For New Technology Network

NTN®

NTNcorporation

# BEAREE

## High Performance Multi-Purpose Engineering Plastics

CAT. No. 5100-Ⅲ/E

# Warranty

**NTN** warrants, to the original purchaser only, that the delivered product which is the subject of this sale (a) will conform to drawings and specifications mutually established in writing as applicable to the contract, and (b) be free from defects in material or fabrication. The duration of this warranty is one year from date of delivery. If the buyer discovers within this period a failure of the product to conform to drawings or specifications, or a defect in material or fabrication, it must promptly notify **NTN** in writing. In no event shall such notification be received by **NTN** later than 13 months from the date of delivery. Within a reasonable time after such notification, **NTN** will, at its option, (a) correct any failure of the product to conform to drawings, specifications or any defect in material or workmanship, with either replacement or repair of the product, or (b) refund, in part or in whole, the purchase price. Such replacement and repair, excluding charges for labor, is at **NTN**'s expense. All warranty service will be performed at service centers designated by **NTN**. These remedies are the purchaser's exclusive remedies for breach of warranty.

**NTN** does not warrant (a) any product, components or parts not manufactured by **NTN**, (b) defects caused by failure to provide a suitable installation environment for the product, (c) damage caused by use of the product for purposes other than those for which it was designed, (d) damage caused by disasters such as fire, flood, wind, and lightning, (e) damage caused by unauthorized attachments or modification, (f) damage during shipment, or (g) any other abuse or misuse by the purchaser.

**THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

In no case shall **NTN** be liable for any special, incidental, or consequential damages based upon breach of warranty, breach of contract, negligence, strict tort, or any other legal theory,and in no case shall total liability of **NTN** exceed the purchase price of the part upon which such liability is based. Such damages include, but are not limited to, loss of profits, loss of savings or revenue, loss of use of the product or any associated equipment, cost of capital, cost of any substitute equipment, facilities or services, downtime, the claims of third parties including customers, and injury to property. Some states do not allow limits on warranties, or on remedies for breach in certain transactions. In such states, the limits in this paragraph and in paragraph (2) shall apply to the extent allowable under case law and statutes in such states.

Any action for breach of warranty or any other legal theory must be commenced within 15 months following delivery of the goods.

Unless modified in a writing signed by both parties, this agreement is understood to be the complete and exclusive agreement between the parties, superceding all prior agreements, oral or written, and all other communications between the parties relating to the subject matter of this agreement. No employee of **NTN** or any other party is authorized to make any warranty in addition to those made in this agreement.

This agreement allocates the risks of product failure between **NTN** and the purchaser. This allocation is recognized by both parties and is reflected in the price of the goods. The purchaser acknowledges that it has read this agreement, understands it, and is bound by its terms.

# BEAREE Products

## NTN High Performance Multi-Purpose Engineering Plastics

***High performance sliding bearings, mechanical parts and materials use state-of-the-art engineering plastics.***

Products of NTN Engineering Plastics Corporation can be purchased from NTN Corporation and NTN Bearing Corporation. Contact our nearest branch office, sales division or representatives.

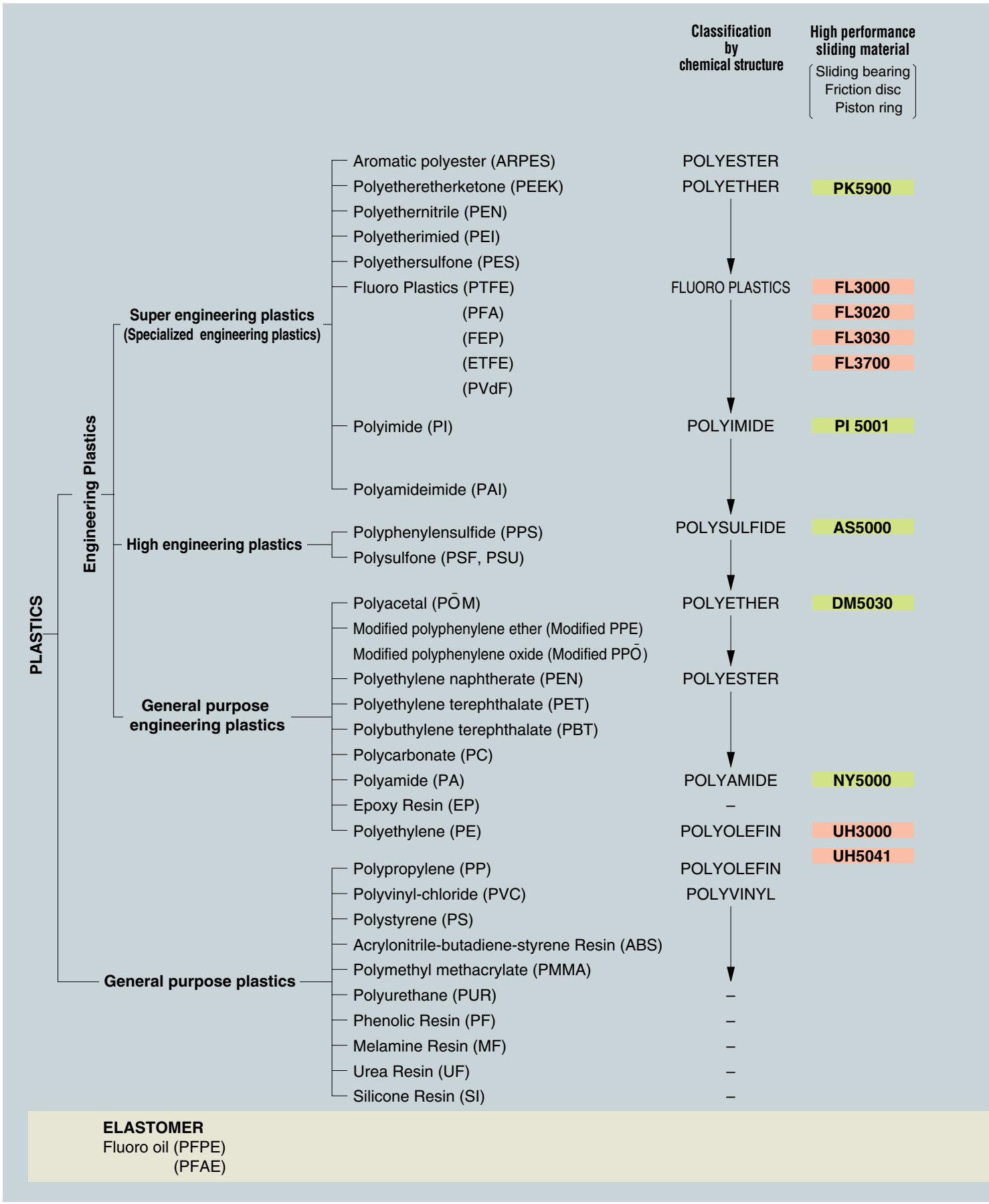
PAGE



Confirmation sheet of conditions for use can be found on the last page for your convenience.

# 1 Material Grades of NTN Engineering Plastics

## Low friction and lubrication free materials provide longer life, lighter weight and other benefits for



## a variety of high technology uses

Materials for machining
Injection molding materials
Coating materials

| For soft mating material (Aluminum etc.) (Sliding bearing, Seal ring) | For sliding under water and chemical liquid (Sliding bearing, Hot water pump bearing) | For specialized application (Electric conductivity, Reinforced with bronze mesh, Food contact machinery) | For seal ring (Compressor) | Gear materials (Heat insulating sleeve, Bearing, Bearing cage, Lens holder) | For picker finger | Coating materials (Picker finger, Roots pump rotor) |
|---|---|---|---|---|---|---|
| | | | | | LC5020 | |
| PK5300 | | PK5030 | PK5300 | | | |
| | | | | | | FL7060 |
| FL3030 | FL3700 | FL3060 | FL3000 | | | FL7075 |
| FL3040 | | FL3305 | FL3030 | | | FE7010 |
| FL3050 | | FL3642 | FL3050 | | | FE7030 |
| | | FL3900 | FL3070 | | | FE7080 |
| | | FL9000 | FL3900 | | | FE7092 |
| | | PI 5001 | | PI 5030 | PI 5022 | PI 7000 |
| PI 5010 | | PI 5040 | | PI 5033 | | |
| | | | | AI 5003 | AI 5003 | |
| AS5000 | AS5700 | AS5910 | AS5001 | AS5040 | AS5021 | |
| AS5005 | | AS5950 | AS5700 | AS5044 | AS5025 | |
| AS5053 | | AS5961 | | AS5045 | | |
| DM5030 | | | | | | |
| | | NY5910 | | NY5010 | | |
| | | NY5911 | | NY5910 | | |
| | | UH3000 | | | | |
| | | UH3954 | | | | |
| | | UH5000 | | | | |
| | | UH5043 | | | | |

BEAREE FL 3000
- MATERIAL NO.
- MATERIAL GRADE

ER3000, ER3600

**Table 1 Base Resins and Characteristics of Major Grades** [ ]: Molding method

| Grade | Base Resin | Characteristics |
|---|---|---|
| **BEAREE FL** | Fluoro Plastics (Tetrafluoroethylene) | The base resin of BEAREE FL is a Fluoro plastic with excellent characteristics such as low friction, non-stick quality, and resistance to wear, heat, chemicals, and weather. Special additives are used in BEAREE FL to ensure the best performance in sliding applications. (Compression molding, extrusion, and coating) |
| **BEAREE FE** | Fluoro Plastics (other than Tetrafluoroethylene) Fluoro oil | The performance of BEAREE FE is slightly lower than that of BEAREE FL, but it has better productivity. It is excellent for low friction and wear resistance, and is suitable for an antistick coating material. (Injection molding, extrusion, and coating) |
| **BEAREE PI** | Polyimide | BEAREE PI has excellent heat resistance and mechanical strength. This material has special fillers to improve the properties of polyimide, which is known as the highest heat-resistant plastic. Thermosetting and thermoplastic types are available, and selected by the application. The high water absorption of this type should be taken into consideration in product design. (Injection molding, extrusion, compression molding and coating) |
| **BEAREE AI** | Polyamideimide | Heat resistance of BEAREE AI is slightly lower than BEAREE PI, however it has excellent mechanical properties such as shock and fatigue resistance. The high water absorption of this type should be taken into consideration in product design. (Injection molding, extrusion, compression molding and coating) |
| **BEAREE UH** | Polyethylene | This material has lower performance than the "super" engineering plastics; however, this material takes advantage of the excellent properties of polyethylene, such as low friction, high resistance to wear, chemicals, and shocks, non-stick quality, and good electrical properties. The shrinkage factor during molding and coefficient of thermal expansion are high, and the material is difficult to bond. (Injection molding, extrusion, and compression molding) |
| **BEAREE AS** | Polyphenylensulfide | BEAREE AS is widely applicable because its base resin of polyphenylenesulfide has excellent heat and wear resistance, mechanical properties and moldability. Also, this material is suited for cost effective mass production. (Injection molding) |
| **BEAREE LC** | Aromatic polyester | This material has excellent heat resistance and mechanical strength, especially rigidity. When used with materials based on liquid crystal polymer designers should consider the anisotropy of the material at product design. (Injection molding) |
| **BEAREE PK** | Polyetheretherketone | BEAREE PK is based on polyetheretherketone, which has excellent properties close to polyimide in heat, chemical, shock and fatigue resistance, and self lubrication. Therefore, the characteristics of this material is similar to BEAREE PI and AI, however water absorption is less. It should be noted at product design that the shrinkage factor at molding is high. (Injection molding and extrusion) |
| **BEAREE NY** | Polyamide | This material is based on polyamide, one of the most popular general purpose engineering plastics, and is superior in shock and wear resistance. The heat resistance of this material is lower than "super" engineering plastics, however, it is much more economical. It should be noted at product design that the shrinkage factor at molding is high. (Injection molding) |
| **BEAREE DM** | Polyoxymethylene (Polyacetal) | This material is based on polyoxymethylene that is superior in fatigue, creep and wear resistance and dimensional stability; however, because of the high levels of oxygen in the molecular structure, fire retardance is difficult. Like BEAREE NY, this material is much more economical than "super" engineering plastic based materials. (Injection molding) |
| **BEAREE ER** | Elastomer ("Sliding Rubber") | BEAREE ER is based on an elastomer. This "Sliding Rubber" is a fluoro plastic with elasticity and is superior in elasticity, non stick quality, low friction and resistance to heat, wear and creep. |

Products using materials such as BEAREE PI, BEAREE AI, BEAREE LC and BEAREE PK are considered strategic products as defined by the "Foreign Exchange and Trade Control Law" in specified use and figure. When exporting a product that comes under the regulation, an export license by the Japanese government is requested. Contact us for details.

# 2 Standard Series of NTN Engineering Plastics Sliding Bearings

The following six series of standard bearings are prepared for a wide variety of applications.

## Type AR 〔Sleeve Bearing〕

AR series is machined from a bar or pipe made of BEAREE FL 3000 material.
This bearing only carries radial load and the standard bore size is $\phi$3 to $\phi$50mm.

## Type ARF 〔Flanged Sleeve Bearing〕

Type ARF adds a flange to type AR and can carry radial and axial load. The standard bore size is $\phi$3 to $\phi$50mm.

## Type BRF 〔Flanged Sleeve Bearing〕

Type BRF is made by injection molding and its material is BEAREE AS 5005. This bearing is flanged to carry radial and axial load. The standard bore size is $\phi$3 to $\phi$25mm. Lighter weight and more compact designs than with the ARF type are possible.

## Type TW 〔Thrust Washer〕

The Type TW thrust washer is made from BEAREE FL 3000 tape, the thickness is 0.8mm and standard bore is $\phi$6 to $\phi$50mm.

## Type ML 〔M Liner bearing〕

Type ML is a rolled steel plate bushing with BEAREE FL 3060 liner bonded on its bore, and the steel plate is zinc coated for rust prevention. This bearing carries higher pressure than types AR or ARF, having a thin wall, and a more compact design is possible. The standard bore size is $\phi$3 to $\phi$70mm and several widths are available for each bore.

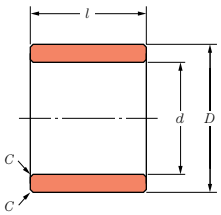
## MLC TYPE 〔MLC bearing〕

The MLC type is a three layered bearing composed of a special filler containing tetrafluoroethylene impregnated on the porous sintered layer made of bronze powder sintered on the back metal steel plate. The MLC Bearing for radial loads, the flanged MLCF bearing that can accept radial and axial loads, and thrust load MLCW bearings are standardized.

**1. BEAREE FL can be deformed or scratched by shock load, etc. and BEAREE PI can be cracked or chipped.**
**2. Surface roughness of the mating material greatly affects bearing life. NTN recommends surface roughness of 0.1-0.8Ra.**
**3. The operating temperature may loose the clearance in the shaft and result in overheating, burning and seizing of the mechanism. Completely check the relation between fittings and clearances before application.**

## Type AR

Sleeve Bearing



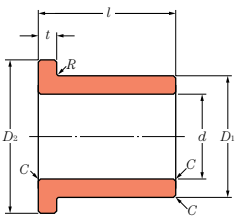

Dimensions to be measured at 25˚C

| Part No. | Dimension mm | | | | Recommended Fit mm | | Minimum Mounted Clearance mm |
|---|---|---|---|---|---|---|---|
| | $d$ tolerances | $D$ tolerances | $l$ tolerances | $C$ | Shaft h6 | Housing M7 | |
| R-AR0305 | $3^{+0.21}_{+0.16}$ | $6^{+0.09}_{+0.04}$ | $5^{0}_{-0.20}$ | 0.3 | $3^{0}_{-0.006}$ | $6^{0}_{-0\ 012}$ | 0.06 |
| R-AR0406 | $4^{+0.21}_{+0.16}$ | $7^{+0.09}_{+0.04}$ | $6^{0}_{-0.20}$ | 0.3 | $4^{0}_{-0.006}$ | $7^{0}_{-0.015}$ | 0.06 |
| R-AR0506 | $5^{+0.21}_{+0.16}$ | $8^{+0.09}_{+0.04}$ | $6^{0}_{-0.20}$ | 0.3 | $5^{0}_{-0.008}$ | $8^{0}_{-0.015}$ | 0.06 |
| R-AR0608 | $6^{+0.21}_{+0.16}$ | $9^{+0.09}_{+0.04}$ | $8^{0}_{-0.20}$ | 0.3 | $6^{0}_{-0.008}$ | $9^{0}_{-0.015}$ | 0.06 |
| R-AR0708 | $7^{+0.23}_{+0.18}$ | $11^{+0.10}_{+0.05}$ | $8^{0}_{-0.20}$ | 0.5 | $7^{0}_{-0.009}$ | $11^{0}_{-0.018}$ | 0.06 |
| R-AR0808 | $8^{+0.23}_{+0.18}$ | $12^{+0.10}_{+0.05}$ | $8^{0}_{-0.20}$ | 0.5 | $8^{0}_{-0.009}$ | $12^{0}_{-0.018}$ | 0.06 |
| R-AR0910 | $9^{+0.23}_{+0.18}$ | $13^{+0.10}_{+0.05}$ | $10^{0}_{-0.25}$ | 0.5 | $9^{0}_{-0.009}$ | $13^{0.}_{-0.018}$ | 0.06 |
| R-AR1010 | $10^{+0.24}_{+0.19}$ | $14^{+0.10}_{+0.05}$ | $10^{0}_{-0.25}$ | 0.5 | $10^{0}_{-0.009}$ | $14^{0}_{-0.018}$ | 0.07 |
| R-AR1210 | $12^{+0.24}_{+0.19}$ | $16^{+0.10}_{+0.05}$ | $10^{0}_{-0.25}$ | 0.5 | $12^{0}_{-0.011}$ | $16^{0}_{-0.018}$ | 0.07 |
| R-AR1515 | $15^{+0.27}_{+0.20}$ | $21^{+0.10}_{+0.05}$ | $15^{0}_{-0.25}$ | 0.5 | $15^{0}_{-0.011}$ | $21^{0}_{-0.021}$ | 0.08 |
| R-AR1715 | $17^{+0.27}_{+0.20}$ | $23^{+0.10}_{+0.05}$ | $15^{0}_{-0.25}$ | 0.5 | $17^{0}_{-0.011}$ | $23^{0}_{-0.021}$ | 0.08 |
| R-AR2020 | $20^{+0.33}_{+0.21}$ | $26^{+0.11}_{+0.06}$ | $20^{0}_{-0.25}$ | 0.8 | $20^{0}_{-0.013}$ | $26^{0}_{-0.021}$ | 0.08 |
| R-AR2220 | $22^{+0.33}_{+0.21}$ | $28^{+0.11}_{+0.06}$ | $20^{0}_{-0.25}$ | 0.8 | $22^{0}_{-0.013}$ | $28^{0}_{-0.021}$ | 0.08 |
| R-AR2525 | $25^{+0.33}_{+0.21}$ | $31^{+0.11}_{+0.06}$ | $25^{0}_{-0.25}$ | 0.8 | $25^{0}_{-0.013}$ | $31^{0}_{-0.025}$ | 0.08 |
| R-AR2830 | $28^{+0.33}_{+0.21}$ | $34^{+0.11}_{+0.06}$ | $30^{0}_{-0.25}$ | 0.8 | $28^{0}_{-0.013}$ | $34^{0}_{-0.025}$ | 0.08 |
| R-AR3030 | $30^{+0.33}_{+0.21}$ | $36^{+0.11}_{+0.06}$ | $30^{0}_{-0.25}$ | 0.8 | $30^{0}_{-0.013}$ | $36^{0}_{-0.025}$ | 0.08 |
| R-AR3230 | $32^{+0.38}_{+0.22}$ | $40^{+0.11}_{+0.06}$ | $30^{0}_{-0.25}$ | 1.0 | $32^{0}_{-0.016}$ | $40^{0}_{-0.025}$ | 0.09 |
| R-AR3535 | $35^{+0.38}_{+0.22}$ | $43^{+0.11}_{+0.06}$ | $35^{0}_{-0.25}$ | 1.0 | $35^{0}_{-0.016}$ | $43^{0}_{-0.025}$ | 0.09 |
| R-AR4040 | $40^{+0.38}_{+0.22}$ | $48^{+0.11}_{+0.06}$ | $40^{0}_{-0.25}$ | 1.0 | $40^{0}_{-0.016}$ | $48^{0}_{-0.025}$ | 0.09 |
| R-AR4550 | $45^{+0.39}_{+0.23}$ | $53^{+0.11}_{+0.06}$ | $50^{0}_{-0.25}$ | 1.0 | $45^{0}_{-0.016}$ | $53^{0}_{-0.030}$ | 0.09 |
| R-AR5050 | $50^{+0.39}_{+0.23}$ | $60^{+0.11}_{+0.06}$ | $50^{0}_{-0.25}$ | 1.0 | $50^{0}_{-0.016}$ | $60^{0}_{-0.030}$ | 0.09 |

Remark 1. Use $1.0\times10^{-7}$ mm$^3$/N·Em as a guide line for the specific wear rate $K$.

## Type ARF

Flanged Sleeve Bearing



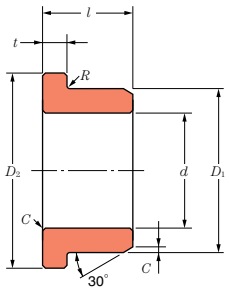

Dimensions to be measured at 25˚C

| Part No. | Dimension mm | | | | | Recommended Fit mm | | Minimum Mounted Clearance mm |
|---|---|---|---|---|---|---|---|---|
| | $d$ tolerances | $D_1$ tolerances | $l$ tolerances | $D_2$ | $t$ tolerances | Shaft h6 | Housing M7 | |
| R-ARF0305 | $3^{+0.21}_{+0.16}$ | $6^{+0.09}_{+0.04}$ | $5^{0}_{-0.20}$ | 9 | $1.5^{+0.10}_{0}$ | $3^{0}_{-0.006}$ | $6^{0}_{-0.012}$ | 0.06 |
| R-ARF0406 | $4^{+0.21}_{+0.16}$ | $7^{+0.09}_{+0.04}$ | $6^{0}_{-0.20}$ | 9 | $1.5^{+0.10}_{0}$ | $4^{0}_{-0.008}$ | $7^{0}_{-0.015}$ | 0.06 |
| R-ARF0508 | $5^{+0.21}_{+0.16}$ | $8^{+0.09}_{+0.04}$ | $8^{0}_{-0.20}$ | 11 | $1.5^{+0.10}_{0}$ | $5^{0}_{-0.008}$ | $8^{0}_{-0.015}$ | 0.06 |
| R-ARF0608 | $6^{+0.21}_{+0.16}$ | $9^{+0.09}_{+0.04}$ | $8^{0}_{-0.20}$ | 12 | $1.5^{+0.10}_{0}$ | $6^{0}_{-0.008}$ | $9^{0}_{-0.015}$ | 0.06 |
| R-ARF0710 | $7^{+0.23}_{+0.18}$ | $11^{+0.10}_{+0.05}$ | $10^{0}_{-0.25}$ | 15 | $2^{+0.10}_{0}$ | $7^{0}_{-0.009}$ | $11^{0}_{-0.018}$ | 0.06 |
| R-ARF0810 | $8^{+0.23}_{+0.18}$ | $12^{+0.10}_{+0.05}$ | $10^{0}_{-0.25}$ | 16 | $2^{+0.10}_{0}$ | $8^{0}_{-0.009}$ | $12^{0}_{-0.018}$ | 0.06 |
| R-ARF0910 | $9^{+0.23}_{+0.18}$ | $13^{+0.10}_{+0.05}$ | $10^{0}_{-0.25}$ | 17 | $2^{+0.10}_{0}$ | $9^{0}_{-0.009}$ | $13^{0}_{-0.018}$ | 0.06 |
| R-ARF1015 | $10^{+0.24}_{+0.19}$ | $14^{+0.10}_{+0.05}$ | $15^{0}_{-0.25}$ | 18 | $2^{+0.10}_{0}$ | $10^{0}_{-0.009}$ | $14^{0}_{-0.018}$ | 0.07 |
| R-ARF1215 | $12^{+0.24}_{+0.19}$ | $16^{+0.10}_{+0.05}$ | $15^{0}_{-0.25}$ | 20 | $2^{+0.10}_{0}$ | $12^{0}_{-0.011}$ | $16^{0}_{-0.018}$ | 0.07 |
| R-ARF1520 | $15^{+0.27}_{+0.20}$ | $21^{+0.10}_{+0.05}$ | $20^{0}_{-0.25}$ | 27 | $3^{+0.10}_{0}$ | $15^{0}_{-0.011}$ | $21^{0}_{-0.021}$ | 0.08 |
| R-ARF1720 | $17^{+0.27}_{+0.20}$ | $23^{+0.10}_{+0.05}$ | $20^{0}_{-0.25}$ | 29 | $3^{+0.10}_{0}$ | $17^{0}_{-0.011}$ | $23^{0}_{-0.021}$ | 0.08 |
| R-ARF2025 | $20^{+0.33}_{+0.21}$ | $26^{+0.11}_{+0.06}$ | $25^{0}_{-0.25}$ | 32 | $3^{+0.10}_{0}$ | $20^{0}_{-0.013}$ | $26^{0}_{-0.021}$ | 0.08 |
| R-ARF2225 | $22^{+0.33}_{+0.21}$ | $28^{+0.11}_{+0.06}$ | $25^{0}_{-0.25}$ | 34 | $3^{+0.10}_{0}$ | $22^{0}_{-0.013}$ | $28^{0}_{-0.021}$ | 0.08 |
| R-ARF2530 | $25^{+0.33}_{+0.21}$ | $31^{+0.11}_{+0.06}$ | $30^{0}_{-0.25}$ | 37 | $3^{+0.10}_{0}$ | $25^{0}_{-0.013}$ | $31^{0}_{-0.025}$ | 0.08 |
| R-ARF2830 | $28^{+0.33}_{+0.21}$ | $34^{+0.11}_{+0.06}$ | $30^{0}_{-0.25}$ | 40 | $3^{+0.10}_{-0.05}$ | $28^{0}_{-0.013}$ | $34^{0}_{-0.025}$ | 0.08 |
| R-ARF3035 | $30^{+0.33}_{+0.21}$ | $36^{+0.11}_{+0.06}$ | $35^{0}_{-0.25}$ | 42 | $3^{+0.10}_{-0.05}$ | $30^{0}_{-0.013}$ | $36^{0}_{-0.025}$ | 0.08 |
| R-ARF3235 | $32^{+0.38}_{+0.22}$ | $40^{+0.11}_{+0.06}$ | $35^{0}_{-0.25}$ | 48 | $4^{+0.10}_{-0.05}$ | $32^{0}_{-0.016}$ | $40^{0}_{-0.025}$ | 0.09 |
| R-ARF3540 | $35^{+0.38}_{+0.22}$ | $43^{+0.11}_{+0.06}$ | $40^{0}_{-0.25}$ | 51 | $4^{+0.10}_{-0.05}$ | $35^{0}_{-0.016}$ | $43^{0}_{-0.025}$ | 0.09 |
| R-ARF4045 | $40^{+0.38}_{+0.22}$ | $48^{+0.11}_{+0.06}$ | $45^{0}_{-0.25}$ | 56 | $4^{+0.10}_{-0.05}$ | $40^{0}_{-0.016}$ | $48^{0}_{-0.025}$ | 0.09 |
| R-ARF4550 | $45^{+0.39}_{+0.23}$ | $53^{+0.11}_{+0.06}$ | $50^{0}_{-0.25}$ | 61 | $4^{+0.10}_{-0.05}$ | $45^{0}_{-0.016}$ | $53^{0}_{-0.030}$ | 0.09 |
| R-ARF5060 | $50^{+0.39}_{+0.23}$ | $60^{+0.11}_{+0.06}$ | $60^{0}_{-0.25}$ | 70 | $5^{+0.10}_{-0.05}$ | $50^{0}_{-0.016}$ | $60^{0}_{-0.030}$ | 0.09 |

Remarks 1. The corner radius of flange is 0.2 mm or smaller.
2. Dimensions of chamfer is the same as Type AR for the same bore.
3. The minimum mounting clearance shall be the value when the product is mounted on the M7 ultra strong housing.
4. Use $1.0\times10^{-7}$ mm$^3$/N·Em as a guide line for the specific wear rate $K$.

## Type BRF

Flanged Sleeve Bearing



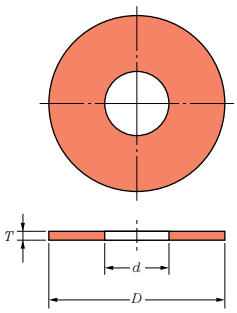

Dimensions to be measured at 25˚C

| Part No. | Dimension mm | | | | | Recommended Fit mm | | Minimum Mounted Clearance mm |
|---|---|---|---|---|---|---|---|---|
| | $d$ tolerances | $D_1$ tolerances | $l$ tolerances | $D_2$ | $t$ tolerances | Shaft h7 | Housing H7 | |
| R-BRF0304 | $3^{+0.21}_{+0.16}$ | $6^{+0.11}_{+0.06}$ | 4 ±0.2 | 9 | 1.5±0.1 | $3^{0}_{-0.010}$ | $6^{+0.012}_{0}$ | 0.05 |
| R-BRF0404 | $4^{+0.22}_{+0.17}$ | $7^{+0.12}_{+0.06}$ | 4 ±0.2 | 10 | 1.5±0.1 | $4^{0}_{-0.012}$ | $7^{+0.015}_{0}$ | 0.05 |
| R-BRF0505 | $5^{+0.22}_{+0.17}$ | $8^{+0.12}_{+0.06}$ | 5 ±0.2 | 11 | 1.5±0.1 | $5^{0}_{-0.012}$ | $8^{+0.015}_{0}$ | 0.05 |
| R-BRF0605 | $6^{+0.22}_{+0.17}$ | $9^{+0.12}_{+0.06}$ | 5 ±0.2 | 12 | 1.5±0.1 | $6^{0}_{-0.012}$ | $9^{+0.015}_{0}$ | 0.05 |
| R-BRF0806 | $8^{+0.26}_{+0.20}$ | $12^{+0.14}_{+0.07}$ | 6 ±0.2 | 15 | 2 ±0.1 | $8^{0}_{-0.015}$ | $12^{+0.018}_{0}$ | 0.06 |
| R-BRF1008 | $10^{+0.27}_{+0.21}$ | $14^{+0.14}_{+0.07}$ | 8 ±0.2 | 17 | 2 ±0.1 | $10^{0}_{-0.015}$ | $14^{+0.018}_{0}$ | 0.07 |
| R-BRF1208 | $12^{+0.28}_{+0.21}$ | $16^{+0.14}_{+0.07}$ | 8 ±0.2 | 19 | 2 ±0.1 | $12^{0}_{-0.018}$ | $16^{+0.018}_{0}$ | 0.07 |
| R-BRF1510 | $15^{+0.30}_{+0.23}$ | $21^{+0.15}_{+0.07}$ | 10 ±0.2 | 24 | 3 ±0.1 | $15^{0}_{-0.018}$ | $21^{+0.021}_{0}$ | 0.08 |
| R-BRF2012 | $20^{+0.31}_{+0.23}$ | $26^{+0.15}_{+0.07}$ | 12 ±0.2 | 29 | 3 ±0.1 | $20^{0}_{-0.021}$ | $26^{+0.021}_{0}$ | 0.08 |
| R-BRF2515 | $25^{+0.32}_{+0.24}$ | $31^{+0.16}_{+0.08}$ | 15 ±0.2 | 34 | 3 ±0.1 | $25^{0}_{-0.021}$ | $31^{+0.025}_{0}$ | 0.08 |

Remarks 1. Dimension of chamfer is 0.3 mm for 6mm or smaller bore and 0.5mm for 8 mm or larger bore.
2. The corner radius of flange is 0.2 mm or smaller.
3. Use $1.5\times10^{-7}$ mm$^3$/N·Em as a guide line for the specific wear rate $K$.

## Type TW

Thrust Washer



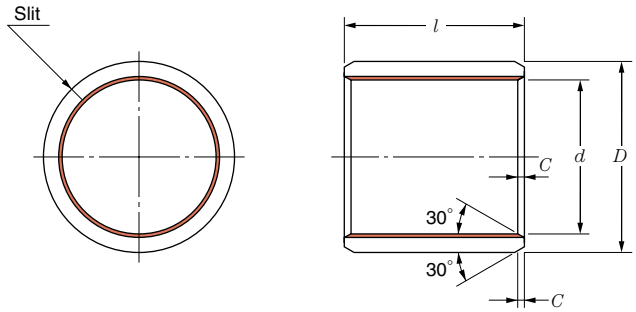

Dimensions to be measured at 25˚C

| Part No. | Dimension mm | | |
|---|---|---|---|
| | $d$ $^{+0.25}_{0}$ | $D$ $^{0}_{-0.25}$ | $T$ ±0.06 |
| R-TW0613 | 6.2 | 12.8 | 0.8 |
| R-TW0715 | 7.2 | 14.8 | 0.8 |
| R-TW0815 | 8.2 | 14.8 | 0.8 |
| R-TW0920 | 9.2 | 19.8 | 0.8 |
| R-TW1020 | 10.2 | 19.8 | 0.8 |
| R-TW1225 | 12.2 | 24.7 | 0.8 |
| R-TW1530 | 15.3 | 29.7 | 0.8 |
| R-TW1735 | 17.3 | 34.6 | 0.8 |
| R-TW2040 | 20.4 | 39.6 | 0.8 |
| R-TW2245 | 22.4 | 44.5 | 0.8 |
| R-TW2550 | 25.4 | 49.5 | 0.8 |
| R-TW2855 | 28.4 | 54.4 | 0.8 |
| R-TW3060 | 30.4 | 59.4 | 0.8 |
| R-TW3260 | 32.4 | 59.4 | 0.8 |
| R-TW3565 | 35.6 | 64.3 | 0.8 |
| R-TW4070 | 40.6 | 69.3 | 0.8 |
| R-TW4575 | 45.6 | 74.2 | 0.8 |
| R-TW5080 | 50.8 | 79.2 | 0.8 |

Remark 1. Use $1.0\times10^{-7}$ mm$^3$/N·Em as a guide line for the specific wear rate $K$.

# Type ML

M Liner Bearing




| Inner diameter $d$ mm | Outer diameter $D$ mm | Part No. Length $l$ (Tolerances $^{0}_{-0.25}$) mm | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 12 | 15 | 20 |
| 3 | 5 | R-ML0303 | R-ML0304 | R-ML0305 | R-ML0306 | | | | | | |
| 4 | 6 | | R-ML0404 | | R-ML0406 | | R-ML0408 | | | | |
| 5 | 7 | | R-ML0504 | R-ML0505 | R-ML0506 | | R-ML0508 | | | | |
| 6 | 8 | | | R-ML0605 | R-ML0606 | R-ML0607 | R-ML0608 | R-ML0610 | | | |
| 7 | 9 | | | R-ML0705 | | R-ML0707 | | R-ML0710 | R-ML0712 | | |
| 8 | 10 | | | | R-ML0806 | | R-ML0808 | R-ML0810 | R-ML0812 | | |
| 9 | 11 | | | | | | | R-ML0910 | | | |
| 10 | 12 | | | | R-ML1006 | R-ML1007 | R-ML1008 | R-ML1010 | R-ML1012 | R-ML1015 | R-ML1020 |
| 12 | 14 | | | | R-ML1206 | | R-ML1208 | R-ML1210 | R-ML1212 | R-ML1215 | R-ML1220 |
| 13 | 15 | | | | | | | | | R-ML1315 | |
| 14 | 16 | | | | | | | R-ML1410 | R-ML1412 | R-ML1415 | R-ML1420 |
| 15 | 17 | | | | | | | R-ML1510 | R-ML1512 | R-ML1515 | R-ML1520 |
| 16 | 18 | | | | | | | R-ML1610 | R-ML1612 | R-ML1615 | R-ML1620 |
| 17 | 19 | | | | | | | | | R-ML1715 | |
| 18 | 20 | | | | | | | R-ML1810 | R-ML1812 | R-ML1815 | R-ML1820 |
| 19 | 22 | | | | | | | | | R-ML1915 | |
| 20 | 23 | | | | | | | R-ML2010 | R-ML2012 | R-ML2015 | R-ML2020 |
| 22 | 25 | | | | | | | R-ML2210 | R-ML2212 | R-ML2215 | R-ML2220 |
| 24 | 27 | | | | | | | | | R-ML2415 | R-ML2420 |
| 25 | 28 | | | | | | | R-ML2510 | R-ML2512 | R-ML2515 | R-ML2520 |
| 26 | 30 | | | | | | | | | | R-ML2620 |
| 28 | 32 | | | | | | | | R-ML2812 | R-ML2815 | R-ML2820 |
| 30 | 34 | | | | | | | | R-ML3012 | R-ML3015 | R-ML3020 |
| 31 | 35 | | | | | | | | | | |
| 32 | 36 | | | | | | | | | | R-ML3220 |
| 35 | 39 | | | | | | | | R-ML3512 | | R-ML3520 |
| 38 | 42 | | | | | | | | | | R-ML3820 |
| 40 | 44 | | | | | | | | R-ML4012 | | R-ML4020 |
| 45 | 50 | | | | | | | | | | R-ML4520 |
| 50 | 55 | | | | | | | R-ML5010 | | | R-ML5020 |
| 55 | 60 | | | | | | | | | | |
| 60 | 65 | | | | | | | | | | |
| 65 | 70 | | | | | | | | | | |
| 70 | 75 | | | | | | | | | | |

Remark 1. Use $1.2\times10^{-7}$ mm$^3$/N·Em as a guide line for the specific wear rate $K$.

**▼ Indication of Serial Number**

R-ML○○○○

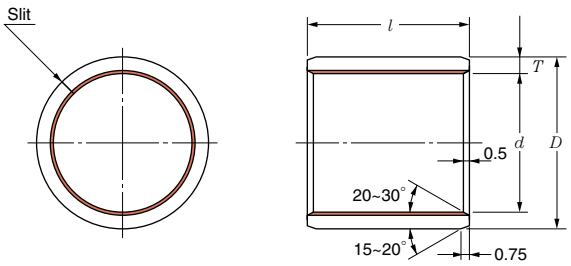
- Length
- Inner diameter
- Model code

Dimensions to be measured at 25˚C

| Part No. Length $l$ (Tolerances $^{0}_{-0.25}$) mm | | | | | | Dimension $C$ | Recommended Fit mm | | Mounted clearance mm (When mounted in H7 housing made of carbide) | |
|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 30 | 40 | 50 | 60 | 80 | mm | Shaft h7 | Housing H7 | Minimum | Maximum |
| | | | | | | 0.3 | $3^{0}_{-0.010}$ | $5^{+0.012}_{0}$ | 0.025 | 0.075 |
| | | | | | | 0.5 | $4^{0}_{-0.012}$ | $6^{+0.012}_{0}$ | 0.025 | 0.085 |
| | | | | | | 0.5 | $5^{0}_{-0.012}$ | $7^{+0.015}_{0}$ | 0.025 | 0.095 |
| | | | | | | 0.5 | $6^{0}_{-0.012}$ | $8^{+0.015}_{0}$ | 0.025 | 0.095 |
| | | | | | | 0.5 | $7^{0}_{-0.015}$ | $9^{+0.015}_{0}$ | 0.025 | 0.100 |
| | | | | | | 0.5 | $8^{0}_{-0.015}$ | $10^{+0.015}_{0}$ | 0.025 | 0.100 |
| | | | | | | 0.5 | $9^{0}_{-0.015}$ | $11^{+0.018}_{0}$ | 0.025 | 0.100 |
| | | | | | | 0.5 | $10^{0}_{-0.015}$ | $12^{+0.018}_{0}$ | 0.025 | 0.100 |
| | | | | | | 0.5 | $12^{0}_{-0.018}$ | $14^{+0.018}_{0}$ | 0.025 | 0.115 |
| | | | | | | 0.5 | $13^{0}_{-0.018}$ | $15^{+0.018}_{0}$ | 0.025 | 0.115 |
| | | | | | | 0.5 | $14^{0}_{-0.018}$ | $16^{+0.018}_{0}$ | 0.025 | 0.115 |
| R-ML1525 | | | | | | 0.5 | $15^{0}_{-0.018}$ | $17^{+0.018}_{0}$ | 0.025 | 0.115 |
| R-ML1625 | | | | | | 0.5 | $16^{0}_{-0.018}$ | $18^{+0.018}_{0}$ | 0.025 | 0.115 |
| | | | | | | 0.5 | $17^{0}_{-0.018}$ | $19^{+0.021}_{0}$ | 0.025 | 0.115 |
| R-ML1825 | | | | | | 0.5 | $18^{0}_{-0.018}$ | $20^{+0.021}_{0}$ | 0.025 | 0.115 |
| | | | | | | 0.7 | $19^{0}_{-0.021}$ | $22^{+0.021}_{0}$ | 0.025 | 0.130 |
| R-ML2025 | R-ML2030 | | | | | 0.7 | $20^{0}_{-0.021}$ | $23^{+0.021}_{0}$ | 0.025 | 0.130 |
| R-ML2225 | | | | | | 0.7 | $22^{0}_{-0.021}$ | $25^{+0.021}_{0}$ | 0.025 | 0.130 |
| R-ML2425 | R-ML2430 | | | | | 0.7 | $24^{0}_{-0.021}$ | $27^{+0.021}_{0}$ | 0.025 | 0.130 |
| R-ML2525 | R-ML2530 | | | | | 0.7 | $25^{0}_{-0.021}$ | $28^{+0.021}_{0}$ | 0.025 | 0.130 |
| R-ML2625 | R-ML2630 | | | | | 0.9 | $26^{0}_{-0.021}$ | $30^{+0.021}_{0}$ | 0.025 | 0.130 |
| | R-ML2830 | | | | | 0.9 | $28^{0}_{-0.021}$ | $32^{+0.025}_{0}$ | 0.025 | 0.135 |
| R-ML3025 | R-ML3030 | R-ML3040 | | | | 0.9 | $30^{0}_{-0.021}$ | $34^{+0.025}_{0}$ | 0.025 | 0.135 |
| R-ML3125 | | R-ML3140 | | | | 0.9 | $31^{0}_{-0.025}$ | $35^{+0.025}_{0}$ | 0.035 | 0.165 |
| R-ML3225 | R-ML3230 | R-ML3240 | | | | 0.9 | $32^{0}_{-0.025}$ | $36^{+0.025}_{0}$ | 0.035 | 0.165 |
| R-ML3525 | R-ML3530 | R-ML3540 | R-ML3550 | | | 0.9 | $35^{0}_{-0.025}$ | $39^{+0.025}_{0}$ | 0.035 | 0.165 |
| | | R-ML3840 | | | | 0.9 | $38^{0}_{-0.025}$ | $42^{+0.025}_{0}$ | 0.035 | 0.165 |
| R-ML4025 | R-ML4030 | R-ML4040 | R-ML4050 | | | 0.9 | $40^{0}_{-0.025}$ | $44^{+0.025}_{0}$ | 0.035 | 0.165 |
| R-ML4525 | R-ML4530 | R-ML4540 | R-ML4550 | | | 1.1 | $45^{0}_{-0.025}$ | $50^{+0.025}_{0}$ | 0.035 | 0.165 |
| | R-ML5030 | R-ML5040 | R-ML5050 | R-ML5060 | | 1.1 | $50^{0}_{-0.025}$ | $55^{+0.030}_{0}$ | 0.035 | 0.165 |
| | R-ML5530 | R-ML5540 | | R-ML5560 | | 1.1 | $55^{0}_{-0.030}$ | $60^{+0.030}_{0}$ | 0.045 | 0.195 |
| | R-ML6030 | R-ML6040 | | R-ML6060 | | 1.1 | $60^{0}_{-0.030}$ | $65^{+0.030}_{0}$ | 0.045 | 0.195 |
| | R-ML6530 | R-ML6540 | | R-ML6560 | | 1.1 | $65^{0}_{-0.030}$ | $70^{+0.030}_{0}$ | 0.045 | 0.195 |
| | | R-ML7040 | | R-ML7060 | R-ML7080 | 1.1 | $70^{0}_{-0.030}$ | $75^{+0.030}_{0}$ | 0.045 | 0.195 |

# MLC TYPE

MLC bearing




Note) The chamfering dimensions for a bush, 10mm or less in outside diameter or 7mm or less in length, should be limited to those needed for deburring, regardless of dimensioning in the drawing.

| Inner diameter $d$ | Outer diameter $D$ | Length $l$ (Tolerances $^{0}_{-0.4}$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 12 | 15 | 20 | 25 | 30 |
| 3 | 5 | MLC0303 | MLC0304 | MLC0305 | MLC0306 | | | | | | | | |
| 4 | 6 | MLC0403 | MLC0404 | | MLC0406 | | MLC0408 | | | | | | |
| 5 | 7 | | MLC0504 | MLC0505 | MLC0506 | | MLC0508 | | | | | | |
| 6 | 8 | | | MLC0605 | MLC0606 | MLC0607 | MLC0608 | MLC0610 | | | | | |
| 7 | 9 | | | MLC0705 | | MLC0707 | | MLC0710 | MLC0712 | | | | |
| 8 | 10 | | | MLC0805 | MLC0806 | MLC0807 | MLC0808 | MLC0810 | MLC0812 | | | | |
| 9 | 11 | | | | | MLC0907 | | MLC0910 | | | | | |
| 10 | 12 | | | | MLC1006 | MLC1007 | MLC1008 | MLC1010 | MLC1012 | MLC1015 | MLC1020 | | |
| 12 | 14 | | | | MLC1206 | | MLC1208 | MLC1210 | MLC1212 | MLC1215 | MLC1220 | | |
| 13 | 15 | | | | | | MLC1308 | MLC1310 | | MLC1315 | | | |
| 14 | 16 | | | | MLC1406 | | | MLC1410 | MLC1412 | MLC1415 | MLC1420 | | |
| 15 | 17 | | | | | | MLC1508 | MLC1510 | MLC1512 | MLC1515 | MLC1520 | MLC1525 | |
| 16 | 18 | | | | | | | MLC1610 | MLC1612 | MLC1615 | MLC1620 | MLC1625 | |
| 17 | 19 | | | | | | | | | MLC1715 | MLC1720 | | |
| 18 | 20 | | | | | | | MLC1810 | MLC1812 | MLC1815 | MLC1820 | MLC1825 | |
| 19 | 22 | | | | | | | MLC1910 | | MLC1915 | | | |
| 20 | 23 | | | | | | | MLC2010 | MLC2012 | MLC2015 | MLC2020 | MLC2025 | MLC2030 |
| 22 | 25 | | | | | | | MLC2210 | MLC2212 | MLC2215 | MLC2220 | MLC2225 | MLC2230 |
| 24 | 27 | | | | | | | MLC2410 | | MLC2415 | MLC2420 | MLC2425 | MLC2430 |
| 25 | 28 | | | | | | | MLC2510 | MLC2512 | MLC2515 | MLC2520 | MLC2525 | MLC2530 |
| 26 | 30 | | | | | | | | | MLC2615 | MLC2620 | | MLC2630 |
| 28 | 32 | | | | | | | MLC2810 | MLC2812 | MLC2815 | MLC2820 | MLC2825 | MLC2830 |
| 30 | 34 | | | | | | | MLC3010 | MLC3012 | MLC3015 | MLC3020 | MLC3025 | MLC3030 |
| 31 | 35 | | | | | | | | | MLC3115 | | MLC3125 | |
| 32 | 36 | | | | | | | | | | MLC3220 | MLC3225 | MLC3230 |
| 35 | 39 | | | | | | | MLC3510 | MLC3512 | MLC3515 | MLC3520 | MLC3525 | MLC3530 |
| 38 | 42 | | | | | | | | | | MLC3820 | MLC3825 | MLC3830 |
| 40 | 44 | | | | | | | | MLC4012 | MLC4015 | MLC4020 | MLC4025 | MLC4030 |
| 45 | 50 | | | | | | | | MLC4512 | | MLC4520 | MLC4525 | MLC4530 |
| 50 | 55 | | | | | | | | MLC5012 | MLC5015 | MLC5020 | MLC5025 | MLC5030 |
| 55 | 60 | | | | | | | | MLC5512 | | | MLC5525 | MLC5530 |
| 60 | 65 | | | | | | | | | MLC6015 | MLC6020 | | MLC6030 |
| 65 | 70 | | | | | | | | | MLC6515 | | | MLC6530 |
| 70 | 75 | | | | | | | | | MLC7015 | MLC7020 | | MLC7030 |
| 75 | 80 | | | | | | | | | | MLC7520 | | MLC7530 |
| 80 | 85 | | | | | | | | | MLC8015 | MLC8020 | | MLC8030 |
| 85 | 90 | | | | | | | | | | | | MLC8530 |
| 90 | 95 | | | | | | | | | | MLC9020 | | |
| 95 | 100 | | | | | | | | | | | | MLC9530 |
| 100 | 105 | | | | | | | | | | | | MLC10030 |
| 105 | 110 | | | | | | | | | | | | |
| 110 | 115 | | | | | | | | | | MLC11020 | | MLC11030 |
| 120 | 125 | | | | | | | | | | | | |
| 130 | 135 | | | | | | | | | | MLC13020 | | |
| 140 | 145 | | | | | | | | | | | | |
| 150 | 155 | | | | | | | | | | | | |
| 160 | 165 | | | | | | | | | | | | |

Remarks 1. The minimum clearance is 0.025 mm when the preferred shaft and housing are used.
2. Use $1.7\times10^{-7}$ mm$^3$/N·Em as a guide line for the specific wear rate $K$.

## ▼ Indication of Serial Number

R-MLC○○○○

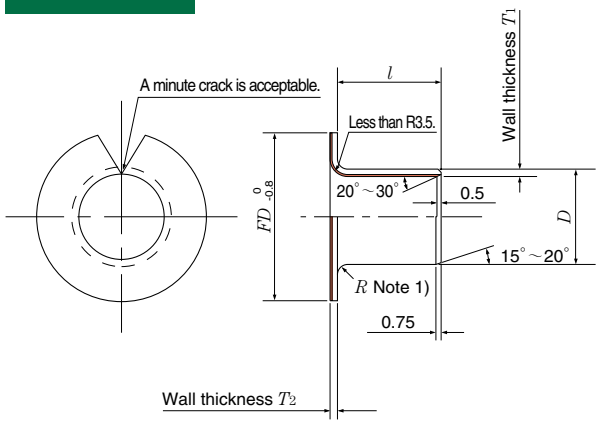
- ○○○○ — Length
- ○○ — Inner diameter
- MLC — Model code

Dimensions to be measured at 25˚C / unit in mm

| Length $l$ (Tolerances $^{0}_{-0.4}$) | | | | | | | | | Wall thickness $T$ | Recommended shaft $da$ | Recommended housing $Da$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 40 | 50 | 60 | 70 | 80 | 90 | 95 | 100 | | | |
| | | | | | | | | | 1.0 $^{0}_{-0.025}$ | 3 $^{-0.025}_{-0.035}$ | 5 $(H7)^{+0.012}_{0}$ |
| | | | | | | | | | | 4 $^{-0.025}_{-0.037}$ | 6 $(H7)^{+0.012}_{0}$ |
| | | | | | | | | | | 5 $^{-0.025}_{-0.037}$ | 7 $(H7)^{+0.015}_{0}$ |
| | | | | | | | | | | 6 $^{-0.025}_{-0.037}$ | 8 $(H7)^{+0.015}_{0}$ |
| | | | | | | | | | | 7 $^{-0.025}_{-0.040}$ | 9 $(H7)^{+0.015}_{0}$ |
| | | | | | | | | | | 8 $^{-0.025}_{-0.040}$ | 10 $(H7)^{+0.015}_{0}$ |
| | | | | | | | | | | 9 $^{-0.025}_{-0.040}$ | 11 $(H7)^{+0.018}_{0}$ |
| | | | | | | | | | | 10 $^{-0.025}_{-0.040}$ | 12 $(H7)^{+0.018}_{0}$ |
| | | | | | | | | | | 12 $^{-0.025}_{-0.043}$ | 14 $(H7)^{+0.018}_{0}$ |
| | | | | | | | | | | 13 $^{-0.025}_{-0.043}$ | 15 $(H7)^{+0.018}_{0}$ |
| | | | | | | | | | | 14 $^{-0.025}_{-0.043}$ | 16 $(H7)^{+0.018}_{0}$ |
| | | | | | | | | | | 15 $^{-0.025}_{-0.043}$ | 17 $(H7)^{+0.018}_{0}$ |
| | | | | | | | | | | 16 $^{-0.025}_{-0.043}$ | 18 $(H7)^{+0.018}_{0}$ |
| | | | | | | | | | | 17 $^{-0.025}_{-0.043}$ | 19 $(H7)^{+0.021}_{0}$ |
| | | | | | | | | | | 18 $^{-0.025}_{-0.043}$ | 20 $(H7)^{+0.021}_{0}$ |
| | | | | | | | | | 1.5 $^{0}_{-0.030}$ | 19 $^{-0.025}_{-0.046}$ | 22 $(H7)^{+0.021}_{0}$ |
| | | | | | | | | | | 20 $^{-0.025}_{-0.046}$ | 23 $(H7)^{+0.021}_{0}$ |
| | | | | | | | | | | 22 $^{-0.025}_{-0.046}$ | 25 $(H7)^{+0.021}_{0}$ |
| | | | | | | | | | | 24 $^{-0.025}_{-0.046}$ | 27 $(H7)^{+0.021}_{0}$ |
| MLC2535 | MLC2540 | | | | | | | | | 25 $^{-0.025}_{-0.046}$ | 28 $(H7)^{+0.021}_{0}$ |
| | | | | | | | | | 2.0 $^{0}_{-0.030}$ | 26 $^{-0.025}_{-0.046}$ | 30 $(H7)^{+0.021}_{0}$ |
| | | | | | | | | | | 28 $^{-0.025}_{-0.046}$ | 32 $(H7)^{+0.025}_{0}$ |
| MLC3035 | MLC3040 | | | | | | | | | 30 $^{-0.025}_{-0.046}$ | 34 $(H7)^{+0.025}_{0}$ |
| | MLC3140 | | | | | | | | | 31 $^{-0.025}_{-0.050}$ | 35 $(H7)^{+0.025}_{0}$ |
| MLC3235 | MLC3240 | MLC3250 | | | | | | | | 32 $^{-0.025}_{-0.050}$ | 36 $(H7)^{+0.025}_{0}$ |
| MLC3535 | MLC3540 | MLC3550 | | | | | | | | 35 $^{-0.025}_{-0.050}$ | 39 $(H7)^{+0.025}_{0}$ |
| MLC3835 | MLC3840 | | | | | | | | | 38 $^{-0.025}_{-0.050}$ | 42 $(H7)^{+0.025}_{0}$ |
| MLC4035 | MLC4040 | MLC4050 | | | | | | | | 40 $^{-0.025}_{-0.050}$ | 44 $(H7)^{+0.025}_{0}$ |
| MLC4535 | MLC4540 | MLC4550 | | | | | | | 2.5 $^{0}_{-0.040}$ | 45 $^{-0.025}_{-0.050}$ | 50 $(H7)^{+0.025}_{0}$ |
| MLC5035 | MLC5040 | MLC5050 | MLC5060 | | MLC5080 | | | | | 50 $^{-0.025}_{-0.050}$ | 55 $(H7)^{+0.030}_{0}$ |
| MLC5535 | MLC5540 | MLC5550 | MLC5560 | | | | | | | 55 $^{-0.025}_{-0.055}$ | 60 $(H7)^{+0.030}_{0}$ |
| MLC6035 | MLC6040 | MLC6050 | MLC6060 | MLC6070 | | | | | | 60 $^{-0.025}_{-0.055}$ | 65 $(H7)^{+0.030}_{0}$ |
| | MLC6540 | MLC6550 | MLC6560 | MLC6570 | | | | | 2.47 $^{0}_{-0.050}$ | 65 $^{+0.035}_{+0.005}$ | 70 $(H7)^{+0.030}_{0}$ |
| MLC7035 | MLC7040 | MLC7050 | MLC7060 | | MLC7080 | | | | | 70 $^{+0.035}_{+0.005}$ | 75 $(H7)^{+0.030}_{0}$ |
| MLC7535 | MLC7540 | MLC7550 | MLC7560 | | MLC7580 | | | | | 75 $^{+0.035}_{+0.005}$ | 80 $(H7)^{+0.030}_{0}$ |
| | MLC8040 | MLC8050 | MLC8060 | | MLC8080 | | | | | 80 $^{+0.035}_{+0.005}$ | 85 $(H7)^{+0.035}_{0}$ |
| | MLC8540 | MLC8550 | MLC8560 | | MLC8580 | | | | | 85 $^{+0.035}_{0}$ | 90 $(H7)^{+0.035}_{0}$ |
| MLC9035 | MLC9040 | MLC9050 | MLC9060 | | | MLC9090 | | | | 90 $^{+0.035}_{0}$ | 95 $(H7)^{+0.035}_{0}$ |
| MLC9535 | MLC9540 | | | | | | | | | 95 $^{+0.035}_{0}$ | 100 $(H7)^{+0.035}_{0}$ |
| MLC10035 | MLC10040 | MLC10050 | | MLC10070 | | | MLC10095 | | | 100 $^{+0.035}_{0}$ | 105 $(H7)^{+0.035}_{0}$ |
| | | MLC10550 | | | | MLC10590 | MLC10595 | | | 105 $^{+0.035}_{0}$ | 110 $(H7)^{+0.035}_{0}$ |
| MLC11035 | MLC11040 | MLC11050 | MLC11060 | MLC11070 | MLC11080 | MLC11090 | MLC11095 | | | 110 $^{+0.035}_{0}$ | 115 $(H7)^{+0.035}_{0}$ |
| | MLC12040 | MLC12050 | MLC12060 | MLC12070 | | | MLC12095 | | | 120 $^{+0.035}_{0}$ | 125 $(H7)^{+0.040}_{0}$ |
| | | MLC13050 | | | MLC13080 | | | | | 130 $^{+0.035}_{-0.005}$ | 135 $(H7)^{+0.040}_{0}$ |
| | | MLC14050 | | MLC14070 | MLC14080 | | | MLC140100 | | 140 $^{+0.035}_{-0.005}$ | 145 $(H7)^{+0.040}_{0}$ |
| | MLC15040 | MLC15050 | | | MLC15080 | | | MLC150100 | | 150 $^{+0.035}_{-0.005}$ | 155 $(H7)^{+0.040}_{0}$ |
| | | MLC16050 | | | MLC16080 | | | MLC160100 | | 160 $^{+0.035}_{-0.005}$ | 165 $(H7)^{+0.040}_{0}$ |

## MLCF TYPE

MLC bearing




Note 1) The dimension $R$ shown in the above drawing is less than 0.75 when the wall thickness $T_1$ = 1.0, but less than 1.0 when the wall thickness $T_2$ is larger than 1.5.

### ▼ Indication of Serial Number

**R-MLCF○○○○**

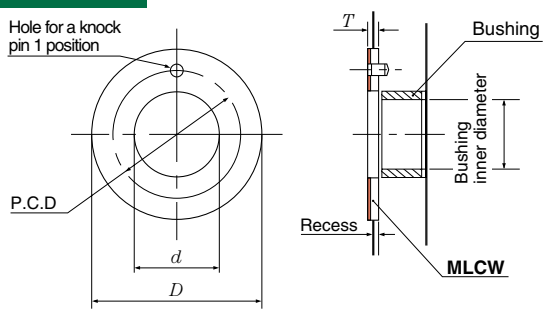
- Length
- Inner diameter
- Model code

| Inner diameter $d$ | Outer diameter $D$ | Collar diameter $FD$ | Length $l$ (Tolerances $^{0}_{-0.4}$) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 3 | 4 | 5 | 6 | 7 | 8 |
| 3 | 4.6 | 7 | MLCF0303 | | | | | |
| 4 | 5.6 | 9 | | MLCF0404 | | | | |
| 5 | 7 | 10 | | MLCF0504 | MLCF0505 | | | |
| 6 | 8 | 12 | | | MLCF0605 | MLCF0606 | MLCF0607 | MLCF0608 |
| 7 | 9 | 13 | | | MLCF0705 | | MLCF0707 | |
| 8 | 10 | 15 | | | | MLCF0806 | | MLCF0808 |
| 10 | 12 | 18 | | | | MLCF1006 | MLCF1007 | MLCF1008 |
| 12 | 14 | 20 | | | | MLCF1206 | | MLCF1208 |
| 14 | 16 | 22 | | | | | | |
| 15 | 17 | 23 | | | | | | |
| 16 | 18 | 24 | | | | | | |
| 18 | 20 | 26 | | | | | | |
| 20 | 23 | 31 | | | | | | |
| 22 | 25 | 33 | | | | | | |
| 24 | 27 | 35 | | | | | | |
| 25 | 28 | 36 | | | | | | |
| 26 | 30 | 38 | | | | | | |
| 28 | 32 | 40 | | | | | | |
| 30 | 34 | 42 | | | | | | |
| 31 | 35 | 45 | | | | | | |
| 32 | 36 | 46 | | | | | | |
| 35 | 39 | 49 | | | | | | |
| 38 | 42 | 52 | | | | | | |
| 40 | 44 | 54 | | | | | | |
| 45 | 50 | 60 | | | | | | |
| 50 | 55 | 65 | | | | | | |
| 55 | 60 | 70 | | | | | | |
| 60 | 65 | 75 | | | | | | |

Remarks 1. The minimum clearance is 0.025 mm when the preferred shaft and housing are used.
2. Use $1.7\times10^{-7}$ mm$^3$/N·Em as a guide line for the specific wear rate $K$.

## MLCW TYPE

MLC bearing




### ▼ Indication of Serial Number

**R-MLCW○○**

- Bushing inner diameter
- Model code

| Bushing inner diameter for combination | Part No. | Inner diameter $d$ mm | Outer diameter $D$ mm | Wall thickness $T$ mm |
|---|---|---|---|---|
| 6 | MLCW06 | $8^{+0.25}_{0}$ | $16^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 8 | MLCW08 | $10^{+0.25}_{0}$ | $18^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 10 | MLCW10 | $12^{+0.25}_{0}$ | $24^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 12 | MLCW12 | $14^{+0.25}_{0}$ | $26^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 14 | MLCW14 | $16^{+0.25}_{0}$ | $30^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 16 | MLCW16 | $18^{+0.25}_{0}$ | $32^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 18 | MLCW18 | $20^{+0.25}_{0}$ | $36^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 20 | MLCW20 | $22^{+0.25}_{0}$ | $38^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 22 | MLCW22 | $24^{+0.25}_{0}$ | $42^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 24 | MLCW24 | $26^{+0.25}_{0}$ | $44^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 25 | MLCW25 | $28^{+0.25}_{0}$ | $48^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 30 | MLCW30 | $32^{+0.25}_{0}$ | $54^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 35 | MLCW35 | $38^{+0.25}_{0}$ | $62^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 40 | MLCW40 | $42^{+0.25}_{0}$ | $66^{0}_{-0.25}$ | $1.5^{-0.03}_{-0.08}$ |
| 45 | MLCW45 | $48^{+0.25}_{0}$ | $74^{0}_{-0.25}$ | $2.0^{-0.03}_{-0.08}$ |
| 50 | MLCW50 | $52^{+0.25}_{0}$ | $78^{0}_{-0.25}$ | $2.0^{-0.03}_{-0.08}$ |

Remark 1. The minimum clearance is 0.025 mm when the preferred shaft and housing are used.

Dimensions to be measured at 25˚C / unit in mm

| Length $l$ (Tolerances $^{0}_{-0.4}$) | | | | | | | | | | Wall thickness | | Recommended shaft | Recommended housing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 12 | 15 | 20 | 25 | 30 | 40 | 45 | 50 | 60 | $T_1$ | $T_2$ | $da$ | $Da$ |
| | | | | | | | | | | $0.8\,^{0}_{-0.025}$ | $0.8\,^{0}_{-0.2}$ | $3\,^{-0.025}_{-0.035}$ | $4.6\,(H7)^{+0.012}_{0}$ |
| | | | | | | | | | | | | $4\,^{-0.025}_{-0.037}$ | $5.6\,(H7)^{+0.012}_{0}$ |
| | | | | | | | | | | $1.0\,^{0}_{-0.025}$ | $1.0\,^{0}_{-0.2}$ | $5\,^{-0.025}_{-0.037}$ | $7\,(H7)^{+0.015}_{0}$ |
| MLCF0610 | | | | | | | | | | | | $6\,^{-0.025}_{-0.037}$ | $8\,(H7)^{+0.015}_{0}$ |
| MLCF0710 | MLCF0712 | | | | | | | | | | | $7\,^{-0.025}_{-0.040}$ | $9\,(H7)^{+0.015}_{0}$ |
| MLCF0810 | MLCF0812 | | | | | | | | | | | $8\,^{-0.025}_{-0.040}$ | $10\,(H7)^{+0.015}_{0}$ |
| MLCF1010 | MLCF1012 | MLCF1015 | | | | | | | | | | $10\,^{-0.025}_{-0.040}$ | $12\,(H7)^{+0.018}_{0}$ |
| MLCF1210 | MLCF1212 | MLCF1215 | MLCF1220 | | | | | | | | | $12\,^{-0.025}_{-0.043}$ | $14\,(H7)^{+0.018}_{0}$ |
| MLCF1410 | MLCF1412 | MLCF1415 | MLCF1420 | | | | | | | | | $14\,^{-0.025}_{-0.043}$ | $16\,(H7)^{+0.018}_{0}$ |
| MLCF1510 | MLCF1512 | MLCF1515 | MLCF1520 | MLCF1525 | | | | | | | | $15\,^{-0.025}_{-0.043}$ | $17\,(H7)^{+0.018}_{0}$ |
| MLCF1610 | MLCF1612 | MLCF1615 | MLCF1620 | MLCF1625 | | | | | | | | $16\,^{-0.025}_{-0.043}$ | $18\,(H7)^{+0.018}_{0}$ |
| MLCF1810 | MLCF1812 | MLCF1815 | MLCF1820 | MLCF1825 | | | | | | | | $18\,^{-0.025}_{-0.043}$ | $20\,(H7)^{+0.021}_{0}$ |
| MLCF2010 | MLCF2012 | MLCF2015 | MLCF2020 | MLCF2025 | MLCF2030 | | | | | $1.5\,^{0}_{-0.030}$ | $1.5\,^{0}_{-0.2}$ | $20\,^{-0.025}_{-0.046}$ | $23\,(H7)^{+0.021}_{0}$ |
| MLCF2210 | MLCF2212 | MLCF2215 | MLCF2220 | MLCF2225 | | | | | | | | $22\,^{-0.025}_{-0.046}$ | $25\,(H7)^{+0.021}_{0}$ |
| | | MLCF2415 | MLCF2420 | MLCF2425 | MLCF2430 | | | | | | | $24\,^{-0.025}_{-0.046}$ | $27\,(H7)^{+0.021}_{0}$ |
| MLCF2510 | MLCF2512 | MLCF2515 | MLCF2520 | MLCF2525 | MLCF2530 | | | | | | | $25\,^{-0.025}_{-0.046}$ | $28\,(H7)^{+0.021}_{0}$ |
| | | MLCF2615 | MLCF2620 | | | | | | | $2.0\,^{0}_{-0.030}$ | $2.0\,^{0}_{-0.2}$ | $26\,^{-0.025}_{-0.046}$ | $30\,(H7)^{+0.021}_{0}$ |
| | MLCF2812 | MLCF2815 | MLCF2820 | MLCF2825 | MLCF2830 | | | | | | | $28\,^{-0.025}_{-0.046}$ | $32\,(H7)^{+0.025}_{0}$ |
| | MLCF3012 | MLCF3015 | MLCF3020 | MLCF3025 | MLCF3030 | MLCF3040 | | | | | | $30\,^{-0.025}_{-0.046}$ | $34\,(H7)^{+0.025}_{0}$ |
| | | | | MLCF3125 | | | | | | | | $31\,^{-0.025}_{-0.050}$ | $35\,(H7)^{+0.025}_{0}$ |
| | | | MLCF3220 | MLCF3225 | MLCF3230 | | | | | | | $32\,^{-0.025}_{-0.050}$ | $36\,(H7)^{+0.025}_{0}$ |
| | MLCF3512 | | MLCF3520 | MLCF3525 | MLCF3530 | MLCF3540 | MLCF3545 | MLCF3550 | | | | $35\,^{-0.025}_{-0.050}$ | $39\,(H7)^{+0.025}_{0}$ |
| | | | MLCF3820 | MLCF3825 | MLCF3830 | MLCF3840 | | | | | | $38\,^{-0.025}_{-0.050}$ | $42\,(H7)^{+0.025}_{0}$ |
| | MLCF4012 | | MLCF4020 | MLCF4025 | MLCF4030 | MLCF4040 | | MLCF4050 | | | | $40\,^{-0.025}_{-0.050}$ | $44\,(H7)^{+0.025}_{0}$ |
| | | | MLCF4520 | MLCF4525 | MLCF4530 | MLCF4540 | | MLCF4550 | | $2.5\,^{0}_{-0.040}$ | $2.5\,^{0}_{-0.3}$ | $45\,^{-0.025}_{-0.050}$ | $50\,(H7)^{+0.025}_{0}$ |
| | | | MLCF5020 | MLCF5025 | MLCF5030 | MLCF5040 | | MLCF5050 | MLCF5060 | | | $50\,^{-0.025}_{-0.050}$ | $55\,(H7)^{+0.030}_{0}$ |
| | | | | | MLCF5530 | MLCF5540 | | MLCF5550 | MLCF5560 | | | $55\,^{-0.025}_{-0.055}$ | $60\,(H7)^{+0.030}_{0}$ |
| | | | | | MLCF6030 | MLCF6040 | | MLCF6050 | MLCF6060 | | | $60\,^{-0.025}_{-0.055}$ | $65\,(H7)^{+0.030}_{0}$ |

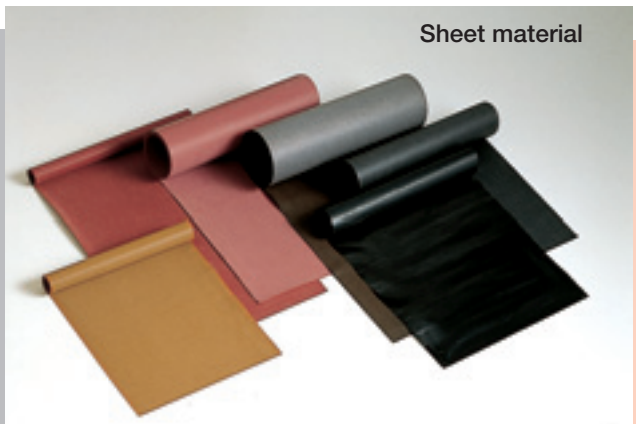
Dimensions to be measured at 25˚C

| Knock pin hole diameter mm | Position of a knock pin P.C.D mm | Depth of the housing recess mm |
|---|---|---|
| 1.100～1.300 | 12 ±0.12 | 0.95～1.20 |
| 1.100～1.300 | 14 ±0.12 | 0.95～1.20 |
| 1.625～1.875 | 18 ±0.12 | 0.95～1.20 |
| 2.125～2.375 | 20 ±0.12 | 0.95～1.20 |
| 2.125～2.375 | 23 ±0.12 | 0.95～1.20 |
| 2.125～2.375 | 25 ±0.12 | 0.95～1.20 |
| 3.125～3.375 | 28 ±0.12 | 0.95～1.20 |
| 3.125～3.375 | 30 ±0.12 | 0.95～1.20 |
| 3.125～3.375 | 33 ±0.12 | 0.95～1.20 |
| 3.125～3.375 | 35 ±0.12 | 0.95～1.20 |
| 4.125～4.375 | 38 ±0.12 | 0.95～1.20 |
| 4.125～4.375 | 43 ±0.12 | 0.95～1.20 |
| 4.125～4.375 | 50 ±0.12 | 0.95～1.20 |
| 4.125～4.375 | 54 ±0.12 | 0.95～1.20 |
| 4.125～4.375 | 61 ±0.12 | 1.45～1.70 |
| 4.125～4.375 | 65 ±0.12 | 1.45～1.70 |

# 3 NTN Engineering Plastics Material Standard Dimensions

NTN Engineering Plastics are widely used in many areas such as the machinery, electric, chemical industries. Among the materials of NTN Engineering Plastics, the most popular series of fluoroplastics based **(BEAREE FL 3000, FL 3020, FL 3030, FL 3700, FL 3305)** and ultra-high-molecular-weight polyethylene **(BEAREE UH 3954, UH 3000)** are prepared in sheets, rods or pipes for your own fabrication.

Sheet material



Rod material

Pipe material

# Sheet material

Sheet material is skived (turned) from a large billet made by compression molding.
Surface treatment (etching) is required to make the sheet bondable.
In the case of using the sheet by bonding with adhesives, the material should be treated through the preparation process for bonding (TOS).

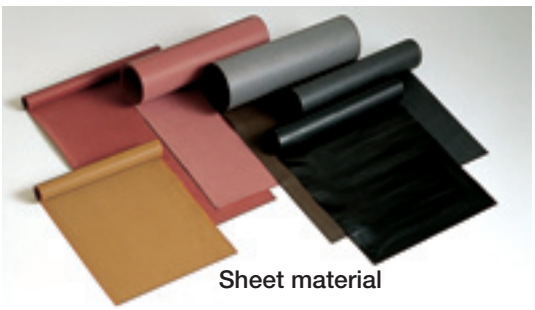
BEAREE UH 3954 cannot be etched.
One side of BEAREE FL 3305 sheet is pre-etched for bonding unless otherwise requested.

**Sheet material dimension table** (Unit in mm)

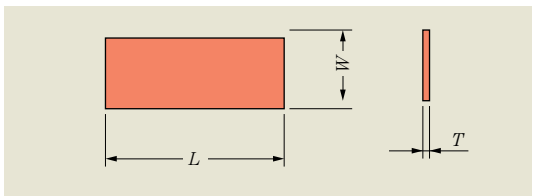
| Dimension | | | Material | | | | | |
|---|---|---|---|---|---|---|---|---|
| Thickness ($T$) | Width ($W$) | Maximum continuous length* ($L$) m | BEAREE FL3000 | BEAREE FL3020 | BEAREE FL3030 | BEAREE FL3700 | BEAREE FL3305 | BEAREE UH3954 |
| 0.1±0.02 | 300 $^{+30}_{0}$<br>500 $^{+30}_{0}$ for BEAREE FL3020 | 10 | | | | | | ○ |
| 0.2±0.02 | | | | | | | | ○ |
| 0.3±0.03 | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 0.4±0.04 | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 0.5±0.05 | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 0.6±0.06 | | | ○ | ○ | ○ | ○ | ○ | |
| 0.8±0.06 | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 1 ±0.1 | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 1.2±0.1 | | 5 | ○ | ○ | ○ | ○ | ○ | |
| 1.5±0.1 | | | ○ | ○ | ○ | ○ | ○ | |
| 2 ±0.2 | | | ○ | ○ | ○ | ○ | ○ | |
| 2.5±0.2 | | 1 | ○ | ○ | ○ | ○ | ○ | |
| 3 ±0.3 | | | ○ | ○ | ○ | ○ | ○ | |
| 4 ±0.3 | | | ○ | ○ | ○ | ○ | ○ | |
| 5 ±0.4 | | | ○ | ○ | ○ | ○ | ○ | |
| 6 ±0.5 | | | ○ | ○ | ○ | ○ | ○ | |

Marked (○) is available; however, these materials are made to order.
Please contact NTN if these materials are drawn as there is a possibility of cracking with certain drawing ratios.

* Length code for 1 m is M1.



Sheet material




<Applications>
- Slider tape
- Packing
- Washer
- Other machine parts

Use the following designation of part number when making an order.

R-T□×□×M1□T0

- Suffix (T0 for pre-etched on one side, no mark for without etching)
- Material code (No mark : BEAREE FL 3000, B : BEAREE FL 3020, J : BEAREE FL 3030, W : BEAREE FL 3700, TA : BEAREE FL 3305, Q : BEAREE UH 3954)
- Length code: 1 m (Unit length is 1 m)
- Width code: 300 mm (500 mm for BEAREE FL 3020)
- Thickness code: Thickness in mm
- Shape code for sheet
- Prefix for NTN Engineering Plastics

(Example) R-T0.3 ×300 ×M1T0
BEAREE FL 3000 sheet with 0.3mm in thickness, 300mm in width, 1m in length and pre-etched on one side.

NOTE : For more than 1m in length, designate "CONTINUOUS SHEET"

# Rod material

This material is formed by ram extrusion as a round bar.
This material is made by ram extrusion to size. This material can be machined to the required profile by turning or milling.

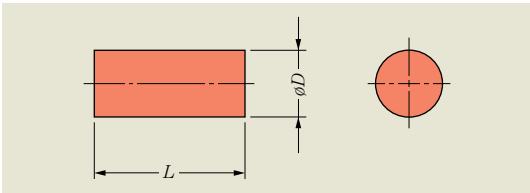
**Rod material dimension table** (Unit in mm)

| Dimension | | Material | | | |
|---|---|---|---|---|---|
| O.D. ( $\phi D$) | Length ($L$) | BEAREE FL3000 | BEAREE FL3030 | BEAREE FL3700 | BEAREE UH3000 |
| 9 | 1,000* | ○ | ○ | ○ | |
| 12 | | ○ | | | |
| 13 | | | | ○ | |
| 15 | | ○ | | ○ | |
| 17 | | ○ | ○ | ○ | ○ |
| 19 | | ○ | | ○ | |
| 20 | | | | ○ | |
| 21 | | | | | ○ |
| 22 | | ○ | | ○ | |
| 23 | | ○ | | ○ | |
| 28 | | ○ | | ○ | |
| 30 | | | | | ○ |
| 33 | | ○ | | ○ | |
| 37 | | ○ | | ○ | |

Marked (○) is available; however these materials are made by order.
The machining allowance should be deducted from the above shown dimensions.
Material dimensions exclude the turning surplus.

* Length code for 1000 mm is M1.

Rod material




<Applications>
- ●Bearing bushing
- ●Washer
- ●Packing
- ●Other machine parts

Use the following designation of part number when making an order.

R-R□×M1□

- Material code
  - No mark: BEAREE FL 3000
  - J: BEAREE FL 3030
  - W: BEAREE FL 3700
  - HA: BEAREE UH 3000
- Length code : 1 m (Available in 1 m only)
- O.D. code : O.D. dimension in mm
- Shape code for rod

(Example) R-R13×M1W
BEAREE FL 3700 rod material, 13mm in O.D. and 1m in length.

# Pipe material

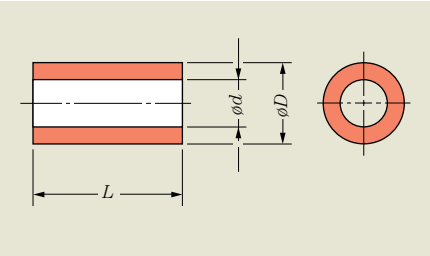
This pipe material is made by ram extrusion to a cylinder. This material can be machined to the required profile by turning or milling.

**Dimension table for pipe material** (Unit in mm)

| Dimension | | | Material | | | |
|---|---|---|---|---|---|---|
| I.D.( $\phi d$) | O.D.( $\phi D$) | Length($L$) | BEAREE FL 3000 | BEAREE FL 3030 | BEAREE FL 3700 | BEAREE UH 3000 |
| 7 | 22 | 1,000* | | ○ | | |
| 9 | 19 | | ○ | | ○ | |
| 10 | 25 | | | | | ○ |
| 11 | 20 | | ○ | | | |
| 13 | 21 | | | | | ○ |
| 13 | 23 | | | ○ | ○ | |
| 13 | 28 | | ○ | | | |
| 15 | 20 | | | | ○ | |
| 15 | 26 | | ○ | | | |
| 15 | 28 | | | | ○ | |
| 15 | 30 | | ○ | | | |
| 17 | 26 | | | | ○ | |
| 17 | 27 | | | ○ | | |
| 18 | 33 | | ○ | | ○ | |
| 19 | 34 | | | | | ○ |
| 21 | 31 | | | ○ | | |
| 21 | 38 | | ○ | | ○ | |
| 21 | 42 | | | | ○ | |
| 21 | 45 | | | | | ○ |
| 27 | 43 | | ○ | | | |
| 27 | 45 | | | | | ○ |
| 29 | 36 | | | ○ | | |
| 35 | 43 | | | ○ | | |
| 38 | 46 | | | ○ | | |

Marked ○ is available however these materials are made by order.
The machining allowance should be deducted from the above shown dimensions.
Material dimensions exclude the turning surplus.

* Length code for 1000 mm is M1.




Pipe material

<Applications>
- Sliding bearing
- Washer
- Valve seat
- Other machine parts

Use the following designation of part number when making an order.

R-U□×□×M1□

- Material code: The same as rod material
- Length code: 1 m (Available in 1 m only)
- O.D. code: O.D. dimension in mm
- I.D. code: I.D. dimension in mm
- Shape code for pipe

(Example) R-U13×23×M1J
BEAREE FL 3030 pipe material, 13mm in I.D., 23mm O.D. and 1m in length.

# 4 Introduction of Materials and Products for Applications

## 4-1

This high performance sliding bearing uses base materials such as polyimide (PI), polyamideimide (PAI), polyphenylensulfide (PPS), polyacetal (POM), polyamide (PA), polyethylene (PE) featuring the fluoro plastics (PTFE) as a main material.

Bearings, piston rings and seal rings with unique characteristics of each base plastics can be manufactured according to orders.

**Table 1 Allowable pressure, feature and applications**

| Properties / Grade | Base Resin | Allowable pressure | | Characteristics | Applications |
|---|---|---|---|---|---|
| | | MPa | kgf/cm$^2$ | | |
| BEAREE FL 3000 | PTFE | 7 | 70 | Fluoro plastics standard material. | Bearings, seal rings |
| BEAREE FL 3030 | PTFE | 7 | 70 | Suitable material for the soft material. | Sliding bearings, seal rings |
| BEAREE FL 3700 | PTFE | 7 | 70 | Suitable for use in water. | Bearings in water |
| BEAREE PI 5001 | PI | 50 | 500 | Suitable for conditions of high $PV$. | Bearings, seal rings |
| BEAREE AS 5000 | PPS | 20 | 200 | Standard material for extrusion forming. | Parts for standard office equipment |
| BEAREE DM5030 | POM | 10 | 100 | Highly economical for the low $PV$. | Parts for standard office equipment |
| BEAREE NY 5000 | PA | 20 | 200 | Highly economical for the low $PV$. | Parts for standard office equipment |
| BEAREE UH 3000 | PE | 5 | 50 | Highly economical for the low $PV$. | Parts for standard office equipment |

Allowable face pressure is the value at normal temperature.
Refer to page 51 for the allowable face pressure under the high temperature atmosphere.

Refer to the test data.
BEAREE FL3000····page 55
BEAREE PI5001····page 56

## 4-2 Sliding materials for soft mating materials

The wear resistance of sliding bearing material itself is naturally required, but it is also necessary not to abrade the mating materials. Ordinary plastic materials sometimes abrade deeply the soft mating materials such as stainless steel, aluminum and brass.

**<Feature>**

- Does not abrade the soft mating materials (**See table 2**).
- Superior wear resistance
- Superior chemical resistance
- Superior electrical insulation properties
- Stable coefficient of friction

**Table 2 Wear test (*PV* value: 21 MPa·m/min. No lubrication)**

| Shaft Material | Before the test | After the test | |
|---|---|---|---|
| | | BEAREE FL 3030 | PTFE filled with 25% glass fiber |
| Aluminum |  |  1000 hours |  1 hour |
| Brass |  |  1000 hours |  1 hour |
| SUS304 Stainless steel |  |  1000 hours |  1 hour |

NTN developed the following materials to solve the above noted problem.

**Table 3 Allowable pressure and wear factor**

| Properties / Grade | Base Resin | Allowable pressure MPa | Allowable pressure kgf/cm² | Applications | Production |
|---|---|---|---|---|---|
| **BEAREE FL 3030** | PTFE | 7 | 70 | Sliding bearings | Machining |
| **BEAREE FL 3040** | PTFE | 7 | 70 | Elevator guide shoe | Machining |
| **BEAREE FL 3050** | PTFE | 7 | 70 | High temperature bearings | Machining |
| **BEAREE PI 3018** | PI | 50 | 500 | Sliding bearings | Injection molding |
| **BEAREE AS 5000** | PPS | 20 | 200 | Office machiney parts | Injection molding |
| **BEAREE AS 5005** | PPS | 20 | 200 | Office machiney parts | Injection molding |
| **BEAREE AS 5050** | POM | 10 | 100 | Office machiney parts | Injection molding |
| **BEAREE DM 5010** | PEEK | 35 | 350 | Seal ring for the aluminum cylinder | Injection molding |

**Photograph 1**
**Products for the soft mating materials**

Refer to the test data.
BEAREE FL3000····page 55
BEAREE PI5001····page 56

## 4-3 Sliding materials for use in water or chemicals

Even materials designed and suitable for exposure to air (dry) may experience premature wear and damage to the mating material. **NTN** has developed materials to solve these problems.

**<Applications>**
- Bearing for under water (including sea water)
- Chemical pump, medical liquid pump
- Vane, rotor and casing for vane pump
- Bearing for sewage processing system

**Table 4 Allowable pressure and features**

| Grade | Allowable pressure Mpa {kgf/cm$^2$} | Features |
|---|---|---|
| **BEAREE FL 3700** | 7 {70} | Superior wear resistance under light load |
| **BEAREE PI 3700** | 100 {1,000} | For heavy load |
| **BEAREE AS 5700** | 20 {200} | Mass productivity and flexibility of part shape is possible through injection molding |

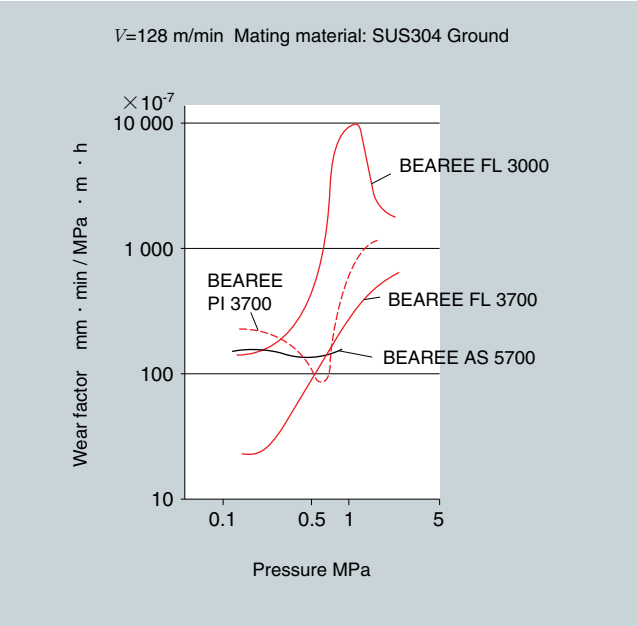



**Figure 1 Wear under water test by thrust type test rig**

**Photograph 2 The sliding bearings use for water (chemical)**

## 4-4 Materials for food processing equipment

So far, any material has failed to fully satisfy the functions required of a sliding material for food processing machinery. For example, an allowable operating temperature range with super molecular weight polyethylenes is small, while natural PTFE have a higher friction coefficient and are not aesthetically acceptable.
Our novel fluoro resin "BEAREE FL 3642" is a unique material that positively solves these problems.

■ "Plastic Container or Wrapping Standard Test (Japan Food Research Laboratories)" approved.

◆Test conditions; Ring-on-disk tester
Bearing pressure : 0.98 MPa
Peripheral speed : 32 m/min
Mating material : SUS304
Lubrication : dry or water
Test duration : 50 hrs.

**<Features>**
1. Low friction
2. Superior wear resistance
3. High allowable PV value
4. Less stick-slip phenomena at start up or extremely low speed
5. Better non-abrading characteristics against mild steel or stainless steel
6. Hygienic tone -pale yellow
7. Super chemical resistance

**<Applications>**
・Food processing machine
・Pharmaceutical production equipment
・Food or beverage vending machine

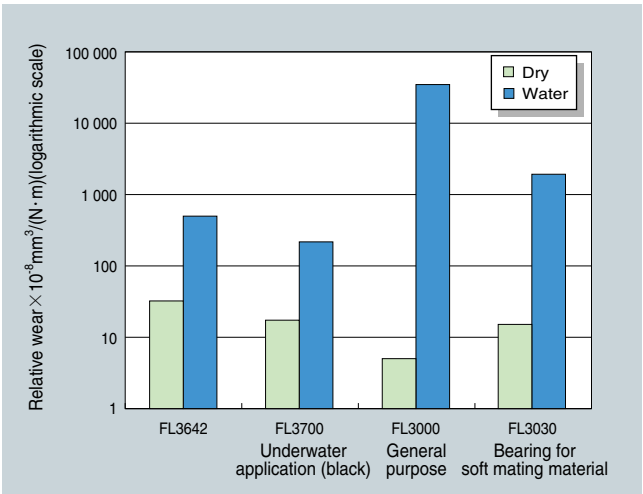



**Figure 2 Comparison of wear resistance of FL3642 with other NTN beating materials**

We also have approved materials other than BEAREE FL 3642 which are suitable for each operation condition.

**Table 5 Major "Plastic Container or Wrapping Standard Test" approved material**

| Grade | Color | Applications |
|---|---|---|
| **BEAREE FL 3040** | Black | Bearing for soft mating material |
| **BEAREE FL 3700** | Black | Under water application |
| **BEAREE UH 3000** | White | Excellent friction / wear characteristics under low $PV$ value |
| **BEAREE AS 5000** | Light brown | High temperature, suitable for mass production |

**Photograph 3 BEAREE FL 3642 Products**

**Photograph 4 Products for food processing equipment**

## 4-5 Rubber with sliding capability

This material has both the elasticity of rubber and the sliding characteristics of fluoro plastics, and the following features.

**<Features>**
1. The elastic material seals well.
2. Superior chemical resistance (Refer to Table 21 on page 45)
3. Superior heat resistance (allowable continuous service temperature is 230˚C)
4. Low friction coefficient and excellent wear resistance
5. Superior creep resistance
6. Excellent non-stick quality
7. Can be used for food contact application

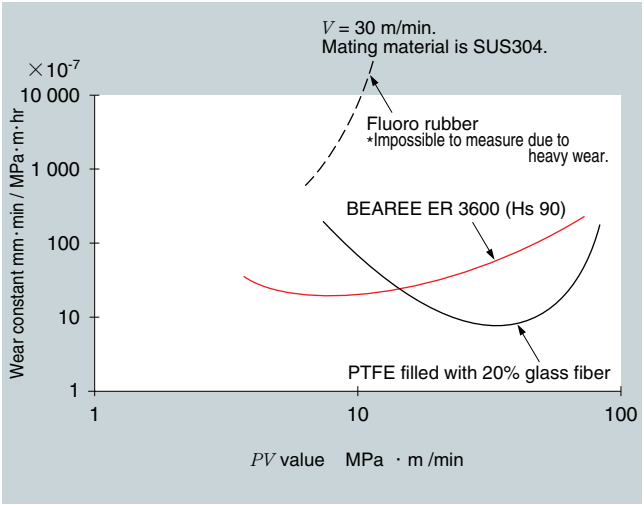



**Figure 4 $PV$ value versus wear factor**

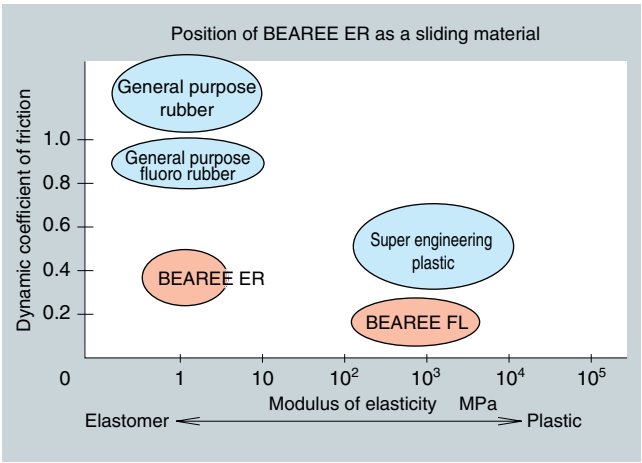



**Figure 3 Position of BEAREE ER as a sliding material**

**Photograph 5 Sliding rubber products**

**Table 6 Features and applications of BEAREE ER**

| Grade | Hardness | Color | Features | Applications |
|---|---|---|---|---|
| **BEAREE ER 3000** | Hs 70 | Black | Wear resistance | Bearings |
| | Hs 80 | | | |
| | Hs 90 | | | |
| **BEAREE ER 3600** | Hs 70 | White | Superior sliding characteristics against soft mating material | Seals and bearings for food processing machinery |
| | Hs 80 | | | |
| | Hs 90 | | | |

Refer to the test data.
BEAREE FL3000 · · · · page 55

## 4-6 NBR rubber with sliding capability : BEAREE ER3200

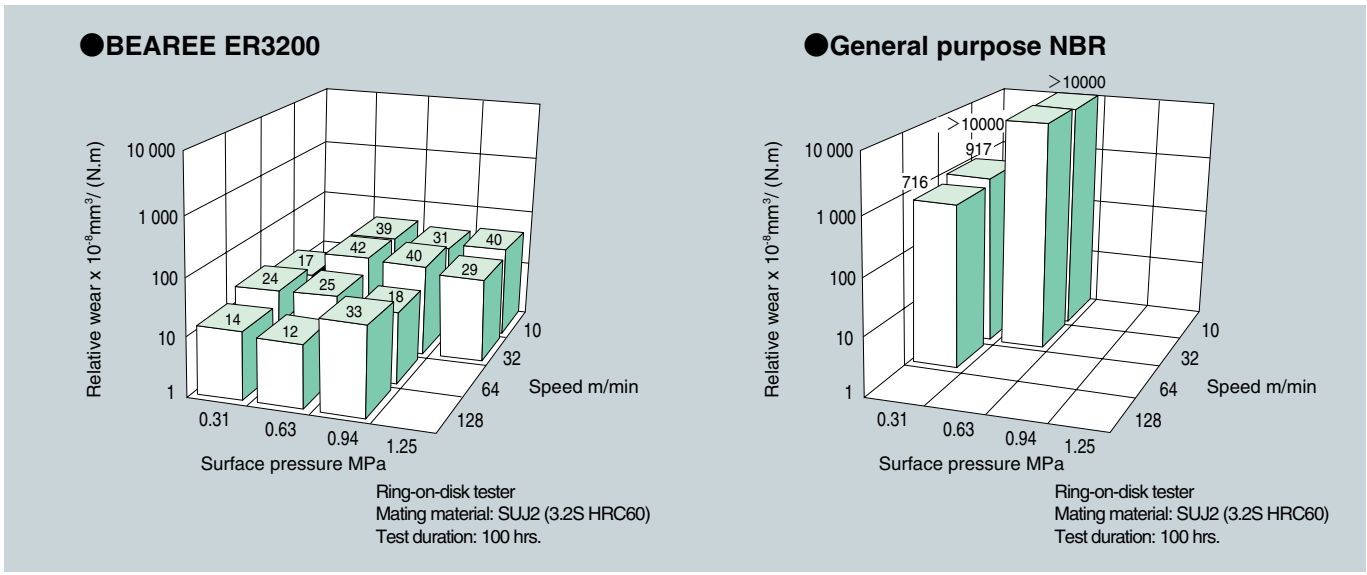
Using acrylonitrile butadiene rubber (NBR) as a base material, BEAREE ER3200 boasts low friction, low wear resistance characteristics while maintaining advantages of rubber material.

**<Features>**
1. Excellent friction and wear characteristics
2. Retains advantages of rubber material.
3. Better ozone resistance than general purpose NBR
4. Capable of composite molding together with metal material, etc.
5. More economical than sliding-capable fluoro rubber (such as BEAREE ER3000)

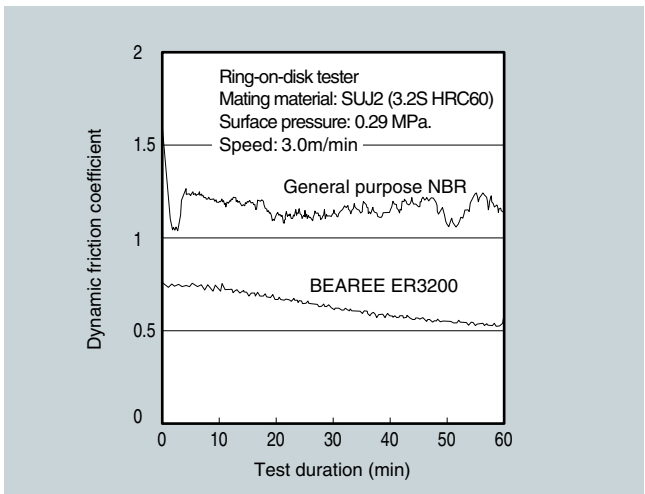
**<Applications>**

| Field | Applications |
|---|---|
| **Automobile** | Glassran<br>Wiper blade<br>Shock absorber seal |
| **Office equipment (photocopier, printer)** | Cleaning blade<br>Toner seal<br>Paper feed roller<br>Mirror slider |
| **Industrial machinery** | Mechanical seal in wet environment<br>Grease seal<br>Oil seal<br>Gas seal<br>Seal for damper |

**<Wear resistance>**




**<Wear resistance>**




**<Basic characteristics>**

| Item | Test method | Unit | Measurement |
|---|---|---|---|
| Hardness | JIS-K6253 | JIS-A | 70 |
| Specific gravity | JIS-K6220 | — | 1.33 |
| Tensile strength | JIS-K6251 | MPa | 11 |
| Elongation | JIS-K6251 | % | 430 |
| Tearing strength | JIS-K6252 | N/cm | 294 |
| Permanent set | JIS-K6262 | % | 11 |
| Compression set 120°C, 70 hrs. | JIS-K6262 | % | 24 |
| Ozone resistance 40°C, 50 Pphm 96 hrs., elongation 20% | JIS-K6259 | — | No fissure |

## 4-7 Sliding materials with electrical conductivity (Preventing electrostatic charges)

This material has not only excellent friction and wear characteristics but also has electrical conductivity. Utilizing this material as bearings for which anti-static properties are required, the grounding device could be removed.
Unlike conventional carbon brushes, these materials are less prone to cracking or chipping. They also operate more quietly.

**<Applications>**

- Sliding and grounding parts for computer related equipment.
- Bearings, gears for photo copiers, printers and facsimile machines.

**Table 7 Volume resistivity and major applications**

| Grade | Volume resistivity (Ω · cm) | Major applications |
|---|---|---|
| **BEAREE FL 3900** | 10 | Grounding button for disk drive |
| **BEAREE PI 5040** | $1 \times 10^5$ | Gear |
| **BEAREE AS 5950** | $5 \times 10^5$ | Bearing |
| **BEAREE AS 5951** | $1 \times 10^4$ | Bearing |
| **BEAREE NY 5910** | 10 | Gear |
| **BEAREE NY 5911** | $1 \times 10^3$ | Gear |

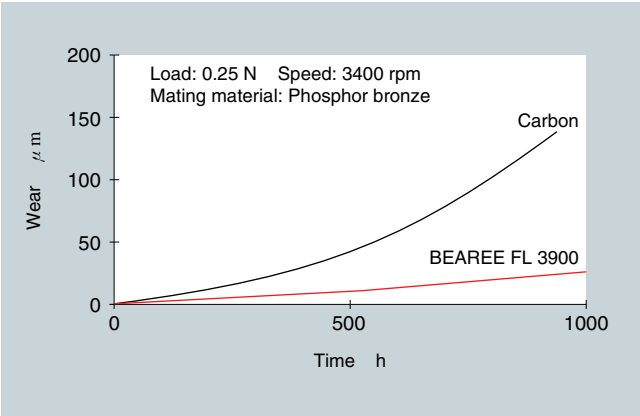



**Figure 5 Wear comparison between BEAREE FL 3900 and Carbon**

**Photograph 6 Grounding buttons for disk drivers**

**Photograph 7 Conductive bearings, gears**

## 4-8 Sliding materials for high contact pressures

In general, the allowable pressure for plastics material is low when compared with metal material; however, it can be used under high pressure by bonding it to a backing metal or using a thin layer of plastics which is reinforced with filler.

### 1. BEAREE PI

The BEAREE PI series, with a base resin of polyimide, can carry 50 to 100 MPa of allowable pressure. The grade to be adopted is selected according to temperature, sliding velocity and manufacturing method.

**Table 8 Allowable pressure and manufacturing method**

| Grade | Allowable pressure MPa {kgf/cm$^2$} | Manufacturing method |
|---|---|---|
| **BEAREE PI 5001** | 50 { 500 } | Extrusion forming |
| **BEAREE PI 7000** | 250 {2,500 } | Coating |

**<Applications>**
Non lubrication type pillow block
Anchor bearing for buoy
Transmission thrust bearings

Refer to the test data.
BEAREE P15001 · · · · page 56

### 2. BEAREE FL 9000

This material can carry up to 200 MPa of pressure under low speed conditions.
The bronze mesh in this material prevents creep, and makes it possible for use in high pressure applications.

**Figure 21** shows the section view of this material. Compact design can be achieved due to its thickness of 0.5mm. It is recommended to bond this material to a stiff material like metal in applications where the pressure is higher than 40 MPa.

**Table 9 Allowable pressure and Structure**

| Grade | Allowable pressure MPa {kgf/cm$^2$} | | Structure |
|---|---|---|---|
| **BEAREE FL 9000** | 100 | 1,000 | PTFE containing mesh gauze |

**<Applications>**
Non lubrication type spherical plain bushing
King-pin bearing
Crane
Shock absorber
Door hinge

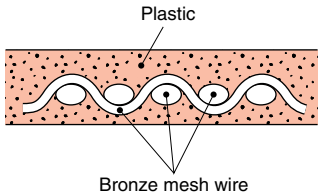



**Figure 6 Structure of BEAREE FL9000**

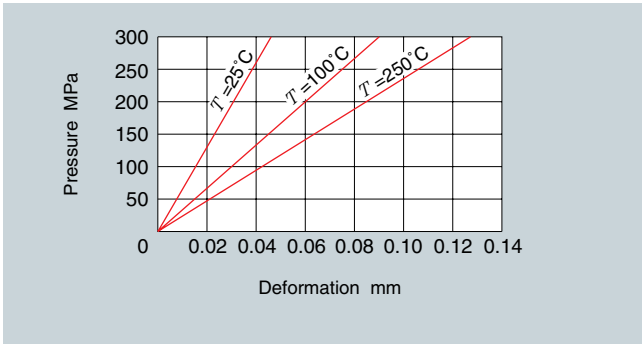



**Figure 7 Deformation ( compressive strain) by load (pressure)**

**Remarks:**
The deformation is measured while BEAREE FL 9000 is clamped between steel plates with load applied for 60 minutes. The deformation lowers or, is reduced, when BEAREE FL 9000 is bonded to backing material.

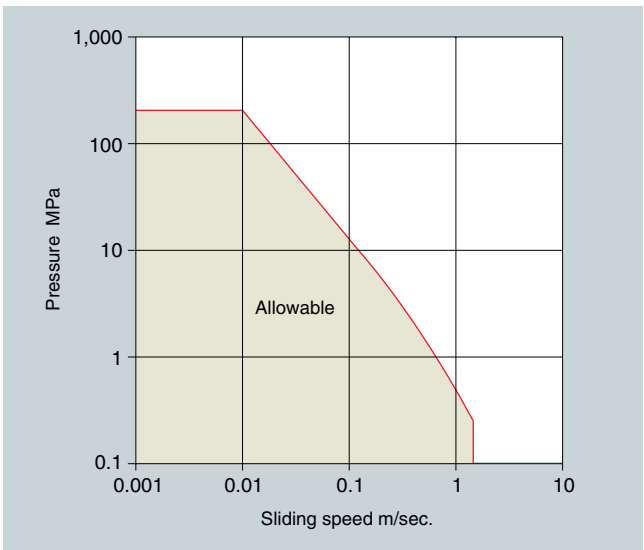



**Figure 8 Allowable $PV$ value-BEAREE FL9000**

**Photograph 8 The sliding bearings for high pressure (load)**

## 4-9 Sliding materials for use in machine tools : BEAREE FL 3305

BEAREE FL 3305, which is based on fluoro plastics with a low friction coefficient, and designed with improved wear and creep resistance and thermal conductivity, is material developed exclusively for machine tools and has the lowest friction coefficient when lubricated with oil.

**<Features>**
1. The lowest coefficient of friction under oil lubrication.
2. No stick-slip.
3. No galling and/or seizure
4. Little compressive deformation
5. No oil film shortage problem at startup; suitable for frequent startups.
6. Low coefficient of friction and durable.

**<Remarks>**
Standard thickness:mm
0.3,0.4,0.5,0.6,0.8,1.0,1.2,1.5,2.0,2.5,3.0

Reciprocating friction test (**Fig.9**, **Fig.10**)
Mating material : Mihanite cast iron(0.3S grinding finish)
Stroke : 60 mm
Lubrication : Application of Shelltoner T68.

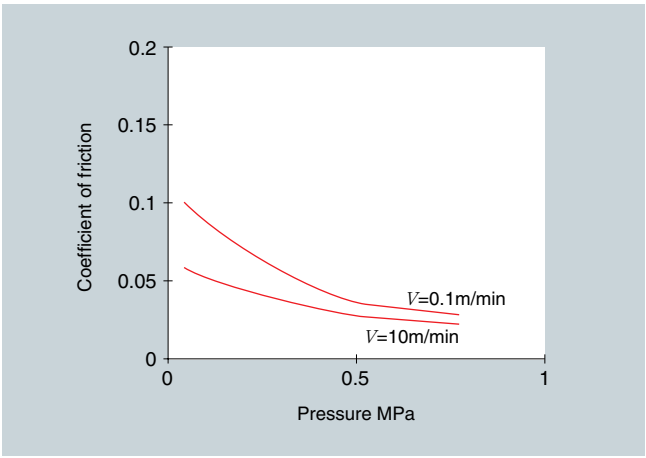



**Figure 9 Friction coefficient versus face pressure**

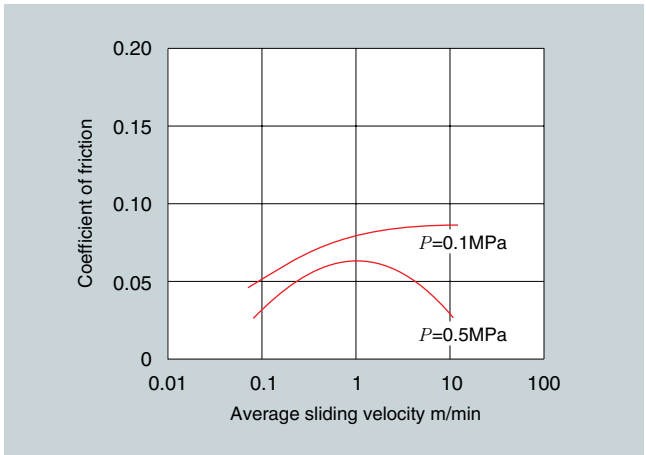



**Figure 10 Friction coefficient versus sliding velocity**

High speed reciprocating friction test
Mating material : Mihanite cast iron (0.3S grinding finish)
Sliding speed : 30 m/min.
Stroke : 200 mm
Lubrication : Application of mineral oil.

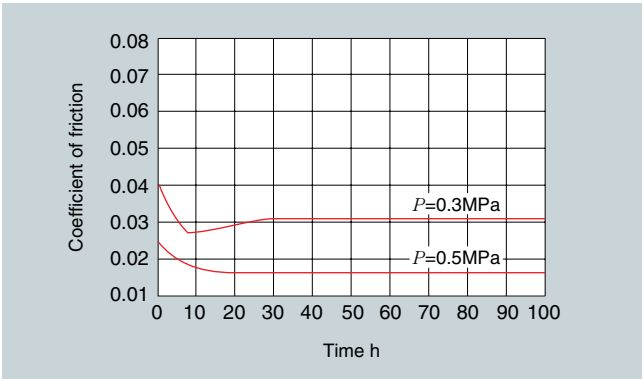
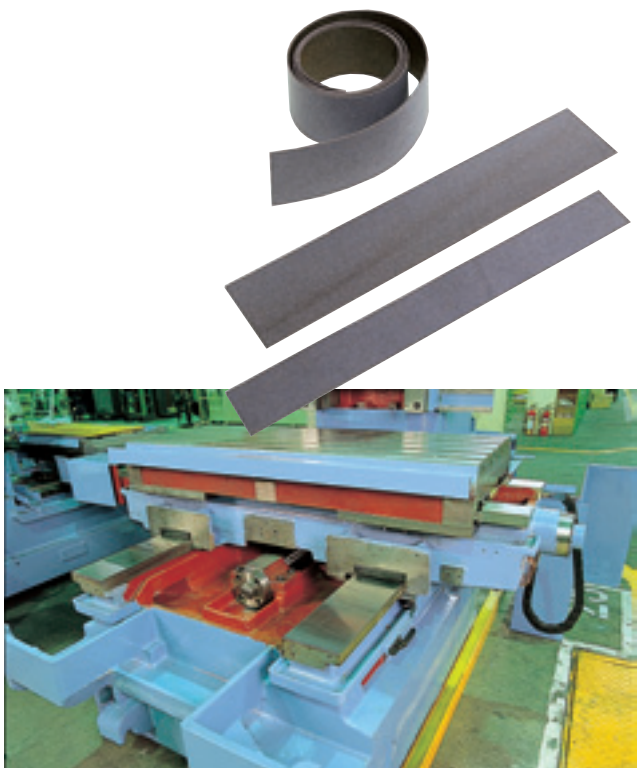



**Figure 11 Friction coefficient versus running time**

Use the original adhesive for easy bonding.
1. N-3 bonding agent : High hardness after hardening.
2. AD-3000 bonding agent : Hardness after hardening is lower than N-3 so that the cutting work is easy.



**Photograph 9 Sliding section of machine**

## 4-10 Plastics materials for gears

Plastics gears are used in various areas due to their light weight, no need for lubrication, low noise, corrosion resistance and ease of mass production. **NTN** Engineering Plastic materials for gears are widely prepared for particular applications or functions, from super engineering plastic to general purpose engineering plastic to ensure the optimum gear.

**<Features>**
1. High strength, durable
2. Superior sliding properties
3. Superior heat resistance

**<Typical configuration>**
Gear type: flat gear, helical gear
Module : 0.8 ～ 1.5
P.C.D . : 15 ～ 60mm

**Table 10 Gear material and features**

| Grade | Base Resin | Performance Evaluation | | | |
|---|---|---|---|---|---|
| | | Heat resistance | Sliding capability | Strength | Electrical conductivity |
| BEAREE PI 5030 | PI | ◎ | | ◎ | |
| BEAREE PI 5033 | | ◎ | | ◎ | |
| BEAREE AI 5006 | PAI | ◎ | | ◎ | |
| BEAREE AS5040 | PPS | ○ | | ◎ | |
| BEAREE AS5045 | | ○ | ○ | ○ | |
| BEAREE NY5010 | PA | | | ○ | |
| BEAREE NY5910 | | | ○ | ○ | ○ |

◎:Excellent ○:Normal

* Material is selected by operating condition, material of mating gear, life, tolerances and so on.


**Photograph 10 Gears**

A: Anti-rotation type (D bore)

B: Anti-rotation type (With key)

C: Idler gear (Made of sliding material)

D: Idler gear (Compound type sliding material on bore)

E: Double gear

F: Helical gear

## 4-11 Materials for separating pins

Photocopiers and printers fix the image formed by toner to the paper by heating and pressing of rollers. To peel off the attached paper from the roller, sharp separating pins are used. For the separating pins, rigidity at a high temperature, sliding properties so as to not to scratch the roller, and superior anti-stick properties are necessary.
**NTN** Engineering Plastics provides a suitable pin and coating materials for the practical temperature.

**<Characteristics>**
- Excellent mechanical strength and heat resistance.
- Satisfactory fluidity and excellent performance in molding the pin tip figure.
- Excellent shock resistance.
- Superior friction and wear resistance.

**Table 11 Combination of the separating pin material and recommended coating material.**

| Material name | Maximum operating temperature ˚C | Recommended coating material | Application |
|---|---|---|---|
| BEAREE PI 5022 | 300 | BEAREE FE 7092 | Pins for the fixing section, high performance. |
| BEAREE LC 5020 | 300 | BEAREE FE 7090 | Pins for the fixing section. |
| BEAREE AI 5017 | 230 | BEAREE FE 7030 | Pins for the fixing section. |
| BEAREE AI 5003 | 230 | BEAREE FE 7030 | Pins for the exposure drum. |
| BEAREE AS 5021 | 230 | BEAREE FE 7080 | Pin for the fixing section, highly economic. |
| BEAREE AS 5025 | 230 | — | Pin for the fixing section, highly economic. |

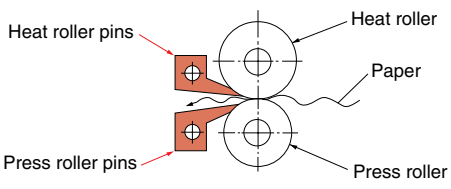



**Fig.12 Application of separating pins**

## 4-12 Sliding materials for the guide roller

As the guide roller for the high speed running of video tape recorders (VTR), computer backup devices and digital audio tape recorders (DAT), BEAREE UH 5041 presents a wide range of superior friction and wear properties with less torque change from the tape's low speed running to high speed running.

**Table 12 Materials and Characteristics**

| Material name | Base resin | Characteristics |
|---|---|---|
| **BEAREE UH5041** | PE | · Low revolution torque at high speed rotation<br>· Constant revolution at low speed rotation<br>· Superior durability in many environmental conditions |

**Test conditions (Revolution torque test)**

Test unit : Revolution torque measurement unit
Test sample : Guide roller
Load : 0.3N{30gf}
Revolution : 100-21,000 rpm
Lubrication : None
Ambient temp : Room temperature

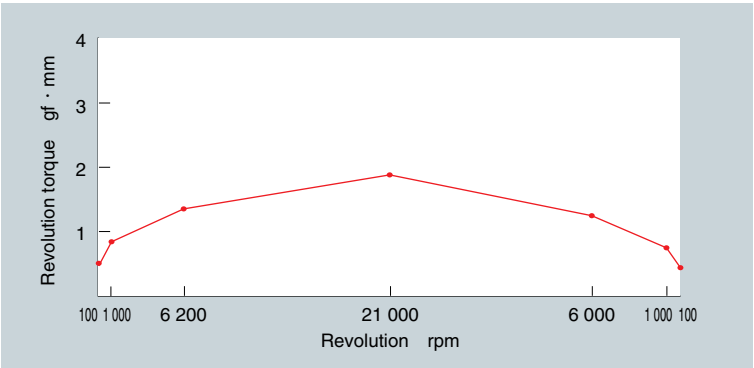



**Fig.13 Revolution torque of guide roller versus revolution**

**Test conditions (Endurance test)**

Test sample : Guide roller
Load : 0.3N{30gf}
Revolution : 25 000 rpm
(Revolution for measurement of torque: 18,000 rpm)
Lubrication : None
Ambient temp : Room temperature
Operation pattern : Clockwise/ counterclockwise revolution
Test time : 1,000 hours

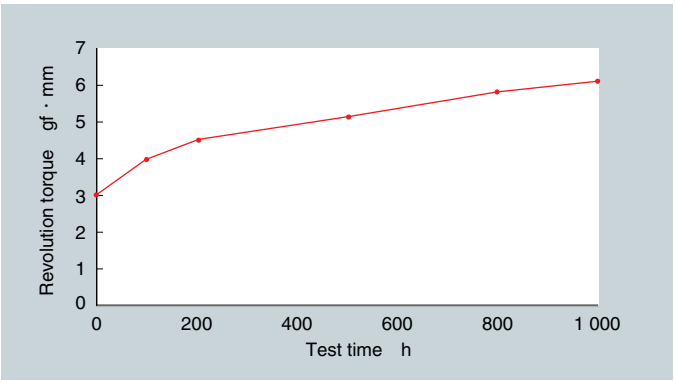



**Fig.14 Revolution torque of guide roller versus test time**

## 4-13 Seal materials for sliding applications

NTN Engineering Plastics have excellent sealing capabilities against gas and liquid, good wear resistance, and low friction characteristics.

**<Features>**
1. Superior sealing capability due to the high compliance.
2. Low coefficient of friction and superior wear resistance
3. No lubrication is necessary due to the self lubricating capability.
4. Superior chemical resistance; can be used in corrosive environments.
(See **Table 9** at page 17 for chemical resistance.)

**Table 13 Selection and Applications**

| Grade | Mating material | | | Atmosphere | | | Elongation | Processing Method | Application |
|---|---|---|---|---|---|---|---|---|---|
| | Mild steel | Cast iron | Aluminum | Dry | Oil | Water | (%) | | |
| **BEAREE FL 3000** | ○ | ○ | × | ○ | ○ | △ | 200 | Machining | General purpose, power steering A/T transmission |
| **BEAREE FL 3030** | ○ | ○ | ○ | ○ | ○ | × | 170 | Machining | Air suspension Air compressor |
| **BEAREE FL 3050** | ○ | ○ | ○ | ○ | ○ | △ | 160 | Machining | Air suspension Air conditioner compressor |
| **BEAREE FL 3070** | ○ | ○ | ○ | × | ○ | △ | 230 | Machining | Car air conditioner A/T transmission |
| **BEAREE FL 3900** | ○ | ○ | × | × | ○ | △ | 34 | Machining | A/T transmission |
| **BEAREE AS 5001** | ○ | ○ | ○ | △ | ○ | △ | 1.0 | Injection molding | Scroll compressor |
| **BEAREE AS 5700** | ○ | ○ | ○ | △ | ○ | ○ | 2.0 | Injection molding | Vane under water |
| **BEAREE PK 5015** | ○ | ○ | ○ | × | ○ | △ | 1.1 | Injection molding | Scroll compressor |
| **BEAREE PK 5300** | ○ | ○ | ○ | × | ○ | ○ | 1.3 | Injection molding | A/T transmission |

○: Satisfactory △:Normal ×:Unsuitable

Refer to the test data.
BEAREE FL3000・・・・page 55

**Photograph 11 Seal rings**

## 4-14 Sound damping material for curtain walls

Tall buildings constructed with curtain wall structures require a sliding material to smooth the relative movement between the steel frame and other building materials. Movement caused by differences in thermal expansion, earthquakes, wind, etc. is smoothed, eliminating jarring sounds. **NTN** Engineering Plastics include materials for this purpose.

**Table 14 Features**

| Grade | Features | |
|---|---|---|
| **BEAREE FL 3000** | · Low coefficient of friction with no lubrication<br>· Prevention of jarring sound between metals<br>· High load carrying capability<br>· Superior weather resistance<br>· Resistant for most of chemicals | · Fire or flame retardant capability<br>· Superior electric insulating characteristics |
| **BEAREE UH 3954** | | · Superior shock resistance |
| **BEAREE FL 7075** | | · Can be applied in this layers to complicated shapes |

Refer to the test data.
BEAREE FL3000 · · · · page 55
BEAREE FL7075 · · · · page 57

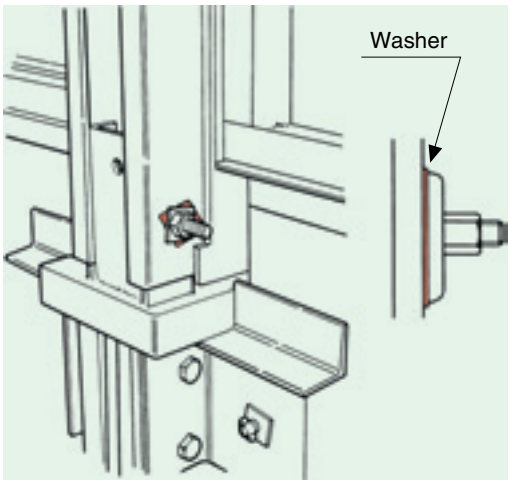
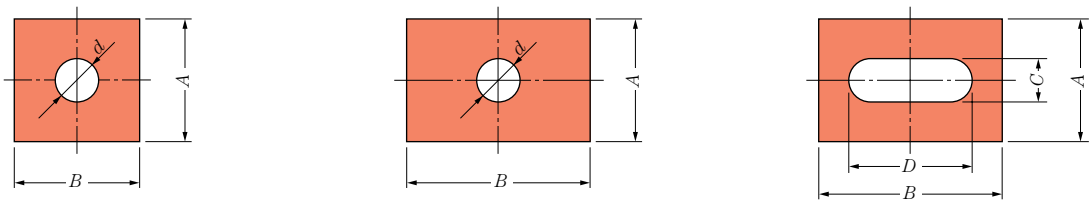



**Fig.15 Sound dampening washer of the curtain wall.**

**<Remarks>**
1) Thickness (Unit in mm)
BEAREE FL 3000 0.3, 0.4, 0.5, 0.6, 0.8, 1.0
BEAREE UH 3954 0.1, 0.3, 0.4, 0.5, 1.0
BEAREE FL 7075 0.02 (Coating layer)
2) Pressure sensitive adhesive
Product with pressure sensitive adhesive on one side is available
3) To place your order
Specify $A \times B \times$ thickness, hole dimension ($d$ or $C \times D$), material and requirements for pressure sensitive adhesive.
Specify the surface to be coated for coating product (BEAREE FL 7075), or the coating of your product is also available.




**<Applications>**
Fastener
Liner
Bracket
Joint sleeve
Shaft
Hinge washer
Other metal sliding portion.

## 4-15 Sliding materials for bridges and anti-earthquake structures

A bridge repeatedly expands and contracts due to daily and seasonal temperature changes. One side of the bridge bearings smoothly slides with the bridge to relieve the generated stress on the bridge.
An anti-earthquake device has a mechanism to reduce an earthquake's power by sliding the building according to the earthquake's intensity. As one means to slide the building, sliding materials are utilized. For these bridges and anti-earthquake devices, BEAREE FL3020 is used, which is excellent for big loads with low friction and resistant to the climate changes.

**Table 15 Materials and Characteristics**

| Material name | Base resin | Characteristics |
|---|---|---|
| **BEAREE FL 3020** | PTFE | · Low friction coefficient under the high surface pressure<br>· Superior durability in many environmental conditions |

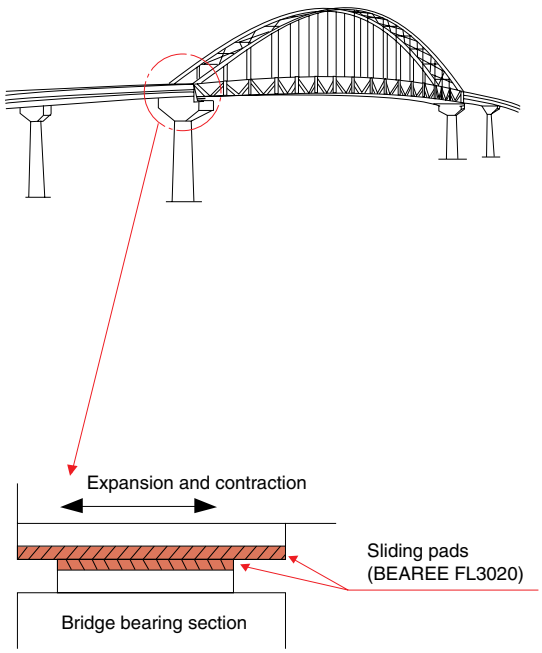



**Fig.16 Sliding pad for bridge bearings**

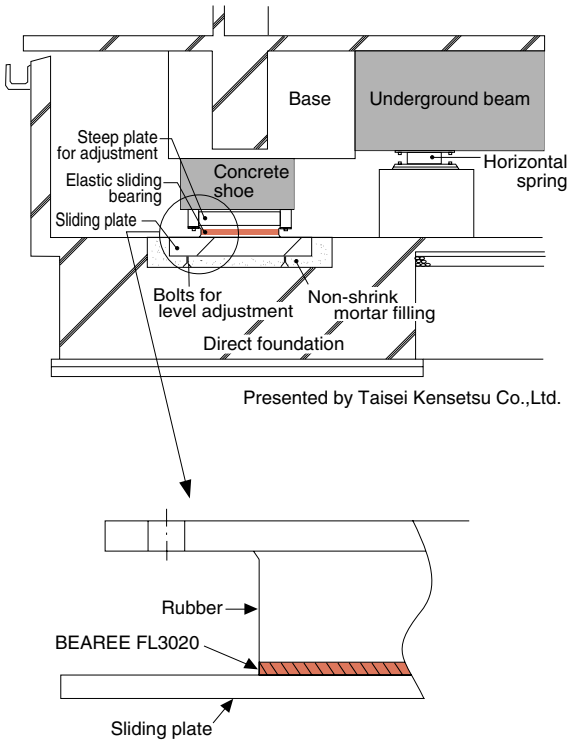



**Fig.17 Anti-earthquake device with the elastic sliding bearing**
Presented by Tokyo Fabric Industry Co.,Ltd.

## 4-16 Compound products

By combining BEAREE materials with other materials, the advantages of each material can be utilized.

**<Features>**
1. Allowable pressure can be increased.
2. Reinforcement material can be selected by application.
3. Weight can be reduced.
4. Thermal expansion can be decreased.
5. Processing accuracy can be improved.
6. Compact design is available by integrating the mating housing.
7. Number of components can be decreased.

**<Applications>**
Copying machine: Heat roller bearing, pressure roller and mirror slide bearing
Printer carriage bearing
Slide bearing for data recorder
Seal ring for automobile
Door guide shoe for elevator

**<Examples of composite>**
- BEAREE material + Rubber
- BEAREE material + Rubber + Metal
- BEAREE material + Metal
- BEAREE material + General implantation + Metal

**Photograph 12 Composite products**

## 4-17 Coating materials

BEAREE coating material provides a hard, thin and uniform layer, and is applied to the location where thermal expansion should be small or precision is required.
Also, the characteristics of wear resistance and non-stick quality can be utilized.
Coating methods such as spray, powder coating, dipping, etc., are adopted according to the kind of material.

**<Features>**
1. Superior wear and friction characteristics
2. Superior non-stick quality
3. Superior heat resistance
4. Superior chemical resistance

**Table 23 Materials for coating and its characteristics**

| Grade | Characteristics | | | Remarks | Baking temperature (˚C) | Layer thickness ($\mu$m) | Applications |
|---|---|---|---|---|---|---|---|
| | Low coef. of friction | Wear resistance | non-stick quality | | | | |
| **BEAREE FL 7060** | ○ | ○ | | Superior under low pressure | 230 | 10～30 | Guide pin |
| **BEAREE FL 7061** | ○ | ○ | | For oil lubricated | 230 | 10～30 | Reciprocating bearing in oil |
| **BEAREE FL 7075** | ○ | ○ | | General purpose | 230 | 10～30 | Piston, washer vane |
| **BEAREE FE 7010** | | ○ | | For high pressure, thick layer | 315 | 500～2 000 | Rotor for super charger |
| **BEAREE FE 7080** | ○ | | ○ | Extremely thin layer | 150 | Below 1 | Guide pin, picker for copier |
| **BEAREE FE 7000** | ○ | ○ | | For high pressure | 230 | 300 | Bearing |
| **BEAREE FE 7030** | | | ○ | | 230 | 10～30 | Slide guide picker finger for copier |
| **BEAREE FE 7090** | | | ○ | | 370 | 10～30 | Picker finger for copier |

* Can be coated on plastics as well as metals; however, the plastics should be resistant to the baking temperature of coated BEAREE.
* Surface treatment of BEAREE FE7080 is processed in the range from room temperature up to 250˚C.

Refer to the test data.
BEAREE FL7075・・・・page 57

**Photograph 13 The coated products**

# 5 Materials for Bearing Applications

## 5-1 Various grades and their characteristics

**Table 17 Materials for machining (ram extrusion and compression molding)**

| Grade | Base Resin | Characteristics | | Applications |
|---|---|---|---|---|
| **BEAREE FL 3000** | PTFE |  | *Less deformation under compression load<br>*Superior wear, resists friction | *Sliding bearings<br>*Valve seats<br>*Piston rings |
| **BEAREE FL 3020** | PTFE |  | *Low friction under high pressure<br>*Superior weather resistance | *Bearing pads |
| **BEAREE FL 3030** | PTFE |  | *Does not abrade soft mating material<br>*Stable coefficient of friction | *Sliding bearings<br>*Seal rings<br>*Piston rings, friction plate |
| **BEAREE FL 3040** | PTFE |  | *Does not abrade soft mating material | *Sliding bearings<br>*Piston cup seals |
| **BEAREE FL 3050** | PTFE |  | *Does not abrade soft mating material<br>*Superior wear resistance under high temperature | *Sliding bearings |
| **BEAREE FL 3060** | PTFE |  | *Superior creep resistance | *Exclusively for ML bearings |
| **BEAREE FL 3070** | PTFE |  | *Superior sliding characteristics and creep resistance | *Compressor seals |
| **BEAREE FL 3305** | PTFE |  | *Low coefficient of friction under oil lubrication | *Sliding table for machine tools |
| **BEAREE FL 3641** | PTFE |  | *Passed regulations for food processing equipment<br>*Superior wear resistance | *Sliding bearings<br>*Seals |
| **BEAREE FL 3700** | PTFE |  | *Superior under water wear resistance<br>*Superior chemical resistance | *Bearings for under water and /or chemical liquid |
| **BEAREE FL 3900** | PTFE |  | *Conductive<br>(Volume resistive: 10 Ω · cm)<br>*Superior wear, resists friction | *Grounding buttons<br>*Brushes |
| **BEAREE UH 3000** | PE |  | *Superior friction resistance and wear under low $PV$ value<br>*Superior shock resistance | *Sliding bearings<br>*Washers |
| **BEAREE UH 3954** | PE |  | *Effective for anti-static<br>*Less abrasion wear<br>(Wear from paper or sand lapping) | *Sound damping washers<br>*Cassette tape shims |
| **BEAREE FL 9000** [2)] | PTFE |  | *Suitable under low speeds high pressures | *Sliding bearings<br>*Rocking bearings |
| **BEAREE ER 3000** | E [1)] |  | *Has elasticity and low friction<br>*Superior sealing anti-stick property and chemical, heat wear and creep resistance<br>*Meets regulations for rubber packaging and containers | *Food processing equipment seals<br>*Sliding bearings |
| **BEAREE ER 3600** | E [1)] | | | |

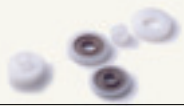
NOTE 1) E : Elastomer
2) BEAREE FL 9000 is the special material for tapes.

| Specific gravity | Compressive creep % | Hardness[1] | Tensile strength MPa | Tensile strength kgf/cm² | Elongation % | Flexural strength MPa | Flexural strength kgf/cm² | Flexural modulus MPa | Flexural modulus kgf/cm² | Water absorption % | Coef. of thermal expansion[2] ×10⁻⁵/℃ | Max. service temp. ℃ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.28 | 8.1 | 66 | 15 | 150 | 200 | —— | —— | —— | —— | 0.03 | 8.3 | 260 |
| 2.23 | 7.0 | 64 | 22 | 220 | 250 | —— | —— | —— | —— | 0.03 | —— | 260 |
| 1.98 | 5.0 | 62 | 12 | 120 | 170 | —— | —— | —— | —— | 0.09 | 9.0 | 260 |
| 2.19 | 6.0 | 63 | 14 | 140 | 170 | —— | —— | —— | —— | 0.02 | 8.5 | 260 |
| 1.94 | 6.0 | 63 | 11 | 110 | 160 | —— | —— | —— | —— | 0.01 | 8.7 | 260 |
| 3.80 | 3.2 | 70 | 10 | 100 | 100 | —— | —— | —— | —— | 0.09 | 6.8 | 260 |
| 2.09 | —— | 68 | 18 | 180 | 230 | —— | —— | —— | —— | —— | 6.3 | 260 |
| 3.39 | 4.0 | 70 | 11 | 110 | 90 | —— | —— | —— | —— | —— | 6.8 | 260 |
| 2.25 | 10.6 | 65 | 13 | 130 | 140 | —— | —— | —— | —— | 0.02 | 9.1 | 260 |
| 2.10 | 3.0 | 70 | 16 | 160 | 130 | —— | —— | —— | —— | 0.07 | 7.2 | 260 |
| 2.07 | 1.4 | 70 | 14 | 140 | 30 | —— | —— | —— | —— | —— | 8.7 | 260 |
| 0.94 | 11.0 | 65 | 20 | 200 | 200 | 20 | 200 | 610 | 6 100 | 0.01 | 20.0 | 80 |
| 0.94 | 10.0 | 65 | 40 | 400 | 200 | —— | —— | —— | —— | 0.01 | 17.0 | 80 |
| 4.25 | —— | —— | 46 | 460 | 15 | —— | —— | —— | —— | —— | 1.9 | 260 |
| 1.78 | —— | Hs70,80,90 | 10 | 100 | 290 | —— | —— | —— | —— | 0.05 | 10.0 | 230 |
| 2.10 | —— | Hs70,80,90 | 12 | 120 | 290 | —— | —— | —— | —— | 0.05 | 10.0 | 230 |

NOTE 1) Hardness: no code = durometer; Hs = rubber hardness; others = Rockwell hardness
2) Coefficient of linear expansion: the mean coefficient of linear expansion in the range from room temperature up to 150˚C.

Values in the above table are representative test results.

**Table 18 Injection molding materials**

| Grade | Base Resin | Characteristics | | Applications |
|---|---|---|---|---|
| **BEAREE PI 5001** | PI |  | *Excellent wear resistance | *Sliding bearings<br>*Washers<br>*Piston rings |
| **BEAREE PI 5010** | PI |  | *Non-abrasive to soft mating materials | *Sliding bearings<br>*Thrust bearings |
| **BEAREE PI 5022** | PI |  | *Precision moldable | *Picker fingers<br>*Electrical and electronic parts |
| **BEAREE PI 5030** | PI |  | *High mechanical strength | *Gears<br>*Retainers (bearing cages) |
| **BEAREE PI 5040** | PI |  | *High rigidity and electrical conductivity | *Gears<br>*Heat insulating sleeves |
| **BEAREE AI 5003** | PAI |  | *Excellent impact resistance<br>*High mechanical strength | *Heat insulation<br>*Electrical and electronic parts |
| **BEAREE AI 5017** | PAI |  | *Excellent friction and wear properties<br>*High mechanical strength<br>*Small drop in heat resistance due to water absorption | *Picker fingers<br>*Sliding bearings<br>*Washers |
| **BEAREE UH5000** | PE |  | *Excellent impact resistance<br>*Excellent resistance against abrasive wear | *Sliding bearings |
| **BEAREE UH5041** | PE |  | *Excellent sliding properties at low pressure | *Guide rollers |
| **BEAREE AS5000** | PPS |  | *Excellent sliding properties at high temperature<br>*High max. allowable bearing pressure ($P$max = 20 MPa)<br>*Non-abrading soft mating material | *Sliding bearings<br>*Friction plates<br>*Reciprocating bearings |
| **BEAREE AS5005** | PPS |  | *Excellent sliding properties at high temperature<br>*High max. allowable bearing pressure ($P$max = 20 MPa)<br>*Non-abrading soft mating material | *Sliding bearings |
| **BEAREE AS5021** | PPS |  | *Excellent strength for separating pins | *Picker fingers |
| **BEAREE AS5053** | PPS |  | *Excellent sliding properties at high temperature | *Fixing roller bearing |
| **BEAREE AS5961** | PPS |  | *Excellent sliding properties at high temperature | *Fixing roller bearing |

| Specific gravity | Compressive creep % | Hardness[1] | Tensile strength MPa | Tensile strength kgf/cm² | Elongation % | Flexural strength MPa | Flexural strength kgf/cm² | Flexural modulus MPa | Flexural modulus kgf/cm² | Water absorption % | Coef. of thermal expansion[2] ×10⁻⁵/℃ | Max. service temp. ℃ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.49 | —— | M94 | 67 | 670 | 1.3 | 108 | 1 080 | 8 500 | 85 000 | 0.10 | 2.2 | 240 (300)[3] |
| 1.46 | ＜0.2 | M70 | 76 | 760 | 7 | 116 | 1 160 | 3 700 | 37 000 | 0.25 | 4.5 | 240 (300)[3] |
| 1.80 | —— | M107 | 138 | 1 380 | 1 | 190 | 1 900 | 14 100 | 141 000 | 0.3 | 3.4 | 240 (300)[3] |
| 1.58 | ＜0.2 | M99 | 160 | 1 600 | 3 | 250 | 2 500 | 11 000 | 110 000 | 0.22 | 1.5 | 240 (300)[3] |
| 1.43 | ＜0.2 | M99 | 130 | 1 300 | 2 | 360 | 3 600 | 21 000 | 210 000 | 0.25 | 0.4 | 240 (300)[3] |
| 1.40 | ＜0.2 | E91 | 190 | 1 900 | 12 | 220 | 2 200 | 4 700 | 47 000 | 0.28 | 4.0 | 250 |
| 1.51 | ＜0.2 | M105 | 82 | 820 | —— | 170 | 1 700 | 8 800 | 88 000 | 0.18 | 4.1 | 250 |
| 0.94 | 11.0 | R60 | 41 | 410 | 10 | 41 | 410 | 1 600 | 16 000 | 0.01 | 17.0 | 80 |
| 0.95 | —— | —— | 48 | 480 | 8.8 | 33 | 330 | 970 | 9 700 | 0.06 | 12.4 | 80 |
| 1.53 | 0.3 | 80 | 51 | 510 | 3 | 61 | 610 | —— | —— | 0.05 | 8.1 | 230 |
| 1.55 | 0.3 | 81 | 51 | 510 | 3 | 61 | 610 | —— | —— | 0.03 | 7.0 | 230 |
| 1.69 | —— | —— | 103 | 1 050 | —— | 164 | 1 670 | 11 760 | 120 000 | 0.01 | —— | 230 |
| 1.60 | —— | R95 | 67 | 670 | 4 | 86 | 860 | 3 700 | 37 000 | —— | 10.8 | 230 |
| 1.56 | —— | R91 | 51 | 510 | 5 | 80 | 800 | 3 600 | 36 000 | —— | 7.5 | 230 |

NOTE 1) Hardness: no code = durometer; others = Rockwell hardness
2) Coefficient of linear expansion: the mean coefficient of linear expansion in the range from room temperature up to 150˚C.
3) Max. service temperature shown in brackets ( ): for the products after crystallizing treatment

Values in the above table are representative test results.

**Table 18**

| Grade | Base Resin | Characteristics | | Applications |
|---|---|---|---|---|
| **BEAREE AS5700** | PPS |  | *Superior wear resistance in water<br>*Superior chemical resistance | *Bearings in water<br>*Bearings in chemicals |
| **BEAREE AS5910** | PPS |  | *High modulus | *Lens holders |
| **BEAREE LC5020** | ARPES |  | *High mechanical strength high heat resistance<br>*Picker fingers mold well because of material's fluidity | *Picker fingers |
| **BEAREE PK5030** [4)] | PEEK |  | *Excellent wear resistance | *Washers |
| **BEAREE PK5900** | PEEK |  | *Excellent wear resistance<br>*Superior shock resistance | *Sliding bearings<br>*Bearings in oil |
| **BEAREE PK5300** | PEEK |  | *Excellent wear, friction, chemical and heat resistance<br>*Superior sealing | *Seal rings |
| **BEAREE NY5000** | PA |  | *Excellent friction and wear characteristic at low $PV$ value | *Sliding bearings<br>*Door wheels |
| **BEAREE DM5030** | POM |  | *Excellent wear resistance ensuring stable low friction coefficient for a long period of time<br>*Suitable for aluminum or copper mating material | *Sliding bearings<br>*Gears<br>*Rollers |

**Table 19 Coating materials**

| Grade | Characteristics | | Applications |
|---|---|---|---|
| **BEAREE FL7075** |  | *Excellent friction and wear characteristics<br>*Strong coat layer | *Washers<br>*Valve plates<br>*Rollers |
| **BEAREE FE7010** |  | *Thick, strong layer is achievable | *Roots pump rotors |
| **BEAREE FE7031** |  | *Excellent anti-stick properties<br>*Strong coat layer | *Picker fingers<br>*Slide guides |
| **BEAREE FE7080** |  | *Accuracy of coated parts can be maintained due to extremely thin layer of coating<br>*Excellent anti-stick properties | *Picker fingers<br>*Sliding bearings |
| **BEAREE FE7092** |  | *Excellent anti-stick properties | *Picker fingers |

| Specific gravity | Compressive creep % | Hardness[1] | Tensile strength MPa | Tensile strength kgf/cm² | Elongation % | Flexural strength MPa | Flexural strength kgf/cm² | Flexural modulus MPa | Flexural modulus kgf/cm² | Water absorption % | Coef. of thermal expansion[2] ×10⁻⁵/℃ | Max. service temp. ℃ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.70 | —— | R120 | 60 | 600 | 2 | 110 | 1 100 | 10 000 | 100 000 | 0.03 | 2.3 | 230 |
| 1.93 | —— | R121 | 41 | 410 | 1 | 110 | 1 100 | 35 000 | 350 000 | 0.03 | 1.4 | 230 |
| 1.82 | —— | —— | 173 | 1 730 | 3 | 198 | 1 980 | 23 700 | 237 000 | —— | —— | 300 |
| 1.30 | —— | —— | 130 | 1 300 | 100 | —— | —— | —— | —— | 0.13 | 5.0 | 250 |
| 1.39 | —— | R118 | 126 | 1 260 | 2 | 207 | 2 070 | 7 400 | 74 000 | —— | 4.4 | 250 |
| 1.63 | —— | M79 | 82 | 820 | 1 | 130 | 1 300 | 9 900 | 99 000 | —— | 3.0 | 250 |
| 1.40 | 0.6 | 68 | 20 | 200 | 20 | —— | —— | —— | —— | —— | —— | 100 |
| 1.42 | —— | —— | 50 | 500 | 35 | 80 | 800 | 2 650 | 26 500 | —— | —— | 100 |

NOTE 1) Hardness: no code = durometer; others = Rockwell hardness
2) Coefficient of linear expansion: the mean coefficient of linear expansion in the range from room temperature up to 150˚C.
Values in the above table are representative test results.

| Layer thickness μm | Bond strength: Cross-cut test | Bond strength: Pencil hardness test: Causing scratches | Bond strength: Pencil hardness test: Causing tear | Bond strength: Pin scratching test | Max. continuous service temperature | Baking temperature | Coating method: Spray coating | Coating method: Dip coating | Coating method: Powder coating |
|---|---|---|---|---|---|---|---|---|---|
| 10～30 | 100/100 | H | 3H | 5 | 180 | 230 | ○ | | |
| 500～1 000 | 100/100 | 6H | —— | 5 | 180 | 315 | | | ○ |
| 10～20 | 100/100 | 3H | 5H | 5 | 180 | 230 | ○ | | |
| ＜1 | 100/100 | —— | —— | —— | 180 | —— | ○ | ○ | |
| 10～20 | 100/100 | B | H | 4 | 330 | 370 | ○ | | |

Values in the above table are representative test results.
Surface treatment temperature of BEAREE FE7080 performs in the range from room temperature up to 250˚C.

**Table 20 Testing methods for each property**

| | Unit | Testing methods | | | | |
|---|---|---|---|---|---|---|
| | | Fluoroplastic based material | General plastics | Rubber | Coating | FL3020 |
| Specific gravity | —— | ASTM D792 | ASTM D792 | JIS K6350 | —— | JIS K6888 |
| Compressive creep | % | ASTM D621 | ASTM D621 | JIS K6301 | —— | —— |
| Hardness | | ASTM D2240 | ASTM D785 | JIS K6301 | —— | JIS K7215 |
| Tensile strength | MPa {kgf/cm$^2$} | ASTM D638 | ASTM D638 | JIS K6301 | —— | JIS K6888 |
| Elongation | % | ASTM D638 | ASTM D638 | JIS K6301 | —— | JIS K6888 |
| Flexural strength | MPa {kgf/cm$^2$} | —— | ASTM D790 | —— | —— | —— |
| Flexural modulus | MPa {kgf/cm$^2$} | —— | ASTM D790 | —— | —— | —— |
| Compressive strength | MPa {kgf/cm$^2$} | ASTM D695 | ASTM D695 | JIS K6301 | —— | JIS K7208 |
| Water absorption | % | ASTM D570 | ASTM D570 | JIS K6301 | —— | JIS K7209 |
| Coef. of thermal expansion | $\times 10^{-5}$/°C | TMA method | TMA method | TMA method | —— | —— |
| Cross-cut | Score (0～10) | —— | —— | —— | JIS K5400 | —— |
| Pencil hardness | Pencil hardness | —— | —— | —— | JIS K6894 | —— |
| Pin scratching | Score (0～5) | —— | —— | —— | JIS K6894 | —— |

The material property values shown in the catalog are only representative test results obtained from the tests under specific test conditions.
This data may not be directly applicable to applications under different service conditions.
Those characteristic values are merely representative test results which are not to be used as specifications.

## 5-2 Chemical compatibility of each grade

**NTN** engineering plastics materials are inert against almost all chemicals. Chemical resistance of the base resins of BEAREE materials are shown in **table 21.**
The following table shows the characteristics of base resin on each grade, therefore they may differ according to the contained filler. Contact us for selection.

**Table 21 Chemical properties of NTN Engineering Plastics materials.**

| | Chemicals | BEAREE FL | BEAREE FE | BEAREE PI | BEAREE AI | BEAREE UH | BEAREE AS | BEAREE LC | BEAREE PK | BEAREE NY | BEAREE DM | BEAREE ER <3000type> |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acids | Concentrated sulfuric acid | ◎ | ◎ | × | | ○ | ○ | ◎ | × | × | × | ○ |
| | 15% Acetic acid | ◎ | ◎ | △ | ◎ | ○ | ◎ | ◎ | ◎ | × | × | × |
| | 75% Acetic acid | ◎ | ◎ | △ | ◎ | × | ◎ | ◎ | ◎ | × | × | × |
| | Hydrochloric acid | ◎ | ◎ | ◎ | ○ | ◎ | ◎ | ◎ | ◎ | × | × | ◎ |
| | 15% Nitric acid | ◎ | ◎ | ○ | | ○ | ○ | ◎ | ◎ | × | × | ○ |
| | 70% Nitric acid | ◎ | ◎ | △ | × | × | × | ◎ | △ | × | × | ○ |
| | Formic acid | ◎ | ◎ | △ | × | ◎ | ◎ | ◎ | × | × | × | × |
| | 85% Phospheric acid | ◎ | ◎ | △ | ◎ | × | ◎ | ◎ | ◎ | × | × | ○ |
| | 40% Chromic acid | ◎ | ◎ | | | × | ○ | ◎ | ○ | × | × | ○ |
| | 100% Lactic acid | ◎ | ◎ | △ | ◎ | ◎ | ◎ | ◎ | ◎ | × | | ◎ |
| | Hydrogen peroxide | ◎ | ◎ | | | ○ | ○ | ○ | ◎ | × | ○ | ◎ |
| Alkali | 30% Ammonia aqueous solution | ◎ | ◎ | △ | ○ | ◎ | ○ | × | ○ | × | ○ | ◎ |
| | Iron chloride | ◎ | ◎ | △ | ◎ | ◎ | ◎ | ◎ | | ◎ | ○ | ◎ |
| | Calcium chloride | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ○ | ○ | ◎ |
| | Sulfate | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | △ | ○ | △ |
| | Calcium hydroxide | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | × | ◎ | ○ | ○ | ○ |
| | Mineral water | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ○ | ○ | ◎ |
| Solvents | Methyl alcohol | ◎ | ◎ | ◎ | ◎ | ○ | ◎ | ◎ | ○ | × | ○ | ○ |
| | Acetone | ◎ | ◎ | ○ | ◎ | × | ◎ | ◎ | ◎ | ◎ | ○ | × |
| | Benzene | ◎ | ◎ | ○ | ◎ | × | ◎ | ◎ | ◎ | ◎ | ○ | ○ |
| | Carbon tetrachloride | ◎ | ◎ | × | ◎ | × | ◎ | ◎ | ◎ | ◎ | ○ | ○ |
| | Ethyl-ether | ◎ | ◎ | ◎ | ◎ | × | ◎ | ◎ | ◎ | ◎ | ○ | × |
| | Ethylene glycol | ◎ | ◎ | △ | ◎ | ◎ | ◎ | ◎ | ○ | ◎ | ○ | ◎ |
| Oils Kerosene | Diesel engine oil | ◎ | ◎ | ◎ | ◎ | | ◎ | ◎ | ◎ | ◎ | ○ | ○ |
| | Lubricating oil | ◎ | ◎ | ◎ | ◎ | × | ◎ | ◎ | ◎ | ◎ | ○ | ◎ |
| | Animal oil, Vegetable oil | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ○ | ◎ |
| | Kerosene | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ○ | ◎ |
| | Naphtha | ◎ | ◎ | ○ | ◎ | × | ◎ | ◎ | ○ | ◎ | △ | ◎ |
| Others | Nitrate | ◎ | ◎ | △ | ◎ | | ○ | ○ | ◎ | ◎ | ○ | × |
| | Hydro-carbon fuel | ◎ | ◎ | ◎ | ◎ | ○ | ◎ | ◎ | ◎ | ◎ | ○ | ◎ |
| | Fluorine gas | ◎ | ◎ | △ | ◎ | | ×* | △ | × | × | | △ |
| | Molten metallic sodium | × | × | × | | | × | | × | | | |
| | CFC (Freon) 134a | ◎ | ◎ | ◎ | ◎ | | ◎ | ◎ | ◎ | ◎ | ○ | × |
| | Liquid oxygen | ◎ | ◎ | ○ | ◎ | ◎ | ◎ | ◎ | ○ | ◎ | | ○ |
| | Cabon dioxide | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ○ | ○ |
| | Nitrogen dioxide | ◎ | ◎ | △ | ◎ | ◎ | ◎ | ◎ | | | | ◎ |

Description of symbols: ◎ : Excellent, ○ : Normal × : Incompatible ＊Under high temperature and pressure
The above shown chemical resistance is the resistance of the base resin only, and characteristics of each grade may differ depending on its filler.

# 6 Design and Selection for Bearing Applications

It is important to know the required specifications, such as operating temperature, load, sliding velocity, $PV$ value, mating material, torque, tolerances, type of motion and expected life, when designing with **NTN** Bearee.

## 6-1 Selection of bearing material ($PV$ value)

When selecting the bearing material, examine the operating temperature, mating material, lubrication condition and so forth, along with the allowable pressure and sliding velocity.
$PV$ value, the product of pressure "$P$" and sliding velocity "$V$", is often used as the criteria to determine if the operating condition is allowable for the sliding material or not.
Each sliding material has its own allowable $PV$ value; however, it also has an independent allowable value for pressure and velocity. Therefore, the allowable range is shown in **Figure 18.**

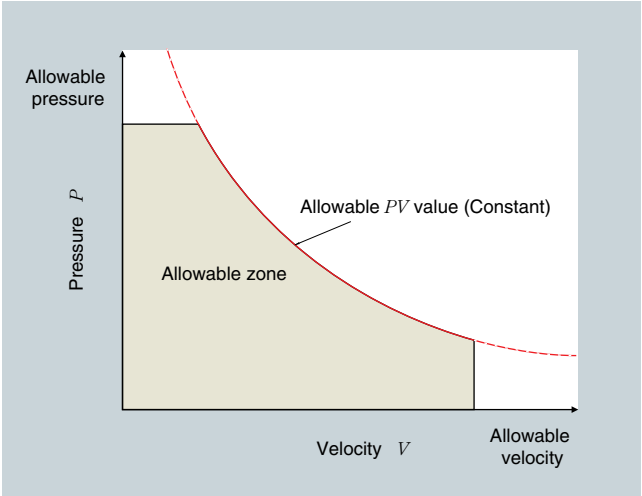



**Figure 18 Allowable $PV$ value**

$PV \leqq$ Allowable $PV$ value
$P \leqq$ Allowable $P$
$V \leqq$ Allowable $V$
Pressure "$P$" and sliding velocity "$V$" is given by following formula.

$$P = Fr / d \cdot l$$

$$V = \pi \cdot d \cdot n \times 10^{-3}$$

$P$ : pressure MPa
$Fr$ : Radial load N
$d$ : Shaft diameter mm
$l$ : Length of bearing mm
$V$ : Sliding velocity m / min
$n$ : Shaft rotation rpm

## 6-2 Estimation of wear

The life of an **NTN** Engineering Plastics bearing is defined by the wear of sliding surface, as with an ordinary plain bearing.
The amount of wear varies with operating conditions such as sliding velocity, pressure, type of motion, surface roughness of mating material and operating temperature. Generally, the estimation of wear is given by the following formula.

$$R = K \cdot P \cdot V \cdot T$$

where
$R$ : The amount of wear mm
$K$ : Wear factor mm·min / MPa·m·h
$P$ : pressure MPa
$V$ : Sliding velocity m / min
$T$ : Time h
Surface roughness of the mating material influences the wear of the NTN Engineering Plastics bearing; therefore, finish the surface to 0.1 to 0.8a. Moreover, **NTN** recommends the hardness of shaft to be HRc 22 or higher since it is possible to reduce the wear when the shaft is harder.

**<Example>**
Determine the amount of wear of R-AR1515 sleeve bearing made of BEAREE FL 3000 for the following operating condition.

**<Specification>**
Shaft diameter $d$ : 15mm
Bearing load $Fr$: 300N
Shaft rotation $n$ : 300rpm
Temperature : Room temperature
Service hours : 1000 hours
Lubrication : None
Pressure $P$ (MPa) $= Fr / d \cdot l = 300 / 15 \times 15 \fallingdotseq 1.33$ MPa
Sliding velocity $V$ (m/min) $= \pi \cdot d \cdot n = 3.14 \times 15 \times 300/1000 \fallingdotseq 14.1$ m/min
Wear factor at room temperature is given by page 10
$K = 1.0 \times 10^{-7}$mm³/ N ·m
$PV = 1.33 \times 14.1 \fallingdotseq 18.8$ MPa·m/min
$T = 1000$h $= 60\,000$ min
Therefore the amount of wear R$= K \cdot P \cdot V \cdot T$ is;
$R = 1.0 \times 10^{-7} \times 18.8 \times 60\,000 = 0.113$
The wear after 1000 hours of service is 0.113 mm.

## 6-3 Fits and clearance

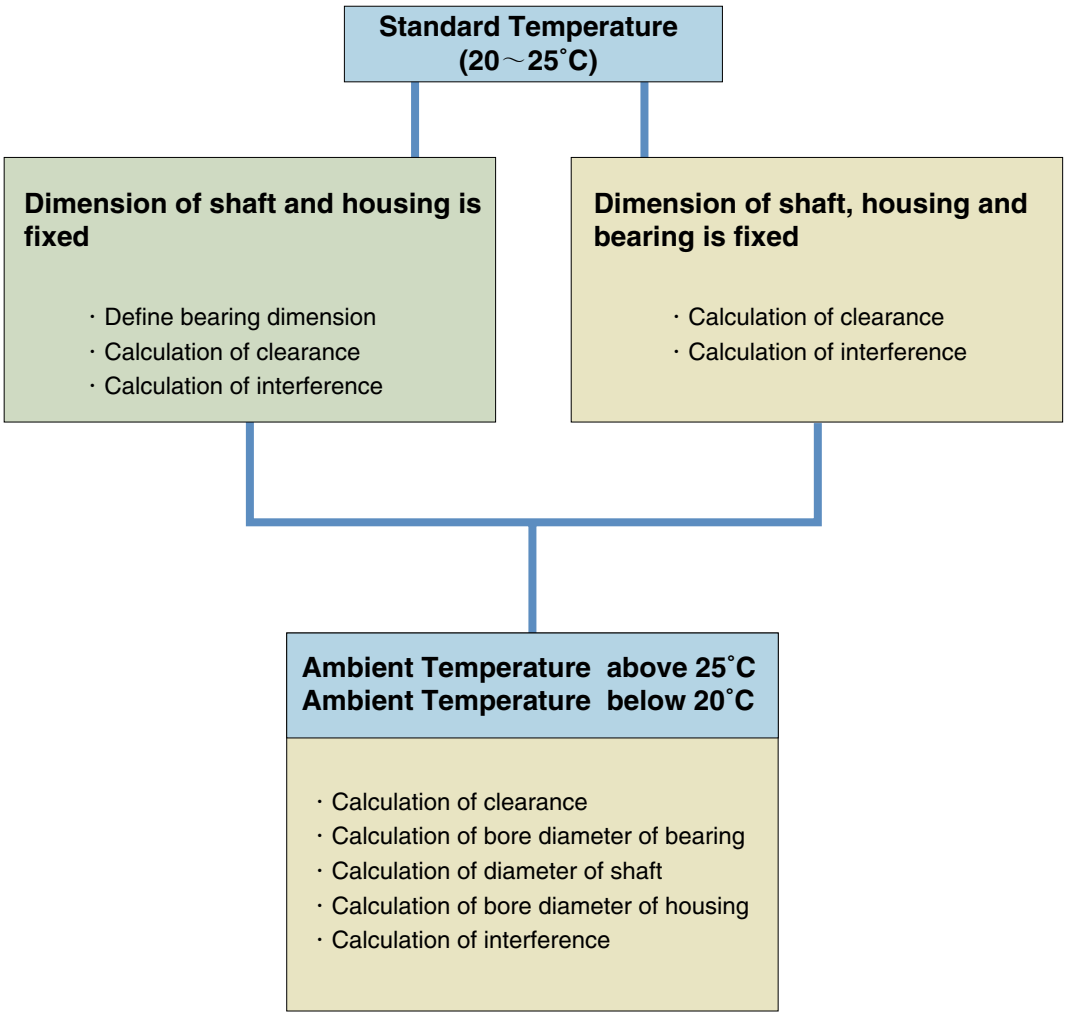
Plain bearings are usually pressed into a housing. The minimum clearance for operation varies by the size of shaft though it can be as small as 0.025mm. When the operating temperature varies widely, the thermal expansion of bearing material should be taken into consideration. Increase the clearance by the amount of thermal expansion, with decreases the operating clearance.

It is also possible to finish the bore of mounted bearing by turning or reaming when accurate operation with small clearance is required. Although recommended shaft and bore diameters and mounted clearance are listed in the tables of standard series of **NTN** Engineering Plastics Sliding Bearings, the mounted clearance may increase for soft material housings such as aluminum and plastics, or thin wall housing. Also, it is recommended to fix the bearing with a knock-pin, key, or bonding since the interference fit might be lost when the bearing is used under low temperature.

- **Calculation of bearing clearance (Except M-Liner bearing)**

The calculation step for "Standard temperature", "Above 25˚C" and "Below 20˚C" is different. The step chart is shown below.

Calculation Step of Clearance for BEAREE Plain Bearing




Note: Usually, the calculation for standard temperature is applicable to the ambient temperature range of 15～50˚C

**1. Calculation of clearance for standard temperature (25˚C)**

1) Interference
Maximum: $F_H = D_H - H_L$
Minimum : $F_L = D_L - H_H$

2) Reduction of bearing bore dimension due to interference fit
Maximum: $E_{max} = \lambda \cdot F_H$ ( $\lambda = 1.0$)
Minimum : $E_{min} = \lambda \cdot F_L$ ( $\lambda = 1.0$)

3) Bore dimension of bearing at standard temperature when mounted
Maximum: $d_{25H} = d_H - E_{min}$
Minimum : $d_{25L} = d_L - E_{max}$

4) Mounted clearance at standard temperature
Maximum: $C_{max} = d_{25H} - S_L$
Minimum : $C_{min} = d_{25L} - S_H$

Where
$S_H$ : Maximum shaft diameter
$S_L$ : Minimum shaft diameter
$H_H$ : Maximum housing bore diameter
$H_L$ : Minimum housing bore diameter
$d_H$ : Maximum bore diameter of bearing
$d_L$ : Minimum bore diameter of bearing
$D_H$ : Maximum outer diameter of bearing
$d_L$ : Minimum outer diameter of bearing

NOTE
1. The minimum clearance for **NTN** Engineering Plastic bearing is required 2 ~ 7/1000 of shaft diameter to reduce heat generation when used with no lubrication.
2. Shrink ratio by fit interference usually is set as 100%

<Example>
Calculate the clearance of type AR sleeve bearing R-AR1010 made of BEAREE FL 3000.
Assume shaft and housing bore dimensions follow **NTN** recommendation.
Shaft : $\phi$ 10, h6 ( $^{0}_{-0.009}$ ) therefore $S_H = 10$, $S_L = 9.991$
Housing : $\phi$ 14, M7 ( $^{0}_{-0.018}$ ) therefore $H_H = 14$, $H_L = 13.982$
Bearing I.D. : $\phi$ 10 ( $^{+0.24}_{+0.19}$ ) therefore $d_H = 10.24$, $d_L = 10.19$
Bearing O.D. : $\phi$ 14 ( $^{+0.10}_{+0.05}$ ) therefore $D_H = 14.10$, $D_L = 14.05$
Maximum interference : $F_H = D_H - H_L = 14.10 - 13.982 = 0.118$
Minimum interference : $F_L = D_L - H_H = 14.05 - 14.00 = 0.05$
Reduction of bearing bore : $E_{max} = F_H \times \lambda = 0.118 \times 1 = 0.118$
$E_{min} = F_L \times \lambda = 0.05 \times 1 = 0.05$
Bearing bore at 25˚C when mounted
$d_{25H} = d_H - E_{min} = 10.24 - 0.05 = 10.19$
$d_{25L} = d_L - E_{max} = 10.19 - 0.118 = 10.072$
Mounted clearance at 25˚C:
$C_{max} = d_{25H} - S_L = 10.19 - 9.991 = 0.199 \fallingdotseq 0.2$
$C_{min} = d_{25L} - S_H = 10.07 - 10 = 0.072 \fallingdotseq 0.07$

**2. Calculation of clearance for high temperature ($T_H$˚C)**

1) Housing bore dimension
Maximum: $HH_H = H_H \{1 + \alpha_1 (T_H - 25)\}$
Minimum : $HH_L = H_L \{1 + \alpha_1 (T_H - 25)\}$

2) Shaft diameter
Maximum: $SH_H = S_H \{1 + \alpha_2 (T_H - 25)\}$
Minimum : $SH_L = S_L \{1 + \alpha_2 (T_H - 25)\}$

3) Clearance during operation
Maximum:

$$CH_{max} = \sqrt{(H_H)^2 \{1+\alpha_1(T_H-25)\}^2 - \{(H_H)^2-(d_{25H})^2\} \{1+\alpha_3(T_H-25)\}^2} - S_L \{1+\alpha_2(T_H-25)\}$$

Minimum:

$$CH_{min} = \sqrt{(H_L)^2 \{1+\alpha_1(T_H-25)\}^2 - \{(H_L)^2-(d_{25L})^2\} \{1+\alpha_3(T_H-25)\}^2} - S_H \{1+\alpha_2(T_H-25)\}$$

Where
$\alpha_1$: Coefficient of linear expansion of housing for $T_H$˚C
$\alpha_2$: Coefficient of linear expansion of shaft for $T_H$˚C
$\alpha_3$: Coefficient of linear expansion of bearing for $T_H$˚C

***Reference Coefficient of linear expansion of various materials ($\times 10^{-5}$/˚C)**

| Material | $\alpha_1$, $\alpha_2$ |
|---|---|
| Mild steel | 1.1 |
| Aluminum | 2.3 |
| Stainless steel | 1.73 |

**3. Calculation of clearance for low temperature ($T_L$°C)**

1) Housing bore dimension

Maximum: $HL_H = H_H \{1+\alpha_{11}(T_L-25)\}$

Minimum : $HL_L = H_L \{1+\alpha_{11}(T_L-25)\}$

2) Shaft diameter

Maximum: $SL_H = S_H \{1+\alpha_{22}(T_L-25)\}$

Minimum : $SL_L = S_L \{1+\alpha_{22}(T_L-25)\}$

3) Clearance during operation

Maximum:

$$CL_{max} = \sqrt{(H_H)^2\{1+\alpha_{11}(T_L-25)\}^2 - \{(H_H)^2-(d_{25H})^2\}\{1+\alpha_{33}(T_L-25)\}^2} - S_L\{1+\alpha_{22}(T_L-25)\}$$

Minimum:

$$CL_{min} = \sqrt{(H_L)^2\{1+\alpha_{11}(T_L-25)\}^2 - \{(H_L)^2-(d_{25L})^2\}\{1+\alpha_{33}(T_L-25)\}^2} - S_H\{1+\alpha_{22}(T_L-25)\}$$

Where

$\alpha_{11}$ : Coefficient of linear expansion of housing for $T_L$°C

$\alpha_{22}$ : Coefficient of linear expansion of shaft for $T_L$°C

$\alpha_{33}$ : Coefficient of linear expansion of bearing for $T_L$°C

## 6-4 Handling

**(a) Assembling method**

Avoid hammering when pressing the bearing into the housing.

Use press machine with press arbor shown in **Figure 19** after centering bearing; and be sure that the housing chamfer is adequately large.

Use a knock pin or key to prevent rotation of the bearing, or use an adhesive to fasten the bearing for low temperature application, because the fitting might be loosened.

Remarks) Large-sized plastic bearings can be installed easily by cooling the bearing with dry ice.

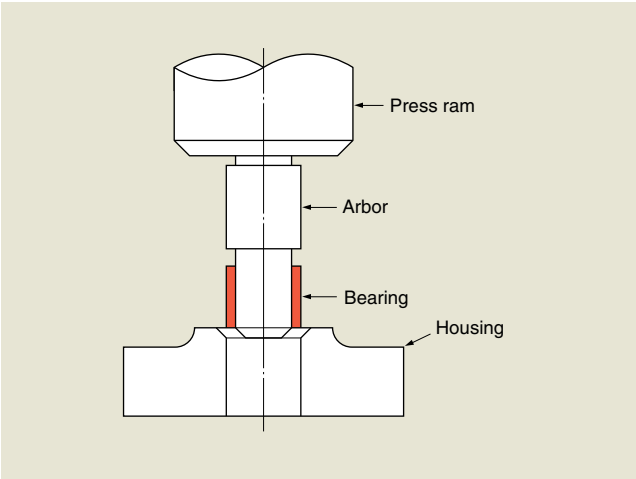



**Figure 19 Assembling method**

**(b) Notice for handling**

(1) BEAREE FL could be deformed or scratched by a shock load, etc. and BEAREE PI could be cracked or chipped.

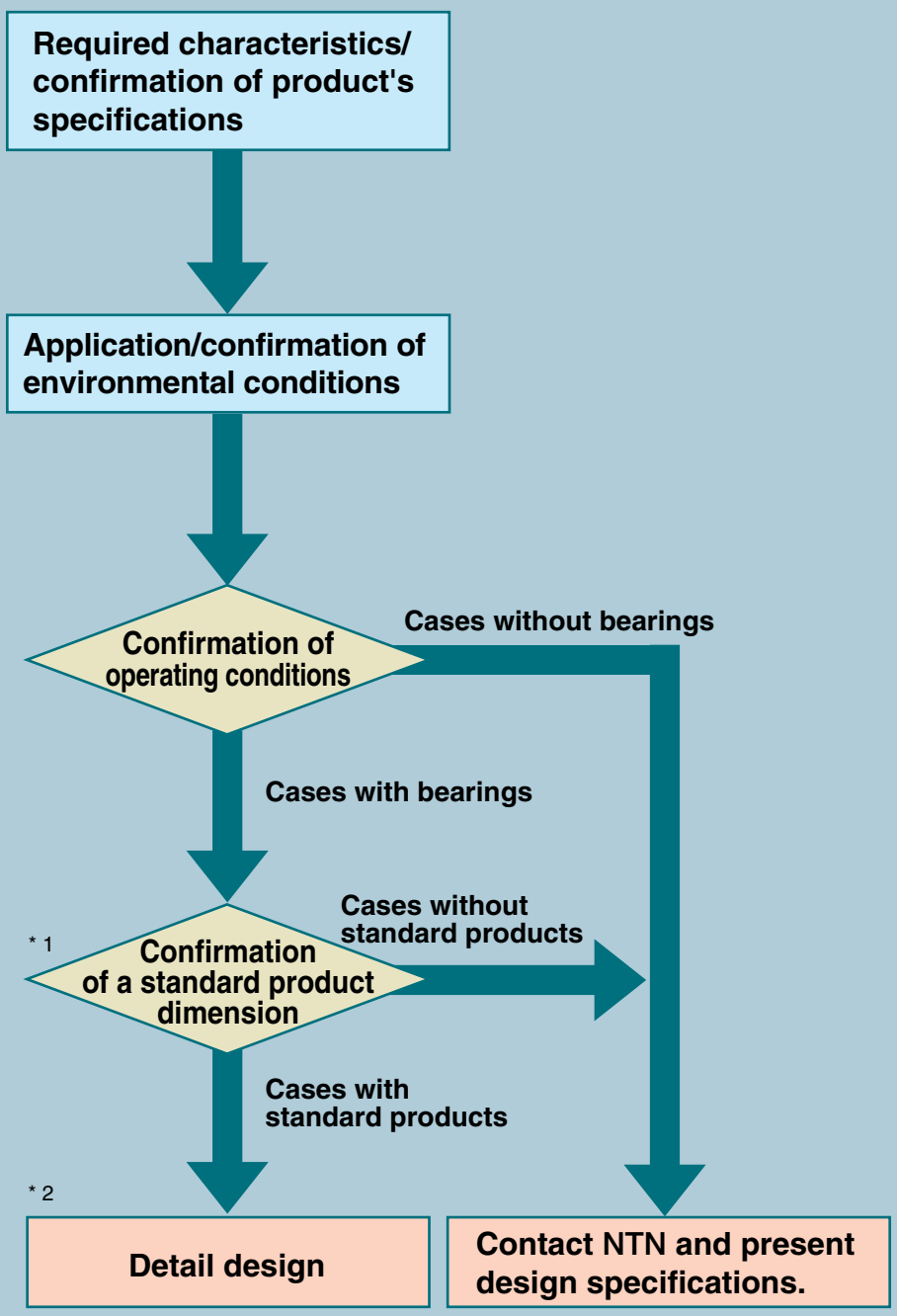
(2) The surface roughness of mating material greatly affects bearing life.
**NTN** recommends surface roughness of 0.1 ~ 0.8a.

(3) To fasten BEAREE bearing with adhesive, the bearing surface should be treated (etched) to make it bond-able. In that case, please advise us that, "*Pre-etched one is required*".

(4) For bonding BEAREE bearing, an epoxy type adhesive is preferred.

(5) Under some circumstances the operating temperature may loosen the clearance in the shaft and result in overheating, burning and seizing of the mechanism. Completely check the relation ship between fittings and clearances before application.

## 7-1 Design guideline of sliding performance parts




**Introduction of Materials and Products for Applications**



**Load／Speed／Temperature**

See page 39～44, 51～54

**A demand wearing life**

See page 46, 10～17 and 53

* 1) Even for selecting a standard product, determine if the materials are suitable for use. Further, if the proper dimensions can not be found, design after selecting materials.

* 2) In the case of using the standard product, check the fittings and clearance according to the calculation on pages 47 to 49.

Remarks: If the application is for bearings and seal rings, use the "check list of conditions for use".

## 7-2 Temperature and allowable face pressure

The allowable face pressure of plastic sliding bearings depends on the base resin materials, it decrease when the temperature rises.
**Table 22** shows the guideline.

**Table 22 Temperature and the allowable face pressure of bearings**

| | Ambient temperature ℃ Over | Below | BEAREE FL3000 (PTFE) | BEAREE AS5000 (PPS) | BEAREE PI 5001 (PI) | BEAREE UH3000 (PE) | BEAREE PK5300 (PEEK) | BEAREE NY5000 (PA) | BEAREE DM5030 (POM) | BEAREE FL7075 (Coating) |
|---|---|---|---|---|---|---|---|---|---|---|
| Allowable face pressure $P$ MPa | — | 20 | 7 | 20 | 50 | 5 | 35 | 15 | 10 | 50 |
| | 20 | 60 | 6 | 20 | 50 | 2 | 35 | 10 | 7 | 50 |
| | 60 | 100 | 5 | 15 | 50 | 0.5 | 30 | 5 | 3 | 40 |
| | 100 | 140 | 4 | 10 | 40 | — | 25 | 1 | — | 30 |
| | 140 | 180 | 3 | 10 | 30 | — | 20 | — | — | 20 |
| | 180 | 220 | 1 | 7 | 20 | — | 15 | — | — | 10 |
| | 220 | 260 | 0.5 | — | 10 | — | 10 | — | — | — |
| Allowable sliding velocity : $V$ m/min | | | 200 | 200 | 200 | 30 | 150 | 30 | 50 | 50 |
| Allowable pressure $PV$ MPa·m/min | | | 60 | 60 | 200 | 10 | 80 | 10 | 20 | 40 |

Allowable face pressure: Means the guideline for bearings.
Allowable sliding velocity, allowable $PV$ value: Means the allowable value at room temperature.

## 7-3 Friction coefficient

The friction coefficient of plastic sliding bearings can vary widely in application conditions. **Table 23** shows the friction coefficients and test conditions for typical material grades of **NTN** Engineering Plastics.

**Table 23 Friction coefficient of NTN Engineering Plastics materials**

| Materials | Test condition | | | | | | Friction coefficient |
|---|---|---|---|---|---|---|---|
| | Test type | Mating material | Face pressure MPa | Sliding velocity m/min. | Lubrication | Ambient temperature °C | |
| **BEAREE FL3000** | Thrust | SUJ2 | 1.0 | 10.0 | None | Room temperature | 0.13 |
| **BEAREE FL3030** | Thrust | SUS304 | 1.96 | 36.0 | None | Room temperature | 0.18 |
| **BEAREE PI 5001** | Thrust | SUJ2 | 1.0 | 10.0 | None | Room temperature | 0.3 |
| | Thrust | SUJ2 | 0.5 | 128.0 | None | Room temperature | 0.1 |
| **BEAREE UH5041** | Thrust | SUJ2 | 1.0 | 10.0 | None | Room temperature | 0.12 |
| **BEAREE AS5053** | Thrust | A5056 | 0.25 | 3.4 | None | 165 | 0.13 |
| | Thrust | A5056 | 0.35 | 2.8 | None | 200 | 0.09 |
| **BEAREE PK5900** | Thrust | SUS304 | 1.0 | 10.0 | None | Room temperature | 0.28 |
| **BEAREE NY5000** | Thrust | SUJ2 | 0.3 | 32.0 | None | Room temperature | 0.21 |
| **BEAREE DM5030** | Thrust | SUJ2 | 1.0 | 10.0 | None | Room temperature | 0.21 |
| | Thrust | A5056 | 1.0 | 10.0 | None | Room temperature | 0.13 |
| **BEAREE ER3000** | Thrust | SUJ2 | 0.3 | 1.0 | None | Room temperature | 0.28 |
| | Thrust | SUS304 | 0.3 | 1.0 | None | Room temperature | 0.22 |
| **BEAREE FL7075** | Thrust | A5056 | 0.22 | 2.4 | None | Room temperature | 0.13 |

## 7-4 Specific wear rate

The specific wear rate (wear factor) of plastic bearings can vary widely in application conditions. **Table 24** shows the specific wear rate and test conditions for typical material grades of **NTN** Engineering Plastics.

**Table 24 Specific wear rate of NTN Engineering Plastics materials**

| Materials | Test condition | | | | | | Specific wear rate |
|---|---|---|---|---|---|---|---|
| | Test type | Mating material | Face pressure MPa | Sliding velocity m/min. | Lubrication | Ambient temperature °C | $\times 10^{-7}$mm$^3$/N·m |
| **BEAREE FL3000** | Thrust | SUJ2 | 0.25 | 128.0 | None | Room temperature | 1.0 |
| **BEAREE FL3030** | Thrust | SUS304 | 1.96 | 36.0 | None | Room temperature | 1.6 |
| **BEAREE PI 5001** | Thrust | SUJ2 | 1.95 | 128.0 | None | Room temperature | 6.23 |
| | Thrust | SUJ2 | 0.2 | 128.0 | None | Room temperature | 1.0 |
| **BEAREE UH5041** | Thrust | SUJ2 | 0.3 | 32.0 | None | Room temperature | 0.3 |
| **BEAREE AS5053** | Radial | A5056 | 0.25 | 3.4 | None | 165 | 13.0 |
| | Radial | A5056 | 0.35 | 2.8 | None | 200 | 17.0 |
| **BEAREE PK5900** | Thrust | SUS304 | 0.5 | 100.0 | None | Room temperature | 6.2 |
| **BEAREE NY5000** | Radial | S45C | 0.19 | 70.0 | None | Room temperature | 8.3 |
| **BEAREE DM5030** | Thrust | SUJ2 | 0.3 | 32.0 | None | Room temperature | 1.5 |
| | Thrust | A5056 | 0.3 | 32.0 | None | Room temperature | 5.0 |
| **BEAREE ER3000** | Thrust | SUJ2 | 0.23 | 128.0 | None | Room temperature | 3.3 |
| | Thrust | A2017 | 0.23 | 128.0 | None | Room temperature | 2.9 |
| **BEAREE FL7075** | Thrust | SUS304 | 0.5 | 30.0 | None | Room temperature | 10.0 |

## 7-5 Thermal expansion coefficient

**Table 25** shows the linear expansion coefficient of BEAREE FL. PTFE has a conversion point at 23˚C, and it's volume changes drastically at this point. Therefore, the dimensions measurement should be performed at 25˚C. Also, since the expansion rate is different along the longitudinal (M.D.) and lateral (C.D.) direction regarding the molding direction, more caution is requested to determine the clearance.

**Table 25 Linear expansion coefficient of BEAREE(FL) ($\times 10^{-5}$/˚C)**

| Range of temperature change˚C | BEAREE FL3000 | | BEAREE FL3030 | | BEAREE FL3700 | | PTFE |
|---|---|---|---|---|---|---|---|
| | C.D. | M.D. | C.D. | M.D. | C.D. | M.D. | |
| –50～+ 20 | 6.7 | 9.6 | 9.2 | 9.2 | | | 13.5 |
| –18～+ 20 | 8.2 | 12.6 | 9.2 | 9.2 | 9.0 | 7.9 | 16.2 |
| +20～+ 25 | 22.2 | 36.8 | 19.1 | 29.8 | 24.6 | 33.5 | 50.2 |
| +25～+100 | 8.0 | 10.1 | 9.0 | 9.8 | 7.2 | 8.5 | 12.4 |
| +25～+150 | 8.3 | 10.7 | 9.0 | 9.8 | 7.7 | 9.9 | 13.5 |
| +25～+200 | 9.3 | 11.7 | 10.4 | 11.2 | 8.5 | 10.6 | 15.1 |
| +25～+260 | 11.0 | 13.6 | 11.1 | 11.8 | 9.7 | 13.5 | 18.0 |

Remarks M.D.: Longitudinal direction (Compression molding, the axial direction of continuously molded rod or pipe.)
C.D.: Lateral direction (Right angled direction to the axial direction mentioned above.)

## 7-6 Test data

Applications of plastic bearings are rapidly increasing.
The latest test data are shown as follows.

### BEAREE FL3000

Test condition (Friction test)
Test unit : Thrust type friction and wear test unit.
Mating material : Bearing steel(SUJ2). Rotation sample piece
Face pressure : 0.5-10 MPa
Sliding velocity : 10 m/min.
Lubrication : None

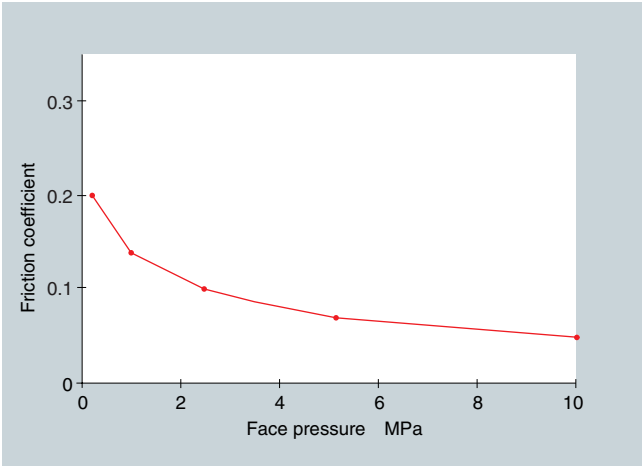



**Fig.20 Friction coefficient versus face pressure**

### BEAREE FL3000

Test condition (Friction test)
Test unit : Thrust type friction and wear test unit.
Mating material : Bearing steel(SUJ2). Rotation sample piece
Face pressure : 1 MPa
Sliding velocity : -100 m/min.
Lubrication : None

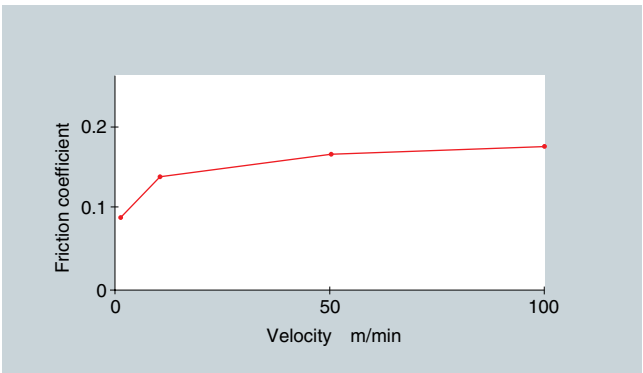



**Fig.21 Friction coefficient versus sliding velocity**

### BEAREE FL3000

Test condition (Wear test)
Test unit : Thrust type friction and wear test unit.
Mating material : Bearing steel(SUJ2). Rotation sample piece
Face pressure : 0.08-0.8 MPa
Sliding velocity : 128 m/min.
Lubrication : None
Test time : 100 hours

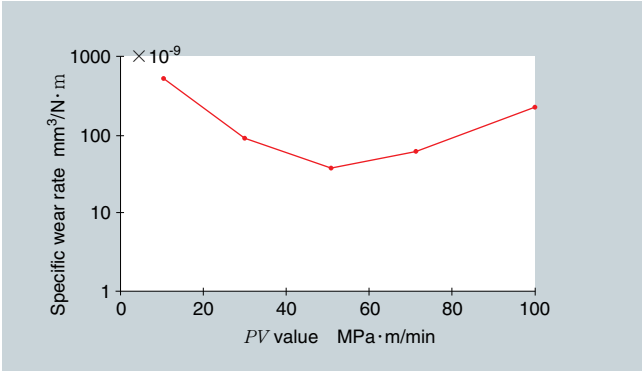



**Fig.22 Specific wear rate versus $PV$ value**

## BEAREE PI5001

Test condition (Friction test)
Test unit : Thrust type friction and wear test unit.
Mating material : Bearing steel(SUJ2). Rotation sample piece
Face pressure : 0.5, 0.8 MPa
Sliding velocity : 128 m/min.
Lubrication : None
Ambient temperature: 100˚C

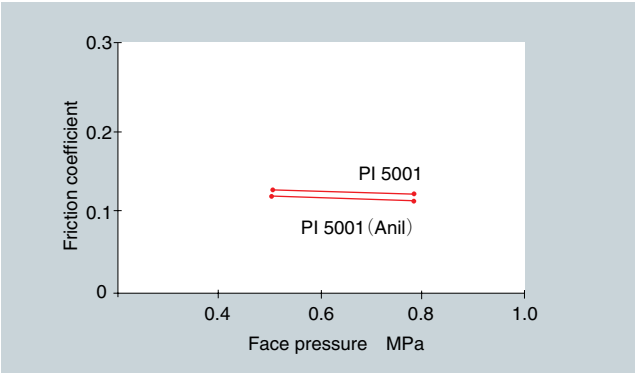



**Fig.23 Friction coefficient versus face pressure**

## BEAREE PI5001

Test condition (Wear test)
Test unit : Thrust type friction and wear test unit.
Mating material : Bearing steel(SUJ2). Rotation sample piece
Face pressure : 0.2-2.0 MPa
Sliding velocity : 128 m/min.
Lubrication : None
Ambient temperature: Room temperature

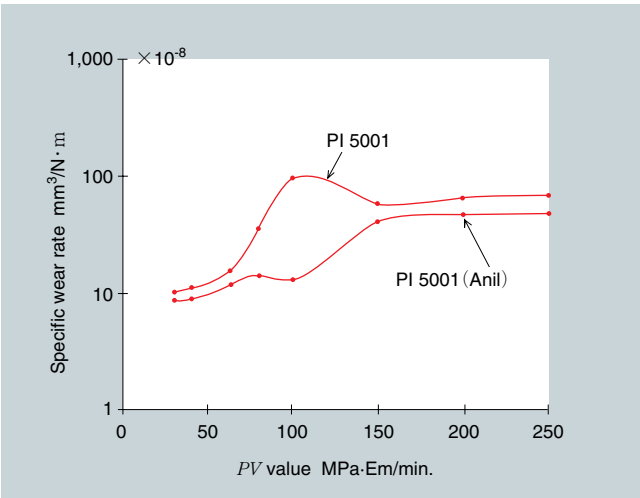



**Fig.24 Specific wear rate versus *PV* value**

## BEAREE AS5053

Test condition (Wear test)
Test unit : Radial type friction and wear test unit.
Mating material : A5056(3.2S, HV45)
Face pressure : 0.35 MPa
Sliding velocity : 2.8 m/min.
Lubrication : None
Ambient temperature: 200˚C
Test time : 50 hours
Specific wear rate : $1.7 \times 10^{-6}$ mm³/N·m

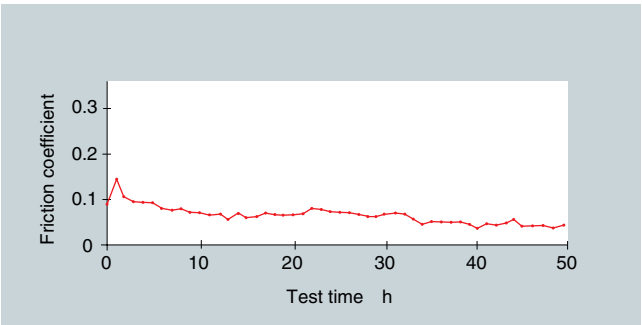



**Fig.25 Friction coefficient during the wear test**

## BEAREE DM5030

Test condition (Friction test)

| | |
|---|---|
| Test unit | : Thrust type friction and wear test unit. |
| Mating material | : Bearing steel(SUJ2). A5056 |
| Face pressure | : 1 MPa |
| Sliding velocity | : 10 m/min. |
| Lubrication | : None |
| Ambient temperature | : Room temperature |
| Test time | : 60 minutes |

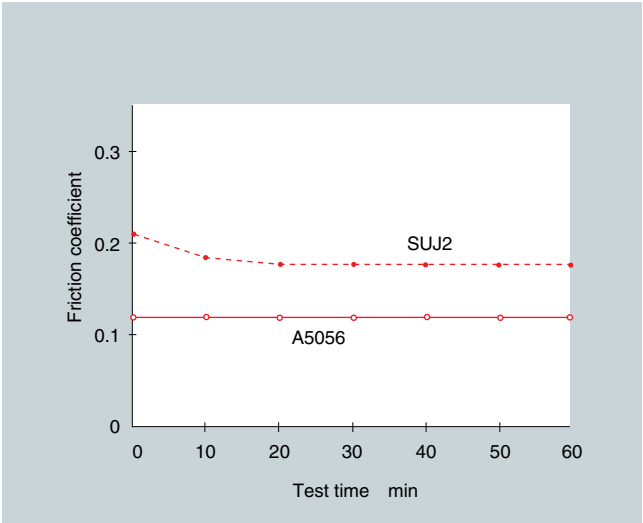



**Fig.26 Friction coefficient versus running time**

## BEAREE ER3000

Test condition (Friction test)

| | |
|---|---|
| Test unit | : Thrust type friction and wear test unit. |
| Mating material | : Bearing steel(SUJ2) |
| Face pressure | : 0.3 MPa |
| Sliding velocity | : 1.0 m/min. |
| Lubrication | : None |
| Ambient temperature | : Room temperature |

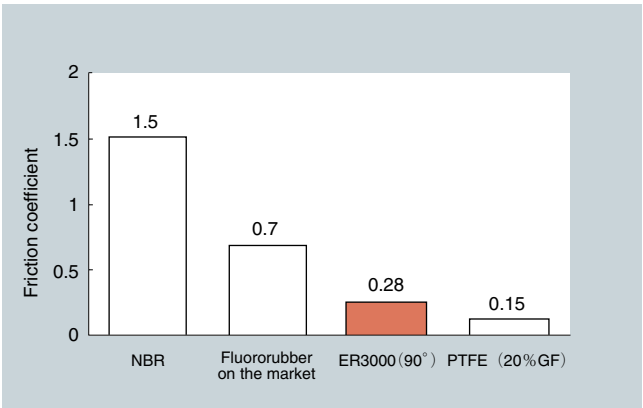



**Fig.27 Friction coefficient comparison mating SUJ2**

## BEAREE FL7075 (Coating)

Test condition (Friction test)

| | |
|---|---|
| Test unit | : Thrust type friction and wear test unit. |
| Mating material | : SUS304 |
| Face pressure | : 0.01, 0.2 MPa |
| Sliding velocity | : 0.01-10 m/min. |
| Lubrication | : None |
| Ambient temperature | : Room temperature |

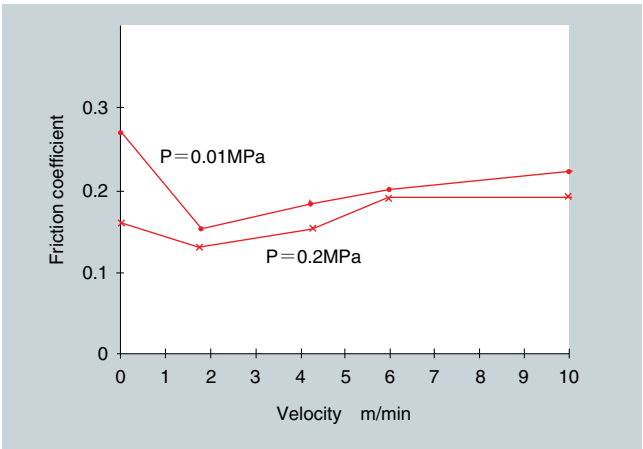
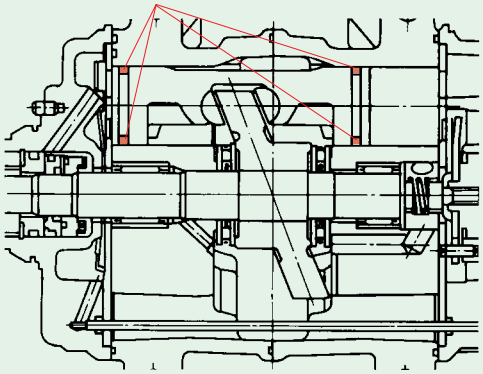
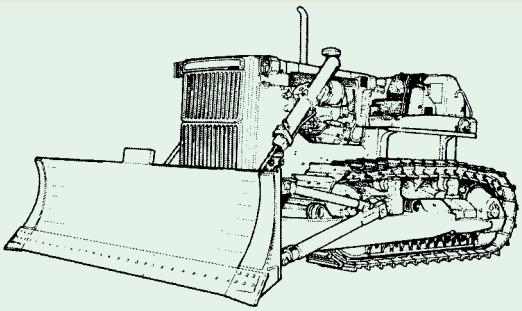


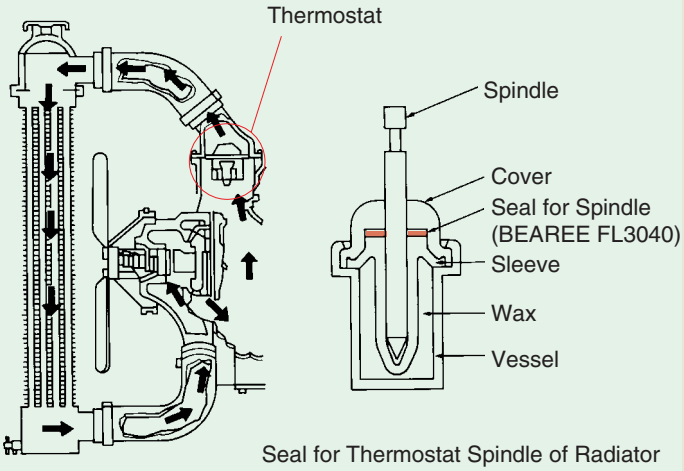

**Fig.28 Friction coefficient versus sliding velocity**

Piston Seal Ring
(BEAREE FL 3000, FL 3030)

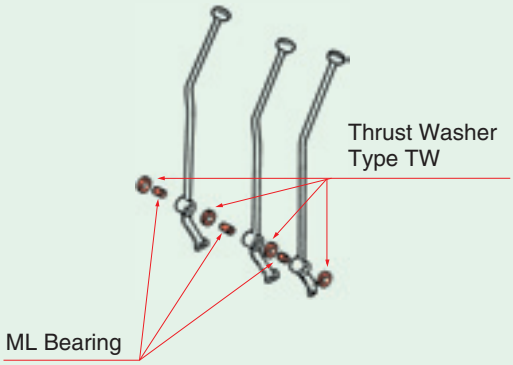


Piston Seal Ring for Car Air Conditioner Compressor

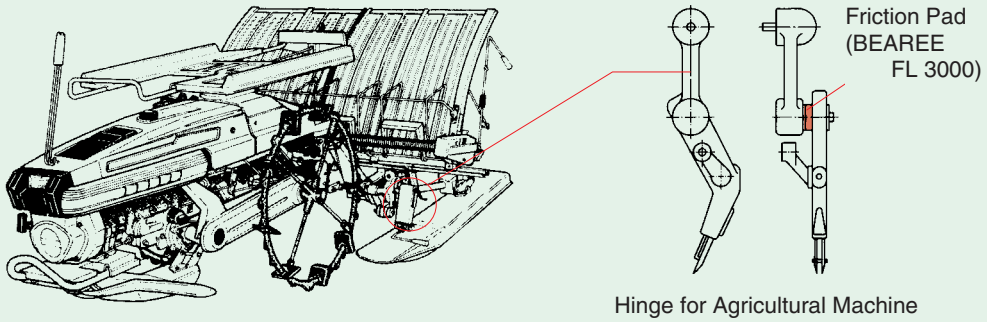




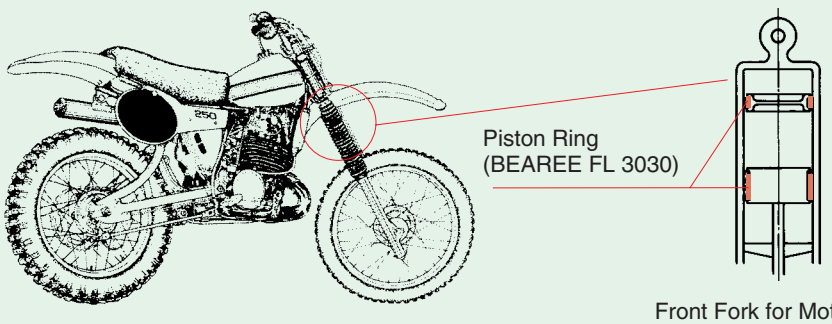

Seal for Thermostat Spindle of Radiator



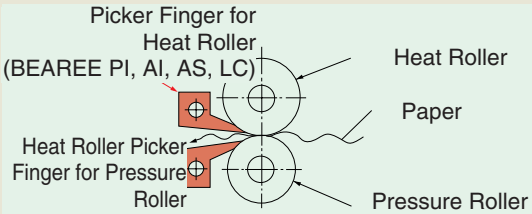

Control Lever for Construction Machine



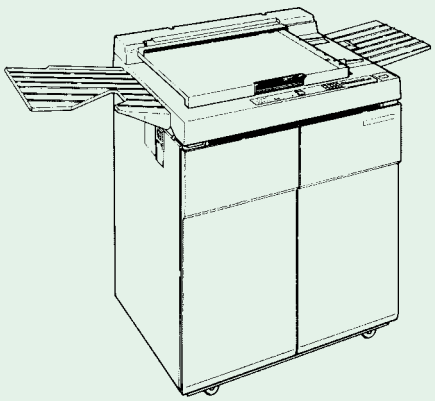

Hinge for Agricultural Machine

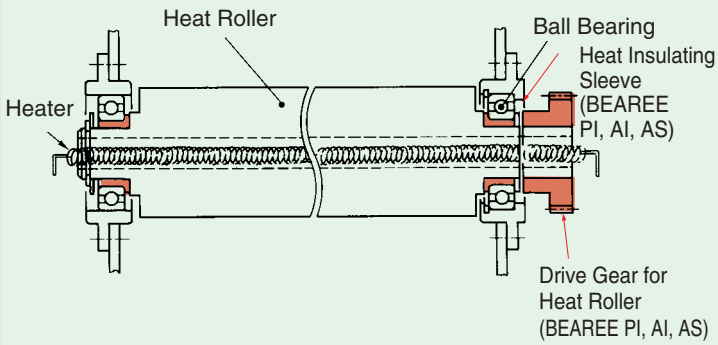



Front Fork for Motorcycle

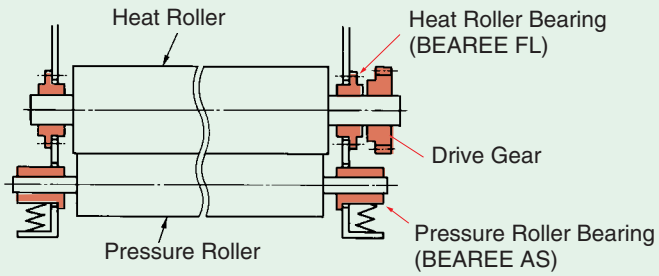



Picker Finger for Fixing Part of Copy Machine

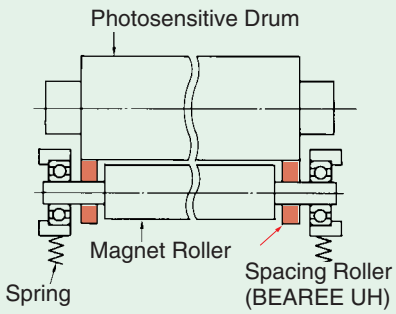




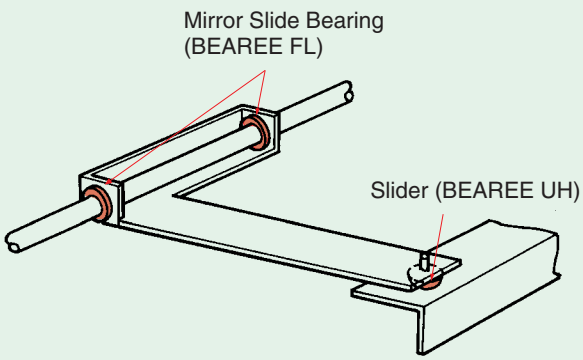

Heat Roller Drive Gear and Heat Insulating Sleeve for Copy Machine



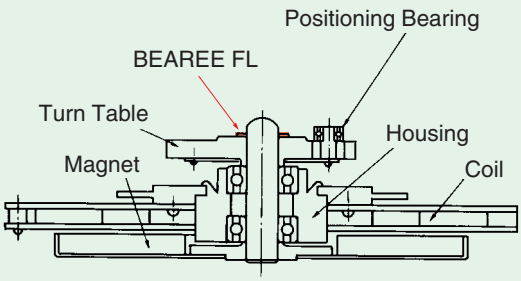

Heat Roller and Pressure Roller Bearing for Copy Machine



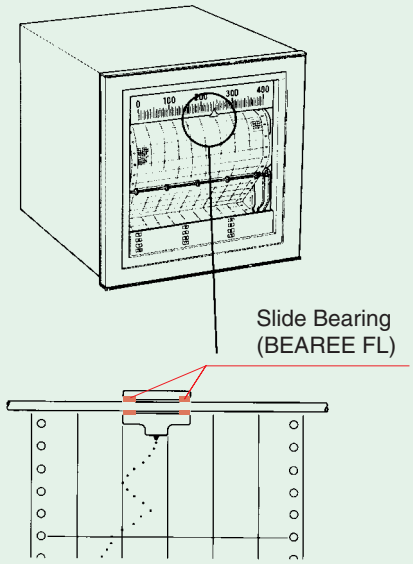

Spacing Roller for Developing Part of Copy Machine



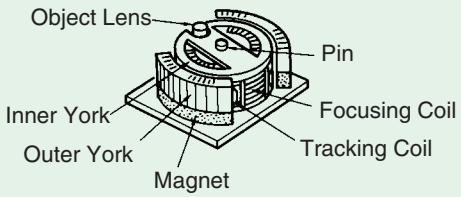

Mirror Slide Bearing and Slider for Optical Part of Copy Machine

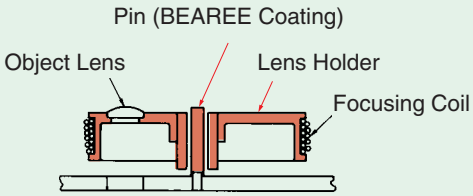



Turn Table for 3.5" FDD

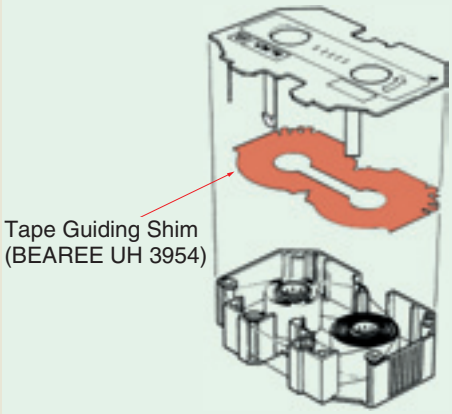



Sliding Part for Pen Recorder

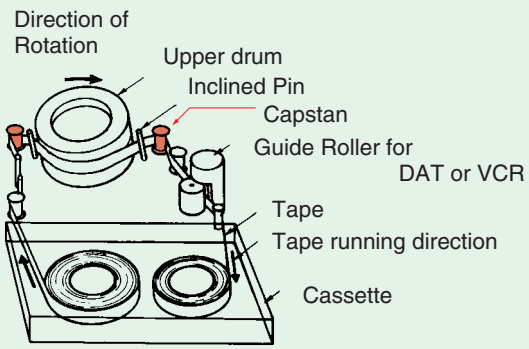


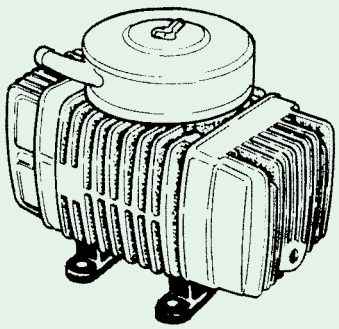

Pickup Focusing Unit for Optical Disk

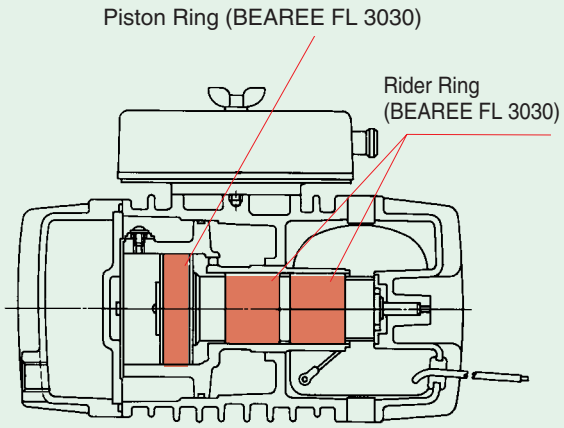



Ink Ribbon Cassette for Printer

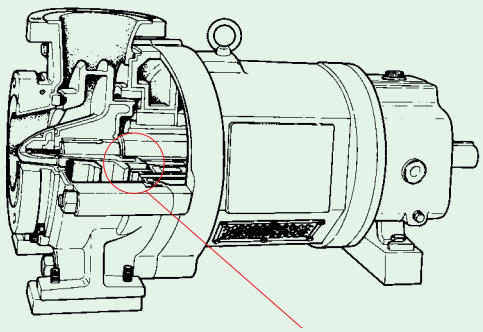



Guide Roller for DAT or VCR

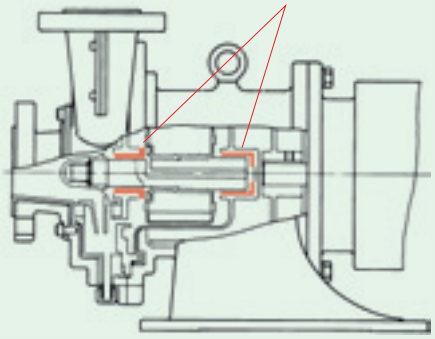





Piston Ring for Air Compressor

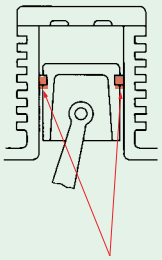


Bearing (BEAREE FL 3000, FL 3700)

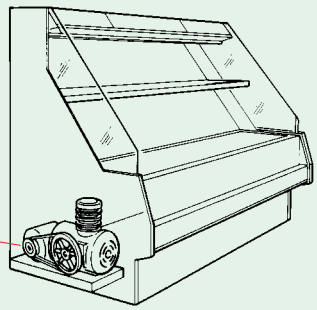


Rotating Part of Chemical Pump

Chemical Pump Bearing

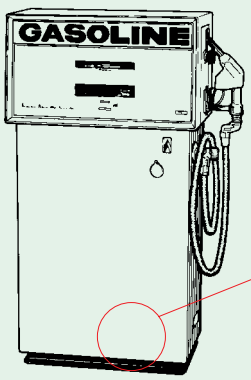


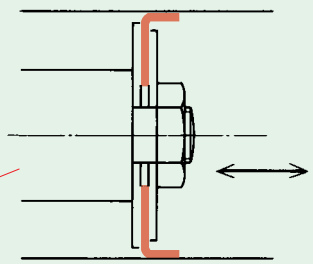
Seal Ring (BEAREE FL 3000)



Showcase

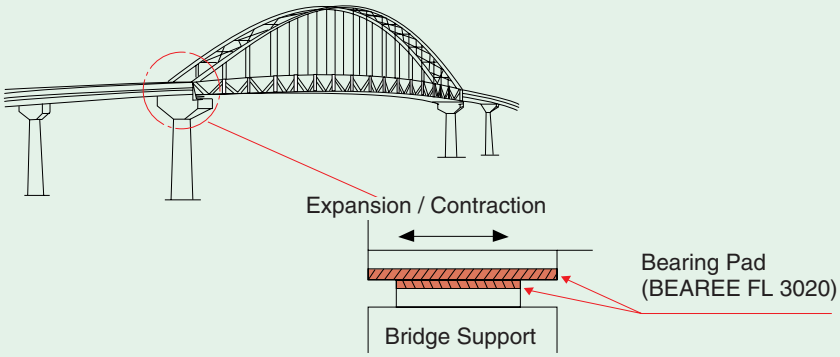
Piston Ring of Compressor for Refrigerator or Showcase

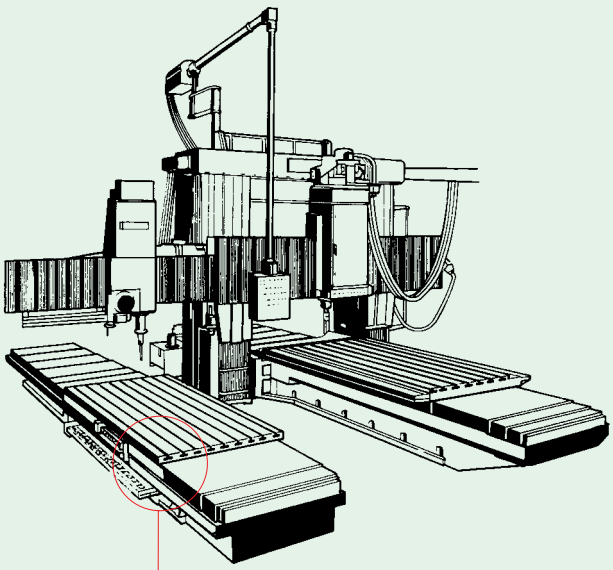


Cup Seal (BEAREE FL 3000)

Fuel Measuring Pump



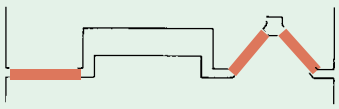
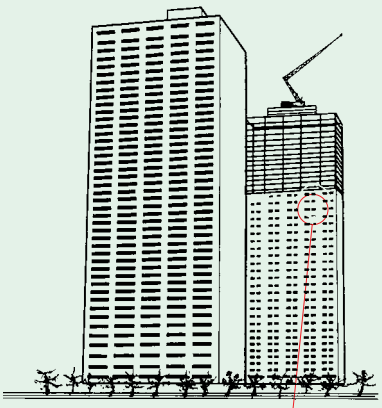
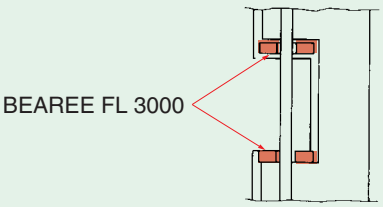
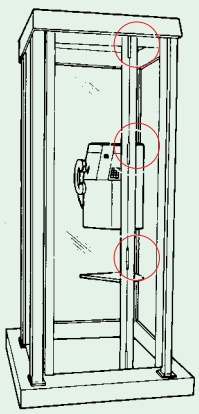



Table Slide of NC or MC Machine Tools

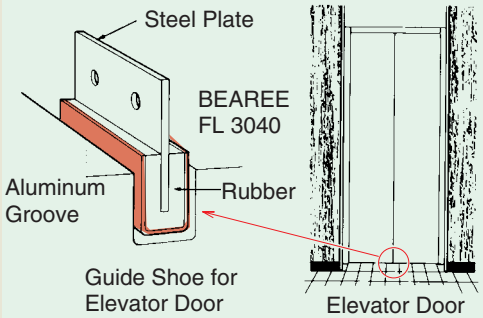


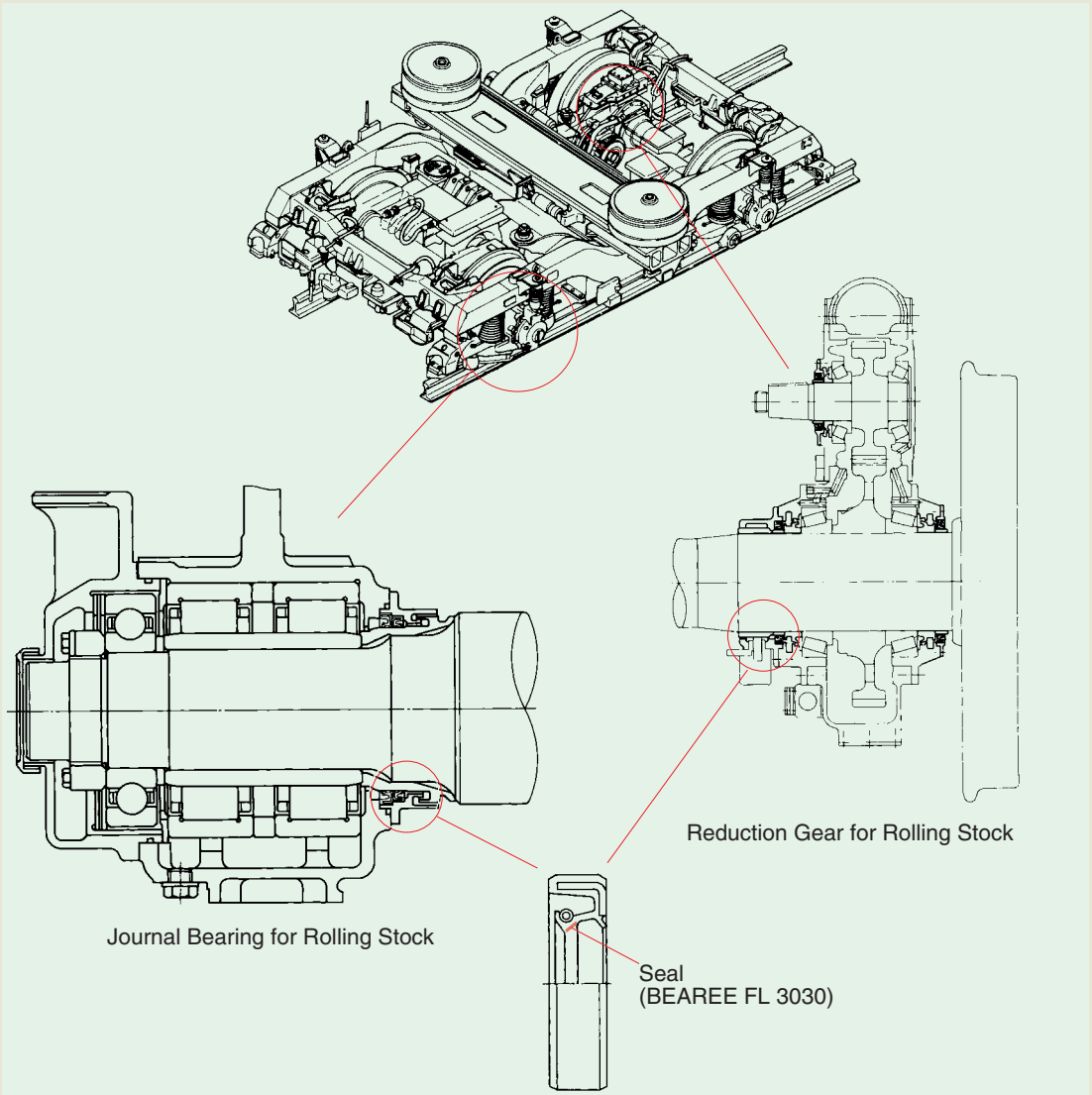

Curtain Wall of Tall Building

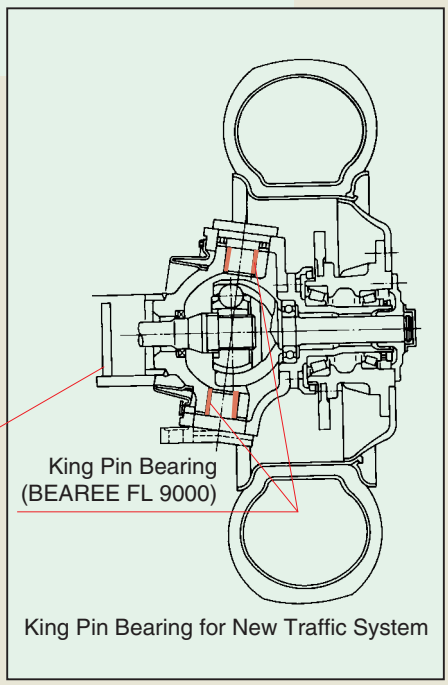


Thrust Bearing for Door Hinge of Telephone Booth




Reduction Gear for Rolling Stock
Journal Bearing for Rolling Stock
Seal
(BEAREE FL 3030)


King Pin Bearing
(BEAREE FL 9000)
King Pin Bearing for New Traffic System

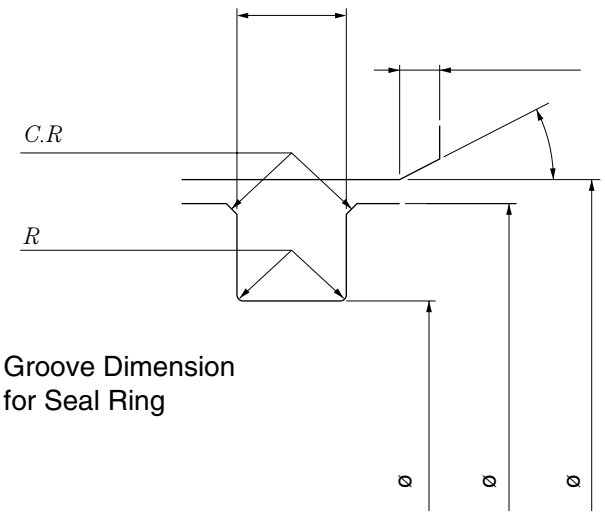
**Company name/Division**

**Your name**

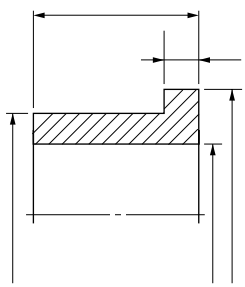
**Phone** **Fax**

# NTN Engineering Plastics Application Inquiry

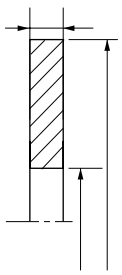
| Items | Confirmation |
|---|---|
| 1. Equipment | |
| 2. Application | |
| 3. Ambient temperature | Max. Min. ˚C |
| 4. Ambient humidity | % |
| 5. Environment | Air, Water, Sea Water |
| 6. Type of load | Static, Dynamic, Shock, Vibration, Repetition Other( ) |
| 7. Type of motion | Rotation, Rocking, Oscillation, Other( ) |
| 8. Operating time | h/day<br>cycle/min |
| 9. Speed | rpm |
| 10. Sliding velocity | m/min |
| 11. Load | Axial, Radial, N {kgf} |
| 12. Pressure(Seal ring) | MPa {kgf/cm²} |
| 13. Lubrication | |
| 14. Shaft | Dimension : |
| | Material : |
| | Hardness : |
| | Roughness : |
| 15. Housing | Dimension : |
| | Material : |
| | Hardness : |
| | Roughness : |
| 16. Remarks | |
| | |
| | |
| | |
| | |
| | |




Groove Dimension
for Seal Ring



Bushing



Thrust Washer