

# 工业轴承的维修和再制造

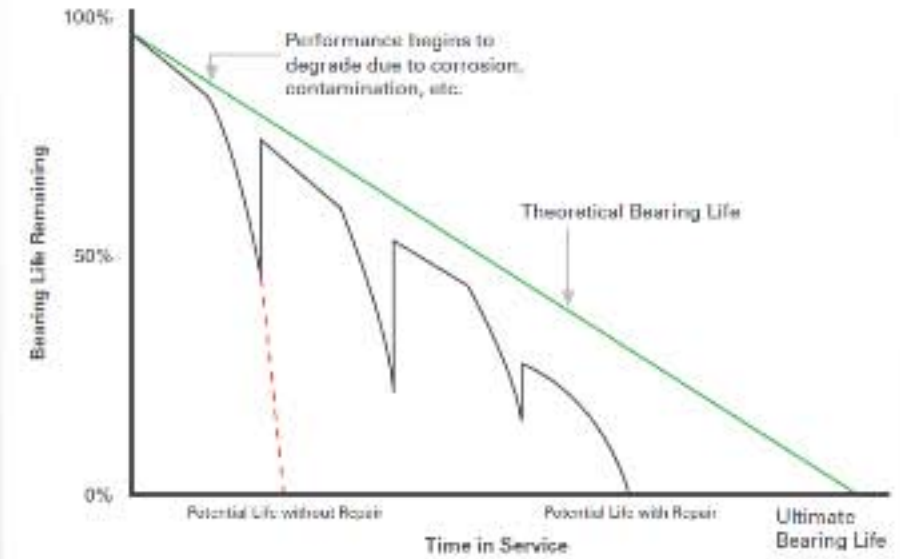
Bearing repair and remanufacturing



# Introduction of

Bearing repair is not a new concept, but it is increasing in popularity with heavy industrial customers, providing a tangible value. Advancements in bearing design, steel cleanliness, bearing maintenance and repair processes have greatly improved the potential benefits for bearing repair.

When a bearing is damaged, the entire operation will suffer, resulting in additional costs, lengthened maintenance work schedules, unnecessary downtime and extended on-time-delivery to final customers. In most heavy industrial applications, bearings are removed from service before they have reached their full useful and economic life . Bearing repair can be an effective way to extend the life of the bearing further along its theoretical bearing life, making it an economical alternative to purchasing new.



Before

After

## Birth of repair service

Large-size rolling bearings are consumed worldwide in the metallurgical, mining and cement industries. Rolling mill bearings, as well as rolls, grease and seals, are a significant expense for rolling mills. China and India are currently the world's most important steel producers. We are all looking for ways to reduce production costs. Then steel mills and bearing manufacturers set up innovative ways of doing business. Both sides have always believed that this is a work of great significance and value. What a waste of an expensive and huge bearing just because one of the parts is damaged ! How to make it reborn?

So the good idea was born!

At present, some world famous bearing brands have opened the repair business department. In fact, they directly or indirectly entrust our factory to perform this service.

# Why bearings can be repaired (overhaul) .

In fact, our maintenance workers are already doing some simple(easy) repair work for bearings and try to extend its working time as much as possible.

## Repair to portion flaking occurred



- 1 Remove the edges of the portion flaking occurred (with a polishing grinder).



- 2 Finish of the surface of the portion flaking occurred.



- 3 Finish the surface by lapping the modified portion.

But we have no way to repair the more serious bearing damage.



# The value of the bearing itself

## MATERIAL OF ROLLING BEARING

The steel used in the manufacture of rolling mill bearings is the purest high-grade alloy steel.

These steels are rich in Ni and Mo.

These advanced steels are manufactured by vacuum degassing or electroslag remelting processes.

So this is an important factor for the relatively expensive rolling mill bearings.

## Average chemical composition

Steel designation according to EN 10027-1	Quality level	C %	Si %	Mn %	S max. %	Cr %	Ni %	Mo %
100Cr6	BQ	0.97	0.25	0.35	0.015	1.50	-	-
100Cr6 mod. F	BQ	0.97	0.27	0.35	0.015	1.50	-	-
100Cr mod. Q	IQ	0.95	0.30	0.30	0.002	1.50	-	-
100Cr mod. Z	BQ	0.97	< 0.15	0.35	0.015	1.45	-	-
100Cr mid. D	BQ	1.02	0.30	0.35	0.025	1.50	-	-
70SiCrMnMo6-5	BQ	0.70	1.55	1.40	0.015	1.10	-	0.25
65SiCrMnMo6-5 mod. Q	IQ	0.65	1.50	1.40	0.002	1.10	-	0.25
100CrMo7	BQ	0.97	0.30	0.30	0.015	1.80	-	0.20
100CrMo7-3	BQ	0.97	0.30	0.70	0.015	1.80	-	0.30
100CrMo7-4	BQ	0.97	0.35	0.70	0.015	1.80	-	0.45
100CrMnMoSi8-4-6	BQ	0.97	0.50	0.90	0.015	1.90	-	0.55
100CrMnSi4-4	BQ	0.97	0.60	1.10	0.015	1.00	-	-
100CrMnSi6-4	BQ	1.00	0.60	1.10	0.015	1.50	-	-
26MnCr6-326	BQ	0.20	0.27	0.80	0.025	0.50	-	-
20NiCrMo2-2	BQ	0.21	0.25	0.75	0.015	0.50	0.55	-
17MnCr5	BQ	0.16	0.25	1.15	0.035	0.95	-	-
18CrNiMo14-6	PBQ	0.16	0.27	0.55	0.005	1.45	3.50	0.20
18CrMnMoNi9-5-5	BQ	0.18	0.35	1.30	0.030	2.20	0.50	0.50
18CrMnMoNi9-5-5 mod. Q	PBQ	0.18	0.35	1.30	0.030	2.20	0.50	0.50

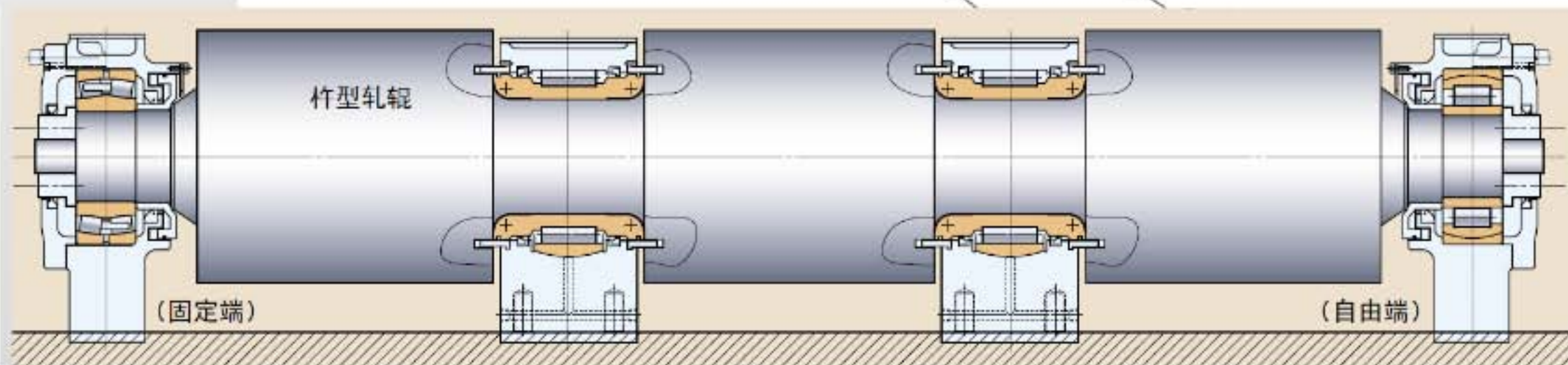
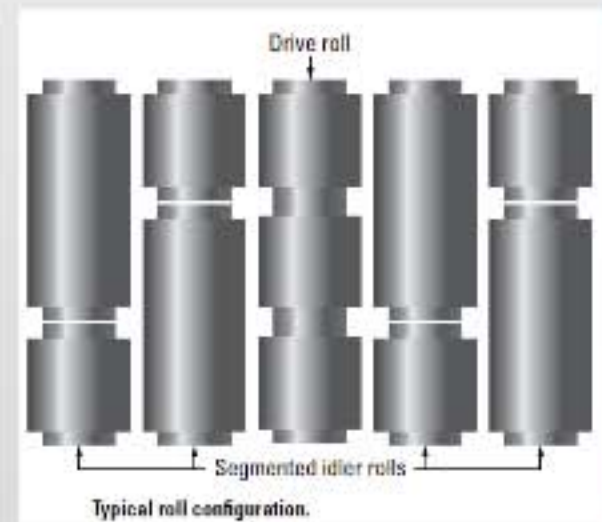
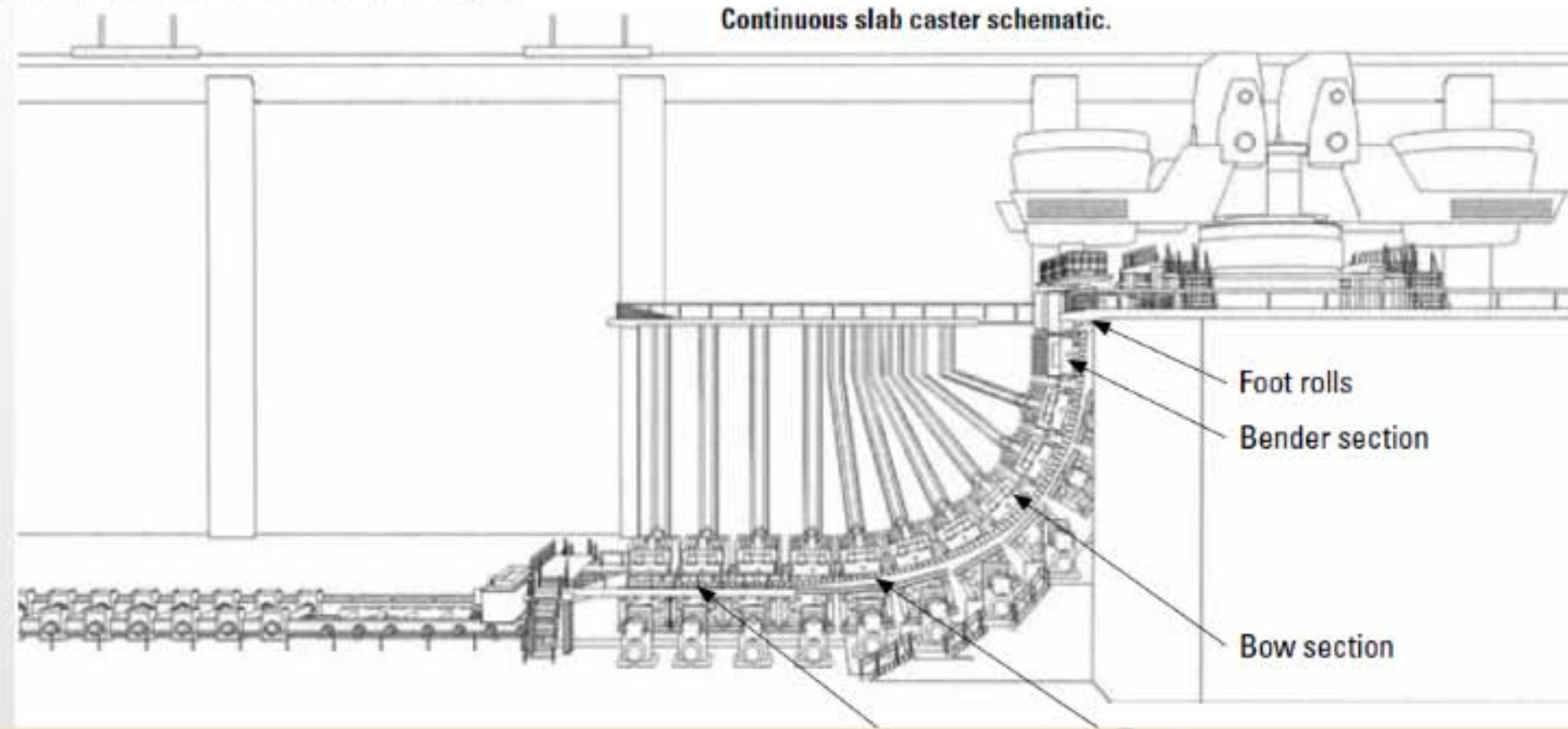
## TYPICAL CASE-HARDENING STEEL

EN-standard*	Comments	Typical analysis						
		C	Si	Mn	Cr	Mo	Ni	Other
16NiCrMo7	Ingot cast steel used for medium-sized components	0.2	0.1	1.0	1.1	0.1	0.8	
20NiCrMo2-2	A high cleanliness steel used for small-sized bearing and transmission components	0.2	0.3	0.9	0.6	0.2	0.5	
20NiCrMo7	A high cleanliness steel used for medium-sized bearing and transmission components	0.2	0.2	0.6	0.5	0.2	1.7	
20NiMo9-7F	Steel giving reduced surface oxidation after gas carburising	0.2	0.1	0.3	0.4	0.7	2.3	
18CrNiMo7-6	Carburising steel used for bearing and transmission components	0.2	0.2	0.7	1.7	0.3	1.6	
18CrMo8-5F	Steel designed for nitriding	0.2	0.3	0.8	1.8	0.5		
16MnCr5	Ingot cast steel used for small-sized components	0.2	0.2	1.2	1.0			
12NiCr14-6F	A high cleanliness steel used for large-sized bearing and transmission components	0.1	0.3	0.5	1.5	0.1	3.3	
14NiCrMo13-4	High hardenability, excellent toughness, high wear resistance, good dimensional stability	0.2	0.2	0.6	1.2	0.2	2.9	
18NiCrMo14-6	High hardenability carburising steel	0.2	0.3	0.5	1.4	0.2	3.3	
24NiCrMo15-5F	High hardenability carburising steel	0.2	0.3	0.7	1.2	0.3	3.6	
16CrMnNiMo9-5-2F	Steel suitable for carburising and nitriding. Possible to gas/air harden	0.2	0.2	1.3	2.1	0.5	0.5	V
30MoCrV20-7F	Temperature resistant carburising steel	0.3	0.2	0.3	1.7	1.8		V

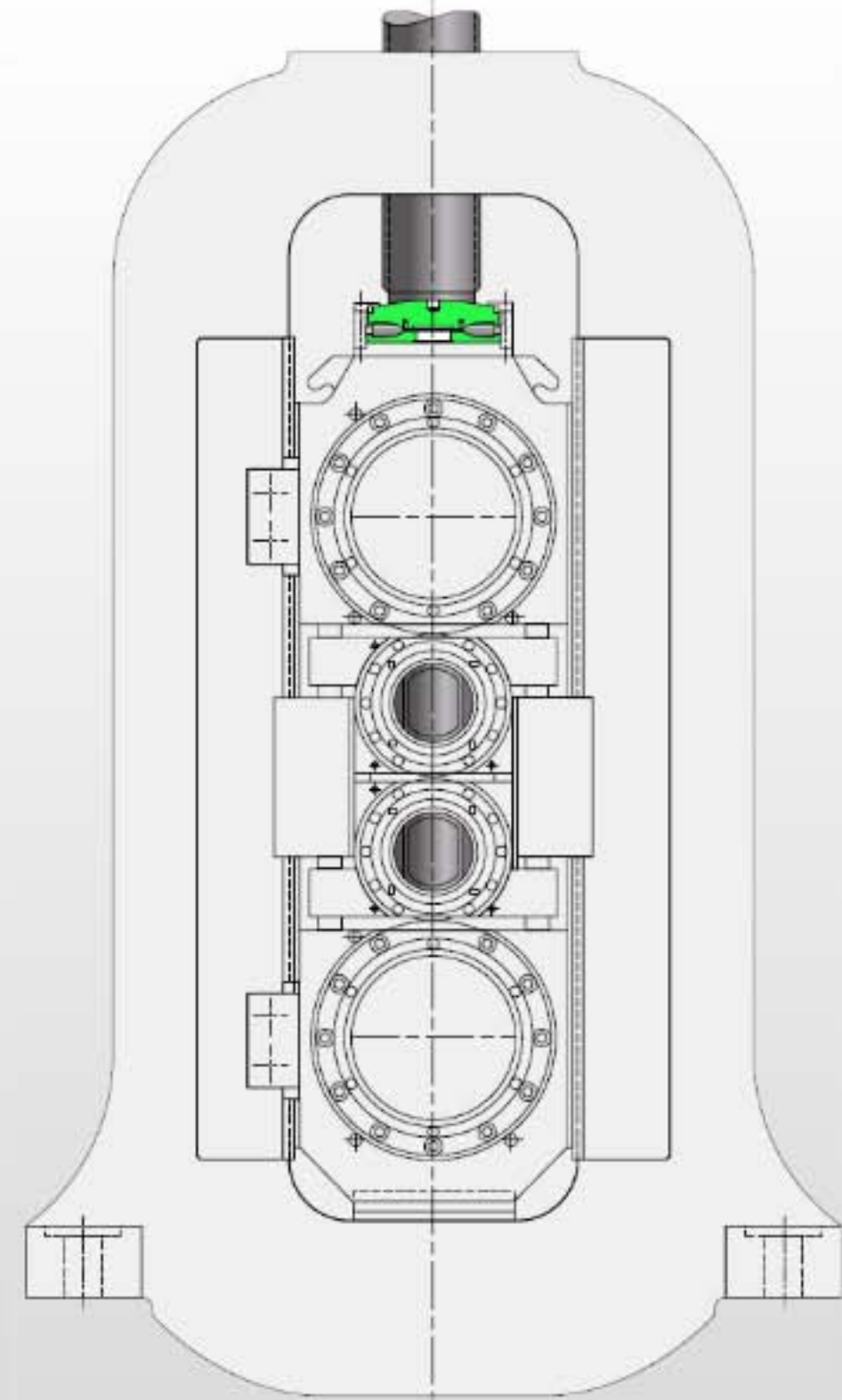
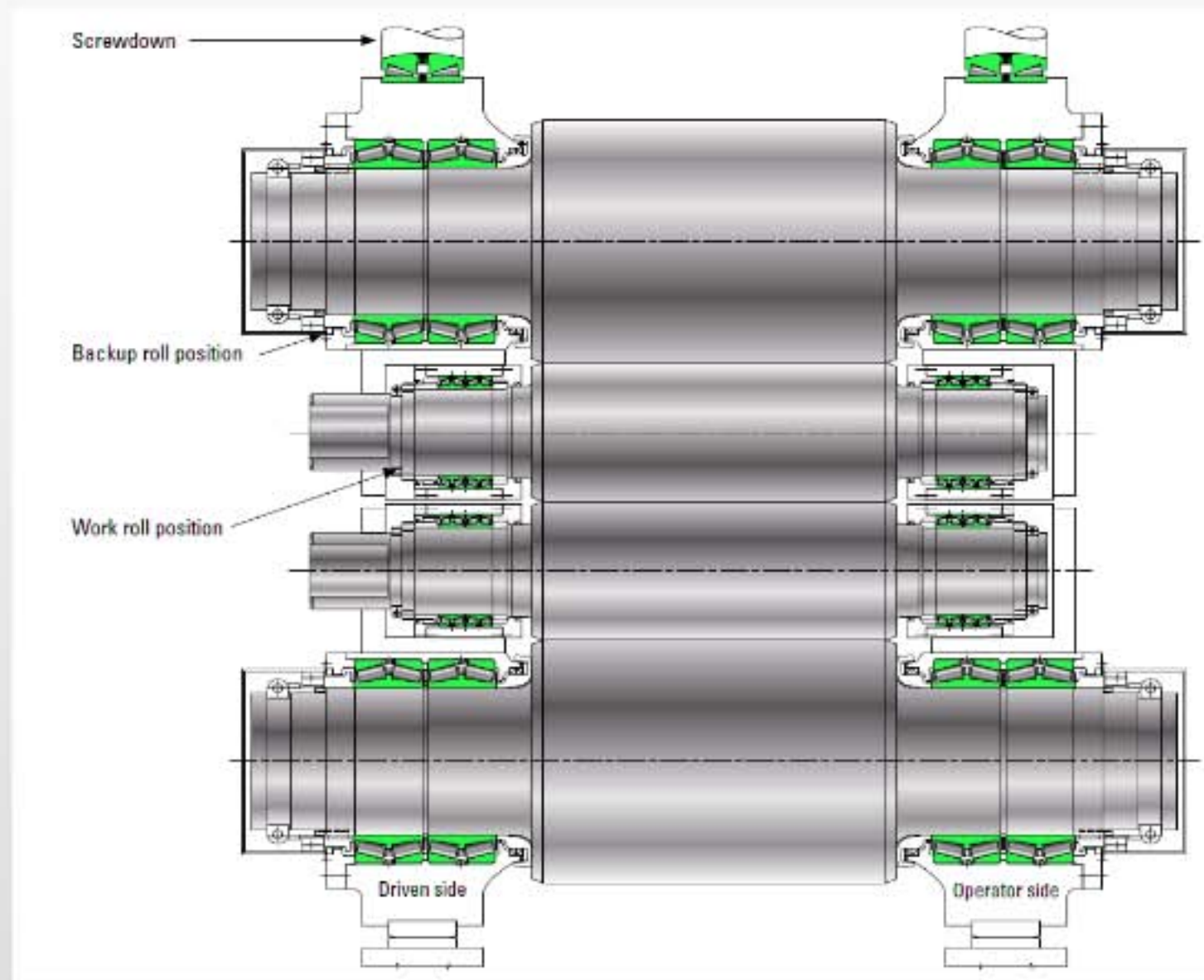


# ROLLING BEARINGS IN STEEL PLANT

- Ladle turret bearings
- Mold oscillator bearings
- Foot roll bearings
- Slab support segment bearings

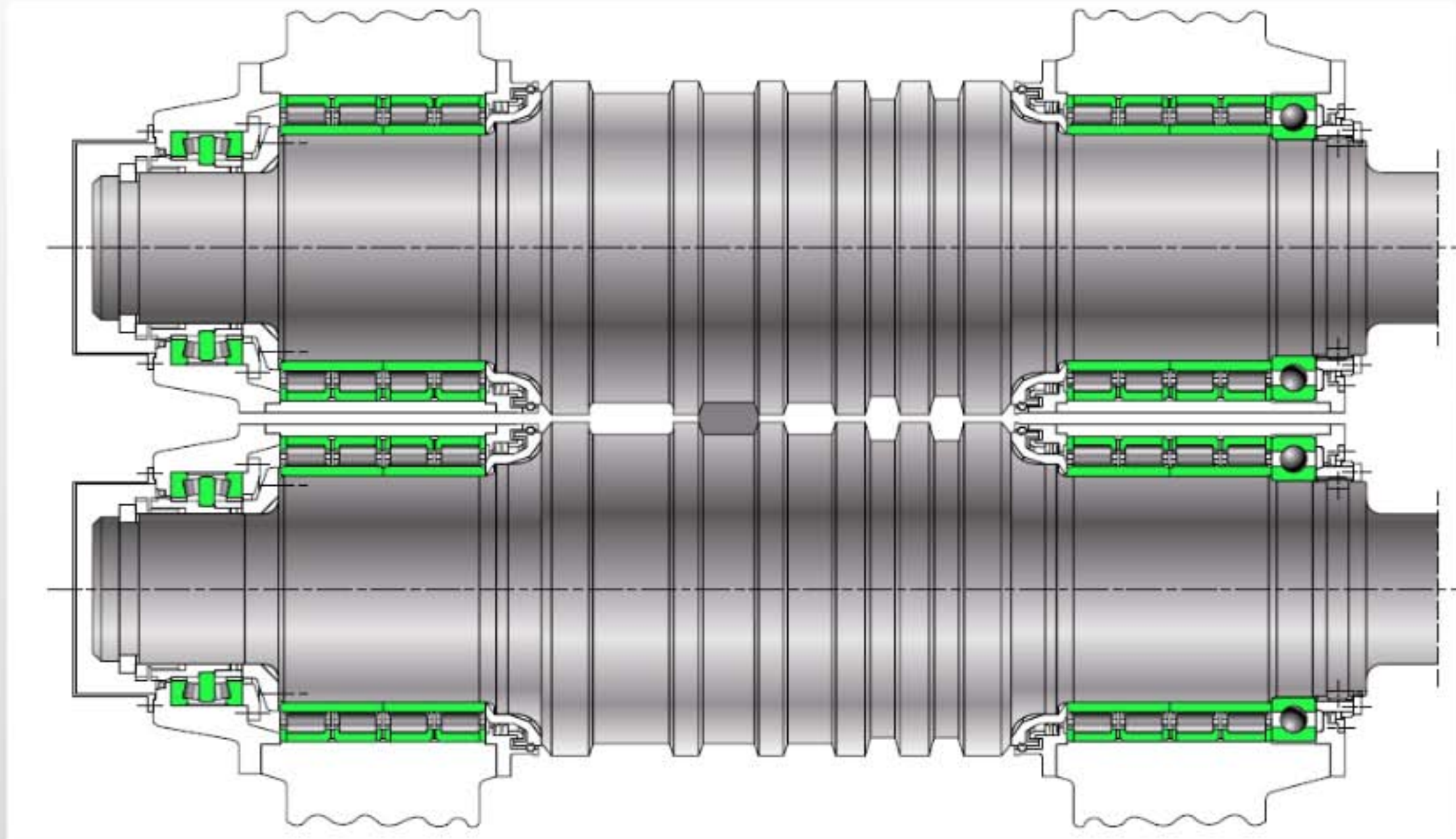


# BEARINGS OF FLAT MILL

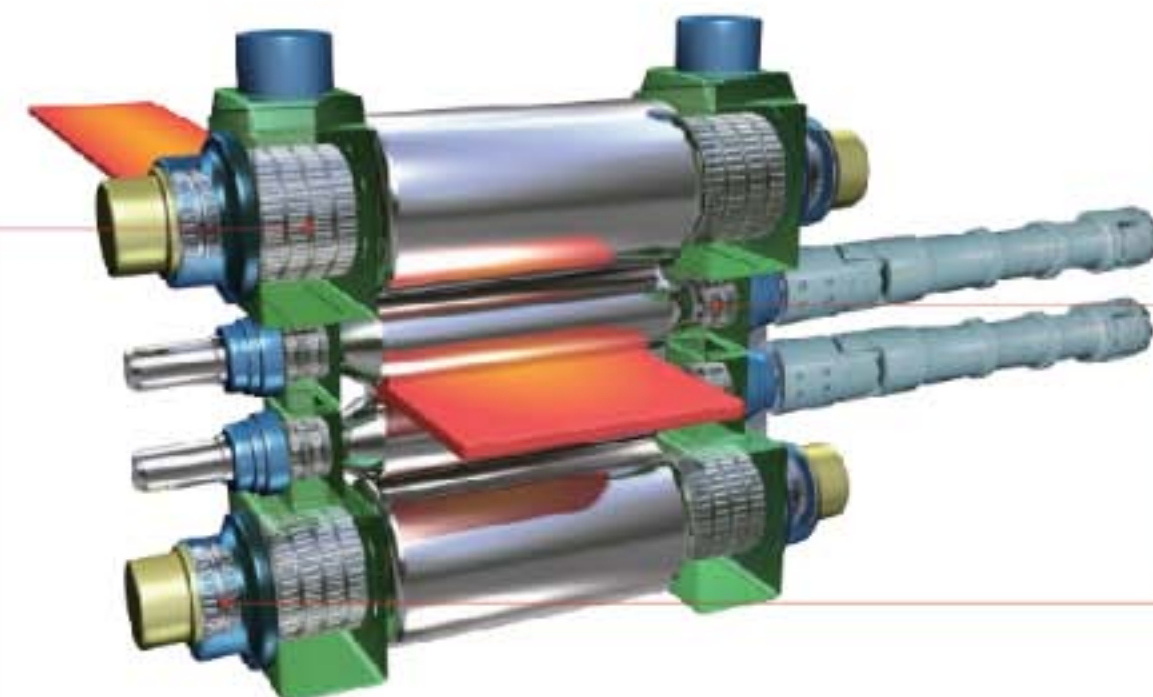




# BEARINGS OF LONG PRODUCT ROLLING MILL



# HOT STRIP MILL / COLD STRIP MILL



Sealed type four-row tapered roller bearings



Four-row tapered roller bearing (Open type)



Four-row cylindrical roller bearing

These bearings are mainly used for the work rolls and intermediate rolls of cold strip mills.

Bore diameter	Boundary dimensions (mm)			Basic load ratings (kN)		Fatigue load limit (kN/mm <sup>2</sup> )	Bearing No.	Mass (kg)
	Outside diameter	Inner diameter	Outside width	C <sub>r</sub>	C <sub>0r</sub>			
220	285	315	315	1 930	3 910	429	47TS443032	53
240	305	340	340	2 300	5 300	500	47TS453434	65
240	345	310	310	3 150	6 020	631	47TS483531	90
260	370	354	354	3 300	7 410	778	47TS523732	120
275.4	395.7	320	320	3 510	6 900	702	47TS553332	120
280	380	340	340	3 520	6 940	710	47TS533834	108
310	410	360	360	4 110	7 870	777	47TS621336A	148
310.050	407.050	354	354	3 590	7 030	665	47TS631636ED	110
482.6	615.95	330.2	330.2	6 560	12 400	1 130	4TR516C	239
711.2	914.4	420	420	9 370	22 370	1 640	4TR711	678

These bearings are mainly used for the work rolls and intermediate rolls of hot strip mills and cold strip mills.

Bore diameter	Boundary dimensions (mm)			Basic load ratings (kN)		Fatigue load limit (kN/mm <sup>2</sup> )	Bearing No.	Mass (kg)
	Outside diameter	Inner diameter	Outside width	C <sub>r</sub>	C <sub>0r</sub>			
343.050	457.050	254	254	3 560	6 970	680	47TR046P5	111
415	530	310	310	6 150	12 900	1 210	45TR05137	309
482.6	615.95	330.2	330.2	6 540	15 000	1 330	4TR16D	241
505.945	634.924	315	315	7 250	16 700	1 460	4TR019A	315
602.6	787.4	351.35	351.35	6 320	19 800	1 680	EE604 C210311D	461
711.2	914.4	375	375	8 350	18 600	1 560	4TR711	531

These bearings are mainly used for the back-up rolls of cold strip mills.

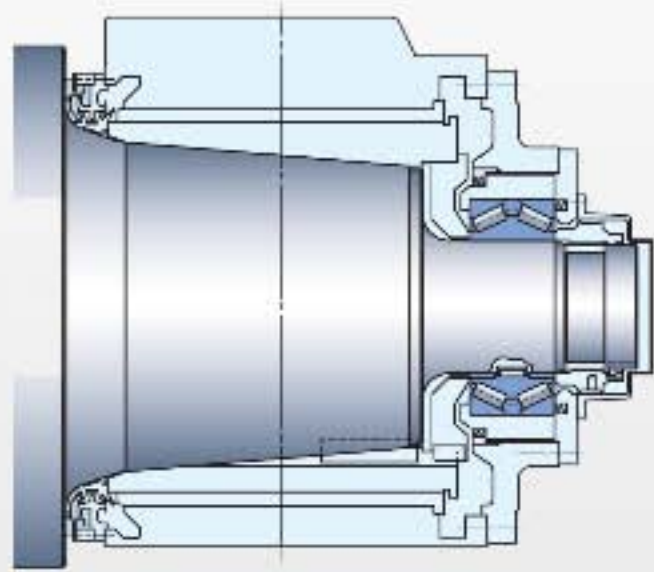
Bore diameter	Boundary dimensions (mm)				Basic load ratings (kN)		Fatigue load limit (kN/mm <sup>2</sup> )	Bearing No.	Mass (kg)
	Outside diameter	Inner diameter	Outside width	Inside width	C <sub>r</sub>	C <sub>0r</sub>			
680	950	700	700	760	24 100	32 300	4 240	138FC087G0	1 630
765	1 070	700	700	837	29 000	39 300	4 740	151FC10750A	2 820
770	1 075	770	770	847	29 000	39 500	4 950	154FC10770A	2 830
800	1 100	800	800	860	29 300	39 900	5 110	161FC12800	2 820
850	1 180	850	850	940	31 800	42 700	5 610	175FC14850	2 910
900	1 220	940	940	980	34 600	46 300	6 240	185FC17260A	3 000

These bearings are mainly used for the roll neck thrust bearings of hot strip mills and cold strip mills.

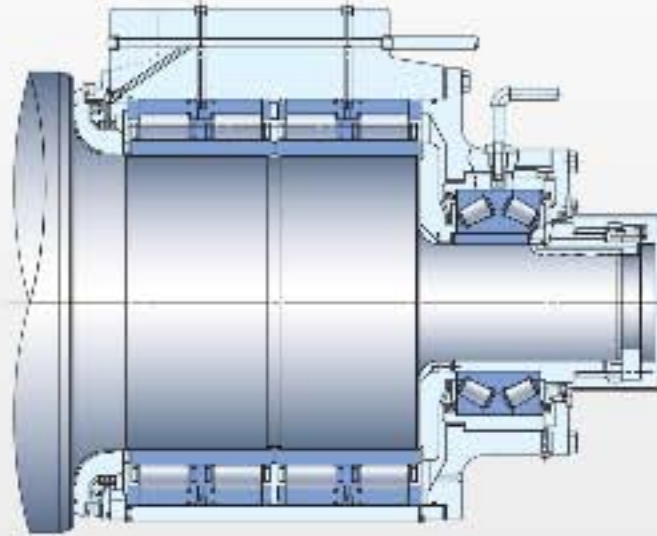
Bore diameter	Boundary dimensions (mm)			Basic load ratings (kN)		Fatigue load limit (kN/mm <sup>2</sup> )	Bearing No.	Mass (kg)	Internal clearance (mm)
	Outside diameter	Inner diameter	Outside width	C <sub>r</sub>	C <sub>0r</sub>				
305	400	200	200	2 320	6 490	638	45T618020	148	3.5
400	550	240	240	4 070	11 000	966	3TR100L	290	6.5
500.068	733.5	290.02	290.02	7 070	6 880	850	3TR510	280	5.2



# Structure of rolling mill bearings



(1) Plain bearing

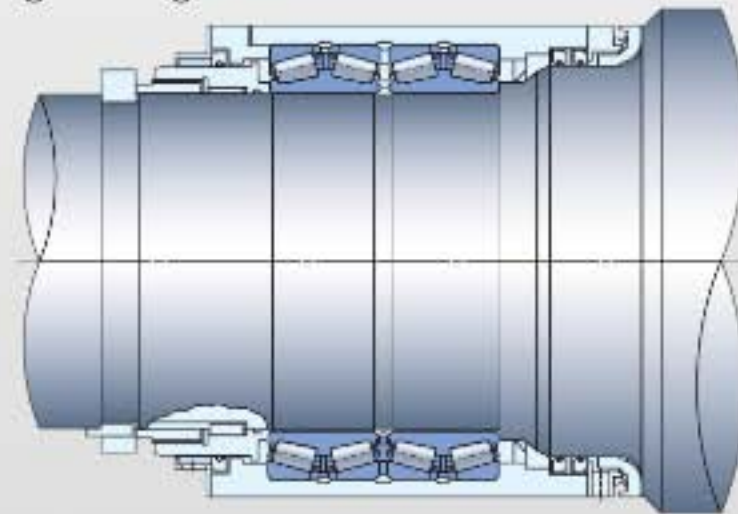


(2) Rolling bearing

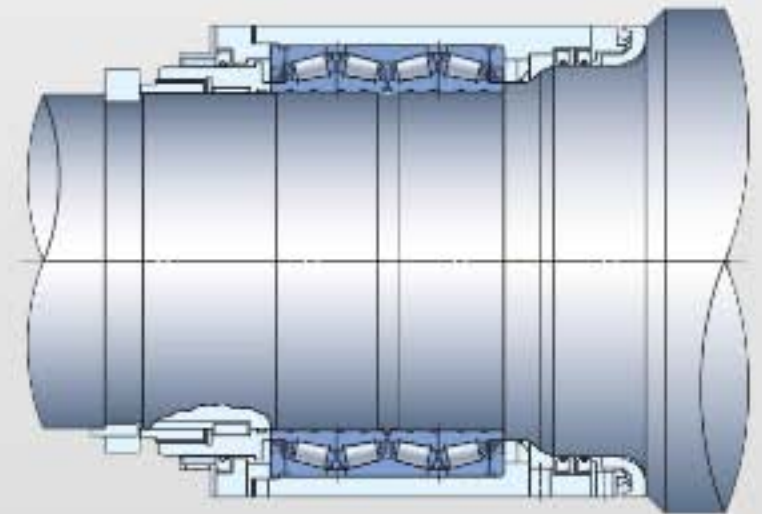
**Thrust roller bearings**

**4-row cylindrical roller bearings**

**4-row tapered roller bearings  
open type / sealed type**



(1) Open type four-row tapered roller bearing

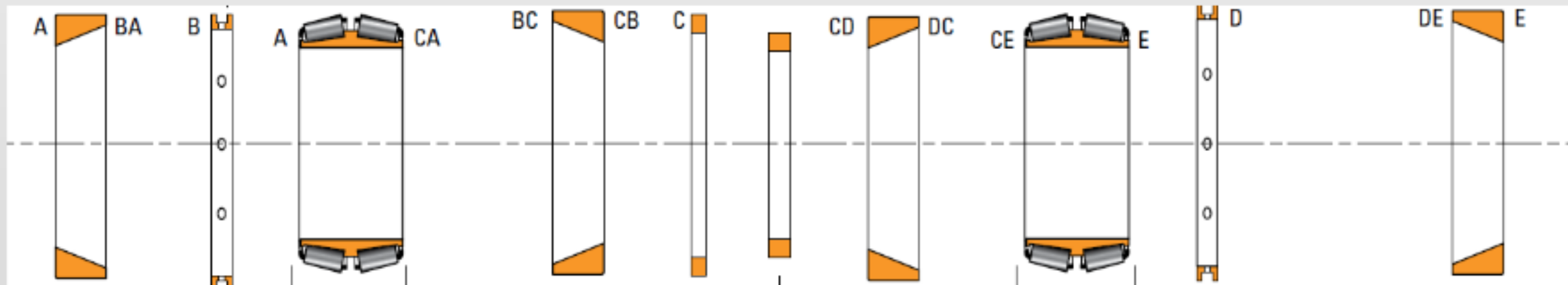
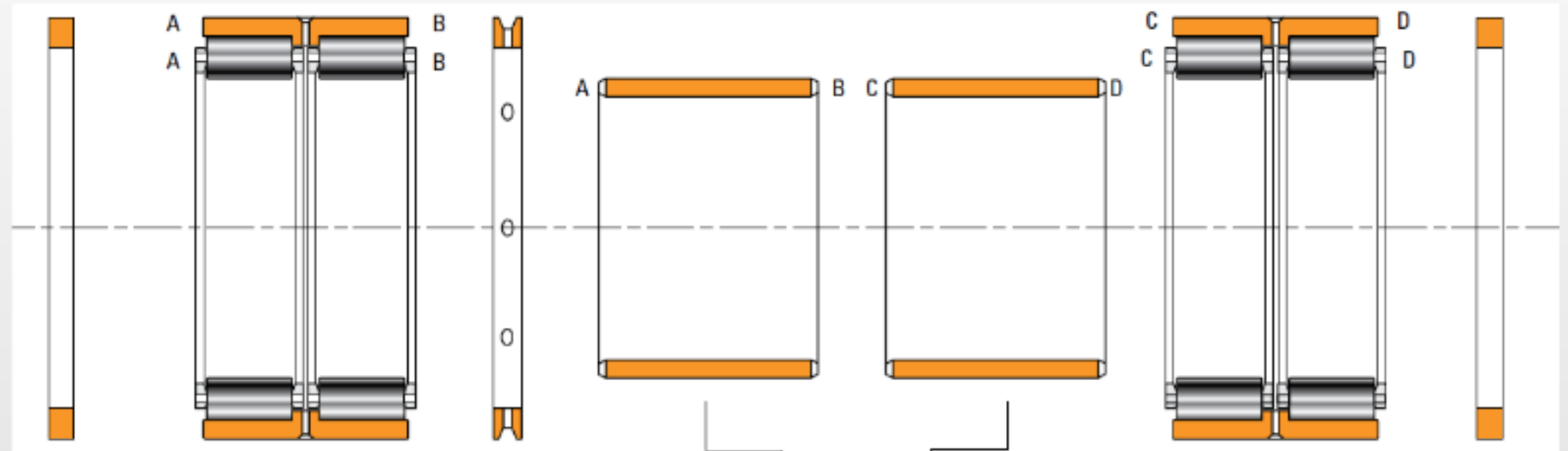


(2) Sealed four-row tapered roller bearing

# PARTS OF ROLL NECK BEARINGS

Rolling mill bearing is usually a bearing with multiple rollers under combined force. Multi rings and spacers work together to control the internal clearance. They are the most complex of the bearing categories.

**4-CR**



**4-TR**



# How to repair

The actual working life of many rolling mill bearings is very low. Maybe it is because one of the bearing parts is damaged. But other parts of the bearing are still strong. Customers want them to be reborn. It can also create more wealth.

But there are actually many rings and rollers that are not interchangeable. They have different dimensions or inconsistent contact angles. If they are swapped at will, it will have unimaginable consequences.

But bearing manufacturers have the ability to solve this problem. However, not all bearing manufacturers have the ability to repair bearings. Especially these special rolling mill bearings.



# Conditions for repairing rolling mill bearings

- Professional metallurgical bearing manufacturer.
- Extensive experience in materials, heat treatment and advanced manufacturing process.
- Advanced measuring instruments and powerful production equipment.  
(CMM, metallographic analyzer, hardness tester, roughness tester and various measuring tools)  
(Material, Forged, Heat treatment equipment, Lathe, grinder, superfinishing machine and machining center )
- Mature and perfect bearing repair process.



# Bearing Repair Eligibility

Although it offers many benefits, repair is not always the best option for a damaged bearing. The challenge of properly utilizing bearing repair services

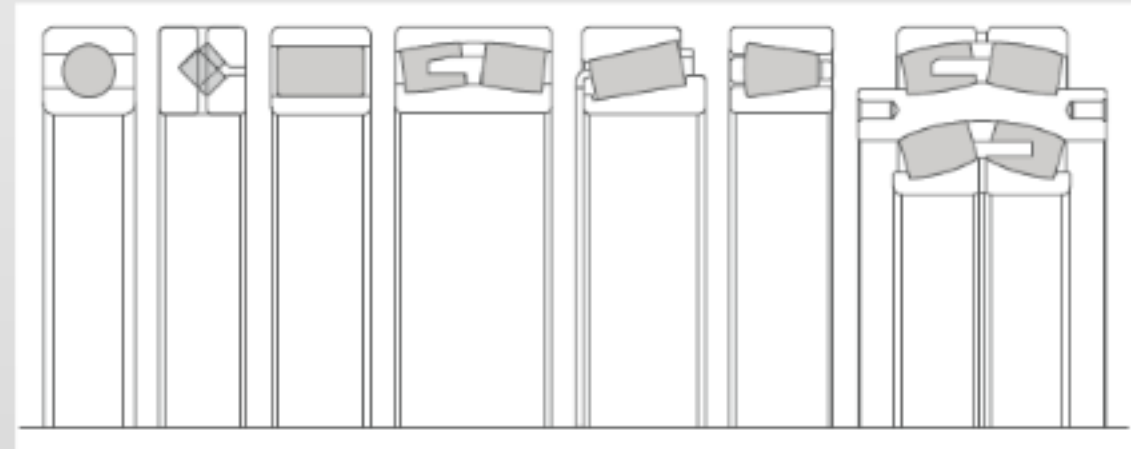
is determining if and when bearings need to be repaired and deciding which option is the best economical and long-term decision.

Depending on the repair facility, limitations exist on the minimum and maximum size of bearings and product types that can be repaired. There are many different types of repair suppliers, ranging from small facilities limited in their scope of work and knowledge to large bearing manufacturers with an unlimited range of products and services.

The scope of work also limits the size of bearing that can be repaired.

All bearing types are eligible for repair regardless of the original manufacturer, including:

- Ball bearings
- Class 3 precision bearings (all types)
- Cross roller bearings
- Cylindrical roller bearings
- Spherical roller bearings
- Tapered roller bearings
- Thrust bearings (all types)
- Triple-ring bearings



# Bearing Repair Eligibility

A critical step in any bearing repair program is to recognize potential problems through regular monitoring and inspection. Careful review of the output will help to identify the need for repair, such as:

- The bearing is nearing or has exceeded its suggested life expectancy
- Operating temperatures have exceeded 200° F
- Exposure to excessive vibration
- Sudden changes in lubrication and temperatures
- Emits excessive noise
- Loss of bearing seal integrity

Properly trained and experienced personnel involved in routine inspections serve as the first line in deciding if a bearing needs repair. Early detection of a problem through routine checks, preventive and predictive maintenance, and vibration analysis can reduce unnecessary downtime and expense, and help to capitalize on the capabilities and benefits of bearing repair.



# Remanufacturing Process

Once a product is returned to a repair service center, all bearings undergo a thorough cleaning process. Next, the bearing is disassembled. During disassembly, trained repair technicians will:

- Record the bearing information
- Record actual internal clearances
- Complete the disassembly and tag with unique identifiers

Next, a detailed inspection of all the bearing components is performed and findings are recorded. The initial inspection includes looking for major problems or damage, such as fractures, major spalling or bluing due to heat damage. These are indicators that the bearing may not be eligible for repair. Components also are examined to determine the scope of work required to return them to a like-new condition.

In addition, technicians measure the bore, O.D. and width of the bearing, as well as record the roundness of the major race components. The type and degree of damage determines whether it can be repaired and the appropriate method of repair. The level of detail supplied in this inspection report depends on the facility performing the work.



A wide range of repair services/methods are available. Depending on the facility capabilities and level of damage, some repairs can be performed onsite using existing personnel or a bearing manufacturer's service personnel (Fig 6). In general, onsite programs are suited for recertification or reconditioning processes, not for the remanufacturing process. Below is a detailed description of the repair service levels.

**Recertification (Type 1):** Bearing assemblies cleaned, examined, measured for verification of internal clearances, inspected, preserved and packaged. This process is used to recertify a bearing for service – generally applying to an unused product with an outdated shelf life.

**Reconditioning (Type 2):** Bearing assemblies cleaned, examined, polished, honed or tumbled to remove minor surface defects (primarily rust or corrosion), measured for verification of internal clearances, inspected, preserved and packaged.

**Remanufacturing (Type 3):** Bearing assemblies cleaned, examined, raceways reground, new roller sets and major components manufactured and replaced as required, internal clearances reset, inspected, preserved and packaged.

Regrounding raceways requires the manufacture of oversized rollers to compensate for the removed material and to maintain bearing geometry and clearance where radial internal clearance is critical. When lateral clearance is critical, oversized rollers, new spacers or additional shims are provided.

**Reclamation:** Typically used for bearings with a 3in. - 8in. I.D. (larger, economical quantities required). Bearing assemblies cleaned, polished using our proprietary vibratory process, inspected, preserved and packaged.

Once the proper repair choice is made and the process completed, the bearings are reassembled and packaged for storage and transportation. Generally, a final inspection is performed on the bearing to ensure that it meets the assembly criteria specified by the bearing design. Again it must be noted that different suppliers perform different levels of inspection and packaging. Bearing manufacturers that perform bearing repair often follow the same standards as with a new bearing.





# Types of Damage

The types of damage discovered during bearing repair vary significantly.

Damage may be evident in the form of visible corrosion, scuffs, stains and dents. Or, it may be barely noticeable, such as fine cracks or fractures that indicate the potential for more serious damage to occur (Fig 6).

Typical bearing damage falls into the following categories (see the Types of Bearing Damage sidebar for more detailed definitions):

- Chemical Damage: etching, stains, corrosion pitting, rust or fretting corrosion
- Heat Damage: discoloration or checks
- Electrical Damage: burns, fluting or pitting
- Mechanical Damage: fatigue flaking, cracks, spalling, fractures, nicks, peeling or smearing, brinelling, indentation, scoring, abrasive wear, installation damage, misalignment or lubrication failure

Most resource manuals describe the above types of damage and offer methods to help eliminate their causes. However, resource manuals often fail to mention that, with the exceptions of torch heat damage, extreme spalling, fractures and heavy etching, most damage conditions are repairable.

Therefore, it's recommended to contact a bearing service technician to provide a damage assessment and determine the feasibility of a repair.

# Types of Bearing Damage

1. The variety of damage encountered during bearing repair service includes:
2. Brinelling: Permanent deformation (displaced metal, not just wear) of bearing surfaces at roller/raceway contact areas caused by excessive load or impact
3. Corrosion/Etching: Chemical action (rust) that attacks bearing component surfaces
4. Cracking/Fracturing: Significant visible surface cracks; usually caused by abuse or unusual operating conditions
5. Debris Denting: Localized surface depressions caused by debris or foreign material
6. Fretting: Usually shows up in red or black oxides of iron occurring under close-fit conditions; also called friction oxidation
7. Heat Checks: Surface cracks caused by heat from sliding contact; usually formed in direction of motion
8. Scuffing: Smearing, scoring or galling as a result of removed and transferred metal from one bearing component to another due to sliding contact
9. Staining: Surface discoloration without pitting, such as from oil oxidation
10. Spalling: Breaking away of metal on raceway or rolling element in flakes or scale-like particles; also called flaking, fine grain or coarse grain spalling
11. Wear: Contact surface degraded and worn away by mechanical action in use

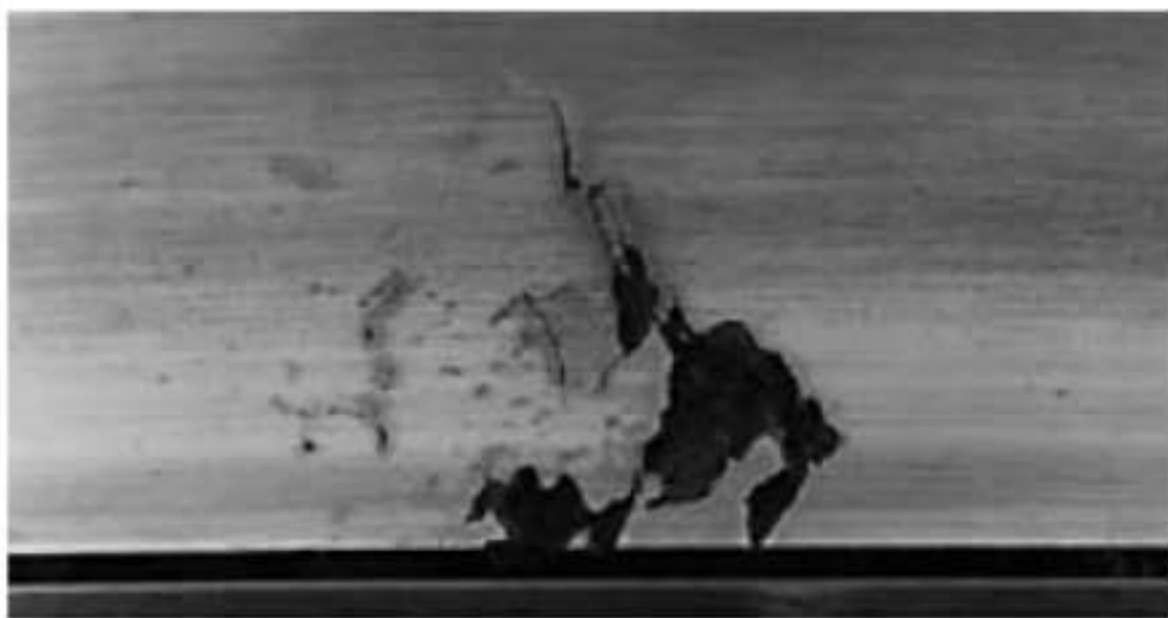




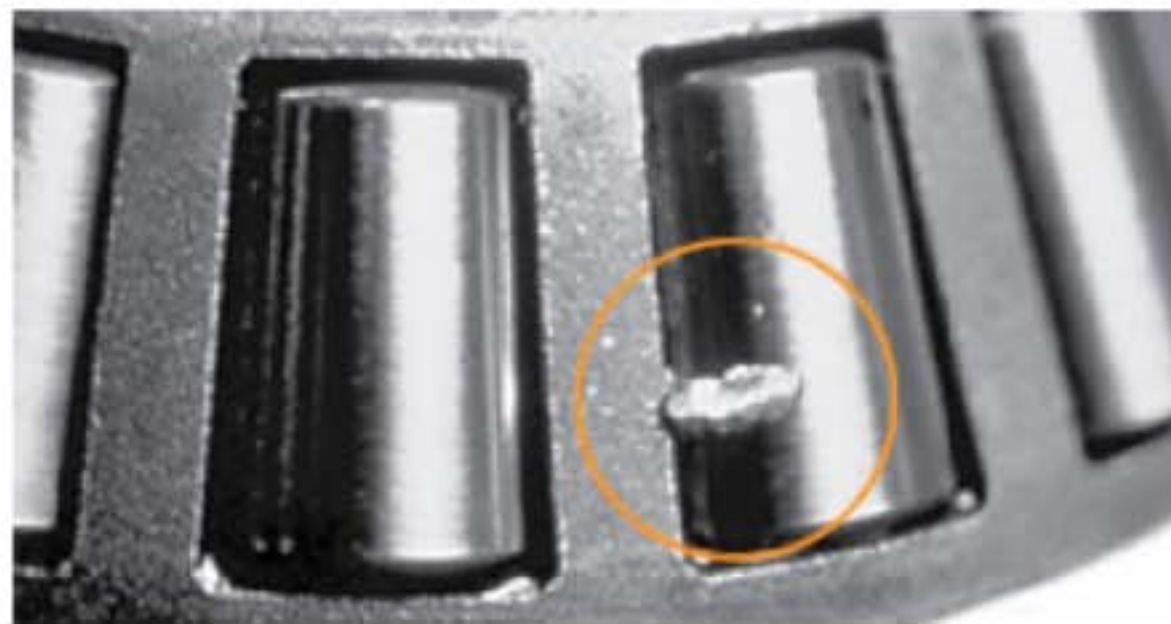
**Brinelling**



**Debris Denting**



**Spalling**



**Wear**

# Repair Limitations

Although bearing repair has proven to be a cost-effective solution, like any service, it is subject to limitations.

Bearings can be repaired, often more than once, but not indefinitely. A general rule of thumb is that bearings should not have more than three regrinds. Regrinding removes surface material, so it needs to be done carefully.

If done correctly, repaired bearings offer like-new performance. However, it is important to recognize and understand how repair options address damage modes. For example, polishing can address a variety of damage modes but is not effective for the removal of debris indentations or wear. Therefore, in such cases, do not expect like-new performance if the bearing is only polished since that does not repair all damage.

It is recommended to consult with a bearing manufacturer representative and/or application engineer to help determine the cause, extent and suggested repair of the damage. It also is critical to have any bearing repair performed by properly trained and experienced personnel because unnecessary repairs can lead to additional damage and limited bearing life. Common repair mistakes include:

- Improper polishing techniques that cause changes to geometry and/or profiles that do not correct worn geometry and contact conditions
- Improper grinding techniques and processes that can cause surface cracks and damage or improper geometry and/or profiles
- Mixing of preset components
- Improper profile, internal geometry, finishes and clearance settings that can cause bearing failure. In addition to expertise, proper equipment is required to fix the problem and ensure damage has been reviewed and properly removed. The appropriate measuring equipment, such as laser tracing and profiling equipment, CMM and precise measuring machines, are essential to perform thorough inspections on repaired product.

## Case for bearing repair



The outer race of a spherical roller bearing in need of bearing remanufacture.



The outer race of a large spherical roller bearing after remanufacture, which includes the process of removing aggressive surface damage by using a grinding or hard-turning process.





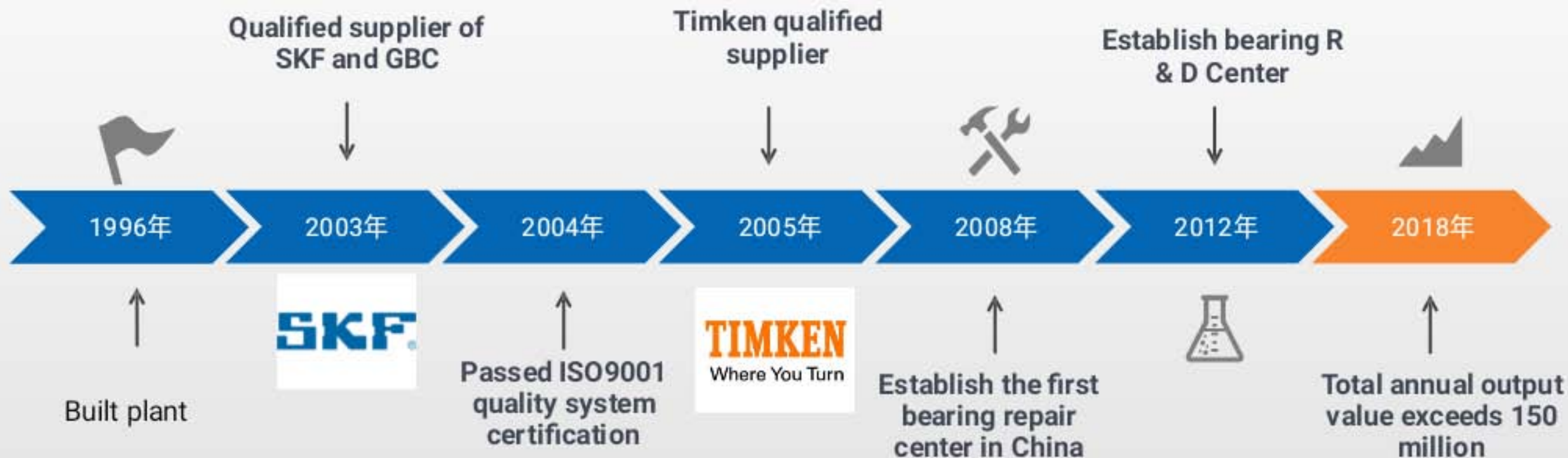
# Our remanufacturing capability



Our FV rolling mill bearing manufacturing plant is located in Dalian, a heavy industry base in Northeast China. Many world famous bearing brands have set up factories here. It is the headquarters of Anshan Iron and Steel Group, Northeast Special Steel Group. Chinese bearings have a manufacturing history of more than 70 years. Although it can't be compared with a century old enterprise like SKF. But the manufacturing of Chinese bearings integrates the cash technology of many world famous brands. The quality of bearings has ranked the second echelon in the world. Best value for money.



# Experience





# Company profile

FV is a rolling mill bearing repair and remanufacturing factory certified and authorized by Anshan (Timken) Industrial Service Corp in north of China. And we OEM part of Timken's bearings.

- Plant area: 120000 square meters
- Workshop area: 40000 square meters.
- Qty of main workshops: 8
- Total number of employees: 350
- Total assets: 280 million RMB
- Maximum capacity: 20 million pcss / year (Dim  $\approx$  350mm)
- Manufacturing category: all kinds of ball and roller bearings, some metallurgical accessories. 100mm  $\leq$  diameter  $\leq$  2m
  
- Domestic / export ratio: 5:1





# Workshop profile

Equipment disassembled - Workshop

In China. We can provide the whole process. Because we have large heating and freezing equipment. So we can help customers remove the bearing from the heavy equipment. Many bearings are installed with interference fit. Operation here can minimize the damage to the equipment.



Dismantle the bearings of cement grinding roller.



# Workshop profile

Bearing disassembled - Workshop

The main work of this workshop includes:  
Clean, Disassemble, Mark, Inspects and Store parts temporarily.

Workers and inspectors will summarize the physical examination report to the technical department. Then the technical department makes the overhaul plan.



Dismantle the bearings



# Workshop profile

Vehicle processing - Workshop

CNC Turning and grinding precision production line





# Workshop profile

Vehicle processing - Workshop

6 heat treatment lines  
(annealing, carburizing, quenching, tempering)





# Workshop profile

Superfine Grinding process- Workshop

Super precision is an indispensable process in the production of high-precision bearings. High rotation accuracy and excellent surface roughness can improve the working life of the bearing.



0.6m ~ 1.8m CNC vertical mill production line



# Workshop profile

Timken , GBC - OEM Workshop

Such as: AP - bearings , CJ spherical roller bearings, CCM & CSP roll bearings , long producton mill bearing and railway bearing accessories.





# Workshop profile

## Bearing assembly - Workshop

Main work: demagnetization, cleaning, final inspection, marking, matching assembly and rust prevention.





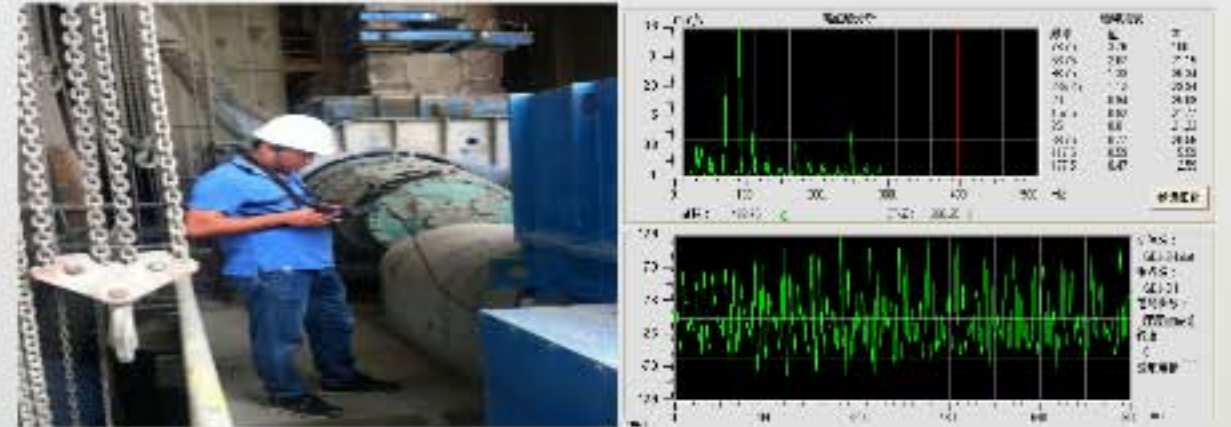
# Packing & Storage





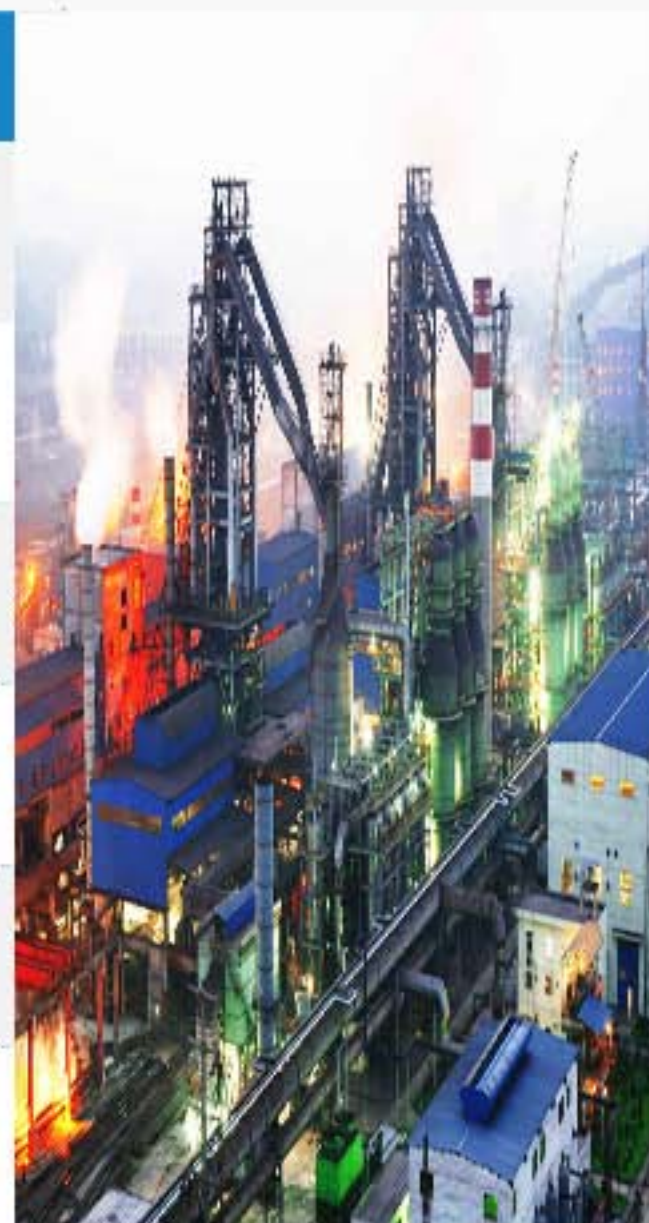
# Perfect quality and after-sales service system

- Establish customer basic information file;
- Establish customer's unique product traceability file;
- Establish the data tracking of the repaired bearing;
- Archive database management of new products and repaired products;
- According to the needs of customers, offline detection of repair products can be carried out, and online detection can be carried out regularly according to the plan.



## Repair cases in China ( STEEL INDUSTRIES )

客户名称	原轴承厂家	维修项目
西南不锈钢	<b>SKF</b>	380671HC/3706/305X4/HCC9YAB
柳州银海铝业	<b>TIMKEN</b> Where You Turn	M66794DW/3706/519X4
广西南南铝	<b>TIMKEN</b> Where You Turn	M272449DGW/272410/M272410D
东北轻合金	<b>TIMKEN</b> Where You Turn	AAAG910-912
燕山钢铁	<b>TIMKEN</b> Where You Turn	NA6915/NA6917/24026 24024/24030/23220/24132
攀钢集团	<b>NSK</b>	STF690RV9812DgAS8CR460P5AU1 400KDH6502DGCS8SCU1





# Repair cases in China ( STEEL INDUSTRIES )

客户名称	原轴承厂家	维修项目
莱钢集团	<b>NSK</b>	22311/24022/24030
日照钢铁	<b>TIMKEN</b> Where You Turn	24024/24020/M260149DW/10
淮南钢管	<b>SKF</b>	F3131G
山西建龙	<b>TIMKEN</b> Where You Turn	EE755280DGW
鞍钢集团	<b>TIMKEN</b> Where You Turn	277TQS9801GF4
本钢集团	<b>NSK</b>	310KVS4302EGS3



# Main domestic customers ( STEEL INDUSTRIES )





# FV explores overseas

FV has sales and service offices in Turkey and India. We will actively serve the Belt and Road countries for many years to come. The Indian market is our most loyal market. We hope overseas friends know and trust FV bearing.



Exported countries: India, Turkey, Austria, America, Italy, Russia, France, Thailand, Vietnam, Philippines. Egypt. Jordan. Iran, Saudi Arabia. Algeria. Libya. Australia. Brazil, etc.





# Conclusion

If you are interested in this kind of cooperation,  
please contact our Indian sales engineer.  
Perhaps this new type of cooperation will become  
possible.





**Explanation is over !**

**Thank you very much!**

