Mechanics of Materials-Moment Diagrams

Moment Force Diagrams

We learned from the previous section that the shear force diagram indicates how a force applied perpendicular to the axis of a beam is transmitted along the length of that beam.

Now a bending moment diagram will show how the applied loads to a beam create a moment variation along the length of the beam.

The reason why V(Shear) and M(Moment) diagrams need to be drawn is because this is how many member fail, regardless of whether these members are part of a bridge, fuel pump, or computer power supply. One of the principal tenets of engineering is to understand why things occur and anticipate or preclude failure. **V and M** diagrams provide such information.

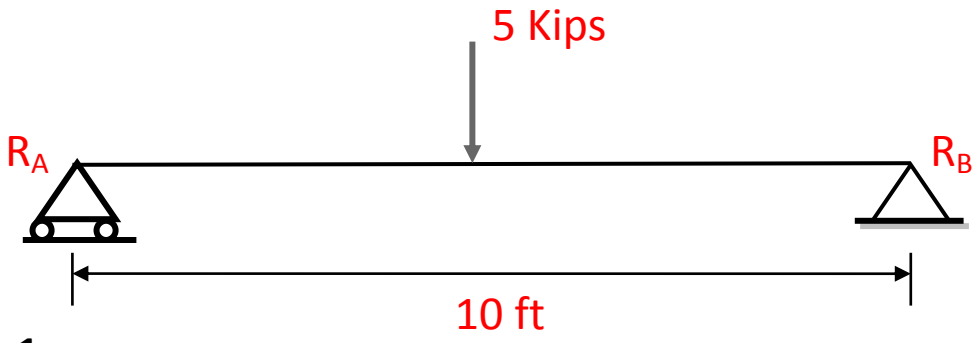
The drawing of V and M diagrams start with the correct calculation of beams reactions. These calculations themselves depend on proper modeling of loads and boundary conditions.

Guidelines:

1. The area under the shear diagram = moment.
2. Maximum or minimum moments occur when shear crosses the zero line.
3. Moment diagrams start and end at zero moment (except for cantilever beams).

Example 1(Calculate the bending moment diagram,M)

Draw the bending moment diagram for the simple beam below supporting a 5 Kip concentrated load, 5 ft from reaction A, as shown below.



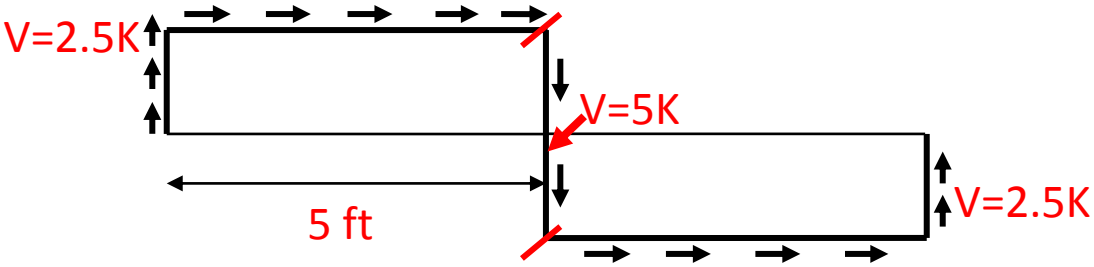
Step1:

From the shear diagram notes we calculated

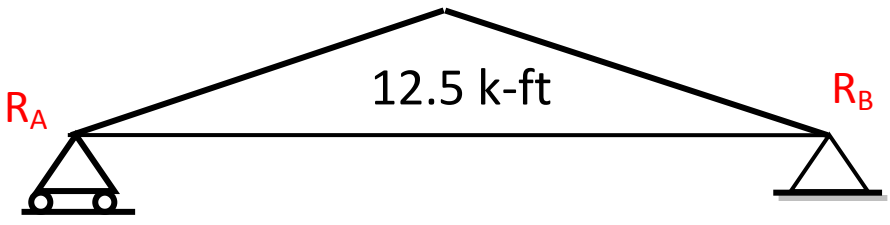
R_B = 2.5k and R_A = 2.5k and

the Maximum shear force, V = 2.5 k.

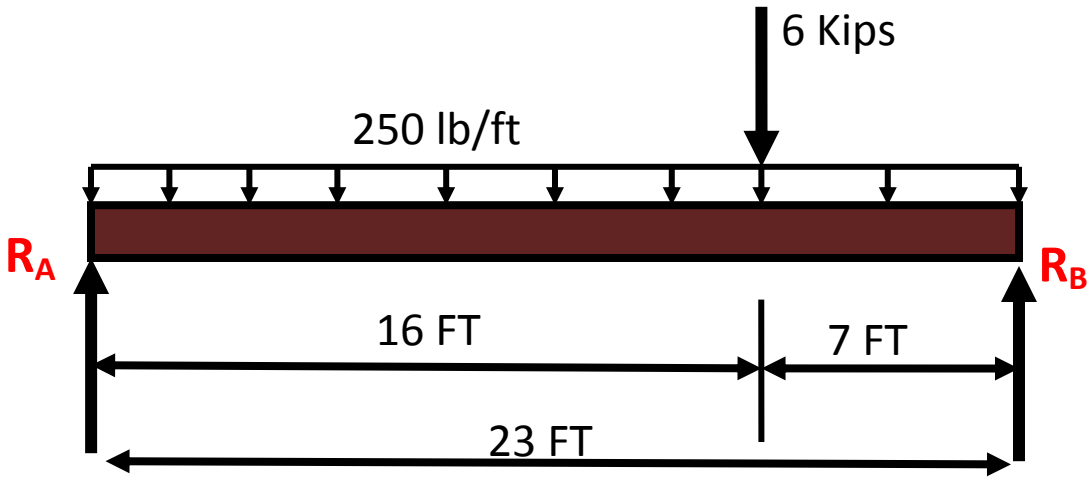
Step 2: Draw the Moment diagram, M



To calculate the moment, we will calculate the area of the shear diagram rectangle above, M = 2.5k x 5 ft = 12.5 K-ft



Example 2(Find the maximum moment and draw the bending moment diagram for the beam below)

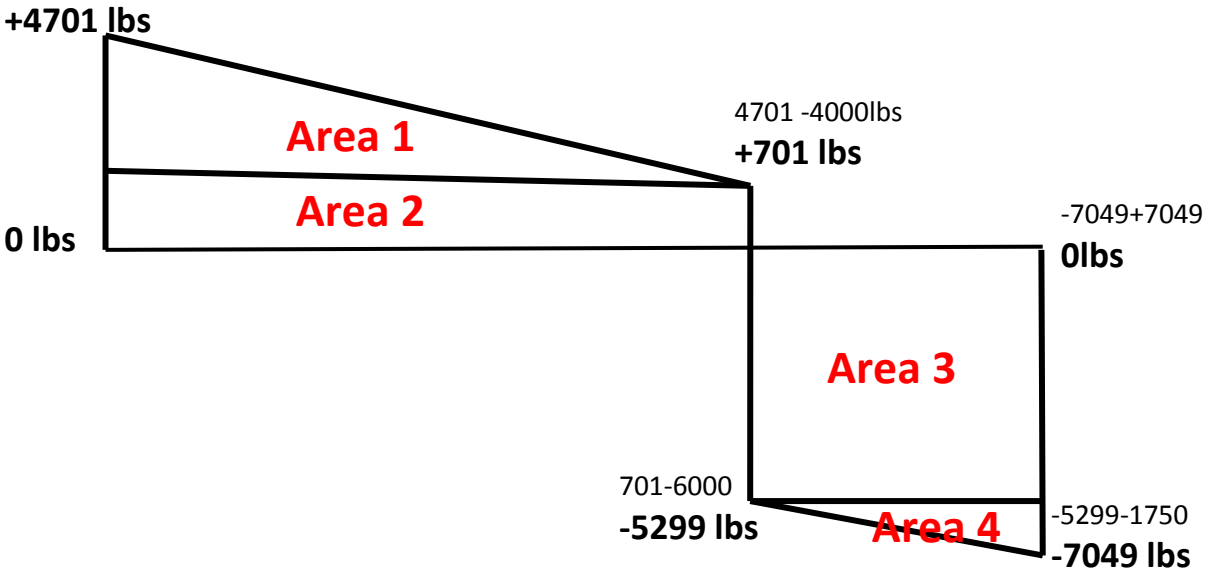


Step1:

From the shear diagram notes we calculated

R_A = 4.701 k and R_B = 7.049 k and

the Maximum shear force, V = 7.049 k.



Step 2: Moment diagram

As we said earlier the moment = The area under the shear diagram.

Area 1 = 0.5 x (4701 - 701) (16') = 32000 Ft-lb

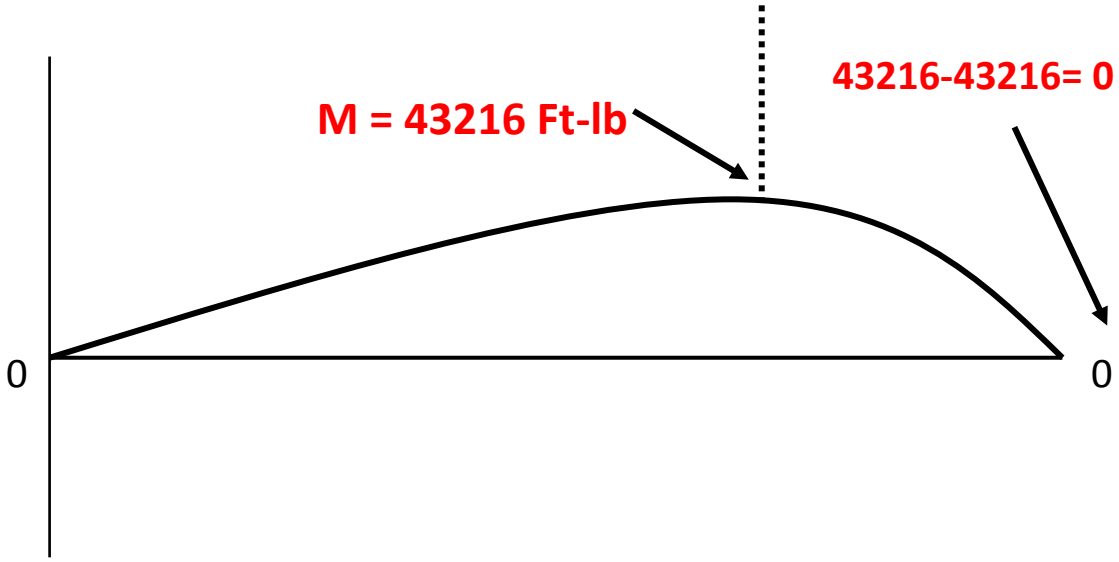
Area 2 = 16 X 701 = 11216 Ft-lb

Area 1 + Area 2 = 43216 Ft-lb

Area 3 = 5299 X 7 = 37093 Ft-lb

Area 4 = 0.5 x (7049 - 5299) (7') = 6125 Ft-lb

Area 3 + Area 4 = 43216 Ft-lb



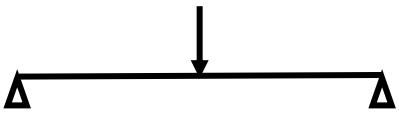
Moment diagram in 60 seconds

During the PE exam sometime you will be working on a section and leaving structure to the end OR just working on structure section but fear time strain.
In this section you will learn some tricks on how to avoid wrong answers from the four solutions available, by just looking at the question, in **60 seconds or less.**

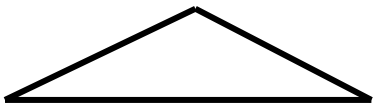
It will all boil down to, how the line is drawn, either constant, linear OR parabolic (curved).

This section will show the different types of beam loads you need to be familiar with in the morning section.

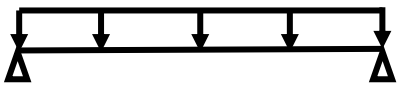
(A) Beam with a point load:



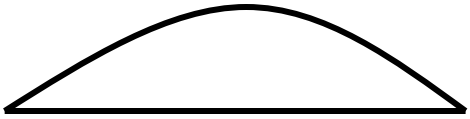
Since the beam is carrying a point load on a simple beam(NOT FIXED reactions on any end) then it will be LINEAR.
No matter what the load is. It will start from original go linear and stop on the center, where the load is applied, and then go back to the other support.
Moment



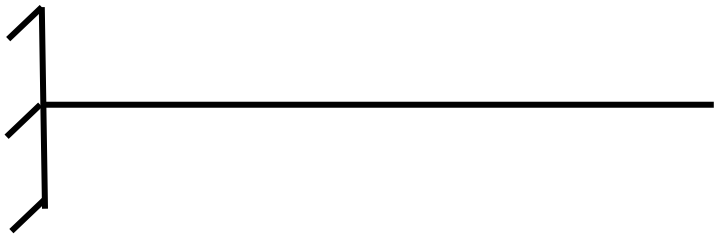
(B) Beam with linear-distributed load:



The distributed load will act as a parabolic shape **NOT linear**. So if the question showed a distributed load and any of solutions is showing a linear curve, you would know which one to cancel, by looking at the figure.

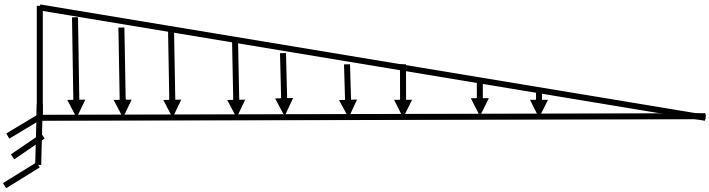


(C) Beam with fixed reaction with cantilever end:

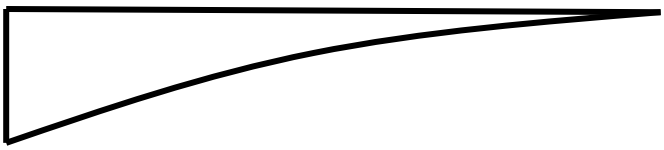


At fix end location, the moment is highest and a linear trend follows.

(D) Beam with triangular distributed load.

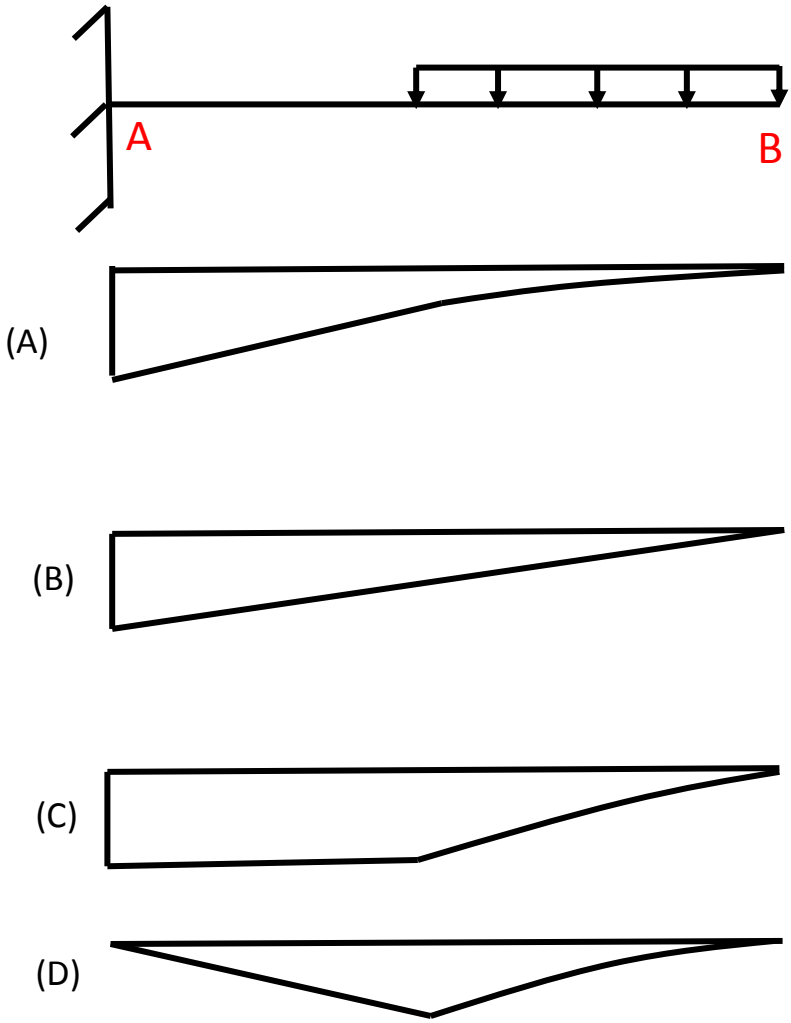


Moment is highest at fix end location and then parabolic (NOT linear).



Example Problem (1)

Which diagram below best describes the MOMENT diagram for the beam below?

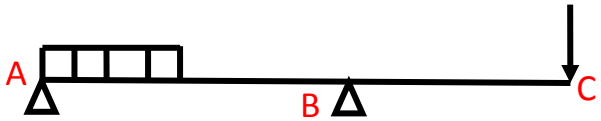


Solution:

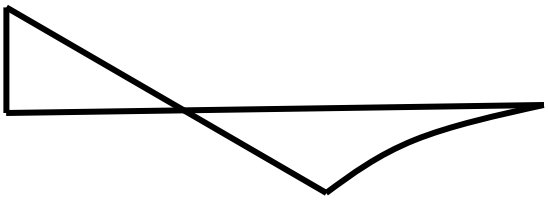
Answer **D**, the highest moment is at point A while the figure shows a zero moment, which is not the case.
Answer **C**, the line from point A to the distributed load area is constant, which is not the case in a fixed moment end.
Answer **B**, the line from point A cannot be linear all the way between point A and B, because it did not represent the parabolic shape shift beneath the distributed load.
Answer **A**, load is Max at point A, fixed end, going linear to the distributed load section and then shift parabolic beneath distributed load.
The correct answer, is A.

Example Problem (2)

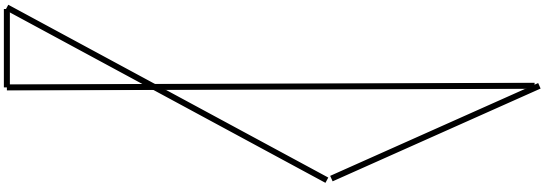
Which diagram below best describes the MOMENT diagram for the beam below?



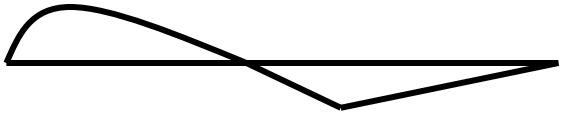
(A)



(B)



(C)



(D)

Solution:

Figure **A**, the distributed load (point A-B) cannot be linear.
Figure **B**, the distributed is linear too.
Figure **C**, the distributed load is parabolic (A-B) and the moment between B and C is linear.
Figure **D**, the moment line cannot be constant from point A to B.

The correct answer is **C**