SAMICK
Linear Bushing System

ISO 9001

SAMICK

CATALOG NO. - 0401E

SAMICK Linear Bushing

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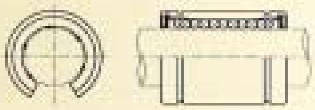
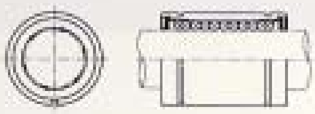
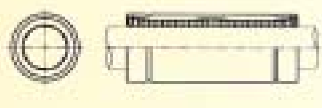
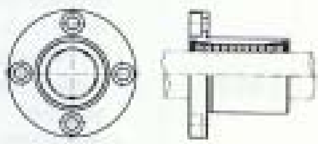
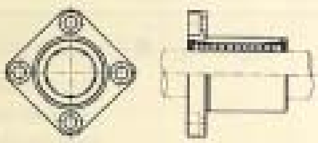
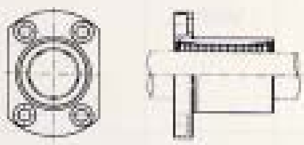
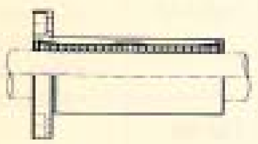
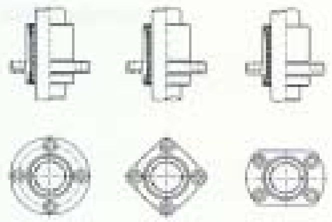
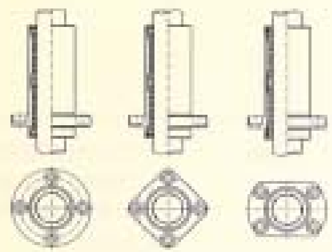
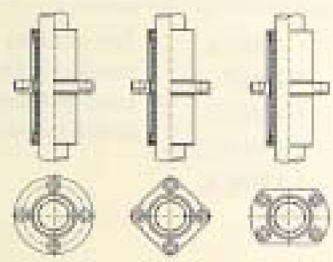
LINEAR BUSHING

TYPE	DESCRIPTION	PART NUMBER	FEATURE	PAGE
STANDARD TYPE 		LM LME	• Cylindrical shape with precision dimension for smoother linear movenent.	32
OPEN TYPE 		LM□OP LME□OP	• One ball circuit is removed from standard type which provide maximum rigidity and stiffness when combined with Support Rail Unit.	32
ADJUSTABLE TYPE 		LM□AJ LME□AJ	• Outer sleeve is slotted in axial direction to adjust the clearance between shaft and Linear Bushing.	32
LONG TYPE 		LM□L LME□L	• Two retainers are installed in Long type series for severe moment loads.	36

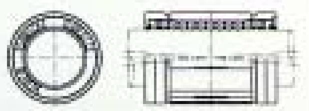
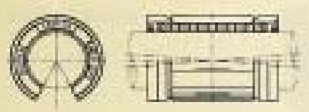
FLANGED TYPE LINEAR BUSHING

TYPE	DESCRIPTION	PART NUMBER	FEATURE	PAGE
CIRCULAR TYPE 		LMF LMEF	• Single-bodied Flange with mounting holes. • Easy installation and compactness.	38
SQUARE TYPE 		LMK LMEK	• More compact design is available due to the lower center height.	38
OVAL TYPE 		LMH	• The most compact design is available due to the lowest center height.	38
FLANGED LONG TYPE 		LMF□L LMEF□L LMK□L LMEK□L LMH□L	• Two retainers are installed in Flanged Long type series for severe moment loads.	42

FLANGED TYPE LINEAR BUSHING

TYPE	DESCRIPTION	PART NUMBER	FEATURE	PAGE
PILOT STANDARD TYPE 		LMFP	■ For using under load • Easy installation is available due to the single body shape. • No Housing is reguired • Compact design is available. • High rigidity. • Interchangeable.	46
		LMKP		46
		LMHP		46
PILOT LONG TYPE 		LMFP−L	■ For using under load • Easy installation is available due to the single body shape. • No Housing is reguired. • Compact design is available. • High rigidity. • Interchangeable.	48
		LMKP−L		48
		LMHP−L		48
MIDDLE FLAVSED TYPE 		LMFM LMEFM	■ For using under load with long stroke • Easy installation is available due to the single body shape. • No Housing is reguired. • Compact design is available. • High rigidity. • Interchangeable.	50
		LMKM LMEKM		50
		LMHM		50

SUPERBALL

TYPE	DESCRIPTION	STANDARD	PART NUMBER	FEATURE	PAGE
STANDARD TYPE 		ISO (mm)	LMES	• High load capacity. • Self alignment. • Light weight and silent motion. • maximum travel life and maximum smooth motion. • Composed with specially designed ball plate and engineering plastic case.	58
		IMPERIAL (inch)	LMBS		60
OPEN TYPE 		ISO (mm)	LMES□OP	• One ball circuit is removed from standard SUPERBALL which provide maximum rigidity and stiffness. • Self alignment.	59
		IMPERIAL (inch)	LMBS□OP		61

CASE UNIT AND SUPPORT RAIL UNIT

TYPE AND PART NUMBER		FEATURE		PAGE
CASE UNIT	SC SCE		• The light Aluminum Case Unit with Linear Bushing. • Providing easy installation and compactness.	64, 66, 68
	SC□W SCE□W		• Aluminum Case Unit with two Linear Bushing. • For severe moment loads.	64, 66, 68
	SC□V SCE□V		• More compact and light weight design are available than SC type.	64, 66, 68
	ADJUSTABLE SCJ		• Adjustable Aluminum Case with AJ type Linear Bushing. • The clearance between the shaft and Linear Bushing can be easily adjusted by adjusting bolt.	70
SUPPORT RAIL UNIT	SBS TBS		• Support Rail Unit provides maximum rigidity and stiffness even under severe load. • Bottom supported shaft for deflection free movement offers maximum rigidity and stiffness.	73, 74

SUPPORT RAIL UNIT AND LM SHAFT

TYPE AND PART NUMBER		FEATURE		PAGE
SUPPORT RAIL UNIT	SBR		• Open type Aluminum Case with OP type Linear Bushing. • For a long stroke application with SBS type.	75
	TBR		• Open type Aluminum case with OP type Linear Bushing. • For a long stroke application with TBS type. • Clearance Adjustable type.	76
	SBR□S		• Assembled with SBR type Aluminium Case Unit, Support Rail, and LM Shaft. • Providing cost reduction, smooth motion, and high rigidity and stiffness.	75
	TBR□S		• Assembled with TBR type Aluminium Case Unit, Support Rail, and LM Shaft. • Providing cost reduction, smooth motion, and high rigidity and stiffness.	76
SHAFT SUPPORT	SK		• Aluminum Shaft Support is light and compact, and also can fix the LM Shaft.	78
LM SHAFT	SF		• Shafts for SAMICK Linear Bushing.	81

SAMICK LINEAR BUSHING SYSTEM

TECHNICAL INFORMATION

LINEAR MOTION SYSTEM

Load Rating and Service Life of Linear Motion Systems

Load Rating and Travel Life

When you determine a model that would best suit for your service conditions of a linear motion system, the load rating and travel life of the model must be considered. To consider the load rating, you should know the static safety factor of the model, which is calculated based on the basic static load rating. The service life can be assessed by calculating the nominal life, based on the basic dynamic load rating, and you need to check if the values thus obtained meet your requirements.
The total travel life of a linear motion systems refers to the total travel distance until the surface of the linear system flakes off because of the rolling contact fatigue on the material caused by repeated stress on raceways and rolling elements.

Basic Load Rating

There are two basic load ratings of a linear motion systems: basic static load rating(C_0), which sets the static load allowance limit, and basic dynamic load rating(C), which is using for calculating travel life.

Basic Static Load Rating (C_0)

If a linear motion system, whether at rest or in motion, receives an excessive load or large impact, a local permanent deformation develops between the raceway and rolling elements. And if the magnitude of the permanent deformation exceeds a certain limit, it hinders the smooth motion of the linear motion system.
The basic static load rating refers to a static load in a given direction with given magnitude, which total permanent deformation of rolling elements and raceway at the contact area is approximately 0.0001 of the rolling element diameter. In a linear motion systems, the basic static load rating is defined as the radial load. Thus, the limit of static load allowance is the basic static load rating. For the rating values of individual linear motion systems, see the respective specification tables in this catalog.

Static Safety Factor (fs)

A linear motion system may possibly receive an unpredictable external force due to the vibration or impact while it is at rest or in motion, or inertia as a result of starting and stopping. It is, therefore, necessary to consider the static safety factor against operating loads.

Static Safety Factor (fs)

The static safety factor(fs) indicates the ratio of a linear motion system load carrying capacity(basic static load rating, C_0) to the load exerted there on.

$$f_S = \frac{C_0}{P} \quad or \quad f_S = \frac{M_0}{M} \quad \cdots\cdots (1)$$

f_S	: Static safety factor	
C_0	: Basic static load rating	(N)
M_0	: Static permissible moment	$(N \cdot mm)$
P	: Calculated load	(N)
M	: Calculated moment	$(N \cdot mm)$

To calculate a load exerted on the linear motion system, the mean load for calculating the service life and the maximum load for calculating the static safety factor must be obtained in advance. A system can have unexpected excessive load when it is subject to frequent starts and stops, placed under machining loads, or when the severe moment is applied by overhanging loads. When selecting the correct type of a linear motion system for your application, be sure that the type you are considering can bear the maximum possible load when stopped and in operation. The table below specifies the standard values for the static safety factors.

Table 1. Standard Values for The Static Safety Factors(fs)

Machine used	Loading conditions	fs lower limit
Ordinary Industrial Machine	Receives no vibration or impact Receives vibration and impact	1.0~1.3 2.0~3.0
Machine tool	Receives no vibration or impact Receives vibration and impact	1.0~1.5 2.5~7.0

For large radial loads	$\frac{f_H \cdot f_T \cdot f_C \cdot C_0}{P} \geq f_S$

C_0	: Basic static load rating(radial)	(N)
P	: Calculated load(radial)	(N)
f_H	: Hardness factor	(see Fig 1)
f_T	: Temperature factor	(see Fig 2)
f_C	: Contact factor	(see Table 2)

Basic Dynamic Load Rating (C)

The basic dynamic load rating (C) refers to a load in a given direction with given magnitude when identical linear motion systems in a group are interlocked with one another under the same conditions. The nominal life (L) of the systems is 50km (L=50km) if the systems use balls, and 100km(L=100km) if they use rollers. The basic dynamic load rating (C) is used to calculate the service life of a set of linear motion systems which are interlocked with one another in response to a load. For rating values of individual linear motion systems, see the respective specification tables in this catalog.

Nominal Life (L)

The service lives of linear motion systems more or less vary from systems to systems even if they are manufactured under the same specifications, and remain in service under the same operating conditions. Hence a guideline for determining the service life of a linear motion system is given based on nominal life, which is defined as follows. The nominal life refers to the total travel distance that 90% of identical linear motion systems in a group, when interlocked with one another under the same conditions, can achieve without flaking developed.
The nominal life (L) of a linear motion system can be obtained from the basic dynamic load rating (C) and applied load(P) by the following equations:

● For linear motion system with balls

$$L = \left(\frac{C}{P}\right)^3 \times 50 \quad \cdots\cdots (2)$$

$$L_{100} = \left(\frac{C_{100}}{P}\right)^3 \times 100 \quad \cdots\cdots (3)$$

$$C_{100} = \left(\frac{C}{1.26}\right)$$

● For linear motion system with rollers

$$L = \left(\frac{C}{P}\right)^{\frac{10}{3}} \times 100 \quad \cdots\cdots (4)$$

L	: Nominal life of 50km	(km)
L_{100}	: Nominal life of 100km	(km)
C	: Basic dynamic load rating of 50km	(N)
C_{100}	: Basic dynamic load rating of 100km	(N)
P	: Applied load	(N)

However the equation considering the factors which can affect service life is as follows:

Travel Life Equation

The travel life of the linear motion system can be obtained using the following equation :

$$L = \left(\frac{f_H \times f_T \times f_C}{f_W} \times \frac{C}{P}\right)^3 \times 50 \quad \cdots\cdots (5)$$

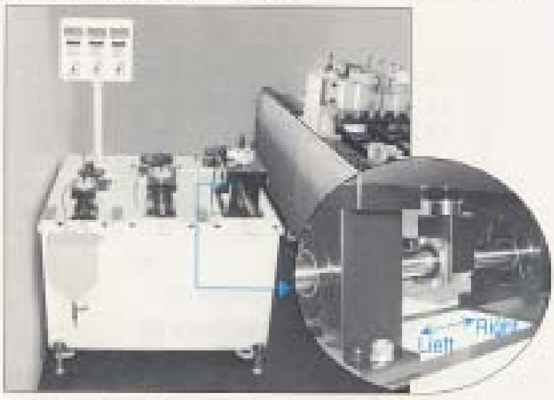
$$L_{100} = \left(\frac{f_H \times f_T \times f_C}{f_W} \times \frac{C_{100}}{P}\right)^3 \times 100 \quad \cdots\cdots (6)$$

L	: Nominal life of 50km	(km)
L_{100}	: Nominal life of 100km	(km)
C	: Basic dynamic load rating of 50km	(N)
C_{100}	: Basic dynamic load rating of 100km	(N)
P	: Calculated load	(N)
f_H	: Hardness factor	(see Fig 1)
f_T	: Temperature factor	(see Fig 2)
f_C	: Contact factor	(see Table 2)
f_W	: Load factor	(see Table 3)

Once nominal life (L) is obtained by using this equation, the Linear Bushing's travel life can be calculated by using the following equation, if the stroke length and the number of strokes per minute are constant :

$$L_h = \frac{L \times 10^6}{2 \times \ell_S \times N_1 \times 60} \quad \cdots\cdots (7)$$

L_h	: travel life in hours	(hr)
ℓ_S	: Stroke	(mm)
N_1	: Number of strokes per minute	(cpm)



Endurance Testing Equipment

Hardness factor (f_H)

To ensure achievement of the optimum load rating of the Linear Bushing, the raceway hardness must be 58 to 64 HRC. In case a hardness is below this range, the basic dynamic and static load ratings are decreased. Therefore the ratings must be multiplied by the respective hardness factors(f_H).

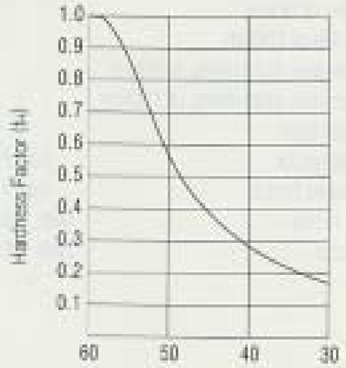


Fig. 1. Hardness Factor (f_H)

Temperature factor (f_T)

For Linear Bushing used at ambient temperatures over 100℃, a temperature factor from the diagram below must be taken into consideration. In addition, please note that the selected Linear Bushing must be a model of high-temperature specifications.

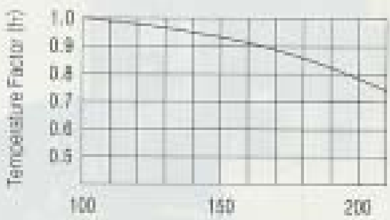


Fig. 2. Temperature Factor (f_T)

Note) For higher than 80℃ application, the seals, end plates, and retainer must be changed for high-temperature specifications.
(Temperature Range : −20℃ ~ 80℃)

Contact factor (f_C)

When multiple Linear Bushings are used laid beside one another, moments or mounting-surface precision will affect operation, therefore it is difficult to achieve uniform load distribution. For using Linear Bushing laid beside one another, it is necessary to multiply the basic load rating (C or Co) by a contact factor selected from the table below.

Table 2. Contact factors (f_C)

Number of Linear Bushings on a shaft	Contact facor (f_C)
2	0.81
3	0.72
4	0.66
5	0.61
6 or more	0.6
In normal use	1.0

Load factor (f_W)

In general, machines in reciprocal motion are likely to cause vibration and impact during operation, and it is particularly difficult to determine the magnitude of vibration during the high-speed operation, as well as that of impact during repeated starting and stopping in normal use. Therefore, where the effects of speed and vibration are estimated to be significant, the basic dynamic load rating(C) has to be devided by a load factor selected from the table below.

Table 3. Load factors (f_W)

Operating conditions	Load factor (f_W)
Low speed operation(V<15m/min) No impact and vibration	1.0~1.5
Medium speed operation(V<60m/min) Slight impact and vibration	1.5~2.0
High speed operation(V>60m/min) Considerable impact and vibration	2.0~4.0

Load Consideration

When designing a linear motion system, it is necessary to consider how the variables of operation will affect the performance.
The following examples demonstrate how the position of the load and the center of gravity can influence the product selection. When evaluating your application, please review each of the forces acting on your system and determine the best product for your needs.

Terms :

d_0 = Distance between centerlines of case unit

d_1 = Distance between centerlines of LM Shaft

d_2 = Distance from centerline of carriage to load action point

d_3 = Distance from centerline of carriage to load action point

W = Load (N)

F_{NX} = Force in the X-axis direction (N)

F_{NY} = Force in the Y-axis direction (N)

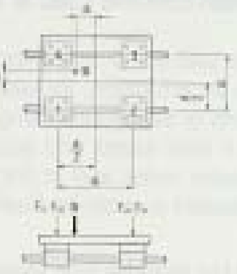
F_{NZ} = Force in the Z-axis direction (N)

$$F_{1Z} = \frac{W}{4} + \left(\frac{W}{2}\cdot\frac{d_2}{d_0}\right) - \left(\frac{W}{2}\cdot\frac{d_3}{d_1}\right)$$

$$F_{2Z} = \frac{W}{4} - \left(\frac{W}{2}\cdot\frac{d_2}{d_0}\right) - \left(\frac{W}{2}\cdot\frac{d_3}{d_1}\right)$$

$$F_{3Z} = \frac{W}{4} - \left(\frac{W}{2}\cdot\frac{d_2}{d_0}\right) + \left(\frac{W}{2}\cdot\frac{d_3}{d_1}\right)$$

$$F_{4Z} = \frac{W}{4} + \left(\frac{W}{2}\cdot\frac{d_2}{d_0}\right) + \left(\frac{W}{2}\cdot\frac{d_3}{d_1}\right)$$



Horizontal Application

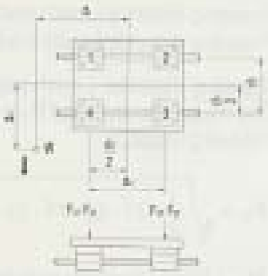
At the time of movement with uniform velocity or at the time of stop.

$$F_{1Z} = \frac{W}{4} + \left(\frac{W}{2}\cdot\frac{d_2}{d_0}\right) - \left(\frac{W}{2}\cdot\frac{d_3}{d_1}\right)$$

$$F_{2Z} = \frac{W}{4} - \left(\frac{W}{2}\cdot\frac{d_2}{d_0}\right) - \left(\frac{W}{2}\cdot\frac{d_3}{d_1}\right)$$

$$F_{3Z} = \frac{W}{4} - \left(\frac{W}{2}\cdot\frac{d_2}{d_0}\right) + \left(\frac{W}{2}\cdot\frac{d_3}{d_1}\right)$$

$$F_{4Z} = \frac{W}{4} + \left(\frac{W}{2}\cdot\frac{d_2}{d_0}\right) + \left(\frac{W}{2}\cdot\frac{d_3}{d_1}\right)$$



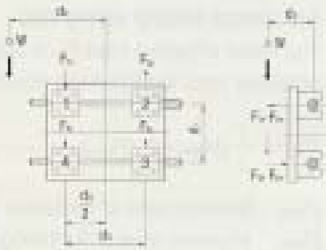
Horizontal Application

At the time of movement with uniform velocity or at the time of stop.

$$F_{1Y} = F_{4Y} = \left(\frac{W}{4}\cdot\frac{d_3}{d_1}\right)$$

$$F_{1Z} = F_{2Z} = \frac{W}{4} + \left(\frac{W}{2}\cdot\frac{d_2}{d_0}\right)$$

$$F_{3Z} = F_{4Z} = \frac{W}{4} - \left(\frac{W}{2}\cdot\frac{d_2}{d_0}\right)$$



Side Mounted Application

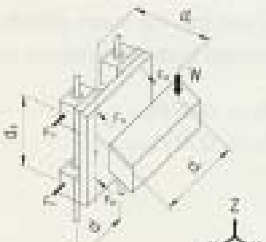
At the time of movement with uniform velocity or at the time of stop.

$$F_{1X} = F_{4X} = \frac{W}{2}\cdot\frac{d_2}{d_0}$$

$$F_{1Y} = F_{4Y} = \frac{W}{2}\cdot\frac{d_3}{d_0}$$

$$F_{1X} + F_{4X} \sim F_{2X} + F_{3X}$$

$$F_{1Y} + F_{4Y} \sim F_{2Y} + F_{3Y}$$



Vertical Application

At the time of movement with uniform velocity or at the time of stop.
At the time of start and stop, the load varies because of inertia.

Mean Effective Load at Varying Load (P_n)

The load acting on a linear system changes depending on the application, for example, when the linear system starts or stops reciprocating motion, while it is operating at a fixed speed, and according to whether the linear system carries work or not. For a fluctuating load, it is important to obtain the mean effective load.

1) For stepwise load according to the traveling distance

Traveling distance L_1 with load P_1
Traveling distance L_2 with load P_2

Traveling distance L_n with load P_n
The mean effective load P_m is obtained from the following equation :

$$P_m = \sqrt[3]{\frac{1}{L}(P_1^3 \cdot L_1 + P_2^3 \cdot L_2 \cdots + P_n^3 \cdot L_n)} \cdots\cdots (1)$$

P_m : Mean effective load in fluctuation (N)
L : Total traveling distance (mm)

2) For almost linearly varing load

The mean effective load P_m is approximately obtained from the following equation :

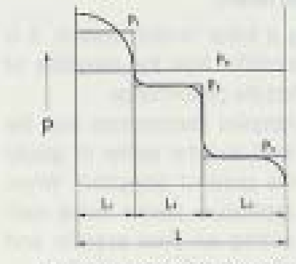
$$P_m \fallingdotseq \frac{1}{3}(P_{min} + 2 \cdot P_{max}) \cdots\cdots (2)$$

P_{min} : Minimum value of fluctuating load (N)
P_{max} : Maximum value of fluctuating load (N)

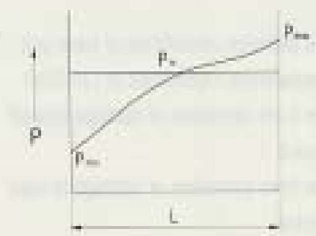
3) When the load draws a sine curve as in (a) or (b)

(a) and (b), the mean effective load P_m is obtained from the following equation :

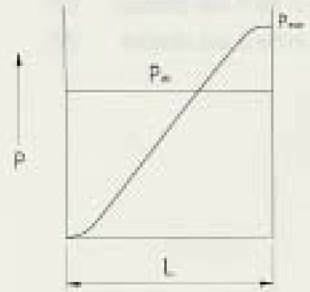
a) $P_m \fallingdotseq 0.65 P_{max}$ ·········· (3)
b) $P_m \fallingdotseq 0.75 P_{max}$ ·········· (4)

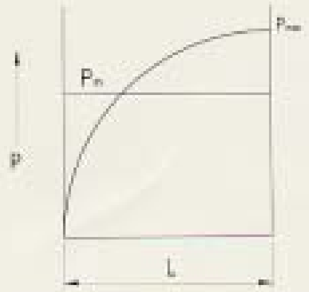


For loads that changes stepwisely



For loads that changes monotonously



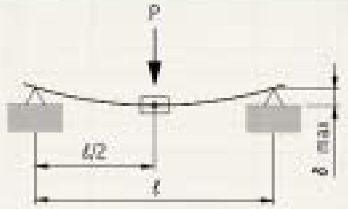
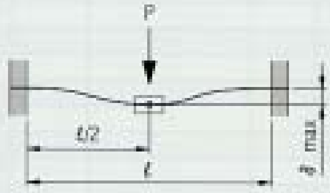
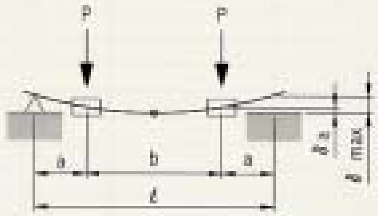
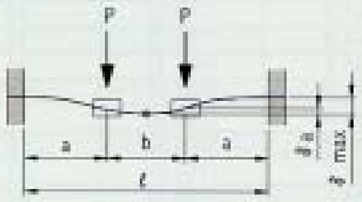
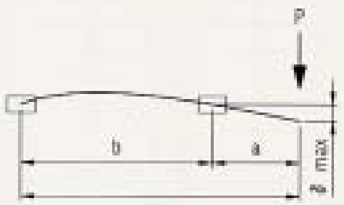


For loads that changes sinusoidally

SAMICK LINEAR BUSHING SYSTEM

References

Equations for shaft deflection amount calculation

Variations of support and Load	Equation for Deflection Amount (mm)
	$\delta_{max} = \dfrac{P \cdot \ell^3}{48 \cdot E \cdot I} = 2.021 \times 10^{-5} \dfrac{P \cdot \ell^3}{d^4}$
	$\delta_{max} = \dfrac{P \cdot \ell^3}{192 \cdot E \cdot I} = 5.053 \times 10^{-6} \dfrac{P \cdot \ell^3}{d^4}$
	$\delta_a = \dfrac{P \cdot a^2}{6 \cdot E \cdot I}(2a+3b) = 1.617 \times 10^{-4} \dfrac{P \cdot a^2(2a+3b)}{d^4}$ $\delta_{max} = \dfrac{P \cdot a}{24 \cdot E \cdot I}(3\ell^2-4a^2) = 4.042 \times 10^{-5} \dfrac{P \cdot a \cdot (3\ell^2-4a^2)}{d^4}$
	$\delta_a = \dfrac{P \cdot a^3}{6 \cdot E \cdot I}(2-\dfrac{3a}{\ell}) = 1.617 \times 10^{-4} \dfrac{P \cdot a^3}{d^4}(2-\dfrac{3a}{\ell})$ $\delta_{max} = \dfrac{P \cdot a^2}{24 \cdot E \cdot I}(2a+3b) = 4.042 \times 10^{-5} \dfrac{P \cdot a^2 \cdot (2a+3b)}{d^4}$
	$\delta_{max} = \dfrac{P \cdot a^2 \ell}{3 \cdot E \cdot I} = 3.234 \times 10^{-4} \dfrac{P \cdot a^2 \ell}{d^4}$

E : Modulus of Longitudinal Elasticity : 2.1×10^4(kgf/mm²)
P : Applying Load (kgf) ;
I : Geometrical Moment of Inertia(mm⁴) ; $I = \pi d^4/64$ for solid shaft,
and $I = \pi (d^4 - d_i^4)/64$ for hollow shaft
[d_i : shaft inside diameter(mm), d : diameter(mm)]

Hardness Conversion Table

Rockwell C Scale HRC	Vickers Hardness Hv	Brinell Hardness HB		Rockwell Hardness		Shore Hardness Hs
		Standard Ball	Tungsten Carbon Ball	HRA A Scale	HRB B Scale	
68	940	–	–	85.6	–	97
67	900	–	–	85.0	–	95
66	865	–	–	84.5	–	92
65	832	–	739	83.9	–	91
64	800	–	722	83.4	–	88
63	772	–	705	82.8	–	87
62	746	–	688	82.3	–	85
61	720	–	670	81.8	–	83
60	697	–	654	81.2	–	81
59	674	–	634	80.7	–	80
58	653	–	615	80.1	–	78
57	633	–	595	79.6	–	76
56	613	–	577	79.0	–	75
55	595	–	560	78.5	–	74
54	577	–	543	78.0	–	72
53	560	–	525	77.4	–	71
52	544	500	512	76.8	–	69
51	528	487	496	76.3	–	68
50	513	475	481	75.9	–	67
49	498	464	469	75.2	–	66
48	484	451	455	74.7	–	64
47	471	442	443	74.1	–	63
46	458	432	432	73.6	–	62
45	446	421	421	73.1	–	60
44	434	409	409	72.5	–	58
43	423	400	400	72.0	–	57
42	412	390	390	71.5	–	56
41	402	381	381	70.9	–	55
40	392	371	371	70.4	–	54
39	382	362	362	69.9	–	52
38	372	353	353	69.4	–	51
37	363	344	344	68.9	–	50
36	354	336	336	68.4	(109.0)	49
35	345	327	327	67.9	(108.5)	48
34	336	319	319	67.4	(108.0)	47
33	327	311	311	66.8	(107.5)	46
32	318	301	301	66.3	(107.0)	44
31	310	294	294	65.8	(106.0)	43
30	302	286	286	65.3	(105.5)	42
29	294	279	279	64.7	(104.5)	41
28	286	271	271	64.3	(104.0)	41
27	279	264	264	63.8	(103.0)	40
26	272	258	258	63.3	(102.5)	38
25	266	253	253	62.8	(101.5)	38
24	260	247	247	62.4	(101.0)	37
23	254	243	243	62.0	100.0	36
22	248	237	237	61.5	99.0	35
21	243	231	231	61.0	98.5	35
20	238	226	226	60.5	97.8	34
(18)	230	219	219	–	96.7	33
(16)	222	212	212	–	95.5	32
(14)	213	203	203	–	93.9	31
(12)	204	194	194	–	92.3	29
(10)	196	187	187	–	90.7	28
(8)	188	179	179	–	89.5	27
(6)	180	171	171	–	87.1	26
(4)	173	165	165	–	85.5	25
(2)	166	158	158	–	83.5	24
0	160	152	152	–	81.7	24

Fitting Tolerances for Shaft and Housing Bore Diameter (Metric Series)

(Unit : μm)

Nominal Diameter (mm)		Tolerance of Shaft Diameter									Tolerance of Housing Bore Diameter															
		f	g	h	js			j		k	H	Js				J			K			M				
over	incl	f5 f6 f7	g5 g6 g7	h5 h6 h7 h8	js5	js6	js7	j5 j6	j7	k5 k6 k7	H5 H6 H7 H8	JS5	JS6	JS7	JS8	J6	J7	J8	K6	K7	K8	M6	M7	M8		
–	3	-6 -10 -12 -16	-2 -6 -8 -12	0 -4 -6 -10 -14	±2	±3	±5	+2 +4 -2	+6 -4	+4 +6 +10 0	+4 +6 +10 +14 0	±2	±3	±5	±7	+2 -4	+4 -6	+6 -8	0 -6	0 -10	0 -14	-2 -8	-2 -12	-2 -16		
3	6	-10 -15 -18 -22	-4 -9 -12 -16	0 -5 -8 -12 -18	±25	±4	±5	+3 +6 -2	+8 -4	+6 +9 +13 +1	+5 +8 +12 +18 0	±25	±4	±6	±9	+5 -3	+6 -6	+10 -8	+2 -6	+3 -9	+5 -14	-1 -9	0 -12	+2 -16		
6	10	-6 -19 -22 -28	-5 -11 -14 -20	0 -6 -9 -5 -22	±3	±45	±7	+4 +7 -2	+10 -5	+7 +10 +16 +1	+6 +9 +15 +22 0	±3	±45	±7	±11	+5 -4	+8 -7	+12 -10	+2 -7	+5 -10	+6 -16	-3 -12	0 -15	+1 -21		
10	14	-16 -24 -27 -34	-6 -14 -17 -24	0 -8 -11 -18 -27	±4	±55	±9	+5 +8 -3	+12 -6	+9 +12 +19 +1	+6 +11 +18 +27 0	±4	±55	±9	±13	+6 -5	+10 -8	+15 -12	+2 -9	+6 -12	+8 -19	-4 -15	0 -18	+2 -25		
14	18																									
18	24	-20 -29 -33 -41	-7 -16 -20 -28	0 -9 -13 -21 -33	±45	±65	±10	+5 +9 -4	+13 -8	+11 +15 +23 +2	+9 +13 +21 +33 0	±45	±65	±10	±16	+8 -5	+12 -9	+20 -13	+2 -11	+6 -15	+10 -23	-4 -17	0 -21	+4 -29		
24	30																									
30	40	-25 -36 -41 -50	-9 -20 -25 -34	0 -11 -16 -25 -39	±55	±8	±12	+6 +11 -5	+15 -10	+13 +18 +27 +2	+11 +16 +25 +39 0	±55	±8	±12	±19	+10 -6	+14 -11	+24 -15	+3 -13	+7 -18	+12 -27	-4 -20	0 -25	+5 -34		
40	50																									
50	65	-30 -43 -49 -60	-10 -23 -29 -40	0 -13 -19 -30 -46	±65	±95	±15	+6 +12 -7	+18 -12	+15 +21 +32 +2	+13 +19 +30 +46 0	±65	±95	±15	±23	+13 -6	+18 -12	+28 -18	+4 -15	+9 -21	+14 -32	-5 -24	0 -30	+5 -41		
65	80																									
80	100	-36 -51 -58 -71	-12 -27 -34 -47	0 -15 -22 -35 -54	±75	±11	±17	+6 +13 -9	+20 -15	+18 +25 +38 +3	+15 +22 +35 +54 0	±75	±11	±17	±27	+16 -6	+22 -13	+34 -20	+4 -18	+10 -25	+16 -38	-6 -28	0 -35	+6 -48		
100	120																									
120	140																									
140	160	-43 -61 -68 -83	-14 -32 -39 -54	0 -18 -25 -40 -63	±9	±125	±20	+7 +14 -11	+22 -18	+21 +28 +43 +3	+18 +25 +40 +63 0	±9	±125	±20	±31	+18 -7	+26 -14	+41 -22	+4 -21	+12 -28	+20 -43	-8 -33	0 -40	+8 -55		
160	180																									

Fitting Tolerances for Shaft and Housing Bore Diameter (Inch Series)

Tolerance of housing bore

	SIZE		H5		H6		H7		H8	
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
Over	0.1181	3	0.0002	0.005	0.0003	0.008	0.0004	0.012	0.0007	0.018
To	0.2362	6	0	0	0	0	0	0	0	0
Over	0.2362	6	0.0002	0.006	0.0003	0.009	0.0003	0.015	0.0008	0.022
To	0.3937	10	0	0	0	0	0	0	0	0
Over	0.3937	10	0.0003	0.008	0.0004	0.011	0.0007	0.018	0.0010	0.027
To	0.7087	18	0	0	0	0	0	0	0	0
Over	0.7087	18	0.0003	0.009	0.0005	0.013	0.0008	0.021	0.0013	0.033
To	1.1811	30	0	0	0	0	0	0	0	0
Over	1.1811	30	0.0004	0.011	0.0006	0.016	0.0009	0.025	0.0015	0.039
To	1.9685	50	0	0	0	0	0	0	0	0
Over	1.9685	50	0.0005	0.013	0.0007	0.019	0.0011	0.030	0.0018	0.046
To	3.1496	80	0	0	0	0	0	0	0	0
Over	3.1496	80	0.0005	0.015	0.0008	0.022	0.0013	0.035	0.0021	0.054
To	4.7244	120	0	0	0	0	0	0	0	0

Tolerance of shaft

	SIZE		g5		g6		g7		h5		h6		h7	
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
Over	0.1181	3	−0.0001	−0.004	−0.0001	−0.004	−0.0001	−0.004	0	0	0	0	0	0
To	0.2362	6	−0.0003	−0.009	−0.0004	−0.012	−0.0006	−0.016	−0.0002	−0.005	−0.0003	−0.008	0.0004	−0.012
Over	0.2362	6	−0.0002	−0.005	−0.0002	−0.005	−0.0002	−0.005	0	0	0	0	0	0
To	0.3937	10	−0.0004	−0.011	−0.0005	−0.014	−0.0007	−0.020	−0.0002	−0.006	−0.0003	−0.009	−0.0006	−0.015
Over	0.3937	10	−0.0002	−0.006	−0.0002	−0.006	−0.0002	−0.006	0	0	0	0	0	0
To	0.7087	18	−0.0005	−0.014	−0.0006	−0.017	−0.0009	−0.024	−0.0003	−0.008	−0.0004	−0.011	−0.0007	−0.018
Over	0.7087	18	−0.0002	−0.007	−0.0002	−0.007	−0.0002	−0.007	0	0	0	0	0	0
To	1.1811	30	−0.0006	−0.016	−0.0007	−0.020	−0.0011	−0.028	−0.0003	−0.009	−0.0005	−0.013	−0.0008	−0.021
Over	1.1811	30	−0.0003	−0.009	−0.0003	−0.009	−0.0003	−0.009	0	0	0	0	0	0
To	1.9685	50	−0.0007	−0.020	−0.0009	−0.025	−0.0013	−0.034	−0.0004	−0.011	−0.0006	−0.016	−0.0009	−0.025
Over	1.9685	50	−0.0004	−0.010	−0.0004	−0.010	−0.0004	−0.010	0	0	0	0	0	0
To	3.1496	80	−0.0009	−0.023	−0.0011	−0.029	−0.0015	−0.04	−0.0005	−0.013	−0.0007	−0.019	−0.011	−0.030
Over	3.1496	80	−0.0004	−0.012	−0.004	−0.012	−0.0004	−0.012	0	0	0	0	0	0
To	4.7244	120	−0.00010	−0.027	−0.0013	−0.034	−0.0018	−0.047	−0.0006	−0.015	−0.0008	−0.022	−0.0013	−0.035