Development and Application of PTFE Compound Bearings

Mr. Seiji Yamajo
Kobelco Eagle Marine Engineering Co., Ltd.

Mr. Fumitaka Kikkawa
Mikasa Corporation

Return to session directory

Fig.1 Structure of three-layer bearing

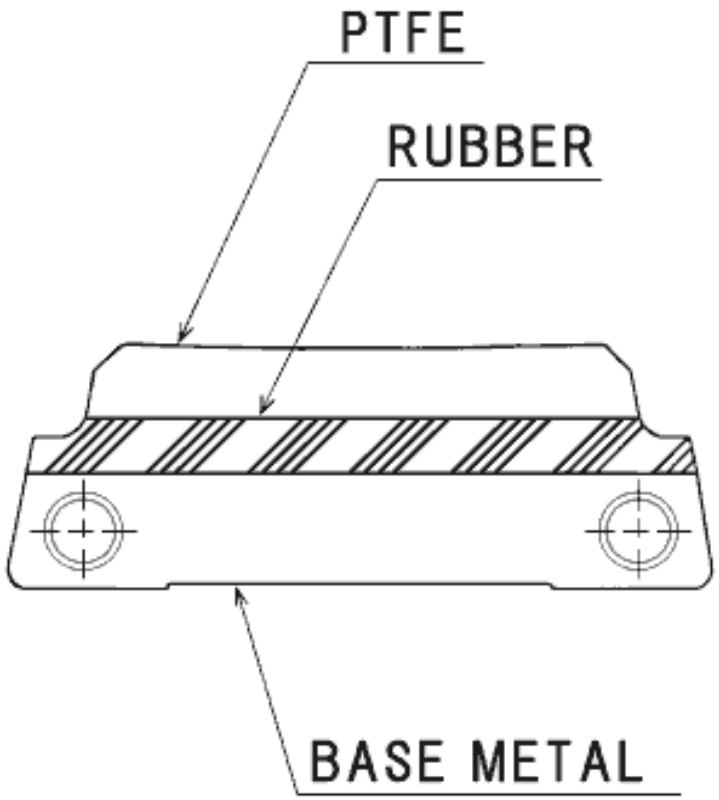

Table 1 Characteristics of three-layer bearing

Required performance			Rubber	Plastic	Three-layer Bearing
Excellent performance against wear	⇨	Material must be hard.	Soft	Hard	Hard
Flexible against poor alignment	⇨	Material must be flexible to make bearing pressure small.	Flexible	Not-flexible	Flexible

Fig. 2 Manufacturing equipment of PTFE bearing

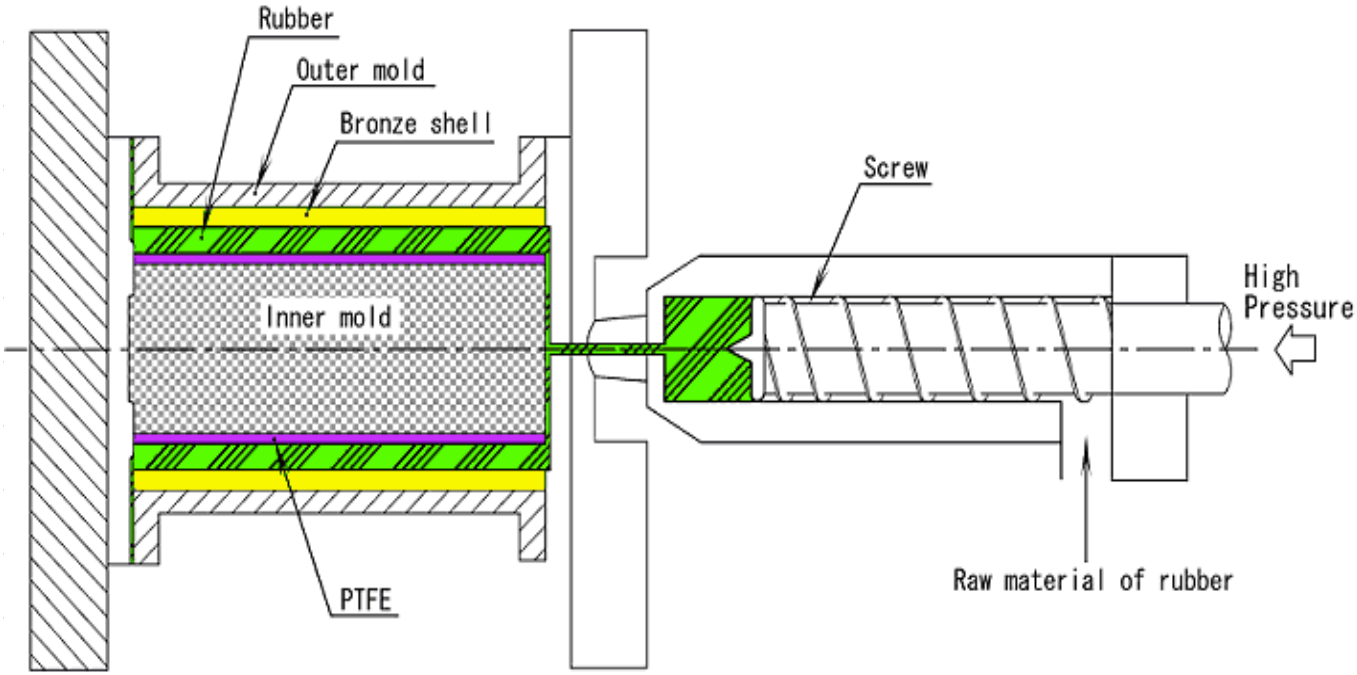

Fig. 3 Construction of PTFE bearing

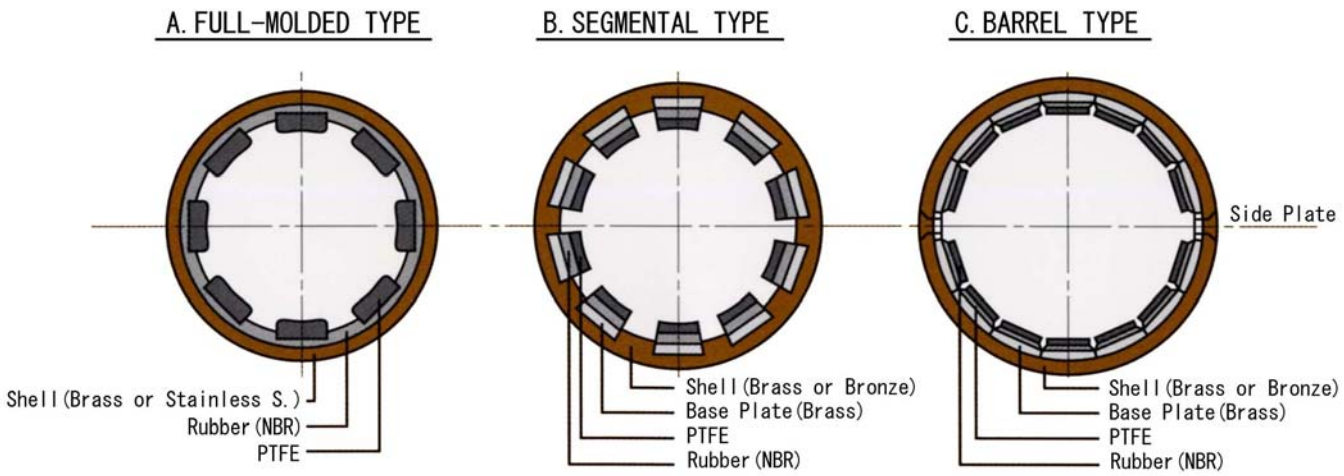

Table 2 Comparison between rubber bearing and PTFE bearing

Item	Rubber bearing	PTFE bearing
Allowable pressure (Average pressure)	0.25 MPa	0.56 MPa
Max. partial pressure	1.0 MPa	2.5 MPa
Coefficient of friction (V > 2.5 m/s)	0.04	0.01
Operating time in dry condition (P = 0.05MPa)	0	1 min. 56 sec.
Necessary water supply	3d liter/min. (d cm = shaft dia.)	2d liter/min. (d cm = shaft dia.)

Fig. 4 Friction characteristics

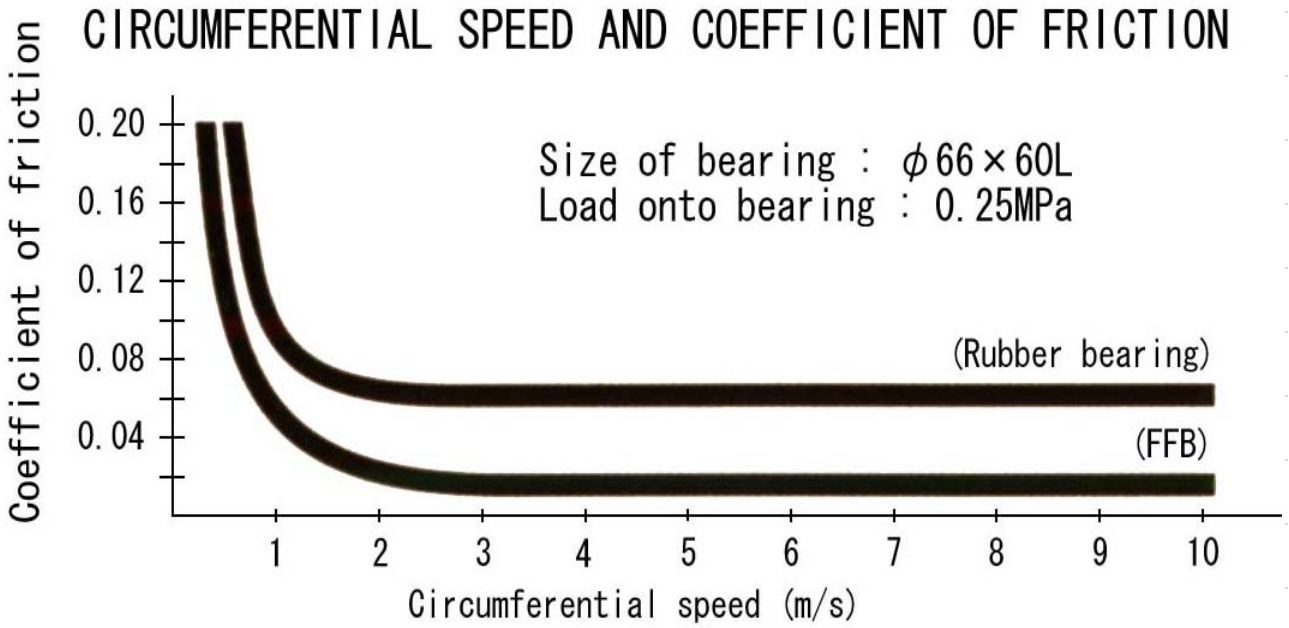

Table 3 Test condition of friction coefficient test

Item		Condition
Shaft Sleeve	Material	70-30 Copper-Nickel
	Diameter	140 mm (5½ inches)
Bearing	Material	PTFE Compound Bearing
	Diameter	$140\ ^{+0.5}_{+0.6}$ mm
	Length	140mm
Shaft Revolution		6~490 r.p.m. (0.04~3.5 m/s)

Fig. 5 Dynamic and static friction coefficients

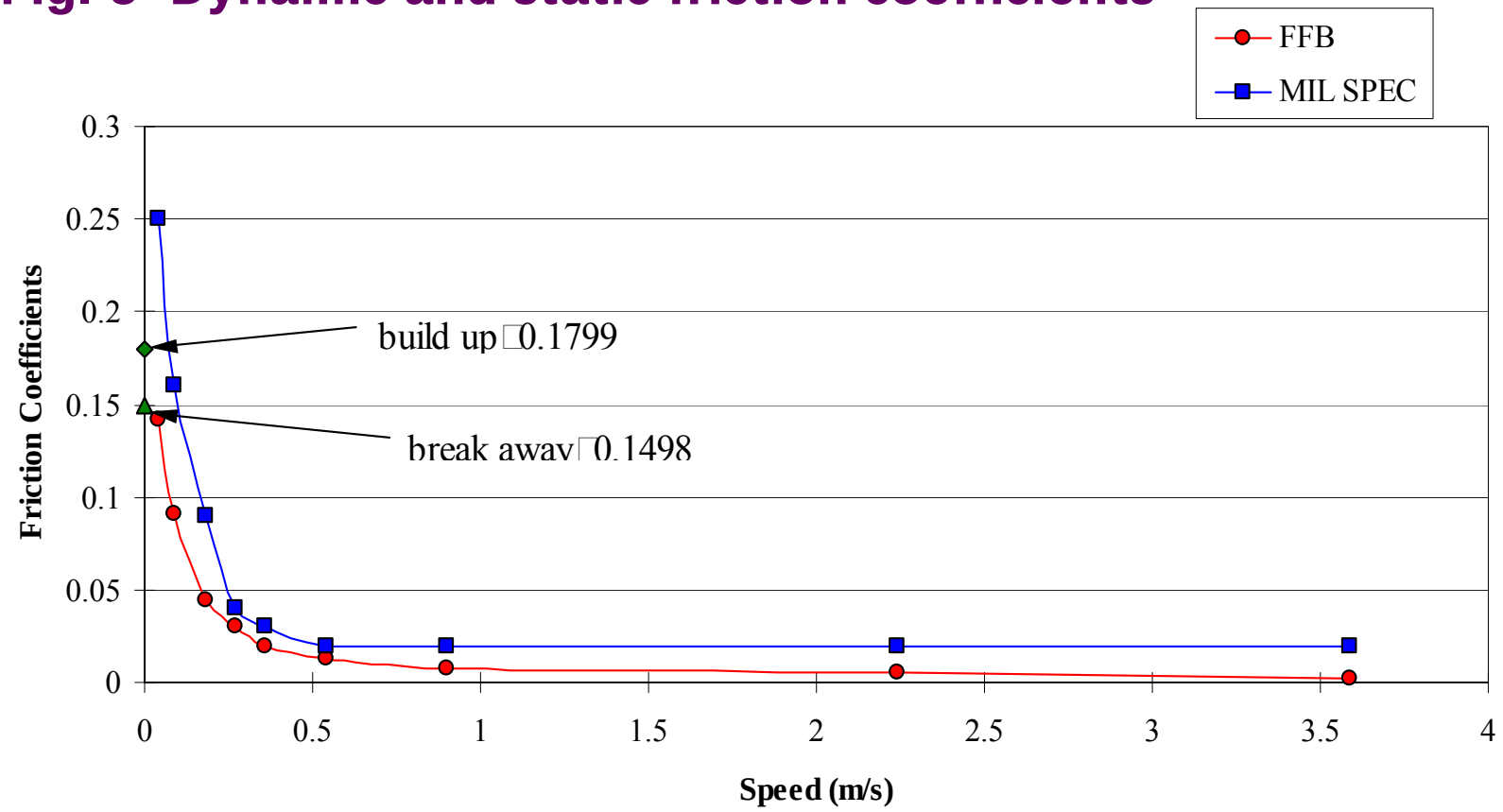

Table 4 Heat resistance

MATERIAL	HEAT RESISTANCE (DRY)	HYDROLYSIS IN WATER	MELTING POINT
PTFE	260°C	-	324°C
URETHANE	100°C	AROUND 60°C OR MORE	263°C

Fig. 6 Swelling in seawater

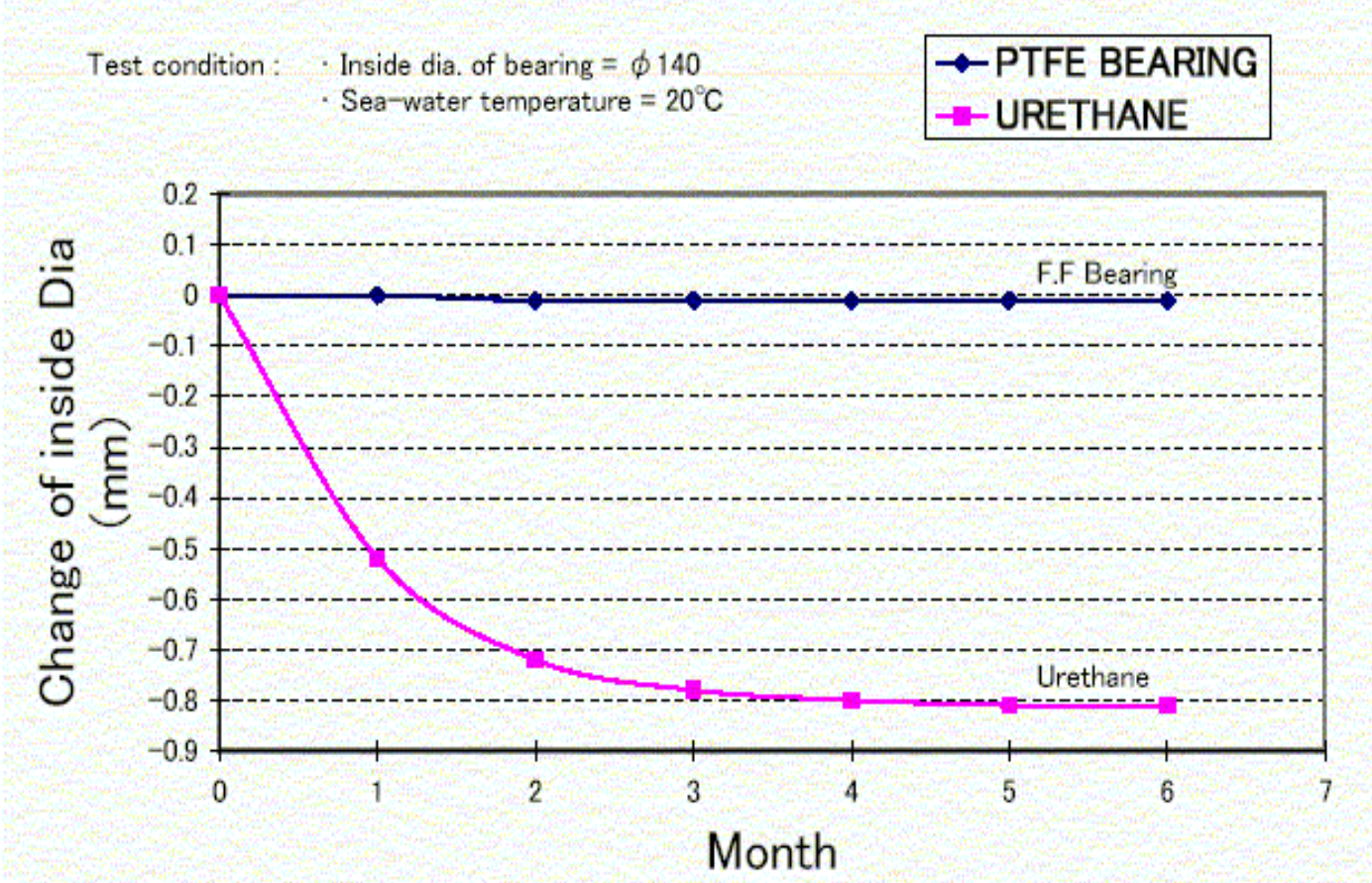

Table 5 Young's modulus of bearing

KIND OF BEARING	YOUNG'S MODULUS
PTFE BEARING	50 MPa
RUBBER BEARING	10 MPa
URETHANE BEARING	1500 MPa

Fig. 7 Bearing pressure on bracket bearing

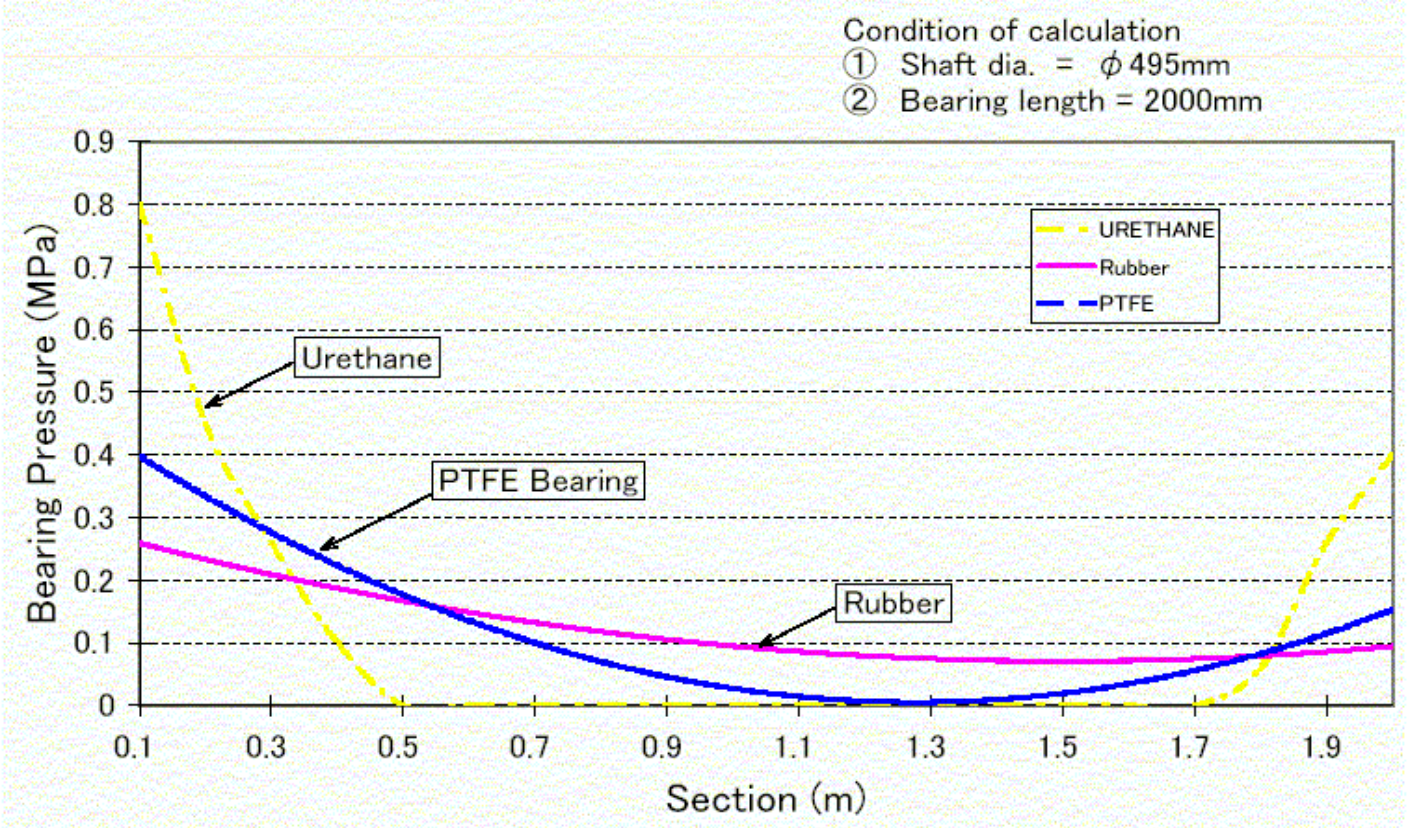

Fig. 8 Durability in dry condition

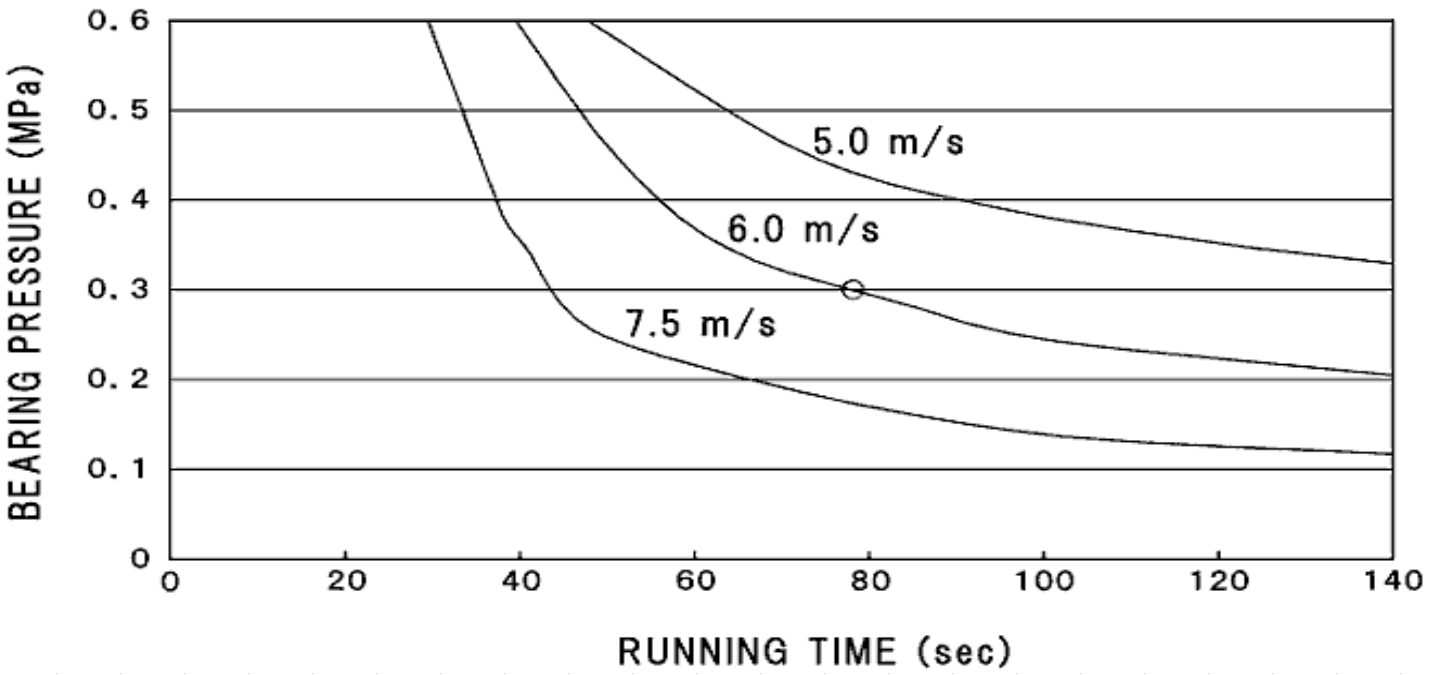

Fig. 9 No water supply test equipment

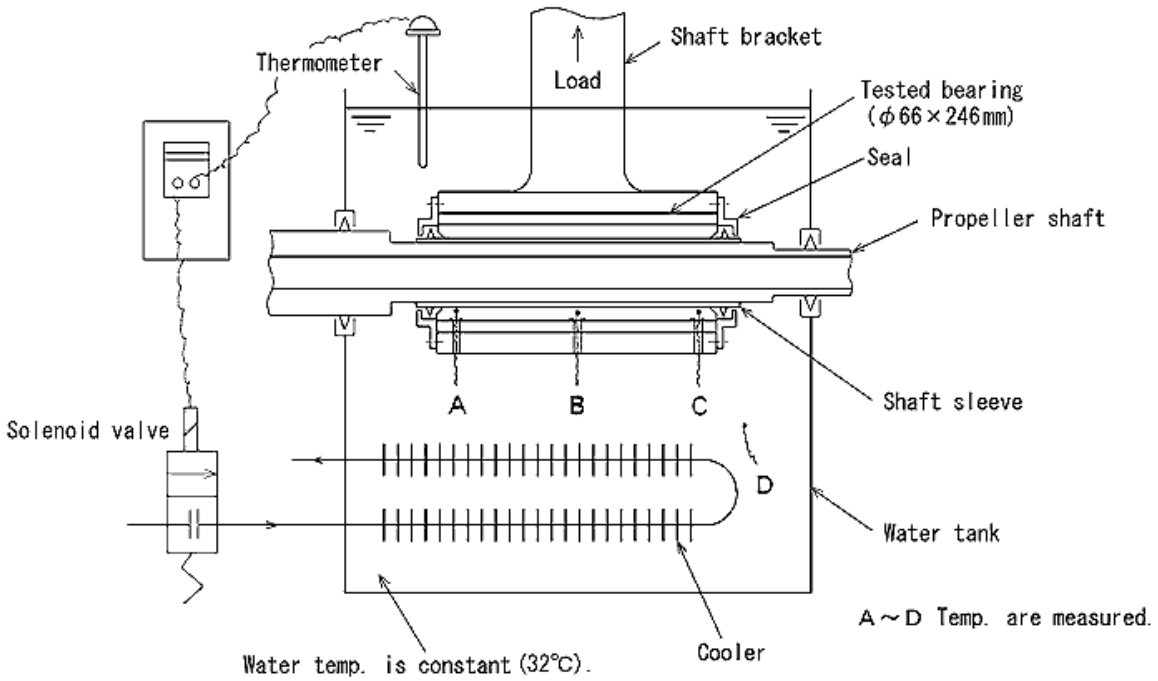

Fig. 10 Temperature of bearing

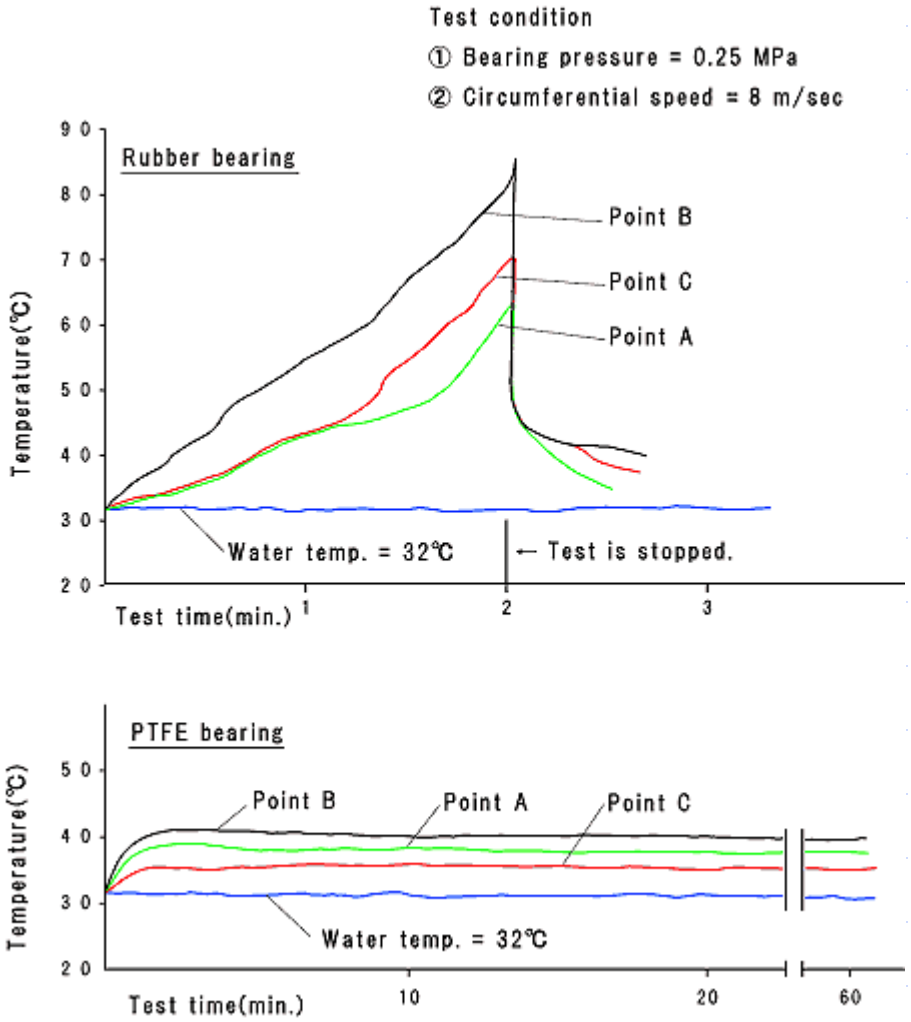

Fig. 11 Abrasion test equipment (Shaft dia. – 200mm)

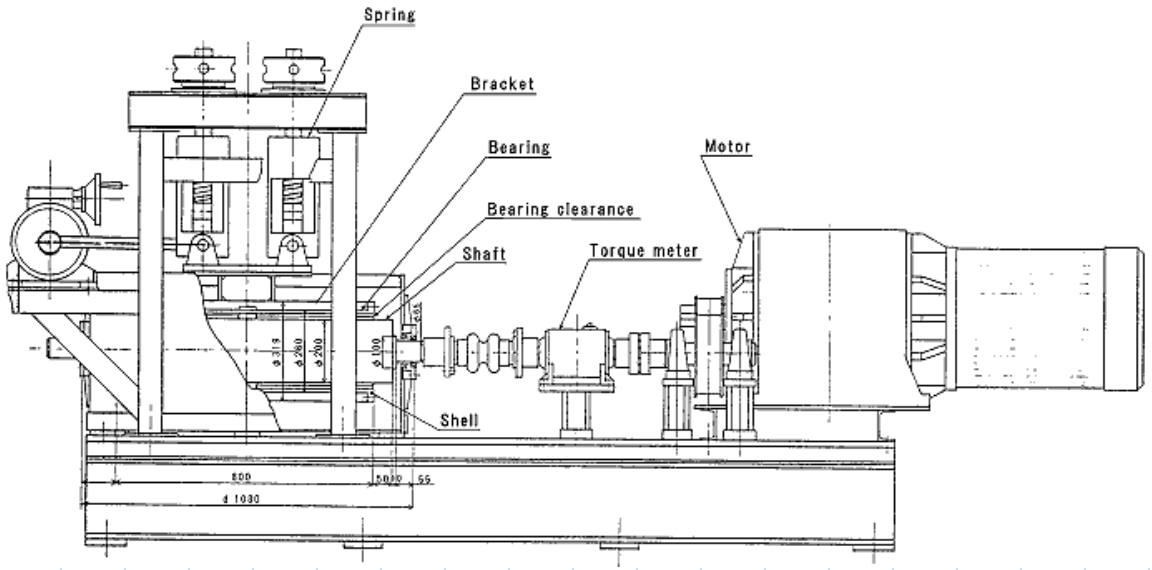

Fig. 12 Water supply line of test equipment

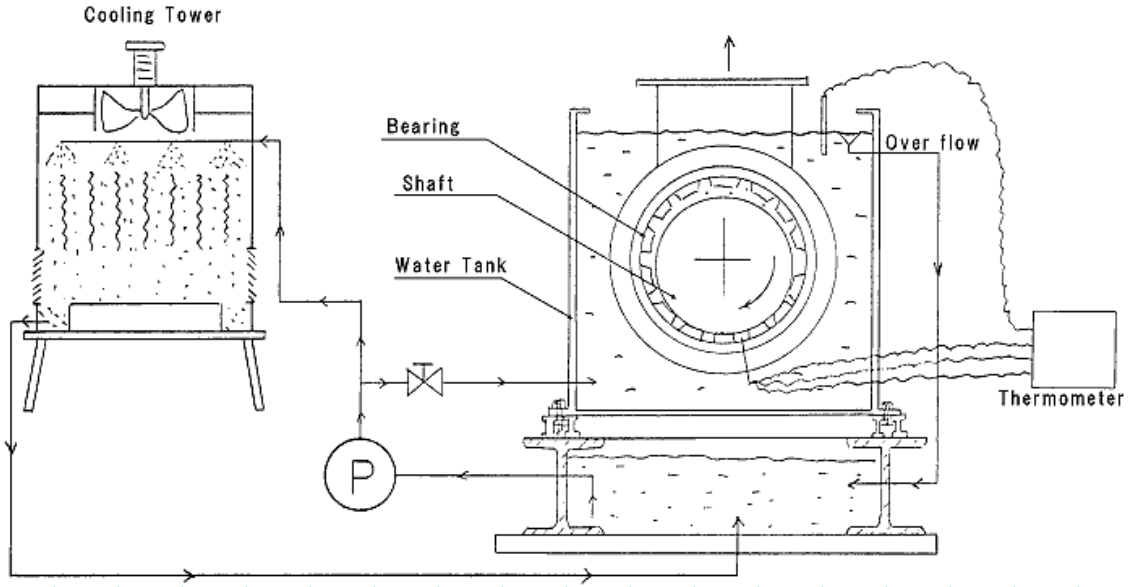

Table 6 Test condition (1)

Item		Condition
Shaft sleeve	Material	BC2 + 0.5% Ni
Bearing	Type	Barrel Type
	Size	φ200 mm × 400 mm
	Clearance	0.7 ~ 0.8 mm
Test condition	Average pressure	1 MPa
	Revolution	600 r.p.m. (v=6.28 m/s)
	Volume of sand	0.3 % (weight % in water)
	Water temperature	20°C ~ 25°C
	Test hours	1000 Hr

Fig. 13 Wear after 1000 hours

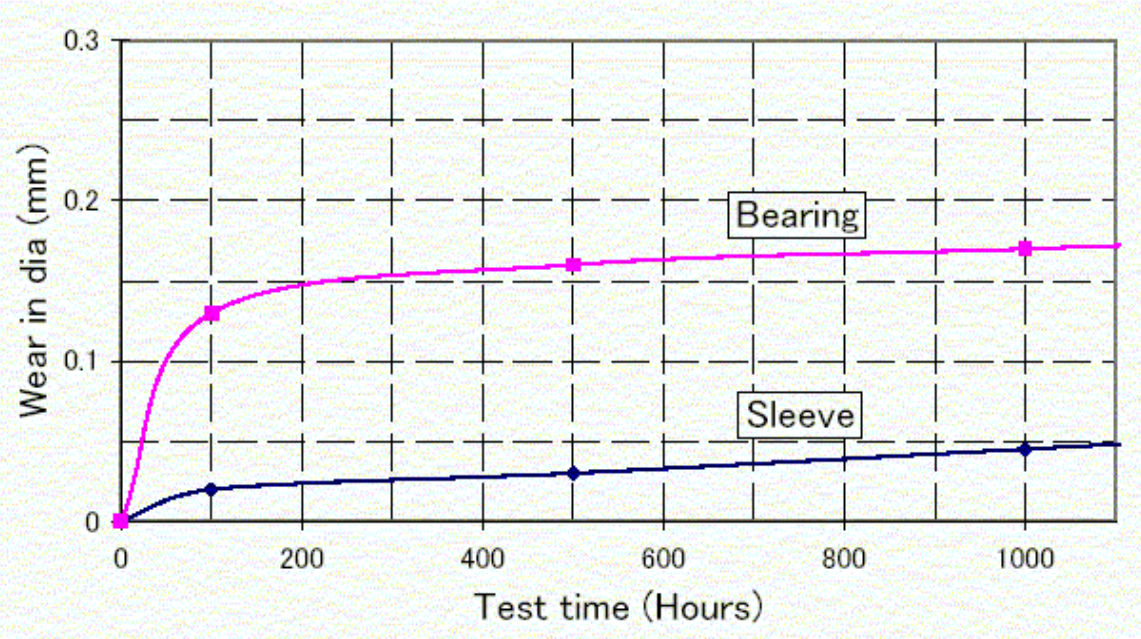

Fig. 14 Abrasion test equipment (Shaft dia. = 300mm)

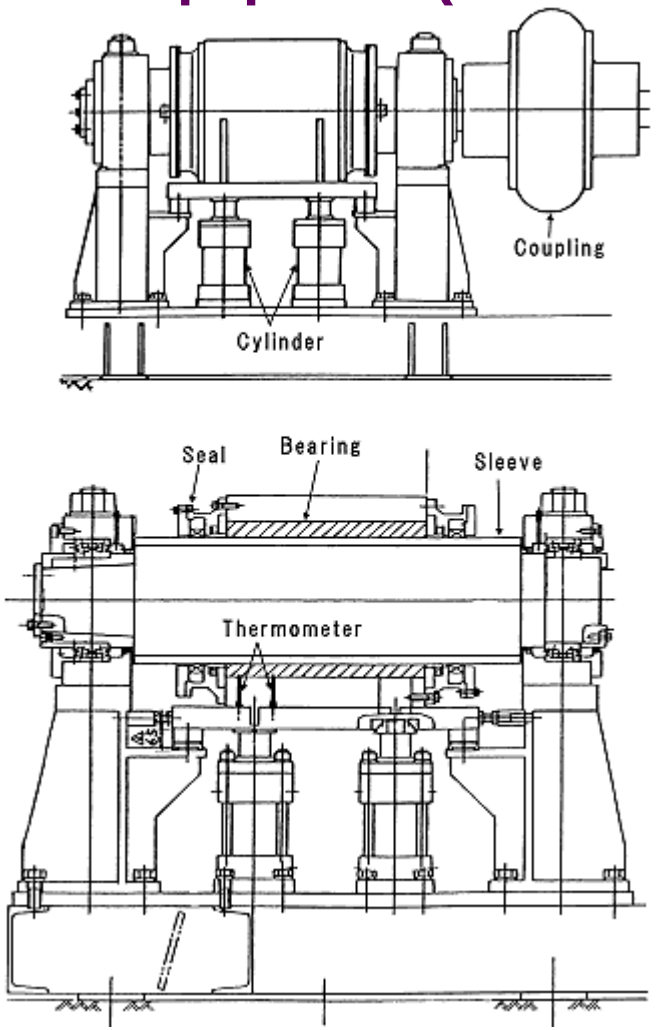

Table 7 Test condition (2)

Item		Condition
Bearing	Type	Full mold type
	Dimension	L=450mm, Do=φ380mm, Di=φ300mm
Sleeve	Material Dimension	BC2 + 0.5% Ni L=650mm, Do=φ300mm, Di=φ260mm
Bearing Clearance		1.0 mm
Supplied water	Kind	Pure water without sand
	Quantity	2000 liter/hr
	Temperature	24°C~ 27°C
Test condition	Revolution	60 r.p.m.(1m/s)
	Test period	4 months

Table 8 Load condition

Load	Average bearing pressure	AFT : Center : FWD	Tested period
A	0.5 MPa	P_{AFT}=0.7MPa, P_{CENTER}=0.5MPa, P_{FWD}=0.3MPa	1 month
B	1.0 MPa	P_{AFT}=1.4MPa, P_{CENTER}=1.0MPa, P_{FWD}=0.6MPa	2 month
C	1.5 MPa	P_{AFT}=2.1MPa, P_{CENTER}=1.5MPa, P_{FWD}=0.9MPa	1 month

Fig. 15 Wear test for four months

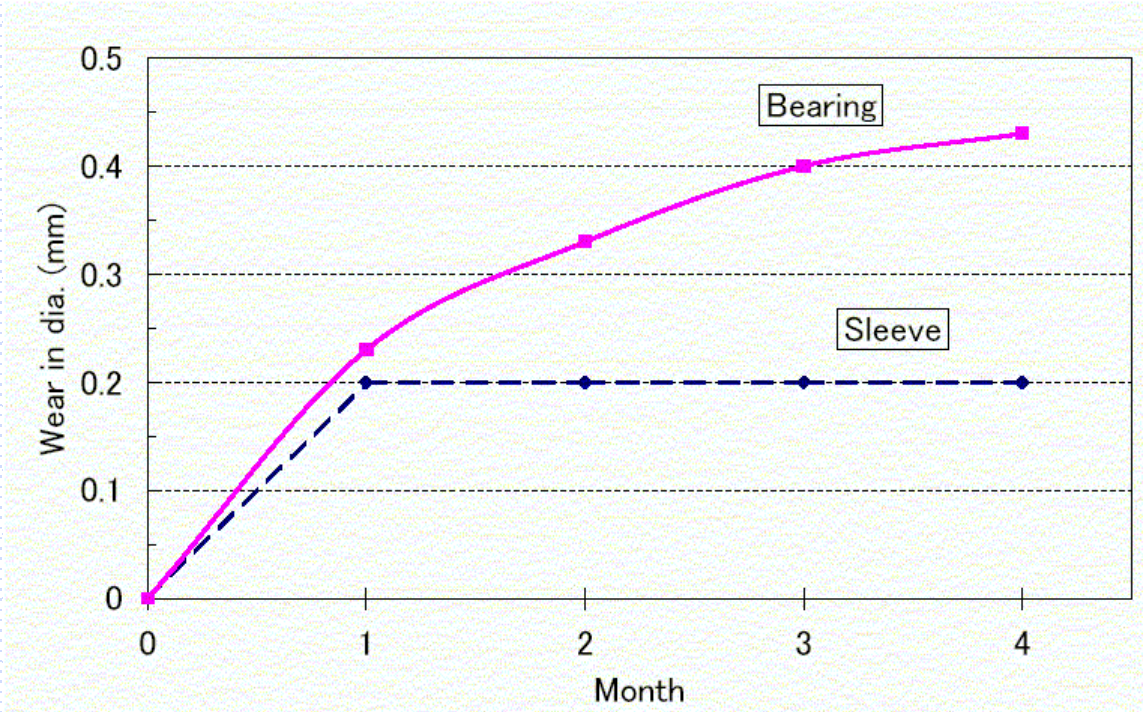

Table 9 ABS Design Assessment

Item		Condition
Lubrication		Water Lubricated Stern Tube Bearing
Shaft Diameter (D)		40mm (1.6 inch) ~ 1,000mm (40 inch)
Bearing Length (L)		L ≥ 2 x D
Load on Bearing	Average Pressure	Less than 6 kgf/cm²
	Max. Local Pressure	Less than 20 kgf/cm²

Fig. 16 Change of clearance on a Destroyer

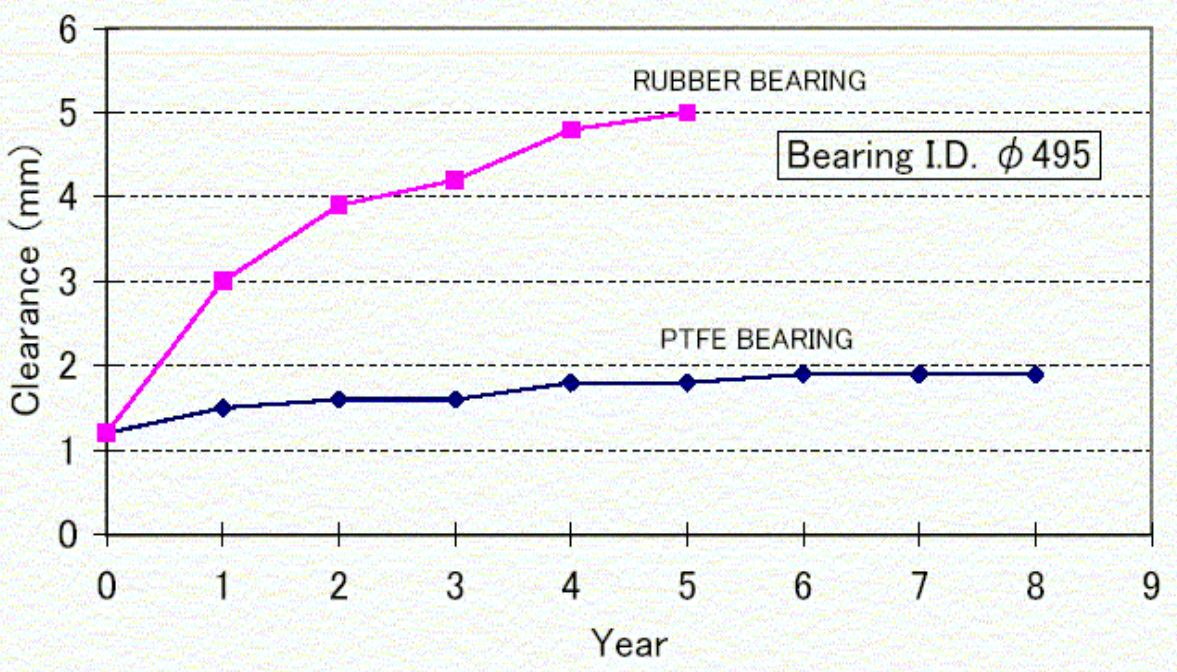

Fig. 17 Change of clearance on a Guided Missile Destroyer

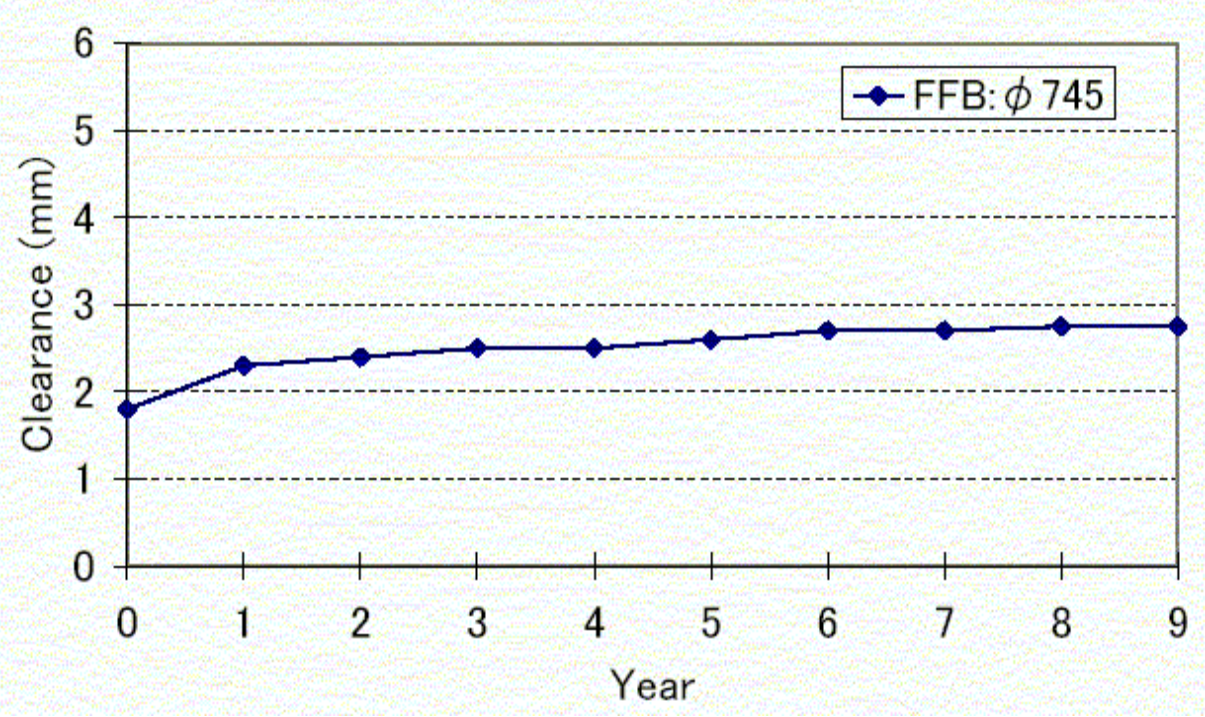

Fig. 18 Outlook of bearing on a Guided Missile Destroyer

Fig. 19 Structure of cruising ferry

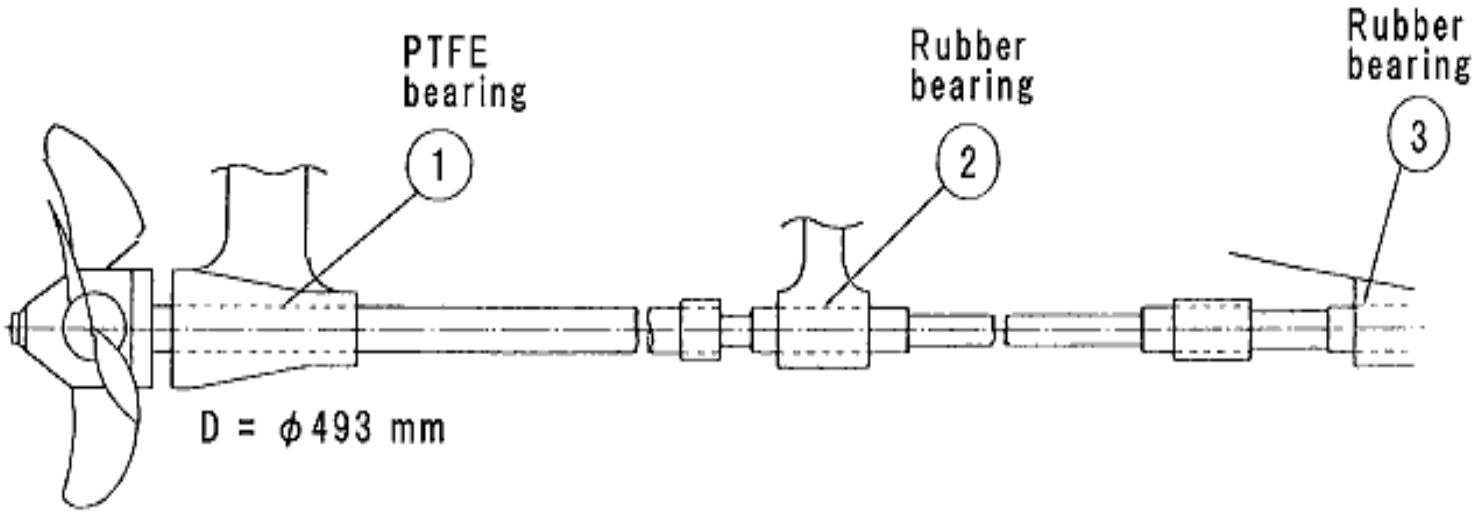

Fig. 20 Clearance of bearing at position ①

Table 10 Reference list of PTFE compound bearing

No.	Type of Vessel	Delivery	Bearing Size	Q'ty
1	Fishing Boat	May-03	Strut ; Ø305 x 1180L	2
			S/T ; Ø305 x 1180L	2
2	Fishing Boat	Jun-03	Strut ; Ø198 x 600L	2
			S/T ; Ø198 x 600L	2
3	Fishing Boat	Oct-03	Strut ; Ø241 x 900L	2
			S/T ; Ø241 x 900L	2
4	Fishing Boat	Feb-04	Strut ; Ø165 x 570L	2
			S/T ; Ø165 x 570L	2
5	Ocean Tug Boat	Apr-04	Strut ; Ø368 x 1300L	2
			S/T Aft ; Ø368 x 700L	2
			S/T Fwd ; Ø367 x 700L	2
6	Supply Boat	May-04	Strut ; Ø203 x 700L	1