

## Cylinders' theoretic force



unit : N

Bore (mm)		12	16	20	25	32	40	50	63	80	100	125	160	
Rod (mm)		6	6	8	10	12	16	20	20	25	25	32	40	
Area (mm <sup>2</sup> )	A	113	201	314	491	804	1257	1963	3117	5027	7854	12271	20106	
	B	85	173	264	412	691	1056	1649	2803	4536	7363	11468	18850	
Operating pressure (MPa)	0.1	A	11	20	31	49	80	126	196	312	502	785	1227	2011
		B	8.5	17	26	41	69	106	165	280	453	736	1147	1885
	0.2	A	23	40	63	98	161	251	393	623	1005	1571	2454	4021
		B	17	35	53	82	138	211	330	561	907	1473	2294	3770
	0.3	A	34	60	94	147	241	377	589	935	1508	2356	3681	6032
		B	25	52	79	124	207	317	495	841	1361	2209	3440	5655
	0.4	A	45	80	126	196	322	503	785	1247	2011	3142	4908	8042
		B	34	69	106	165	276	422	660	1121	1814	2945	4587	7540
	0.5	A	57	101	157	245	402	629	982	1559	2514	3927	6135	10053
		B	42	87	132	206	346	528	825	1402	2268	3682	5734	9425
	0.6	A	68	121	189	294	482	754	1178	1870	3016	4712	7363	12064
		B	51	104	158	247	415	634	989	1682	2722	4418	6881	11310
	0.7	A	79	141	220	343	563	880	1374	2182	3519	5498	8589	14074
		B	59	121	185	289	484	739	1154	1962	3175	5154	8027	13195
	0.8	A	90	161	251	393	643	1006	1570	2494	4022	6283	9816	16085
		B	68	138	211	330	553	845	1319	2242	3629	5890	9174	15080
	0.9	A	102	181	283	442	724	1131	1767	2805	4524	7069	11043	18096
		B	76	155	238	371	622	950	1484	2523	4082	6627	10321	16965
	1.0	A	113	201	314	491	804	1257	1963	3117	5027	7854	12271	20106
		B	85	173	264	412	691	1056	1649	2803	4536	7363	11468	18850

• For the actual output force of pneumatic cylinders, please refer to the aforesaid figure and multiply it by the safety factor (60%~70% is suggested).

## The method of calculation (Cylinders' force)

$$F = P \times A - f$$

F: Cylinders' force (N)

P: Air pressure (MPa)

 A: Piston area (mm<sup>2</sup>)

## Varied Pressure Interchange Chart

	Pa	kPa	Mpa	bar	mbar	kgf/cm <sup>2</sup>	cmH <sub>2</sub> O	mmH <sub>2</sub> O	mmHg	p.s.i.
Pa	1	10 <sup>-3</sup>	10 <sup>-6</sup>	10 <sup>-5</sup>	10 <sup>-2</sup>	10.2 × 10 <sup>-3</sup>	10.2 × 10 <sup>-3</sup>	101.97 × 10 <sup>-3</sup>	7.5 × 10 <sup>-3</sup>	0.15 × 10 <sup>-3</sup>
kPa	10 <sup>3</sup>	1	10 <sup>-3</sup>	10 <sup>-2</sup>	10	10.2 × 10 <sup>-3</sup>	10.2	101.97	7.5	0.15
Mpa	10 <sup>6</sup>	10 <sup>3</sup>	1	10	10 <sup>4</sup>	10.2	10.2 × 10 <sup>3</sup>	101.97 × 10 <sup>3</sup>	7.5 × 10 <sup>3</sup>	0.15 × 10 <sup>3</sup>
bar	10 <sup>5</sup>	10 <sup>2</sup>	10 <sup>-1</sup>	1	10 <sup>3</sup>	1.02	1.02 × 10 <sup>3</sup>	10.2 × 10 <sup>3</sup>	750.06	14.5
mbar	10 <sup>2</sup>	10 <sup>-1</sup>	10 <sup>-4</sup>	10 <sup>-3</sup>	1	1.02 × 10 <sup>-3</sup>	1.02	10.2	0.75	14.5 × 10 <sup>-3</sup>
kgf/cm <sup>2</sup>	98066.5	98.07	98.07 × 10 <sup>-3</sup>	0.98	980.67	1	1000	10000	735.56	14.22
cmH <sub>2</sub> O	98.0665	98.07 × 10 <sup>-3</sup>	98.07 × 10 <sup>-6</sup>	0.98 × 10 <sup>-3</sup>	0.98	10 <sup>-3</sup>	1	10	0.74	14.22 × 10 <sup>-3</sup>
mmH <sub>2</sub> O	9.80665	9.807 × 10 <sup>-3</sup>	9.807 × 10 <sup>-6</sup>	9.807 × 10 <sup>-6</sup>	98.07 × 10 <sup>-3</sup>	10 <sup>-4</sup>	0.1	1	73.56 × 10 <sup>-3</sup>	1.42 × 10 <sup>-3</sup>
mmHg	133.32	133.32 × 10 <sup>-3</sup>	133.32 × 10 <sup>-6</sup>	1.33 × 10 <sup>-3</sup>	1.33	1.36 × 10 <sup>-3</sup>	1.36	13.6	1	19.34 × 10 <sup>-3</sup>
p.s.i.	6894.76	6.89	6.89 × 10 <sup>-3</sup>	68.95 × 10 <sup>-3</sup>	68.95	70.31 × 10 <sup>-3</sup>	70.31	703.07	51.71	1

## Compressed air consumption



unit : l/min

Bore (mm)	12	16	20	25	32	40	50	63	80	100	125	160	
Rod (mm)	6	6	8	10	12	16	20	20	25	25	32	40	
Area (mm <sup>2</sup> )	A	113	201	314	491	804	1257	1963	3117	5027	7854	12271	20106
	B	85	173	264	412	691	1056	1649	2803	4536	7363	11468	18850
Operating pressure (MPa)	0.1	0.040	0.075	0.116	0.181	0.299	0.462	0.722	1.183	1.912	3.042	4.724	7.753
	0.2	0.059	0.112	0.173	0.271	0.448	0.693	1.083	1.775	2.867	4.563	7.075	11.610
	0.3	0.079	0.150	0.231	0.361	0.598	0.924	1.444	2.367	3.823	6.084	9.425	15.467
	0.4	0.099	0.187	0.289	0.451	0.747	1.156	1.805	2.959	4.779	7.605	11.776	19.324
	0.5	0.119	0.224	0.347	0.542	0.897	1.387	2.167	3.550	5.734	9.126	14.126	23.181
	0.6	0.138	0.262	0.405	0.632	1.046	1.618	2.528	4.142	6.690	10.647	16.477	27.038
	0.7	0.158	0.299	0.463	0.722	1.196	1.849	2.889	4.734	7.646	12.168	18.827	30.895
	0.8	0.178	0.336	0.520	0.812	1.345	2.080	3.250	5.325	8.602	13.689	21.177	34.752
	0.9	0.198	0.374	0.578	0.903	1.495	2.311	3.611	5.917	9.557	15.209	23.528	38.609
	1.0	0.218	0.411	0.636	0.993	1.644	2.542	3.972	6.509	10.513	16.927	25.878	42.466

● The table is for a complete cycle in 100mm stroke

## The method of calculation (Compressed air consumption)

$$Qn = (Aa + Ab) \times L \times \frac{P + 0.101}{0.101} \times n \times 10^{-6}$$

Qn: Compressed air consumption (l/min)

 Aa: Piston area of A (mm<sup>2</sup>)

 Ab: Piston area of B (mm<sup>2</sup>)

L: Stroke of cylinder (mm)

P: Air pressure (MPa)

n: Cycle of operation (cycle/min)

## Varied Flow Rate Interchange Chart

	m <sup>3</sup> /s	l/s	cm <sup>3</sup> /s	m <sup>3</sup> /h	m <sup>3</sup> /min	l/h	l/min	ft <sup>3</sup> /min (scfm)	gallon min UK	gallon min USA
m <sup>3</sup> /s	1	10 <sup>3</sup>	10 <sup>6</sup>	3.6 × 10 <sup>6</sup>	60	3.6 × 10 <sup>5</sup>	60 × 10 <sup>3</sup>	2.12 × 10 <sup>3</sup>	13.2 × 10 <sup>3</sup>	15.85 × 10 <sup>3</sup>
l/s	10 <sup>-3</sup>	1	10 <sup>3</sup>	3.6	60 × 10 <sup>-3</sup>	3.6 × 10 <sup>3</sup>	60	2.12	13.2	15.85
cm <sup>3</sup> /s	10 <sup>-6</sup>	10 <sup>-3</sup>	1	3.6 × 10 <sup>-3</sup>	60 × 10 <sup>-6</sup>	3.6	60 × 10 <sup>-3</sup>	2.12 × 10 <sup>-3</sup>	13.2 × 10 <sup>-3</sup>	15.85 × 10 <sup>-3</sup>
m <sup>3</sup> /h	0.28 × 10 <sup>-3</sup>	0.28	0.28 × 10 <sup>3</sup>	1	16.67 × 10 <sup>-3</sup>	10 <sup>3</sup>	16.67	0.59	3.67	4.4
m <sup>3</sup> /min	16.67 × 10 <sup>-3</sup>	16.67	16.67 × 10 <sup>3</sup>	60	1	60 × 10 <sup>3</sup>	10 <sup>3</sup>	35.31	219.97	264.17
l/h	0.28 × 10 <sup>-6</sup>	0.28 × 10 <sup>-3</sup>	0.28	10 <sup>-3</sup>	16.67 × 10 <sup>-6</sup>	1	16.67 × 10 <sup>-3</sup>	0.59 × 10 <sup>-3</sup>	3.67 × 10 <sup>-3</sup>	4.4 × 10 <sup>-3</sup>
l/min	16.67 × 10 <sup>-6</sup>	16.67 × 10 <sup>-3</sup>	16.67	60 × 10 <sup>-3</sup>	10 <sup>-3</sup>	60	1	35.31 × 10 <sup>-3</sup>	219.97 × 10 <sup>-3</sup>	264 × 10 <sup>-3</sup>
ft <sup>3</sup> /min (scfm)	0.47 × 10 <sup>-3</sup>	0.47	0.47 × 10 <sup>3</sup>	1.699	28.32 × 10 <sup>-3</sup>	1.699 × 10 <sup>3</sup>	28.32	1	6.23	7.48
gallon min UK	75.79 × 10 <sup>-6</sup>	75.77 × 10 <sup>-3</sup>	75.77	0.273	4.55 × 10 <sup>-3</sup>	0.273 × 10 <sup>3</sup>	4.55	0.16	1	1.2
gallon min USA	63.09 × 10 <sup>-6</sup>	63.09 × 10 <sup>-3</sup>	63.09	0.227	3.79 × 10 <sup>-3</sup>	0.227 × 10 <sup>3</sup>	3.79	0.13	0.83	1

## Buckling Calculation

The calculations for buckling are carried out as follows

Calculation according to Tetmajer's formula:

$$F = \frac{d^2 \cdot \pi (329 - 0.61 \cdot \lambda)}{4 \cdot \nu}, \text{ if } \lambda \leq Cc$$

Calculation according to Euler's formula:

$$F = \frac{\pi^2 \cdot E \cdot I}{\nu \cdot L_e^2}, \text{ if } \lambda > Cc$$

Example: **DHB50N100CA+Y** can receive max. allowable load

1. Calculation of fixed length:

$$L = \frac{(2 \cdot 1000) + 219 + 60}{\text{Stroke}} = 2279$$

2. Mounting model each column as a Pinned-pinned column, for details see page 28 , the allowable load is:

$$W = 1.9 \text{ kN} (= 195 \text{ kgf})$$

F: Load (N)

E: Modulus of elasticity (N/mm<sup>2</sup>)

I: Moment of inertia (mm<sup>4</sup>)

for circular cross-sectional area,

$$I = \frac{d^4 \cdot \pi}{64}$$

$\nu$ : Safety factor  $\nu = 4.5$

$L_e$ : Effective buckling length (mm)

(depending on mounting model, see drawing A.B.C)

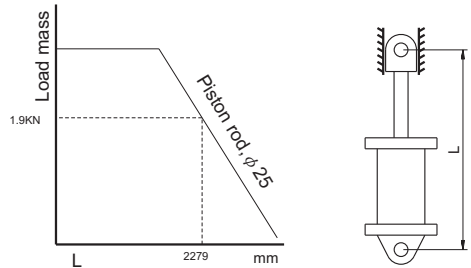
d: Piston rod (mm)

$\lambda$ : Slenderness ratio

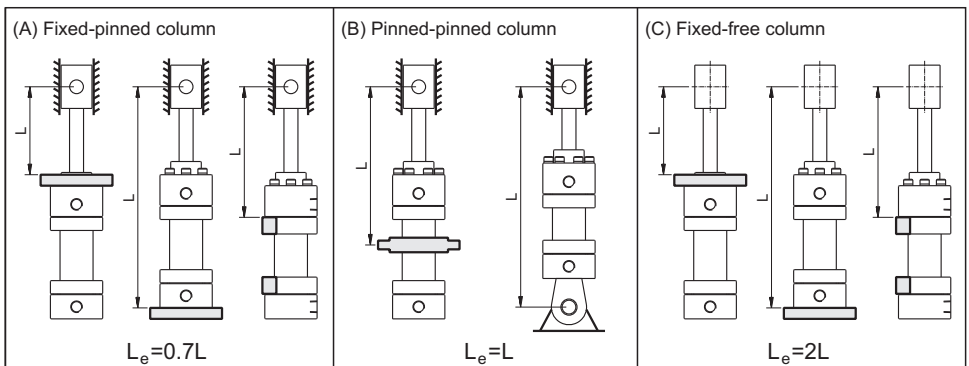
$$\lambda = \frac{4 \cdot L_e}{d}, Cc = \sqrt{\frac{\pi^2 \cdot E}{0.8 \cdot \sigma_y}}$$

Cc: Critical slenderness ratio

$\sigma_y$ : Yield strength of piston rod material (N/mm<sup>2</sup>)

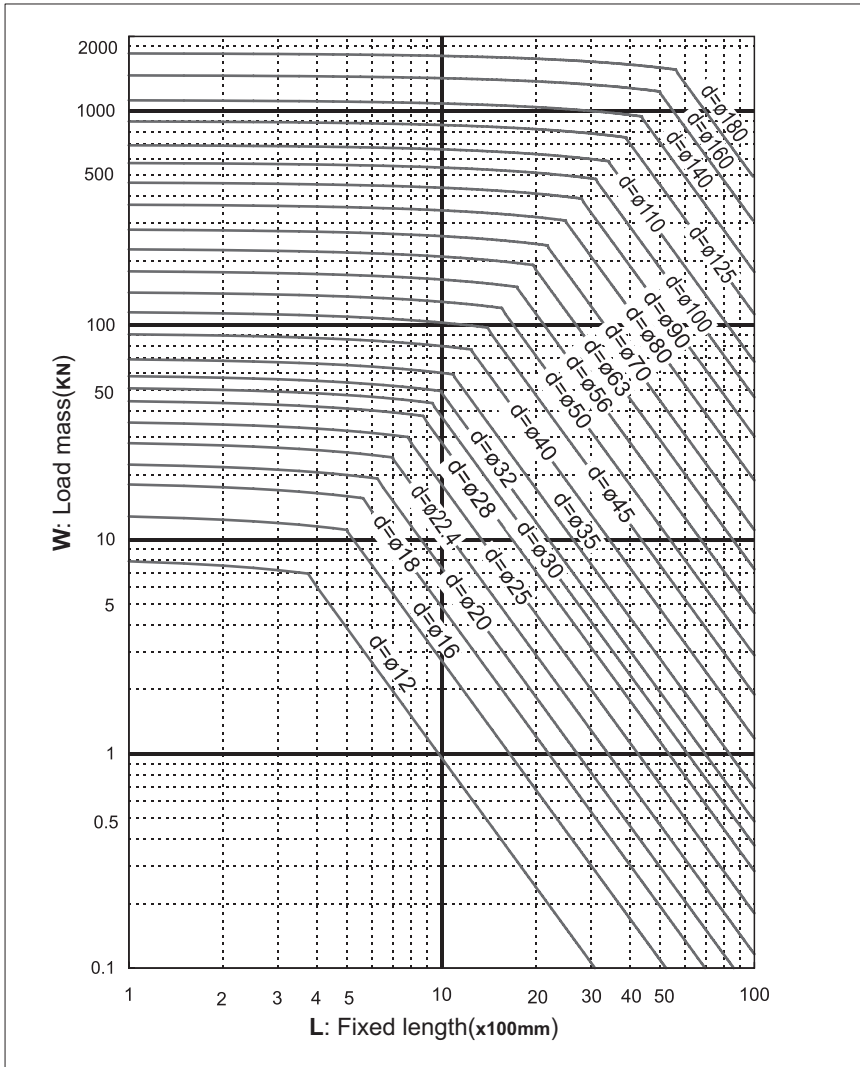
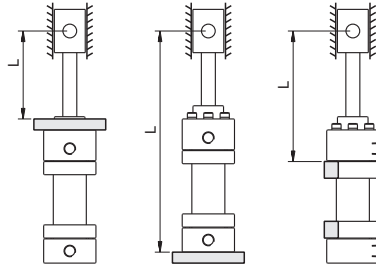


## Mounting model



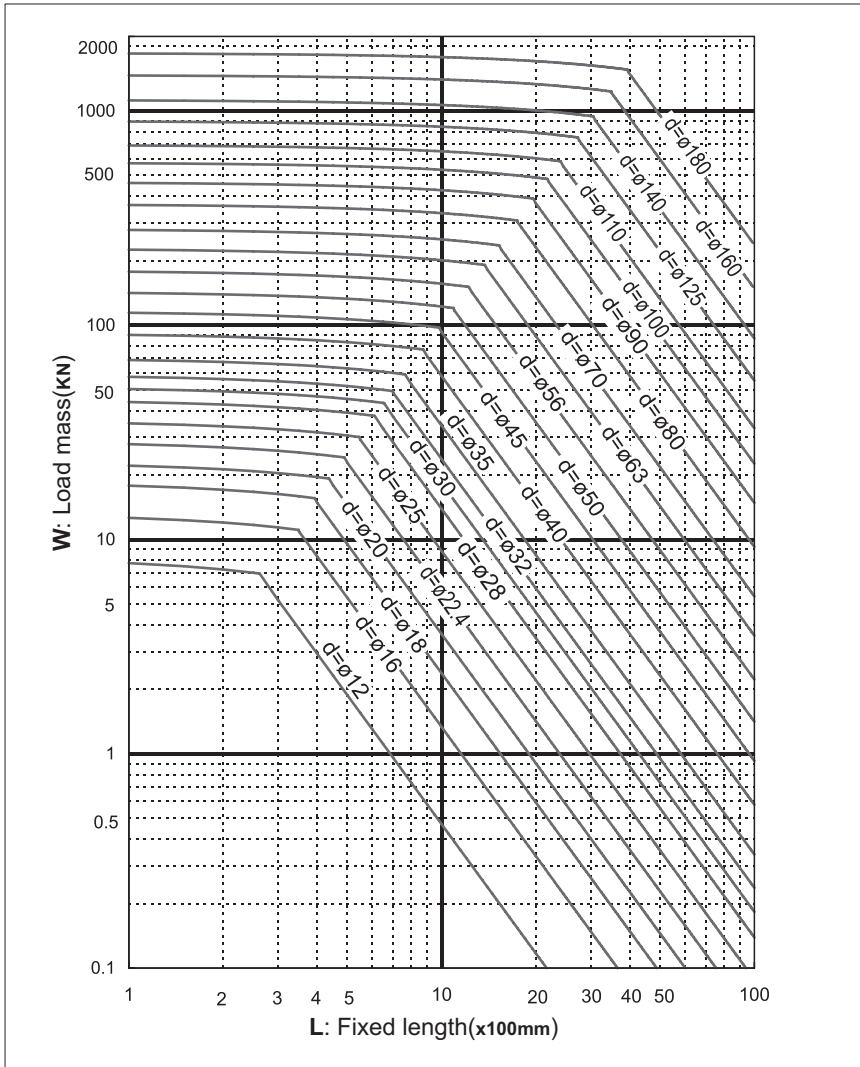
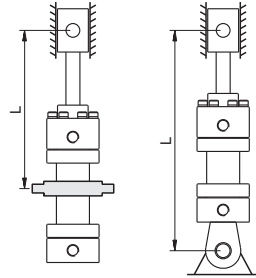
Buckling of a column due to allowable loads of piston rod:

- Fixed-pinned column (FA,FB,LA,LB)



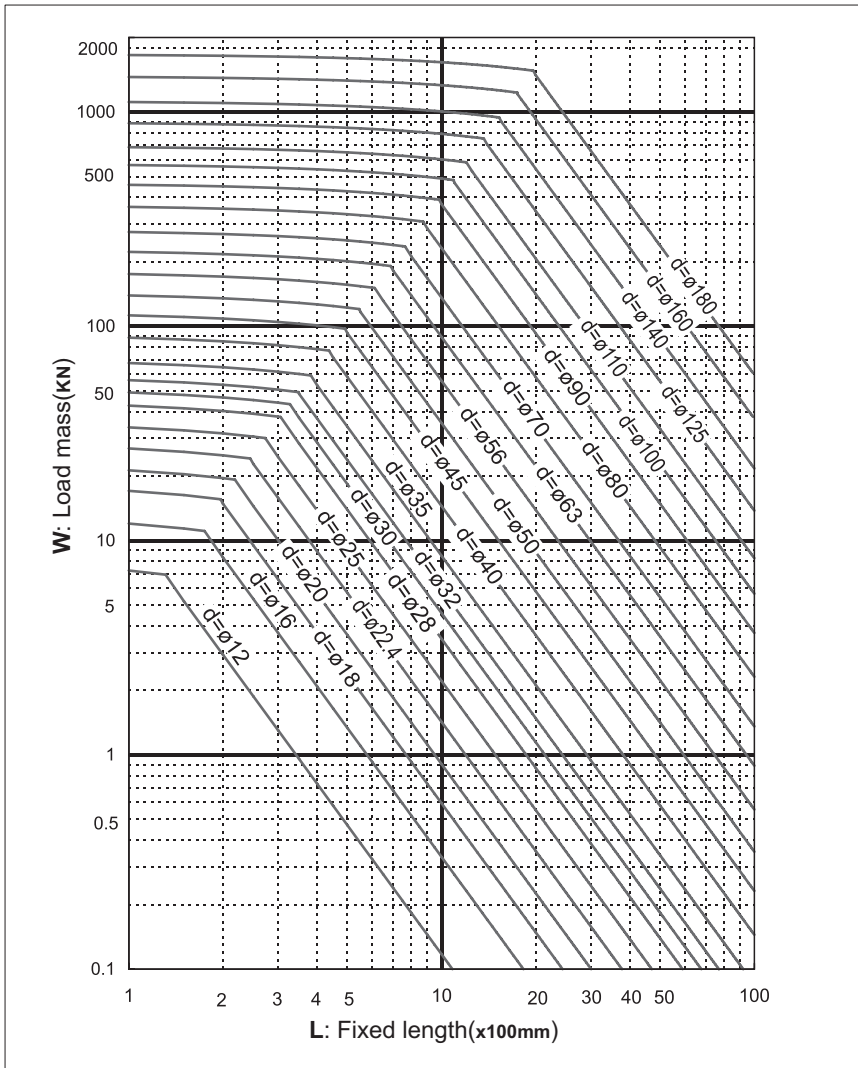
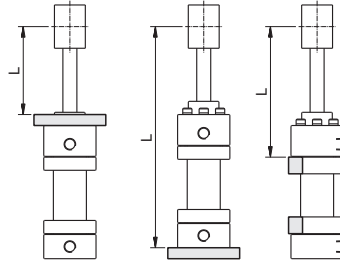
Buckling of a column due to allowable loads of piston rod:

- Pinned-pinned column (TC,CG,CA,CB)

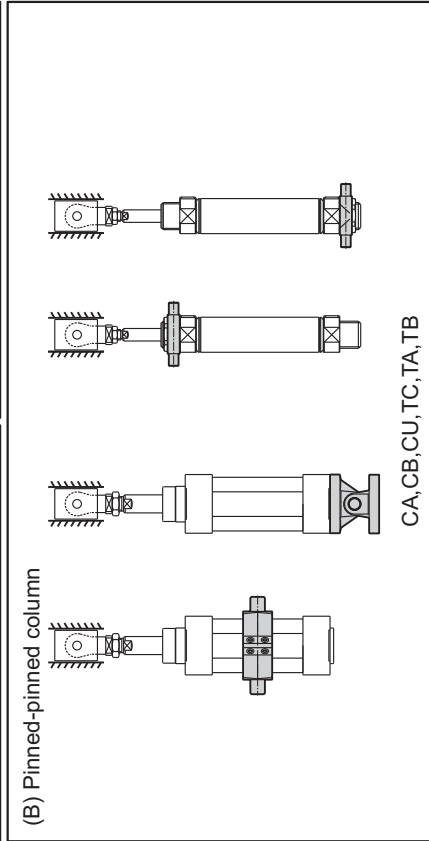
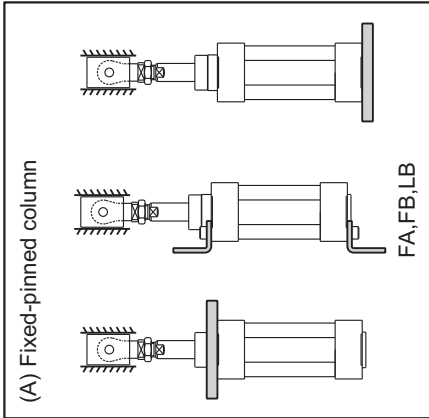
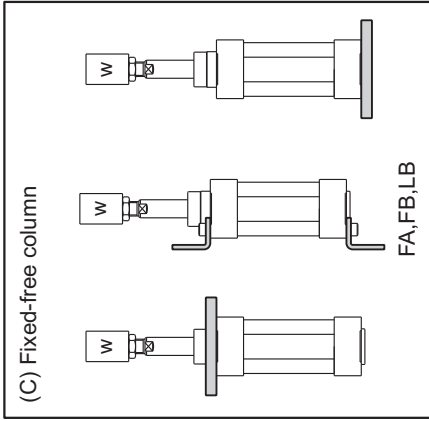


Buckling of a column due to allowable loads of piston rod:

- Fixed-free column (FA,FB,LA,LB)







Series	D	BNB-HK													
		$\phi$ 32	$\phi$ 40	$\phi$ 50	$\phi$ 63	$\phi$ 80	$\phi$ 100	$\phi$ 120	$\phi$ 150	$\phi$ 200	$\phi$ 250				
Model	MPa	$\phi$ 12	$\phi$ 16	$\phi$ 20	$\phi$ 25	$\phi$ 32	$\phi$ 40	$\phi$ 50	$\phi$ 63	$\phi$ 80	$\phi$ 100	$\phi$ 120	$\phi$ 150	$\phi$ 200	$\phi$ 250
(A)	0.3	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
FA,LB	0.5	1477	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
	0.7	1248	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
(A)	0.3	881	1283	1500	1237	1500	1181	869	964	1210	921	1143	869	964	1210
FB	0.5	656	964	1210	921	1143	869	964	1210	921	1143	869	964	1210	921
	0.7	537	794	997	752	936	703	794	997	752	936	703	794	997	752
(B)	0.3	576	851	1070	806	1005	754	851	1070	806	1005	754	851	1070	806
CA,CB	0.5	419	627	791	584	732	535	627	791	584	732	535	627	791	584
	0.7	335	508	642	466	587	419	508	642	466	587	419	508	642	466
(C)	0.3	671	962	1203	947	1165	918	962	1203	947	1165	918	962	1203	947
FA,LB	0.5	514	738	923	725	892	699	738	923	725	892	699	738	923	725
	0.7	441	629	787	619	763	599	629	787	619	763	599	629	787	619
(C)	0.3	273	411	522	388	490	362	411	522	388	490	362	411	522	388
FB	0.5	195	299	382	277	353	253	299	382	277	353	253	299	382	277
	0.7	153	239	308	218	281	195	239	308	218	281	195	239	308	218
(B)	0.3	841	1219	1500	1183	1461	1132	1219	1500	1183	1461	1132	1219	1500	1183
TC	0.5	632	921	1156	888	1097	840	921	1156	888	1097	840	921	1156	888
	0.7	520	763	958	730	904	686	763	958	730	904	686	763	958	730

Series	D	BNK													
		$\phi$ 32	$\phi$ 40	$\phi$ 50	$\phi$ 63	$\phi$ 80	$\phi$ 100	$\phi$ 120	$\phi$ 150	$\phi$ 200	$\phi$ 250				
Model	MPa	$\phi$ 12	$\phi$ 16	$\phi$ 20	$\phi$ 25	$\phi$ 32	$\phi$ 40	$\phi$ 50	$\phi$ 63	$\phi$ 80	$\phi$ 100	$\phi$ 120	$\phi$ 150	$\phi$ 200	$\phi$ 250
(A)	0.3	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
FA,LB	0.5	1485	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
	0.7	1246	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
(A)	0.3	850	1255	1500	1207	1500	1135	1184	890	1108	824	1184	890	1108	824
FB	0.5	625	936	1184	890	1108	824	936	1184	890	1108	824	936	1184	890
	0.7	506	766	971	722	901	658	766	971	722	901	658	766	971	722
(B)	0.3	554	832	1054	786	982	721	832	1054	786	982	721	832	1054	786
CA,CB	0.5	397	608	775	565	709	503	608	775	565	709	503	608	775	565
	0.7	313	489	626	447	564	387	489	626	447	564	387	489	626	447
(C)	0.3	679	974	1220	962	1187	943	974	1220	962	1187	943	974	1220	962
FA,LB	0.5	522	750	940	740	914	724	750	940	740	914	724	750	940	740
	0.7	439	631	792	622	769	608	631	792	622	769	608	631	792	622
(C)	0.3	242	383	496	358	455	317	383	496	358	455	317	383	496	358
FB	0.5	164	271	356	247	318	207	271	356	247	318	207	271	356	247
	0.7	122	211	282	188	246	149	211	282	188	246	149	211	282	188
(B)	0.3	798	1177	1500	1131	1402	1062	1177	1500	1131	1402	1062	1177	1500	1131
TC	0.5	588	879	1108	836	1038	770	879	1108	836	1038	770	879	1108	836
	0.7	477	720	910	679	845	616	720	910	679	845	616	720	910	679



Unit: mm

## All series of allowable stroke lengths: Allowable stroke lengths at ..

Series	DO					DX • DW					DM					DH								
	φ 20	φ 32	φ 40	φ 50	φ 63	φ 80	φ 100	φ 40	φ 50	φ 63	φ 80	φ 100	φ 40	φ 50	φ 63	φ 80	φ 100	φ 40	φ 50	φ 63	φ 80	φ 100	φ 125	φ 150
Model	MPa	φ 12	φ 16	φ 22.4	φ 22.4	φ 28	φ 35	φ 20	φ 25	φ 35	φ 40	φ 50	φ 20	φ 25	φ 35	φ 40	φ 50	φ 20	φ 25	φ 35	φ 40	φ 50	φ 60	φ 80
	MPa	3.5	800	961	1200	933	1122	1421	1192	1200	1600	1600	2000	1192	1200	1600	1600	2000	1192	1200	1600	1600	2000	2000
(A)	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
FA	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
FA/LB/LA	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(A)	7	386	421	427	555	419	506	539	687	1120	1148	1453	539	687	1120	1148	1453	539	687	1120	1148	1453	1674	2000
	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
FB	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(B)	7	242	261	267	355	260	307	331	428	722	733	934	331	428	722	733	934	331	428	722	733	934	1072	1678
	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CA, CB	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(C)	7	305	332	328	421	327	397	400	508	816	836	1049	400	508	816	836	1049	400	508	816	836	1049	1207	1826
	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
FA/LB/LA	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(C)	7	103	106	118	82	164	116	143	190	341	346	445	143	190	341	346	445	143	190	341	346	445	516	815
	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
FB	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(B)	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TC	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Series	DK					DK					DK					DK								
	φ 50	φ 63	φ 80	φ 100	φ 125	φ 160	φ 200	φ 250	φ 315	φ 400	φ 500	φ 630	φ 800	φ 1000	φ 1250	φ 1600	φ 2000	φ 250	φ 315	φ 400	φ 500	φ 630	φ 800	φ 1000
Model	MPa	φ 28	φ 32	φ 36	φ 40	φ 45	φ 56	φ 63	φ 70	φ 70	φ 70	φ 70	φ 70	φ 70	φ 70	φ 70	φ 70	φ 80	φ 90	φ 90	φ 100	φ 110	φ 110	φ 125
	MPa	16	864	1139	1469	1142	1417	1826	1409	1746	2000	1749	2234	2798	2200	2887	3000	2848	2887	3000	2458	3000	3000	3000
(A)	21	743	982	1269	984	1222	1579	1214	1505	1926	1507	1928	2420	1898	2493	3000	2458	3000	2458	3000	2458	3000	3000	3000
FA	25	674	891	1155	893	1110	1437	1103	1367	1753	1369	1753	2204	1725	2266	2926	2235	2780	2235	2780	2235	2780	3000	3000
(A)	16	774	1049	1379	1042	1317	1726	1290	1627	2000	1611	2096	2660	2045	2732	3000	2636	3000	2636	3000	2636	3000	3000	3000
	21	653	892	1179	884	1122	1479	1095	1386	1807	1369	1790	2282	1743	2338	3000	2246	2844	2246	2844	2246	2844	3000	3000
LA	25	584	801	1065	793	1010	1337	984	1248	1634	1231	1615	2066	1570	2111	2771	2023	2568	2023	2568	2023	2568	3000	3000
(A)	16	311	448	613	435	572	777	553	721	962	705	948	1250	903	1247	1659	997	1296	997	1296	997	1296	1430	1939
	21	250	370	513	356	475	653	455	601	811	584	795	1041	752	1050	1409	936	1266	936	1266	936	1266	1643	1939
FB	25	216	324	456	310	419	582	400	532	725	515	707	933	666	936	1266	885	1158	885	1158	885	1158	1476	1664
(B)	16	148	242	358	223	317	460	291	406	574	385	541	749	502	736	1025	676	913	676	913	676	913	1149	1449
	21	106	187	288	167	248	373	223	322	469	300	444	617	396	598	850	539	744	539	744	539	744	987	939
CG	25	82	155	248	136	209	323	184	273	408	252	383	541	336	519	750	461	647	461	647	461	647	870	544
(C)	16	311	413	528	412	514	657	509	635	804	634	810	1008	796	1050	1339	1034	1286	1034	1286	1034	1286	1564	1612
	21	269	358	458	356	446	571	441	551	698	549	703	876	690	912	1164	898	1118	898	1118	898	1118	1360	1075
FA	25	245	326	418	325	406	521	402	503	638	501	642	800	630	833	1064	819	1021	819	1021	819	1021	1244	982

Series	DK																				
	φ 50	φ 50	φ 50	φ 63	φ 63	φ 63	φ 80	φ 80	φ 80	φ 100	φ 100	φ 100	φ 125	φ 125	φ 125	φ 160	φ 160	φ 200			
Model	MPa	D	φ 32	φ 36	φ 40	φ 45	φ 56	φ 56	φ 63	φ 70	φ 70	φ 70	φ 80	φ 80	φ 90	φ 100	φ 110	φ 110	φ 125		
(C)	16	221	323	438	312	414	557	390	516	685	496	672	870	641	895	1184	822	1074	1352	988	1361
LA	25	179	268	368	256	346	471	322	432	579	411	565	738	535	757	1009	686	906	1148	824	1151
(C)	16	34	85	143	70	121	192	103	166	250	148	236	335	201	328	473	285	411	550	344	531
FB	25	13	58	108	42	67	124	69	124	197	105	182	269	148	259	385	217	327	448	262	426
(B)	16	296	421	575	412	538	728	520	672	897	661	883	1146	842	1155	1576	1109	1425	1796	1332	1796
TC	25	239	348	482	338	446	613	429	560	756	548	740	970	702	971	1343	927	1200	1524	1114	1516
(A)	16	207	305	429	296	394	546	376	496	676	484	658	869	621	866	1209	822	1071	1368	989	1355

Series	DK															
	φ 140	φ 140	φ 140	φ 160	φ 180	φ 250	φ 250	φ 250	φ 250	φ 250	φ 250	φ 250	φ 250	φ 250	φ 250	φ 250
Model	MPa	D	φ 140	φ 140	φ 140	φ 160	φ 180	φ 250	φ 250	φ 250	φ 250	φ 250	φ 250	φ 250	φ 250	φ 250
(A)	16	3000	3837	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
FA	25	3000	3491	4604	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
(A)	16	3000	3193	4306	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
LA	25	3000	2596	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421	3421
(A)	16	2164	1592	2202	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921	2921
FB	25	1948	1419	1976	2635	2635	2635	2635	2635	2635	2635	2635	2635	2635	2635	2635
(B)	16	1571	1082	1566	2143	2143	2143	2143	2143	2143	2143	2143	2143	2143	2143	2143
CG	25	1307	870	1290	1793	1793	1793	1793	1793	1793	1793	1793	1793	1793	1793	1793
(C)	16	2034	1613	2122	2699	2699	2699	2699	2699	2699	2699	2699	2699	2699	2699	2699
FA	25	1770	1402	1846	2350	2350	2350	2350	2350	2350	2350	2350	2350	2350	2350	2350
(C)	16	1783	1315	1824	2401	2401	2401	2401	2401	2401	2401	2401	2401	2401	2401	2401
LA	25	1519	1104	1548	2052	2052	2052	2052	2052	2052	2052	2052	2052	2052	2052	2052
(C)	16	742	480	735	1023	1023	1023	1023	1023	1023	1023	1023	1023	1023	1023	1023
FB	25	610	375	597	849	849	849	849	849	849	849	849	849	849	849	849
(B)	16	2358	1764	2410	3179	3179	3179	3179	3179	3179	3179	3179	3179	3179	3179	3179
TC	25	2006	1482	2042	2713	2713	2713	2713	2713	2713	2713	2713	2713	2713	2713	2713
(A)	16	1804	1321	1830	2446	2446	2446	2446	2446	2446	2446	2446	2446	2446	2446	2446

(A) Fixed-pinned column

(B) Pinned-pinned column

(C) Fixed-free column

FA,FB,LA

CA,CB,CG,TC

FA,FB,LA,LA