TAPERED ROLLER BEARING CAGES

STAMPED-STEEL CAGES

The most common type of cage used for tapered roller bearings is the stamped-steel cage. These cages are mass produced from low-carbon sheet steel using a series of cutting, forming and punching operations. These cages can be used in high temperature and harsh lubricant environments.

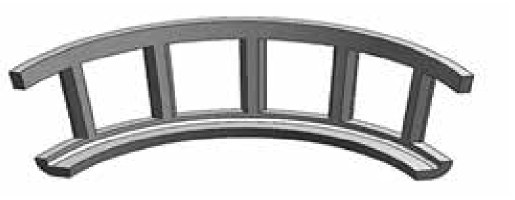


Fig. 8. Stamped-steel cage.

POLYMER CAGES

Cages for tapered roller bearings made of polymer material are used primarily for pre-greased and sealed package designs. The most common polymer materials used are Nylon thermoplastics with glass reinforcement. Polymer cages can be mass produced in large quantities and offer more design flexibility than stamped-steel types. Polymer cages are lightweight and easy to assemble. In some instances, increased bearing rating can be achieved by allowing one or two extra rollers in the bearing complement. Care should be exercised when using aggressive lubricants with EP (extreme-pressure) additives in combination with elevated temperatures greater than 107° C (225° F).

MACHINED CAGES

Machined cages for tapered roller bearings are robust in design and are suited for high-speed and high-load applications. Machined cages use alloy steels and are produced through milling and broaching operations. Assembly does not require a close-in operation and rollers can be retained using nibs or staking. Oil holes also can be easily added for extra lubrication for demanding applications. Some designs are silver plated for special applications.

PIN-TYPE CAGES

Tapered roller bearing pin-type cages retain the rolling elements by the use of a pin located through an axial hole in the center of the roller. Pin-type cages for tapered roller bearings consist of two rings with roller pins attached by screw threads at one end and welding at the other end. These types of cages are primarily used for larger tapered roller bearing designs (greater than 400 mm [15.7480 in.] O.D.). Pin-type cages are machined out of steel and typically allow for an increased number of rolling elements. Pin-type cages are restricted to low-speed applications (less than 20 m/sec [4000 ft/min] rib speed).

OPERATING TEMPERATURES

Bearings operate in a wide range of applications and environments. In most cases, bearing operating temperature is not an issue. Some applications, however, operate at extreme speeds or in extreme temperature environments. In these cases, care must be taken not to exceed the temperature limits of the bearing. Minimum temperature limits are primarily based on lubricant capability. Maximum temperature limits are most often based on material and/or lubricant constraints, but also may be based on accuracy requirements of the equipment that the bearings are built into. These constraints/limitations are discussed below.

BEARING MATERIAL LIMITATIONS

Standard bearing steels with a standard heat treatment cannot maintain a minimum hardness of 58 HRC much above 120° C (250° F).

Dimensional stability of Timken bearings is managed through the proper selection of an appropriate heat-treat process. Standard Timken tapered roller and ball bearings are dimensionally stabilized from -54° C (-65° F) up to 120° C (250° F), while standard spherical roller bearings are dimensionally stabilized up to 200° C (392° F) and standard cylindrical roller bearings are stabilized up to 150° C (302° F). Upon request, these bearings can be ordered to higher levels of stability as listed below. These designations are in agreement with DIN Standard 623.

TABLE 33.

Stability Designation	Maximum Operating Temperature	
	°C	°F
S0	**150**	302
S1	**200**	392
S2	**250**	482
S3	**300**	572
S4	**350**	662

With dimensionally stabilized product, there still may be some changes in dimensions during service as a result of microstructural transformations. These transformations include the continued tempering of martensite and decomposition of retained austenite. The magnitude of change depends on the operating temperature, the time at temperature and the composition and heat-treatment of the steel.

Temperatures exceeding the limits shown in table 33 require special high-temperature steel. Consult your Timken engineer for availability of specific part numbers for non-standard heat stability or high-temperature steel grades.

Suggested materials for use in balls, rings and rollers at various operating temperatures are listed in table 34. Also listed are chemical composition recommendations, hardness recommendations and dimensional stability information.

Operating temperature affects lubricant film thickness and setting, both of which directly influence bearing life. Extremely high temperatures can result in a reduced film thickness that can lead to asperity contact between contacting surfaces.

Operating temperature also can affect performance of cages, seals and shields, which in turn can affect bearing performance. Materials for these components and their operating temperature ranges are shown in table 35.

LUBRICATION LIMITATIONS

Starting torque in grease-lubricated applications typically increases significantly at cold temperatures. Starting torque is not primarily a function of the consistency or channel properties of the grease. Most often, it is a function of the rheological properties of the grease.

The high-temperature limit for greases is generally a function of the thermal and oxidation stability of the base oil in the grease and the effectiveness of the oxidation inhibitors.

See the LUBRICATION AND SEALS section on page 55 for more information on lubrication limitations.

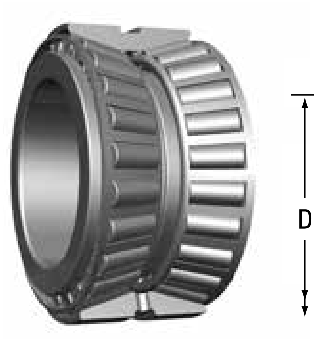
EQUIPMENT REQUIREMENTS

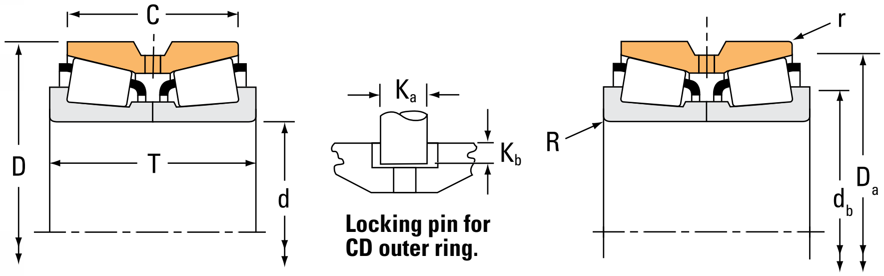
The equipment designer must evaluate the effects of temperature on the performance of the equipment being designed. Precision machine tool spindles, for example, can be very sensitive to thermal expansions. For some spindles, it is important that the temperature rise over ambient be held to 20° C to 35° C (36° F to 45° F).

Most industrial equipment can operate at considerably higher temperatures. Thermal ratings on gear drives, for example, are based on 93° C (200° F). Equipment such as gas turbines operates continuously at temperatures above 100° C (212° F). Running at high temperatures for extended periods of time, however, may affect shaft and housing fits, if the shaft and housing are not machined and heat-treated properly.

Although bearings can operate satisfactorily up to 120° C (250° F),

TYPE TNA





Locking pin for CD outer ring.

Bearing Dimensions				Load Ratings							
Bore d	O.D. D	Width T	Double Outer Ring Width C	Dynamic[(1)] $C_{1(2)}$	Factors[(2)] e	 Y_1	 Y_2	 C_{90}	Dynamic[(3)] C_{a90}	 $C_{90(2)}$	Factors[(2)] K
mm in.	**mm** in.	**mm** in.	**mm** in.	**N** lbf				**N** lbf	**N** lbf	**N** lbf	
44.450 1.7500	**95.250** 3.7500	**65.090** 2.5626	**44.450** 1.7500	**174000** 39200	0.74	0.91	1.36	**26000** 5840	**32900** 7390	**45200** 10200	0.79
44.450 1.7500	**98.425** 3.8750	**65.090** 2.5626	**44.450** 1.7500	**174000** 39200	0.74	0.91	1.36	**26000** 5840	**32900** 7390	**45200** 10200	0.79
50.000 1.9685	**90.000** 3.5433	**50.010** 1.9689	**42.070** 1.6563	**177000** 39900	0.32	2.11	3.14	**26400** 5930	**14400** 3250	**46000** 10300	1.83
50.800 2.0000	**93.264** 3.6718	**65.088** 2.5625	**52.388** 2.0625	**213000** 47800	0.34	1.99	2.97	**31700** 7120	**18300** 4120	**55100** 12400	1.73
50.800 2.0000	**107.950** 4.2500	**65.090** 2.5626	**53.975** 2.1250	**236000** 53100	0.34	2.01	3.00	**35200** 7900	**20200** 4540	**61200** 13800	1.74
50.800 2.0000	**112.712** 4.4375	**65.088** 2.5625	**46.038** 1.8125	**185000** 41600	0.88	0.76	1.14	**27600** 6200	**41700** 9380	**48000** 10800	0.66
53.975 2.1250	**111.125** 4.3750	**79.375** 3.1250	**63.500** 2.5000	**300000** 67400	0.30	2.28	3.39	**44600** 10000	**22700** 5090	**77700** 17500	1.97
53.975 2.1250	**117.475** 4.6250	**73.025** 2.8750	**53.975** 2.1250	**259000** 58300	0.63	1.08	1.60	**38600** 8680	**41400** 9310	**67200** 15100	0.93
53.975 2.1250	**123.825** 4.8750	**77.788** 3.0625	**55.562** 2.1875	**287000** 64600	0.74	0.92	1.36	**42800** 9620	**54000** 12100	**74500** 16800	0.79
55.000 2.1654	**100.000** 3.9370	**52.388** 2.0625	**42.862** 1.6875	**188000** 42200	0.35	1.91	2.84	**28000** 6280	**16900** 3810	**48700** 10900	1.65
60.000 2.3622	**110.000** 4.3307	**52.388** 2.0625	**46.038** 1.8125	**172000** 38700	0.40	1.68	2.50	**25600** 5760	**17600** 3970	**44600** 10000	1.45
60.000 2.3622	**120.000** 4.7244	**65.090** 2.5626	**53.975** 2.1250	**250000** 56100	0.38	1.75	2.61	**37200** 8360	**24500** 5500	**64700** 14600	1.52
60.325 2.3750	**123.825** 4.8750	**79.375** 3.1250	**63.500** 2.5000	**332000** 74700	0.35	1.95	2.90	**49400** 11100	**29300** 6590	**86100** 19400	1.69
63.500 2.5000	**139.700** 5.5000	**77.788** 3.0625	**51.803** 2.0395	**353000** 79300	0.87	0.78	1.16	**52600** 11800	**77900** 17500	**91500** 20600	0.67
66.675 2.6250	**127.000** 5.0000	**80.962** 3.1875	**65.088** 2.5625	**342000** 76900	0.36	1.86	2.76	**50900** 11400	**31700** 7130	**88600** 19900	1.61
69.850 2.7500	**120.000** 4.7244	**65.090** 2.5626	**53.975** 2.1250	**250000** 56100	0.38	1.75	2.61	**37200** 8360	**24500** 5500	**64700** 14600	1.52
69.850 2.7500	**136.525** 5.3750	**95.250** 3.7500	**76.200** 3.0000	**406000** 91200	0.36	1.86	2.78	**60400** 13600	**37400** 8420	**105000** 23600	1.61

[(1)]Based on 1 x 10^6 revolutions L_{10} life, for the ISO life-calculation method. $C_{1(2)}$ is the double-row radial value.
[(2)]Consult your Timken engineer for instructions on use or review the Timken Engineering Manual on timken.com/catalogs.
[(3)]Based on 90 x 10^6 revolutions L_{10} life, for The Timken Company life-calculation method. C_{90} and C_{a90} are radial and thrust values for a single row. $C_{90(2)}$ is the double-row radial value.

Part Number		Dimensions						Bearing Weight
		Shaft		Housing		Pin		
Inner	Outer	Max Shaft Fillet Radius R(4)	Backing Shoulder Dia. d_b	Max Housing Fillet Radius r(4)	Backing Shoulder Dia. D_a	K_a	K_b	
		mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**kg** lbs.
NA53176	53376D	**2.3** 0.09	**61.0** 2.40	**0.8** 0.03	**89.0** 3.50	– –	– –	**1.92** 4.21
NA53176	53390D	**2.3** 0.09	**61.0** 2.40	**1.5** 0.06	**90.0** 3.54	– –	– –	**2.10** 4.62
NA366	363D	**3.5** 0.14	**61.0** 2.40	**0.8** 0.03	**84.0** 3.31	– –	– –	**1.18** 2.61
NA3780	3729D	**3.5** 0.14	**64.0** 2.52	**0.8** 0.03	**87.9** 3.46	– –	– –	**1.83** 4.02
NA455	452D	**3.5** 0.14	**65.0** 2.56	**0.8** 0.03	**100.0** 3.94	– –	– –	**2.76** 6.10
NA55200	55444D	**2.3** 0.09	**69.0** 2.72	**1.5** 0.06	**105.0** 4.13	– –	– –	**2.85** 6.25
NA539	533D	**3.5** 0.14	**68.0** 2.68	**1.5** 0.06	**100.0** 3.94	– –	– –	**3.35** 7.39
NA66212	66462D	**3.5** 0.14	**73.0** 2.87	**0.8** 0.03	**111.0** 4.37	– –	– –	**3.56** 7.82
NA72212	72488D	**2.3** 0.09	**74.0** 2.91	**1.5** 0.06	**115.0** 4.53	– –	– –	**4.08** 9.00
NA385	384CD	**3.5** 0.14	**67.0** 2.64	**0.8** 0.03	**93.0** 3.66	**7.94** 0.31	**4.77** 0.19	**1.56** 3.45
NA397	394D	**3.5** 0.14	**74.0** 2.91	**0.8** 0.03	**104.4** 4.11	– –	– –	**2.04** 4.51
NA476	472D	**3.5** 0.14	**76.0** 2.99	**0.8** 0.03	**114.0** 4.49	– –	– –	**3.45** 7.59
NA558	552D	**3.5** 0.14	**76.0** 2.99	**1.5** 0.06	**115.0** 4.53	– –	– –	**4.31** 9.50
NA78250	78549D	**2.3** 0.09	**85.0** 3.35	**1.5** 0.06	**131.0** 5.16	– –	– –	**5.11** 11.28
NA569	563D	**3.5** 0.14	**82.0** 3.23	**1.5** 0.06	**119.0** 4.69	– –	– –	**4.36** 9.64
NA482	472D	**3.5** 0.14	**83.0** 3.27	**0.8** 0.03	**114.0** 4.49	– –	– –	**2.93** 6.46
NA643	632D	**3.5** 0.14	**86.0** 3.39	**1.5** 0.06	**125.0** 4.92	– –	– –	**5.88** 12.92

(4)These maximum fillet radii will be cleared by bearing corners.
NOTE: For desired fitting practice and resultant mounted setting range information, contact your Timken engineer.