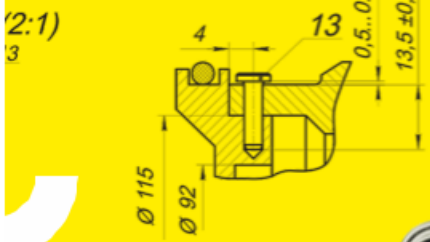


ROLLING BEARINGS

Basics Of Roller Bearings



About National Engineering Industries Ltd. (NBC Bearings)

A symbol of dependability and flexible engineering solutions, NBC Bearings is the brand of National Engineering Industries. Founded in 1946, National Engineering Industries Ltd (NEI) is India's leading bearings manufacturer and exporter, renowned for excellence in quality and delivery. In 2021, NBC bearings completed 75 years of its incorporation.

Headquartered in Jaipur, Having started with 30,000 bearings in 19 sizes in 1946, NBC has evolved to manufacture over 200 million bearings each year offering in 2300+ variants to serve a host of customers in India and over 30 other countries across five continents in automotive, railways and industrial segments. NBC also serves the Indian aftermarket through a countrywide network of 550+ authorized stockists and thousands of retailers.

Award & Recognitions :

NBC has been the recipient of several award and accolades for its quality consciousness and manufacturing prowess. Most prominent being the coveted Deming Grand Prize which is the highest honour in quality awarded to a company for excellence in Total Quality Management (TQM). NBC bearings is the only bearing manufacturer to win both - The Deming Application Award and The Deming Grand Prize Award.

The award is given by the Japanese Union of Scientists and Engineers (JUSE) to companies for demonstrating practicing TQM in the areas of production, customer service, safety, human resource, corporate social responsibility, environment, etc. NBC stands committed to an endless journey of continuous improvement through TQM.



2 WHEELERS



3 WHEELERS



4 WHEELERS



TRACTORS



LCV, HCV



INDUSTRIES



RAILWAYS



WOMEN DEMING GRAND PRIZE

01 Basics of Rolling Bearing

1.1 Type of Rolling Bearings

When two metal parts of a machine comes in contact, a large amount of friction is produced, and this can lead to the wear and tear of sliding parts. To reduce friction between sliding parts bearing was introduced. Bearings are mechanical elements designed to enable rotational movement in a device. They are used to reduce friction between moving parts and to enhance the speed and efficiency of a system. At the same time, bearings are used to support other parts of a machine by handling various amounts of stress.

The functions of the bearing are :

- (I) Free rotation of the shaft or the axle with minimum friction.
- (ii) Supports the shaft or the axle and holds it in the correct position.
- (iii) Transmit forces by sliding or rolling

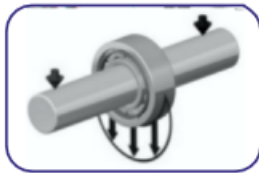
Due to their wide availability and versatility, rolling element bearings are, perhaps, the most widely used bearing type.

From a design perspective, bearings can be classified into:

Plain Bearings - They are used for sliding, rotation, oscillating or reciprocating motion. With a cylindrical shape and no moving parts, they are used in machines with a rotating or sliding shaft component. Plain bearings can be made of metal or plastic and can use a lubricant like oil or graphite for reducing the friction. Also referred to as bush or sleeve bearings.

Rolling Bearings - These bearings are used for supporting higher loads. They consist of rolling elements such as balls or rollers which are placed between a turning and a stationary raceways of rings. The relative motion of the rings causes the movement of the rolling elements. They are classified into radial bearings or thrust bearings depending upon the load direction. Radial bearing mainly take radial loads. Most types of radial bearings can also take thrust loads. Thrust bearings generally take thrust loads only and not radial loads

Radial Bearing



Thrust Bearing



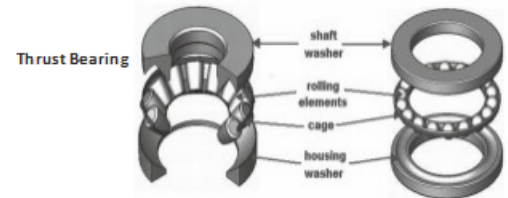
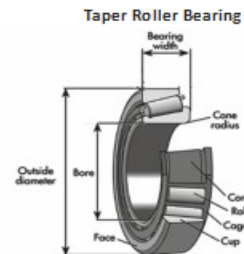
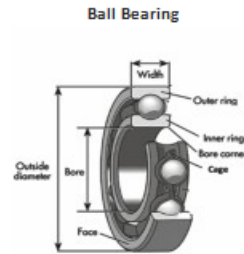
In addition depending upon the type of rolling elements these are further classified into

- Ball bearing (Bearing using ball as rolling element)
- Roller bearing (Bearing using rollers as rolling element)

Due to their wide availability and versatility, rolling element bearings are, perhaps, the most widely used bearing type.

Depending on the design of the rolling bearing, the rolling surfaces may vary, but the standard configuration of a rolling element bearing comprises two rings (inner and outer), rolling elements like rollers or balls and a cage which keeps the rolling element apart and guides them. Some bearings also have seals as integrated components.

Thrust bearings are used for carrying load in axial direction. In case of thrust bearing, the raceway of thrust bearing is called "raceway washer," the inner ring is called the "shaft raceway washer" and the outer ring is called the "housing raceway washer."



Raceway: The surface on which rolling elements roll is called the "raceway surface". The load on the bearing is supported by the raceway in contact with rolling elements. Generally the inner ring fits on the axle or shaft and the outer ring in the housing.

Rolling Elements: Two type of rolling elements are present in bearing i.e. balls and rollers. Balls geometrically contact with the raceway surfaces of rings at a "point", while the contact surface of rollers is a "line" contact. Rollers come in four types: cylindrical, needle, tapered, and spherical.

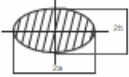
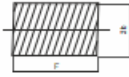


1.2 Characteristics of Rolling Bearings

When compared with sliding bearings, rolling bearings have the following advantages:

- The starting friction coefficient is lower
- They are internationally standardized, interchangeable
- They are easy to lubricate with oil or grease
- Bearing can carry both radial and axial loads at the same time.
- May be used in either high or low temperature applications.
- Bearing rigidity can be improved by preloading.
- Bearing can run at high rpm

Table 1.1 Comparison of Ball and Roller bearing

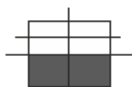
	Ball Bearing	Roller Bearing
Contact with	 <p>Point Contact Contact surface is oval when load is applied</p>	 <p>Linear Contact Contact surface is generally rectangular when load is applied.</p>
Characteristics	Because of point contact there is little rolling resistance, ball bearings are suitable for low torque and high-speed applications. They also have superior acoustic characteristics.	Because of linear contact, rotational torque is higher for roller bearings than for ball bearings, but rigidity is also higher.
Load Capacity	Load capacity is lower for ball bearings, but radial bearings are capable of bearing loads in both the radial and axial direction.	Load capacity is higher for rolling bearings. Cylindrical roller bearing equipped with a lip can bear slight radial loads. Combining tapered roller bearings in pairs enables the bearings to bear an axial load in both directions.

BALLS



Small Contact Area

ROLLERS

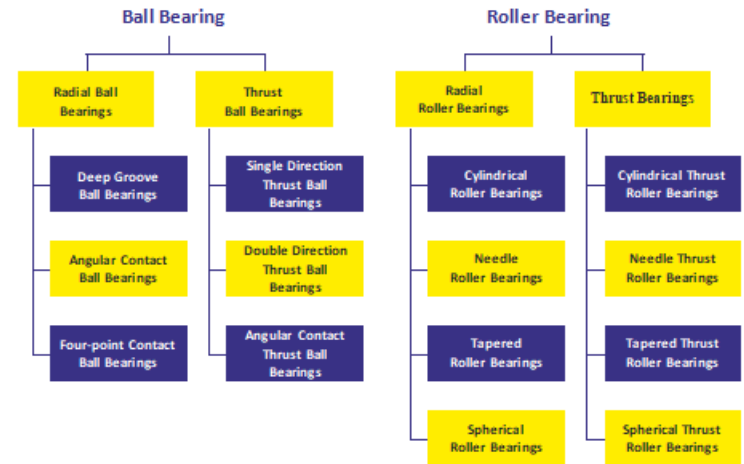


Large Contact Area

1.3 Rolling Bearing Classification

Generally rolling bearings are classified based on rolling element and direction of load

- Depending upon the direction of load to be supported
- Depending upon the type of loading (Steady or fluctuating load)
- Depending upon the type of rolling element (ball or roller)



1.3.1 Single Deep Groove Ball Bearing

The Single row radial ball bearings accommodate pure radial, pure axial or any combination of radial and axial loads within its capacity. These can operate at very high speeds. For these reasons and its economical price, it is the most widely used bearing. Owing to high degree of conformity between balls and raceways, the self-aligning capability of deep groove ball bearing is small.

Due to this these bearings are well aligned for mountings. Deep groove ball bearings include shield bearings and sealed bearings with grease. Deep groove ball bearings also include bearings with a locating snap-ring to facilitate positioning when mounting the outer ring, which absorb dimension variation of the bearing fitting surface due to housing temperature.



Dust Shield

Rubber Seal

N-Groove & Snap Ring

Plain Bearing

NBC offers TMB Ball bearings have the same boundary dimensions as standard deep groove ball bearings, but have undergone a special heat treatment that considerably extends wear life. These bearings were especially effective in countering reduced wear life due to the effects of infiltration of dust and other foreign matter.

1.3.2 Angular Contact Bearing

The single row angular contact ball bearings are generally designed with three angles 25, 30 & 40 degrees. These bearings have higher axial load capacity and must be used in pairs or in combinations. The bearings can carry axial load in one direction only and should be adjusted against another bearing, if axial load is coming from both the directions. An axial load acts directly along a straight line through the bearing, whereas a radial load acts obliquely and tends to separate the races axially. So the angle of contact on the inner race is the same as that on the outer race. Angular contact bearings better support combined loads (both the radial and axial). The larger the contact angle, the higher the axial load supported. Also there are four-point contact bearings which are radial single row angular contact bearings which can support an axial load in both directions. The outer ring with ball and cage assembly can be mounted separately from the two inner ring halves.

Single Row Angular Contact



Double Row Angular Contact

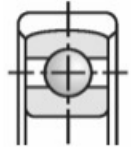


Four Point bearing



Single Row Externally Aligned Ball Bearing

The Single Row Externally Aligning ball bearings are used where accurate alignment cannot be ensured between bearing positions. This bearing type can mainly take radial loads. Axial loads can also be accommodated. The shell housing must not be made an interference fit on their outside diameter. If an interference fit is used, the shell housing may contract and prevent alignment. These bearings can be located end wise in both the directions.



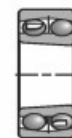
1.3.3 Self-Aligning Ball Bearing

Self-aligning bearings have a common spherical raceway in outer ring and two groove in inner raceway. The self-aligning ball bearings are used where accurate alignment cannot be guaranteed between shaft and housing. The bearings have the same external dimensions as there equivalent single row radial ball bearings. They can take radial loads and very light axial loads. They can be located endwise in both the directions.

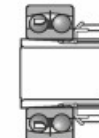
The double row self-aligning ball bearings with tapered clamping sleeve and nut are identical to double row self-aligning ball bearing except that these have a tapered bore. Bearing are mounted on the shaft using a sleeve and nut for clamping.



Cylindrical Bore



Tapered Bore



Tapered Clamping Sleeve and Nut



Self-Aligning Ball Bearing

1.3.4 Cylindrical Roller Bearing

The bearing consists of inner ring, outer ring, rollers and cage (mostly steel or brass). They have greater radial load capacity than ball bearings of same external dimensions. The bearing features a modified line contact between rollers and raceways to eliminate edge stressing. These bearings have a high radial load capacity and are suitable for high speeds. The inner and outer rings can be separated to facilitate assembly. Due to detachable design, have advantage of mounting inner ring and outer ring separately. The direction of axial load which a bearing can take depending upon the geometry of the bearing. Many variants are available such as NU, NJ, N, NF, NUP, NH. The bearings are also available in double-row and four row configurations.



Cylindrical Roller Bearing with Brass & Steel Cage



Single Row

Double Row

Four Row

1.3.5 Taper Roller Bearing

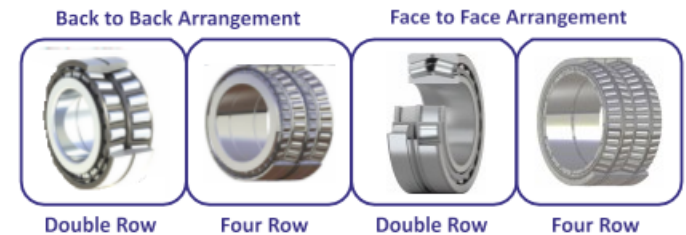
Tapered roller bearings consists of cup, cone, retainer and tapered rollers. Tapered roller bearings are designed in such a way that vertices of the cone for each roller and those for the cone and cup raceways coincides on the bearing axis or extensions of the raceways and rollers converge at a common point on the axis of rotation. This results in true rolling motion of the rollers on the raceways at every point along the rollers



Tapered roller bearings support radial loads and axial loads from one direction only. The line contact between rollers and raceways provide the bearings with a high load carrying capacity. Steep angle tapered roller bearing with exceptionally steep cone angle enables the bearings to take heavier axial load. The bearings are of separable type, enabling separate mounting of cups and cones.

Since the tapered roller bearings can absorb thrust loads in one direction only, these bearings should generally be installed as opposed mountings. The correct amount of radial and axial clearance is obtained by adjusting the two bearings against each other.

Double row and four row tapered roller bearings are also widely used for heavy loads in rolling mills. These bearings are preset assemblies and mounted on roll neck. Bearing configuration is face to face or back to back arrangement.



Back to Back Arrangement

Face to Face Arrangement

Double Row

Four Row

Double Row

Four Row

1.3.6. Spherical Roller Bearing

Spherical roller bearing permits low friction, and angular misalignment. The bearings consist of an inner ring with two raceways inclined at an angle to the bearing axis. It consists of an outer ring with a common spherical raceway, spherical rollers and cages (brass or steel). In certain designs, also internal guide rings are present to support cage. Typically these bearings support a rotating shaft in the bore of the inner ring that may be misaligned in respect to the outer ring. The misalignment is possible due to the spherical internal shape of the outer ring and spherical rollers. Bearing are available with straight and tapered bore.



Cylindrical bore



Tapered bore



Spherical Roller Bearing

1.3.7 Thrust Bearing

A thrust bearing permit rotation between parts, but they are designed to support mainly axial load. They have steel or brass cage. Thrust bearings are divided into single and double direction types. The single is able to accommodate axial load in one direction, while the double direction is able to accommodate the load in both the directions. Thrust bearings are not suitable for applications that involve radial load or high-speed rotation. This type of bearing is commonly used in automotive, pumps and marine applications.

Thrust bearings come in several varieties.

- Thrust ball bearings, consists of balls supported in a ring, can be used in low thrust applications where there is little axial load.
- Cylindrical thrust roller bearings consist of cylindrical rollers arranged flat with their axes pointing to the axis of the bearing.

- Tapered roller thrust bearings consist of tapered rollers arranged so that their axes converge at a point on the axis of the bearing.
- Spherical roller thrust bearings use asymmetrical rollers of spherical shape. They can carry heavy axial load. They can accommodate combined radial and axial loads and also accommodate misalignment of the shafts.



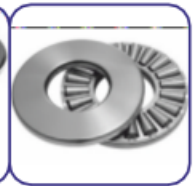
Spherical Roller Thrust Bearing



Ball Thrust Bearing



Cylindrical Roller Thrust Bearing



Taper Roller Thrust Bearing

1.3.8 Bearing Units

Units consists of radial ball bearing, seal, and a housing which are greased and sealed. The outer surface of the bearing and the internal surface of the housing are spherical, so that the unit is self-aligning thus they are able to compensate for misalignment of the shaft with respect to the housing. These bearing units are ready-to-mount. Series 62 and 63 of the deep groove ball bearing are used in these units. A seal and a slinger is provided on both sides. They are completely sealed, and provided with a re-lubrication feature.



1.3.9 Needle Roller Bearing

Needle roller bearings are generally composed of needle rollers and cages. Several needle rollers placed between two hardened and smooth surfaces and cage prevent the needle rollers to contact each other to accommodate smooth rolling action. The diameter of rolling element in Needle roller bearing is relatively small and having relatively large length/diameter ratio, this allows for more load carrying capacity and ideal for oscillation motion.

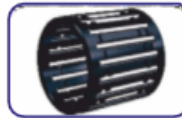


In comparison to other roller bearings, needle roller bearings are having small radial section height and smaller mass, which allows for more compact design and suitable for application where low inertia force is required.

Needle roller bearings depending upon different customer applications requirements

Needle Roller and Cage Assembly

A needle roller and cage assembly comprises of needle rollers and a cage that guides and hold the rollers on its position to accommodate smooth rolling action.



Needle roller and cage assembly for connecting rod bearings

A Needle roller and cage assembly for connecting rod bearings comprises of needle rollers and a cage that guides and hold the rollers on its position.



Shell Type Needle Roller Bearing

Shell type needle roller bearing comprises of an outer shell ring made from special thin steel, needle rollers and cage. A hardened and ground inner ring/ shaft is used as the raceway.



1.4 Cage

The cage is an important component of a rolling bearing. The functions performed by the cage are:

- It prevents the mutual contact between the rolling elements by keeping it apart.
- Due to the cage, the rolling elements are evenly spaced which ensures even load distribution.
- It guides the rolling elements and prevent them from falling.

There are pressed cages as well as solid cages:

Pressed cages are made from sheet steel, or sometimes from brass sheet. Their main advantages are light weight and low material cost.

Solid cages are made from brass, steel, light metal or laminated phenolic resin. They are manufactured either by machining, by injection molding of plastic materials or by sintering metals.



Stamp Type Cage



Pin Type Cage



Finger Type Cage



Brass Cage



Molded Type Cage

1.5 Seals and Shield

Seals/shields have significant effect on the life of rolling bearing.

The shields are non-contact type and made of sheet steel. Provides protection from dirt and dust. Mostly used in application with inner rotating.

The seals are made of rubber and are light to heavy contact type.

The materials used for seals are NBR (Acrylonitrile-butadiene rubber) or FKM (Fluoro rubbers) for higher temperatures.

The main function of the seal in rolling bearing is to:

- Retain lubricants
- Exclude - dirt/contaminants/dust/water ingress
- Confine pressure

If the sealing device fails to function, foreign matter or leakage will cause bearing damage, as a result bearing seizure can take place during operation. Temperatures, speeds, pressures, lubricants and other operating conditions greatly impact seal life and bearing performance. Therefore, it is necessary to choose the most suitable seals according to operating conditions.

For right choice of seal for an application, consider the following key factors:

- Bearing type
- Lubricant (oil or grease)
- Seal friction and torque
- Surface speed
- Physical space available



1.6 Bearing Material

The selected material must be suitable for the operating environment and must meet the technical requirements for the application. The components of rolling bearing during operation are subjected to cyclic load and deformation, still they must maintain dimensional accuracy.

To accomplish this, the raceways and rolling elements must be made of a material having following properties:

- High Hardness,
- Resistant to Rolling Fatigue,
- Wear Resistant,
- Good Dimensional Stability
- High Impact Strength
- Corrosion Resistance
- Uniformity of Structure

The bearings are made of either high carbon or low carbon steel. Depending upon the selection of material, process of hardening is selected.

The bearing components are hardened by the following method.

Through-Hardening

Through-hardened bearings feature a uniform hardness throughout the cross section. Mostly used in application which are not highly misaligned and shock loads are moderate. This is a regular process for most of the bearing used in various applications.

Induction-Hardening

It is a type of surface hardening in which a 'metal part' is induction-heated and then quenched. Hardening may be done on the surface or throughout the entire surface and properties of the remaining part remains unaffected.