14. Shaft and Housing Design

14.1 Fixing of bearings

When fixing a bearing in position on a shaft or in a housing, there are many instances where the interference fit alone is not enough to hold the bearing in place. Bearing ring must be fixed in place by various methods so they do not axially move when placed under load.

The most common method of fixing bearings in place is to hold the ring end face against the shaft or housing abutment by means of bolts or screws. Fig. 14.1 illustrates inner ring clamping methods, and Fig. 14.2 outer ring clamping methods. Fig. 14.3 and 14.4 show the use of snap ring methods which also make construction extremely simple.

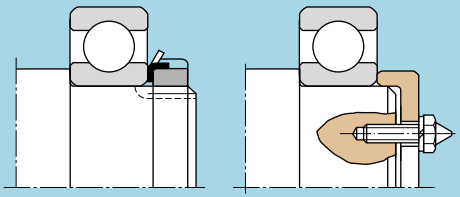


Fig. 14.1 Inner ring clamping

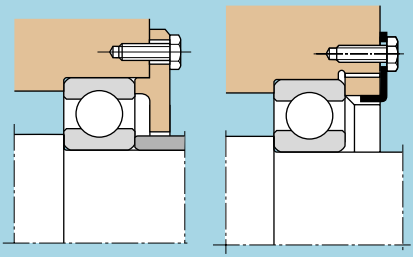


Fig. 14.2 Outer ring clamping

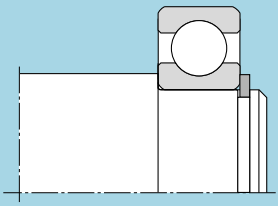


Fig. 14.3 Snap ring (Shaft)

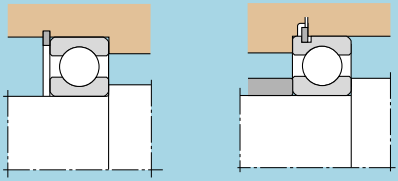


Fig. 14.4 Snap ring (Housing)

For bearings with tapered bores, examples of the use of adapters are shown in Fig. 14.5. When fitting bearings on non-stepped shafts, fixing the bearing axially depends on the friction between the sleeve and the shaft. Fig. 14.6 shows the use of withdrawal sleeves and clamping with nuts or end-plates on shaft ends. For installing tapered bore bearings directly on tapered shafts, the bearing is held in place by a split ring inserted in groove provided in the shaft, and tightened on the shaft by the split ring nut (Fig. 14.7).

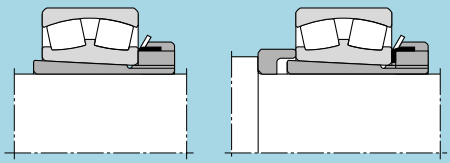


Fig. 14.5 Adapter sleeve mounting

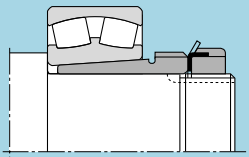


Fig. 14.6 Withdrawal sleeve mounting

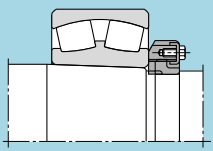


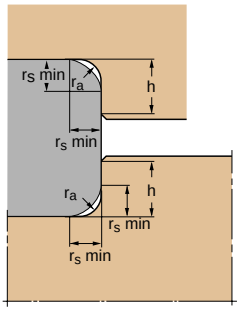
Fig. 14.7 Split ring mounting

14.2 Bearing fitting dimensions

The shaft and housing abutment height (*h*) should be larger than the bearings' maximum allowable chamfer dimensions ($r_{s\,max}$), and the abutment should be designed so that it directly contacts the flat part of the bearing end face. The fillet radius must be smaller than the bearing's minimum allowable chamfer dimension ($r_{s\,min}$) so that it does not interfere with bearing seating. Table 14.1 lists abutment height (*h*) and fillet radius (r_a). For bearings subjected to heavy axial loads, shaft abutments (*h*) should be higher than the values in the table.

In cases where a fillet radius (r_a) larger than the bearings' chamfer dimension is required to maximize shaft strength or to minimize stress concentration (Fig. 14.8a); or where the shaft abutment height is too low to afford adequate contact surface with the bearing (Fig. 14.8b), spacers may be used effectively.

Relief dimensions for ground shaft and housing fitting surfaces are given in Table 14.2.



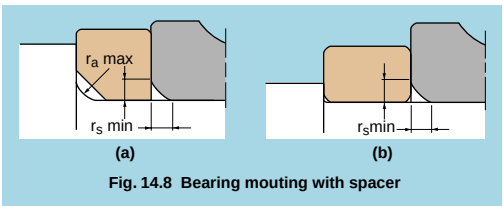


Fig. 14.8 Bearing mouting with spacer

Table 14.1 Fillet radius *r*a and abutment height *h*

Unit mm

Chamfer dimension *r*s min	Fillet radius *r*as max	Minimum shoulder height *h*	
		Normal use1)	Special use2)
0.1	0.1	0.4	
0.15	0.15	0.6	
0.2	0.2	0.8	
0.3	0.3	1.25	1
0.6	0.6	2.25	2
1	1	2.75	2.5
1.1	1	3.5	3.25
1.5	1.5	4.25	4
2	2	5	4.5
2.1	2	6	5.5
2.5	2	6	5.5
3	2.5	7	6.5
4	3	9	8
5	4	11	10
6	5	14	12
7.5	6	18	16
9.5	8	22	20

1) For bearings subjected to heavy axial loads, shaft adjustments (h) should be higher than the values listed in the table.

2) The values in the "Special Case" column should be adopted in cases where thrust loading is extremely small;with the exception of tapered roller bearings, angular contact bearings, or spherical roller bearings.

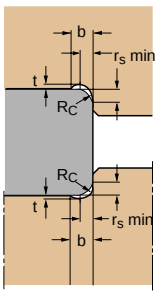


Table 14.2 Relief dimensions for ground shaft

Unit mm

Chamfer dimension *r*s min	Relief dimensions		
	b	*t*	*R*c
1	2	0.2	1.3
1.1	2.4	0.3	1.5
1.5	3.2	0.4	2
2	4	0.5	2.5
2.1	4	0.5	2.5
3	4.7	0.5	3
4	5.9	0.5	4
5	7.4	0.6	5
6	8.6	0.6	6
7.5	10	0.6	7

14.3 Shaft and housing accuracy

For normal use, the accuracies for shaft and housing fitting surface dimensions and configurations, as well as fitting surface roughness and abutment squareness, are given in Table 14.3.

Table 14.3 Accuracy of shaft and housing Units (μm)

Characteristics		Shaft	Housing
Circularity Cylindricity (max.)		IT3	IT4
Sqareness of step (max.)		IT5	IT5
Surface roughness	Small size bearings	0.8a	1.6a
	Large size bearings	1.6a	3.2a