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TIMKEN

DUNBELT

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TIMKEN ESPAÑA

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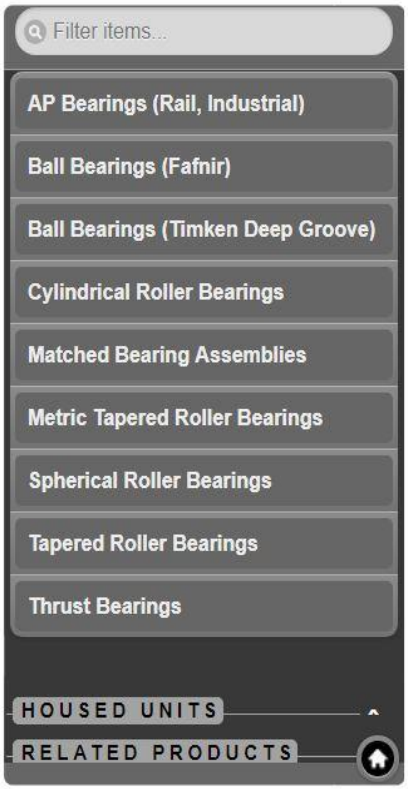

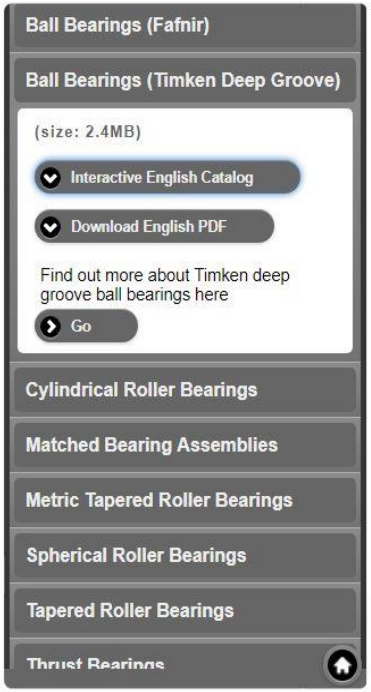

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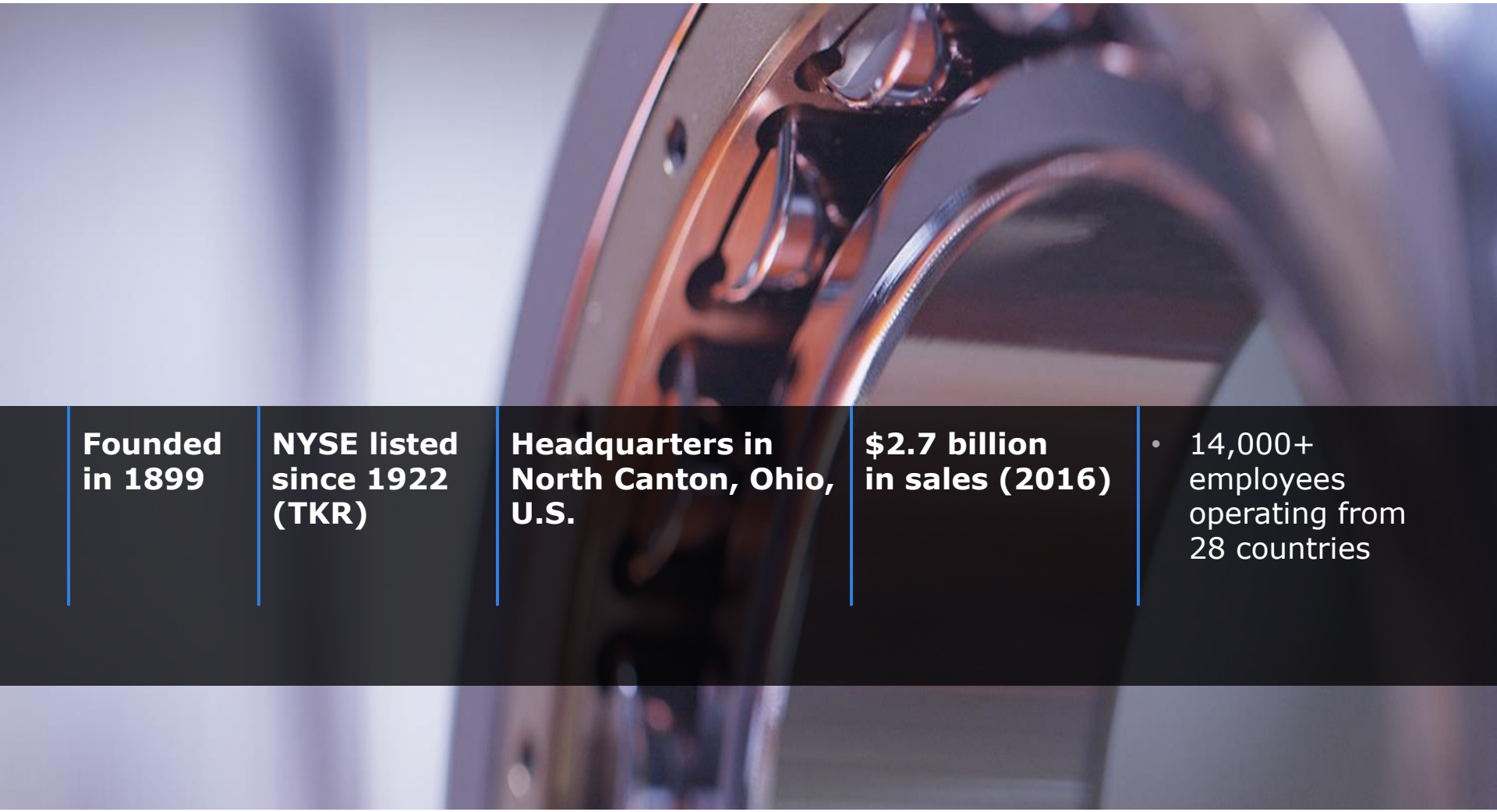
At a Glance



Founded in 1899

NYSE listed since 1922 (TKR)

Headquarters in North Canton, Ohio, U.S.

$2.7 billion in sales (2016)

- 14,000+ employees operating from 28 countries

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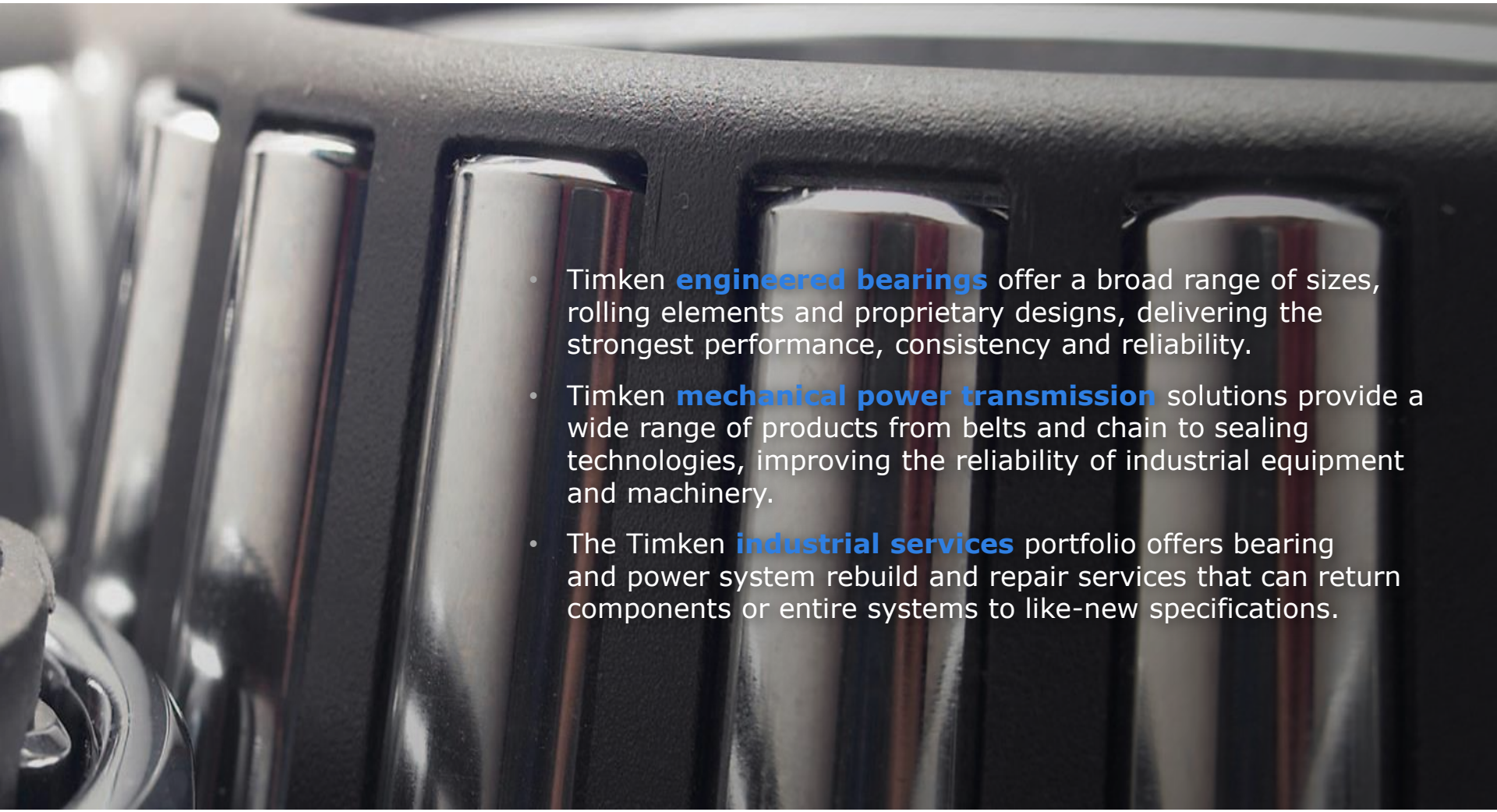
Inside the World's Industries



- Timken **engineered bearings** offer a broad range of sizes, rolling elements and proprietary designs, delivering the strongest performance, consistency and reliability.
- Timken **mechanical power transmission** solutions provide a wide range of products from belts and chain to sealing technologies, improving the reliability of industrial equipment and machinery.
- The Timken **industrial services** portfolio offers bearing and power system rebuild and repair services that can return components or entire systems to like-new specifications.

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Our Portfolio of Brands

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Broadening Our Offering Through Acquisition

QM Bearings	Philadelphia Gear	DRIVES	WAZEE	INTERLUBE	SMITH SERVICES	STANDARD MACHINE
Spherical roller bearing steel housed unit bearings, elastomeric and steel couplings	Industrial gear drive and repair services	Chain and augers	Electric motor repair, related services and up-tower wind maintenance and repair	Lubrication systems	Electric motor repair and services	Industrial gear drive and repair services
2010	2011	2011	2012	2013	2013	2013

SCHULZ	REVOLVO	CARLISLE	Lovejoy	edt	TORSION CONTROL PRODUCTS	PTTECH POWERING INNOVATION	GROENEVELD
Electric motor repair and services	Split roller housed unit bearings	Industrial and commercial belts	Industrial couplings and universal joints	Polymer housed unit bearings and stainless steel ball bearings	Spring couplings	Industrial clutches and brakes	Lubrication systems
2014	2014	2015	2016	2016	2017	2017	2017

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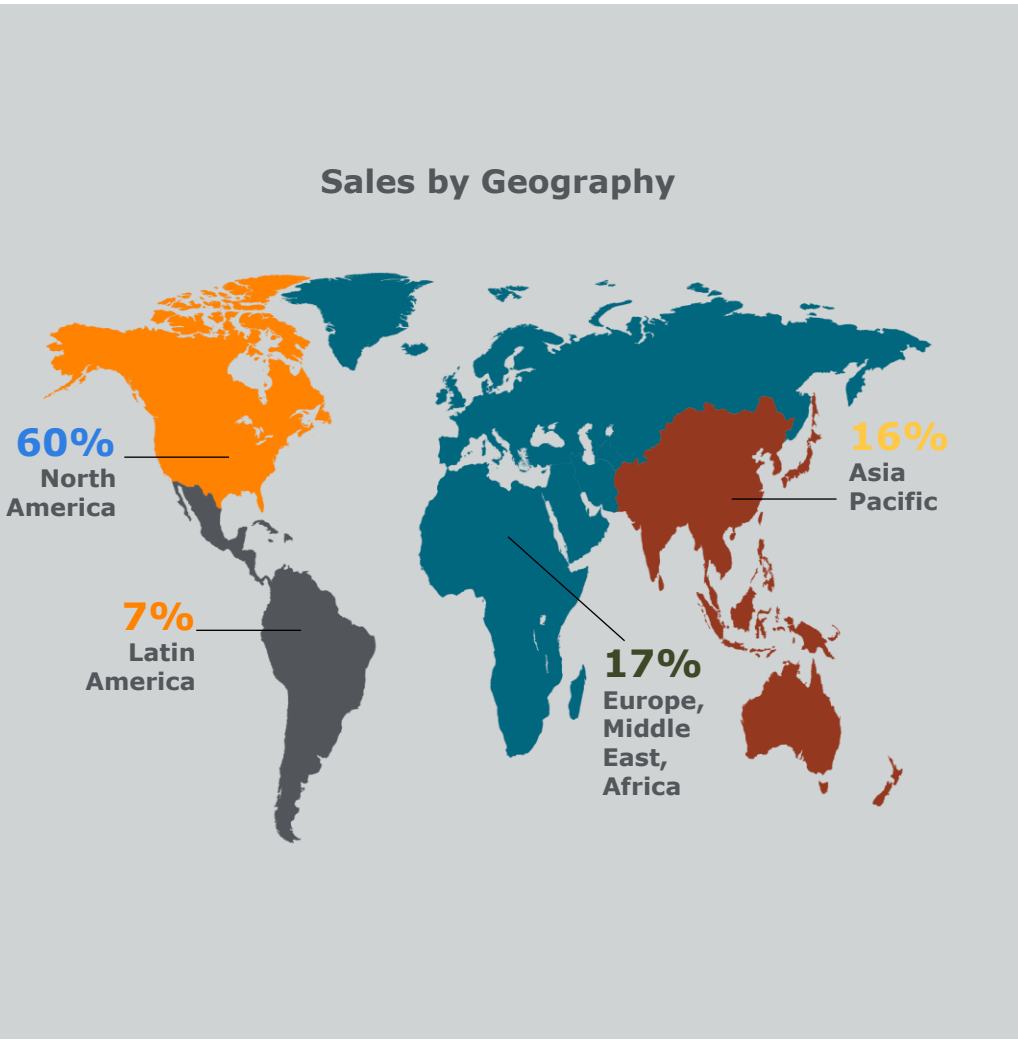
Global Footprint

28
countries

57
sales offices

14K
associates



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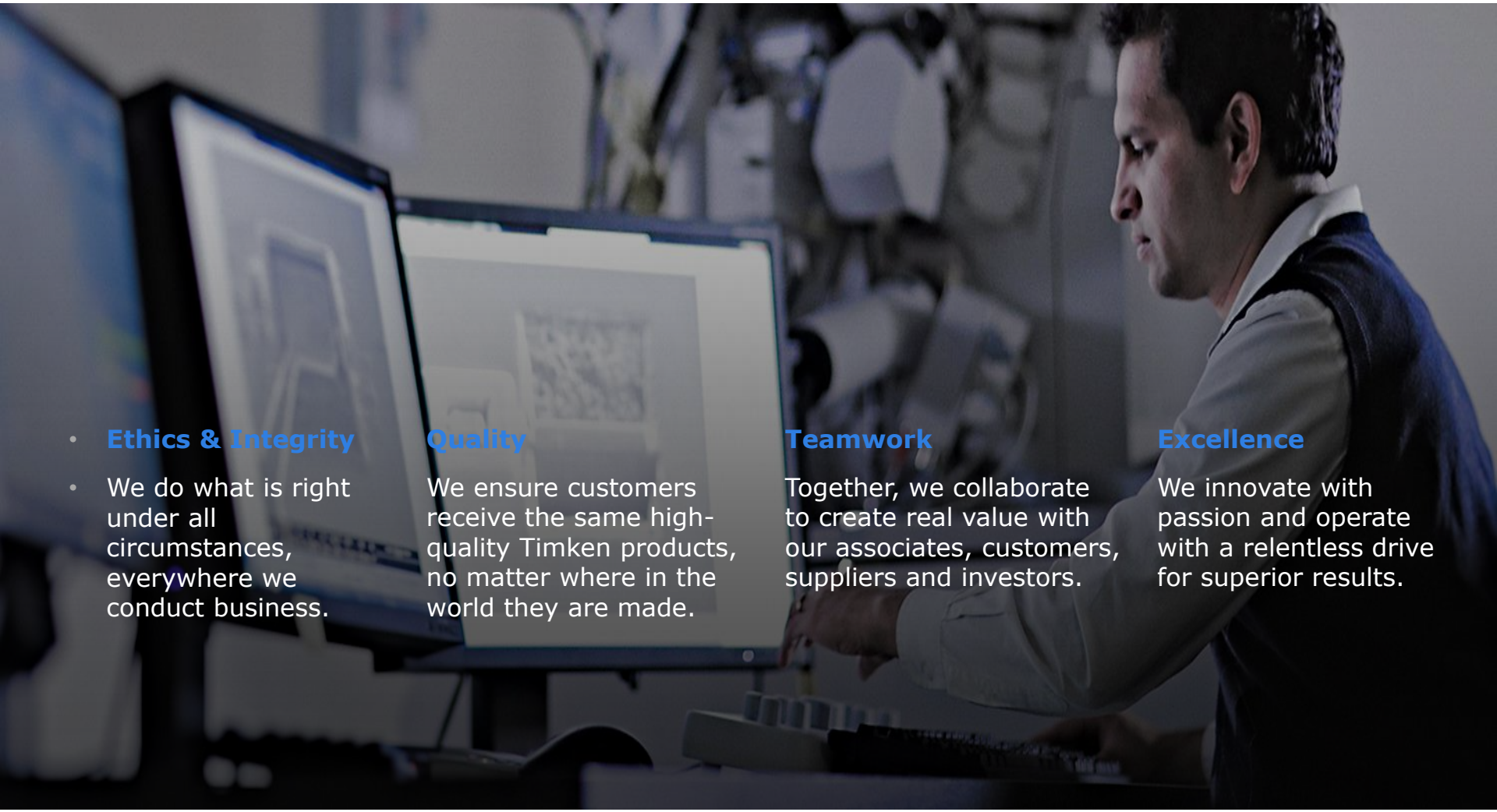
Our Core Values Define Us



- **Ethics & Integrity**
- We do what is right under all circumstances, everywhere we conduct business.

Quality

We ensure customers receive the same high-quality Timken products, no matter where in the world they are made.

Teamwork

Together, we collaborate to create real value with our associates, customers, suppliers and investors.

Excellence

We innovate with passion and operate with a relentless drive for superior results.

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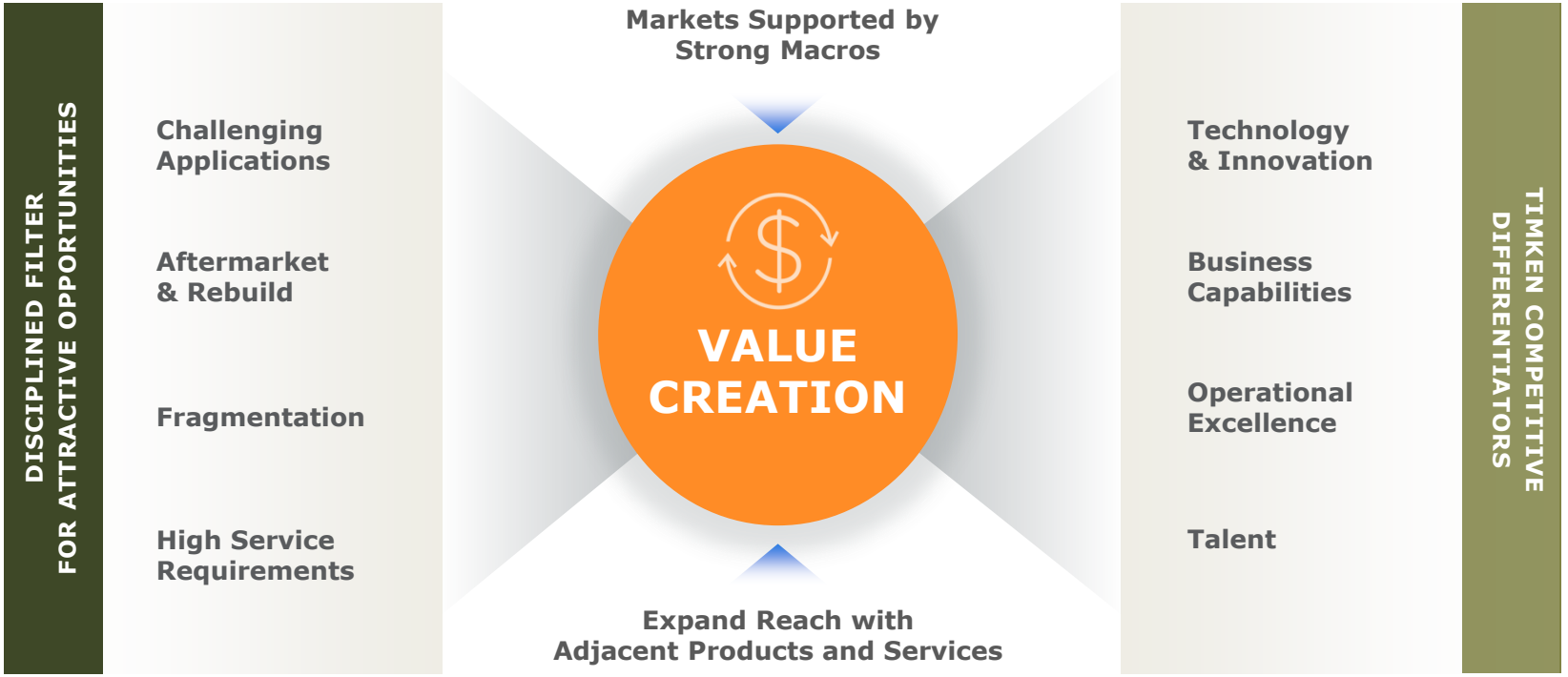
Timken Business Model



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Collaborating to Exceed Expectations

- Travel to Mars aboard the Curiosity rover
- Power many of the world's largest wind turbines
- Support drilling of the world's longest rail tunnel

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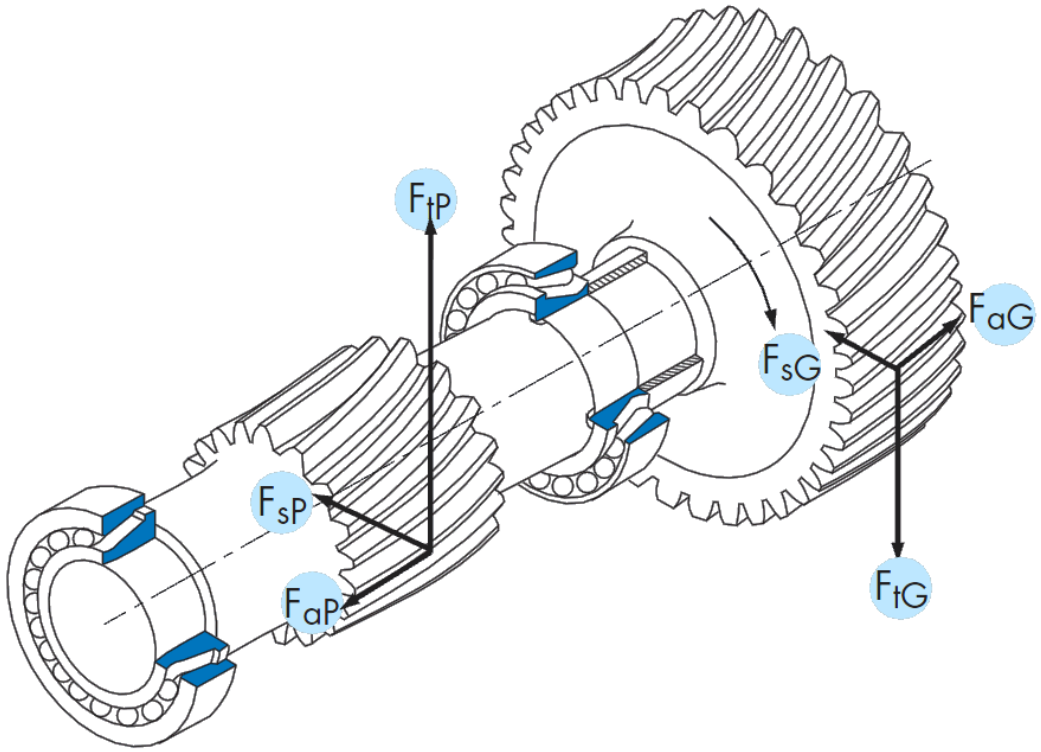
Bearing basics



Introduction to Anti-Friction Bearings

WHY DO WE USE A BEARING IN A MECHANIC SYSTEM?

THE 4 FUNCTIONS OF A BEARING ARE*

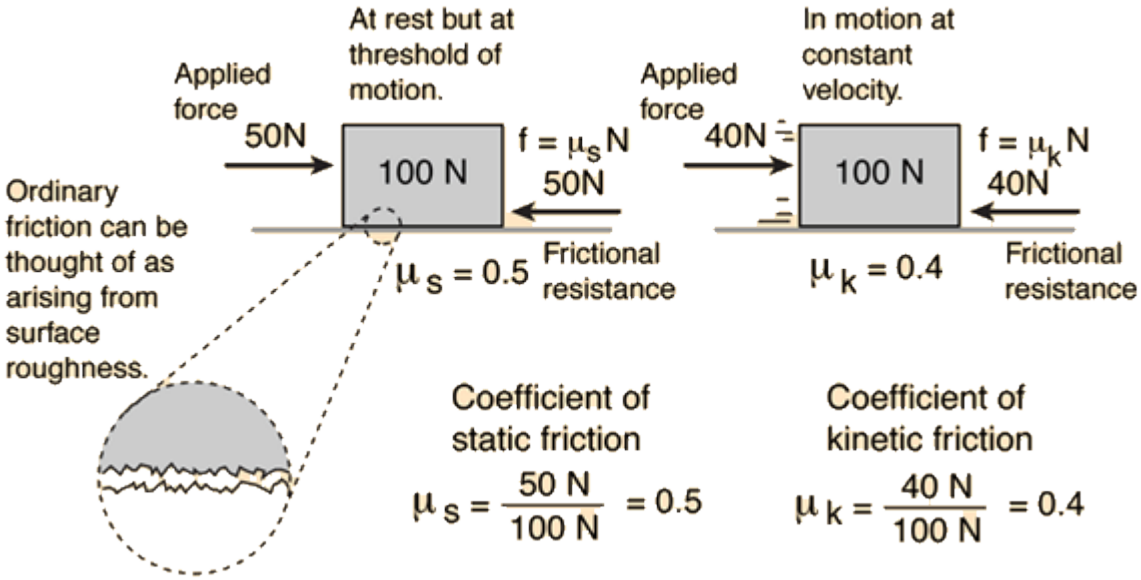
- to eliminate friction
- to radially support and align the shaft
- to carry & disperse loads
- to locate the shaft axially

Note:
* valid for any type

1. To eliminate friction

Friction induces problems of

- torque
- heat
- wear
- inefficiency, power loss



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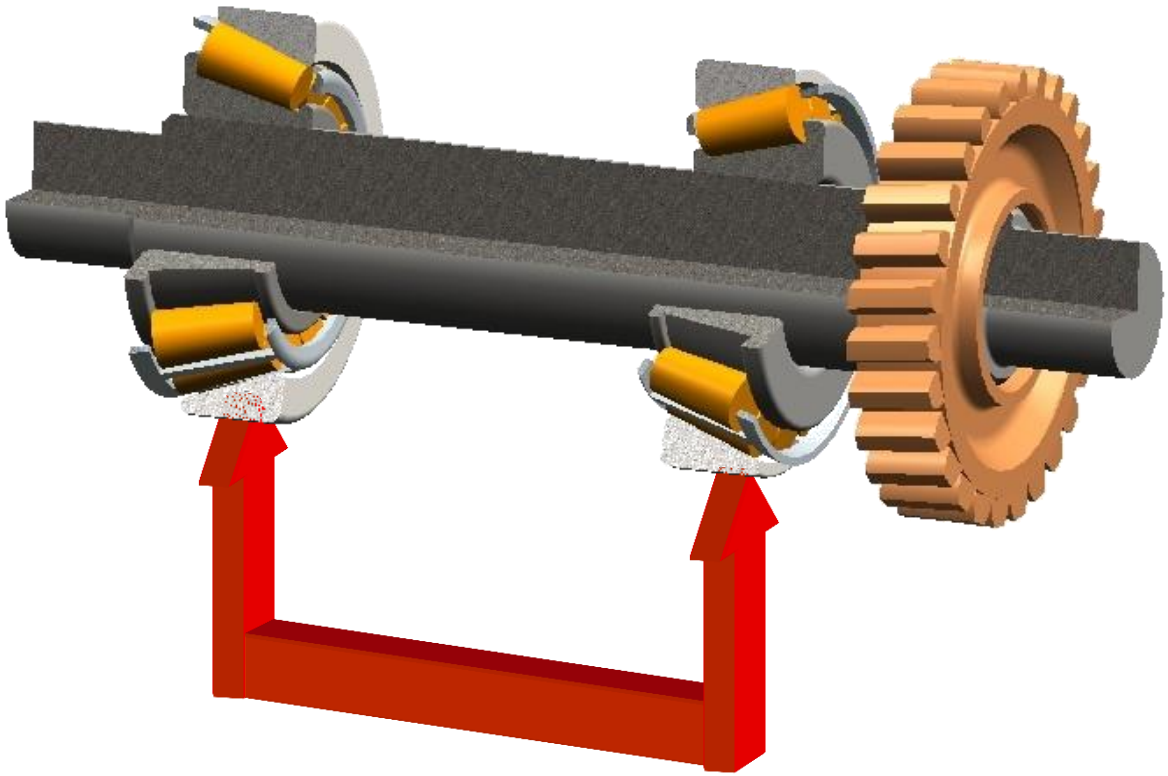
2. To radially support and align the shaft



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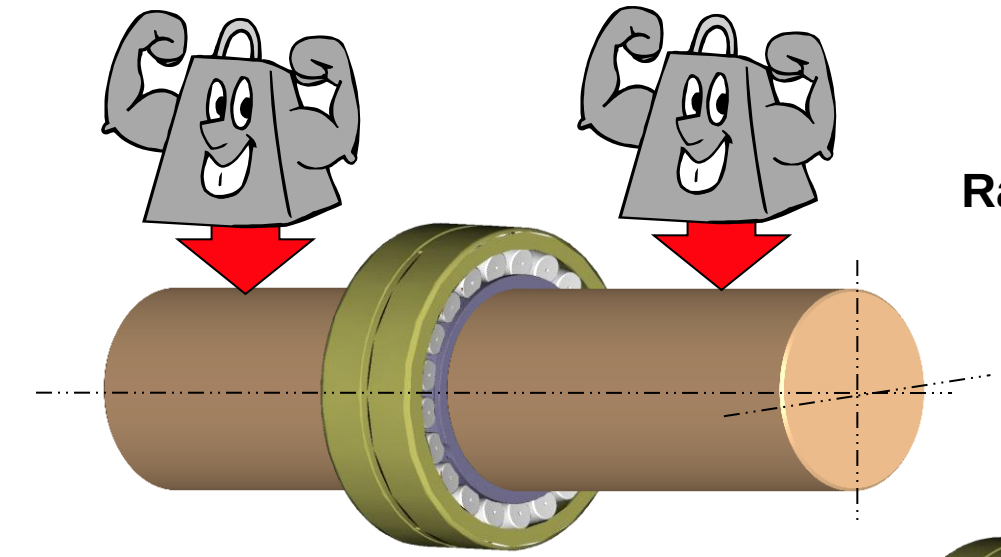
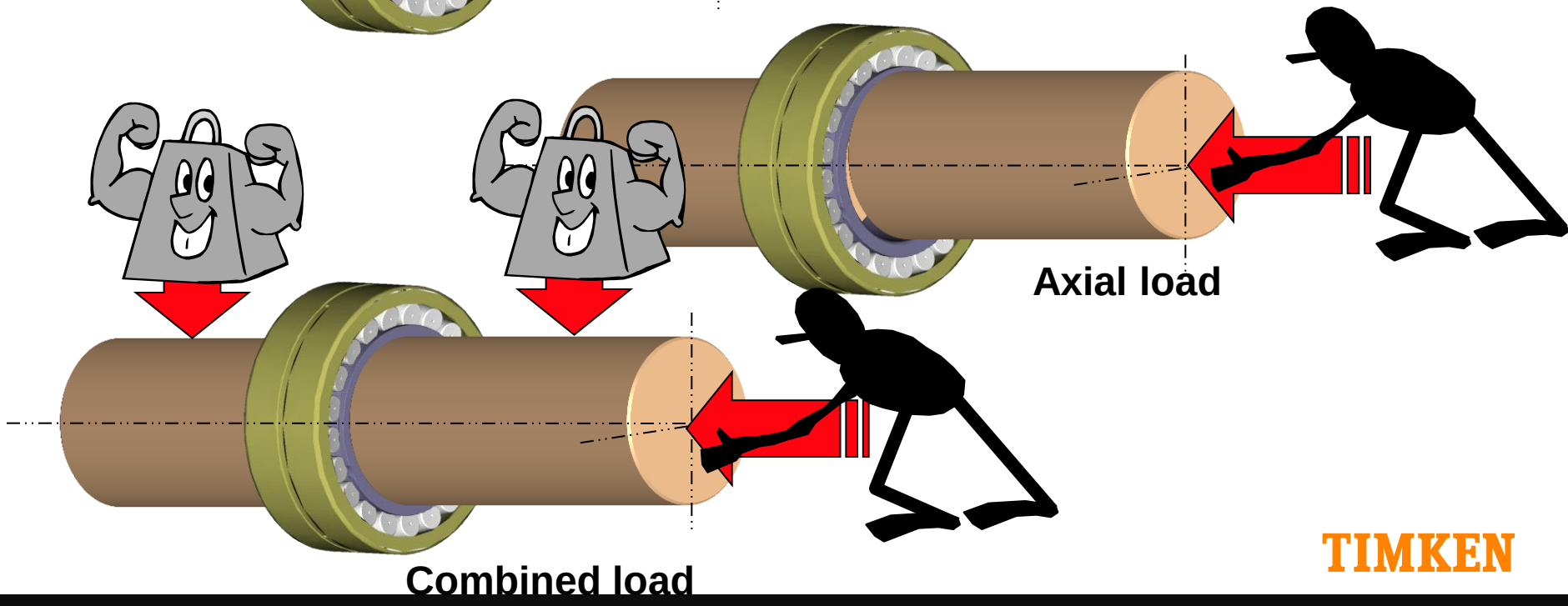
3. To carry & disperse loads



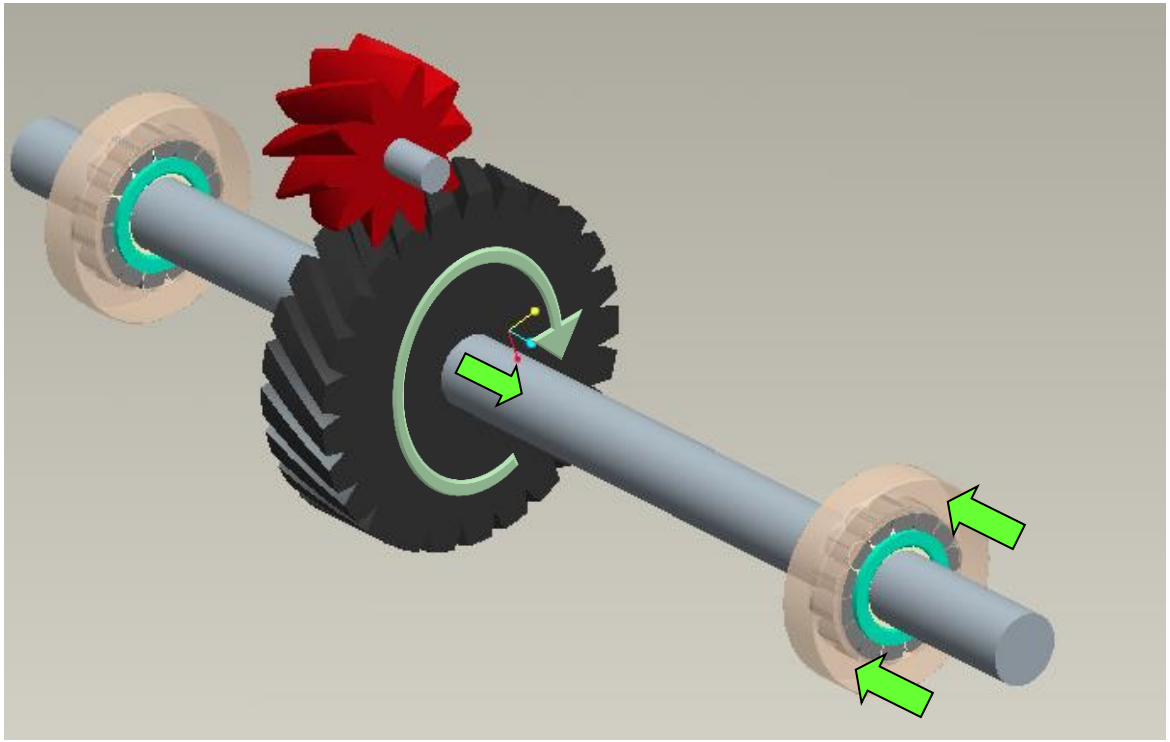
Radial load



Axial load

Combined load

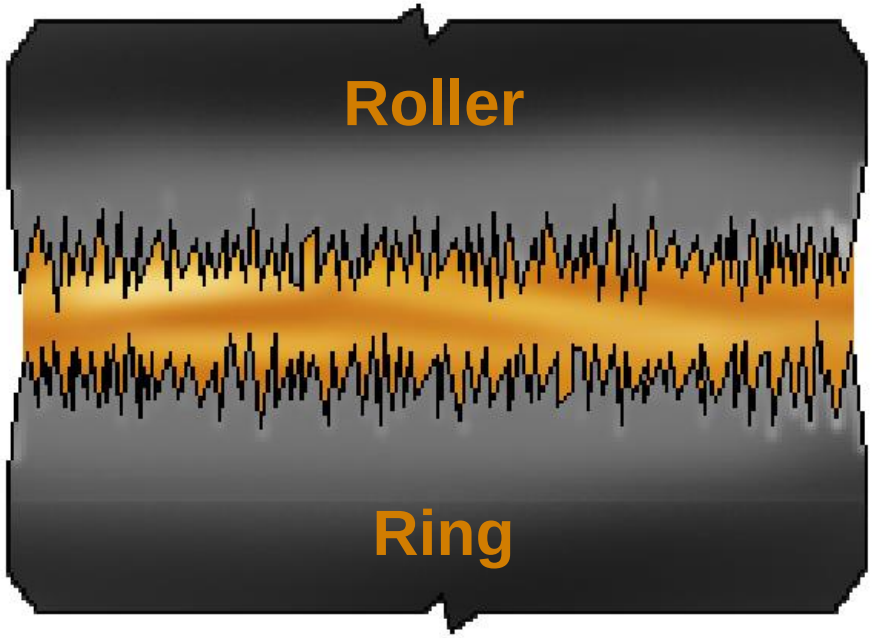
4.To locate the shaft axially



FRICTION

In a bearing, friction is affected by:

- Rolling element
- Surface finish
- Lubrication



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Friction Bearing

- **Bushings**
- **Plain Bearing**

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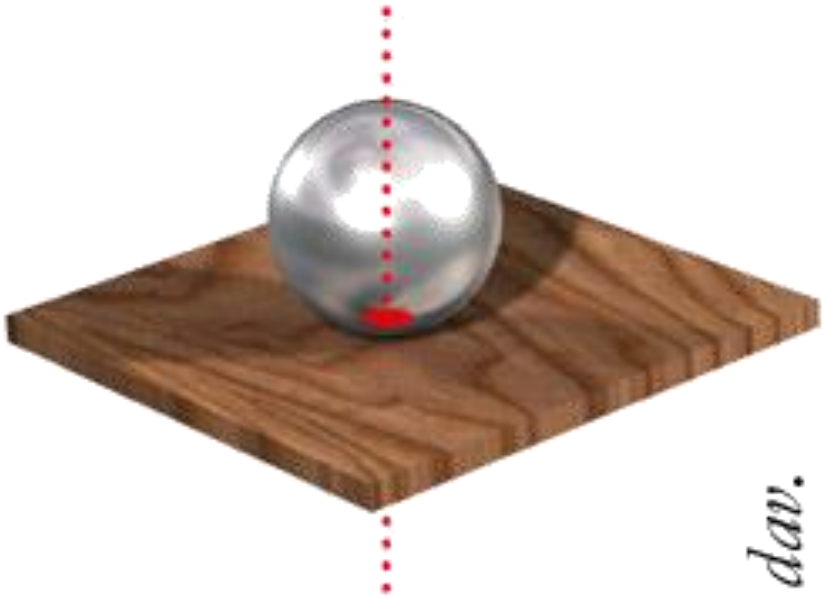
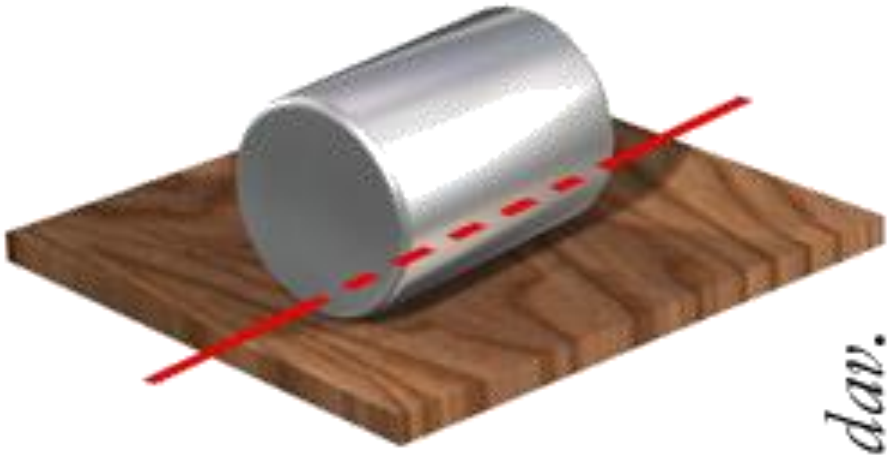
ROLLING FRICTION





Low friction

Low temperature

High speed

Light load

High friction

High Temperature

Low speed

High load

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Anti-friction bearings

Stronger.

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Anti-Friction Bearings

- Tapered roller bearing
- Ball bearing
- Cylindrical roller bearing
- Spherical roller bearing
- Needle roller bearing

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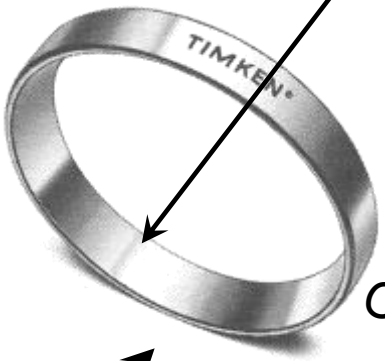
Anatomy of a anti-friction bearing

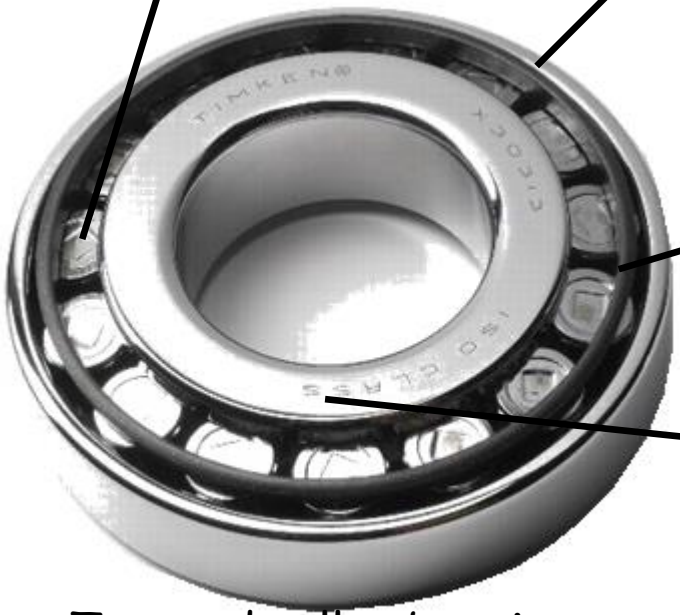
Rollers

Raceway outer ring



Outer Ring

Cage



Tapered roller bearing

Inner Ring

Raceway Inner ring

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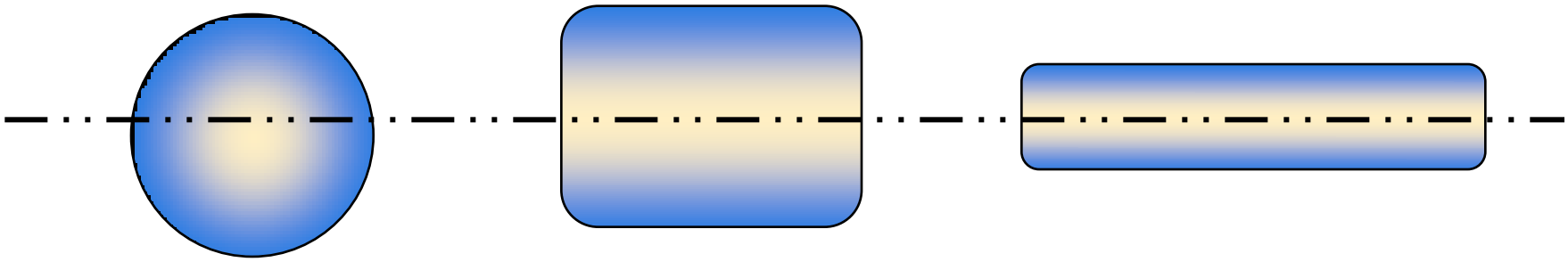
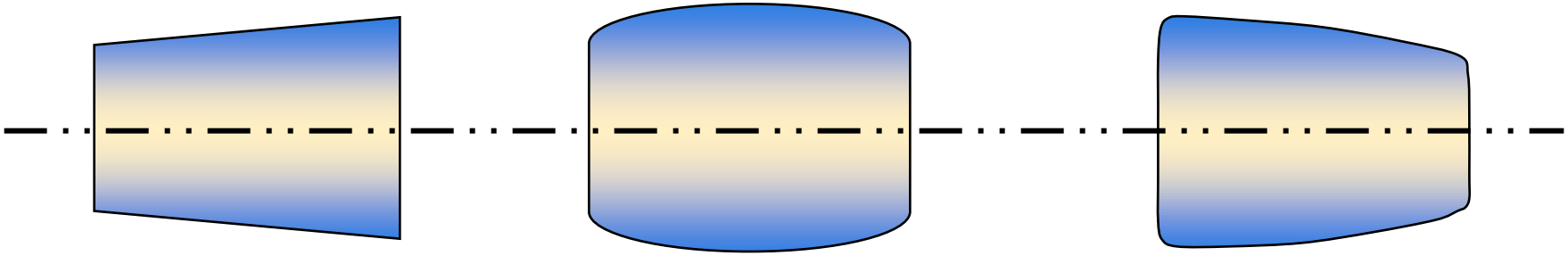
ROLLING ELEMENTS



Ball

Cylindrical roller

Needle roller



Tapered roller

Symmetrical barrel roller

Asymmetrical barrel roller

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Cage

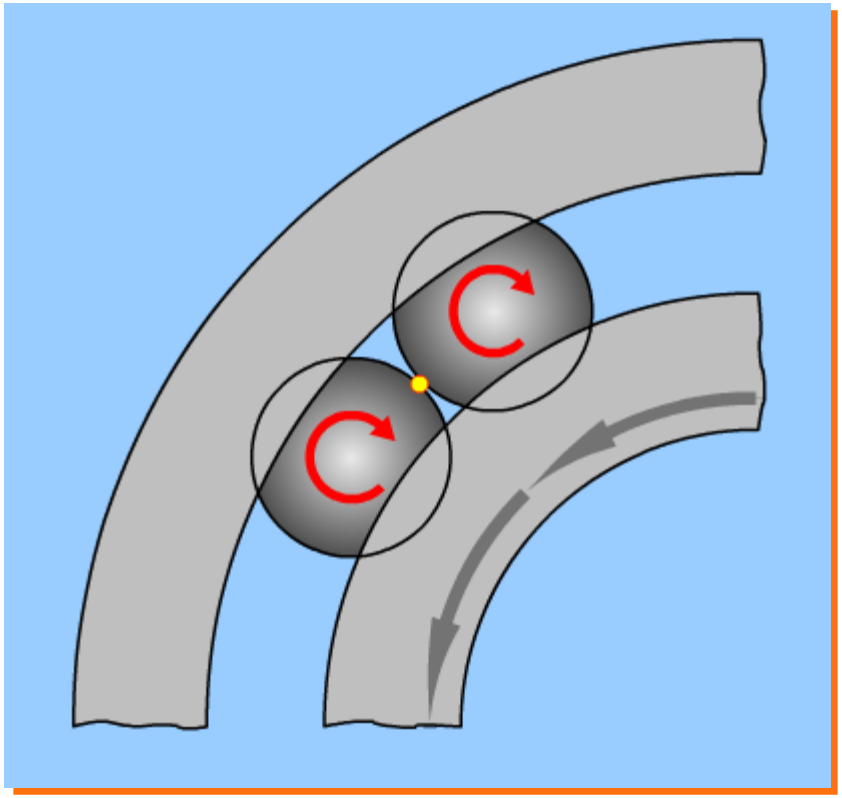
Functions:

- Separates rollers to prevent inter-roller rubbing
- Retains and guides the rollers
- Noise damping
- Increases space for lubricant

Effect of Contra-rotation on Rollers

Although all rollers are revolving the same way, at the contact point they are travelling in opposite directions (contra-rotation)

This results in friction, heat and wear



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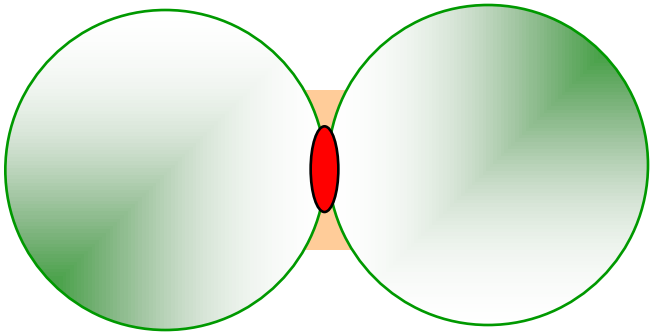
Inter-Roller Rubbing

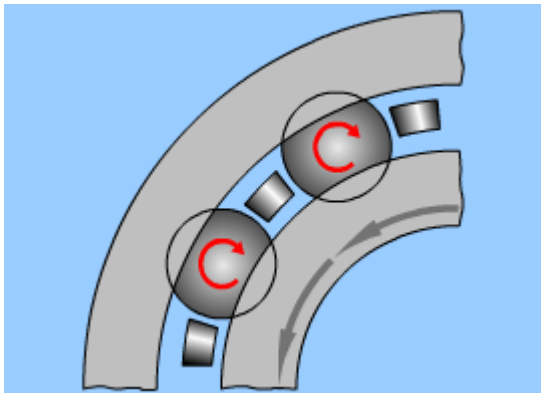


Non separated rollers gives inter-roller rubbing

Produces heat and expansion

Not suitable for high speed running

Cage separates rollers and lowers friction



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CAGES

- Pressed steel cages

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CAGES

- **Machined brass cages**

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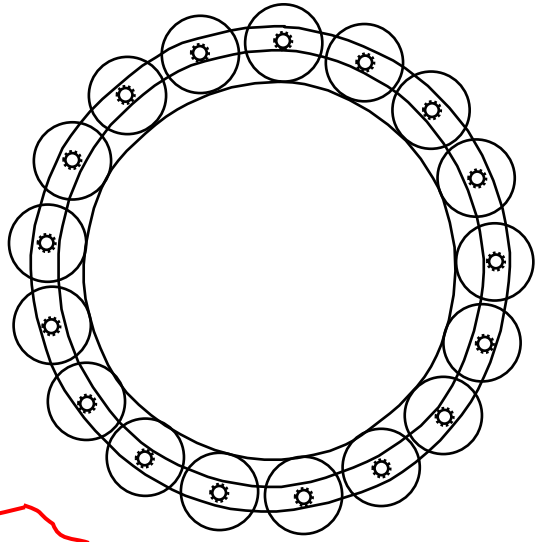
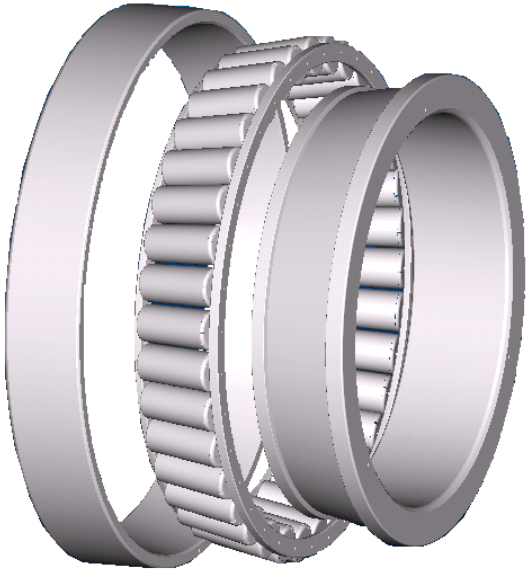
Cages

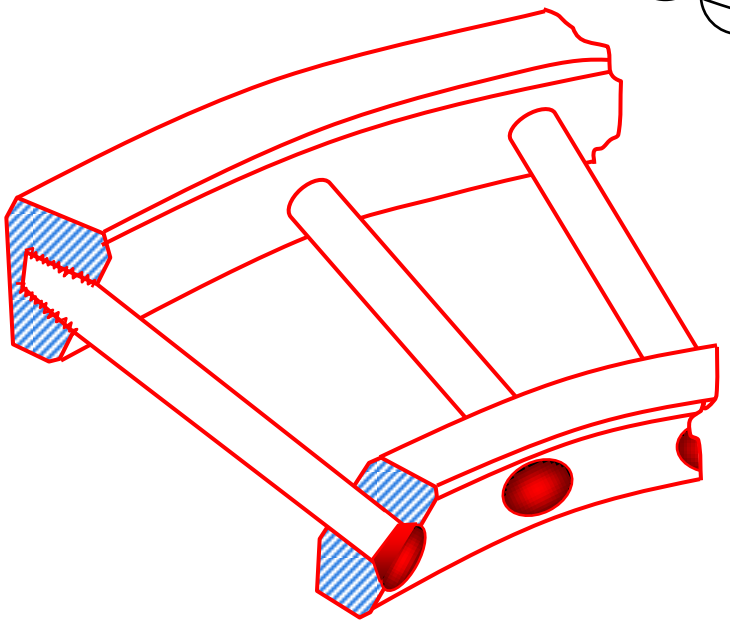
- **Moulded polymer cages**

Cages

- **Pin type**







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Boundary dimensions

Bearing Industry Standards

- ANSI - American National Standards Institute
- ABMA - American Bearing Manufacturers Association
- ISO - International Standardization Organization
- DIN - Deutsches Institut für Normung
- JIS - Japanese Industrial Standards
- Bearing manufacturers internal specifications

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Where You Turn

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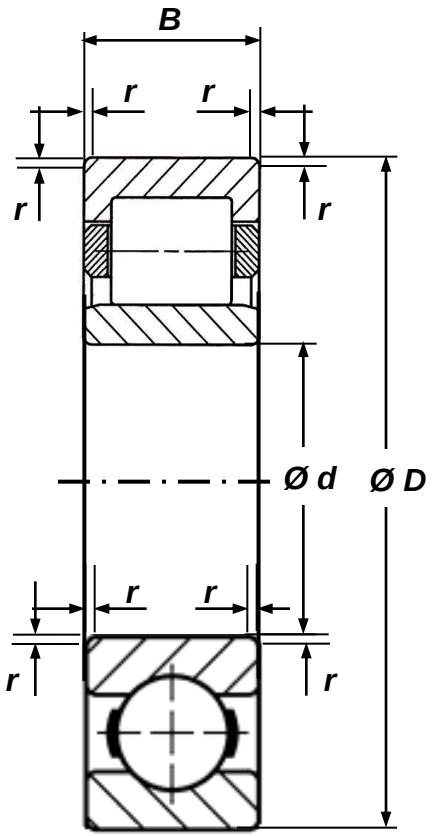
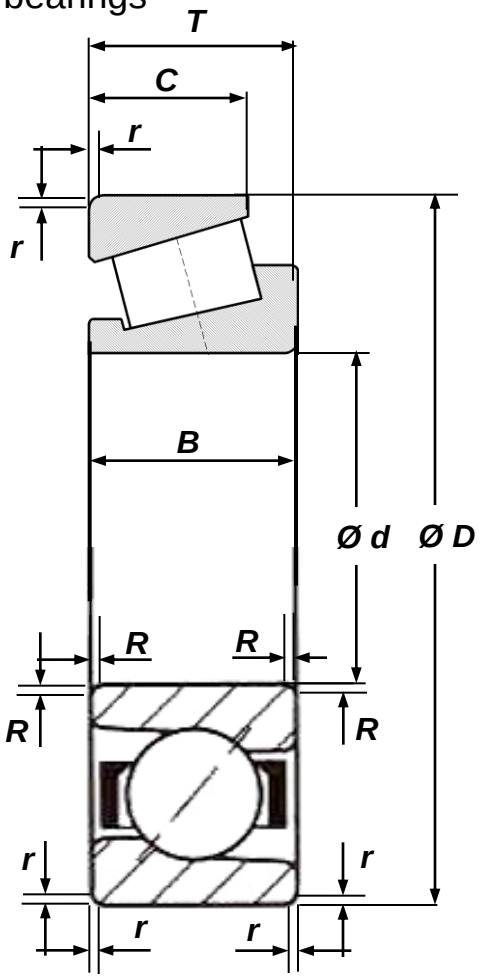
Boundary Dimensions

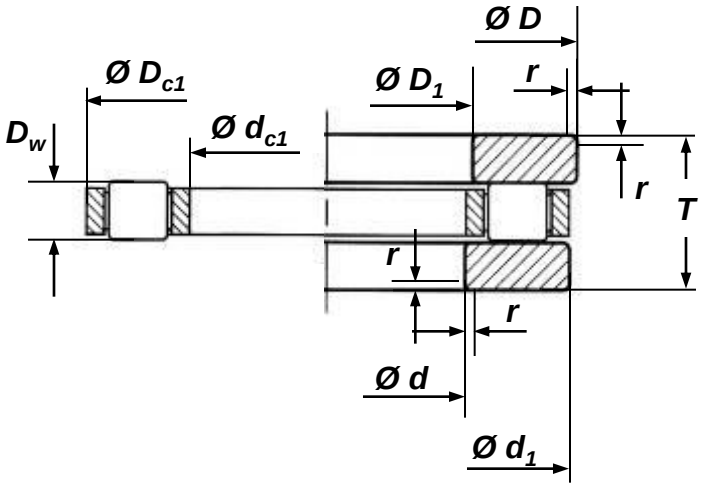
Radial ball & roller bearings

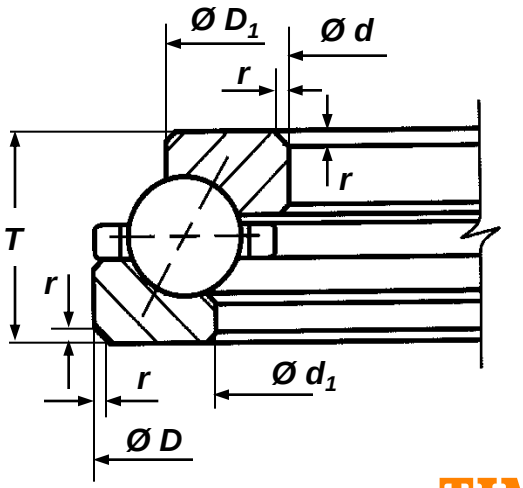


Angular contact ball & roller bearings



Thrust ball & roller bearings





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World Part Numbering system for Metric (ISO) bearings

Bearing serie codes

\#
or ##
or ###
or ####

Dimensions (Width & Diameter) serie codes

\# #

Bore size

\# #
or / ###
or / ####

Examples:

23292 → 2 | 32 | 92

NNU4980 → NNU | 49 | 80

240 / 800 → 2 | 40 | / 800

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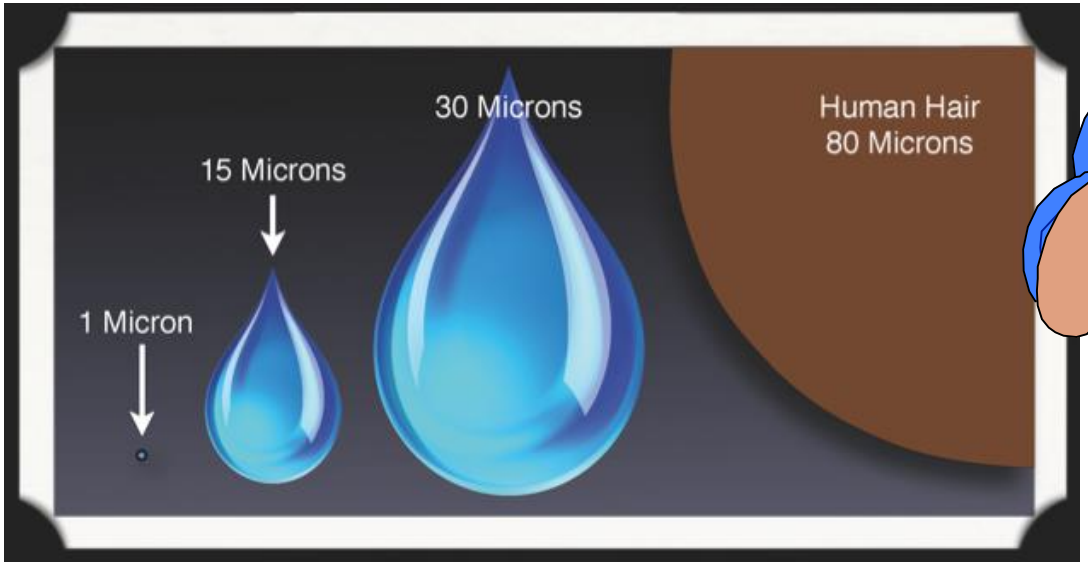
Precision Classes & Tolerances

Level of Precision

What does ONE (1) Micrometer look like?



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ISO and ABMA Tolerance Classes for Metric Roller bearings except TRB

ISO

- Normal
  (Designated P0 or without any indication)
- 6 - More Accurate than Normal
  (Designated P6)
- 5 - More Accurate than P6
  (Designated P5)
- 4 - More Accurate than P5
  (Designated P4)
- 2 - More Accurate than P4
  (Designated P2)

ABMA

- ABEC/RBEC 1 (≈ P0)
- ABEC/RBEC 3 (≈ P6)
- ABEC/RBEC 5 (≈ P5)
- ABEC/RBEC 7 (≈ P4)
- ABEC/RBEC 9 (≈ P2)

Comparison with Metric TRB

CRB/SRB	
ISO	ABMA (metric)
P0	ABEC/RBEC 1
P6	ABEC/RBEC 3
P5	ABEC/RBEC 5
P4	ABEC/RBEC 7
P2	ABEC/RBEC 9

TRB		
ISO	ABMA (metric)	ABMA (inch)
Normal	K	4
6X	N	2
5	C	3
4	B	0
2	A	00
	AA	000

CRB/SRB Tolerances are NOT Equivalent to TRB Tolerances

Slide Intended to Show General Class Structure ONLY!

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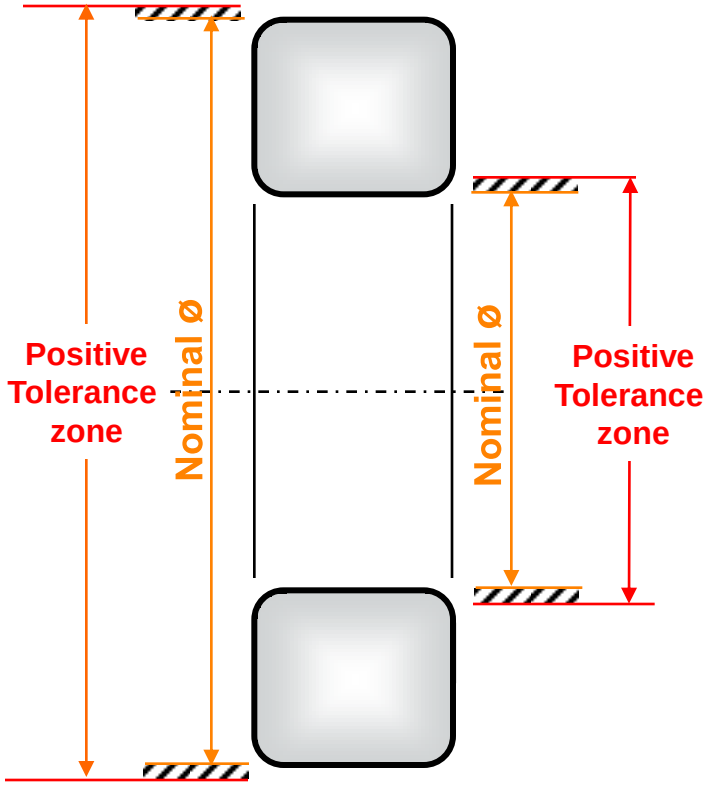
Radial tolerances

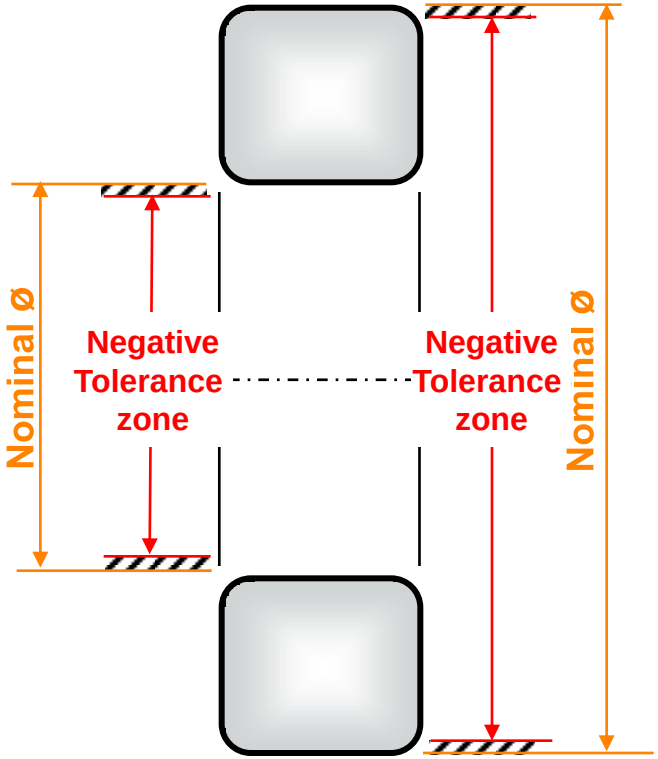
Inch design (ABMA) have

Positive tolerances



Metric designed (ISO) have

Negative tolerances



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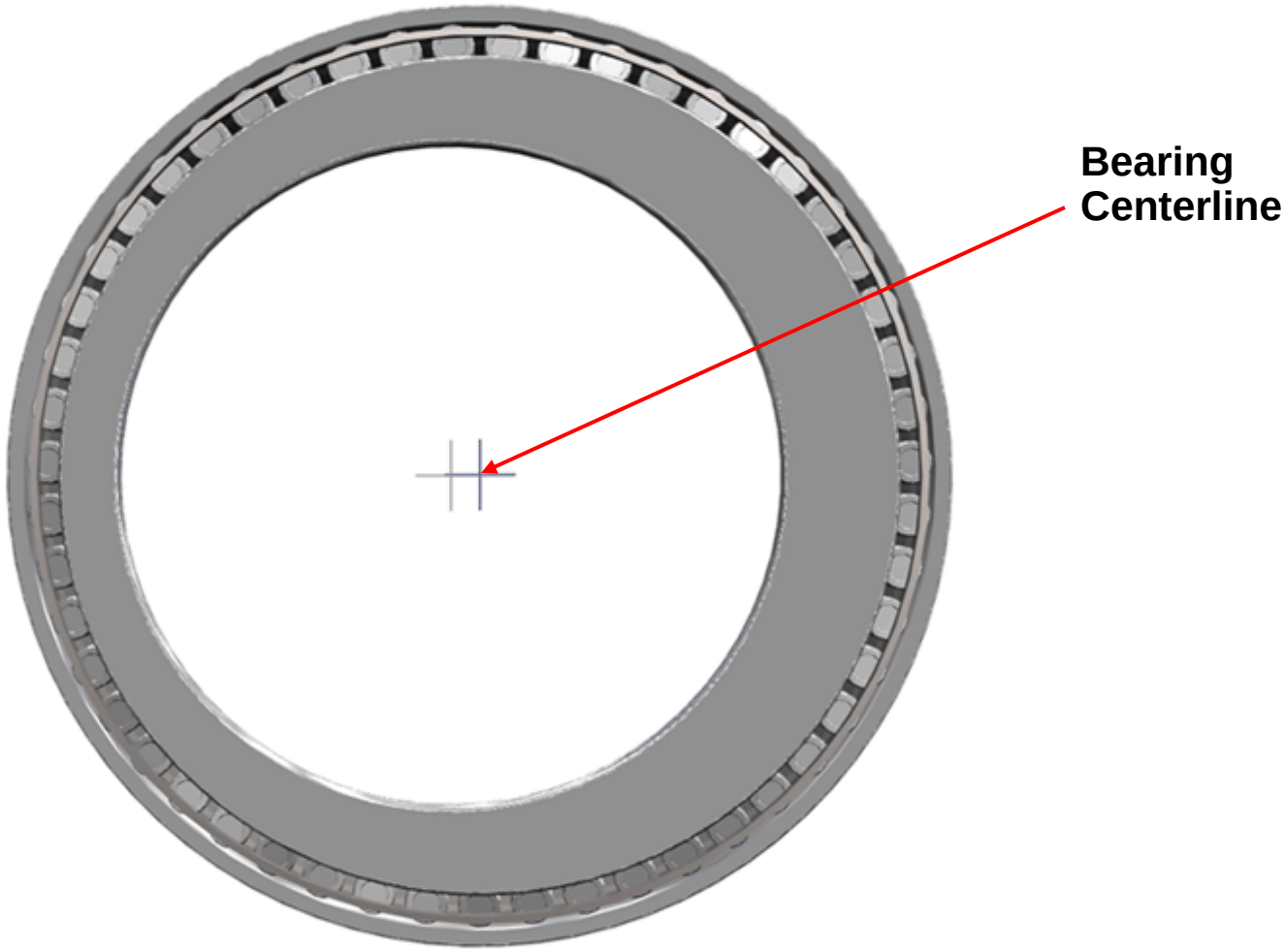
Radial Runout



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Why Bearings Fail

- Improper lubrication or lubricant failure 43%
  - Insufficient lubrication, either quantity or viscosity
  - Deterioration of lubricant; Improper relube interval or excess temperatures
  - Contamination of lubricant and/or bearing
  - Use of grease when oil was required
  - Incorrect grease selection for the application
- Improper mounting 27%
- Metal fatigue 9%
- Other causes 21%

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The Importance of Lubrication

- Permit to achieve the provided bearing life
  - Avoid metal/metal contact (reduce friction & wear)
  - Protect the bearing surfaces from corrosion and outside contaminants
  - Add an additional sealing barrier (grease)
- Transfer heat from the bearing surfaces (with oil)
- Separate the sliding contacts

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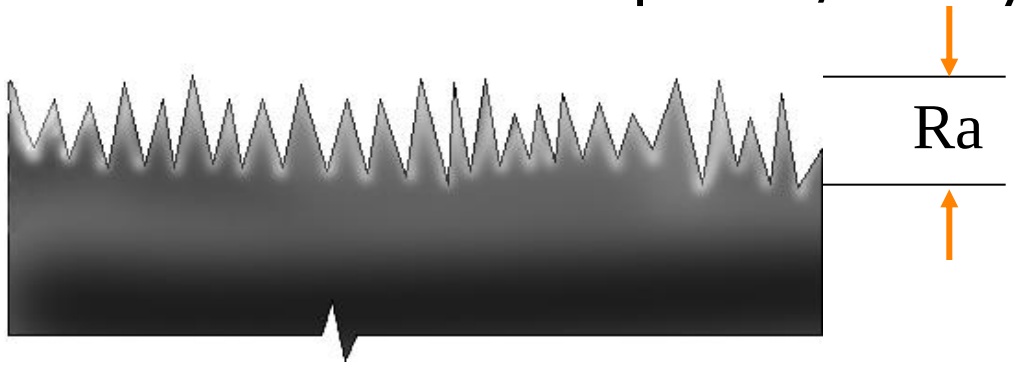
Surface finish

- Average Surface Roughness (Ra) is the average distance between surface peaks/valleys



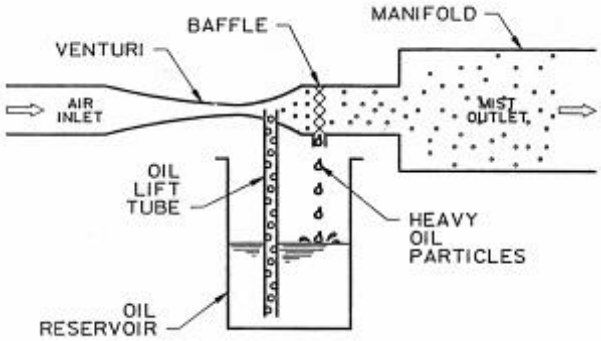
Super finish	0.05 μm
Hone	0.070 à 0.250 μm
Grind	0.250 à 0.635 μm
Turn	>0.635 μm

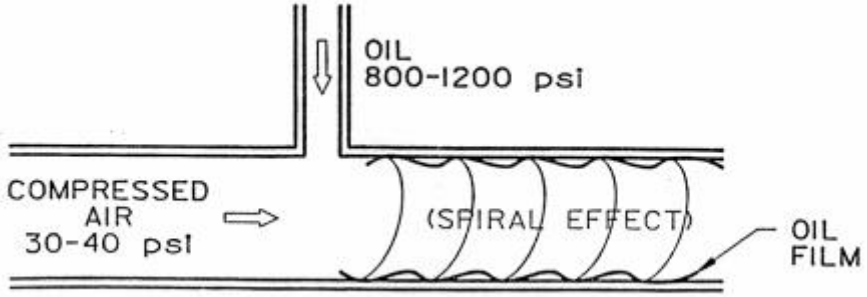
Film thickness

- Lubricant film thickness on raceway depends on the operating conditions
  - Surface velocity
  - Loads
  - Lubricant viscosity
  - Pressure/viscosity relationship
- Required minimum film thickness: 0.1 µm

Basic methods of Lubrication

- Grease
- Oil - Mist
- Air- Oil
- Oil bath
- Circulating oil





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Maximum Operating Temperatures for Standard Timken Bearings-Guidelines

- The following are guidelines for how standard Timken bearings are generally produced.

Maximum Operating Temperatures for Standard Bearings

	Case Carburized	Through Hardened
Taper	**120°C (250°F)**	**120°C (250°F)**
Cylindrical (one row)	**120°C (250°F)**	**200°C (392°F)<300mm bore**
Spherical	**120°C (250°F)**	**200°C (392°F) <300mm bore**
Ball	**120°C (250°F)**	**120°C (250°F)**

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Maximum Operating Temperatures for Enhanced Dimensional Stability Timken Bearings

- Bearings with enhanced dimensional stability are available from Timken.
- These special bearings are made to DIN 623-1, Paragraph 3.3.6

SN	Rings or washers suitable for operation at service temperatures up to **120°C**
S0	Rings or washers suitable for operation at service temperatures up to **150°C**
S1	Rings or washers suitable for operation at service temperatures up to **200°C**
S2	Rings or washers suitable for operation at service temperatures up to **250°C**
S3	Rings or washers suitable for operation at service temperatures up to **300°C**
S4	Rings or washers suitable for operation at service temperatures up to **350°C**

- Enhanced Dimensional Stability bearings are marked with either the DIN code in the case of CRBs/SRBs/BBs (e.g. '–S2', '-S3') or a modified code in the case of Tapers.

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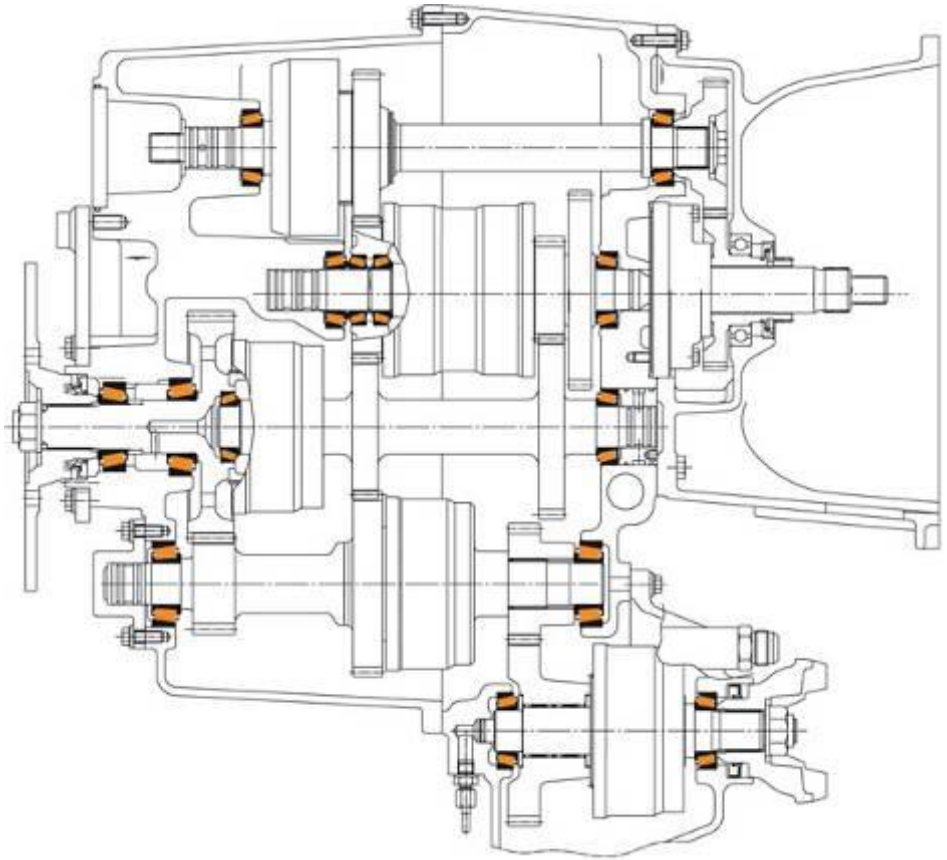
Mounting types



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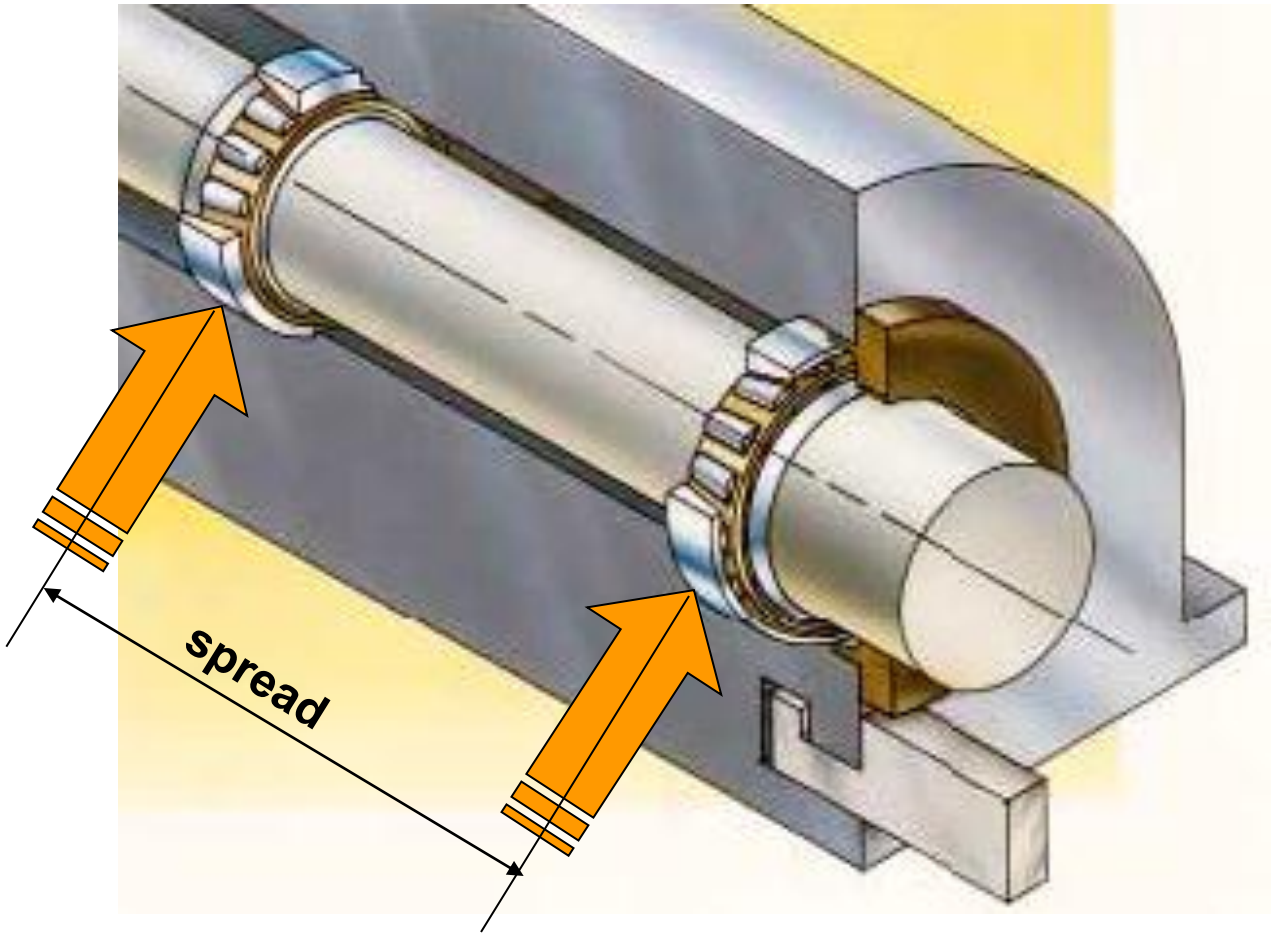
Bearing arrangement

In order to guide and support a rotating shaft, at least **two bearings** are required which are arranged at a certain distance from each other that we call “spread”



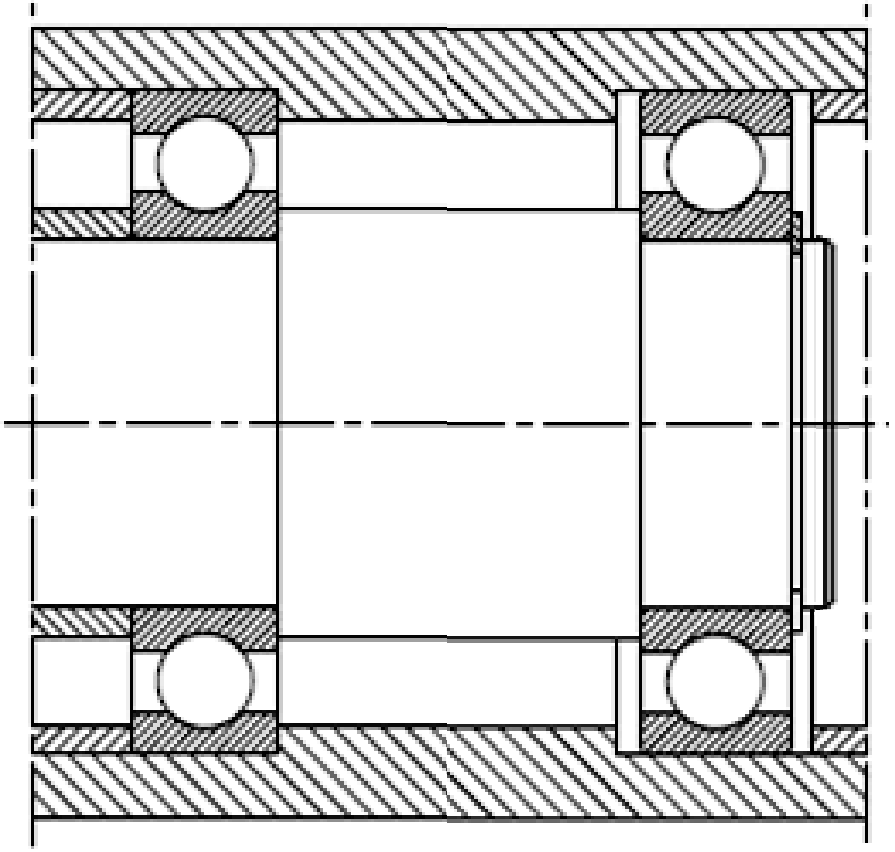
Bearing arrangement

- Depending on the types of bearing used and the application, different bearing arrangements can be selected:

1. with locating and floating bearings,
2. with adjusted bearings
3. with floating bearings

1. Locating-floating bearing arrangement

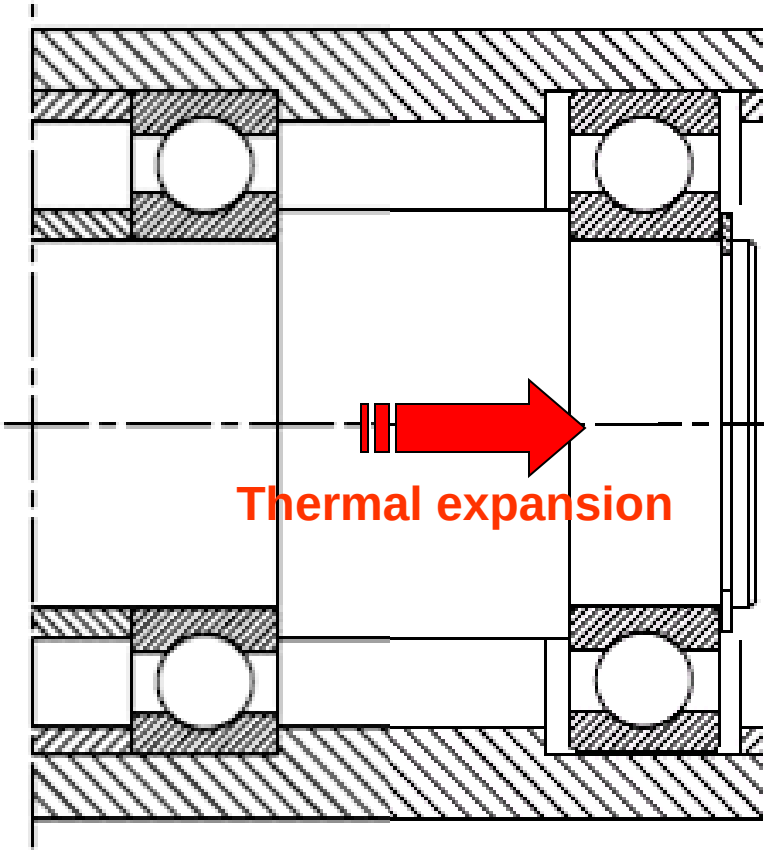
Locating or Fixed bearing



Non locating or Floating bearing

TIMKEN

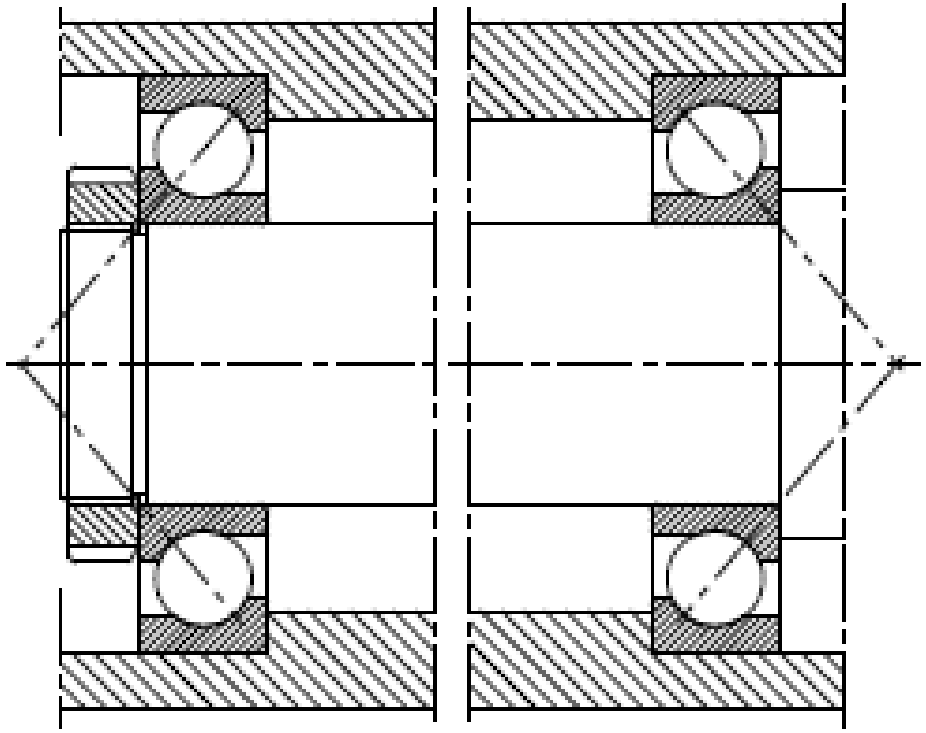
1. Locating-floating bearing arrangement

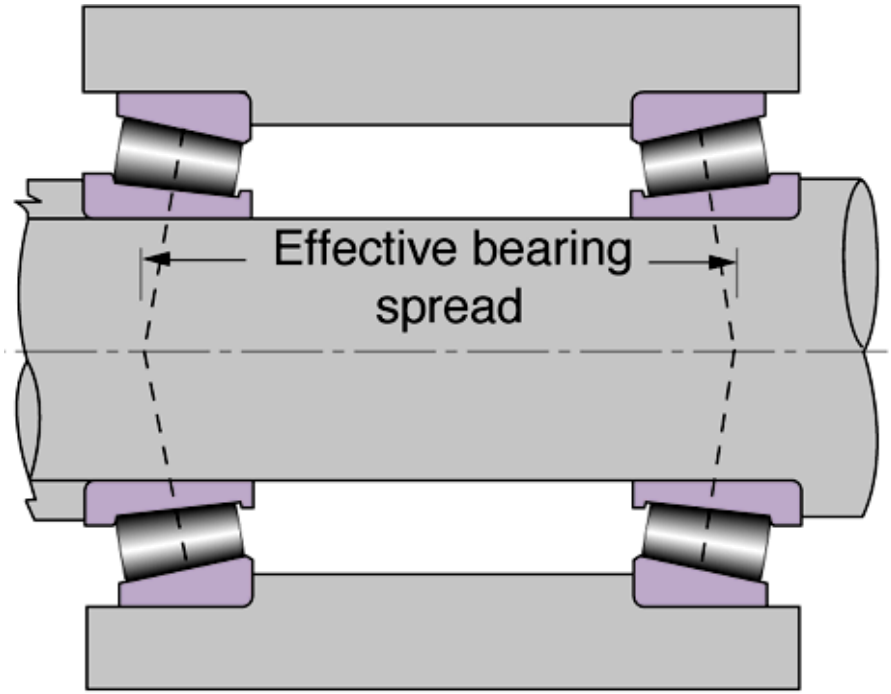


2. Adjusted bearings

As a rule, an adjusted bearing arrangement consists of two symmetrically arranged angular contact ball bearings or tapered roller bearings. During mounting, the required *bearing clearance* or the preload must be set.

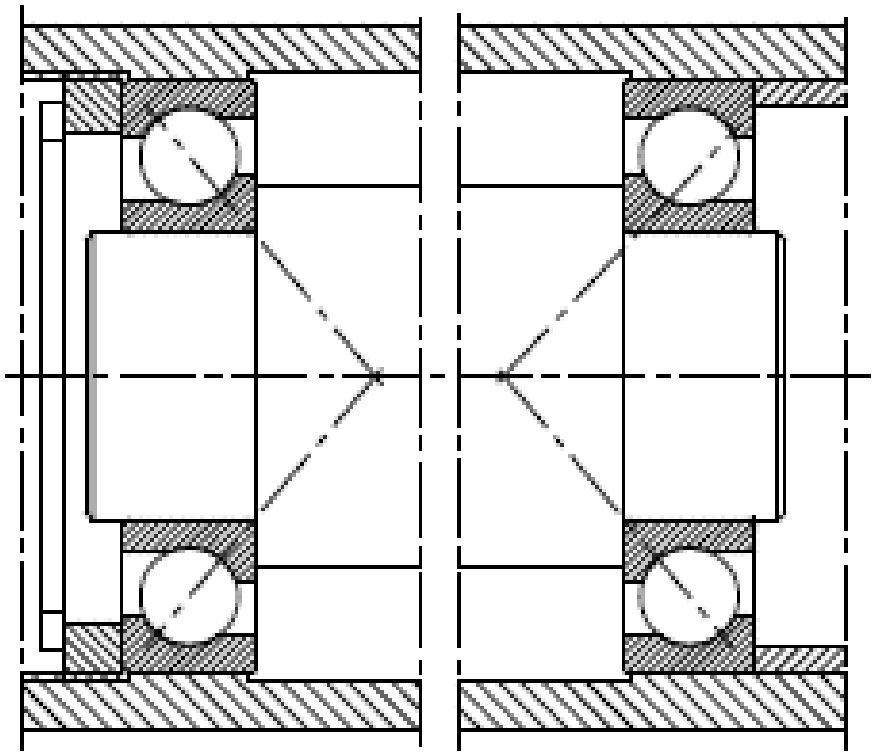
Indirect or “O” mounting

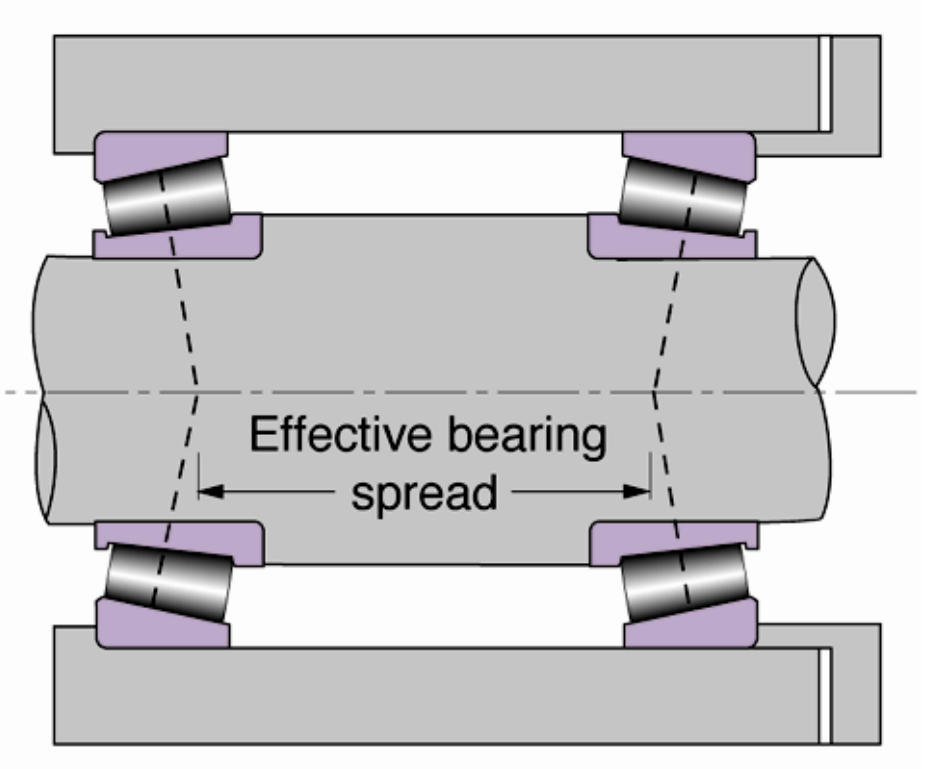




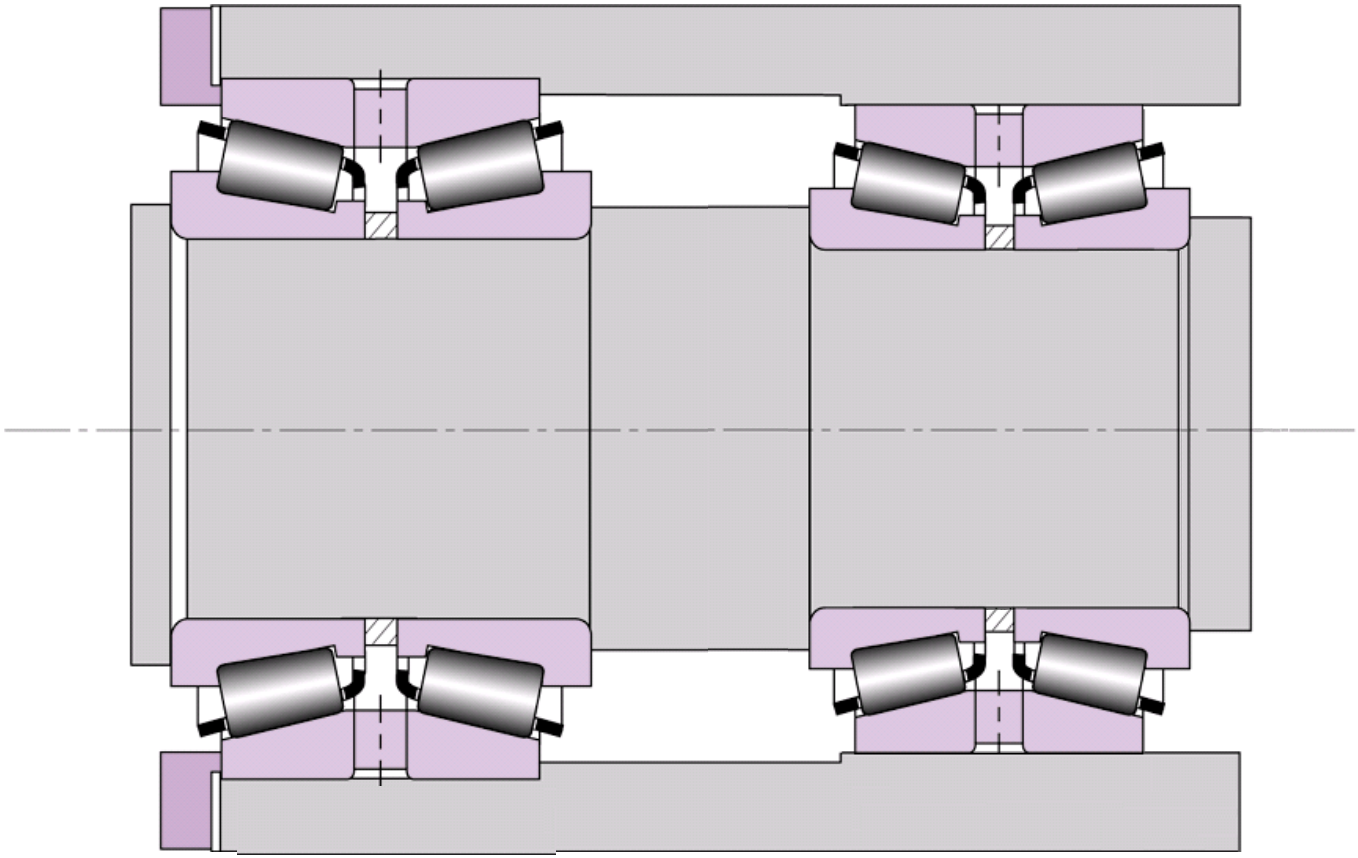
2. Adjusted bearings

Direct or “X” mounting





Double row Tapered bearing arrangement



TIMKEN

Bearing life

Stronger.

Performance

- Bearing life,
- Speed capability,
- Temperature,
- General environment,
- ...

Cost

- Bearing cost,
- Assembly, mounting,
- Existing, new product,
- Available product,
- ...

Some definitions:

Bearing life
In a broad sense, bearing life is the period during which bearings continue to operate and satisfy their required function.

Rolling fatigue life
Rolling fatigue life – also called “fatigue life” -- is defined by the number of revolutions before the bearing surface begins to flake due to stress.
The bearing surface is generally an inner ring and an outer ring raceway.

Bearing L_{10} Life

- Life that 90% of a group of apparently identical bearings will complete or exceed before the area of spalling reaches a defined limit.
  (Timken = 6 mm^2 or .01 in^2)
  - L = fatigue life of a rolling element bearing
  - 10 = 10% of population that failed criteria (reliability)

TIMKEN L_{10} LIFE

$$L_{10} = \left(\frac{C_{90}}{P}\right)^{10/3} \times \left(90 \times 10^{6}\right) \text{ Revolutions}$$

$$L_{10} = \left(\frac{C_{90}}{P}\right)^{10/3} \left(\frac{1.5 \times 10^{6}}{S}\right) \text{ Hours}$$

- **2 X Load = 1/10 Life**
- **1/2 Load = 10 X Life**

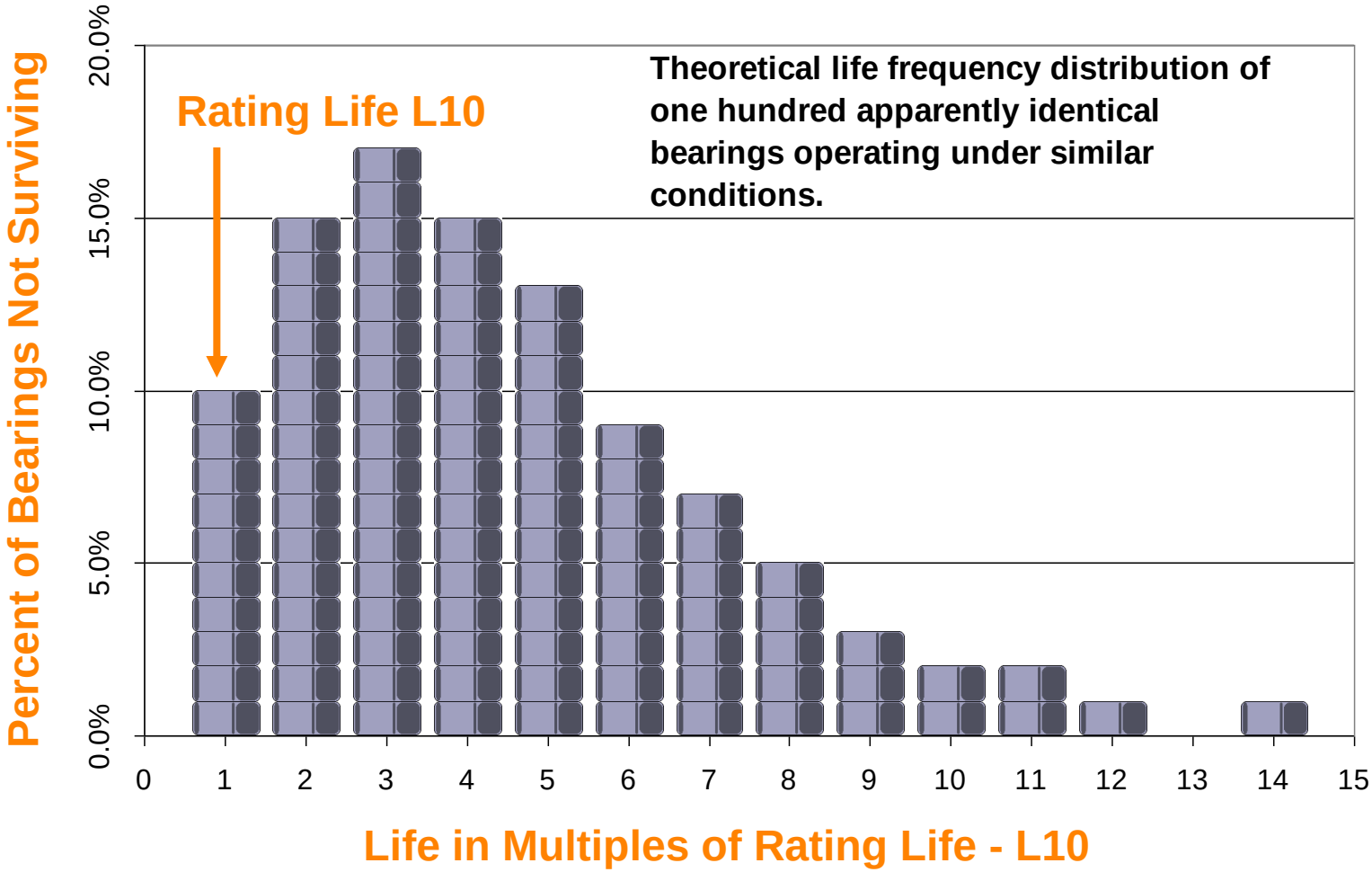
- **2 X Speed = 1/2 Life**
- **1/2 Speed = 2 X Life**

Linear contact => Power = (10/3)
Point contact => Power = 3

TIMKEN

Weibull Distribution of Bearing Fatigue Life

For Timken bearings, the average or mean life is approximately 4 times L10. This is defined by a spall criteria which is very conservative for many applications.



TIMKEN

TIMKEN

Bearing Ratings

What is a Rating?

- Describes the expected life and performance of a product

TIMKEN

Bearing Ratings

- Used by customers to:
  - Select the right Timken bearing for their application
  - Compare bearings
  - Compare bearings with competitor bearings

Ratings are defined by:

- Roller diameter
- Contact length
- Contact angle
- Number of rollers
- Number of bearing rows

TIMKEN

Dynamic Ratings

Dynamic Load Rating

- Based on:
  - Stress cycles per revolution
  - Bearing life test empirical data
- Load ratings based on algorithms that are empirically tested.
  - Insures brand promise
- The load that 90% or more of a large group of bearings could survive for 90 million revolutions before a 0.01 in^2 (6mm^2) spall develops

C_{90} or C(90) = radial rating

C_{a90} or C_a(90) = thrust rating

C1 Rating Equations

- Timken uses C90 (90 million revolutions) and C1 (1 million revolutions)
- To convert C_1 to C_{90}

$$C_1 = 90^{\frac{3}{10}} C_{90}$$

$$C_1 = 3.86 C_{90}$$

- Using C_1 in L_{10} equation

$$L_{10} = \left(\frac{C_1}{P} \right)^{10/3} \times \left(1 \times 10^6 \right) \text{Revolution s}$$

TIMKEN

Bearing Ratings

- C_1 is a theoretical number.

The bearing should never be loaded to this magnitude.

- "Working" load range is 1/3 to 1/4 of the C rating for roller contact bearings.
- Ball products – "Working" load up to or <70% of the static rating (C0)

- Life testing for other bearing types done at C90 load levels.

Other Rating Equations

- Most organizations use C1
  - ISO (International Standards Organization)
  - ANSI (American National Standards Institute)
  - ABMA (American Bearing Manufacturers Association)
  - Competitors

- Ratings may differ from ISO / ABMA / ANSI ratings due to:
  - Different internal dimensions
  - Different material factors
  - Other factors

TIMKEN

Static Load Ratings

Static Load Rating (ISO 76)

- Used to determine maximum permissible load that can be applied to a non-rotating bearing
  - Load that can be applied without altering the physical properties in a way that degrades bearing performance when it is rotated with a lesser load
  - Based on maximum contact stress of 580,000 psi (580 KSI or 4000 MPa) with a load zone of 180 degrees
  - Based on system stiffness – shaft/housing, the actual load may vary.
  - Static load ratings good for comparison from 1 part number to another or 1 bearing type to another.

C_0 = Radial

C_{0a} = Thrust

TIMKEN

Static Load Rating

- For applications where sound, vibration, and rolling torque are critical to bearing performance, a rule of thumb is to load the bearing to no more than approximately 1/2 the static rating

Shock Load Rating

- Maximum allowable shock load that can be applied to a stationary bearing is 1/2 the static rating
  - Implies impact loading from “G” loading
  - Rule of thumb
- True for both radial and thrust loading
- Factor applicable for ball and roller bearings

TIMKEN

What create the load on a bearing?

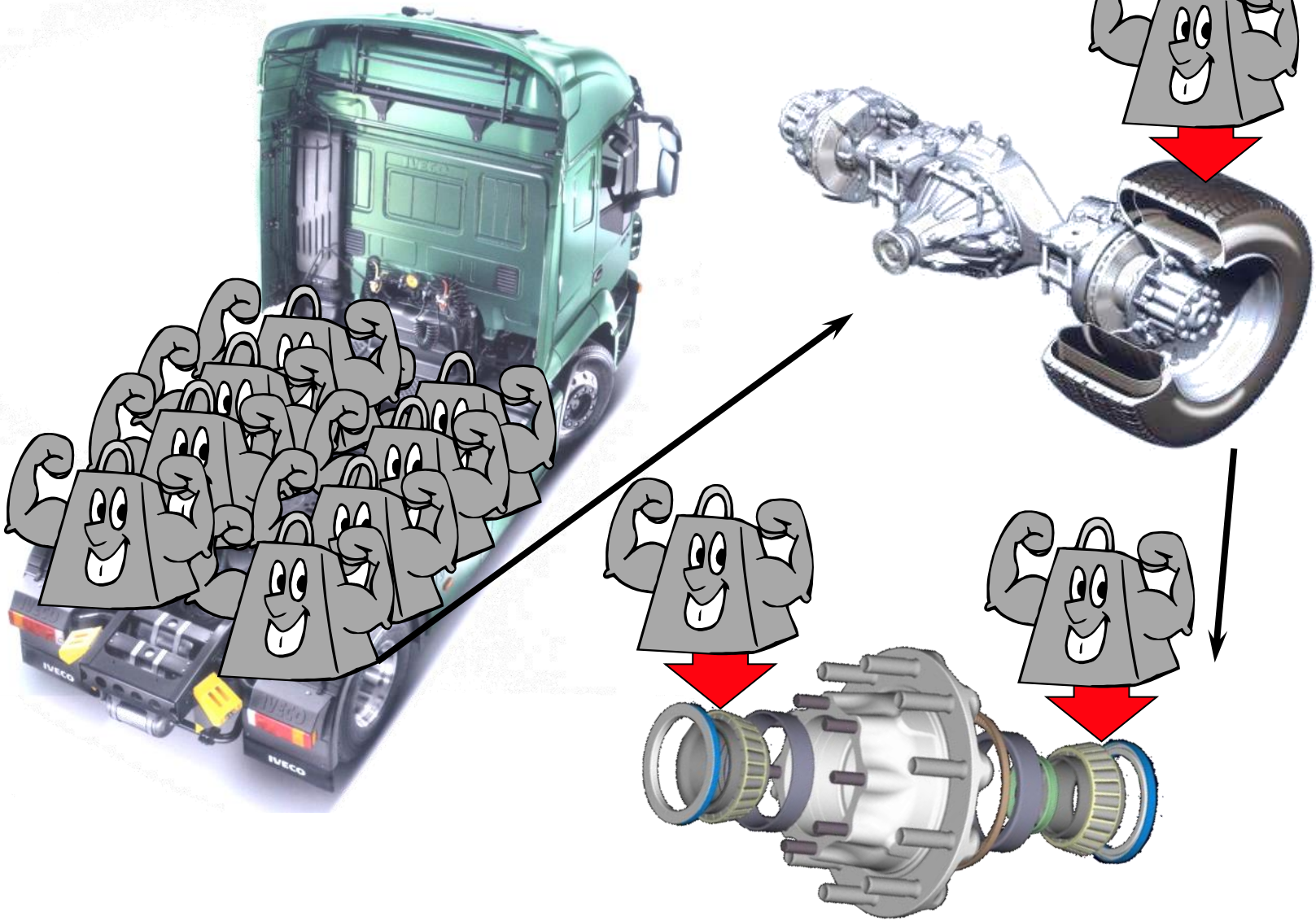
External Load of the bearing system

- Gear,
- Pulley,
- Wheel,
- Tool,
- Acceleration,
- Shocks
- …

Internal load of the system

- **Thermal expansion,**
- **System Preload,**
- **Induced load,**
- **…**

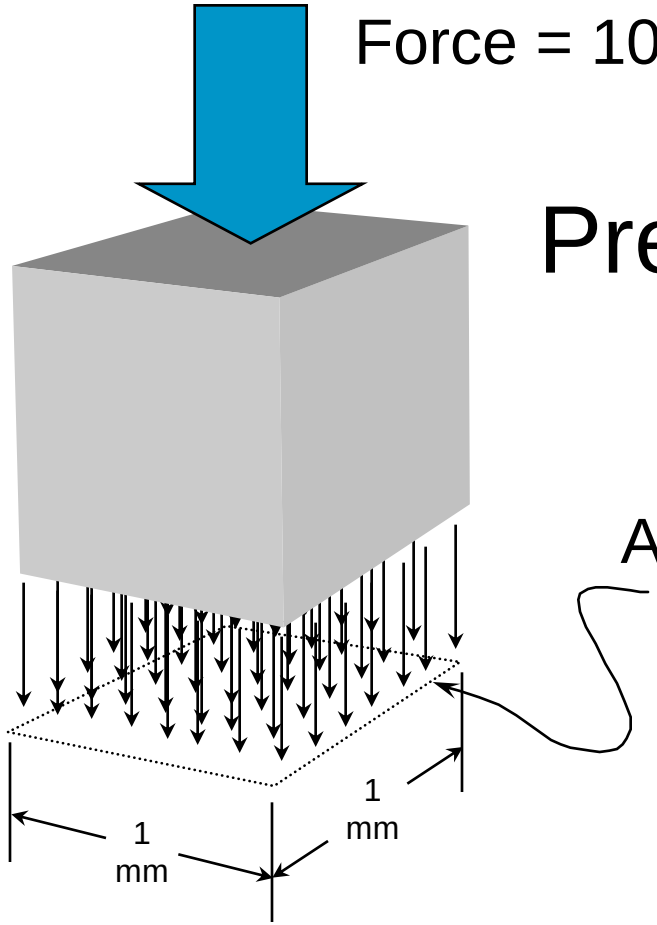
Loading condition



TIMKEN

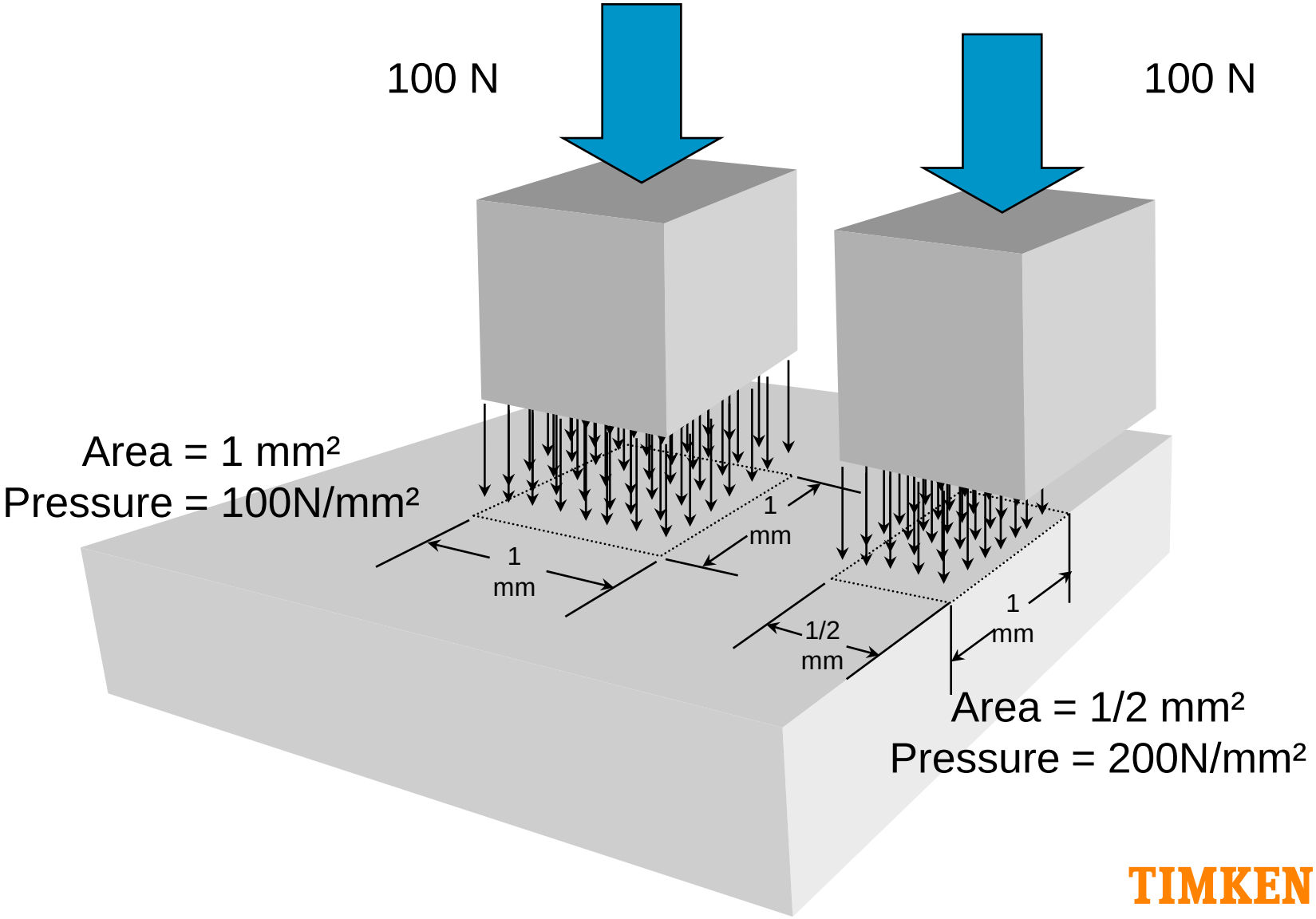
Load zone and contact pressure

Pressure



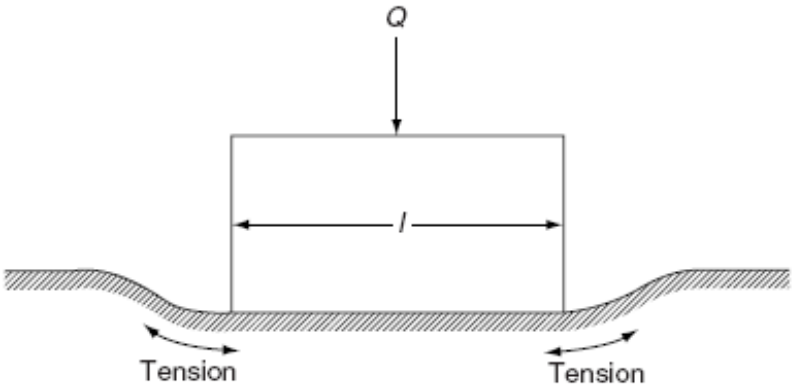
$$\text{Pressure} = \frac{\text{force}}{\text{area}}$$

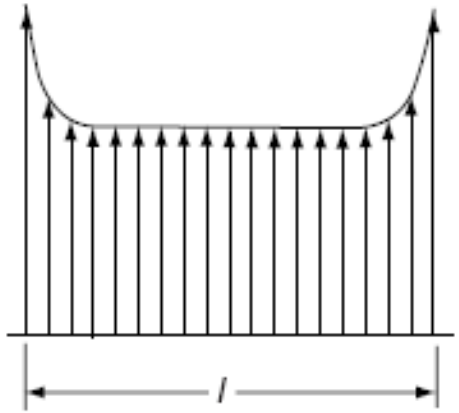
Pressure


100 N
100 N
Area = 1 mm²
Pressure = 100N/mm²
1
mm
1
mm
1/2
mm
1
mm
Area = 1/2 mm²
Pressure = 200N/mm²

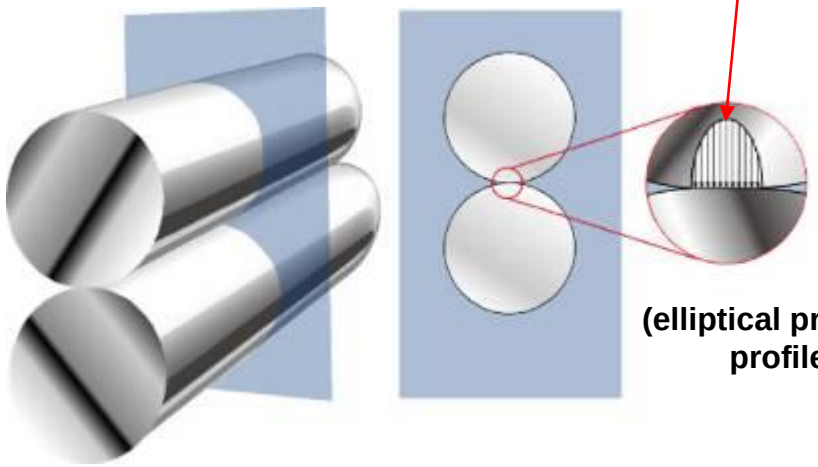
PROFILES

- Hertzian pressure creates elastic deformation





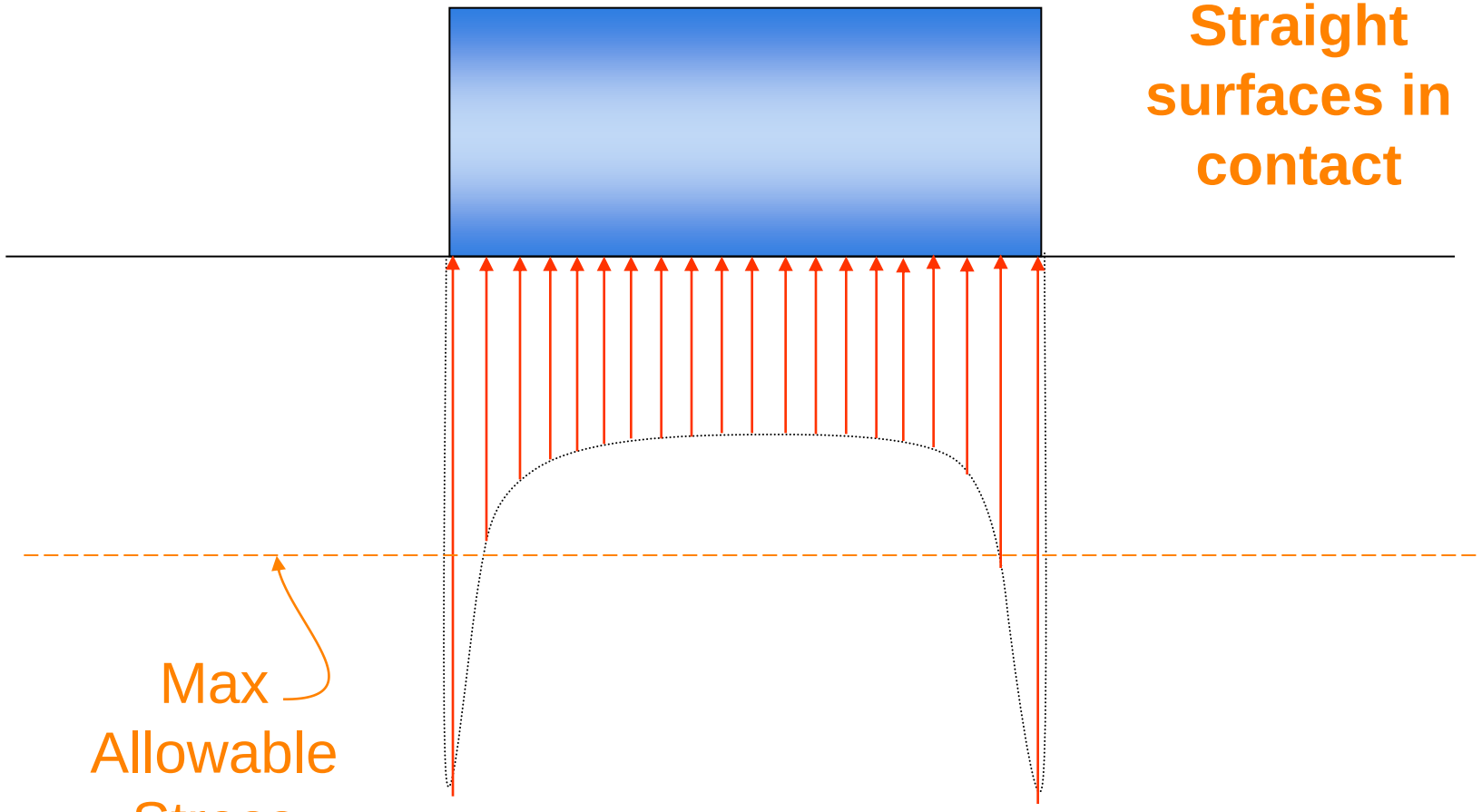
Amount of stress



Two cylinders pressed together under load form line contact.

- At the end of the loaded roller, the raceway deforms and create a tension generating stress concentration.

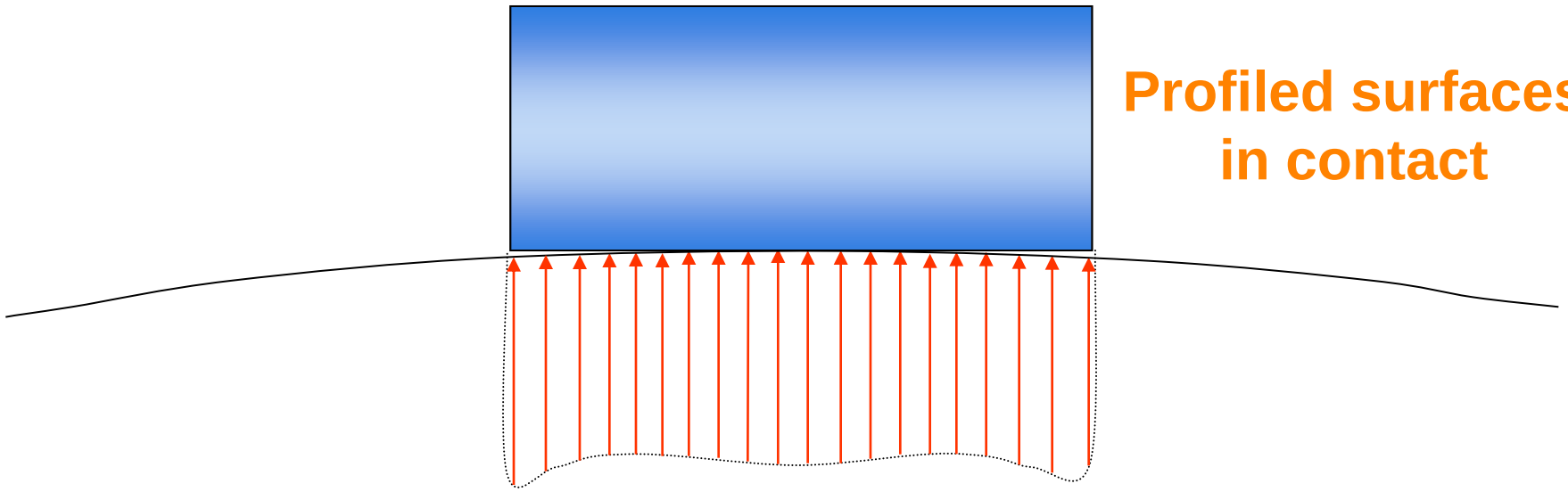
Edge Stress



Edge stresses are too high

TIMKEN

Edge Stress



Profiled surfaces in contact

Edge stresses are reduced to a reasonable level

Max Allowable Stress

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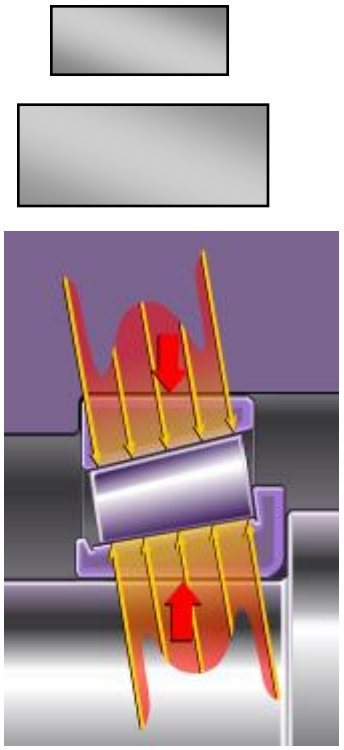
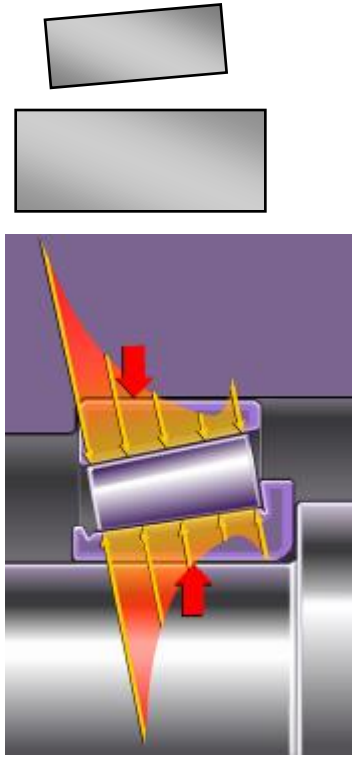
PROFILES

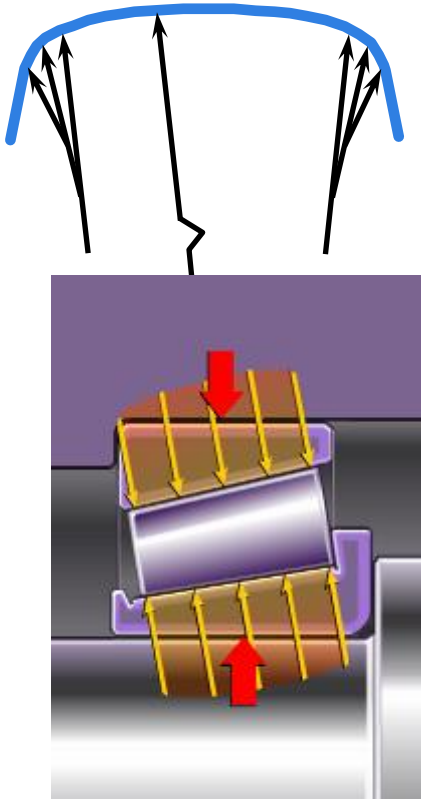
Objective : better stress distribution



Standard roller
under heavy load



Standard roller
under misalignment



Specific profile roller
under heavy load

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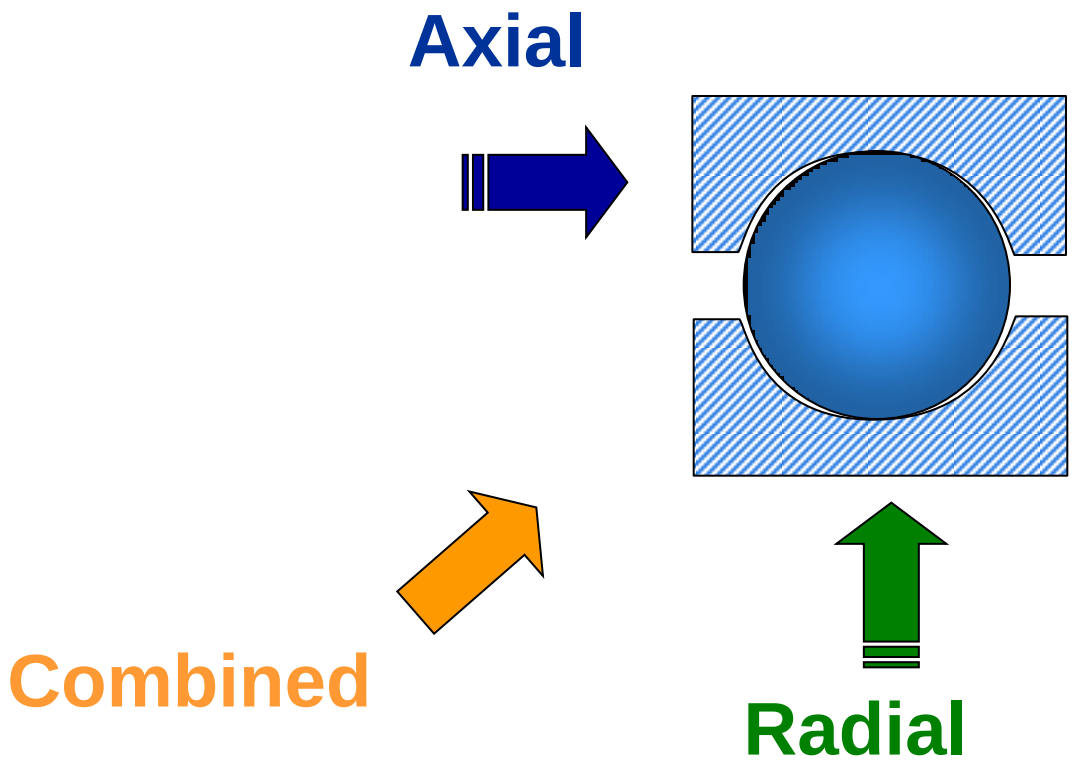
LOAD ZONE

- A bearing load can be radial, axial or combined.
- Each kind of bearing will tolerate these loads in different ways.



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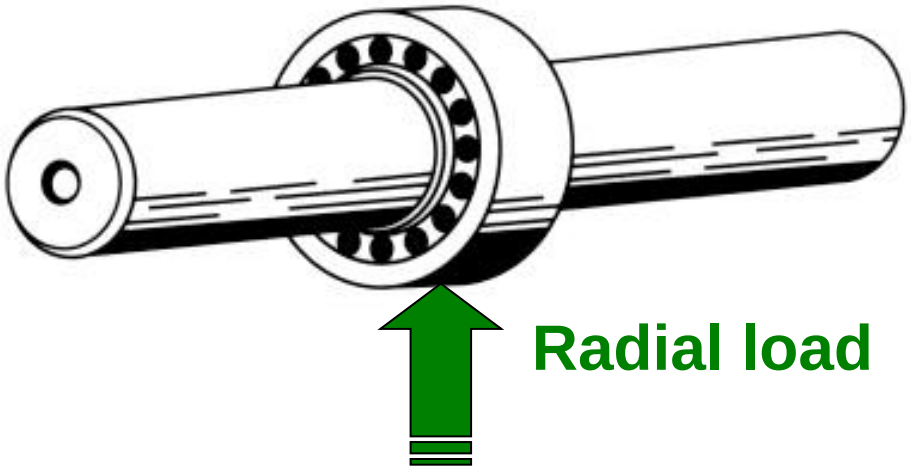
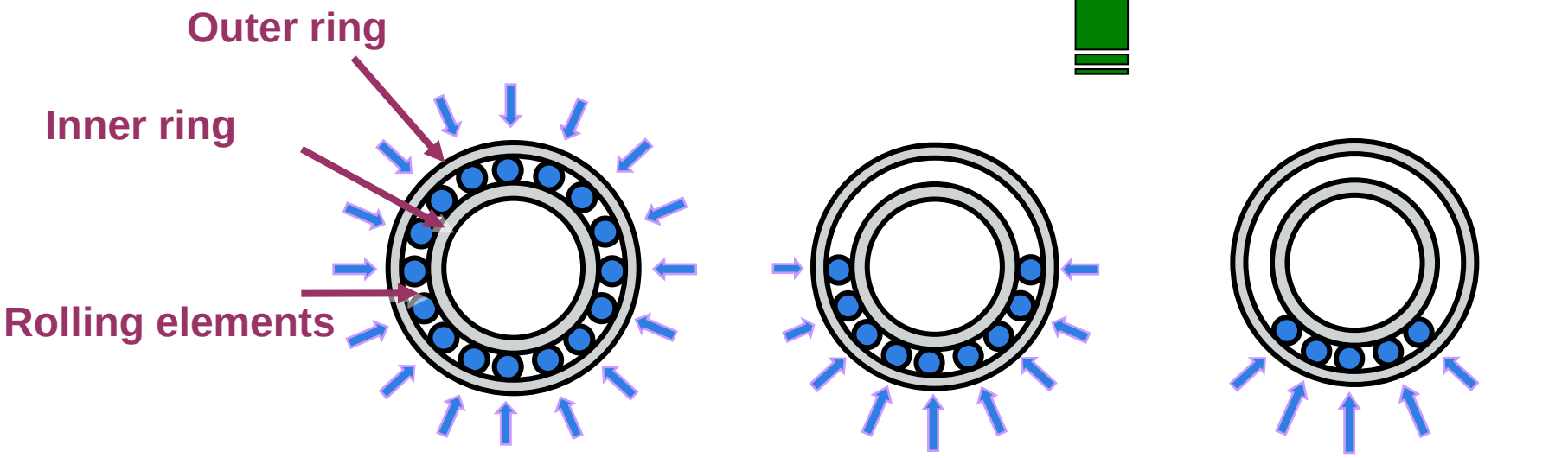
LOAD ZONE


Radial load

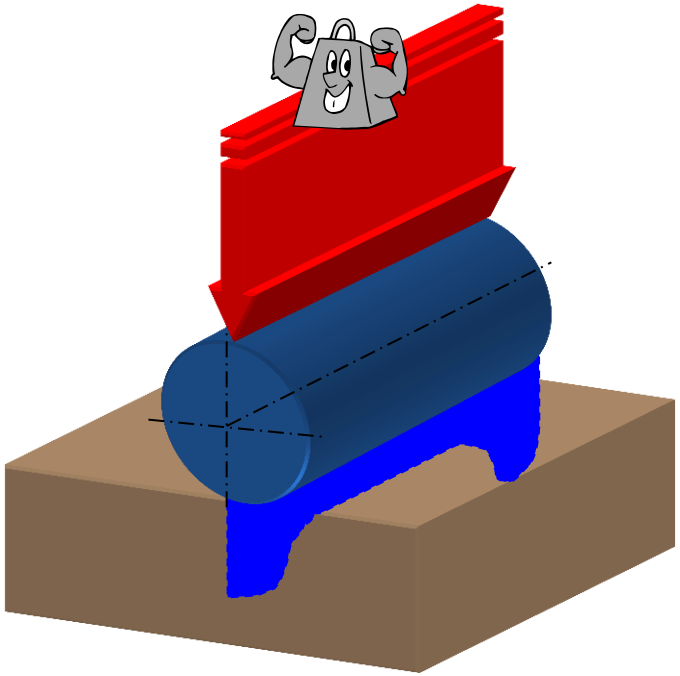

Outer ring
Inner ring
Rolling elements
Load zone 360°
Load zone 180°
Load zone 90°

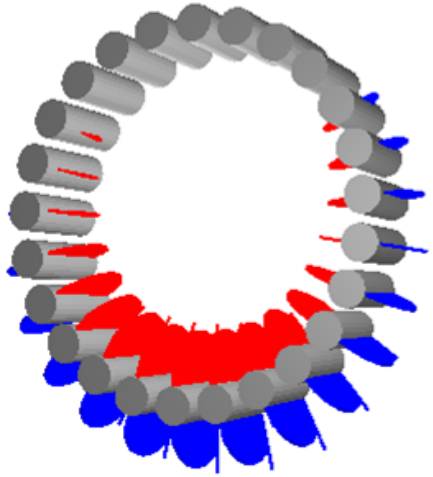
LOAD ZONE

General load distribution

In a ball or roller bearing, the rolling elements transmit the external load from one ring to the other.

The external force generally composed of a radial force and an axial force is always distributed over a number of rolling elements.





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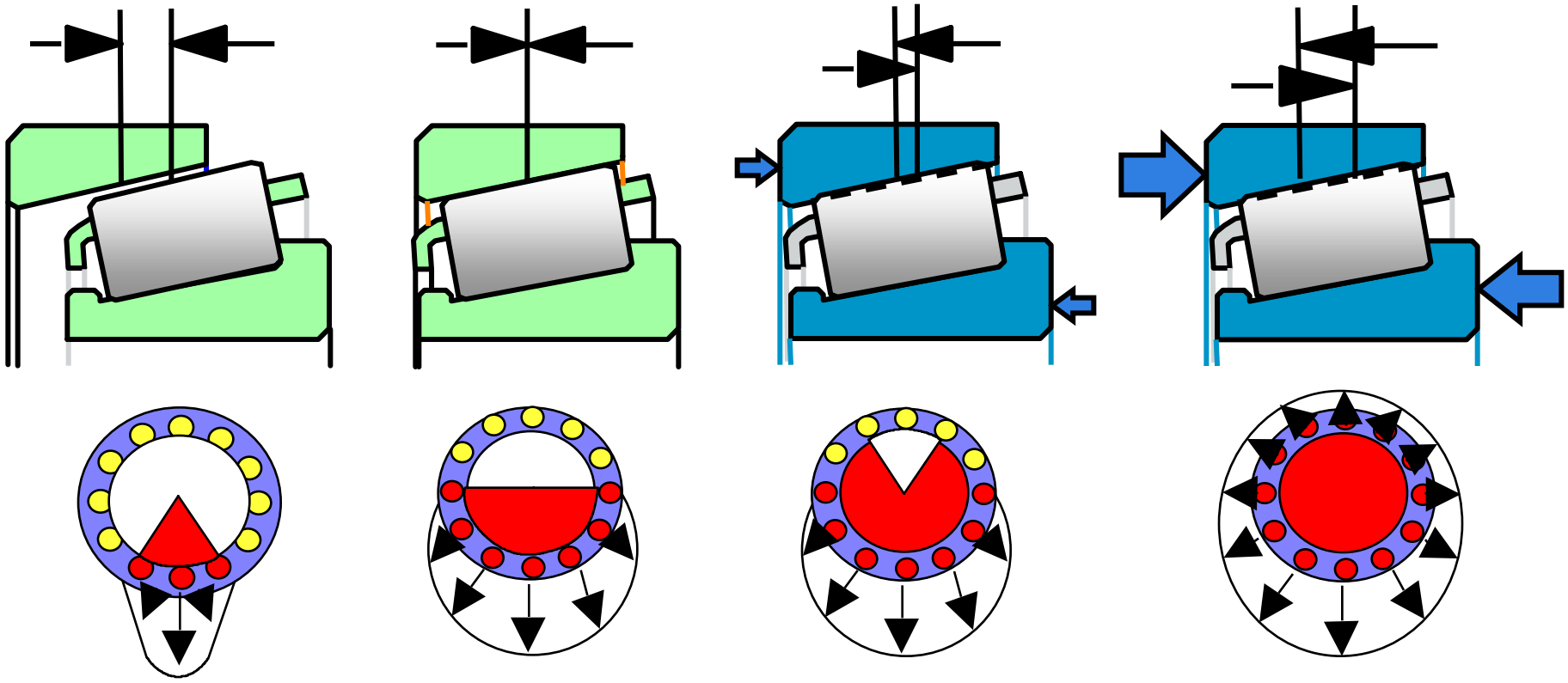
Load zone conditions



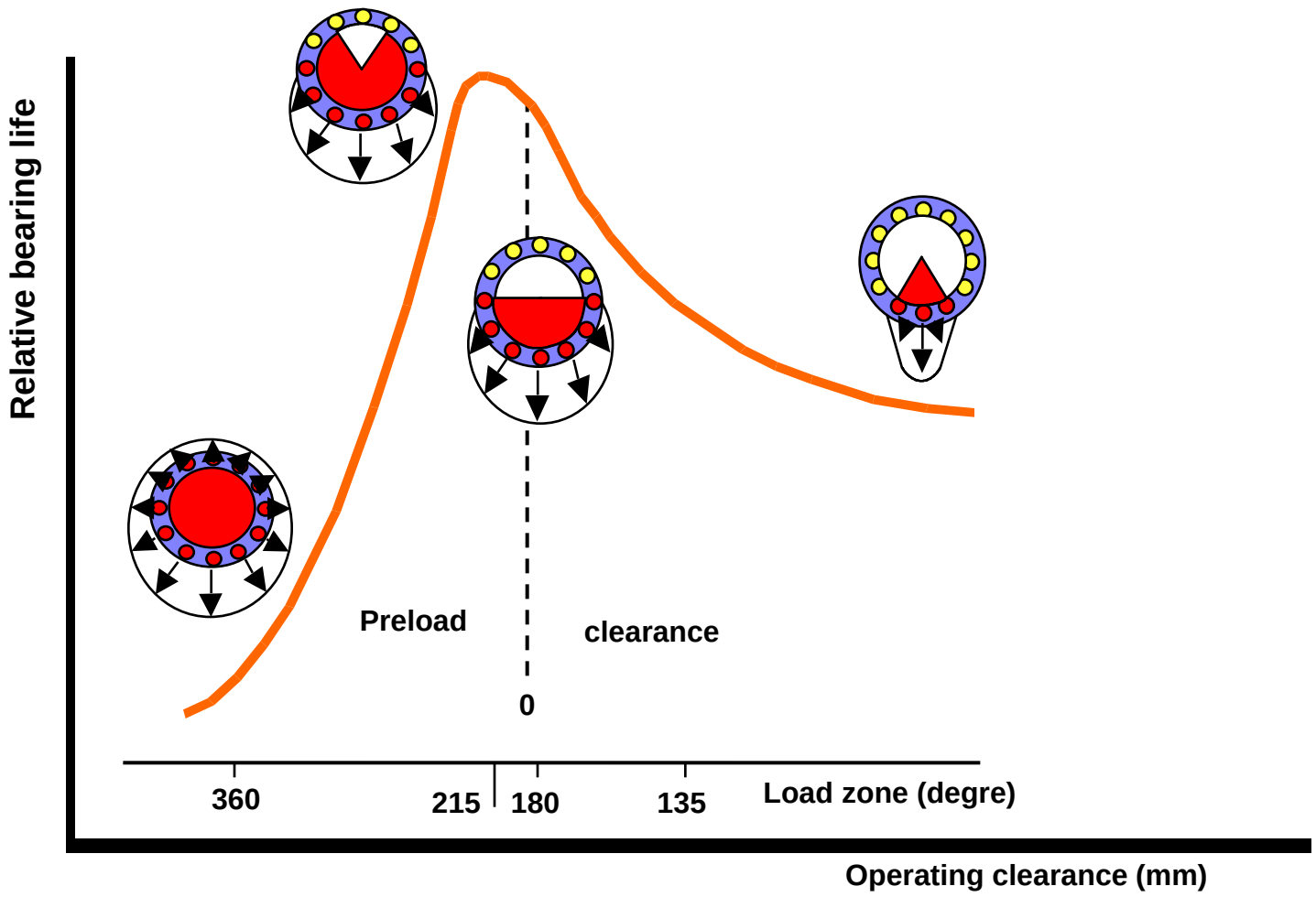
1) CLearance

2) Zero clearance

3) Light preload

4) Heavy preload

RELATIONSHIP OF SETTING TO BEARING LIFE



Note – the optimum setting is obtained at light preload value.

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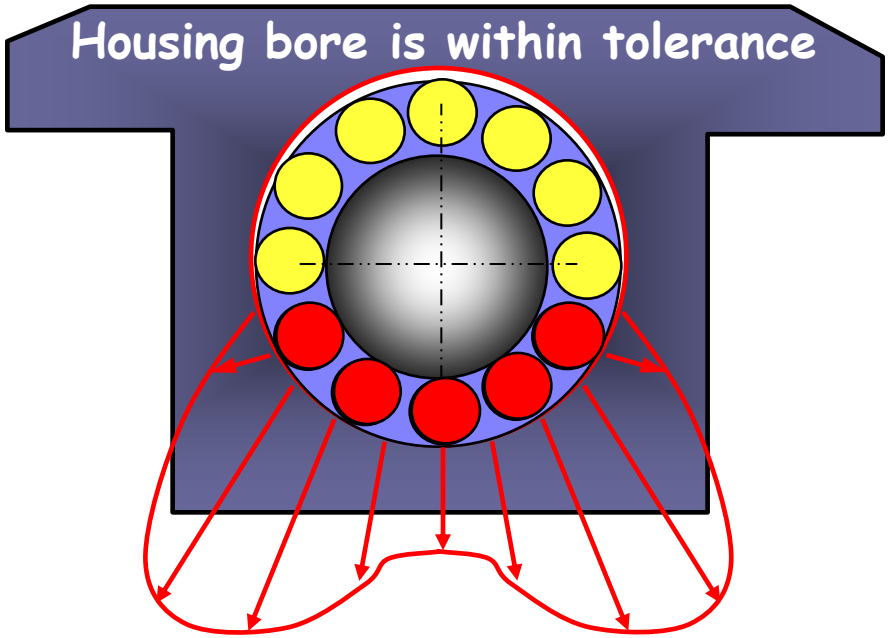
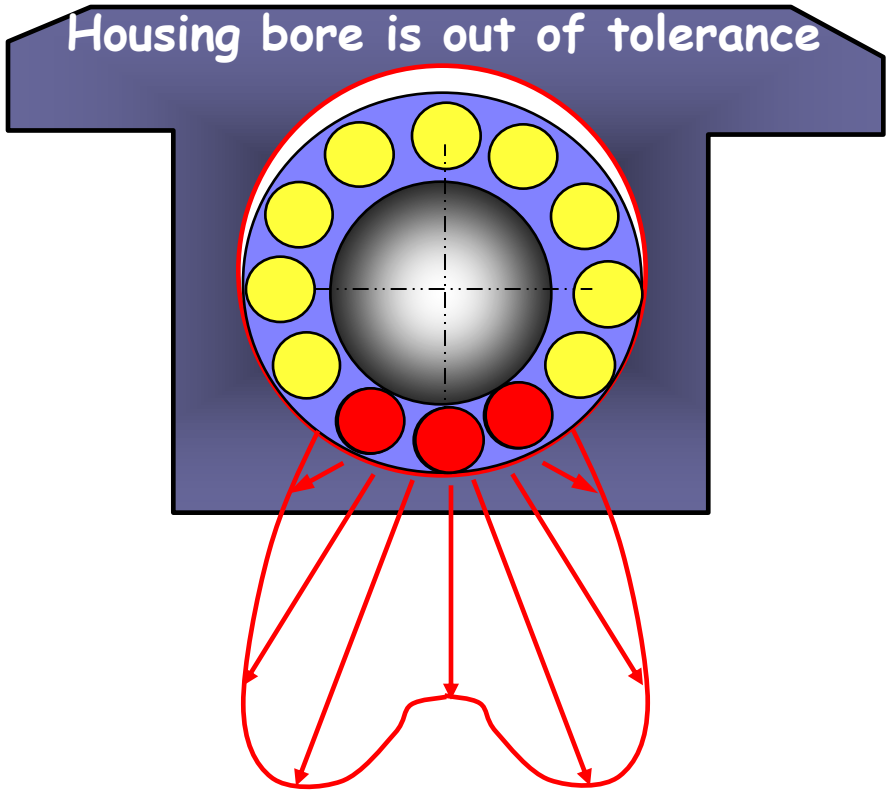
Relationship of setting to bearing life
Related to housing geometry



Large load zone



Small load zone

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Select Bearing Type

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Bearing setting

- Adjustable bearings

  By moving the raceways

- Non-adjustable bearings

  Tight fits

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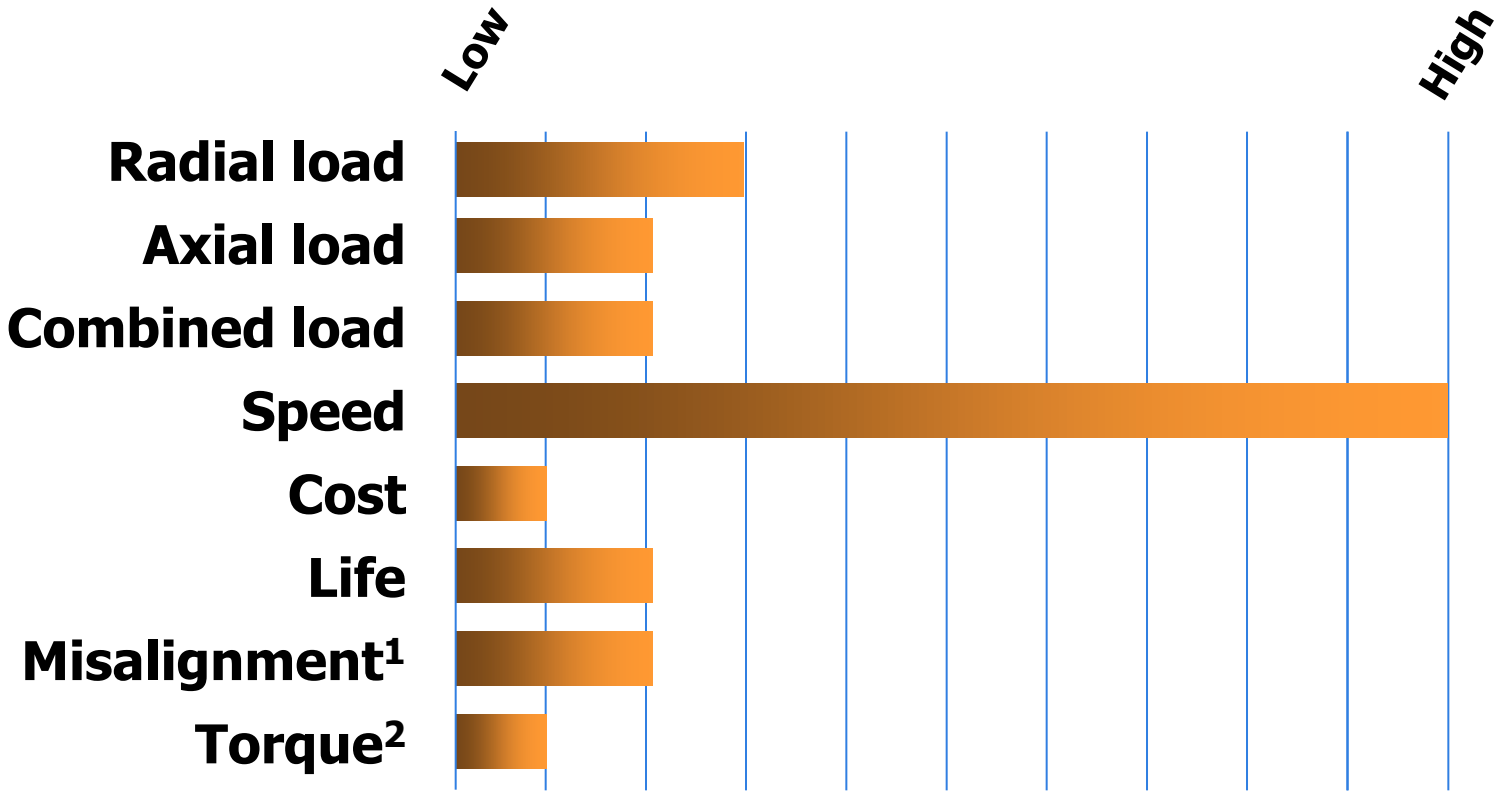
BALL BEARING PERFORMANCE



1) A low performance indicates a bearing life reduction due to misalignment

2) A low torque level = improved efficiency

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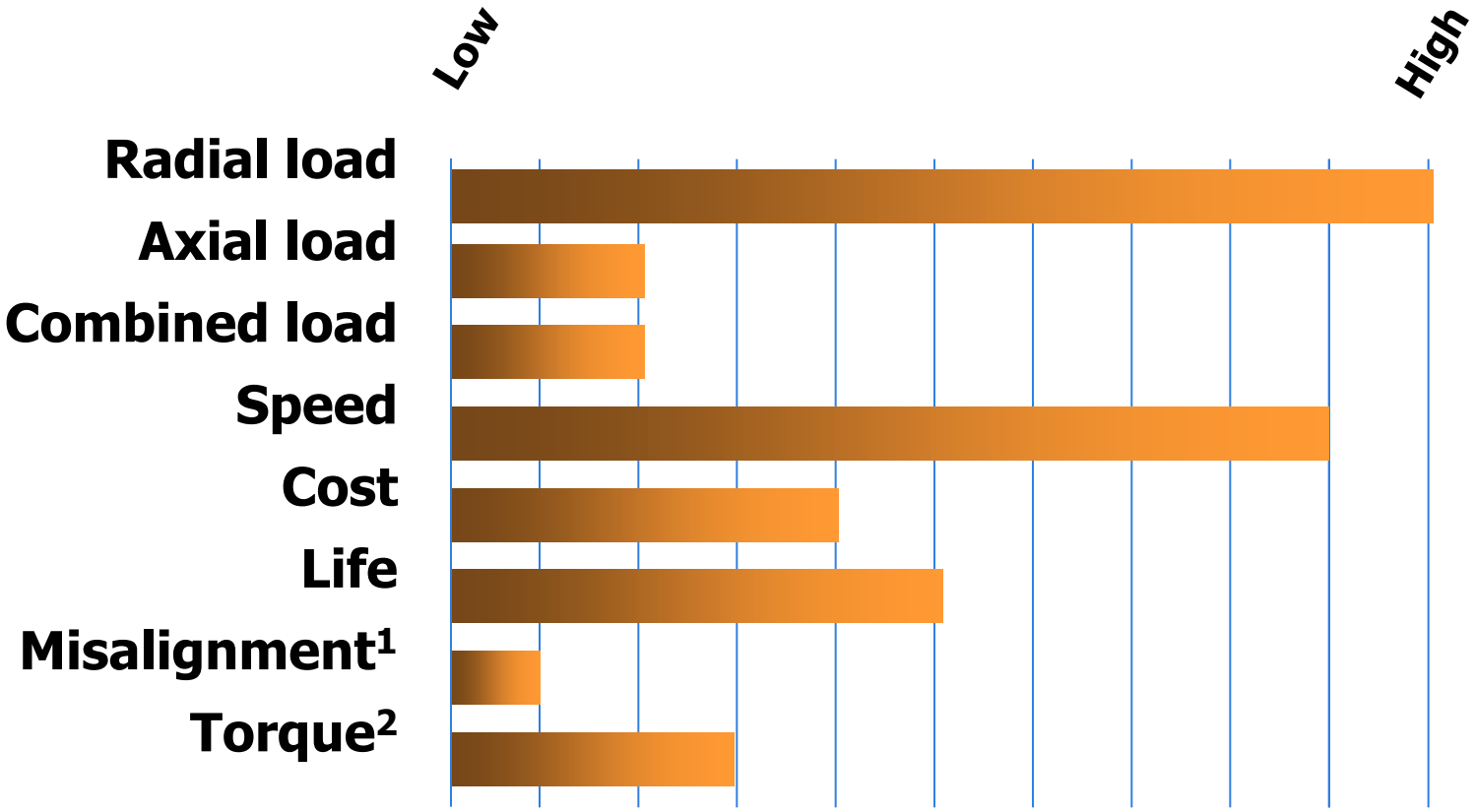
CYLINDRICAL ROLLER BEARING PERFORMANCE

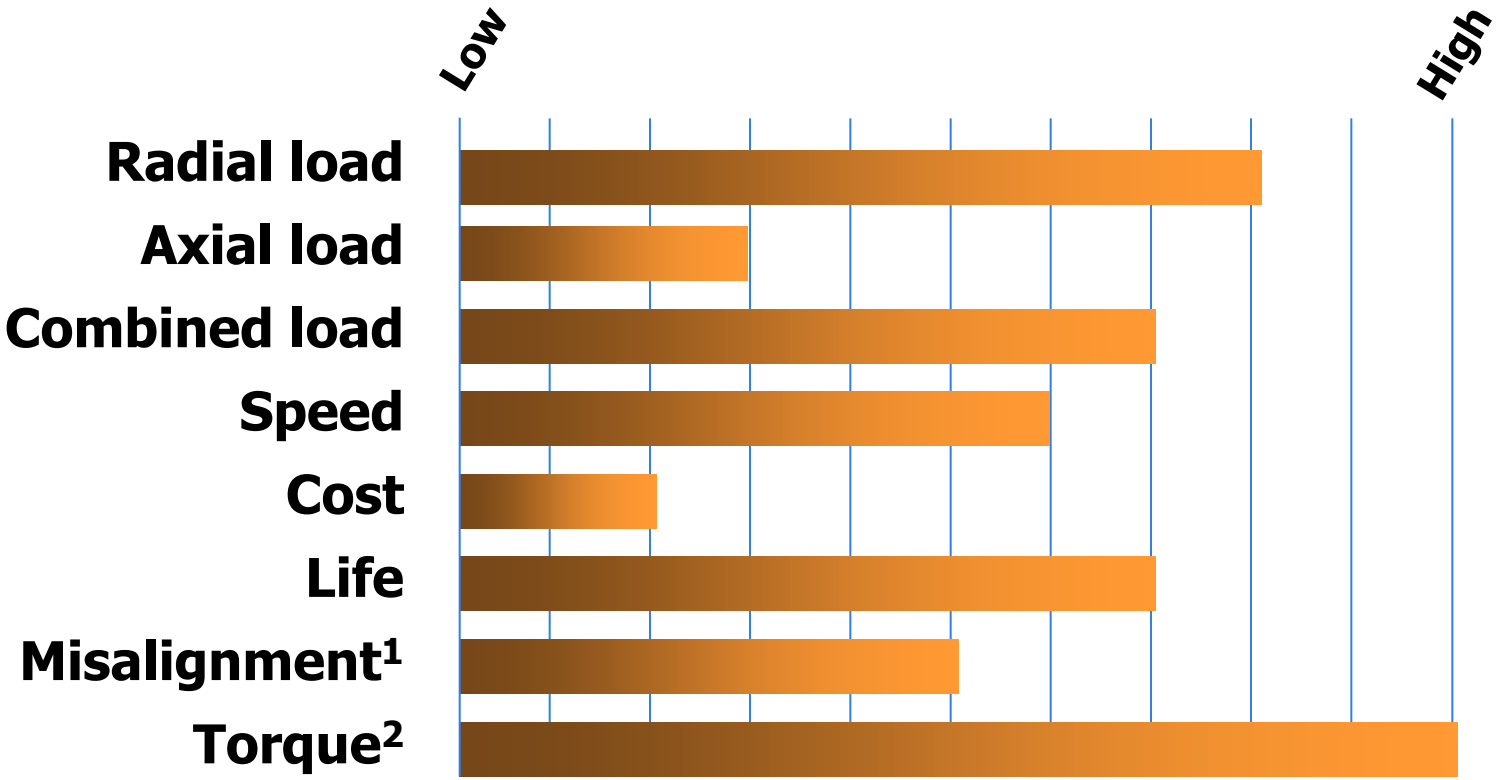


1) A low performance indicates a bearing life reduction due to misalignment

2) A low torque level = improved efficiency

TIMKEN

SPHERICAL ROLLER BEARING PERFORMANCE

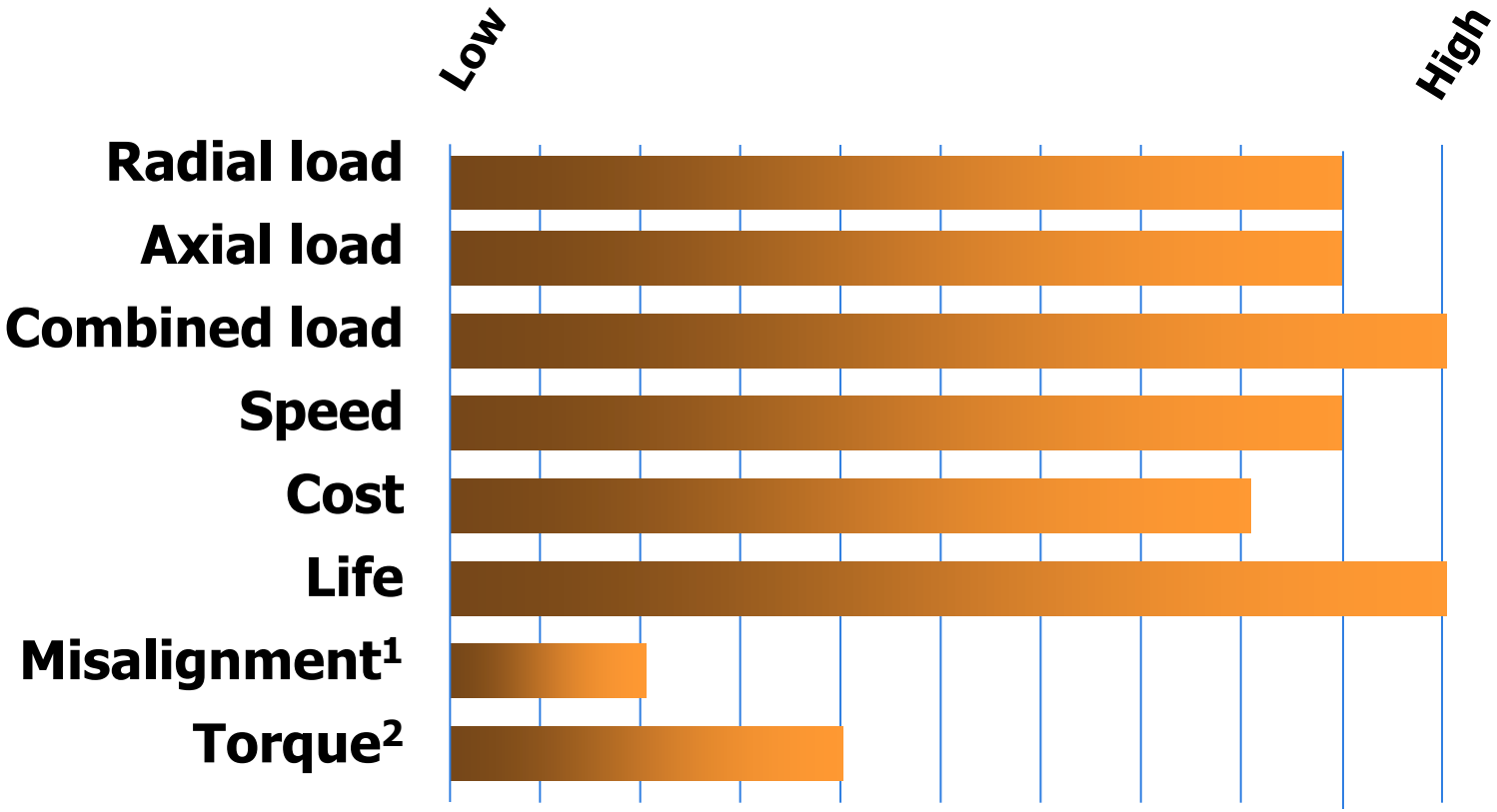


1) A low performance indicates a bearing life reduction due to misalignment

2) A low torque level = improved efficiency

TIMKEN

TAPERED ROLLER BEARING PERFORMANCE



1) A low performance indicates a bearing life reduction due to misalignment

2) A low torque level = improved efficiency

TIMKEN

TIMKEN PORTFOLIO SOPORTES

- **Ball Housed Units**
  - **Y-Series**
  - **UC-Series**
- **Roller Housed Units**
  - **Split block**
    - **Solid Bearings**
    - **Split Bearings**
  - **Solid block**
    - **Spherical Roller Bearings**
    - **Tapered Roller Bearings**

Fafnir

UC Type

SNT & SAF

Split CRB

Solid SRB

Type E

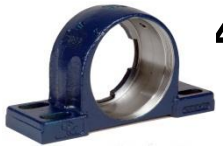
TIMKEN

Solid block Housed Units Styles

#1  **2-Bolt Pillow Block**

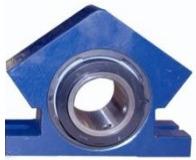
#2  **Flange Block (Square & Round)**

#3  **Piloted Flange Or Flange Cartridge**

#4  **4-Bolt Pillow Block**

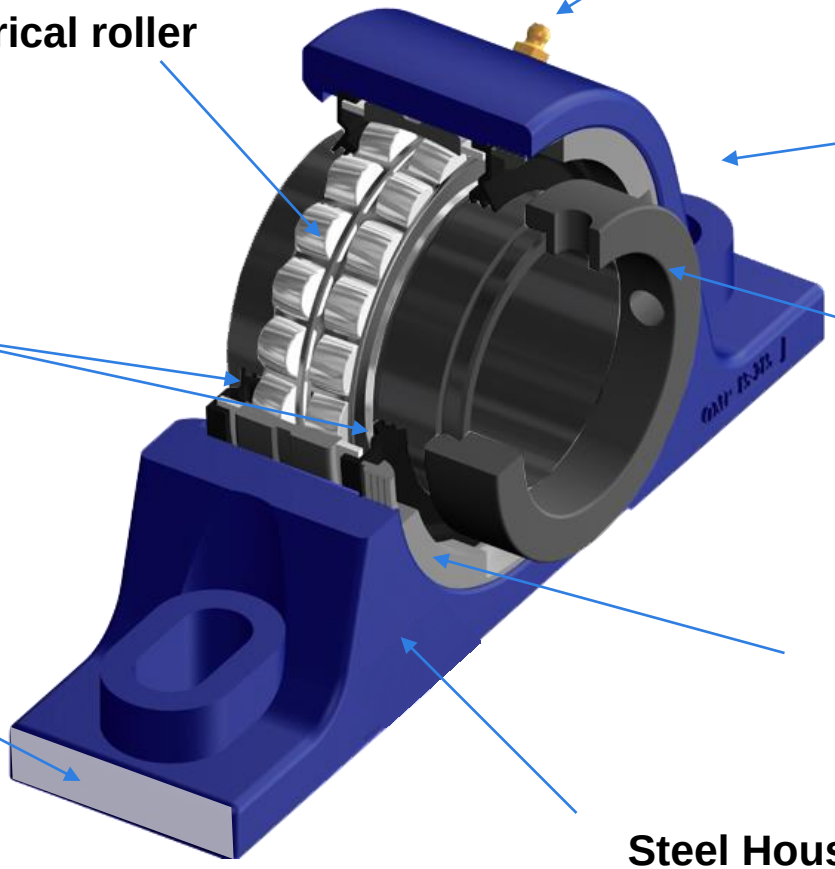
#5  **Take-Up**

#6  **Cartridge**

#7  **Specials**

TIMKEN

OVERVIEW



Grease port second port or purge on other side of unit

Double row spherical roller

Optional secondary seals not shown in cross section

primary seals

Locking collar

Machined feet

Converts to fixed or float on either side

Steel Housing

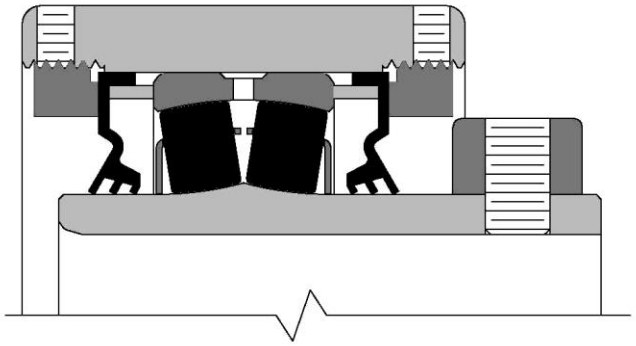
TIMKEN

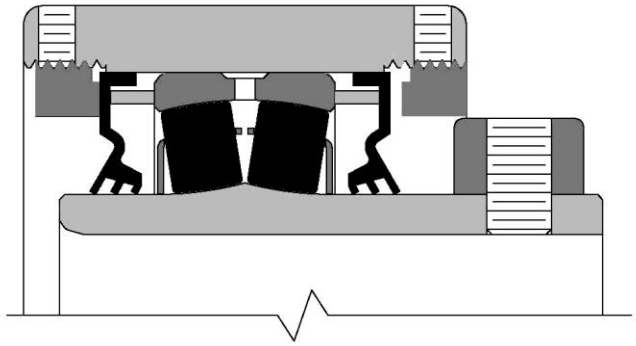
INTERNAL GEOMETRY DOUBLE V

TIMKEN

Convert Side to "Float"

- Loosen the housing nut set screw on the top of the unit
- Back the float side housing nut off 2½ turns max
- Tighten down the housing nut set screw.

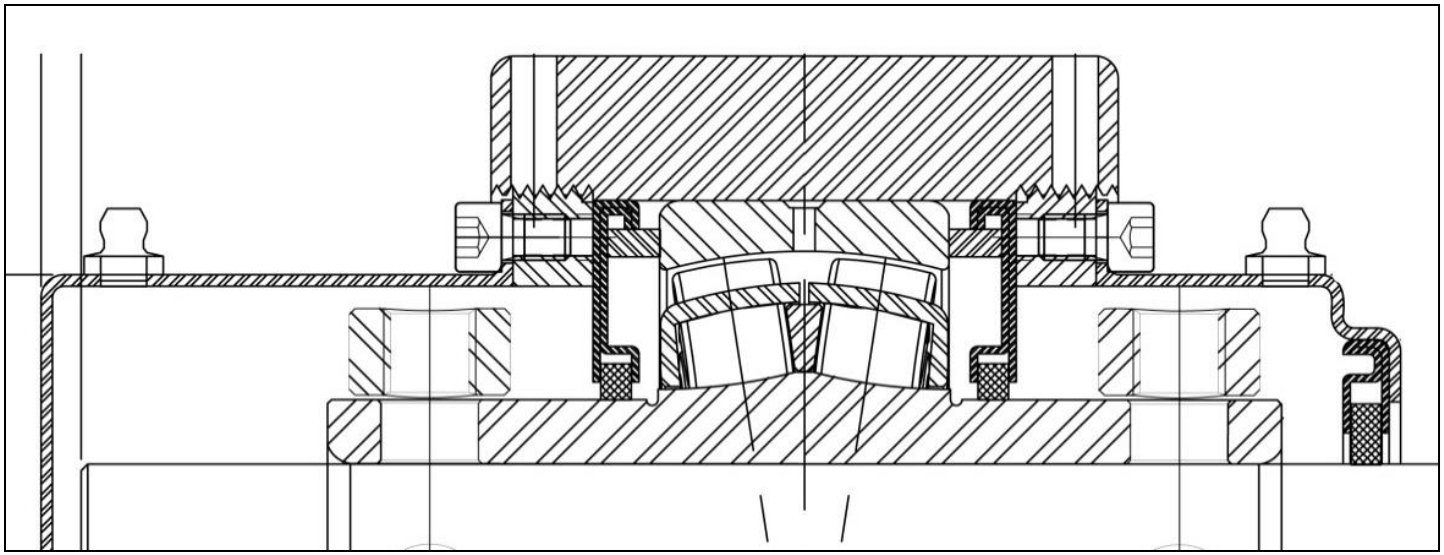




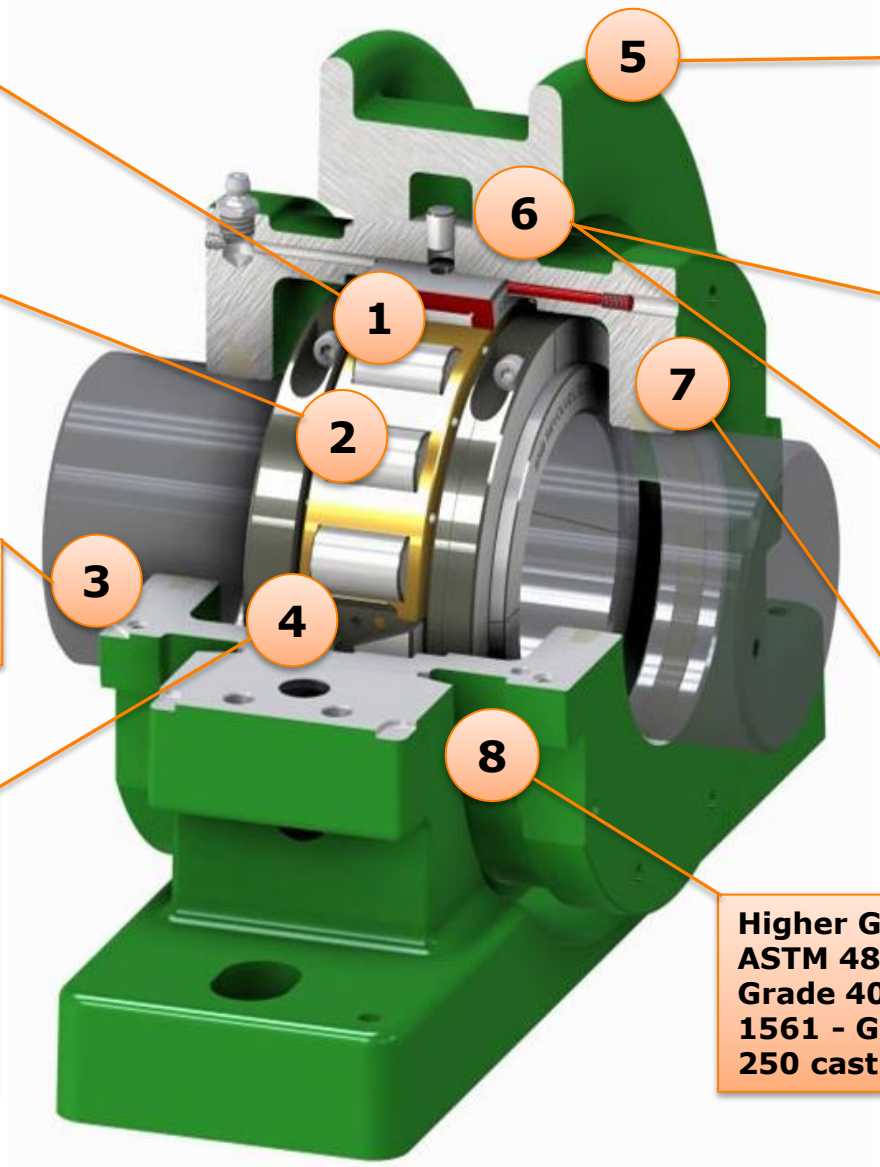
TIMKEN

Secondary Auxiliary Seals

- Install and tighten the set screws on secondary seal covers over the sleeve.



TIMKEN – REVOLVO – SPLIT ROLLER BEARING



1. Machined brass cage as standard offers long life
2. Profiled rolling elements reduce edge loading and extend life
3. Pry slots assist assembly and disassembly
4. Innovative cage clip design retains the clip on the cage to prevent loss during assembly
5. Robust housing and pedestal design incorporating stiffening ribs
6. Misalignment capability of +/- 1.5 degrees
7. Retains seal concentricity to the shaft
8. Eight (8) seal styles available plus custom designs.

Higher Grade ASTM 48A – Grade 40 / BS 1561 - Grade 250 cast iron

TIMKEN

PRODUCT RANGE

- Widest range of product style and sealing types
  - Maximum diameter 1500 mm

Plummer

Bore: 35- 600 mm (1-3/16”- 24”)

Flange Unit

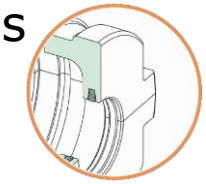
Bore: 35 - 305 mm (1-3/16” - 12”)

Take-Up Unit

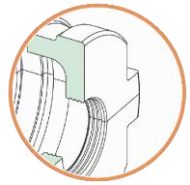
Bore: 35 - 160 mm (1-3/16”- 6)

Hanger Unit

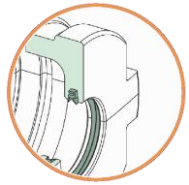
Bore: 35 -115 mm (1-3/16”- 4-1/2”)



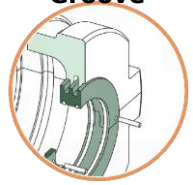
FS = Felt Seal



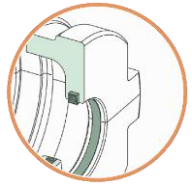
LGG = Labyrinth Grease Groove



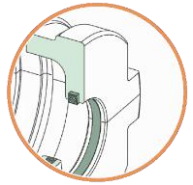
RSS = Nitrile Single Lip



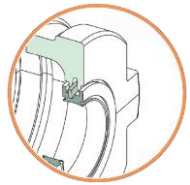
ATL= Aluminium Triple Labyrinth



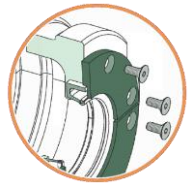
KPS = Kevlar Packing Seal



HTPS = High Temperature Packing Seal



NTL = Neoprene Triple Labyrinth



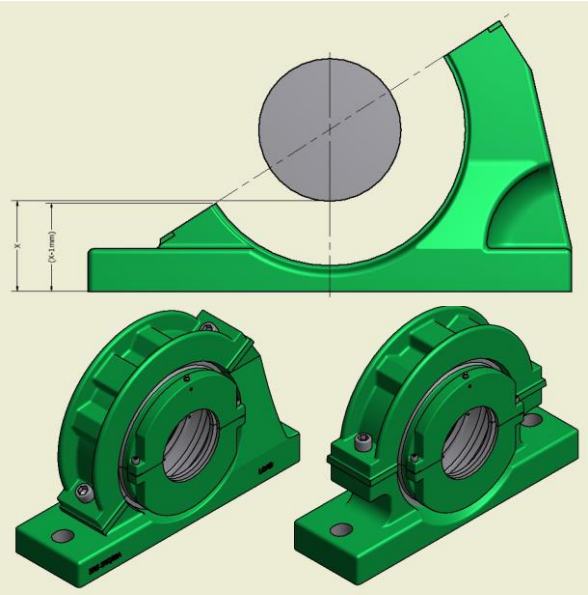
WSRP = Single Lip with Garter Spring/Retaining Plate

Units up to 150mm (6 inch) readily available

TIMKEN

SNQ/SAFQ – INNOVACION

- New and unique concept
  - Angled split bearing support allows for the lower section to fit underneath the shaft
- Features:
  - Simplifies mounting
  - No requirement to lift shaft to allow mounting



- **Benefits**
  - **Further reduces downtime compared to conventional split bearing supports for many applications**
- **Interchangeable with SN, SD and SAF**

TIMKEN SPLIT BEARING SOLUTION

Solves issues with difficult to access or high cost to service "**TRAPPED**" bearing locations

- Downtime reduced from days to hours.
- Lost production cut to a minimum
- Health and safety risk mitigated - no need to move heavy surrounding components
- Maintenance cost savings opportunity
- Operational profitability improved

Typical Applications:

Conveyors

Fans and Blowers

Mills and Crushers

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QUESTIONS

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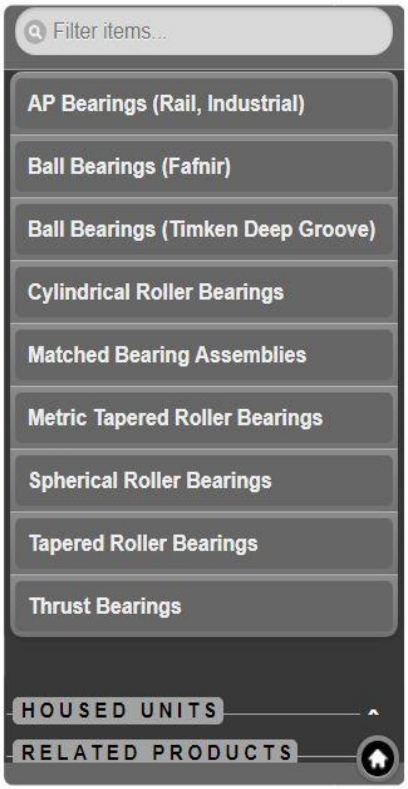

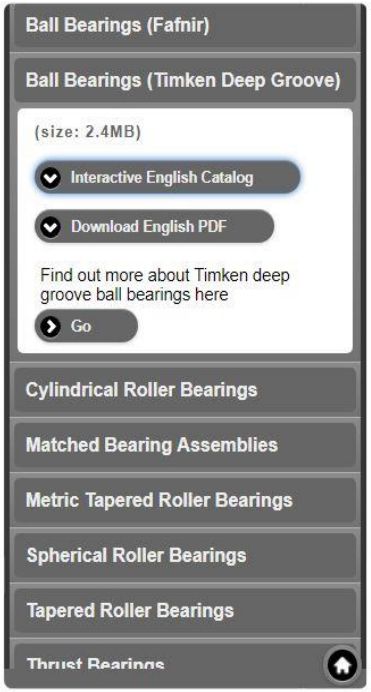

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