Design and Function of Star Discs

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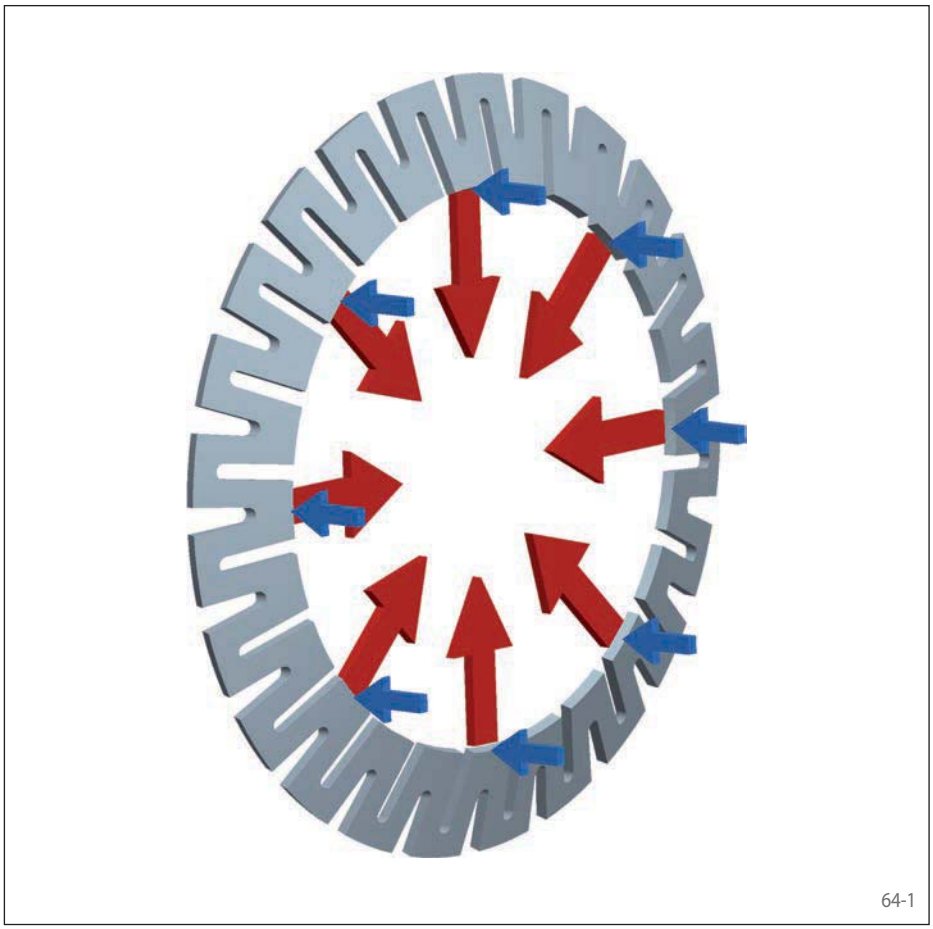
The RINGSPANN Star Disc is a flat conical ring made of special hardened spring steel. The characteristic slot pattern, alternating from the outside to the inside edge, gives the Star Discs its very high elasticity. The outer circumference of the Star Disc is supported in the bore of the hub to be connected. The axial actuating force applied to the inner circumference of the Star Disc causes an elastic change in the conical angle and thus reduces the inner circumference of the Star Disc (see figure 64-1). A particular advantage of this configuration is that the axial actuating force is converted virtually without friction loss into a much higher radial force. This facilitates simple actuating devices, such as clamping with the aid of a central clamping screw or a manually adjusted knurled nut, for example.

Depending upon the torque required, Star Discs are used singly or in multiple arrangements as disc packs, generally consisting of a maximum of 16 discs. This arrangement provides for space-saving, clamping connections.

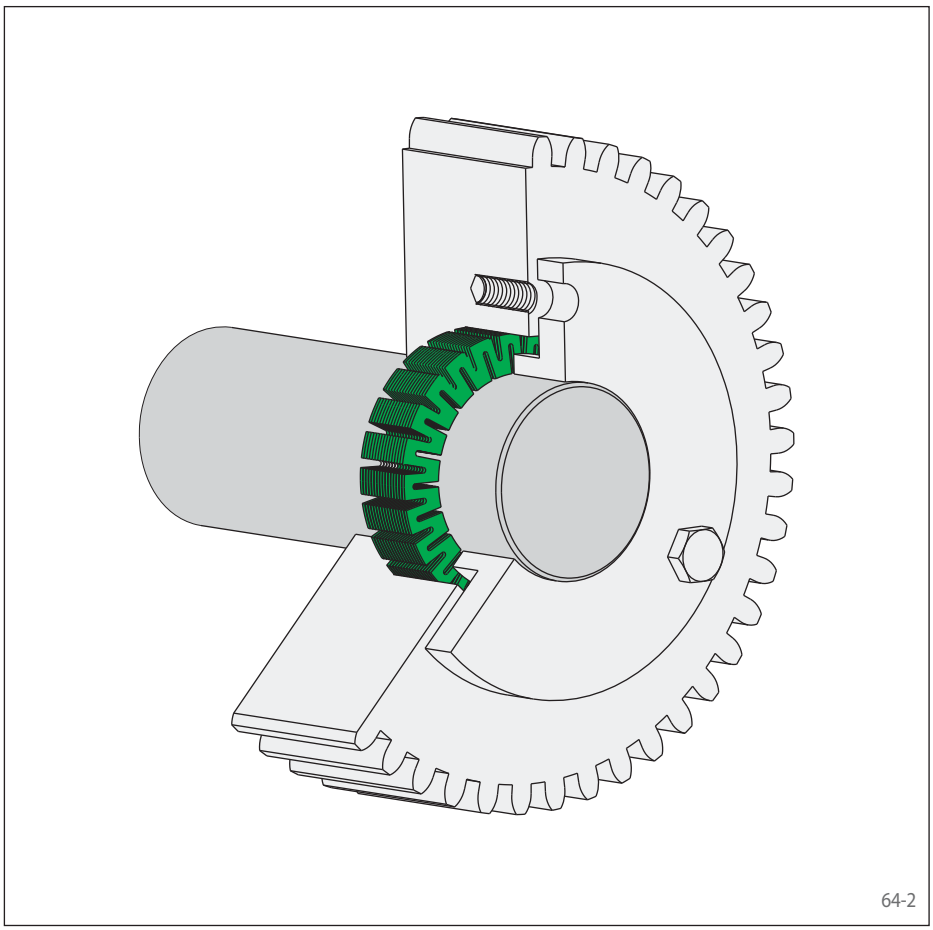
Clamping connections with Star Discs are easy to release even after frequent clamping. This makes the Star Disc the ideal clamping element, e.g. in adjustment devices.



64-1

Features

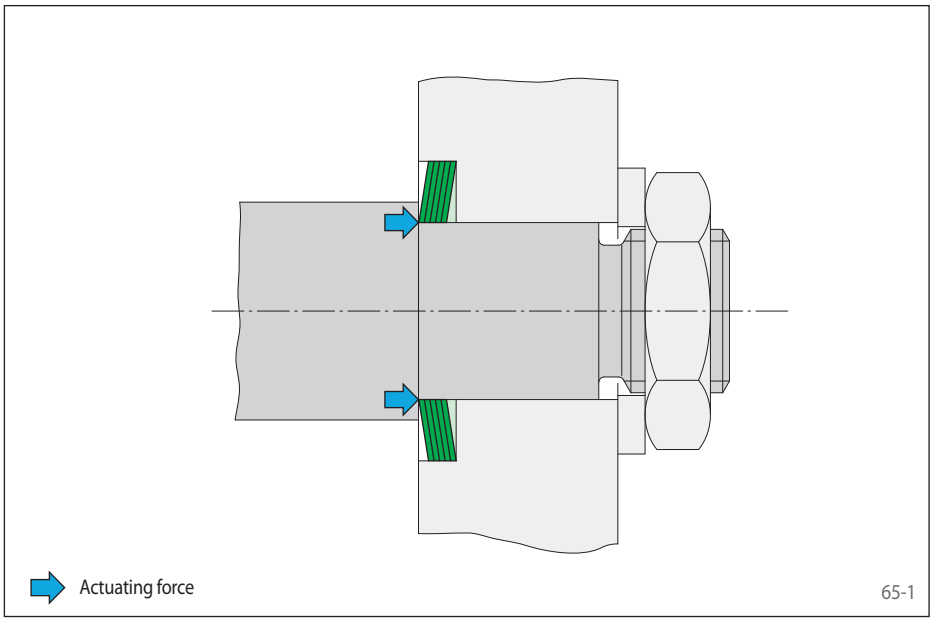
- For frequent clamping and release
- Short axial width
- Adjustable to the required torque by multiple arrangements in the form of disc packs
- Low actuating force required, thus ideal for manual actuation



64-2

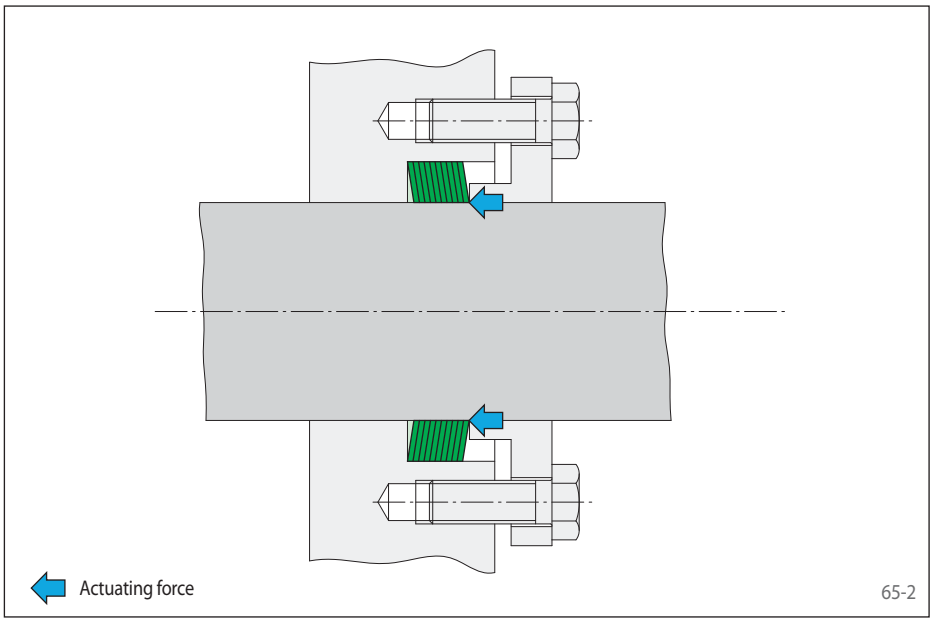
Clamping connection at the shaft end

Figure 65-1 shows a clamping connection with a disc pack that consists of five Star Discs. The preload force of the clamping nut is transmitted to the disc pack by the opposite shaft shoulder.



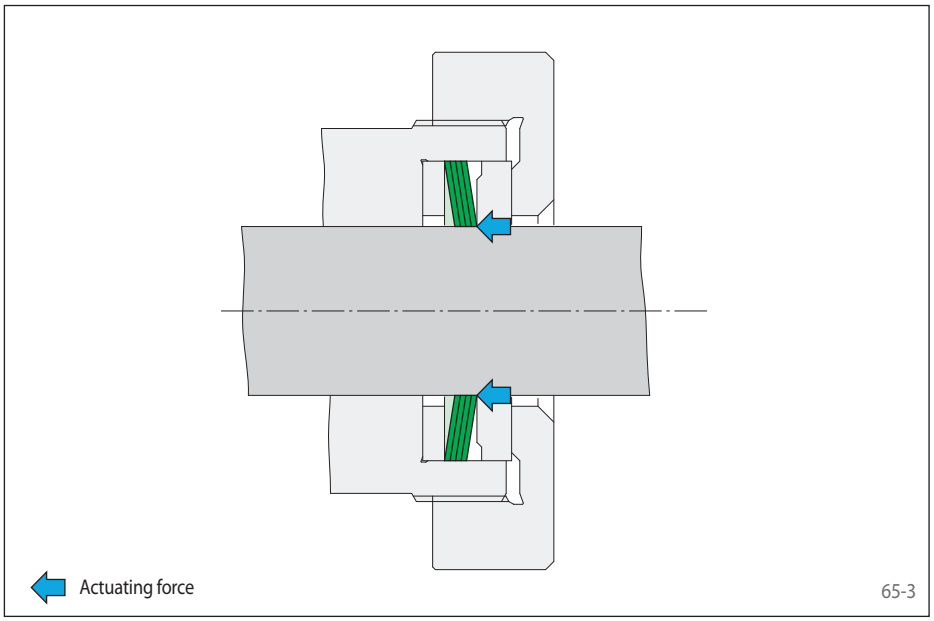
Clamping connection on a continuous shaft

Figure 65-2 shows a clamping connection with a disc pack consisting of ten Star Discs. The preload force of the screws acts on the disc set through a clamping flange.



Clamping connection with a threaded ring

Figure 65-3 shows a clamping connection with a disc pack consisting of four Star Discs and a manually adjusted threaded ring. Between the disc pack and the threaded ring, there is a pressure disc. It transmits the axial actuation force to the disc pack inner diameter and thereby prevents the disc pack from turning as well when the threaded ring is tightened.



Star Discs

for frequent clamping and loosening short axial width

Features

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- Short axial width
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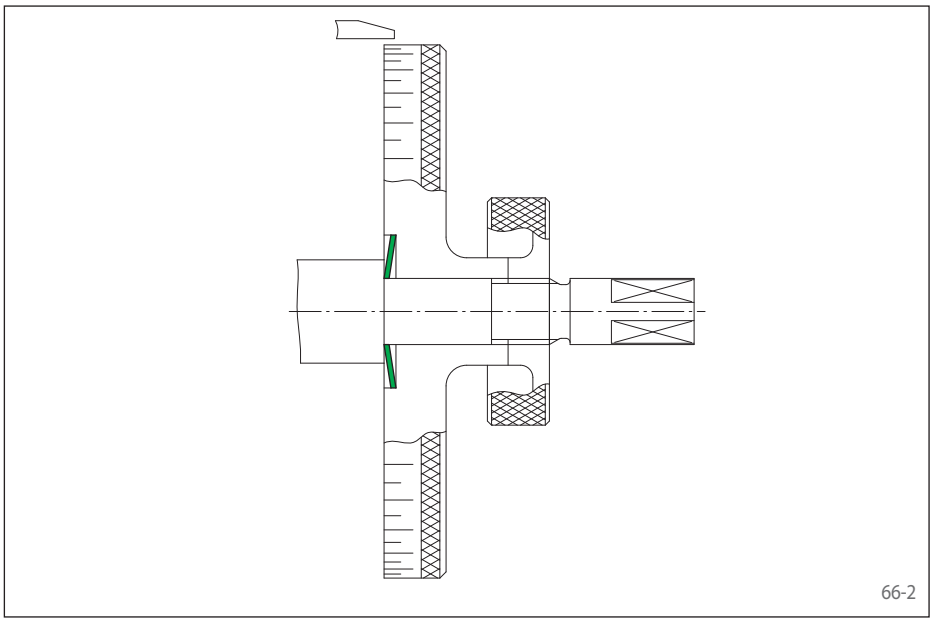

Application example

Backlash free attachment of a graduated dial in a feed unit with a Star Disc. After release of the right knurled nut, the dial can be adjusted in circumferential direction.

Transmissible torques

The transmissible torques or axial forces listed on the following page are subject to the following information about disc pack, tolerances, surface characteristics and material requirements. Please contact us in the case of deviations.

Disc Pack

The torque M stated in the table applies for one star disc. In case of multiple arrangements of star discs in disc packs of up to 16 star discs, the following applies:

Torque	$M_n = n \cdot M$
Preload force	$E_n = n \cdot E$
Load-bearing axial width	$L_1 \approx n \cdot s$

Tolerances

- h9 for shaft diameter d
- H9 for hub bore D

Surfaces

Average surface roughness at the contact surfaces between the shaft and the hub bore: $R_z = 10 \ldots 25$ µm.

Materials

The following apply to the shaft and the hub:

- Yield strength $R_e \geq 300$ N/mm^2
- E-module ≥ 170 kN/mm^2

Example for ordering

100 Star Discs for shaft diameter d = 20 mm:

- 100 pcs. A 20 SS 37
  Article number 1032-037004-000000

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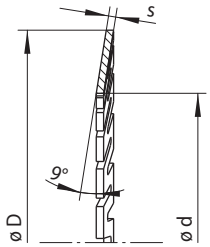
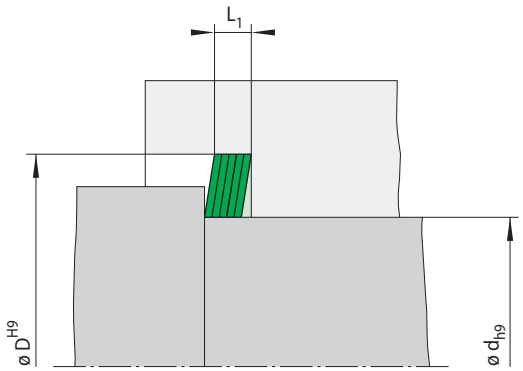


67-1



67-2

Dimensions			Technical Data					Type	Article number
Size			Transmissible torque	Contact pressure at Shaft	Contact pressure at Hub	Preload force	Weight		
d mm	D mm	s mm	M Nm	P_W N/mm²	P_N N/mm²	E N	kg/100 pieces		
4	14	0,50	0,16	100	29	140	0,3	A 4 SS 14	1032-014002-000000
5	14	0,50	0,29	116	41	210	0,3	A 5 SS 14	1032-014003-000000
6	18	0,50	0,34	94	31	180	0,5	A 6 SS 18	1032-018001-000000
8	18	0,50	0,72	113	50	310	0,5	A 8 SS 18	1032-018003-000000
10	22	0,60	1,26	105	48	430	0,9	A 10 SS 22	1032-022002-000000
11	22	0,60	1,53	105	53	500	0,8	A 11 SS 22	1032-022003-000000
12	27	0,65	1,95	104	46	520	1,4	A 12 SS 27	1032-027001-000000
14	27	0,65	2,80	110	57	680	1,3	A 14 SS 27	1032-027003-000000
15	27	0,65	3,30	113	63	770	1,2	A 15 SS 27	1032-027004-000000
16	37	0,90	5,10	111	48	1030	3,7	A 16 SS 37	1032-037001-000000
17	37	0,90	5,90	113	52	1150	3,6	A 17 SS 37	1032-037002-000000
18	37	0,90	6,80	117	57	1270	3,5	A 18 SS 37	1032-037003-000000
20	37	0,90	8,70	121	65	1540	3,2	A 20 SS 37	1032-037004-000000
22	42	0,90	9,90	114	60	1490	4,3	A 22 SS 42	1032-042001-000000
24	42	0,90	12,2	118	67	1760	4,0	A 24 SS 42	1032-042002-000000
25	42	0,90	13,5	120	71	1900	3,8	A 25 SS 42	1032-042003-000000
28	52	1,15	21,0	116	63	2550	8,2	A 28 SS 52	1032-052001-000000
30	52	1,15	25,0	121	70	2900	7,7	A 30 SS 52	1032-052002-000000
35	52	1,15	33,5	119	80	3750	6,3	A 35 SS 52	1032-052004-000000
38	62	1,15	40,5	122	75	3600	10,2	A 38 SS 62	1032-062001-000000
40	62	1,15	45,5	124	80	4000	9,5	A 40 SS 62	1032-062002-000000
42	62	1,15	51,0	126	85	4450	8,8	A 42 SS 62	1032-062003-000000
45	62	1,15	60,0	129	94	5200	7,7	A 45 SS 62	1032-062004-000000
48	70	1,15	68,0	128	88	5000	11,0	A 48 SS 70	1032-070001-000000
50	70	1,15	75,0	130	93	5500	10,2	A 50 SS 70	1032-070002-000000
55	70	1,15	93,0	134	105	7000	8,0	A 55 SS 70	1032-070003-000000
60	80	1,15	112	135	101	6800	11,9	A 080 060 IV	1032-080001-000000
65	90	1,15	131	135	97	6700	16,5	A 090 065 IV	1032-090001-000000
70	90	1,15	154	137	106	8000	13,6	A 090 070 IV	1032-090002-000000
75	100	1,15	176	136	102	7800	18,6	A 100 075 IV	1032-100001-000000
80	100	1,15	205	139	111	9300	15,3	A 100 080 IV	1032-100002-000000
85	110	1,15	230	138	107	9000	20,7	A 110 085 IV	1032-110001-000000
100	120	1,15	325	141	118	11900	18,7	A 120 100 IV	1032-120001-000000

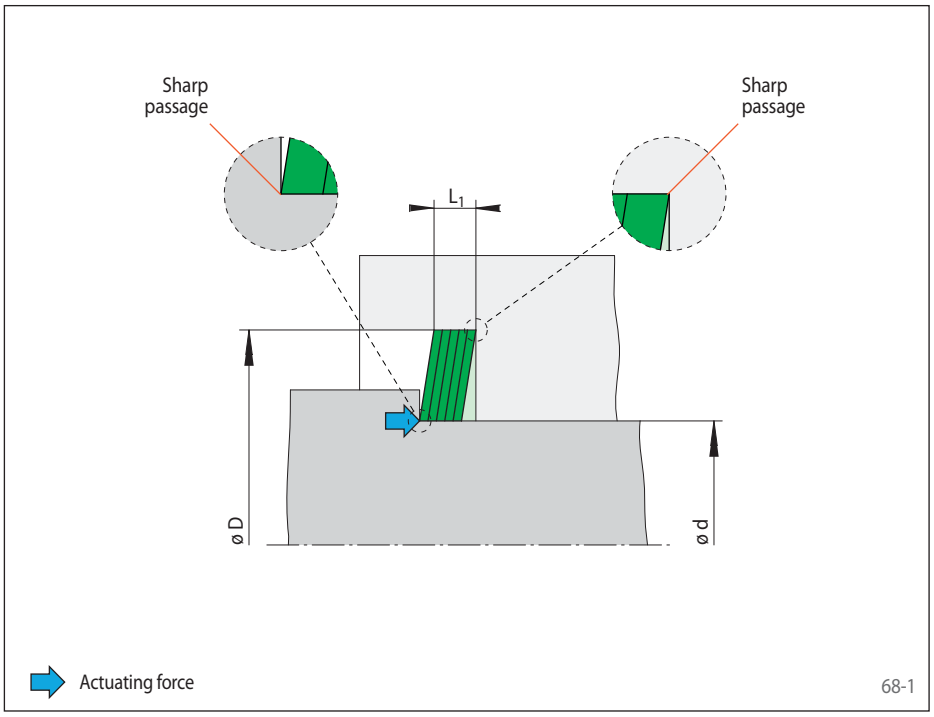
Design points

The outer diameter D of the Star Disc is supported in the bore of the hub to be connected. The Star Disc seats with the concave face of the cone against the fixed backstop point of the hub. The axial actuation force must be applied opposite at the front side of the inner diameter d.

The passages from shaft diameter d and supporting diameter D to the respective plane surfaces must be sharp-edged, without corner arc or undercut.

The shaft must be centred according to the requirements.

If a torque M_A and an axial force F_A are to be transmitted at the same time, please contact us.



Frequent clamping and release

Clamping connections with Star Discs can be easily released repeatedly. They can be clamped and released up to 5 000 times. Star Discs from size A 080 060 IV are durable and not subject to this limitation.

For loosening the clamping connection, displace the hub against the shaft

Preload force

The preload force is achieved by clamping screws to be provided by the customer, with the tightening torque M_S and the preload force for metric screws E_S to be taken from the table to the right.

The preload forces indicated in the table are corrected for friction value deviations.

Size	Preload force E_S [kN]			Tightening torque for μ_k=0,1 M_S [Nm]		
	8.8	10.9	12.9	8.8	10.9	12.9
M 4	3,8	5,5	6,7	2,6	3,9	4,5
M 5	6,3	9,4	11,0	5,2	7,6	8,9
M 6	9,1	13,2	15,5	9,0	13,2	15,4
M 8	16,3	24,0	28,2	21,6	31,8	37,2

Number z and size of the clamping screws are to be chosen so that

E or $E_n = z \cdot E_S \cdot 1\,000$

If the preload force E or E_n is exceeded, the Star Disc will be overstressed or the permissible contact pressure will be exceeded.

Disc Pack

Star Discs are used separately or combined to disc packs according to the required torque. For multiple arrangements in a disc pack of n = 16 Star Discs, the following applies:

Torque $M_n = n \cdot M$

Preload force $E_n = n \cdot E$

Load-bearing axial width $L_1 \approx n \cdot s$

For disc packs with more than 16 Star Discs, any Star Discs exceeding 16 will only transmit approx. 50% of the torque M. The maximum number of Star Discs in a pack is limited to 25.

Hollow Shafts

When clamping Star Discs on hollow shafts, the tangential stress σ_{tWi} must not exceed the yield strength R_e of the hub material.

$$\sigma_{tWi} = 1{,}27 \cdot P_W \cdot \frac{2}{1 - C_W^2} \quad \text{with}$$

$$C_W = \frac{d_{Wi}}{d}$$

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Hub Design

The contact pressure P_W leads to radial stress in the shaft that is usually not critical for solid steel shafts.

There is always a tangential stress σ_t in the hub, and for thin-walled hubs it may be a multiple of the initiated pressure P_N. The amount of the applicable tangential stress depends on the load-bearing hub width N_{min} the hub outer diameter K_{min} and the pressure P_N. For the load-bearing hub width N_{min} is taken into account, that the hub pressure P_N is carried by the load-bearing width L_1, and in an angle of ca. 26,5° beyond it (see figure 69-1).

When the load-bearing hub width N_A and the yield strength R_e of the hub material are given, the required hub outer diameter K_{min} can be calculated approximately as follows:

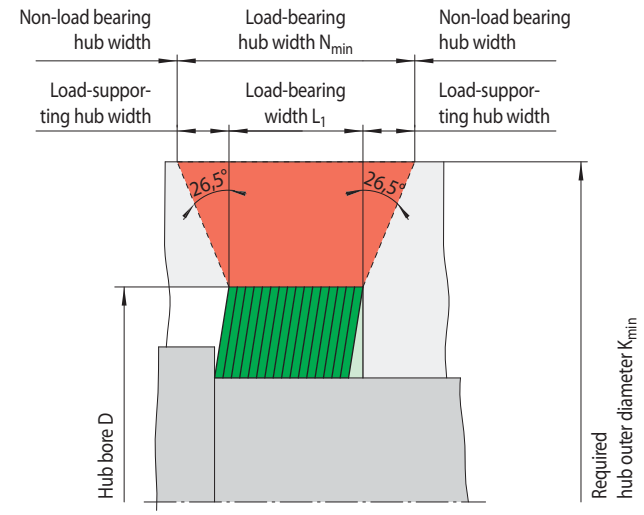
$$K_{min} = 1{,}2 \cdot D \cdot \frac{H - 1{,}25}{H - 3} \quad \text{with}$$

$$H = \left(\frac{R_e}{1{,}27 \cdot P_N} \cdot \frac{N_A}{L_1} \right)^2$$

When the hub width N_A and the hub outer diameter K_A are given, the hub material yield strength R_e must be higher than the equivalent stress σ_v in the hub.

$$\sigma_v = 1{,}27 \cdot P_N \cdot \frac{L_1}{N_A} \cdot \frac{\sqrt{3 + C_N^4}}{1 - C_N^2} \quad \text{with}$$

$$C_N = \frac{D}{K_A}$$



Load-bearing hub width 69-1

Formula symbols

d = Shaft diameter [mm]
d_{Wi} = Inner hollow shaft diameter [mm]
D = Hub bore [mm]
E = Preload force according to table [N]
E_n = Preload force disc pack [N]
E_S = Preload force for metric screws according to table [kN]
F_A = Maximum actual application axial force [kN]
K_A = Hub outer diameter in the application [mm]
K_{min} = Required hub outer diameter according to table or calculation [mm]
L_1 = Load-bearing axial width [mm]
M = Transmissible torque according to table [Nm]
M_A = Maximum actual application torque [Nm]
M_n = Max. transmissible torque of the Star Disc pack [Nm]
M_S = Screw tightening torque [Nm]
n = Number of star discs in the pack
N_A = Load-bearing hub width in the application [mm]
P_N = Contact pressure at the hub according to table [N/mm²]
P_W = Contact pressure at the shaft according to table [N/mm²]
R_e = Hub material yield strength [N/mm²]
s = Axial width according to table [mm]
z = Number of clamping screws
σ_t = Tangential stress in the hub [N/mm²]
σ_{tWi} = Tangential stress in the hollow shaft [N/mm²]
σ_v = Equivalent stress in the hub [N/mm²]

C_N, C_W and H are reference values without units.