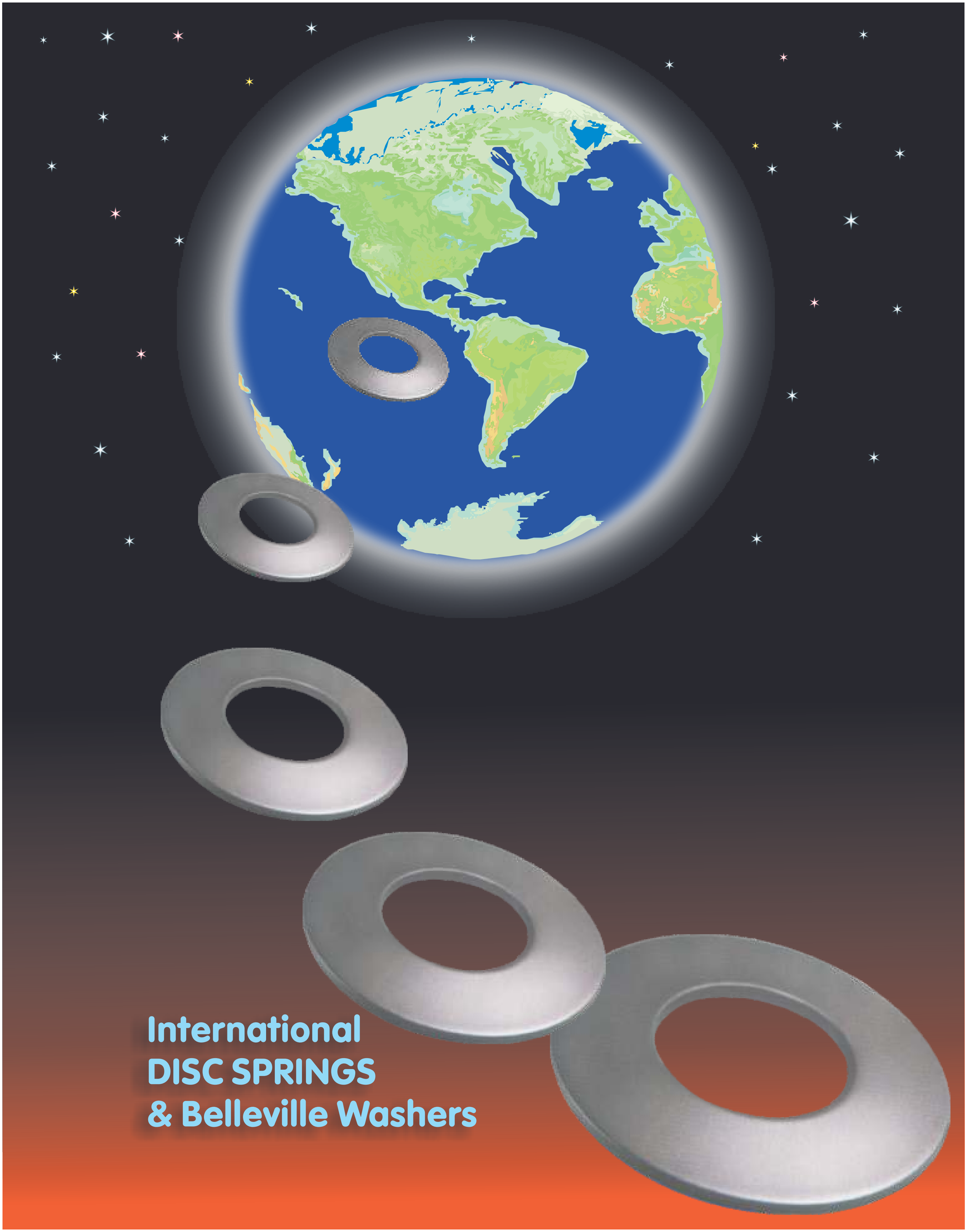

International
DISC SPRINGS
& Belleville Washers

COMPANY PROFILE

International Industrial Springs, Thane established in the year 1967 has specialized in manufacture of Coil Springs, Sheet Metal Components and Disc Springs, catering to the requirements of domestic and International Customers. IIS continued its steady gr owth by implementing modern manufacturing methods. Our Engineers have utilized their engineering backgrounds, experience/ and skills in designing and improving the manufacturing process to enhance quality product. Extensive product development and testing laboratories are available and used for our in house production and also for customer's proprietory development.

Our main goals are individual attention, custom engineering, continous improvement and managements commitment to product Quality and customer satisfaction.

INTRODUCTION

Disc Sprigs are conically formed annular discs, which are loaded in the axial direction. Disc Springs offer a well-developed solution to many engineering problems through a unique combination of high force in a small space. Disc Springs can be used as single disc or arranged in stacks. A spring stack can consist of either single spring or parallel spring sets. Disc Springs are available with or without contact flats. Disc Springs and Belleville Washers are manufactured to DIN 2093 AND DIN 6796. Heavy series Disc Springs are manufactured from forgings. We have computerized design program to assist our customers for their specific applications. Disc Springs are manufactured from imported 50CrV4 material.

Our Disc Springs are AUSTEMPERED. This method of heat treatment is particularly effective for springs, as it gives the maximum toughness and therefore considerable durability

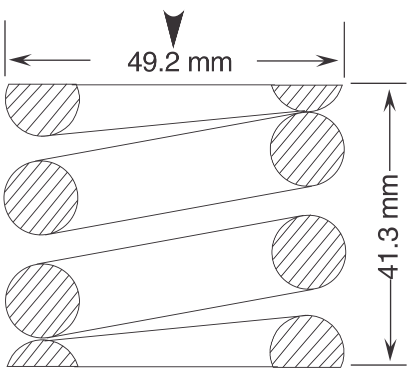
Advantages of Disc Springs

1. **No Deformation or Fatigue under normal loads.**
2. **High Energy Storage Capacity.**
3. **Long Service Life.**
4. **Stock keeping is minimized as the individual spring sizes can be combined universally.**
5. **Space Saving.**
6. **Largely Self-damping, giving good shock absorption and energy dissipation.**
7. **Efficient use of space and high spring force with small deflections.**
8. **Adaptable to stacking in numerous configurations.**
9. **Combination use as a modular spring element.**
10. **Low Maintiance cost**
11. **Greater Security**

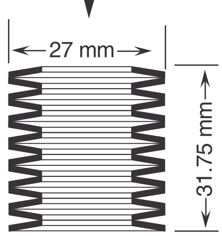
Disc Spring Stack Compared to Helical Spring.

Note that the same load is achieved at substantial reduction in space. Disc stacks may be designed for extremely high loads where coil springs are not feasible at all.

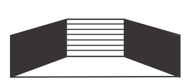
Coil spring weight : .26 kg.
Volume ; 78.5 cm^3
409 kg.



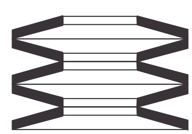
Disc spring weight : .08 kg.
Volume ; 18.2 cm^3
409 kg.



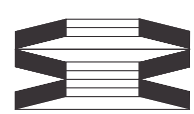
Disc Springs in Series & Parallel Combinations



Stacked in parallel TOTAL DEFLECTION = Deflection of 1 disc. TOTAL LOAD = Load on 1 disc x no. of discs.



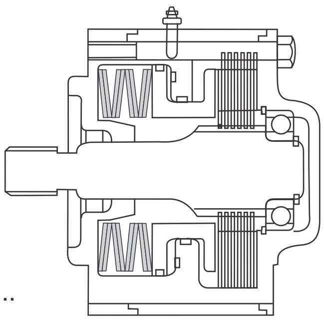
Series :- TOTAL DEFLECTION = Deflection of 1 disc X no. discs in stack. TOTAL LOAD = Load on 1 disc.



Parallel Series :- COMBINATIONS can be designed to accommodate virtually any load or deflection and to obtain progressive or regressive characteristics.

Disc Springs are used in all types of applications

- Automotive & Engines
- Brakes & Clutches
- Dampers
- Hoists
- Machine Tools
- Shock Mounts
- Vibrators
- And many more applications......



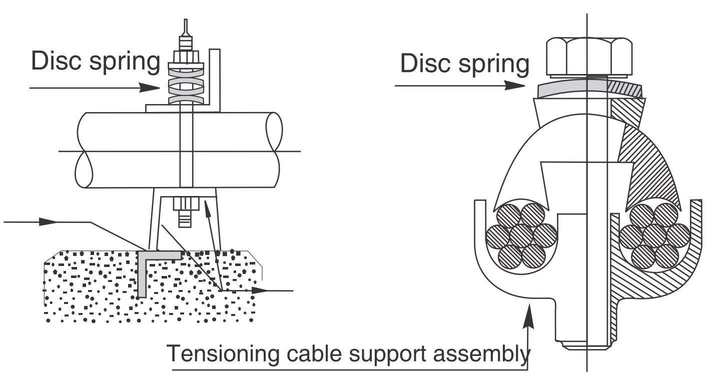
Selection

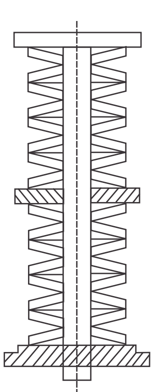
a) If the application involves large numbers of deflection cycles, i.e. “dynamic” application, or if the required forces or deflections are of a critical nature, we strongly recommend that you select from the range of Disc Springs that confirms to the DIN 2093 specification.

b) From the range available, select the largest possible Disc Spring compatible with the desired characteristics. This will assist in maintaining the lowest possible stresses, thus enhancing the fatigue life. In case of stacked columns the greater deflection offered by the larger diameter springs will ensure the shortest possible stack length.

c) For static or dynamic application, select a Disc Spring that, at 75% of its total available deflection offers the maximum force and deflection required.

d) As a result of manufacturing processes, residual tensile stresses occur at I, the upper inside diameter edge, which will revert to normal compressive stresses when the Disc Spring is deflected by up to approximately 15% of its total deflection.





Stack Length

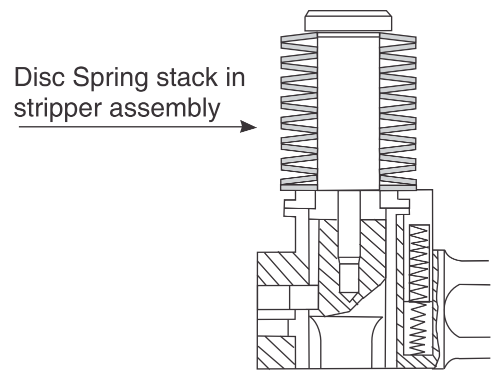
When stacking Disc Springs, effort should be made to keep the stacks as short as possible. Friction and other influences make a stack more uneven. It deflects more on the side of the loading. This effect usually can be neglected for a “normal” spring stack, but not for long stacks. If it is longer, the stack can be stabilized by dividing it with guide washers, which as a rule of thumb should have a thickness of atleast one and a half times the guide diameter.

Installation

a) Dynamic applications, involving large numbers of deflection cycles, will require that in addition to hardened seating faces the guide surfaces must also be sufficiently hard to prevent excessive wear or “stepping”. For both support washers and guide elements, a polished surface with hardness of 58HRC is sufficient, and case depth should be 0.60mm min.

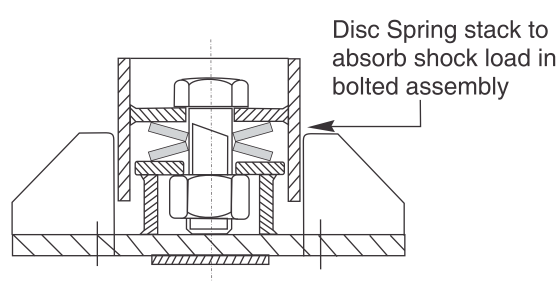
b) A most important aid to efficient and extended life of Disc Spring is the provision of some form of lubrication. For relatively low-duty Disc Spring application, a liberal application of suitable solid lubricant, (e.g. molybdenum-disulphide, grease), to the contact points and locating surfaces of the spring is adequate.

For more severe applications of a dynamic or highly corrosive nature, the Disc Springs will benefit from maintained lubrication, and are often housed in an oil or grease filled chamber.



Disc Spring with Contact Flats and Reduced Thickness.

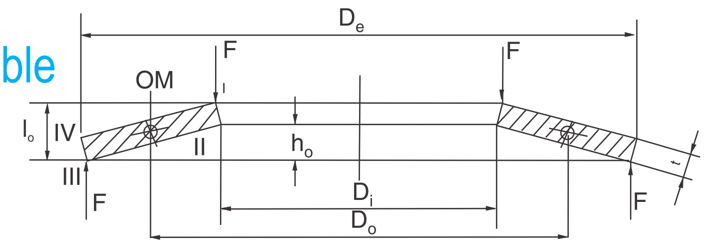
For Disc Springs with a thickness of more than 6mm, DIN 2093 specifies small contact surfaces at point I and III in addition to the rounded corners. These contact flats improve definition of the point of load application and reduce friction at the guide rod. Contact flat increase spring load, which is to be compensated by a reduction in the thickness from 't' to 't''.



Stacking

a) Series Stacking : The cumulative effect of bearing point friction of large numbers of Disc Springs stacked in series, can result in the Disc Springs at each end of the stack deflecting more than those in the centre. In extreme cases this may result in over-compression and premature failure of the end springs. A “rule of thumb” is that the length of the stacked Disc Springs should not exceed a length approximately equal to 3 times the outside diameter of the Disc Spring.

Standard sizes available as per DIN 2093



GROUP CLASSIFICATION OF DISC SPRINGS

In accordance with DIN 2093 Standard, Disc Springs are classified into 3 groups as given in the table :

Group	Thickness of single disc in mm	Single disc with Ground ends and reduced material thickness (t')
1	Less than 1.25	No
2	From 1.25 to 6	No
3	Over 6 upto 14	Yes

SERIES A

D_e h12	D_1 H12	t	h_0	l_0	S (0.75ho)	F N
8.0	4.2	0.4	0.2	0.60	0.15	210
10	5.2	0.5	0.25	0.75	0.19	329
12.5	6.2	0.7	0.3	1.00	0.23	673
14	7.2	0.8	0.3	1.10	0.23	813
16	8.2	0.9	0.35	1.25	0.26	1000
18	9.2	1.0	0.4	1.4	0.30	1250
20	10.2	1.1	0.45	1.55	0.34	1530
22.5	11.2	1.25	0.5	1.75	0.38	1950
25	12.2	1.5	0.55	2.05	0.41	2910
28	14.2	1.5	0.65	2.15	0.49	2850
31.5	16.3	1.75	0.7	2.45	0.53	3900
35.5	18.3	2.0	0.8	2.80	0.60	5190
40	20.4	2.25	0.9	3.15	0.68	6540
45	22.4	2.5	1.0	3.50	0.75	7720
50	25.4	3.0	1.1	4.10	0.83	12000
56	28.5	3.0	1.3	4.30	0.98	11400
63	31	3.5	1.4	4.90	1.05	15000
71	36	4.0	1.6	5.60	1.20	20500
80	41	5.0	1.7	6.70	1.28	33700
90	46	5.0	2.0	7.00	1.50	31400
100	51	6.0	2.2	8.20	1.65	48000
112	57	6.0	2.5	8.50	1.88	43800
125	64	8.0	2.6	10.60	1.95	85900
140	72	8.0	3.2	11.20	2.40	85300
160	82	10	3.5	13.50	2.63	139000
180	92	10	4.0	14.00	3.00	125000
200	102	12	4.2	16.2	3.15	183000
225	112	12	5.0	17	3.75	171000
250	127	14	5.6	19.6	4.20	249000

SERIES B

D_e h12	D_1 H12	t	h_0	l_0	S (0.75ho)	F N
8.0	4.2	0.3	0.25	0.55	0.19	119
10	5.2	0.4	0.3	0.7	0.23	213
12.5	6.2	0.5	0.35	0.85	0.26	291
14	7.2	0.5	0.40	0.9	0.30	279
16	8.2	0.6	0.45	1.05	0.34	412
18	9.2	0.7	0.5	1.2	0.38	572
20	10.2	0.8	0.55	1.35	0.41	745
22.5	11.2	0.8	0.65	1.45	0.49	710
25	12.2	0.9	0.7	1.6	0.53	868
28	14.2	1.0	0.8	1.8	0.60	1110
31.5	16.3	1.25	0.9	2.15	0.68	1920
35.5	18.3	1.25	1.0	2.25	0.75	1700
40	20.4	1.5	1.15	2.65	0.86	2620
45	22.4	1.75	1.3	3.05	0.98	3660
50	25.4	2.0	1.4	3.4	1.05	4760
56	28.5	2.0	1.6	3.6	1.20	4440
63	31	2.5	1.75	4.25	1.31	7180
71	36	2.5	2.0	4.5	1.50	6730
80	41	3.0	2.3	5.3	1.73	10500
90	46	3.5	2.5	6.0	1.88	14200
100	51	3.5	2.8	6.3	2.10	13100
112	57	4.0	3.2	7.2	2.40	17800
125	64	5.0	3.5	8.5	2.63	30000
140	72	5.0	4.0	9.0	3.00	27900
160	82	6.0	4.5	10.5	3.38	41100
180	92	6.0	5.1	11.1	3.83	37500
200	102	8.0	5.6	13.6	4.20	76400
225	112	8.0	6.5	14.5	4.88	70800
250	127	10	7.0	17	5.25	119000

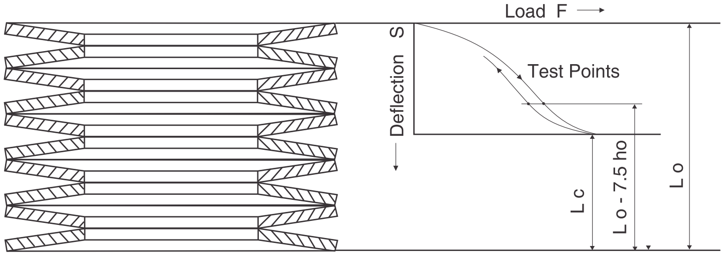
SERIES C

D_e h12	D_1 H12	t	h_0	l_0	S (0.75ho)	F N
8.0	4.2	0.2	0.25	0.45	0.19	39
10	5.2	0.25	0.3	0.55	0.23	58
12.5	6.2	0.35	0.45	0.8	0.34	152
14	7.2	0.35	0.45	0.8	0.34	123
16	8.2	0.4	0.5	0.9	0.38	155
18	9.2	0.45	0.6	1.05	0.45	214
20	10.2	0.50	0.65	1.15	0.49	254
22.5	11.2	0.60	0.80	1.40	0.60	425
25	12.2	0.70	0.90	1.60	0.68	601
28	14.2	0.80	1.00	1.80	0.75	801
31.5	16.3	0.80	1.05	1.85	0.79	687
35.5	18.3	0.90	1.15	2.05	0.86	831
40	20.4	1.00	1.30	2.30	0.98	1020
45	22.4	1.25	1.60	2.85	1.20	1890
50	25.4	1.25	1.60	2.85	1.20	1550
56	28.5	1.50	1.95	3.45	1.46	2620
63	31	1.80	2.35	4.15	1.76	4240
71	36	2.00	2.60	4.60	1.95	5140
80	41	2.25	2.95	5.20	2.21	6610
90	46	2.5	3.20	5.70	2.40	7680
100	51	2.70	3.50	6.20	2.63	8610
112	57	3.00	3.90	6.90	2.93	10500
125	64	3.50	4.50	8.00	3.38	15400
140	72	3.80	4.90	8.70	3.68	17200
160	82	4.30	5.60	9.90	4.20	21800
180	92	4.80	6.20	11.00	4.65	26400
200	102	5.50	7.00	12.50	5.25	36100
225	112	6.50	7.10	13.60	5.33	44600
250	127	7.00	7.80	14.80	5.85	50500

Symbols and Units

Symbol	Unit	Term
De	mm	Outside diameter
Di	mm	Inside diameter
Do	mm	Mean diameter
E	N/mm2	Modulus of elasticity
F	N	Spring load of a single disc (with or without ground ends)
ho	mm	Formed height
lo	mm	Free overall height of spring in its initial position
s	mm	Deflection of single disc
t	mm	Thickness of single disc
t'	mm	Reduced thickness of single disc in the case of springs with ground ends (group 3)
µ		Poisson's ratio
σOM,σI,σII, σIII, & σIV,	N/mm2	Design stresses at the points designated OM, I, II, III, and IV (see figure)
▲F	N	Relaxation

Testing of Disc Spring Stack



For the determination of the variation between loading and unloading, a stack of 10 springs in single series is used. The stack is fitted with a guide rod exactly in the same manner used for testing of Disc Springs. Before testing, the stack should be loaded with twice the spring force F(s = 0.75 h_0).

During unloading the measured spring force at the length L0 - 7.5 h_0 must atleast reach the loading characteristic shown in the fig.

Disc Spring Tolerances

The following maximum deviations are laid down in DIN 2093. They are valid for all Disc Springs as per the DIN and our works standards. In general IIS also applies these tolerances to special sizes, however, if they deviate greatly from the DIN, wider tolerances must be specified.

This applies to our ball-bearing Disc Springs. If closer tolerances are required than those tolerances in DIN 2093, please consult us.

Thickness Tolerances

Group	t or t' (mm)	Tolerance for t (mm)
1	0.2 to 0.6 > 0.6 to <1.25	+ 0.02 / - 0.06 + 0.03 / - 0.09
2	1.25 to 3.8 > 3.8 to 6.0	+ 0.04 / - 0.12 + 0.05 / - 0.15
3	> 6.0 to 14.0	+ 0.10 / - 0.10

Free Height Tolerances

Group	t	Tolerance for t (mm)
1	< 1.25	+ 0.10 / - 0.05
2	1.25 to 2.0 > 2.0 to 3.0 > 3.0 to 6.0	+ 0.15 / - 0.08 + 0.20 / - 0.10 + 0.30 / - 0.15
3	> 6.0 to 14.0	+ 0.30 / - 0.30

Load Tolerances

The static load F must be determined at the proof test height of the Disc Spring. Calculation must be based upon the nominal material thickness of the Disc Spring t and not with the reduced material thickness t[1] . Measurements must be made during loading of the Disc Spring. The loading plates must be hardened, ground & polished. Appropriate lubrication must be used during the testing.

The tolerances on spring laod

Group	t mm	Spring Load "F" Tolerance %
1	< 1.25	+ 25.0 - 7.5
2	1.25 to 3.0	+ 15.0 - 7.5
	> 3.0 to 6.0	+ 10.0 - 5.0
3	> 6.0 to 14.0	± 5.0

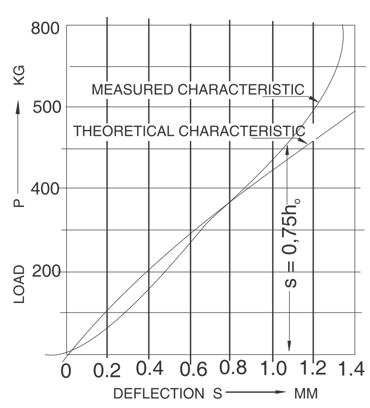
To ensure the specified spring forces, DIN 2093 allows the overall height tolerance to be slightly exceeded.

Presetting of Disc Springs

After heat treatment, each spring is flattened at least once. This reduces the overall height by means of plastic deformation. Tensile stress results on the upper side, which counteracts the compressive stress caused by subsequent loadings and so reduces the stress peaks. Further plastic deformation is thereby avoided during later loading of the spring.

Theoretical vs Measured Characteristic of a Disc Spring

The characteristic of the individual Disc Spring is non-linear. Its shape depends on the ratio ho/t. At the lower portion of the deflection range the characteristic in practice departs slightly from the theoretical. When S/ho>0.75 the characteristic in practice again departs increasingly from the theoretical because the Disc Springs roll upon one another or upon the supporting surface and this leads to a continuous shortening of the lever arm. For this reason, the spring force is only indicated at S=0.75 ho in DIN 2093

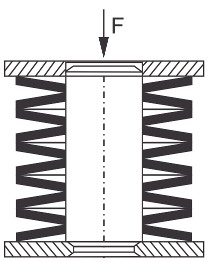


Installation of Disc Spring Stacks

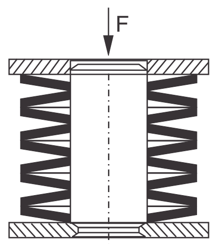
To minimize friction and to ensure that the correct force is obtained, the guiding of disc spring stack is crucial.

In the dynamic cycling of disc springs in stacks, there is a small relative movement in a radial direction between the end disc springs and the end plates. This leads to wear as a consequence of the high line contact pressure.

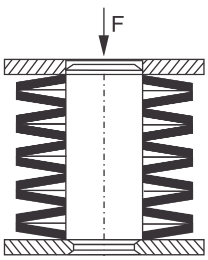
When an uneven number of disc springs must be used in a disc spring stack, the disc spring at the end of the stack on the moving end of the stack (relative to the movement between the end Disc Spring and the guide element)should be oriented in such a manner that the outside diameter surface of the disc spring is in contact with the end plate.



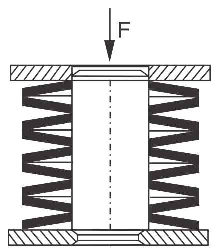
Correct Orientation



Correct Orientation



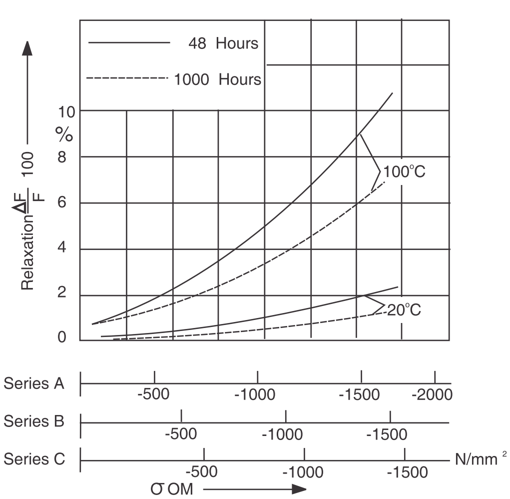
Incorrect Orientation



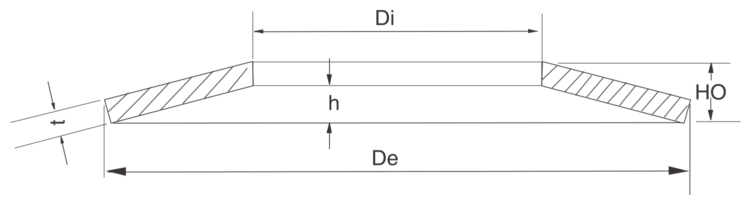
Incorrect Orientation

Setting of Disc Springs

All springs experience a loss of load or relaxation in the course of time, which is primarily dependent on the occurring stress and the temperature - time curve. For disc springs the stress distribution in the cross-section also plays a role determined by the dimensional relationships δ and h_o/t. Creeping is described as a loss of length which the spring suffers under a constant load F, and relaxation as a loss in load Δ F if the spring is installed at a constant length. Approximate values for the permissible relaxation of Disc Springs under static loads are provided in figures given below.



Permissible relaxation for Disc Springs of Standard Carbon Steel

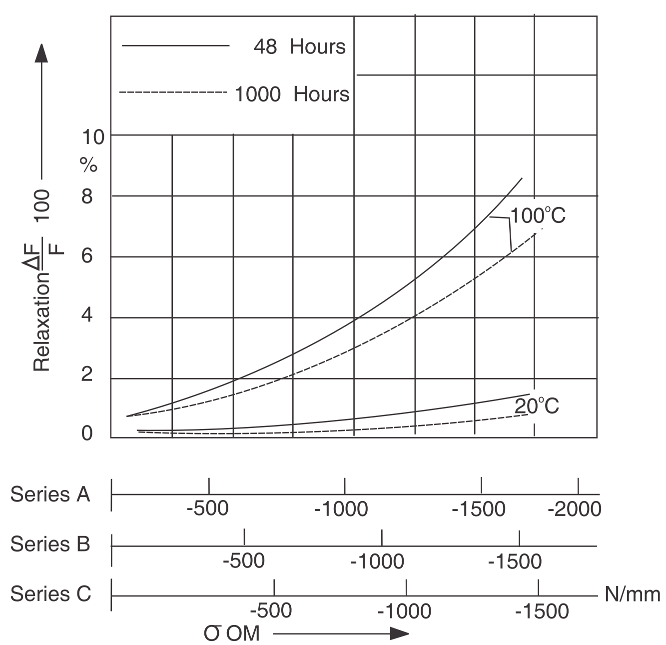


Disc Springs for use with Ball Bearings

Disc Springs are specially designed as preloading springs for use with radial ball bearings. They help maintain portioning accuracy of the bearing with no end play. They also minimize vibration and shaft deflection. Proper preloading will increase bearing rigidity and eliminate excessive running noise.

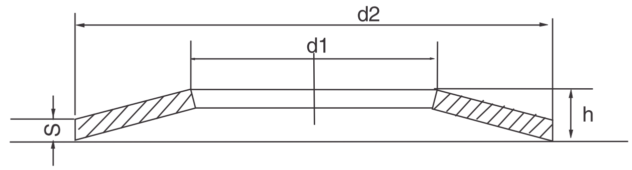
BALL BARING Ref. No.		METRIC						Deflection at F= .75ho	
		De	Di	t	h	Overall Ht. HO	h/t	P Load kg.	F Deflections mm
623		9.8	6.2	.20	.20	.40	1.00	2.5	.15
624		12.8	7.2	.25	.25	.50	1.00	3.1	.19
625	634	15.8	8.2	.25	.30	.55	1.20	2.4	.23
626	635	18.8	9.2	.30	.35	.65	1.17	3.3	.26
607		18.8	10.2	.35	.35	.70	1.00	5.3	.26
608	627	21.8	12.3	.35	.40	.75	1.14	4.8	.30
609		23.7	14.3	.40	.50	.90	1.25	8.4	.38
6000	629	25.7	14.3	.40	.50	.90	1.25	6.6	.38
6001		27.7	17.3	.40	.60	1.00	1.50	8.3	.45
6200		29.7	17.4	.40	.70	1.10	1.75	8.6	.53
6002	6201	31.7	20.4	.40	.70	1.10	1.75	8.4	.53
6300		34.6	20.4	.40	.70	1.10	1.75	6.4	.53
6003	6202	34.6	22.4	.50	.70	1.20	1.40	12.4	.53
6301		36.6	20.4	.50	.80	1.30	1.60	11.5	.60
6203		39.6	25.5	.50	.80	1.30	1.60	11.5	.60
6004	6302	41.6	25.5	.50	.90	1.40	1.80	11.8	.68
6005	6204 6303	46.5	30.5	.60	.91	1.50	1.52	16.0	.68
6205	6304	51.5	35.5	.60	.91	1.50	1.52	14.1	.68
6006		54.5	40.5	.60	.91	1.50	1.52	14.7	.68
6007	6206 6305	61.5	40.5	.70	1.10	1.80	1.57	18.3	.83
6008		67.5	50.5	.70	1.00	1.70	1.43	16.8	.75
6306		71.5	45.5	.70	1.40	2.10	2.00	19.3	1.05
6207		71.5	50.5	.70	1.41	2.10	2.01	22.8	1.05
6009		74.5	55.5	.80	1.11	1.90	1.39	22.0	.83
6307		79.5	50.5	.80	1.51	2.30	1.89	23.7	1.13
6010	6208	79.5	55.5	.80	1.51	2.30	1.89	27.5	1.13
6209		84.5	60.5	.90	1.61	2.50	1.79	37.4	1.21
6308		89.5	60.5	.90	1.61	2.50	1.79	34.9	1.20
6011	6210	89.5	65.5	.90	1.61	2.50	1.79	34.9	1.21
6012		94.5	75.5	1.00	1.21	2.20	1.21	33.9	.91
6309		99	65.5	1.00	1.60	2.60	1.60	30.4	1.20
6013	6211	99	70.5	1.00	1.60	2.60	1.61	34.6	1.21
6310		109	70.5	1.25	1.45	2.70	1.16	37.1	1.09

Permissible relaxation for Disc Springs of chrome vanadium - alloy steel as per DIN 17221, DIN 17222 & DIN 17224.



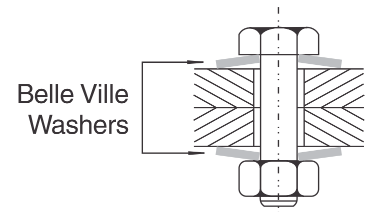
HEAVY DUTY BELLEVILLE WASHERS TO DIN 6796

BOLT SIZE MM	d1 H14	d2 h14	s	h max	h min	Approx Force to Flat N	Bolt Size Inches
2	2.2	5.0	0.4	0.60	0.50	628	
2.5	2.7	6.0	0.5	0.72	0.61	946	
3	3.2	7.0	0.6	0.85	0.72	1320	1/8
3.5	3.7	8.0	0.8	1.06	0.92	2410	
4	4.3	9.0	1.0	1.30	1.12	3770	5/32
5	5.3	11.0	1.2	1.55	1.35	5480	3/16
6	6.4	14.0	1.5	2.00	1.70	8590	1/4
7	7.4	17.0	1.75	2.30	2.00	11300	
8	8.4	18.0	2.0	2.60	2.24	14900	5/16
10	10.5	23.0	2.5	3.20	2.80	22100	3/8
12	13.0	29.0	3.0	3.95	3.43	34100	1/2
14	15.0	35.0	3.5	4.65	4.04	46000	
16	17.0	39.0	4.0	5.25	4.58	59700	5/8
18	19.0	42.0	4.5	5.80	5.08	74400	
20	21.0	45.0	5.0	6.40	5.60	93200	3/4
22	23.0	49.0	5.5	7.05	6.15	113700	7/8
24	25.0	56.0	6.0	7.75	6.77	131000	
27	28.0	60.0	6.5	8.35	7.30	154000	
30	31.0	70.0	7.0	9.20	8.00	172000	11/8



Belle ville washers / conical spring washers to Din 6796

Belleville Springs have been specifically designed for Heavy Bolted Sections such as Bus Bars, Transformers, Rectifiers, Heat Exchangers, Transmissions, etc. These springs are intended to counteract the effect of setting which results in bolt/nut assemblies working loose. They do not effectively prevent loosening of the assembly under varying radial load and are designed for use with short bolts predominantly subject to thrust.



Disc Spring Materials

Springs in accordance with this standard shall be made from high-grade steel with a modulus of elasticity, E of 206 000 N/mm as specified in either DIN 17221, DIN 17222 & DIN 17224. It being noted that Ck steel shall be only be used for the manufacture of group 1 Springs

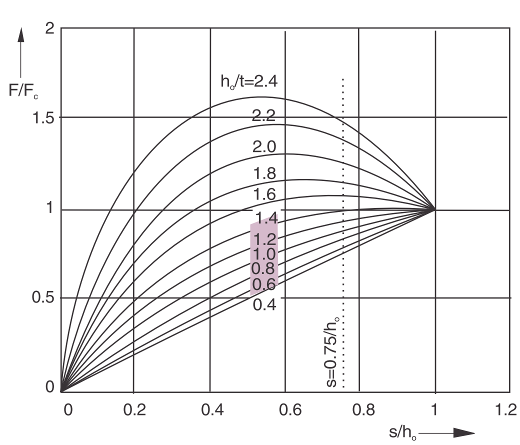
Material Grade	Din Ref No.	Chemical Composition C	Si	Mn	P	S	Cr	V	Ni	Mo
50.CrV4 (Chrome Vanadinum)	1.8159	0.47 to 0.55	0.15 to 0.40	0.70 to 1.10	0.035	0.035	0.90 to 1.20	0.10 to 0.20	-	-
51 CrMoV4	1.7701	0.48-0.56	0.15-0.40	0.70-1.10	0.035	0.035	0.90-1.20	0.07-0.12	-	0.15-0.25
EN42J	-	0.75-0.90	0.35	0.6-0.9	0.05	0.05	-	-	-	-
(X22 Cr MOV 121 (High Temp steel)	1.4923)	0.2	0.3	0.6	0.035	0.035	12.0	0.3	0.6	1.0
Wark Hardened Stainless steel AISI 304	-	0.08	1.0	2.0	0.045	0.03	18-20	-	8-12	-

We can also make Disc Springs from other high temperature material like Inconel X-718, Nimonic 90 etc

Load/ deflection characteristic curve of Disc Spring

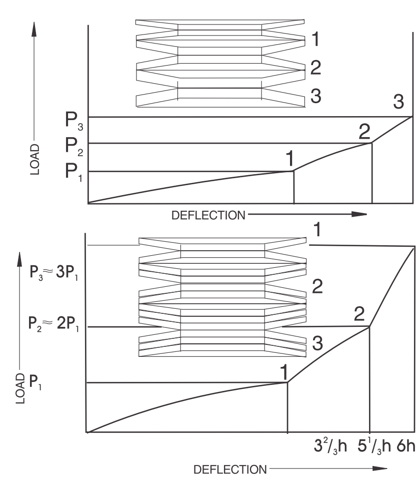
Depending upon the dimensions of the Disc Spring, it is possible to achieve load/ deflection characteristic curves which are nearly linear or strongly curved. The form of the Disc Spring characteristic curve is dependent upon the ratio h_o/t

Load / deflection characteristic curve with respect to h_o / t and s / h_o:



Disc Springs May be used Singly or in Combinations

Disc springs of differing thickness can be stacked in series to obtain a progressively rising load. This effect is also obtained using same thickness springs but incrementally increasing the units in the stack. Care must be taken not to over-stress the spring in the stack. Note : (Friction forces between springs must be considered.)



ISO 9001: 2008
BUREAU VERITAS
Certification

International Industrial Springs

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