IWATA DENKO

## (1) Characteristics 特征

1. If the stored energy for a unit volume of BELLEVILLE SPRINGS is compared to an equal volume of coil-less springs, it will be found to be significantly greater. Thus, although coned disc springs fit into a small space and have a small stroke, they possess a relatively large load capacity.
2. BELLEVILLE SPRINGS have load/deflection curves that have either linear or non-linear characteristics and these cone disc springs can be selected to fit many different requirements as related to different specific uses.
3. The spring characteristics can be varied, as necessary, by Increasing or decreasing the number of layers of discs and using discs in series or parallel configurations, in various combinations.
4. If they are used properly, the range of possible uses is very broad and they will perform effectively to achieve many different objectives.
5. If they are used within their permissible stress ranges, they can endure long periods of continuous use.
6. They are very effective for absorbing shock loads and when they used in multiple-disc stacks, their ability to dampen shocks effectively is very high.

1. 蝶簧的单位体积所储存的能量比圆柱弹簧要大得多，具有在很小的空间，很小压缩量的情况下获得很大负荷的能力。
2. 负荷 / 压缩量的特性曲线对使用条件为线性，特别是对非线性使用条件的情况，可以有效地选择。
3. 通过片数的增减、垂直排列、并列等组合方式的变化，可以改变弹簧特性。
4. 使用方法适当的话，适用范围广泛、而且功能多，效率高。
5. 在许用应力范围内使用的话，可以获得很长的使用寿命。
6. 具有很强的缓冲能力，尤其是重叠的状态的缓冲效果更好。

## (2) Load tolerances 负荷公差

Computed values for the load tolerances of BELLEVILLE SPRINGS are indicated in the table in Figure 1. The values for BELLEVILLE SPRINGS exceeding 1mm in thickness are greater than those for BELLEVILLE SPRINGS less than 1mm in thickness.

实际负荷值与计算值的偏差如附表 1 所示。板厚小于 1mm 蝶簧的负荷公差比板厚大于 1mm 的公差要大。

| Thickness ( t ) ranges : 板厚 t 的范围 | Clearances for load P where f = 0.75h f = 0.75h 的负荷 P 的公差 |
|---|---|
| 0.3mm ～至 0.9mm | + 25% − 7.5% |
| 1.0mm ～至 3.5mm | + 15% − 7.5% |
| 4.0mm ～至 16 mm | + 5% − 5% |

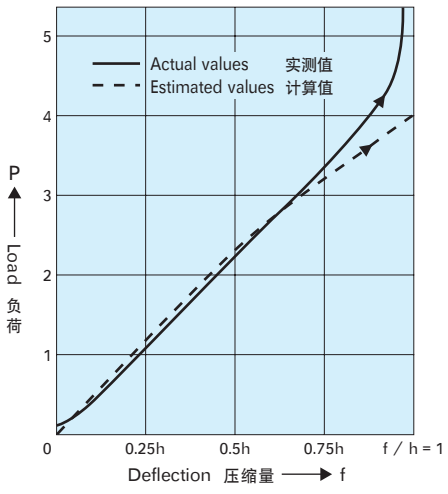
Appendix : Table 1 附表 1

## (3) Permissible stress 许用应力

### Uses involving static loads 静负荷使用时

The BELLEVILLE SPRINGS that are included in the Standards Table, presuming that the rated load does not fluctuate, can be used up to the deflection (f) indicated. The characteristic curve, as indicated in the graph in Figure 2, when used in situations where f = 0.75h>, indicates load/deflection curve values are directly proportional and are close to the calculated values. However, when f = 0.75h<, as the value approaches f = h the curve changes and actual values significantly exceed the calculated values.

该规格表中所记载的蝶簧在负荷不变的使用条件下，变形量 f 可以使用到 h。负荷特性如附表 2 所示，当使用变形量 f 小于 0.75h 时，负荷与变形量成比例，且与计算值很相近。当使用变形量 f 从 0.75h 到接近 h 时，实际负荷逐渐严重偏离计算值，为上升曲线。




Appendix : Table 2 附表 2

### Uses involving dynamic loads 动负荷使用时

Compared to static loads, when BELLEVILLE SPRINGS are used in situations involving dynamic loads, the length of their stress life becomes an important question and the frequency of such problems as spring damage and the fatigue life come to be greatly influenced by such factors as the qualities of the materials used, the heat treatment methods and the processing technology, and also by the scale of the stress caused by the deflection range and differences in the number of repetitive deflection cycles. In the case of dynamic loads, if the maximum permissible deflection has been is set at = 0.75h > and, for the preliminary stage deflection in order to stabilize the small shifts of the upper inside diameter edge of the Belleville spring that is subject to the maximum compressive stress, at a minimum, when f = 0.15h <, in other words, when d 1 = −60kg/mm2 <, preloading must be used. The objective of using preloaded springs is to stabilize the load and to eliminate cracks in the upper inside diameter edge. As an example, when the permissible range of the deflection is determined and the range in the number of repetitive deflection cycles is assumed to be 2 million cycles or less, the repetitive cycle stress life is as shown in the above Table. When the plate thickness is from 1mm < to over 4mm >, the total working deflection can be estimated to fall between the values indicated in the Table. If a repetitive deflection cycle life of less than 100,000 cycles is acceptable for a given application, the total working deflection is can be calculated for 1mm < at 12% and for 4mm = at 6%, using the table above.

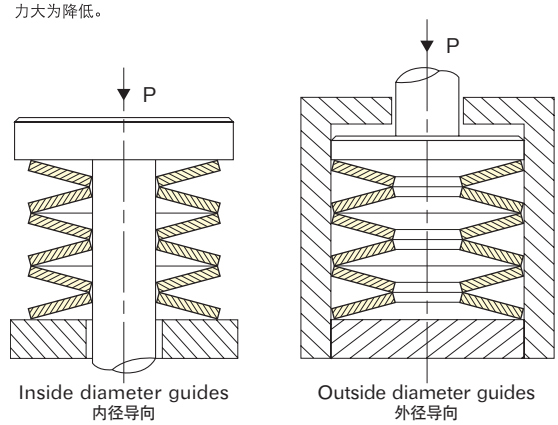
| BELLEVILLE SPRING first-stage deflection options 蝶簧的任意预压缩量 | More than 1mm in thickness 板厚小于 1mm | Less than 4mm in thickness 板厚大于 4mm |
|---|---|---|
| When first-stage deflection is 15% | Total working deflection : 50% | 45 % |
| When first-stage deflection is 25% | Total working deflection : 56% | 50 % |
| When first-stage deflection is 50% | Total working deflection : 68% | 63 % |
| 预压缩量 15% 时 | 使用全压缩量 50% | 45 % |
| 预压缩量 25% 时 | 使用全压缩量 56% | 50 % |
| 预压缩量 50% 时 | 使用全压缩量 68% | 63 % |

相对于静负荷，在动负荷条件下使用时，寿命是个很大的问题。破损、疲劳寿命不仅在很大程度上受材料、热处理、加工方法的左右，而且因应力振幅范围内的循环次数的不同而产生差异。动负荷的最大许用变形量 f 限定小于 0.75h，而且为使蝶簧内径的上端部在承受最大压缩应力时所产生微小移动能够稳定，初期变形量 f 最少应在 0.15h 以上，即必须施加 60Kg/m ㎡的预压。施加预压的目的在于保证负荷的稳定性和防止内径上端部产生裂纹。例如，限定压缩量的使用范围，200 万次循环寿命时的使用压缩量如下表所示。
板厚在 1mm 至 4mm 之间时，使用全压缩量可按上表的中间值估算。要求循环次数 10 万次以下的寿命时，板厚小于 1mm 的蝶簧其全压缩量可加 12%，板厚大于 4mm 时，全压缩量可加 6%。

## (4) The use of guides 导向方法

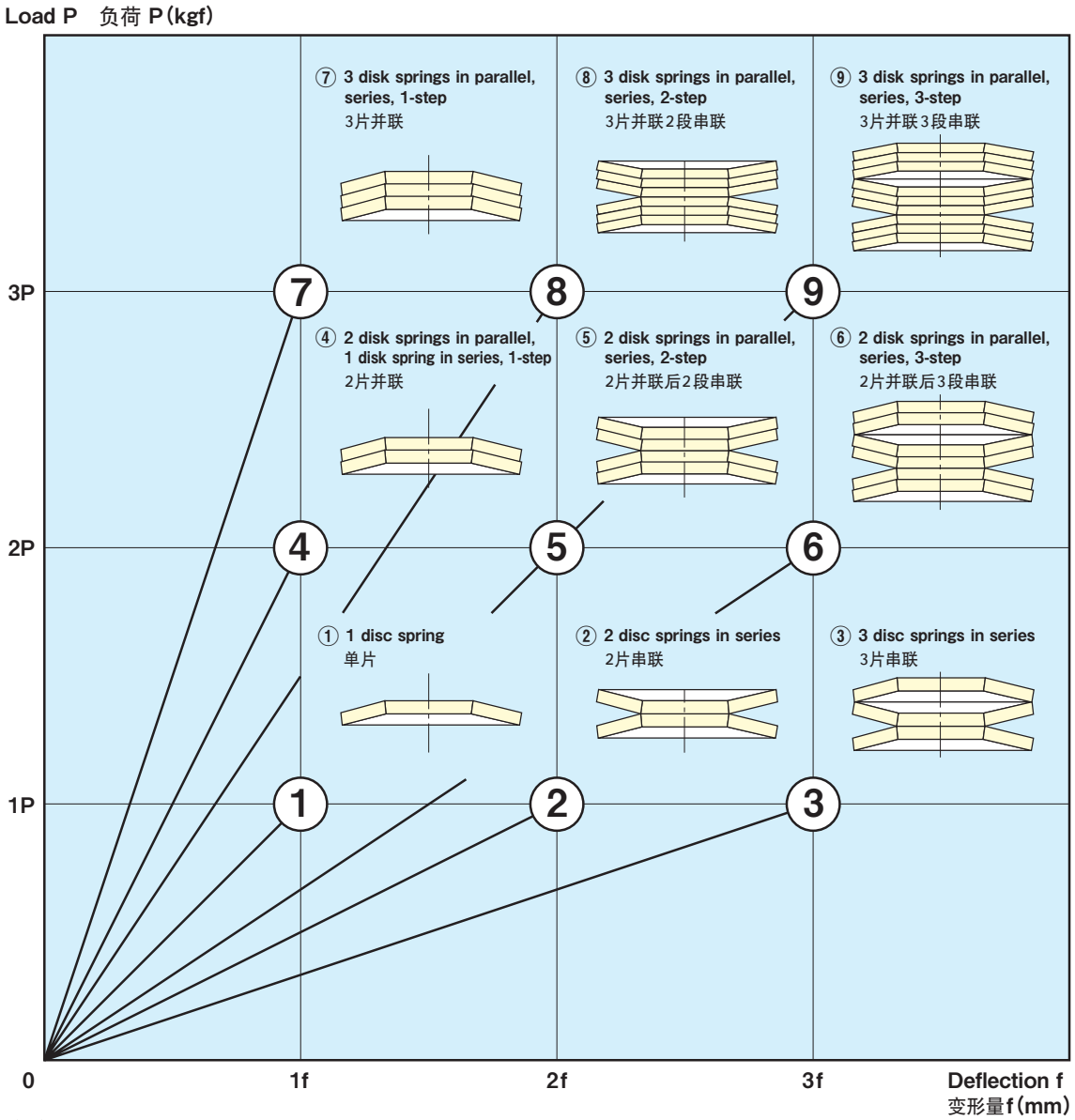
When BELLEVILLE SPRINGS are stacked, guides are used to prevent the springs from shifting position horizontally. Guides also generate actual friction so that when calculating the load, this friction must be taken into account by lowing the estimation of the load. Regarding how to use guides, as is shown graphically in Figure 3, either inside diameter and outside diameter type guides can be chosen to meet design requirements. However, in actual use, outside diameter guides are the most frequently used type and provide a stable guide method. Especially in cases where guides are used in situations involving heavy loads, the guide rod must have a heat treated surface hardness of at least 45 < ~ 55 > and it is also desirable that the surface be polished. In addition, for lubrication, if molybdenum dioxide grease is applied to the surfaces of BELLEVILLE SPRINGS, this will help to effectively reduce the friction force.

蝶簧重叠使用时，通过导向以防止横向滑动。在实际使用中，蝶簧和导向之间会产生摩擦力，计算负荷时需要考虑摩擦力，应将蝶簧负荷偏低估算。如图 3 所示导向方法有内径导向和外径导向，根据设计条件可任意选择导向方式。一般情况下使用内径导向的较多，而且导向稳定性好。对于重负荷使用条件，希望对导向棒进行表面热处理使其硬度达 HRc45-55，并对表面进行磨削加工。如果在蝶簧表面上涂上二氧化钼黄油作为润滑剂，则可以使摩擦力大为降低。




Appendix : Table 3 附表 3

## (5) Combinations and load characteristics 组合及负荷特性




## (6) Guide clearance 导向间隙

When BELLEVILLE SPRINGS are deflected from their free state, a slight change in the dimensions of the inside diameter will occur. Therefore, guide clearance is necessary. Concerning guide clearances, the standards applying to BELLEVILLE inside diameters, are shown by the values in Figure 4 and should be followed.

蝶簧从自由状态下变形时，内外径的尺寸会发生微小的变化。因此必须留有导向间隙。导向间隙以蝶簧的内径为基准如附表 4 所示。

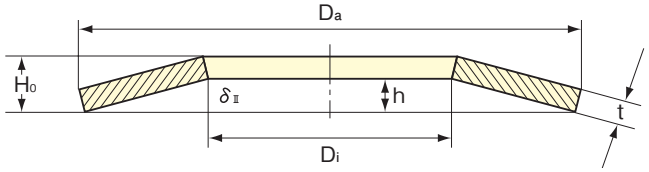
| BELLEVILLE SPRING inside diameter dimensions (DI) 蝶簧的内径 Di | Guide clearance 导向间隙 |
|---|---|
| 3.7mm to 到 14.3mm | 0.2mm |
| 15.3mm to 到 18.3mm | 0.3mm |
| 20.4mm to 到 25.4mm | 0.4mm |
| 28.4mm to 到 28.5mm | 0.5mm |
| 31 mm to 到 64 mm | 1 mm |
| 72 mm to 到 127 mm | 2 mm |

Appendix : Table 4 附表 4

## (7) Materials 使用材料

| Materials 材 料 | Degree of heat resistance〔℃〕 耐热温度℃ |
|---|---|
| Thickness 4mm > SK5M | ～ + 150 |
| Thickness 4mm < SUP10 | ～ + 150 |
| 板厚小于 4mm 时, SK 5 M | + 150 以下 |
| 板厚大于 4mm 时, SUP10 | + 150 以下 |

## (8) Standard dimensions and loads 标准尺寸与负荷




Methods used for spring labeling to indicate dimensions:BELLEVILLE SPRINGS labeling example : Spring with Outside diameter Da=16, Inside diameter Di = 8.2, Plate thickness t = 0.9 is labeled using the form, "16 × 8.2 × 0.9". The name of the size is:"H=16"

Explanations of abbreviated terms and symbols

| | |
|---|---|
| f mm | BELLEVILLE SPRING displacement and options related to amount of deflection |
| H₀ mm | The total height of unloaded, single BELLEVILLE SPRINGS |
| P kgf | Load |
| δⅡ Kgf/mm² | Types of stress related to BELLEVILLE SPRINGS Stress ( Tensile stress ) |

尺寸表示法 外径 Da=16、内径 Di=8.2、板厚 t=0.9 的蝶黄表示为 16×8.2×0.9 称呼为 H=16

符号说明

| | | | |
|---|---|---|---|
| f mm | 蝶簧的任意变形量 | P kgf | 负荷 |
| H₀ mm | 无负荷状态下单个蝶簧的全高度 | δⅡ Kgf/mm² | 蝶簧的应力（拉应力） |

Sales unit quantities
销售单位

| | | | | |
|---|---|---|---|---|
| Da | 8 | ~ | 28 | = 50 片 |
| Da | 31.5 | ~ | 63 | = 10 片 |
| Da | 71 | ~ | 250 | = 1 片 |

Heavy load type : "H" 重负荷用 H

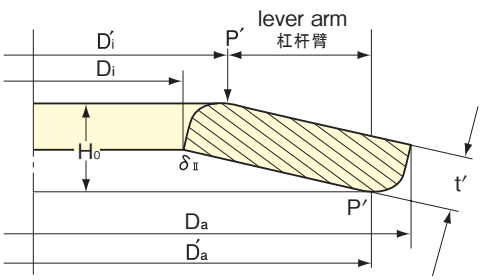
| Outside diameter 外径 Da | Inside diameter 内径 Di | Thickness 板厚 t | Thickness 板厚 t' | Deflection 压缩量 h | Total length 总高度 H₀ | f = 0.25h | | | f = 0.5h | | | f = 0.75h | | | f = h | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | P | f | δⅡ | P | f | δⅡ | P | f | δⅡ | P | f | δⅡ |
| 8 | 4.2 | 0.4 | | 0.2 | 0.6 | 8 | 0.05 | 34.8 | 15 | 0.1 | 76 | 21.4 | 0.15 | 124 | 27.5 | 0.2 | 178 |
| 10 | 5.2 | 0.5 | | 0.25 | 0.75 | 12.4 | 0.063 | 34.1 | 23.3 | 0.125 | 74.5 | 33.3 | 0.188 | 121 | 42.7 | 0.25 | 174 |
| 12.5 | 6.2 | 0.7 | | 0.3 | 1 | 24.5 | 0.075 | 41.1 | 46.7 | 0.15 | 87.9 | 67.4 | 0.225 | 141 | 87.3 | 0.3 | 199 |
| 14 | 7.2 | 0.8 | | 0.3 | 1.1 | 29 | 0.075 | 39 | 55.8 | 0.15 | 82.6 | 81.3 | 0.225 | 131 | 106 | 0.3 | 184 |
| 16 | 8.2 | 0.9 | | 0.35 | 1.25 | 37 | 0.088 | 39.1 | 71.2 | 0.175 | 83.1 | 103 | 0.263 | 132 | 135 | 0.35 | 186 |
| 18 | 9.2 | 1 | | 0.4 | 1.4 | 46 | 0.1 | 38.9 | 88.3 | 0.2 | 82.9 | 128 | 0.3 | 132 | 167 | 0.4 | 186 |
| 20 | 10.2 | 1.1 | | 0.45 | 1.55 | 56 | 0.113 | 38.6 | 107 | 0.225 | 82.4 | 155 | 0.338 | 131 | 202 | 0.45 | 185 |
| 22.5 | 11.2 | 1.25 | | 0.5 | 1.75 | 70.8 | 0.125 | 38.7 | 136 | 0.25 | 82.3 | 197 | 0.375 | 131 | 256 | 0.5 | 185 |
| 25 | 12.2 | 1.6 | | 0.55 | 2.15 | 127 | 0.138 | 47.2 | 247 | 0.275 | 99.2 | 361 | 0.413 | 156 | 473 | 0.55 | 218 |
| 28 | 14.2 | 1.6 | | 0.65 | 2.25 | 126 | 0.163 | 41.2 | 242 | 0.325 | 87.8 | 351 | 0.488 | 140 | 456 | 0.65 | 197 |
| 31.5 | 16.3 | 1.75 | | 0.7 | 2.45 | 142 | 0.175 | 38.6 | 272 | 0.35 | 82.1 | 395 | 0.525 | 131 | 514 | 0.7 | 184 |
| 35.5 | 18.3 | 2 | | 0.8 | 2.8 | 190 | 0.2 | 39.5 | 365 | 0.4 | 85 | 530 | 0.6 | 135 | 689 | 0.8 | 190 |
| 40 | 20.4 | 2.25 | | 0.9 | 3.15 | 239 | 0.225 | 39.9 | 458 | 0.45 | 84.9 | 664 | 0.675 | 135 | 863 | 0.9 | 190 |
| 45 | 22.4 | 2.5 | | 1 | 3.5 | 283 | 0.25 | 38.7 | 543 | 0.5 | 82.3 | 788 | 0.75 | 131 | 1025 | 1 | 185 |
| 50 | 25.4 | 3 | | 1.1 | 4.1 | 435 | 0.275 | 42.9 | 840 | 0.55 | 90.7 | 1224 | 0.825 | 143 | 1599 | 1.1 | 201 |
| 56 | 28.5 | 3 | | 1.3 | 4.3 | 423 | 0.325 | 37.1 | 806 | 0.65 | 79.6 | 1163 | 0.975 | 127 | 1506 | 1.3 | 181 |
| 63 | 31 | 3.5 | | 1.4 | 4.9 | 550 | 0.35 | 39.2 | 1055 | 0.7 | 83.4 | 1531 | 1.05 | 133 | 1991 | 1.4 | 187 |
| 71 | 36 | 4 | 3.75 | 1.6 | 5.6 | 783 | 0.4 | 33.5 | 1470 | 0.8 | 73 | 2092 | 1.2 | 119 | 2729 | 1.6 | 186 |
| 80 | 41 | 5 | 4.7 | 1.7 | 6.7 | 1246 | 0.425 | 38.9 | 2376 | 0.85 | 83.1 | 3425 | 1.275 | 133 | 4487 | 1.7 | 204 |
| 90 | 46 | 5 | 4.7 | 2 | 7 | 1195 | 0.5 | 32.7 | 2248 | 1 | 71.1 | 3199 | 1.5 | 115 | 4165 | 2 | 176 |
| 100 | 51 | 6 | 5.6 | 2.2 | 8.2 | 1842 | 0.55 | 36.2 | 3433 | 1.1 | 78.2 | 4909 | 1.65 | 126 | 6404 | 2.2 | 195 |
| 112 | 57 | 6 | 5.6 | 2.5 | 8.5 | 1650 | 0.625 | 30.3 | 3103 | 1.25 | 66.7 | 4470 | 1.875 | 109 | 5801 | 2.5 | 168 |
| 125 | 64 | 8 | 7.5 | 2.6 | 10.6 | 3176 | 0.65 | 39.4 | 6076 | 1.3 | 84 | 8771 | 1.95 | 134 | 11514 | 2.6 | 204 |
| 140 | 72 | 8 | 7.5 | 3.2 | 11.2 | 3143 | 0.8 | 34.9 | 6008 | 1.6 | 76 | 8689 | 2.4 | 123 | 11314 | 3.2 | 190 |
| 160 | 82 | 10 | 9.4 | 3.5 | 13.5 | 5161 | 0.875 | 39.4 | 9824 | 1.75 | 84.5 | 14124 | 2.625 | 135 | 18478 | 3.5 | 208 |
| 180 | 92 | 10 | 9.4 | 4 | 14 | 4780 | 1 | 32.7 | 8993 | 2 | 71.1 | 12796 | 3 | 115 | 16661 | 4 | 176 |
| 200 | 102 | 12 | 11.25 | 4.2 | 16.2 | 6794 | 1.05 | 36.3 | 12925 | 2.1 | 77.8 | 18674 | 3.15 | 125 | 24450 | 4.2 | 193 |
| 225 | 112 | 12 | 11.25 | 5 | 17 | 6559 | 1.25 | 30.2 | 12286 | 2.5 | 66 | 17401 | 3.75 | 108 | 22667 | 5 | 166 |
| 250 | 127 | 14 | 13.1 | 5.6 | 19.6 | 9511 | 1.4 | 33.4 | 17871 | 2.8 | 72.8 | 25391 | 4.2 | 118 | 33083 | 5.6 | 182 |

⚠ Do not use deflection rates that exceed f = 0.75h 动负荷条件下，不可在超过 f = 0.75h 的压缩量下使用

## Cautions concerning use of the products 使用时的注意事项

As shown in the graph (Figure 5), the contact surfaces of BELLEVILLE SPRINGS are beveled and for thicknesses of less than 4mm, thickness (t′) is a given. Therefore, when using stacked discs in parallel, the entire length/height (including the thickness of the plate) is calculated using the following formula:
Where n = Number of discs stacked
Total length ( $L_o$ ) : $L_o = H_o + (n - 1)\,t'$
The value, $L_o$ (Total length) when used in the case of dynamic loads, requires that the first-stage deflection should be set at f = 0.15h ~ 0.2h and, for the total deflection, it is desirable for that it be in the range of f = 0.75h > .

如附图 5 所示，板厚大于 4mm 的蝶簧，内外接触面处有倒角，板厚用 t′ 表示。为此并联重叠使用时，包括板厚在内的全长 L。可按以下公式计算，n 为重叠片数。
全长 $L_o = H_o + (n - 1)\,t'$
在动负荷条件下使用时，预压缩量至少要 0.15h ~ 0.20h。并建议在 0.75h 以内的范围使用。




Appendix : Table 5 附表 5

| Light load type : "L" 轻负荷用 L | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outside diameter 外径 Da | Inside diameter 内径 Di | Thickness 板厚 t | Thickness 板厚 t' | Deflection 压缩量 h | Total length 总高度 $H_o$ | f = 0.25h | | | f = 0.5h | | | f = 0.75h | | | f = h | | |
| | | | | | | P | f | δ Ⅱ | P | f | δ Ⅱ | P | f | δ Ⅱ | P | f | δ Ⅱ |
| 8 | 4.2 | 0.3 | | 0.25 | 0.55 | 5.3 | 0.063 | 17.9 | 9.1 | 0.125 | 45.4 | 12 | 0.188 | 82.6 | 14.5 | 0.25 | 129 |
| 10 | 5.2 | 0.4 | | 0.3 | 0.7 | 9 | 0.075 | 22.2 | 15.9 | 0.15 | 53.4 | 21.4 | 0.225 | 93.6 | 26.2 | 0.3 | 143 |
| 12.5 | 6.2 | 0.5 | | 0.35 | 0.85 | 12.3 | 0.088 | 22.5 | 22 | 0.175 | 52.6 | 30 | 0.263 | 90.2 | 37.1 | 0.35 | 136 |
| 14 | 7.2 | 0.5 | | 0.4 | 0.9 | 12.3 | 0.1 | 17 | 21.4 | 0.2 | 42 | 28.5 | 0.3 | 75 | 34.5 | 0.4 | 116 |
| 16 | 8.2 | 0.6 | | 0.45 | 1.05 | 17.6 | 0.113 | 19.6 | 31.1 | 0.225 | 47 | 41.9 | 0.338 | 82.3 | 51.3 | 0.45 | 125 |
| 18 | 9.2 | 0.7 | | 0.5 | 1.2 | 23.8 | 0.125 | 21.9 | 42.5 | 0.25 | 51.7 | 57.8 | 0.375 | 89.3 | 71.4 | 0.5 | 135 |
| 20 | 10.2 | 0.8 | | 0.55 | 1.35 | 31.1 | 0.138 | 23.1 | 55.8 | 0.275 | 53.9 | 76.4 | 0.413 | 92.3 | 94.9 | 0.55 | 138 |
| 22.5 | 11.2 | 0.8 | | 0.65 | 1.45 | 31.3 | 0.163 | 17.3 | 54.5 | 0.325 | 42.9 | 72.2 | 0.488 | 76.9 | 87.3 | 0.65 | 119 |
| 25 | 12.2 | 0.9 | | 0.7 | 1.6 | 37.4 | 0.175 | 18.1 | 65.8 | 0.35 | 43.8 | 88 | 0.525 | 77.3 | 107 | 0.7 | 119 |
| 28 | 14.2 | 1 | | 0.8 | 1.8 | 48.7 | 0.2 | 17.2 | 85 | 0.4 | 42.4 | 113 | 0.6 | 75.7 | 137 | 0.8 | 117 |
| 31.5 | 16.3 | 1.25 | | 0.9 | 2.15 | 80.7 | 0.225 | 22.6 | 144 | 0.45 | 53.5 | 195 | 0.675 | 92.7 | 241 | 0.9 | 140 |
| 35.5 | 18.3 | 1.25 | | 1 | 2.25 | 74.7 | 0.25 | 16.9 | 130 | 0.5 | 41.7 | 174 | 0.75 | 74.6 | 210 | 1 | 116 |
| 40 | 20.4 | 1.6 | | 1.15 | 2.75 | 133 | 0.288 | 22.9 | 237 | 0.575 | 54.1 | 322 | 0.863 | 93.7 | 397 | 1.15 | 142 |
| 45 | 22.4 | 1.75 | | 1.3 | 3.05 | 156 | 0.325 | 21.1 | 276 | 0.65 | 50.4 | 372 | 0.975 | 87.8 | 457 | 1.3 | 133 |
| 50 | 25.4 | 2 | | 1.4 | 3.4 | 199 | 0.35 | 23.1 | 357 | 0.7 | 54.1 | 487 | 1.05 | 92.9 | 603 | 1.4 | 140 |
| 56 | 28.5 | 2 | | 1.6 | 3.6 | 195 | 0.4 | 17.2 | 341 | 0.8 | 42.4 | 453 | 1.2 | 75.6 | 549 | 1.6 | 117 |
| 63 | 31 | 2.5 | | 1.75 | 4.25 | 300 | 0.438 | 22.8 | 537 | 0.875 | 53.3 | 732 | 1.313 | 91.4 | 907 | 1.75 | 137 |
| 71 | 36 | 2.5 | | 2 | 4.5 | 296 | 0.5 | 17.2 | 516 | 1 | 42.4 | 687 | 1.5 | 75.7 | 833 | 2 | 117 |
| 80 | 41 | 3 | | 2.3 | 5.3 | 454 | 0.575 | 19.4 | 800 | 1.15 | 47 | 1074 | 1.725 | 82.8 | 1311 | 2.3 | 127 |
| 90 | 46 | 3.5 | | 2.5 | 6 | 596 | 0.625 | 21.9 | 1064 | 1.25 | 51.7 | 1446 | 1.875 | 89.3 | 1786 | 2.5 | 135 |
| 100 | 51 | 3.5 | | 2.8 | 6.3 | 574 | 0.7 | 16.2 | 1003 | 1.4 | 39.9 | 1335 | 2.1 | 71.3 | 1618 | 2.8 | 110 |
| 112 | 57 | 4 | 3.75 | 3.2 | 7.2 | 836 | 0.8 | 10.6 | 1414 | 1.6 | 29 | 1812 | 2.4 | 59.4 | 2200 | 3.2 | 98.7 |
| 125 | 64 | 5 | 4.7 | 3.5 | 8.5 | 1330 | 0.875 | 16.1 | 2315 | 1.75 | 40.9 | 3055 | 2.625 | 74.5 | 3784 | 3.5 | 119 |
| 140 | 72 | 5 | 4.7 | 4 | 9 | 1309 | 1 | 10.8 | 2217 | 2 | 30.6 | 2845 | 3 | 59.4 | 3453 | 4 | 98.2 |
| 160 | 82 | 6 | 5.6 | 4.5 | 10.5 | 1880 | 1.125 | 12.1 | 3230 | 2.25 | 33 | 4186 | 3.375 | 62.6 | 5131 | 4.5 | 103 |
| 180 | 92 | 6 | 5.6 | 5.1 | 11.1 | 1825 | 1.275 | 7.7 | 3040 | 2.55 | 24.5 | 3829 | 3.825 | 50.4 | 4588 | 5.1 | 86.6 |
| 200 | 102 | 8 | 7.5 | 5.6 | 13.6 | 3404 | 1.4 | 16 | 5911 | 2.8 | 40.7 | 7791 | 4.2 | 74.3 | 9659 | 5.6 | 119 |
| 225 | 112 | 8 | 7.5 | 6.5 | 14.5 | 3363 | 1.625 | 9.9 | 5669 | 3.25 | 28.8 | 7237 | 4.875 | 56.5 | 8731 | 6.5 | 94.2 |
| 250 | 127 | 10 | 9.4 | 7 | 17 | 5303 | 1.75 | 16.2 | 9219 | 3.5 | 41.1 | 12168 | 5.25 | 74.8 | 15071 | 7 | 119 |

⚠ Do not use deflection rates that exceed f = 0.75h 动负荷条件下，不可在超过 f = 0.75h 的压缩量下使用