SKF Supergrip Bolt for rotating flanges

Contents

Cut down on downtime

At a time when maintenance cost efficiency in heavy industries is a make-or-break factor in operational economy, the time-saving SKF Supergrip concept can cut costs and increase revenues dramatically.

When you connect your flanges with SKF Supergrip Bolts, there is no uncertainty about the length of downtime for removing the bolts. No worry about whether the bolts have jammed or seized in the holes. You know that once the tension and expansion pressure has been released, each bolt will slide out as easily as it went in.

In the marine industry, couplings have to be disassembled periodically for surveys. Ships equipped with SKF Supergrip Bolts have consistently cut the time to remove and remount propeller shaft coupling bolts.

Steam and gas turbine couplings must be separated at certain intervals for overhaul, inspection and levelling. A study released by the Swedish State Power Board on the comparison of individually fitted bolts with SKF Supergrip Bolts, showed a significant reduction in the time required to disassemble and reassemble the couplings of two turbine sets (eight couplings).

The unit equipped with SKF Supergrip Bolts was reconnected to the power grid 48 hours earlier than the unit with conventional bolts. Total saving was 19 200 000 kWh (48 hours x 400 MW).

The potential savings with SKF Supergrip Bolts over the lifetime of a ship or power station are substantial when translated into profit. It is easy to see therefore, why we have delivered some 150 000 bolts over the years!

New technology meets an old challenge

Struggling with conventional bolts

Prior to the introduction of the SKF Supergrip Bolt, mounting and dismounting of large rotating flange couplings connected with fitted bolts was a poor economical and technical solution.

Fitted bolts that have to be "mauled" into place with a sledge hammer after time-consuming honing of the holes and individual grinding of the bolts can hardly be termed high technology.

Even with the most qualified bolt fitter, it is hard to achieve an interference fit. In most cases, there will be a small gap, and after a certain time in service, the clearance may increase, resulting in high bolt stresses and vibrations.

No matter what the application, at some time in the future, you will be right back where you started as each of the bolts will have to be removed. And the job will be further complicated by trying to drive or bore out conventional bolts that have seized in the hole due to fretting, over-stressing, or too tight a fit.

The SKF Supergrip Bolt offers a significantly better solution for connecting rotating flanges. Compared with traditional bolt systems, SKF Supergrip Bolt are easier to install and remove, taking much less time, holding the coupling halves together far more securely and they are fully reusable.

The torque in a coupling connected with SKF Supergrip Bolt is transmitted in two ways: Mainly by the shear strength of the expanded bolt in the hole, and by the friction effect at the flange faces created by preloading the bolt. Both effects are controlled and measurable.

Hand pump

Flexible hose with quick disconnect coupling

Air-driven pump

Compact bolt with tools

Toolbox

Tools for hydraulic bolts

Advantages

Designed specifically for such high torque applications as propeller shafts, rudder assemblies, gas and steam turbines generators, rolling mills and similar applications, the SKF Supergrip Bolt offers significant advantages:

- Simplified machining of the holes and no grinding of the bolts. You eliminate re-reaming and re-honing. The bolts are designed to be inserted and removed with an initial clearance fit. There is no risk of seizure.
- Easy to install and remove. Compared with conventional systems, you can drastically cut the time required for installing and replacing bolts.
- Expansion and preload set to predetermined levels. Coupling slippage is eliminated due to the powerful interference fit (zero clearance) and high axial preload.
- Simplified shaft alignment. Controlled and gradual bolt expansion ensures that concentricity between the flanges is quickly restored.
- Fully interchangeable and can be used repeatedly. No need for a set of spare bolts.
- The SKF Supergrip Bolt has been approved for use by all leading international and national classification societies and regulatory bodies.

Additional savings at the design stage

Due to the uniform torque transmission between the bolts, combined with the friction force created between the flanges, the number and/or diameter of the bolts in the coupling can be reduced, while still retaining a good safety margin.

By reducing the bolt diameter, the flange diameter can also be reduced, resulting in more compact and less expensive coupling flanges.

Tools and pumps
Tool set for SKF Supergrip Bolts consists of: tensioner, dismounting collar, mounting collar, distance collar and tommibar.

Tool set for SKF Power Bolts also includes: safety adapter, extension pipe and mandrel.

All tools are manually operated and hand portable. The tools will be delivered in a toolbox.

For mounting the bolts, a pump is required; a hand pump or an air-driven pump is recommended.

How SKF Supergrip works

The bolt is threaded at both ends and has a tapered shank. An expansion sleeve with a corresponding tapered bore fits over the shank. Two nuts complete the unit.

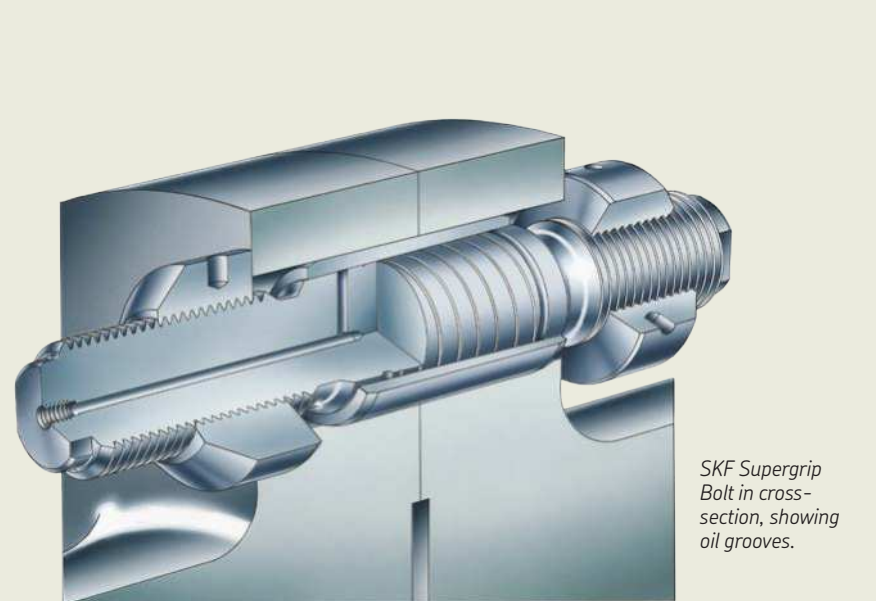
The outside of the sleeve is cylindrical and dimensioned for an initial clearance fit in the bolt hole corresponding to 0,05 to 0,15% of the bolt hole diameter. There is no high surface finish requirement in the hole. Normal boring is sufficient.

The bolt is inserted into the hole by hand. The sleeve is expanded to a radial interference fit by drawing the tapered shank into the tapered bore of the sleeve. The bolt is then tensioned against one nut while the other nut is hand tightened. A preload is exerted on the bolt by releasing the pressure on the tensioner.

Preloading will cause a slight reduction in the bolt diameter. However, this contraction has already been offset by the expansion of the sleeve.

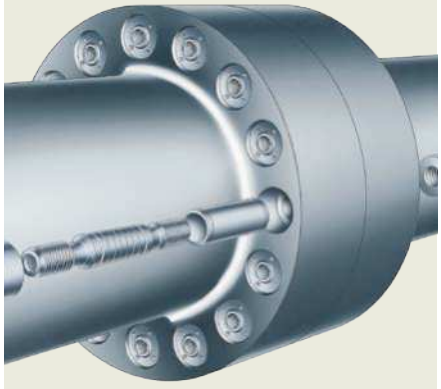
Sleeve expansion and tensioning of the bolt are carefully controlled by using the tensioner included in the tool set.

For removal, the bolt is released from the sleeve by injecting oil between the mating tapered surfaces. The oil is fed through a connection in the center of the bolt.
The maximum working pressure of the tensioner is 150 MPa (*21 300 psi*). A pressure gauge on the pump permits accurate control of the expansion and tensioning forces.



SKF Supergrip Bolt in cross-section, showing oil grooves.

The complete SKF Supergrip Bolt program



The compact SKF Supergrip Bolt – OKBC

SKF Supergrip combination system – OKBS & OKBT

SKF Supergrip dowel pin – OKBD

The compact SKF Supergrip Bolt – OKBC

Compact SKF Supergrip Bolts are designed with flush bolt ends to save space. Flush ends are normally a requirement for connecting steam turbine couplings, to reduce windage and noise levels.

SKF Supergrip Bolts can be used with straight or counter bored flanges.

When a close weight tolerance of the coupling is required for shaft balancing, the bolts can be delivered to meet weight specifications.

SKF Supergrip combination system – OKBS & OKBT

When mounting SKF Supergrip Bolts in couplings with a set number and diameter of the bolts, (such as crankshaft and gearbox flanges) or when retrofitting existing couplings, the number of bolts can often be reduced, while still ensuring a rigid fit for transmitting the torque.

However, in order to guarantee a symmetrical load distribution, the minimum number of bolts in a coupling should not be less than eight. To fulfill this requirement, we have developed a system in which the SKF Supergrip Bolts are combined with free-fitting tie bolts.

The tie bolts are tensioned and preloaded in the same way, and with the same tensioner, as the SKF Supergrip Bolts.

This combination system is particularly advantageous when bending and axial force are high in relation to torque. The tie bolt requires less machining due to clearance and the total cost per coupling is reduced, as the tie bolt is used only for clamping.

SKF Supergrip dowel pin – OKBD

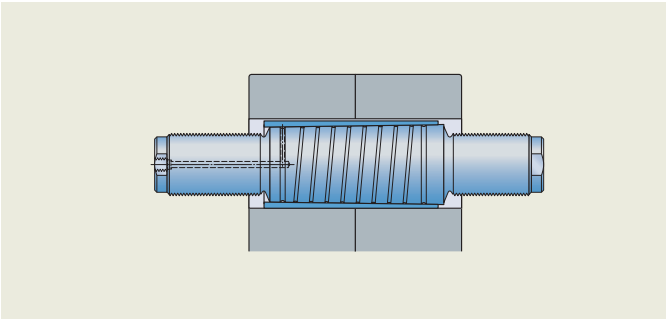
For connecting a flange to a hub with blind holes, we have developed a special SKF Supergrip system, featuring a unique dowel pin combined with tensioned tie bolts.

Applications include build up of electrical rotors, flange-mounted propellers, bolt-on propeller blades and exciter couplings. The dowel pin can also be used to firmly position machinery and to plug drain pipes or holes in pressure vessels.

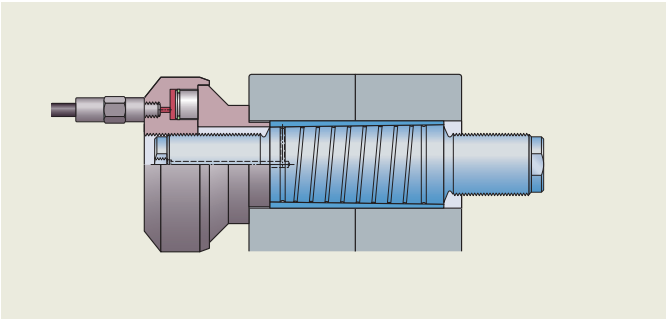
The dowel pin is also an excellent solution for plugging holes in nuclear power reactor vessels. SKF Supergrip dowel pins have already been proven in a reactor vessel during modification programs, when the piping connected to the reactor vessel had to be removed. SKF Supergrip pins plugged the holes from the inside of the vessel in an active environment, at a depth of nine meters. Installation was easy and the plugging action was secure.

Fitting the SKF Supergrip Bolt

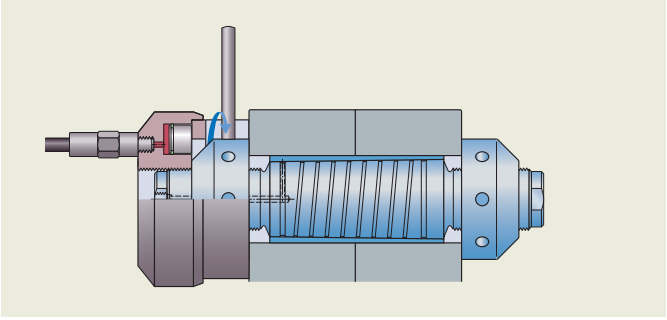
1. Since the bolt is initially smaller than the hole, it is easily inserted by hand.



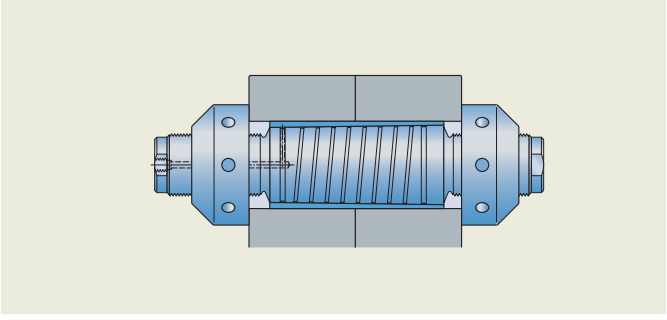
2. The tapered shank is drawn into the sleeve by the tensioner, creating a controlled radial interference fit.



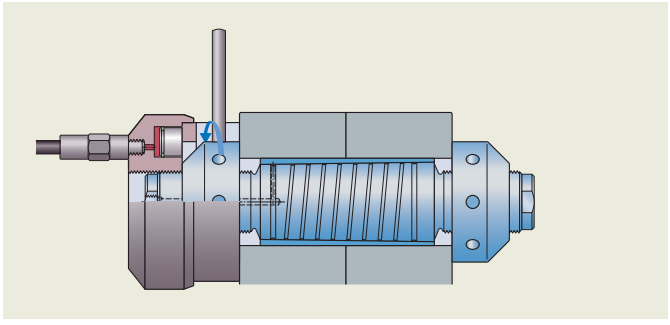
3. After mounting the nuts, the bolt is tensioned to a high axial preload.



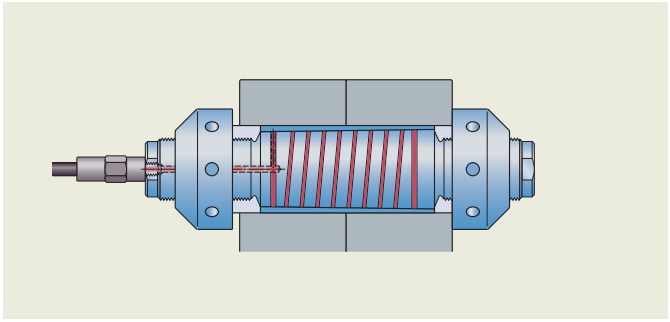
4. After disconnecting the pump and tensioner, the bolt is ready to transmit high torque.



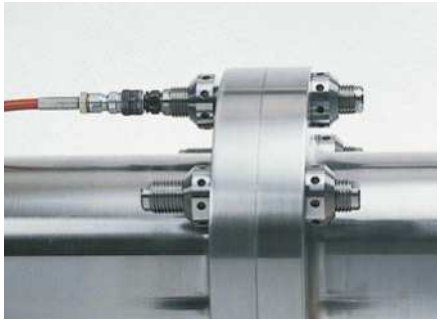
Removing the SKF Supergrip Bolt

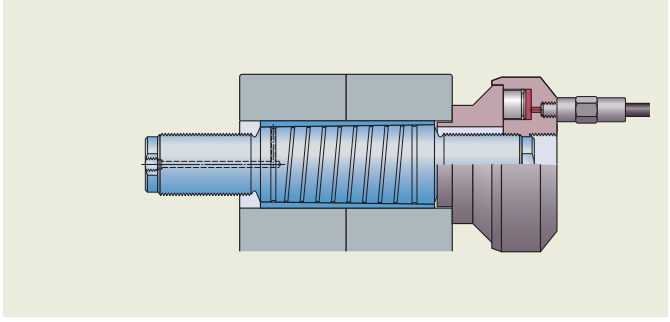


5. The tensioner is connected and pressurized and one nut is released.

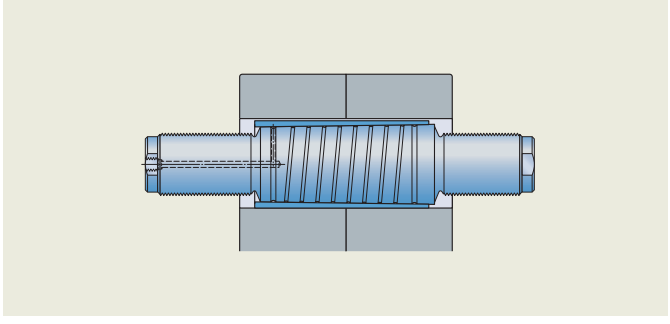


6. The pump is connected to the center of the bolt. Oil is injected to release the bolt from the sleeve. The bolt slides out of the taper and the sleeve immediately regains its original diameter.



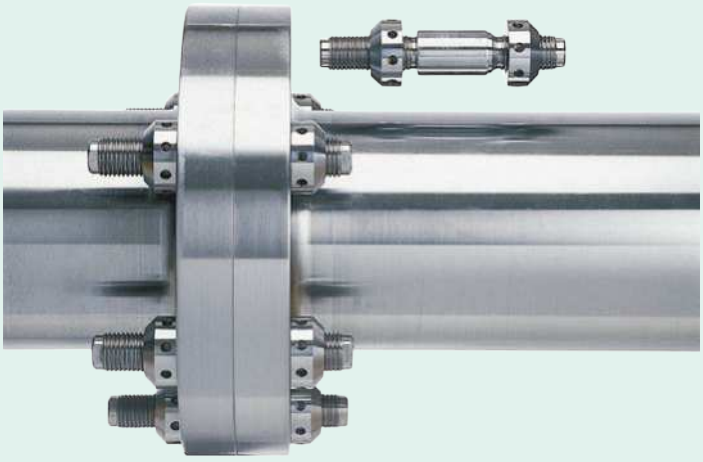


7. As an alternative, the bolt can be pulled out from the sleeve, with the tensioner mounted on the opposite side.



8. After unscrewing the nuts, the bolt and sleeve can be easily withdrawn by hand.

Design and size recommendations



Sizing us up

The aim in designing the flange coupling is to optimize the number and size of the bolts for the flange coupling, as well as the dimensions of the flanges.

The number of bolts in a coupling should not be less than eight.

The standard SKF Supergrip Bolt is designed for a maximum shear stress of 280 N/mm^2 and a maximum axial stress of 350 N/mm^2.

Definitions

T_N	Nominal torque [Nm]
T_D	Design torque [Nm]
T_S	Torque transmitted by Supergrip Bolts [Nm]
T_T	Torque transmitted by tie bolts [Nm]
n_1	Number of Supergrip Bolts
n_2	Number of tie bolts
S	Shock factor
K_1	Max shear force [N]
K_2	Tensioning force on the Supergrip [N] Bolts (from Table 2)
K_3	Tensioning force on the tie bolts [N] (from Table 2)
a	Flange material factor (from Diagram 1)
b_1	Factor for remaining prestress in Supergrip Bolts = 0,7
b_2	Factor for remaining prestress in tie bolts = 0,8

Geometrical dimensions

E	Pitch circle diameter [mm]
d_1	Nominal hole diameter Supergrip Bolt [mm]
d_2	Nominal hole diameter tie bolt [mm]
d_3	Shaft diameter [mm]
G	Bolt thread [mm]
D_1	Outer diameter of the flange [mm]
D_D	Outer diameter of the tensioner [mm]
B_1	Long threaded bolt end Supergrip Bolt [mm]
B_2	Short threaded bolt end Supergrip Bolt [mm]
B_3	Short threaded bolt end tie bolt [mm]
C_{min}	Min thickness of both flanges together [mm]
D_M	Nut diameter [mm]
F	Nut thickness [mm]
R_{min}	Min radius for use of standard tool design [mm]
H_1	Min space to operate tensioner [mm]

Design torque

The design torque is determined in accordance with

$T_D = T_N\, S$ [Nm] [**1**]

The shock factor S can be selected from the table below.

Table 1

Shock factor S

Type of power source	Type of load on the driven machine		
	Uniform load[1]	**Moderate shock loads**[2]	**Heavy shock loads**[3]
	Group 1	Group 2	Group 3
Electric motor, turbine	2,0–2,25	2,25–2,5	2,5–2,75
Multiple cylinder piston engine	2,25–2,5	2,5–2,75	2,75–3,0
Single cylinder piston engine	2,75–3,0	3,0–3,25	3,25–4,0

1) Centrifugal pumps, fans, light conveyors, turbo compressors, agitators
2) Piston compressors, small piston pumps, cutting tool machines, packeting machines, wood working machines
3) Excenter presses, draw benches, plane machines, large piston compressors

When the bolt is intended for marine applications, the shock factor must be approved by the classification society involved.

Number of SKF Supergrip Bolts

Start with assuming a bolt size, then determine the pitch circle diameter E as follows

$E = d_3 + D_D + 10$ [mm] [**2**]

Calculate max shear force per bolt for the selected bolt size

$$K_1 = 280\, \frac{\pi\, d_1^2}{4}\, a \text{ [N]} \qquad [\mathbf{3}]$$

The number of Supergrip Bolts is then determined from

$$n_1 = \frac{T_D\, 2}{E(K_1 + K_2\, b_1\, 0{,}15)}\, 10^3 \qquad [\mathbf{4}]$$

If the number of SKF Supergrip Bolts is less than eight, select a smaller bolt size and repeat the calculation.

Outer diameter of the flange

The outer diameter of the flange is determined from

$D_1 = E + 1{,}6\, d_1$ [**5**]

Combination system

In situations where the SKF Supergrip combination system is used, for instance at retrofitting, the numbers of SKF Supergrip Bolts and tie bolts are selected as follows.

The design torque is determined in accordance with formula.

Select an SKF Supergrip Bolt size and determine the pitch circle diameter in accordance with formula.

The number of tie bolts should be a multiple of the number of SKF Supergrip Bolts (1, 2, 3 etc.).

Select a suitable number of SKF Supergrip Bolts n_1 not less than four.

Calculate the torque transmitted by the SKF Supergrip Bolts:

$$T_S = n_1 \frac{E}{2} 10^{-3}(K_1 + K_2 b_1 0{,}15) \text{ [Nm]}$$

Determine the torque needed to be transmitted by the tie bolts from
$T_T = T_D - T_S$ [Nm]

The number of tie bolts n_2 is then calculated from

$$n_2 = \frac{T_T 2}{K_3 b_2 E 0{,}15} 10^3$$

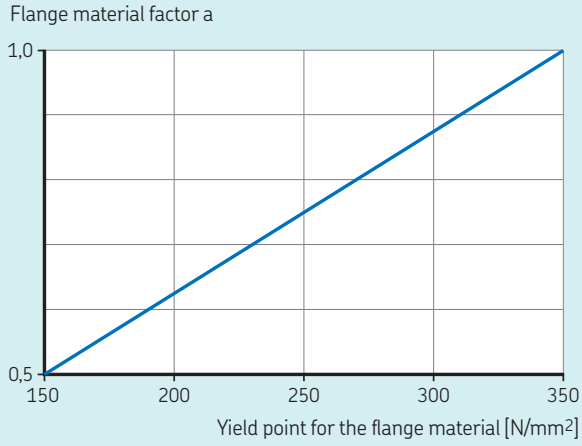
Table 2

Bolt diameter over	to	Thread	$K_2 x 10^3$	$K_3 x 10^3$
mm			N	
40	44	M33	302	366
44	49	M36	352	429
49	51	M39	427	518
51	55	M42	488	592
55	58	M45	573	696
58	62	M48	647	786
62	68	M52	779	946
68	73	M56	898	1 090
73	78	M60	1 053	1 278
78	83	M64	1 194	1 450
83	88	M68	1 372	1 666
88	93	M72	1 562	1 896
93	98	M76	1 764	2 142
98	104	M80	1 978	2 402
104	112	M85	2 264	2 749
112	118	M90	2 569	3 119
118	124	M95	2 893	3 513
124	130	M100	3 236	3 930
130	138	M105	3 599	4 370

Flange material factor a

Due to the contact stress in the flange when the coupling is in service, the flange material must be considered.

Diagram 1

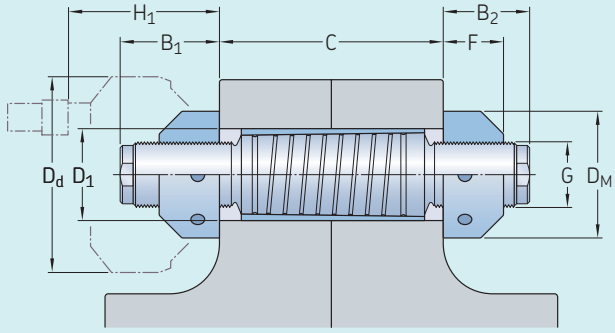


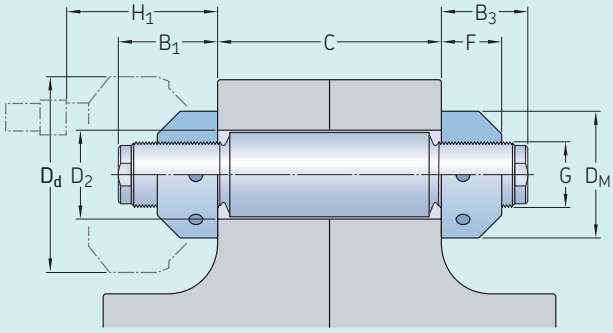
Material specification

Bolt shank, sleeve and nuts:
Grade SS 2541 equivalent to B.S. 817M40
DIN 34NiCrMo6
SAE 4337
Mechanical properties: R_eL = 700 N/mm²
A_5 = min 15%

Conversion table

1 N = 0,102 kp = 0,225 lb
1 Nm = 0,102 kpm = 0,738 lb × ft
1 MPa = 10,2 kp/cm² = 0,145 × 10^3 lb/in²
1 N/mm² = 0,102 kp/mm² = 0,145 × 10^3 lb/in²
1 m = 39,37 in.
1 mm = 0,03937 in.
1 in. = 25,4 mm
0 °C = 273,15 K = 32 °F





Typical dimensions

SKF Supergrip Bolt									Tie bolt				Mounting tools	
Nom. hole diameter D_1	Thread	Recomm. thickness of both flanges C_{min}	Long threaded bolt end B_1	Short threaded bolt end B_2	Nut thick-ness F	Nut dia-meter D_M	Total weight Compl. bolt	Addition for every 10 mm $>C_{min}$	Nom. hole dia-meter D_2 + 0,1 mm	Short threaded bolt end B_3	Total weight Compl. bolt	Addition for every 10 mm $>C_{min}$	Outer diam. of ten-sioner D_d	Min. space to operate ten-sioner H_1
mm	–	mm					kg	mm			kg	mm		
40–(44)	M33x3,5	126	64	51	27	58	2,5–2,7	0,05	34	35	1,9	0,05	88	142
44–(49)	M36x4	140	70	56	29	63	3,3–3,6	0,06	37	37	2,5	0,06	102	149
49–(51)	M39x4	143	78	62	31	67	4,1–4,2	0,07	40	41	3,5	0,07	102	157
51–(55)	M42x4,5	155	83	66	34	72	5,0–5,3	0,08	43	44	4,3	0,08	118	157
55–(58)	M45x4,5	160	87	69	36	76	6,0–6,2	0,09	46	46	5,2	0,09	118	161
58–(62)	M48x5	172	91	72	39	81	7,3–7,6	0,10	49	49	6,3	0,10	136	177
62–(68)	M52x5	185	99	78	42	89	9,2–9,8	0,13	53	52	8,0	0,13	136	185
68–(73)	M56x5,5	199	106	83	45	96	11,5–12,2	0,14	57	55	10,0	0,14	156	198
73–(78)	M60x5,5	209	114	90	48	102	14,1–14,8	0,17	61	60	12,2	0,17	156	206
78–(83)	M64x6	222	122	96	52	109	17,2–18,1	0,19	65	64	14,9	0,19	178	231
83–(88)	M68x6	233	128	101	55	116	20,4–21,3	0,22	69	67	17,7	0,22	178	237
88–(93)	M72x6	243	134	105	58	122	24,0–25,0	0,25	73	70	21,0	0,25	198	245
93–(98)	M76x6	254	140	110	61	130	28,3–29,5	0,28	77	73	24,5	0,28	198	251
98–(104)	M80x6	267	146	114	64	137	33,0–34,6	0,32	81	76	28,5	0,32	236	282
104–(112)	M85x6	284	154	120	68	147	39,9–42,3	0,36	86	80	34,3	0,36	236	290
112–(118)	M90x6	297	162	126	72	155	47,5–49,5	0,41	91	84	40,6	0,41	268	310
118–(124)	M95x6	309	170	132	76	164	55,6–57,9	0,46	96	88	47,4	0,46	268	318
124–(130)	M100x6	321	178	138	80	172	64,2–66,6	0,52	101	92	55,1	0,52	296	334
130–(138)	M105x6	339	186	144	84	182	74,6–78,3	0,58	106	96	64,0	0,58	296	342

The table above shows the typical dimensions. All bolts are tailor-made to suit each specific application. Other dimensions are possible on request.

Hole preparation and initial installation

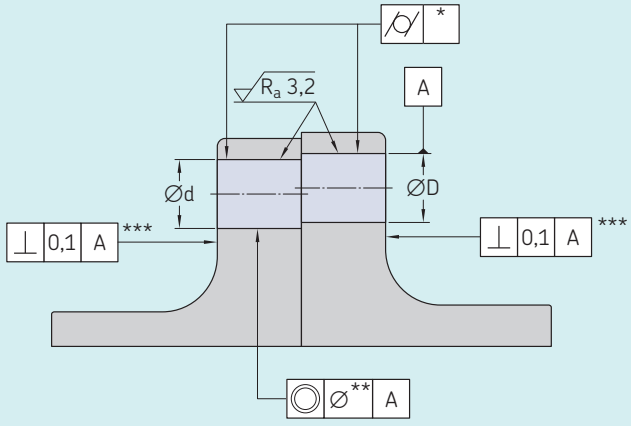
Individual bolt hole quality is an important part of realizing the time-saving benefits of using the SKF Supergrip Bolt.

For most applications, the recommended method is to pull the flanges together using temporary bolts and make sure that the holes match and the shafts are aligned according to the specifications. With the flanges together, the holes in the flanges can then be machined as one hole, simplifying the process significantly.

You only require a one-off investment for machining your holes and a one-off purchase of bolts – as they are fully re-usable over the lifetime of your equipment. The earlier you install the SKF Supergrip Bolt, the more you will benefit from the available time-savings.

For applications which require other machining processes and holes outside the specified recommendations please consult with SKF for advice on the best solution.

SKF can provide complete packages for line boring, sleeve machining and installation that minimize impact on the critical path and optimize bolt function with holes and sleeves machined to specification.



Normal diameter D, d	**Hole tolerance**	**Cylindricity (*)** ISO IT7/2 or IT8/2	**Coaxiality (**)** ISO IT7 or IT8
mm	mm	mm	mm
40–(50)	H7 $^{+0,025/0,0}$	0,013	0,025
50–(58)	H7 $^{+0,030/0,0}$	0,015	0,030
58–(80)	H8 $^{+0,046/0,0}$	0,023	0,046
80–(120)	H8 $^{+0,054/0,0}$	0,027	0,054
120–180	H8 $^{+0,063/0,0}$	0,032	0,063

* Cylindricity
** Coaxiality
*** Nut face area

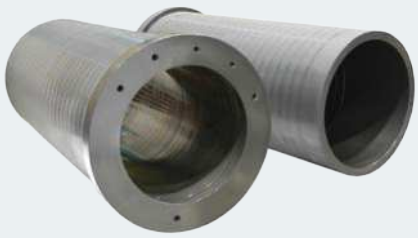
Our track record in torque transmission

Since the 1940s, more than 50 000 SKF OK oil-injection shaft couplings have been delivered to owners and operators in the marine, steel, power and other industries for high-torque transmission applications.

The innovative SKF OK coupling, which requires only a cylindrical shaft, is based on the principle of transmitting torque by applying a powerful interference fit, instead of using shaft-weakening keyways.

And with the SKF oil injection method, mounting and dismounting of these couplings takes only a fraction of the time required for conventional devices.

The same advanced design has been applied to the coupling bolt. SKF Supergrip Bolts represent a "quantum leap" in improving the technology of connecting rotating flange couplings. They are already on the job – on land and at sea – delivering the performance that supports the claim of them being better than any other coupling bolt available on the market.



SKF Propeller sleeve – OK00

SKF High-friction flange coupling – OKFX

SKF Flange coupling – OKF

SKF High-friction shaft coupling – OKCX

Shaft flange with SKF Supergrip Bolts

SKF Hydraulic coupling – OKC

SKF Supergrip Bolts have been installed on rotating flange couplings in a wide range of marine, power and many other industrial applications worldwide. The SKF Supergrip Bolt has been approved for use by all leading international and national classification societies and regulatory bodies.

The cruise liner Seven Seas Explorer was launched in 2016. The 224 meter, 10-deck passenger vessel carries up to 750 passengers. Selected products supplied: 60 SKF Supergrip Bolts – OKBS and 4 SKF coated hydraulic couplings – OKCX.

With a TEU capacity of 16,652 the MSC Hamburg is one of the largest container vessels in the world. Selected products supplied: 36 SKF Supergrip Bolts as well as toolsets.

In 2007, the container vessel Elly Maersk became the sixth of the eight vessels currently in the Maersk E-Class of container ships. Selected product supplied: SKF hydraulic nut, OKTC size 880.

Did you know that the Harmony of the Seas is bigger than the Eiffel Tower? With a beam of 66.5 meters, length of 361 meters, this ship really is superlative. Selected products supplied: SKF OK propeller sleeve size 630 – OK00.

TEPCO (Tokyo Electric Power Company) is a leading provider of electricity and power generation. Since the first delivery of SKF Supergrip Bolts in 1991, these products have helped TEPCO to reduce costs by decreasing the number of regular inspections required.

SKF Coupling Systems was established in the early 1940s when SKF's Chief Engineer, Erland Bratt, invented the SKF oil injection method. As a result of continuous development, SKF is currently a world leader in selected market niches.

Our business concept is to develop, produce and supply products based on the SKF oil injection method. These products significantly reduce downtime while decreasing maintenance costs of the capital-intensive equipment in which they are used.

couplings.skf.com | skf-marine.com

PUB 43/P2 17232 EN · May 2017

SKF Sverige AB
SKF Coupling Systems

SE-813 82 Hofors, Sweden.
Tel: +46 290 284 00. Fax: +46 290 282 70
E-mail: skf.coupling.systems@skf.com