SLEWING RING SELECTION

- SLEWING RINGS FUNCTIONS
- OTHER FEATURES
SLEWING RING FUNCTIONS

LOADS SELECTION

The slewing ring, being the link between a mobile element and a fixed base, must have the capacity to transmit the stresses of the mobile part towards the base. It is necessary to accurately define all the actual stresses applied so that a suitable slewing ring with adequate capacity can be selected. This should include the effects due to masses and inertias of the payloads and structures.

It is necessary to distinguish the fixed loads and the variable loads as well as the effects due to dynamic loads, the latter constituting "fatigue" stresses. The direction of forces affecting the slewing ring must be well defined so that the active tilting moment can be established.

We distinguish:
- The AXIAL LOADS whose direction is parallel to the slewing ring rotation axis. The resultant of these loads is called $F_A$.
- The RADIAL LOADS contained in planes perpendicular to the rotation axis. The resultant of these loads is called $F_R$.

AXIAL LOADS

RADIAL LOADS
SLEWING RING FUNCTIONS

LOADS SELECTION

- TILTING MOMENTS (bending) : in planes parallel to the rotation axis. The resulting moment working in the plane containing the rotation axis is called $M_T$.

- SLEWING TORQUE $C_D$ controls the slewing ring rotation.

CALCULATION OF THE EQUIVALENT LOAD

For the calculation, the resultant of the radial loads $F_R$ is transposed into an equivalent axial load using a factor $K_R$ as follows:

For standard slewing ring:

- if $F_R < 0,25$ then $F_A$
- if $0,25 < F_R < 1$ then $F_A$
- if $F_R > 1$ then $F_A$

For light series and solid sections:

For horizontally mounted slewing rings: vertical rotation axis:

$F_{eq} = F_A + K_R . F_R$

For vertically mounted slewing rings: horizontal rotation axis:

$F_{eq} = F_A + 1,2 . K_R . F_R$

The equivalent loads $F_{eq}$ can be obtained by the following formula:

$\rightarrow K_R = 3,225$

TILTING MOMENT

\[
C_D
\]

\[
M_T
\]
**DESIGN DATA SHEET**

<table>
<thead>
<tr>
<th>Section</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>COMPANY : Tel. :</td>
</tr>
<tr>
<td>1.2</td>
<td>Address : Fax :</td>
</tr>
<tr>
<td>1.3</td>
<td>Person in charge of the project : Fonction :</td>
</tr>
<tr>
<td>2.1</td>
<td>DESCRIPTION OF THE APPLICATION + sketch (to be attached with loads applied)</td>
</tr>
<tr>
<td>2.2</td>
<td>Machine / project reference : New project : Yes ☐ No ☐</td>
</tr>
<tr>
<td>2.3</td>
<td>Slewing ring position : Horiz. ☐ Vert. ☐ Other ☐ Utilisation mode : Continu. ☐ Intermittent ☐ Other ☐</td>
</tr>
<tr>
<td>3.1</td>
<td>LOADS ON THE BEARING (including structural loads) : Applied ☐ Suspended ☐</td>
</tr>
<tr>
<td>3.2</td>
<td>Static</td>
</tr>
<tr>
<td>3.3</td>
<td>Nominal</td>
</tr>
<tr>
<td>3.4</td>
<td>Utilisation % Time</td>
</tr>
<tr>
<td>3.5</td>
<td>Axial kN</td>
</tr>
<tr>
<td>3.6</td>
<td>Radial kN</td>
</tr>
<tr>
<td>3.7</td>
<td>Moment kNm</td>
</tr>
<tr>
<td>3.8</td>
<td>Rotating ring : Ext ☐ Int ☐ Speed (RPM)</td>
</tr>
<tr>
<td>3.9</td>
<td>Load factors applied : Excluded ☐ Included ☐ Values :</td>
</tr>
<tr>
<td>3.10</td>
<td>Required life :</td>
</tr>
<tr>
<td>4.1</td>
<td>GEAR External ☐ Internal ☐ Without gear ☐</td>
</tr>
<tr>
<td>4.2</td>
<td>Geometry External S.R. Pinion</td>
</tr>
<tr>
<td>4.3</td>
<td>Required Module Tangentiel load (kN)</td>
</tr>
<tr>
<td>4.4</td>
<td>Number of teeth required Torque (kNm)</td>
</tr>
<tr>
<td>4.5</td>
<td>Addendum modif. factor</td>
</tr>
<tr>
<td>5.1</td>
<td>CRITICAL ITEMS Dimensions Others :</td>
</tr>
<tr>
<td>5.2</td>
<td>Classification ☐ Commission ☐ FEM ☐ LLOYDS ☐ API ☐ BV ☐ DNV ☐ Other</td>
</tr>
<tr>
<td>5.3</td>
<td>Specification relative to the application :</td>
</tr>
<tr>
<td>6.1</td>
<td>SPECIFIC REQUIREMENTS OF THE APPLICATION</td>
</tr>
<tr>
<td>6.2</td>
<td>Environment : Operating temperature :</td>
</tr>
<tr>
<td>6.3</td>
<td>Vibrations, shocks loads : Storing temperature :</td>
</tr>
<tr>
<td>6.4</td>
<td>Acceleration : Deceleration : Inert. mom./Rotation axis : Varied :</td>
</tr>
<tr>
<td>7.1</td>
<td>QUANTITY Yearly requirements : Qty per delivery :</td>
</tr>
<tr>
<td>8.1</td>
<td>REQUIRED DELIVERY TIME :</td>
</tr>
</tbody>
</table>
SKETCH OF YOUR APPLICATION
SHOWING THE LOAD POSITIONS
SLEWING RING FUNCTIONS

BEARING FUNCTION

The knowledge of loads and working conditions is necessary to allow us to design and dimension the "BEARING" function of the slewing ring i.e.: movement type, speed, accelerations, temperatures, environment, etc.

The transmission of loads from one raceway to another varies according to the nature of applied loads. In order to calculate the ideal dimensions of the raceway, we define the load equivalent to all external efforts in the most stressed areas. These loads are corrected by factors according to the application, the usage, etc.

We distinguish between:
- the application factor \( K_A \)
- the usage factor \( K_U \)
- the safety factor \( K_S \)

THE APPLICATION FACTOR \( K_A \) is a coefficient taking into account the application specificity in relation to the slewing ring element. This factor is established from ROLLIX experience. It is defined in the table "APPLICATION FACTORS".

THE USAGE FACTOR \( K_U \) is defined according to the particular operating conditions: vibrations, shocks, occasional or accidental overloading, etc. If no other value is specified, then the nominal value is taken as 1.

THE SAFETY FACTOR \( K_S \) is defined from standardized criteria for applications which must meet specific regulations such as: FEM, LLOYDS, API... This generally has the value 1, as the designer of the machine must include the regulation factors in the calculation of the loads applied on the bearing.
### SLEWING RING FUNCTIONS

#### BEARING FUNCTION

##### APPLICATION FACTORS

<table>
<thead>
<tr>
<th>MACHINES</th>
<th>Average speed</th>
<th>Applications factors</th>
<th>Rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armament turret</td>
<td>1,5</td>
<td>1,5</td>
<td></td>
</tr>
<tr>
<td>Bucket</td>
<td>1,5</td>
<td>1,65</td>
<td></td>
</tr>
<tr>
<td>Cable shovel</td>
<td>2</td>
<td>1,65</td>
<td></td>
</tr>
<tr>
<td>Compacter</td>
<td>2,5</td>
<td>1,80</td>
<td></td>
</tr>
<tr>
<td>Concrete mixer</td>
<td>5</td>
<td>2,40</td>
<td></td>
</tr>
<tr>
<td>Concrete pump</td>
<td>1,5</td>
<td>1,65</td>
<td></td>
</tr>
<tr>
<td>Dragline</td>
<td>1,5</td>
<td>1,65</td>
<td></td>
</tr>
<tr>
<td>Dock crane</td>
<td>1</td>
<td>1,65</td>
<td></td>
</tr>
<tr>
<td>Fairlead</td>
<td>0,8</td>
<td>1,35</td>
<td></td>
</tr>
<tr>
<td>Fork-lift truck</td>
<td>1</td>
<td>1,35</td>
<td></td>
</tr>
<tr>
<td>Fork-lift wheel</td>
<td>1,5</td>
<td>1,50</td>
<td></td>
</tr>
<tr>
<td>Grabbing crane</td>
<td>1,5</td>
<td>1,80</td>
<td></td>
</tr>
<tr>
<td>Heavy winch</td>
<td>2</td>
<td>1,65</td>
<td></td>
</tr>
<tr>
<td>Hydraulic lift platform</td>
<td>1</td>
<td>1,50</td>
<td></td>
</tr>
<tr>
<td>Hydraulic shovel</td>
<td>2,5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Loading dock crane</td>
<td>1</td>
<td>1,65</td>
<td></td>
</tr>
<tr>
<td>Merry-go-round</td>
<td>5</td>
<td>2,40</td>
<td></td>
</tr>
<tr>
<td>Mine digging machinery</td>
<td>1,5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Mobile fixed boom crane</td>
<td>1</td>
<td>1,5</td>
<td></td>
</tr>
<tr>
<td>Mobile grapple crane</td>
<td>1</td>
<td>1,80</td>
<td></td>
</tr>
</tbody>
</table>

These factors are determined statistically and are based on a large number of observations for each type of application.

The standard parameters retained are as follows:

- Theoretical service life: 6000 hours.
- Work under normal weather conditions.
- Conventional application (and not specific).
SLEWING RING FUNCTIONS

BEARING FUNCTION

Selection of the ring according to capacity

The load capacity of the slewing ring is calculated according to its performance in function of:

- its geometric envelope,
- the nature of the ring materials,
- the heat treatment carried out,
- the nature, the number and the dimension of the rolling elements,
- the contact parameters of the rolling elements.

The curve of the maximum permissible capacity is drawn on a graph whose Ox axis bears the equivalent axial load and the Oy axis bears the tilting moment. To simplify it, it is represented by a straight line called the "LIMIT CURVE".

The ring size is determined by plotting the representative point of loads onto this curve. This point, called "application point" has the following coordinates:

- on the horizontal axis: \( P_x = F_{eq} \cdot K_A \cdot K_U \cdot K_S \)
- on the vertical axis: \( P_y = M_T \cdot K_A \cdot K_U \cdot K_S \)

In any case, the application point P must be under the limit curve.

Service life

Many external factors have a very important influence on the service life of the bearing. Among others, we can cite:

- geometric quality of supports,
- structure deformation under load,
- climatic conditions and environment,
- quality of operating maintenance
- conditions of use: repeated exposures to shocks, vibrations or sudden or intermittent movements can considerably reduce the theoretical service life.

\[ K_T = \frac{OL}{OP} \]

An estimate of the theoretical service life can be obtained by comparing the application point to the limit curve: the ratio OL/OP is called \( K_T \).
SLEWING RING FUNCTIONS

BEARING FUNCTION

Service Life

An estimate of the service life D can be obtained using the opposite graph:
- The curve indicates the estimated service life (hours) directly from the KT value on the horizontal axis.

Rotational speed influence

The service life D, estimated on the graph is only valid for the applications having a low rotational speed: 1 RPM. The value obtained must be multiplied by the speed factor KV indicated on the opposite graph when speeds differ from this.

\[ D(n) = KV \times D \]

For applications having oscillating movements, the following formula applies:

\[ n_{\text{average}} = 0,60 \times n_{\text{real}} \]
SLEWING RING FUNCTIONS

FASTENING FUNCTION

In order to transmit the loads previously defined, it is necessary to realize an adequate mechanical fastening of the bearing on the associated frames, thus forming rigid connection of the ring and its supports.

While several fastening methods are feasible, the most efficient one remains the use of screws and nuts. Welding operations are absolutely prohibited.

The slewing ring proper functioning and the application safety are dependent on the correct bolting definition and fastening method during installation, complying with our workmanship.

BOLTS QUALITY

The ISO 898-1 standards define the bolting grade adapted to structure assemblies such as slewing rings. ROLLIX recommends the use of HIGH TENSILE bolts grade 10.9 and exceptionally grade 8.8 or 12.9 with rolled threads after heat treat.

The nuts must be of a same or higher grade as the associated screw. For a screw diameter d, a nut height of 1.d is recommended.

For rings in normalized steel Z or N, the use of hardened flat washers is required.

Minimal properties should be:

- a yield strength greater than or equal to 600 Mpa,
- a diameter : \( D_R = 2d \),
- a thickness : \( h \geq 0.3d \)

External hexagon head screws must be preferred to cap screws (internal hexagon) whenever possible.

ROLLIX recommendation: screws and nuts, with guaranteed mechanical properties, matched, prelubricated so as to obtain a known and permanent screw/nut friction factor. The surface coating on the bolts must not generate any embrittlement.

Minimal mechanical characteristics (according to ISO)

<table>
<thead>
<tr>
<th>GRADE</th>
<th>TENSILE (MPa)</th>
<th>YIELD (MPa)</th>
<th>FATIGUE (MPa)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.8</td>
<td>800</td>
<td>640</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>10.9</td>
<td>1040</td>
<td>940</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>12.9</td>
<td>1220</td>
<td>1100</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>
SLEWING RING FUNCTIONS

FASTENING FUNCTION

BOLTING CALCULATION
The ROLLIX calculation formulae take into account the current standards and regulations as well as the many research and experimental findings. These calculations are mainly inspired by the AFNOR FD E 25.030, the recommendation VDI 2230 (1988) and the standard API 2C (1995).

Supported loads must be distinguished from hanging (suspended) loads acting in tension. Consult ROLLIX, in the case of hanging (suspended) loads.

Standard calculation hypotheses
• Supported loads acting in compression.
• Equispaced bolts; i.e. equally positioned on the pitch circles.
• Steel rings and supports.
• Supports complying with our instructions: thickness, stiffness, surface evenness (see chapter STRUCTURES page 42).
• Rings bolted directly onto its supports.
• In cases of heavy radial loads, we recommend to use pilots or to glue so that bolts will not be subjected to shear stresses.
• The clamping length must be at least equal to five times the diameter: \( L_K \geq 5 \cdot d \).
SLEWING RING FUNCTIONS

FASTENING FUNCTIONS

Calculation of the number of bolts
When the ring has been previously selected according to its utilization and its load capacity, the bolting is then determined to correspond to the bearing capacity. The calculation of the minimum number of fasteners is carried out according to the following formula for the most unfavourable load case. In any case, a sufficient number of bolts ensuring an effective connection between ring and support frames must be kept, in order to avoid any ring deformation.

\[ N = \frac{1.6 \cdot F_k \cdot (4 \cdot M_T - F_A \cdot D_f)}{D_f \cdot (T_S - F_{pc})} \]

where :
- \( N \) = Number of bolts theoretically necessary.
- 1.6 = Tightening factor (assembly error factor) for torque wrench Grade B according to FD E 25-030.
- \( F_k \) = Bolt stretch factor, see sketch.
- \( M_T \) = Total tilting moment applied to the ring in kNm.
- \( F_A \) = Axial load in kN.
- \( D_f \) = Fastener pitch circle diameter in m.
- \( T_S \) = Tightening tension.
- \( d \) = Bolt diameter in mm.
- \( \Omega m \) = Raceway mean diameter in m.
- \( F_{pc} \) = Loss of tension due to embedding in kN, see graph.
- \( L_k \) = Clamping length in mm.

Bolt stretch factor \( F_k \)

This factor takes the assembly geometry into account. It is based on the bolt diameter and the ratio of clamping length to diameter. The best fastening is obtained with through-holes in the ring and the supports: by using screws and nuts, the clamping length is long, bolt stiffness is satisfactory and tension losses are minimised.

In case of screw fastening into tapped holes, the setting depth must not be less than 1.25\(d\).
SLEWING RING FUNCTIONS

FASTENING FUNCTIONS

Tightening tension \( T_s \)
Tightening tension of fastening bolts must be sufficient to warrant the absence of looseness which is essential to ensure the resistance of the assembly fatigue.

Calculation of the minimum fastener preload:
It is useful to check that the standar-dized preload of the chosen bolt diameter is sufficient compared to the dynamic stresses imposed when operating.

\[
T_s > \left( \frac{2.25}{N} \right) \left( \frac{4.M_T}{\varnothing m} \right) - FA + 80 \text{ N.d.10}^{-3} \]

The standar-dized tightening tension at 80% of Re must be selected from the following table according to the chosen bolt diameter: bolting grade 10.9.

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>20</th>
<th>22</th>
<th>24</th>
<th>27</th>
<th>30</th>
<th>33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension (kN)</td>
<td>56</td>
<td>77</td>
<td>106</td>
<td>166</td>
<td>208</td>
<td>239</td>
<td>315</td>
<td>385</td>
<td>480</td>
</tr>
</tbody>
</table>

Loss of tension:
During tightening and under external loads, peening of the surface roughness of the contact parts occurs, reducing the initial bolts elongation and thus producing a loss of tension, which decreases the preload in the assembly. This loss of tension has been tabulated on the following graph which shows values in function of diameter \( d \) and the ratio \( \frac{L_k}{d} \).

Calculation of under head contact pressure:
Usually, this calculation is not required when treated flat washers are used. It is however recommended when cap screws are used. (Chc).

We must have:

\[
\frac{F_B}{A_c} < P_{adm} \]

with

\[
F_B = T_s + 0.13.F_E \]

with

\[
F_E = \left( \frac{1}{N} \right) \left( \frac{4.M_T}{\varnothing m} \right) - FA \]

and

\[
A_c = \left( \frac{\pi}{4} \right) (D_w^2 - D_i^2) \]

Allowable pressure:
for steels N and Z 400 MPa
for steels D and X 620 MPa
for steels type E36 270 MPa

IMPORTANT REMARK
The use of elastic washers whatever the type or model is absolutely prohibited and will void all warranty.
SLEWING RING FUNCTIONS

SLEWING FUNCTION

ROLLIX slewing rings generally incorporate a SLEWING mechanism to control rotation of the mobile part. This function can be achieved by various means:

1. gear drive (the most frequent case)
2. belt drive
3. chain drive
4. direct drive

GEOMETRY

Most of the ROLLIX bearings have a gear improved by positive addendum modification which notably decreases pressures as well as by a truncation avoiding teeth root interference at the pinion. It is also essential to make a positive addendum modification on the pinion teeth, in order to avoid the geometric interference which appears under 18 teeth.

Furthermore, the drive stresses induce shaft bending and gear deformation which are harmful to good meshing. To prevent these faults, we recommend profile corrections be carried out on the pinions: i.e. crowning and tip relief. Our Engineering Department will assist upon request.

RESISTANCE

Our rating graphs indicate the values of allowable maximum tangential force in fatigue $T$.

The continuous operating capacity is obtained by the application of a suitable load moderating factor.

$$T = 2 \frac{C_d}{D_{\text{ref}}}$$

$C_d =$ Torque on gear
$D_{\text{ref}} =$ Reference diameter

Unless otherwise stated, the indicated values are valid for geared rings made of normalized steel XC45: code Z. When these values are not sufficient, ROLLIX can proceed with contour hardening which considerably improves the resistance to tooth root bending and the resistance to contact pressure. For very heavy loading conditions, ROLLIX carries out complete hardening of the tooth and of its root in the wheel rim. When only a better wear resistance is required, surface hardening of tooth flanks only is possible.
SLEWING RING FUNCTIONS

SLEWING FUNCTION

GEAR QUALITY
Unless stated otherwise, ROLLIX manufactures slewing ring gears according to AFNOR or DIN standards which meet the following criteria:

WITHOUT SUPERFICIAL HEAT TREATMENT

<table>
<thead>
<tr>
<th>DIN class</th>
<th>AFNOR class</th>
<th>Maximum diameter</th>
<th>Maximum module</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>12</td>
<td>all sizes</td>
<td>25</td>
<td>Module 45 with special tooling</td>
</tr>
<tr>
<td>10-11-12</td>
<td>11-10-9</td>
<td>all sizes</td>
<td>20</td>
<td>Specific equipment necessary</td>
</tr>
<tr>
<td>9-10</td>
<td>8-9</td>
<td>3100</td>
<td>22</td>
<td>• made upon request</td>
</tr>
<tr>
<td>7-8</td>
<td>7</td>
<td>2500</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

SUPERFICIALLY HARDENED GEAR
• Generally, by contour hardening to 55 HRc (± 5).
• The gear classes stated above are offset and ROLLIX can meet AFNOR or DIN standards for grades 11-12.

IMPORTANT
ROLLIX considers that the relevant gear characterizing parameters for each quality class defined by AFNOR, DIN or ISO must be met. In case a customer does not require all of the parameters and needs to meet only one or two of them, ROLLIX can achieve higher qualities.
OTHER FEATURES

PRECISION - TOLERANCES

Standard ring tolerances are generally defined according to ISO 286-1 and 2 standards.
For applications requiring a higher precision level: robotics, radars, etc. a better grade is considered. The tolerance values are then indicated on the bearing drawing. For bearings of large diameter with thin cross sections where radial stiffness is low, the tolerance values must be considered when bearing is assembled to its supports, these ensuring proper circularity.

GEOMETRY

The selected criteria are:
• For the diameters: Js 13
• For the centerings
  Bores: H9
  Shafts: f9
• For the overall height: ± 1 mm

FASTENING

The bolt circle diameters are machined to tolerance Js10 with a minimum of ± 0,2 mm.

GENERAL TOLERANCES TABLE (ACCORDING TO ISO 286-2)

<table>
<thead>
<tr>
<th>Diameter Js13 (in mm)</th>
<th>± 0,36</th>
<th>± 0,405</th>
<th>± 0,445</th>
<th>± 0,485</th>
<th>± 0,55</th>
<th>± 0,625</th>
<th>± 0,70</th>
<th>± 0,825</th>
<th>± 0,975</th>
<th>± 1,15</th>
<th>± 1,4</th>
<th>± 1,65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter Js10 (in μm)</td>
<td>± 92</td>
<td>± 105</td>
<td>± 115</td>
<td>± 125</td>
<td>± 140</td>
<td>± 160</td>
<td>± 180</td>
<td>± 210</td>
<td>± 250</td>
<td>± 300</td>
<td>± 350</td>
<td>± 430</td>
</tr>
<tr>
<td>Spigot f9 (in μm)</td>
<td>± 62</td>
<td>± 68</td>
<td>± 76</td>
<td>± 80</td>
<td>± 86</td>
<td>± 98</td>
<td>± 110</td>
<td>± 120</td>
<td>± 130</td>
<td>± 130</td>
<td>± 145</td>
<td>± 145</td>
</tr>
<tr>
<td>Pilot H9 (in μm)</td>
<td>- 165</td>
<td>- 185</td>
<td>- 202</td>
<td>- 223</td>
<td>- 251</td>
<td>- 280</td>
<td>- 316</td>
<td>- 358</td>
<td>- 420</td>
<td>- 490</td>
<td>- 570</td>
<td>- 685</td>
</tr>
</tbody>
</table>

GEAR

The value of the total run-out is indicated in the drawing title block. The measurement and tolerance over K teeth are also indicated on the drawing. This dimension includes the contribution of the ring to the meshing backlash.

BEARING

• The AXIAL RUN-OUT of the supporting faces is measured using a dial gauge over one full revolution (see opposite sketch).
OTHER FEATURES

PRECISION - TOLERANCES

- THE RADIAL RUN-OUT of the spigots is also measured by rotation (following sketch).

These measurements are carried out by placing the magnetic base of a dial gauge on the fixed ring, while the filler is taken in contact with the element to be measured. The reading will be obtained during one rotation of the turning ring (value T.I.R).

- THE DEFLECTION UNDER MASTER LOAD is measured as follows:

One of the bearing rings is fastened to a rigid support and a master load $F$ is applied axially on the other ring to a point closely located to the raceway. The deflection under load $F$ is measured using a dial gauge whose base is attached to the other ring. The deflection under standard load of every slewing ring is measured at the factory. This value is compared to the allowable limits, and is registered.

DEFLECTION UNDER MASTER LOAD
OTHER FEATURES

SLEWING TORQUE

Calculation of the necessary torque to enable a rotation of the whole assembly takes into account:
• loads on the machine,
• rotating masses,
• distance of these masses to the rotation axis,
• speeds and accelerations,
• resisting torques.

Two types of torques are distinguished:
Start up slewing torque: \[ C_d = C_{rv} + C_{rc} \]
Acceleration slewing torque: \[ C_g = C_{rv} + C_{rc} + C_a \]

Where:
- \( C_{rv} \) = Friction torque of unloaded bearing
- \( C_{rc} \) = Rotating torque due to loads
- \( C_a \) = Acceleration torque
- \( C_d \) = Starting torque

All these torques are expressed in kNm.

Crc : ROTATION TORQUE DUE TO LOADS

The starting torque required takes into consideration loads on the bearing and friction of the components.

Balls type slewing ring
\[ C_{rc} = \frac{13,11}{\bar{\Omega}} M_T + 3 F_A + 11,34 F_R \bar{\Omega} \times 10^{-3} \]

Crossed rollers type slewing ring:
\[ C_{rc} = \frac{15,3}{\bar{\Omega}} M_T + 3,75 F_A + 8,19 F_R \bar{\Omega} \times 10^{-3} \]

Where:
- \( M_T \) = Resulting moment in kNm
- \( \bar{\Omega} \) = Raceway mean \( \bar{\Omega} \) in meters
- \( F_A \) = Axial load in kN
- \( F_R \) = Radial load in kN

Ca : ACCELERATION TORQUE

The torque needed to accelerate the loads from the initial speed up to the final speed, during time \( t \) is defined by:
\[ C_a = \frac{\pi}{30} \times n \times I \times 10^{-3} \]

Where:
- \( t \) = Acceleration time in sec.
- \( n \) = Speed variation in RPM
- \( I \) = Moment of inertia of the machine in Kg \( \times m^2 \)

Generally we have:
\[ I = I_1 + I_2 + I_3 + \ldots + I_n \]

Where \( I_1 \) to \( I_n \) = moments of inertia of the moving loads with regard to the rotation axis expressed in Kg \( \times m^2 \).

Note: The resisting torque depends on the support surface flatness and lubrication.
OTHER FEATURES

SLEWING TORQUE

The friction torque of standard slewing rings is defined in the following graph. ROLLIX, upon request, can supply slewing rings with lower or higher torque values.

LOADS APPLIED ON THE RING
Axial $F_A : 68 \text{kN} + 5 \text{kN} = 73 \text{kN}$
Radial $F_R : 0,29 \text{kN}$, negligible
Moment $M_T : 5 \text{kN} \times 1,5 \text{m} = 7,5 \text{kNm}$

SLEWING TORQUE : Raceway mean $\varnothing = 2$ meters
Crv : according to the graph : $1 \text{kNm}$

$C_{rc} = \left[ \frac{13,11 \times 7,5}{2} + (73 \times 3) + (11,34 \times 0) \right] 2 \times 10^{-3}$

$C_{rc} = 0,536 \text{kNm}$

Slewing torque at start up
$C_d = 1 + 0,536 = 1,536 \text{kNm}$

Platform moment of inertia :
$\frac{M R^2}{2} = \frac{6800 \times 2^2}{2} = 13600 \text{ Kg m}^2$

Cube moment of inertia :
$M r^2 = 500 \times 1,5^2 = 1125 \text{ Kg m}^2$

Total moment of inertia :
$13600 + 1125 = 14725 \text{ Kg m}^2$

Acceleration torque :
$n = 6 - 2 = 4 \text{ RPM}$

Acceleration time : 20 sec
$C_a = \frac{14725 \times \pi \times 4}{30 \times 20} 10^{-3} = 0,3084 \text{kNm}$

Slewing torque during acceleration
$C_g = 1 + 0,536 + 0,3084 = 1,845 \text{kNm}$

APPLICATION EXAMPLE
Platform diameter : 4 m.
Platform mass : 6800 kg
Cube mass : 500 kg
Ball type slewing ring
raceway mean $\varnothing : 2$ m.
Distance from the cube to the rotation axis : 1,5 m.
Initial speed : 2 RPM
Final speed : 6 RPM
Acceleration time : 20 sec.
OTHER FEATURES

PROTECTION

SEALS
ROLLIX slewing rings are generally equipped with protecting seals on both sides of the raceway. These seals have the function of:
- protecting raceways against small-sized contaminating agents,
- retaining the lubricant in the raceway.
For specific requirements, ROLLIX designs suitable protective devices, such as:
- standard and specific seals,
- lip seals
- combination of two or more seals.

SHROUDS
For severe application conditions and in order to limit the effects of aggressive agents such as:
- swarf and metal chips
- welding grains
- abrasives
- mud
- sand
- water and heavy sea splashes
- cutting fluids...
ROLLIX strongly recommends to install effective protective shields.
Furthermore, during cleaning with solvents or pressurised water, it is advisable to avoid working in the protective device area.

SURVEY
If, during regreasing, large grease discharges are noticed, it is advisable to check:
- that seal is still correctly positioned,
- that seal is not damaged (cut, torn, worn),
- that seals are still capable for proper bearing operation.
Therefore, this seal can either be reinstalled or replaced.

SEAL RANGE TABLE

<table>
<thead>
<tr>
<th>Operating conditions</th>
<th>Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Normal&quot; - 30°C ≤ θ + 70°C</td>
<td>NITRILE-BASED elastomer</td>
</tr>
<tr>
<td>&quot;Extreme&quot; θ &lt; -30°C ; 70°C &lt; θ &lt; 200°C</td>
<td>FLUOR-BASED elastomer</td>
</tr>
<tr>
<td>&quot;Special&quot; : Various physical or chemical aggressive agents.</td>
<td>NITRILE-BASED elastomer modified or others</td>
</tr>
</tbody>
</table>

PROTECTIVE SURFACE COATING

For particular applications, ROLLIX suggests a protective surface treatment, such as:

1. Zinc plating (+ chromate coating)
2. Phosphate coating
3. Chemical nickel plating
4. Paint
5. Miscellaneous treatments, for example, chrome plating, Schoop’s metal spraying process, anodic oxidization, etc.