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DESIGN OF MACHINE MEMBERS UNDER SIMPLE STRESS

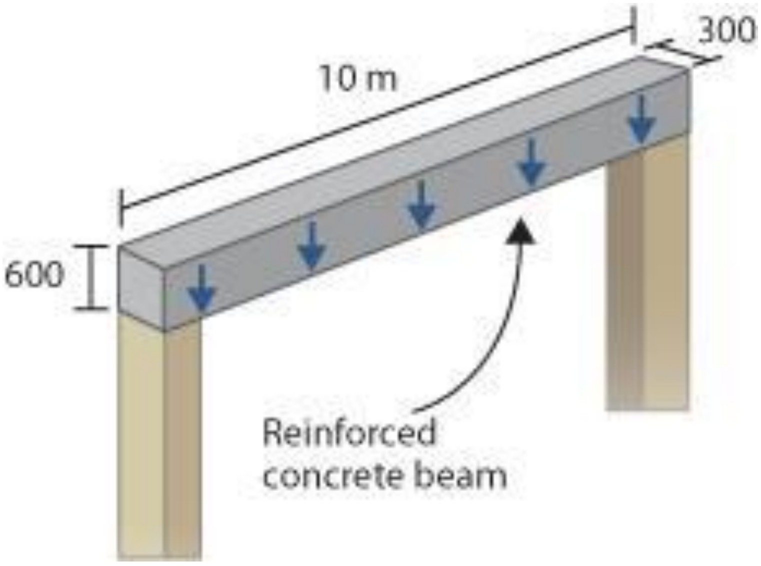
Dead Load:

Dead load on a structure is the result of the weight of the permanent components such as beams, floor slabs, columns and walls. These components will produce the same constant 'dead' load during the lifespan of the building. Dead loads are exerted in the vertical plane.

Dead load = volume of member x unit weight of materials

By calculating the volume of each member and multiplying by the unit weight of the materials from which it is composed, an accurate dead load can be determined for each component.

The different components can then be added together to determine the dead load for the entire structure.



Volume of beam 10.0 x 0.6 x 0.3 = 1.8 m3

Unit weight of reinforced concrete = 24 kN/m3

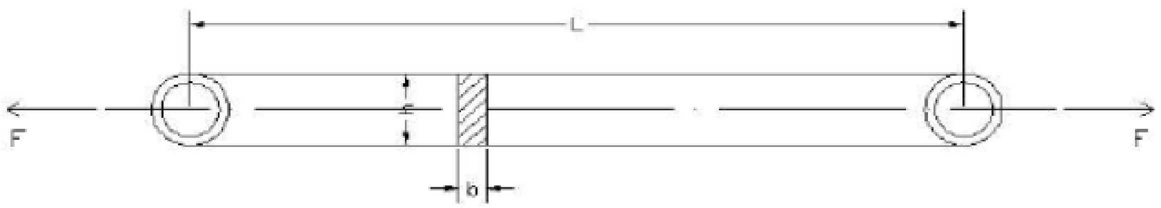
Therefore, dead load of beam = volume x unit weight

= 1.8 m3 x 24 kN/m3

= 43.2 kN

Problem-1:

The link shown, made of AISI C1045 steel, as rolled, is subjected to a tensile load of 8000 lb. Let $h = 1.5b$. If the load is repeated but not reversed, determine the dimensions of the section with the design based on (a) ultimate strength, (b) yield strength. (c) If this link, which is 15 in. long., must not elongate more than 0.005 in., what should be the dimensions of the cross section?



Solution:
For AISI C1045 steel, as rolled (Table AT 7)

$s_u = 96\ ksi$

$s_y = 59\ ksi$

$E = 30 \times 10^6\ \ psi$

$$s_d = \frac{F}{A}$$

where

$F = 8000\ lb$

$A = bh$

but

$h = 1.5b$

therefore $A = 1.5b^2$

(a) Based on ultimate strength

N = factor of safety = 6 for repeated but not reversed load (Table 1.1)

$$s_d = \frac{s_u}{N} = \frac{F}{A}$$

$$\frac{96{,}000}{6} = \frac{8000}{1.5b^2}$$

$b = 0.577\ in$ say $\frac{5}{8}\ in$.

$h = 1.5b = \frac{15}{16}\ in$

(b) Based on yield strength

N = factor of safety = 3 for repeated but not reversed load (Table 1.1)

$s_d = \frac{s_u}{N} = \frac{F}{A}$

$\frac{59{,}000}{3} = \frac{8000}{1.5b^2}$

$b = 0.521\ in$ say $\frac{9}{16}\ in$.

$h = 1.5b = \frac{27}{32}\ in$

(c) Elongation = $\delta = \frac{FL}{AE}$

where,

$\delta = 0.005\ in$

$F = 8000\ lb$

$E = 30 \times 10^6\ psi$

$L = 15\ in$

$A = 1.5b^2$

then,

$\delta = \frac{FL}{AE}$

$0.005 = \frac{(8000)(15)}{(1.5b^2)(30 \times 10^6)}$

$b = 0.730\ in$ say $\frac{3}{4}\ in$.

$h = 1.5b = 1\frac{1}{8}\ in$

Problem-2:

A short compression member with $D_o = 2D_i$ is to support a dead load of 25 tons. The material is to be 4130 steel, WQT 1100 F. Calculate the outside and inside diameters on the basis of (a) yield strength, (b) ultimate strength.

Solution:
From Table AT 7 for 4130, WQT 1100 F

$s_u = 127\ ksi$

$s_y = 114\ ksi$

From Table 1.1 page 20, for dead load

$N_u = 3 \sim 4$, say 4

$N_y = 1.5 \sim 2$, say 2

Area, $A = \frac{\pi}{4}\left(D_o^2 - D_i^2\right) = \frac{\pi}{4}\left(4D_i^2 - D_i^2\right) = \frac{3\pi D_i^2}{4}$

$F = 25\ tons = 50\ kips$

(a) Based on yield strength

$$A = \frac{3\pi D_i^2}{4} = \frac{N_y F}{s_y} = \frac{(2)(50)}{114}$$

$$D_i = 0.61\ in \text{ say } \frac{5}{8}\ in$$

$$D_o = 2D_i = 2\left(\frac{5}{8}\right) = 1\frac{1}{4}\ in$$

(b) Based on ultimate strength

$$A = \frac{3\pi D_i^2}{4} = \frac{N_u F}{s_u} = \frac{(4)(50)}{127}$$

$$D_i = 0.82\ in \text{ say } \frac{7}{8}\ in$$

$$D_o = 2D_i = 2\left(\frac{7}{8}\right) = 1\frac{3}{4}\ in$$