Spring Design Equations

GARDNER SPRING INC.
A Vulcan Spring company.

The following equations may be used when determining rate, load, and other basic data relating to helical Compression, Extension, and Torsion Springs, and Belleville Disc Springs. Please consult the Material Properties Table for information specific to various available spring materials. Please email us at tech@gardnerspring.com with specific questions.

Nomenclature:

Cp = Pitch (Distance Between Coils)
d = Wire Diameter
D = Mean Diameter (Outside Diameter – d)
Di = Inside Diameter
Do = Outside Diameter
E = Modulus of Elasticity
f = Deflection
G = Modulus of Rigidity
h = Unloaded Dish (Inside) Height of Disc Spring
Lf = Free (Uncompressed) Length of Compression Spring
Ln = Logarithm
N = Number of Active Coils
P = Load
P1 = Initial Tension
R = Spring Rate
Rd = Radius
s = Working Deflection of Disc Spring
T = Torque
t = Material Thickness
α = Calculation Coefficient
δ = Ratio of Diameters
Θ = Degrees
μ = Poisson's Ratio

SPRING RATE (COMPRESSION OR EXTENSION)

$$R = \frac{Gd^4}{8D^3N}$$

LOAD AT DEFLECTION (EXTENSION)

$$P = Rf + P_1$$

NUMBER OF COILS (COMPRESSION OR EXTENSION)

$$N = \frac{Gd^4}{8RD^3}$$

SPRING RATE (TORSION)

$$R = \frac{\Delta T}{\Delta\theta} = \frac{Ed^4}{10.8DN}$$

PITCH (COMPRESSION)

$$C_P = L_f \div N$$

LOAD AT DEFLECTION (BELLEVILLE DISC SPRINGS)

$$P = \frac{Ef}{(1-\mu^2)\alpha R_d^2}\left[\left(h - \frac{f}{2}\right)(h - f)t + t^3\right]$$

SOLID HEIGHT (COMPRESSION)

$$SH = Nd$$

$$\alpha = \frac{6}{\pi L_n \delta}\frac{(\delta-1)^2}{\delta^2}$$

$$\delta = \frac{D_o}{d_i}$$

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