2/13/2015

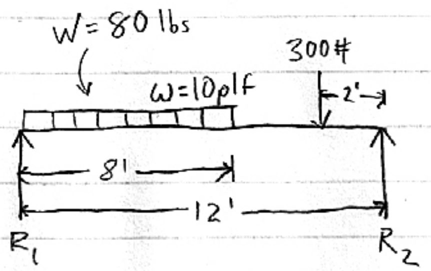
Notes on homework

- FBD has no pictures - simple lines and numbers only
- only include the forces actually in the system and make sure you include dimensions
- LABEL YOUR UNITS ALWAYS
- analyzing units can tell you if you are solving the problem correctly

FBD

$\Sigma V = \emptyset$
$\Sigma H = \emptyset$
$\Sigma M_{R_1} = \emptyset$
$\Sigma M_{R_2} = \emptyset$

Check if all these are true every time. Only way to make sure you are not making an error



1. Find Total Distributed Load
   $10 p/f \cdot 8' = 80$ lbs
2. Moment of Distributed Load is measured at its center (4' from left side)

R_1 is the reference point

$\Sigma M_{R_1} = \emptyset = (0' \cdot R_1) + (4' \cdot 80 \text{lbs}) + (10' \cdot 300 \text{lbs}) - (12' \cdot R_2)$

$\emptyset = 320 \text{ ft-lbs} + 3000 \text{ ft-lbs} - (12' \cdot R_2)$

$12' \cdot R_2 = 3320 \text{ ft-lbs}$

$R_2 = \dfrac{3320 \text{ ft-lbs}}{12'} = 276.67 \text{ lbs}$

R_2 is the reference point

$\Sigma M_{R_2} = \emptyset = (0' \cdot R_2) - (2' \cdot 300 \text{lbs}) - (8' \cdot 80 \text{lbs}) + (12' \cdot R_1)$

$\emptyset = -600 \text{ ft-lbs} - 640 \text{ ft-lbs} + 12' \cdot R_1$

$-(12' \cdot R_1) = -1240 \text{ ft-lbs}$

$R_1 = \dfrac{-1240 \text{ ft-lbs}}{-12'} = 103.33 \text{ lbs}$

$\Sigma V = 103.33 \text{lbs} - 80 \text{lbs} - 300 \text{lbs} + 276.67 \text{lbs} = \emptyset$ ✓

Homework 2 Question 7

Units included in question: inches, pounds, psi

If your answer should be in pounds, what do you have to do to psi? Multiply it times in^2: $\frac{pounds}{in^2} \cdot in^2 = pounds$

How do you get in^2? Finding cross-sectional area

Knot O' the Day: Figure-8 knot - good for putting a stopper hitch in a line so it doesn't slip out of a block

Overhand loop, around working end, and down through loop

Should look like a figure-8 in the end

Minimum Design Factor for fiber rope (hemp, nylon, etc) static or running = 10

Heterogeneous material, usually knotted, often reused

high design factor should be used

Static Wire Rope: DF = 5

Running Wire Rope: DF = 8

Life Safety (for example, held over an audience): DF = 10

Mechanical Advantage

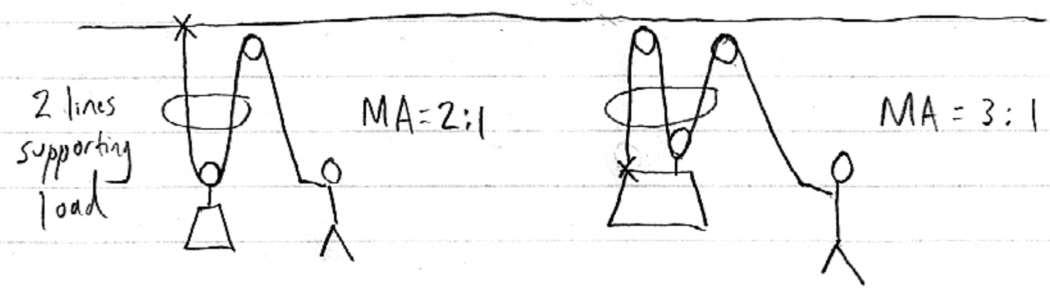
Rescue block / Split block - cheeks open to allow you to put on rope without feeding it all the way through

Allows the same amount of force do more work

For more details about pulleys: BH: 70, 71, 99

SRH: 43-45

Mechanical advantage lets you lift more with fewer people
Expressed as a ratio of output : input



This is theoretical MA, does not include friction

In the real world, adding pulleys increases friction until they actually begin reducing MA

Starting on p. 52 of SRH, tables showing MA gained from different types of sheaves with different friction forces
We are usually dealing with 3% -5% friction

LLP - Lead Line Pull - how much you are pulling

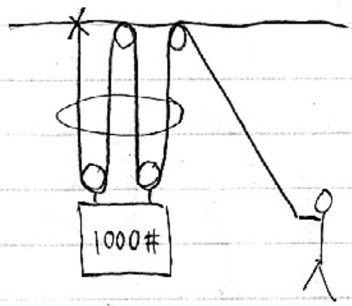
$$LLP = \frac{Load}{R}$$

R= Actual Mechanical Advantage (derived from table in the book)

On average, people can comfortably lift 35-50 lbs
A Lead Line Pull of 200 lbs needs four people to lift it

$LLP \cdot R = Load$ What is the heaviest load you can lift with the people & equipment on hand?

Sheaves have 5% friction force



TMA = 4:1 (4 lines)
AMA: (Derived from table on pg 53)
3.28 : 1

LLP: $\frac{1000 \text{ lbs}}{3.28}$ = 305 lbs

Requires about six people
This can get really awkward
Communication is critical

3% friction
AMA: 3.54:1
LLP: $\frac{1000 \text{ lbs}}{3.54}$ = 282.49 lbs

1% friction
AMA: 3.85:1
LLP: $\frac{1000 \text{ lbs}}{3.85}$ = 259.7 lbs

If we have a crew of six, our LLP is 300 lbs
Our theater has a 6:1 system with 3% friction bearings
Maximum load we can lift
R = 5.04
Max load = 300 lbs × 5.04 = 1512 lbs

Rope with WLL = 950 lbs
5:1 System with 5% friction
AMA = 3.9
Maximum load this system can lift = 950 lbs × 3.9 = 3705 lbs

$\frac{\text{LOAD}}{\text{WLL -or- LLP}}$ = R needed for the system

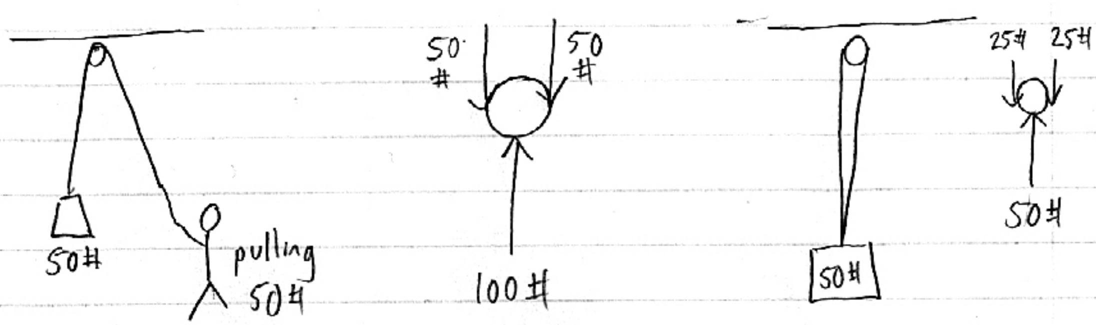
450 lbs and 3 people
LLP = 150 lbs
LOAD = 450 lb
$R_{required}$ = 450 lb / 150 lbs = 3:1

For homeworks, use WLL limit information from Backstage Handbook

These are only minimum standard or may be out-of-date

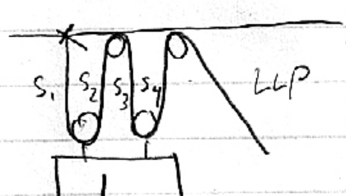
You should always use spec sheets for the actual component you are going to use in real life

Rope WLL BH pg. 85



The load while it is being lifted is twice as much as when it is just hanging

We need to calculate Total Dynamic Load (TDL) p. 51 SRH



<u>Theoretically</u>

TMA = 4:1

TDL = L + LLP = 1.25L

S_1 has no friction – holds 1/4 of load

$S_2 = S_1 + S_1 \cdot \text{friction } (F)$

$S_3 = S_2 + S_2 \cdot F$

$S_4 = S_3 + S_3 \cdot F$