STATIC LOAD AND SERVICE LIFE

▪ Rolling bearing

Maximal permissible load

The maximal permissible load is defined by the static basic load rating $C0$. If static loads are a combination of radial and axial loads, the equivalent static load will have to be calculated.

P_0	Static equivalent load [kN] Series BRM, BRF, PM, PF, WLK: $P_0 = F_r + Y_0 \cdot F_a$ Series BRTF, BRTM, WLT: $P_0 = F_r + 5 \cdot F_a$
F_a	Axial load [kN]
F_r	Radial load [kN]
Y_0	Axial factor, static, see tables
C_0	Basic static load rating [kN]

Permissible load

$$P_0 \leq \quad C_0 \quad (N)$$

Nominal service life

DURBAL - Premium - products with integral self-aligning ball bearing series.
Type BRM, BRF, PM, PF, WLK

P	Dynamic equivalent load [kN] Series BRM, BRF, PM, PF, WLK: $P_0 = F_r + Y \cdot F_a$ Series BRTF, BRTM, WLT: $P_0 = F_r + 9{,}5 \cdot F_a$
C	Basic dynamic load rating [kN], see tables
Y	Axial factor, dynamic, see tables
Gh_{rot}	Nominal service life for rotation (hours of operation)
Gh_{osz}	Nominal service life for oscillating movement (hours of operation)
β	Half of swivelling angle (degree), β= 90 should be used for rotation Condition: swivelling angle $\beta \geq 3°$ For swivelling angles $\beta < 3°$ we recommend the use of DURBAL heavy-duty plain bearing rod ends
n	Rotation speed (min^{-1})
f	Frequency of oscillation (min^{-1})

Rotating:

$$Gh_{rot.} = 10^6 \frac{\left(\frac{C}{P}\right)^3}{60 \cdot n} (h)$$

Oscillating:

$$Gh_{osz.} = 10^6 \frac{C}{\frac{P \sqrt[3]{\frac{\beta}{90}}}{60 \cdot f}} (h)$$

Calculation example

At the rotating side of a crank mechanism a DURBAL®- Premium – rolling bearing rod end should be installed. The expected service life amounts to at least 5000 hours.

Know: roration speed n = 300 min^{-1}, radial load Fr = 0.75 kN

Selected: BRF 8 C = 4.0 kN

$$Gh_{rot.} = 10^6 \frac{\left(\frac{C}{P}\right)^3}{60 \cdot n} (h)$$

$$= 10^6 \frac{\left(\frac{4.0}{0.75}\right)^3}{60 \cdot 300} = 842\ h\ > 5000\ h$$

▪ Sliding bearing

Permissible load

The maximal permissible load is calculated by using equation (1), which considers factors based on the application parameters. If static loads are a combination of radial and axial loads, the equivalent static load is calculated by using the equation (2).

P_{max}	Maximum permissible load [kN]
C_0	Static basic load [kN], see tables
C_2	Temperature factor, see Tab. 2
C_5	Factor for type of load, see Fig.1
P	Equivalent dynamic load [kN]
Gh_{osz}	Nominal service life for oscillating movement (hours of operation)
F_r	Radial load [kN]
F_a	Axial load [kN], condition : $F_a \leq 0.3 \text{ x } F_r$

$$P_{max} = C_0 \cdot C_2 \cdot C_5 \quad (1)$$

$$P = F_r \cdot Y \cdot F_a \quad (2)$$

The axial factor Y is taken from the table below. Intermediate values can be interpolate linearly.

Load ratio Fa/Fr	Fattore Y
0.1	0.8
0.2	1
0.3	1.5

Tab.1

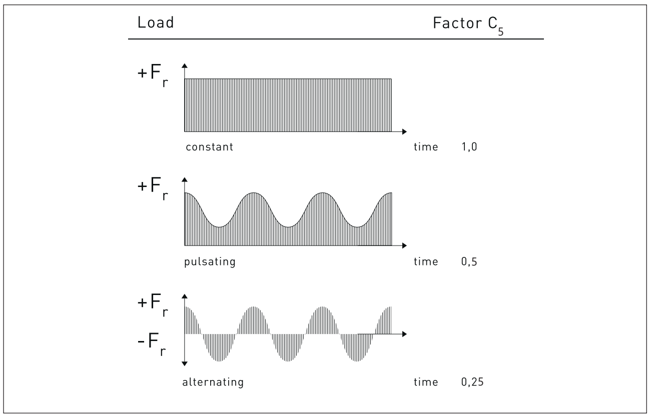

Fig.1

Temperature factor C2					
Construction technology	60 °C	90 °C	120 °C	150 °C	180 °C
Polymer (Glide)	1	0.75	/	/	/
Sintered bronze/steel (Tescubal)	1	1	0.9	*	*
PTFE (Basic-Tesno)	1	1	0.9	0.7	0.5

*Please, contact our technical department.

Tab.2

Permissible sliding velocity

The permissible sliding velocity of our heavy-duty rod ends and spherical-plain bearings mainly depends on the load and temperature conditions. Heat generated by friction in our products is the main limitation on sliding velocity. When selecting our product size, it is necessary to determine the sliding velocity and the pv-value, which is a product of the specific bearing load p (N/mm2) and the sliding velocity v (m/s).

P Specific bearing load [N/mm²]

C Basic dynamic load rating [N], see tables

k Specific load factor [N/mm²]

$$P = k \cdot \frac{P}{C}$$

Construction technologies	Specific load factor k
Steel/Sintered Bronze	70
Steel/Sintered Steel	90
Polymer (Glide)	50
Steel/PTFE mesh	150

Tab.3

Vm Average sliding speed [m/s]

d_k pivot ball diameter [mm], see tables

β Half swiveling angle (degree), for swiveling angle > 180°: ß=90°

f Frequency of oscillation (min-1)

$$V_m = 5.82 \cdot 10^{-7} \cdot d_k \cdot \beta \cdot f \leq V_{max}$$

Construction technologies	Vmax
Steel/Sintered Bronze	0.5
Steel/Sintered Steel	0.33
Glide	0.15
Steel/PTFE mesh	0.4

Tab.4

Permissible factor pV

P Specific pressure [N/mm²]
Vm Avarage sliding speed [m/s]

$$p \cdot V_m \leq pV_{max}$$

Construction technologies	Vmax
Steel/Sintered Bronze	0.7
Steel/Sintered Steel	0.5
Glide	0.5
Steel/PTFE mesh	0.4

Tab.5

Nominal service life

G Nominal service life (number of oscillations)
G_h Nominal service life (hours)
C_1 Load direction factor, see Tab.6
C_3 Material factor, see alignment chart, see Fig.2
C_4 Oscillation factor, see Tab.7

$$G = C_1 \cdot C_2 \cdot C_3 \cdot C_4 \cdot \frac{3}{dk \cdot \beta \cdot f} \cdot \frac{C}{P} \cdot 10^8$$

$$G = C_1 \cdot C_2 \cdot C_3 \cdot C_4 \cdot \frac{5}{dk \cdot \beta \cdot f} \cdot \frac{C}{P} \cdot 10^6$$

Load direction factor C1	
Single load direction	1
Alternating load direction at f < 30 rpm	0.25
Alternating load direction at f > 30 rpm	0.125

Tab.6

Oscillation factor C4			
	Tescubal	Glide	PTFE
ß ≤ 10	0.7	0.95	0.15
10 < ß ≤ 30	1	0.8	0.13
ß > 30	1.2	0.53	0.07

Tab.7

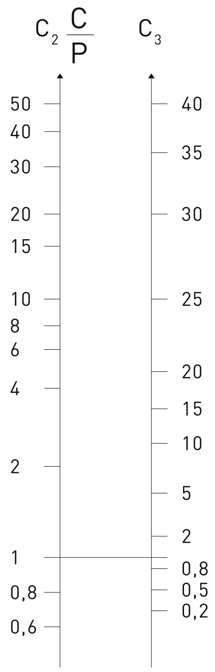

Fig.2

▪ **Axial holding load of the rod end**

An additional check that must be made, only for the ranges Tescubal, Tesno and Basic (except DPOS and DPHS) of our portfolio, is the one related to the maximum axial load that can be applied to the rod ends.

We have already underline previously that the axial load must be maximum equal to the 30% of the radial load, but in the mentioned above product lines there is also a limit related to the chamfering system that retain the spherical plain bearing inside the housing; this limit depends on the size and it is shown in the chart below:

Inner ring bore diameter	Max axial load [kN]
5	1
6	1.2
8	1.7
10	2
12	2.7
14	4
15	4.5
16	5.5
17	5.6
18	5.8
20	6
22	7
25	8
30	12
35	14
40	16.5
45	18
50	20

Tab.8

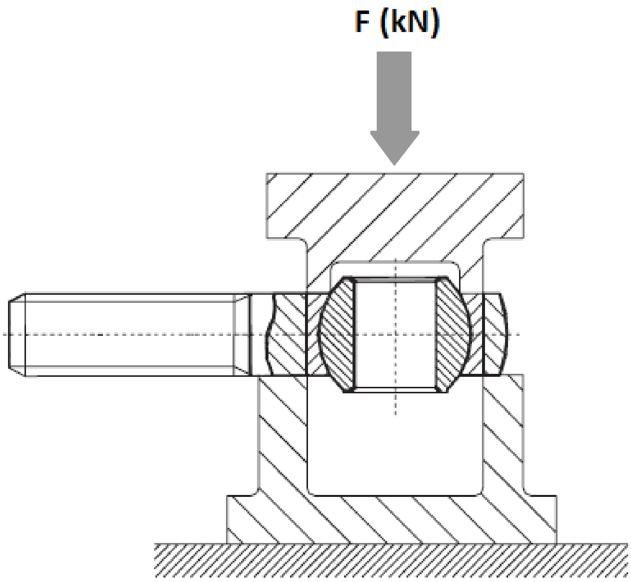

Fig.3

Note:

In all cases the user has to coordinate the theoretical selection criteria with the concrete installation situation and check the suitability of the rod end respectively spherical-plain bearing. In this context the user has to define sufficient security factors and maintenance intervals. In case of special applications we cannot take any responsibility for the product since we are unable to foresee the actual use to which it will be put.

▪ Calculation example

The rod end assembly of a conveyor equipment calls for a heavy-duty rod end with a service life of 7000 hours in conjunction with an alternating acting load of 5 kN. 25 swivelling movements with a swivelling angle of 20° take place per minute. The operating temperature amounts to approx. 55° C. The choice is a DURBAL®-heavy-duty rod end EF 15-20-501 with: C = 13,4 kN, dk = 22 mm.

▫ Checking the permissible load of the rod end

C_0 = 42.7 kN

C_2 = 1.0 (temperature 55 °C)

C_4 = 0.2 (alternating load)

$$Pmax = 42.7 \cdot 1 \cdot 0.25 = 10.67\ kN > 5\ kN$$

▫ Checking the permissible sliding velocity

$$Vm = 5.82 \cdot 10^{-7} \cdot 22 \cdot 10 \cdot 25 = 0.0032\ m/s < 0.15\ m/s$$

▫ Checking the pV value

$$p = K \cdot \frac{P}{C} = 50 \cdot \frac{5}{13.4} = 18.66\ N/mm^2$$

$$pV = p \cdot Vm = 18.66 \cdot 0.0032 = 0.06\ N/mm^2 < 0.5\ N/mm^2 \cdot m/s$$

▫ Nominal life calculation

C_1 = 0.25 (alternating load direction with f < 30 min^{-1})

D_k = 22 mm

ß = 10° (half of the swiveling angle 20°)

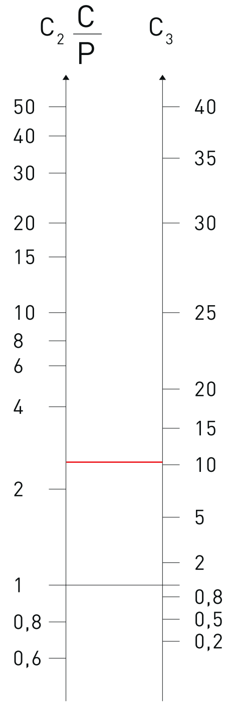

Fig.4

Determine C3

$$C_2 \cdot \frac{P}{C} = 1 \cdot \frac{13.4}{5} = 2.68$$

See alignment Tab.4: C_3 = 12.3

$$G = C_1 \cdot C_2 \cdot C_3 \cdot C_4 \cdot \frac{5}{dk \cdot B \cdot f} \cdot \frac{C}{P} \cdot 10^6 = 0.25 \cdot 1 \cdot 12.3 \cdot \frac{5}{22 \cdot 10 \cdot 25} \cdot \frac{13.4}{5} \cdot 10^6 = 7490\ h > 7000h$$

beyond motion