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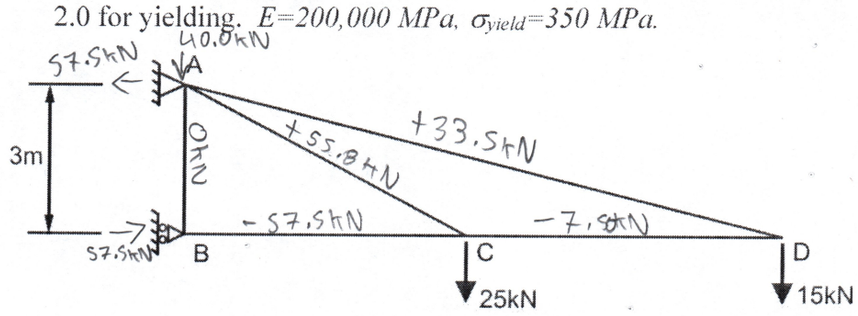
CIV102F Quiz #7: 1300h-1500h Thursday October 24, 2019

Design of Trusses

(a) Solve for the support reactions and forces in each member of the truss show below. Write the magnitudes of the forces on the diagram beside the members, and clearly indicate tension (+) and compression (-) forces. Also draw the support reactions on the diagram.

(b) If you are to use only one type of square HSS for all the members, what is the lightest HSS designation that can be safely used? Use a factor of safety of 3.0 for buckling and 2.0 for yielding. *E=200,000 MPa*, σ_{yield}=*350 MPa*.



$\Sigma F_x = 0$

$\Sigma F_y = 0$

$\Sigma M = 0$

I USED THE WRONG TRIANGLE TO CALCULATE AD_x.

$\frac{6}{3} = \frac{F_x}{F_y}$

$F_x = 2F_y$

$\frac{h}{3} = \frac{F_T}{F_y}$

$\frac{6.71}{3} \cdot F_y = F_T$

a.)

$\Sigma F_y = 0 = A_y - AC_y - AD_y$

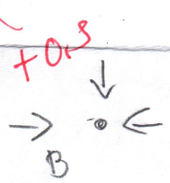
$\therefore A_y = AC_y + AD_y$

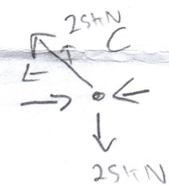
$A_y = 40.0kN$ +1

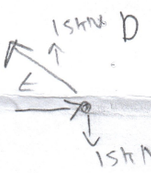
$\Sigma F_x = 0 = AC_x + AD_x - A_x$

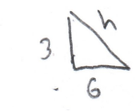
$\therefore A_x = AC_x + AD_x$

$A_x = 57.5kN$ X +0.5









$h = 6.71m$

$\Sigma F_y = 0 = AB$

$\therefore AB = 0kN$

$\Sigma F_x = 0 = B_x - BC$

$\therefore B_x = BC = 57.5kN$

$B_x = 57.5kN$ X

$\Sigma F_y = 0 = AC_y - 25kN$

$\therefore AC_y = 25kN$ +1

$\therefore AC_x = 50kN$

$AC = 55.8kN$

$\Sigma F_x = 0 = BC - AC_x - CD$

$BC = 57.5kN$ +1

$\Sigma F_y = 0 = AD_y - 15kN \therefore AD_y = 15kN$

$\therefore AD_x = 7.5kN$

$AD = 33.5kN$ +1

$\Sigma F_x = CD - AD_x = 0$ a

$\therefore CD = 7.5kN$

b.) Yield check;

$\sigma_y = 350MPa$

$E = 200000MPa$

$FS_y = 2.0$

$FS_B = 3.0$

$A_{min} = \frac{F.S. \cdot P}{\sigma_y} = \frac{2.0 \cdot 57500N}{350MPa} = 325.7mm^2 \simeq 326mm^2 = A_{min}$ ← wrong value due to a)

HSS 32x32x3.2

$r_{min} = \frac{L_{max}}{200} = \frac{13420mm}{200} \simeq 67.1mm = r_{min}$ X +0.5

HSS 178x178x4.8

$AD = \sqrt{12^2 + 3^2} \simeq 13.42m$

Longest member in compression is also the member with the highest compression +1

$I_{min} = \frac{2.0 \cdot 57500N \cdot (6000mm)^2}{\pi^2 \cdot 200000MPa} = 3146022mm^4 \simeq 3.15 \times 10^6 mm^4 = I_{min}$

HSS 102x102x6.4

A truss with these A_{min}, r_{min}, and I_{min} properties may use HSS 178x178x4.8 as the lightest HSS designation that can be safely used, +1

PROPER FBD ON BACK

$\frac{12}{3} = \frac{F_x}{F_y}$

$\therefore 4F_y = F_x$

$h = 12.37m$

$\frac{12.37}{3} = \frac{F_T}{F_y}$

$\therefore F_T = \frac{12.37}{3} F_y$

$\Sigma F_y = 0 = AD_y - 25.0kN$

$\therefore AD_y = 25.0kN$

$AD_x = 100.0kN$

$AD = -103.1kN$