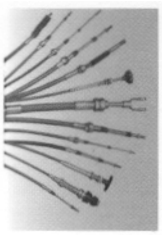
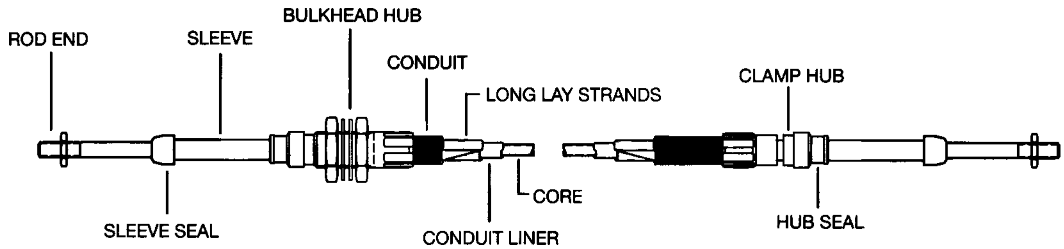
Cable Design and Application



Cable Terminology



Backlash

Backlash, which is apparent as lost motion under light push-pull input forces, is caused by the core member of the cable assembly moving from the inside to the outside of the bends in the cable with the change in direction of movement. It is a function of the clearance between the core and liner, the input force, and the total number of degrees of bend in the cable. See Figure 1.

Cable Series	Maximum Backlash for 360°
20	.120 inches (3.1mm)
30	.120 inches (3.1mm)
40	.150 inches (3.8mm)
60	.180 inches (4.6mm)
80	.230 inches (5.8mm)

These figures are for input forces just sufficient to move the core. Lost motion, the sum of backlash plus core and conduit elongation (stretch and compression) will increase as cable length, degrees of bend, and loads are increased. The use of larger cable sizes for a given load will decrease the elongation portion of lost motion.

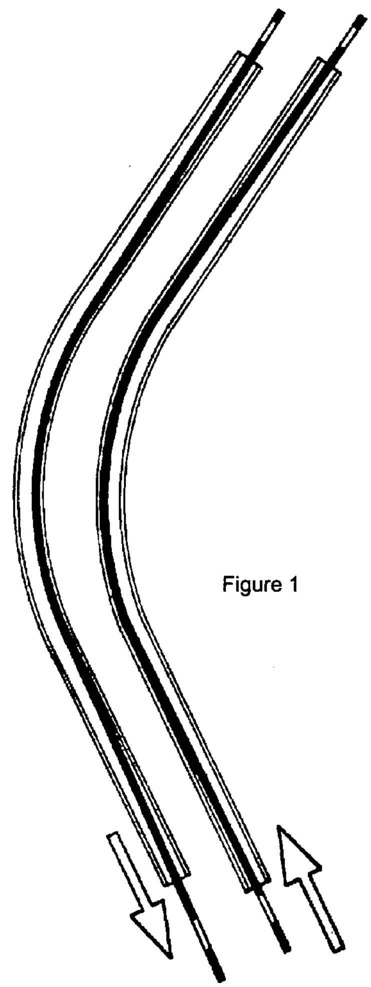


Figure 1

Temperature

Teleflex Morse cables, with standard lubricant, will operate at sustained temperatures from -40°F (-40°C) to +210°F (99°C). For operation at temperatures up to a maximum of +300°F (150°C) consult the Teleflex Morse Engineering Department.

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Efficiency

Efficiency, or the relationship between the required input force for a given output load is primarily determined by bends in the cable, see Figure 2. The required input, or the available output, may be calculated by using the following formula:

Input Force = (Output Load) (Bend Factor)

$$\text{Out Force} = \frac{\text{Input Force}}{\text{Bend Factor}}$$

Total Degrees of Bend in Cable	90º	180º	270º	360º	450º
Bend Factors	1.2	1.4	1.6	1.8	2.0

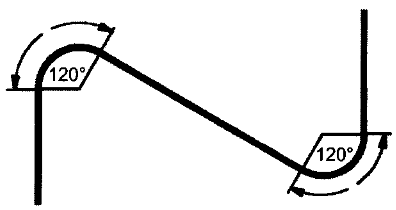

Figure 2

Dynamic Seal

All Teleflex Morse cables have patented Dynamic Seal rod seals. Their one-piece design was tested up to pressures of 50 psi after 1.3 million cycles. The seals are made from a proprietary thermoplastic composite impregnated with lifetime lubricant to minimize operating friction and reduce breakaway force by at least 30%. That translates into improved efficiency with reduced operator effort when Teleflex Morse cables are used.

Lifetime Lubrication

There are two sources of lubrication in Teleflex Morse cables, the lubricants impregnated in the core cover and the specialty lubricants applied to the core's exterior during manufacturing. The combination of these lubricants creates a low-friction environment that provides superior efficiency over the entire life of the cable, outlasting other cable designs.

Bend Radius

The Teleflex Morse cable has a recommended minimum bend radius of 5". This simply means that installations of 5" bend radius or greater will render optimum cable life. Installations requiring less than 5" can easily be achieved but may shorten the cable's life.

Other variables affecting cable life include: output loads, cable length, and total degrees of cable bend in the installation. The sum effect of higher bend radii, lower loads, shorter lengths, and fewer degrees of total bend will all contribute to longer cable life.

Minimum Recommended Bend Radii

Cable bend radii should always be as generous as possible for maximum cable life and efficiency. The following are the minimum bend radii recommended. The life specified for the smaller bend radii reflects the fatigue life of the core. See Figure 3.

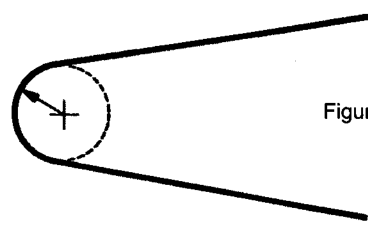

Figure 3

Cable Series	Long life Minimum Bend Radius	150,000 Cycle Life Minimum Bend Radius
20	4"	*
30	8"	*
40	8"	5"
60	10"	5"
80	12"	7"

*Consult Teleflex Morse Engineering Department

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Maximum Recommended Imput Loads

Recommended load ratings reflect the best balance between load and life characteristics. Cable operating life can be extended by utilizing less than the maximum recommended load rating.

Infrequent, or momentary loads, may exceed recommended load ratings considerably without causing failure. This will however, shorten cable operating life.

Cable Series	PULL Loads Same For All Travels	PUSH (By Travel) 2" (50.8mm)	3" (76.2mm)	4" (101.6mm)
20	15 lbs 6.8 kg	Vary with amount of exposed core wire		
30	50 lbs 22.7 kg	50 lbs 22.7 kg	40 lbs 18.2 kg	30 lbs 13.6 kg
40	See 40 Series			
60	200 lbs 90.7 kg	200 lbs 90.7 kg	180 lbs 81.7 kg	150 lbs 68.0 kg
80	700 lbs 317.5 kg	700 lbs 317.5 kg	600 lbs 272.2 kg	500 lbs 226.8 kg

Output Loads

1. Measure the force required to operate the object to be controlled (valve, throttle, PTO, etc.)

   For the best efficiency and longest operating life, install the cable so that it encounters the heaviest load in the "pull" mode of operation as shown in Figure 4.

2. Using appropriate lever lengths, adjust the load and travel required to fall within load and travel capabilities of the cables.

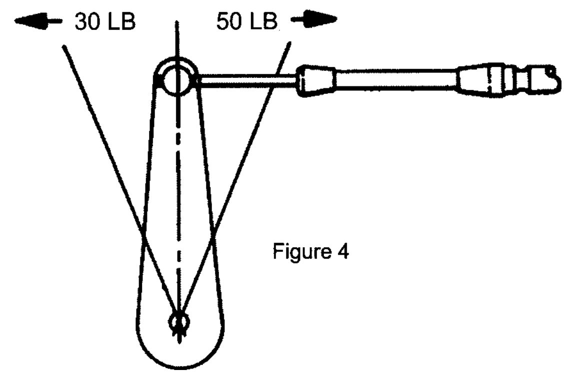

Figure 4

The cable travel required to move a lever of a given length through a given number of degrees can be computed as follows (See Figure 5):

Travel = 2 (sin0)(lever length)

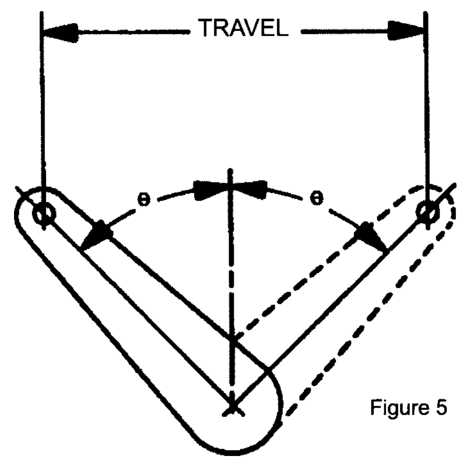

Figure 5

The output motion of the workend of the cable is essentially the same as the input motion. For example, a 3" pushing movement at the input end will result in a 3: pushing movement (less backlash) at the output end. If a differential between input/output and/or direction of movement is desired, it must be accommodated in the design of the lever and attaching point at the workend. See Figure 6 on next page.

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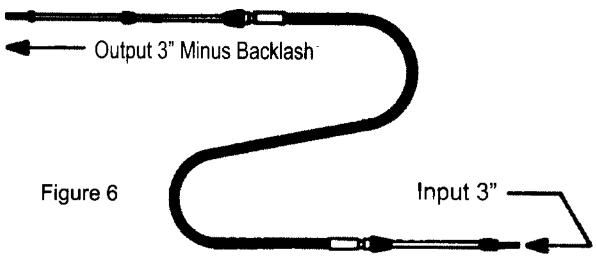

Figure 6

Layout

1. Control & Work End

a. Where cable ends are to be connected to objects requiring linear movement only, (such as valve spools, etc.), maximum life and efficiency can be achieved by accurately aligning in both planes, the cable hubs with the objects to be controlled. See Figure 7.

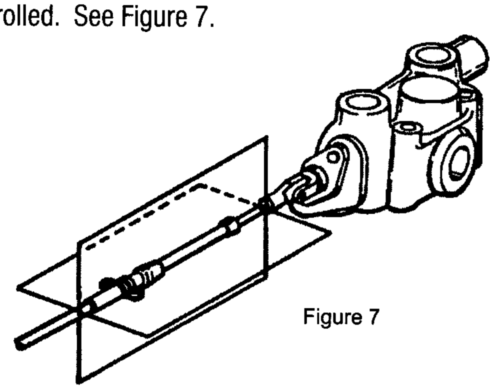

Figure 7

b. Where cable ends are to be connected to levers, etc., the connection point will describe an arc as the cable moves through its travel. Standard cables with rod and sleeve type end fittings have a built-in swivel to accommodate this deflection.

For best operating life and efficiency, keep this deflection to a minimum. This can be accomplished by locating the cable center line as shown in Figure 8.

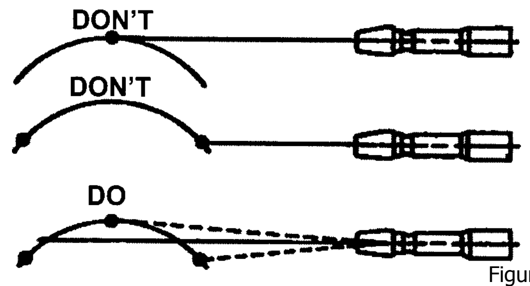

Figure 8

c. Anchor the cable securely, so that the anchor point will not move as load is applied. In most cases, the cable end must be anchored to the object to be controlled. This is especially important on engine and transmission controls, where power package "roll" could otherwise cause inadvertent operation of the control. See Figure 9.

2. Cable Path

Although cables are flexible motion transfer devices, the best performance and life can be attained by keeping the number of bends to a minimum. Where bends are required, allow as generous a radius as is practical.

3. Protection

Teleflex Morse cables are sealed and resist abrasion and contamination. They should, however, be protected against pinching, shearing and crushing, and the effects of excess heat. The operating ends should be shielded against direct spray and excessive dust.

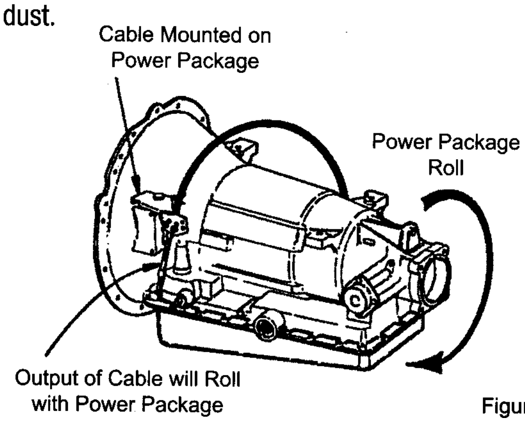

Figure 9