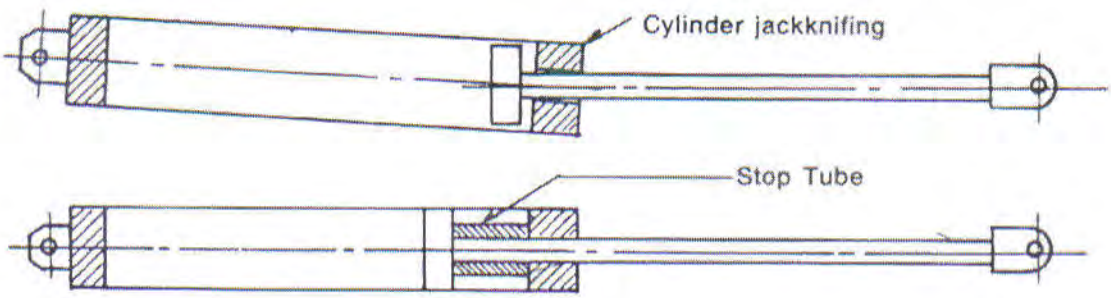
Stop Tube

In long cylinders which are pushing a load, internal stop tubes are used to prevent excessive bearing wear and jackknifing of the cylinder. They are installed between the piston and the head, providing additional bearing support by increasing the distance between the piston and the head in the fully extended position.

For long, trouble free bearing service, the bearing loads should not exceed about 200 psi. Standard cylinders are not designed for heavy eccentric loads.

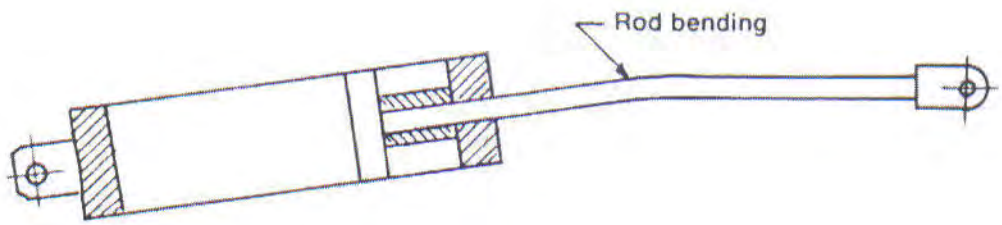
The use of oversize rods to reduced bearing loads is not recommended. They are not as effective as stop tubes, and if misalignment occurs the additional rod stiffness will actually increase bearing loads. For long push stroke cylinders, a stop tube may be required to limit radial bearing loads to a safe value and prevent jackknifing. They are especially desirable in long stroke pivoted centerline style mountings. The effect of a stop tube may be duplicated by providing additional unused stroke and stopping the cylinder extension by external means.



Column Strength Considerations

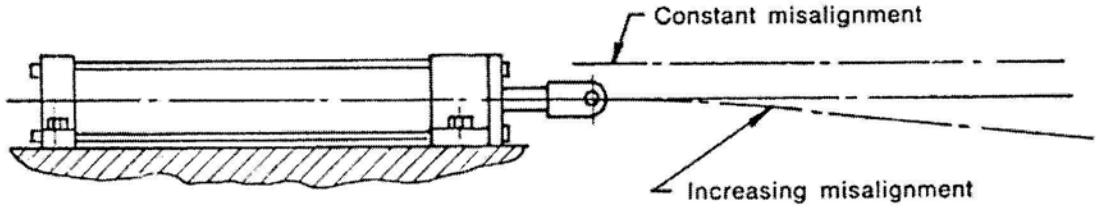
Standard size rods are recommended for use in cylinder applications where column strength, rod sag, or rate of cylinder return do not require an oversize rod. Being more flexible, standard rods absorb shock loads and minimize bearing loads caused by misalignments.

For long push stroke cylinders, an oversize rod may be required to prevent column failure and rod bending. Total cylinder length, extended is considered in column strength. Refer to the tables on the following pages for calculations regarding the column strength and stop tube required for a cylinder application.



Mounting Considerations for Cylinders - Fixed Non Centerline Mountings

Fixed mount cylinders can tolerate a slight misalignment that is zero at full retraction and increases slightly with stroke. With other than very large rods, a misalignment of about .003" to .005" per foot of stroke is usually permissable. Rigid mounted cylinders cannot tolerate a fixed misalignment, particularly at full retraction.



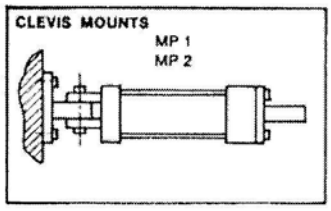
Mounting Considerations for Cylinders - Pivoted Centerline Mountings

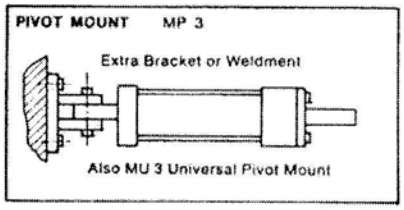
If the path of the load is curved or misalignment is a problem, a pivoted centerline mounting should be used. This compensation of nonlinear travel is in one plane only, as would occur during the operation of a lever. Pivot mounts require the rod end attachment to also be a pivot type. Close tolerance pins should be used and it is recommended that the cylinder manufacturer's accessory brackets be used to maintain good fits.

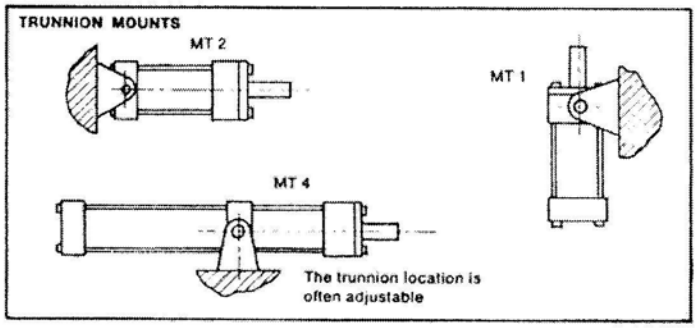
For short strokes, medium or smaller bore cylinder applications, the clevis mount is recommended. This is probably the most widely used cylinder mounting. Where the clevis mount should normally be used, but would cause the overall length of the cylinder to be excessive, the cap trunnion mount can be used. Head end trunnions should be carefully applied to either short strokes or to application where the weight of the cylinder falls vertically below the pin.

For long stroke cylinders and/or heavy cylinders, the center or intermediate trunnion mount is recommended. This mount supports the weight of the cylinder and should be located near the balance point of the cylinder at the time of maximum thrust. For general applications, a good estimate for the location of the intermediate trunnion is 1/3 back from the head end.

The MP5 (universal) type mount is a pivot mount with a spherical bearing fitted into the pivot to permit 5 to 10 degrees of movement in a plane perpendicular to the major plane of pivot movement. It is probably the most serviceable of the pivoted centerline mounts. For maximum effectiveness, a spherical bearing type rod end fitting should be utilized at the same time.

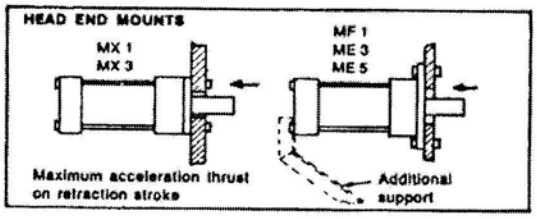


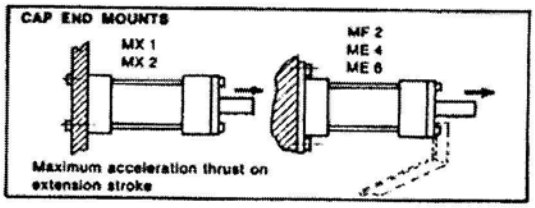


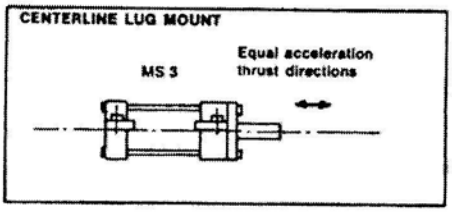


Mounting Considerations for Cylinders - Fixed Centerline Mountings

These mounting styles, illustrated below, tend to be more stable against sway on the power extension stroke. Rigid machine frame members are required to prevent misalignment under loads. The travel path of the rod end should be linear and be guided if at all possible. Long supported extension of the rod end must be avoided. Refer to the stop tube calculation data which shows the advantages of supporting and using reliable guiding on the rod end. Long stroke cylinders with fixed end mounts may require additional support at the free end of the cylinder body. This is illustrated in dotted outlines in the sketches below.



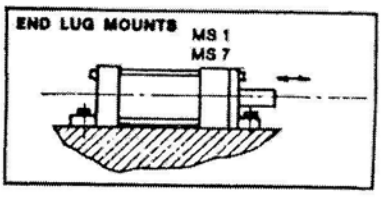


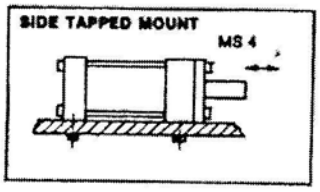


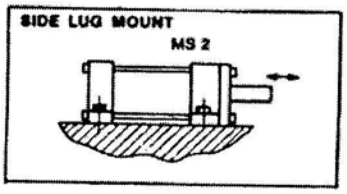
Mounting Considerations for Cylinders - Fixed Non Centerline Mountings

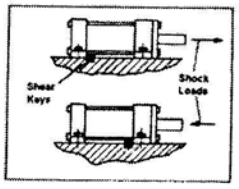
These types of mounts are perhaps the easiest to use for mounting and replacement ease. The offset thrust line introduces bending stresses and additional loads on the mounting bolts. This type should be very well aligned for maximum service life. The load must travel in a very linear path and be supported and guided both horizontally and vertically as the data for calculating stop tube and column strength illustrates.

When applying these mounts with offset thrust under high pressure or shock loads, properly located shear pins or keys can be used. These provide positive location and prevent slight movement of the cylinder under shock conditions, which the normal clearance in the mounting bolt holes would allow. Very close tolerances (.001") should be maintained between keys and keyways. Keys should be located as illustrated below, at one end of the cylinder. When using dowel pins, do no pin across opposite corners, as serious twisting stresses will result.









Mounting Considerations for Cylinders

Selection of mounting style depends primarily upon the operating specifications of the application. Mountings are generally one of the following three types:

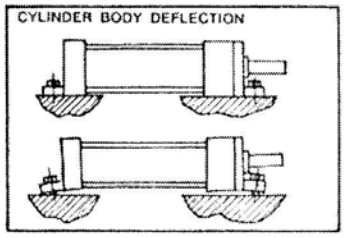
1. Fixed Centerline Mountings
   Where the thrust of the cylinder is focused on the centerline of the cylinder rod.
2. Fixed Non-Centerline Mountings
   Where the thrust of the cylinder is aligned parallel to, but not on, the centerline of the cylinder rod.
3. Pivoted Centerline Mountings
   Where the centerline of the cylinder may swing in one or more directions. Usually major movement is in one plane.

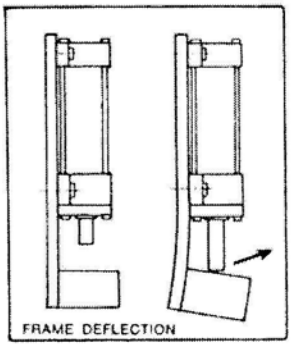
A very important general consideration is to keep the cylinder thrust as close as possible to the centerline of the piston rod and free from misalignment or side thrust. Off-center thrust or side loads subtract substantially from the anticipated rod bearing and rod seal service life.

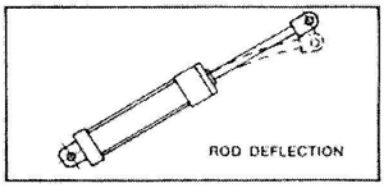
Off-center thrust and side loading can be caused by cylinder deflection under load, machine frame deflection, rod bending or sagging, cylinder pivot binding, nonlinear load movement, shifting of load; some of which are shown below.

In addition to the mounting styles, several other factors should be considered when mounting a cylinder. Care should be taken to avoid painting or damaging the exposed portion of the piston rod during construction. Threaded pieces should be pulled tight against thread shoulders to minimize bending and reduce fatigue stress. Rotation of the piston rod within the cylinder should be avoided to prevent possible scoring of the cylinder tube and damage to piston seals. Long cylinders may require additional body support to prevent damaging sag.

Major consideration must be given to the factors which might cause premature failure of the cylinder: unusual acceleration, unusual deceleration, alignment, support of cylinder weight, linear or curvilinear travel path of the load being moved, jackknifing of the cylinder, and the column strength of the rod. Some mounting styles are more suited than others to each of the above application factors.







Buckling

The permissible stroke with a flexible guided load and a 3.5 factor of safety against buckling can be obtained from the relevant table. For deviating cylinder installation positions, the permissible stroke length has to be interpolated. Permissible strokes for non-guided loads on request.

Calculations for buckling are determined using the following formulas:

1. Calculation according to Euler

$$F = \frac{\pi^2 \bullet E \bullet I}{\nu \bullet L_K^2} \quad \text{if } \lambda > \lambda g$$

2. Calculation according to Tetmajer

$$F = \frac{d^2 \bullet \pi\,(335 - 0.62 \bullet \lambda)}{4 \bullet \nu} \quad \text{if } \lambda \leq \lambda g$$

Explanation:

E = Modulus of elasticity in psi

= 30×10^6 for steel

I = Moment of inertia in inches^4 for circular cross-sectional area

$$= \frac{d^4 \bullet \pi}{64} = 0.0491 \bullet d^4$$

ν = 3.5 (safety factor)

L_K = Free buckling length in inches (depending on mounting type, see sketches A, B, C)

d = Piston rod Ø in inches

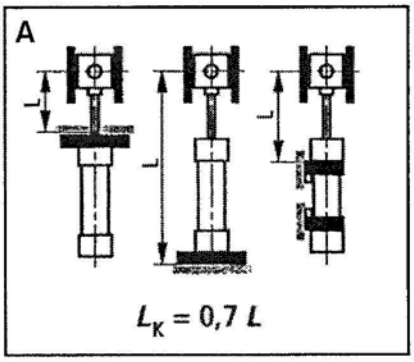
λ = Slenderness ratio

$$= \frac{4 \bullet L_K}{d} \qquad \lambda g = \pi \sqrt{\frac{E}{0.8 \bullet R_e}}$$

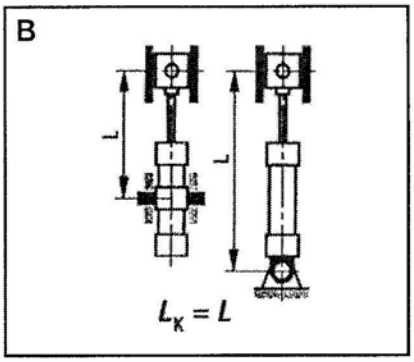
R_e = Yield strength of the piston rod material

Influence of the mounting type on buckling length:

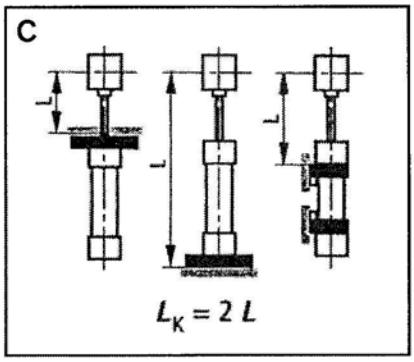
A



B



C



Stop Tube

To determine whether a stop is required on push stroke cylinders:

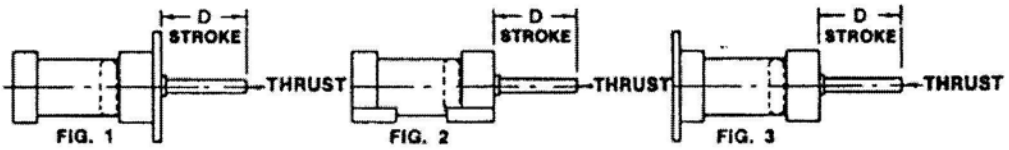
Step 1 - Determine which example below corresponds to your application.

Step 2 - Determine the value of "L" from the instructions given. The find "L" dimension in the table at the right for the required stop tube length. (Specify the effective stroke plus the stop tube length when ordering).

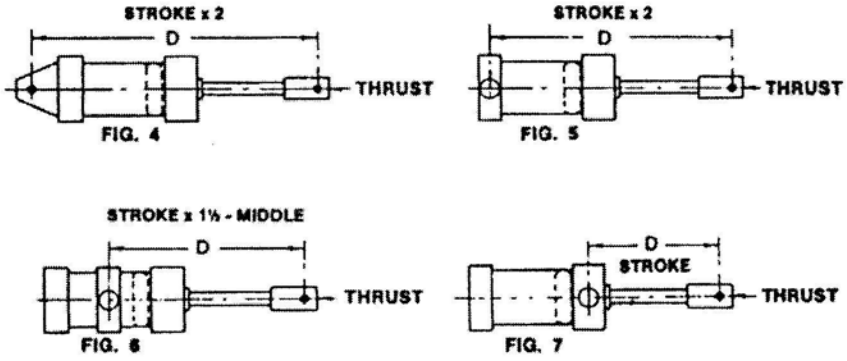
Step 3 - Add stop tube length to original "L" dimension to obtain your adjusted "L" dimension.

Example: "L" = 96", therefore, Stop Tube = 6"
Adjusted L = 102" (96+6)

Step 4 - Use adjusted "L" to figure rod column strength at maximum pressure rating of the cylinder, page 34.

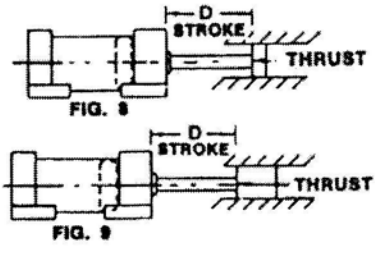


Typical rigidly mounted cylinders with rod unsupported at free end. May be mounted either horizontally or vertically. Use the equation L = 4D to determine values of "L" for all cylinder mountings in this category.



"L" Inches	Stop Tube Length (inches)
0-40	0
41-50	1
51-60	2
61-70	3
71-80	4
81-90	5
91-100	6
101-110	7
111-120	8

Typical trunnion mounted cylinders may be mounted either horizontally or vertically. Use the equation L = D to determine values of "L" for all cylinder mountings in this category. For center trunnion mounted cylinders (Figure 6), the position of the trunnion for most favorable bearing loads is obtained when "D" dimension with the rod retracted is approximately 1/3 overall length of cylinder with rod retracted.



Typically rigidly mounted cylinder with free end of rod supported with short guide. May be mounted either horizontally or vertically. Use the equation L = D to determine values of "L" for all cylinder mountings in this category.

Typical rigidly mounted cylinder with free end of rod supported with long closely-fitted guide. May be mounted either horizontally or vertically. Use the equation L = 1/2 D to determine values of "L" for all cylinder mountings in this category.

Column strength and oversize rod selection

Standard rod diameters are recommended for all Pull Stroke applications. To determine the correct rod diameter required for Push Stroke application, follow these simple steps:

Step 1 – Determine the value of "L_K" from the illustrations shown on page 40. (Use Adjusted "L_K" dimension for cylinder with Stop Tube).

Step 2 – From your cylinder size and maximum operating pressure, determine your Push Stroke Thrust.

Step 3 – Find your thrust in the left hand column and located your "L_K" dimension (or Adjusted "L_K" dimension in the same horizontal line to the right; (if your exact "L_K" or adjusted "L_K" dimension is not shown, move to the right in the same horizontal column to the next larger number). Read vertically up from this number to the rod diameter shown. This is the required rod diameter for your application.

Example: Adjusted L_K of 80" at 16,000# would required 2-1/2" rod in the cylinder.

Thrust in Pounds Force at End of Rod	Rod Diameters											
	5/8	1	1-38	1-34	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2
50	67											
100	58	110										
150	53	103										
250	43	94	146									
400	37	83	134	186								
700	30	68	118	168	202	275					Values of "L_K"	
1,000	27	60	105	155	190	257	330					
1,400	24	53	92	142	174	244	308	385				
1,800	22	48	82	127	160	230	296	366	440			
2,400	19	45	75	114	145	213	281	347	415	488		
3,200	16	41	67	103	130	194	261	329	400	461		
4,000	13	38	63	94	119	175	240	310	378	446		
5,000	9	34	60	87	110	163	225	289	360	426	494	
6,000		30	56	82	102	152	208	274	342	410	476	
8,000		26	50	76	93	137	188	245	310	375	447	
10,000		21	45	70	89	125	172	222	279	349	412	485
12,000		17	41	65	84	118	152	210	269	326	388	454
16,000			34	57	75	110	142	188	235	292	350	420
20,000			28	52	68	103	136	172	218	270	326	385
30,000				39	55	87	120	156	189	230	285	330
40,000				22	43	74	108	142	177	210	248	294
50,000					30	66	96	130	165	200	234	269
60,000						57	88	119	154	190	225	256
80,000						36	71	104	137	170	204	240
100,000							57	90	120	154	199	222
120,000							45	77	108	146	175	207
140,000								64	98	128	160	194