History and Aesthetics in Suspension Bridges

(Othmar Ammann, NYC Bridges, and 20th century bridge engineering)

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
Locations of Ammann’s New York bridges

Gustav Lindenthal (1850-1935)

Hellgate Bridge - Gustav Lindenthal - 1916 - 977 feet
a brief tour of suspension bridge aesthetics (or lack of)
returning now to Lindenthal, Amman, and the design and development of the GWB
How is this bridge stiffened?
George Washington Bridge - Othmar Ammann - 3500 feet - 1931

Deer Isle Bridge - David Steinman
Tacoma Video

First Tacoma Narrows Bridge
Consider the aesthetics and scientific function of towers particularly Ammann’s vs. Steinman’s towers
Golden Gate Bridge
1937
4200 feet
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."
Load Path
All forces or loads must eventually get to the ground. Can we trace the path of tension or 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.

Tower base reaction

Gravity

Cable tension

Cable tension

Tower base reaction

Main span length/2

Equilibrium

\[ \Sigma M_A = 0 \]

Notation

\[ V_B \]

\[ w \]

\[ H \]

\[ L/2 \]

\[ d \]

\[ A \]
Equilibrium

\[ \Sigma M_A = 0, \quad H_d - \frac{wL^2}{8} = 0, \quad H = \frac{wL^2}{8d} \]

Cable tension

\[ H = \frac{wL^2}{8d} \]
\[ w = \text{load} \]
\[ L = \text{size} \]
\[ R = \text{form} \]
\[ H = \text{function} \]

R, L transform w into H

George Washington Bridge Study

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

R = 6, H = 1.3 \times 10^5
Cable tension

\[ H = \frac{wL^2}{8d} \]

\[ w = \text{load} \]
\[ L = \text{size} \]
\[ R = \text{form} \]
\[ H = \text{function} \]

\[ R, L \text{ transform } w \text{ into } H \]

Cable stress = cable tension / cable area

\[ \sigma = \frac{H}{A} \]
safety factor = allowable stress \\
           cable stress

safety factor > 1  ?
safety factor < 1  ?
safety factor = 1  ?

efficiency versus safety