CivE 495 Assignment 1

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September 22, 2021

Assignment 1

Question 1

Conifers are more desirable than deciduous trees because they are geotropic. In contrast, deciduous trees are phototropic. This makes conifers typically grow straighter than deciduous trees, which is better for sawn lumber. Deciduous trees are also often slow growers in North America, while conifers grow much quicker.

Question 2

The hole in the middle of a wood cell is called a vessel. See Figure 1 below:

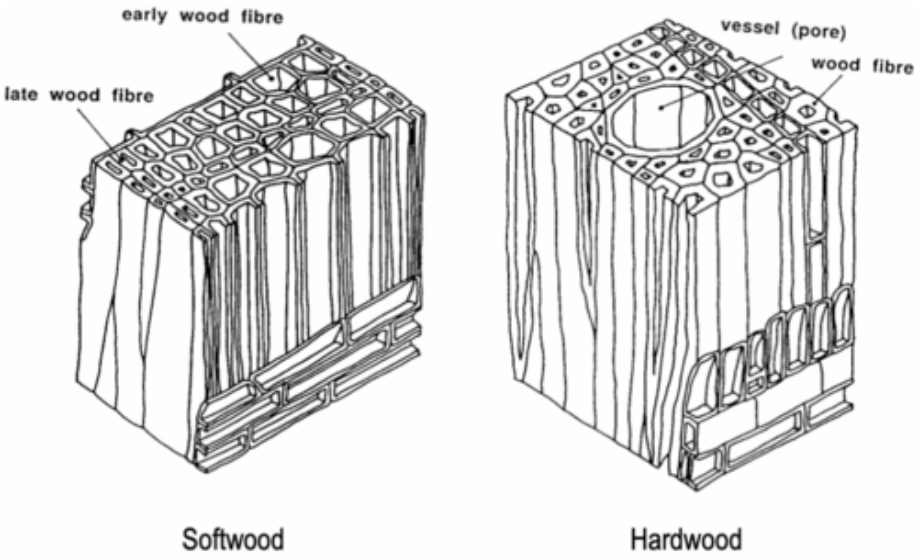


Figure 1: Wood Cell Layers

Question 3

The moisture content of wood changes as boards season. When it decreases, it shrinks, and as it increases, it swells. This can result in twisting, or buckling, if there is not room enough for the board to expand. If it is connected to a connection that does not allow for torsion, radial or tangential shrinkage may result in torsion of the member away from the connection.

Question 4, 5, and 6

See scans below:

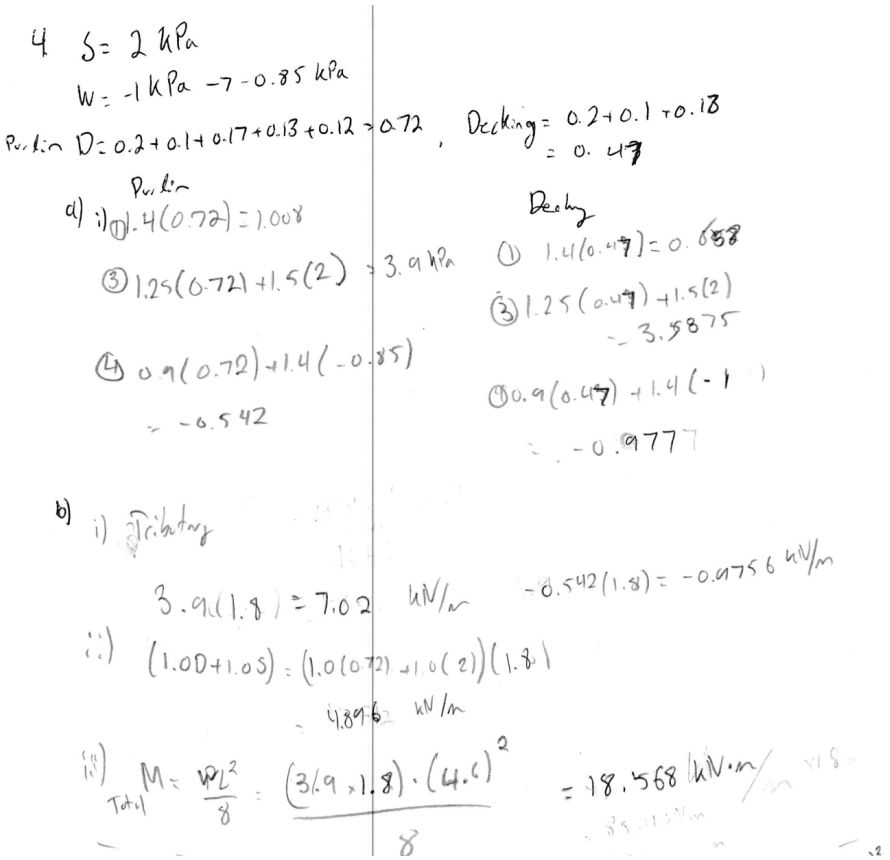


Figure 2: Question 4 Part 1

iv) SLS Total load = $1.0D + I_{(snow)} + 0.5L$

$= 1.0(0.72) + 0.9(2)$

$= 2.52\ kN/m^2 \times 1.8 = 4.536\ kN/m$

Transient = $I_{(snow)} = 0.9(2) = 1.8\ kN/m^2 \times 1.8 = 3.24\ kN/m$

$\Delta_1 = L/180 = \frac{4600}{180} = 25.56mm$

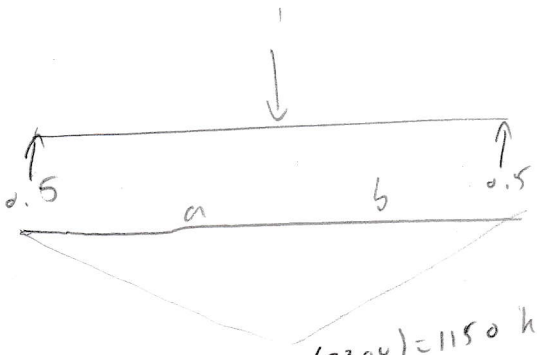
$\Delta_2 = L/240 = \frac{4600}{240} = 19.17mm$

Total moment = $\frac{(4.536)(4.6)^2}{8}$

$= 11.994772\ kN.m$

Transient moment = $\frac{(3.24)(4.6)^2}{8}$

$= 8.57\ kN.m$



$0.5(2300) = 1150\ kN.mm$

From table, $\Delta_1 = \frac{1}{EI}\left(\frac{1}{3} M_1 m_3 \left[\frac{a+b}{L} + L\right]\right)$, $a = 2300$, $b = 2300$

$25.56 = \frac{1}{EI}\left(\frac{1}{3} \cdot 1150 \cdot 11998 \cdot \left[\frac{2300^2}{4600} + 4600\right]\right)$

$EI = 1034.65\ kN.m^2$

$19.17 = \frac{1}{EI}\left(\frac{1}{3} \cdot 1150 \cdot 85707 \left[\frac{2300^2}{4600} + 4600\right]\right)$

$= 985.38\ kN.m^2$

5. $w_1 = 5\ 19/32"$ $\quad R_{shrinkage} = 2.4\%$

$w_2 = 5\ 20/32"$ $\quad T_{shrinkage} = 5\%$ $\quad 100 - \frac{\text{Dan's}}{\text{Fred's}}$

$\therefore \Delta = 1/32"$ $\quad Avg = 3.7\%$

$\frac{\text{Smaller}}{\text{original}}$

$$\frac{3.7}{28-0} = \frac{1 - \frac{5\ 20/32}{5\ 19/32}}{19 - x}$$

$x = 19.042\%$ moisture

6. 2x12, Black Spruce, $MC_1 = 19\%$, $MC_2 = 11\%$

$H = 2(286) + 7(38)$

$= 838$ mm

$R_{shrinkage} = 4.1$

$T_{shrinkage} = 6.8$

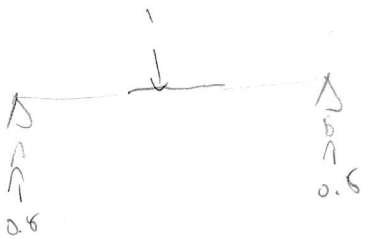
$Avg_{shrinkage} = 5.45$

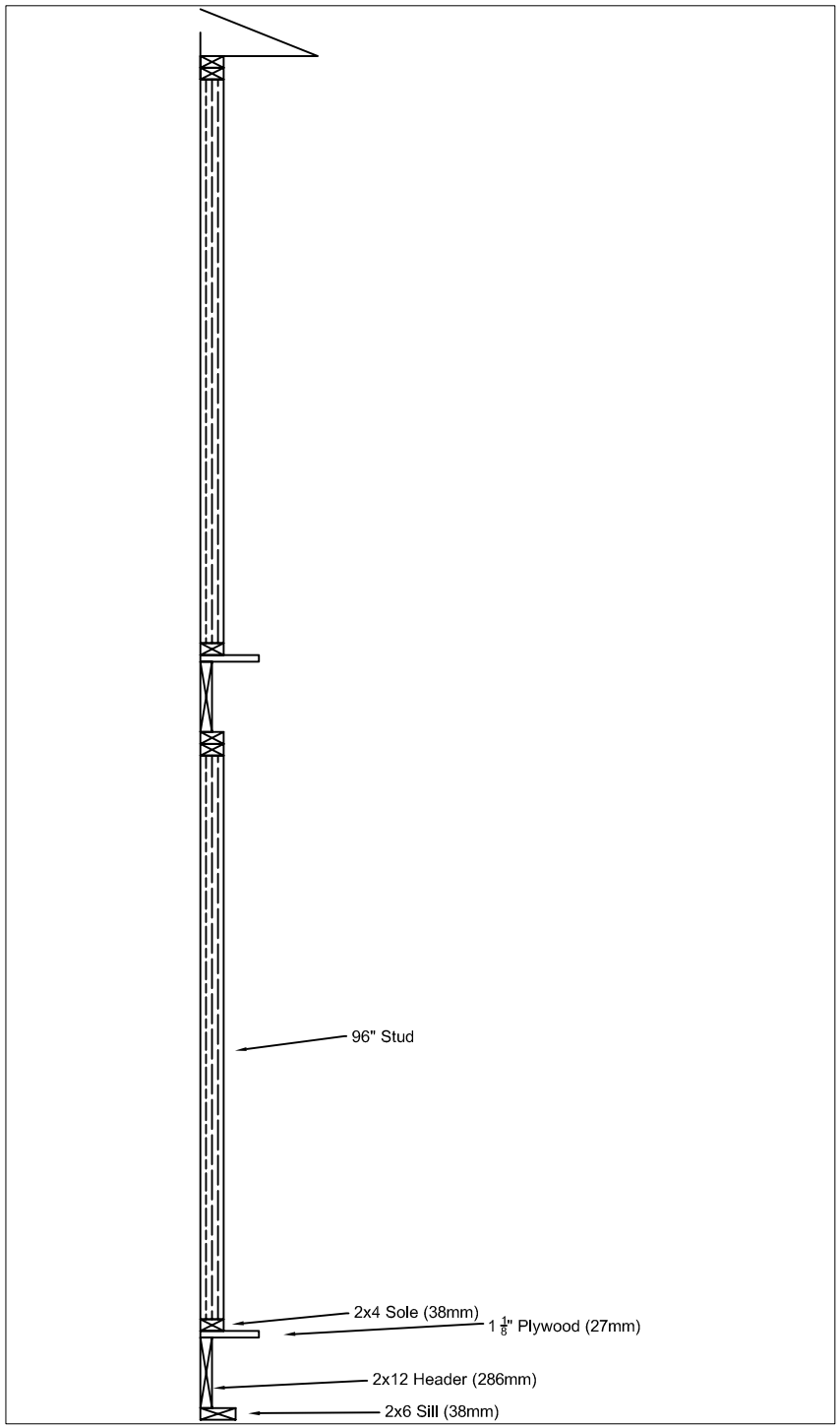
$$\frac{5.48}{28-0} = \frac{x}{19-11}$$

$x = 1.566\%$

$Shrinkage = 838\ (1.566\%)$

$= 13.1$ mm





Drawn By: Benjamin Klassen
Date: September 17, 2021

Question 7

It is likely that this member experienced a large shrinkage due to a reduction in moisture content. As a result, cracking formed along the member. It is also visible that failure happened along a knot. This could indicate a weak piece of lumber used.

In the event that the knot caused failure, the other joist is not at risk of failure. However, if failure occurred due to shrinkage, and the other joist is under similar loading, it would experience the same stress and material behaviour. As such, it could also fail.