Vibration analysis applied to conveyor belt.

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Abstract - In this project, a conveyor belt was made to be able to carry out an analysis of mechanical vibration frequencies, with which a data comparison was made, since the measurements will be made with different weights on the conveyor belt, the first one was made with a weight of 1 Kg, which is the weight with which the band normally works, and the second measurement was made with a weight of 4 Kg, which causes an effort for the band.

In order to carry out the comparison of the frequency analysis, mechanical vibration measurement equipment was used, from there we obtained data to be able to carry out the calculations. The other data was obtained from some components of the conveyor belt, such as bearings and the motor. In order to carry out this analysis, we use graphs and different mathematical formulas to obtain the results and thus carry out the comparison.

The entire procedure of how all the mathematical calculations were made and how we arrived at the results is shown. The calculations are made taking the data provided in each element measured.

Finally, there are all the results that we obtained after performing the calculations, these are shown in a table with the final comparison and there are the comparisons of the frequencies of the bearings and the motor of the conveyor belt that was where they were made measurements and compared the results of both weights on the conveyor belt.

Key Words: Conveyor belt, geared motor, tape, rolling elements.

1. INTRODUCTION

The conveyor belt is a transport system with an important presence in the industry. The operation consists of the movement of drive drums and rollers distributed along the belt, which continuously moves the belt. The belt has the function of moving products or materials from point A to point B, and ensures the integrity of the products.

The biggest problem with a conveyor belt is the vibration and noise generated by the rolling elements that show some damage. The vibration analysis is applied to a conveyor belt that has a capacity to transport a product of 1 kg, (in this case, it transports 1L water bottles) from which a comparison of the behavior of the rolling elements with different weights ranging between 1 and 4 kg is made. This belt transports the product with the help of a gearmotor, which rotates at a speed of 70 rpm.

The objective of this project is to determine the vibration frequencies of the bearings implemented in a conveyor belt, such as bearings and other rolling elements, as well as to determine the fundamental frequencies and belt frequencies, and thus make a comparison. This comparison will be achieved thanks to the results obtained with the help of vibration measurement equipment. For this, the corresponding calculations must be carried, by calculations of the frequency; of deterioration of the outer track (BPFO), frequency of deterioration of the inner track (BPFI), frequency of deterioration of the rolling elements (BSF), frequency of deterioration of the cage (FTF), in the same way, the frequencies of the band are calculated. This is done in order to extend the useful life of each bearing and as result, reduce extra maintenance costs.

METHODOLOGY

The fundamental element for carrying out the vibration analysis was vibration measurement equipment, in the same way, a conveyor belt was needed to make the corresponding measurements on its rolling elements.

1. Equipment configuration

To start performing the analysis, it is important to configure the measurement equipment according to the analysis to be performed. (In this case, it was vibration analysis).

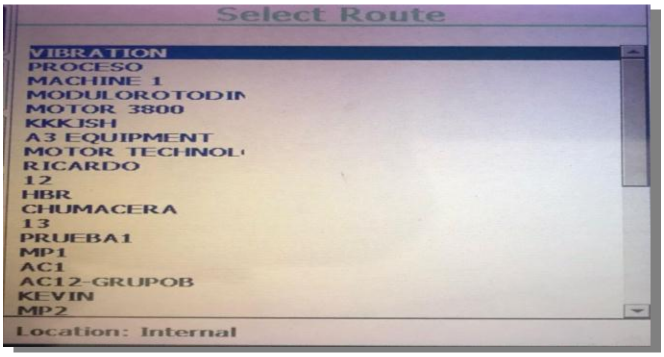


Figure 1. Analysis type: vibration analysis. Source: Own.

2. Frequency selection

Once the analysis is selected, we must know what frequency is used, whether it is low or high.

Figure 2. Frequency selection. Source: Own

3. Locate the points to measure

It is necessary to locate the points to be measured since these can be tangential, axial, and radial.

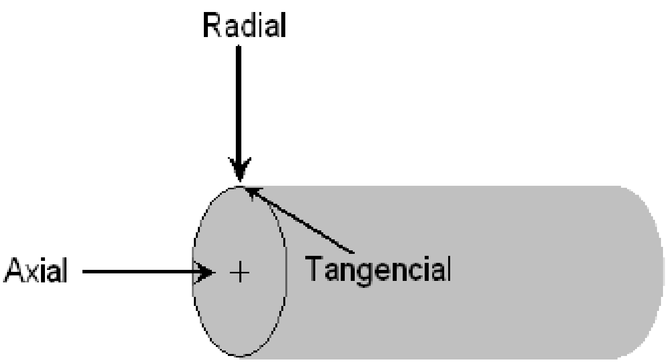


Figure 3. Types of measures. Source: Azmadli

4. Position the accelerometer correctly

Let's remember that the accelerometer is a magnet, therefore, it must be placed on a metallic area so that it adheres strongly, in the same way, it must be placed in the correct position so that it does not move and that does not interfere with the measurements.

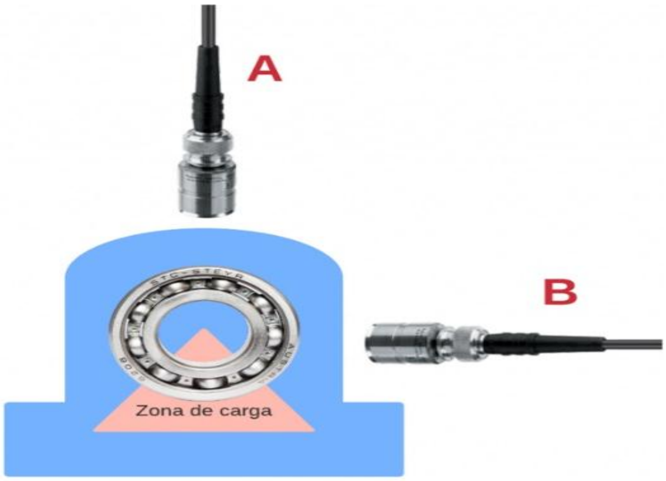


Figure 4. Accelerometer position. Source: Sedisa sac

5. Name the new job

Before starting the analysis with the measurement equipment, we must give a name to our new analysis, remember that this measurement equipment has a memory that will save all the analyzes carried out.

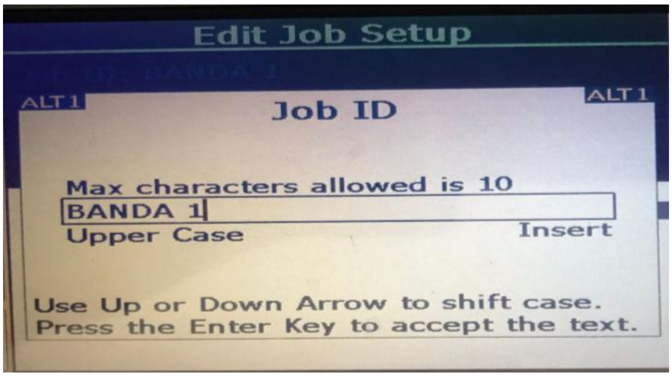


Figure 5. Name of the job. Source: Own.

6. Save all the measurements made

Let us remember that within the vibration analysis we must make measurements at different points of the machine (conveyor belt) for which we must make sure to save each one.

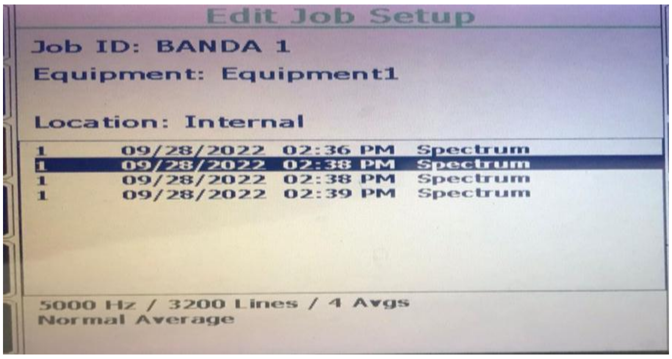


Figure 6. Save measurements. Source: Own.

7. Connect to software

Once the analysis is done, it is important to export all the data to software that works together with the measurement equipment, in order to have the data and graphs obtained on our PC.

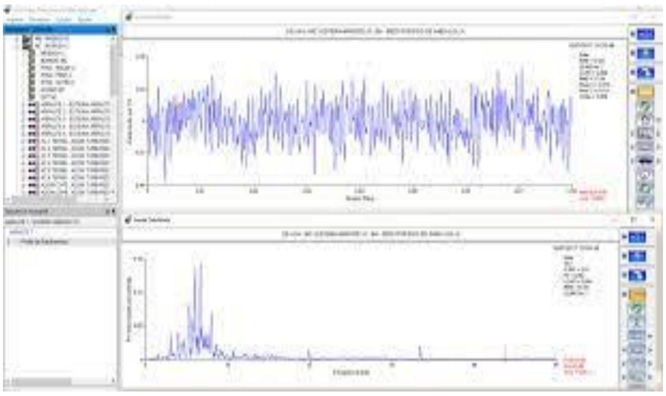


Figure 7. Software. Source: Own

RESULTS

Below are the results obtained through the calculations that are made to obtain the corresponding comparison and determine the appropriate use of weight for the conveyor belt.

Data:
revolutions =**70rpm**
Fan =**9 blades**
Pulley 1 =**4 in**
Pulley 2 = **3 in**
Bearing = **UC-201-8**
Distance between pulleys = **36.5cm.**

Formulas to use:

- $BPFO = (0.5)(N)(n)(1-(d/D)(\cos\Phi))$
- $BPFI = (0.5)(N)(n)(1+(d/D)(\cos\Phi))$
- $BSF = (0.5)(N)(D/d)(1-(d/D)^2(\cos\Phi)^2)$
- $FTF = (0.5)(N)(1-(d/D)(\cos\Phi))$

Where:
N= turning speed (rpm)
n= number of balls or rollers
D= mean bearing diameter (in)
d= diameter of balls or rollers (in)
Φ= contact angle (rad)

- $LB = (\prod/2)(D2+D1) + 2C$

Where:
D1= Pulley diameter 1 (cm)
D2= Pulley diameter 2 (cm)
C= Distance between pulleys (cm)

- $FB = (\prod)(D1)(W)/LB$

Where:
D1= Pulley diameter 1 (cm)
W= Revolutions
LB= band length

Operations

- **Fundamental frequency**

70/60=<u>1.16Hz</u>

- **Fan frequency**

$9X70 = 630/60 = 10.5Hz$
$Pulley\ 1 = 4X2.54 = 10.16cm$
$Pulley\ 2 = 3X2.54 = 7.62cm$
$LB = (\prod/2) + (10.16 + 7.62) + 2(36.5)$
$LB = (\prod/2) + 17.78 + 73$
$LB = 1.57 + 90.78$
$LB = 92.35cm$

- **Band frequency**

Graph 1. Data obtained through calculations.

$FB = ((\prod)(10.16)(70))/92.35$
$FB = 2{,}234.30/92.35$
$FB = 24.19/60$
$FB = 0.4032Hz$

- **Bearing frequencies UC-201-8**

n= 9
N= 1
d=12.7mm= 0.5in
D=49.3mm=1.94in
35°=0.61rad

- **Deterioration of the outer track** $(BPFO) = (0.5)(N)(n)(1-(d/D)(\cos\Phi))$

$BPFO = 0.5(1)(9)(1-(.5/1.94))(\cos 0.61)$
$BPFO = (4.5)(0.74)$
$BPFO = 3.34Hz$

- **Frequency of deterioration of the inner track** $(BPFI) = (0.5)(N)(n)(1+(d/D)(\cos\Phi))$

$BPFI = 0.5(1)(9)(1+(.5/1.94))(\cos 0.61)$
$BPFI = (4.5)(1.25)$
$BPFI = 5.65Hz$

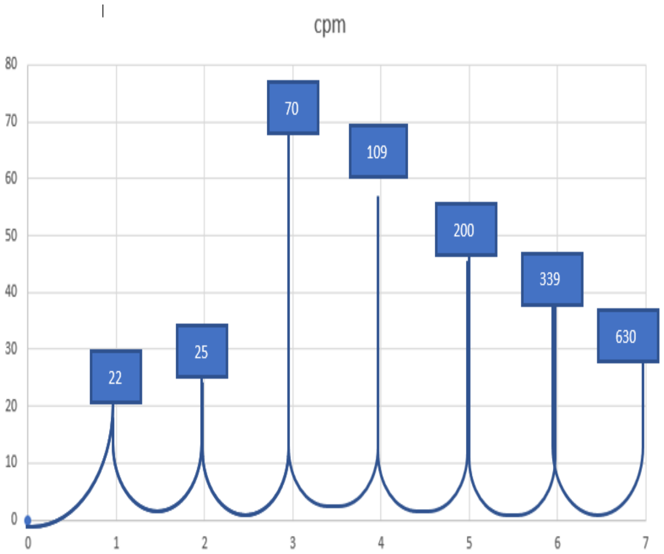
- **Frequency of deterioration of the rolling elements** $(BSF) = (0.5)(N)(D/d)(1-(d/D)^2(\cos\Phi)^2)$

$BSF = 0.5(1)(1.94/.5)(1-((.5/1.94)^2)((\cos .61)^2)$
$BSF = (1.94)(0.93)$

$BSF = 1.81Hz$

- **Frequency of deterioration of the cage** $(FTF) = (0.5)\,(N)\,(1-(d/D)\,(cos\Phi))$

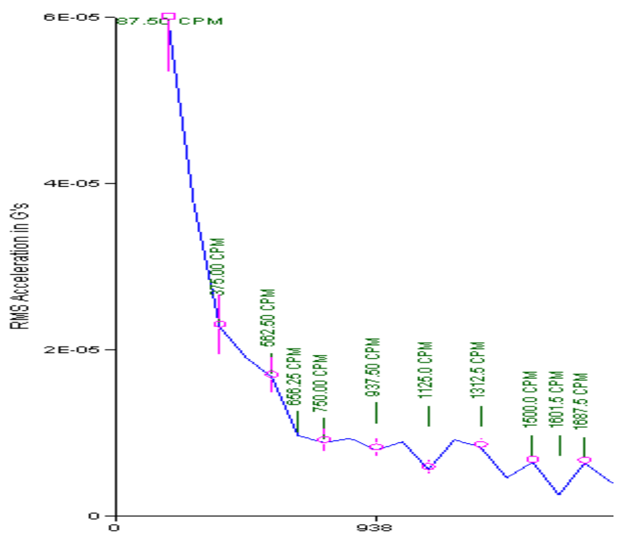
$FTF = 0.5(1)\,(1-(.5/1.94))\,(cos0.61)$
$FTF = (0.5)\,(0.74)$
$FTF = 0.37H$



Graph - 1. Data obtained through calculations.

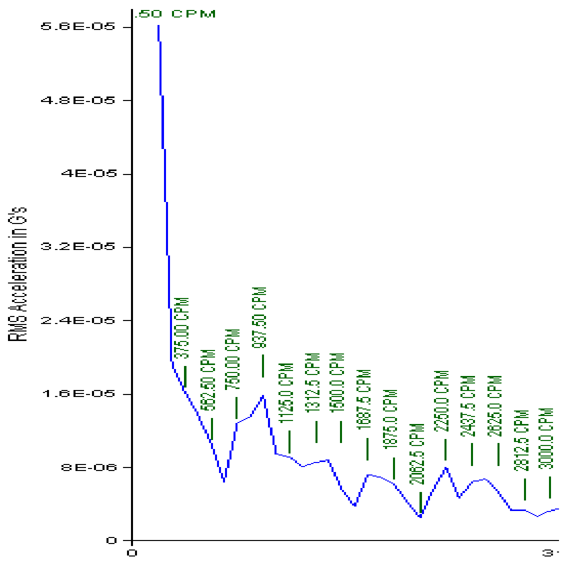
Graph 1 shows the results obtained through the calculations made by the previously seen formulas; we must know that these data are without a load on the conveyor belt. Likewise, this graph shows the values of the analysis that was carried out, the measured values are represented as the bearings and the frequencies of the geared motor.

MEASUREMENTS WITH A WEIGHT OF 1KG



Graph - 2. Medicines of bearing with a weight of 1 kg

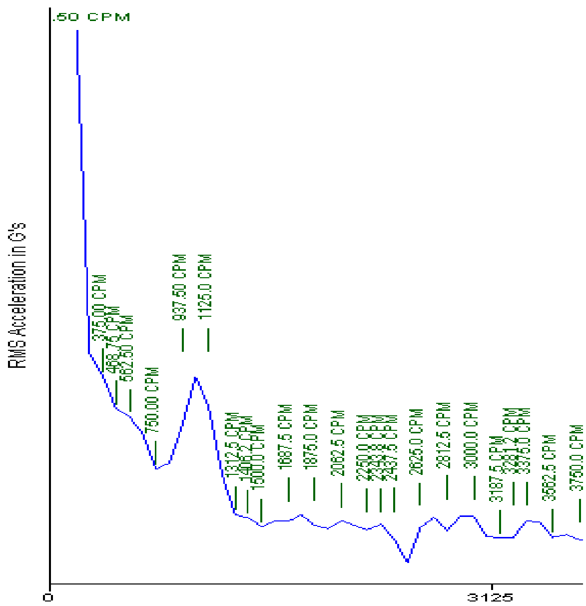
Graph 2 shows some of the values that were obtained with the help of the mechanical vibration measurement equipment, values which will serve us for the comparison that will be made below.



Graph – 3. Measurements of the rear part of the geared motor

Graph 3 shows the values obtained in the measurements, but this time from the rear of the geared motor, where it can be seen that they are different results. Similarly, these data will be taken into account for the comparison.

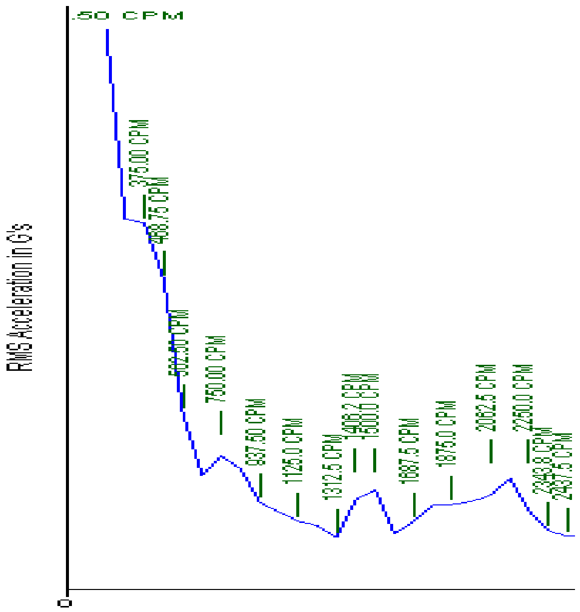
We must remember that the measurements are made on the metal parts of the engine, since the accelerometer has a magnet and thus helps to obtain more accurate data.



Graph -4. Front measurement of geared motor.

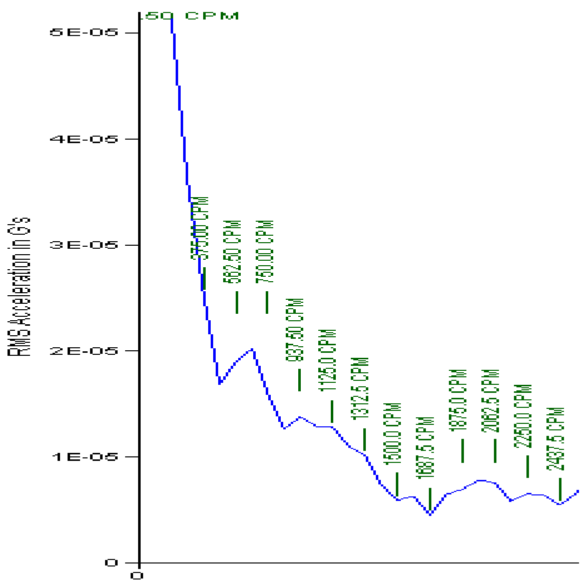
Graph 4 shows the spectrum obtaining the frequencies and thus observing the behavior of the frequencies on the front side of the geared motor. We can see from the graph above that despite being the same geared motor, the vibrations are different at different points. This can be verified with the comparison of graph 3 and graph 4.

MEASUREMENTS WITH 4 KG OF WEIGHT



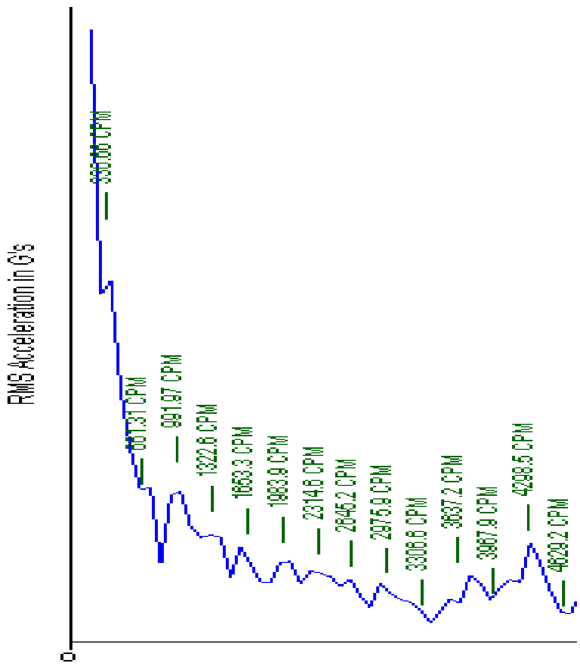
Graph – 5. Bearing Measurements 1

Graph 5 shows the values obtained with the applied analysis, in this way you can see the values necessary to make the comparison.



Graph – 6. Rear measurement of the geared motor.

In graph 6 you can see a difference both in the spectrum and in the values, which helps a lot when making the comparison.



Graph – 7. Front measurement of geared motor

In graph 7 we can see that the spectrum contains more peaks with more frequency data, which will be able to be compared with the data of the previous graphs.

Table 1. Comparison table.

Frequency		Weightless Results	Results 1 kg	Results 4 kg
		rpm	rpm	rpm
Fundamental		70 rpm	75 rpm	88 rpm
fan		630 rpm	642 rpm	658 rpm
Band		25 rpm	25 rpm	25 rpm
chumacera UC-201-8	BPFO	200 rpm	195 rpm	188 rpm
	BPFI	339 rpm	375 rpm	375 rpm
	BSF	109 rpm	109 rpm	109 rpm
	FTF	22 rpm	22 rpm	22 rpm

Table 1 shows the results obtained from the vibration analysis, where a difference between the values is observed, this indicates that there is a different effort with each of the loads. Therefore, there is a greater effort when the belt transports a product weighing 4 kilograms.

As a result, we identified that in order to have greater durability in the rolling elements, it is recommended to use the belt with a weight of 1 kilogram.

3. CONCLUSIONS

When making the comparison with the data obtained during the analysis, it is concluded that a greater effort is caused with a load of 4 kg, despite the fact that the conveyor belt supports and moves the 4 kg without any problem with this analysis we determine that with this load the rolling elements show greater wear, which shortens their useful life. However, if the conveyor belt moves the product with the recommended weight, which is 1 kg, moves it without any problem, only that with this weight the rolling elements show less wear, which lengthens the useful life of the rolling element. To explain the above more clearly, the values 630 rpm are taken as an example, which is a measurement without weight on the conveyor belt, 642 rpm is a measurement with a weight of 1 kg on the conveyor belt, and 658 is a measurement with a weight of 4 kg on the band, for which a greater alteration of the value is observed with a weight of 4 kg taking as reference the measurement without weight on the tape. In this way, it is observed which rolling element has greater wear with the different weights.

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