A semi elliptical laminated Vehicle Spring to carry a load of 6000N is to consist of Seven leaves 65mm wide, two of the leaves extending the full length of the Spring. The Spring is to be 1.1 m and attached to the axle by two U-bolts 80mm apart. The bolts hold the central portion of the Spring so rigidly that they may be considered equivalent to a band having a width equal to the distance between the bolts. Assume a design stress for spring material as 350MPa.

Determine

1) Thickness of leaves, 2) Deflection of Spring
3) Diameter of eye, 4) Length of leaves
5) Radius to which leave Should initially bent.

Sketch the Semi elliptical leaf Spring arrange

Given

$2W = 6000N$

$W = 3000N$

$n = 7$

$b = 65mm$

$n_f = 2$

① → (16)

$2L_1 = 1.1\,m$

$2L_1 = 1100\,mm$

$l = 80\,mm$

$\sigma = 350\,MPa = 350\,N/mm^2$

To find

(i) t
(ii) b
(iii) d
(iv) Length of leaves
(v) R

Solution:

$2L = 2L_1 - l$

$2L = 1100 - 80 \Rightarrow 2L = 1020$

$\boxed{L = 510\,mm}$

$n_g = n - n_f = 7 - 2$

$\boxed{n_g = 5}$

$$\sigma_f = \frac{18\,WL}{bt^2(2n_g + 3n_f)}$$

$$350 = \frac{18 \times 3000 \times 510}{65 \times t^2(2(5) + 3(2))}$$

$t = 8.35\,mm \approx 9\,mm$

$$\delta = \frac{12WL^3}{Ebt^3(2n_g + 3n_f)}$$

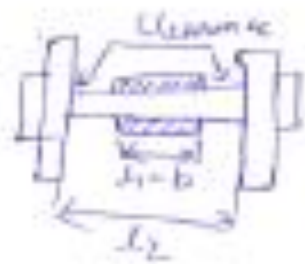
$E = 2\times10^5\ N/mm^2$

$$\delta = \frac{12 \times 3000 \times 510^3}{2\times10^5 \times 65 \times t^3 (2(5) + 3(2))}$$

$$\delta = \frac{12 \times 3000 \times 510^3}{2\times10^5 \times 65 \times (8.35)^3 [2(5)+3(2)]}$$

$\delta = 39.4\,mm$

For diameter of eye,



$l_2 = l_1 + 2\times2$

$l_2 = 65 + 4$

$l_2 = 69\,mm$

Maximum bending Moment $M = \frac{W l_2}{4}$

$$= \frac{3000 \times 69}{4}$$

$M = 51750\ N\text{-}mm$

(1) → (17)

Section modulus

$$Z = \frac{\pi}{32} \times d^3$$

$$\boxed{Z = \frac{\pi}{32} \times d^3}$$

WKT bending stress (σ_b)

$$\boxed{\sigma_b = 80 \text{ N/mm}^2}$$

considering

$$\sigma_b = \frac{M}{Z}$$

$$80 = \frac{51750}{\frac{\pi}{32} \times d^3}$$

$$d = 18.7 \text{ mm} \simeq 19 \text{ mm}$$

Length of leaves

Length of smallest leaf = $\frac{\text{Effective length}}{n-1}$ + Ineffective length

$$= \frac{1020}{7-1} + 80$$

Length of smallest leaf = 250 mm

Length of 2nd leaf = $\frac{\text{Effective length}}{n-1} \times 2$ + Ineffective length

$$= \left(\frac{1020}{7-1}\right) \times 2 + 80$$

$$= 420 \text{ mm}$$

Length of 3rd leaf

$$= \frac{1020}{7-1} \times 3 + 80$$

$$= 590 \text{ mm}$$

Length of 4th leaf

$$= \left(\frac{1020}{7-1}\right) \times 4 + 80$$

$$= 760 \text{ mm}$$

Length of 5th leaf

$$= \left(\frac{1020}{7-1}\right) \times 5 + 80$$

$$= 930 \text{ mm}$$

Length of 6th leaf

$$= \frac{1020}{7-1} \times 6 + 80$$

$$= 1100 \text{ mm}$$

Here the seventh leaf is the master leaf

$$= 2L_1 + \pi(d+t) \times 2$$

$$= 1020 + \pi(19+9) \times 2$$

$$= 1195.9 \text{ mm}$$

$$\simeq 1200 \text{ mm}$$

① → ⑫

$y(2R - y) = (L_1)^2$

y = deflection of spring

$39.4\,(2R - 39.4) = (550)^2$

$y = \delta$

~~R/2 ...~~

$$\boxed{R = 3858.5\ mm}$$

<u>Result:</u>

$b = 8.35\ mm \simeq 9\ mm$

$\delta = 39.4\ mm$

$d = 19\ mm$

$l_1 = 250\ mm$

$l_2 = 420\ mm$

$l_3 = 590\ mm$

$l_4 = 760\ mm$

$l_5 = 930\ mm$

$l_6 = 1,100\ mm$

$l_7 = 1200\ mm$

$R = 3858.5\ mm$