Distributed Loading

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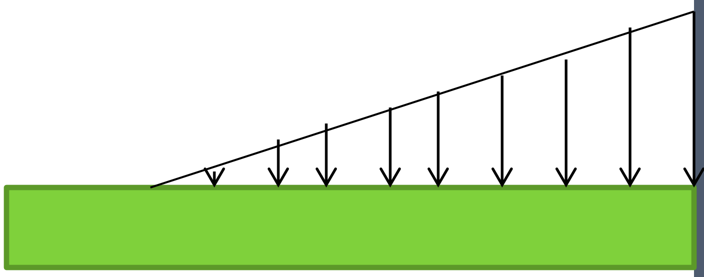
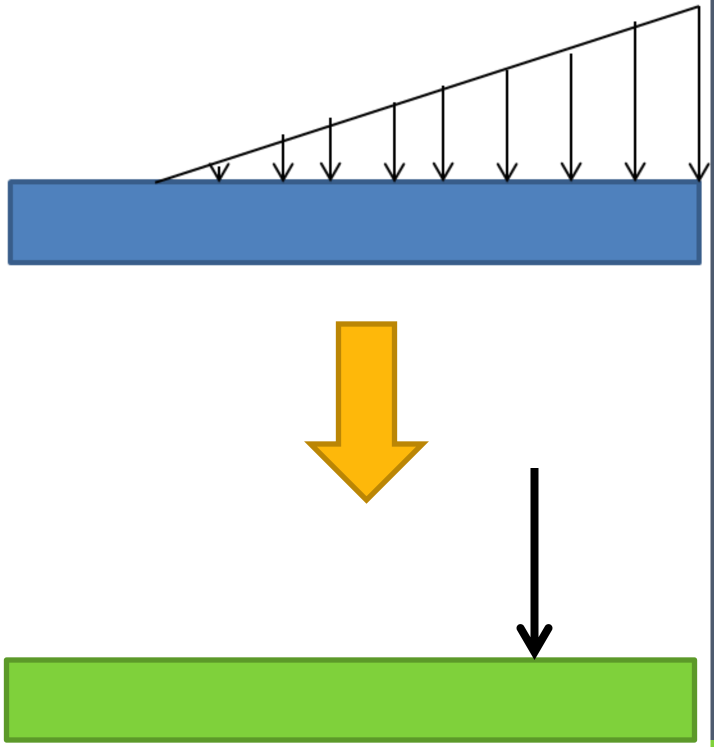
What is a Distributed Load?

- A load applied across a length or area instead of at one point



Analyzing Distributed Loads

- A distributed load can be equated with a concentrated load applied at a specific point along the bar



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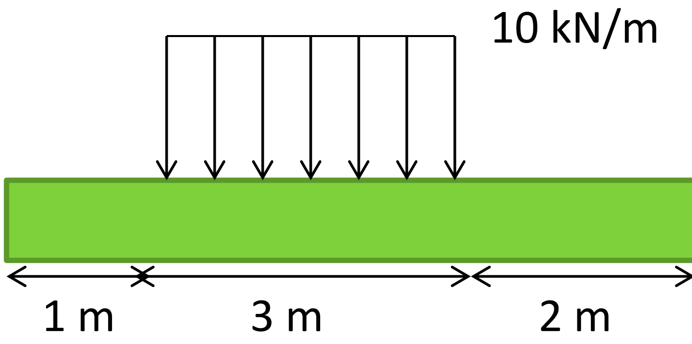
Geometry Method

- The magnitude of the resultant force is equivalent to the area under the curve of the distributed load



$$F_r = b * h = 10 \, {}^{kN}\!/_{m} * 3m$$

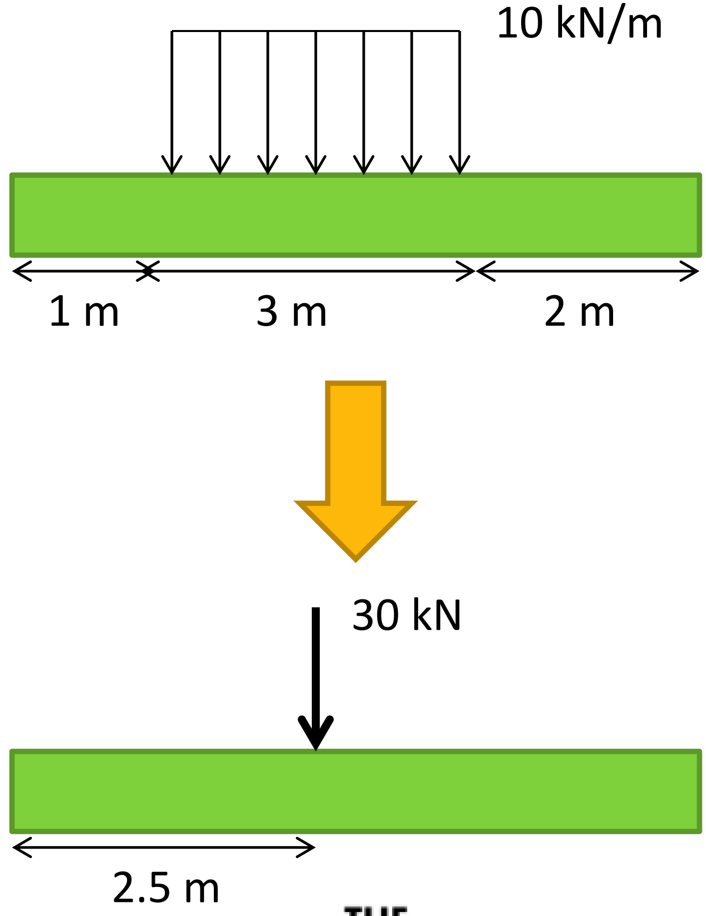
$$F_r = 30 \, kN$$

Geometry Method

- The location of the resultant force is at the center of mass of the distributed load.

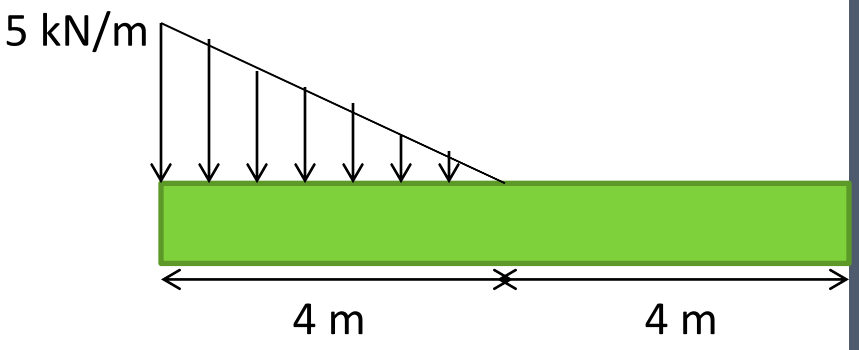
$$\bar{x} = x_0 + \frac{1}{2}b = 1m + \frac{1}{2} * 3m$$

$$\bar{x} = 2.5m$$



Geometry Method – Example

- For a triangular distributed load, the magnitude of the resultant force is the area of the triangle, ½*b*h



$$F_r = \frac{1}{2} b * h = .5 * 5 \, {}^{kN}\!/_{m} * 4m$$

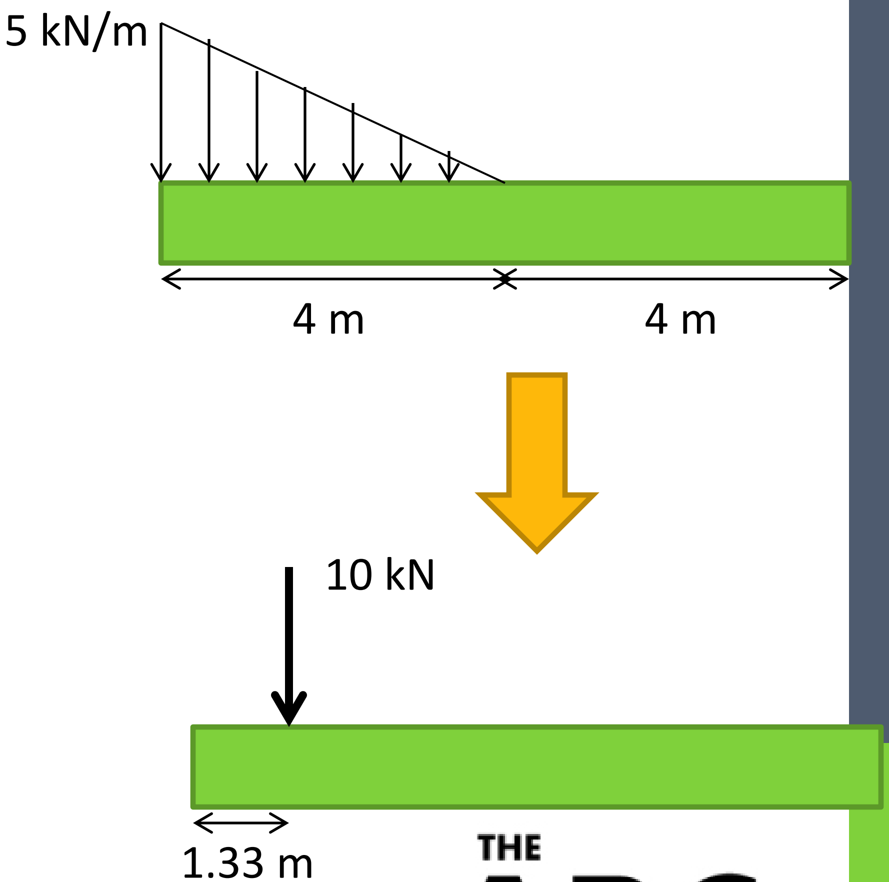
$$F_r = 10 \, kN$$

Geometry Method – Example

- For a triangular distributed load, the location of the resultant force is 1/3 of the length of the load, from the larger end

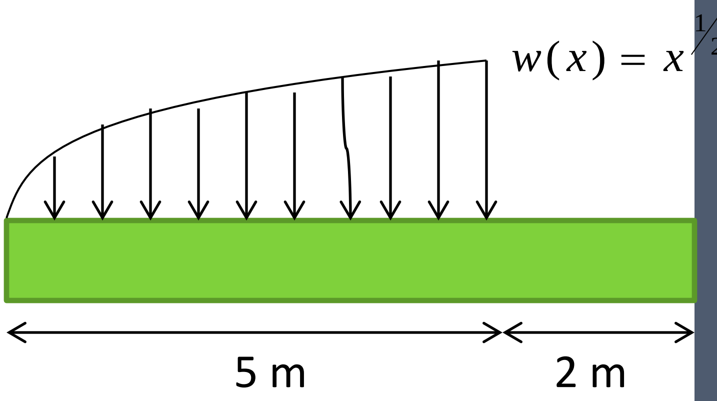
$$\bar{x} = x_0 + \frac{1}{3}b = 0m + \frac{1}{3} * 4m$$

$$\bar{x} = {}^{4}\!/_{3}\, m$$



Integral Method

- The magnitude of the resultant force is given by the integral of the curve defining the force, w(x)



$$F_r = \int_{x=0}^{5m} w(x)dx = \int_{x=0}^{5m} x^{1/2} dx$$

$$F_r = \frac{2}{3}[x^{3/2}]_0^{5m}$$

$$F_r = 7.45\, kN$$

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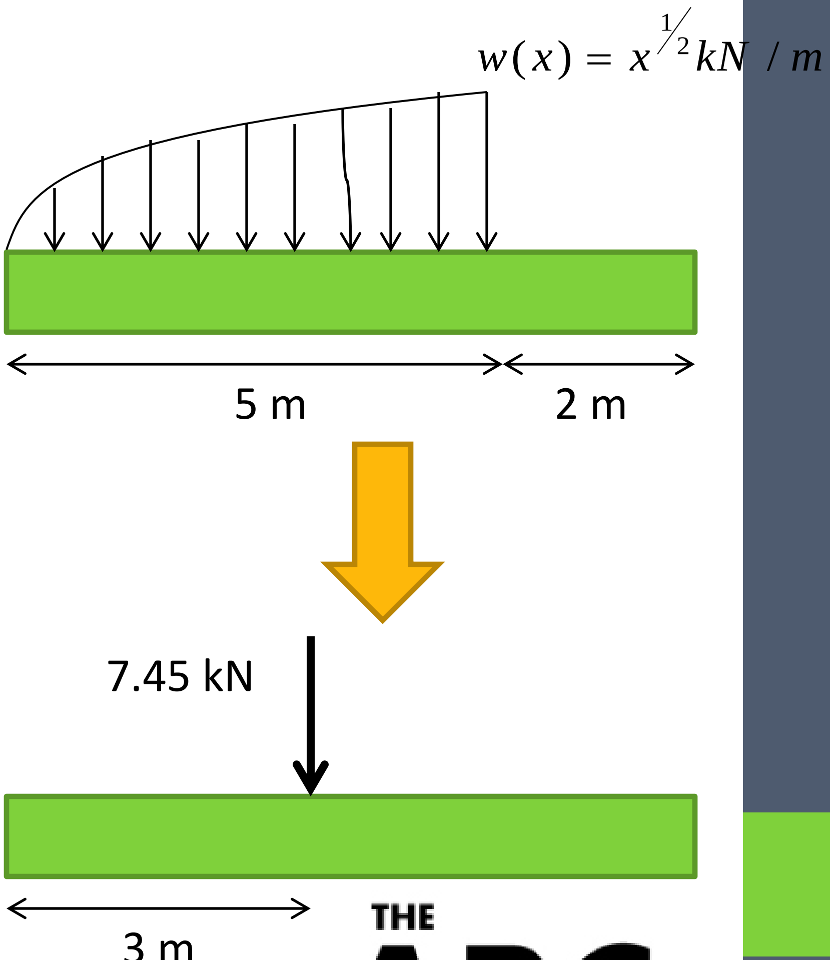
Integral Method

- The location of the resultant force is given by the centroid of the area under the curve

$$\bar{x} = \frac{\int_0^L w(x)\,x\,dx}{\int_0^L w(x)\,dx} = \frac{\int_0^{5m} x^{3/2}\,dx}{7.45}$$

$$\bar{x} = \frac{2}{5 * 7.45}[x^{5/2}]_0^{5m}$$

$$\bar{x} = 3.0m$$



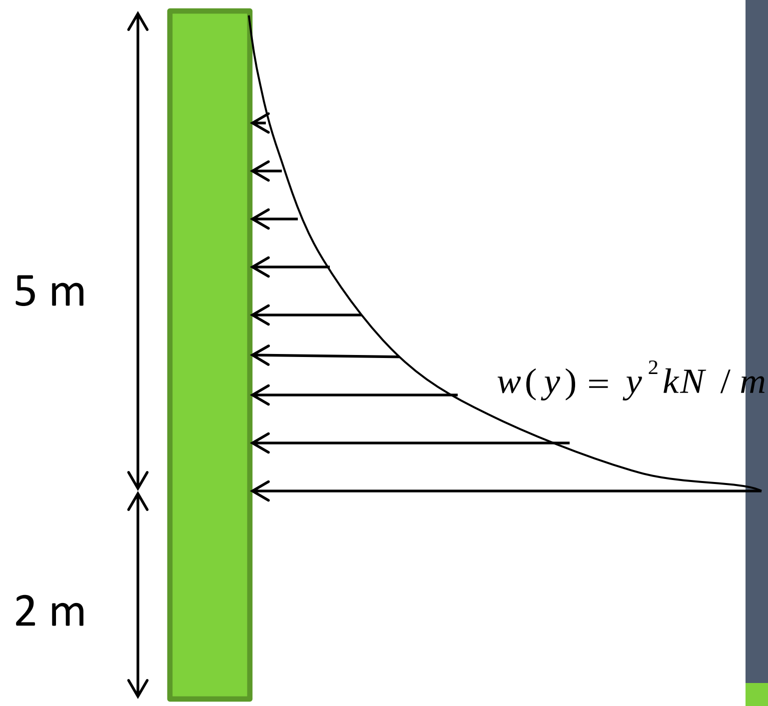
Integral Method – Example

- For a vertical bar, simply integrate with respect to y instead of x

$$F_r = \int_{y=0}^{5m} w(y)dy = \int_{y=0}^{5m} y^2 dy$$

$$F_r = \frac{1}{3}[y^3]_0^{5m}$$

$$F_r = 41.7 kN$$



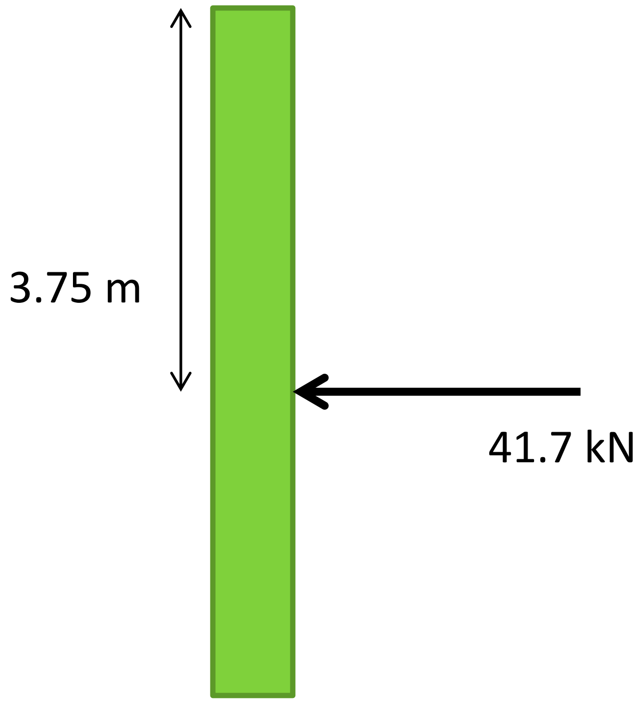
Integral Method – Example

- For a vertical bar, simply integrate with respect to y instead of x

$$\bar{y} = \frac{\int_0^L w(y)\,y\,dy}{\int_0^L w(y)\,dy} = \frac{\int_0^{5m} y^3\,dy}{41.7}$$

$$\bar{y} = \frac{1}{4*41.7}[y^4]_0^{5m}$$

$$\bar{y} = 3.75\,m$$



References

- Vector Mechanics for Engineers: Statics (Beer, 9th ed)
- Distributed Load on Beams
  - www.engr.uky.edu/statics/Content/Chapter.../Chapter%205%20D.doc
- Resolving Distributed Loads
  - http://pages.uoregon.edu/struct/courseware/461/461_lectures/461_lecture20/461_lecture20.html
- Distributed Load on a Beam (Centroid)
  - http://www.youtube.com/watch?v=K4ocb9KwPjo