NEW YORK INSTITUTE OF TECHNOLOGY

Bending and Shear in Simple Beams

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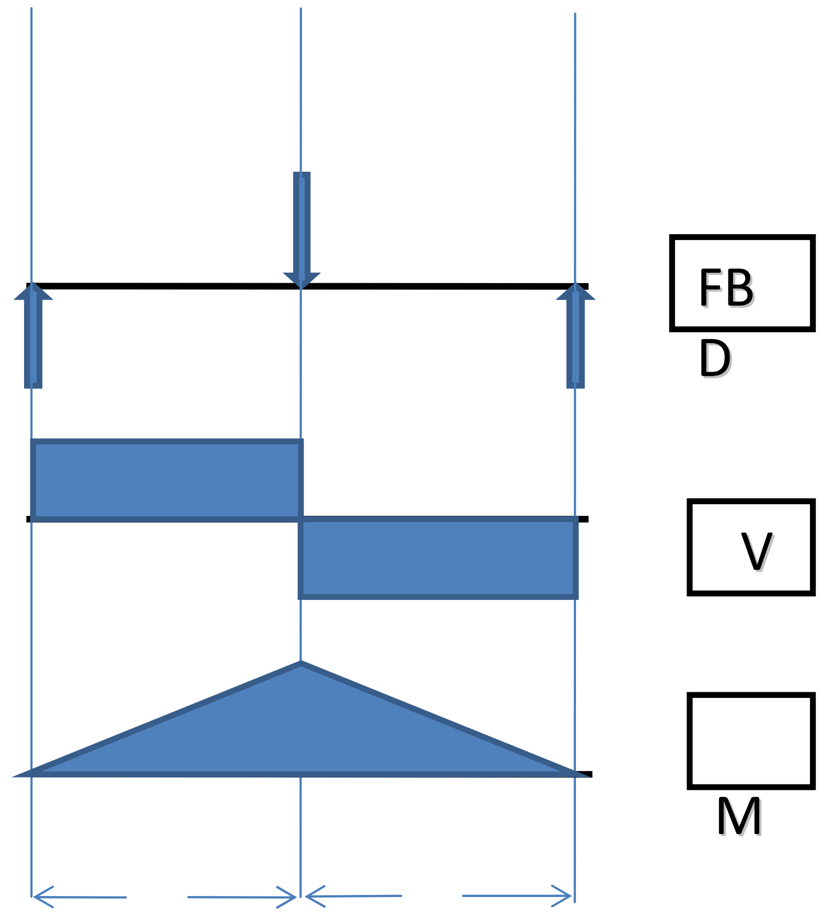
Beams

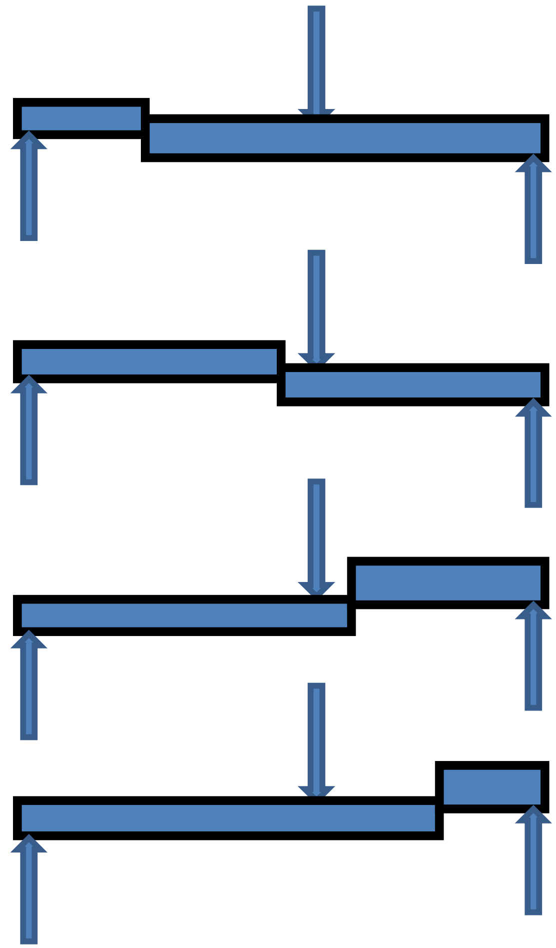
- Beams resist loads usually applied perpendiculat to its longitudinal axis.
- These loads cause bending, which in turn causes internal stresses as it resists this load.

Moment and Shear Diagrams

- Graphs that show the magnitude and direction of the internal shear and moment forces along the length of a beam

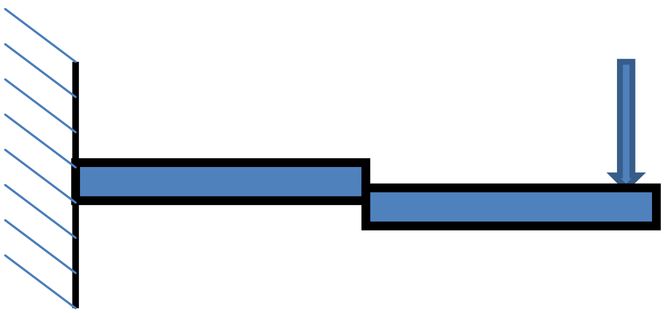


Sign Convention, Shear



Sign Convention, Shear

- Shear at a section is considered positive (+) when the portion of the beam to the left of the section cut tends to be in the up position with respect to the section in the right



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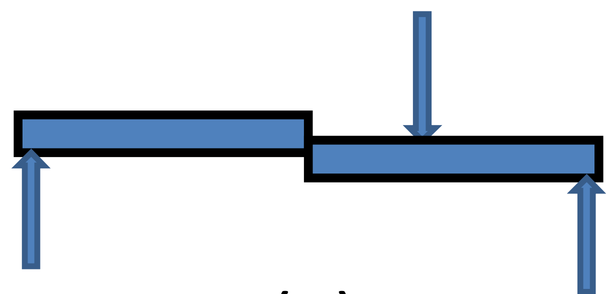
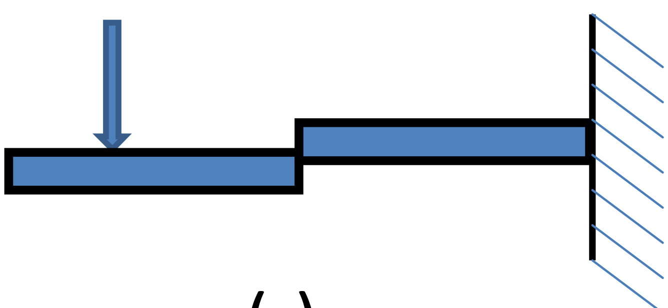


(+)



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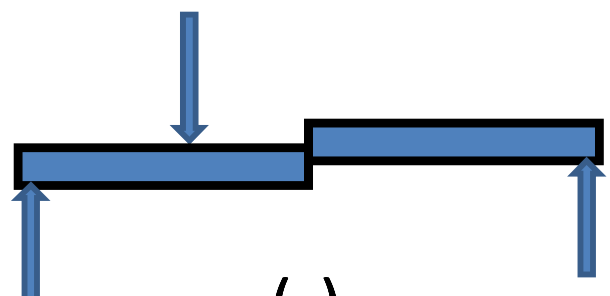
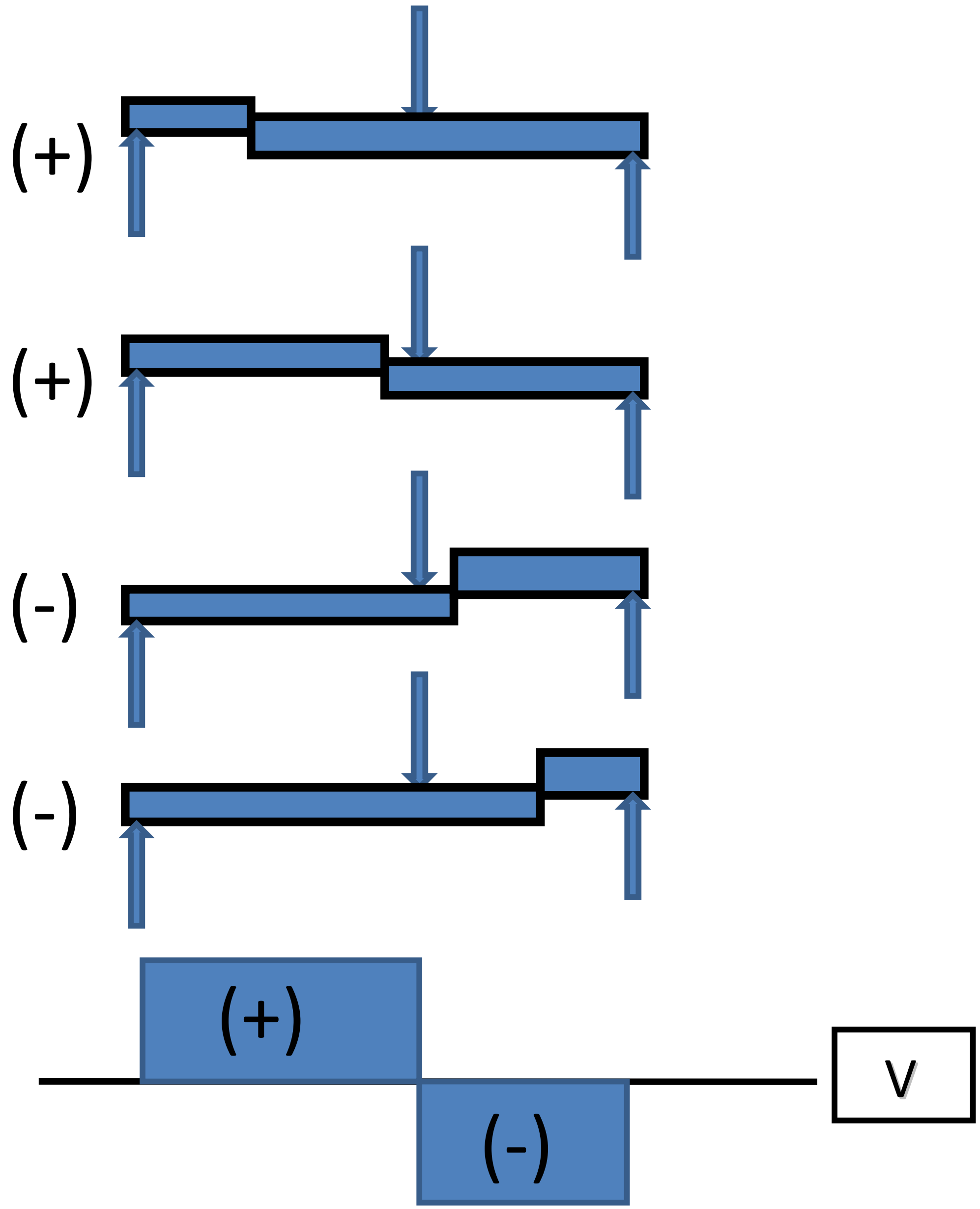


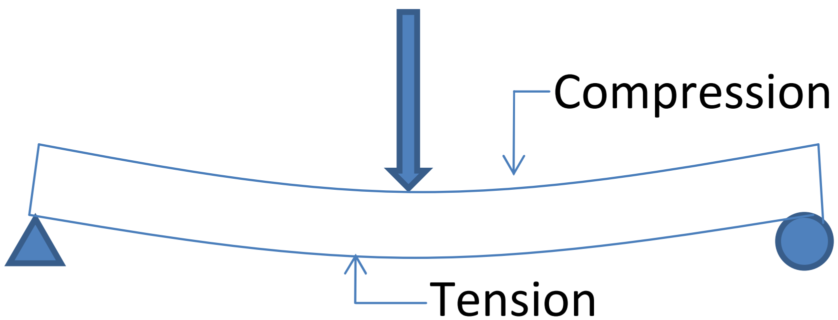
(-)

Sign Convention, Shear



Sign Convention, Moment

- Positive (+) moment occurs at sections for which the top fibers of the beam are in compression and the bottom fibers in tension.



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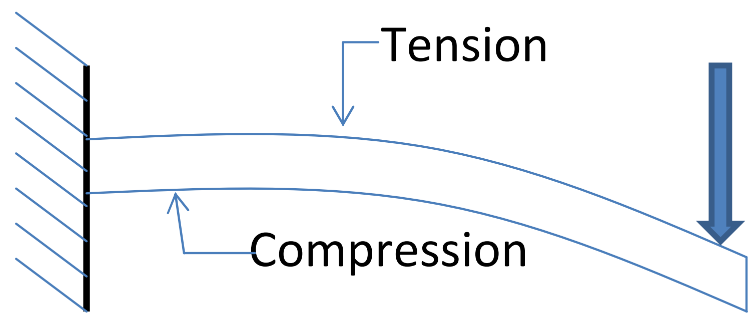

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Sign Convention, Moment

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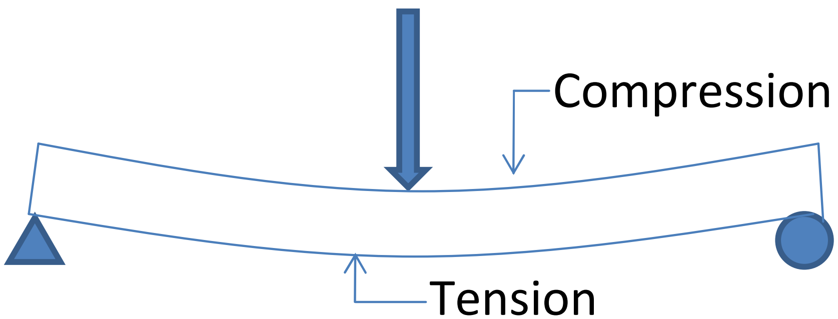

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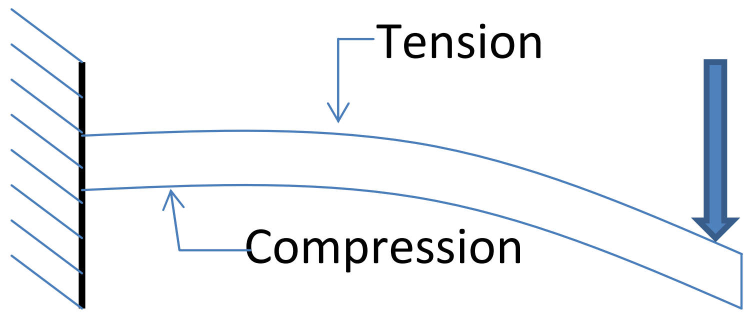

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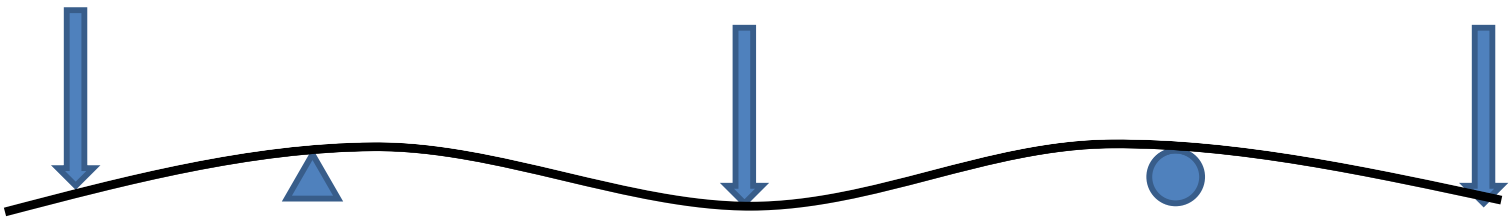
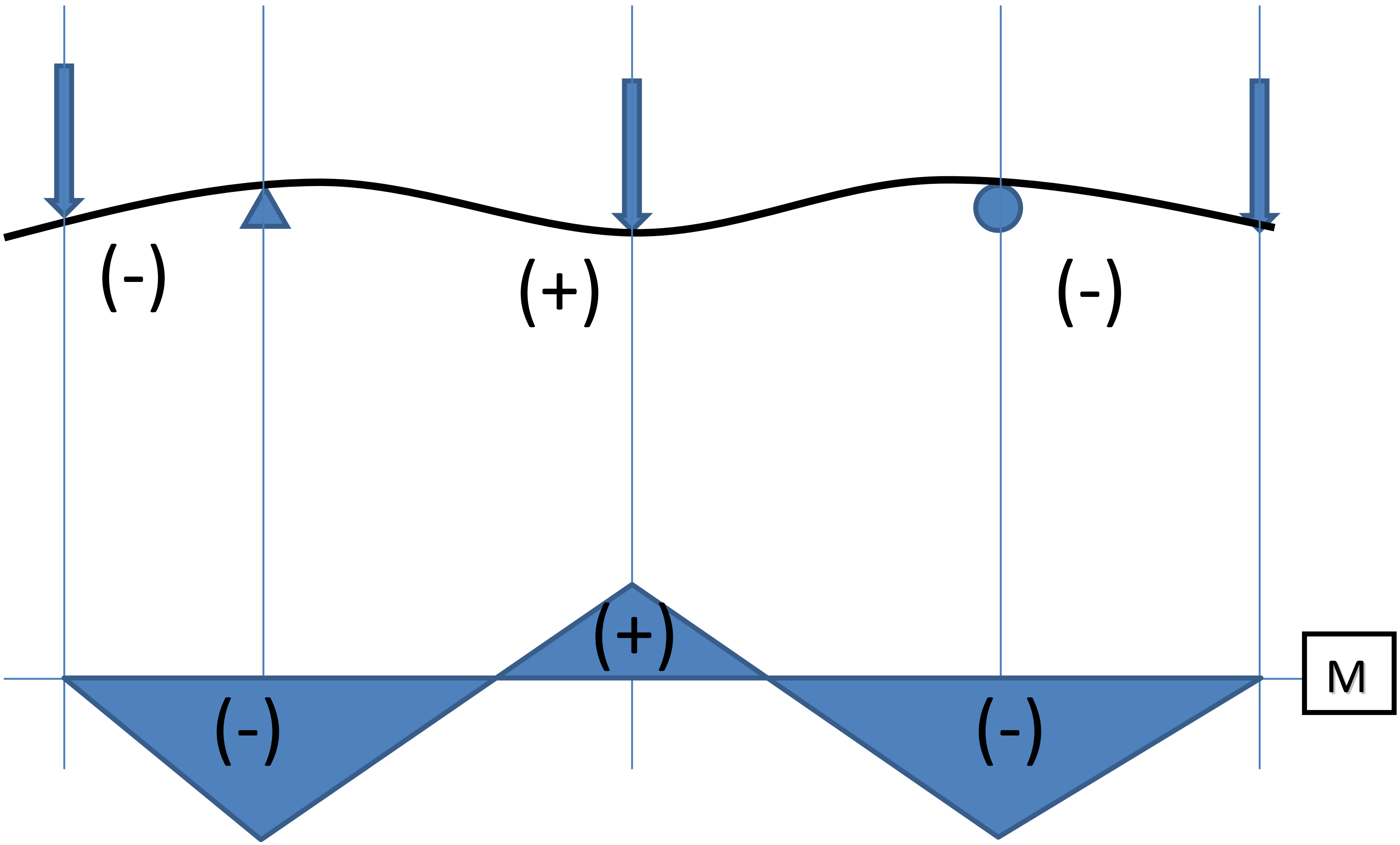
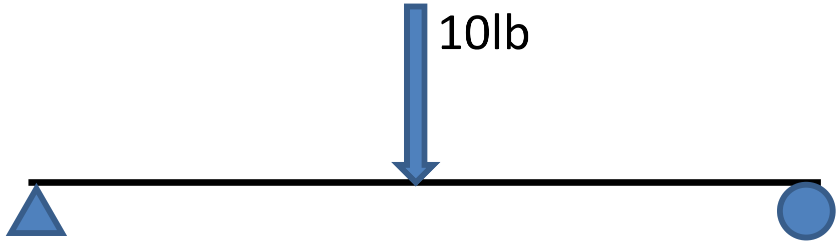
Sign Convention, Moment



Sign Convention, Moment



Constructing Moment and Shear Diagrams



$\Sigma M_a = 0$

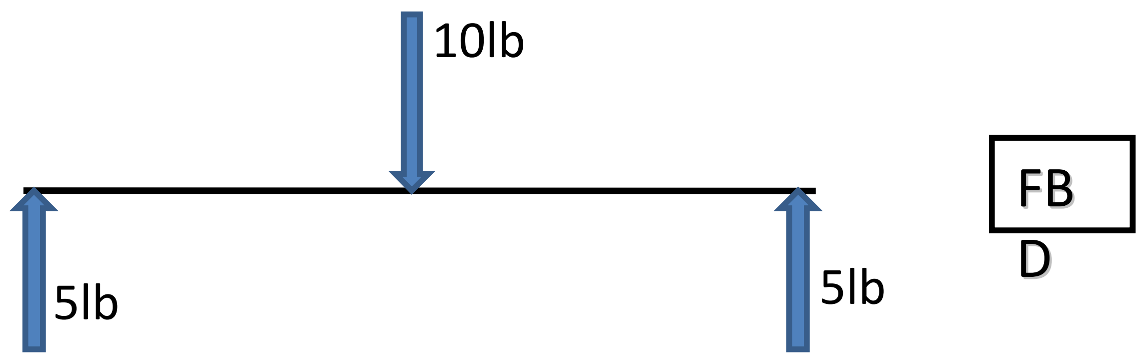
$-(10lb)(1ft)+(Ry_2)(2ft)=0$

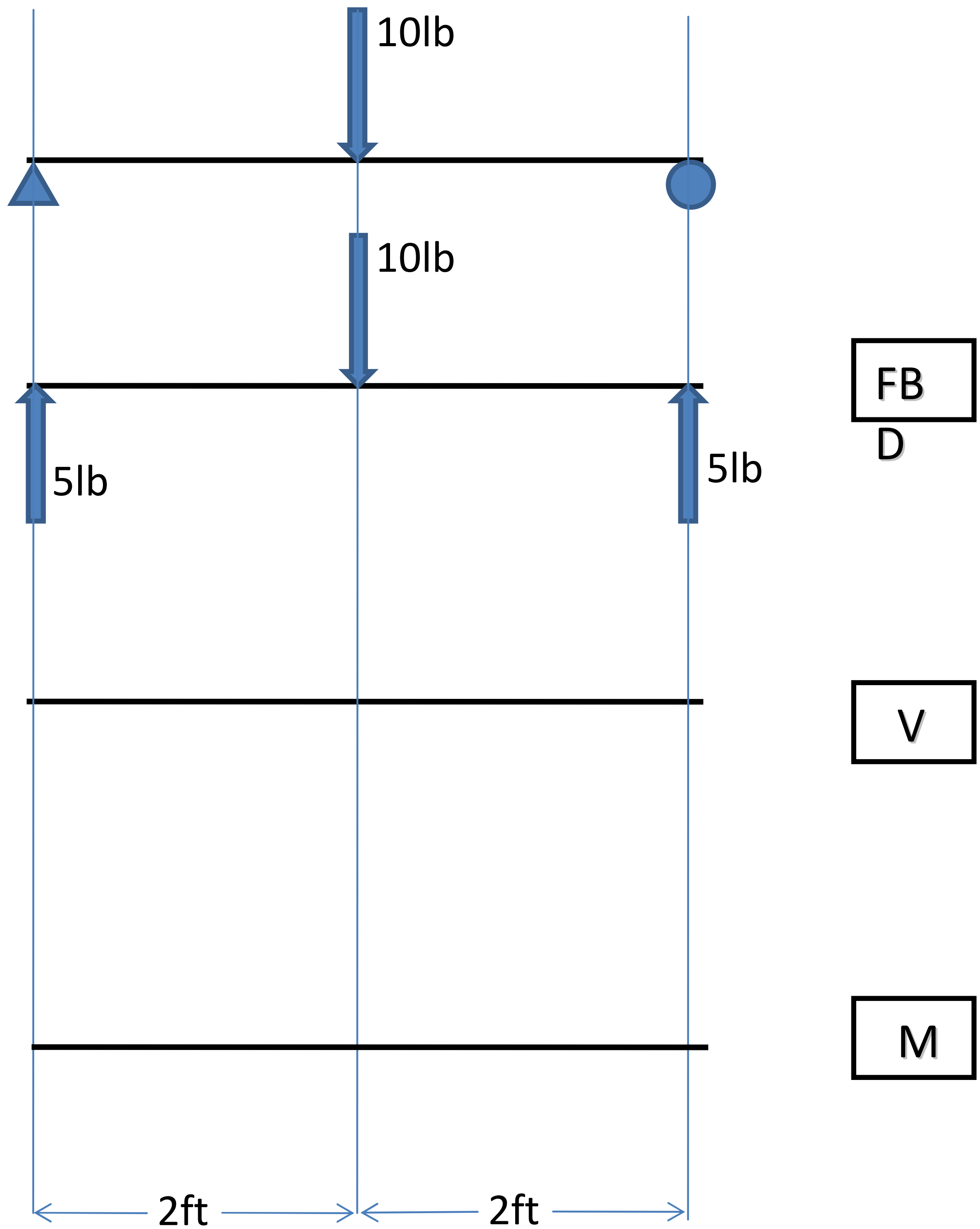
$Ry_2 = 5lb$

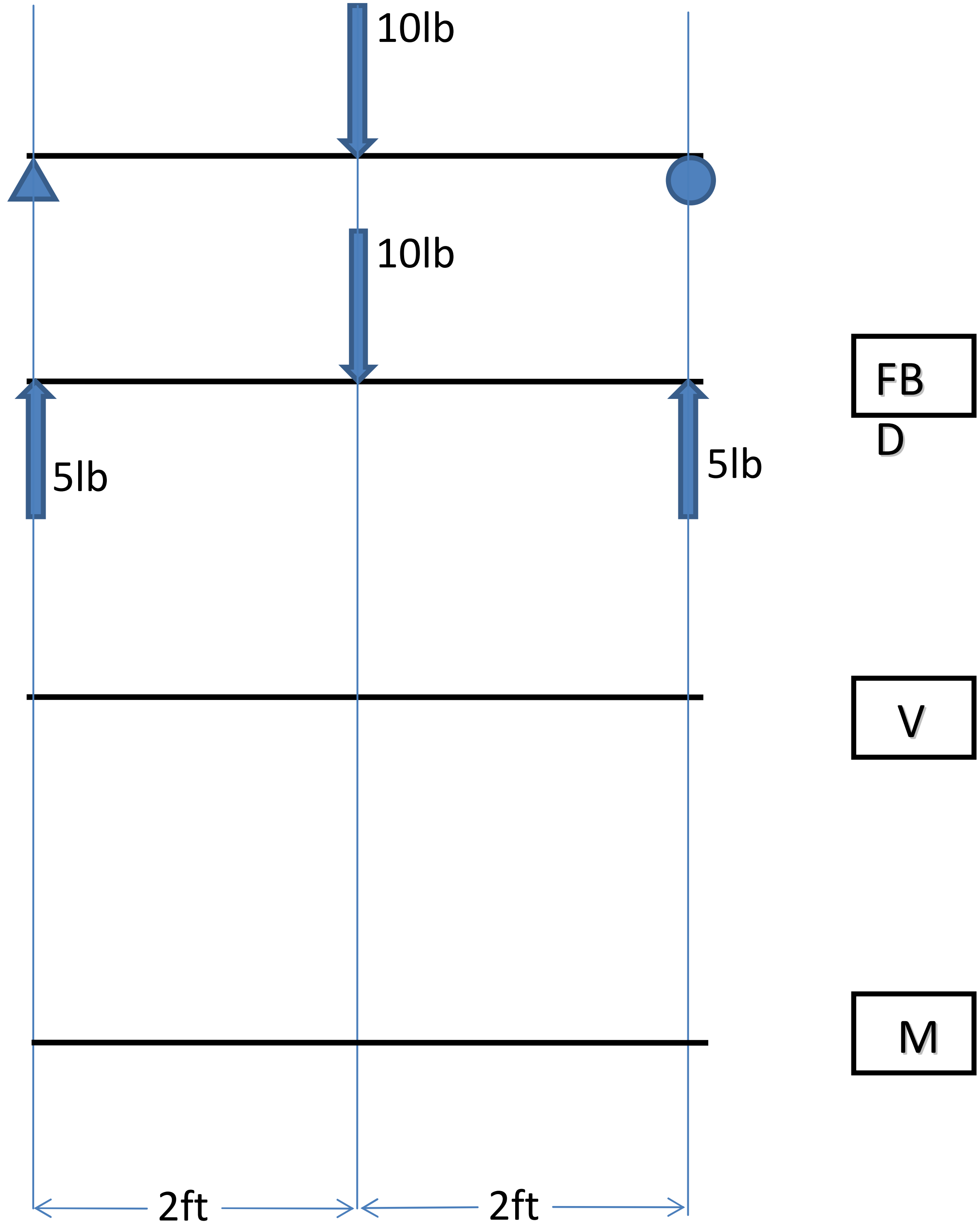
$\Sigma F_y = 0$

$Ry_1 - 10lb + 5lb = 0$

$Ry_1 = 5lb$

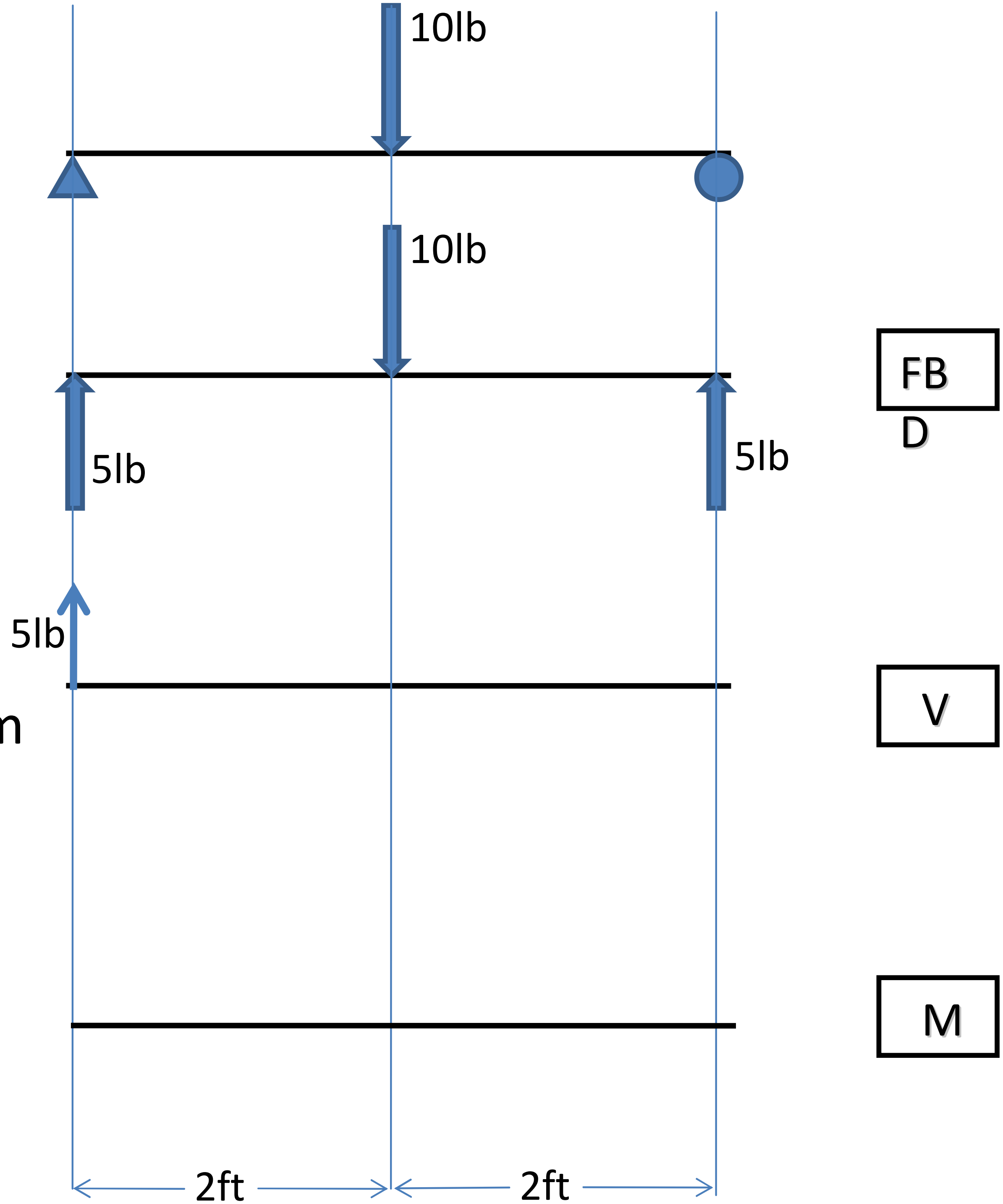



10lb
10lb
FB
D
5lb
5lb
V
M
2ft
2ft

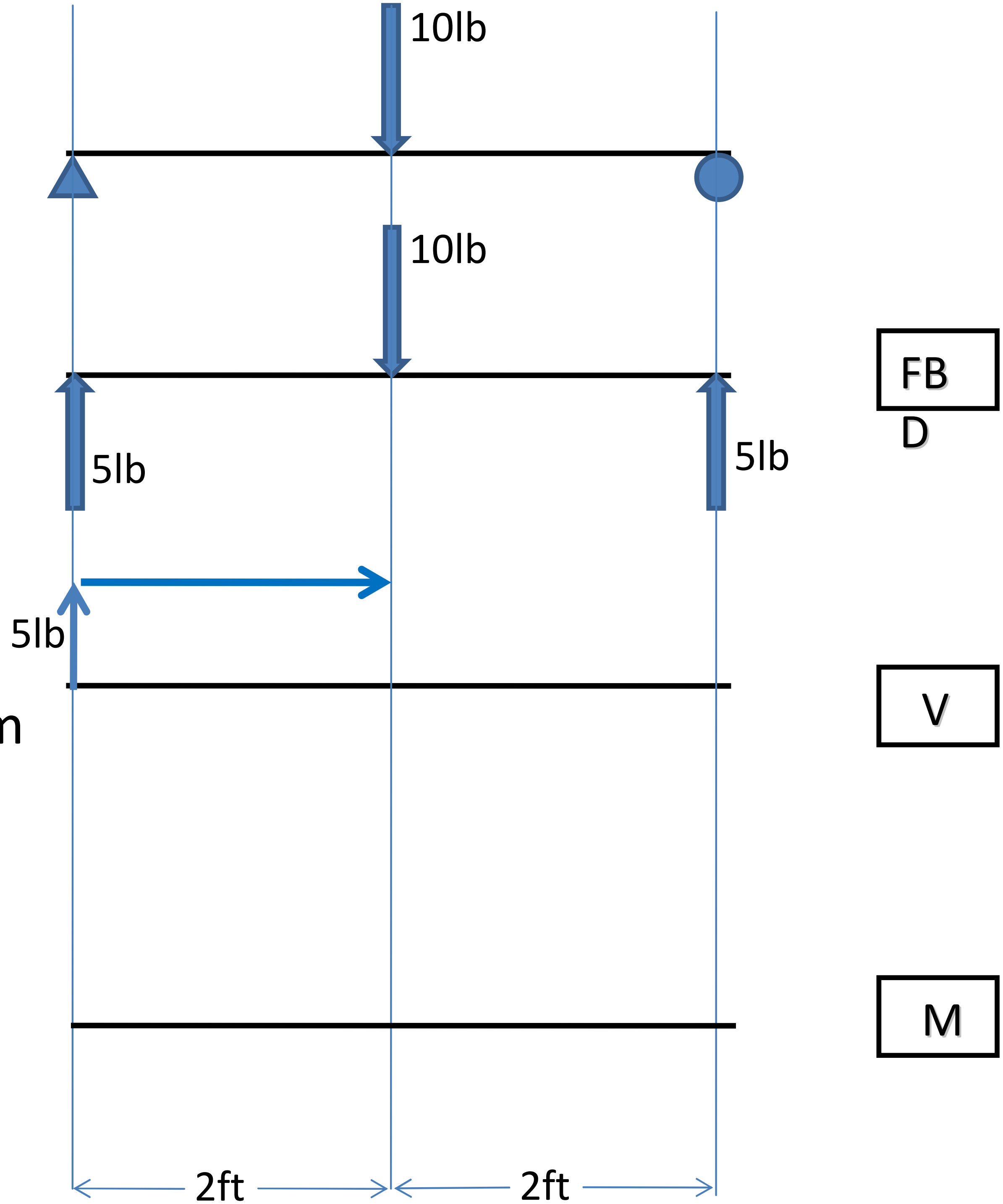


Concentrated loads shift the SHEAR diagram up or down

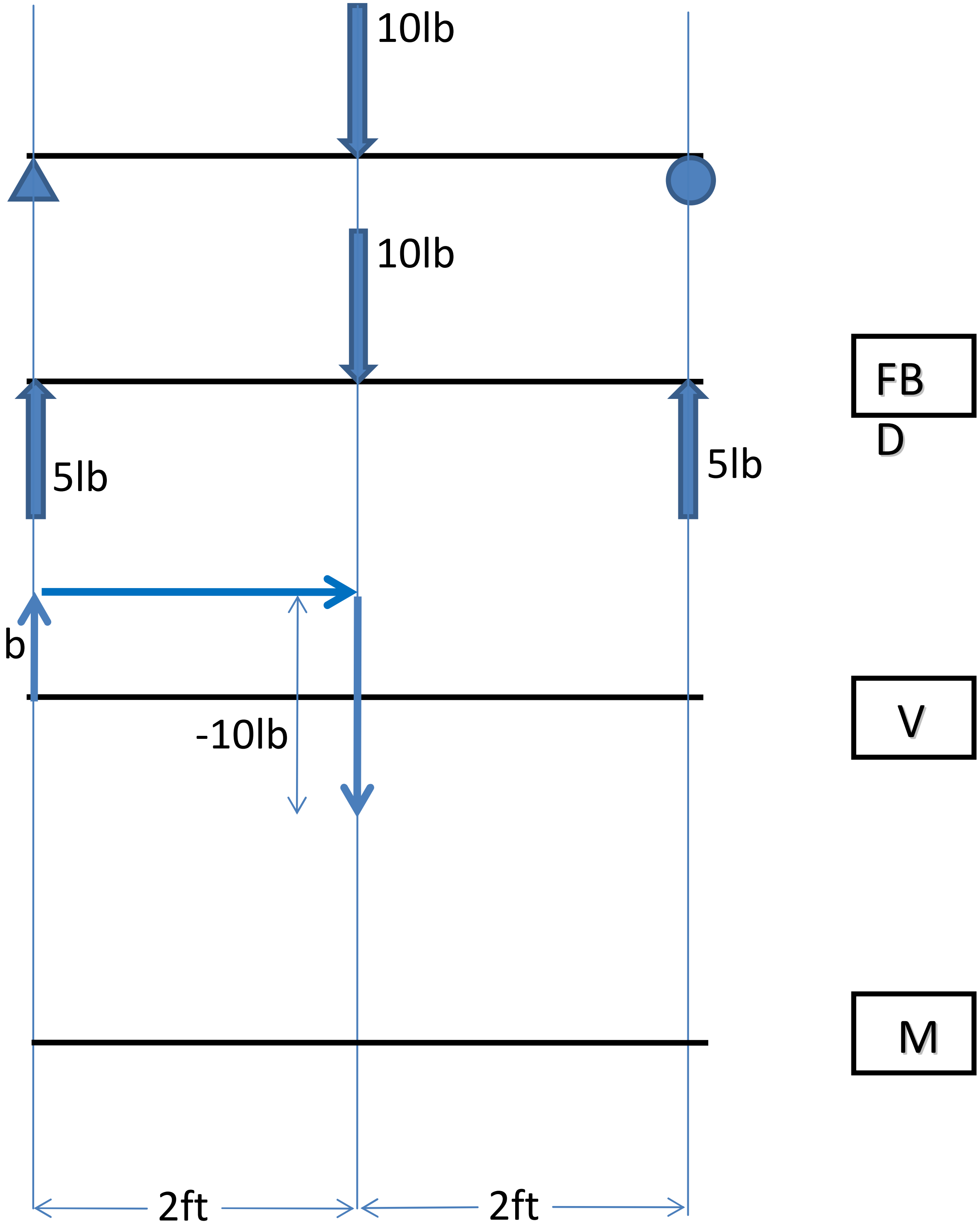
Concentrated loads shift the SHEAR diagram up or down



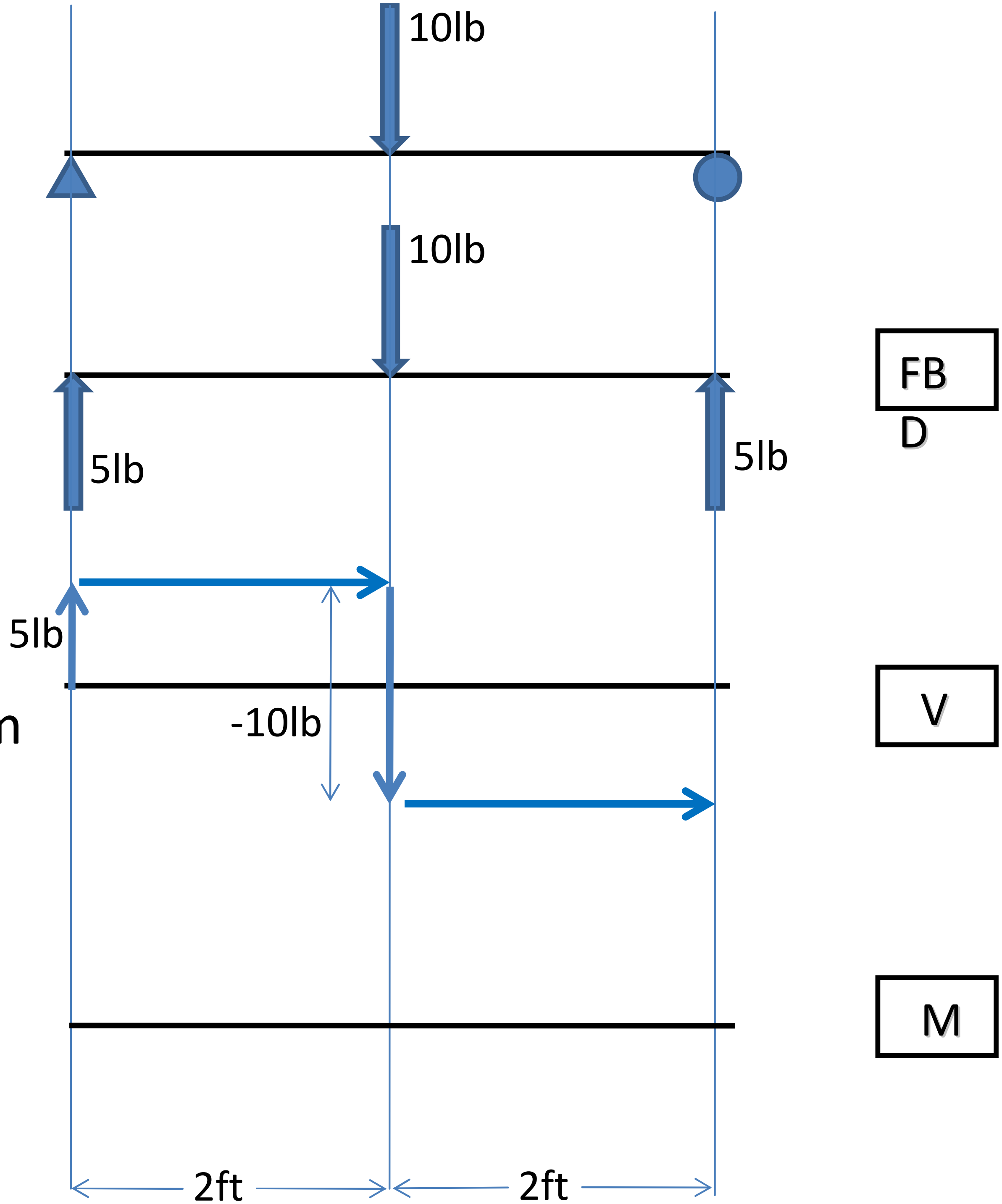
Concentrated loads shift the SHEAR diagram up or down



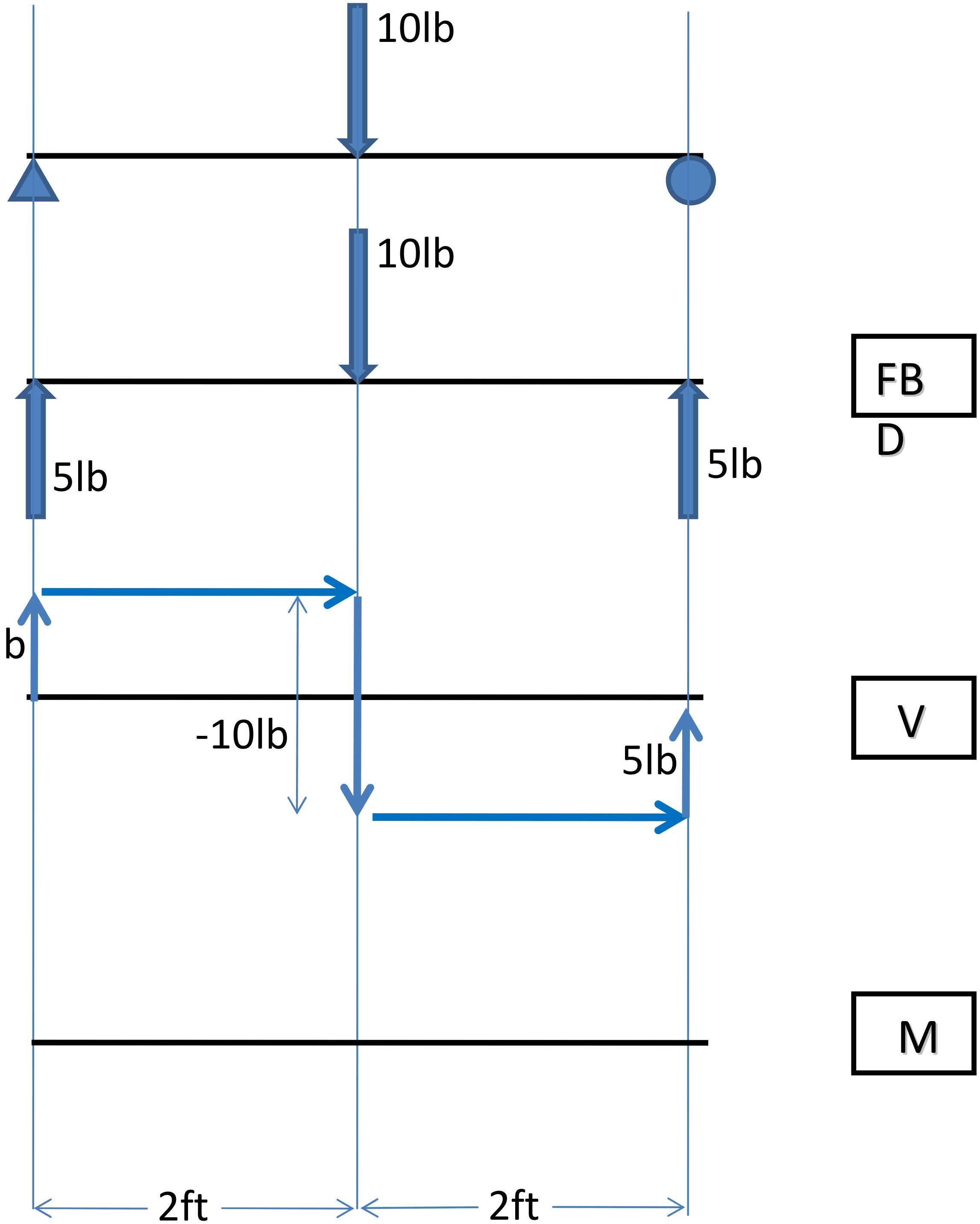
Concentrated loads shift the SHEAR diagram up or down



Concentrated loads shift the SHEAR diagram up or down



Concentrated loads shift the SHEAR diagram up or down



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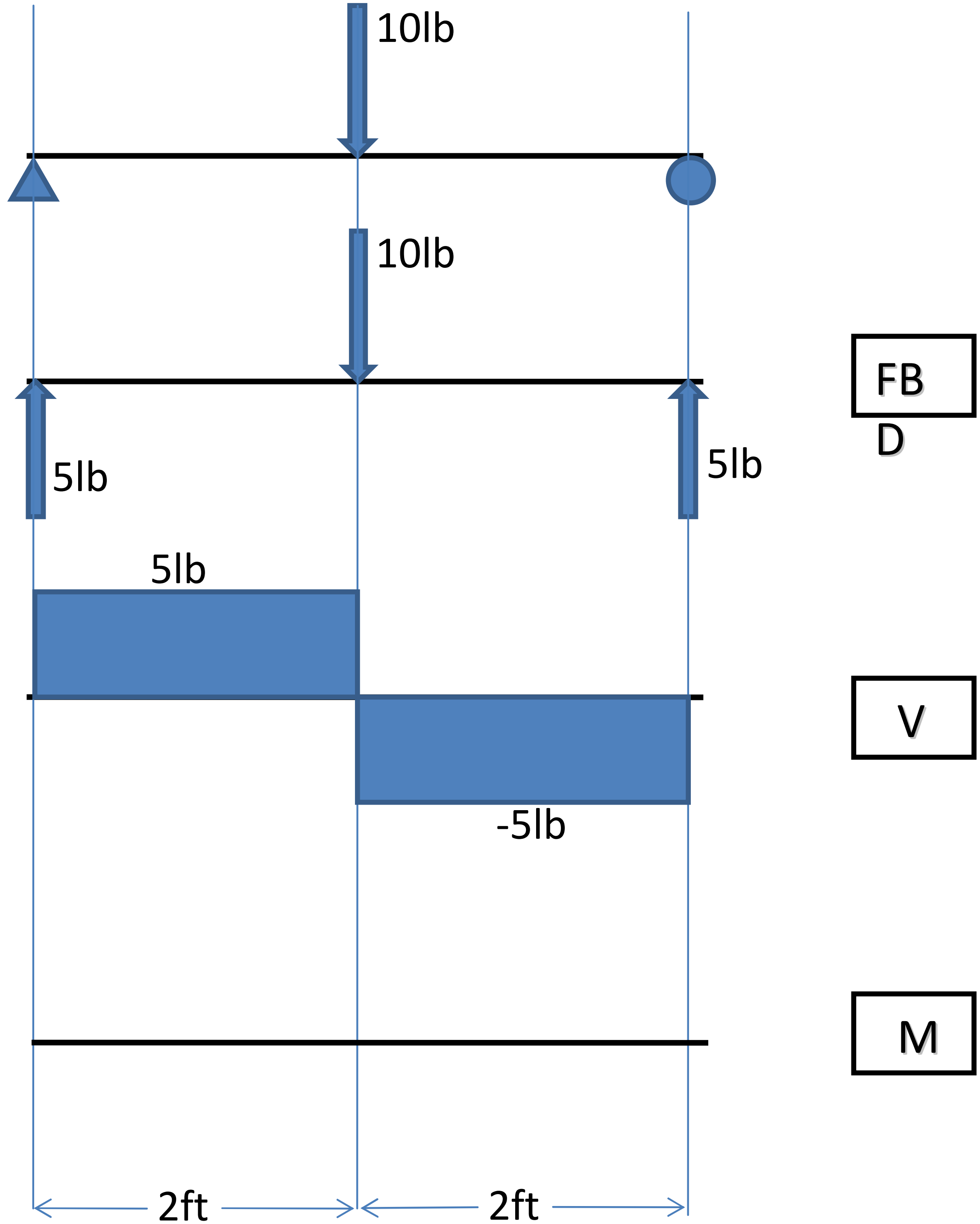
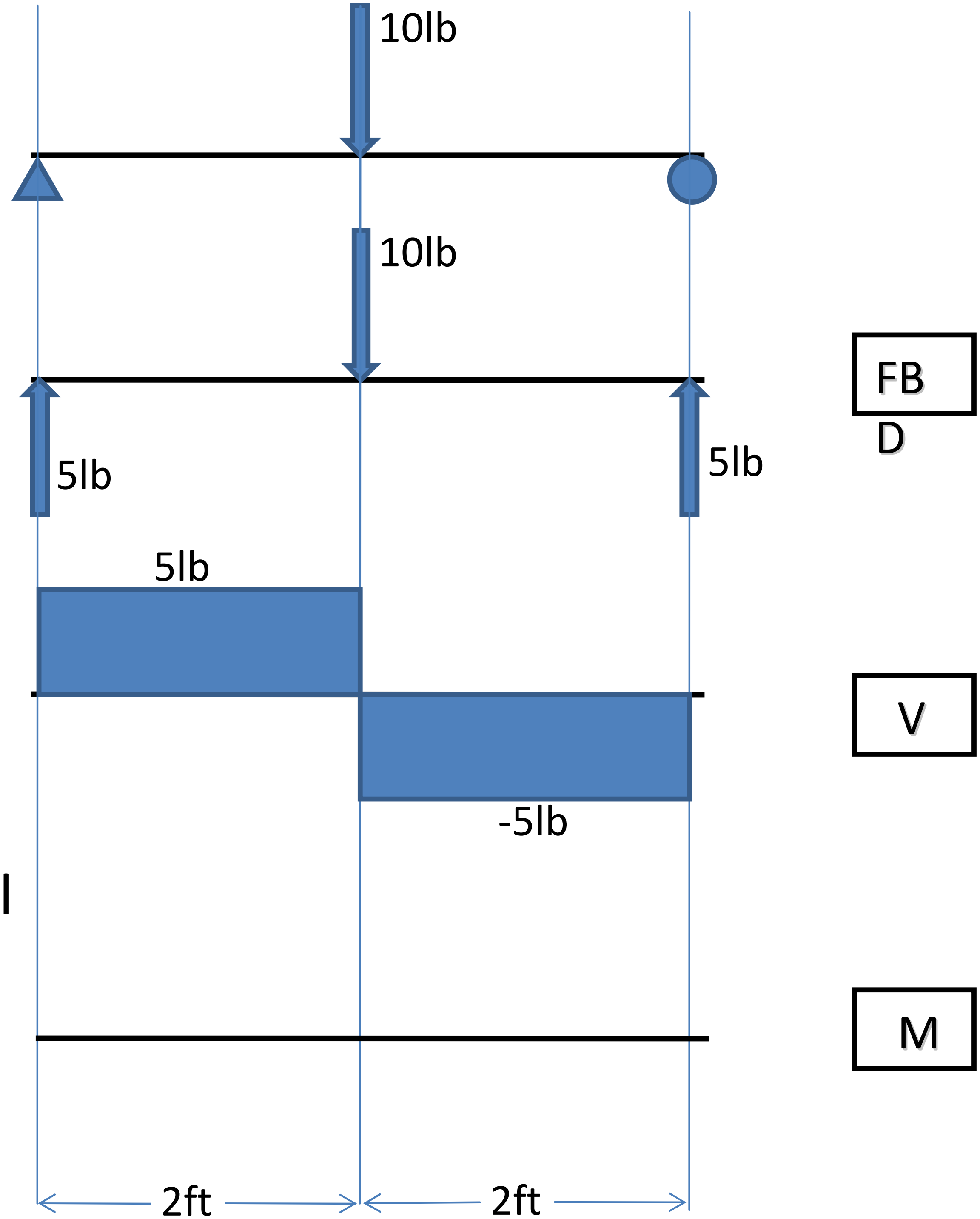
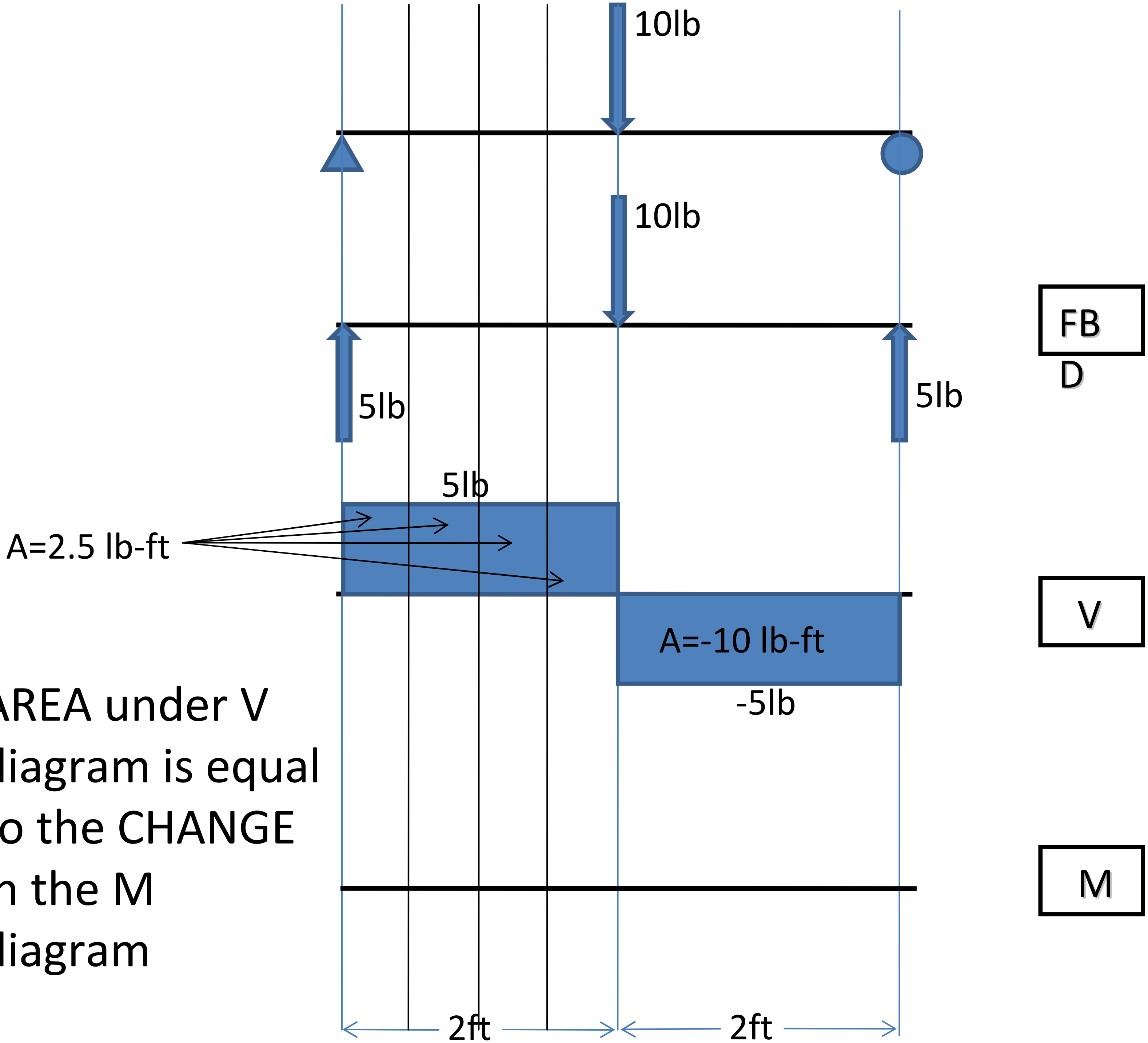
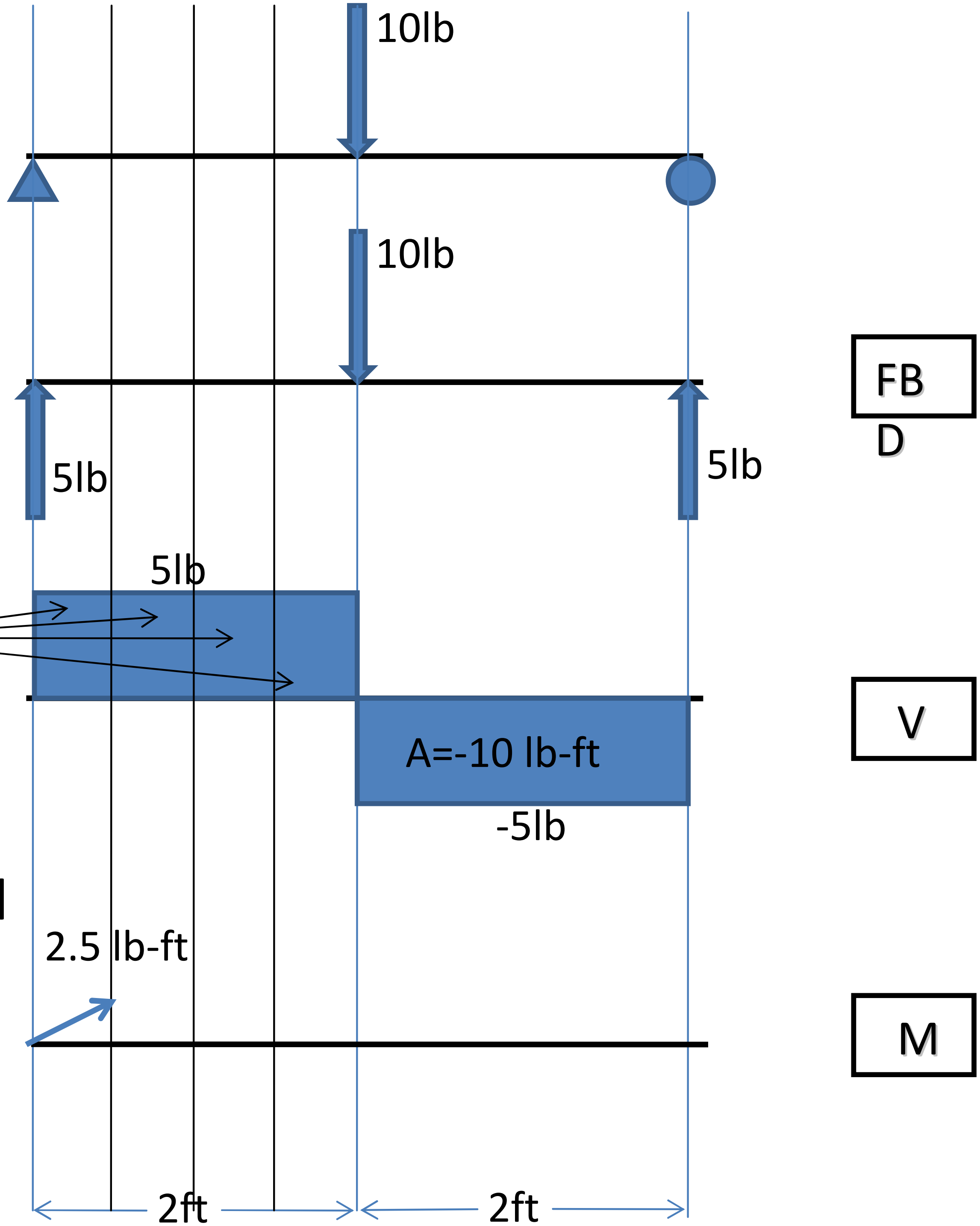




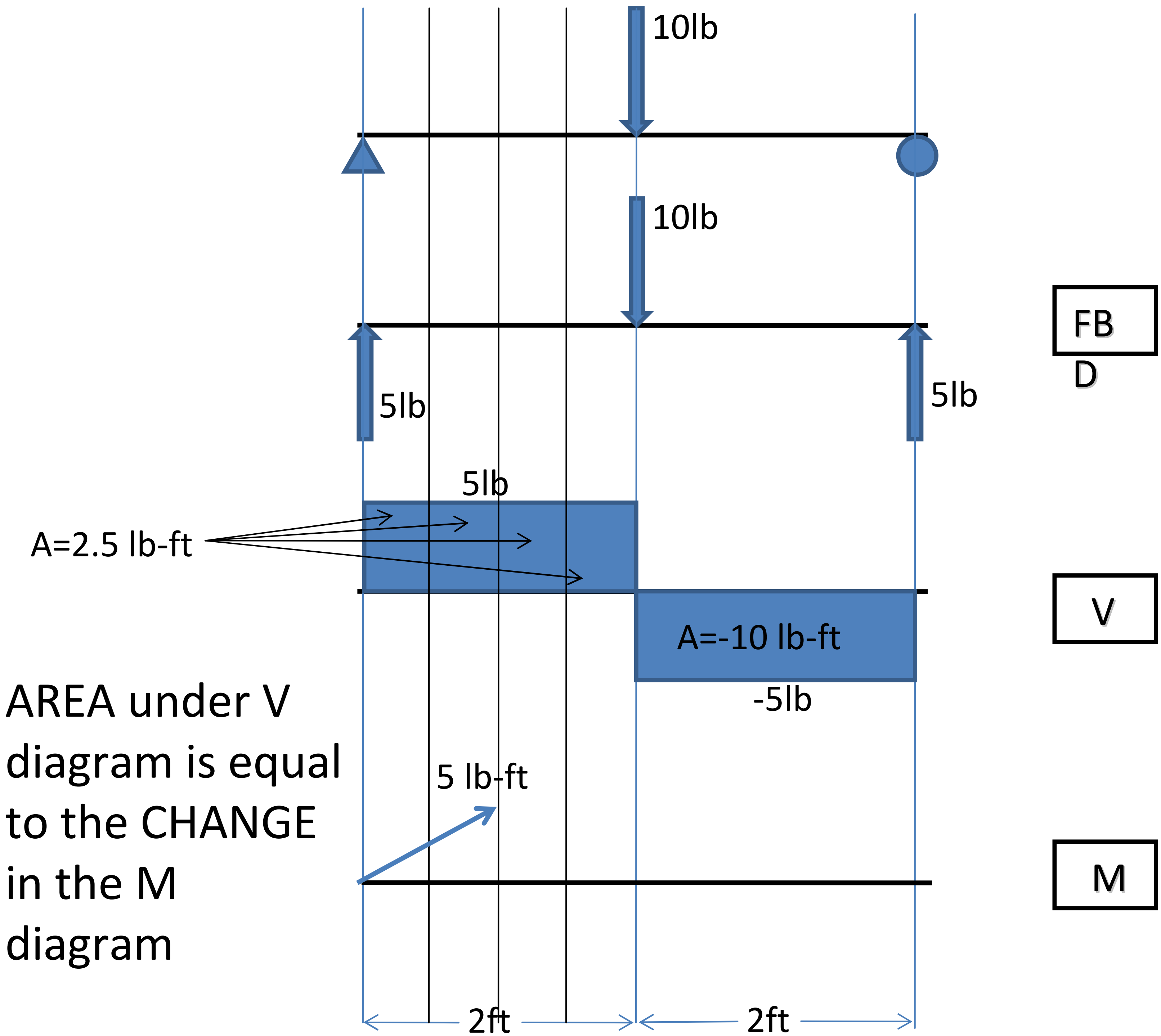
AREA under V diagram is equal to the CHANGE in the M diagram

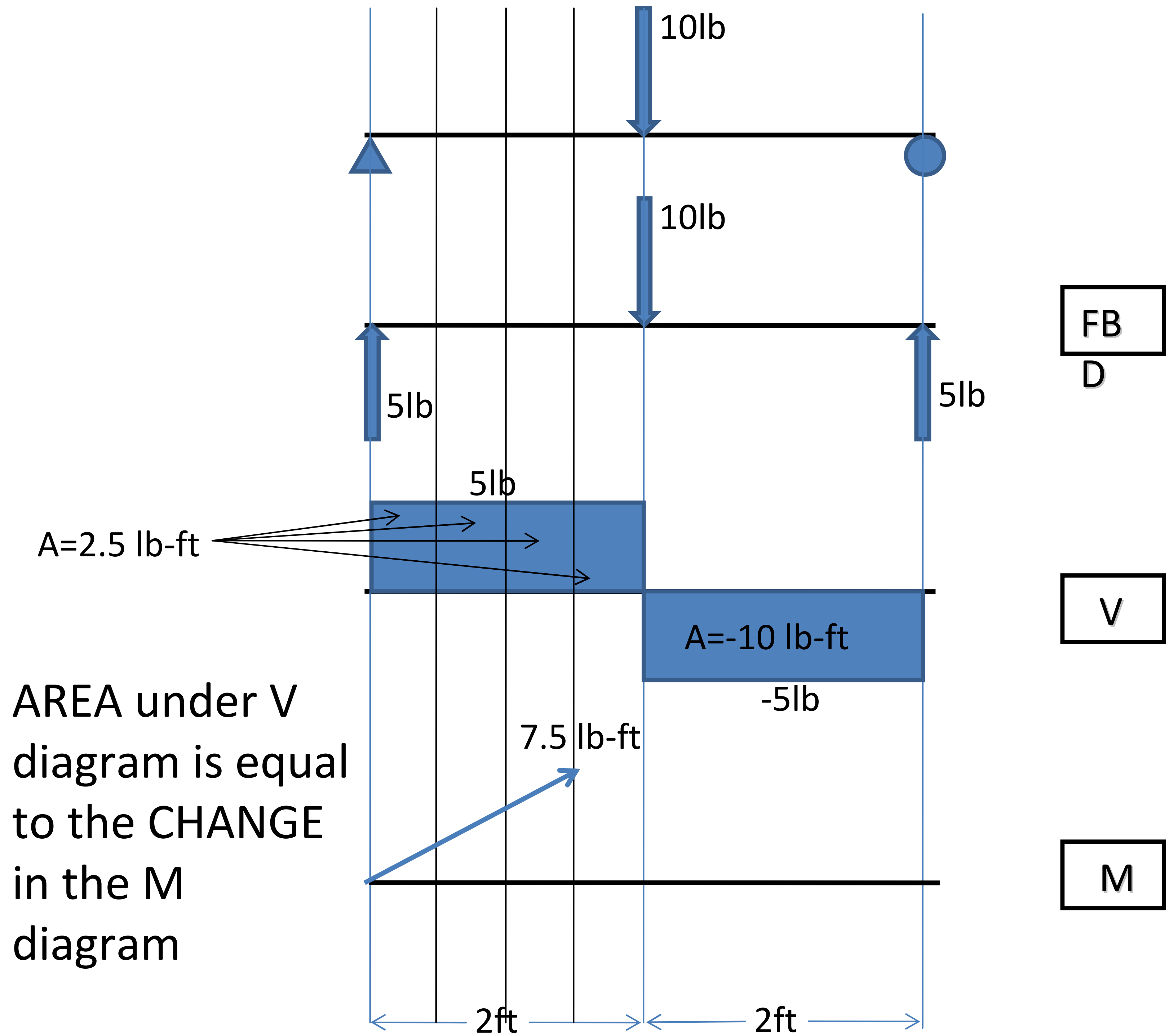


AREA under V diagram is equal to the CHANGE in the M diagram

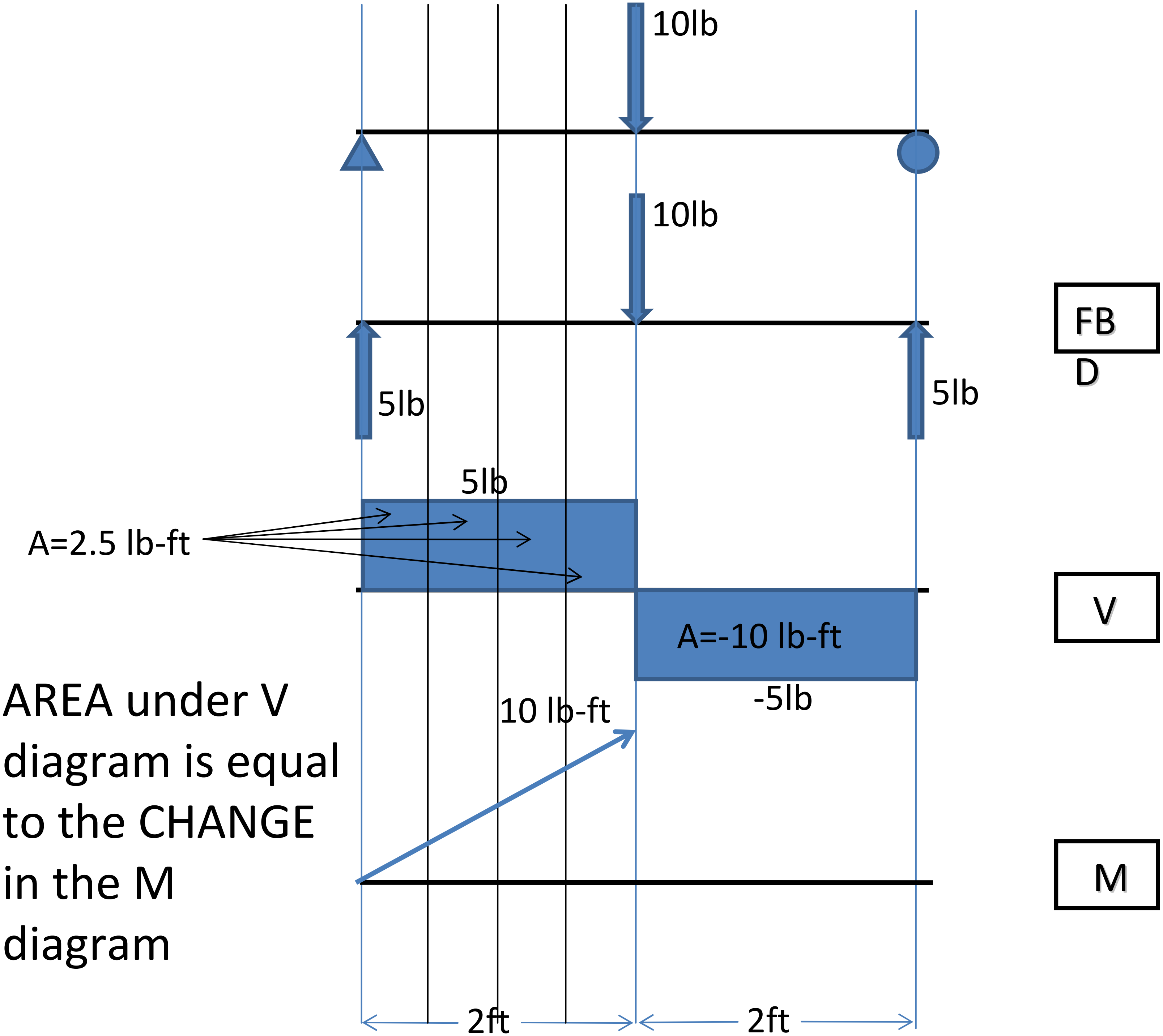


AREA under V diagram is equal to the CHANGE in the M diagram

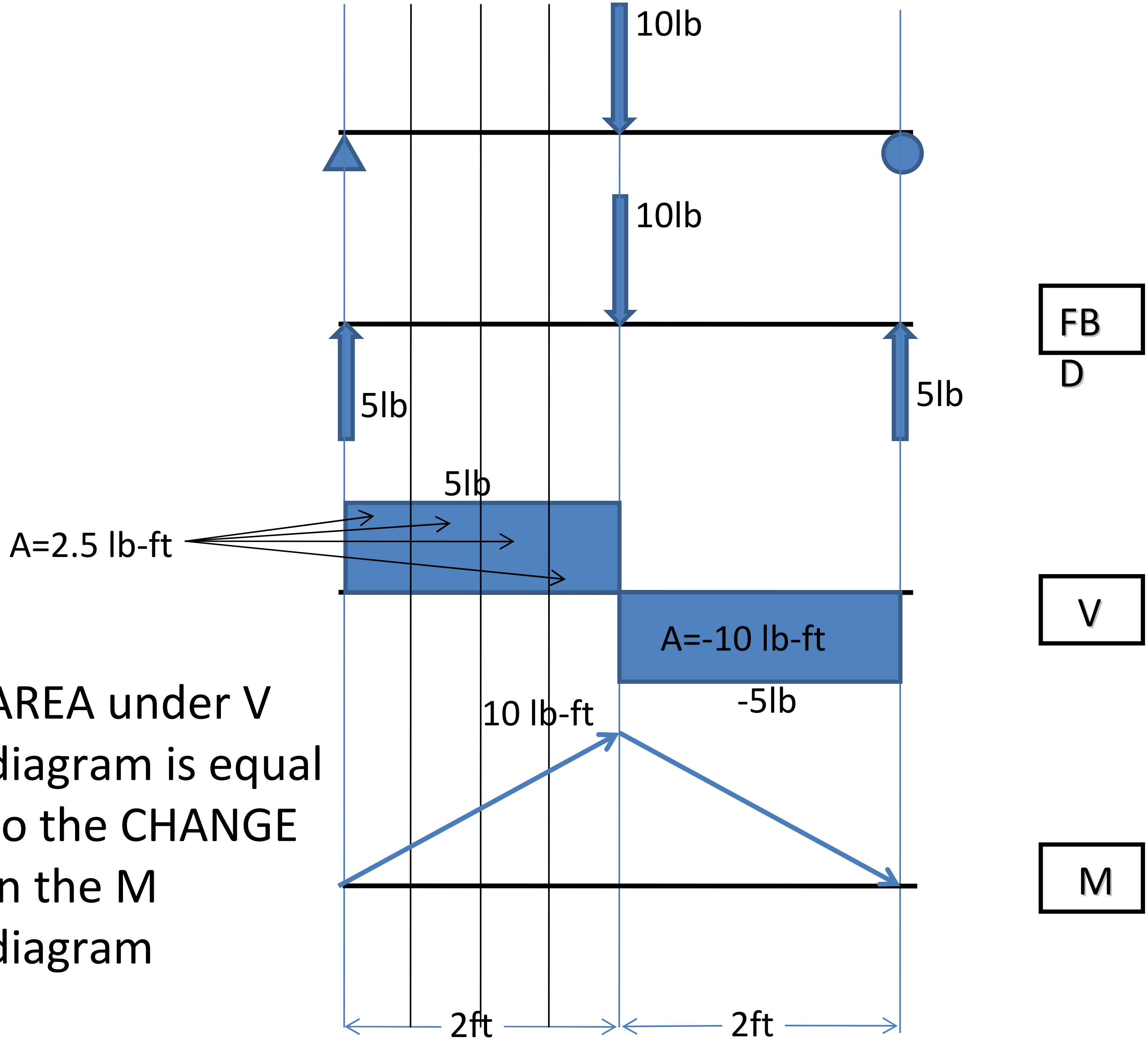

10lb
10lb
FB
D
5lb
5lb
5lb
A=2.5 lb-ft
V
A=-10 lb-ft
-5lb
AREA under V diagram is equal to the CHANGE in the M diagram
5 lb-ft
M
2ft
2ft



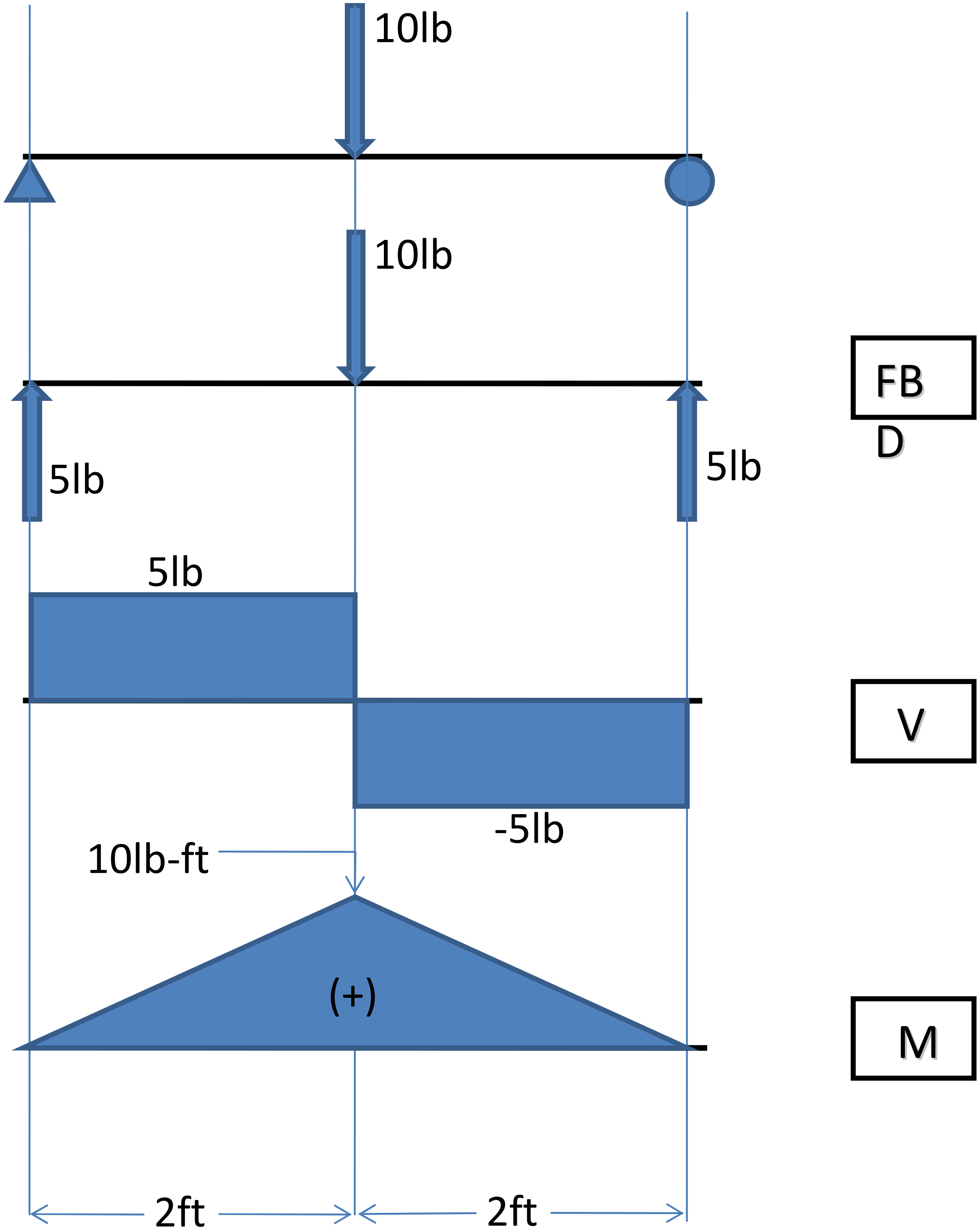
10lb
10lb
5lb
5lb
FB
D
5lb
A=2.5 lb-ft
V
A=-10 lb-ft
-5lb
AREA under V diagram is equal to the CHANGE in the M diagram
7.5 lb-ft
M
2ft
2ft



AREA under V diagram is equal to the CHANGE in the M diagram

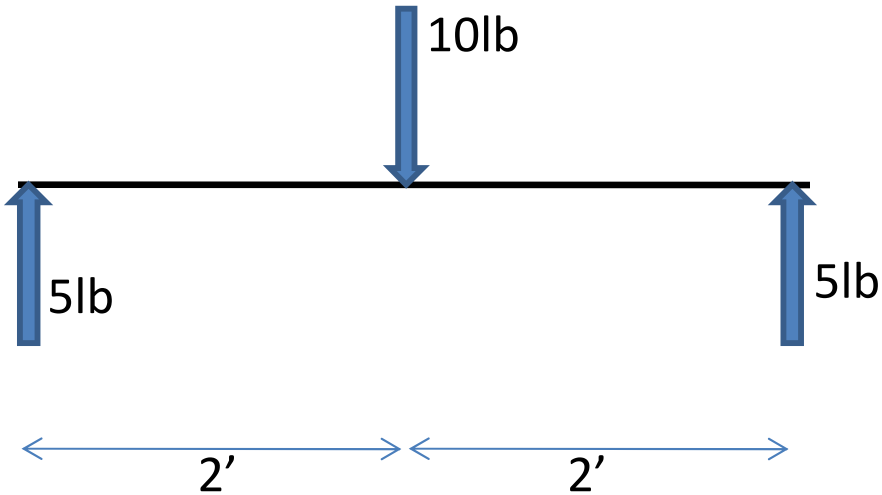


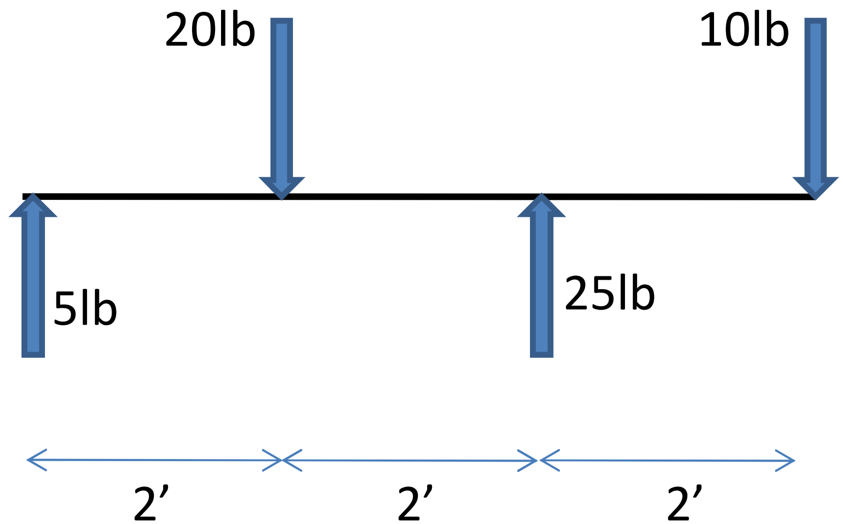
AREA under V diagram is equal to the CHANGE in the M diagram

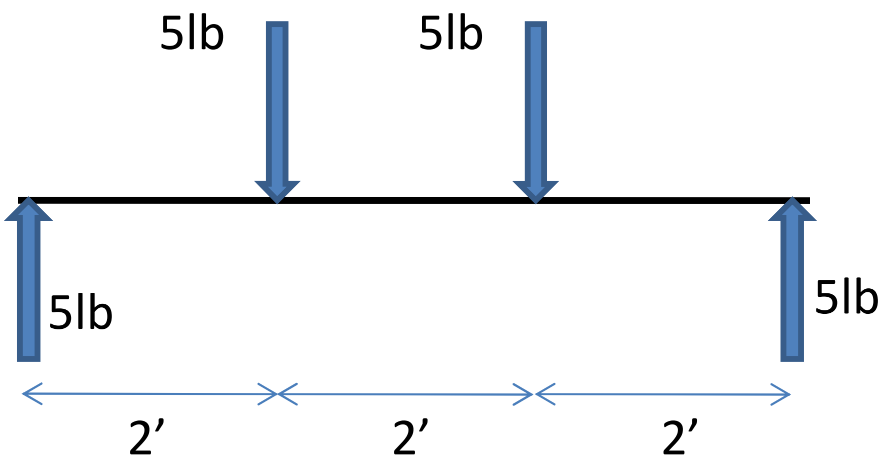


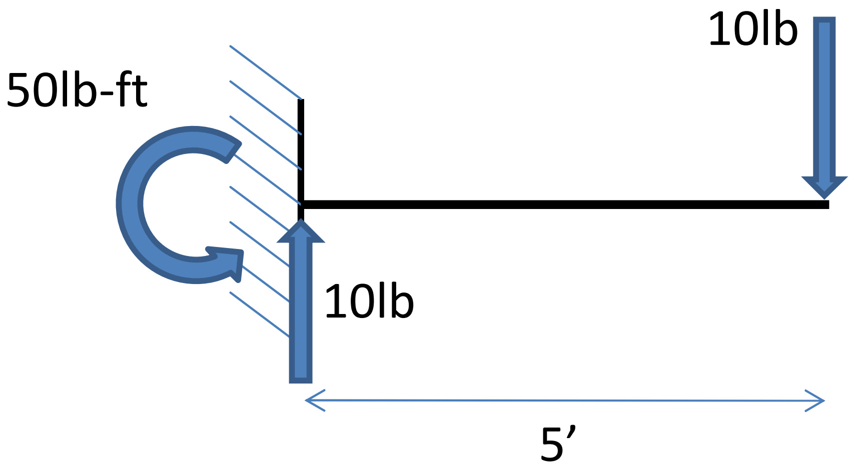
Notice: Value of V diagram is slope of M diagram

In-Class Examples



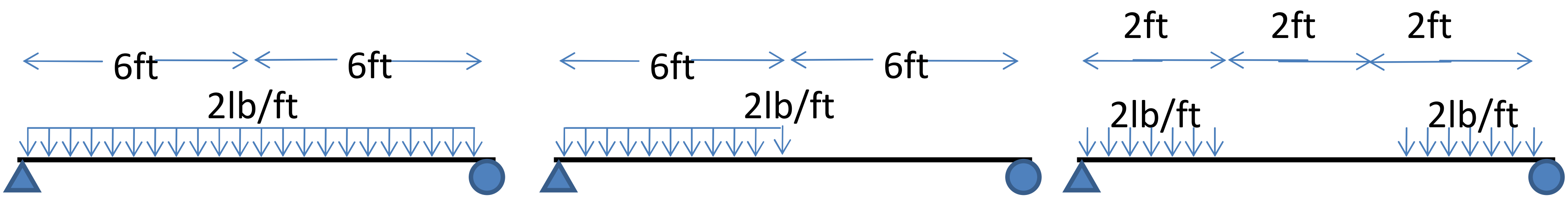




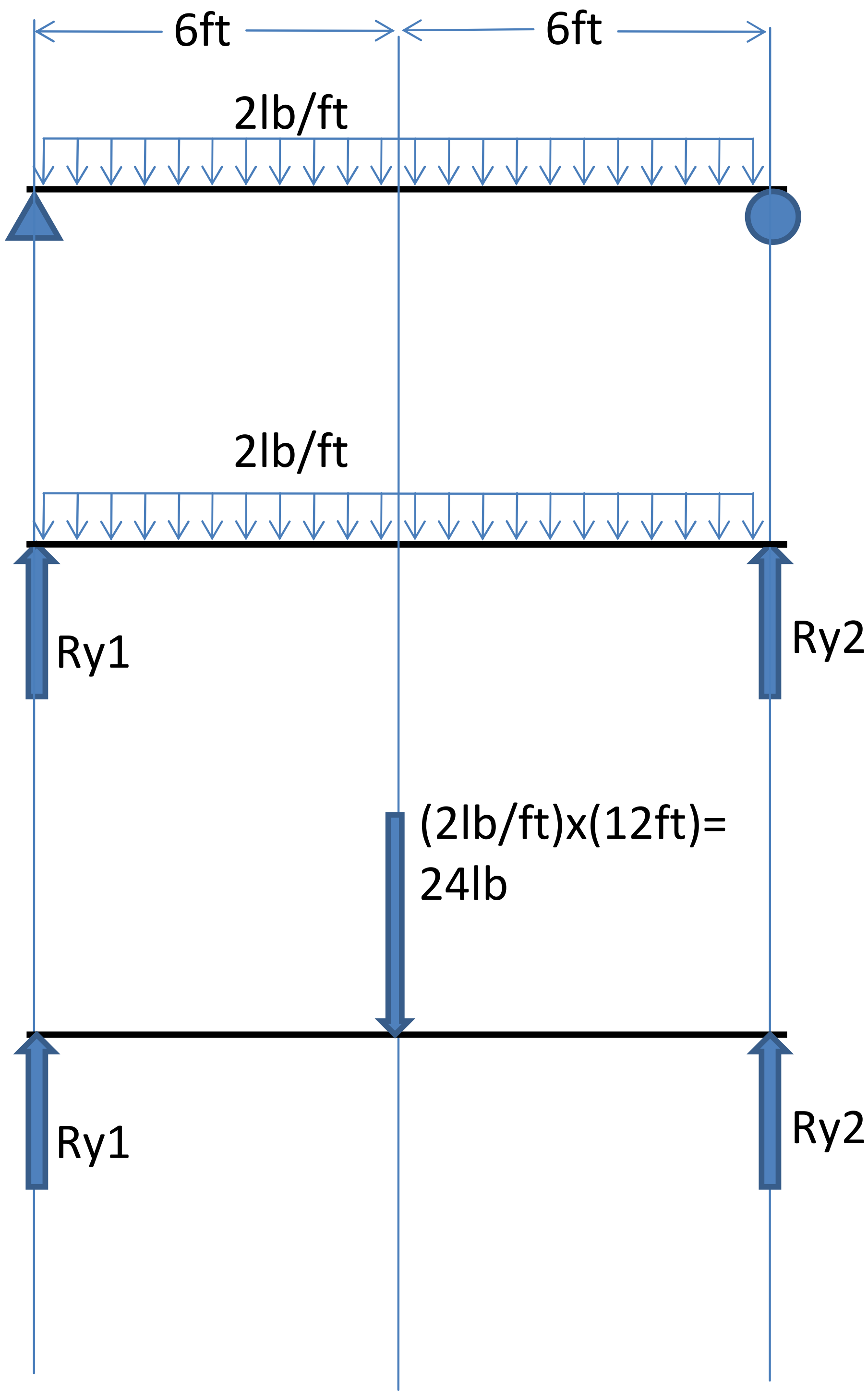


Moment-Shear Diagrams for Distributed Loads

Finding Reactions for beams with a distributed load



- For the purpose of FINDING THE REACTIONS for a beam with a distributed load, the distributed load can be assumed to be a concentrated load at the center of the distributed load.



FB
D

$\Sigma Ma=0$

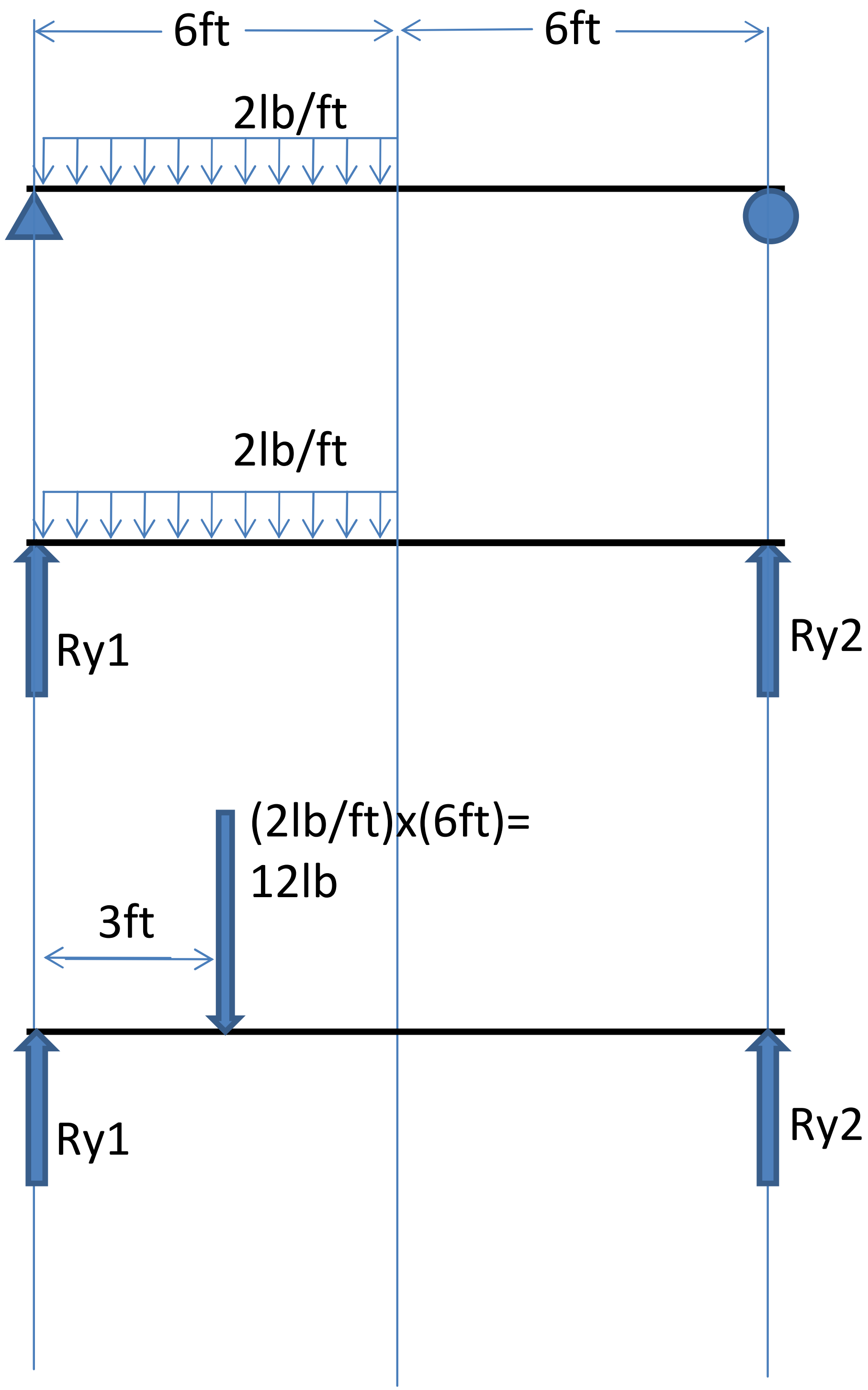
$-(24lb)(6ft)+(Ry_2)(12ft)=0$

$Ry_2=12lb$

$\Sigma Fy=0$

$Ry_1-24lb+12lb=0$

$Ry_1=12lb$



FBD

$\Sigma M_a = 0$

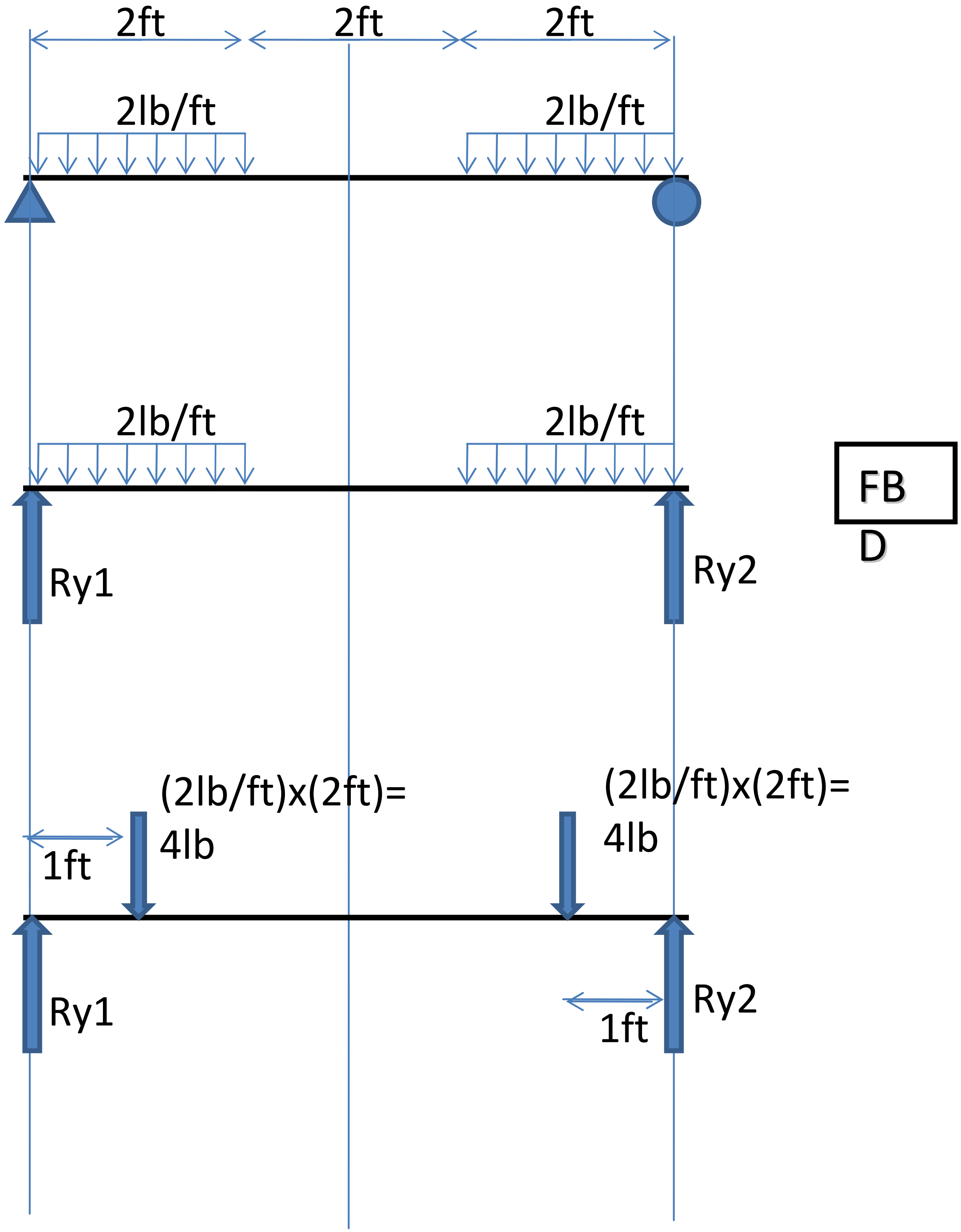
$-(12lb)(3ft)+(Ry_2)(12ft)=0$

$Ry_2 = 3lb$

$\Sigma F_y = 0$

$Ry_1 - 12lb + 3lb = 0$

$Ry_1 = 9lb$



$\Sigma Ma=0$

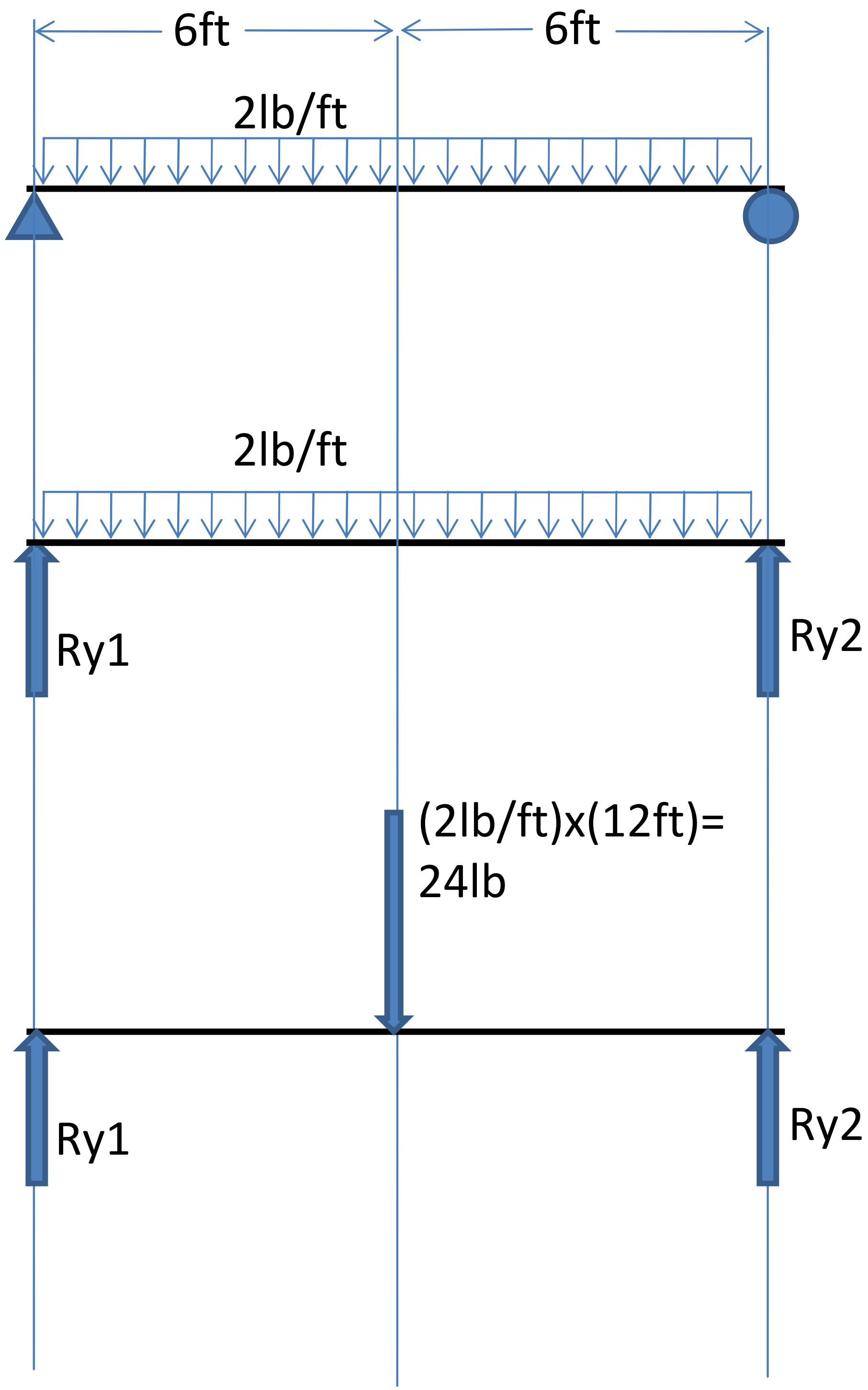
$-(4lb)(1ft)-(4lb)(5ft)+(Ry_2)(6ft)=0$

$Ry_2=4lb$

$\Sigma Fy=0$

$Ry_1-4lb-4lb+4lb=0$

$Ry_1=4lb$



FBD

$\Sigma M_a = 0$

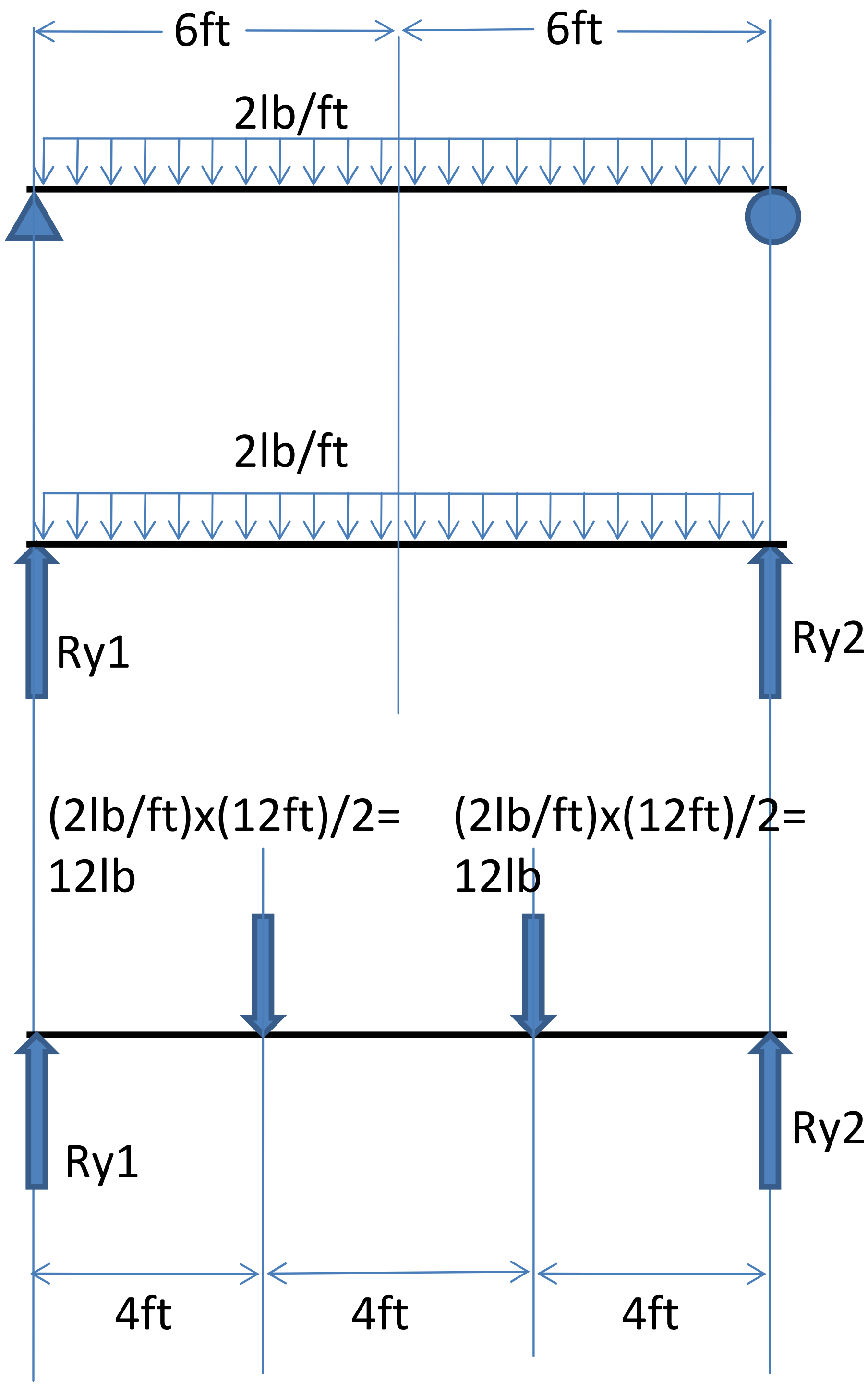
$-(24\text{lb})(6\text{ft}) + (Ry_2)(12\text{ft}) = 0$

$Ry_2 = 12\text{lb}$

$\Sigma F_y = 0$

$Ry_1 - 24\text{lb} + 12\text{lb} = 0$

$Ry_1 = 12\text{lb}$



FB
D

$\Sigma Ma=0$

$-(12lb)(4ft)-(12lb)(8ft)+(Ry_2)(12ft)=0$

$-48lb\text{-}ft - 96lb\text{-}ft = -(Ry_2)(12ft)$

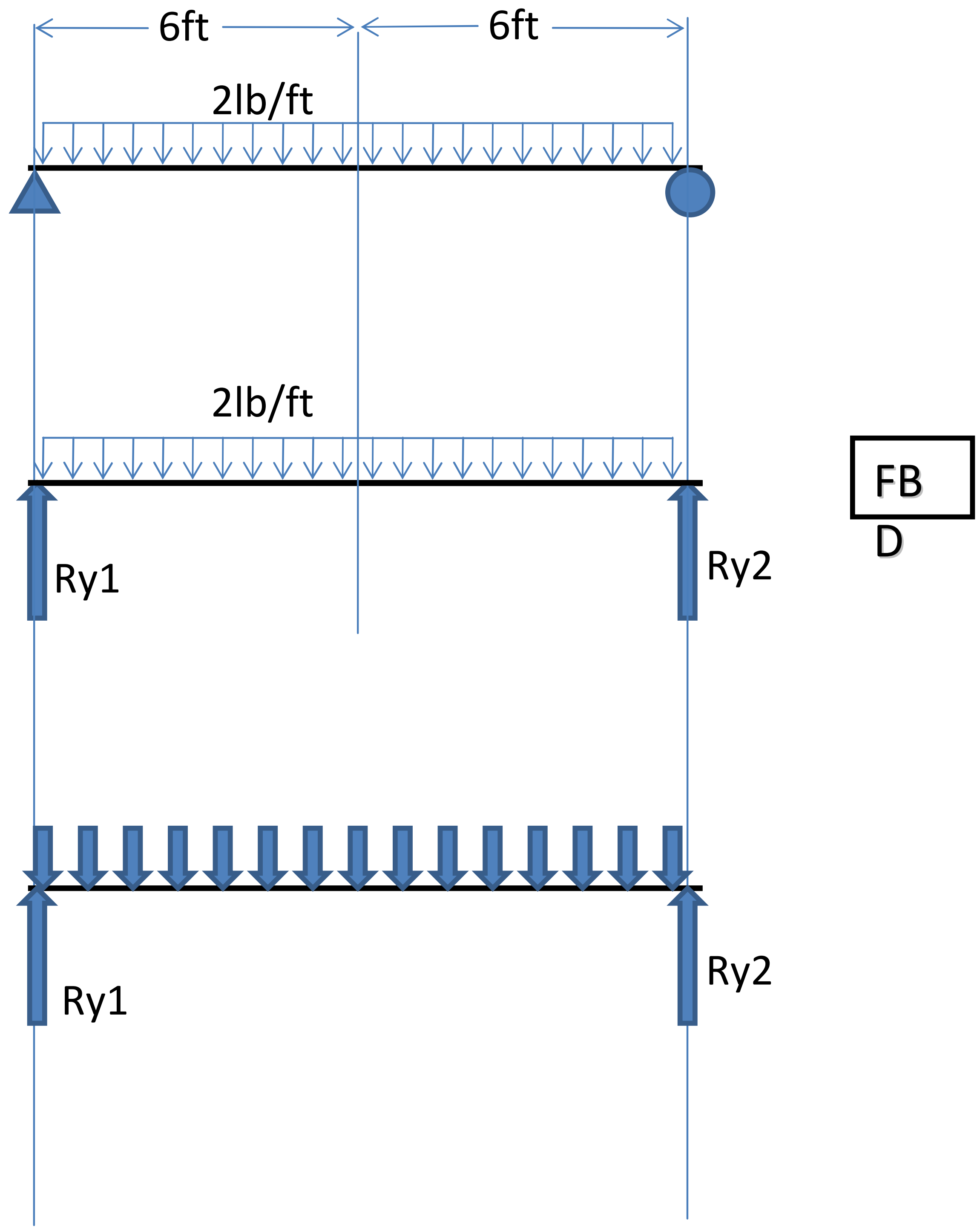
$-144/-12 = Ry_2$

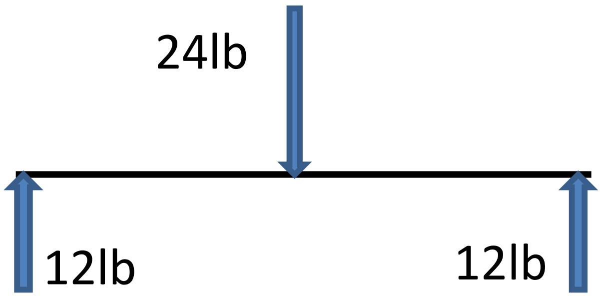
$Ry_2=12lb$

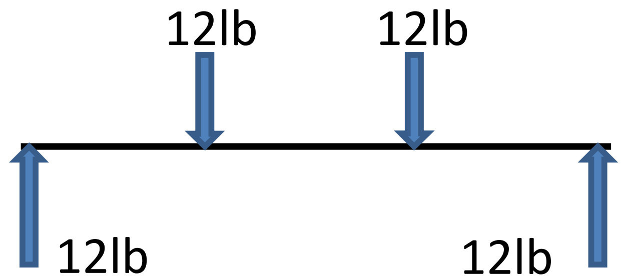
$\Sigma Fy=0$

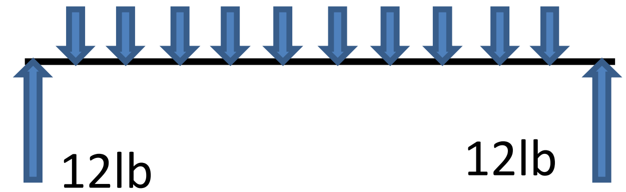
$Ry_1-12lb-12lb+12lb=0$

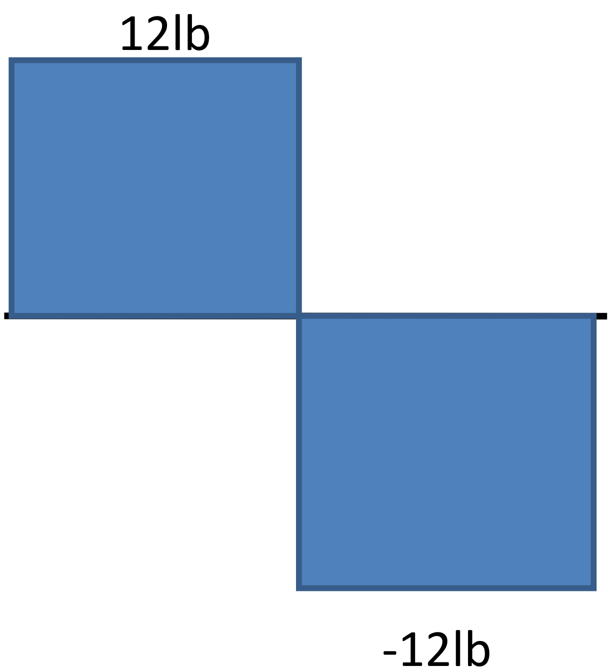
$Ry_1=12lb$

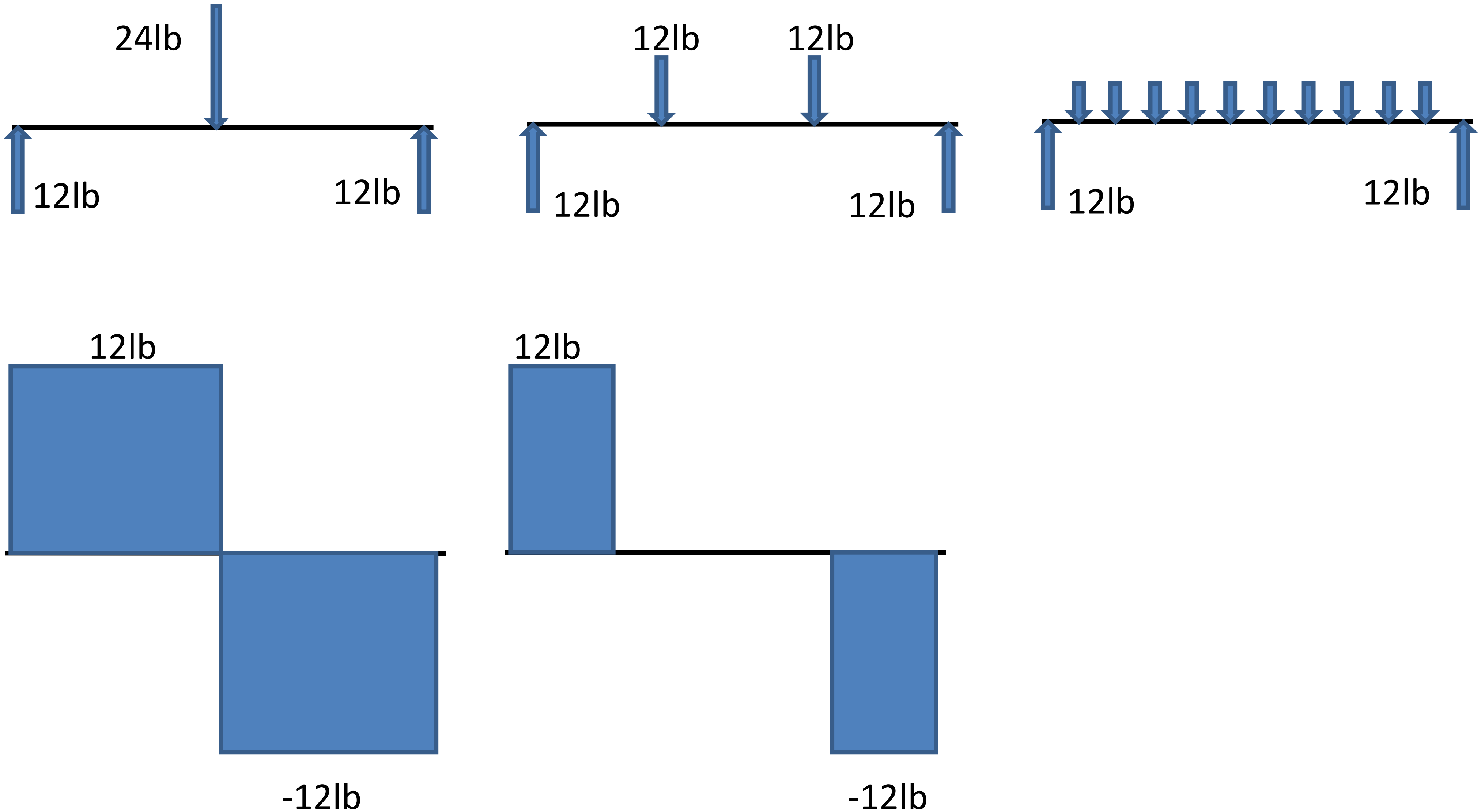

6ft
6ft
2lb/ft
2lb/ft
Ry1
Ry2
FBD
Ry1
Ry2


24lb
12lb
12lb

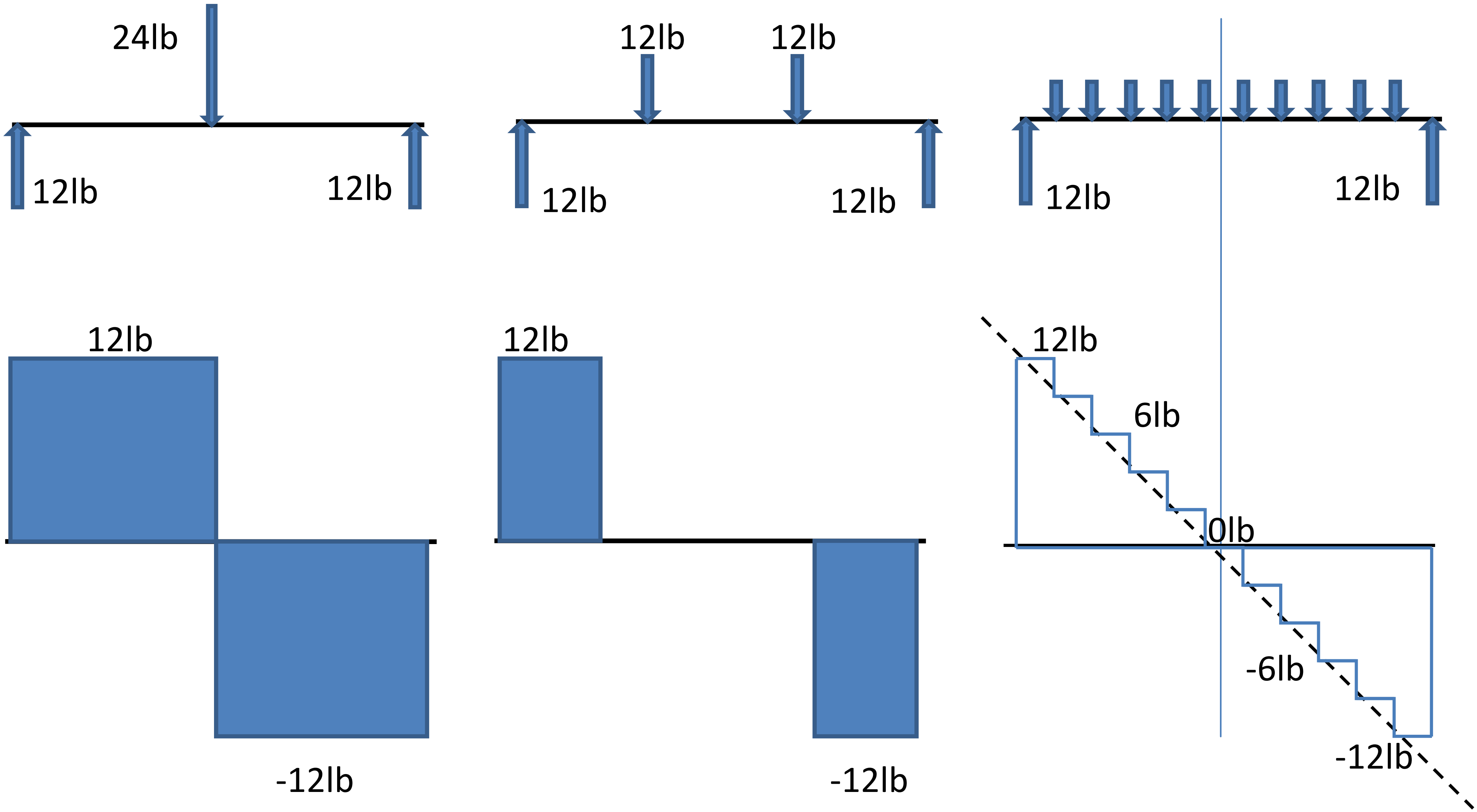

12lb
12lb
12lb
12lb


12lb
12lb

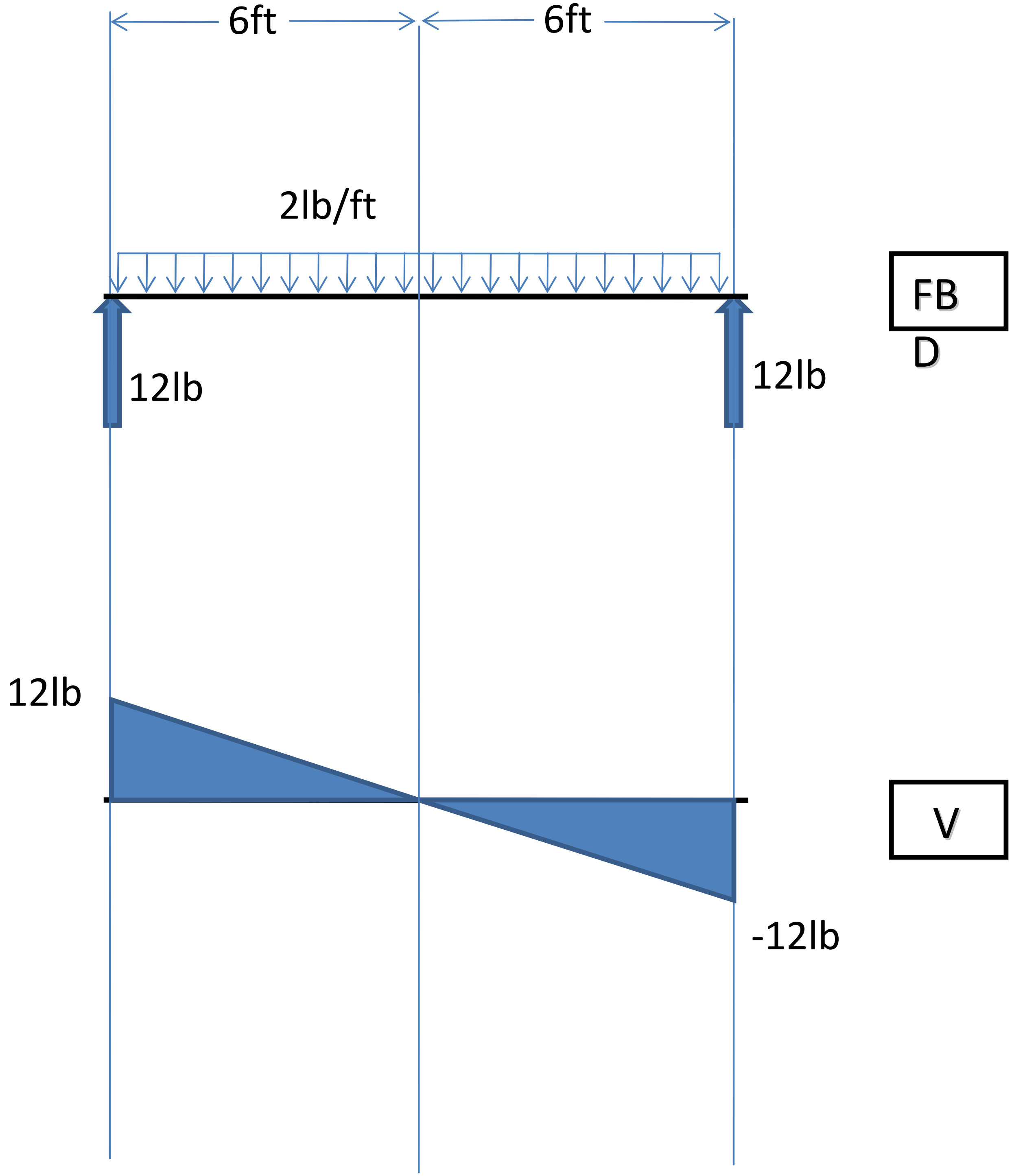

12lb
-12lb

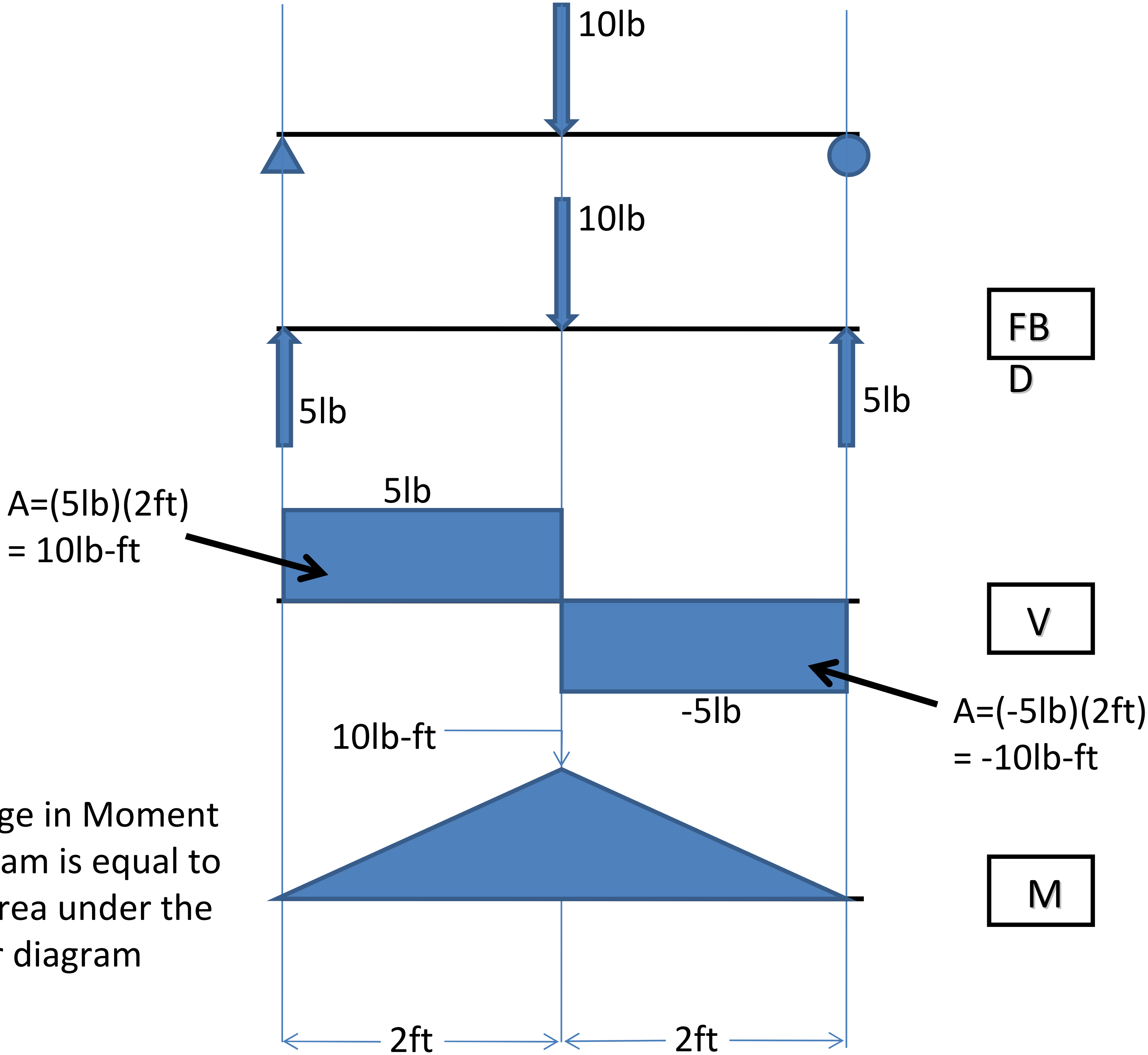


24lb
12lb
12lb
12lb
12lb
12lb
12lb
12lb
12lb
12lb
12lb
-12lb
-12lb

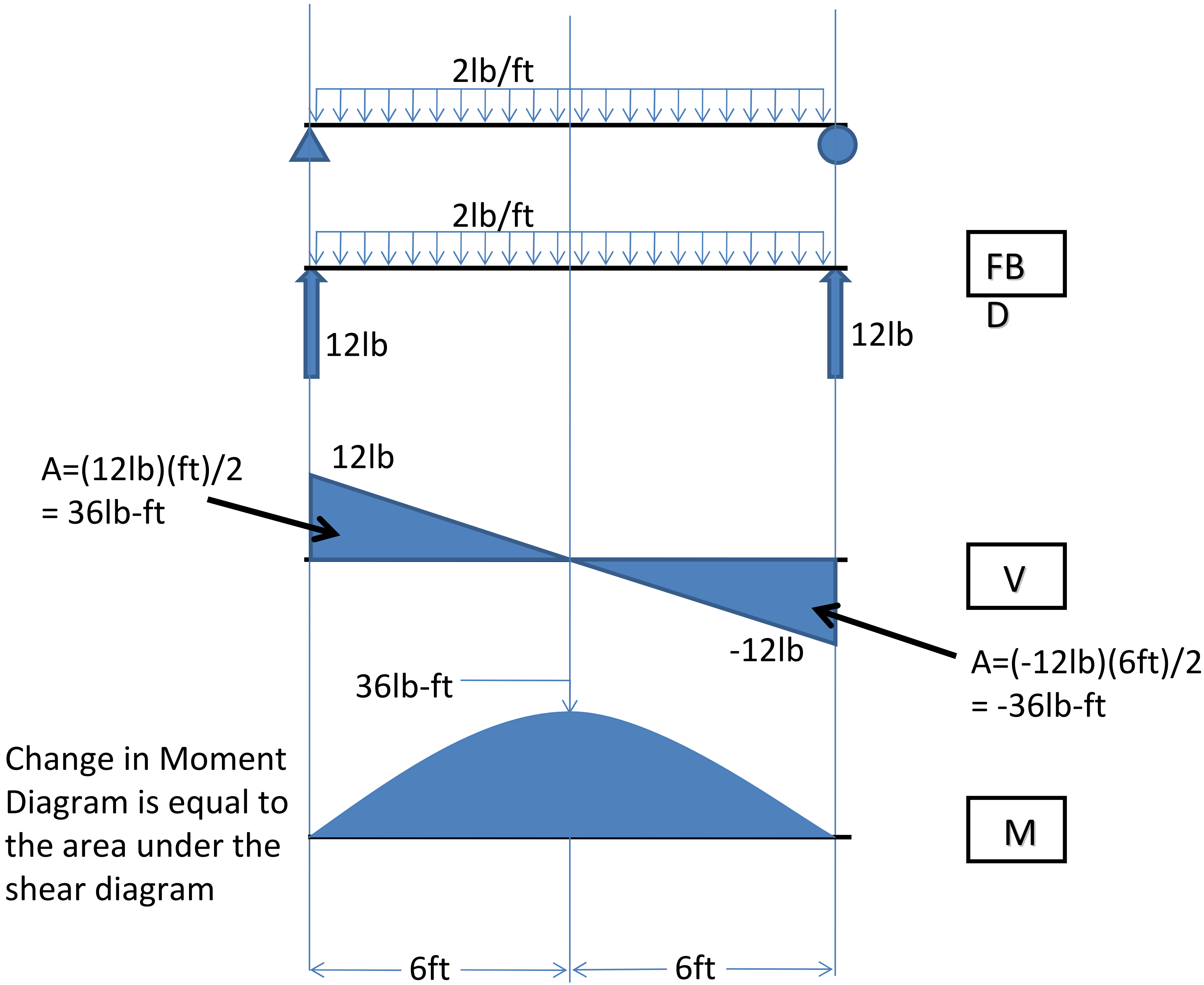


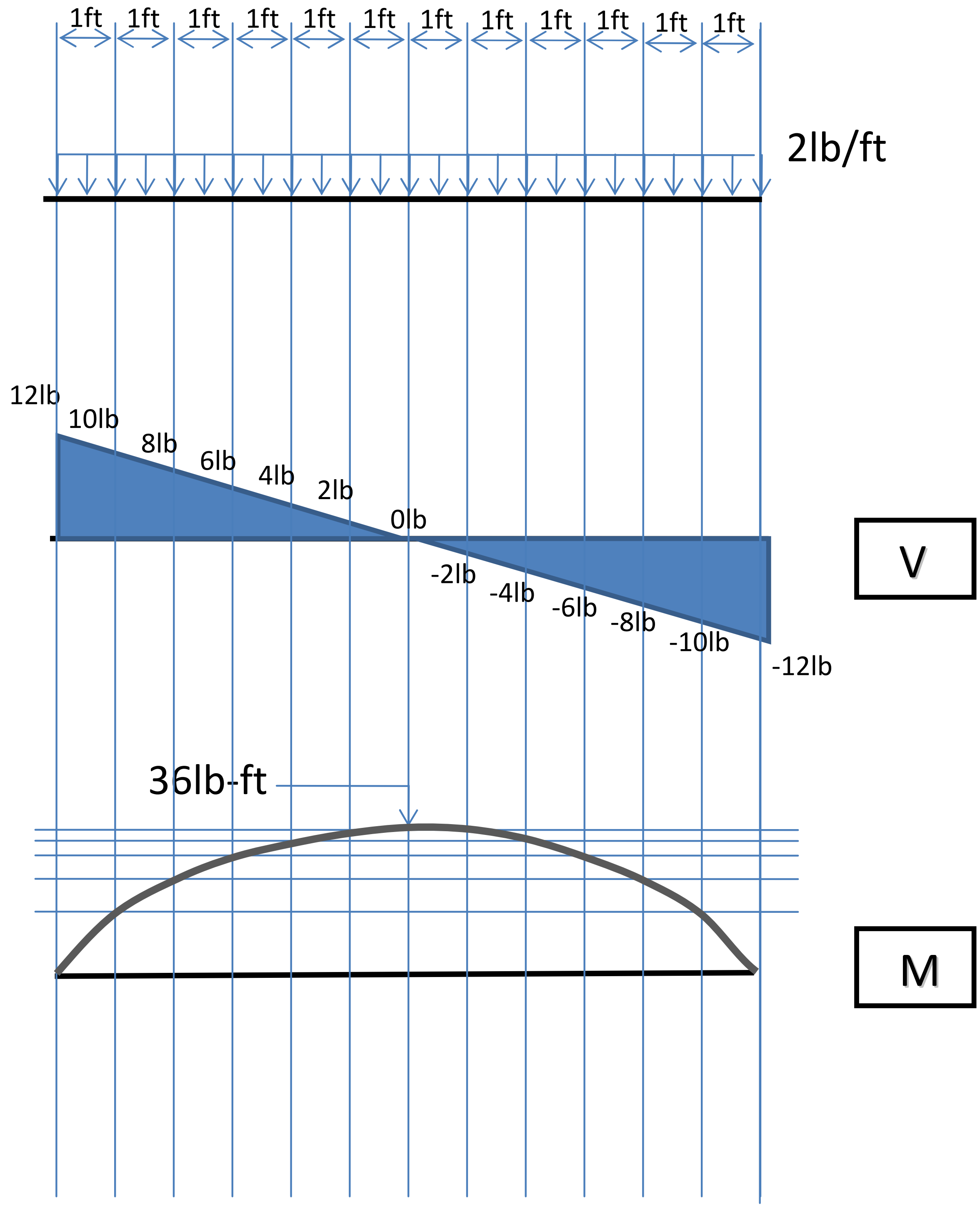
24lb
12lb
12lb
12lb
12lb
12lb
12lb
12lb
12lb
12lb
-12lb
12lb
-12lb
12lb
6lb
0lb
-6lb
-12lb


6ft
6ft
2lb/ft
12lb
12lb
FBD
12lb
-12lb
V



Change in Moment Diagram is equal to the area under the shear diagram


2lb/ft
2lb/ft
FB
D
12lb
12lb
12lb
A=(12lb)(ft)/2
= 36lb-ft
V
-12lb
A=(-12lb)(6ft)/2
= -36lb-ft
36lb-ft
Change in Moment Diagram is equal to the area under the shear diagram
M
6ft
6ft



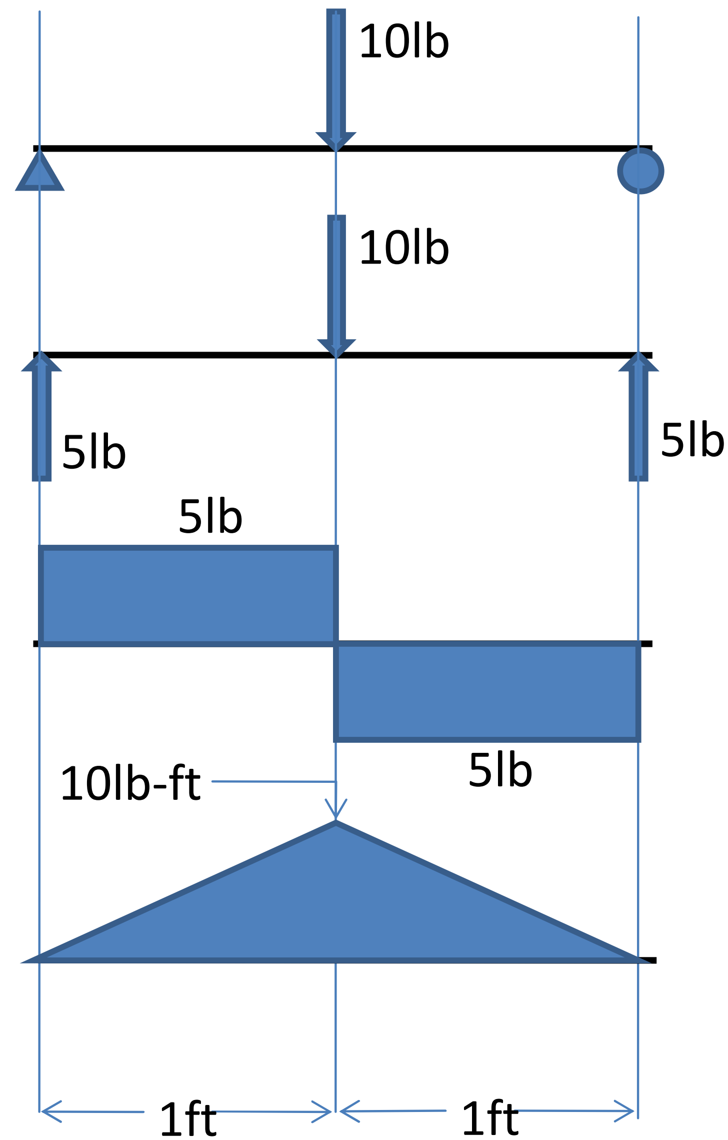
The VALUE at a point in the shear diagram is equal to the SLOPE of the moment diagram at that same point.

An external point load shifts the shear diagram an amount equivalent to its magnitude in its same direction.

A distributed load shifts the shear diagram linearly with a SLOPE equal to the magnitude of the distributed load in its same direction.

Change in Moment Diagram is equal to the area under the shear diagram.

The VALUE at a point in the shear diagram is equal to the SLOPE of the moment diagram at that same point.



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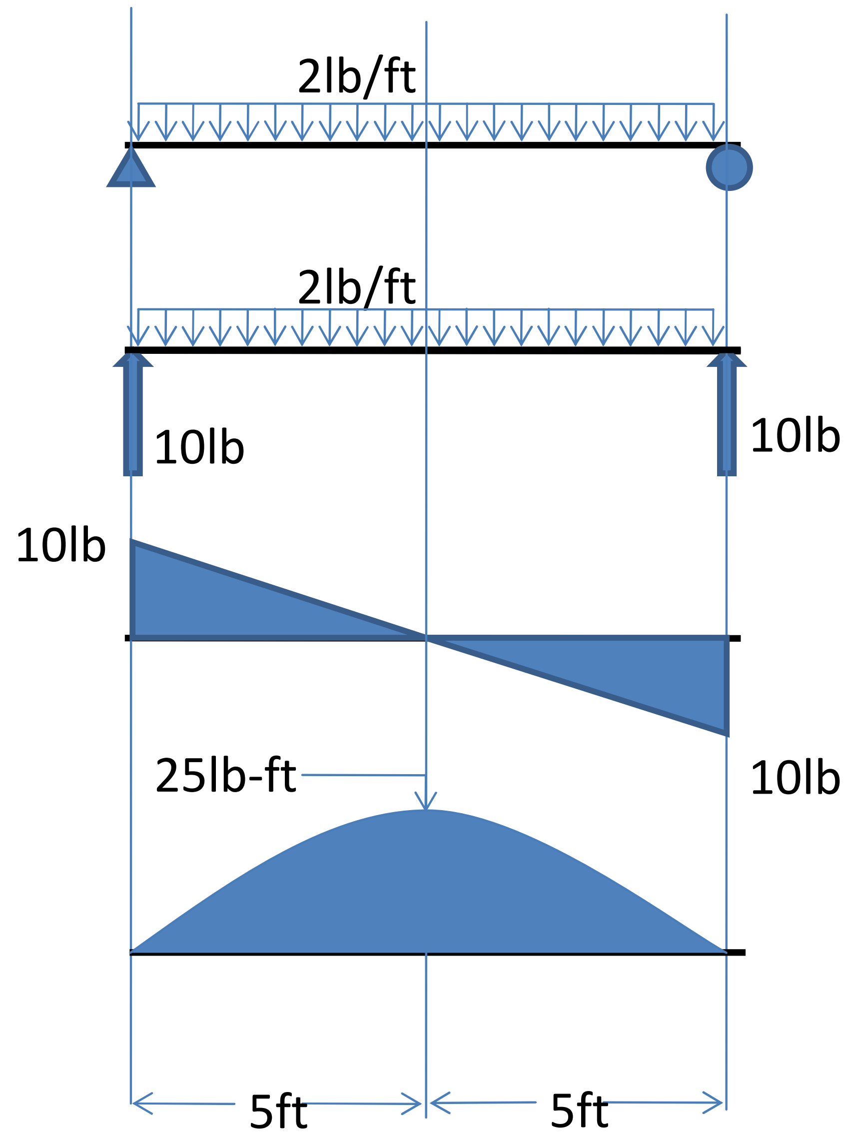
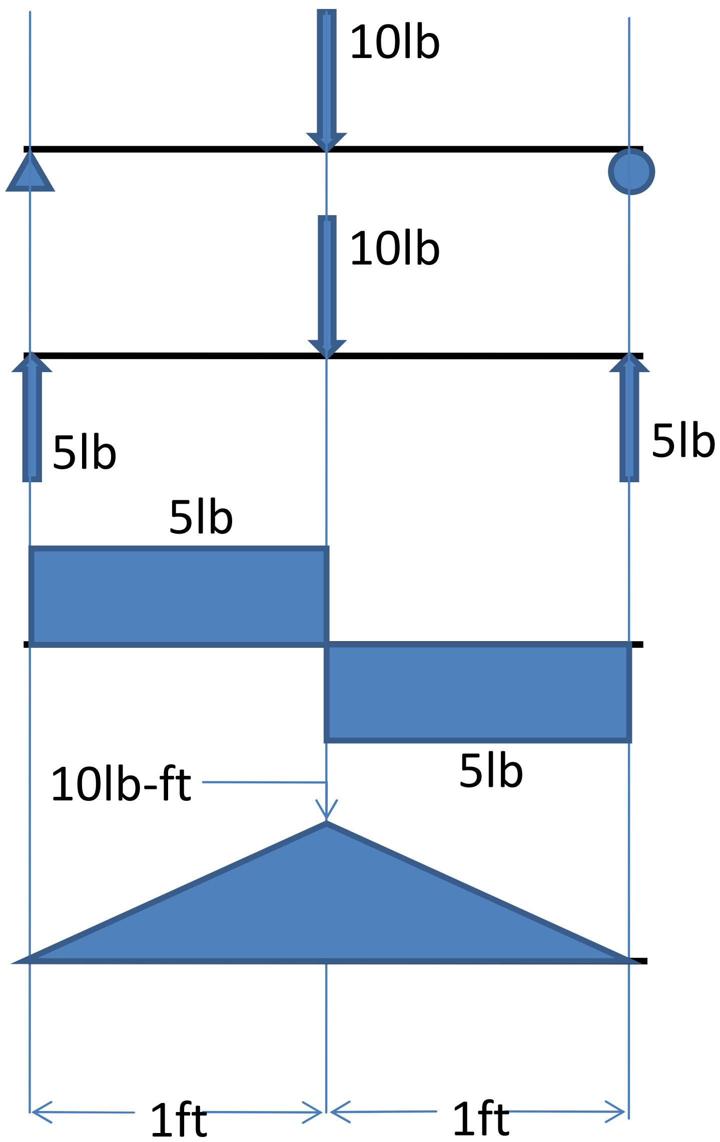
A distributed load shifts the shear diagram linearly with a SLOPE equal to the magnitude of the distributed load in its same direction.

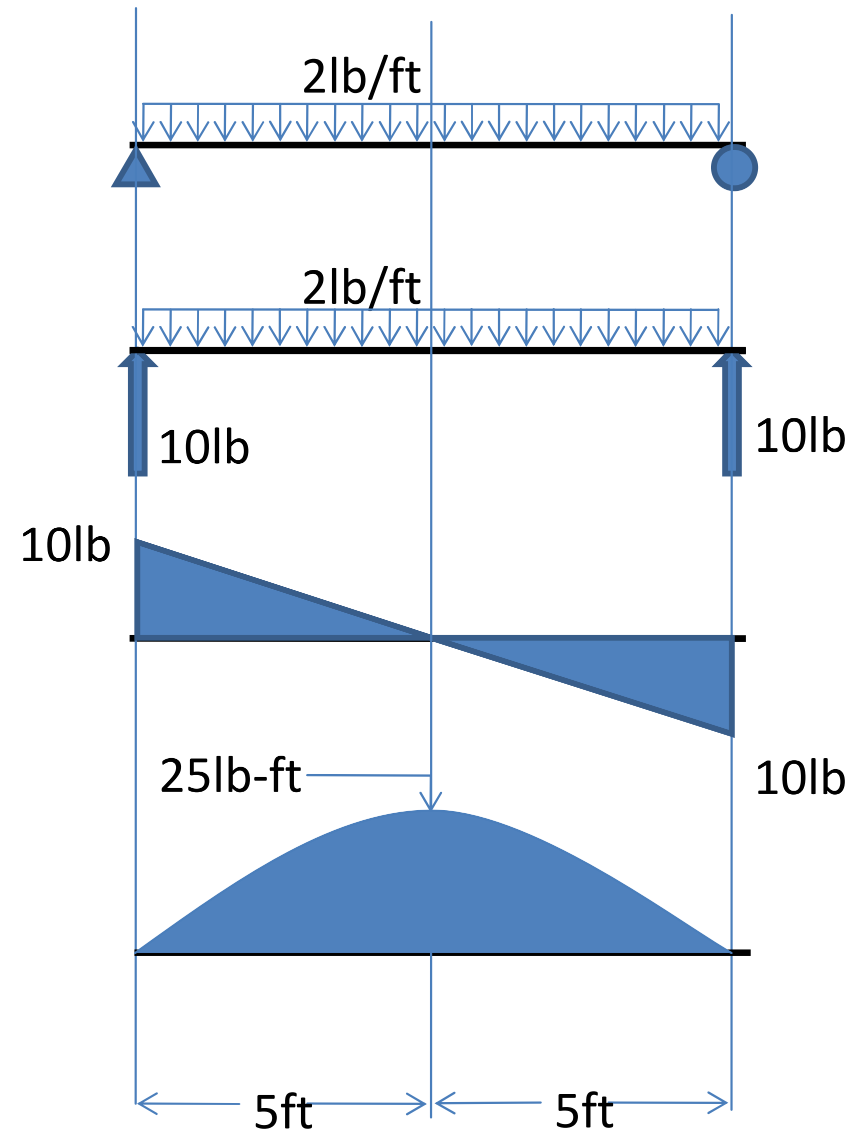
Change in Moment Diagram is equal to the area under the shear diagram.

The VALUE at a point in the shear diagram is equal to the SLOPE of the moment diagram at that same point.





10lb
10lb
5lb
5lb
5lb
10lb-ft
5lb
1ft
1ft



2lb/ft
2lb/ft
10lb
10lb
10lb
25lb-ft
10lb
5ft
5ft