Cylinder Gap Shock and its Impact on Quality of Prints in Offset Printing Technique

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There are many factors in offset printing technique, which determine the final quality of the printouts. Next to ink, dampening liquid and paper properties, significant role plays here construction of printing unit and its technical condition.
Many works, where problem of vibrations was investigated, point canals in plate and blanket cylinders as source of vibrational excitation in printing unit. The canals may generate vibrations of inking and dampening rollers, as well cylinders themselves. If wear of bearings, looseness and unbalance of rotating cylinders and rollers will be additionally taken into account, there may be expected, that excited vibrations will seriously influence on the results obtained during printing process. Some undesired artifacts, for instance, cross stripes may be noticeable on the prints then.
The main scope of the researches presented in this paper was to find relation between vibrations in offset printing unit and their influence on quality of the printed image. For this purpose, while printing, measurements of vibrations of printing unit have been made. Afterwards printed test image have been precisely analyzed in search of undesired phenomena, which can be an effect of excessive vibrations in printing unit. Then comparison between position of the artifacts on the prints and the results of vibration measurements has been made. Effects of the experiment are presented in this paper.

Key words: vibrations, offset printing, printing machine, streaking

Introduction

Vibrations in machinery, especially in this with many rotating parts, are problem very common and widely discussed in scientific literature, for instance in reference [1]. There are also several works [2-5], which investigate problem of vibrations of offset printing presses, that are most often used in graphic industry. Great advantage of these machines is excellent quality of the prints, i.e. good reproduction of colours and details of images.

However, construction of those machines may be the reason of undesired phenomena, for instance, streaking.

Streaking is a problem, which is caused by disturbances in ink transfer within printing unit. It reveals on the prints in a form of stripes parallel to the cylinder's axis. These stripes may significantly deteriorate quality of images, especially those, where broad surfaces are evenly covered with the ink. Problem of streaking is mostly noticeable there.

The most often spotted source of streaking are gaps in plate and blanket cylinders [2,5,6], which are shown in figure 1. In these gaps, locks for fixing printing plate and offset blanket (sheet of multilayer composite made of rubber and textile) are located.

During printing, plate and blanket cylinder are pressed each other. At the beginning of gaps, pressure between cylinders suddenly falls down to zero (contact between cylinders disappear) and afterwards immediately grows up to the maximum when cylinders again get into the contact. This phenomenon, called *cylinder gap shock* (CGS) generates vibrations of cylinders. In consequence plate inking and dampening rollers may be excited to vibrations as well. Thus they may also become the reason of streaking phenomenon.

Some works, in which problem of cylinders' vibrations was investigated, emphasise influence of CGS on the quality of the prints. However, none of them explains, how in fact CGS affects on the process of ink transfer in printing unit, which is crucial in investigations of streaking phenomenon.

In this script attempts to find relation between vibrations of cylinders as well as other printing unit's elements and the intensity of streaking phenomenon are presented.

Experiment

The experiment was carried out on the Romayor 314 offset printing press. This machine is construction of the old type, i.e. cylinders does not have cylinder bearers (rings on the cylinders' edges, which role is to reduce vibrations, see fig. 1). This type of the printing press has been chosen, because of simplicity of its construction. It was supposed that analysis of such printing unit would be helpful in recognition and evaluation of factors that influence on quality of the prints.

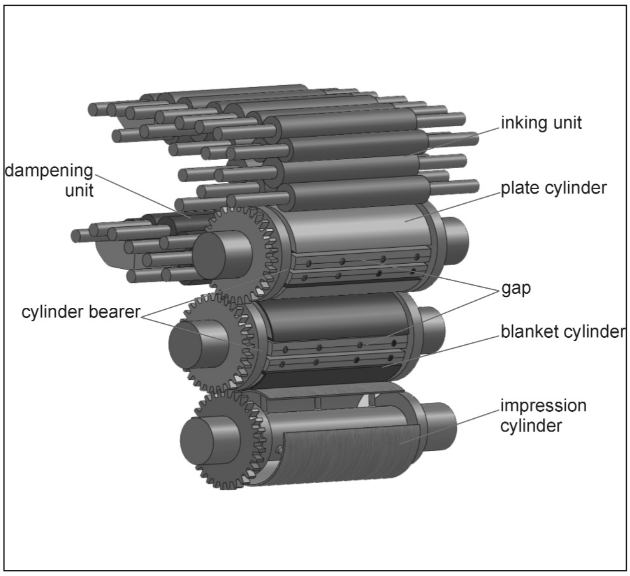


Figure 1 Offset printing unit

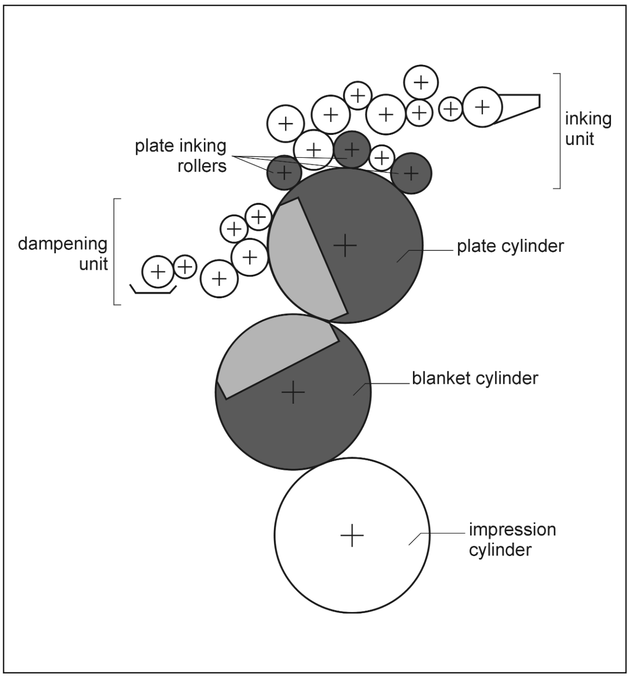


Figure 2 Printing unit of Romayor 314 printing press and its parts investigated in experiment (shadowed)

Measurement system that was used in the experiment consisted of: two accelerometers, data acquisition device, PC computer with LabView Signal Express® software. Data were analysed with Matlab® and NI Diadem® software.

The use of two accelerometers made it possible to analyse simultaneously vibrations of two different parts and their influence on each other. In the experiment, vibrations of plate and blanket cylinder as well as plate inking rollers were taken under consideration. These elements were analysed in the following pairs: plate-blanket cylinder, plate cylinder-inking roller. We had to resign form measuring of vibrations of impression cylinders, because there was no space available to mount accelerometer on it.

Figure 2 presents printing unit of Romayor 314 printing press and the elements, which were investigated during experiment.

Measurements of vibrations were carried out with three different printing speeds: 45,5 [rpm] (minimal possible), 70[rpm] (50% of maximal speed) and, 95 [rpm] (80% of maximal speed). During measurements the test image was being printed. Parameters of this image and printing process are shown in Table 1.

The printed test image was scanned in a gray scale with resolution equal to the screen ruling. In that way we obtained matrix of pixels, where certain pixel corresponds to one screen dot and its tone value (TV; parameter, which informs how dark or bright the colour is). Afterwards tone values data of every three neighbouring pixels have been averaged Such attitude let us analyse image with high precision of 0,5mm.

Results of experiment

Figure 3 presents variations of tone values (TV) in dependence on position on the print and printing velocity.

Table 1 Parameters of printed test form and printing process conditions

Test form	
Parameter	Value
Tone value	70%
Screen dot	Round
Screen angle	0°
Ruling	150lpi
Printing process	
Parameter	Value
Papers	Gloss-coated, white, mass per area: 115gsm Uncoated, white, mass per area: 120gsm
Ink colour	Cyan
Printing velocity	45,5 [rpm], 70 [rpm] 70 [rpm], 95[rpm]
Dampening	Minimal possible
Colour of full tone patch	In accordance with ISO 12647-2

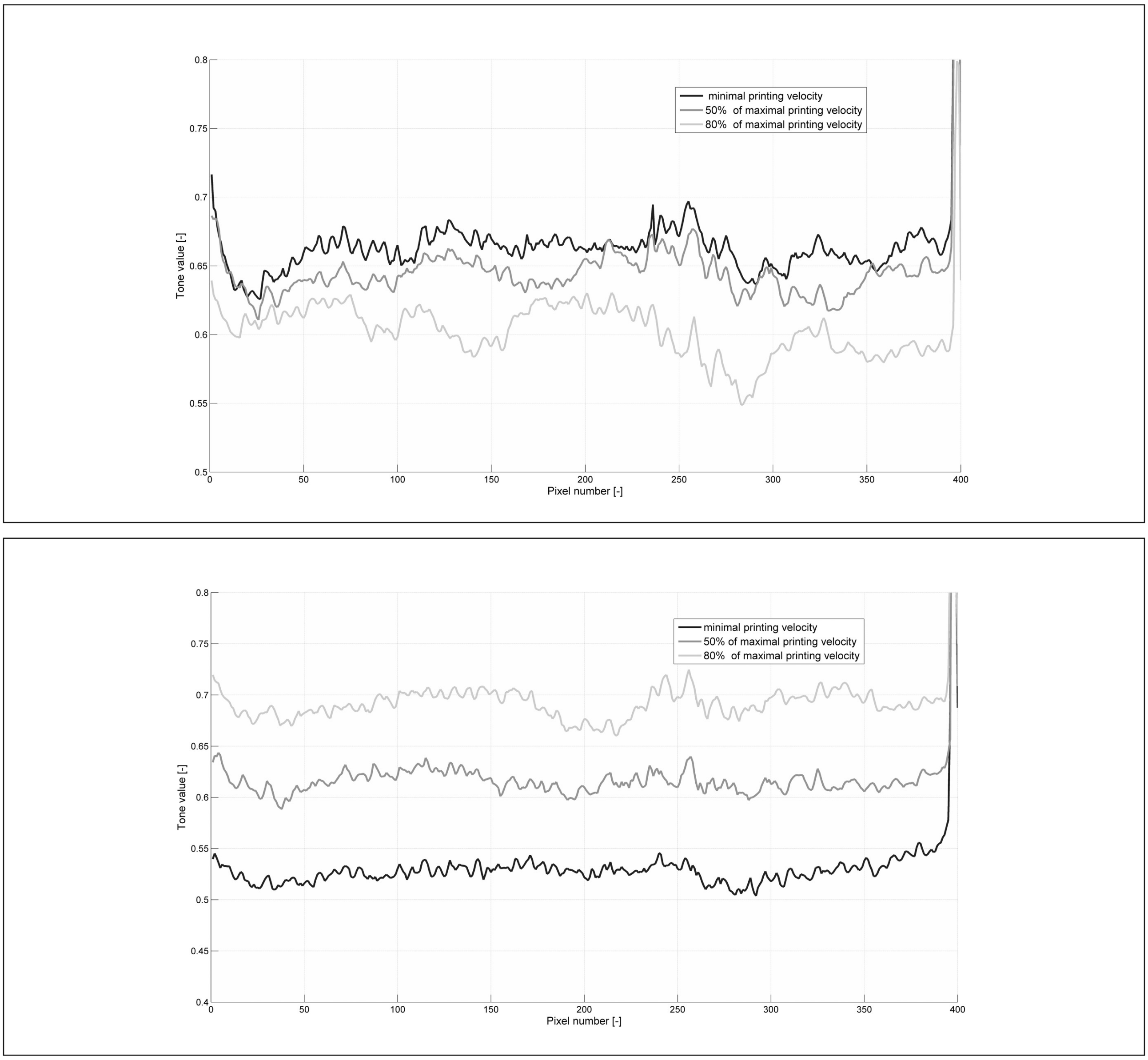


Figure 3 Variations of tone value in dependence on printing velocity for coated (a) and uncoated (b) paper

TV on the image should be equal through the whole paper length, but, as one can see, they vary a lot. One of the most important sources of these fluctuations may be vibrations of printing unit.

For coated paper (fig. 3 (a)) fluctuations of tone values are distinctly bigger than for uncoated one (fig. 3 (b)). In Table 2 variances of tone values for both analysed papers and different printing velocities are presented. We can see that TV variance on coated paper, for maximal analysed velocity, is almost two times bigger than for the lowest one. The difference for uncoated paper is only one half times. An explanation for this situation may be better smoothness and lower ink absorptivity of the surface of coated paper. Another reasons of such differences between images printed on both papers may be higher elasticity and better vibration damping properties of uncoated paper.

Figure 4 presents measurements of vibrations of plate and blanket cylinder within one cycle of printing (one revolution of cylinders). Diagram shows exemplary results, obtained for velocity 95rpm (80% of maximal printing speed), but there is visible strong correlation between vibrations of both cylinders for all three analysed velocities.

Such excessive vibrations may influence on the process of ink transfer between cylinders. The question is, what is correlation, if any, between cylinders vibrations and position of stripes on the prints. Figure 5 shows these relations for plate and blanket cylinder.

As diagrams in figure 5 show, there are many peaks of tone value along the printed paper, which often do not correspond to peaks of cylinders vibrations. This discrepancy is especially visible in diagram (a) and (d), where streaking (TV fluctuations) is significant, but there are almost no characteristic amplitudes on the vibration curves. When

Table 2 Variance of tone values for coated and uncoated paper and several printing velocities

Printing velocity [rpm]	Uncoated paper	Coated paper
	Variance	Variance
45,5	1,03e-4	1,6e-4
70	0,9e-4	1,7e-4
95	1,5e-4	3,1e-4

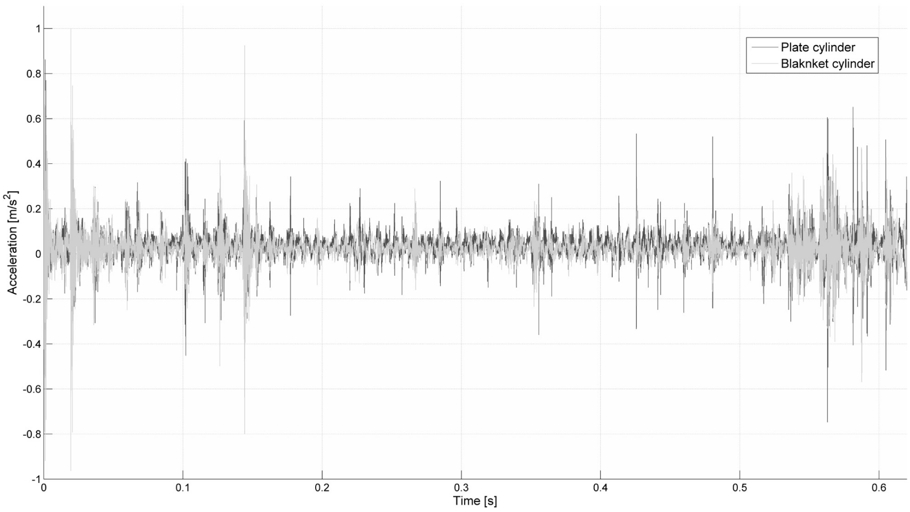


Figure 4 Vibrations of plate and blanket cylinder

analysing diagrams of two higher velocities, one can see that in some cases, tone value peaks correlate with vibrations, however, this relation is not very strong. This situation may take place, because of consistent displacements of cylinders. In other words, although amplitudes of vibrations of both cylinders are significant, the relative displacement between them is small. Hence vibrations do not have huge influence on ink transfer between cylinders and, in result, on strengthening of streaking.

Elasticity and compressibility of the blanket may also be the factor, which depreciates influence of vibrations on intensity of streaking phenomenon.

At the beginning of each cycle presented on diagrams of figure 5, we can see high frequency vibrations with large amplitudes, which are most likely related to the cylinder gap shock. These intensive vibrations correlate with very high and rapidly decreasing tone values. In result we can observe wide dark stripe on the print.

Measurements performed on inking rollers showed, that plate cylinder excites rather small vibrations in the rollers, i.e. peaks were slightly higher than level of signal noise. Influence of cylinder on the rollers varied for each roller and was most intensive for the middle one.

Correlation between vibrations of inking rollers and tone value peaks on the print is ambiguous. Results of measurements are presented in fig. 6.

Conclusions

The experiment revealed complexity of the streaking problem. Results of the measurements show that there may be correlation between vibrations of plate and blanket cylinders, inking rollers and the intensity of streaking phenomenon. However, the influence of vibrations of these elements on the uniformity of ink transfer is very difficult to be distinguished and evaluated. Tone value variations on the prints show that hereinabove mentioned elements of printing unit are not the only factors, which contribute to forming streaking phenomenon.

Experiment also showed how different types of paper and printing velocities affect on intensity of streaking phenomenon. The growth of tone value variance on coated paper, which surface is hard and smooth is significantly higher than on the rough and soft uncoated paper. In result stripes on the printed image are more visible on coated paper.

Results of experiment let us suppose, that elasticity and damping properties of paper (especially uncoated one) as well as offset blanket may meaningfully reduce intensity of streaking phenomenon.

There are further investigations needed to find reasons and to evaluate contribution of printing unit's elements to forming streaking phenomenon.

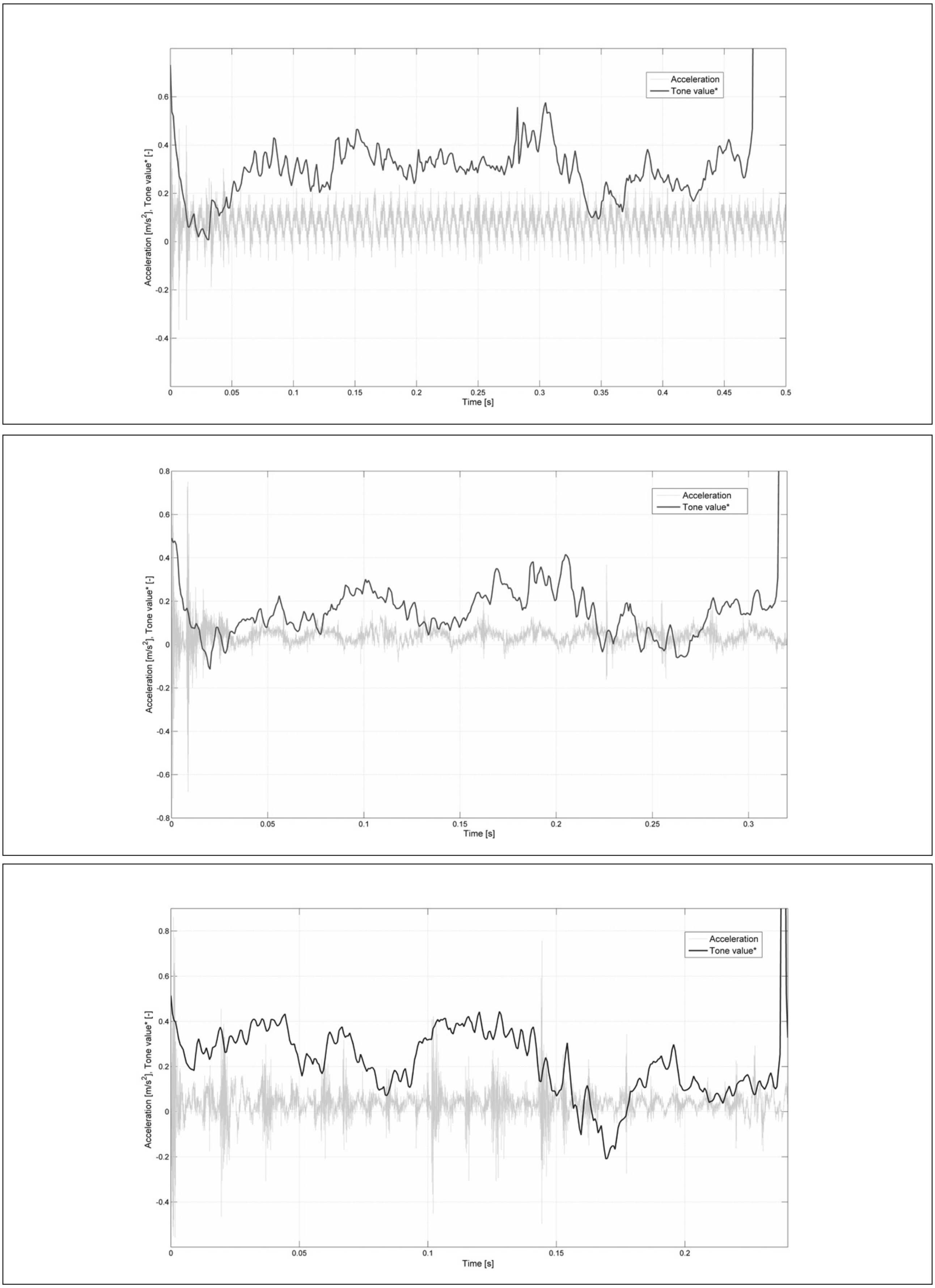
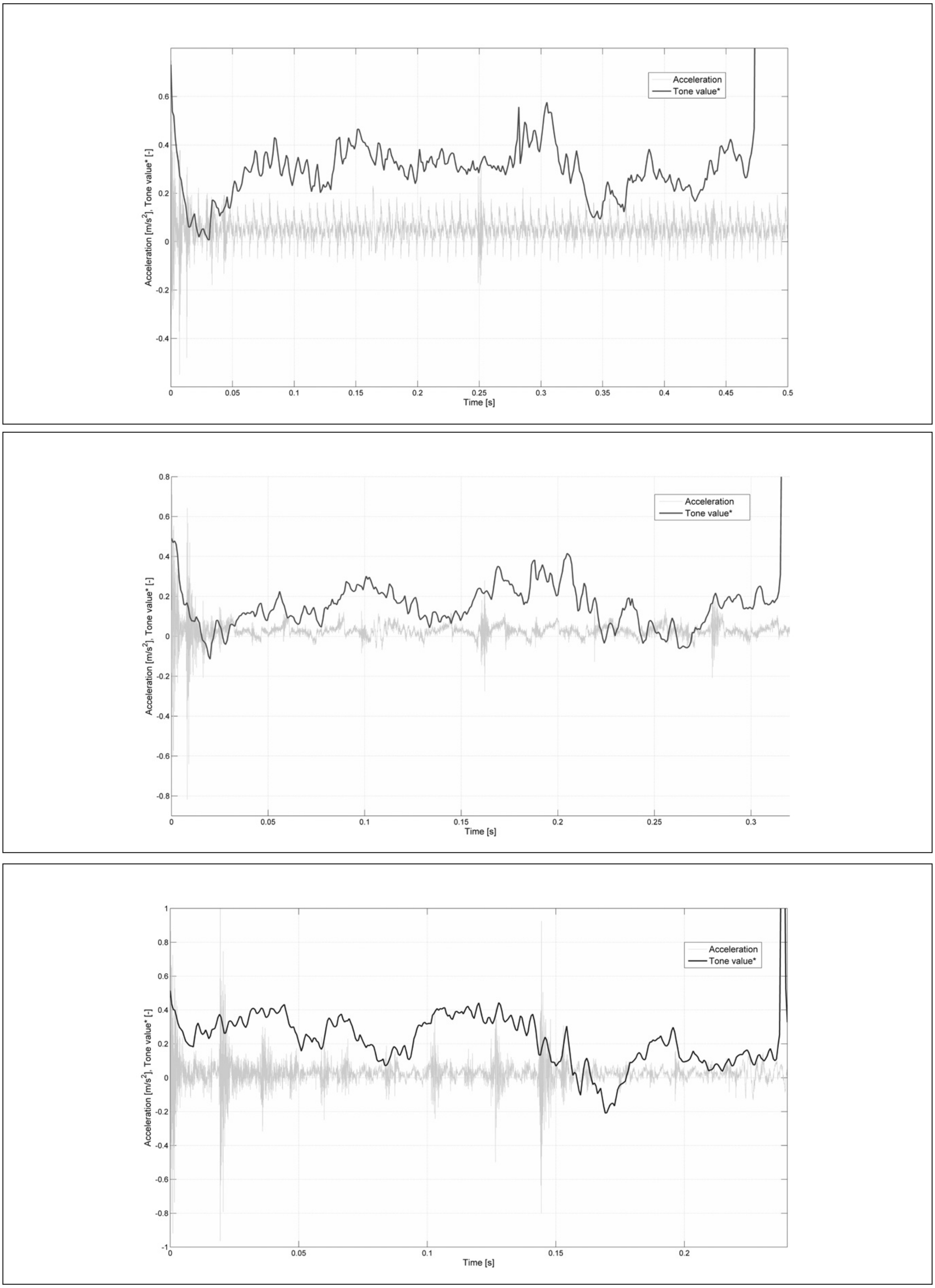


Figure 5. Vibrations of plate (a-c) and blanket (d-f) cylinder and changes of tone value on the prints for velocities: minimal (a, d), 50% of maximal (b, e) and 80% of maximal (c, f)



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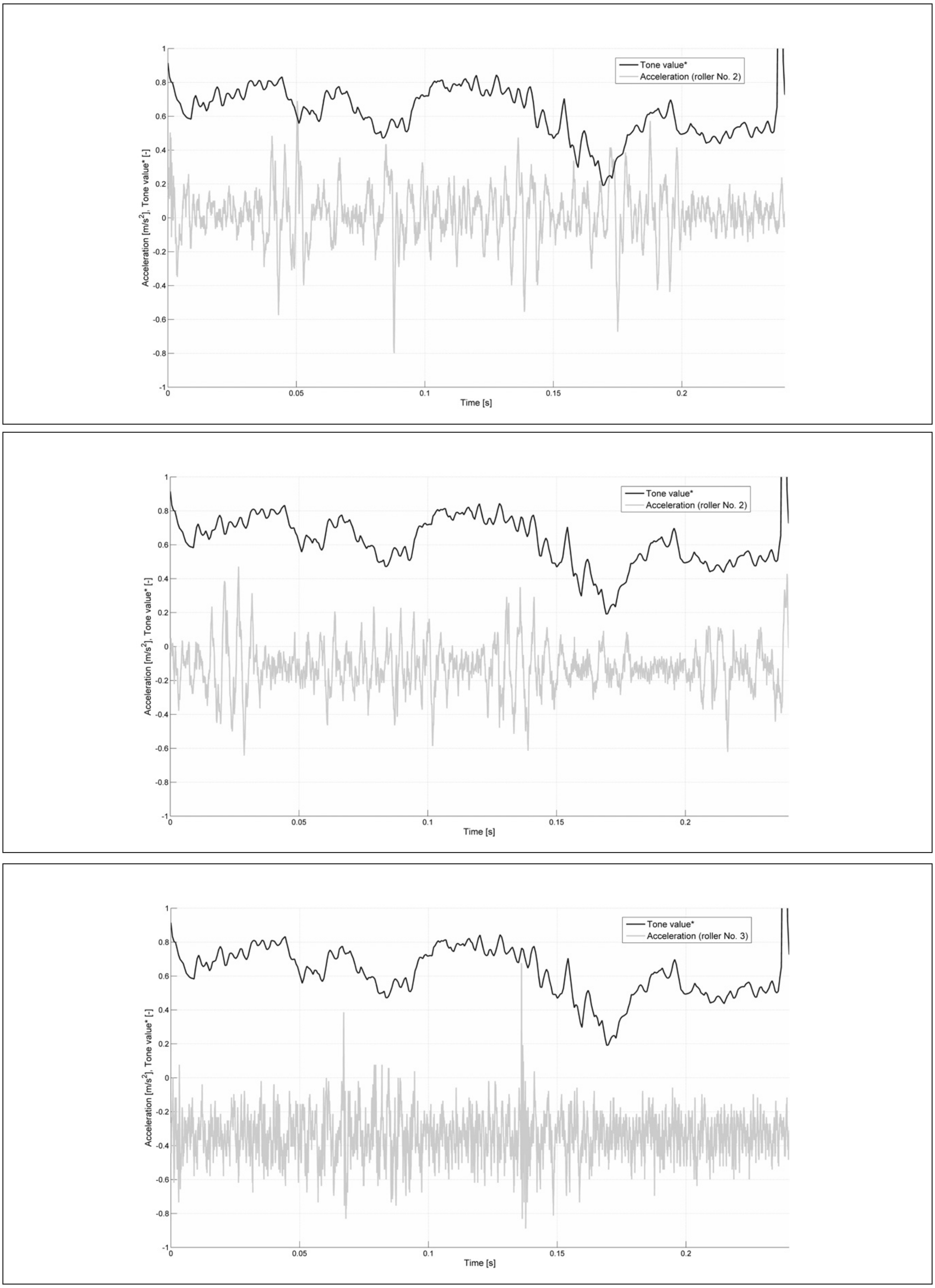

Figure 6 Vibrations of three inking rollers and tone value variations (80% of maximal printing velocity)

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