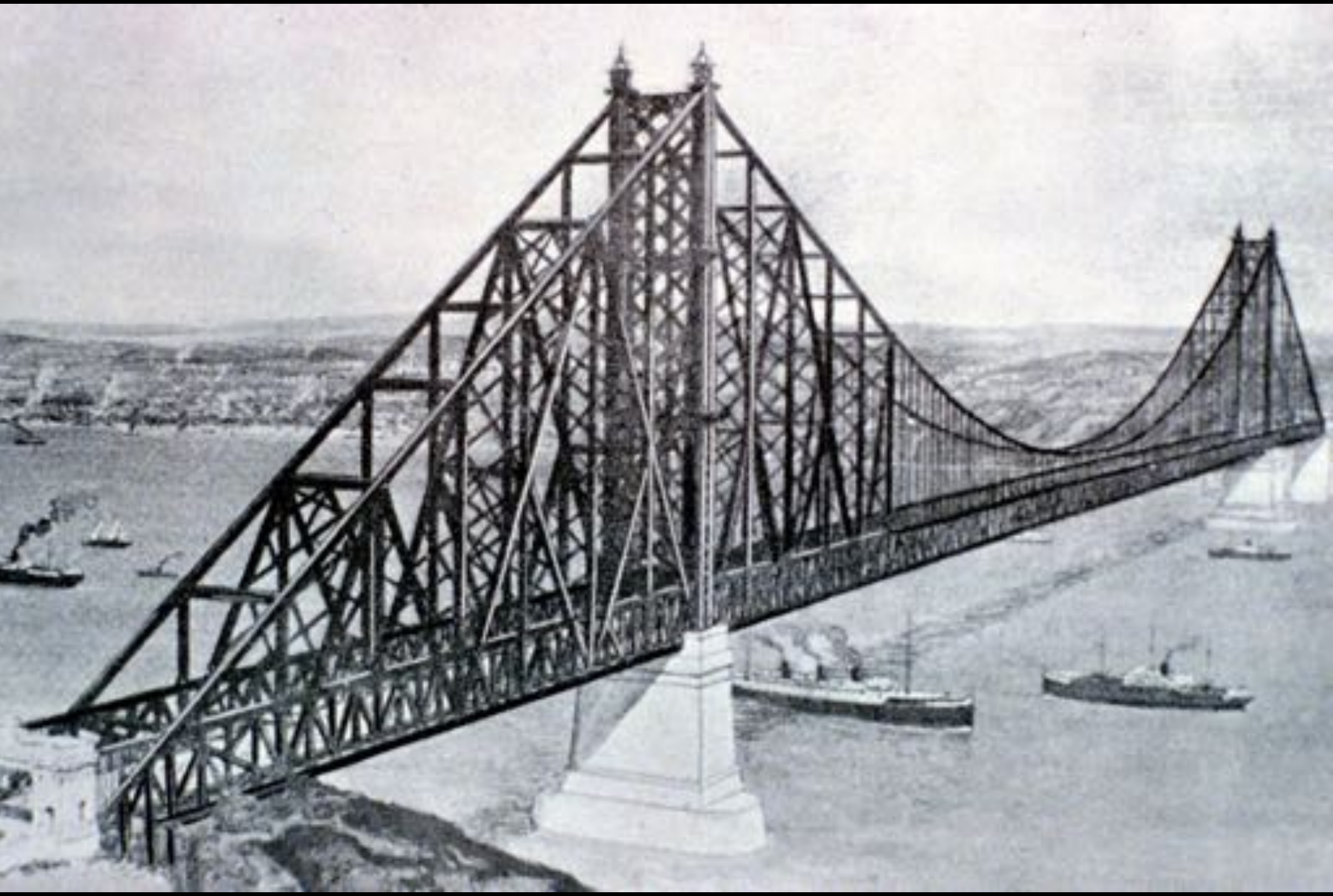
R,L transform w into H

$R = 10, H = 2 \times 10^5$

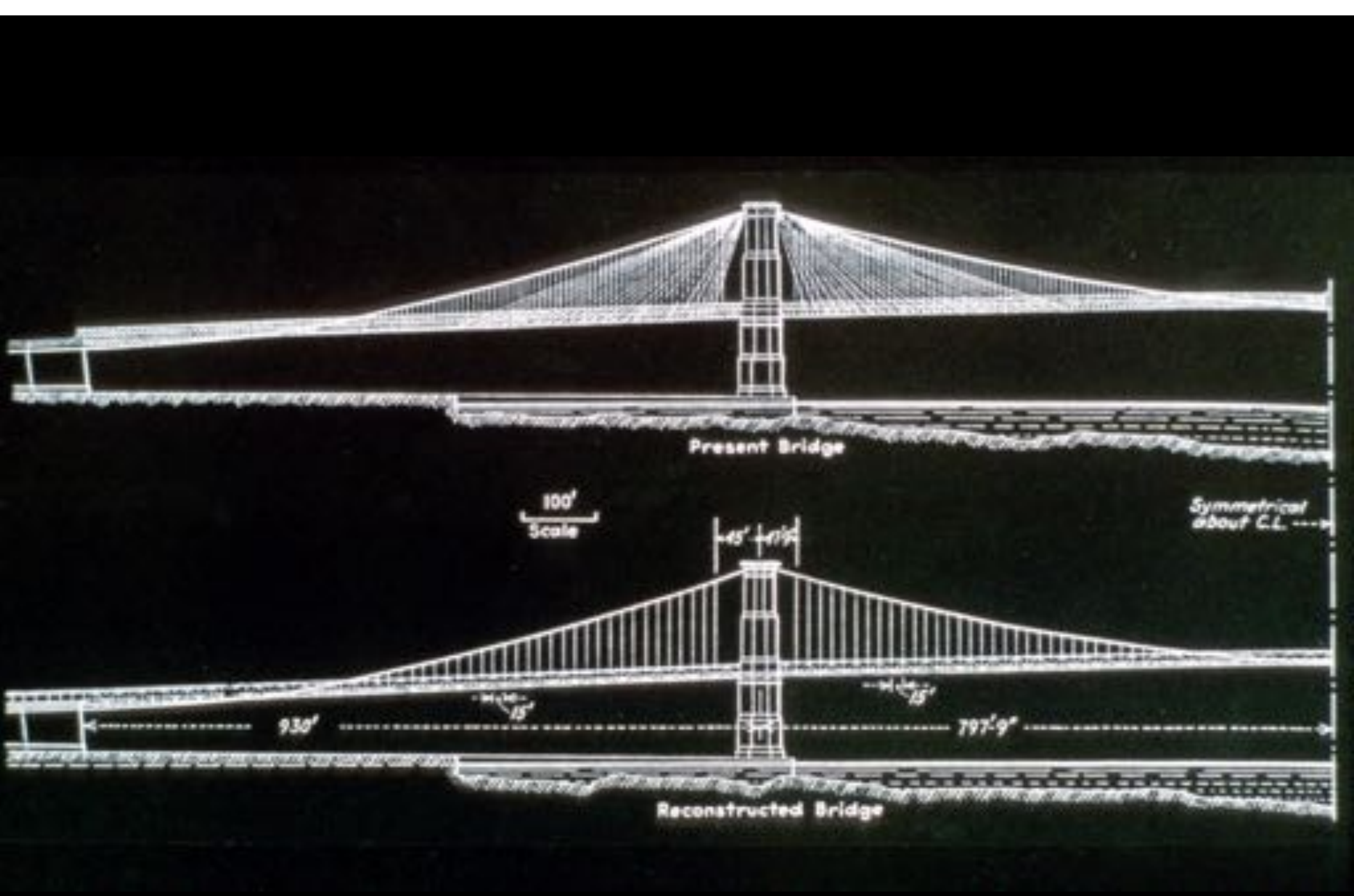


$R = 6, H = 1.3 \times 10^5$





returning to NYC mid twentieth century and the work of Amman (and Steinman)


Present Bridge
100'
Scale
45'
Symmetrical
about C.L.
15'
15'
930'
797'-9"
Reconstructed Bridge

PROPOSED BRIDGE OVER THE NARROWS

Verrazano Narrows, Amman, 4260 ft [1298 m], 1964 (world’s longest at completion)

Verrazano Narrows, Amman, 4260 ft [1298 m], 1964 (world’s longest at completion)

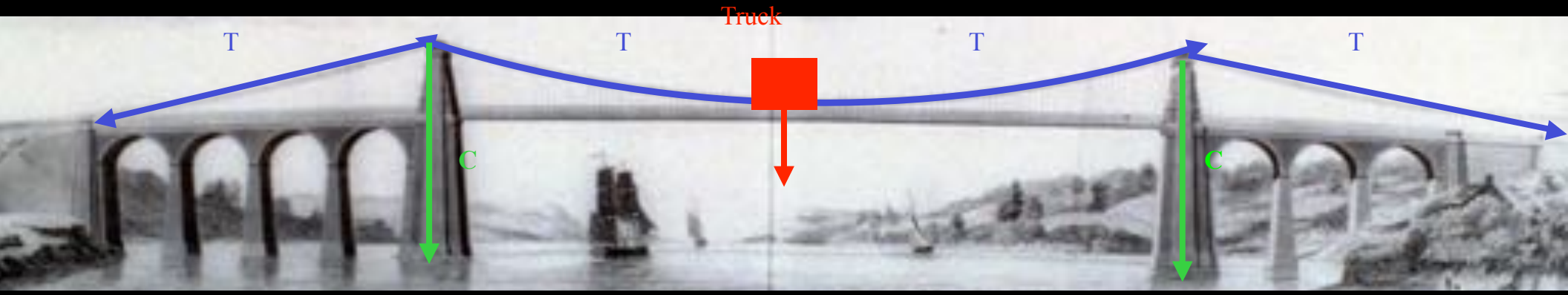
Othmar Ammann (1879 - 1965)

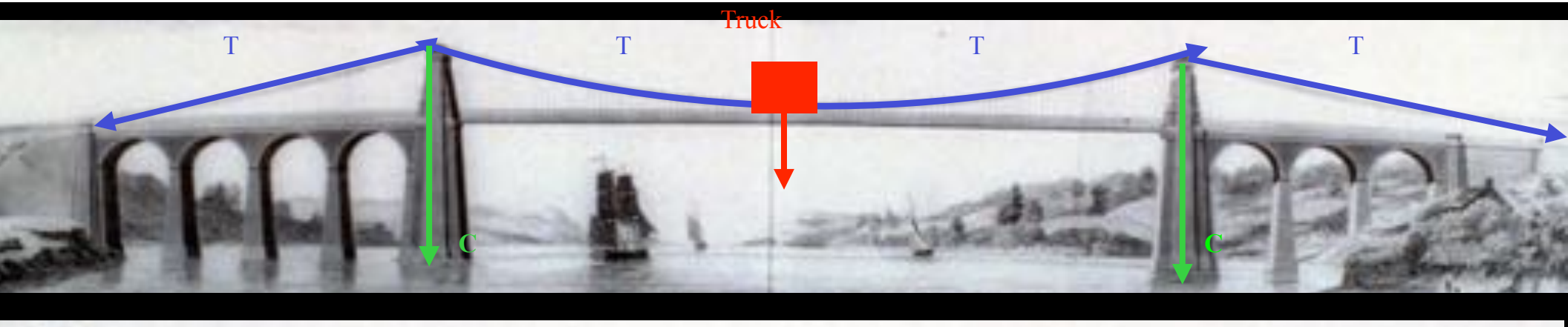
"For a half-century of distinguished leadership in the design of great bridges which combine beauty and utility with bold engineering concept and method."

Suspension Bridge Statics

Load Path

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

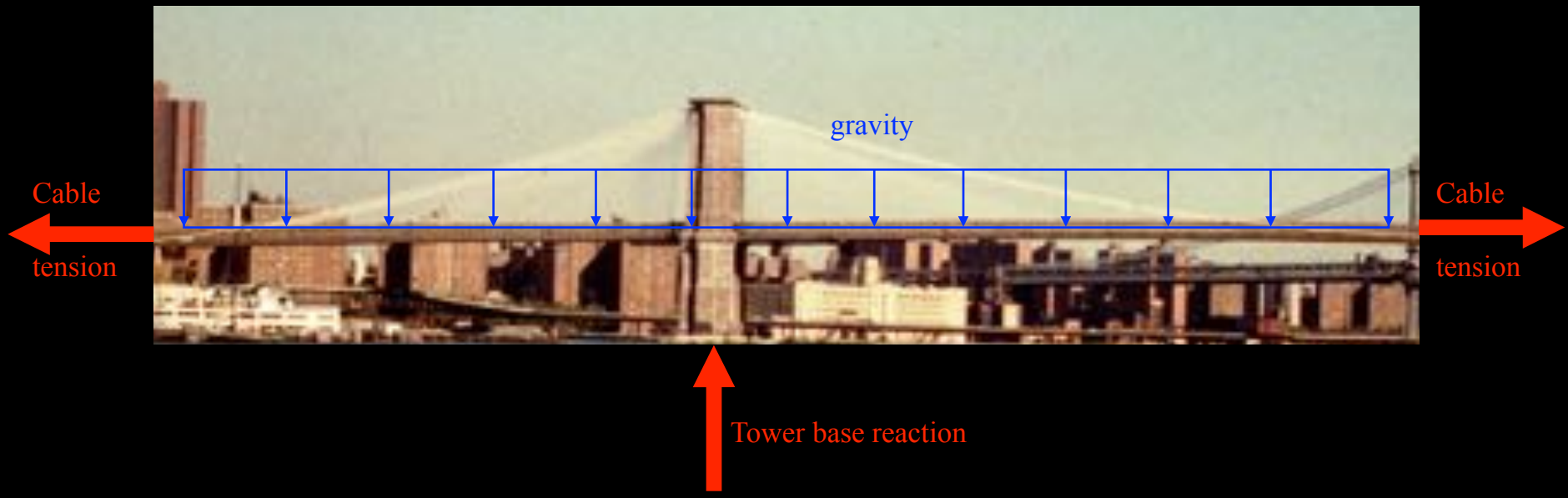


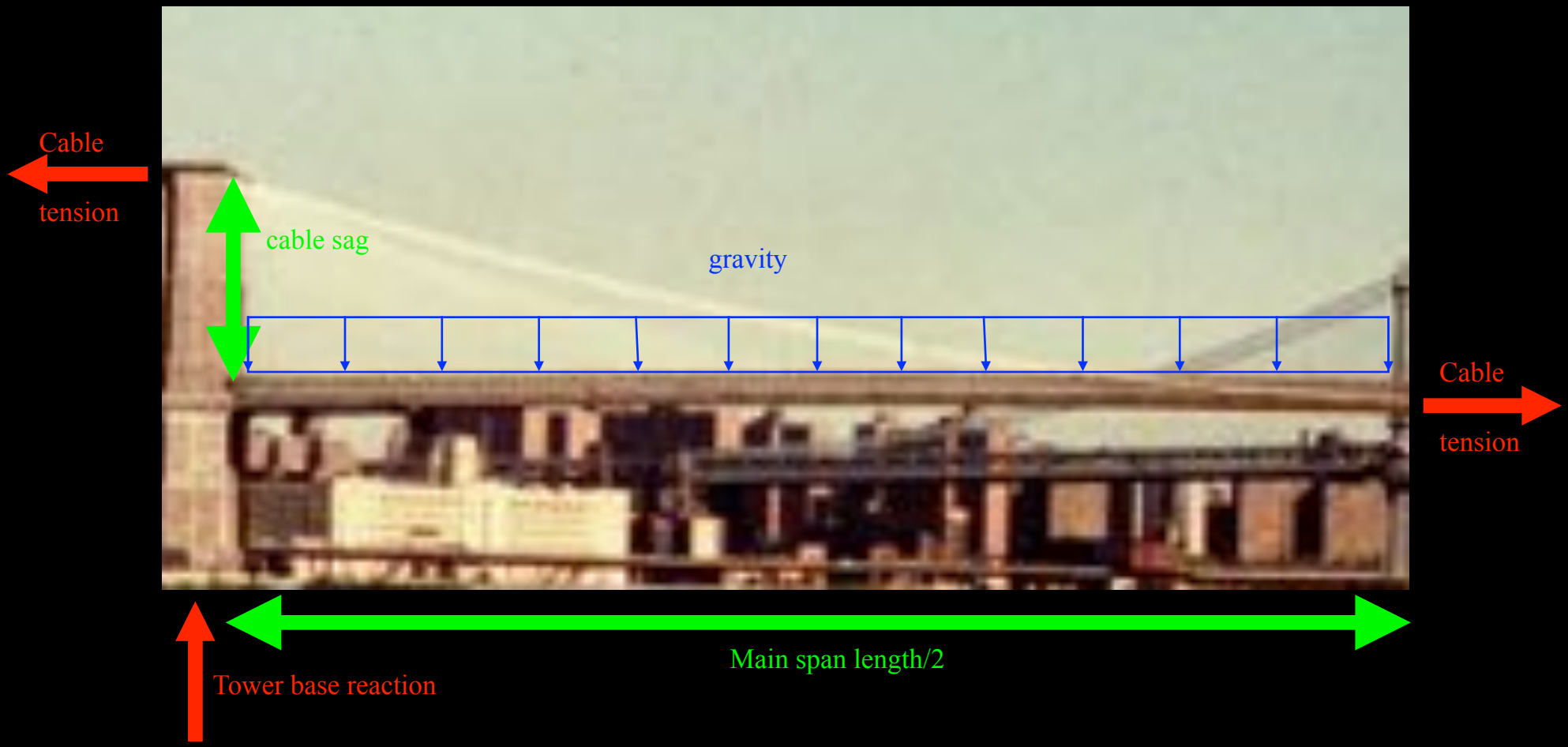


How does Roebling's introduction of diagonal stays introduce ambiguity to the load path?

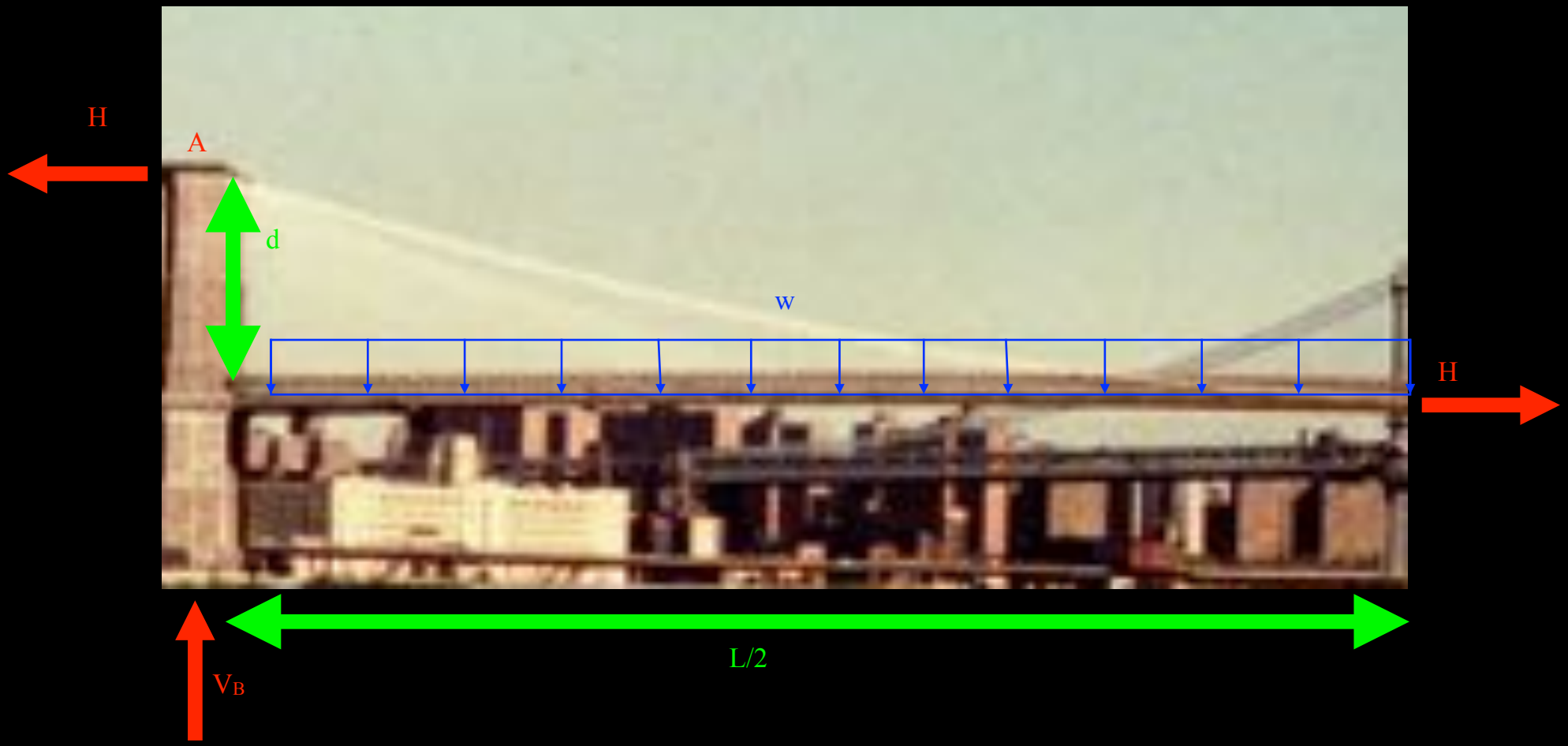
Free Body Diagrams

A sketch of all or part of a structure, detached from its support

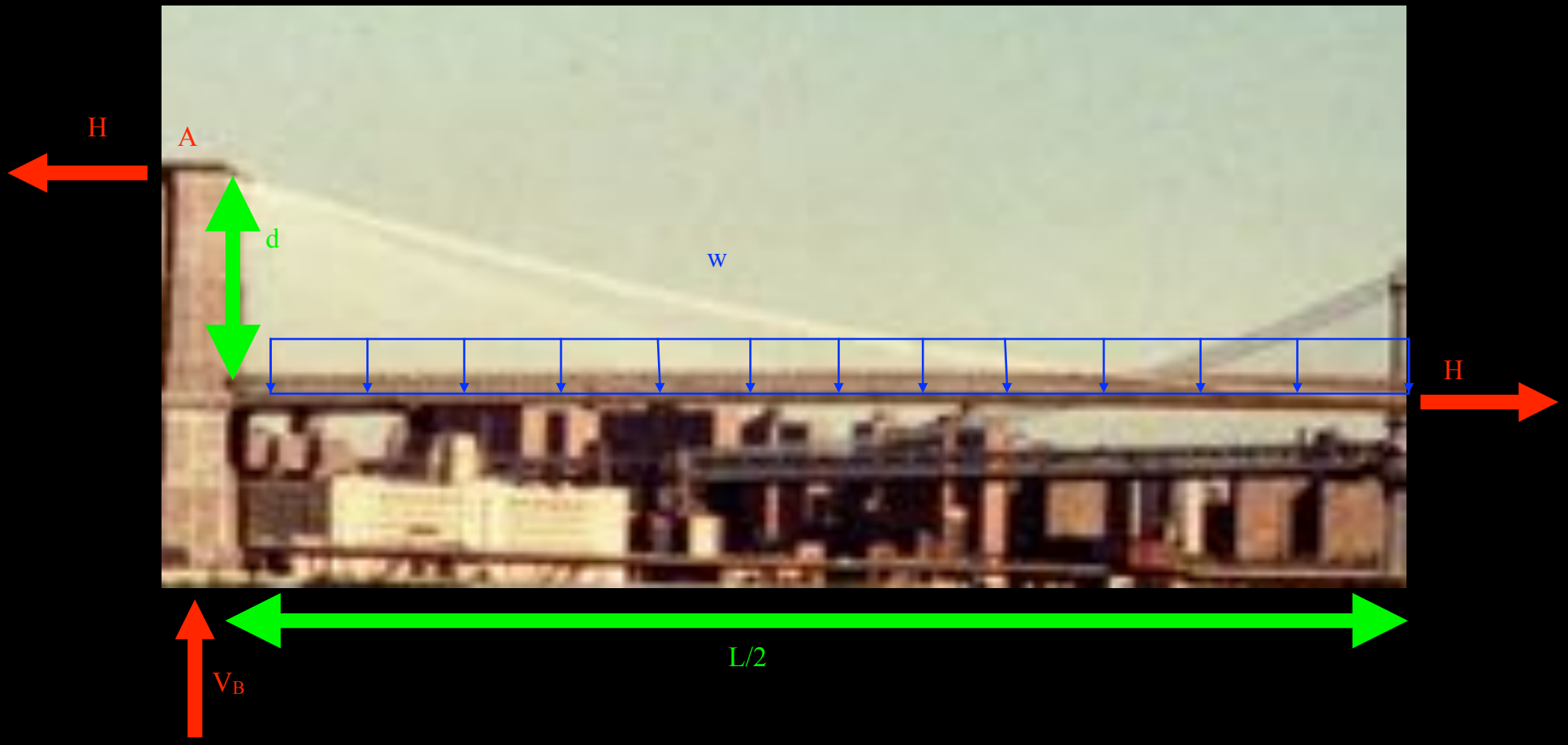



Cable
tension
cable sag
gravity
Cable
tension
Tower base reaction
Main span length/2

Notation

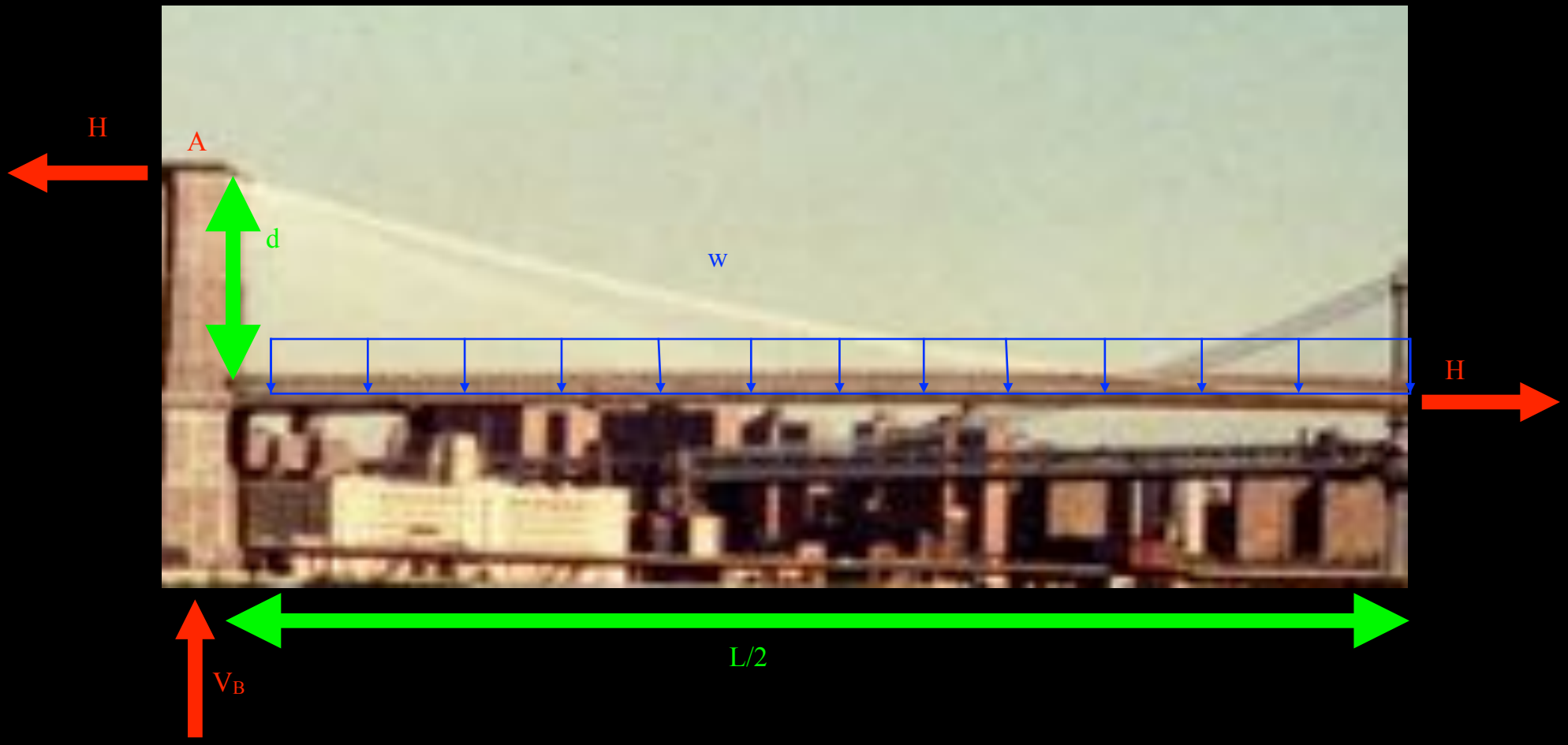


Equilibrium



$$\Sigma M_A = 0$$

Equilibrium



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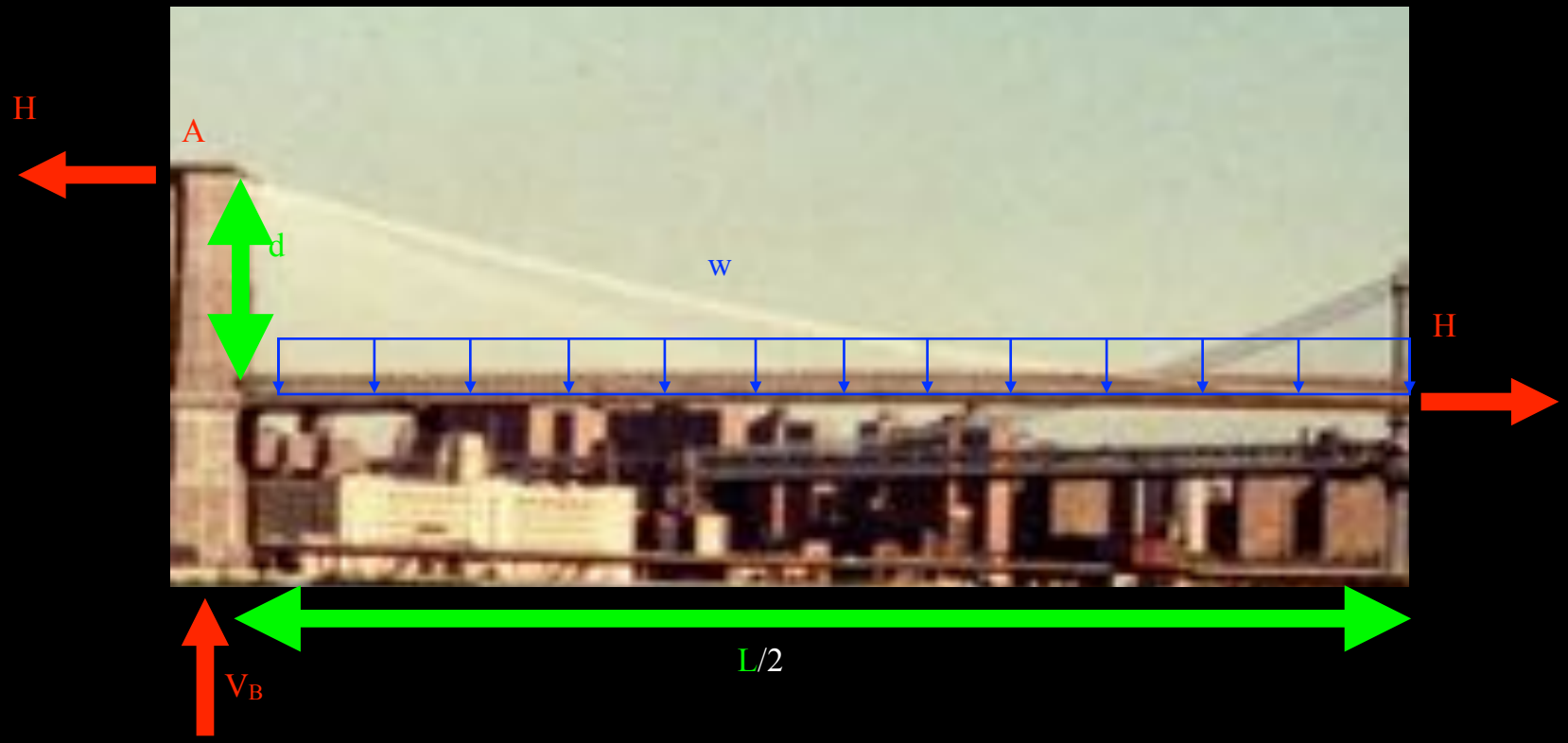
Cable tension



$H = wL^2/8d$

$R = L/d$

$H = wLR/8$

w = load

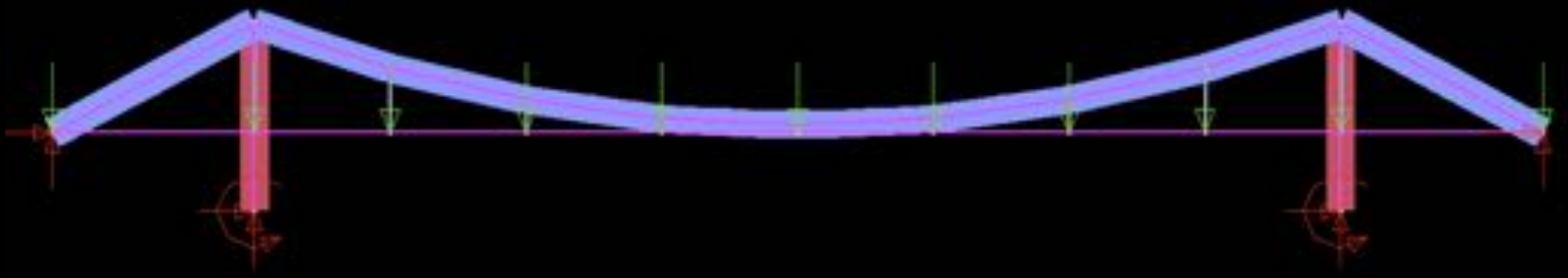
L = size

R = form

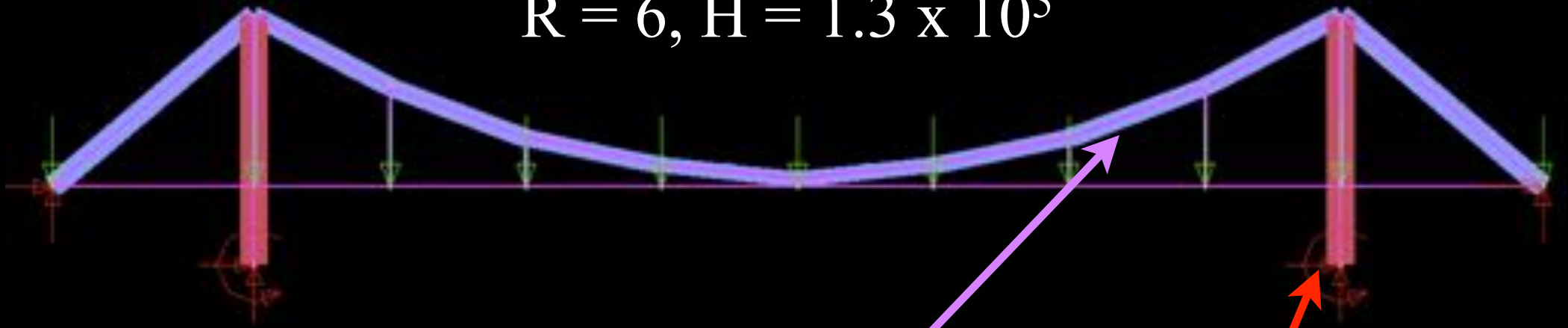
H = function

R,L transform w into H

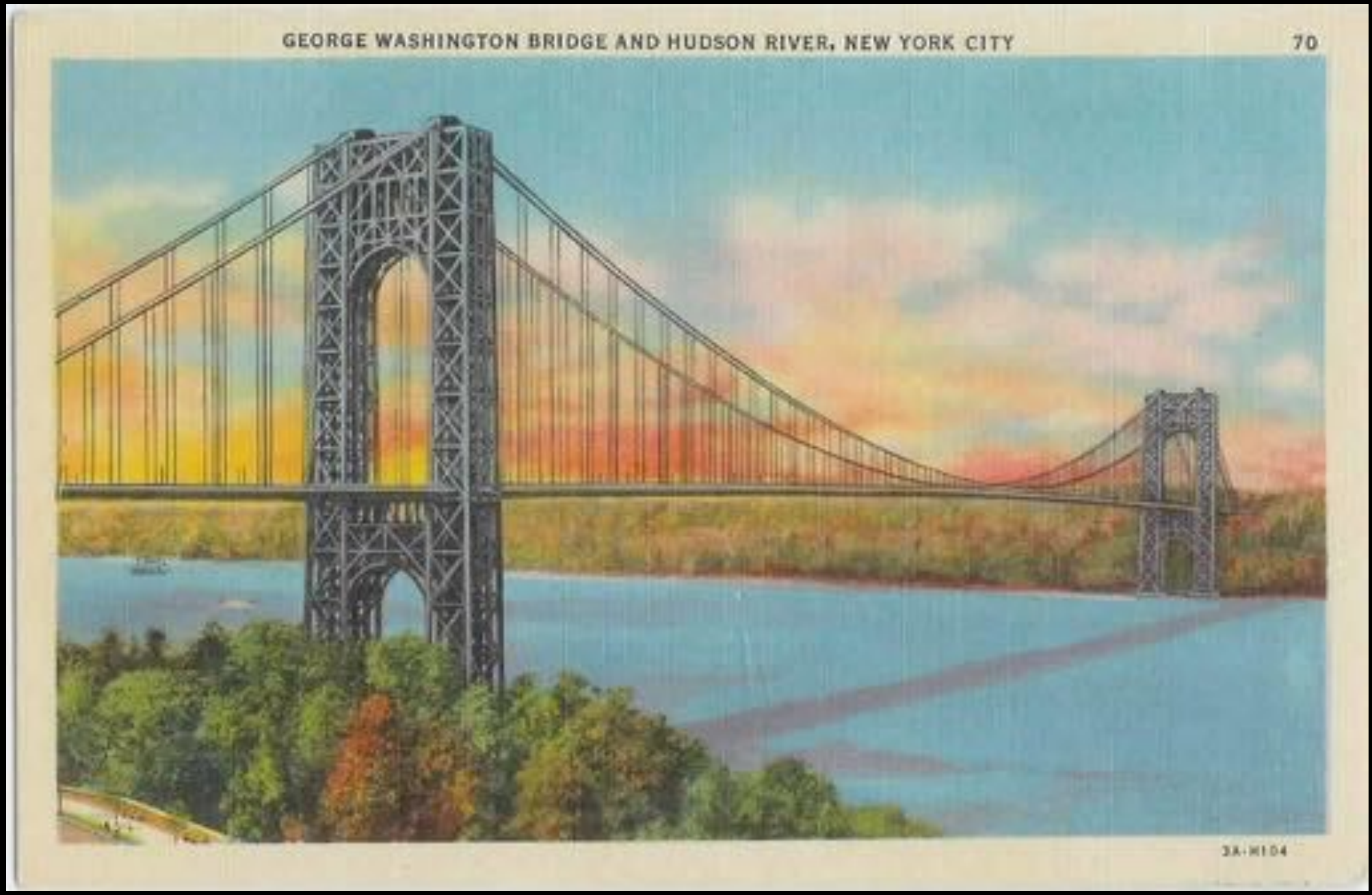
$R = 10, H = 2 \times 10^5$



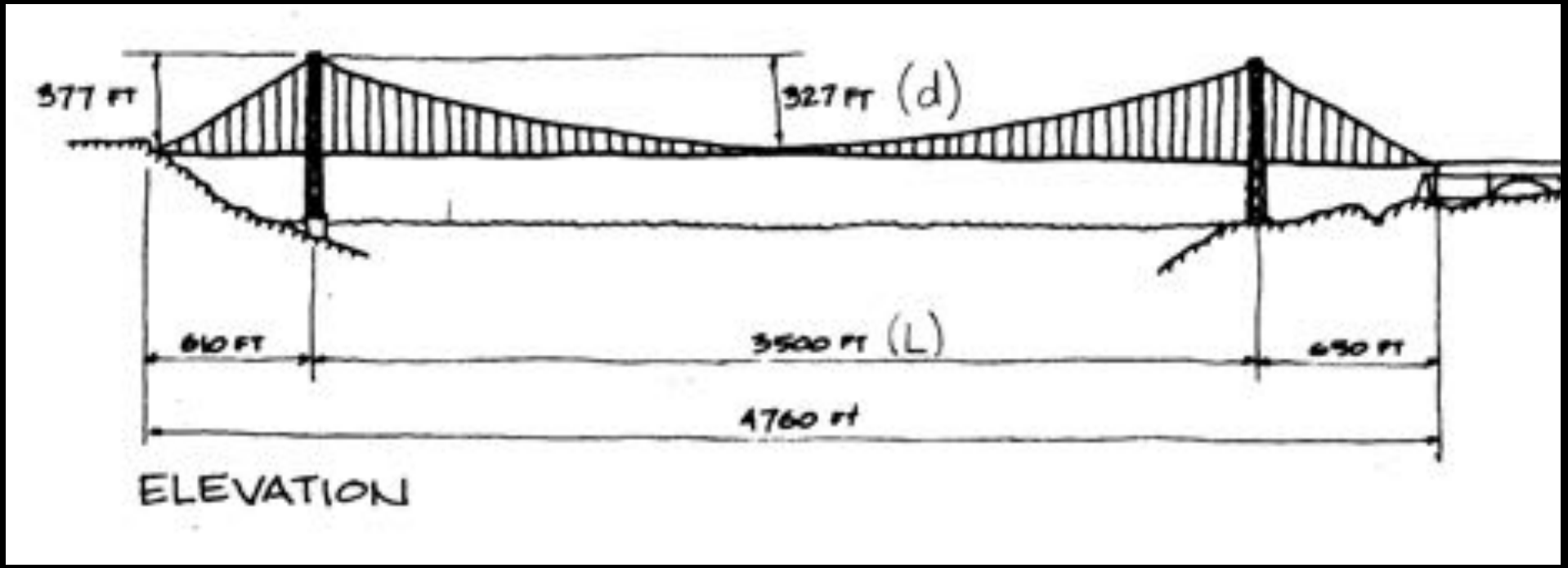
$R = 6, H = 1.3 \times 10^5$

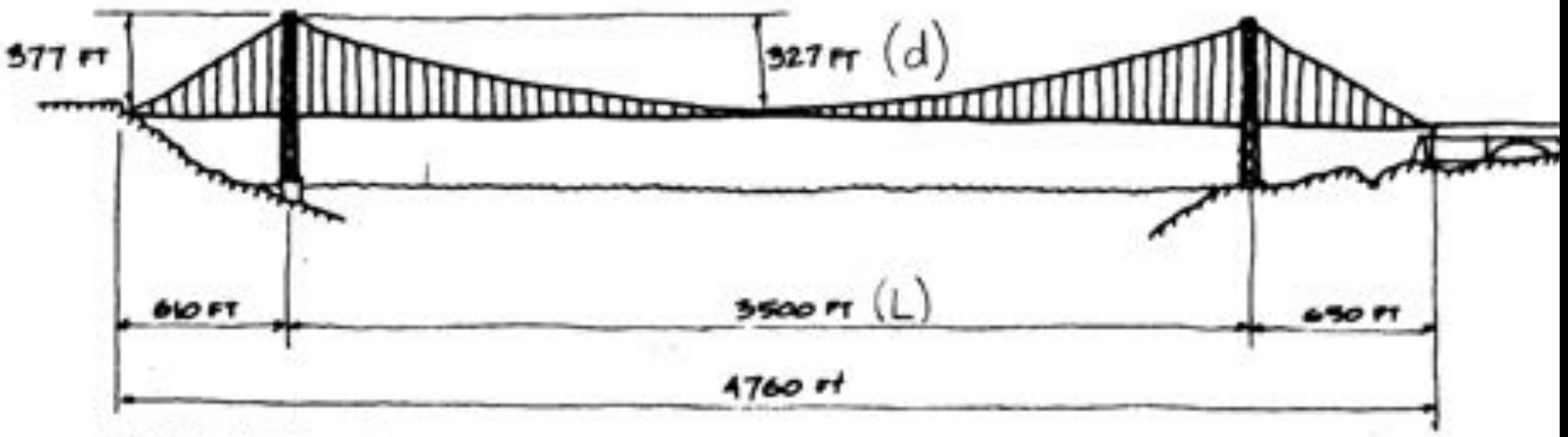


George Washington Bridge Study

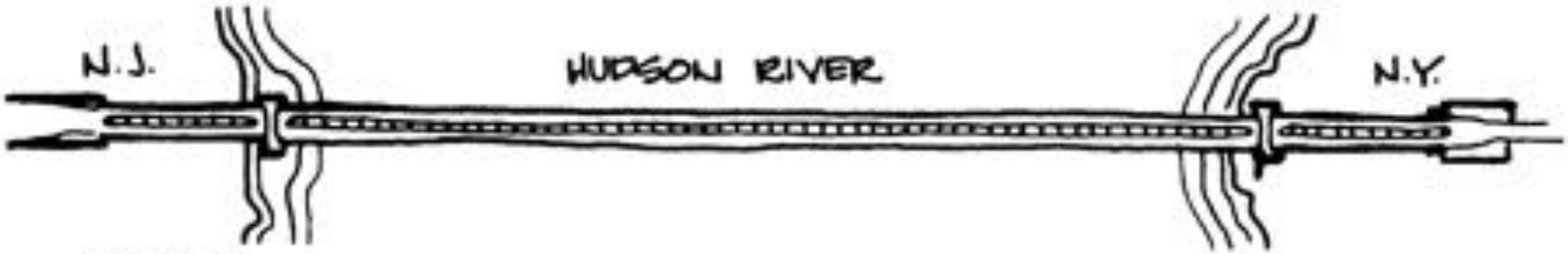


http://www.sbe.hw.ac.uk/staff/arthur/frbpc/GoldenGate%20Bridge.htm


577 FT
327 FT (d)
610 FT
3500 FT (L)
650 FT
4760 ft
ELEVATION

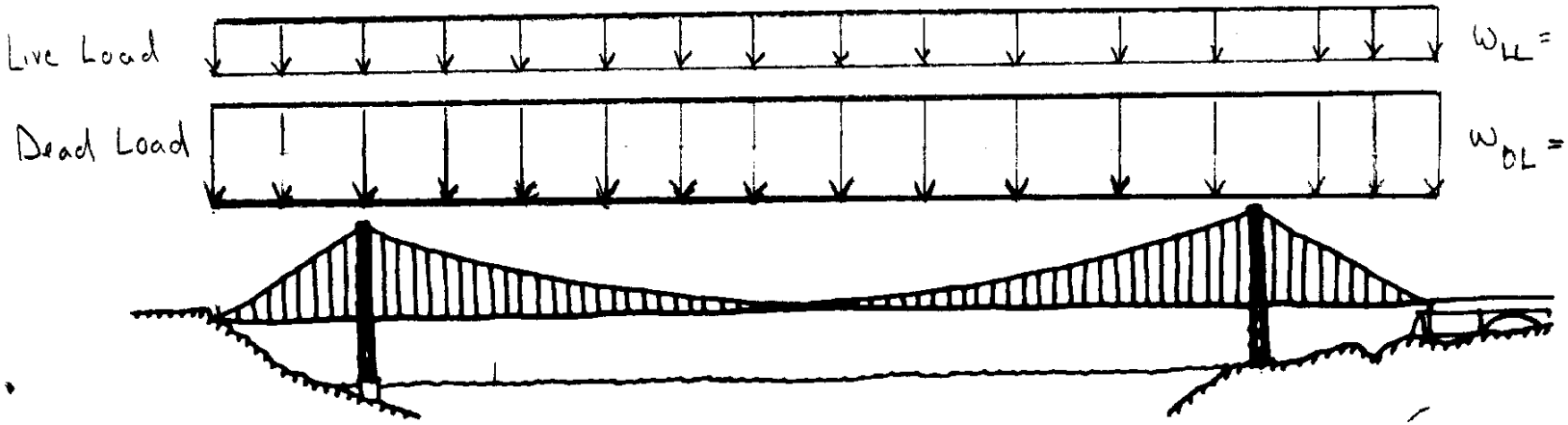


ELEVATION

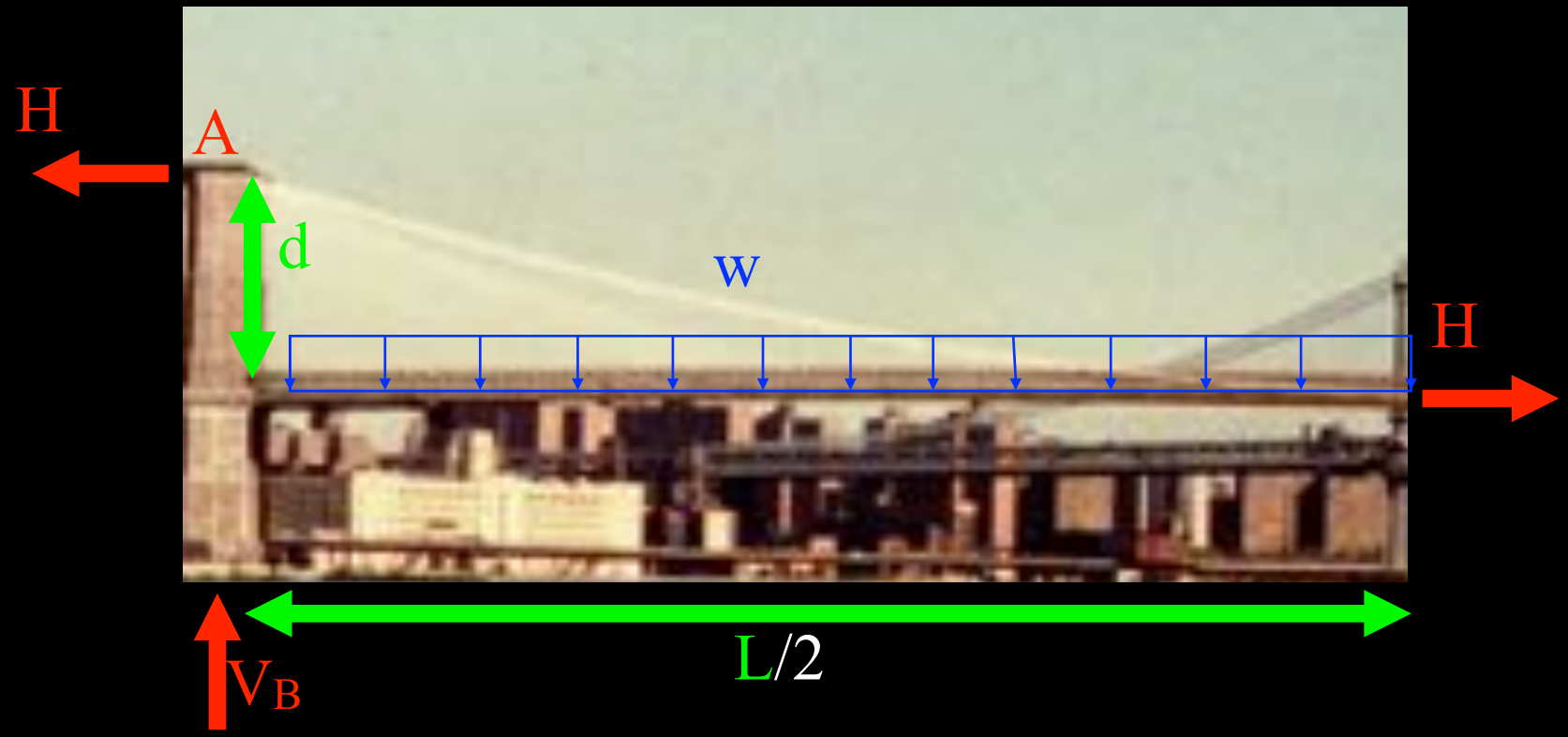


PLAN

Design Loads



Cable tension



$H = wL^2/8d$

$R = L/d$

$H = wLR/8$

w = load

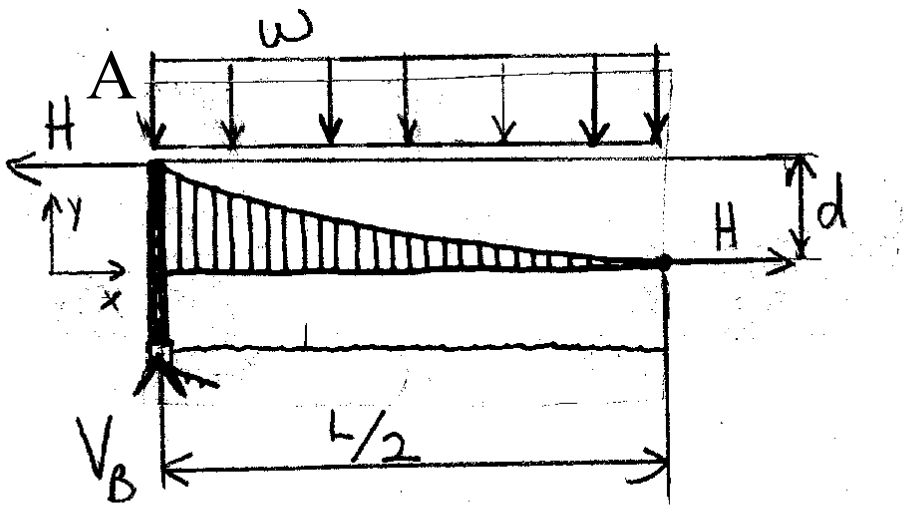
L = size

R = form

H = function

R,L transform w into H

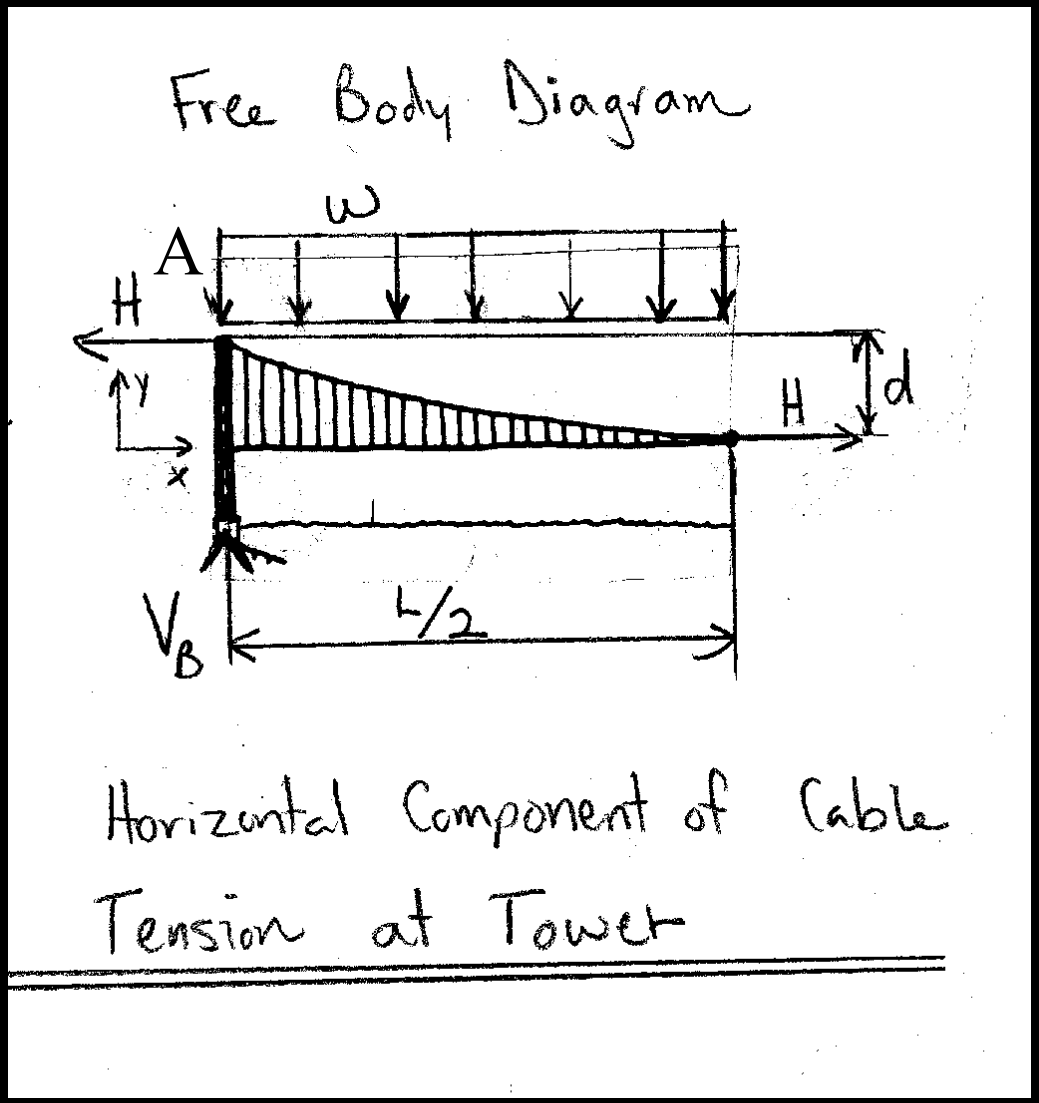
Free Body Diagram



Horizontal Component of Cable Tension at Tower

$$H = \frac{wL}{8} R$$

$$R = \frac{L}{d}$$



$$H = \frac{wL}{8} R$$

$$\text{cable stress} = \frac{\text{cable tension}}{\text{cable area}}$$

$$\sigma = H/A$$

$$\text{safety factor} = \frac{\text{allowable stress}}{\text{cable stress}}$$

safety factor > 1 ?

safety factor < 1 ?

safety factor = 1 ?

efficiency versus safety