AGATHON AG, Normalien
P.O. Box, 4503 Solothurn/Switzerland
Telephone: +41 (0)32 617 4502
Telefax: +41 (0)32 617 4701
Email: normmail@agathon.ch
Internet: www.agathon.com

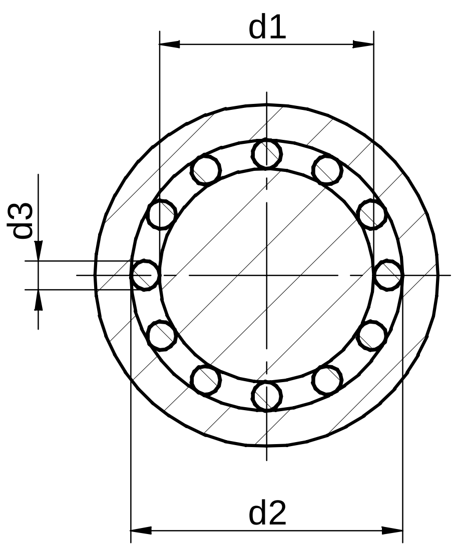
Press Release

Our ref.: Mr Markus Allenspach
Date: 24.05.2007

Preloaded, clearance-free antifriction guide elements for machine and fixture construction and apparatus engineering

Pillar-type antifriction guides are used for linear movement and/or simultaneous rotary motion, with high demands on angular alignment (clearance-free guide) and smooth-running properties. The ease of assembly of the guide unit lends itself to widespread use in many different applications. The **zero backlash of the antifriction** guide is achieved by the preload. Therefore, the total stroke length is limited by the length of the guide bushing.
On initial consideration, the importance of the preload on the guide's qualities is often underestimated. However, it is the preload that is essential for the optimal function and long life cycle of the guide unit. It is definitively responsible for the internal "play", and respectively, the side load capacity and running properties of an antifriction guide.
Preload is the mathematical difference of a guide bushing's inner diameter (d_2), minus 2x the rolling element's diameter (d_3) minus the pillar diameter (d_1). The result in the negative range (µ) identifies the preload, related to the diameter (i.e. the individual components must compensate this value through deflection). The maximum material resilience until permanent deformation is specified by the Hertzian surface pressure (in our case it is 4'400 N/mm^2 for ball guides, respectively 4'200 N/mm^2 for roller guides with a linear shaped contact zone).

Drawing, definition of the deformation:



$V = d_1 + 2d_3 – d_2$ (mm)
$d_2 = d_1 + 2d_3 – V$ (mm)
V = preload

Direct contact:
Telephone: +41 (0)32 617 4504
Telefax: +41 (0)32 617 4704
Email: markus.allenspach@agathon.ch

Subsidiaries:
AGATHON Inc.
Bethel, CT 06801-USA
AGATHON (U.K.) Ltd.
Daventry Northants NN11 5EA

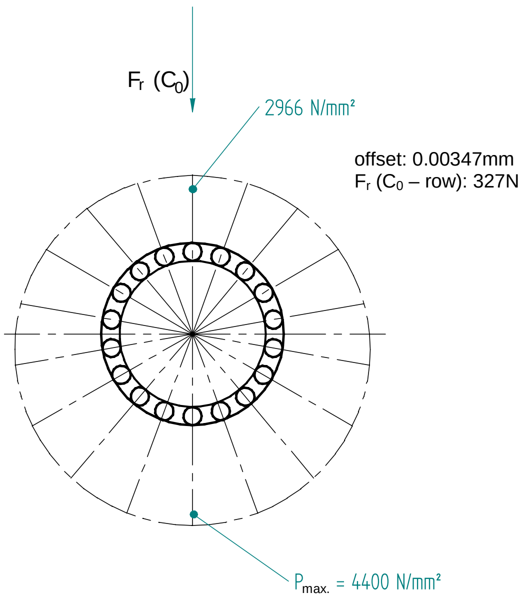
AGATHON
SWITZERLAND

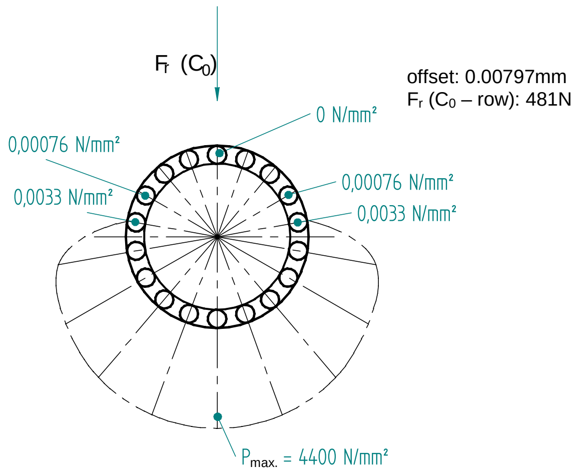
A guide element manufactured with high **preload** results in a **stiffer guide** (with little angular misalignment), however the radial **load capacity** and the life cycle of the guide are reduced. Therefore it is necessary to operate within a very strict preload tolerance. In order to guarantee an ideal preload with prefabricated single components, the particular **tolerances** (on pillars, bushings and rolling elements of the cage) have to be chosen extremely close. Furthermore, the components must be manufactured with the **highest surface finish**.

Depending on the pillar diameter, a radial force effect will have a different impact on the rolling elements. An increased pillar diameter results in a higher load capacity of the guide thanks to the better **load distribution** and the larger curvature radius from pillar to rolling element (= bigger contact zone). Moreover, each individual rolling element is loaded less because of the higher number of rolling elements around the circumference of the cage. Here, not only the quantity of the rolling elements but also **their optimal distribution** is important. Depending on the stroke velocity it is important to consider the heat conductivity of the cage material. This way, the heat that may arise can be dissipated away from the rolling elements in high load requirements.

The following drawings demonstrate the influence of the preload:

Higher preload less angular misalignment and lower radial load capacity, respectively shorter life cycle on higher loads	Less preload more angular misalignment and higher radial load capacity, respectively longer life cycle on lower loads





The comparison applies to a pillar diameter 32mm. The **difference of the preload between the left and the right drawing is 9µ.**
Here, the ball is loaded to the maximum surface pressure on the line of force (Fr). The static load rating C_0 corresponds to the load between the highest loaded ball/roller and the bushing/pillar contact point, where a permanent overall deformation of 1/10'000mm (0.1µ) of the ball/roller diameter is generated. According to the manufacturer of radial ball bearings (SKF, FAG, etc.), this deformation is reached when the surface pressure at the contact zones of the rolling elements reaches 4'400N/mm^2 (balls).

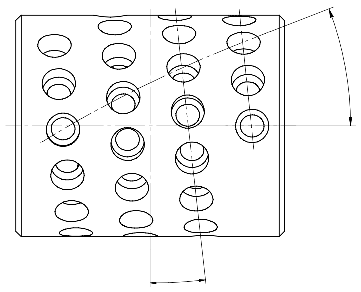
Direct contact:
Telephone: +41 (0)32 617 4504
Telefax: +41 (0)32 617 4704
Email: markus.allenspach@agathon.ch

Subsidiaries:
AGATHON Inc.
Bethel, CT 06801-USA
AGATHON (U.K.) Ltd.
Daventry Northants NN11 5EA

In order to keep the **wear** on the pillar and bushing to a minimum, the rolling elements in the cage are **displaced** by a few degrees in **axial direction**. This allows each single rolling element to roll on its own track and thereby increasing the life cycle of the guide unit. Special cages can be manufactured for applications requiring a very consistent lead-in of the ball/roller into the preload with minimal effort (e.g. applications in callipers, etc.). There the rolling elements are additionally **displaced** in a **radial direction** as well. This means that each rolling element individually enters the preload. As a result of this **double-spiralled arrangement of the rolling elements**, the ball/roller placement on the peripheral zone of the cage is no longer ideal. For applications with high moment forces, a high density of the rolling elements on the peripheral zone is very important. Therefore, cages with double-spiralled arrangement of the rolling elements are not suitable for such applications. When defining the ball alignment and the dimensions of the cage, the load of the rolling elements must be considered.

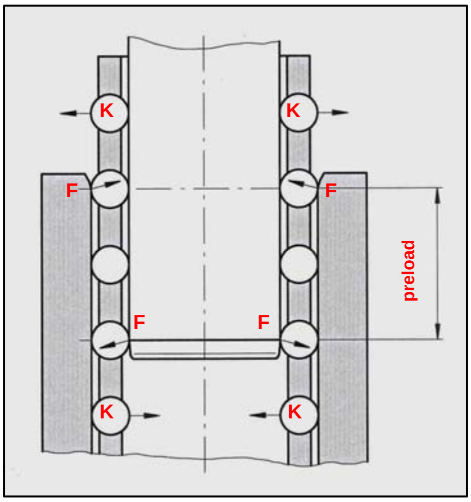
However, applications with **rotary motion** imperatively require the double-spiralled arrangement of the rolling elements, so that each rolling element rotates on its own path. In addition, a low preload is necessary, and calculated into the cage design/preload requirements.

Drawing, double-spiralled arrangement of the rolling elements:



Special lead-in geometries on pillars and bushings as well as an accurately defined clearance of the rolling elements combined with an ideal staking method of the rolling elements in the cage also guarantee a smooth movement of the rolling elements into the preload and results in an **increased life cycle** of the cage.

The below drawing illustrates the forces (F) when the rolling elements (K) enter into the preload:



AGATHON Ltd., Standards is worldwide known as a leading manufacturer of press-tool Standards, as well as **guide elements** for the mould, **machine and fixture construction and apparatus engineering.**
The products of this Swiss company are recognized for the highest material quality and surface finish, together with the closest tolerances.
An outstanding price/performance ratio and availability from stock are other convincing characteristics.
To facilitate your construction we recommend using our CAD-catalogue with our standardized parts on our homepage.
For customized products we provide advisory service and support in defining the ideal layout.

The **guide element program** for the **machine and fixture construction** as well as for the **apparatus engineering** features the following:

- **Miniature ball guide units**
- **Pillars and bushings as per AGATHON and ISO/DIN standardization**
- **Slide guide bushings** for high loads with a minimum of sliding clearance
- **Ball cages** for smooth, frictionless and backlash free operation (patent)
- **Roller cages** for frictionless and backlash free operation, high rigidity and with radial forces (patent)
- **Customized parts**, e.g. rust-resistant materials, ball cages in special synthetic material (used in high temperatures), profile rollers for linear shaped contact, etc.

Our products guarantee the following:
- *Interchangeability:* closer form and positional tolerances (bushings js4 on the mounting diameter)
- *Easier assembly:* f8 lead-in tolerances
- *Higher loading capacity:* quantity and allocation of the rolling elements
- *Longer life cycle:* optimized lead-in geometries, reduced ball/roller play

Direct contact:
Telephone: +41 (0)32 617 4504
Telefax: +41 (0)32 617 4704
Email: markus.allenspach@agathon.ch

Subsidiaries:
AGATHON Inc.
Bethel, CT 06801-USA
AGATHON (U.K.) Ltd.
Daventry Northants NN11 5EA