Elevator Rope Stretch

One of the inherent properties of all wire rope is stretch. Wire rope is essentially an elastic member, stretching or elongating when under load. This elongation is the result of two separate factors: constructional stretch and elastic stretch.

Constructional Stretch

When a load is applied to a wire rope, the helically-laid wires and strands react in a constricting manner, compressing the core and bringing all of the elements of the rope into closer contact. The result is a slight reduction in diameter and an accompanying lengthening of the rope.

Figure 1 shows the diameter range of Bethlehem Elevator Rope as manufactured. Usually constructional stretch will cease at an early stage in the rope's life. However, some fiber core ropes, when lightly loaded, may continue to display a degree of constructional stretch over a considerable portion of its life.

As might be expected, ropes with strand cores or independent wire rope cores (IWRC's) have less constructional stretch than those with fiber cores. Steel cores do not compress as much as fiber cores, and the stretch characteristics of steel versus sisal (fiber) are significantly different.

A finite value for constructional stretch cannot be defined since it is influenced by the:

- type of core
- grade(s) of steel
- construction of the rope
- degree of preforming
- length of the helixes

Because of these conditions, along with individual operating conditions such as car weights, rope speed, roping configuration, breaking and acceleration speeds, shaft height and rope lengths, and sheave conditions, it is difficult to determine the actual rate of constructional stretch for various elevator ropes.

As shown in Figure 2, there is a difference in constructional stretch between prestretched and non-prestretched elevator ropes. 8-strand ropes show greater constructional stretch than six-strand ropes. This is due to the fiber core's being larger in an 8-strand rope, allowing the rope to stretch and compact more.

Figure 1: **Diameter Range for Bethlehem Elevator Rope, as Manufactured**

Diameter (inches)	Loaded Rope (inches)	Unloaded Rope (inches)
3/8	.375/.390	.382/.397
1/2	.500/.515	.510/.525
5/8	.625/.643	.637/.654
11/16	.687/.708	.701/.722
3/4	.750/.772	.765/.787
13/16	.812/.836	.828/.852
7/8	.875/.901	.892/.918
1	1.000/1.030	1.020/1.050
1-1/16	1.062/1.094	1.083/1.115

Loaded weight is approximately 10% of published breaking strength

Figure 2: **Stretch Factors for Bethlehem Wire Rope Non-Prestretched**

	Elastic Stretch (per 100ft.)	+	Constructional Stretch (per 100ft.)	=	Total Stretch (per 100ft.)
6-strand traction	1.5″ to 2″	+	4″ to 6″	=	5.5″ to 8″
6-strand EHS traction	2″ to 2.5″	+	4″ to 6″	=	6″ to 8.5″
8-strand traction	2.5″ to 3″	+	6″ to 9″	=	8.5″ to 12″
8-strand EHS traction	3″ to 3.5″	+	6″ to 9″	=	9″ to 12.5″

Figure 3: **Bethlehem Wire Rope Prestretched**

6-strand traction	1.5″ to 2″	+	1.5″ to 3″	=	3″ to 5″
6-strand EHS traction	2″ to 2.5″	+	1.5″ to 3″	=	3.5″ to 5.5″
8-strand traction	2.5″ to 3″	+	2″ to 4″	=	4.5″ to 7″
8-strand EHS traction	3″ to 3.5″	+	2″ to 4″	=	5″ to 7.5″

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Other factors in rope design may influence rope stretch. Tests have shown that Lang lay ropes have a slightly higher stretch value than regular lay ropes. This is the result of wire helix and lay lengths. Extra High Strength (EHS) Traction ropes have a slightly higher stretch value as well, due to the higher loads applied to EHS ropes.

Synthetic cores have different stretch characteristics than normal sisal cores. Although synthetic core ropes normally have greater stretch, various manufacturing and design techniques are available which may reduce the stretch values to more conventional parameters.

Tensioning of Ropes

To this point, this technical bulletin assumes that all ropes within a set are from the same manufacturer and are all of the same material, grade, construction and diameter. The A17.2 code recommends, but does not restrict, the rope be from the same production run. With consistencies in the product, variations between reels are minimal.

Greater concern should be placed on the consistency of the rope tensions. If the ropes are not tensioned equally, each rope will stretch in relationship to the load placed upon it. Unequal tensioning causes:

- a change in safety factors
- unequal sheave wear
- slippage
- vibration
- short rope life

Tensioning of ropes by pulling on them by hand is not recommended by Wirerope Works (WW) nor is it recommended by the elevator OEM'S. Specially-designed tools and procedures have been established to eliminate the guesswork in tensioning cables.

Proper inspection of the sheaves prior to re-roping, along with equal tensioning and good field lubrication practices are the three most important factors for extending rope service life.

Prestretching

Constructional stretch of hoist ropes may require frequent rope adjustments. In high rise buildings and structures where pit clearance is shallow and overhead run by is limited, WW recommends prestretched rope. Prestretched ropes reduce or eliminate the number of shortenings required by removing the majority of constructional stretch and therefore may be very cost effective.

The limits of constructional stretch (after installation of prestretched elevator hoist ropes) shown in Figure 3 are derived from data obtained through WW's in-house testing and actual field measurements. The values shown represent rope prestretched by a method called continuous prestretching, a separate process used by WW to prestretch elevator rope. If a manufacturer uses in-line prestretching, double the number shown in appropriate column for an approximate value of constructional stretch.

Elastic Stretch

Elastic stretch results from the recoverable elongation of the steel wires and strands. Elastic properties for wire ropes are well documented and enable computations to be made in determining the elastic stretch in the rope. The following equation can provide a reasonable determination to calculate this increase in rope length due to a change in load.

$$\text{Changes in Length (ft)} = \frac{\text{Change in Loads (lbs)} \times \text{Length of One Rope (ft)}}{\text{Area of One Rope (In}^2\text{)} \times \text{Modulus of Elasticity (psi)}}$$

The modulus for 6-strand fiber core ropes is 10,800,000 psi, and 8,100,000 psi for 8-strand fiber core ropes. Rope areas can be provided by your wire rope supplier.

Hoist ropes will stretch while in service, primarily as a result of constructional stretch. Once constructional stretch occurs, it will not return to the rope. The time required to remove the constructional stretch in a rope varies with each application. Prestretching greatly reduces the constructional stretch after rope installation. As the load is changed on each rope, that rope will stretch elastically. Excessive stretch may therefore indicate excessive loading or unusual operating conditions which may result in significant rope diameter reduction and premature removal.

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