

# Ball Bearing Steels

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# BALL BEARING STEELS

## Classification & General Features

Ball bearing is a vital component used in transmission of dynamic loads in machine parts that continuously move. A bearing helps reduce the friction force between the moving parts, allowing smooth transfer of motion.

Bearings are classified in three major types :

- 1 **Tapered roller bearings/Cylindrical roller bearings**  
Generally used for transmitting large impact loads, eg. Gears, Axles, etc.
- 2 **Ball bearings**  
Generally used for application involving moderate loads with conditions of low friction.
- 3 **Needle roller bearings**  
Generally used in reducing friction on large contact area.

Needle roller bearings differ in design from taper roller and ball bearings significantly and are mainly used for reduction of frictional forces rather than transmission of major loads.

The application of each bearing is different. It is mainly decided by the following considerations :

- 1 **The type of force - i.e. tensile, torsion or combination of these.**
- 2 **The magnitude of force.**
- 3 **The design features of the machine.**

There are four major components in a bearing :

- 1 **The outer racer**
- 2 **The inner racer**
- 3 **The rollers or the balls**
- 4 **The cage to hold the balls/rollers in position, between the two racers.**

Due to its typical application, the bearing is under continuous fatigue strain during service and its maintenance is of vital importance in its overall service life. All bearings carry a guarantee of life in service. Any deviation from these guarantees calls for a free replacement by the original equipment manufacturer.

Automobiles, railways, earth moving, defence, aircraft are the major application areas for bearings. Apart from these, areas of power generation, compressors and any other moving machinery parts call for application of bearings.

## Broad outline for manufacture of bearings

Steps	Method of Manufacture	Purpose
i) Manufacture of inner and outer racers	Hot forging press or machine	To obtain desirable basic shape with correct flow line configuration to improve its strength
ii) Spheroidising of the racers	Heat treatment in a continuous or bogie furnace.	To achieve the desired machinability to give final shape
iii) Machining and final grinding of racers	C.N.C. machining and grinding coupled with lapping	To obtain machining contours as precisely as possible to reduce friction and vibration
iv) Pre-shaping of balls/rollers (from spheroidised annealed bright bars)	Cold forging machine or a press	To obtain compact grain structure and a preshape
v) Final shaping of Balls and/or rollers	Fine machining and grinding and lapping	To obtain the final shape to fit correctly between the outer and inner racers and achieve vibration free movement
vi) Heat treatment of individual parts	Racers, rollers and balls are all hardened and tempered to achieve uniform hardness with fine tempered martensite and dispersion of carbides	To obtain a wear free situation between the racers and balls or rollers during service
vii) Assembly and packing in a steel or plastic cage and greasing	Mechanical press fitting	To facilitate packing and storage without rusting or damage



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## Requirement of Ball Bearing Steels

Keeping the importance of role of the ball bearing in mind and also taking note of the fatigue strength requirements of ball bearing steel, certain steps in its manufacture are of extremely vital significance. These are enlisted below, stagewise :

Steps	Action	Purpose
Iron Making - DRP & MBF	Low tramp levels	Use of right raw material, free of undesirable tramp elements
Steel making E.A.E	Low tramp Levels due to use of own virgin raw material such as DRI & Pig Iron (Mo, Ni, V, Pb, Sn, As, Sb)	To avoid formation of undesirable compounds which would impair the bearing properties
	Low phosphorous opening	To avoid cold shortness resulting in reduction in fatigue life
	To obtain a reasonable carbon opening	To achieve low starting oxygen
	No oxidising slag transfer to LRF station	To avoid reversion of phosphorus and titanium
	Low Ti opening	To achieve final low Ti in steel to avoid Ti carbonitride inclusion formation
Ladle furnace Steel making	To obtain low final Ti & P by avoiding slag transfer from EAF	To improve fatigue life
	To obtain the chemistry of final steel within narrow limits in respect of Cr, C, Mn	To achieve a close and uniform hardenability for the steel
	Low sulphur levels by making good refining slag and attain low Ti in final steel	To achieve cleanliness in terms of non metallics, especially Sulphides and Titanium Carbonitrides
	To achieve correct Al level and temperature before degassing	To avoid any reheating or Al addition after VD treatment
Vacuum Degassing	No CaSi wire feeding	To avoid formation of globular oxides of CaO and Al <sub>2</sub> O <sub>3</sub>
	To attain deep vacuum of 1m bar and hold it for atleast 20 minutes	To reduce to minimum, levels of the gases viz O <sub>2</sub> , N <sub>2</sub> , H <sub>2</sub> to attain a significantly high fatigue life of the bearing
	To obtain a thorough mixing of metal and slag to allow further de-sulphurisation to very low levels	To obtain very low levels of sulphur and sulphide inclusions
	To obtain complete homogeneity of temperature and composition	To facilitate casting and further processing of bearing steel
Continuous Casting	To maintain low superheat	To avoid C, S and Cr segregation in cast billet
	To maintain uniform casting speed and adequate electromagnetic stirring	To obtain uniform, compact, dendrite free macro of the cast billets and controlled carbide banding
	To do perfect shrouding of ladle and tundish streams and cover the tundish metal	To minimise O <sub>2</sub> level ≤ 10 ppm to get good fatigue life
	To maintain correct heating and soaking temperatures with optimum rolling rates	To obtain good control over dimensions and decarb levels and maintain optimum finishing temperatures
Rolling	To maintain proper pass condition and alignment of guides	To obtain bar dimensions in close control and get defect free surface for the same



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These major process steps are monitored closely in order to satisfy the quality requirements of Ball Bearing Steels related to following vital properties :

- **Fatigue life**
- **Uniform heat treatment response**
- **Compact structure with uniform grain flow and fine grain size imparting high impact toughness.**

Inspection activities before despatch are designed to address the monitoring of all the quality requirements of bearing steels. Any process and quality deviation is recorded and analysed closely for taking suitable corrective actions to meet the product quality requirements of this critical grade of steel.

## Certification of quality :

Following important quality features are tested and certified on all Ball Bearing heats made at Sunflag.

• Chemistry	Including tramp levels and Titanium
• Gases	O <sub>2</sub> , N <sub>2</sub> and H <sub>2</sub>
• Macrostructure of bars (internal quality)	As per ASTM E-381 or as specified by the customer
• Dimensional tolerances	As specified by the customer.
• Decarburisation level	Less than 1% of diameter or as specified by the customer
• Surface quality of bar	Checked and certified on 100% basis by pickling process and 100% magnetic particle inspection.
• Non metallic inclusion level	As per ASTM-E-45 (A and B not greater than 1.0, C is 0.0 and D not greater than 0.5)
• Microstructure (Banding)	6.3 & 7.3 Max (As per SEP-1520 DIN Standard Chart)

Any other special testing requirement found desirable by the customer can be satisfied.

## Sizes and condition of supply

No.	Size (mm)	Condition of supply	Application
1	12 - 60 Dia	Stress relief /spheroidised annealed	Forging of rings
2	10 - 56 Dia	Peeled and ground bars in spheroidised annealed condition	Machining of racers or cold forging of bars /rollers
3	5.5 - 38 Dia	Spheroidised annealed	Machining of racers or cold forging of bars /rollers

## International Specifications of Ball Bearing Steels

No.	Country	Grade		Chemistry					
				C	Mn	Si	P	S	Cr
1	U.S.A.	SAE 52100	Min	0.98	0.25	0.15	-	-	1.30
			Max	1.10	0.45	0.30	0.025	0.025	1.60
2	Germany	100Cr6	Min	0.95	0.25	0.15	-	-	1.30
			Max	1.10	0.45	0.30	0.030	0.030	1.60
3	Indian	103Cr2	Min	0.95	0.25	0.15	-	-	1.4
			Max	1.10	0.45	0.35	0.025	0.025	1.6
4	Japanese	SUJ 2	Min	0.95	0.50	0.15	-	-	1.30
			Max	1.10	Max	0.35	0.025	0.025	1.60