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Tech Note

Technical Notes from the Technical Committee, NIBA – The Belting Association

#16 Conveyor Belt Modulus of Elasticity

Belt modulus is a measure of a belt's resistance to stretching. Frequently, the degree to which a belt stretches in a given application is a problem source. Understanding the belt modulus values and their use can help us recommend the proper belt. This understanding can also help provide a solution in a problem situation. It is useful to remember that **the higher the belt modulus value, the lower the belt elongation or stretch will be at any given tension.**

The modulus value of conveyor belting is primarily dependent upon the fabric type or fiber used in the belt's running direction (polyester, nylon, aramid, steel, etc.) and the weaving pattern (straight warp, plain weave, cord, etc.) Other factors that determine the belt modulus include belt manufacturing techniques and the specific tension range over which the value is determined.

As an example, nylon belts will generally be more stretchy than polyester belts. The nylon belt would therefore be expected to have a lower modulus value than the polyester belt.

Conveyor belts are constructed of elastic materials. Therefore, these materials change dimension when some force is applied upon them. It is necessary for us to develop some tool or expression to accurately predict the relationship of stress (force or load) to strain (extension or stretch as a result of that load). Understanding this relationship, how belts resist stretching under a given load, allows us to closely predict conveyor belt performance under normal operating conditions.

An expression referred to as the belt modulus of elasticity, or elastic belt modulus, is the tool used for many belt and conveyor calculations. The modulus of elasticity in tension, sometimes referred to as Young's modulus, is defined as the ratio of the increment of unit stress to increment of unit deformation within the elastic limit. This is also stated as the change in stress divided by the change in strain.

Elasticity is the ability of a material to return to its original dimensions after the removal of stresses. This can be likened to stretching a rubber band and watching it return to its original shape as you let go.

Using the belt modulus value, normally expressed in pounds per inch of belt width, we can determine the expected amount of take-up travel in specific belt circuits. We can calculate the minimum transition distance required for belt troughing. With respect to convex-concave curves, the belt modulus helps to establish the minimum allowable radius of vertical curves or the rate of horizontal lift allowed while maintaining contact with the belt support idler rolls.

Typical values for conveyor belt modulus may range from 1000 piw to 100,000 piw.



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Determination of the value used for elastic modulus calculations has varied among manufacturers and engineers within our industry. One such method of determination that is widely used is the international standard ISO 9856. This test is described as a dynamic test method because a series of cyclic loads are applied and relieved from the test sample in determination of the value.

Under this method, a sample cut from the full thickness of the belt in the longitudinal direction is cyclically loaded with stresses between 2% and 10% of the minimum breaking load for at least 200 cycles. The elastic modulus value is derived from the graph of this dynamic test.

A determination is also made in ISO 9856 for the permanent elongation. This can be described as the belt stretch that is somewhat inelastic or unable to be easily recovered simply by removing the tension. The value reported from this test as permanent elongation will give insight as to the amount of initial stretch that will be encountered upon routine start up of the belt on any given system.

The values derived from this test method will accurately predict how a belt will change dimension upon initial installation and start up as well as its dynamic stress strain characteristics during normal operation. This test can be performed by an independent laboratory on any type of conveyor belt.

Determination of the elastic modulus of some light conveyor belts is unsuitable via ISO 9856. That group has therefore developed another standard which is under consideration for adoption. This document reference is 41/3 N.806. The essential differences noted in this method are that the belt is cyclically loaded between specific amounts of elongation (usually 1% and 2%), irrespective of load, and for a considerably higher number of cycles.

There has been some tendency to use modulus values determined from examination of the graph of a static, or one time pull test on belts. This method is less reliable, but more easily obtained and may prove adequate as a comparative method of belt performance. In this respect, it is most valuable to examine an area of the stress-strain curve that brackets the working tension of the belt and divide the change in stress by the change in strain. ASTM D 378 describes under section 12 the method of obtaining a stress-strain curve for conveyor belts. It also recommends, however, that data gained from the one time static pull should not be used for determination of modulus values. It further recommends that data be obtained after repeatedly loading and unloading the belt.

It is recommended that the belt manufacturer be contacted for the value and method of determination used for elastic belt modulus.

To use the elastic modulus value in determination of how much belt stretch might be expected, it is common to divide the belt modulus into the conveyor operating tension. For example, a belt with a modulus of 5000 piw operating at 200 piw would be expected to elongate by 4.0 percent..... $200 / 5000 = .04$