

1. Die-sets

AGATHON's precision die-sets stand up with their high accuracy relative to reg. parallelism, right angle and parallelism of the guide pillars (of 0.005mm on 100mm length) and the quality of material. Cut-outs, turn-outs, machining and bores are carried out accurately to customer's drawings. Slide-, ball- or roller guide elements can be mounted precisely into the die set, depending on its application.

in cast iron ...

- fine blanking pillar die-sets
- 11 standard types, 220 sizes, 750 models available any time from stock
- made from high quality perlite cast iron, high wear resistance, high damping characteristics

in steel ...

- special executions to customers drawing up to approx. 900 x 1500mm, available in short-term from stock
- plates cleanly milled on all sides, surface ground flat and parallel on both sides
- material: CK 45

in aluminum ...

- special executions to customers drawing up to approx. 900 x 1500mm, available in short-term from stock
- plates cleanly milled on all sides, surface ground flat and parallel on both sides
- special anticorrosional B alloy of 460 - 550 N/mm²

1.1. Advantages / Disadvantages of use

Cast iron die-set	
Use:	<ul style="list-style-type: none"> • generally ~<800 strokes/min • small / mid series • combination die / precision blanking • progressive die / compound die • assembly functions
Advantage:	<ul style="list-style-type: none"> • short delivery time (from stock) • reasonable cost
Disadvantage:	<ul style="list-style-type: none"> • no big breaking through possible (stability) • no "big tools"

Steel die-set	
Use:	<ul style="list-style-type: none"> • follow-on composite tool • < 1000 strokes/min • also large sizes possible
Advantage:	<ul style="list-style-type: none"> • flexible regarding dimensions --> customer drawing • large breaking through for workpiece • choice of material / material quality
Disadvantage:	<ul style="list-style-type: none"> • weight

Aluminum die-set	
Use:	<ul style="list-style-type: none"> • high-speed presses • mass production more then ~>1000 strokes/min • thin materials
Advantage:	<ul style="list-style-type: none"> • easy handling • flexible dimensions, good machining properties • weight
Disadvantage:	<ul style="list-style-type: none"> • cost • thermal expansion coefficient

2. AGATHON guide elements

Application

AGATHON guide elements not only find application in press tool manufacture, but also in machine, appliance, measuring tool and vehicle construction. Their special features are high resistance to wear, as well as high precision.

Our comprehensive product program includes:

- Guide pillars with press-in, flange, quick-change guide pillars with cylindrical or conical receiver (diameter 3 - 63mm).
- Headed bushings, flange bushings and cylindrical bushings with high surface quality and tolerances.
- Special sizes and material to customer's specifications

Slide bushings

Cost-effective solution but not play-free. Limited stroke speed. For long strokes with stroke speed up to 30m/min. Bronze-plated and self-lubricating bushings for pillar diameter of 15 - 63mm. Bronze-plated bushes can be manufactured to large sizes as special executions.

Ball cages

For easy movement and play-free guide (preload). For high speed. Radial and axial movements with limited stroke. Cages for pillar diameter of 3 - 63mm (80mm), in aluminum or brass. With anti-skid unit or with circlip limiting the stroke. Equipped with a high number of balls. Special execution made of synthetic material with stainless balls. Ball cages with double offset can be manufactured for the machine construction.

Roller cages (with AGATHON's patented profile rollers)

For absolutely play-free guide, high rigidity and radial load. Cages for pillar diameter 15 - 63mm in aluminum with anti-skid unit. For high speed, axial movements and limited strokes. Cages with profiled rollers for linear transmission contact. They are used in applications with very high radial loads, but with low stroke speed. Customer specific sizes and lengths can be manufactured as special executions.

2.1. Determining the guide elements

Plan guide	
Use:	<ul style="list-style-type: none"> • bronze-plated ~15-30m/min • sintered guide bushes 15-30m/min for maintenance-free operation
Advantage:	<ul style="list-style-type: none"> • long-stroke movements • price • radial and axial movements • high forces allowed, depending on the K-value
Disadvantage:	<ul style="list-style-type: none"> • lower accuracy, due to minimal play • maintenance, if not self-lubricating

Ball guide	
Use:	<ul style="list-style-type: none"> • universal, accurate guide • "pre-loaded" • up to 150 m/min
Advantage:	<ul style="list-style-type: none"> • good value to quality provided • high accuracy due to play-free running (preload) • less liable to contamination/dirt • radial and axial movements
Disadvantage:	<ul style="list-style-type: none"> • limited stroke(cage makes 1/2 stroke) • limited loading capacity

Roller guide (AGATHON patent)	
Use:	<ul style="list-style-type: none"> • for higher radial forces • for high accuracy • "pre-loaded" • up to 150 m/min
Advantage:	<ul style="list-style-type: none"> • higher stiffness • high accuracy (die clearance < 5µm) • higher load possible due to lateral forces
Disadvantage:	<ul style="list-style-type: none"> • no radial movement possible • limited stroke (cage makes 1/2 stroke) • higher costs

2.2. AGATHON slide guides

These bushes can be used with steel and aluminum die sets.

Slide guides from **hardened steel** (Standards 701x/716x) **with bronze plated running surface** (thickness of layer 0.25 – 0.3mm) and a running clearance of 0.003 – 0.017mm and an optimum lubrication allow a slide speed of 15 - 30m/min, depending on the pillar diameter. Bronze-plated bushes can be manufactured in further sizes and lengths as special executions.

The AGATHON **sintered guide bush** (Norm 702x) is an element which provides the ideal solution for all those applications in tool-making, machine tool and instrument manufacture requiring a self-lubricating plain bearing (with excellent emergency running properties] AGATHON sintered guide bushes stand out for their open, rising through pore volumes. This helps to soak with liquid lubricant or the bringing in of solid lubricant. Because the pores are linked together, the liquid lubricant is able to circulate. It flows dependably between the slide surfaces, where it builds up, together with the movements, a hydrodynamic lubrication film. The solid lubricant is spread among the whole bush, so that new pores are opened and the lubrication is guaranteed. The ideal inset for axial movements is between 10 - 30m/min. It is well known in practice that for exact application a running play of 2 - 12µm has proved best.

Interchangeability:

Thanks to the uniform pick-up diameter, all of the bushes (ISO/DIN program) can be exchanged for each other.

Running play:

If larger running play is required, it has to be specified with your order.

Assembling of straight bushes:

Glueing-fit is standard. If the bushes are meant for pressing-fit, it must be specified explicitly (diff. Tolerance).

We recommend glue-fit.

Advantage of glue fit:

1. Guide elements are not changed
2. Interchangeability also with tools of highest accuracy, when assembling bore is chosen correctly

Glue clearance:

1. Cylinder bushes with groove $\pm 0.003\text{mm}$
2. 0.01 - 0.02mm for cylinder bushes without groove (pay attention to the glue instructions of the manufacturer)

Glue:

e.g. Loctite 648 medium strength adhesive (exchange)

2.3. AGATHON bearing guides

AGATHON bearing guides are used where slide guides are insufficient due to lubricating problems (e.g. high-speed presses, short strokes and precise, play-free longitudinal guides).

Bearing guides are preferred by toolmakers because of their easy movement, which facilitates fitting an assembling press tools.

Features:

- Due to this preload, the cage path is only ever half as long as the stroke of the guide bush or pillar.
- High accuracy due to precision machined bearing surfaces and roller elements of the same size.
- Easy running due to rolling motion.
- Play-free guides due to preloading.
- Long lifespan.
- Withdraw the cage max. 50% from the bush. (Exception: with cage retainer system CRS, a complete withdraw of the cage is possible).

Preload:

- Lifespan / stability --> optimum preload.
- The radial load capacity increases as the preload increases at the expense of the ease of running. Excessively high preload leads to and overload due to excessively high surface pressure.

Number of balls / rollers:

Optimum (high) equipment with roller elements. --> More stable guide/longer life expectancy (smaller support parts of the individual roller element).

Offset of balls / rollers:

In axial direction, spiral-shaped arrangement, radial offset (10°) --> separate path of the roller element. Roller cages with axial and radial offset (for radial movements) can be manufactured as special execution.

Cages with profiled rollers for linear transmission contact. contact. They are used in applications with very high radial loads, but with low stroke speed. Customer specific sizes and lengths acne be manufactured as special executions.

Assembly assistance:

- AGATHON specialty --> Standards 761x and 766x.
- easy assembly of the tool without assistance.
- does not heat up despite slight friction.
Replacement possible: Please state length of diameter or the width in m (2 widths).

Hardness of the pillars:

62 +2/-0 +HRC = 745 - 800 HV

< \varnothing 15mm: through-hardened

>= \varnothing 15mm: inductive hardened, thickness of layer 1.5 +1/-0mm

Lifespan:

- average 30 - 100 million strokes (~ 30mm diameter of pillar)
- The lifespan depends on:
 1. Contamination
 2. Stroke length and number of strokes
 3. Geometry of the tool (distance of pillars, parallelism)
 4. Pollution
 5. Storage
 6. General conditions of manufacture
 7. Stability of the press/machine

Max. acceleration:

Accelerations of 25 ms⁻² are easily reached in all applications. Applications with some 100 ms⁻² are known with roller- or ball guides. For very high acceleration, plain guides are usually used.

Lubrication:

- Grease: e.g. Klueber "Microlube GB0", Shell Alvania EP No. 1 or No 2, Avia, OKS 4220 for high temperatures up to +280°C (for a short period up to +300°C) --> 300°C is not permitted for pillars and bushings.
- Oil: e.g. Shell Tonne TAX 220 (recommended for vertical applications).

Assembling of straight bushes:

Gluing-fit is standard!

If the bushes are meant for pressing-fit, it must be specified explicitly (diff. tolerance).

We recommend glue-fit!

Advantage of glue fit:

1. Guide elements are not changed (preload).
2. Interchangeability also with tools of highest accuracy, when assembling bore is chosen correctly.

Glue clearance:

1. Cylinder bushes with groove $\pm 0.003\text{mm}$.
2. 0.01 – 0.02mm for cylinder bushes without groove (pay attention to the glue instructions of the manufacturer).

Glue:

e.g. Loctite 648 medium strength adhesive (exchange).

2.4. AGATHON ball sleeves

The important feature of AGATHON ball sleeves is the high quality of manufacture and thus a long working life. The working surfaces of the individual guide elements are super-finished. The ball cages are equipped with a high number of balls, thus allowing high loads and universal application.

Construction and function:

The AGATHON ball sleeve consists of guide pillar, steel bush and ball cage. Speed approx. 150m/min. These three elements are delivered with a pre-load of 0.005 – 0.018mm, depending on the diameter of the pillar. Due to the pre-load of the balls, the ball cage makes a forced movement, i.e. the ball cage only moves half the amount of the die-set stroke. This fact must be taken into consideration when determining the length of bushes and cages.

Interchangeability:

When changing over the ball guide to a roller guide or vice versa, the bush must be replaced (different preload / tolerances). The individual elements can be changed where plain guides and ball guides are concerned, but we generally recommend that the entire element is changed (or re-machining possibly necessary).

Aluminum ball cages:

The important feature of aluminum ball cages compared to other materials is the lower weight. Due to the carrying function of the cage, every reduction of weight results in lower forces of gravity, particularly at the reversing points of a longitudinal movement. The slipping effect of the ball cage occurring at quick changes of direction is considerably reduced by its low mass and is also reduced via our anti-skid unit.

Brass ball cages:

Brass ball cages are designed for universal use. The high mechanical resistance results in a great abrasion resistance and stability. They are used where lower strokes, absolute soft running or special use for limited strokes with Seeger ring are demanded.

Maintenance:

AGATHON ball cages require practically no maintenance. Appropriate lubrication with a high-performance bearing grease is sufficient for continuous operation. A regular lubrication increases the lifespan of the bearing guide.

Special types:

AGATHON also manufactures guide pillars, steel sleeves and ball cages, as well as complete ball sleeve units to customer's drawings. This is also valid for different materials and applications e.g. guide pillars, steel sleeves and balls in stainless steel. On request we also manufacture ball cages in synthetic material (e.g. POM) for special applications (e.g. in the food industry).

2.5. AGATHON roller sleeves

AGATHON roller sleeves, which are patented in most industrial countries, have a wide range of applications:

- punching tools and mould construction,
- general machine and appliance construction.

The extensive manufacturing program of AGATHON roller sleeves consists not only of standard parts, but also special parts to customer's specifications.

Construction and function:

The AGATHON roller guide consists of guide pillar, steel bush and roller cage, equipped with high precision machined profile rollers. Speed approx. 150 m/min.

The forces are uniformly distributed to four contact ellipses. The pre-loaded profile rollers move between guide pillar and steel bush without noticeable friction.

The different profile shape, compared to conventional profile rollers, allows a higher pre-load and prevents from asymmetric loads.

Rigidity

Constant high rigidity at slightest wear (compared to balls, several times more rigid and capable of carrying heavier loads).

Interchangeability:

In most cases roller guide units are paired with adjustment of the bush for the pillar and cage. This is necessary because the profile roller is sorted into the admissible tolerances. Cages are equipped with rollers of the same quality. One has to take in consideration that elements are not changed with such other elements. In case of replacement we recommend to change the whole guide unit.

Cages in the same roller tolerance class can be exchanged if the used guide units are still in mind condition.

The tolerance class of the quality, which is engraved on the cage, must be mentioned on order.

(Available on request)

Lifespan:

The life span of roller guides under max. load corresponds to approx. 65% of the max. loaded ball guide.

When the max. load is not reached, a substantial longer lifespan can be expected, under consideration of normal and clean working operations. If the max. allowed stroke is exceeded, the lifespan might be reduced.

Maintenance:

AGATHON roller guides are slightly oiled before delivery. Lubricated before installation, they can be used maintenance-free for longer continuous operation. To reach a longer lifespan we recommend a regular following lubrication. Foreign particles become bounded (grease) or washed out (oil) and will not get between the bearing elements. We recommend a lubricant with a high lever, because our guide elements are pre-loaded.

Special types:

Cages with profile rollers for linear transmission contact. They are used in applications with very high radial loads, but with low stroke speed.

3. Information regarding application, Cage Retaining System CRS (Norm 664x)

Description of CRS

Movable cage retainer in light metal with retaining system for the cage retainer for ball cages in aluminium or brass for mounting into pillars of Standards No. 6509 / 6579.

When the cage must run completely out of the preload with each stroke, our 761x-style aluminium ball cage is recommended. The anti-skid unit inside these cages should be removed.

If the CRS is used as an assembly device, and does not carry the cage during the working stroke, our ball cages in brass with circlip (Standard 7631) could be used. The circlip prevents the cage from creeping during operation.

Handling and Maintenance

With the scallops on the CRS disc, the flipping of the tool's top plate (on the bench) can be made possible without damaging the CRS. Before flipping the plate, simply position the disc so that one of the scallops is pointing in the same direction you will flip.

The CRS is mechanically locked in its uppermost (closed) position, and therefore allows the tool's top plate to lean on the pillars without the cages hanging off the end of them, where they could be damaged by the tool's weight. This mechanism engages in the last 3mm of the CRS stroke.

Therefore, the CRS has to be laid out with a security distance (S) of 6 to 10mm, so that in the working stroke it does not drive completely into the pillar (take attention for regrinding).

The CRS will not extend under its own weight. Therefore, it will not fall into press T-slots, or get jammed when the tool is slid into or out of the press. Transporting the tool will be easier as well as, because the CRS will not stick out of the bottom of the die shoe.

Defining the length of the bushing, pillar and CRS

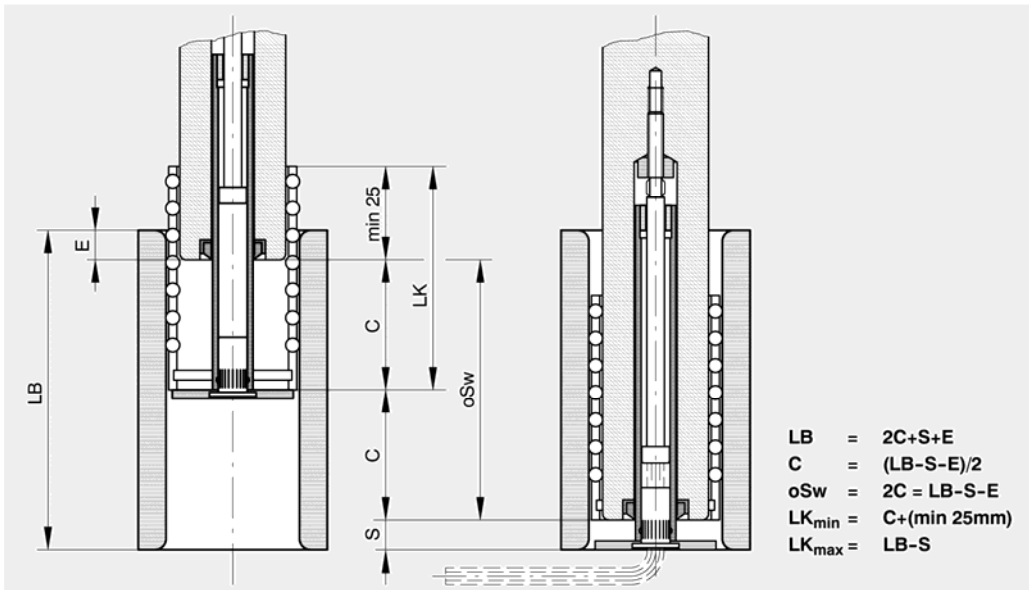
Purpose of the variable length of the CRS-screw (value C)

The value C is defined on the basis of the stroke, length of cage, resp. bushing and the application. In this regard, the value C has to be chosen in a way that the cage can move on the pillar on a minimum length of 25mm (approx. 3 rows of balls). The cage has to be positioned so that the groove for mounting aid is in the lower part.

The stroke C permits the driving-out of the cage, even then when the cage has "traveled" a little bit due to the acceleration and stroke. Because of the "traveling" of the cage, the beginning running-out position does not correspond anymore to the position of the running-in. This difference can be corrected up to a certain value by the CRS, but the consequence is that the preload of the rolling elements has to be overcome. When the driving-out force is too high, the breaking point of the CRS will give free the disc in order to prevent further damage. After a breaking, the whole CRS has to be replaced.

The CRS is installed in the pillar using a hexagon socket screw key (SW 4mm, 5/32"). For safety reasons, the screw should be glued with Loctite (non-permanent).

Important: The "traveling" of the cages should not exceed 7mm! Otherwise corresponding precautions have to be taken (e.g. distance ring) in order to prevent this.



Defining the elements for CRS applications

- LB length of the bushing
- LK length of the cage
- C length of the running-out of the CRS (see catalog)
- oSw max. travel of the pillar under preload
- E run-in geometry pillar and bushing = 7mm
- S safety distance of 6 to 10mm (regrinding not taken into account)

$$LB = 2C + S + E \quad oSw = 2C = LB - S - E$$

$$LK_{min} = C + (\text{min. } 25\text{mm})$$

$$LK_{max} = LB - S$$

$$C = \frac{LB - S - E}{2}$$

4. Cutting elements

Punching forces

Following factors influence the magnitude of the punching force:

The material and thickness of the part to be punched, the die clearance, the arrangement and condition of the cutting edges on the punch and die-plate.

If the cutting edges of the punch and die-plate are parallel, then the punching force is calculated as follows:

$$F = k_s \cdot U \cdot s \text{ [N]}$$

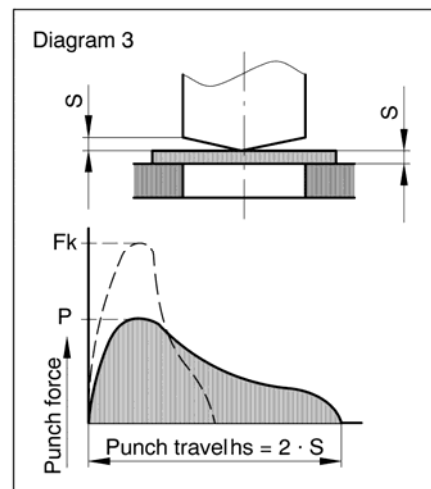
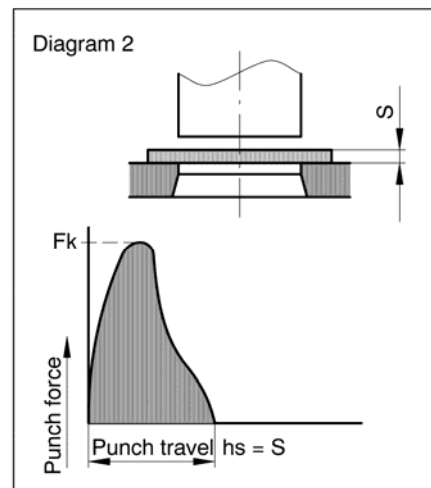
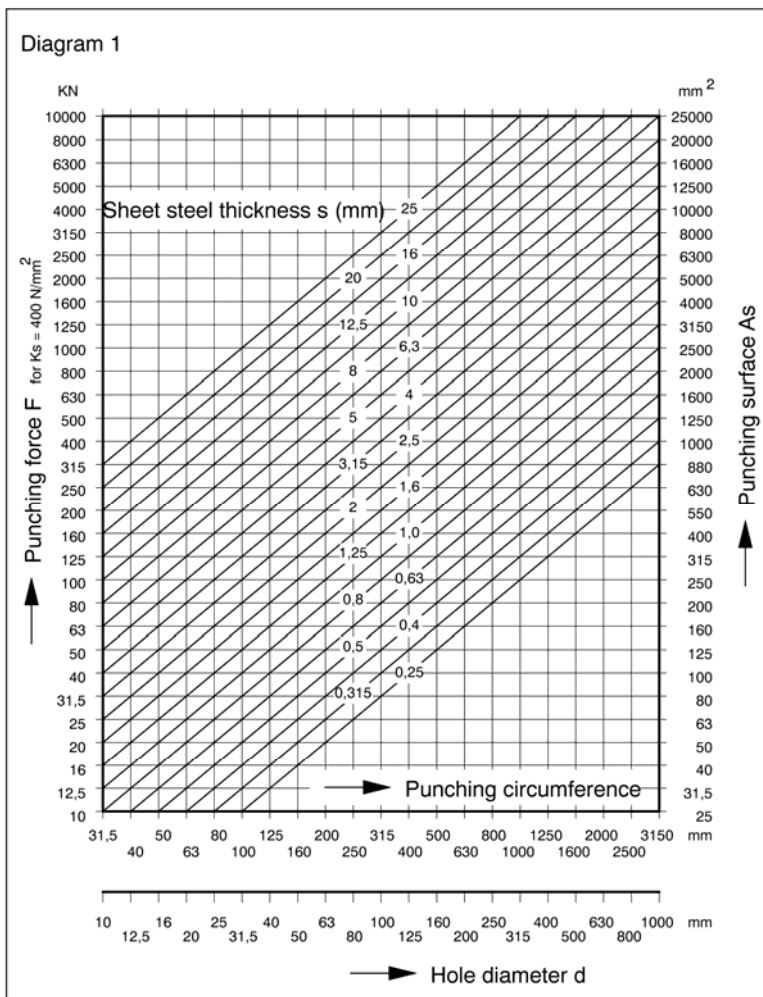
k_s = Shear resistance in N/mm^2

U = Punching circumference in mm

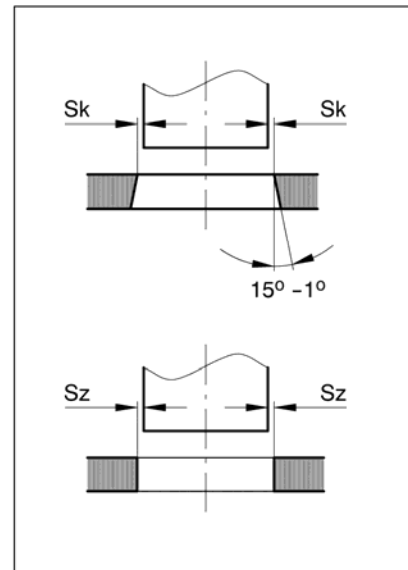
s = Sheet steel thickness in mm

The punching force can be considerably reduced if a taper or wave is ground on the punch or die-plate. Depending on the shape of the cutting edges, the punching force is also reduced to 0.5-0.67*F.

$$F_s = 0,67k_s \cdot U \cdot s \text{ [N]}$$



Sheet steel thickness mm	Sheet steel gauge No.	Thickness deviations allowed ± mm	Die clearance in μ*) at a shear resistance k_s of					
			100...250 N/mm ²		250...400 N/mm ²		400...600 N/mm ²	
			S_k	S_z	S_k	S_z	S_k	S_z
0,18	32	0,02	2,7	5,4	4,5	7,2	6,3	9
0,20	31	0,02	3	6	5	8	7	10
0,22	30	0,02	3,3	6,6	5,5	8,8	7,7	11
0,24	29	0,02	3,6	7,2	6	9,6	8,4	12
0,28	28	0,02	4,2	8,4	7	11,2	9,8	14
0,32	27	0,02	4,8	9,6	8	12,8	11,2	16
0,38	26	0,03	5,7	11,4	9,5	15,2	13,3	19
0,44	25	0,03	6,6	13,2	11	17,6	15,4	22
0,50	24	0,04	7,5	15	12,5	20	17,5	25
0,56	23	0,04	8,4	16,8	14	22,4	19,6	28
0,63	22	0,05	9,5	18,9	15,8	25,2	22	31,5
0,75	21	0,06	12	22,5	18,8	30	26,2	37,5
0,88	20	0,06	13,2	26,4	22	35,3	30,8	44
1,00	19	0,07	15	30	25	40	35	50
1,13	18	0,08	17	33,9	28,3	45,2	39,5	56,5
1,25	17	0,09	18	41	35	55	48	69
1,38	16	0,10	21	41	35	55	48	69
1,50	15	0,11	23	45	38	60	53	75
1,75	14	0,12	26	53	44	70	61	88
2,00	13	0,13	30	60	50	80	70	100
2,25	12	0,14	34	68	57	90	79	113
2,50	11	0,15	37	75	63	100	88	125
2,75	10	0,15	41	82	69	110	96	138
3,25	8	0,25	49	98	82	130	114	163
3,50	7	0,25	53	105	88	140	123	175
4,00	5	0,30	60	120	100	160	140	200
4,50	3	0,30	68	135	113	180	158	225
5,00	2	0,30	75	150	125	200	175	250
5,50	1	-	83	165	138	220	193	275
6,30	-	-	95	189	158	252	220	315
7,00	-	-	105	220	175	280	245	350
8,00	-	-	120	240	200	320	280	400
9,00	-	-	135	270	225	360	315	450
10,00	-	-	150	300	250	400	350	500



S_k = Die clearance for tapered die-plates

S_z = Die clearance for cylindrical die-plates

Punch clearance = $2 \cdot S_k$ or S_z

Determining for the workpiece dimensions are:

When blanking out: the opening of the die-plate.

When punching: the punch.

Die clearance

When blanking out and punching, the die clearance influences the punching force and the surface quality of the workpiece. The die clearance depends on the thickness s and the shear resistance k_s of the material. For sheet steels up to 3mm thick:

$$S_z = c \cdot s \cdot (k_s \cdot 10^{-1})^{0.5}$$

$c = 0.005$ for high punching surface quality

$c = 0.01$ for normal punching surface quality

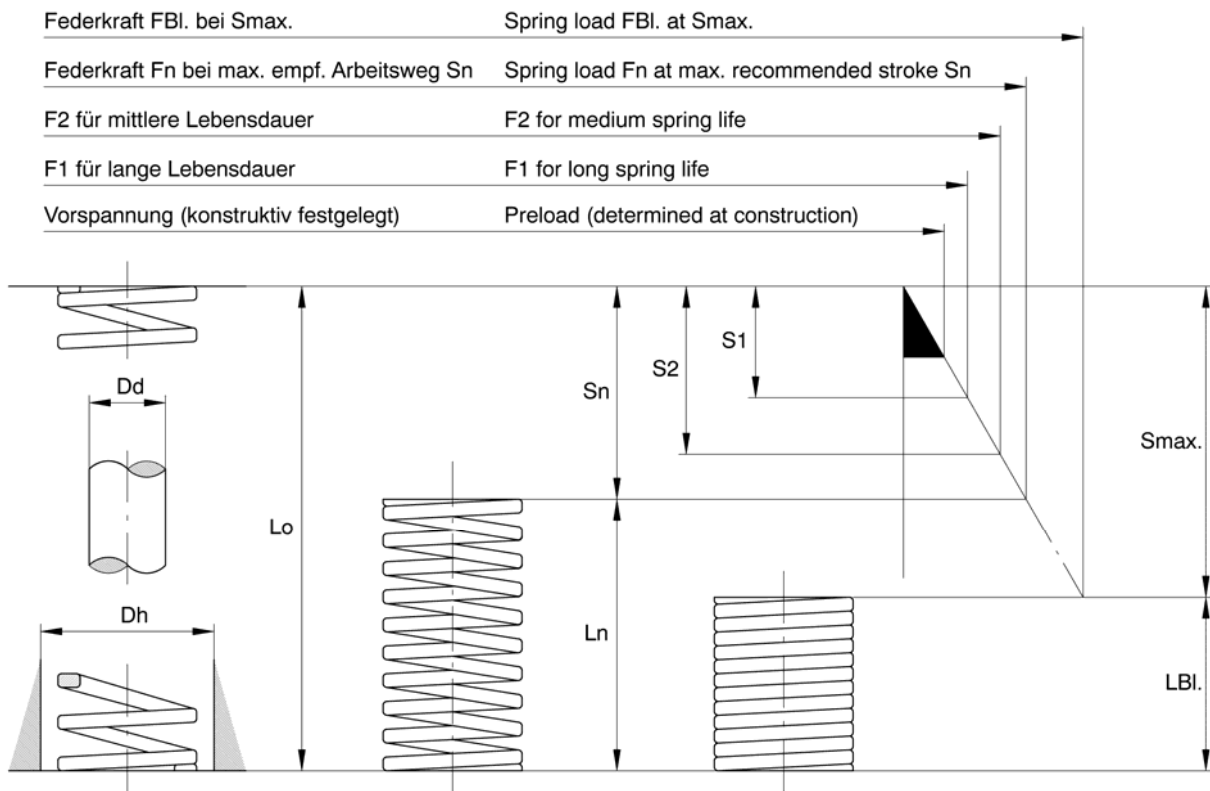
For sheet steels over 3mm thick:

$$S_z = (0.01 \cdot s - 0.015) \cdot (k_s \cdot 10^{-1})^{0.5}$$

5. Cylindrical pressure springs

Classification and technical description

In order to simplify the correct selection of the spring for the specific job, the following charts offer values on total spring loads for medium, long life and maximum travel stroke, the total spring load capacity, as well as the single and constant load capacity (admissible load to compress the spring by 1mm).



Explanations:

- Dd Rod diameter in mm (internal guide)
- Dh Hole diameter in mm (external guide)
- L_o Length of unloaded spring in mm
- L_n Length of loaded spring in mm
- L_{Bl} Block length of spring in mm (all windings are in contact)
- F1 to F_n Load of spring in N, corresponding to stroke S_1 to S_n
- S_1 Long spring life
- S_2 Medium spring life
- S_n maximum travel stroke
- $S_{max.}$ maximum stroke of spring