LINEAR SPRING RATE DESIGN

The following procedure is followed to obtain the specifications for the manufacturing of linear spring.

Step-1 Before designing you must know what is the travel required and what the spring rate for your design is. So, I would be taking an example of travel (x) =127mm and spring rate (k) = 27 N/mm. Therefore maximum spring force (P) = 127*27=3429 N

Step-2 Wire Diameter (d)

Assume a suitable value for spring index (C). Let me suppose C=8 and then find out value of Whal factor by using the formula

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

For C=8 we would find K= 1.18

Then use following formula

$\tau = K(\frac{8PC}{\pi d^2})$ where τ = 545 N/mm i.e. shear stress for spring steel and d is the wire diameter.

$545 = 1.18(\frac{8*3429*8}{3.14*d^2})$

d= 12.30 ~ 13 mm

Step-3 Mean coil diameter (D)

To find out mean coil diameter use D=Cd = 8*13= 104 mm

Step-4 Number of active coils and total coils

Coils which participate in the movement of spring are called active coils. They are found out by the formula

$x = \frac{8PND^3}{Gd^4}$ where G= Shear modulus which is equal to the 81370 MPa for spring steel

On solving we find out N= 9.56 ~ 10 coils

Total number of coils = 10+2= 12 (inactive coils are generally 2)

Step-5 Free length of the spring

To find out free length we use the formula

Free length= Spring Travel +Total Gap + Solid Length

Assuming Gap of 1 mm between two consecutive coil

Total gap = (N+1)*Gap

And solid Length= (N+2)*d

Therefore Free length = 127 + 11*1 + 11*13 = 294 mm

Step-6 Pitch of the coil

Pitch of the coil is given by

p= Free length/(N+1)=294/11= 26 mm

Step-7 Check for the buckling

Buckling is the very crucial problem for the spring designer one must care about this fact otherwise spring would not work and all of your design would fail.

To check for buckling we ensure

$\frac{Free\ Length}{Mean\ Coil\ Diameter} \leq 2.6$ Design is buckling free

$\frac{Free\ Length}{Mean\ Coil\ Diameter} \geq 2.6$ We must provide guides to prevent buckling. Generally one should avoid using guides as they reduce life of the suspension systems.

In our case, if we look in our design we find 294/104= 2.82, therefore, guides are necessary for our design and we have to change the value of spring index (C) so that we could achieve Buckling ratio <2.6.