Rolling Contact Bearings

- **Rolling contact bearings:** Load is transferred through elements in rolling contact.
- Also called anti-friction bearing due to its low friction characteristics.
- Advantage: Lower price, low maintenance, ease of operation
- Application: Extensively used

Ball bearings
Source: RAS Bearings and Industrial Components

Types of Rolling Contact Bearings

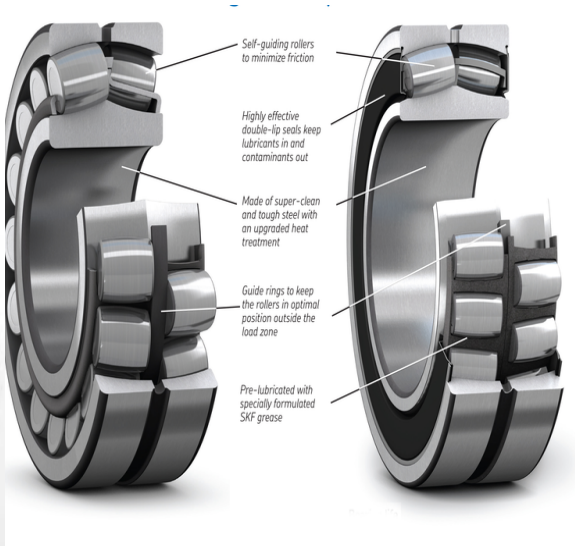
- **Rolling bearings Types:**

- Ball Bearings: Rolling elements are spherical balls
- Roller Bearings: Rolling elements are rollers (cylindrical or straight, tapered, spherical)

Ball bearing
Source: indiantradebird.com

Straight roller
globalcpec.com

Tapered roller bearing
Source: globalcpec.com

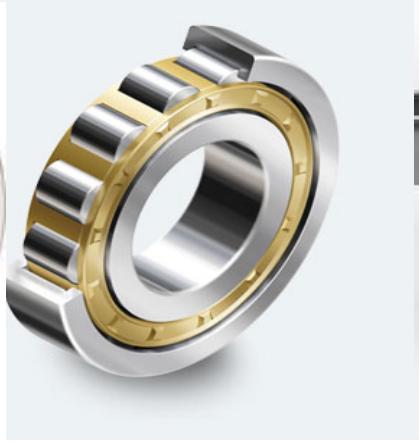


Spherical roller bearing
Source: SKF

- Ball Bearings: Can take radial and axial thrust load
- Straight Roller Bearings: Larger load capacity than ball bearings
  Zero misalignment required
  Can not take axial thrust

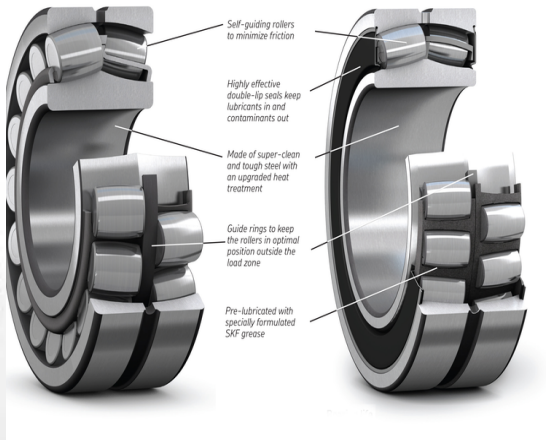
Types of Rolling Contact Bearings

Ball bearing
indiantradebird.com



Straight roller
globalcpec.com

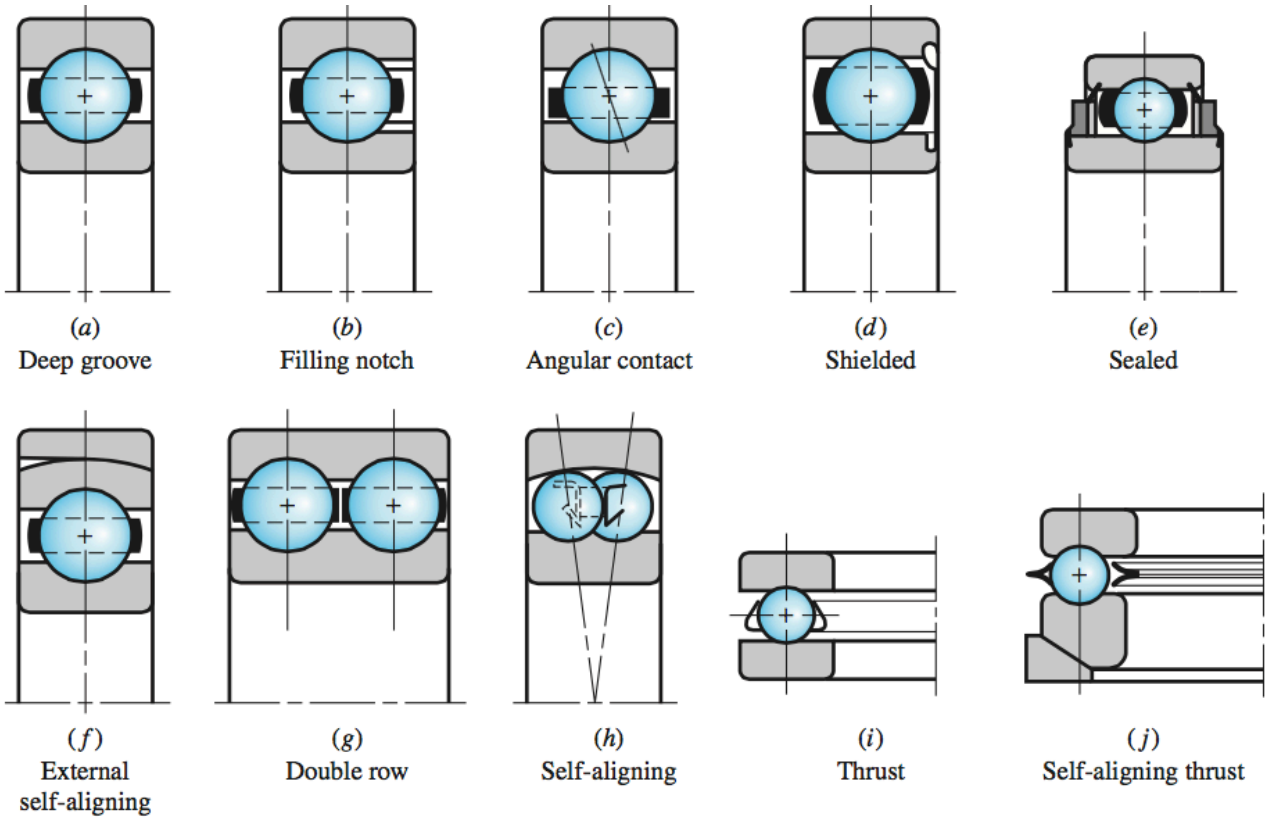
Tapered roller bearing
Source: globalcpec.com



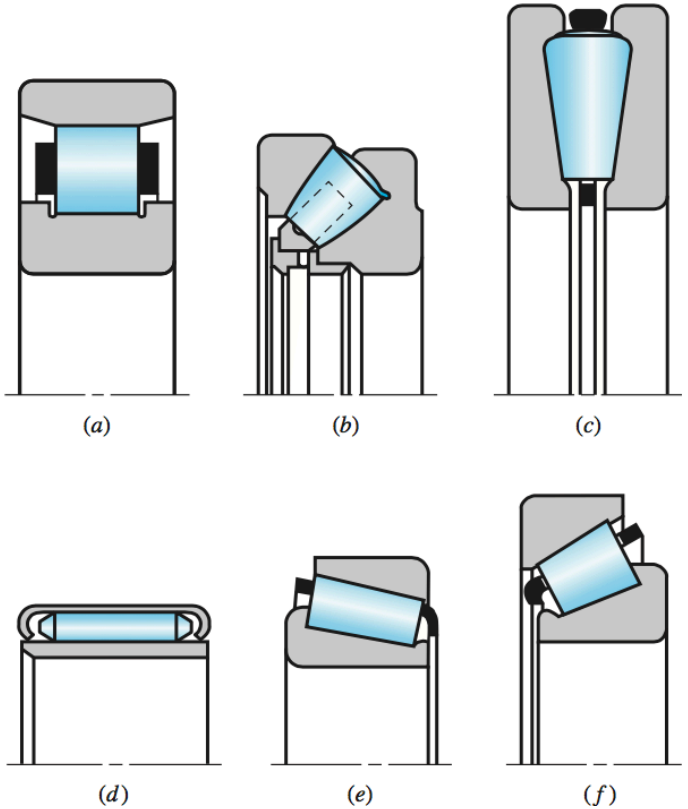
Spherical roller bearing
Source: SKF

- Ball Bearings: Lower load capacity, Can take radial and axial thrust load
- Straight Roller Bearings: Larger load capacity than ball bearings, Zero misalignment required
  Can not take axial thrust
- Tapered Roller Bearings: High load capacity, Some misalignment permitted,
  Load: Radial, axial thrust and combined radial and thrust
- Spherical Roller Bearings: Heavy load capacity, Large misalignment permitted,
  Increases contact area with increased load

Types of Rolling Contact Bearings



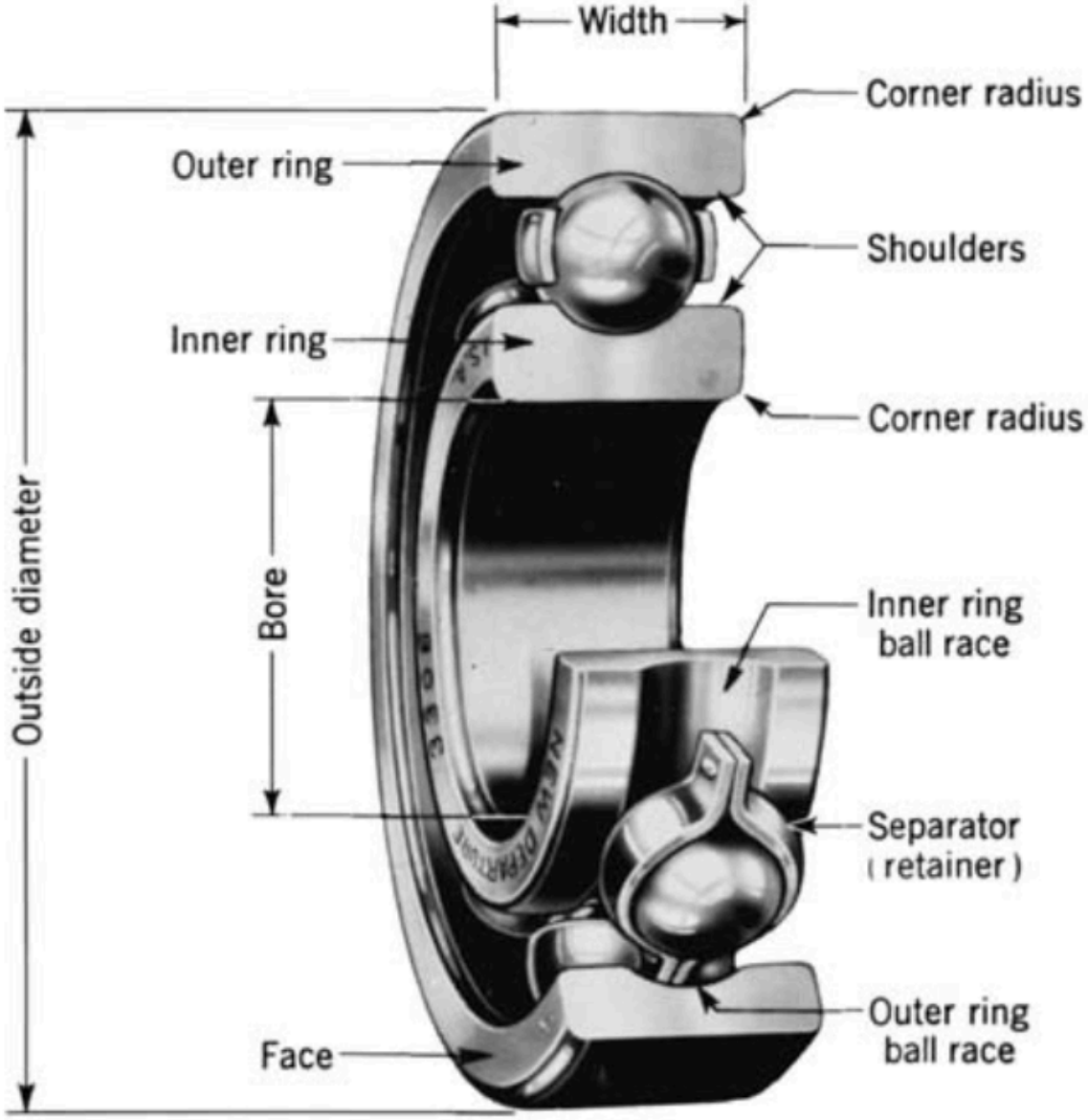
Types of Ball Bearings:



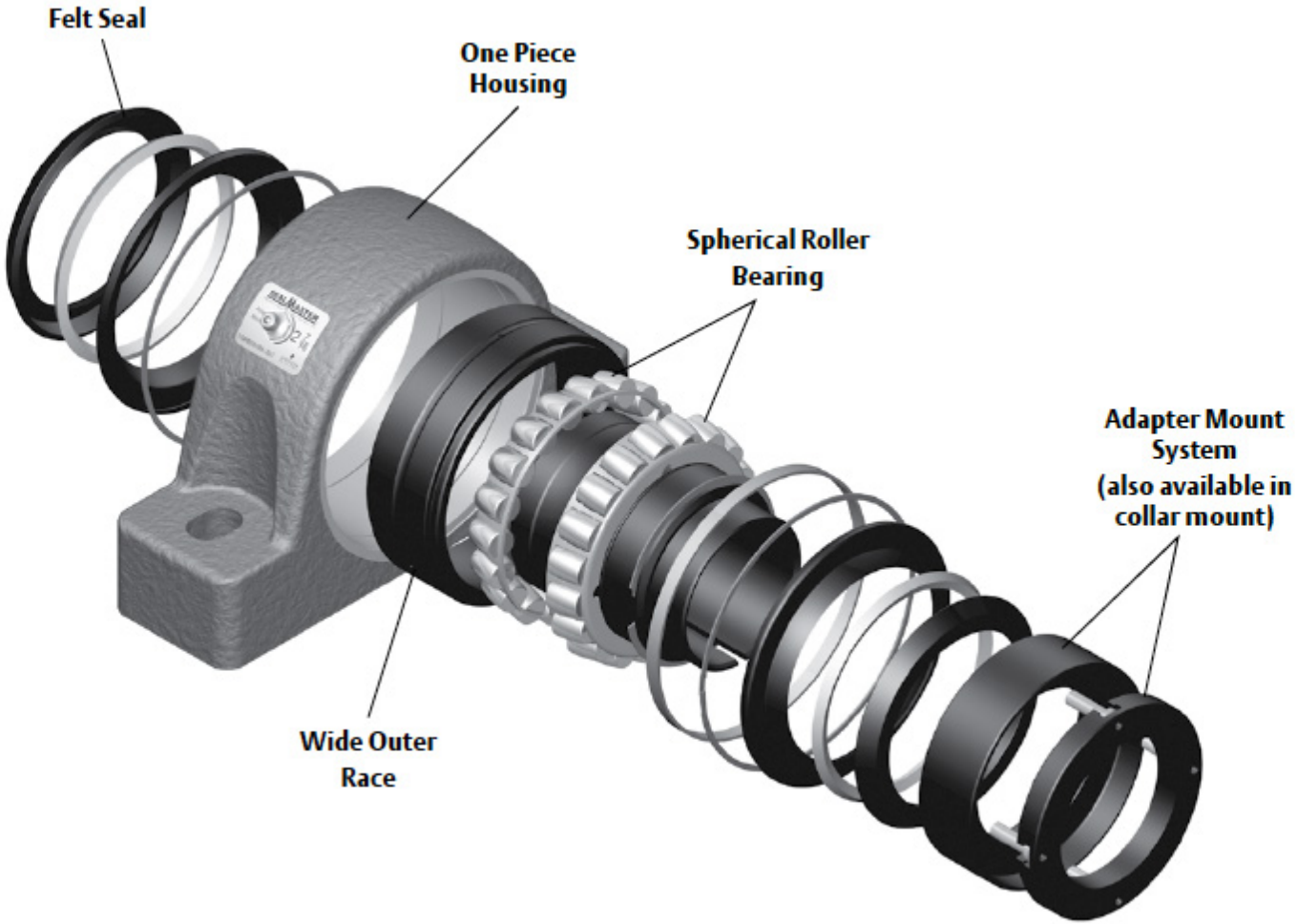
Types of Roller Bearings:

(*a*) straight roller; (*b*) spherical roller, thrust; (*c*) tapered roller, thrust; (*d*) needle; (*e*) tapered roller; (*f*) steep-angle tapered roller. *(Courtesy of The Timken Company.)*

Bearing Components



Bearing Assembly

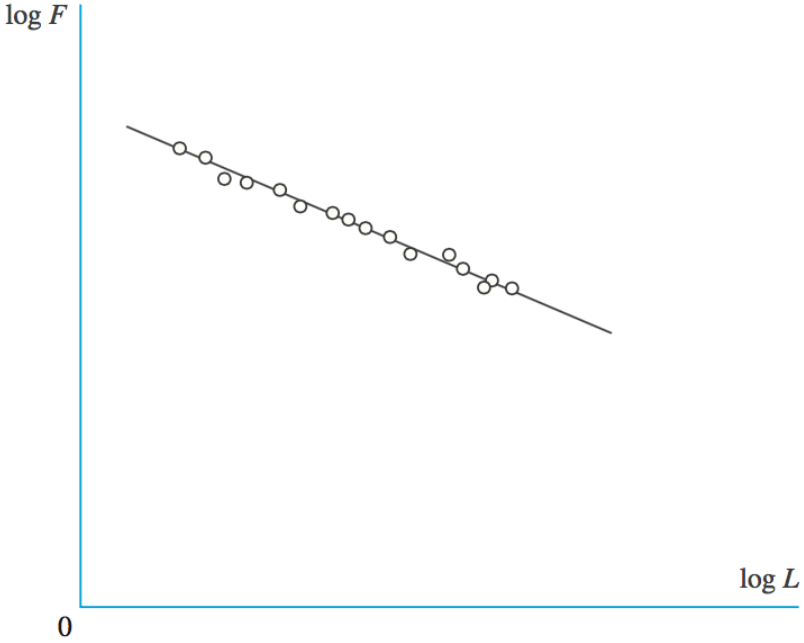


Bearing Assembly

Source: Aggregates and Mining Today

Bearing Life

- Load on Bearings: Fluctuating contact stress (on ball or roller, and the races)
- Failure Scenario: Fatigue (for proper lubrication, mounting, sealing, temperature and Dust control)
- Measure of Life: (1) Number of revolutions of inner ring with outer fixed before fatigue.
  (2) Hours of operation at constant angular speed before fatigue
- Fatigue Criterion: Pitting or spalling of an area 0.01 square inch (6.5 sq. mm)



Typical Bearing Life: log-log curve

Life - L (in revolutions)

Radial Load - F (in kN)

$$FL^{1/a} = \text{constant}$$

$$a = \begin{cases} 3 & \text{for ball bearings} \\ 10/3 & \text{for roller bearings} \end{cases}$$

This is for constant reliability R

Bearing Selection

- Rated Load and Life: Provided in Manufacturer's Catalog.
  Compare with desired load and life

Rated Life - L_R (in revolutions); Rated Load - F_R (in kN)

Desired Life - L_D (in revolutions); Desired Load - F_D (in kN)

From : $FL^{1/a} =$ constant

$$F_R L_R^{1/a} = F_D L_D^{1/a} \quad \text{or} \quad F_R = F_D \left(\frac{L_D}{L_R} \right)^{1/a} = F_D \left(\frac{\mathcal{L}_D n_D}{\mathcal{L}_R n_R} \right)^{1/a}$$

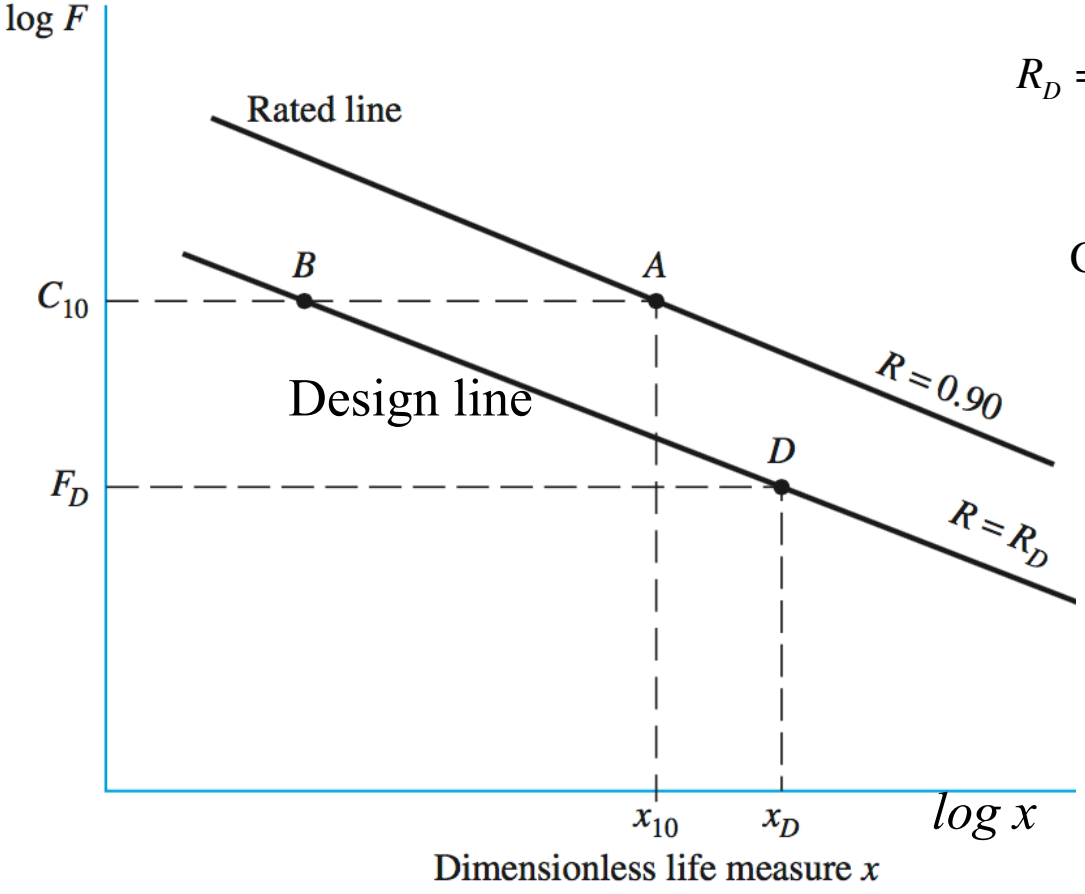
$\mathcal{L}_D / \mathcal{L}_R \coloneqq$ Desired and rated life in hours (measure 2)

$n_D / n_R \coloneqq$ Corresponding speed in rpm ($L_{D/R} = \mathcal{L}_{D/R}(60 \bullet n_{D/R})$

- From Catalog select a bearing with rating F_R or higher.
- This is for constant reliability R
- For 90 % reliability ($R=0.9$): ($F_{R,}$, L_R) are called ($C_{10,}$, L_{1o})

Bearing Selection

- **For different reliability**
  - At constant load reliability follows Weibull distribution (line AB)



$$R_D = \exp\left[-\left(\frac{x_B - x_0}{\theta - x_0}\right)^b\right] \Rightarrow x_B = x_0 + (\theta - x_0)\left(\ln\frac{1}{R_D}\right)^{1/b}$$

Constant Reliability Line (BD) : $FL^{1/a} =$ constant

$$\Rightarrow F_B x_B^{1/a} = F_D x_D^{1/a}$$

$$\Rightarrow \quad F_B = F_D\left(\frac{x_D}{x_R}\right)^{1/a} = F_D\left(\frac{x_D}{x_0 + (\theta - x_0)\left(\ln(1/R_D)\right)^{1/b}}\right)^{1/a}$$

With the use of application factor:

$C_{10} = a_f \bullet F_B$ and $\ln(1/R_D) \approx (1 - R_D)$

$$C_{10} \approx a_f F_D\left(\frac{x_D}{x_0 + (\theta - x_0)\left(1 - R_D\right)^{1/b}}\right)^{1/a}$$

- From Catalog select a bearing with rating C_{10} or higher.