A belt with a centered and stable trajectory in time, does it exist? … Yes ! provided that …

Mastery of trajectory of belts and mastery of hazards

2nd part : Components setting Adjustment procedures and tolerances.

This article is valid only if the operators have strictly applied the prerequisites developed in our article / 1st part, under the title "*Control of the belt trajectory of conveyor and control of the vagaries - The prerequisites*".

This second part contains adjustment procedures and adjustment tolerances to "warranty" the correct geometrical position of the conveyor components that influence the path of the belt.

Because the safety of the operators is the 1st commandment of the companies, the procedures of adjustment, described in this article, answer them with the highest safety, for an unparalleled speed, efficiency and durability..

All settings are "conveyor off" !

Foreword

When the conveyors adjusted with the usual methods, we can say that, when the belt appears centered on the conveyor axis, this belongs to a stability who's "precarious and random", because a slight variation of one force and/or a coefficient to generate a side creep of belt without apparent logic.

To say that a belt is adjusted in running and empty, then in to load, reveals a certain weakness in the mastery and comprehension of the subject. C3 Expert says a belt is adjusted with a conveyor stopped and stopped!

Experiments to be tested

Since in any field there are skeptics that we must respect, it is important that these people can experiment by themselves my first warning so that they are convinced of the relevance of the qualifiers "precarious & random" concerning the fragile stability of the belt, after an adjustment with a usual method.

Base of tests

Test to be carried out on a conveyor whose belt trajectory, carry side and return side, is considered well centered and whose adjustment of the idlers was by the usual method.

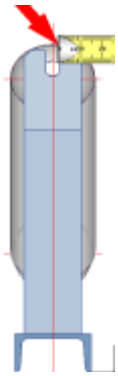
Safety

All manipulations are "conveyor off" according to the approved safety procedures.

1st test / carry side

The section under test relates to the carrying side of a conveyor, over a length of about 10 m, equipped with roller supports. These supports can be flat (1 roller) or trough (3 rollers). The pitch between supports does not matter.

Parallelism between supports



- Hook the zero of a graduated decameter in mm, on the support notch of the axis of the right lateral roller, of the 1st support of the series subjected to measurement (reference n ° 0).

  Measure the distance on the edge of the notch of the right side roller shaft support of the 1st support next (mark # 1).

- Make the same measurements on the left side starting from the same support n°0.

- On the list of right and left measurements, calculate the deviations by affecting the sign [+] and [-] according to the direction of deviation from the reference side. … / …

- Draw an arrow indicating the direction of the forces generated by the rollers and applied to the belt.

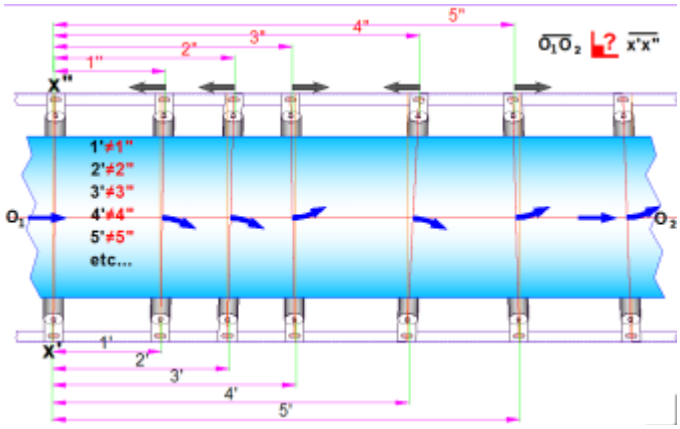


Figure 1: Measurement test on the support positions

Interpretation
The representation of the direction of the forces and the magnitude of the differences speak for themselves!

2nd test / bottom side
The section, subjected to the test, relates to the belt return side of a conveyor, for a length of approximately 50-60 m (distance between 2 pulleys), equipped with return rollers, bare metal[1], arranged at the spacing of 3 m.

Precaution
Before any manipulation, you must test the functioning of the command on/off of the belt in local control (manual) and make sure that after the start of the belt and during 5 to 10 seconds of running, the "stop" function can be operated with immediate effect.

You must not do anything if this "on/off" test does not meet the above criteria.

Appreciation of the perpendicularity of the supports to the conveyor axis:

Preparation
Remove 3 or 4 or 5 successive rolls so as to obtain a sequence of spacing of 9, 12 or 15 m between 2 supports.

This operation must be done without touching the supports of roller to be deposited (without unsettling) and without touching the adjustment of the supports of the remaining rollers. This point is an imperative, since after the test the rolls deposited will be put back in place, strictly in their initial position.

You should not change anything at the belt pre-tension (tension device).

When the roller spacing is lengthened, you must make sure that the belt does not touch, in any case, a structural iron, any obstacle under the belt; otherwise, give up the test.

Belt operating
Recall
The belt was deemed centered before the removal of the return rollers and it is always centered after this removal, since this action was made at a standstill and very carefully, without unsettling the supports.

Test
Start the belt, in local manual control, and stop its advance after a movement of 15 to 20 m, or immediately if the belt while deporting violently and touches the conveyor frame.

The proof
During the belt running and for a few meters of scrolling, you will have observed violent belt lateral creeping, right and / or left; the creep direction and their amplitude being unpredictable.

Interpretation
These belt creeps underlie the fact that, previously, the geometric position of each roller (original assembly) compensates for the positional error of the preceding and following rollers in an approximate manner. By removing several successive rollers, the correction elements have been removed relative to the position defect of the remaining rollers.

It is for this reason that a large number of conveyors have belt creeps that are incomprehensible with idler spacing of 3 m.

End of test
Put the rollers in place again, with the same precautions as above, and return the conveyor to production after you are sure that the belt has resumed its course, supposedly centered.

Read carefully the rest of the article!

THE TOLERANCES

Generality
The tolerance which affects the quality of the geometrical position of each pulley depends on the number of interactive pulleys, to satisfy a general tolerance warrantying the stability of belt trajectory.

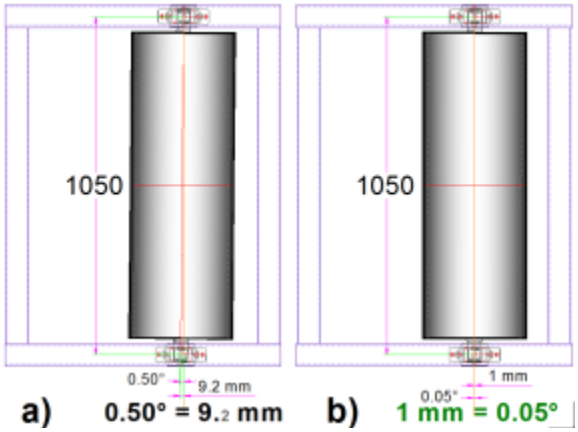


Figure 2: **a)** ½ degree deviation **b)** 1 mm deviation at the bearing housing

The tolerances easily obtained with the various methods described below are of the order of +/- 0.05 ° to 0.03 °, which corresponds to 1 mm / 0.5 mm of displacement at the bearings or idlers. This tolerance quality is necessary and sufficient in all cases of conveyor.

The most complex conveyors can have up to 20 pulleys and more. Regardless of the total pulley number on the conveyor, the important thing is to count down the number of interactive pulleys to set the geometric tolerance (90 ° +/- x °) of the position of each pulley.

When comparing two conveyors each with a head pulley and a tail pulley, the tolerance will be tighter if the center distance of the conveyor is short, since the length of the zones of influence of each pulley reaches or covers all or part of the zone of influence of the other pulley. The conveyor will be considered as a long conveyor when the zones of influence of each pulley do not meet. The lengths of the zones of influence are variable since they depend on the belt tension. As a result, a conveyor considered "long" may become "short" if the length of influence zones increasing with increasing the belt pretension.

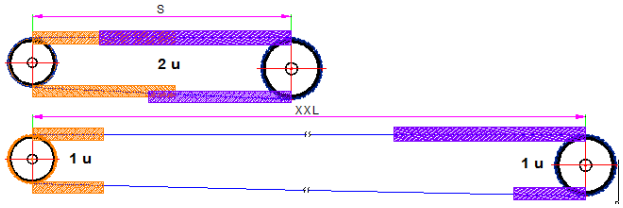


Figure 3.1: Influence zone of short and long conveyor

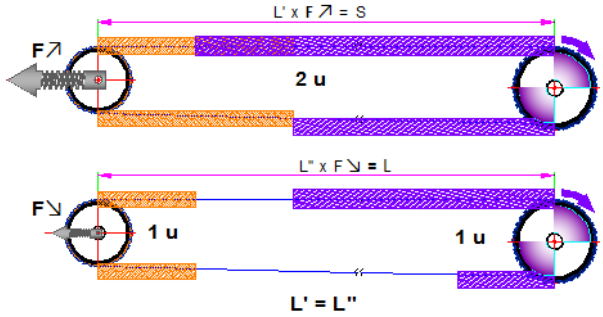


Figure 3.21: Influence zone / belt pulled / conveyors with same length / with belt tension High/Low

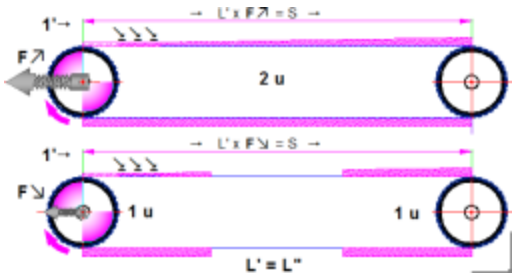


Figure 3.22: Influence zone / belt pushed / conveyors with same length / with belt tension High/Low

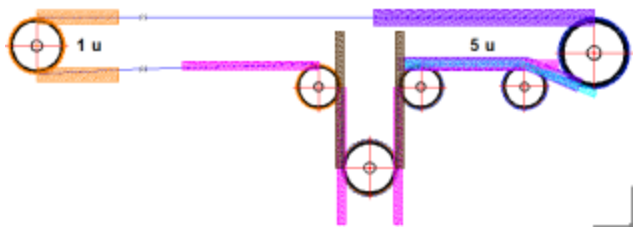


Figure 3.3: Influence zone / 1 isolated pulley, 5 interactiv pulleys

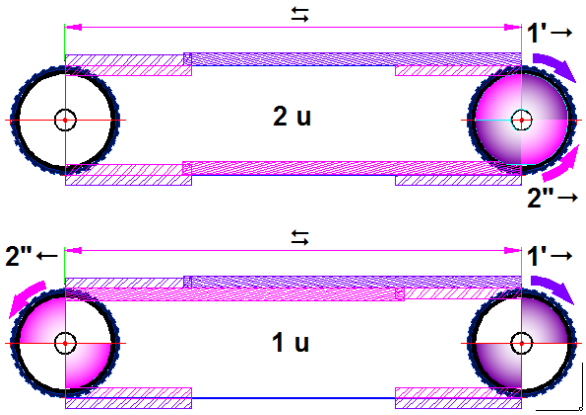


Figure 3.4: Influence zone / double direction belt
With one drive pulley / with 2 drive pulleys

SETTING / METHOD

PULLEYS

Setting method

The setting method used is compatible with the strip in place, provided that it is approximately centered on the pulley to be measured, to leave sufficient room for the installation of metrology v-blocks.
The setting method relates to geometry in space and triangulation (see Figure 5.1).

The geometric pulley position is defined by its Z marks, Y', Y'' and X', X''. In our definition of landmarks, where:

a) the point M on the Z axis determines the pulley middle with respect to the conveyor axis

b) the Y' and Y'' points on the Y axis qualify the horizontality of the pulley.

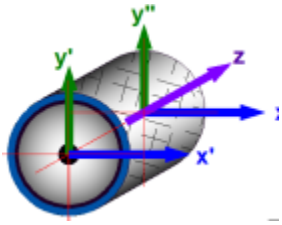


Fig. 5.2: measuring system

c) Les The measurements OX' and OX'', with X' and X'' on the X and O axes aligned on M of the O_1O_2 axis, qualify the "isosceles" property of the triangle X'OX'', of a triangle that is almost equilateral.

- When OX' and OX'' are balanced the pulley is perpendicular (90 ° +/- 0.05° to 0.03 °) to the conveyor axis, if Y' and Y'' are at the same altitude and M and O are well aligned (see Figure 5)).

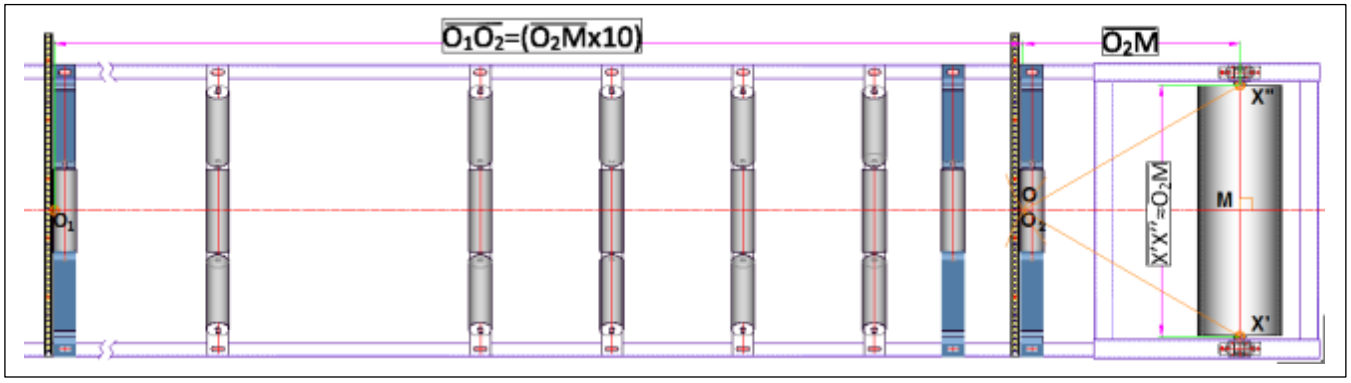


Figure 5.1: construction of the conveyor axis on an existing machine

- A deviation from M to Z does not matter, provided that the point O is in the alignment of M and if this error in Z remains in an acceptable value.

  ❖ Warning: an error in Z is often the source of subsequent tinkering, because of "psychological" incidence (yes, you read correctly!).

Example on "psychological" incidence

Considering an error M of 10 mm in Z, of no importance, the belt will be considered centered when it will be false of the error; that is to say when the range (belt edge / pulley edge) is wider on one side of 10 mm and less wide of 10 mm on the other side, which suggests to a observer non-warned, that the belt is not centered on the pulley, while it is the pulley that is not centered on the conveyor axis. **QED!**

Measuring position of pulley in "Z"

- Locate the frame middle of conveyor, with mark O_1, at a distance of approximately 10 times the O_2M height of the equilateral isosceles triangle to be constructed.
- Locate the frame middle of conveyor, with mark O_2, which will be the O vertex of the isosceles / equilateral triangle to be built. (see Figure 5.1)
- Install a very tight taut piano rope (Ø 0.5 mm) attached to the first O_1 point and passing at closer to and above the second O_2 point and secure the piano rope beyond the pulley to be measured.

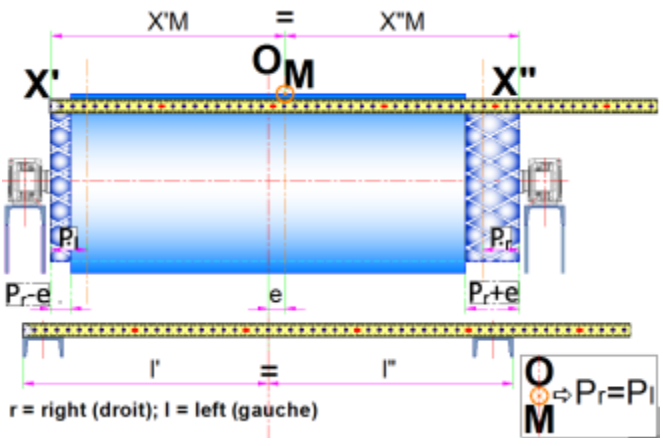


Figure 5.2: mistake in Z

- Mark the middle of the pulley, with mark M.
- Measure the distance and the direction of the error between the piano rope and the point M. Record this difference in the conveyor book by means of a relevant sketch ... Or re-center the pulley.
  - The metrology method and the v-blocks makes it possible to continue measurements in Y and X, in spite an error in Z; the software will do the compensation.

Measuring position of pulley in "Y"

- Adjust the horizontality of v-blocks, placed at the ends of the pulley ferrule, and block the assembly.
- Match the height of the rods (points) of each v-block of metrology and place the rods in the v-blocks.
- Place the digital spirit level on the tips and, if the display does not correspond to 0.00 °, raise the altitude of the faulty rod by turning the threaded knob until you reach a perfect 0.00 °.
- Note the altitude difference in mm of this rod from its initial value and report this value in the software.

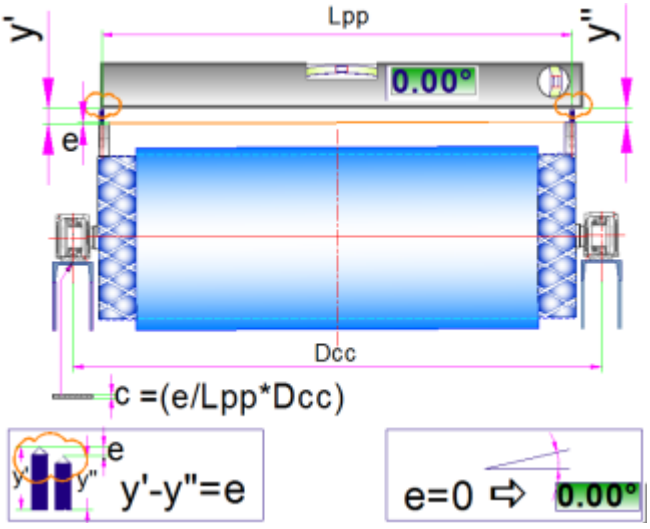


Figure 5.3: erreur en y

Measurement of OX' and OX'' dimensions

- With the greatest care, measure the OX' and OX'' dimensions.
- If OX'= OX'', the pulley is perfectly perpendicular to the conveyor axis, provided the Y and Z values are in accordance with the procedure above.

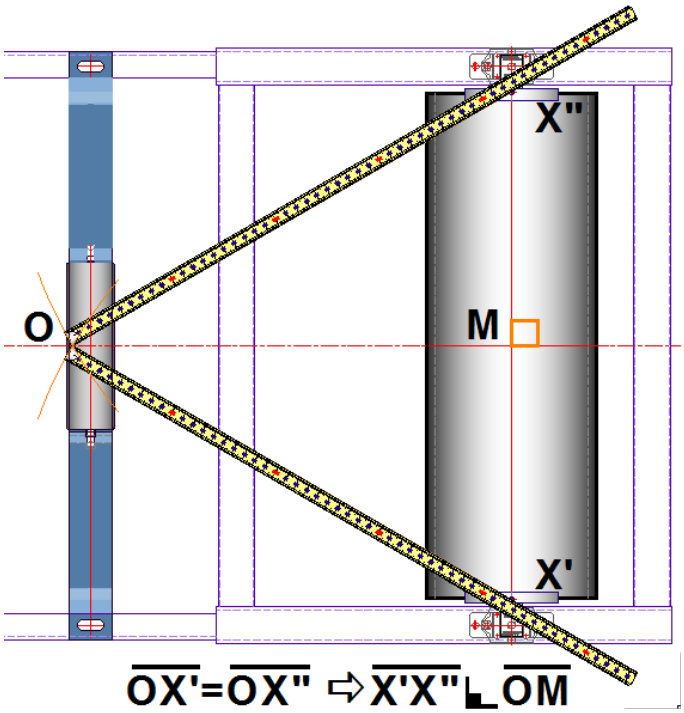


Figure 5.4 : mesure en X

- **if OX' ≠ OX''**
  - note these 2 values in the software
  - With the electronic spirit level, measure the slope of the pulley support frame, right and left sides and transfer these 2 values into the software.
  - start the calculation
  - apply the corrections resulting from the calculation, by moving the bearing-housing(s) in x and y.
  - stamp the warranty points on the frame.
    - ❖ These 2 warranty points are very important since it qualifies the pulley setting for life.

- When the pulley is set, at least in X, stamp the OR and OL landmarks marking a pulley generatrix on the edge of the ferrule. These 2 points are the references of the future measurements for the adjustment of the idlers or of a secondary pulleys (snub, bent, ...) associated with the pulley which has just been adjusted

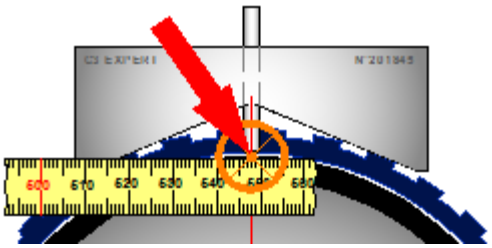


Figure 5.5: point materializing 1 ferrule generatrix of pulley

The idlers (1st serie)

Idlers, carrying side, within 10 m of a adjusted pulley

- This pulley becomes the reference of measurements
- "less than 10 m": because the method uses 2 decameters!

From the pulley which has just been adjusted and which is considered perpendicular to the axis of the conveyor, it is necessary to adjust the rollers supports in the vicinity, parallel to it. When the supports are parallel to this reference pulley, they will, in fact, perpendicular to the conveyor axis (see Figure 6).

Setting method

For a great speed of work, it is necessary to work with a team of 2 * 2 people. 2 people are reading the measurements at the generatrix points OR and OL and the other 2 people hook the tab of zero of its decameter to the support notch that is the support of roller axis, one for the right side, a for the left side of conveyor.
Simply adjust the position of the idler, so that the 2 measurements, right side and left side of the conveyor, are balanced. Proceed in the same way for the following supports until you have deployed the 10 meters of decameter, with a decameter tape still very tight and in a straight line (without deflect on an obstacle).

Trap

Often, when locking the bracket fixing bolt, the idler moves and the setting becomes wrong. To avoid this problem, it simply measure with a slightly tight bolt. Once the bolts are locked check the quality of the adjustment and start again if necessary!

Warranty points

Same as for the pulleys! A warranty point is required for each support side and each support set. There must be 1 point on the frame and 1 point in correspondence at the base of the support.

The idlers (2nd serie)

Idlers, carrying side, more than 10 m from a adjusted pulley.

The reference points are at the ends of a straight line to be constructed perpendicular to the conveyor axis using the Pythagorean Theorem.

Setting method

The method consists of constructing, step by step (approximately every 18 to 20 m) a line perpendicular to the axis of the conveyor. From this reference line, it is necessary to adjust the supports, upstream and downstream of this line, so that the supports are parallel to this line, parallel to each other and, in fact, perpendicular to the conveyor axis.

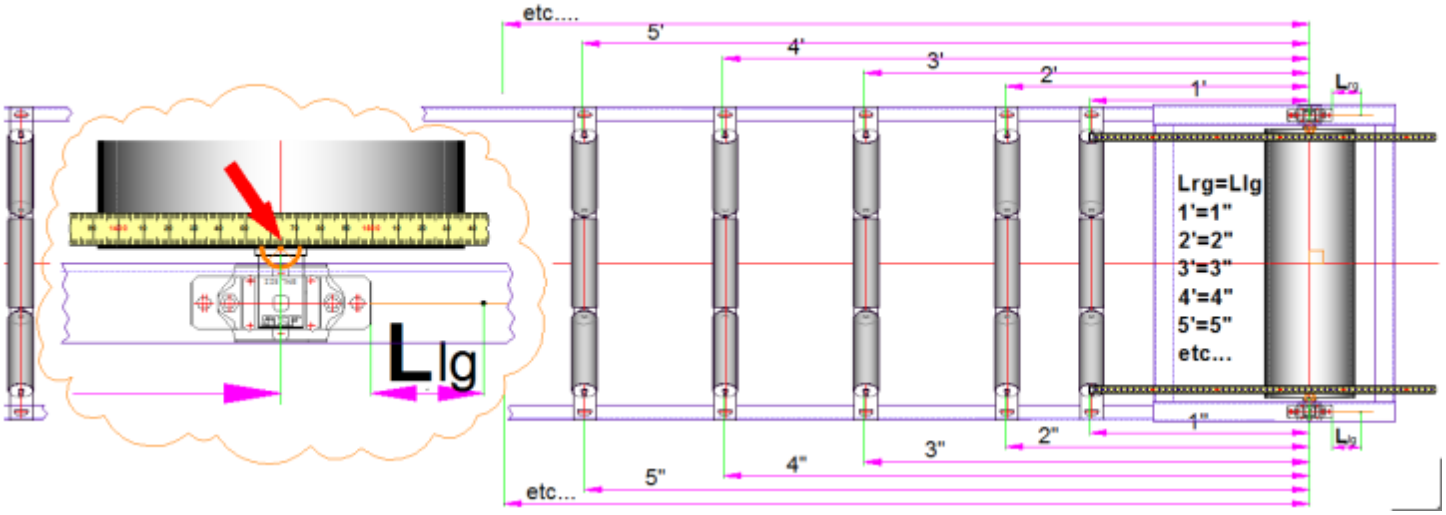


Figure 6: Adjusting of idlers within 10 m of a "adjusted pulley"

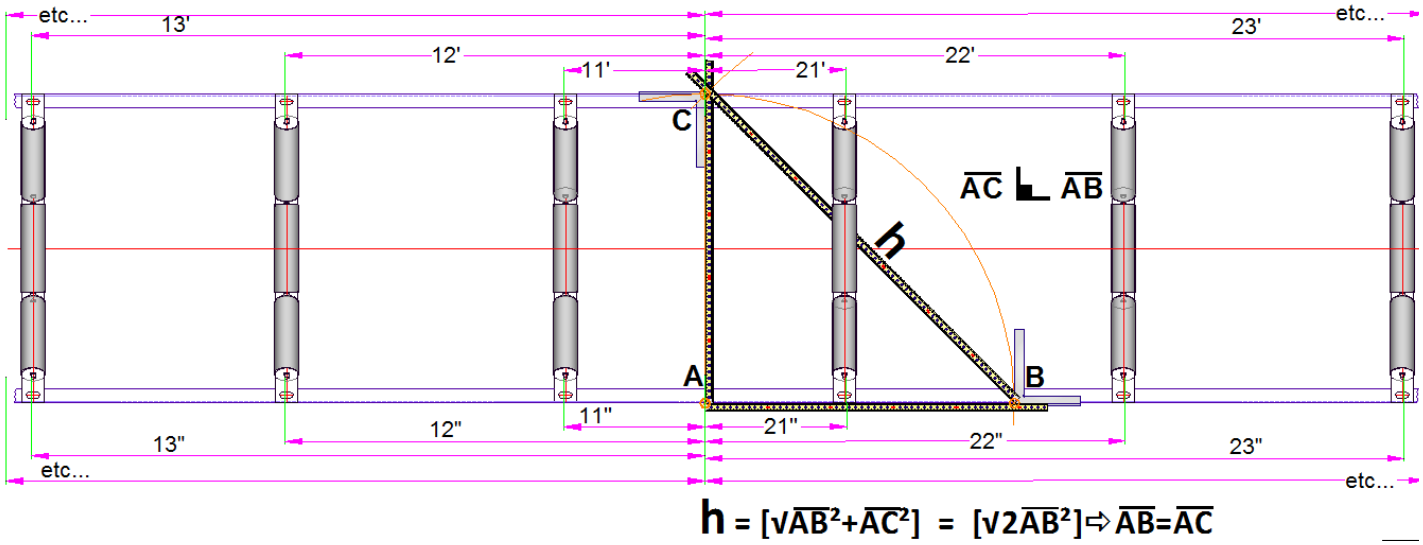


Figure 7: Adjusting idlers more than 10 m from a pulley. Reference system perpendicular to the conveyor axis

<u>Construction & elevation of the straight line of reference</u>

It is a question of constructing a right isosceles triangle according to the theorem of Pythagoras (Figure 7).

- the width of the conveyor frame (outside dimension) is measured;
- this point is marked '' A '', measuring on one side of the frame;
- we report exactly the width of the frame on the beam on the same side as '' A '' and we mark at the point to trace this point '' B '';
- we calculate the hypotenuse of the future isosceles-rectangle triangle: h = [√AB² + AC²] or = [√2AB²] since AB = AC;
- with a thin tape measure (width 1/4 inch) the "zero" tab is attached to point B and on the opposite beam, opposite point A, the calculated dimension (hypotenuse) is found at the intersection with the outside edge of beam;
- this point is labeled "C".
  - thus [AC] is perpendicular to [AB] and to the conveyor axis;
- Make an arch with of angle iron (50 * 50 * 5) so that the horizontal angle iron is at the notches of support of roller shaft.
  - This arch must be securely and rigidly attached to the frame, in the immediate vicinity of points A and C marked on the side members.
- Using the electronic spirit level, mark points A and C on the top of the horizontal angle of arch. These new points A_h and C_h become the references of the measures to come.
- Adjust the position of each idler, upstream and downstream of these A_h and C_h markings, following the same method as for the "<u>Idlers (1)</u> *near an adjusted pulley"*, With this times, the references A_h and C_h, marked on the horizontal angle of the arch, as a reading point of 2 decameters.

Work with the same precautions as before.

Once the idlers have been adjusted, mark the warranty points for each support and on both sides of the conveyor.

Repeat the operation 18-20 m further until the complete adjustment of all the supports.

Note: if there is a difference in distance of more than one millimeter on the right and left measurements taken between the last idler of a series and the 1st idler of the following series, it is because there has been adjustment errors; it is recommended to start the adjustment again with more attention.

For two-way belt conveyors and conveyors with differences in the straightness of frame, the method of adjustment is similar, but with additions to define the theoretical axis of conveyor, to materialize by a piano wire.

The idlers (3rd serie)

Supports, bottom side
Method by comparison (see Figure 8).
Here, the belt will serve as a measuring instrument.

- Principle: the belt creep is proportional to the number of belt meters that scroll on the roller or the rollers in observation, but only for errors of geometric position of idler less than 0.1 °.

Example
In the case of a 25 mm offset (side) for 10 m of belt passing on the roller, I make a correction (conveyor stationary) of 1.0 mm at the idler; then I control the result by again passing 10 m of belt and, at this moment, the belt creep is only 15 mm, this determines a 2nd correction (conveyor switch-off) of the order of 1.5 mm ([1.0 / (25-15) * 15] = 1.5). QED!

Conveyor preparation
Action performed imperatively conveyor stopped, according to the procedures of consignment and exceptional test regime.

- Remove all surplus supports and rollers so that a uniform spacing between the supports of 12 to 15 m is obtained.
  - If, among the remaining rollers, there are self-centering models, anti-clogging with rubber rings, rollers in bad condition, it is important to replace these components by rollers in good condition, standard type (metal ferrule) or sleeved rubber smooth 35 Shore, before removing excess rollers.
  - The belt must not touch structural iron or other; otherwise have your conveyor calculated to determine the permissible spacing between supports.
  - In principle, the belt pre-tension must not be modified when the conveyor is put back into service; except if the calculation specifies a different belt pre-tension value.
- Number all remaining idlers, from 1 to x, starting with the 1st idler following the head pulley
- Slacken the belt, so that the drive pulley is at the limit of slippage under the belt (for memory the belt is empty), without the belt touching any obstacle, bottom side.
  - The low tension of the belt, in adjustment phase, allows a better winding on the return rollers and a very high efficiency (precision) of adjustment.

Recall
At this time, the belt is in the same situation as before the preparation of the belt of bottom side and no one knows what trajectory the belt will follow from its first restart.

- Measure with a mechanic ruler (long 250-300 mm), bottom side, near the head pulley, the free space between the frame (outer side) and the belt edge, on each side of the conveyor. Add the 2 values and divide the result by 2. This calculated value corresponds to the distance between the belt edge and the outside edge of the frame or of a conveyor foot when the belt is centered on the conveyor axis (see Figure 8).

Example
For 1 frame 1122 mm wide and a belt 788 mm wide we have: [1122-788] / 2 = 167 mm.

- Note on the table of adjustment of your notebook, tablet or smartphone this reference value.

Safety
The measurement of the free space between the structure and the belt edge is always done with a mechanic ruler on the frame or the first leg of the frame following a return roller (safety clause).

The use of a tape measure or similar instrument is strictly forbidden.

- Decide which side of conveyor you will do your measurements (reference side) for adjustment operations. Preferably the most accessible side along the conveyor.

- Measure the distance between the frame edge, taken as a reference, and the belt edge with the mechanical ruler of 250-300 mm.
  - This measurement is to be done at the level of the first 4 to 5 rollers, ie at a distance from the head pulley, for example with a pitch of 12 m between rollers, of [12 * 5] = 60 m center distance.

- Note this series of measurements "0-1" in parenthesis or in gray, on your notebook (tablet or smartphone) in front of the number of each idler and note the amplitude and direction of the offset from the dimension reference (our example: 167 mm).

Example
If we have a series of measured dimensions (by way of example) of: 212, 198, 173, 120, 109, with the value '' 167 mm '', previously defined as an example of the '' *centered belt in this frame* '', this gives the following offsets (before the 1st restart of the belt):
1. [212-167] = (+45);
2. [198-167] = (+31);
3. [173-167] = (+6);
4. [120-167] = (-47);
5. [109-167] = (-58).

- Switch-on the conveyor for a first restart under exceptional test conditions (local control) and after having applied the prescribed safety rules.

Warning
- Because the belt offset will certainly be of high amplitude and in an unpredictable direction, the operator at the start button '' on / off '' must be ready to stop the belt on command of the operators who supervising the advance of the belt and, in any case, he will stop the belt after 15-20 m of scrolling on the rollers.
- Start the belt and stop there from 15 to 20 m of scrolling.
- o For a good apprenticeship, the different operators can stand near and after each bottom roller, to observe the belt offsetting as soon as it starts.
- Switch-off the conveyor! (with same safety rule)
- Re-measure the new belt position as before and note the values in front of the number of each idler noting the amplitude and direction of the offset from the reference dimension and compare the evolution of the offsets with the previous measurements.
  - **This 1st phase of work is only educational!**
- On both sides of the conveyor, with a mechanical hat square, position all roll holders perfectly perpendicular to the frame and centered in the bolt slots.
  - ... and there, you will notice that some models of supports are frankly not practical or see dangerous (risk of fall of roller), see un-adjustable.
- At the scribing point (fine pencil, very fine marker), make 2 aligned marks, on the bracket and the frame. These landmarks are provisional.
- Switch on the conveyor for an exceptional test start (local control).
- Start the belt and stop there from 15 to 20 m of scrolling.
- Switch off the conveyor!
- Measure and record the new belt position as before.
  - This time, this series of measurements becomes the starting point "0" of the adjustment method.
- Apply a correction to the position of the two 1st brackets, with adjustment amplitude of 3 mm maximum.
  - Practical side
    - The effects of adjustment are very strong despite a setting so low in amplitude. This is due to the long spacing between brackets!
    - It is better to make several successive corrections when learning the method.
    - With experience and great reasoning power, you can adjust 6 to 8 brackets simultaneously.
    - The setting of the brackets is to straighten the "snake" that forms the belt (seen from above).
  - The meaning of correction
    By convention
    Right side of conveyor: the observer stands in front of the tail pulley and looks ahead to the head pulley; the right side of conveyor is the one on his right hand.
  - If the belt is moving to the left of conveyor (although it is the bottom side);
    ... and that the adjuster stands on the right side of the conveyor, he will move the bracket:
    - to the tail
      ... and that the adjuster stands on the left side of the conveyor, he will move the bracket:
    - to the head
      ... and vice versa for a right shift!
  - Depending on the amplitude of the offset, estimate the correction value of the position of each bracket, without exceeding 3 mm at each correction, and note the value in the notebook (tablet or smartphone).
  - Practical side:
    If the support is held by 2 bolts on each side, tighten only 1 bolt on 2, the upstream or the downstream, but always the same on all the supports (= gain of time), the 2nd bolt remains slightly tighten.
  - Technical principle
    - Each roller has an influence, with respect to the trajectory of belt, on 1 roller upstream and 1 roller downstream.
    - If the belt comes out of one or more rollers (the belt marks a fold on the roller extremity = hard point), make an approximate and temporary correction of the geometric position of these rollers to raise the belt on the roller and thus remove this hard point.
    - If the belt is coming out of the tail pulley, or from the another pulley, bottom side, make an approximate and temporary correction of the geometric position of last or last 2 rollers preceding this pulley (for belt integrity).

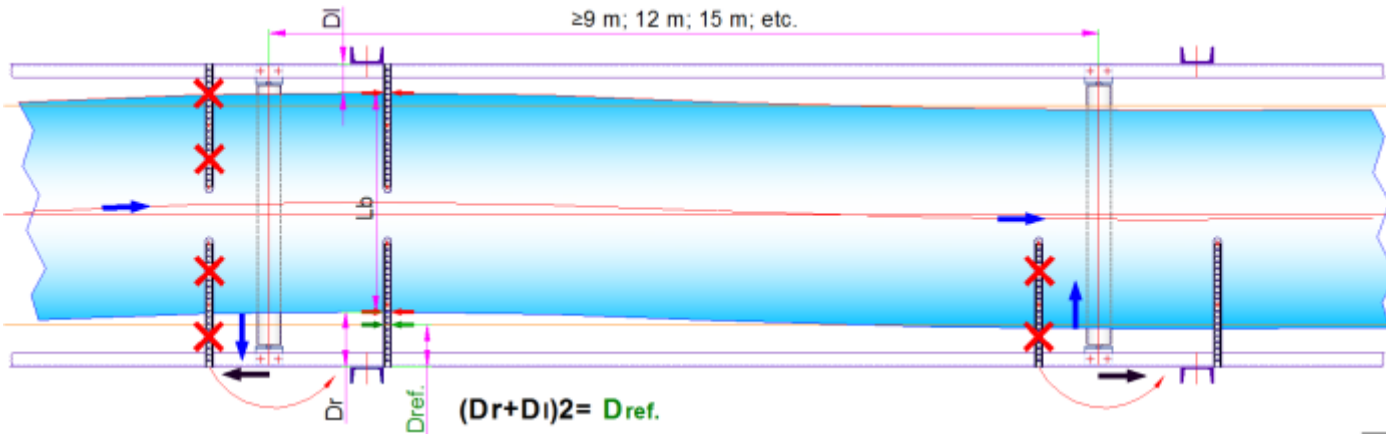


Figure 8 : Adjustment of brackets of bottom side, base of the method

- Switch-on the conveyor for an exceptional test start (local control).
- Start the belt and stop there from 15 to 20 m of scrolling.
- Switch-off the conveyor!
- Measure and record the new belt position as before.
- Compare the gain in terms of belt offset to level of the two 1st brackets, compared to the amplitude of adjustment of each of these brackets and, by a rule of 3, determine the 2nd correction to be applied on these two 1st brackets.
- Perform the adjustment of the first two brackets and restart the procedure as before.
  - With a little practice, you will arrive very quickly to an excellent result in 1 or 2 sequences of adjustment per pair of brackets.
- After a few tries, the belt will be centered, but at that moment it will not be qualified yet.
- To determine the quality of the belt, mark a zero point on the belt (special marker or paint for belt rubber) and switch-on the conveyor.
- Running the belt in manual sequence and continues for 1 to 2 belt periods on conveyor.
- Proximity and after the first bottom roller (out of dangerous zone), measure the amplitude and offset direction of belt with the mechanical ruler and mark with the paint (eg spray paint) offsets of more than 10 mm on the right in a bright color and for those on the left in another color.
  - On the 2nd or 3rd round, you will observe that your color marks will always present the same offset.
- Re-adjust, strictly following the procedure above and if necessary, the first two supports, only when passing the sections of belt '' unpainted '' since these are good quality sections.
- Set all following in pairs of roller brackets.
- Check the quality of your settings and make the necessary minor adjustments if necessary (often of the order of 0.5 mm).
- Put the belt in tension, identical to what was before the adjustments or at the value prescribed by the calculations.
- Check the totality of belt for proper centering.
  - Recall: The painted sections, corresponding to faulty or damaged sections, may have a slightly greater amplitude of offset when the belt is tightened.
- Switch-off the conveyor again and lock all the bolts of the brackets and mark the definitive guarantee points to the right of each bracket on the right and on the left sides of conveyor.

Bravo! ... and welcome to the club.

Your conveyor is settled '' for life ''! (see guarantee points)
From now on, if the belt have creep, it's because there's been a break, a chute jam, and you'll quickly find that implying disorder components and you'll quickly find what the components that imply this disorder.

You have just entered the club of belt adjusters, **belt conveyor stopped, safe method**, in full compliance with the Machine Directive 2006/42/CE.

Marc des Rieux, Expert
www.c3-expert.com

[1] *Anti-clogging rollers with rubber rings are not accepted.*

NB : We are waiting for your comments on this text which establishes the state of the art.

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