5. ROLLING CONTACT BEARING

SLIDING CONTACT BEARING	ROLLING CONTACT BEARING
Friction is more	Friction is less
Static Friction > Running friction	Static Friction ≈ Running friction (Antifriction bearing)

Elements of Rolling Contact Bearing:
1) Rotating member 2) Support 3) Inner Race 4) Outer Race 5) Rolling Element 6) Cage

TYPES OF ROLLING CONTACT BEARING:

As Per Rotating Element	
Sphere	**Cylinder**
Balls as Rotating Element	Cylinder as Rotating Element
Point Contact => Stress ↑ => Life ↓	Line Contact => Stress ↓ => Life ↑
1. Deep Groove Ball Bearing: Radial load and Slight thrust	1. Cylindrical Roller Bearing: Radial space requires more and roller size is more.
2. Angular Contact Ball Bearing: Both Radial and One directional Thrust Load	2. Needle Roller Bearing: More Load can take and roller size is less.
3. Thrust Ball Bearing: No Radial Bur Thrust Load in Both Direction	3. Spherical Roller Bearing: Radial and small Thrust. Used for small miss alignment.
4. Self-Aligning Ball Bearing: Oscillate about axis	4. Tapered Roller Bearing: Radial and thrust Load
	5. Thrust Roller Bearing: Only Thrust load.

DESIGNATION OF ROLLING CONTACT BEARING:

W-X-Y-Z **Y-Z = Shaft Diameter** Y-Z *5 = Diameter 00 = 10mm 01 = 12mm 02 = 15mm 03 = 17mm	d = Bore Diameter D = Outside Diameter B = Bearing Width H = Bearing Height r = Chamfer Radius $\propto$ = Contact Angle
W = Bearing Type 0 = Double raw angular contact ball bearing 1 = Self aligning ball bearing **2 = Spherical Roller Bearing** **3 = Tapered Roller Bearing** 4 = Double Raw Deep Groove Ball Bearing 5 = Thrust Ball Bearing 6 = Single Raw Deep Groove Ball Bearing 7 = Single Raw Angular Contact Ball Bearing **8 = Cylindrical Roller Thrust Bearing**	**X = Dimension Series = Load Caring Capacity** 1 = Extra light Series 2 = Light Series 3 = Moderate Series 4 = Heavy Series 5 = Extra Heavy Series

Static load Caring Capacity (C_o): It's minimum static load that bearing can be withstand to avoid maximum deformation of 0.0001d.
C_o $= Kd^2Z/5$ (For ball bearing) Where, K = Constant that accounts for curvature at point of contact and stiffness of bearing element, Z = No of rolling elements, d = diameter of shaft
C_o $= lKd^2Z/5$ (Roller Bering) Where, l = length of line of contact in roller bearing

Bearing Life (Life of one bearing): No. of revolution/hours (at constant speed) to fatigue failure.
Reliability: % No. of bearing is in service.
Rating Life (Life of group of bearing): It's minimum possible life of the group of bearings for 90% reliability.
Median Life (Average life) (L_{50}): % No. of bearings in service = 50%
$L_{50} > L_{10}$
Min. Criteria of life (For group of bearing)**:** 10^6 Revolution = 1 Million revolution
Dynamic Load Capacity (C): It's maximum load that can be applied over a bearing for a minimum rating life of 10^6 Revolution. It also called as Dynamic load rating, Catalogue load. Used for selection of bearing.

Equivalent Radial load:

$F_e = F_r$ for $\frac{F_a}{F_r} < e$, And $\frac{F_e}{F_r} = C_v \left[\frac{F_a}{F_r}Y + XV\right]$ For $\frac{F_a}{F_r} > e$,

Where, F_e = Equivalent radial load
F_r = Radial load
F_a = Axial load
C_v = Service Factor (>1)
X = Radial load Factor
Y = Axial load factor
V = Race Rotation factor
= 1 (Inner race rotation)
= 1.2 (Outer race rotation)

Load-Life Relationship: $L_{10} = \left(\frac{C}{F}\right)^K$

Where, L_{10} = Rating Life (in Million revolution)
C = Dynamic load rating/ Catalogue load/ Dynamic Load Capacity
K = 3 (For ball bearing)
= 10/3 (For roller bearing)
N = Speed of Rotation (RPM)

Life in hours $L_{hr} = \frac{L_{10}\ 10^6}{60\ N}$

Reliability-Life Relationship: $\frac{\boldsymbol{L}}{\boldsymbol{L_{10}}} = \left[\frac{\ln(1/R)}{\ln(1/R_{90})}\right]^{1/b}$, $(derived\ from\ Weibull\ Distribution\ (R = e^{-(L/a)^b}))$

Where, a = 6.84
b = 1.17
R = Reliability
L = Life of group of bearing

R = 90% => L = L_{10}. Hence $L_{50} = 5\ L_{10}$

Cumulative Damage: $\frac{\sum(NP^K)_i}{\sum N_i} = P_{eq}^K$**, Where,** $C^K = NP_{eq}^K = LP_{eq}^K$, $N = \sum N_i$

IMPORTANT POINT:

1) $L_{hr} = \frac{L_{10}10^6}{60\ N}$

Where, $L_{10} = \left(\frac{C}{F}\right)^K$ = Life at R = 90%

Where F = F_e = $C_v[F_aY + XVF_r]$ = Load Acting on bearings

2) $\frac{L}{L_{10}} = \left[\frac{\ln(1/R)}{\ln(1/R_{90})}\right]^{1/1.17}$ And Average $L_{50} = 5\ L_{10}$

3) $\frac{\sum(NP^K)_i}{\sum N_i} = P_{eq}^K$

Where, K = 3 (For ball bearing)
= 10/3 (For roller bearing)