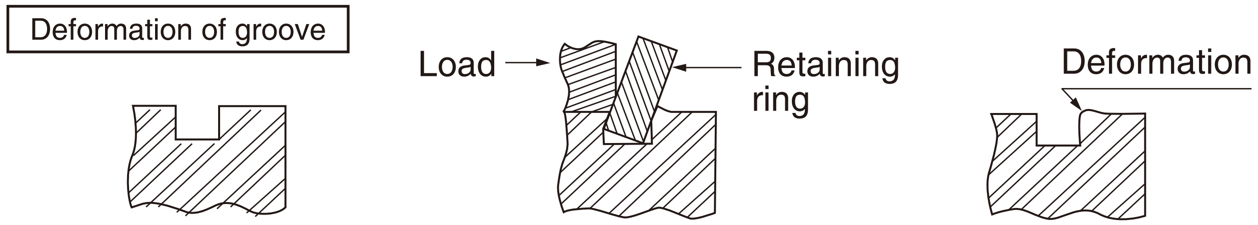
Calculations for Retaining Rings (Reference)

1 Allowable Thrust Load

The allowable thrust load is a load specified when the groove is not deformed and the retaining ring is not sheared.



(1) Allowable Thrust Load of Retaining Ring

The allowable thrust load where static load is applied to a retaining ring can be calculated according to the following formula:

$$R_S = \frac{ADTS_S \pi}{S}$$

R_S: Allowable thrust load of retaining ring (N)

A: Shape factors of retaining ring (See Table 1)

D: Shaft diameter or housing diameter (mm)

T: Plate thickness of retaining ring (mm)

The Beveled Rings need to allow for the plate thickness when fit since they may be fit at half of the groove depth in relation to the retained work.

π: Circumference ratio

S_S: Strength in shear of retaining ring (N/mm²)

Basic External Ring (Carbon steel) : Approx. 980N/mm² as a guideline. (According to the JIS B 2804)

S: Safety factors

General safe factors are listed in a table. (See Table 2)

Using the formula provided above, it is possible to calculate the thrust load of the retaining ring. However, in order to generate the calculated thrust load, it is essential to design the groove in accordance with the thrust load. (If the thrust load in the groove is lower than that of the retaining ring, the groove may deform, causing the retaining ring to disengage, and you won't be able to obtain sufficient thrust load.)

Table 1 Shape factors of retaining rings

Shape of ring	A (Retaining ring)	B (Groove)
Basic External Ring	1.0	1.0
Beveled External Ring	1.0	1.0
Basic Internal Ring	1.0	1.0
Beveled Internal Ring	1.0	1.0
Inverted Internal Ring	0.7	0.5
Inverted External Ring	0.7	0.5
E-Ring	0.3	0.3
C-Ring	0.5	0.5
U-Ring	0.5	0.5

Table 2 Guideline on safe factors (S)

Type of load	Safety factors
Static load	3 or 4
Cyclic load	5
Alternate load	8
Shock load	12

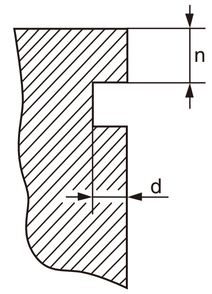
(2) Thrust Load of Groove

It is necessary to design the groove to obtain a sufficient thrust load of retaining ring. It is important to set the edge margin in this design. We recommend that the margin be set as given below to increase the through load of groove.

$$n/d \geqq 3$$

n: Edge margin (mm)

d: Depth of groove (mm)



If the value n/d is less than 3, attention should be paid to since the thrust load in the groove is reduced. Please refer to the table of ring dimensions for the recommended dimension.

If n/d is equal or more than 3, the allowable thrust load can be calculated according to the following formula:

$$G_1 = \frac{BDdG_y \pi}{Sq}$$

G_1: Static thrust load in groove (N)

B: Shape factors of retaining ring (See Table 1)

D: Shaft diameter or housing diameter (mm)

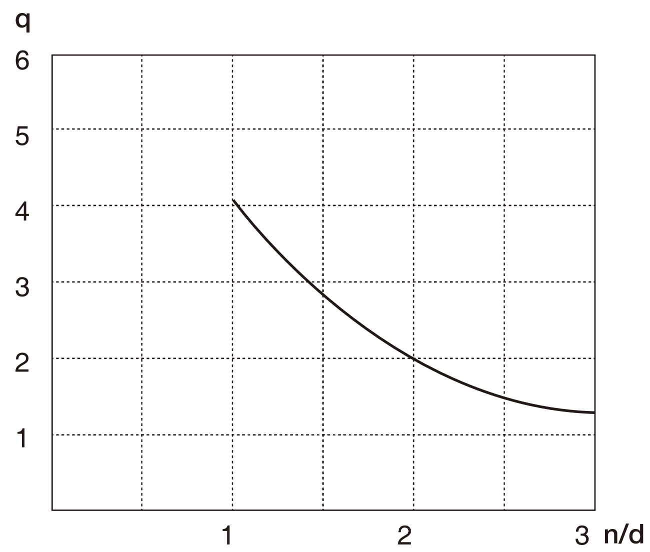
d: Depth of groove (mm)

G_y: Yield strength of groove (N/mm²) See Note

π: Circumference ratio

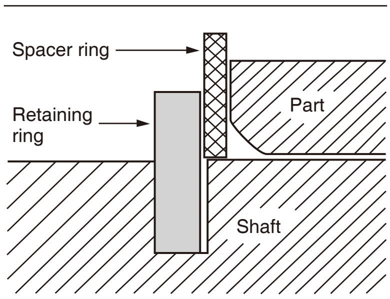
S: Safety factors (See Table 2)

q: Decreasing factor, a value obtained from the value n/d using the graph. However, if the value n/d is 3 or more, the value q is 1.



Note: Since the retaining rings will come off if the groove deforms, the formula takes Yield strength of groove considering the safetiness.

The above formula assumes that retained parts have sharp corners. For retained parts having corner radii, care must be taken as the thrust load is reduced.
If the thrust load does not satisfy the requirement because of retained parts having corner radii or chamfers, the thrust load can be improved by inserting a spacer ring like a rigid flat washer in the groove.



2 Calculation of Stress

This section calculates the maximum stress where a retaining ring is fit.

Basic Ring

When the retaining ring (Basic External Ring) that is circumscribed by two eccentric circles is to be spread in the Y directions as shown in the figure:

M: Bending moment (N·mm)
E: Longitudinal elastic modulus (Carbon spring steel: 206000N/mm²)
I: Second moment of area (mm⁴)
r: Average curvature radius (mm)
ρ: Average curvature radius after (mm)
ξ: Rate of change
d: Average diameter (mm)
d_1: Diameter of outer periphery (mm)
d_2: Diameter of inner periphery (mm)
Z: Section modulus
t: Plate thickness (mm)
b: Maximum rim width (mm)