MY SO PRACTICE TEST

DIVISION C - HIGH SCHOOL, GRADES 9-12

PRACTICE TEST

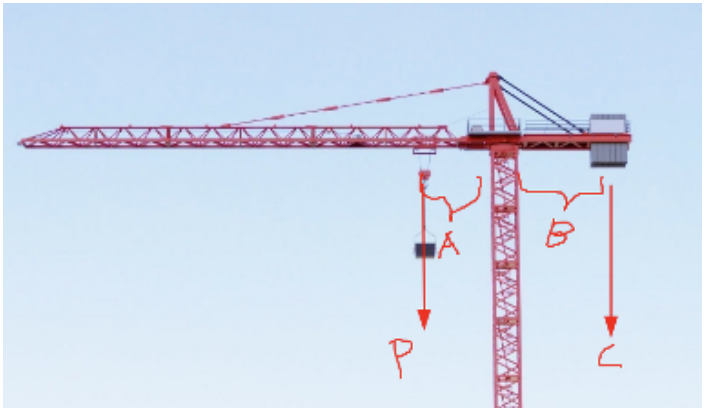
Instructions

- You have 20 minutes to complete this test.
- You may write your answers directly in the test.
- You may use any notes or resources you have created or collected.
- You may use a calculator and scratch paper if necessary.
- Good Luck!

Test Questions

Questions 1-2 use the following diagram and scenario.

A construction crane supports a load P a distance A from the tower, and it has a counterweight a distance B from the tower, exerting a load C.



1. If P = 80,000 lbs, and A = 12 ft, how much should the counterweight weigh if the distance B was known to be 15 ft, so that the tower is only loaded in axial compression?
    a. 60000 lbs
    b. 64000 lbs
    c. 72000 lbs
    d. 80000 lbs
    e. 92000 lbs

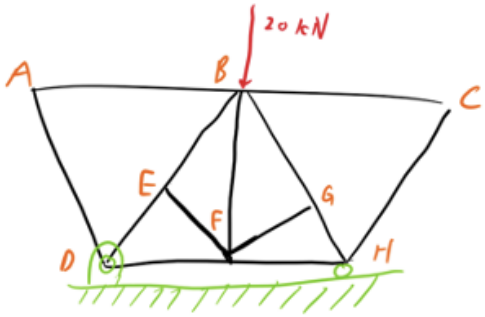
2. Given the above answer, is the calculated weight of the counterweight actually ideal if it were to be used in real life for a crane?
    a. No, since it was calculated for a very specific loading condition, where P and A are already chosen.
    b. No, since the tower can also withstand some off-centered loading causing it to undergo some bending
    c. Yes, cranes have counterweights designed for loads that are only a specific weight and distance away from the tower
    d. Yes, the calculated counter weight is the worst case loading this tower will see given the loading P
    e. Both a) and b) are correct
    f. Both c) and d) are correct

3. What is the use of rebar in concrete?
    a. Rebar increases the tensile strength of concrete
    b. Rebar increases the compressive strength of concrete
    c. Rebar increases both the compressive and tensile strength of concrete by a significant amount
    d. Rebar helps prevent cracks from forming in the concrete

4. Where is the first recorded use of the truss in construction?
    a. In ancient Greek roofs
    b. Primitive lake dwellings around 2500 B.C.
    c. Ancient Roman bridges
    d. Mesopotamia around 3500 B.C.

5. If a rope has a radius of 10 cm and is under a force of 10 N, what is the tensional stress in the rope?
    a. 31.8 kPa
    b. 318 Pa
    c. 0.0318 Pa
    d. Need more information to calculate

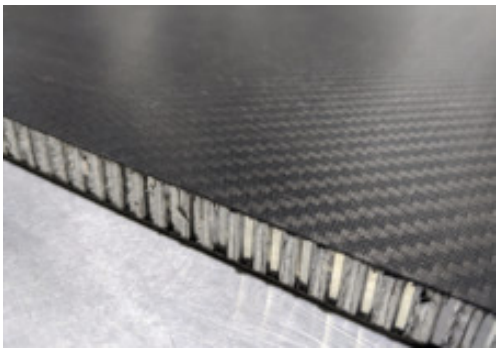
Questions 6 and 7 use the following diagram.



6. Identify the members of the truss that are NOT zero force members.
    a. AD, DB, BH, DH
    b. DB, BH, DH, EF, FG, FB
    c. DB, BH, DH
    d. None of the above

7. In a real scenario, the zero force members in the structure help most to reduce...
    a. Buckling
    b. Tension and compression
    c. Instability
    d. Nothing, they are useless because they carry zero force

8. The picture below shows a sandwich panel which is made up of 2 carbon fiber sheets with an aluminum honeycomb in between and usually held together with adhesive. What is a major advantage to adding an aluminum honeycomb in this fashion instead of just using carbon fiber?



a. Reducing the weight of the panel
b. To make up for carbon fiber's poor shear stress properties
c. Increase the rigidity and resistance of the plate to bending
d. Prevents the carbon fiber from delaminating
e. Allow bees to inhabit the space, resulting in a more eco
f. friendly structure

9. A 10 ft long steel beam has a safety factor of 3. If the current load is 5,000 N then what is the maximum load this steel beam can withstand?
   a. 15,000 N
   b. 20,000N
   c. 1666.67 N
   d. 5,000 N

10. Let's say there exists a beam supported by two pillars on both ends. Let's say it is 63 ft long, and the beam has a mass of 47500 kg. Approximately what is the expected axial load P on each beam?
   a. 172 kN
   b. 168 kN
   c. 237 kN
   d. 233 kN

11. Referencing the previous question, let's say that each pillar is made from a special new 3D printed concrete material that has a maximum compressive strength of 18 MPa. Assuming the concrete pillars have a rectangular cross section, which of the below cross sectional dimensions allow for a safety factor of 1.2?
   a. 11.37 cm by 11.37 cm
   b. 12.46 cm by 12.46 cm
   c. 12.01 cm by 12.01 cm
   d. 2.44 cm by 2.44 cm
   e. 1.44 cm by 1.44 cm

12. A bridge designer is building a very particular bridge that must conserve precious material during construction. The engineer is not worried about the strength of the deck of the bridge, but wants to know how strong the pillars should be in the worst possible loading case. Which of the following describes the worst possible loading case given that the maximum length of a train is 100 ft, the distance between towers of the bridge is 1000 ft, and the bridge will only ever see one train at a time?
    a. A tower is under greatest load when the train is between two towers
    b. A tower is under greatest load when the train is anywhere between two towers
    c. A tower is under greatest load when the middle of a train is directly over top a tower
    d. A tower is under greatest load when the train is moving the fastest across the bridge

13. The are two pistons that can both be pressured to the same maximum internal pressure. One cylinder cavity has a cross section of 50 cm2 and a maximum cylinder length of 10 cm, and another with a cross section of 75 cm2 and a maximum cylinder length of 2 cm. Which piston could deliver a greater maximum actuation force?
    a. The 75 cm2 piston since it has a greater cross sectional area
    b. The 50 cm2 piston since it has a greater internal volume
    c. You can't tell since you need more information to determine the maximum possible actuation force

14. Which of the following may be a cause for failure in a building supported by rebar?
    a. The steel used for the rebar expands faster than the concrete, causing cracks
    b. The rebar is poorly placed, leading to the rebar slipping out of place
    c. The rebar was created with rough edges, causing the concrete to crack
    d. The use of carbon steel rebars in an location with low humidity

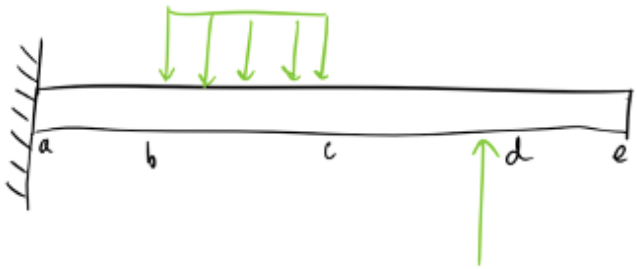
    Questions 15 and 16 use the following scenario.

    The second floor of a single family two story house functions as bedrooms and is 55ft by 40ft.

15. The live load for furnitures and human occupation that needs to be accounted for is 40 pounds per square foot (psf). What is the total live load of this floor?
    a. 8,800 lb
    b. 88,000 lb
    c. 2,200 lb
    d. 22,000 lb

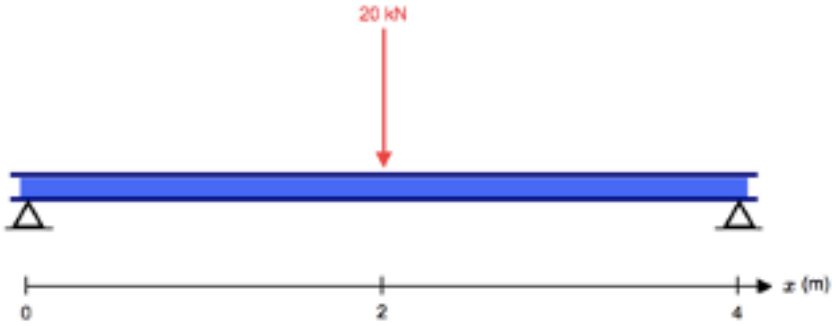
16. Suppose this floor is a ⅞ inch hardwood floor that has a dead load of 4 psf. What is the total load including live and dead load for this floor?
    a. 8,800 lb
    b. 88,000 lb
    c. 96,800 lb
    d. 30,800 lb

17. Describe the shape of the shear stress diagram of the following cantilever beam



a. Linear downwards until B, Linear upwards until C, Horizontal until D, Jumps up and horizontal again until E
b. Horizontal until B, Linear downwards until C, Horizontal until D, Jumps up and horizontal again until E
c. Horizontal until B, Linear upwards until C, Horizontal until D, Jumps down and horizontal again until E
d. Linear upwards until B, Linear downwards until C, linear downwards until D, linear upwards until E

A diagram of a point load acting on a beam is shown below. Questions 18 and 19 will refer to this diagram.



18. Which of the following effects would the point load have on the stress diagram?
    a. A diagonal line
    b. A "jump" (vertical line)
    c. A horizontal line
    d. The point load would have no effect on the stress diagram

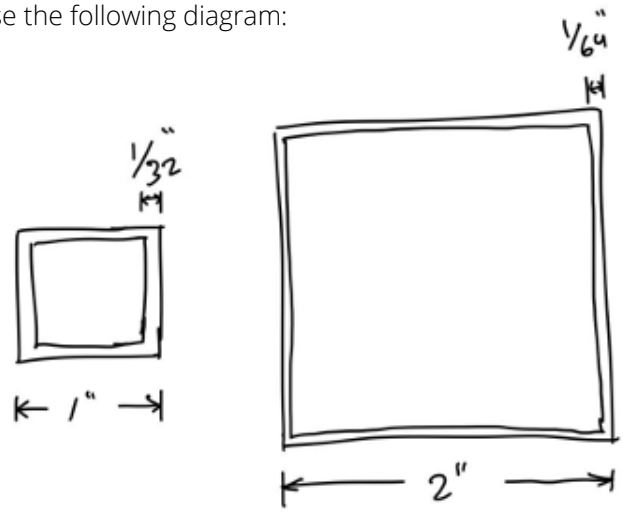
19. Would this effect be in the positive or negative direction on the stress diagram?
    a. Positive
    b. Negative
    c. No effect

20. You are placing books on a very weak bookshelf similar to the one shown below. In order to reduce bending stress on the horizontal "shelves," you should place the books...
    a. Near the center of the shelves
    b. Half against the left edge of the shelf, half against the right edge of the shelf
    c. Spread evenly across the shelf
    d. Does not matter, the book shelves carry the same weight

21. In the shelf from the previous question, how can you place the books in order to reduce the compression load that the legs experience?
    a. Near the center of the shelves
    b. Half against the left edge of the shelf, half against the right edge of the shelf
    c. Spread evenly across the shelf
    d. Does not matter, the book shelves carry the same weight

22. You pick up a strand of carbon fiber and notice that no matter how hard you pull on the ends, the strand does not break. You decide to tie a knot in the strand and you pull again and the strand snaps much more easily. You decide knot to do that again, but are curious why it broke so easily. What is a possible explanation?
    a. By tying the knot, you are loading the strand in shear instead of only tension
    b. By tying the knot, you are causing the strand to rub against itself, wearing down the CF
    c. By tying the knot, you are loading the strand in compression instead of only tension
    d. None, you just got lucky

Questions 23 through 25 will use the following diagram:



23. The two above square box girders have the cross-sections pictured above. Notice that they are different in both their outer dimension and wall thickness. Which of the below statements is true about the strength of the girders when loaded in compression axially down the length of the beam?
    a. The 1″ box girder is significantly stronger than the 2″ box girder
    b. The 2″ box girder is significantly stronger than the 1″ box girder
    c. Both girders can support approximately the same load in axial compression (within 5%)

24. Which of the below statements is true about the strength of the girders when they are loaded in bending (resisting being bent)?
    a. The 1″ box girder is significantly stronger than the 2″ box girder
    b. The 2″ box girder is significantly stronger than the 1″ box girder
    c. Both girders can support approximately the same load in bending

25. Which of the below statements is true about the strength of the girders when the girders are loaded in torsion about an axis down the length of the beam?
    a. The 1″ box girder is significantly stronger than the 2″ box girder
    b. The 2″ box girder is significantly stronger than the 1″ box girder
    c. Both girders can support approximately the same load in torsion

Use the following scenario for questions 26-30.

Say there existed some tall radio tower, with 4 guy wires arranged in a cross configuration, all exerting some tension T at the top of the tower. This tower can support a maximal load P at the top.

26. Some engineer decides to double the amount of guy wires on this tower, so now there are 4 more of the same guy wires (all under tension T), for a total of an eight way cross of guy wires on this tower. What could you say about the load that this tower can now support at the top compared to the original load P?
    a. < P
    b. > P
    c. P
    d. Exactly 2P

27. Some other engineer decides that they want to move the ground anchor points of the guy wires further outward, moving further away from the base of the tower. They do this without changing the tension T exerted at the top of the tower (perhaps some parameters of the guy wires need to be altered to do so). What could you say about the load that this tower can now support at the top compared to the original load P?
    a. < P
    b. > P
    c. P
    d. Exactly 2P

28. Finally another engineer decides that they want to make the guy wires 2 times thicker (the diameter is increased by a factor of two). What could you say about the load that this tower can now support at the top compared to the original load P? (Hint the T that each cable exerts on the tower changes)
    a. < P
    b. > P
    c. P
    d. Exactly 2P

29. Another engineer decides that they want to make the guy wires out of a heavier metal (supposed they switched to a heavier steel alloy, keeping all other dimensions of the cable constant). What could you say about the load that this tower can now support at the top compared to the original load P? (Hint: the T that each cable exerts on the tower changes)
    a. < P
    b. > P
    c. P
    d. Exactly 2P

30. Another engineer decides that they want to make the guy wires out of a lighter metal (supposed they switched from aluminum to steel, but maintained the same T that each cable exerts on the tower). What could you say about the load that this tower can now support at the top compared to the original load P?
    a. < P
    b. > P
    c. P
    d. Exactly 2P

ANSWER KEY

1.	**B**	15.	**B**	29.	**A**
2.	**E**	16.	**C**	30.	**C**
3.	**A**	17.	**B**		
4.	**B**	18.	**B**		
5.	**D**	19.	**B**		
6.	**C**	20.	**B**		
7.	**A**	21.	**D**		
8.	**C**	22.	**A**		
9.	**A**	23.	**C**		
10.	**D**	24.	**B**		
11.	**B**	25.	**B**		
12.	**C**	26.	**A**		
13.	**A**	27.	**B**		
14.	**B**	28.	**A**		