ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

VIBRATIONS MEASUREMENT IN ORDER TO IDENTIFY THE FAULTS TO THE TABLES AND SUPPORTS ON WHICH THE EMBROIDERY MACHINES ARE PLACED

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Abstract: *The aim of this paper is to accurately and quickly identify the faults of the tables and supports on which the embroidery machines are placed through vibrations measuring method. Vibrations measurements on Happy embroidery machine were performed at S.C. CONFIDEX S.R.L Oradea. A FFT spectrum analyzer Impaq was used, made by Benstone Instruments Inc –SUA.*
The measurements were performed in order to seek the role and importance of the rigidity of embroidery machine supports for a better and more efficient performance of the machine. Before performing these measurements was determined the optimal operating mode of the embroidery machine. The vibration measurements were performed in each measuring point, by installing a vibration sensor on the three directions of the Cartesian coordinates system: axial (X), horizontal (Y), vertical (Z). In the present paper is shown only the measuring direction Z (sensor mounting direction) and advance of the material on x direction (the embroidery direction) this is the most relevant direction, as on this part the embroidery is executed.
After performing these vibration measurements on the HAPPY embroidery machine, previously mounted on a big table, after that mounted on a smaller table and a less rigid base. The same vibrations measurements were performed and it was noticed that it is mandatory to position the machine on a big table and a stable base because it will influence both the reliability and the working regime of the machine.

Key words: *vibrations measurements, FFT spectrum analyzer Impaq, table and support for the embroidery machine, faults.*

1. INTRODUCTION

Frequency analysis of vibrations (FFT analysis) is the one that makes it possible to obtain the necessary information for fault detection in industrial equipment [1].

In order to establish the operational status or fault condition of industrial equipment is necessary to monitor certain parameters of industrial equipment. The values of monitored parameters will be determined when the equipment is new and when is worn, respectively. These values of monitored parameters can be used to study the reliability and maintenance based on fuzzy logic [2], [3], [4], [5].

It is known that any technological equipment does not work without vibrating. It is important however that vibration levels are within the permissible limits. Vibrations study showed that each fault has its own characteristic frequency. During operation, all sources transmit their energy through the table supports both to the table on which the machine is mounted and also to the base on which the table which supports the machine. The only problem is capturing the vibrations with a suitable device and unpacking them in component signals, each signal with its own frequency, depending on the source that produced it.

2. THE EXPERIMENTAL PART

The vibration measurements were performed at S.C. CONFIDEX S.R.L Oradea, on HAPPY professional embroidery machine, with the following characteristics [6]:

- ✓ -embroidery head: 1piece
- ✓ -embroidery area for normal frame: 290x290mm
- ✓ -embroidery area for caps: 70x180mm(2,8x7inch)
- ✓ -number of needles: 12 pieces
- ✓ -speed: 300-1000(normal) and 300-750(for caps)
- ✓ -stitches memory: 250.000
- ✓ -power supply: 220V, la 50/60 Hz
- ✓ -weight: 42kg

The aim of the measurements was to seek the role and importance of the embroidery machine supports as well the base the table of the machine stands on.

Fig. 1: *Support and small table, HAPPY embroidery machine*

Before performing such measurements the optimal operating mode of HAPPY embroidery machine was determined. Determining the optimal operating mode for the embroidery machine, through vibration measurement technique was described by the authors in a previous paper [7].

Vibration measurements were performed in each measuring point by installing a vibration sensor on the three directions of the Cartesian coordinate system: axial (X), horizontal (Y), vertical (Z).

In the present paper is shown only the measuring Z direction (sensor mounting direction) and advance of the material on x direction (the embroidery direction) this is the most relevant direction, as on this part the embroidery is executed.

The amplitude of the vibrations recorded on the vertical measuring Z direction (large mass) and advance of the material in the x direction (the direction of embroidery, fabric-textile fabric) is shown in the table below [7]:

Table 1: *Amplitude of vibrations acoording to the operating mode with sensor on Z (advanse x) – large mass*

OPERATING MODE	**VIBRATION AMPLITUDE**		
No. Of sinking/min	**VELOCITY** ***mm/s*** **[rms]**	**DISPLACEMENT** ***μm*** **[rms]**	**ACCELERATION** ***g*** **[rms]**
300	**6.4**	**70**	**0.1**
400	**2.2**	**28**	**0.18**
500	**3.8**	**50**	**0.22**
600	**10.8**	**160**	**0.33**
700	**7.6**	**80**	**0.4**
800	**13.7**	**84**	**0.5**
900	**14.4**	**75**	**0.7**
1000	**14.46**	**76**	**0.8**

Based on this table, were determined the diagrams for the: velocity amplitude, displacement amplitude and acceleration amplitude according to the operating mode.

As we can notice in figure 2, the smallest velocity amplitude which does not affect productivity is 7.6 mm/s at 700 stitches/minute operating mode [7], [8].

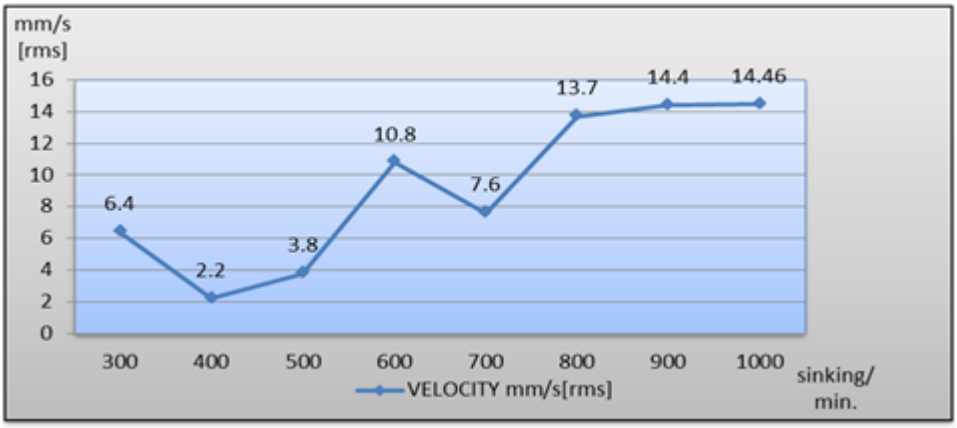

Fig.2: *Amplitude of velocity based on operating modes-large mass*

Displacement amplitude from 700 stitches/minute up to1000 stitches /minute is approximately constant, as can be seen in figure 3.

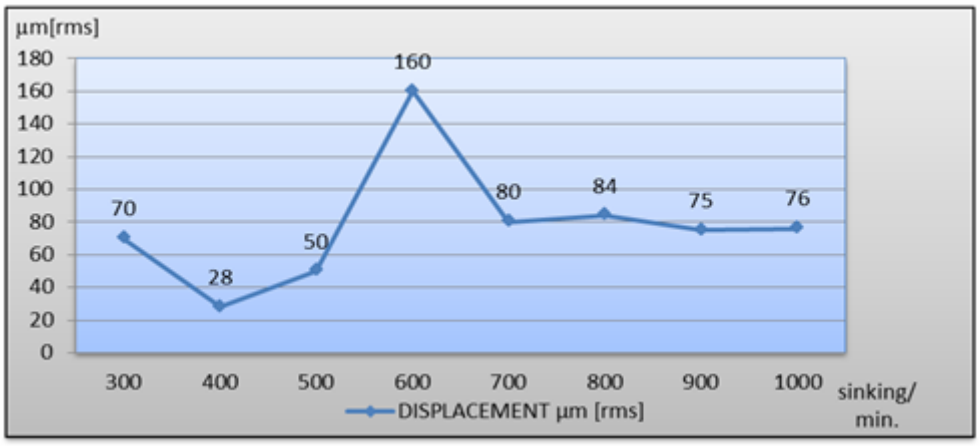

Fig. 3: *Displacement amplitude based on operating modes-large mass*

In figure 4 the acceleration gives the impact "metal on metal", resulting in an almost linear acceleration.

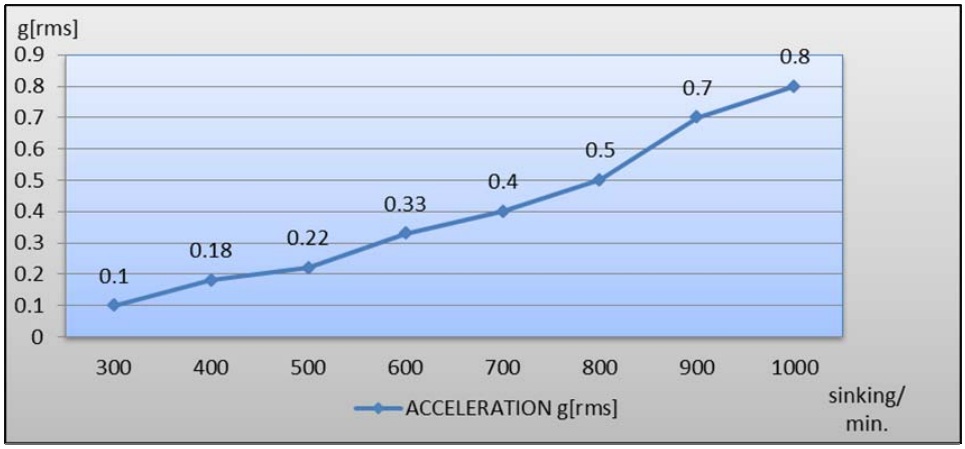

Fig. 4: *The amplitude of acceleration based on operating modes-large mass*

Waveforms and frequency spectrograms obtained for the embroidery "HAPPY" - (large mass), recorded at the measuring point PT1, on the vertical measuring Z direction (sensor mounting direction) and material advance in the x direction (fabric-textile fabric) were presented in the previous paper. [7]

After performing these vibration measurements on Happy embroidery machine, mounted on a large table, the embroidery machine was mounted on a smaller table and a less rigid base and the same vibration measurements were performed.

The vibration amplitude recorded in the vertical measuring Z direction (small mass) and material advance in the x direction (the embroidery direction, fabric-knitted fabric is shown in the table below:

Table 2: *Amplitude of vibrations according to the working regime with sensor on Z (advance x) – small mass*

OPERATING MODE	VIBRATION AMPLITUDE		
No. Of sinking/min	**VELOCITY** ***mm/s*** **[rms]**	**DISPLACEMENT** ***µm*** **[rms]**	**ACCELERATION** ***g*** **[rms]**
500	**4**	**41**	**0,2**
600	**4,5**	**35**	**0,3**
700	**12,9**	**88**	**0,45**
800	**10**	**77**	**0,57**

Based on this table the diagrams for the velocity amplitude, displacement amplitude, and acceleration amplitude according to the operating mode were completed.

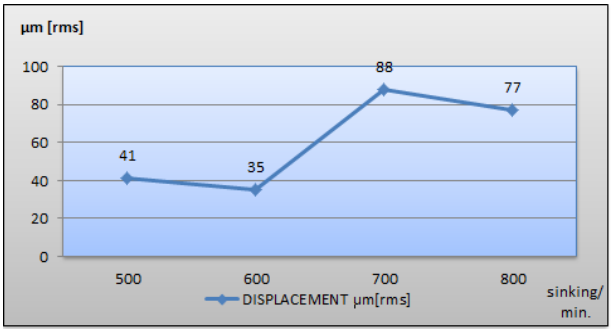

Fig. 5: *Displacement amplitude according to the operating mode with senor mounted on Z vertical 0 small mass (advance on x direction – textile fabric)*

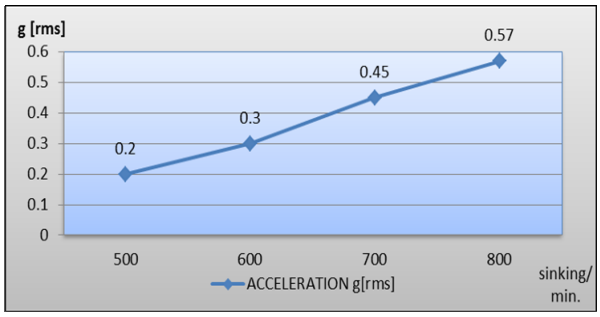

Fig. 6: *Acceleration amplitude according to the operating mode with sensor mounted on Z vertical (advance on x direction – textile fabric)*

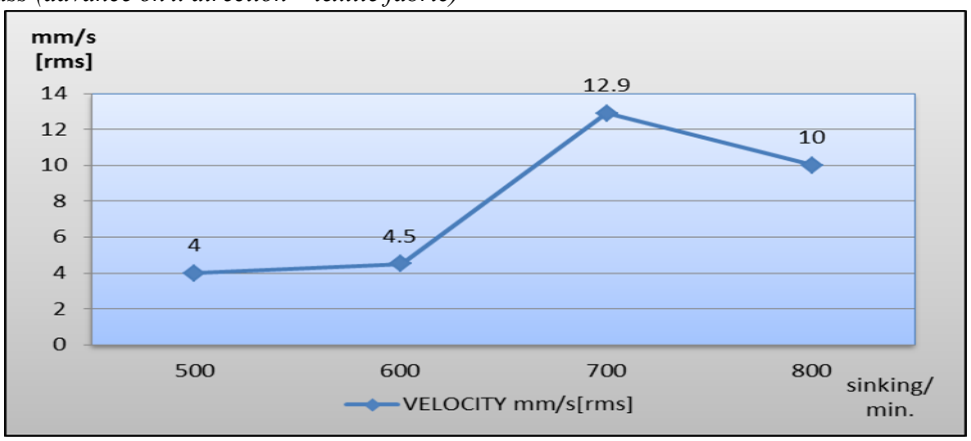

Fig. 7:*Velocity amplitude according to the operating mode with sensor mounted on Z vertical – small mass (advance on x direction – textile fabric)*

Standards in this area indicate that it is appropriate that on any measuring direction should be considered the lowest value of the vibration amplitude.

Waveforms and frequency spectrograms obtained for embroidery machine "HAPPY" - (smaller mass) recorded at the measuring point PT1, on the vertical measuring Z direction (sensor mounting direction) and material advance in the x direction (fabric – textile fabric) are listed below:

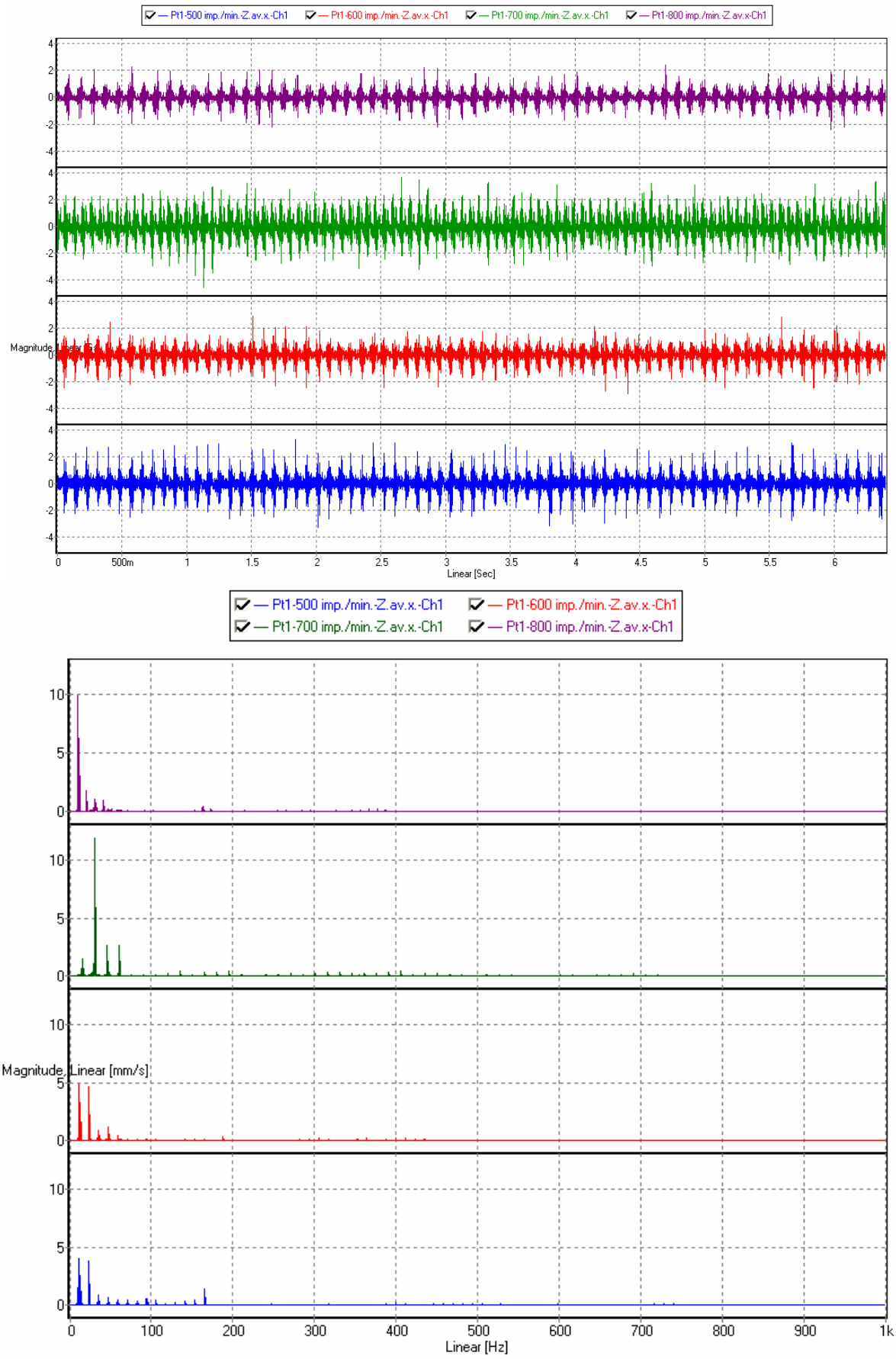

Fig. 8: *Waveforms and frequency spectrograms recorded in measuring point Pt1, on vertical measuring Z direction – (small mass) and material advance in the x direction*

As a result of teh spectral analysis the following were noticed:

a. For 500 stitches/minute operating mode we notice that, the spectral components are relatively similar as dimesion with those of the working regime 600 stitches/minute and the amplitude of vibration velocity has the lowest value 4 mm/s. The disadvantage of this working regime consists in a low productivity.
b. For 600 stitches/minute operating mode in the frequency spectogram can be noticed that bot spectral compoments (1x, 2x) have values aproximatively 5 mm/s, resulting in an increase of global amplitude of vibration velocity reaching the value 4.5 mm/s.
c. For 700 stitches/minute operating mode we can notice in the frequency specrum a significant increase of spectral component 2x over 12 mm/s as well as a slight increase of spectral components order 3 and 4, thus registering an increase of global vibrations over the value 12.9 mm/s. In conclusion this working regime is not recommended because it would lead to decreaseing the machine's reliability.
d. For 800 stitches/minute operating mode we can notice in the frequency spectrum a significant increase of the spectral component 1x over 10 mm/s as well as a decrease of spectral components of 2,3 and 4 order, thus registering an increase of global vibrations.

3. CONCLUSIONS

Following the research performed on HAPPY embroidery machine it was found that the importance of mounting the embroidery machine on a large table and a rigid base has a great influence on the reliability of the machine and implicitly the default operating mode.

At 700 stitches/min operating mode established as optimal by the authors, it is noted that when changing the embroidery machine and its base, the overall vibration level reaches 12.9 mm /s. During this mode is not recommended to work due to the large amplitudes of vibrations which will lead to significantly reducing the reliability of the machine.

When functioning on a small table and a less rigid base, the optimal operating mode of an embroidery machine is 600 stitches/minute because the overall vibration amplitudes have the lowest value. It was found that in this mode and productivity is relatively low.

Hence it can be concluded that for small operating modes the embroidery machine mounted on a small table, the overall vibration level is lower, but the disadvantage is that the productivity is low too.

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