Stresses in arches under half-live load

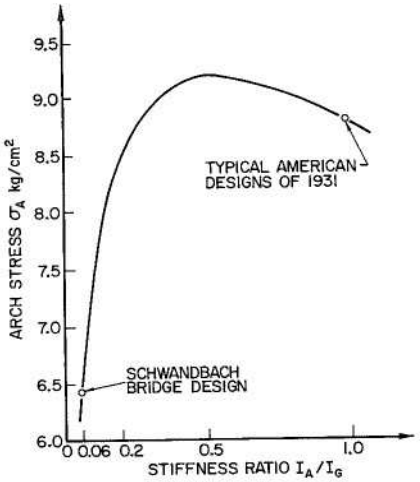
Allen Sit and Sanjay R. Arwade

April 30, 2008

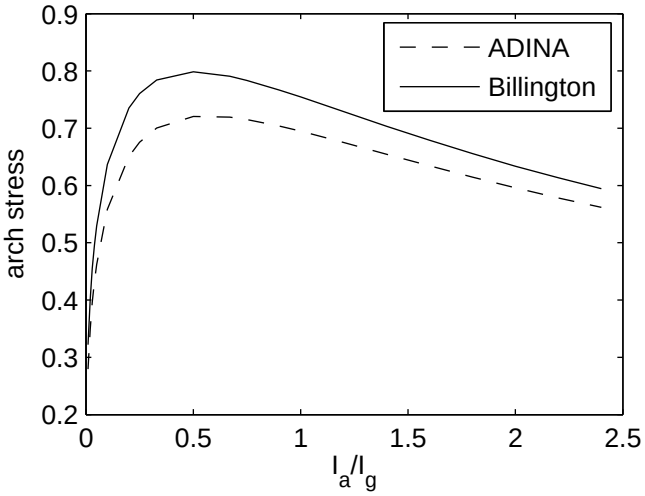
The figure below is taken from Billington's book, *Robert Maillart's Bridges* and is used in that book and in his Structures and the Urban Environment class to show the efficacy of deck stiffening in reducing arch stress. The curve is a plot of the function

$$\sigma_a = \frac{M}{2I_g(\frac{I_a}{I_g h_a} + \frac{1}{h_a})} \tag{1}$$

where I_g and I_a are the arch and deck moment of inertia, h_a is the depth of the rectangular cross section arch, $M = wl^2/64$ is the maximum total bending moment generated by a halfspan live load w, and σ_a is the maximum arch stress. Dead load is neglected.



Allen Sit, an undergrad who is working with me, has developed a model in ADINA of a realistically dimensioned two hinged arch bridge. The figure shown below shows his ADINA results compared with Billington's equation. There is a discrepancy in magnitude that we are trying to work out, but the important part is that the peak in stress occurs at the same point, $I_a/I_g = 0.5$, and the shape of the curves is the same.


ADINA
Billington
arch stress
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
0.5
1
1.5
2
2.5
l_a/l_g