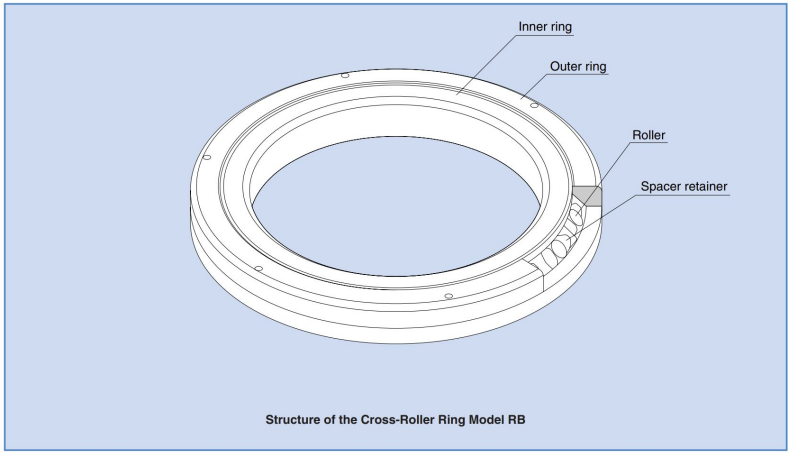
Bearing Selection

Crossed Roller Bearing Selection

- Eliminates the need for a 2 bearing support at each joint (like was done in 2018)
  - Clamp mounting vs slip clearance on a shaft will have lower backlash
- High moment loading stiffness because of line contact of rollers vs point contact of balls

Model RA-C (Single-Split Type)

The major dimensions of this model are the same as that of model RA. Since the outer ring is split at one point to increase the rigidity of the outer ring, this model can also be used for outer ring rotation.



Structure of the Cross-Roller Ring Model RB

With the Cross-Roller Ring, cylindrical rollers are arranged crosswise, with each roller perpendicular to the adjacent roller, in a 90˚ V groove, separated from each other by a spacer retainer. This design allows just one bearing to receive loads in all directions including, radial, axial and moment loads.
Since the Cross-Roller Ring achieves high rigidity despite the minimum possible dimensions of the inner and outer rings, it is optimal for applications such as joints and swiveling units of industrial robots, swiveling tables of machining centers, rotary units of manipulators, precision rotary tables, medical equipment, measuring instruments and IC manufacturing machines.

Question: Is a crossed-roller bearing stiffness enough?

- Reference page 18-18 of manual
- Estimating stiffness based on the slope of the origin to (0.05 kNm, 0.6 rad) data point from this graph
- Result of 833333.3333 Nm/rad
- Roughly 40X the #35 prox chain stiffness, so seems plenty stiff enough

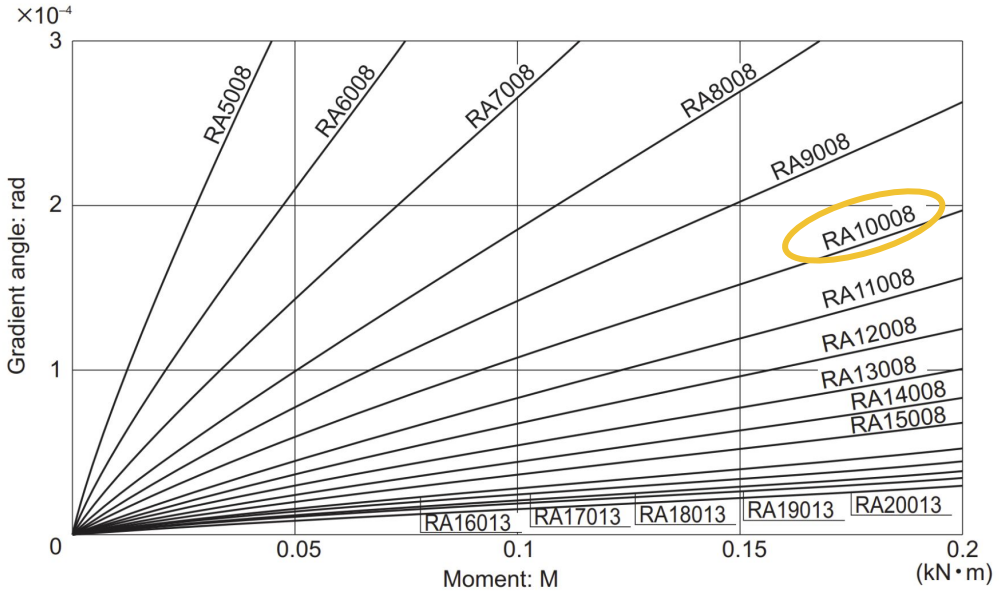


Fig.4

Question: Is our bearing strong enough?

Reference equations from pg 18-9 of the manual for equations to calculate equivalent dynamic load rating

[Dynamic Equivalent Radial Load P_C]

The dynamic equivalent radial load of the Cross-Roller Ring is obtained from the following equation.

$$P_C = X \cdot \left(Fr + \frac{2M}{dp}\right) + Y \cdot Fa$$

P_C	: Dynamic equivalent radial load	(N)
Fr	: Radial load	(N)
Fa	: Axial load	(N)
M	: Moment	(N-mm)
X	: Dynamic radial factor	(see Table2)
Y	: Dynamic axial factor	(see Table2)
dp	: Roller pitch circle diameter	(mm)

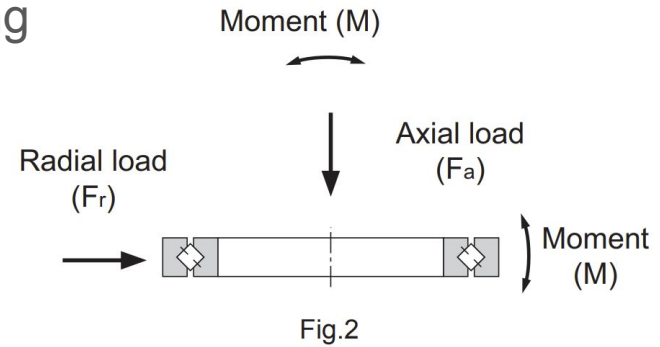


Fig.2

Table2 Dynamic Radial Factor and Dynamic Axial Factor

Classification	X	Y
$\frac{Fa}{Fr + 2M/dp} \leqq 1.5$	1	0.45
$\frac{Fa}{Fr + 2M/dp} > 1.5$	0.67	0.67

Question: Is our bearing strong enough? (cont)

- Assume that our max load is 100 lbf at the end of a fully extended arm (58 in)
  - Estimate someone pushing reasonably hard sideways
- dp = 128 mm
- M = 200*58 in-lbf
- X = 1 (because it is primarily moment loading)
- Pc = 12.1 kN

The max load rating is 16.5 kN. Resulting FOS is 1.6, which seems adequate

Design Detail: How to mount a crossed roller bearing

- Make sure to not clamp past ds or dh