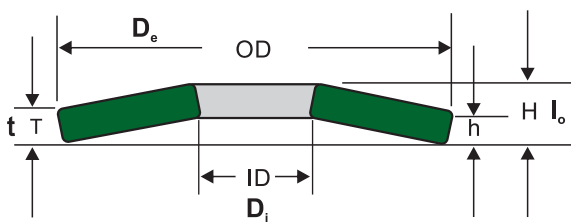


Belleville springs

Belleville springs, disc spring, conical compression washer are all names for the same type of spring.

Figure 1 : A Belleville spring is a conical shaped disc that will deflect (flatten) at a given rate. This spring rate is usually very high, allowing the spring to produce very large loads in very small space.

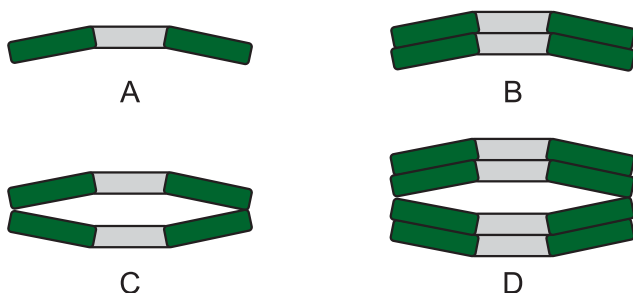
Belleville springs are used in variety of applications where high spring loads are required. They are particularly useful where vibration, differential thermal expansion, relaxation, and bolt creep are problems.



Belleville springs can be stacked in four different ways

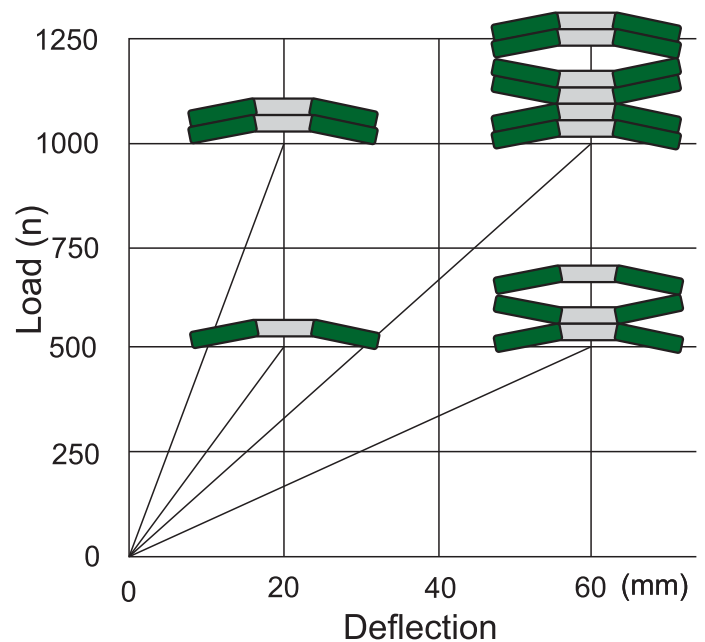
Figure 2:

- A. Single, one spring.
- B. Parallel, all springs stacked the same way.
- C. Series, all springs stacked opposing each other.
- D. Parallel-Series, a combination of the two



A single Belleville spring has a specific load and deflection. Belleville springs in stacked arrangements provide increased load and / or deflection. Two springs stacked in parallel double the load of single springs with no increase in deflection. Two springs stacked in series doubles the deflection of a single spring with no increase in load. The parallel - series combination results in the load of two springs and the deflection of two springs.

Figure 3 :



The load/deflection relationship can be altered by using multiple springs in series or parallel or a combination of both (Figure 3 : Bellevilles are said to be in series when the concave and convex surfaces alternate the direction they are facing [1]1. In other words, they are stacked "Cup to Cup" and "Crown to Crown". Springs staked in parallel face the same direction. The convex side of one spring is "nested" into the concave surface of the next. Bellevilles may also be arranged in "series-parallel" by alternating sets of springs stacked in parallel.

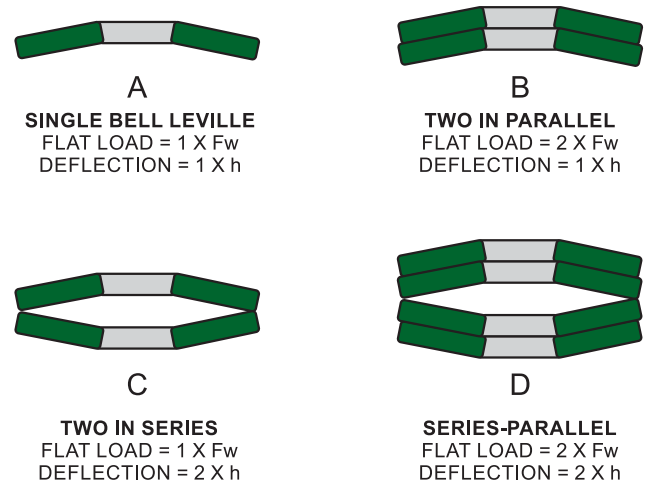


Figure 4 :

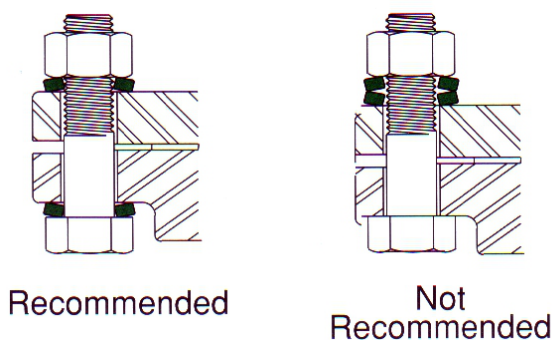
Flat load, deflection or both may be altered by stacking Belleville Springs in various arrangements.

Installation :

Belleville springs must be utilized correctly in order to maximize their benefit. There are several important points when using Belleville springs.

- A. Be sure that the bolts are long enough to account for the thickness of the Belleville.
- B. The OD of the spring should contact the surface of the joint. The ID should contact the bolt head or nut.
- C. If a tensioner is used to pre load the bolts, the Bellevilles must be on the opposite side of the joint.
- D. The OD of the flange washer should contact the flange joint and the ID of the flange washer should contact the bolt head or nut.

Figure 5 :



If the crown of the flange washer is allowed to extend into the hole, then its loading characteristics will be altered. The same is true for a nut that contacts the spring's bottom surface. Since deflections are relatively small, it can be difficult for the installer to see which side is up. Spring Matrix Disc Washers are chamfered at the top of the OD to help the installer to identify the springs top surface.

- E. If a tensioner is used to preload the bolts, then the flange washers must be on the opposite side of the joint.
- F. Flat washers are not normally required for the flange washer's bearing surface. Soft flange materials, such as aluminum, may warrant the use of hardened flat washers to prevent the Bellevilles from embedding in the material.
- G. If they are properly applied, flange washers may be reused. Since Belleville springs are highly stressed parts, they should not be reinstalled if corrosion pitting is observed on the surface. If cracking occurs, it may be necessary to specify a deferent material or coating.

Prestressing

Many Spring Matrix Belleville Springs are pre-stressed by deflecting them to flat. This flattening procedure produces a pre-stressed deflection as the spring recovers height from the flat position. Belleville Springs that are pre stressed have the maximum possible load and deflection for any given size of spring. When the spring is loaded through its pre-stressed deflection, the resultant residual stresses build up from the yield strength of the material instead of from zero stress as with the case of a spring that is not pre-stressed. Pre-stressing is also an excellent inspection method for maintaining the quality of springs. Because pre-stressing produces consistent free heights, springs not meeting free height tolerances are rejected.

Belleville Springs Catalog Tolerances :

Classification according to DIN 2093

Spring Matrix disc springs have been designed & manufactured according to DIN 2093 (Disc Springs, Calculation, Dimensions, Quality requirements). Standard DIN 2093 disc springs are classified into 3 groups.

Group 1 : Disc thickness, t , less than 1.25mm (Manufactured without contact surface).

Group 2 : Disc thickness, t , from 1.25mm to 6mm (Manufactured without contact surface).

Group 3 : Disc thickness, t , over 6mm up to 14mm (Manufactured without contact surface).

Typical Applications of Spring Matrix Belleville Springs :

Pole Line Hardware, Circuit Breakers, Valve Live Loading, Electrical Bus Bar, Substations, Pipe Hold Downs, Structural Members, Small Engines, Torque Limiters, Marine Applications, Coastal Substations, Switchgears, Pipe Flange Fittings, Heat Exchangers, Packing & Gasket Relaxation, Vibrations, High Temperature Bolt Creep, Differential Thermal Expansion, Clamping Tools, Piston Return, Slip Clutch Assembly, Cushioning, Energy Storage, Hydric Cylinders, Brakes, Spindles & etc.,

Spring Matrix Belleville / Disc Springs

Dimensions						Group	Characteristic Values							
							0.25h ₀		0.50h ₀		0.75h ₀		1.0h ₀	
							F (N)	s (mm)	F (N)	s (mm)	F (N)	s (mm)	F (N)	s (mm)
	6.0	3.2	0.30	0.45	-	1	45	0.038	84	0.075	117	0.110	153	0.150
	8.0	3.2	0.20	0.40	-	1	12	0.050	20	0.100	26	0.150	30	0.200
	8.0	3.2	0.30	0.55	-	1	46	0.063	79	0.125	105	0.190	126	0.250
	8.0	3.2	0.40	0.60	-	1	69	0.050	130	0.100	186	0.150	238	0.200
	8.0	3.2	0.50	0.70	-	1	128	0.050	246	0.100	357	0.150	465	0.200
C	8.0	4.2	0.20	0.45	-	1	21	0.063	33	0.125	39	0.190	42	0.250
B	8.0	4.2	0.30	0.55	-	1	52	0.063	89	0.125	119	0.190	142	0.250
A	8.0	4.2	0.40	0.60	-	1	78	0.050	147	0.100	210	0.150	269	0.200
	10.0	3.2	0.30	0.65	-	1	51	0.088	82	0.175	98	0.260	108	0.350
	10.0	3.2	0.40	0.70	-	1	75	0.075	133	0.150	182	0.230	220	0.300
	10.0	3.2	0.50	0.75	-	1	104	0.063	195	0.125	282	0.190	357	0.250
	10.0	4.2	0.40	0.70	-	1	79	0.075	140	0.150	192	0.230	232	0.300
	10.0	4.2	0.50	0.75	-	1	110	0.063	206	0.125	297	0.190	377	0.250
	10.0	4.2	0.60	0.85	-	1	175	0.060	360	0.125	508	0.190	652	0.250
C	10.0	5.2	0.25	0.55	-	1	30	0.075	48	0.150	58	0.230	63	0.300
B	10.0	5.2	0.40	0.70	-	1	88	0.075	155	0.150	213	0.230	257	0.300
A	10.0	5.2	0.50	0.75	-	1	122	0.063	228	0.125	329	0.190	418	0.250
	12.0	4.2	0.40	0.80	-	1	85	0.100	141	0.200	178	0.300	206	0.400
	12.0	4.2	0.50	0.85	-	1	116	0.088	208	0.175	282	0.260	352	0.350
	12.0	4.2	0.60	1.00	-	1	224	0.100	405	0.200	557	0.300	694	0.400
	12.0	5.2	0.50	0.90	-	1	150	0.100	263	0.200	350	0.300	424	0.400
	12.0	5.2	0.60	0.95	-	1	196	0.088	361	0.175	502	0.260	641	0.350
	12.0	6.2	0.50	0.85	-	1	134	0.088	239	0.175	324	0.260	404	0.350
	12.0	6.2	0.60	0.95	-	1	214	0.088	394	0.175	547	0.260	699	0.350
	12.5	5.2	0.50	0.85	-	1	111	0.088	200	0.175	270	0.260	337	0.350
C	12.5	6.2	0.35	0.80	-	1	84	0.113	130	0.225	152	0.340	160	0.450
B	12.5	6.2	0.50	0.85	-	1	120	0.088	215	0.175	291	0.260	363	0.350
A	12.5	6.2	0.70	1.00	-	1	239	0.075	457	0.150	673	0.230	855	0.300
C	14.0	7.2	0.35	0.80	-	1	68	0.113	106	0.225	123	0.340	131	0.450
B	14.0	7.2	0.50	0.90	-	1	120	0.100	210	0.200	279	0.300	338	0.400
A	14.0	7.2	0.80	1.10	-	1	284	0.075	547	0.150	813	0.230	1 040	0.300
	15.0	5.2	0.40	0.95	-	1	101	0.138	154	0.275	175	0.410	181	0.550
	15.0	5.2	0.50	1.00	-	1	133	0.125	221	0.250	280	0.380	321	0.500
	15.0	5.2	0.60	1.05	-	1	171	0.113	302	0.225	409	0.340	499	0.450
	15.0	5.2	0.70	1.10	-	1	214	0.100	395	0.200	555	0.300	704	0.400
	15.0	6.2	0.50	1.00	-	1	138	0.125	229	0.250	291	0.380	334	0.500
	15.0	6.2	0.60	1.05	-	1	178	0.113	314	0.225	426	0.340	519	0.450
	15.0	6.2	0.70	1.10	-	1	222	0.100	411	0.200	578	0.300	733	0.400
	15.0	8.2	0.70	1.10	-	1	256	0.100	474	0.200	666	0.300	844	0.400
	15.0	8.2	0.80	1.20	-	1	367	0.100	689	0.200	982	0.300	1 261	0.400
C	16.0	8.2	0.40	0.90	-	1	84	0.125	131	0.250	155	0.380	165	0.500
B	16.0	8.2	0.60	1.05	-	1	172	0.113	304	0.225	412	0.340	503	0.450
	16.0	8.2	0.70	1.15	-	1	254	0.113	461	0.225	641	0.340	798	0.450
	16.0	8.2	0.80	1.20	-	1	308	0.100	579	0.200	825	0.300	1 059	0.400
A	16.0	8.2	0.90	1.25	-	1	363	0.088	697	0.175	1 004	0.260	1 319	0.350

Spring Matrix Belleville / Disc Springs

Dimensions D _e (mm) D _i (mm) t (mm) l _o (mm) t' (mm)						Group	Characteristic Values							
							0.25h _o		0.50h _o		0.75h _o		1.0h _o	
							F (N)	s (mm)	F (N)	s (mm)	F (N)	s (mm)	F (N)	s (mm)
	18.0	6.2	0.40	1.00	-	1	85	0.150	126	0.300	139	0.450	137	0.600
	18.0	6.2	0.50	1.10	-	1	130	0.150	206	0.300	245	0.450	267	0.600
	18.0	6.2	0.60	1.20	-	1	191	0.150	317	0.300	400	0.450	462	0.600
	18.0	6.2	0.70	1.25	-	1	236	0.138	414	0.275	550	0.410	672	0.550
	18.0	6.2	0.80	1.30	-	1	286	0.125	523	0.250	733	0.380	912	0.500
	18.0	8.2	0.50	1.10	-	1	140	0.150	222	0.300	265	0.450	288	0.600
	18.0	8.2	0.70	1.25	-	1	255	0.138	446	0.275	594	0.410	725	0.550
	18.0	8.2	0.80	1.30	-	1	309	0.125	564	0.250	791	0.380	984	0.500
	18.0	8.2	1.00	1.40	-	1	425	0.100	814	0.200	1 181	0.300	1 537	0.400
C	18.0	9.2	0.45	1.05	-	1	121	0.150	186	0.300	214	0.450	223	0.600
B	18.0	9.2	0.70	1.20	-	1	233	0.125	417	0.250	572	0.380	699	0.500
A	18.0	9.2	1.00	1.40	-	1	451	0.100	865	0.200	1 254	0.300	1 631	0.400
	20.0	8.2	0.50	1.15	-	1	127	0.163	200	0.325	231	0.490	244	0.650
	20.0	8.2	0.60	1.30	-	1	214	0.175	342	0.350	413	0.530	453	0.700
	20.0	8.2	0.70	1.35	-	1	262	0.163	442	0.325	570	0.490	668	0.650
	20.0	8.2	0.80	1.40	-	1	315	0.150	557	0.300	751	0.450	921	0.600
	20.0	8.2	0.90	1.45	-	1	374	0.138	685	0.275	949	0.410	1 201	0.550
	20.0	8.2	1.00	1.55	-	1	494	0.138	917	0.275	1 288	0.410	1 648	0.550
	20.0	10.2	0.40	0.90	-	1	55	0.130	84	0.250	99	0.380	106	0.500
C	20.0	10.2	0.50	1.15	-	1	141	0.163	219	0.325	254	0.490	268	0.650
B	20.0	10.2	0.80	1.35	-	1	304	0.138	547	0.275	745	0.410	929	0.550
	20.0	10.2	0.90	1.45	-	1	412	0.138	754	0.275	1 045	0.410	1 323	0.550
	20.0	10.2	1.00	1.55	-	1	544	0.138	1 010	0.275	1 418	0.410	1 815	0.550
A	20.0	10.2	1.10	1.55	-	1	548	0.113	1 050	0.225	1 531	0.340	1 976	0.450
	20.0	10.2	1.25	1.75	-	1	890	0.125	1 708	0.250	2507	0.380	3 222	0.500
	20.0	10.2	1.50	1.80	-	2	857	0.075	1 695	0.150	2 576	0.230	3 340	0.300
C	22.5	11.2	0.60	1.40	-	1	240	0.200	370	0.400	425	0.600	444	0.800
B	22.5	11.2	0.80	1.45	-	1	306	0.163	533	0.325	710	0.490	855	0.650
A	22.5	11.2	1.25	1.75	-	2	693	0.125	1 330	0.250	1 952	0.380	2 509	0.500
	23.0	8.2	0.70	1.50	-	1	279	0.200	448	0.400	544	0.600	602	0.800
	23.0	8.2	0.80	1.55	-	1	332	0.188	560	0.375	717	0.560	842	0.750
	23.0	8.2	0.90	1.60	-	1	391	0.175	687	0.350	925	0.530	1 119	0.700
	23.0	8.2	1.00	1.70	-	1	507	0.175	909	0.350	1 249	0.530	1 536	0.700
	23.0	10.2	0.90	1.65	-	1	463	0.188	802	0.375	1 055	0.560	1 273	0.750
	23.0	10.2	1.00	1.70	-	1	538	0.175	964	0.350	1 325	0.530	1 629	0.700
	23.0	10.2	1.25	1.90	-	2	870	0.163	1 627	0.325	2 320	0.490	2 955	0.650
	23.0	12.2	1.00	1.60	-	1	475	0.150	872	0.300	1 217	0.450	1 536	0.600
	23.0	12.2	1.25	1.85	-	2	863	0.150	1 630	0.300	2 331	0.450	3 000	0.600
	23.0	12.2	1.50	2.00	-	2	1 159	0.125	2 250	0.250	3 338	0.380	4320	0.500
	25.0	10.2	1.00	1.75	-	1	492	0.188	870	0.375	1 168	0.560	1 436	0.750
C	25.0	12.2	0.70	1.60	-	1	331	0.225	515	0.450	601	0.680	635	0.900
B	25.0	12.2	0.90	1.60	-	1	367	0.175	644	0.350	868	0.530	1 050	0.700
	25.0	12.2	1.00	1.80	-	1	585	0.200	1 021	0.400	1 359	0.600	1 647	0.800
	25.0	12.2	1.25	1.95	-	2	848	0.175	1 573	0.350	2 232	0.530	2 814	0.700
A	25.0	12.2	1.50	2.05	-	2	1 040	0.138	2 007	0.275	2 910	0.410	3 821	0.550
	28.0	10.2	0.80	1.75	-	1	348	0.238	553	0.475	661	0.710	723	0.950
	28.0	10.2	1.00	1.90	-	1	512	0.225	872	0.450	1 135	0.680	1 337	0.900
	28.0	10.2	1.25	2.05	-	2	737	0.200	1 339	0.400	1 853	0.600	2 322	0.800
	28.0	10.2	1.50	2.20	-	2	1 003	0.175	1 899	0.350	2 745	0.530	3 511	0.700

Spring Matrix Belleville / Disc Springs

Dimensions D _e (mm)D _i (mm)t (mm)l _o (mm)t' (mm)						Group	Characteristic Values							
							0.25h _o		0.50h _o		0.75h _o		1.0h _o	
							F (N)	s (mm)	F (N)	s (mm)	F (N)	s (mm)	F (N)	s (mm)
	28.0	12.2	1.00	1.95	-	1	590	0.238	992	0.475	1 266	0.710	1 482	0.950
	28.0	12.2	1.25	2.10	-	2	844	0.213	1 519	0.425	2 089	0.640	2 590	0.850
	28.0	12.2	1.50	2.25	-	2	1 149	0.188	2 159	0.375	3 065	0.560	3 949	0.750
C	28.0	14.2	0.80	1.80	-	1	435	0.250	681	0.500	801	0.750	859	1.000
B	28.0	14.2	1.00	1.80	-	1	476	0.200	832	0.400	1 107	0.600	1 342	0.800
	28.0	14.2	1.25	2.10	-	2	907	0.213	1 634	0.425	2 246	0.640	2 785	0.850
A	28.0	14.2	1.50	2.15	-	2	1 033	0.163	1 970	0.325	2 854	0.490	3 680	0.650
	31.5	12.2	1.00	2.10	-	1	587	0.275	951	0.550	1 170	0.830	1 309	1.100
	31.5	12.2	1.25	2.20	-	2	761	0.238	1 343	0.475	1 800	0.710	2 207	0.950
	31.5	12.2	1.50	2.35	-	2	1 033	0.213	1 912	0.425	2 697	0.640	3 413	0.850
C	31.5	16.3	0.80	1.85	-	1	384	0.263	594	0.525	687	0.790	722	1.050
B	31.5	16.3	1.25	2.15	-	2	791	0.225	1 409	0.450	1 923	0.680	2 359	0.900
	31.5	16.3	1.50	2.40	-	2	1 260	0.225	2 314	0.450	3 249	0.680	4 077	0.900
A	31.5	16.3	1.75	2.45	-	2	1 391	0.175	2 669	0.350	3 905	0.530	5 036	0.700
	31.5	16.3	2.00	2.75	-	2	2 199	0.188	4 239	0.375	6 148	0.560	8 054	0.750
	34.0	12.3	1.00	2.25	-	1	637	0.313	998	0.625	1 175	0.940	1 258	1.250
	34.0	12.3	1.25	2.35	-	2	815	0.275	1 395	0.550	1 825	0.830	2 162	1.100
	34.0	12.3	1.50	2.50	-	2	1 097	0.250	1 982	0.500	2 725	0.750	3 397	1.000
	34.0	14.3	1.25	2.40	-	2	913	0.288	1 546	0.575	1 990	0.860	2 347	1.150
	34.0	14.3	1.50	2.55	-	2	1 224	0.263	2 192	0.525	2 997	0.790	3 704	1.050
	34.0	16.3	1.50	2.55	-	2	1 291	0.263	2 313	0.525	3 163	0.790	3 908	1.050
	34.0	16.3	2.00	2.85	-	2	2 097	0.213	4 003	0.425	5 803	0.640	7 498	0.850
C	35.5	18.3	0.90	2.05	-	1	458	0.288	712	0.575	831	0.860	884	1.150
B	35.5	18.3	1.25	2.25	-	2	731	0.250	1 277	0.500	1 699	0.750	2 059	1.000
A	35.5	18.3	2.00	2.80	-	2	1 864	0.200	3 576	0.400	5 187	0.600	6 747	0.800
	40.0	14.3	1.25	2.65	-	2	904	0.350	1 459	0.700	1 780	1.050	1 984	1.400
	40.0	14.3	1.50	2.75	-	2	1 114	0.313	1 929	0.625	2 550	0.940	3 061	1.250
	40.0	14.3	2.00	3.05	-	2	1 800	0.263	3 363	0.525	4 781	0.790	6 096	1.050
	40.0	16.3	1.50	2.80	-	2	1 224	0.325	2 102	0.650	2 758	0.980	3 281	1.300
	40.0	16.3	2.00	3.10	-	2	1 972	0.275	3 663	0.550	5 195	0.830	6 580	1.100
	40.0	18.3	2.00	3.15	-	2	2 182	0.288	4 030	0.575	5 642	0.860	7 171	1.150
C	40.0	20.4	1.00	2.30	-	1	565	0.325	876	0.650	1 018	0.980	1 072	1.300
B	40.0	20.4	1.50	2.65	-	2	1 109	0.288	1 953	0.575	2 616	0.860	3 201	1.150
	40.0	20.4	2.00	3.10	-	2	2 175	0.275	4 041	0.550	5 730	0.830	7 258	1.100
A	40.0	20.4	2.25	3.15	-	2	2 336	0.225	4 481	0.450	6 544	0.680	8 456	0.900
	40.0	20.4	2.50	3.45	-	2	3 351	0.238	6 453	0.475	9 359	0.710	12 243	0.950
C	45.0	22.4	1.25	2.85	-	2	1 041	0.400	1 620	0.800	1 891	1.200	2 007	1.600
B	45.0	22.4	1.75	3.05	-	2	1 524	0.325	2 701	0.650	3 659	0.980	4 475	1.300
A	45.0	22.4	2.50	3.50	-	2	2 773	0.250	5 320	0.500	7 716	0.750	10 037	1.000
	50.0	18.4	1.25	2.85	-	2	757	0.400	1 178	0.800	1 375	1.200	1 459	1.600
	50.0	18.4	1.50	3.30	-	2	1 379	0.450	2 184	0.900	2 606	1.350	2 837	1.800
	50.0	18.4	2.00	3.50	-	2	1 918	0.375	3 392	0.750	4 586	1.130	5 603	1.500
	50.0	18.4	2.50	4.10	-	2	3 703	0.400	6 733	0.800	9 315	1.200	11 673	1.600
	50.0	18.4	3.00	4.40	-	2	5 043	0.350	9 546	0.700	13 688	1.050	17 650	1.400
	50.0	20.4	2.00	3.50	-	2	1 966	0.375	3 478	0.750	4 702	1.130	5 745	1.500
	50.0	20.4	2.50	3.85	-	2	3 008	0.338	5 601	0.675	7 902	1.010	10 098	1.350
	50.0	22.4	2.00	3.60	-	2	2 247	0.400	3 924	0.800	5 222	1.200	6 329	1.600
	50.0	22.4	2.50	3.90	-	2	3 261	0.350	6 044	0.700	8 510	1.050	10 817	1.400

Spring Matrix Belleville / Disc Springs

Dimensions D _e (mm) D _i (mm) t (mm) l _o (mm) t' (mm)						Group	Characteristic Values							
							0.25h _o		0.50h _o		0.75h _o		1.0h _o	
							F (N)	s (mm)	F (N)	s (mm)	F (N)	s (mm)	F (N)	s (mm)
C	50.0	25.4	1.25	2.85	-	2	854	0.400	1 328	0.800	1 550	1.200	1 646	1.600
	50.0	25.4	1.50	3.10	-	2	1 242	0.400	2 028	0.800	2 512	1.200	2 844	1.600
B	50.0	25.4	2.00	3.40	-	2	1 949	0.350	3 491	0.700	4 762	1.050	5 898	1.400
	50.0	25.4	2.25	3.75	-	2	2 940	0.380	5 249	0.750	7 241	1.130	8 997	1.500
A	50.0	25.4	2.50	3.90	-	2	3 473	0.350	6 437	0.700	9 063	1.050	11 519	1.400
	50.0	25.4	3.00	4.10	-	2	4 255	0.275	8 214	0.550	12 044	0.830	15 640	1.100
C	56.0	28.5	1.50	3.45	-	2	1 458	0.488	2 259	0.975	2 621	1.460	2 766	1.950
B	56.0	28.5	2.00	3.60	-	2	1 910	0.400	3 335	0.800	4 438	1.200	5 379	1.600
	56.0	28.5	2.50	4.20	-	2	3 676	0.430	6 550	0.850	9 004	1.280	11 160	1.700
A	56.0	28.5	3.00	4.30	-	2	4 142	0.325	7 895	0.650	11 441	0.980	14 752	1.300
	60.0	20.5	2.00	4.10	-	2	2 318	0.525	3 802	1.050	4 737	1.580	5 380	2.100
	60.0	20.5	2.50	4.30	-	2	3 018	0.450	5 379	0.900	7 302	1.350	9 006	1.800
	60.0	20.5	3.00	4.70	-	2	4 449	0.425	8 234	0.850	11 615	1.280	14 698	1.700
	60.0	25.5	2.50	4.40	-	2	3 447	0.475	6 081	0.950	8 195	1.430	9 997	1.900
	60.0	25.5	3.00	4.65	-	2	4 495	0.413	8 352	0.825	11 803	1.240	15 002	1.650
	60.0	30.5	2.50	4.30	-	2	3 447	0.450	6145	0.900	8 342	1.350	10 289	1.800
	60.0	30.5	2.75	4.75	-	2	5 125	0.500	9 117	1.000	12 360	1.500	11 430	2.000
	60.0	30.5	3.00	4.70	-	2	5 083	0.425	9 407	0.850	13 269	1.280	16 792	1.700
	60.0	30.5	3.50	5.00	-	2	6 591	0.375	12 574	0.750	18 225	1.130	23 528	1.500
C	63.0	31.0	1.80	4.15	-	2	2 364	0.588	3 658	1.175	4 237	1.760	4 463	2.350
B	63.0	31.0	2.50	4.25	-	2	2 942	0.438	5 270	0.875	7 179	1.310	8 904	1.750
	63.0	31.0	3.00	4.80	-	2	4 891	0.450	8 981	0.900	12 536	1.350	15 825	1.800
A	63.0	31.0	3.50	4.90	-	2	5 399	0.350	10 359	0.700	15 025	1.050	19 545	1.400
	70.0	25.5	2.00	4.50	-	2	2 408	0.625	3 771	1.250	4 441	1.880	4 755	2.500
	70.0	30.5	2.50	4.90	-	2	3 755	0.600	6 297	1.200	8 031	1.800	9 360	2.400
	70.0	30.5	3.00	5.10	-	2	4 676	0.525	8 376	1.050	11 453	1.580	14 152	2.100
	70.0	35.5	3.00	5.10	-	2	5 028	0.525	9 007	1.050	12 316	1.580	15 218	2.100
	70.0	35.5	3.50	5.30	-	2	6 077	0.450	11 380	0.900	16 180	1.350	20 710	1.800
	70.0	35.5	4.00	5.80	-	2	8 757	0.450	16 634	0.900	23 923	1.350	30 919	1.800
	* 70.0	35.5	4.00	5.80	3.75	3	9 167	0.450	17 020	0.900	23 920	1.350	30 250	1.800
	70.0	40.5	4.00	5.60	-	2	8 391	0.400	16 099	0.800	23 351	1.200	30 376	1.600
	* 70.0	40.5	4.00	5.60	3.75	3	8 739	0.400	16 430	0.800	23 350	1.200	29 810	1.600
	70.0	40.5	5.00	6.20	-	2	11 544	0.300	22 728	0.600	33 672	0.900	44 495	1.200
	* 70.0	40.5	5.00	6.20	4.60	3	11 900	0.300	23 070	0.600	33 672	0.900	43 880	1.200
C	71.0	36.0	2.00	4.60	-	2	2 861	0.650	4 432	1.300	5 144	1.950	5 426	2.600
B	71.0	36.0	2.50	4.50	-	2	2 894	0.500	5 054	1.000	6 725	1.500	8 152	2.000
A	71.0	36.0	4.00	5.60	-	2	7 379	0.400	14 157	0.800	20 535	1.200	26 712	1.600
*	71.0	36.0	4.00	5.60	3.75	3	7 685	0.400	14 440	0.800	20 530	1.200	26 210	1.600
	80.0	31.0	2.50	5.30	-	2	3 678	0.700	5 933	1.400	7 239	2.100	8 070	2.800
	80.0	31.0	3.00	5.50	-	2	4 531	0.625	7 847	1.250	10 369	1.880	12 451	2.500
	80.0	31.0	4.00	6.10	-	2	7 319	0.525	13 677	1.050	19 447	1.580	24 791	2.100
	* 80.0	31.0	4.00	6.10	3.75	3	7 783	0.525	14 050	1.050	19 440	1.580	24 150	2.100
	80.0	36.0	3.00	5.70	-	2	5 401	0.675	9 196	1.350	11 936	2.030	14 106	2.700
	80.0	36.0	4.00	6.20	-	2	8 163	0.550	15 168	1.100	21 400	1.650	27 245	2.200
*	80.0	36.0	4.00	6.20	3.75	3	8 626	0.550	15 600	1.100	21 400	1.650	26 500	2.200
C	80.0	41.0	2.25	5.20	-	2	3 698	0.738	5 715	1.475	6 611	2.210	6 950	2.950
B	80.0	41.0	3.00	5.30	-	2	4 450	0.575	7 838	1.150	10 539	1.730	12 844	2.300
	80.0	41.0	4.00	6.20	-	2	8 726	0.550	16 213	1.100	22 874	1.650	29 122	2.200
*	80.0	41.0	4.00	6.20	3.75	3	9 220	0.550	16 670	1.100	22 874	1.650	28 330	2.200
A	80.0	41.0	5.00	6.70	-	2	11 821	0.425	22 928	0.850	33 682	1.280	43 952	1.700
*	80.0	41.0	5.00	6.70	4.70	3	12 350	0.425	23 300	0.850	33 682	1.280	43 300	1.700

Spring Matrix Belleville / Disc Springs

						Group	Characteristic Values							
							0.25h ₀		0.50h ₀		0.75h ₀		1.0h ₀	
							D _e (mm)	D _i (mm)	t (mm)	l ₀ (mm)	t' (mm)	F (N)	s (mm)	F (N)
C	90.0	46.0	2.50	5.70	-	2	4 232	0.800	6 585	1.600	7 684	2.400	8 157	3.200
B	90.0	46.0	3.50	6.00	-	2	5 836	0.625	10 416	1.250	14 189	1.880	17 487	2.500
A	90.0	46.0	5.00	7.00	-	2	11 267	0.500	21 617	1.000	31 354	1.500	40 786	2.000
*	90.0	46.0	5.00	7.00	4.70	3	11 710	0.500	22 040	1.000	31 354	1.500	40 060	2.000
	100.0	41.0	4.00	7.20	-	2	8 714	0.800	15 219	1.600	20 251	2.400	24 547	3.200
*	100.0	41.0	4.00	7.20	3.75	3	9 345	0.800	15 800	1.600	20 251	2.400	23 550	3.200
	100.0	41.0	5.00	7.75	-	2	12 345	0.688	22 937	1.375	32 328	2.060	41 201	2.750
*	100.0	41.0	5.00	7.75	4.75	3	12 940	0.688	23 520	1.375	32 328	2.060	40 330	2.750
C	100.0	51.0	2.70	6.20	-	2	4 779	0.875	7 410	1.750	8 613	2.630	9 091	3.500
B	100.0	51.0	3.50	6.30	-	2	5 624	0.700	9 823	1.400	13 070	2.100	15 843	2.800
	100.0	51.0	4.00	7.00	-	2	8 673	0.750	15 341	1.500	20 674	2.250	25 338	3.000
*	100.0	51.0	4.00	7.00	3.75	3	9 282	0.750	15 910	1.500	20 674	2.250	24 380	3.000
	100.0	51.0	5.00	7.80	-	2	13 924	0.700	25 810	1.400	36 339	2.100	46 189	2.800
*	100.0	51.0	5.00	7.80	4.75	3	14 550	0.700	26 400	1.400	36 340	2.100	45 190	2.800
A	100.0	51.0	6.00	8.20	-	2	17 061	0.550	32 937	1.100	48 022	1.650	62 711	2.200
*	100.0	51.0	6.00	8.20	5.60	3	17 750	0.550	33 590	1.100	48 020	1.650	61 570	2.200
C	112.0	57.0	3.00	6.90	-	2	5 834	0.975	9 038	1.950	10 493	2.930	11 064	3.900
B	112.0	57.0	4.00	7.20	-	2	7 639	0.800	13 341	1.600	17 752	2.400	21 518	3.200
*	112.0	57.0	4.00	7.20	3.75	3	8 192	0.800	13 850	1.600	17 752	2.400	20 650	3.200
A	112.0	57.0	6.00	8.50	-	2	15 800	0.625	30 215	1.250	43 812	1.880	56 737	2.500
*	112.0	57.0	6.00	8.50	5.60	3	16 660	0.625	30 910	1.250	43 800	1.880	55 530	2.500
	125.0	41.0	4.00	8.20	-	2	8 501	1.050	13 943	2.100	17 346	3.150	19 729	4.200
*	125.0	41.0	4.00	8.20	3.75	3	9 146	1.050	14 540	2.100	17 350	3.150	18 720	4.200
	125.0	51.0	4.00	8.50	-	2	10 096	1.125	16 265	2.250	19 829	3.380	22 060	4.500
*	125.0	51.0	4.00	8.50	3.75	3	10 890	1.125	16 970	2.250	19 820	3.380	20 870	4.500
	125.0	51.0	5.00	8.90	-	2	13 063	0.975	22 931	1.950	30 705	2.930	37 342	3.900
*	125.0	51.0	5.00	8.90	4.70	3	14 020	0.975	23 760	1.950	30 700	2.930	35 930	3.900
	125.0	51.0	6.00	9.40	-	2	17 027	0.850	31 514	1.700	44 307	2.550	56 254	3.400
*	125.0	51.0	6.00	9.40	5.60	3	18 090	0.850	32 500	1.700	44 310	2.550	54 550	3.400
	125.0	61.0	5.00	9.00	-	2	14 615	1.000	25 526	2.000	33 965	3.000	41 170	4.000
*	125.0	61.0	5.00	9.00	4.70	3	15 630	1.000	26 470	2.000	33 965	3.000	39 580	4.000
	125.0	61.0	6.00	9.60	-	2	19 789	0.900	36 336	1.800	50 722	2.700	64 028	3.600
*	125.0	61.0	6.00	9.60	5.60	3	21 080	0.900	37 540	1.800	50 720	2.700	61 970	3.600
	125.0	61.0	8.00	10.90	7.50	3	34 434	0.725	65 305	1.450	93 765	2.180	120 218	2.900
C	125.0	64.0	3.50	8.00	-	2	8 514	1.125	13 231	2.250	15 422	3.380	16 335	4.500
B	125.0	64.0	5.00	8.50	-	2	12 238	0.875	21 924	1.750	29 950	2.630	37 041	3.500
*	125.0	64.0	5.00	8.50	4.70	3	13 090	0.875	22 660	1.750	29 940	2.630	35 790	3.500
	125.0	64.0	6.00	9.60	-	2	20 350	0.900	37 360	1.800	52 150	2.700	65 840	3.600
*	125.0	64.0	6.00	9.60	5.60	3	21 670	0.900	38 600	1.800	52 150	2.700	63 720	3.600
	125.0	64.0	7.00	10.00	6.55	3	25 530	0.750	47 610	1.500	67 220	2.250	85 290	3.000
A	125.0	64.0	8.00	10.60	7.50	3	31 118	0.650	59 520	1.300	85 926	1.950	111 056	2.600
	125.0	71.0	6.00	9.30	-	2	19 538	0.825	36 302	1.650	51 304	2.480	65 207	3.300
*	125.0	71.0	6.00	9.30	5.60	3	20 840	0.830	37 410	1.650	51 290	2.480	63 300	3.300
	125.0	71.0	8.00	10.40	7.40	3	30 867	0.600	59 149	1.200	85 494	1.800	110 547	2.400
	125.0	71.0	10.00	11.80	9.20	3	42 963	0.450	84 219	0.900	124 124	1.350	163 035	1.800
C	140.0	72.0	3.80	8.70	-	2	9 514	1.225	14 773	2.450	17 201	3.680	18 199	4.900
**	140.0	72.0	3.80	8.70	3.80	3	11 390	1.225	17 350	2.450	19 780	3.680	20 420	4.900
B	140.0	72.0	5.00	9.00	-	2	12 014	1.000	20 982	2.000	27 920	3.000	33 843	4.000
*	140.0	72.0	5.00	9.00	4.70	3	12 850	1.000	21 760	2.000	27 920	3.000	32 530	4.000
A	140.0	72.0	8.00	11.20	7.50	3	31 903	0.800	59 967	1.600	85 251	2.400	108 813	3.200

Spring Matrix Belleville / Disc Springs

Dimensions D _e (mm) D _i (mm) t (mm) l ₀ (mm) t' (mm)						Group	Characteristic Values							
							0.25h ₀		0.50h ₀		0.75h ₀		1.0h ₀	
							F (N)	s (mm)	F (N)	s (mm)	F (N)	s (mm)	F (N)	s (mm)
*	150.0	61.0	5.00	10.30	-	2	15 292	1.325	25 021	2.650	31 059	3.980	35 207	5.300
	150.0	61.0	5.00	10.30	4.80	3	16 080	1.325	25 710	2.650	31 059	3.980	34 050	5.300
	150.0	61.0	6.00	10.80	-	2	19 560	1.200	34 161	2.400	45 456	3.600	55 098	4.800
*	150.0	61.0	6.00	10.80	5.80	3	20 300	1.200	34 850	2.400	45 456	3.600	53 950	4.800
	150.0	71.0	6.00	10.80	-	2	20 721	1.200	36 189	2.400	48 155	3.600	58 370	4.800
	150.0	71.0	6.00	10.80	5.65	3	22 120	1.200	37 490	2.400	48 155	3.600	56 180	4.800
	150.0	71.0	8.00	12.00	7.50	3	35 296	1.000	64 684	2.000	89 851	3.000	112 487	4.000
	150.0	81.0	8.00	11.70	7.50	3	34 518	0.925	63 876	1.850	89 663	2.780	112 942	3.700
	150.0	81.0	10.00	13.00	9.30	3	50 088	0.750	96 120	1.500	139 128	2.250	180 141	3.000
C **	160.0	82.0	4.30	9.90	-	2	12 162	1.400	18 832	2.800	21 843	4.200	23 022	5.600
	160.0	82.0	4.30	9.90	4.30	3	14 510	1.400	22 120	2.800	25 120	4.200	25 820	5.600
	B 160.0	82.0	6.00	10.50	-	2	17 203	1.125	30 431	2.250	41 051	3.380	50 260	4.500
*	160.0	82.0	6.00	10.50	5.60	3	18 570	1.125	31 630	2.250	41 040	3.380	48 220	4.500
A	160.0	82.0	10.00	13.50	9.40	3	50 547	0.875	96 216	1.750	138 564	2.630	178 214	3.500
C **	180.0	92.0	4.80	11.00	-	2	14 646	1.550	22 731	3.100	26 442	4.650	27 966	6.200
	180.0	92.0	4.80	11.00	4.80	3	17 480	1.550	26 690	3.100	30 410	4.650	31 370	6.200
	B 180.0	92.0	6.00	11.10	-	2	16 558	1.275	28 552	2.550	37 533	3.830	44 930	5.100
*	180.0	92.0	6.00	11.10	5.60	3	17 920	1.275	29 770	2.550	37 530	3.830	42 870	5.100
A	180.0	92.0	10.00	14.00	9.40	3	46 850	1.000	88 141	2.000	125 417	3.000	160 223	4.000
	180.0	92.0	13.00	16.50	12.10	3	85 040	0.880	163 400	1.750	238 300	2.630	309 500	3.500
	200.0	82.0	8.00	14.20	7.60	3	35 029	1.550	60 013	3.100	78 034	4.650	92 176	6.200
	200.0	82.0	10.00	15.50	9.60	3	51 105	1.375	93 357	2.750	129 569	4.130	162 061	5.500
	200.0	82.0	12.00	16.60	11.50	3	66 924	1.150	127 191	2.300	182 737	3.450	235 503	4.600
	200.0	92.0	10.00	15.60	9.50	3	55 136	1.400	100 014	2.800	137 688	4.200	171 214	5.600
	200.0	92.0	12.00	16.80	11.40	3	73 913	1.200	139 548	2.400	199 269	3.600	255 443	4.800
	200.0	92.0	14.00	18.10	13.10	3	95 633	1.025	184 092	2.050	267 623	3.080	346 888	4.100
C **	200.0	102.0	5.50	12.50	-	2	19 817	1.750	30 882	3.500	36 111	5.250	38 423	7.000
	200.0	102.0	5.50	12.50	5.50	3	23 640	1.750	36 260	3.500	41 530	5.250	43 120	7.000
	B 200.0	102.0	8.00	13.60	7.50	3	33 367	1.400	57 955	2.800	76 378	4.200	91 252	5.600
	200.0	102.0	10.00	15.60	9.40	3	58 757	1.400	106 099	2.800	145 357	4.200	179 858	5.600
A	200.0	102.0	12.00	16.20	11.25	3	66 983	1.050	127 401	2.100	183 020	3.150	235 610	4.200
	200.0	102.0	14.00	18.20	13.10	3	103 781	1.050	199 476	2.100	289 181	3.150	374 993	4.200
	200.0	112.0	12.00	16.20	11.10	3	72 257	1.050	136 873	2.100	195 830	3.150	251 108	4.200
	200.0	112.0	14.00	17.50	12.90	3	91 033	0.875	176 156	1.750	257 208	2.630	334 227	3.500
	200.0	112.0	16.00	18.80	14.80	3	105 268	0.700	206 697	1.400	305 100	2.100	401 294	2.800
** C B A	225.0	112.0	6.00	13.60	6.00	3	25 820	1.900	39 660	3.800	45 500	5.700	47 340	7.600
	225.0	112.0	6.50	13.60	6.20	3	23 582	1.775	37 417	3.550	44 594	5.330	48 147	7.100
	225.0	112.0	8.00	14.50	7.50	3	32 870	1.625	55 412	3.250	70 788	4.880	82 002	6.500
	225.0	112.0	12.00	17.00	11.25	3	64 497	1.250	120 738	2.500	171 016	3.750	217 625	5.000
	225.0	112.0	16.00	20.50	15.00	3	128 500	1.130	247 100	2.250	360 100	3.380	467 800	4.500
	250.0	102.0	10.00	18.00	9.60	3	56 867	2.000	97 282	4.000	126 387	6.000	149 323	8.000
	250.0	102.0	12.00	19.00	11.50	3	73 563	1.750	133 130	3.500	182 962	5.250	227 317	7.000
** C B A	250.0	127.0	6.50	14.80	6.50	3	29 700	2.080	45 420	4.150	51 970	6.230	53 880	8.300
	250.0	127.0	7.00	14.80	6.70	3	26 895	1.950	42 527	3.900	50 466	5.850	54 284	7.800
	250.0	127.0	10.00	17.00	9.40	3	51 871	1.750	90 206	3.500	119 053	5.250	142 462	7.000
	250.0	127.0	12.00	19.30	11.25	3	87 633	1.825	156 021	3.650	210 942	5.480	257 630	7.300
A	250.0	127.0	14.00	19.60	13.10	3	93 239	1.400	175 145	2.800	248 828	4.200	317 399	5.600
	250.0	127.0	16.00	21.80	15.00	3	140 941	1.450	267 295	2.900	383 017	4.350	492 058	5.800