Design Calculations for springs in the Suspension of speed Breaker

Assumptions:

Mass of vehicle(m)=1150kg
Acceleration due to gravity(g)=9.81m/s^2
Material of Spring=Alloy Steel (Ultimate tensile strength=723.82MPa)
Factor of safety=1.5
spring index(C) as 6

Calculation of Force on each spring(p)

Total force acting on bumper=mass of vehicle X acceleration due to gravity

$$P = m \times g = 1150 \times 9.81 = 11281.5N$$

Total number of parallel connected springs =4

Force on each spring= $\frac{P}{4}$ = $\frac{11281.5}{4} = 2820.375N$

Hence Force on each spring is 2820.375N

Calculation of Maximum shear stress ($\tau_{\max}$)

$$\tau_{\max} = 0.5S_{ut}$$

$$\tau_{\max} = 0.5 \times 723.82 = 361.91MPa$$

Hence Maximum Shear stress for alloy steel is 361.91Mpa

Calculation of Maximum permissible shear stress ($\tau_{allowable} = \tau$)

$$\tau_{\max} = 361.91MPa$$

F.O.S=1.5

$$\tau_{allowable} = \frac{\tau_{\max}}{F.O.S} = \frac{361.91}{1.5} = 241.27MPa$$

Hence Maximum allowed stress for our speed breaker is 241.27Mpa

Calculation of Wahl factor(kw)

Spring index(C)=6

$$k_w = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

$$k_w = \frac{(4\times 6)-1}{(4\times 6)-4} + \frac{0.615}{6} = 1.15 + 0.1025 = 1.2525$$

Hence Wahl factor is 1.2525

Calculation of Wire diameter(d)

$$\tau = \frac{k_w 8pD}{\pi d^3} = \frac{k_w 8pC}{\pi d^2}$$

$$d^2 = \frac{k_w 8pC}{\pi\tau}$$

$$d^2 = \frac{8 \times 2820.375 \times 6 \times 1.2525}{\pi \times 241.27} = 223.70mm$$

$$d = 14.956 \approx 15mm$$

Hence the wire diameter(d) is 15 mm

Calculation of Mean coil diameter(D)

$$C = \frac{D}{d}$$

$$D = C \times d = 6 \times 15 = 90mm$$

Hence the Spring mean coil diameter(D) is 90 mm

Calculation of Number of turns(N)

Average height of speed breaker in India is 10cm

Individual spring deflection when vehicle passes=10cm=100mm

Shear Modulus of **Alloy Steel**(G)=79000MPa

$$\delta = \frac{8pD^3N}{Gd^4} = \frac{8 \times 2820.375 \times (90)^3 \times N}{79000 \times (15)^4}$$

$$100 = 4.11 \times N$$

$$N = \frac{100}{4.11} = 24.33 \simeq 25Turns$$

For Square and grounded ends, the number of inactive coils is 2

Thus, total number of coils needed is 2

Hence total number of turns of spring required is 27

Calculation of Stiffness of spring(K)

$K = \frac{Gd^4}{8D^3N}$ where,

Shear Modulus of **Alloy Steel**(G)=79000MPa

wire diameter(d) is 15 mm

mean coil diameter(D) is 90 mm

Total number of turns(N)=27

Stiffness(K)= $K = \frac{Gd^4}{8D^3N} = \frac{79000 \times 15^4}{8 \times 90^3 \times 25} = 27.430N/m$

Hence Stiffness of Spring is 27.430N/m

Calculation of Solid Length(l) and Free length(L)

Assumption: Under maximum deflection gap between consecutive coils is 3mm

Total axial Gap = (Number of coils-1) x gap between consecutive coils

= (27-1) x 3mm=78mm

Maximum deflection (δ) =100mm

Solid length of spring(l) = (N x d) =27 x 15 = 405mm

Total Spring length (Free length) = Solid length + Total axial Gap + Maximum deflection

=405mm + 78mm + 100mm=583mm

Hence free length of the spring is 583mm or 58.3cm

SPRING DESIGN IN SOLID WORKS

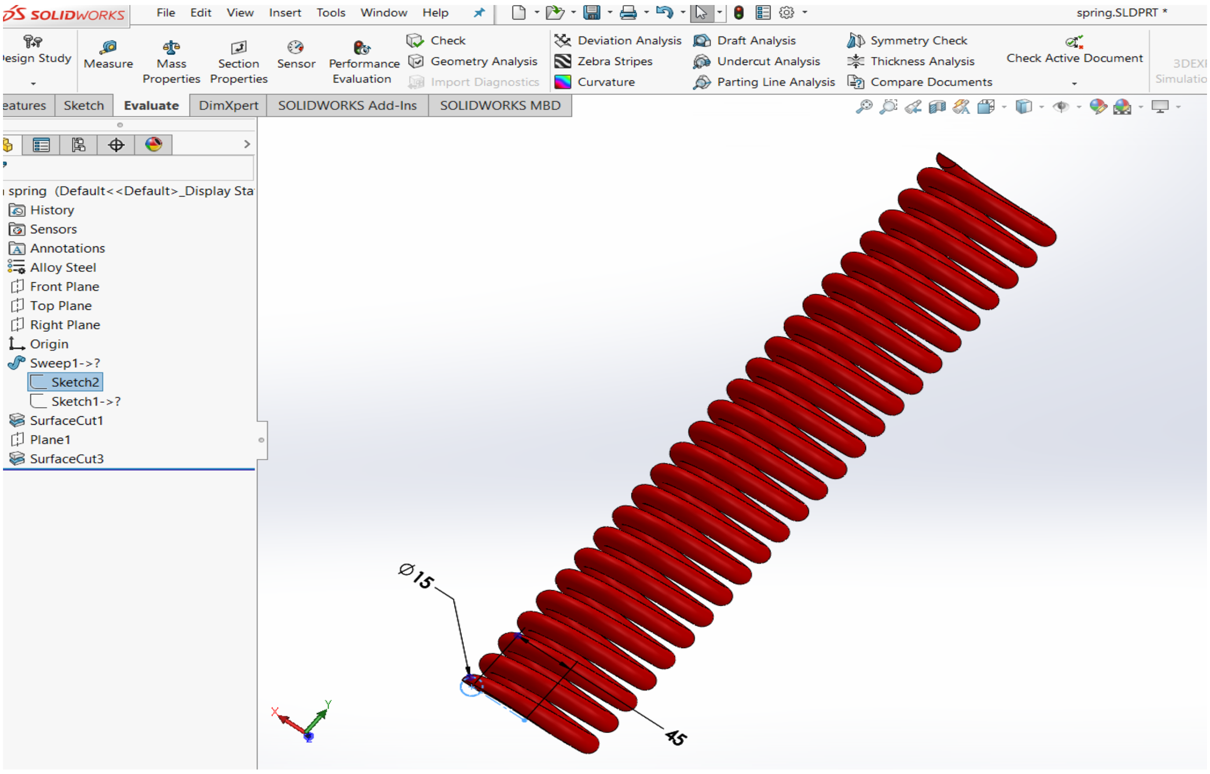

Fig: Spring Mean coil diameter and Wire diameter

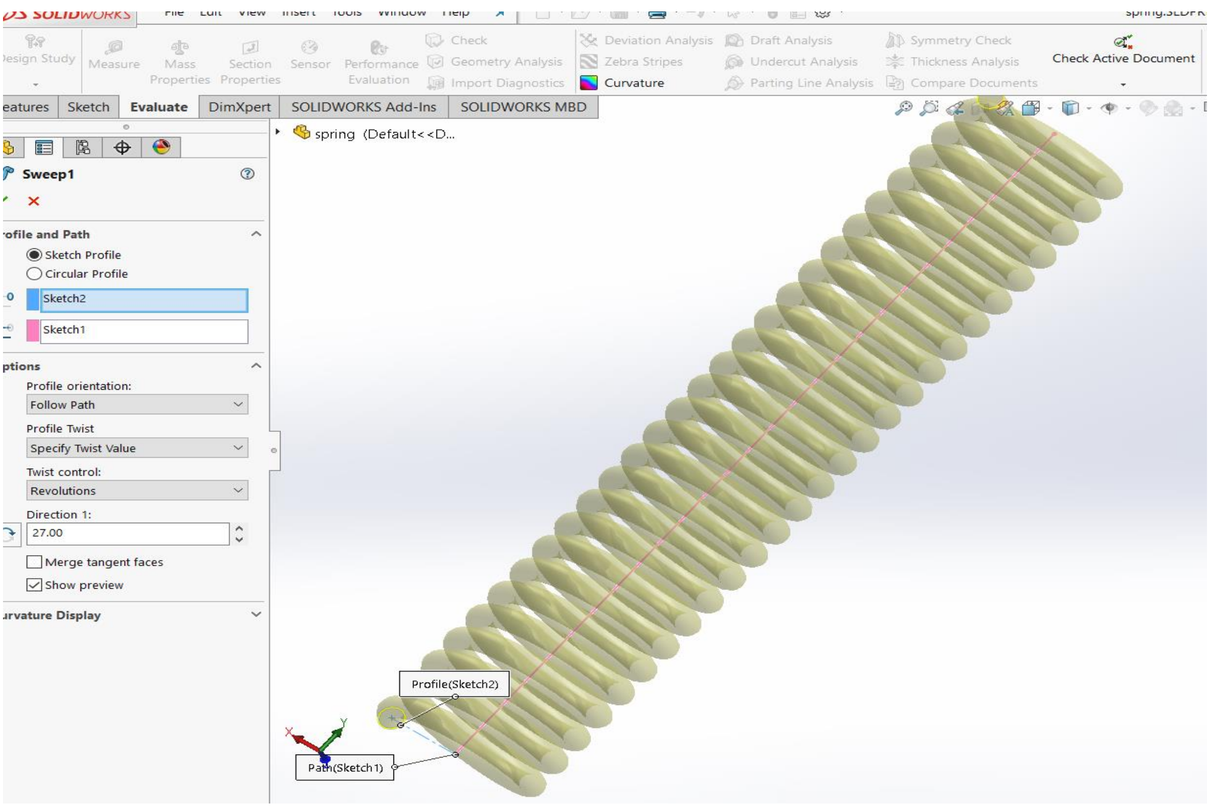

Fig: Spring Total number of coils(N)

SOLIDWORKS PICTURES

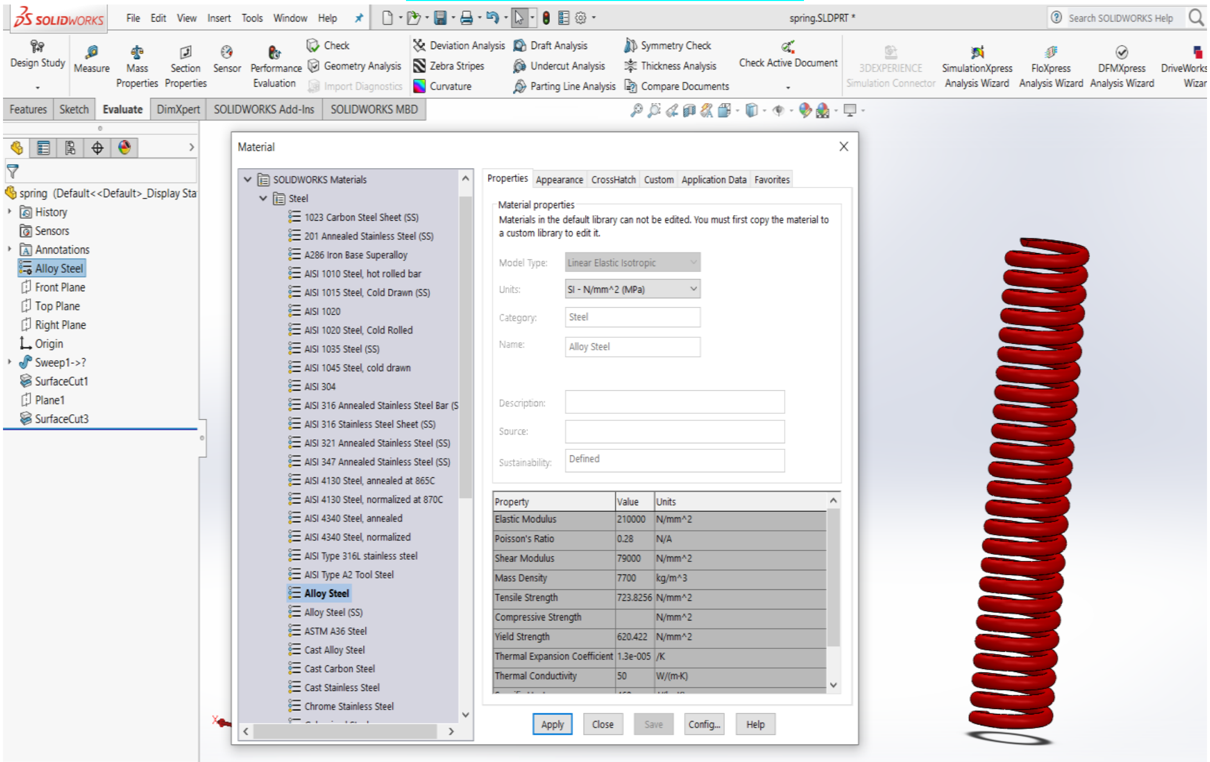

Fig: Mechanical properties of Alloy Steel

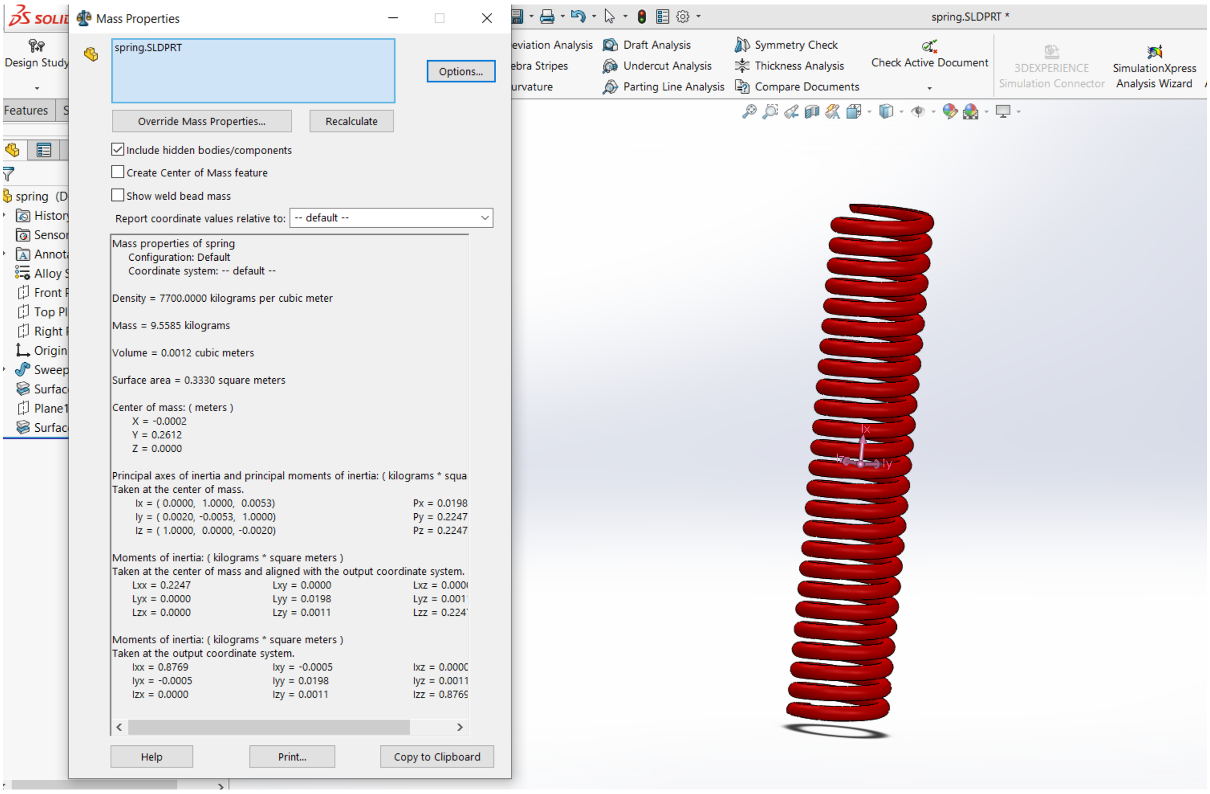

Fig: Mass of the Spring