

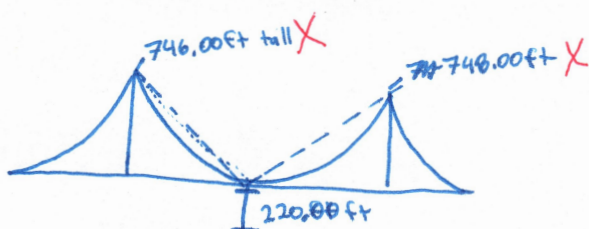
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Name: Leong  
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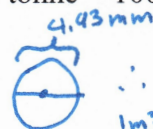
David  
(First)

**CIV102F Quiz # 1: 1300h-1500h Tuesday September 12, 2019**  
**Engineering Computation and Judgment**

Shown on the opposite page is a schematic of the Golden Gate Bridge, located in San Francisco and built in 1937. Each of the two cables which support the deck consists of 27,572 high-strength steel wires wound together into a bundle. The diameter of the individual wires is 4.93 mm and the unit weight of steel is 77 kN/m<sup>3</sup>. Estimate the total weight of steel contained in the primary cables which hold up the bridge (i.e. ignore the vertical wires which connect the primary cables to the bridge deck). Report your answer in units of tonnes (1 tonne = 1000 kg).



Scale: 220ft ~ 1cm on diagram ✓ +1 ✓



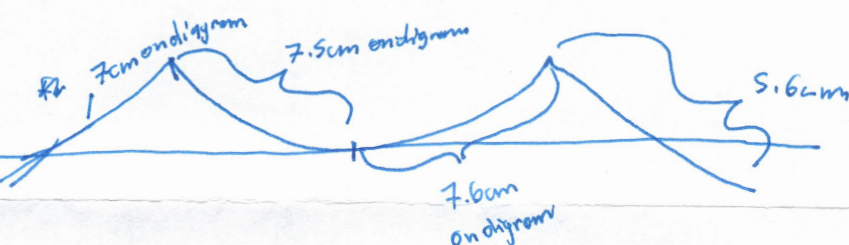
$\therefore r = 2.465 \text{ mm}$   
 $1 \text{ m}^3 = 10^9 \text{ mm}^3$

$A_c = \pi r^2 = \pi (2.465 \text{ mm})^2 = 16.08 \text{ mm}^2$  ✓ +1

$\therefore 16.08 \text{ mm}^2 \cdot 27572 = 443673.76 \text{ mm}^2$  per cable bundle, ✓ +1

$V_B = 443673.76 \text{ mm}^2 \cdot L_{BT}$  ✓ +1

where  $L_{BT}$  is the total length of all ~~cables~~ primary cables



$\therefore T_{\text{tot}} = 27.7 \text{ cm}$

$L_B = 160927.7 \text{ cm} \cdot 220.00 \text{ ft/cm} = 6094 \text{ ft}$

$6094 \text{ ft} \cdot \frac{304.8 \text{ mm}}{1 \text{ ft}} = 1857451.2 \text{ mm}$

$\therefore V_B = \pi 443673.76 \text{ mm}^2 \cdot 1857451.2 \text{ mm}$   
 $\approx 3.11378 \times 10^{11} \pi \text{ mm}^3 = 311 \pi \text{ m}^3$

$\therefore \text{weight} = 77 \text{ kN} \cdot 311 \pi \text{ m}^3 \approx 75300 \text{ kN}$  ✓ +1

Need it in tonnes so  $\frac{\text{weight in kN}}{g} = \text{mass in tonnes}$

Actual:  $L = \sim 4662 \text{ m}$   
 $W_T = \sim 19220 \text{ tonnes}$

Reminder: Please report all final answers using slide-rule precision (ie, four significant figures if the first digit is a "1", three otherwise)

Let  $f(x)$  be a function defined on  $[a, b]$ .  
Then the function  $f(x)$  is said to be continuous at  $x = c$  if

the following conditions are satisfied:  
(i)  $f(c)$  is defined.  
(ii)  $\lim_{x \rightarrow c} f(x)$  exists.  
(iii)  $\lim_{x \rightarrow c} f(x) = f(c)$ .



A function  $f(x)$  is said to be continuous on the interval  $[a, b]$  if it is continuous at every point  $x$  in the interval.

Example: The function  $f(x) = x^2$  is continuous on the interval  $[0, 1]$ .  
Proof: Let  $c$  be any point in  $[0, 1]$ . Then  $f(c) = c^2$  is defined. Also,  $\lim_{x \rightarrow c} x^2 = c^2 = f(c)$ . Hence,  $f(x)$  is continuous at  $c$ . Since  $c$  is arbitrary,  $f(x)$  is continuous on  $[0, 1]$ .



Example: The function  $f(x) = \begin{cases} x^2 & \text{if } x \neq 1 \\ 2 & \text{if } x = 1 \end{cases}$  is not continuous at  $x = 1$ .  
Proof:  $f(1) = 2$  is defined. But  $\lim_{x \rightarrow 1} x^2 = 1 \neq 2 = f(1)$ . Hence,  $f(x)$  is not continuous at  $x = 1$ .

Example: The function  $f(x) = \sin x$  is continuous on the interval  $[-\frac{\pi}{2}, \frac{\pi}{2}]$ .  
Proof: Let  $c$  be any point in  $[-\frac{\pi}{2}, \frac{\pi}{2}]$ . Then  $f(c) = \sin c$  is defined. Also,  $\lim_{x \rightarrow c} \sin x = \sin c = f(c)$ . Hence,  $f(x)$  is continuous at  $c$ . Since  $c$  is arbitrary,  $f(x)$  is continuous on  $[-\frac{\pi}{2}, \frac{\pi}{2}]$ .

Example: The function  $f(x) = \tan x$  is not continuous at  $x = \frac{\pi}{2}$ .  
Proof:  $f(\frac{\pi}{2})$  is not defined. Hence,  $f(x)$  is not continuous at  $x = \frac{\pi}{2}$ .

Example: The function  $f(x) = \frac{1}{x}$  is not continuous at  $x = 0$ .  
Proof:  $f(0)$  is not defined. Hence,  $f(x)$  is not continuous at  $x = 0$ .

Example: The function  $f(x) = \sqrt{x}$  is continuous on the interval  $[0, \infty)$ .  
Proof: Let  $c$  be any point in  $[0, \infty)$ . Then  $f(c) = \sqrt{c}$  is defined. Also,  $\lim_{x \rightarrow c} \sqrt{x} = \sqrt{c} = f(c)$ . Hence,  $f(x)$  is continuous at  $c$ . Since  $c$  is arbitrary,  $f(x)$  is continuous on  $[0, \infty)$ .