The Original

GALPERTI®

TECH SRL

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FORGING PLANT
Lago di Como
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Mandello del Lario
Lugano
LECCO
COMO
Calolziocorte
SS36
Brivio
BERGAMO
Merate
ORIO AL SERIO
A9
Seregno
Varese
A4
Venezia
A8
Saronno
SS36
Cinisello
Balsamo
MONZA
A4
MALPENSA
A4
Torino
MILANO
LINATE
A7
Genova
A1
Bologna
TRENTINO ALTO ADIGE
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VENETO
LOMBARDIA
Milano
PIEMONTE
LIGURIA
EMILIA ROMAGNA
TOSCANA
MARCHE
UMBRIA
LAZIO
ABRUZZO
MOLISE
CAMPANIA
PUGLIA
BASILICATA
SARDEGNA
CALABRIA
SICILIA

Contents

Bearing Applications

Galperti Tech is a subsidiary of Galperti Group. Galperti Group has successfully operated for many years in the petrochemical and energy industries. Galperti Tech manufactures large diameter ball and roller bearings utilized in many applications such as:

Harbor cranes

Harbor cranes

Wind turbines

Forest machines

Solar generators


Bucket wheels


Stacker reclaimers

- Access platforms
- Antennas
- Amusement rides
- Bogie bearing for vehicles
- Boom conveyor
- Bottle filling machines
- Bridge cranes
- Canning and bottling machines
- Crane-hook rotators
- Concrete pumps
- Deck cranes
- Deck winches
- Defense applications
- Dragline
- Earth-drilling machines
- Excavators
- Floating cranes
- Forklift equipment
- Harbor cranes
- Ladle cars
- Manipulators
- Mobile cranes
- Moorings
- Offshore cranes
- Packaging machines
- Plastic film extruders and winders
- Railway cranes
- Rotable trolleys
- Reclaimers
- Robots
- Scrapers
- Shiploaders/-unloaders
- Shipyard cranes
- Swivel
- Stackers
- Steel mill equipment
- Tower cranes
- Tunnel boring machines
- Turntables
- Water treatment
- Welding positioners
- Etc.

Product and Processes Information

Galperti Tech manufactures excellence in large diameter slew bearings. Excellence is met using state of the art design, manufacturing and testing methods, maximizing the value of the experienced senior engineers knowledge and the most reliable calculation methods. Design verification is performed with the newest CAD/CAM design tools and FEA analysis programs. A fully integrated server based computerized system allows manufacturing control on all manufacturing phases, supply chain survey and project management.

Different applications and requirements ask customized solutions for slew bearings. This means different rolling bodies sizes and types and their combination, different rolling bodies races paths and design. Inner or outer gears, no gear, may be required as well. Galperti Tech manufacturing capability to manufacture slew bearings with the mentioned customized solutions dimensionally ranges from 250 mm minimum to 6.200 mm maximum outer diameter.

Manufacturing Process

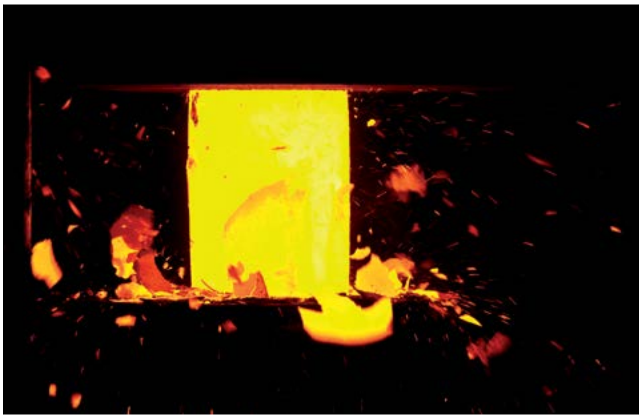
Galperti Tech benefits largely being a subsidiary of Galperti Group. This means that a vertical integrated process allows in house processes of manufacturing with full control sourcing only the steel heats or ingots from selected European Steel Mills, plus consumables.

Forging Process

Material sourcing

Steel cutting

Heating



Die press

Rolling

Heat Treating Process

Furnace heating

Water based polymer quenching

Material Certifications

Certain application as, for instance Marine Applications may require stricter certification of the product, including material certification of tensile strength and impact test values performed on specimen taken from the rolled and heat treated rings, with witnessing inspectors of Certification Bodies, e.g. Lloyds Register, DNV, BV, TÜV, API, etc. Galperti Group Laboratory can perform characterization tests on materials.

Tensile strength

Charpy Test

Spectrographic test

The following certificates and test reports are available on demand:

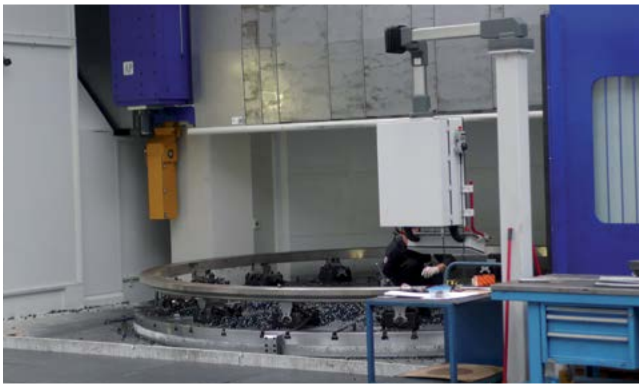
- Ring-Material Certificate: Chemical Composition and Physical Properties certificate of Heat Treatment
- Ultrasonic Test
- Magnetic particle Inspection
- Hardness Test
- Torque Test Record
- Certificate of Compliance: Toleranced dia., Total Height, Position of Holes, Axial Clearance, Radial Clearance, Axial Runout, Radial Runout
- Mechanical Tests on Bearing Rings: Tensile Strength Test, Impact Notch Test.

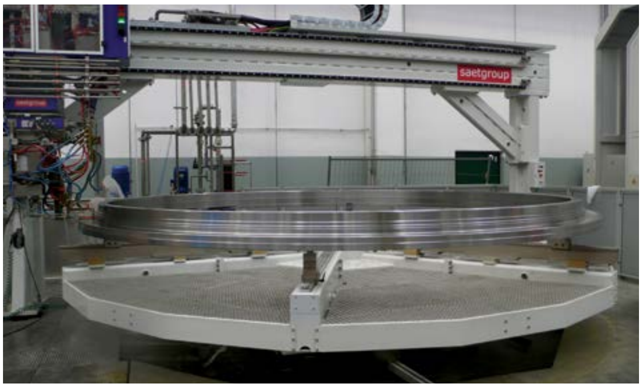
For further Test Certificate, please refer to Galperti Tech Design and Quality Department.

Machining Process

A slew bearing includes the following main elements:

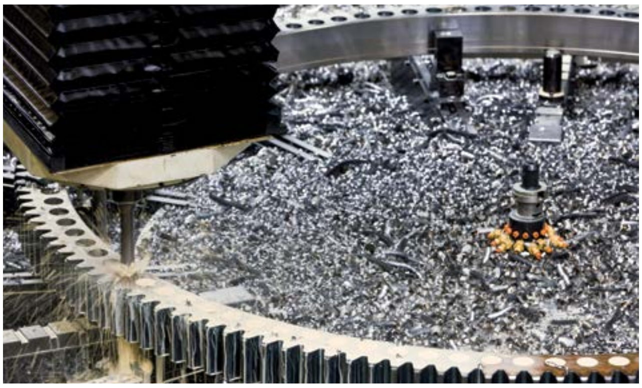
- Inner ring, shaped in turning operation from a forged ring
- Outer ring, shaped in turning operation from a forged ring
- Drills for grease zercs and lubricant refill
- Integral inner or outer gear cut by gear cutting process
- Drills for fasteners (thru or tapped)
- Drills for filler plug(s) and filler plug(s)
- Balls and/or rollers added during the assembling process
- Polymer based spacers or polymer/metal cages added during the assembling process
- Rubber based sealing systems added during the assembling process

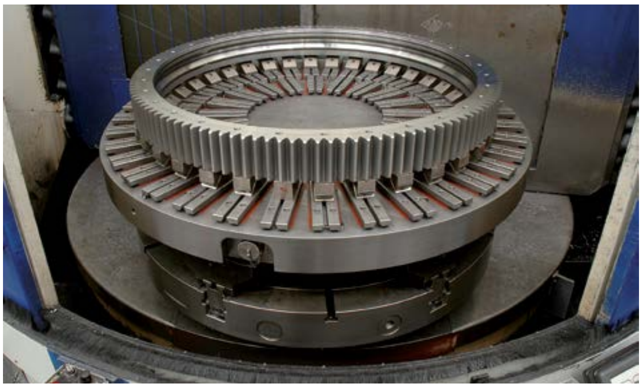

Turning



Induction hardening


Gear cutting

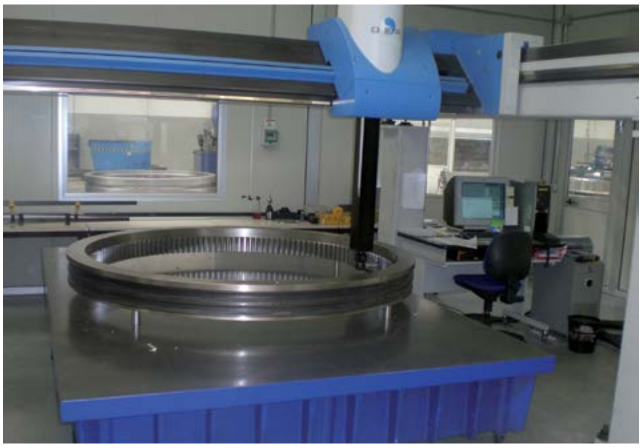

Drilling


Hard turning

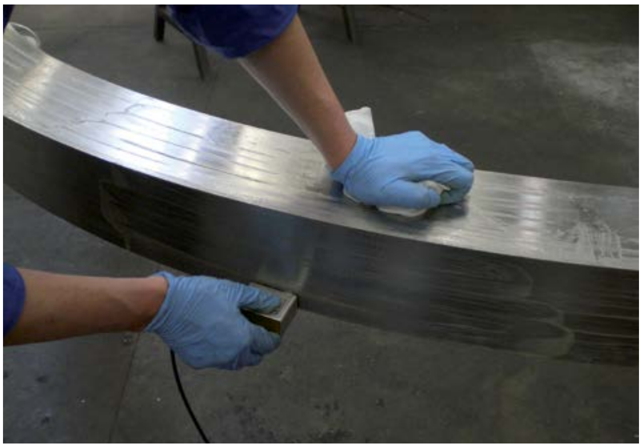

Grind finishing

Quality Verifications

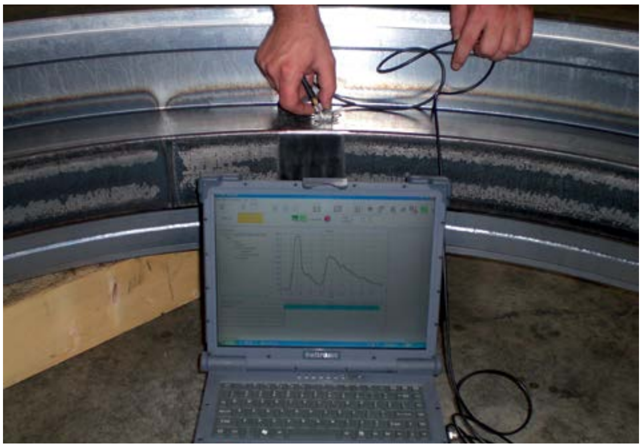
Magnetic particle crack check



Dimensional verification



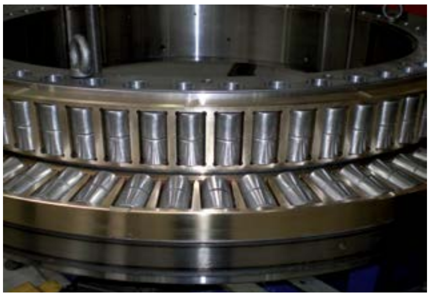
Ultrasonic material defect test



Ultrasonic induction hardening depth verification

Surface hardness test

Assembling and Testing



Galperti Tech inspects 100% of the manufactured bearing for functionality. If the performance doesn't meet the performance as designed, the manufacturing process is reassessed and the affected products are identified, removed and segregated.

Coating & Painting

Zinc coating and paint automatic transfer machine

Automatic paint

Automatic zinc coating

Manual zinc coating

Manual paint

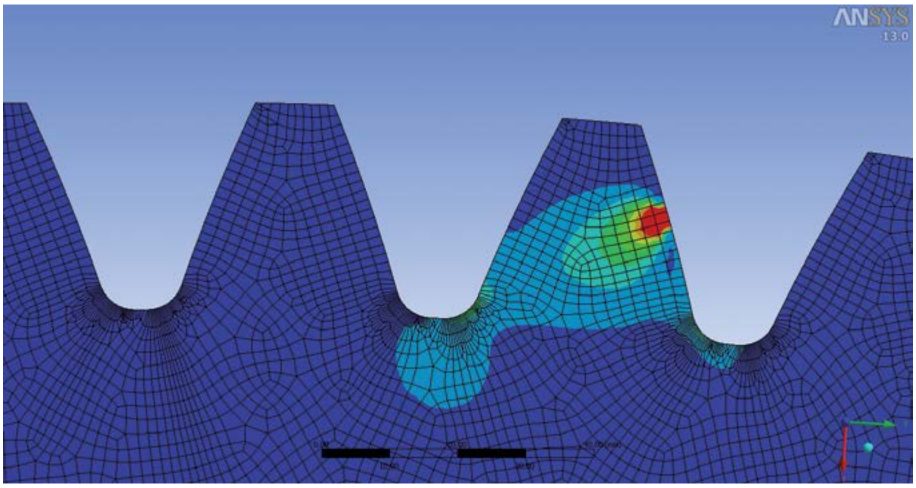
Packing & Delivering

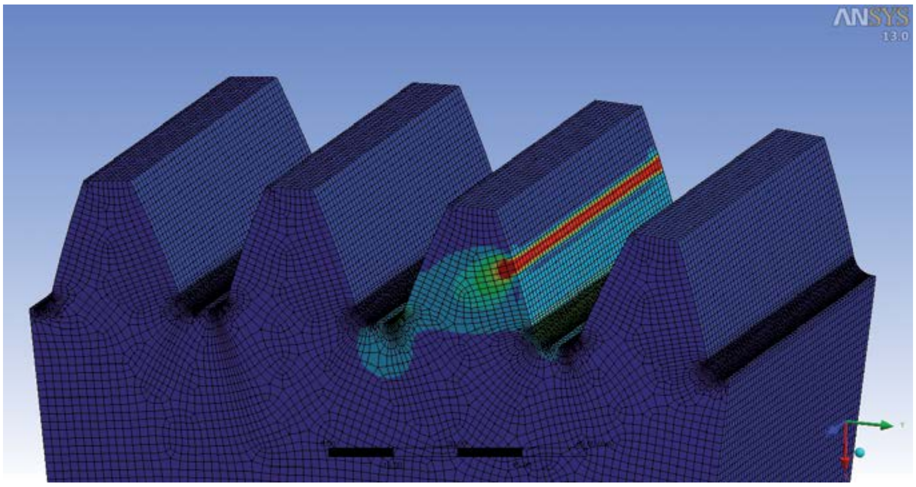
Wrapping

Delivery area

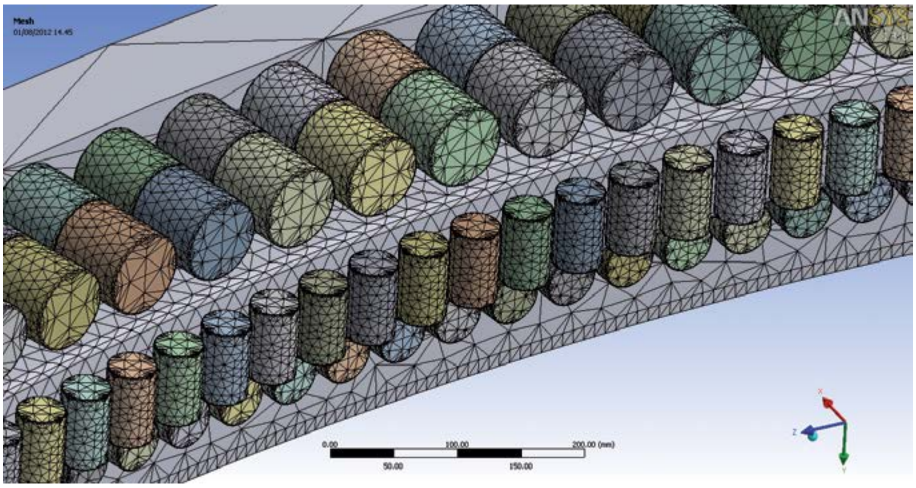
Bearing Design

Galperti Tech has internal design capability. Design can be performed on customized existing product or new product. The design phase allows Galperti Tech to calculate the performance of each and every slew bearing giving the customer the evidence to that the bearing can keep the requested loads and moments, meet the requested torque value and lifetime. Said calculations apply to the slew bearing ball or roller type raceway and to the teeth of the gear.

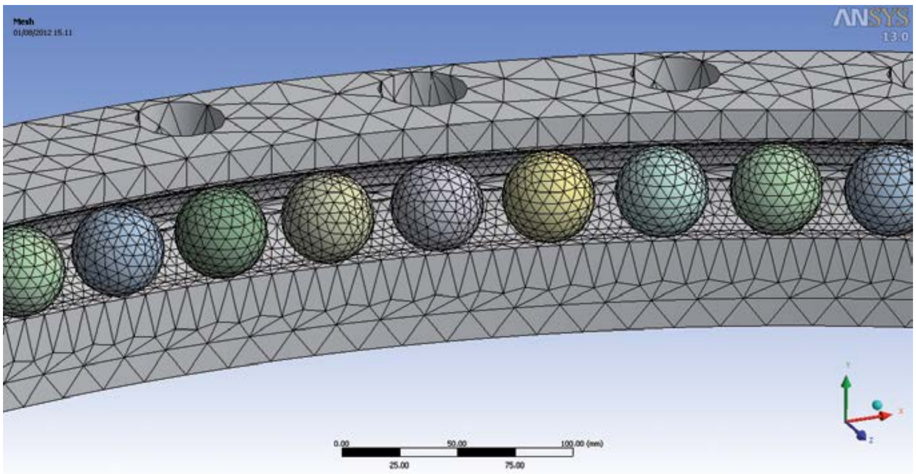


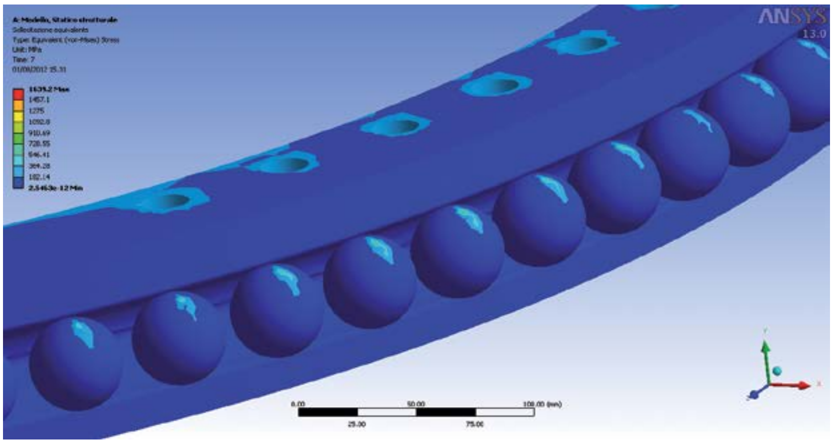


CAD generated drawings illustrate the slew bearing lay-out and summarize the main parameter and information of the slew bearing.
Galperti Tech design requires input data to allow proper dimensioning of the mechanical parts and heat treatment processes parameters determination. A Questionnaire is therefore needed to collect all the data the Customer can fill in. Subsequently to the completeness of the supplied data and its level of confidence, Galperti Tech will be able to process the design phase prior to build the slew bearing.
Galperti Tech technicians can apply conventional load and stress calculation methods thru empirical formulas.

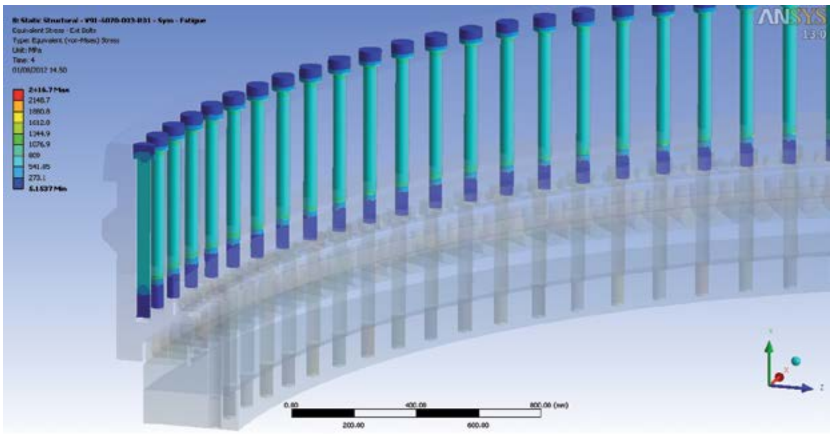


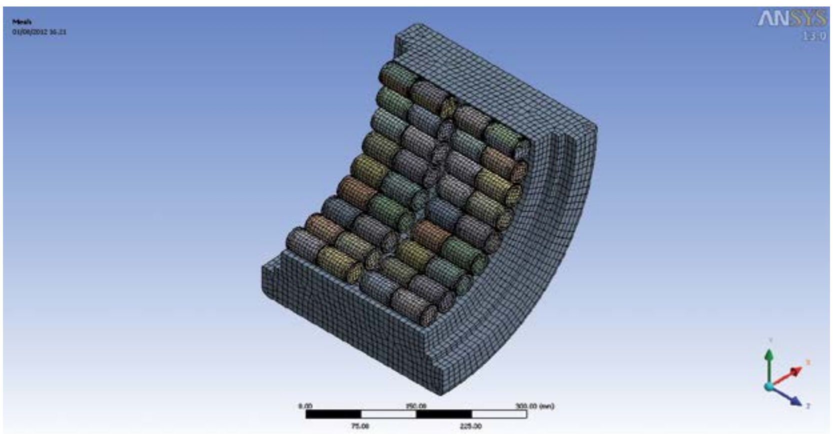
The raceway design determines the load capacity of the slew bearing so that all raceways are induction hardened. Scan induction hardening process leaves a "soft spot" which is where the junction from the induction harden start and stop pattern is. For more information regarding the soft spot topic, please see para. "Hardness Gap" at page 42.

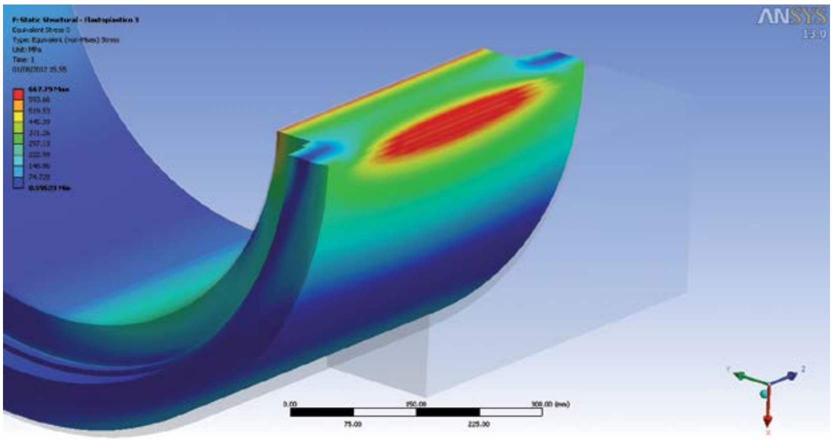


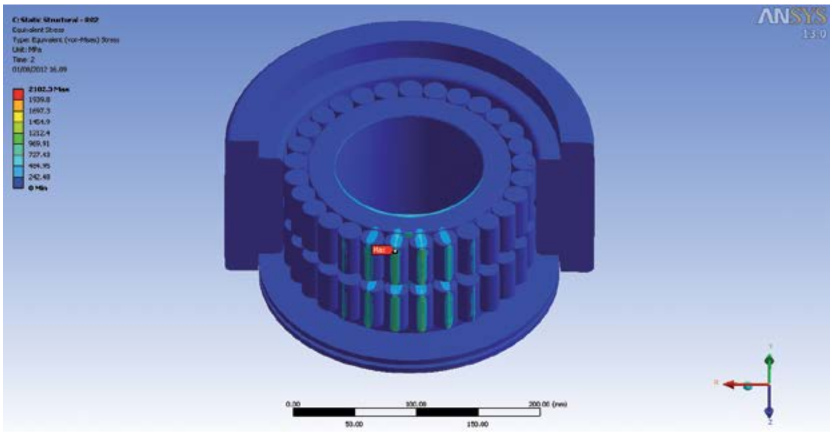


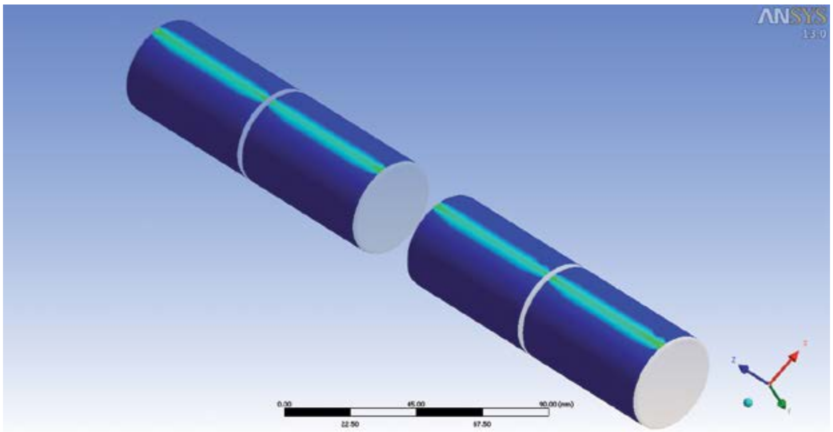
In some circumstances or upon request of the customer specification, Finite Element Analysis can be performed. This occurring, a section or the full 3D model of the slew bearing will be divided by a mesh, boundary conditions will be imposed and the loads or soliciting stresses will be applied.
The FEA calculation will show the stresses and strain response of the slew bearing to the inputed loads in a specific assembly and bolting condition.



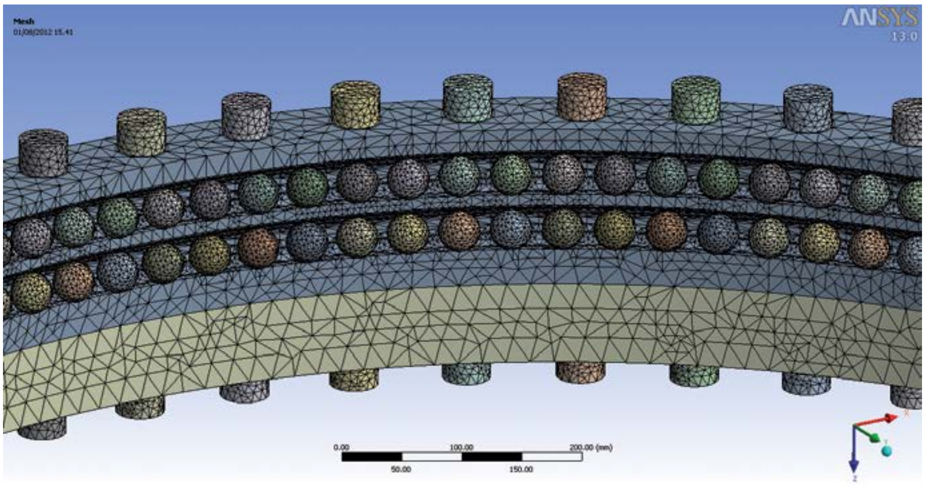


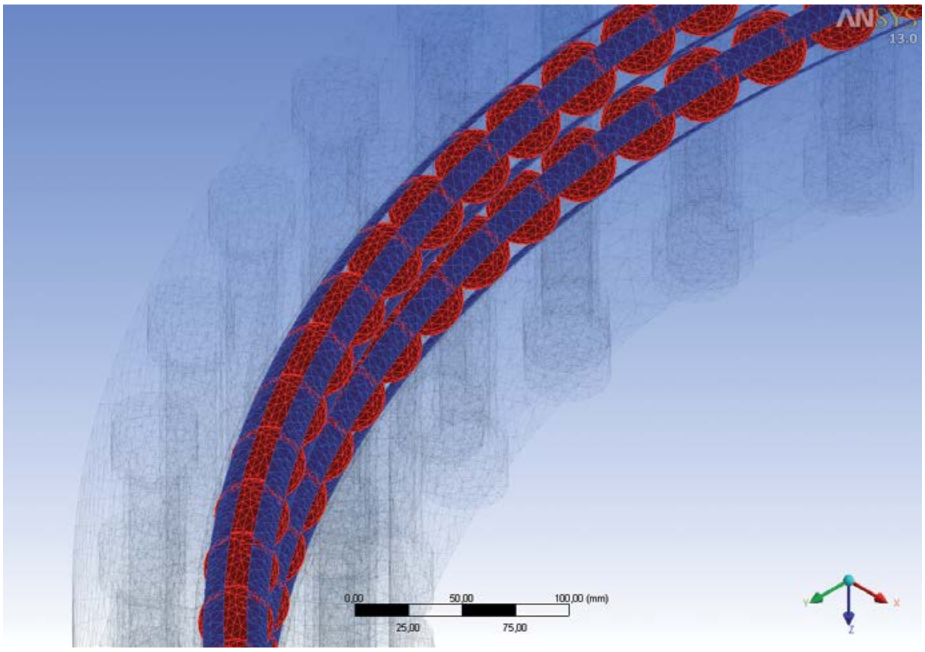

ANSYS
Unit: MPa


ANSYS


ANSYS

To allow proper design verification, a full set of input data is needed. These can be supplied filling with the requested data the questionnaire you can find in the following page.





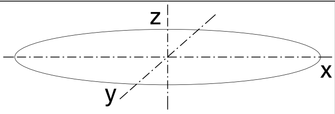
QUESTIONNAIRE

Galperti Tech
Via Prati della Rosa, 30 - 23823 COLICO (LC) - ITALIA
Tel. +39 0341 930 186 - Fax +39 0341 930 252

Application:	Axial loads on bolts under: Compression ☐ Tension ☐

External gear ☐	Axis of rotation: ☐	Slewing ☐	No. of revolutions
Internal gear ☐	Horizontal ☐	Continuos	Norm.: rpm
Without gear ☐	Vertical ☐	Rotating ☐	Max.: rpm

Max. bearing loads, please inform us when factors are already included!

	1 max. operating loads	2 test load (overload condition)	3 survival loads (e.g. shocks)
Axial loads parallel to z-axis kN			
Radial loads parallel to x-axis kN			
Radial loads parallel to y-axis kN			
Res. moments from axial loads kNm			
Res. moments from radial loads kNm			
Resulting moment kNm			

Variable operating loads, required lifetime: Hours ☐ Cycles ☐

loadcaste	F axial kN	Resulting F radial kN	Resulting M tilting kNm	Rpm min^{-1}	% of time	No. of cycles	Slewing angle per cycle
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Drive torque at the bearing center line: Norm: kNm, Max.: kNm	No. of pinions: Position of pinions: Grad

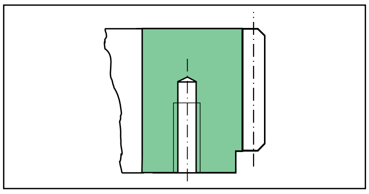
Remarks: Max operational temperature, min operational temperature, min idle temperature, required accuracies, bearing or gear dimensions, certifications etc.

Company:	**Name:**	**Date:**

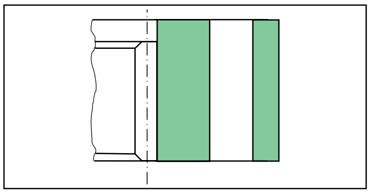
Bearing Types

Galperti Tech technical capability allows to manufacture different types and configurations of slew bearings and geared rings. More types are available or can be developed on demand. Galperti Tech mainly manufactured types are the following:

Geared rings

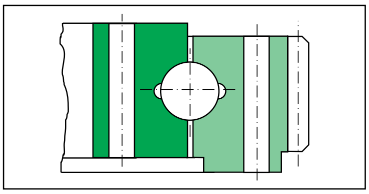


V51.----

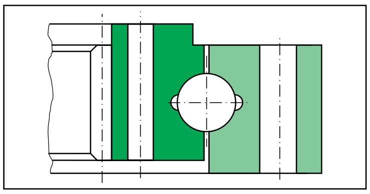


V52.----

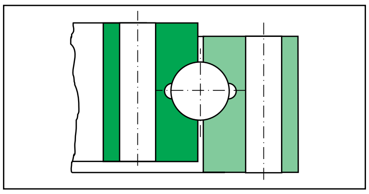
Four-point contact bearings



V41.----

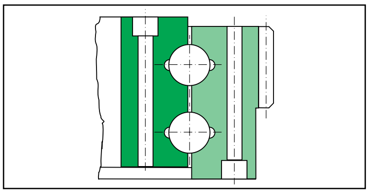


V42.----

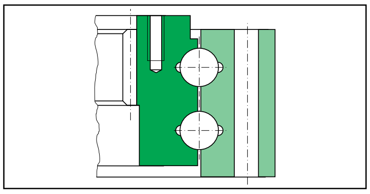


V43.----

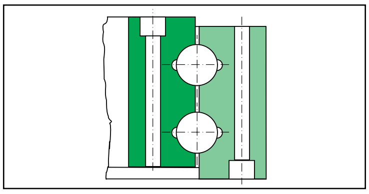
Eight-point contact bearings



V81.----

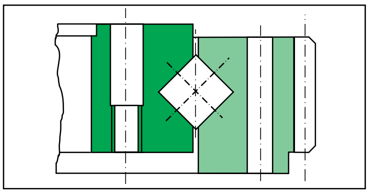


V82.----

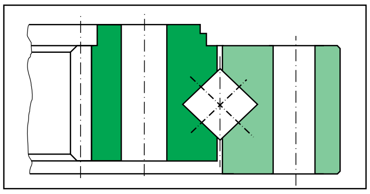


V83.----

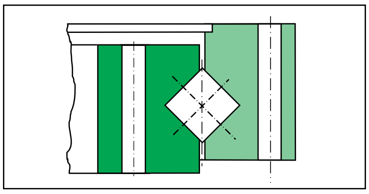
Cross-roller bearings



V01.----

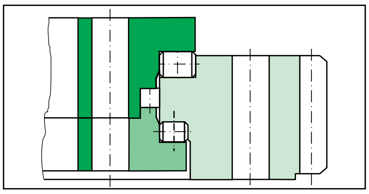


V02.----

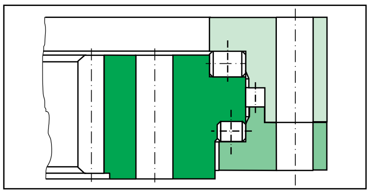


V03.----

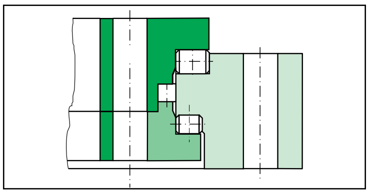
3-Row roller bearing



V91.----

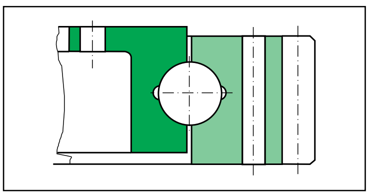


V92.----

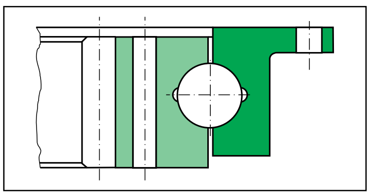


V93.----

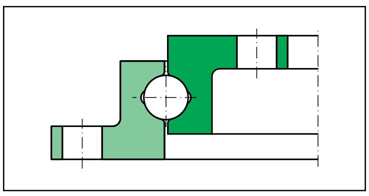
Profile Bearings



V11.----



V12.----



V13.----

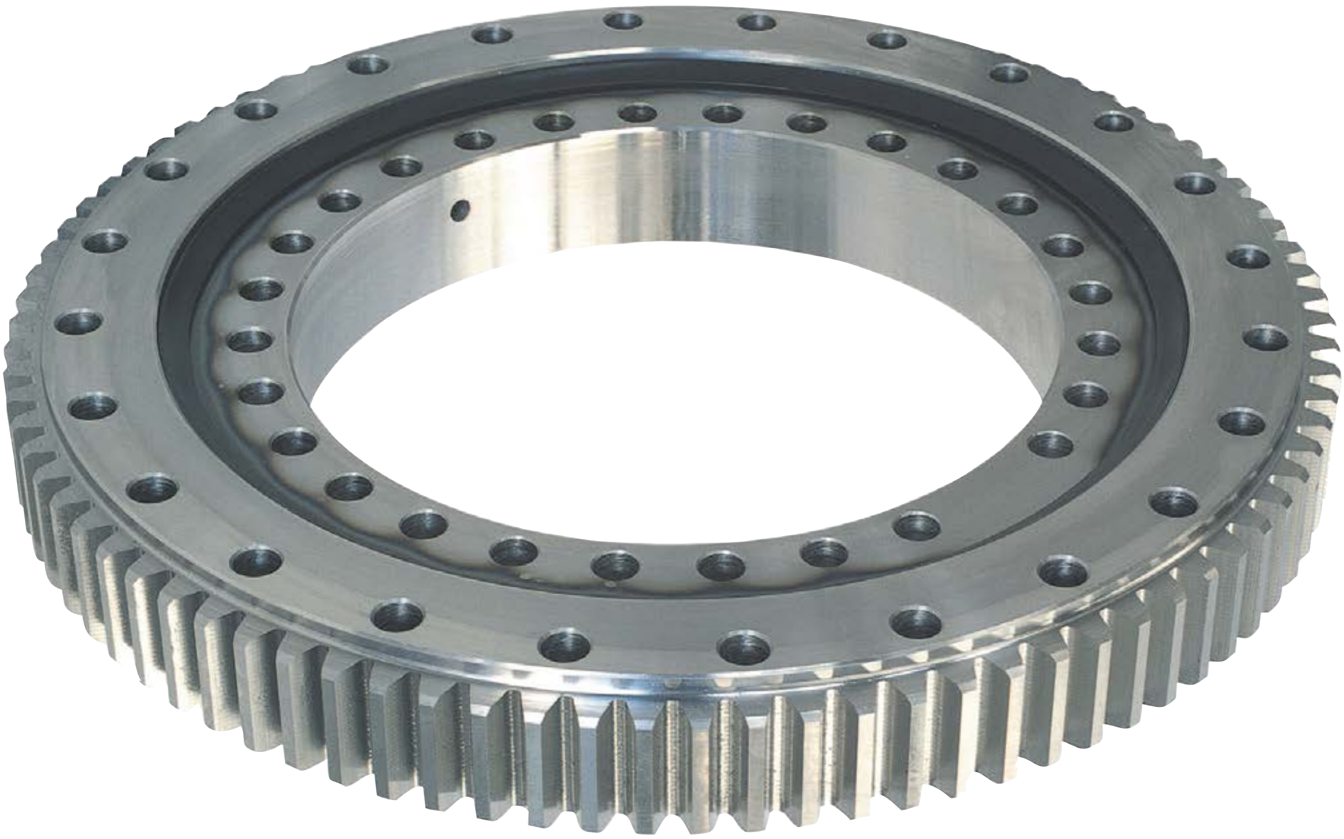
We also design other bearing types for special applications

Product Identification

Galperti Tech manufactured slew bearings are all identified with an ID plate. The ID plate is showing the main data that allow to identify each manufactured bearing and keep traceability of the individual bearing through its life.
The ID plate shows:

Bearing type - drawing number
Manufacturing date
Galperti Tech job number
Serial number

GALPERTI TECH S.R.L.
tel. +39 0341 930 186 fax +39 0341 930 252
galptech@galptech.com
V 41 0654 008 21 35 0520
SERIAL NR. 08/_ _ _ _ YEAR 2008
PAG. / POS. ------/--- WEIGHT 103 Kg
MADE IN ITALY



The drawing number identifies the type of bearing and is a manufacturer code.
The manufacturing date refers to the date of the slew bearing finishing after successful testing.
The serial number identifies the single bearing and includes the batch and year and individual numbering.

Drawing Number

All information regarding the slew bearing are in the drawing, so referring to it during all communications keeps the information flow easy and quick, either in the manufacturing or in the service phase of the slew bearing life.

The drawing number coding main details are in the following coding sketch

V4	1	0434	000	0	1	20	0434
PRODUCT FAMILY:	GEAR:	OUTER DIAMETER: [mm]	INDEX:	STATUS:	PLAYS:	ROLLER/BALL DIAMETER: [mm]	ROLLING DIAMETER: [mm]
V0 Roller **V1** Profile **V4** Single row of balls **V5** Geared rim **V7** Combined ball/roller **V8** Dual row of balls **V9** Three rows of rollers	**1** External gear **2** Internal gear **3** No gear			**0** Development **1** Prototype **2** Production **3** Spare part	**1** Normal **2** Reduced play **3** No play **4** Pre-loaded	**16** = Ball/roller D16.00 **18** = Roller D18.00 **20** = Ball/roller D20.00 **22** = Ball D22.00 **25** = Ball/roller D25.00 **30** = Ball D30.00 **32** = Ball/roller D32.00 **35** = Ball D35.00 **36** = Ball/roller D36.00 **40** = Ball/roller D40.00 **45** = Ball D45.00 **50** = Ball/roller D50.00 **60** = Ball/roller D60.00 **70** = Ball/roller D70.00 **80** = Ball D80.00	

NOTE
The information regarding the rolling bodies and raceway diameters is needed to determine the service life

Bearing Selection

The selection of a slew bearing is dictated by the working condition loads. These must be compared to the load curves for static load capacity of the raceway and the fastening bolts of the slew bearing under analysis. The load limit curves circumscribe the area of the permitted combinations of axial loads Fa and tilting moments M_{tilt}.
Please consider the following general rules:

1. Radial forces can be neglected only if < 0.1 times of the axial loads;
2. The loads must be positive with the configuration shown in Fig.1 and Fig.2 of this page, to be in valid conditions for the load curves;
3. Bolt curves are valid for a specified number of bolts and bolt quality grade 10.9 (see fig. 3).

In case one of the conditions is not met or the radial forces are such that cannot be neglected or the loads are negative or the number of bolts or their grade is insufficient, please refer to Galperti Tech, prior to make a decision.
To get the effective operational loads, the nominal loads, static or dynamic, must be multiplied by the static load factor F_{stat} and the dynamic load factor F_{dyn}. The resulting loads F_A and M_{tilt} determine a load configuration point on the load curve graph, which must be inside the area circumscribed by the load curve of the bearing (see fig.3).
For the static load capacity the maximum load configuration must be considered and for the dynamic load capacity the working load must be considered.

The final calculations with the effective loads in the required operational configurations will be anyway done by Galperti Tech engineers, prior to start the slew bearing manufacturing. This allows Galperti Tech to determine the final choice and design of the slew bearing. For this reason is important that, a request for a slew bearing comes with the QUESTIONNAIRE sheet filled up with as much details as possible, to help Galperti Tech in the design calculations.

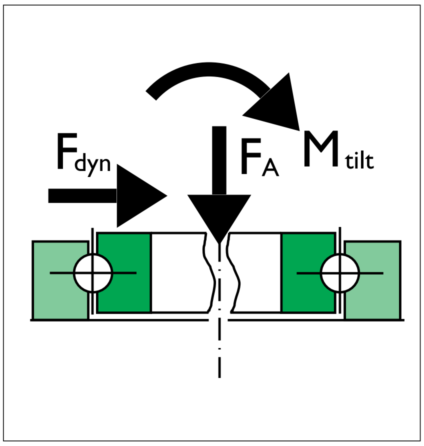


Fig. 1

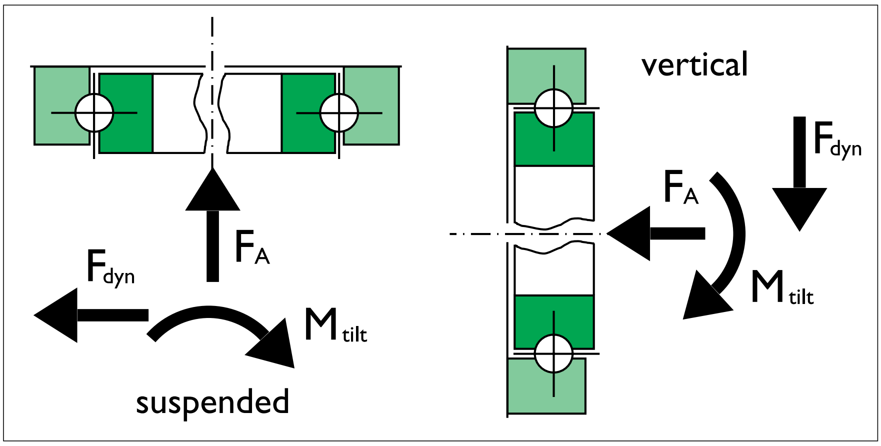
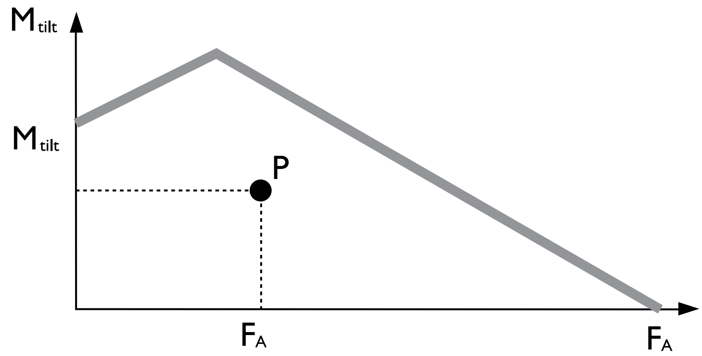


Fig. 2



static load capacity

$F_A = F_A \cdot F_{stat}$
$M_{tilt} = M_{tilt} \cdot F_{stat}$

dynamic load capacity

$F_A = F_A \cdot F_{dyn}$
$M_{tilt} = M_{tilt} \cdot F_{dyn}$

Fig. 3: limiting load curve

NOTE

A properly designed slew bearing has the load point inside the area circumscribed by the load curve.

For negative loads, as in pictures 1 and 2 the displayed load curve cannot be used. In such occurrence please refer to Galperti Tech technical recommendation.

APPLICATION	F_{stat}	F_{dyn}
Stacker (Bucket wheel excavator)	1,15	
Shipdeck crane	1,1	1,0
Conveyor jib	1,1	
Transfer conveyor	1,1	
Revolving table/Turntable	1,15	1,15
Slewing crane (general cargo)	1,25	1,2
Slewing crane (grab/magnet)	1,5	1,8
Overhead rotating trolley	1,5	1,8
Turntable ladder	1,1	1,15
Railway crane	1,0	
Mobile crane (general cargo)	1,1	1,0
Mobile crane (grab)	1,5	1,8
Hydraulic excavator ≤ 1,5 m³ > 1,5 m³	1,5 1,8	
Stockpile tipper	1,1	1,0
Bucket wheel excavator	1,7	2,25
Floating crane (general cargo) (grab)	1,1 1,5	1,0 1,8
Stacker crane	1,25	1,15
Slewing Shovel	1,3	
Cable dredger	1,3	
Ship-loader and unloader	1,35	1,25
Tower crane	1,35	1,35
Travelling bridges	1,5	1,8
Wharf crane or shipyard crane	1,25	1,25

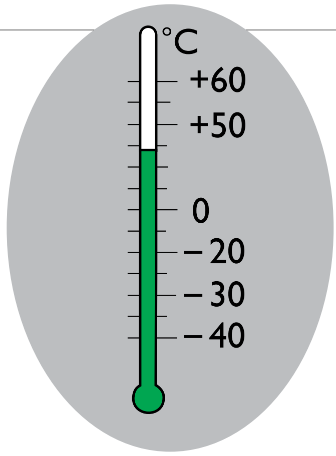
Table: load factors

NOTE

Applications where no value for the F_{dyn} parameter is shown, has largely variable operating conditions. Calculation of the operational life is possible only if the angle width and the swing in time are known

Operating Temperatures

In general the slew bearings are rated to work from +50 °C to -20 °C. with different solutions the operating temperature can be extended to -30 °C and +60 °C, with static extreme temperature of -40 °C. The Customer must state during the preliminary phase of the cooperation which the uppermost and lowermost operating and static temperatures will be required, and the performance required at such temperatures as well.



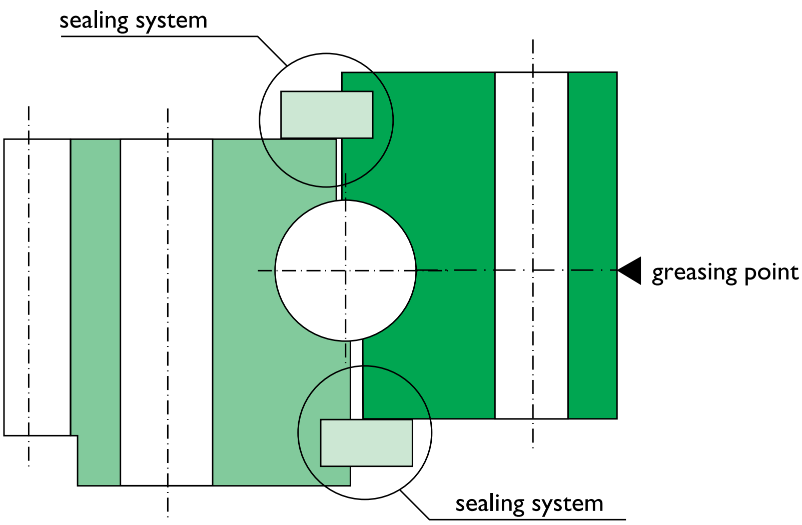
-40°C up to +60 °C.

Sealing Systems

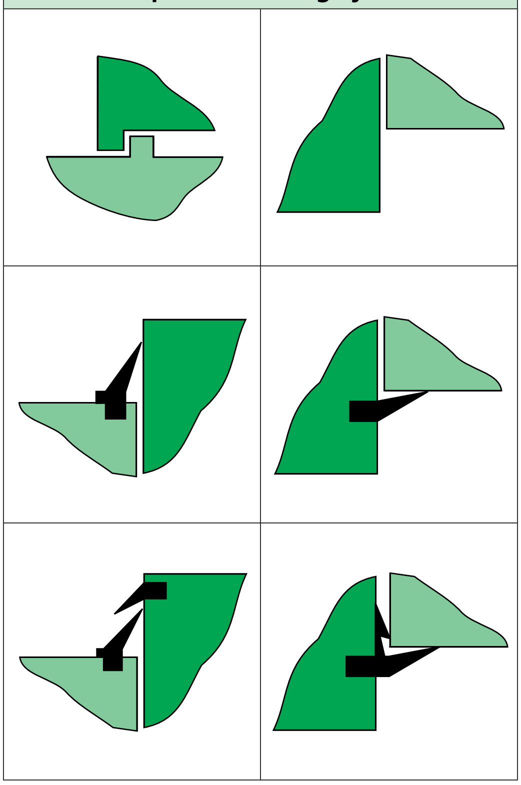
The sealing of a slewing bearing is provided by a labyrinth system filled with grease, or by special seals.
The selection of the seal primarily depends on the operating conditions and leak-proof requirements.
Under extreme conditions such as:

- Ship deck cranes (sprays of water and seawater)
- Bulk materials handling equipment for coal and ore.

Special seals are necessary and special design arrangements are to be made.
A slight increase of the total height or outer diameter increase compared to the standard line of products may be necessary if special sealing systems are required.
For extreme operating conditions, slewing bearings with internal gear are preferred providing an additional protection by means of the surrounding structures.

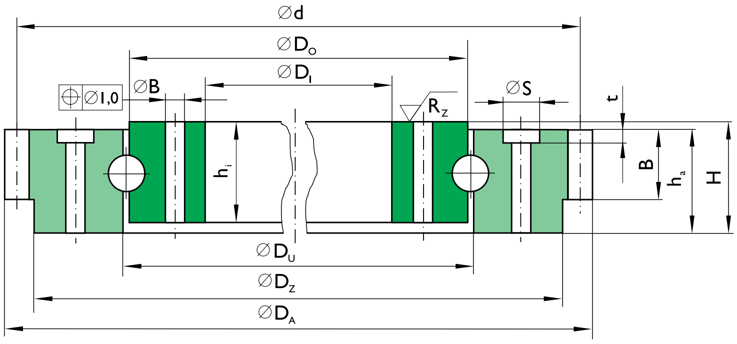


Examples of sealing systems



Bearing Tolerances

Standard bearing tolerances unless otherwise noted.



Surface quality

machined surface	average value R_z in μm
holes	160
mounting surfaces	
VO1 - V02 - V03	40
V41 - V42 - V43	40
V81 - V82 - V83	100
V91 - V92 - V93	25
external surfaces	160
spigot registers, (pilots)	40
gear	40

Gear backlash for quality 12cd27 according to DIN 3962, 3967

reference Ø in mm	module m	addendum circle backlash in mm internal gear D_I (+) external gear D_z (-)	concentricity f_R in mm
560 - 1000	6	0,20	0,25
560 - 1000	8, 10	0,25	0,28
1000 - 1600	10	0,30	0,32
1000 - 1600	12, 14	0,40	0,36
1600 - 2500	12,14,16	0,45	0,36
1600 - 2500	18	0,50	0,40
2500 - 4000	18,20,24	0,60	0,45

Hole tolerance

bolt size	Ø BHI3 DIN ISO 273 "mean" in mm	Ø S in mm	t in mm	∢ deviation from the mounting surface
M16	+0,27	+0,33		
M18		+0,33		
M20			+0,4	0,5°
M22	+0,33			
M24		+0,39		
M27				
M30				
M33				
M36	+0,39	+0,46		0,25°
M39		+0,46		
M42				

Diameter tolerances according to DIN 7168-m

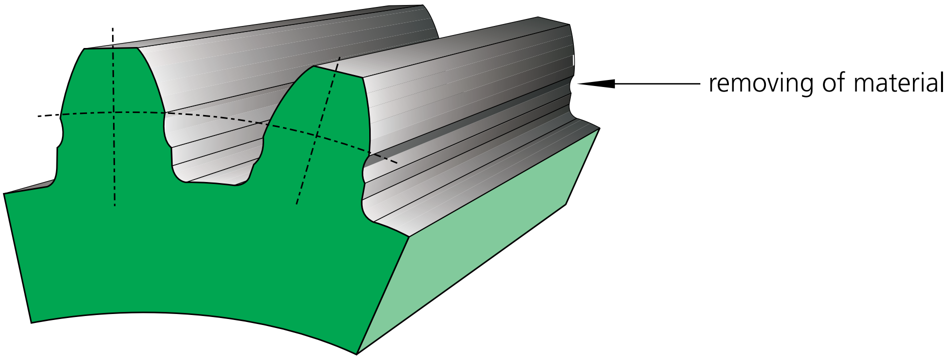
Ø D_I; D_O; D_U; D_A in mm	permissible deviation in mm
≥ 120	± 0,3
≥ 120 ≤ 400	± 0,5
> 400 ≤ 1000	± 0,8
> 1000	± 1,2

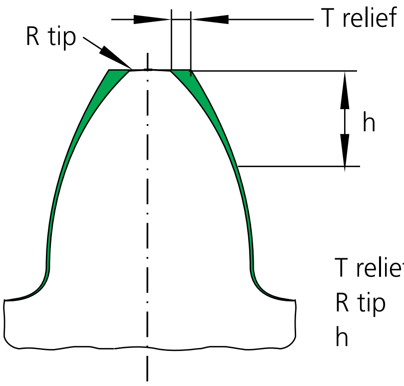
Height tolerance

	permissible deviation in mm
h_a, h_i	± 0,5
H	± 1,0

Tip relief at the pinion

Due to high forces (bending) in combination with pitch errors (manufactoring tolerances) removing of material at the dedendum flank of the wheel may occur as shown in the picture below. These meshing problems are encreased by deflections of the pinion shaft of pinions mounted in overhung position and elastic deformations between slewing drive and companion stucture.
All this influence factors affect the lubrication and metallic contact may occur. To reduce the tooth damage a relief at the pinion and a radius at the tip edges is recommended.
The transition of the tooth tip radius and the tip relief into the flanks must be rounded absolutely free of sharp edges!





T relief = 0,01 x Modul
R tip = 0,1-0,15 x Modul
h = 0,4 - 0,6 x Modul

Integral gears on slew bearings

Slew bearings are mainly manufactured with integral gears. The gear on the slew bearing can be external or internal. If a helical gear is required, Galperti Tech must evaluate the solution. The geared slew bearing are manufactured in steel alloy with different heat treat processes, to improve its behavior:

- Normalized (annealed) steel
- Quench and tempered steel
- Superficial hardened steel

For many application the tooth stresses are well tolerated from a normalized steel. For more performing requirement, as low temperature resilience, a quench and tempered heat treat process is required on the material. Superficial induction hardening is performed to increase the service life time. The possible induction harden profiles are: tooth root and flank hardening or tooth flank hardening.

Friction torque calculation

The value of the turning torque M_{fr} depends from a large number of influence quantities which cannot all be calculated theoretically. The formula below is based on empirical experience as well.
The friction torque is, among others, affected by following factors

- Friction coefficient of bearing type — factor μ
- The loads — F_a, F_r, M_t
- Design of bearing races — factor κ and tan α
- Seals (lubrication and preload of the seals)
- Lubrication of the race system (Type and filling of grease or oil)
- Accuracy and stiffness of the companion structure
- Clearance of the race system
- Temperatures

$$M_{fr} = \mu/2\ (\kappa * M_t + F_a * D + k/2 * F_r * D * \tan \alpha)$$

F_a - Axial load
F_r -Radial load
M_t - Tilting moment

Because of the above mentioned influence factors a variation of approximately +/- 25% can be estimated.

Type of bearing (see page 20)		μ	κ	**tan α**
Ball bearings	(V4-)	0,006	4,37	1,73
Ball bearings	(V8-)	0,009	4,37	1,73
Cross roller bearings	(V0-)	0,004	4,08	1,73
Three rows roller bearings	(V9-)	0,003	4,08	1

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Companion Structures

The cross section of the bearings compared to their diameters are relatively small. The bearings therefore need a rigid structure with low distortions under the operating loads to ensure a good load distribution in the bearing race and the bolt connection.

This means, the deviation curve must rise and fall equally in a sector of 0°- 90°-180°. Peaks in smaller sectors have to be avoided, otherwise tight spots may cause local overloads in the raceway and bolts.

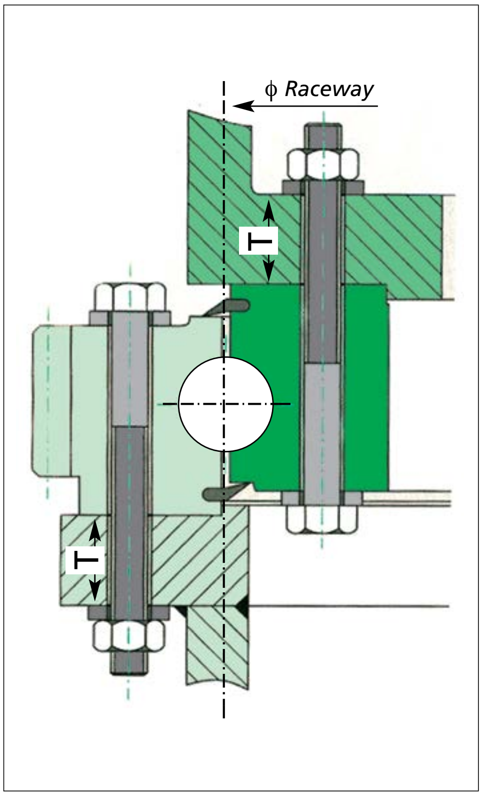
In order to keep the deflections of the supporting structures under max. loads to a minimum the vertical line of force in the companion structures must be near the race diameter.

Space for the bolt tightening tools has to be considered.

Accurate machining of the contact surfaces is required and the surfaces must be flat and clean to prevent the bearing from becoming distorted when it is bolted down.

Lastly mechanical handling is necessary after welding.
We do not recommend the use of stiffening rips welded to the flanges!

Material of the companion structures must be in steel S235JR or better.



Permissible out-of-flatness and deflections referred to 100 mm contact width

Raceway diamater	Out- of-flatness per suppert surface			Max. axial deflections at max. load	Min. Thickness of flange T
	4-Point ball bearings Type V1-.	4-Point and 8-Point ball bearings	Roller bearings		
500	0,2	0,1	0,07	0,35	25
750	0,25	0,12	0,09	0,4	30
1000	0,3	0,15	0,11	0,5	35
1250		0,17	0,13	0,65	40
1500		0,2	0,15	0,8	50
2000		0,22	0,17	1	60
2500		0,25	0,19	1,3	70
3000		0,28	0,21	1,6	80
3500		0,3	0,23	2	90
4000		0,33	0,25	2,5	100
4500		0,35	0,28	3	110

All dimensions in mm

For precision bearings and preloaded bearings above values may not be used.

Bearing Test

Upon completion of the bearing manufacturing process, proper check must be performed to verify the compliance of the bearing performance to the design prescriptions.
Please refer to Galperti Tech Procedure T 02 004 for Testing of the Bearing, of which an abstract can be found in the following lines.

1.0 Scope

This procedure defines the operative method for standard testing of bearings.
This procedure is applicable for bearings with clearance or preload.
The reference testing values (clearance, torque, run-out ..) are reported on the GT assembly drawings.

2.0 References

2.1 Assembly Drawings

3.0 Equipments

3.1 Test bench with load cell or
3.2 Dial Gauge
3.3 C Clamp
3.4 Torque meter (Optional)

4.0 Bearing with clearance

4.1 Radial Clearance

4.1.1 Place the magnetic base of the dial gauge on the fixed ring of the bearing, the feeler pin is placed in contact with the diameter to be measured. Pay attention that the feeler pin is perpendicular to the contact surface (See Fig. 1).
4.1.2 Lock with a C Clamp the two rings of the bearing on the opposite site to the feeler pin in order to generate the force in radial direction (See Figure 1).
4.1.3 Set the dial gauge to zero.
4.1.4 Remove the C Clamp and lock the rings at 180° from the starting position (in the same place of dial gauge)
4.1.5 Read the deviation on the indicator of the dial gauge.
4.1.6 Lock the vice at 90° from previous position and repeat points 4.1.1, 4.1.2, 4.1.3, 4.1.4.
4.1.7 The radial clearance of the bearing is the average between the values of the readings.

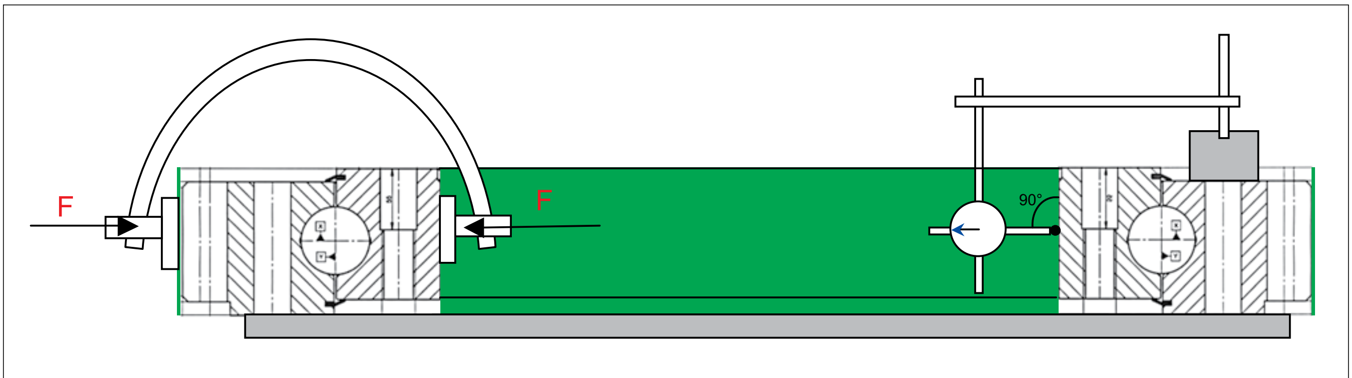


Fig. 1

4.2 Axial Clearance

4.2.1 Place the magnetic base of the dial gauge on the fixed ring of the bearing and place the feeler pin in the contact with the flat face. Pay attention that the feeler pin is perpendicular to contact surface (See fig.2)

4.2.2 Press the external ring on the bench and set the dial gauge to zero.

4.2.3 Lift the external ring from the bench with a metallic lever.

4.2.4 Read the deviation on the indicator of the dial gauge

4.2.5 Place the dial gauge at 90° from previous position and repeat points 4.2.1, 4.2.2, 4.2.3, 4.2.4.

4.2.6 The axial clearance of the bearing is the average between the values of the readings.

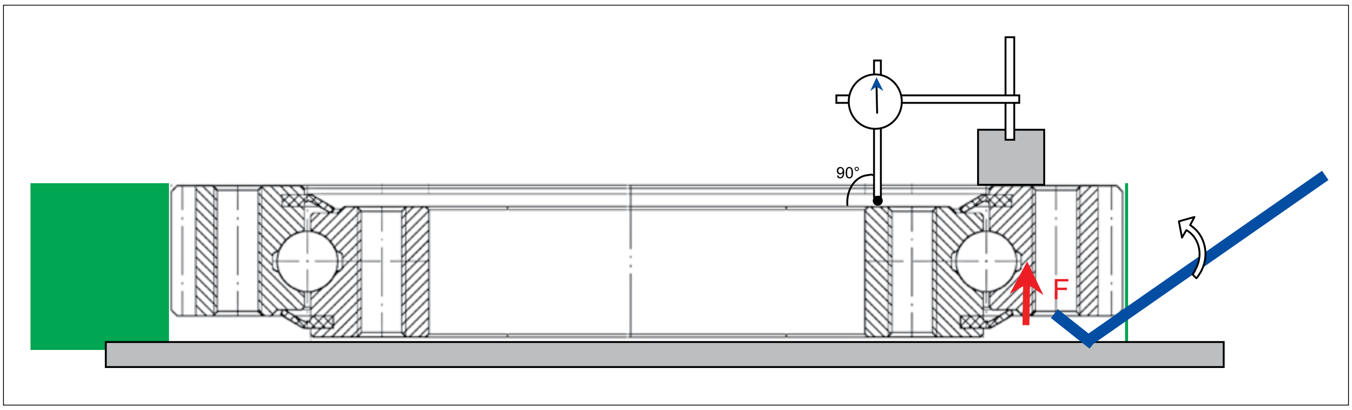


Fig. 2

4.3 Verification of rotation torque

In case the drawing requires the torque values it is necessary to perform the torque test with seal and grease according to section 5.

5.0 Preload bearing

5.1 Rotation torque without grease and seal.

A load cell, assembled on the pinion shaft, is detecting the torque.
The bearing torque value is obtained through following formula:

Tb= Tp x (Zb/Zp)

Tb= Bearing Torque
Tp= Pinion Torque
Zb= Nø teeth of the bearing
Zp= Nø teeth of the pinion

Starting Torque: Detection of starting torque is defined as the maximum value necessary start the rotation of the bearing from still condition with a final rotation speed of 6°/sec.
Six measurements are carried out in equi-spaced position among them.
On the report average value has to be indicated.

Running Torque: The detection of the running torque is defined as the average value throughout a complete 360ø turn at constant rotation speed of 6 °/sec.
On the report average value has to be indicated.

In case the load cell is not available it is possibile to performe the starting torque with the torque meter.

5.2 Rotation Torque with grease and seal

After assembly of the bearing with seal and grease perform the test according to point 5.1

6.0 Gear Run Out

6.1.1 Couple the gear of the special pinion with the gear of the bearing..
6.1.2 Set the linear encoder to zero.
6.1.3 Rotate the bearing.
6.1.4 After a complete round of the bearing, check the maximum deviation on the linear encoder. This value will be considered the run-out of the gear.
6.1.5 Mark the three teeth corresponding with the maximum run-out value.

> **NOTE**
> **In case the test bench is not available, it is possible to perform the measurement with a dial gauge and a calibrated pin.**

7.0 Mounting surface Run-Out

7.1.1 Place the magnetic base of the dial gauge on the external ring. The feeler pin is placed in the inner ring mounting surface (See fig. 3).
7.1.2 Zero the indicator of the dial gauge.
7.1.3 Rotate by 360° the internal ring and check the maximum deviation on the indicator of the dial gauge.
7.1.4 This measurement will be considered the run-out value of inner ring mounting surface.
7.1.5 Place the magnetic base of the dial gauge on the internal ring. The feeler pin on the reference plane of the external ring.
7.1.6 Zero the indicator of the dial gauge.
7.1.7 Rotate by 360° the external ring and check the maximum deviation of the indicator of the dial gauge.
7.1.8 This measurement will be considered the run-out value of outer ring mounting surface.

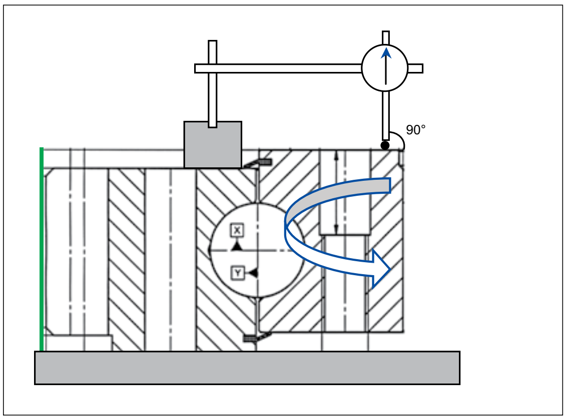


Fig. 3

8.0 Pilot diameter Run Out

8.1.1 Place the magnetic base of the dial gauge on the fixed ring. The feeler pin is placed in the pilot diameter (See fig.4).
8.1.2 Set the indicator of the dial gauge to zero.
8.1.3 Rotate by 360° the ring and check the maximum deviation on the indicator.
8.1.4 This measurement will be considered the run-out value pilot diameter.

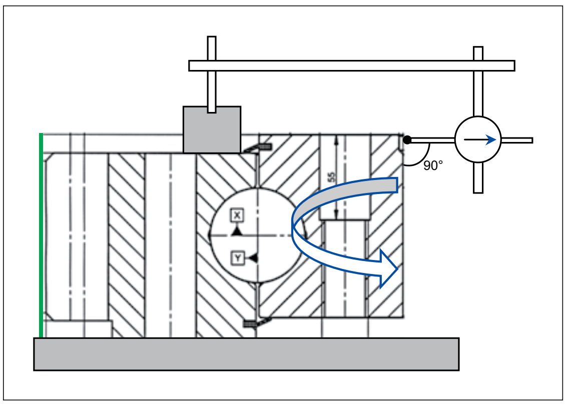


Fig. 4

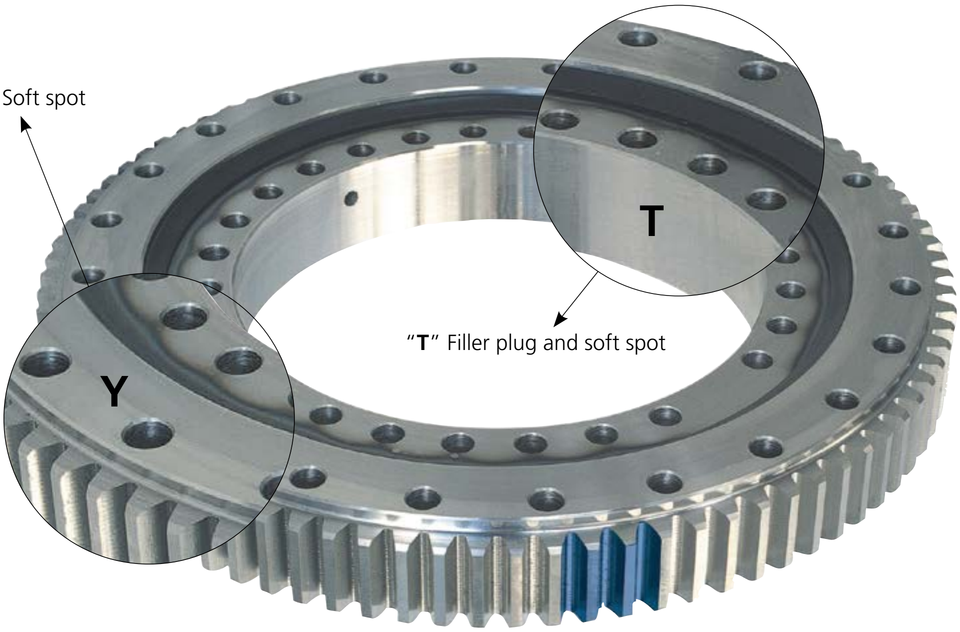
Installation

Prior to installation make sure that all mounting surfaces are free of welding pearls, paint residues, burring and other contaminations. Examination of the contact surfaces by means of a levelling instrument or laser machine is recommended. Do not exceed the values shown in the table on page 17. The bearing should be checked for running by rotating the unbolted bearing two revolutions. After rotating remove the protective coating from the contact surfaces and from the gear. No solvent shall come in contact with the seals or infiltrate the raceways.

Do not perform weld on or around the bearing as the heat generated may cause distortions or destroy seals and plastic spacers. Electric current flow and arching will severely damage the races and balls and must be mandatorily avoided.

Hardness Gap

Most of the induction hardened bearings races have a small unhardened zone between the begin and the end of the hardened path. This spot, called "soft spot" is located on the filler plug, either on the inner or outer ring, or has the type plate nearby.
The letter "**T**" is etched on the filler plug where the soft spot is.
The letter "**Y**" is etched where the soft spot is on the bearing ring that hasn't the filler plug.
The soft spot is identified on all slew bearings with the letter "Y" etched on the slew bearing. The slew bearing design keeps in account the soft spot effect so that the required load capacity is met.
The plug and the soft area should be positioned 90° from the load axis (outside the main load-carrying areas) when possible.



Gear Ring

The backlasch has to be adjusted at the 3 teeth marked with blue (narrowest point) if no fixed center exists. At this point the backlash has to be 0,03 x module. After final tightening the backlash neads to be checked over the entire circumference.

Fastening Bolts

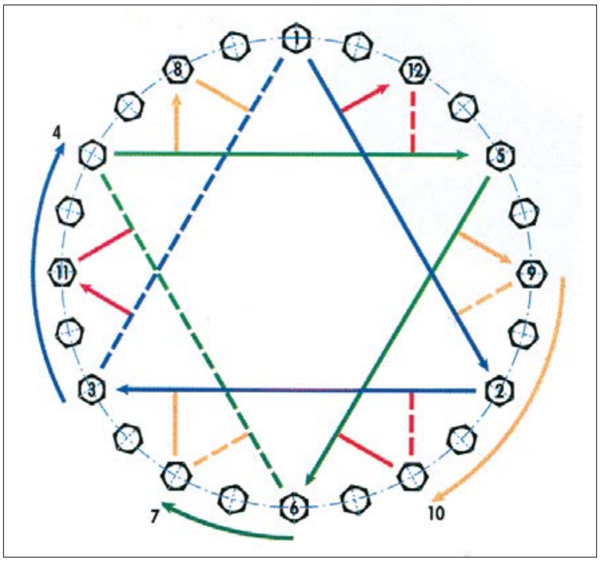
The bolt connection is crucial to the slew bearing life. A proper fastening of the slew bearing is required by relevant calculation. This calculation determines the quantity, size and quality and preload force of the fastening bolts.

Proper preload is met with:

1. Hi precision torque wrench
2. Hydraulic tensioning equipment
3. Length measure on calibrated bolts

The torque is affected by: bolt quality and grade, thread connection friction and friction between the contact surfaces of bolt head, nut and parts themselves.

The fastening hole location of the structure must match those of the bearing or distortions will appear.
Excessive distortion results in high friction and reduced bearing life. If friction increases by tightening the bolts, the bearing should be removed and the contact surfaces checked for flatness. The specified diameters, strength class, quantities and degree of preload must be followed. We recommend a minimum clamping length of 5 x bolt diameter. The bolts must be carefully tightened crosswise to the specified preload, as shown on the right.



The following table gives some recommended values for the tightening torques.
The values are based on lightly oiled threads and contact surfaces. (μ_{TOTAL} = 0,14)

Thread diamater mm	Tightening Torques in Nm			
	hydr. torque wrench	mech. torque wrench	hydr. torque wrench	mech. torque wrench
	8.8	**8.8**	**10.9**	**10.9**
M12	87	78	130	117
M16	215	193	310	279
M20	430	387	620	558
M24	740	666	1060	954
M27	1100	990	1550	1395
M30	1500	1350	2100	1890
	Grade 5	**Grade 5**	**Grade 8**	**Grade 8**
UNC 5/8" - 11"	200	180	286	260
UNC 3/4" - 10"	352	320	506	460
UNC 7/8" - 9"	572	520	803	730
UNC 1" - 8"	855	770	1210	1100
UNC 11/8" - 7"	1068	970	1716	1560
UNC 11/4" - 7"	1507	1370	2410	2190

Dry threads require higher tightening torques whereas heavily oiled threads. The variation, particulary on bolts larger than M27 or 1 1/4" is considerable. We recommend to use hydraulic tensioning cylinders for these sizes.
It is necessary to tighten the bolts to the required preload and to ensure this torque value over the lifetime of operation. We recommend to check the torque after 3 months of operation and then once every year.

NOTE
Securing elements such as lock and spring washers may not be used.
Only the preloading force of the bolt serves to secure the bolt.

Approximate determination of surface pressure underneath the bolt head or nut contact area

Conditions:

$$p = \frac{\frac{F_M}{0.9}}{A_p} \le P_G$$

F_M Mounting prestressing force for selected bolt [N]
A_p Contact area under bolt head or nut [mm²]
P_G Limiting surface pressure [N/mm²] for the pressed parts

with hexagon head bolts, the reduced contact area due to hole chamfer and seating plate must be taken in consideration.

$$A_p = \frac{\pi}{4}(d_w^2 - d_h^2)$$

for $d_w > d_h$)

d_h - Bore diameter
d_a – I.D. of head contact area
d_w – O.D. of head contact area
[N/mm²] for the pressed parts

Material	P_G - Limiting surface pressure
St 37	260 N/mm²
St 50, C 45, 46 Cr 2 N, 46 Cr 4	420 N/mm²
C 45, 46 Cr 4 V, 42 CrMo 4 V	700 N/mm²
GG 25	800 N/mm²
If these surface pressures are exceeded, washers of respective sizes and strengths must be provided	

Tightening Procedures

Tightening the bolt by means of a torque wrench

The preloading force is applied by means of a torque wrench with an adjustable moment. The installation uncertainty as a result of friction depends on

- the length of the thread in contact
- the bolt head or nut support contact area
- the size and angular deviations of the support surfaces
- the surface roughness
- the surface treatment
- the means of lubrication.

These influences are taken into account by a tightening factor α_A. = 1.6.

This tightening method can be used for up to M 30 bolt diameters.
For larger bolts the influence of the friction increases to an extent that the overall stress of the bolt fluctuates considerably.

When using fastening bolts larger than M30, the necessary preloading force can be determined by changing the length of the bolt. Depending on the clamping length I_K and the bolt dimensions, the elasticity α_S of the bolt can be determined. The mathematical installation clamping force F_M of the bolt used is yielded at 70 % of the preloading force as opposed to the elongation limit $R_{p0.2}$.
The change in length Δl to the force allocated to the elastic region F_M (installation tension force) is yielded from

$$\Delta l = F_M \cdot \delta_S$$
$$F_M = 0{,}7 \cdot R_{p0,2} \cdot A_S$$

The bolts are tightened until the required length of elongation is displayed by a suitable measuring instrument. Center holes in the bolt for positioning a measuring gauge are recommended.

The applied torque can be read from the tightening tool. A mean value is determined from several measurements. Both ends of the bolt must be accessible in the screwed down state. If this possibility does not exist, the tightening torque is determined by a test model. For the propagation of the experimental results, all the bolts (including the test bolts) must be from the same production batch, torqued with the same wrench, and the surface quality and the number of joints match.

Hydraulic Tightening of the Bolts

The preloading force is applied by means of hydraulic tensioning equipment. In this case, the section of the bolt projecting beyond the nut is gripped and put under torsion-free tension against the parts to be clamped. When clamping the parts, the nut is raised from the supporting surlace and can be screwed down into contact again.

In the bolt calculation, a tightening factor α_A = 1.4 can be used.

The theoretical clamping force of the bolt is 90 % of the elongation limit. It should be noted that the bolts must be loaded in excess of necessary preloading force, since by relieving the load off the studs, a setting in the thread and the nut contact area occurs, as well as a elastic and plastic deformation in the joints. When washers are used, the outside diameter should be dimensioned such that these are also loaded by the tightening equipment. Setting phenomena means a loss of clamping force. Moreover, the clamping force of the first preloaded bolt will be influenced by the preloading of further bolts.

NOTE

It is necessary to attain the required preloading force on the bolts by repeating the tensioning a second time

With the use of hydraulic tensioning equipment the thread is elastically elongated by the tension force. In order to avoid a jamming of the nut, it is necessary to specify the thread play according to DIN 2510. The bolt length is to be chosen such that the thread projects beyond the nut in order to be gripped by the tensioning equipment. The necessary length of the thread is dependent on the bolt strength rating and the tensioning equipment, and has to be revised with the supplier of the tensioning equipment. In the planning phase, the space requirements of the tightening equipment have to be taken into account.

Mounting Procedure

1. Position the soft spot "Y" of the slew bearing in the less solicited area of the assembly;
2. Check the fastening bolts to be of proper dimensions and class consulting the drawings and technical proposal supplied by Galperti Tech technicians;
3. Check tapped holes – if any – to be of proper dimensions and class to meet the fasteners properly, consulting the drawings and technical proposal supplied by Galperti Tech technicians, an ISO go – no go gage is recommended;
4. Mount the bolts, starting from the geared ring and tighten following the procedure shown into the chapter "fastening bolts", starting with a manual tight;
5. Check slew bearing planar positioning to the companion structure, prior to tight the fasteners, by filling gage;
6. On non geared slew bearings fasten first the spot loaded ring;
7. Check the tooth profile backlash at the color mared teeth and adjust the value to one of (0.03 – 0.04) x module, if required;
8. Tight all fasteners to the prescribed value of preload with a calibrated torque wrench or a hydraulic tensioning equipment;
9. Move the rotating ring to different position every some fasteners are tight;
10. Remove the freight handling cross, if any;
11. Repeat the afore mentioned procedure for the rotating ring;
12. Fasten lubrication lines to the slew bearing lubrication zercs;
13. Fill the lubrication lines till fresh grease exit from the exhaust lines of the slew bearing;
14. Reset the auto lubrication unit (if)to proper lubrication quantity and timing;
15. Properly lubricate the gear;
16. Operate the slew bearing with no load;
17. Check the teeth contact;
18. Prior to operation start or prior to operate a new application, perform the tilting clearance measurement;
19. Start the equipment up.

NOTE

Avoid any welding on the assembled slew bearing, to avoid distortion, with severe consequences on the functionality.

The assembly procedure is to be considered indicative.

Backlash Measurement

During the assembly, the slew bearing gear backlash has to be controlled, to meet proper working conditions of the gear and pinion assembly. To measure the gear backlash, please refer to Galperti Tech Procedure T 00 003, of which an abstract can be found in the following lines.

1.1. Clean the gearing and the pinion teeth.
1.2. Set the driving pinion to the maximum eccentric point of the ring gear. The maximum eccentric point is marked by a blue line.
1.3. Put in contact one flank of the pinion with the correspondent flank of tooth gear. (Fig.1)
1.4. Measure the backlash by feeler-gauge or lead-wire. (Fig. 1)
1.5. The minimum backlash is set at the highest point of the gear. It depends on the module ao the gear and is calculated according the following equation:
J_n = 0.03 to 0.04*m
J_n = Backlash
m = Module

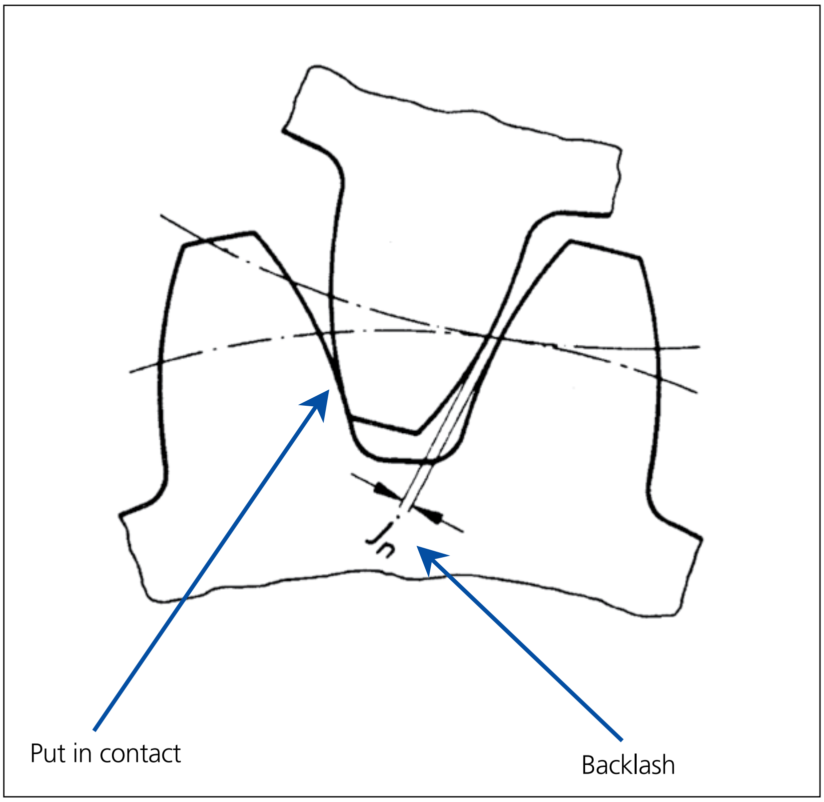
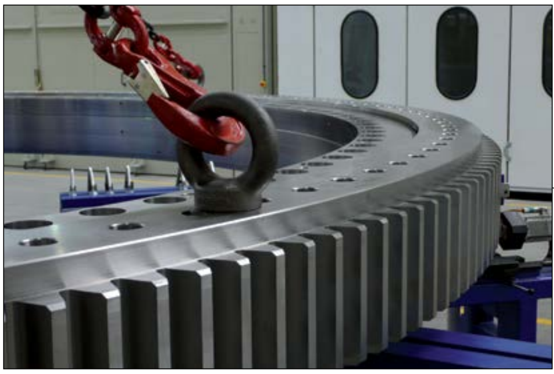


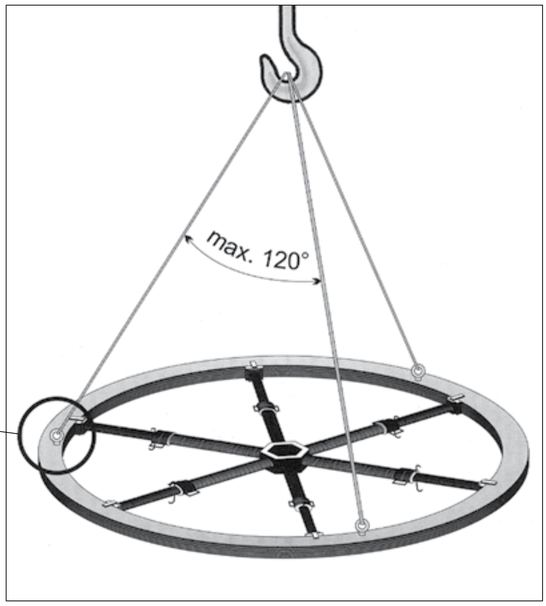
Fig. 1

Bearing Handling

Transport

Large-diameter bearings are machined parts that require careful handling. They should be transported in horizontal direction and any shock to the bearing must be avoided. When large diameter bearing are transported inclined or vertically they require an internal cross support. The support must be removed after installation and the bearing should not be lifted from this point. For transport use the eyebolts only!

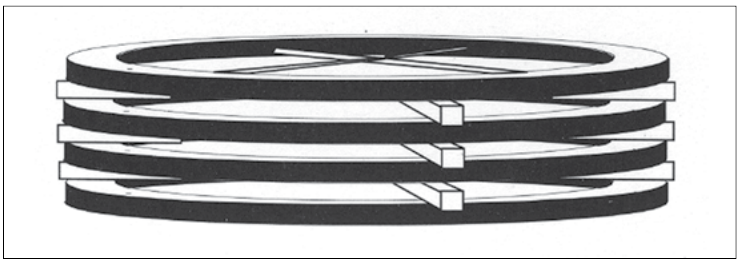




Storage

To fulfill to proper storage procedure, please refer to Galperti Tech Procedure SP01, of which you find an abstract in the following lines.

When the bearings are planned to be stored less than 24 months prior to be used, if the following precautions are adopted they do not need any particular maintenance.
The bearings will be stored indoor. The temperature of storage must be between -20°C and +50°C and should be highest than the dew point temperature. Be sure that the bearings are well protected as described in the packing procedure.
Leave the bearings in their packaging until they will be installed. If the bearings have to be unpacked for inspection purpose, at the end of the operation, be sure to re-pack the protection according to the packing procedure.
Before proceeding with incoming inspection, be sure that no damages and tampering have occurred on the boxes. The boxes shall be opened carefully in order to avoid any damage to the exposed parts of the bearings.
In order to check the integrity of the protection, the bearings shall be inspected at least every five months duly opening the wooden boxes from their top. If the protections are damaged bearings surfaces will have to be checked. After checking, re-pack the bearings as mentioned in the packing procedure.
When the storage periods extends beyond 24 months, the bearings shall be inspected every three months in accordance to the previous paragraph.



For long term storage please please refer to Galperti Tech Procedure SP02, supplied on request.

Bearing Maintenance

Checking the Bolts

Regular maintenance of the fastening bolts is mandatory. Damage to the bolts can result in a loss of preload and ultimately slew bearing failure. A constant check of the preload and restoring of the nominal required preload is necessary to avoid failure. After the slew bearing installation, a check is required after 100 working hours and tightening is required. During the following life of the slew bearing, a check and retighten is required every working 500 hours or 6 months. The time between the checks and retightening can be reduced due to requested control specifications for the relevant working application.

Lubrication

All grease nipples must be easily accessible. Lithium saponified mineral oils of NLGI grade 2 with EP additives must be used. The table below shows a list of lubricants for raceway and gear. Below is a table listing approved lubricants.

MANUFACTURER	RACEWAY	GEAR
KLÜBER	CENTOPLEX 2 EP -20°C to +130°C	Klüberplex AG 11 461/462 -40°C to +150°C
KLÜBER	Klüberplex BEM 41 - 132 -40°C to +150°C	Klüberplex AG 11 461/462 -40°C to +150°C
KLÜBER	Klüberplex AG 11 461/462 -40°C to +150°C	-
AGIP	MUEP 2 -20°C to +120°C	-
ARAL	Aralub HLP 2 -30°C to +130°C	Aralub MKA-Z 1 -25°C to +130°C
BP	Energrease LS-EP 2 -20°C to +120°C	Energrease LC 2 -25°C to +160°C
CASTROL	Spheerol EPL 2 -20°C to +110°C	Castrol LZV-EP -30°C to +150°C
ESSO	Beacon EP 2 -25°C to +135°C	Esso Multi-Purpose Grease (Molly) -25°C to +150°C
MOBIL	Mobilux EP 2 -25°C to +120°C	Mobil Gear OGL 461 -20°C to +120°C
SHELL	Shell Alvania EP 2 -25°C to +130°C	Shell Malleus OGH -10°C to +200°C
TOTAL	Total Multis EP 2 -30°C to +120°C	Total Gardrexa GR 1-AL -20°C to +200°C

Wear Control - Bearing Rocking Test

During its life the bearing is subject to wearing, periodically the bearing must be checked to verify that the wearing is within acceptable limit for proper performance.
To fulfill to proper wear control, please refer to Galperti Tech T 04 003 Bearing Rocking Test, of which you find an abstract in the following lines.

1.0 General

Scope of this procedure is to define the method to perform the bearing rocking test.
Bearing rocking test should be done periodically for recording the bearing wear.
To guarantee repeatability of test the latter needs to be performed without load with only movement of parts that transmit moments loads to bearing.

2.0 Test recurrence

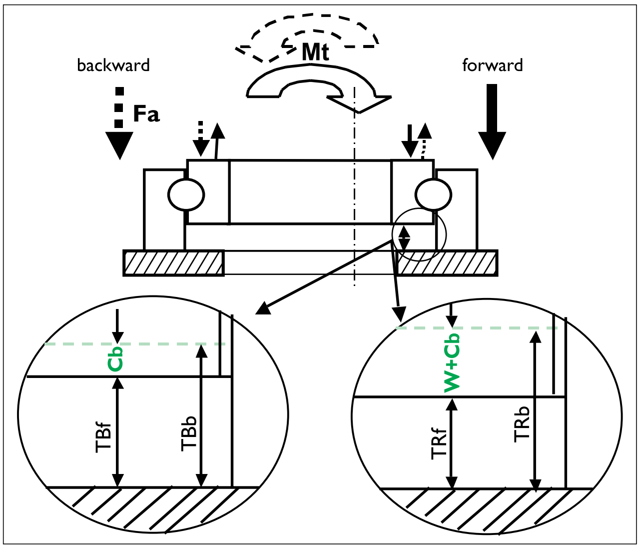
At installation (base measurement), three month after installation and subsequently every six month.

3.0 Equipments

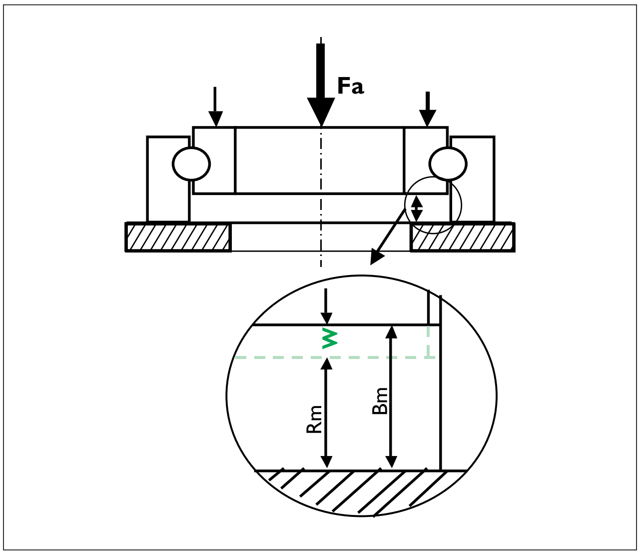
- No one Dial Gauge with magnetic base for tilting clearance measurement
- No one Calliper for axial reduction measurement

4.0 Wear Measurement

For assessing the condition of a bearing, we recommend that its normal wear rate is determined. The wear present in the raceway system shows itself by a change in the axial motion of the bearing. Depending on the individual conditions, wear can be determined either by measuring the tilting clearance or by reduction measurements.
Use a tilting clearance measurement for equipment allowing both positive and negative application of moment loads. See picture 1
Use a axial reduction measurement in case the combination of both positive and negative load are not possible. See picture 2



Picture 1



Picture 2

4.1 Tilting clearance measurement

The first measurement should be performed when the equipment is put into operation in order to obtain a base value for subsequent repeat measurements.
The measuring point should be marked around the circumference while the boom is kept in a specified position.
The measurements are then taken between the lower/upper mating structure and the bearing bolted to the upper/lower structure.
The measurement should be taken as close to the bearing as possible in order to minimize the effect of elastic deformations in the system.
The dial gauges should have an accuracy of 0.01 mm (0.0005 inch).
Start with the maximum backward tilting moment and set the dial gauges to zero. Then apply a forward tilting moment with a lift off load.
Turn the upper structure to the next position and repeat the measurement procedure.
When all position have been measured, record the base values obtained in the annexe table.
The difference between the values measured and the base values represents the wear that has occurred.
The acceptable wear values are mentioned in paragraph 5.0.

4.2 Axial reduction measurement

The first measurement should be performed when the equipment is put into operation in order to obtain a base value for subsequent repeat measurement.
For basic and repeat measurement make measuring points around the circumference.
Take basic measurements on at least 4 points (4x90°) by rotating the upper structure.
The measurements must be repeated under the same conditions.
Record the base values obtained in tabular form and allocate them to the respective base measurements.
The acceptable wear values are mentioned in paragraph 5.0.

4.3 Instruction execution for offshore pedestral mounted cranes

Before starting test it’s necessary to fix No. Four (4) points positioned everyone at 90° on the circle and identified them with increasing number from 1 to 4 on the lower mating structure of bearing.
These are the four position in which to perform rocking test.
Put the forward (and centre) part of the crane (boom side) in correspondence of position No.1 and to place the first dial gauge.
Place the second dial gauge on the opposite side (and backward) of the crane in correspondence of position No. 3.
Put the boom in the position to get the minimum angle.
Reset dial gauge.
Luffing the boom to reach the lower position and to get maximum angle.
Write values indicated from dial gauge in the above matrix.
Check that values doesn’t exceed indication at paragraph 5 for tilting method. Repeat the check for other positions.

5.0 Maximum permissible increase of bearing clearances

Single row ball bearing. (4 point contact) V4.. series

Table 1	Ball diameter									
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
	20	22	25,4	30	35	40	45	50	60	70
Measuring method	**Permessible increase in bearing clearance**									
	mm		mm			mm		mm		
Axial reduction measurement	1,6		2,0			2,6		3,3		
Tilting clearance measurement	2,0		2,6			3,2		4,0		

Double row ball bearing. (8 point contact) V8.. series

Table 2	Ball diameter										
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
	18	20	22	25,4	30	35	40	45	50	60	70
Measuring method	**Permessible increase in bearing clearance**										
	mm				mm		mm			mm	
Axial reduction measurement	1,8				2,2		3,0			3,8	
Tilting clearance measurement	2,5				3,0		4,0			5,0	

Three row roller bearing. V9.. series

Table 3	Roller diameter													
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
	16	20	25	28	32	36	40	45	50	60	70	80	90	100
Measuring method	**Permessible increase in bearing clearance**													
	mm			mm			mm			mm		mm		
Axial reduction measurement	0,40			0,60			0,80			1,00		1,20		
Tilting clearance measurement	0,70			1,00			1,40			1,75		2,10		

6.0 Grease Sample Analysis

Wear can be monitored by periodic grease sample analysis. Grease sample should be collected every twelve month; this period should be shortened if obvious metal or contaminant are present.

The grease sample should be taken at the inner seal of the bearing: one under arm and one sample at 180° in opposite direction.

Clean the seal area where the sample will be taken, push the new grease into the bearing without rotation and collect the first used grease which will come out at the seal.

NOTE

do not take the fresh grease for analysing

Quality Assurance

Galperti Tech is ISO 9001 certified and the product specification comply with the highest standards required by the market.
The bearings are supplied with certification according to EN 10204 2.2, EN 10204 3.1.B or EN 10204 3.1.C.

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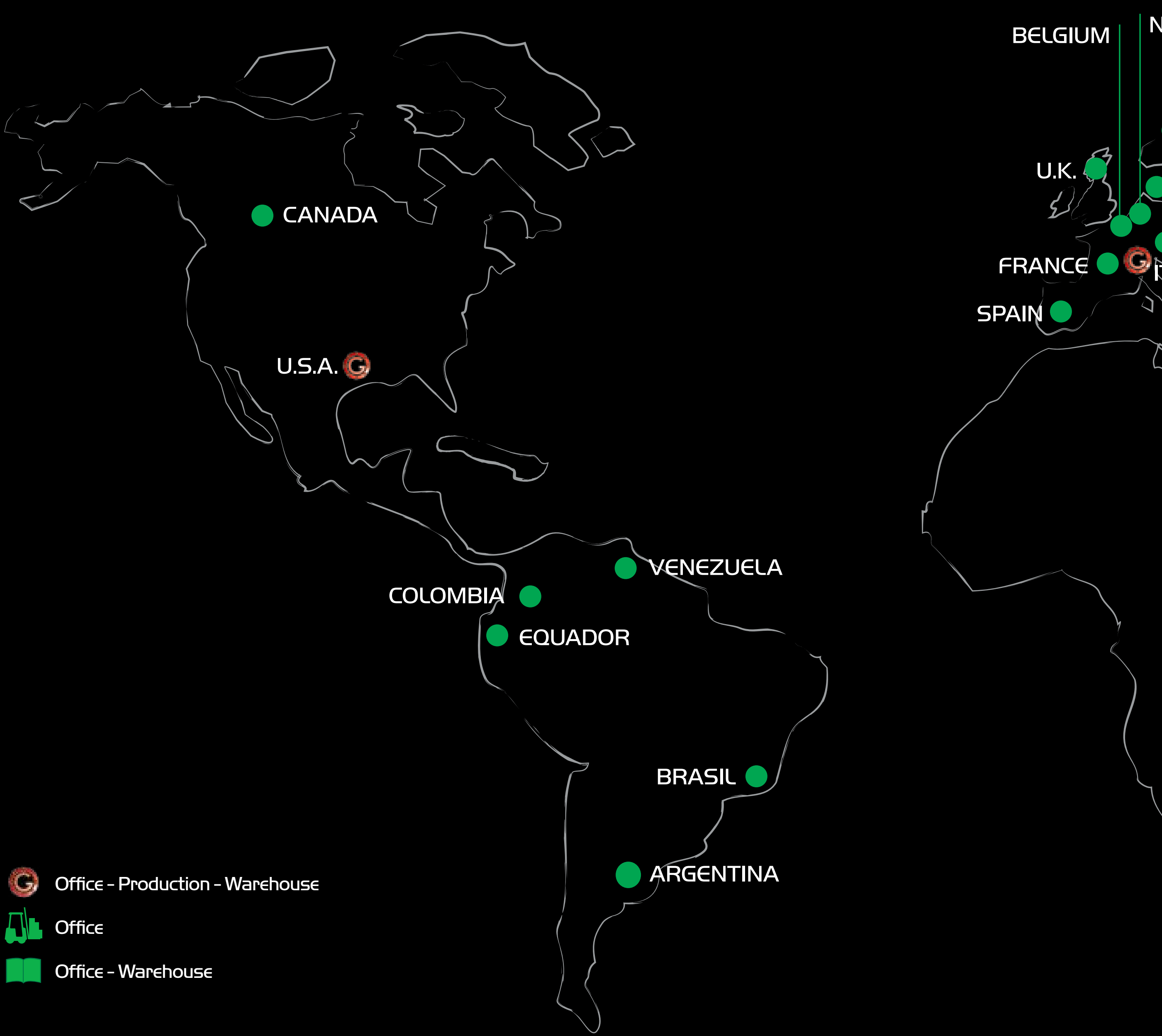

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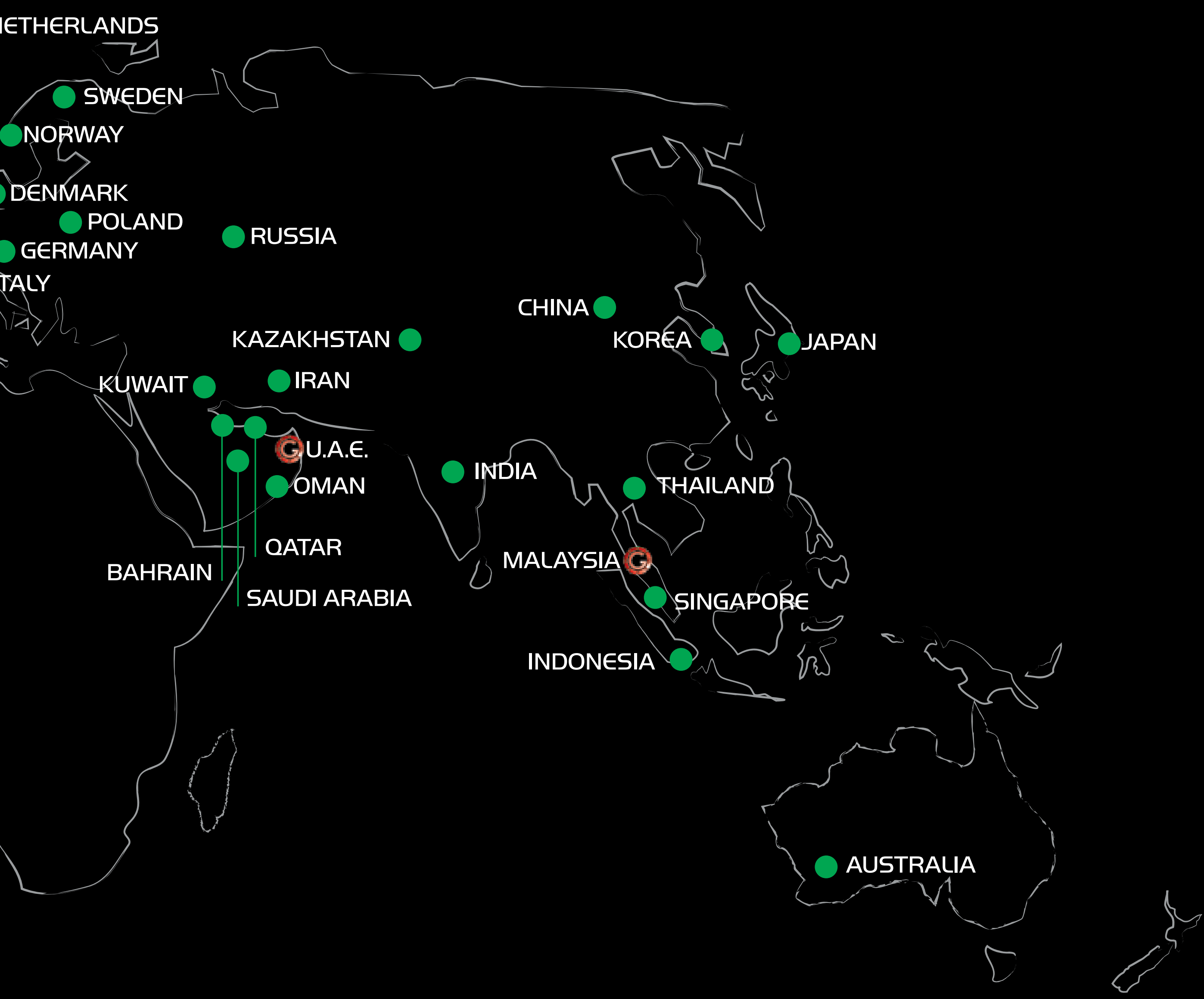

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