

SIZING AND SELECTION

- Select the disc with the largest outside diameter (D_o). This reduces the stresses at a given force (F)/deflection (s) ratio and thus enhances fatigue life. An outside (D_o) to inside diameter (D_i) of 1.7 to 2.2 also enhances performance and longevity.
- Select a disc that achieves the maximum force required at less than 75% of its deflection. Deflection of 75% of cone height (h_o) should be the design maximum. Reducing deflection increases fatigue life.
- Force/deflection curves can be changed by varying the cone height (h_o) to thickness (t) ratio. Curves for discs may be plotted with the force/deflection data provided on pages 9-14 at 25%, 50%, 75% and 100% of deflection.
- Thicker discs have greater damping (hysteresis) characteristics.

ORIENTATION

- Shorter stacks are more efficient. This is particularly important under dynamic loading. Discs at the moving end of the stack are overdeflected whereas discs at the opposite end are underdeflected. This results from the friction between the individual discs as well as the discs and the guiding mandrel or sleeve. Use of the largest practical outside diameter discs will reduce the number of individual discs and total stack height. It is recommended that total stack height not exceed three times the external disc diameter (D_o) or ten total discs.
- When discs are used in parallel, the following factors should be considered:
 1. In dynamic applications, the generation of heat;
 2. The relationship between loading and unloading forces due to friction;
 3. Hysteresis, the increased damping resulting from friction between the discs; and
 4. Lubrication – A must in parallel disc applications.
- Lubrication is required for the efficient use and extended life of discs. In moderate applications, a solid lubricant such as molybdenum disulfide will generally suffice. In severe and corrosive applications, an oil or grease lubricant housed in a chamber may be required.
- Hardened thrust washers will alleviate surface damage/indentation when discs are used in conjunction with soft materials.

FATIGUE LIFE

- Fatigue life can be improved by increasing preload and reducing maximum deflection. This will likely require additional discs in series, but will extend life.
- Shot peening induces favorable compressive stresses on the disc surface. This reduces the likelihood of fatigue failure due to tensile stresses which generally start on the surface.
- Presetting is defined as a single or repeated compression of a heat treated disc to the flat condition. The strains induced give rise to plastic deformation, the spring thereby loses height. The remaining free conical height (h_o) results from the residual stresses being at an equilibrium of forces and moments. The disc will no longer plastically deform during subsequent loading. This allows for higher load stresses and longer fatigue life.

MATERIALS AND FINISHES

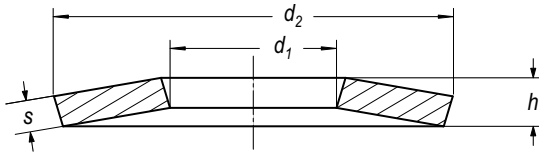
- High carbon and alloy steel materials provide excellent strength and endurance life in most applications. The standard coating of zinc phosphate and oil provides adequate protection from humidity and occasional moisture. More effective protective finishes are available, but these tend to wear off in dynamic applications.
- Electroplated finishes should always be avoided. Hydrogen embrittlement poses too great of a risk in highly loaded discs having a hardness over HRC 40.
- Austenitic stainless steel is a very good choice for static and low cycle applications. It provides high forces and excellent corrosion resistance. This material will continue to work harden with use so cycle life is limited, but creep resistance is good.
- For dynamic applications where corrosion protection is required, precipitation hardening stainless steels are recommended. These steels are nearly as strong as the standard DIN materials and very corrosion resistant.
- At temperatures over approximately 200°F (100°C), standard DIN materials can begin to creep, or take a set. Between 300°F and 400°F (150°C to 200°C) the materials lose their strength and are no longer considered viable. Stainless steels are a bit more temperature resistant, but only up to 575°F (300°C).



CONICAL SPRING WASHERS

Designed in accordance with DIN 6796 for use with high tensile bolts in Classes 8.8 and higher.

Since the spring force exerted is predictable, Spring Washers provide a simple effective means of determining bolt tension required to achieve a properly torqued assembly. In addition, tension, which would otherwise be lost to expansion, wear, or compression set, is maintained.



Nominal Size	d_1 H14	d_2 h14	s	h max ¹⁾	h min ²⁾	Force N Test ³⁾	Force N ⁴⁾
2	2.2	5	0.4	0.6	0.5	920	628
2.5	2.7	6	0.5	0.72	0.61	1540	946
3	3.2	7	0.6	0.85	0.72	2350	1320
3.5	3.7	8	0.8	1.06	0.92	3160	2410
4	4.3	9	1	1.3	1.12	4050	3770
5	5.3	11	1.2	1.55	1.35	6700	5480
6	6.4	14	1.5	2	1.7	9400	8590
7	7.4	17	1.75	2.3	2	13700	11300
8	8.4	18	2	2.6	2.24	17200	14900
10	10.5	23	2.5	3.2	2.8	27500	22100
12	13	29	3	3.95	3.43	40000	34100
14	15	35	3.5	4.65	4.04	55000	46000
16	17	39	4	5.25	4.58	75000	59700
18	19	42	4.5	5.8	5.08	95000	74400
20	21	45	5	6.4	5.6	122000	93200
22	23	49	5.5	7.05	6.15	152000	113700
24	25	56	6	7.75	6.77	175000	131000
27	28	60	6.5	8.35	7.3	230000	154000
30	31	70	7	9.2	8	280000	172000

- 1) Maximum height at delivery
- 2) Minimum height after test for permanent set as specified in DIN 267 Part 26
- 3) Compression test load
- 4) Calculated spring force at deflection equals $h_{min} - s$

MATERIAL	B	Spring steel heat treated to HV 420-510 (HRC 43-50)
FINISH	K	Plain (natural), oiled

TO ORDER: Product / $d_2 \times d_1 \times t$ / material code / finish code
 EXAMPLE: LWR 9 x 4.3 x 1 B K

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