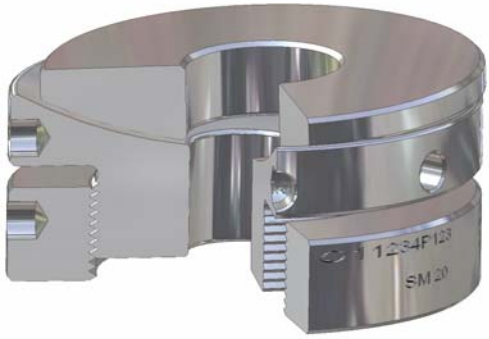
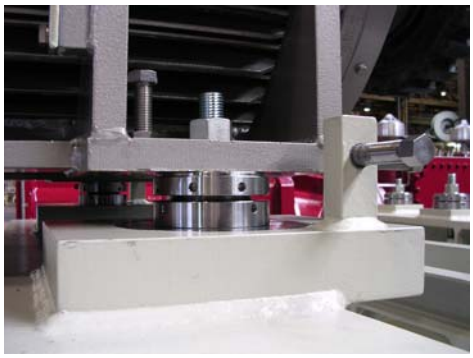
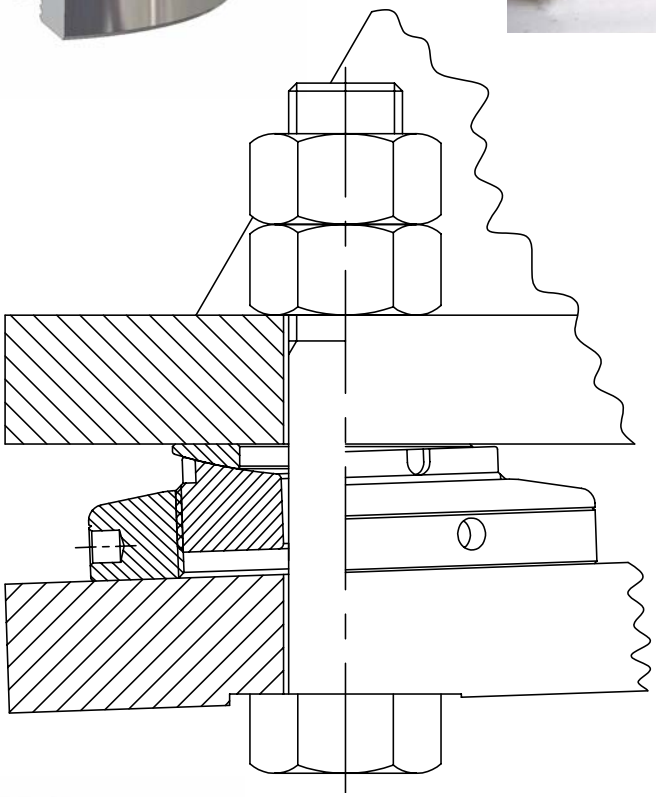
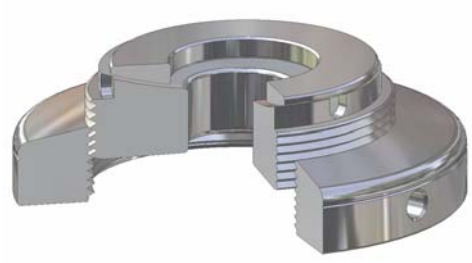
Vibracon®
Application Design Instructions









6 Vibracon® Application Design Instructions

6 Application design instructions

As a service to our customers, Machine Support offers you the engineering of a chocking proposal for your application free of charge. To receive a chocking proposal please take a look at chapter 2 paragraph 2.1 “How to get a Vibracon® chocking proposal free of charge”

This chapter is a guideline to design applications with Vibracon® chocks. The basic designs we are showing here, are approved by most shipbuilding classification societies, if not we will indicate this.

6.1 Choosing the element size

In general, we advise you to follow the machine designer’s rules of foundation bolts. If for example an E-motor should be secured with M36 foundation bolts than just use SM36 Vibracon® chocks. It is always possible to request a detailed calculation of the size of chocks. Machine Support BV has special software for calculating the chock size and bolt data.

Starting to design a Vibracon® chocks application:

- check with all involved parties (machine manufacturer, shipyard, owner, classification society) if they approve on the use of the Vibracon®;
- inform your local dealer or Machine Support if there are any objections against the use of the elements;
- check the available chock height, for new installations we advise to use the nominal element height as the engineering height;
- check the bolt dimension;
- check the minimum distance between two bolts (minimum pitch);
- make sure that the bottom ring of the chock is fully supported;
- make sure that at least 75% of the top part of the chock is covered by the foot of the machine;
- if the pre-selected chock doesn’t fit in your application please inform your local dealer or Machine Support.

For critical applications like propulsion units or large equipment (over 20 tons) we advise you to contact your local dealer or Machine Support for a detailed calculation and sound advice.

The method for determining the size of elements is based on the calculation of two forces:

$$F_{weight} = \frac{M \times 9.81}{n \times 1000} \qquad (1)$$

$$F_{torque} = \frac{P}{R \times W \times 0.5\,n} \times \frac{60000}{2 \times \pi} \qquad (2)$$

Where: F_{weight} = Force due to the weight of the machine (kN)
F_{torque} = Force due to the reaction torque of the machine (kN)
M = Mass (kg)
n = Number of elements (use all bolt holes, unless machine manufacturer has given his approval to reduce the number of bolts).
P = Power (kW)
R = Revolutions (rpm)
W = Width of foundation, measured between bolt holes (mm)

When the chock dimension has to be calculated for a gearbox, it is preferred that the gearbox manufacturer submits the data for the maximum and minimum force on each bolt position.

If the gearbox manufacturer is not able to give these figures Machine Support can calculate these based on introducing a thrust force factor in combination with a tilting line.

The total machine load on the element is now:

$$F_{vibracon} = S \times (F_{weight} + F_{torque} + F_{thrust}) \qquad (3)$$

Where S is a safety factor which is:

1.5 for non-reciprocating machinery like generators, E-motors and gearboxes.
2 for reciprocating machinery like diesel engines and reciprocating compressors.

After we have determined the machine load on the element it is possible to select a **minimum** size of Vibracon® chock with the “Standard Vibracon® Original general design table” figure 6.6.2 of chapter 6 or for the low profile configuration with the “Standard Vibracon® Low Profile general design table” figure 6.7.2 of chapter 6.

Very Important: If the size of the Vibracon® chock is smaller than the corresponding size of the bolt which the manufacturer has determined, then please select the chock that fits to this bolt size.

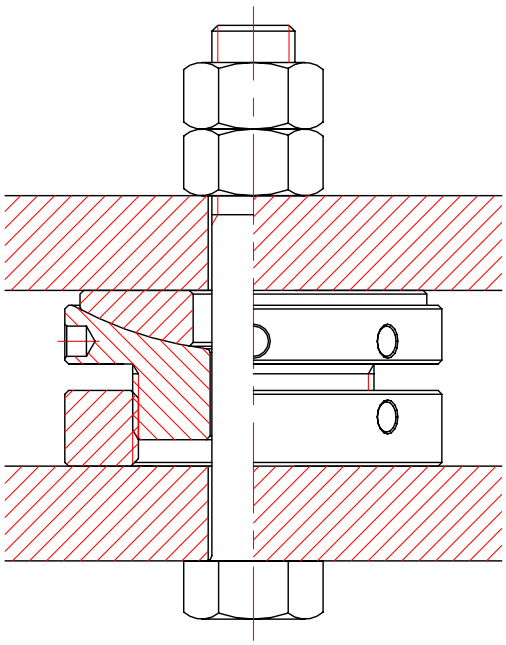


Figure 6.1.1 General arrangement of Vibracon® Original

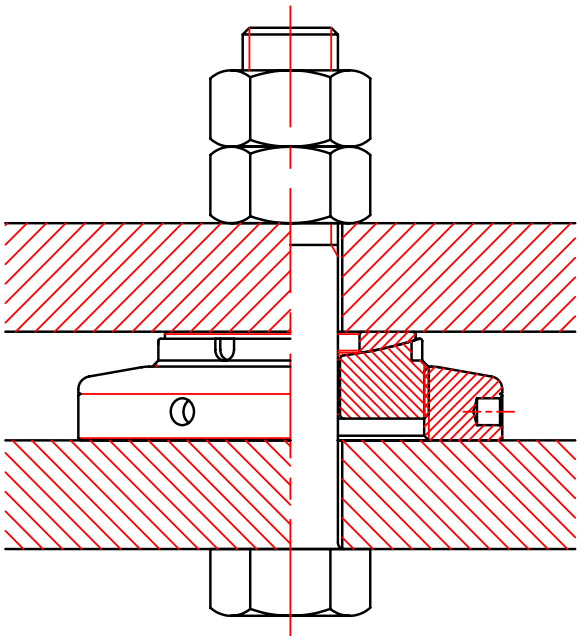


Figure 6.1.2 General arrangement of Vibracon® Low Profile

6.2 Determining the bolt torque and length

We advise to use 8.8 graded bolts, yield strength > 630 N/mm², in Vibracon® applications. The advised bolt torque can be found in the "Standard Vibracon® Original general design table" figure 6.6.2 or for the low profile configuration with the "Standard Vibracon® Low Profile general design table" figure 6.7.2 of chapter 6.

We advise to ensure that the foundation bolt has a minimum elongation of: **0.20 mm**

There are several alternatives to get enough elongation in the foundation bolt, the commonly used are mentioned below:

1. Creating enough clamping length by using an extension sleeve;
2. Reducing the shank diameter (contact your local dealer or Machine Support for a calculation of the elongation).

The clamping length is the total distance between bolt head and nut, this distance is equal to the sum of:

- Machine foot thickness (bed plate thickness)
- Final Vibracon® height
- Foundation thickness (top plate thickness)
- Extension sleeve height (alternatively the length of the spherical washer)

Machine Support recommends the use of so called spherical washers, of which the final height will be determined after the alignment has been performed, to ensure 100% mating surface of bolt head and nut mating surface to prevent bending stresses in the bolt connection.

If spherical washers are used ensure yourself that the mating surfaces are convex / concave instead of convex / conical!

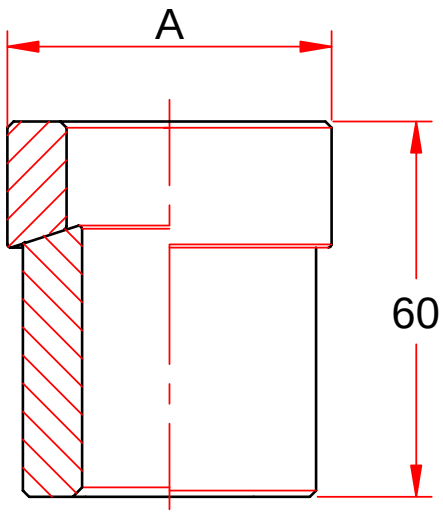


Figure 6.2.1 Machine Support Spherical Washers (SW)

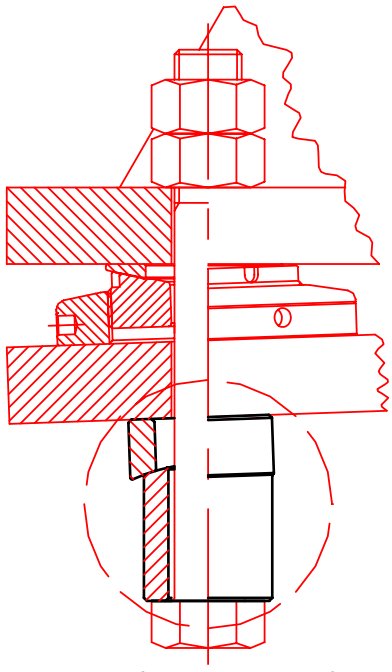


Figure 6.2.2 General arrangement of Machine Support Spherical Washers (SW)

Material: Alloy Steel DIN 1.7225 (other materials on request).

Article no.	***Diameter (A)***
SW16	33 mm
SW20	42 mm
SW24	47 mm
SW27	52 mm
SW30	56 mm
SW36	67 mm
SW42	82 mm
SW48	92 mm
SW56	102 mm
SW64	112 mm

Figure 6.2.3 Machine Support Spherical Washers (SW) table

The height of the Spherical Washer is 60 mm for all types.

6.3 Machining the foundation: Yes or No?

Before installing the chocks on a foundation, it should be checked for its quality:

a) The bottom ring area of the Vibracon® should be covered by the foundation for 100%. The spherical top part of the chock must have at least 75% contact with machine foot;
b) Foundation roughness should be sandblasted quality of Sa 2.5 minimum or machined Ra 6.3;
c) To check the flatness of the top plate of the foundation, at the location of the Vibracon®, a feeler gauge of 0.05 is to be used to fit the circumference of the bottom ring of the element;
d) The contact surface between foundation and bottom ring of the Vibracon® should be checked using the bottom ring of the element until a evenly distributed load bearing surface of a minimum which is given by the machinery manufacturer or classification society. In all other cases we recommend a minimum load bearing surface of 75%;
e) The taper between foundation and machine feet should be less than 4°;
f) The foundation and machine foot should be free from paint and grease.

If machining of the foundation is necessary, Machine Support can offer you the service to execute the machining with the component in position. Minimum required height is approx. 60 mm. With a special developed machining tool, the seating area of the Vibracon® bottom ring will be faced.

6.4 Reducing the height of the Vibracon® chocks

It is possible to reduce the height of the Vibracon® Original chocks, but this will also reduce the adjustment capability. Don't exceed the minimum reduced height as mentioned on the table on the Vibracon® brochure. Both centre part and bottom part of the chock have to be machined to reduce the height.

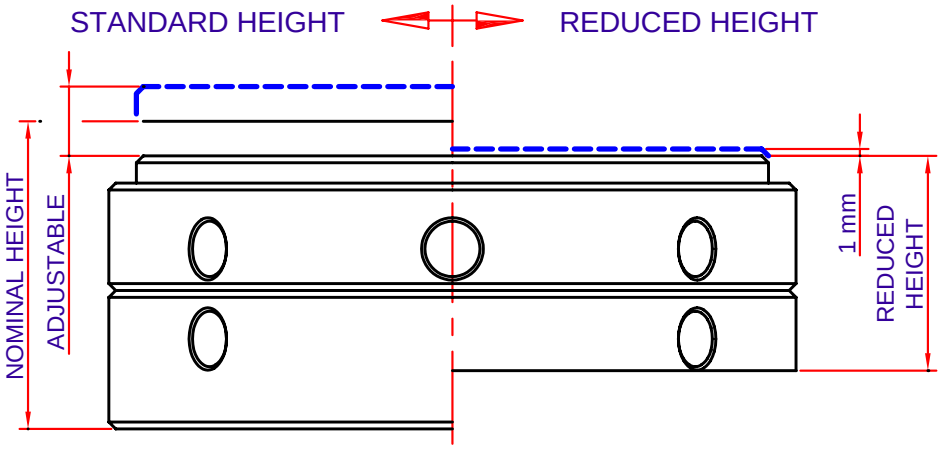


Figure 6.4.1 Reduced height of Vibracon® chock

Type	Nominal height	Adjustability	Reduced height	Adjustability
	(mm)	(mm)	(mm)	(mm)
SM12	34	8	23	1
SM16	40	10	26	1
SM20	45	12	31	1
SM24	51	12	34	1
SM30	56	12	39	1
SM36	61	12	44	1
SM42	66	12	49	1
SM48	77	15	56	1
SM56	82	15	61	1
SM64	87	15	66	1

Figure 6.4.2 Vibracon® chock with reduced height

If you intend to reduce the Vibracon® Low Profile configuration please contact Machine Support for advise!

6.5 Extending the height of the chocks

It is also possible to order additional bottom parts for Vibracon® chocks. As a rule of thumb, the final height of the chock should not exceed the diameter of the chock.

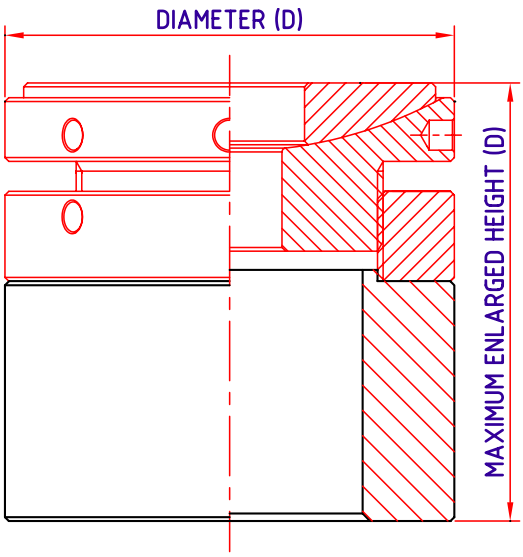


Figure 6.5.1 Extended Vibracon® Original

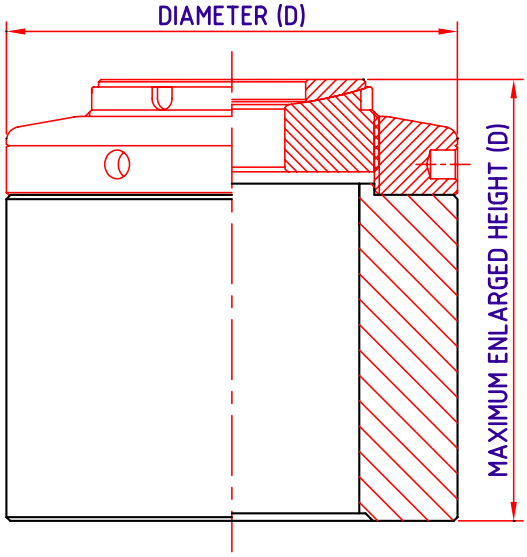


Figure 6.5.2 Extended Vibracon® Low profile

Material: DIN 1.0570 / 1.1191

Article no.	***Height additional ring***	***Max. enlarged height (D) Vibracon® Original***	***Max. enlarged height (D) Vibracon® Low Profile***
SM12EV	22 mm	60 mm	Not available
SM16EV	35 mm	80 mm	65 mm
SM20EV	50 mm	100 mm	80 mm
SM24EV	63 mm	120 mm	93 mm
SM30EV	78 mm	140 mm	108 mm
SM36EV	93 mm	160 mm	133 mm
SM42EV	118 mm	190 mm	163 mm
SM48EV	135 mm	220 mm	Not available
SM56EV	140 mm	230 mm	Not available
SM64EV	155 mm	250 mm	Not available

Figure 6.5.3 Additional bottom ring table

Additional Bottom Ring to be used together with the Vibracon® Original and Low Profile chocks

On request, Vibracon® chocks can be supplied with an extended base plate.

6.6 Enlarging the bolt hole of the Vibracon® chock

For this you always need approval from Machine Support and classification society. It is allowed to enlarge the bolt hole of the chocks in accordance with the following table:

Type	Bolt (M-size)	Enlarged bolt hole (mm)
SM12	16	17
SM16 / SM16LP	20	21
SM20 / SM20LP	24	25
SM24 / SM24LP	30	31
SM30 / SM30LP	36	37
SM36 / SM36LP	42	43
SM42 / SM42LP	48	49
SM48	56	57
SM56	64	65
SM64	72	73

Figure 6.6 Table for enlarged bolt holes

6.7 Fitted bolts

The use of fitted bolts with Vibracon® chocks can be done. It is up to the designer to decide if he wants to ream the elements as well. Machine Support advises reaming of the elements only when there are no dowel pins drilled or if no stoppers are installed around the component. Machine Support can supply special elements with a smaller hole diameter.

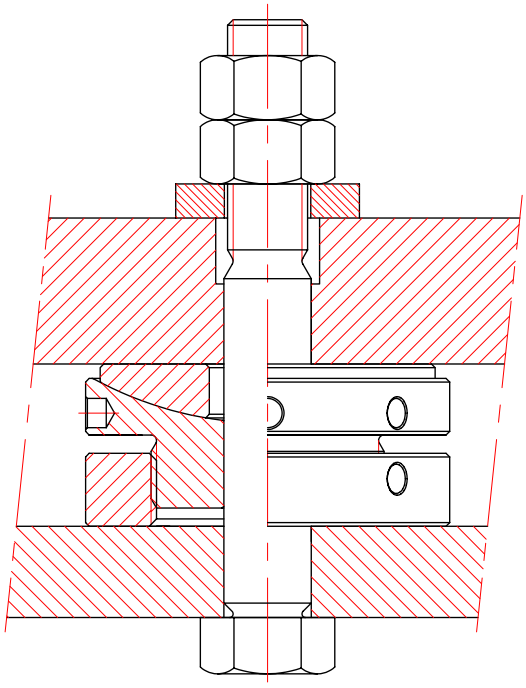


Figure 6.7.1 General arrangement of Vibracon® Original

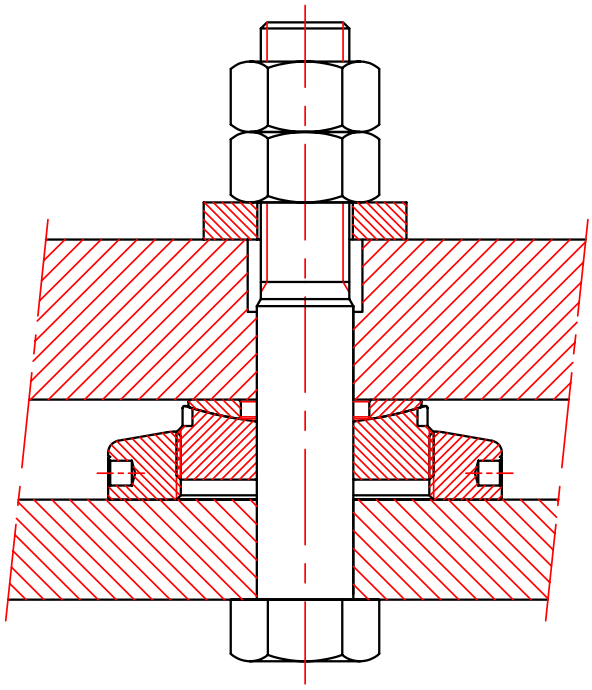


Figure 6.7.2 General arrangement of Vibracon® Low Profile

The transmission of the propeller thrust to the ship's structure must to be achieved via front and rear stoppers. Fitted bolts must be provided exclusively for fixing and securing the plant components: they must not be taken into account in the transmission of propeller thrust.

6.8 General arrangement information Vibracon® Original

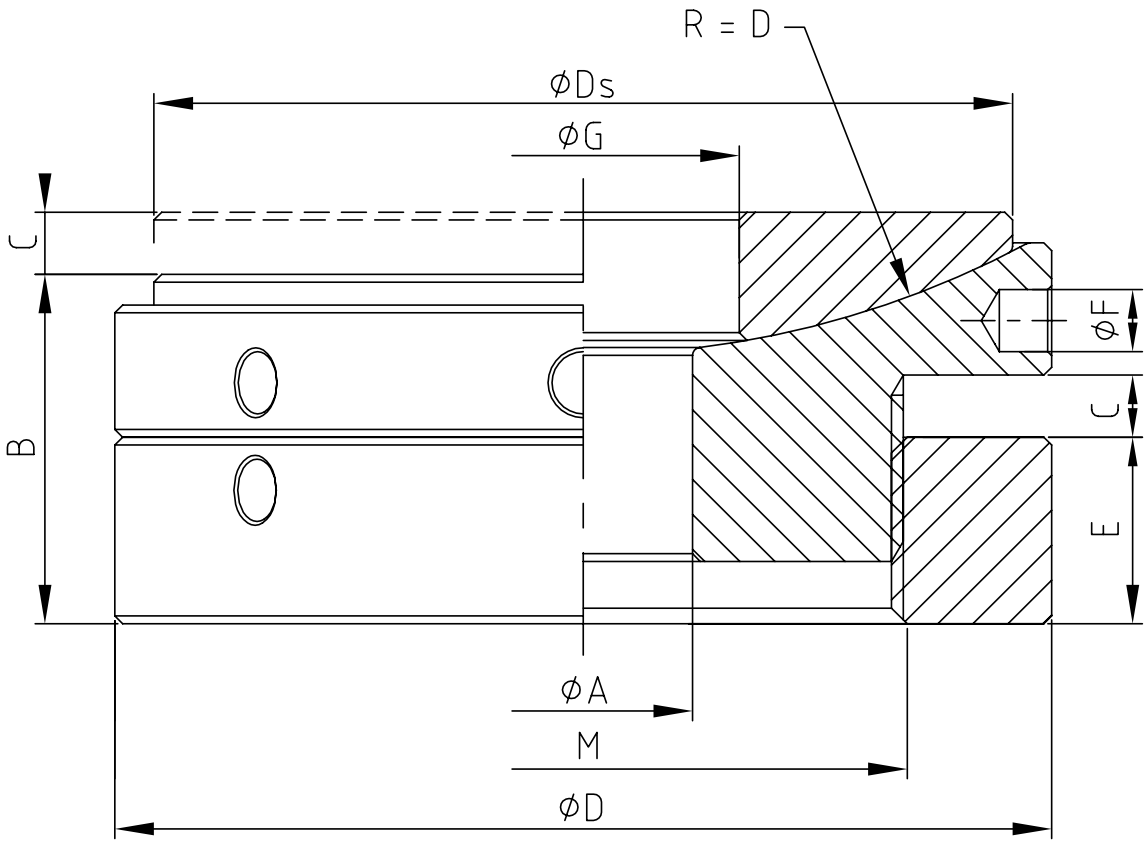
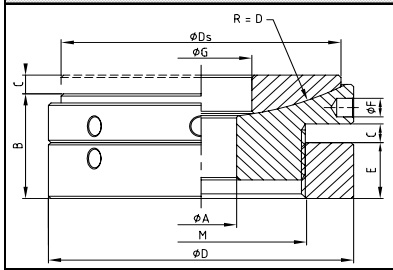


Figure 6.8.1 Vibracon® Original

Type		**SM12**		**SM16**		**SM20**		**SM24**		**SM30**		**SM36**		**SM42**		**SM48**		**SM56**		**SM64**	
Bolt size		M12	M14	M16	M18	M20	M22	M24	M27	M30	M33	M36	M39	M42	M45	M48	M52	M56	M60	M64	M68
Dimensions																					
	A (mm)	15		19		23		28		34		40		46		54		62		70	
	B (mm)	30		35		40		45		50		55		60		70		75		80	
	B min.	23		26		31		34		39		44		49		56		61		66	
	C (mm)	8		10		10		12		12		12		12		15		15		15	
	D (mm)	60		80		100		120		140		160		190		220		230		250	
	Ds (mm)	54		74		92		110		130		145		175		205		217		235	
	E (mm)	15		18		20		24		26		31		36		43		44		48	
	F (mm)	6		6		8		8		10		10		10		10		12		12	
	G (mm)	20		26		32		40		48		58		68		80		84		95	
	M (mm)	42 x 1		52 x 1.5		64 x 2		82 x 2		95 x 2		110 x 2		130 x 2		160 x 3		170 x 3		190 x 3	
	R (mm)	60		80		100		120		140		160		190		220		230		250	
Formula																					
Critical bolt force (8.8)																					
F0.2 = 0.785 x dk^2 x 627	(kN)	48	66	90	110	141	176	203	268	325	406	476	572	655	767	863	1035	1195	1396	1580	1810
Design load Fd																					
Fd = 1.25 x F0.2	(kN)	60	82	113	137	176	221	254	335	407	507	595	715	819	959	1078	1294	1494	1745	1975	2262
Bolt tension Fb																					
Fb = 0.75 x F0.2	(kN)	36		68		106		152		244		357		491		647		896		1185	
Fb = Fe - Fm	(kN)		40		75		115		165		265		385		555		690		925		1200
Machine load Fm																					
max. allowed machine load	(kN)	8		15		25		35		60		90		120		160		225		300	
Shear at thread in element																					
= Fd / (3.142 x M x (E-C))	(N/mm2)	68,0	93,4	90,0	109,4	95,7	119,7	85,8	113,0	101,0	125,9	93,5	112,4	85,8	100,5	79,2	95,0	99,5	116,2	103,1	118,1
Load element / bed plate																					
= Fd / (0.785 x (D^2-M^2))	(N/mm2)	47,6	65,3	42,5	51,7	40,8	51,0	44,9	59,2	51,7	64,5	58,9	70,8	56,5	66,2	62,7	75,2	82,4	96,3	99,0	113,4
Load element / machine																					
= Fd / (0.785 x (Ds^2-G^2)	(N/mm2)	34,3	47,1	32,7	39,7	32,4	40,5	32,7	43,0	37,3	46,5	45,0	54,1	41,7	48,8	39,8	47,8	49,0	57,2	56,1	64,2
Load at spherical part																					
= Fd / (0.785 x (M^2-(G+2)^2))	(N/mm2)	59,4	81,6	74,9	91,0	76,4	95,6	65,2	85,9	79,4	99,0	89,1	107,2	86,9	101,8	72,8	87,3	88,5	103,4	94,3	108,0
Foundation bolt torque (max)																					
Ma = Fb(max) x dM / C (C=5000)	(Nm)	86	112	217	270	423	506	732	891	1464	1749	2570	3003	4126	4995	6211	7176	10038	10360	15168	16320
To become 0,25 mm elongation																					
min. required clamping length	(mm)	163	199	153	176	153	171	154	180	150	167	148	161	146	148	145	159	142	158	140	157
Foundation bolt torque (min)																					
clamping length 150 mm,																					
elongation 0,2 mm																					
Ma = Fb(min) x dM / C (C=5000)	(Nm)	69	90	174	216	339	405	584	713	1171	1399	2056	2402	3300	3996	4969	5741	8028	8880	12134	13056
Maximum element force Fe																					
max. allowed element force	(kN)	48		90		140		200		325		475		675		850		1150		1500	

Calculations are valid for bolts with usual thread, material grade 8.8, yield strength >630 N/mm2, oil-lubricated thread courses and nut mating surfaces without slide additives

Figure 6.8.2 Standard Vibracon® Original general design table

6.9 General arrangement information Vibracon® Low Profile

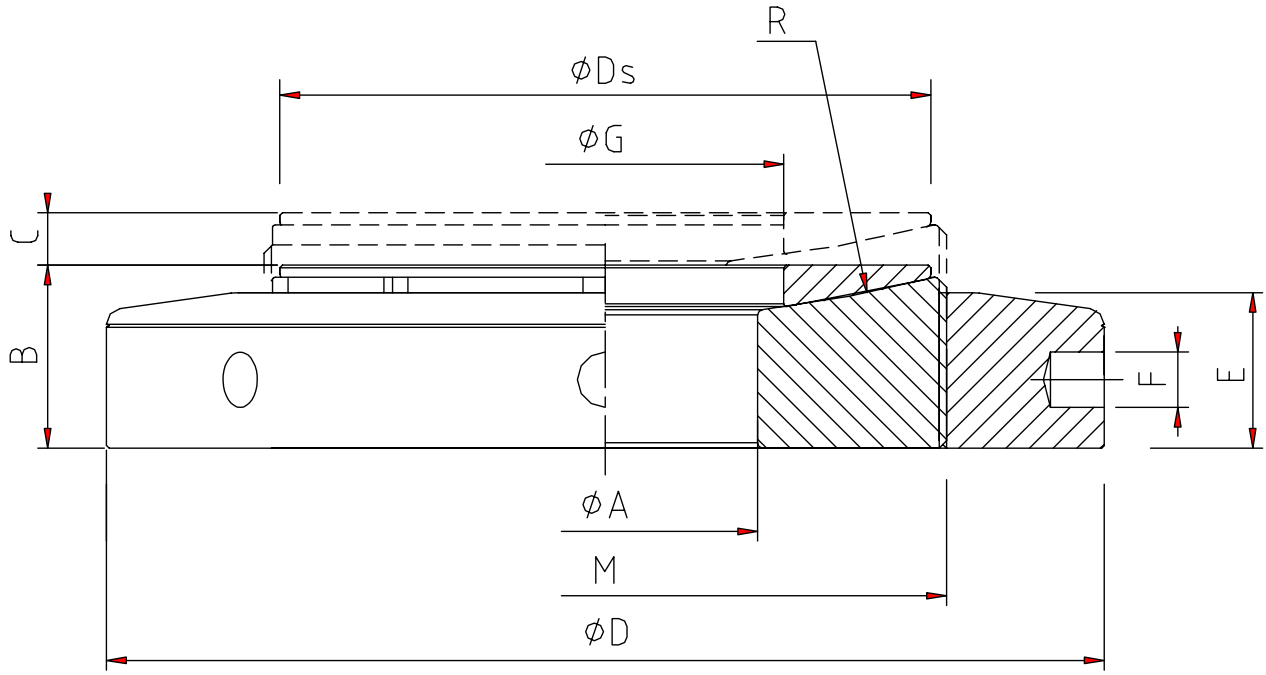
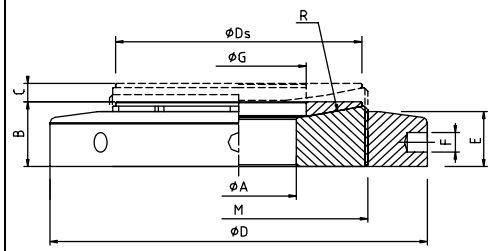


Figure 6.9.1 Vibracon® Low Profile dimensions

Vibracon SM-LP elements		Material DIN 1.7225											
Type		**SM16LP**		**SM20LP**		**SM24LP**		**SM30LP**		**SM36LP**		**SM42LP**	
Bolt size		M16	M18	M20	M22	M24	M27	M30	M33	M36	M39	M42	M45
Dimensions													
	A (mm)	19		23		29		35		40		46	
	B (mm)	20		20		20		20		30		35	
	C (mm)	10		10		10		10		10		10	
	D (mm)	80		100		120		140		160		190	
	Ds (mm)	46		58		76		90		104		124	
	E (mm)	17		17		17		17		27		32	
	F (mm)	6,2		6,2		6,2		6,2		6,2		6,2	
	G (mm)	26		32		40		48		58		68	
	M (mm)	52 x 1,5		64 x 2		82 x 2		95 x 2		110 x 2		130 x 2	
	R (mm)	100		100		100		250		250		250	
Minimum standard height	(mm)	20		20		20		20		30		35	
Nominal standard height	(mm)	25		25		25		25		35		40	
Maximum standard height	(mm)	30		30		30		30		40		45	
Formula													
Critical bolt force (8.8)													
F0.2 = 0.785 x dk² x 627	(kN)	90	110	141	176	203	268	325	406	476	572	655	767
Design load Fd													
Fd = F0.2	(kN)	90		140		200		325		475		675	
Proof load (maximum height)													
Fp	(kN)	248		320		373		609		1626		2499	
Bolt tension Fb													
Fb = 0.75 x F0.2	(kN)	68		106		152		244		357		491	
Fb = Fe - Fm	(kN)		75		115		165		265		385		555
Machine load Fm													
max. allowed machine load	(kN)	15		25		35		60		90		120	
Shear at thread in element													
= (Fb + Fm) / (pi x M x (E-C))	(N/mm²)	72,1	78,7	92,9	99,5	103,8	110,9	145,4	155,6	76,1	80,9	68,0	75,1
Load element / top plate foundation													
= (Fb + Fm) / (0.785 x (D² - M²))	(N/mm²)	28,4	31,0	28,2	30,2	31,1	33,2	36,6	39,2	42,2	44,8	40,6	44,8
Load element / bedplate machine													
= (Fb + Fm) / (0.785 x (Ds² - G²))	(N/mm²)	73,0	79,6	71,2	76,2	57,1	61,0	66,8	71,4	76,4	81,2	72,4	80,0
Load at spherical part inside element													
= (Fb +Fm) / (2 x pi x R x h)	(N/mm²)	71,8	78,3	69,1	74,0	54,4	58,1	68,1	72,9	75,3	80,0	70,9	78,3
Foundation bolt torque (max)													
Ma = Fb(max) x M / C (C = 5000)	(Nm)	215	270	420	500	730	890	1460	1745	2570	3000	4125	4995
To become 0,25 mm elongation													
min. required clamping length	(mm)	153	176	153	171	154	180	150	167	148	161	146	148
Foundation bolt torque (min)													
clamping length 150 mm,													
elongation 0,2 mm													
Ma = Fb(min) x M / C (C=5000)	(Nm)	174	216	339	405	584	713	1171	1399	2056	2402	3300	3996
Maximum element load Fe													
max. allowed element force	(kN)	90		140		200		325		475		675	

Calculations are valid for bolts with usual thread, material grade 8.8, yield strength > 630 N/mm², oil-lubricated thread courses and nut mating surfaces without slide additives

Figure 6.9.2 Standard Vibracon® Low Profile general design table