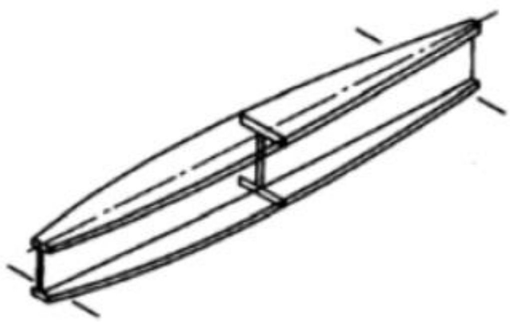
RISD ARCH 2154 STEEL STRUCTURES Fall 2017

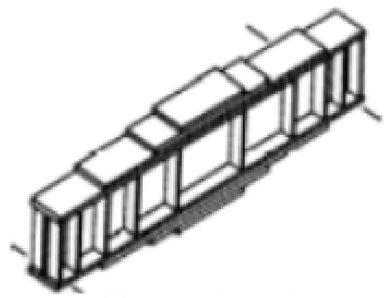
HW 1 SOLN

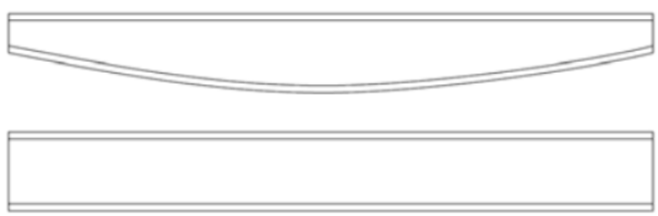
Problem 1

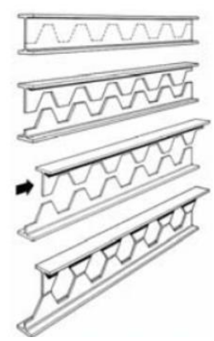
Is an “efficient” steel beam or steel connection “economical”? Why or why not? Most steel beams are I shaped in section (“wide flange beams”) – what makes these sections efficient, what is it about them that makes them not efficient but economical?

The cross section is efficient since the top and bottom have a lot of meat/area. However the along the length of the member it is not efficient since the cross section does not change (it is efficient in the center of the span and inefficient at the ends). It is more economical to keep the cross section along the length of the beam constant – then try to uneconomically but efficiently taper the flanges at the ends or change the depth to follow the moment diagram.









Problem 2

Read MSC article on "How Steel is Made" posted as a PDF on the class website. “We take steel beams for granted as the bones of new buildings, but how are they made?” What did you learn from this article that you did not know before? This should be a quick paragraph of text or so.

Some good points…

Steelmaking originally depended solely on the mining of iron ore. Yet because steel can be melted and remade almost infinitely, American industry recycles more steel than it does anything else. About 95% of the content in Nucor-Yamato’s beams is metal that once existed as something else.

Once the steel is melted to about 3,000 °F and is ready for refining

Three white-hot carbon electrodes, each 2 ft in diameter, descend through openings at the roof's center and strike an arc of electricity into the scrap. A storm begins: Clouds of fire and sparks burst out of gaps in the furnace roof as the electrodes subdue the steel into a blindingly hot porridge.

Carbon desired content is about 0.1% of the molten steel (depends on grade).

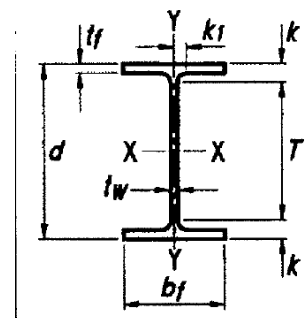
The beam blanks are sent into a 10-ft-deep gas oven and brought to about 2,100 °F. When hot again, they slide into the "breakdown mill," where they are rolled violently back and forth like missiles within flatbed channels, and then through a series of fearsome machines that press them into the correct sizes.

Problem 3

On website you will see link to "AISC Steel Manual 14th Ed Section Props PDF". Open it and find a wide flange beam named... W12x19. Draw this beam on your 8.5"x11" sheet of paper to 1:1 scale using the data shown bf, tf, d, etc etc. Point to what is web, what is flange, and what does the 12 and the 19 mean in the W12x19?

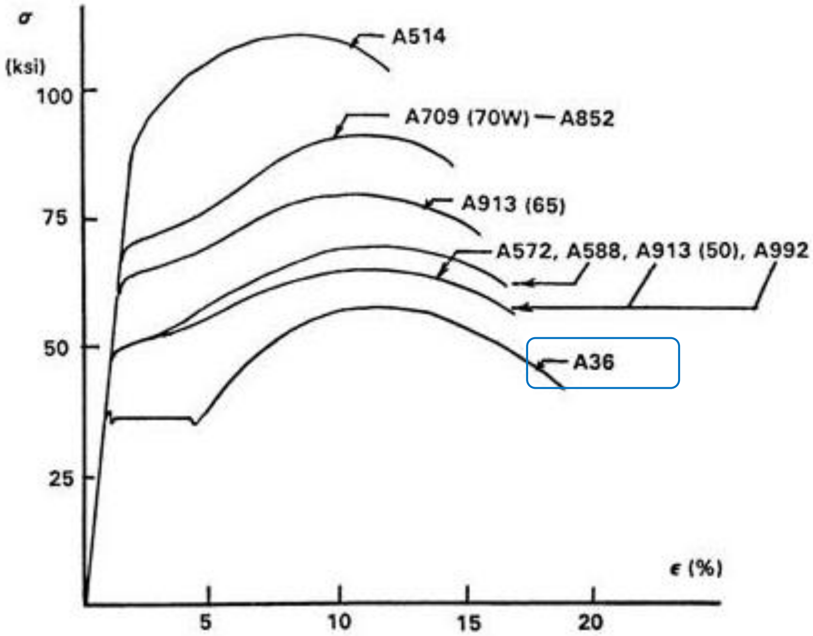
This should be straight forward.

12 is the "nominal" depth, not the actual
19 is the weight in pounds per linear foot



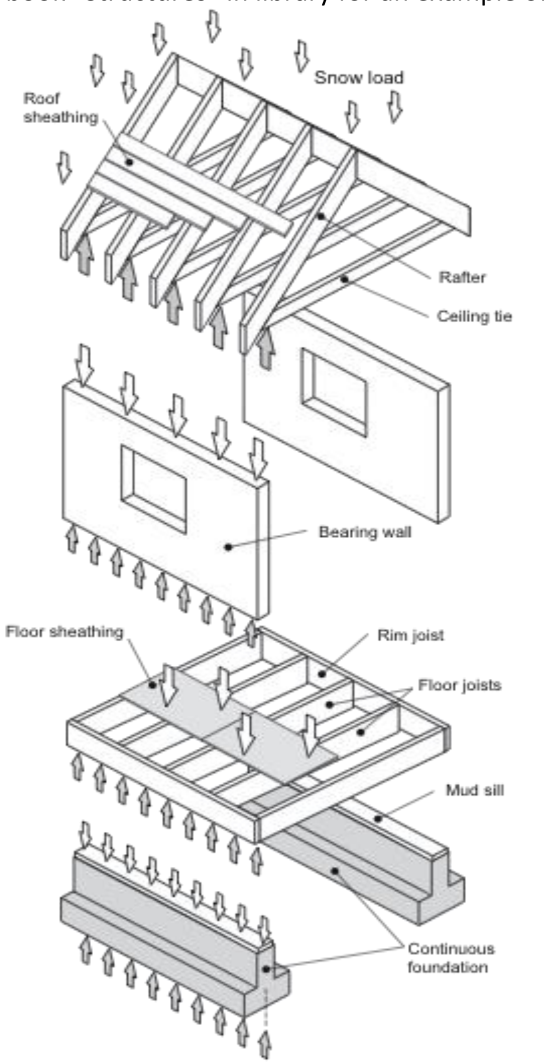
Problem 3

Draw the stress-strain diagram for A36 steel (note Fy = 36ksi) - this is what we did in class.

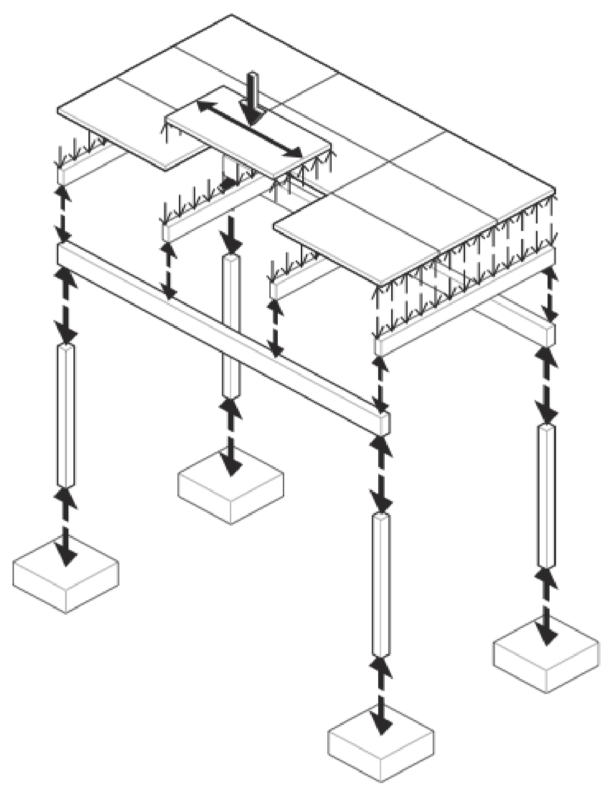


Problem 4

Read the info on load paths on the assigned reading on the website "AISC Architects Guide - Systems" - notice figure 2, and draw a load path of how the BEB building works structurally. To understand load paths, just imagine you are standing on the structure and describe how your weight gets transferred through the structure to the earth in discrete steps (slab to joists, joists to beam/girder/walls, etc). If you are unsure about how the column or wall loads transfer to the earth, you can assume it is on a spread footings or pile caps. Draw figures and describe each step. Also most strength of materials books will help you understand this (for example, see fig 4.15,8.35, 13.21, 13.26, 16.13, 17.1, or 18.2 of “Understanding Structures” or figure 1.4(c) of the book “Structures” in library for an example of describing the load paths of a structure).

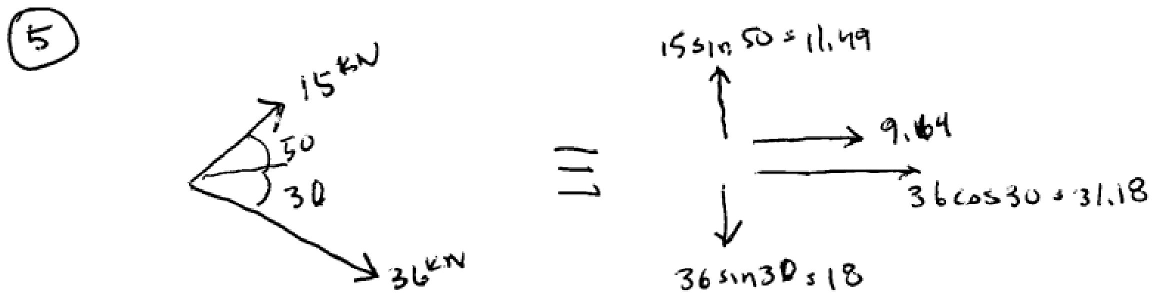


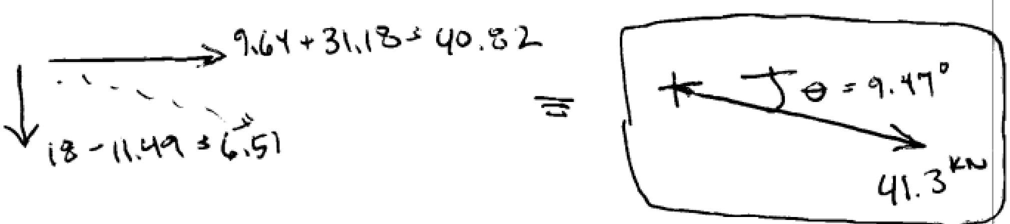
Load paths through a simple wood framed structure



Problem 5

Statics Review: Calculate the magnitude and direction of the Resultant force on this system (answer should be a vector with magnitude and angle from horizontal)



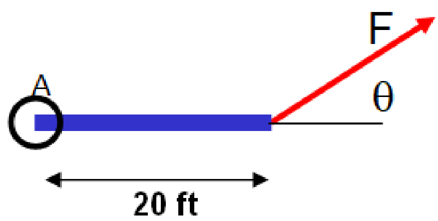


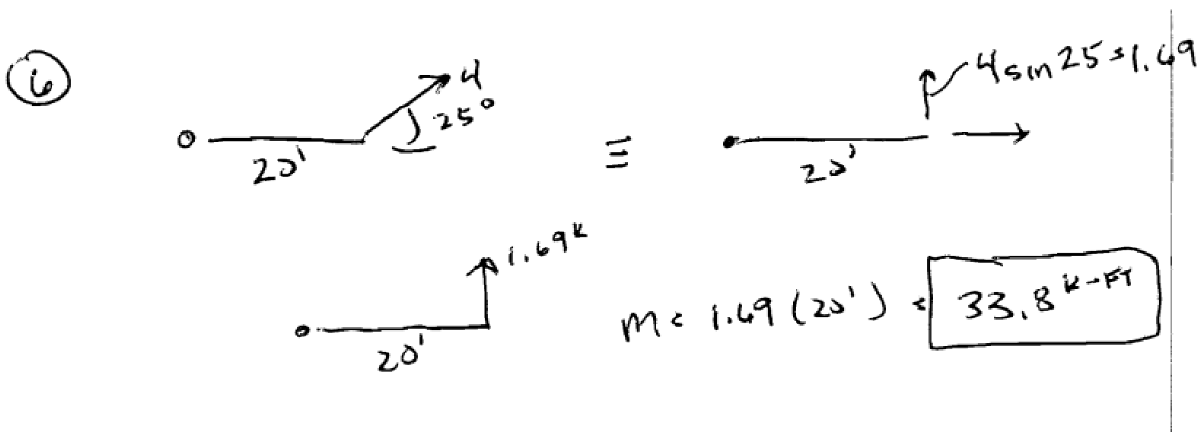
$$\text{MAG} = \sqrt{40.82^2 + 6.51^2} = 41.3$$

$$\theta = \tan^{-1}\left(\frac{6.51}{40.82}\right) = 9.47^\circ$$

Problem 6

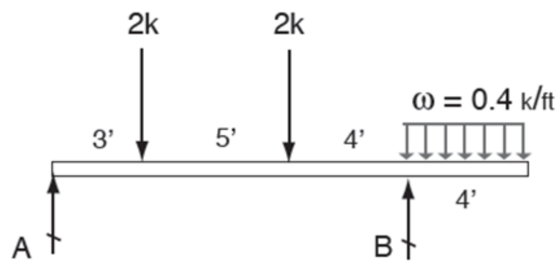
Statics review: The force F = 4 kips and the angle shown is 25 degrees, what the moment about point A?





Problem 7

Statics review: What are the 2 reactions for this beam…. (hint: just the reactions, we will do moments and beam design later)



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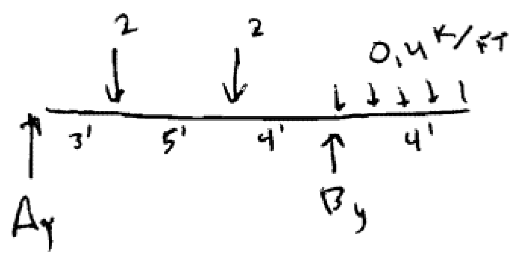

$+\uparrow \sum F_y = 0 = A_y + B_y - 2 - 2 - 0.4(4)$

$A_y + B_y = 5.6^k$

$\circlearrowleft + \sum M_A = 0 = -2^k(3') - 2^k(8') + B_y(12') - 0.4(4')(14')$

$0 = -6 - 16 + 12B_y - 22.4$

$B_y = 3.7^k$

$A_y = 1.9^k$