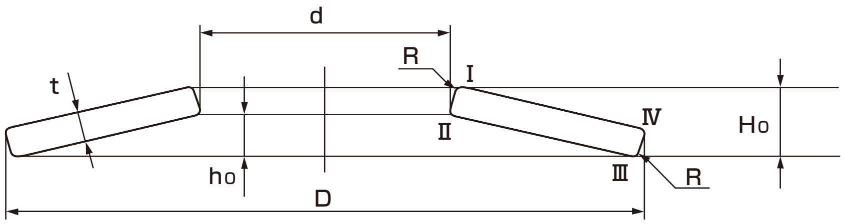
(3) Load and Stress Calculations of Dish Washer (Reference data: JIS B 2006)



D : Diameter of outer periphery (mm)
d : Diameter of inner periphery (mm)
t : Plate thickness (mm)
H_0 : Free hight (mm)
h_0 : Total amount of deflection (H_0-t) (mm)
E : Longitudinal elastic modulus (N/mm^2)
ν : Poisson’ s ratio of material (0.3)
P : Load(N)

δ : Amount of deflection (mm)
k : Load rate (N/mm)
R : Chamfer radius of corner (mm)
σ_{I} : Stress on position I (N/mm^2)
σ_{II} : Stress on position II (N/mm^2)
σ_{III} : Stress on position III (N/mm^2)
σ_{IV} : Stress on position IV (N/mm^2)

The coefficients used for calculation are as follows:

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

$$C_1 = \frac{1}{\pi} \cdot \frac{\left(\frac{\alpha-1}{\alpha}\right)^2}{\frac{\alpha+1}{\alpha-1} - \frac{2}{\ln\alpha}}$$

$$C_2 = \frac{1}{\pi} \cdot \frac{6}{\ln\alpha} \cdot \left(\frac{\alpha-1}{\ln\alpha} - 1\right)$$

$$C_3 = \frac{3}{\pi} \cdot \frac{\alpha-1}{\ln\alpha}$$

Including the correction item $\left(\frac{D-d}{(D-d)-3R}\right)$ that allows for round chamfering of the corner presents the load P by the following formula:

$$P = \frac{D-d}{(D-d)-3R} \cdot \frac{4E}{1-\nu^2} \cdot \frac{t^3}{C_1 D^2} \cdot \delta \cdot \left[\left(\frac{h_0}{t} - \frac{\delta}{t}\right) \cdot \left(\frac{h_0}{t} - \frac{\delta}{2t}\right) + 1\right]$$

The stresses on the positions I, II, III and IV can be calculated according to the formulas given below. A positive value indicates tensile stress while a negative value indicates compression stress.

$$\sigma_{I} = \frac{4E}{1-\nu^2} \cdot \frac{t}{C_1 D^2} \cdot \delta \cdot \left[-C_2 \cdot \left(\frac{h_0}{t} - \frac{\delta}{2t}\right) - C_3\right]$$

$$\sigma_{II} = \frac{4E}{1-\nu^2} \cdot \frac{t}{C_1 D^2} \cdot \delta \cdot \left[-C_2 \cdot \left(\frac{h_0}{t} - \frac{\delta}{2t}\right) + C_3\right]$$

$$\sigma_{III} = \frac{4E}{1-\nu^2} \cdot \frac{t}{\alpha C_1 D^2} \cdot \delta \cdot \left[(2C_3 - C_2) \cdot \left(\frac{h_0}{t} - \frac{\delta}{2t}\right) + C_3\right]$$

$$\sigma_{IV} = \frac{4E}{1-\nu^2} \cdot \frac{t}{\alpha C_1 D^2} \cdot \delta \cdot \left[(2C_3 - C_2) \cdot \left(\frac{h_0}{t} - \frac{\delta}{2t}\right) - C_3\right]$$

The load rate of the spring is non-linear and can be calculated according to the following equation.

$$k = \frac{dP}{d\delta} = \frac{D-d}{(D-d)-3R} \cdot \frac{4E}{1-\nu^2} \cdot \frac{t^3}{C_1 D^2} \cdot \left[\left(\frac{h_0}{t}\right)^2 - 3\frac{h_0}{t} \cdot \frac{\delta}{t} + \frac{3}{2}\left(\frac{\delta}{t}\right)^2 + 1\right]$$