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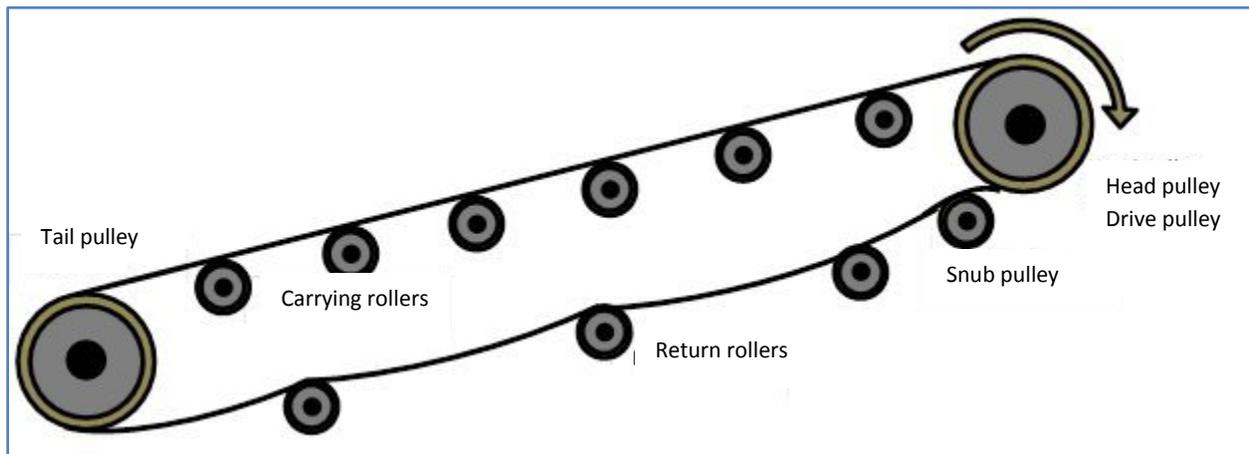
# Tightening the Belt

## (ON BELT-CONVEYOR SCALE SYSTEMS)

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The NIST Office of Weights and Measures (OWM) periodically receive questions about the installation and operation of belt-conveyor scales. More recently, OWM has been asked for information and guidance pertaining to requirements regarding the method(s) of applying tension to the conveyor belt. The objective of this article is to answer those questions and provide guidance for those responsible for the inspection and testing of belt-conveyor scale systems.

Consider the diagram of a simple conveyor belt in Figure 1 below. As one would likely expect, an appropriate amount of friction must be maintained between the conveyor belt and the drive pulley to transfer the motion from the drive pulley to the belt. In other words, the belt must maintain a “grip” on the drive pulley in order for the belt to be set in motion. In many of these systems, specially designed components are needed to ensure that proper belt tension is achieved.



**Figure 1. Conveyor Belt**

In addition to being a critical factor in facilitating the movement of the conveyor belt, appropriate belt tension is crucial for other reasons such as preserving the condition of the belt. Too little or too much belt tension can lead to shortened belt life, uneven belt wear, excessive friction (a potential fire hazard), and mechanical (bearing) failure of the conveyor structure.

Belt-conveyor scale manufacturers will generally specify that belt tension should be consistent for optimal performance of their weighing devices and the belt-conveyor scales should be installed in an area along the conveyor where belt tension is minimal.

The consistency of the belt itself is subject to changes under normal operating conditions. Variations in the ambient temperature at the location site of the belt-conveyor as well as variations in the temperature of the belt imparted through the operation of the conveyor can result in changes in the elasticity of the belt. This change in the elasticity will cause the belt to stretch and contract with those fluctuations in temperature. The magnitude of change in the elasticity of the belt will correspond to the amount of temperature change. These physical characteristics of the belt are also directly related to the type of material and manufacturing process used when the belt is produced.

The potential for significant development of “slack” in the belt due to temperature-related changes will increase as the initial size of the belt increases. In other words, a longer conveyor belt will typically exhibit greater changes in size due to temperature variation than will a shorter conveyor belt. Of course, any substantial amount of slack in the belt will result in a loss of friction between the belt and the drive pulley.

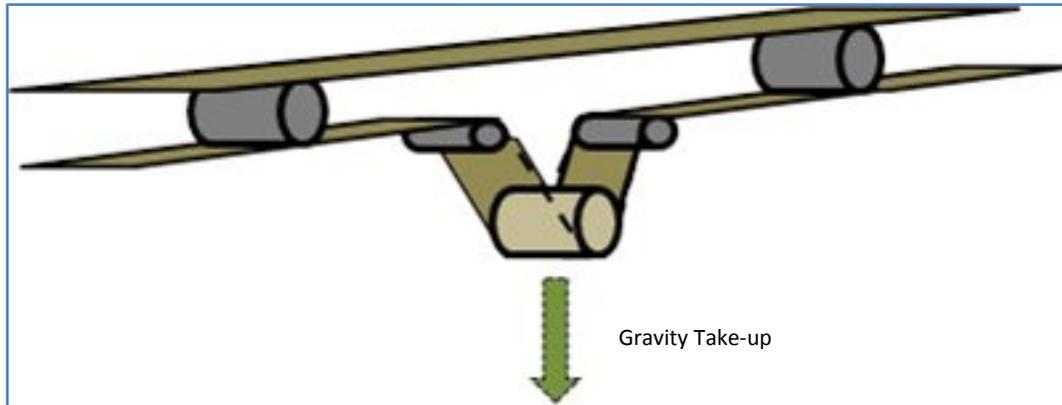
### **TYPES OF BELT TENSION DEVICES**

To account for the changes in belt length that may occur during operation, many conveyor systems are equipped with a means to adjust the tension of the conveyor belt. Some tension devices will make this adjustment by increasing or decreasing the distance between the terminal pulleys (i.e., head and tail pulleys in Figure 1) on the conveyor. Other systems will employ additional pulleys along the conveyor line that are designed to take-up excess slack in the belt.

A significant distinction in belt tension devices is whether they function automatically or, conversely, must be adjusted manually. Considering the previous discussion regarding the effect of temperature on belt elasticity, one might expect that belt tension devices designed to be adjusted manually would require continuous monitoring by an operator and adjustment during operation on systems where changes in belt elasticity and temperature stability are issues. This is the primary reason why leading belt-conveyor scale manufacturers will not recommend the use of manually-adjusted tension devices in “legal for trade” applications.

Automatic belt tension devices are capable of maintaining a more consistent belt tension by making prompt adjustments in direct response to the changes in the belt elasticity. These devices utilize various methods to maintain relatively consistent belt tension. Some examples of these methods include: gravity type take-ups, spring tension, and pneumatic/hydraulic controlled tension.

Currently, the NIST Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, Belt-Conveyor Scale Systems Code only permits the “counter weighted” (or gravity type) take-ups to be used on commercial belt-conveyor scale systems. Of the various methods listed, gravity take-ups are arguably one of the simplest and most commonly used means for automatically controlling tension in belt-conveyor scale systems, particularly on larger systems. As illustrated in figure 2, these devices incorporate a weighted roller suspended from the underside (return side) of the belt. The effect of gravity on the roller effectively pulls that portion of the belt downward, thus, providing a constant tension to automatically account for slack in the conveyor belt.



**Figure2. Counter-weighted or Gravity Take-up Device**

If slack in the belt increases, belt tension is maintained due to the counter weighted take-up device being drawn further downward. If the slack in the belt decreases, the counter-weighted design allows the belt to return towards its original profile.

There are other more sophisticated methods that are reportedly at least as effective as the gravity take-ups. Other automatic types of devices use pneumatic or hydraulic pistons to adjust the position of an attached pulley which in turn will apply more or less tension on the conveyor belt. As to why these methods are not recognized in Handbook 44, it is likely that they may not have existed when the Handbook 44 Belt-Conveyor Scale Code was drafted. These alternatives, therefore, may not have even been considered when the counter weighted take-ups were recognized as being the only type of tension devices appropriate for use in commercial applications.

#### **HANDBOOK 44 REQUIREMENTS FOR MAINTAINING BELT TENSION**

While improper belt tension is certainly problematic for the owner or operators of conveyor systems by causing belt slippage and poor belt tracking, it must also be of considerable concern to officials conducting inspections of belt-conveyor scale systems due to the impact it can have on the accuracy of these weighing devices.

There are requirements in HB44 that can be cited to require a device owner or operator to take corrective action on a conveyor belt operating when the belt tension is not properly maintained; however, those requirements have somewhat limited applications.

General Code paragraph G-UR.2.1. Installation and Belt-Conveyor Scale Systems Code paragraph UR.1.2. Conveyor Installation shown in Figure 3, both relate to the installation of equipment and state that the systems must be installed in accordance with the manufacturer's instructions.

**G-UR.2.1. Installation.** – A device shall be installed in accordance with the manufacturer's instructions, including any instructions marked on the device. A device installed in a fixed location shall be installed so that neither its operation nor its performance will be adversely affected by any characteristic of the foundation, supports, or any other detail of the installation.

**UR.1.2. Conveyor Installation.** – The design and installation of the conveyor leading to and from the belt-conveyor scale is critical with respect to scale performance. The conveyor can be horizontal or inclined, but if inclined, the angle shall be such that slippage of material along the belt does not occur. Installation shall be in accordance with the scale manufacturer's instructions and the following:

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**(d) Take-up Device.** – If the belt length is such that a take-up device is required, this device shall be of the counter-weighted type for either vertical or horizontal travel.

**Figure 3. Handbook 44 Requirements G-UR.2.1. and UR.1.2.**

The application of these two requirements to address concerns about proper belt tension is somewhat dependent upon whether or not the belt-conveyor scale manufacturer's installation instructions specify that a tension device must be installed and how it must be used.

It should be noted that the subparagraph UR.1.2.(d) also shown in Figure 3 is the only requirement in Handbook 44 that specifically addresses belt tension. This requirement also has limited application, in that it only specifies that a take-up device must be the counter-weighted type for either vertical or horizontal travel. It does not require a belt tension device to be incorporated in the system unless the belt is long enough that one is needed.

The central issues of inquiries received by NIST OWM regarding conveyor belt tension have been that: (1) HB44 requirements do not mandate that a take-up device be used unless the belt is of such a length that one is needed, yet the specific length is not defined; and (2) if a tension device is used, it shall only be the "counter-weighted type." A number of field officials believe that the language in Subparagraph UR.1.2.(d) is subjective and that it does not provide clearly defined parameters (for conveyor length) to indicate when a belt tension device is needed. This requirement is also considered by some as being excessively prescriptive because only one particular design type of belt tension device is permitted.

In order to require corrective action to be taken by the owner/operator of a belt-conveyor scale system that is subject to problems related to belt tension, officials would be advised to refer to any available installation instructions for the device. If manufacturer instructions specify that a tension device must

be used, officials can require such in accordance with requirements noted above. In the absence of the manufacturer's installation instructions requiring the use of a belt tension device, the owner may take the position that he or she is not required to install a belt tension device and, therefore, cannot be compelled to add one to comply with weights and measures regulations.

#### PROPOSED CHANGES TO HANDBOOK 44

The NIST U.S. National Working Group (USNWG) on Belt Conveyor Scales is working towards a resolution of this issue as part of a broader USNWG effort to propose changes to a number of sections in the Handbook 44 Belt-Conveyor Scale Systems Code. The current requirements found in the existing Belt-Conveyor Scale Systems Code apply primarily to belt-conveyor scales that are installed in existing conveyor systems. The USNWG's proposed changes are intended to amend the requirements so that they are more applicable to systems that are designed and manufactured as complete conveyor belt units that include integral weighing devices. Some of these proposed changes involve specific requirements that refer to belt length and the required spacing between the locations of different components in the system. During the USNWG's meeting in February 2013, members expressed their support for an amendment to UR.1.2.(d) as shown below in Figure 4. Language to be deleted is shown as ~~strike through text~~ and language to be added is shown as underlined text.

**UR.2.2. Conveyor Installation.** – The design and installation of the conveyor leading to and from the belt-conveyor scale is critical with respect to scale performance. The conveyor can be horizontal or inclined, but if inclined, the angle shall be such that slippage of material along the belt does not occur. Installation shall be in accordance with the scale manufacturer's instructions and the following:

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**(d) Take-up Device.** – ~~If the belt length is such that a take-up device is required, this device shall be of the counter-weighted type for either vertical or horizontal travel.~~ Any take-up device shall provide constant and consistent tension for the belt under all operating conditions.

Figure 4. Proposed HB44 Belt-Conveyor Scale Systems Code UR.2.2.

The proposed amendment attempts to simplify the requirement and to clearly state that adequate belt tension shall be automatically maintained in a constant and consistent manner. This wording is intended to provide clear requirements to ensure that belt tension be maintained without the use of the prescriptive language that appears in the existing requirement. If the proposal is eventually adopted, it is expected to provide the field inspector with a more useful tool for the regulation of belt-conveyor scale systems while also providing greater latitude in design specifications for belt tension devices.

As a critical aspect for the proper operation of a belt-conveyor scale system, belt tension should not be overlooked during the inspection and test of these devices. At this time, field officials have somewhat limited options for requiring device owner/operators to take corrective measures to resolve

inappropriate belt tension. However, if the changes proposed by the USNWG to the Belt-Conveyor Scale Systems Code are adopted, field officials will be provided with the means to help ensure improved belt-conveyor scale performance.

Comments or questions about this article or related matters may be directed to:

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