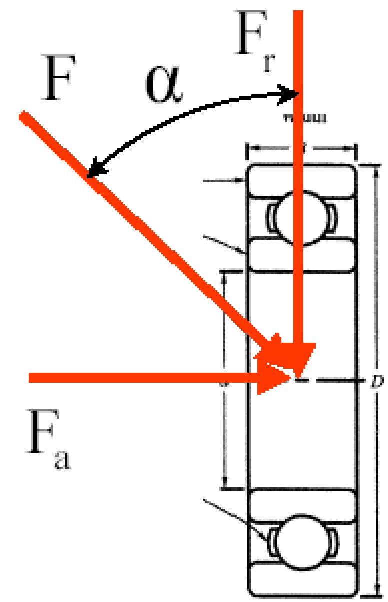
Selection of Ball Bearings:

If both radial and axial (thrust) loads exist then an equivalent radial load should be determined:

$$F_{eq} = P = VXF_r + YF_a$$



Where:

F_{eq} = equivalent radial load.

F_r = applied radial load.

F_a = applied thrust load.

X = radial load coefficient.

Y = axial load coefficient.

V = a rotation factor (V = 1 for rotating inner ring and 1.2 for rotating outer ring)

-

$$F_{eq} \equiv P = F_r \qquad \text{when } \frac{\mathrm{F_a}}{\mathrm{VF_r}} \le e$$

-

$$F_{eq} \equiv P = VXF_r + YF_a \qquad \text{when } \frac{\mathrm{F_a}}{\mathrm{VF_r}} > e$$

e $\rightarrow$ is given in the bearing tables according to the value of $\frac{F_a}{C_o}$,

Where

C_o is the static basic load rating.

Table for X, Y for deep groove ball bearings:

F_a/C_o	e	X	Y
0.025	0.22	0.56	2
0.04	0.24	0.56	1.8
0.07	0.27	0.56	1.6
0.13	0.31	0.56	1.4
0.25	0.37	0.56	1.2
0.5	0.44	0.56	1

Principal dimensions			Basic load ratings		Limiting speeds		Mass	Designations	
			dynamic	static	Lubrication			Bearings with	
					grease	oil		cylindrical bore	tapered bore
d	D	B	C	C_0					
mm			N		r/min		kg	–	
20	47	14	9 950	3 200	15 000	18 000	0,12	**1204**	–
	47	18	12 500	3 900	14 000	17 000	0,14	**2204**	–
	52	15	12 400	4 000	12 000	15 000	0,16	**1304**	–
	52	21	18 200	5 300	11 000	14 000	0,21	**2304**	–
25	52	15	12 100	4 050	13 000	16 000	0,14	**1205**	**1205 K**
	52	18	12 400	4 250	11 000	14 000	0,16	**2205**	**2205 K**
	62	17	17 800	6 000	9 500	12 000	0,26	**1305**	**1305 K**
	62	24	24 200	7 500	9 500	12 000	0,34	**2305**	–

Example:

Select a deep groove ball bearing for the given loading conditions:

$F_r = 3000$ N radial load

$F_a = 1000$ N axial (thrust) load

$n = 2000$ rpm (for inner ring – Shaft)

$L_h = 4$ kh

The diameter of the shaft at the bearing is 25 mm.

Solution:

1-From the bearing catalog select bearing 2205:

$d = 25$ mm, $D = 52$ mm, $B = 18$ mm, $C = 12400$ N, $C_o = 4250$ N

2- Calculate the ratio (F_a / C_o)

$F_a / C_o = 1000 / 4250 = 0.235$

From tables $e = 0.37$

3- calculate the ratio (F_a / VF_r)

$F_a / VF_r = 1000 / 3000 = 0.33333 < e$

4- since $F_a / VF_r < e$, then $X = 1$, $Y = 0$

5- $F_{eq} = XVF_r + YF_a = 1 \text{ x } 1 \text{ x } 3000 + 0 = 3000$ N

6- The required dynamic loading capacity:

$$C_R = k_A F_{eq}\left[\left(\frac{L_D}{L_R}\right)\left(\frac{n_D}{n_R}\right)\right]^{1/a}$$

$$= 1 \times 3000\left[\frac{4000}{500}\,\frac{2000}{(\frac{100}{3})}\right]^{\frac{1}{3}} = 23489.2 \text{ N}$$

Which is greater than the dynamic loading capacity of the selected Bearing (C = 12400 N)

7- select another bearing; bearing 2305

d = 25 mm, d = 62 mm, B = 24 mm, C = 24200 N, C_o = 7500 N

F_a / C_o = 1000 / 7500 = 0.133 then e = 0.31

Since F_a / VF_r = 0.333 > e, then X = 0.56 , Y = 1.4

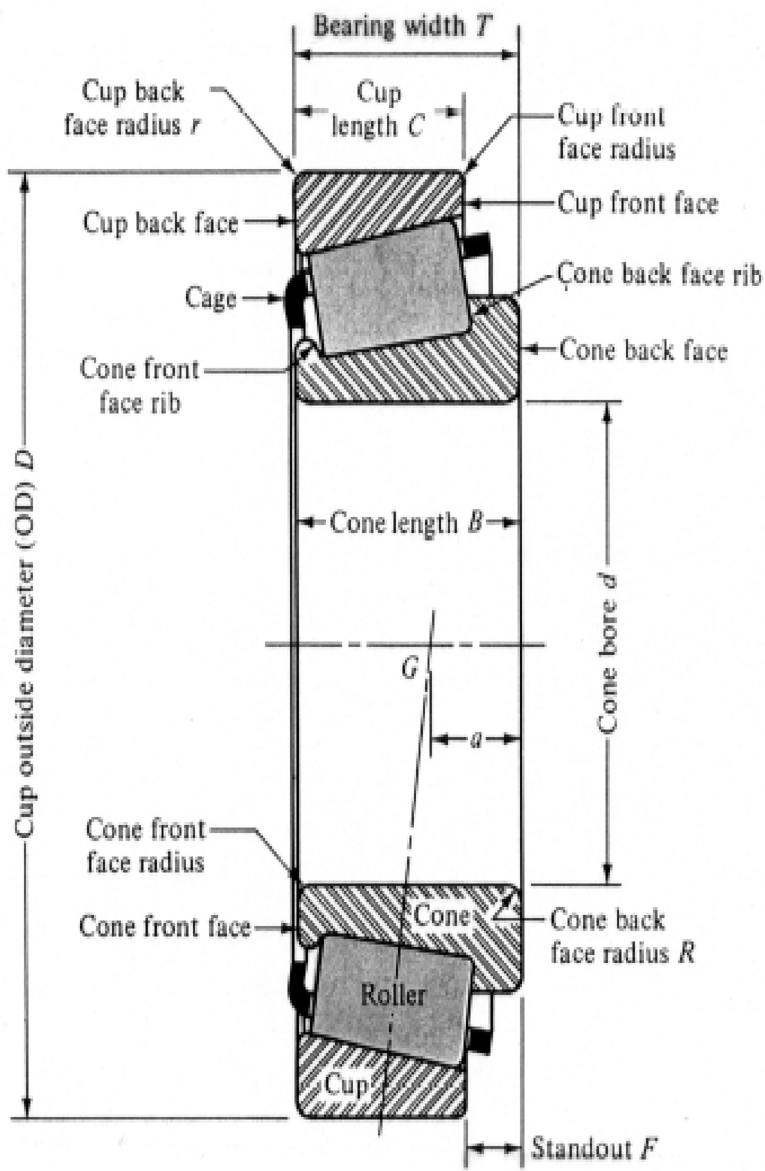
$F_{eq} = XVF_r + YF_a = 0.56 \text{ x } 3000 + 1.4 \text{ x } 1000 = 2680$ N

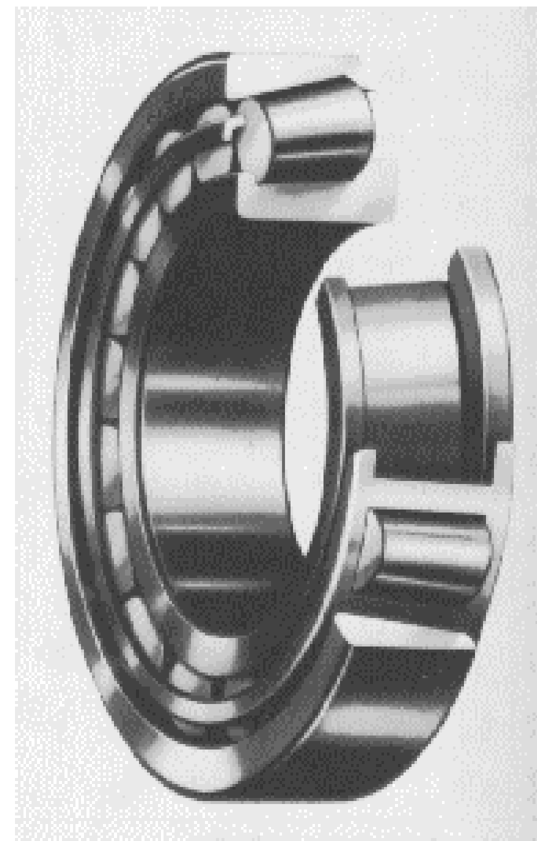
The required dynamic loading capacity

C = 20983.7 N < 24200 N of the selected bearing.

Selection of Taper Roller Bearings

The nomenclature for a taper roller bearings is shown in the figure Below.





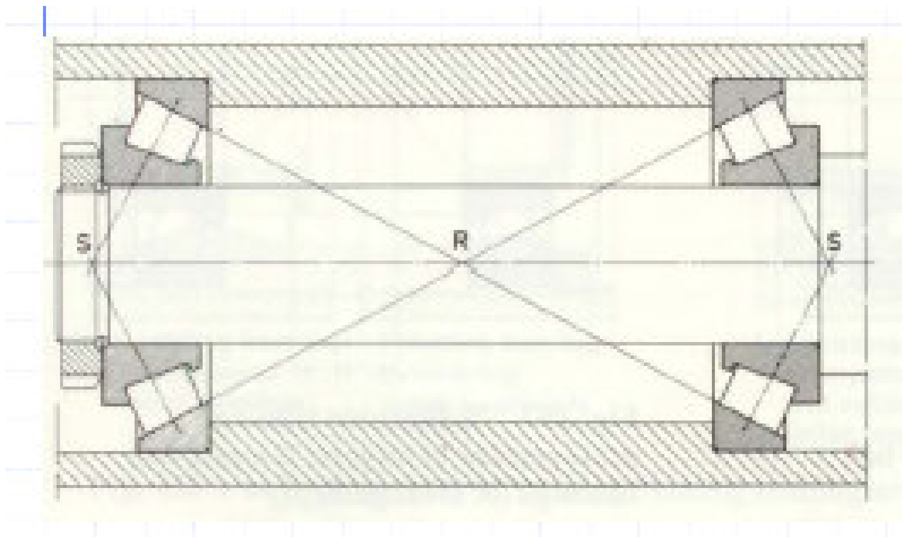
- The inner ring is called the cone, and the outer ring is called the cup.
- It can be seen that, a tapered roller bearing is separable in that the cup can be removed from the cone and roller assembly.
- This type of bearing can carry both radial and axial loads or any combinations of the two.
- However, even when an external axial load is not present, the radial load will induce a thrust (axial) reaction within the bearing because of the taper.

The equivalent dynamic bearing load is given by:

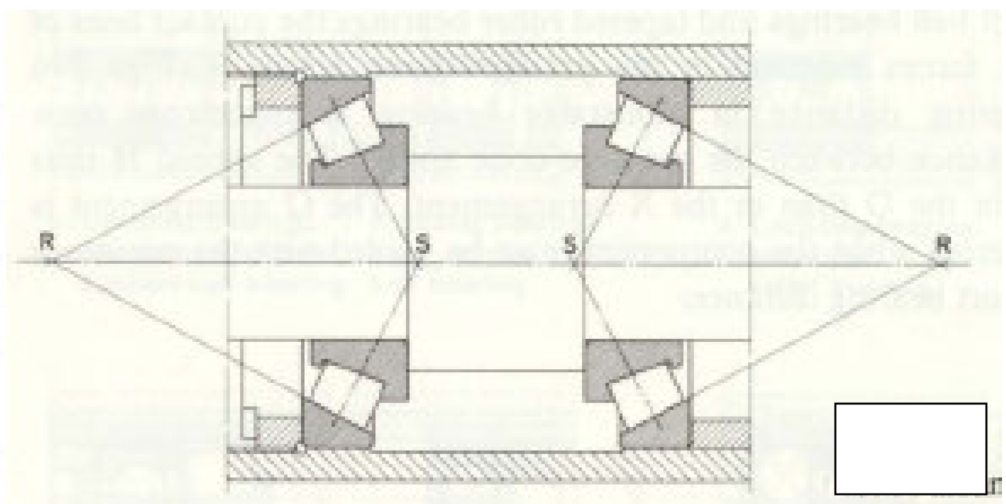
$F = F_r$ when $F_a / F_r <= e$

$F = 0.4\, F_r + YF_a$ when $F_a / F_r > e$

- The mounting of bearings can be as follows:
  a- O-configuration (back-to-back).



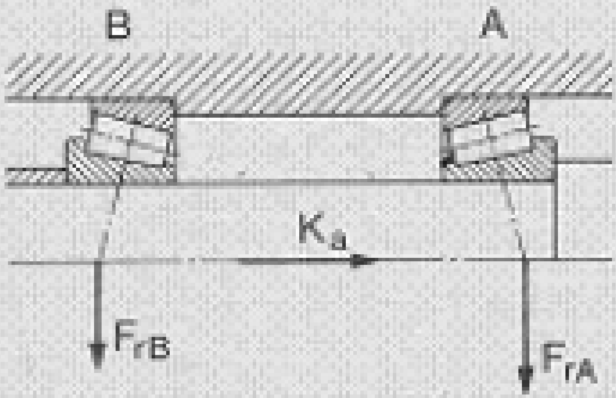
  b- X-configuration (face-to-face).



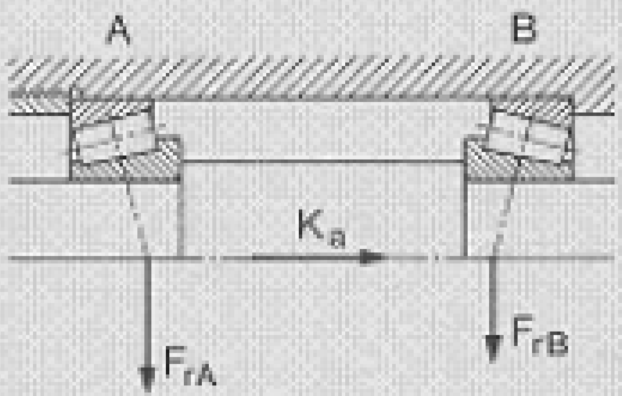
Axial loading of taper roller bearings

Arrangement

Back-to-back

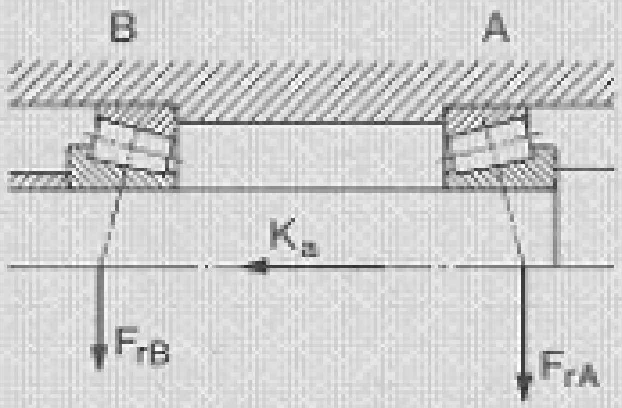


Face-to-face

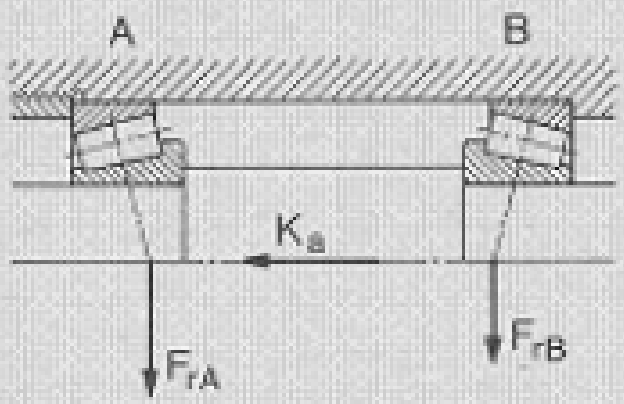


Load case		Axial loads	
1a)	$\frac{F_{rA}}{Y_A} \geq \frac{F_{rB}}{Y_B}$ $K_a \geq 0$	$F_{aA} = \frac{0{,}5\, F_{rA}}{Y_A}$	$F_{aB} = F_{aA} + K_a$
1b)	$\frac{F_{rA}}{Y_A} < \frac{F_{rB}}{Y_B}$ $K_a \geq 0{,}5 \left(\frac{F_{rB}}{Y_B} - \frac{F_{rA}}{Y_A}\right)$	$F_{aA} = \frac{0{,}5\, F_{rA}}{Y_A}$	$F_{aB} = F_{aA} + K_a$
1c)	$\frac{F_{rA}}{Y_A} < \frac{F_{rB}}{Y_B}$ $K_a < 0{,}5 \left(\frac{F_{rB}}{Y_B} - \frac{F_{rA}}{Y_A}\right)$	$F_{aA} = F_{aB} - K_a$	$F_{aB} = \frac{0{,}5\, F_{rB}}{Y_B}$

Back-to-back



Face-to-face



2a) $\dfrac{F_{rA}}{Y_A} \leq \dfrac{F_{rB}}{Y_B}$ $\qquad F_{aA} = F_{aB} + K_a \qquad F_{aB} = \dfrac{0{,}5\ F_{rB}}{Y_B}$

$K_a \geq 0$

2b) $\dfrac{F_{rA}}{Y_A} > \dfrac{F_{rB}}{Y_B}$ $\qquad F_{aA} = F_{aB} + K_a \qquad F_{aB} = \dfrac{0{,}5\ F_{rB}}{Y_B}$

$K_a \geq 0{,}5 \left(\dfrac{F_{rA}}{Y_A} - \dfrac{F_{rB}}{Y_B}\right)$

2c) $\dfrac{F_{rA}}{Y_A} > \dfrac{F_{rB}}{Y_B}$ $\qquad F_{aA} = \dfrac{0{,}5\ F_{rA}}{Y_A} \qquad F_{aB} = F_{aA} - K_a$

$K_a < 0{,}5 \left(\dfrac{F_{rA}}{Y_A} - \dfrac{F_{rB}}{Y_B}\right)$

Designation of Bearing (bearing codes):

- Rolling element bearings re categorized by a code made up of two sections:

A- section 1:

The code for the bearing series which is further divided into:

- a type code,
- a diameter series and

in many cases a width series.

B- section 2:

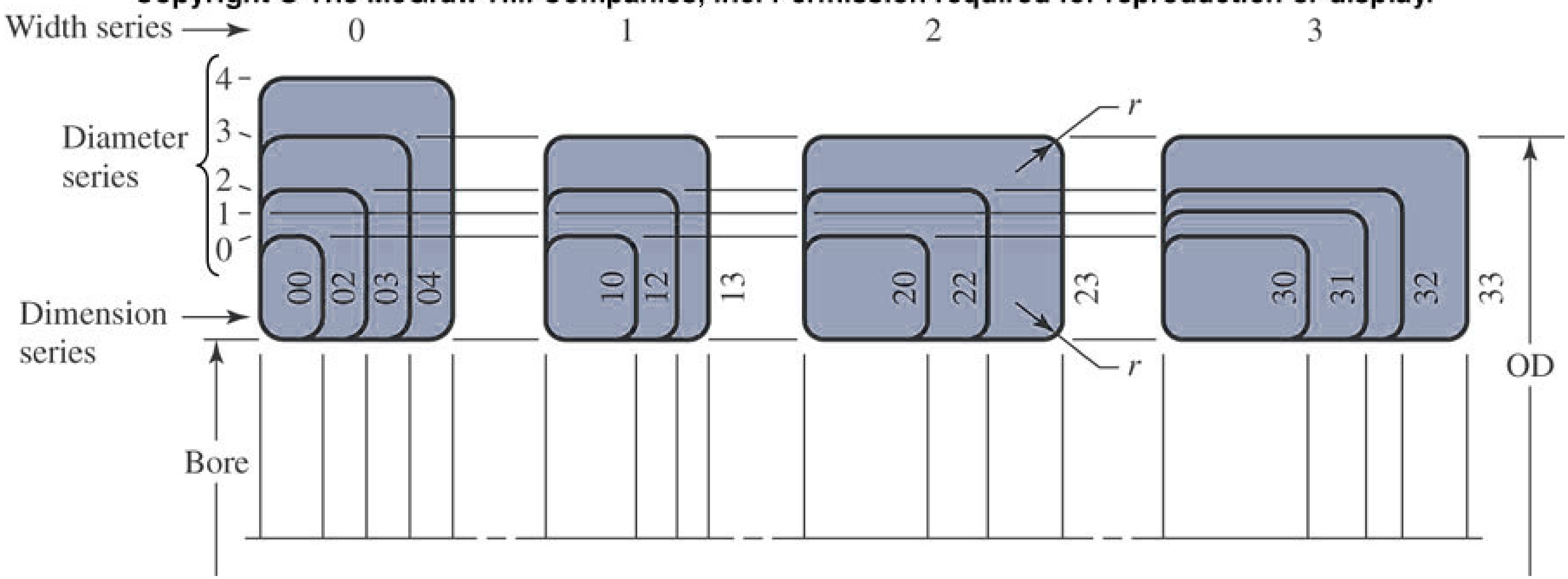
The code for the bore diameter.

- Type code:

The first digit, letter of the bearing code define the bearing type.

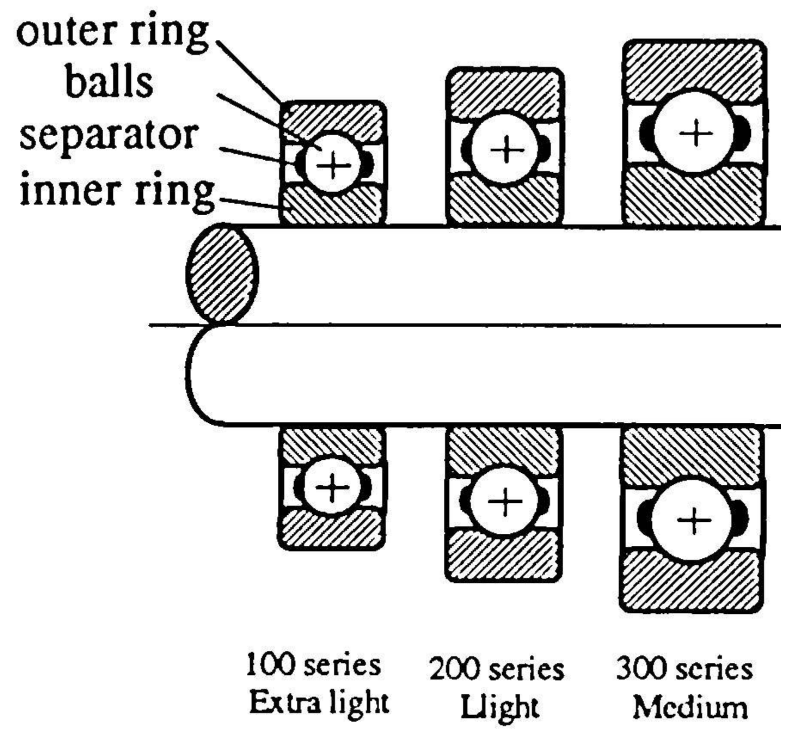
- 1 Self aligning ball
- 2 Type 1 but wider
- 3 Double row angular contact
- 4 Double row ball
- 6 Single row ball (deep groove)
- 7 Single row angular contact
- 16 Type 6 but narrower
- 22 Self aligning roller
- 23 Type 22 but wider
- 51 Thrust ball
- M Radial ball with filling slots
- N Cylindrical roller
- HJ - Separate thrust collar)
- QJ Single row duplex ball

- Diameter and width series (dimension series):
- The second pair of digits define the dimension series.
- The first number is from the width series (0, 1, 2, 3, 4, 5 and 6)
- The second number is from the diameter series (outside diameter). (8, 9, 0, 1, 2 ,3 and 4).



The most common sizes being defined as follows:

0	Extra light
1	Extra light thrust
2	Light
3	Medium
4	Heavy



Note:
For 02, 03, 04 the zero is ignorec

Example: 0 2 (0 is width series, 2 is diameter series).

- Bore code: (inner diameter)

<u>- Bores from 10-17 mm:</u>

Bore diameter	code
10	00
12	01
15	02
17	03
20	04

<u>- Bores from 20-480 mm:</u>

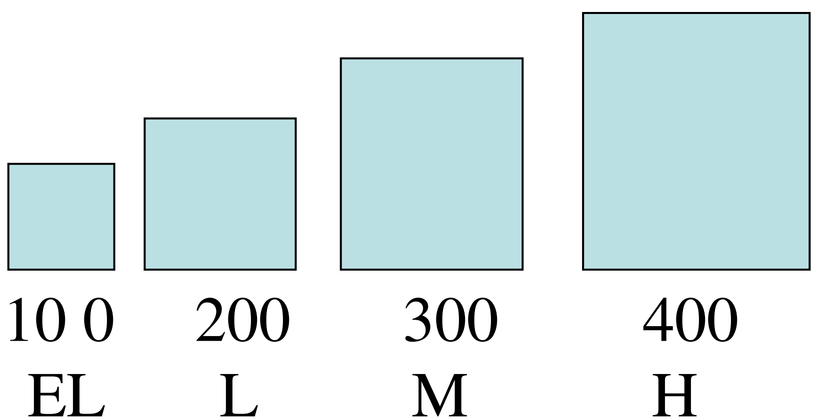
Code no.= Bore diameter / five

Example: NU 2355 Type: Roller Bearing
Width Series 2
Diameter Series 3
Bore Diameter 55

- Designation of Bearing:

Rolling element type

Designation Number	6200	6201	6202	6203	6204	6205
Bore diameter	10	12	15	17	20	25



- EL Extra Light series
- L Light series
- M Medium series
- H Heavy series