VERIFICATION OF TAPPING MACHINES

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ABSTRACT

Six tapping machines of three different models have been verified. Only one of them was fulfilling the specification. All the others fail in at least one of the tests, such as velocity at impact, interval of impact or hammer head dimension.

The high ratio of tapping machines not fulfilling the specification any more points out the need for regular verification.

1. INTRODUCTION

The requirements for tapping machines are specified in annexes to ISO 140-6 to 8 [1]. They are mechanically defined such as number and mass of hammers, angle, timing and velocity of hammer impact, etc. According to ISO 140, some of the parameters only need to be determined once and some should be verified regularly.

A procedure for regular verification of tapping machines has been established at SP. Verification measurements have been made on a batch of two machines of each model B&K 3204, B&K 3207 and Norsonic 211. Two of them were very old, three of them have been used for a while and one was almost brand new.

2. METHODS AND RESULTS

2.1. General

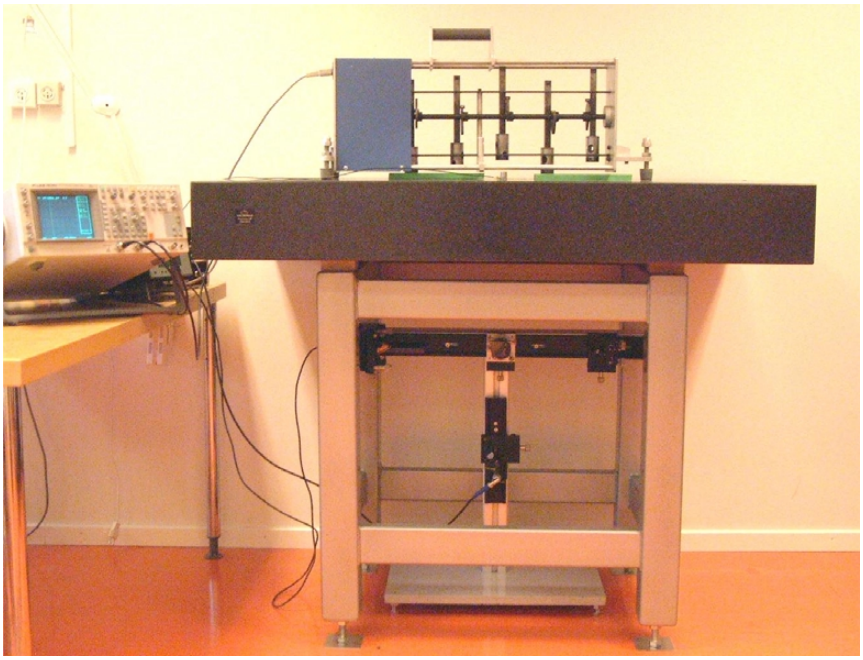
ISO 140 requires that the tapping machine is verified on a test surface that is flat to within ±0,1 mm and horizontal to within 0,1°. To comply with that requirement the tests at SP are carried out on a polished stone table with a mass of 500 kg, designed for precision dimensional measurements.

Besides the tests described below, checks for exceptional sounds are made by listening.

2.2. Impact momentum

The momentum of each hammer that strikes the floor shall be of an effective mass of 500 g, which falls freely from a height of 40 mm. The momentum tolerance is 5 %. As friction of the hammer guidance is not negligible, the hammer velocity at impact has to be measured.

The method used at SP for measuring falling velocity is laser interferometry. A retroreflecting tape is fastened to the impact surface of the hammer, which is positioned over a hole in the stone table. Below the table the laser interferometer beam is pointing at the retroreflector through the hole in the table, measuring the falling velocity.



Picture 1. Test table with laser interferometer below.

As mentioned above, the impact momentum is a function of mass of hammers and velocity at impact. For all tested tapping machines, the mass of hammers were within tolerances. However, three of the tapping machines had at least one hammer with a velocity outside the tolerance. The result of the velocity measurements of the six tapping machines is given in figure 1. The fact that the brand new tapping machine has all its hammers in the two right bars in the figure indicates that the friction of the hammer guidance increases by the use of the machine.

Cleaning and greasing the hammer guidance according to the manufacturer's manuals did not in all cases bring the falling velocity within the tolerance. In some cases the falling height had to be adjusted to a level above the length of the height adjusting rod, supplied with the tapping machine.

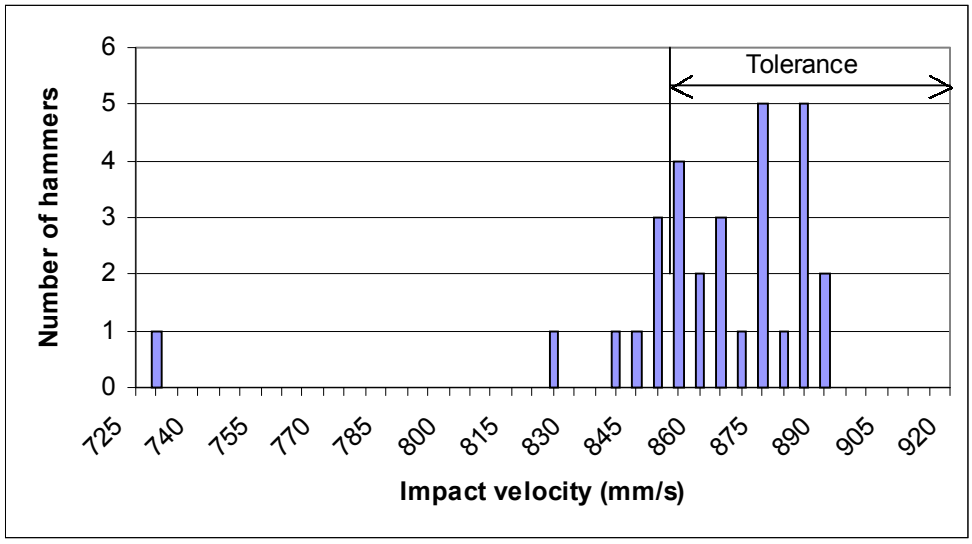


Figure 1. Results of impact velocity measurements.

2.3. Impact interval

According to ISO 140, the time between successive impacts shall be 100 ±20 ms and the mean time between impacts shall be 100 ±5 ms.

The method used to measure the impact timing requires that an accelerometer and a storage oscilloscope are used. The accelerometer is placed on the table with the same distance to the two successive hammers to be measured. All the other hammers are damped.

The results of the impact interval measurements of the six tapping machines are given in figure 2a and 2b. The five hammer pairs outside the tolerance belong to the same tapping machine.

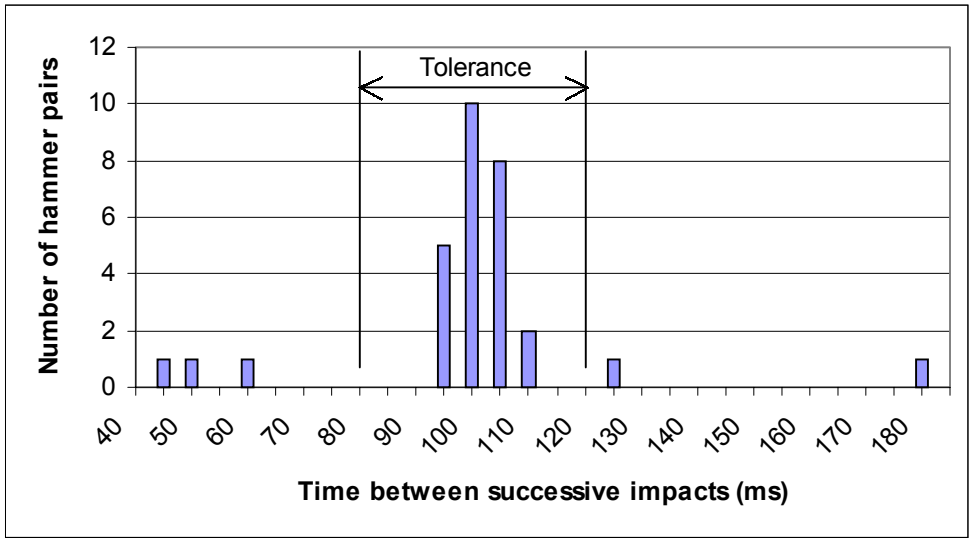


Figure 2a. *Results of impact interval measurements.*

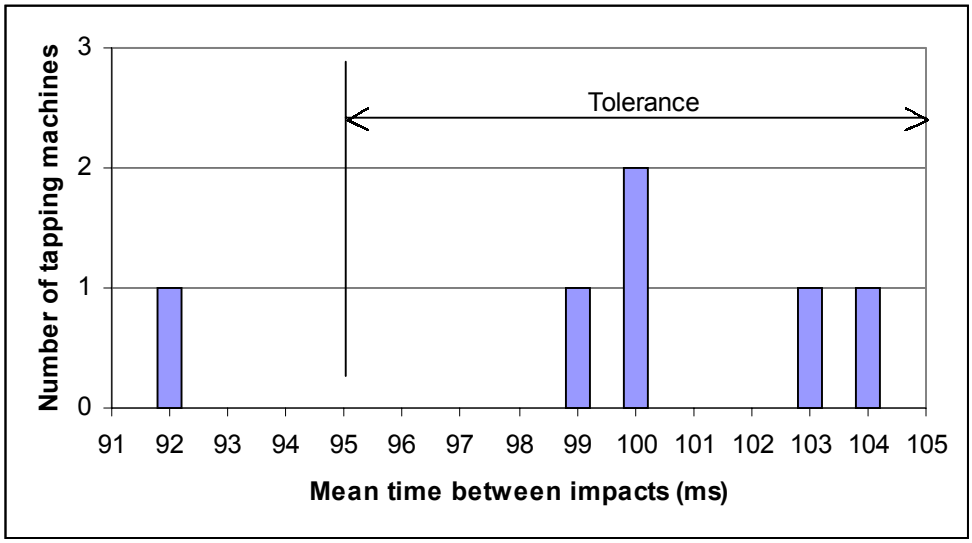


Figure 2b. *Results of mean impact interval measurements.*

2.4. Hammer head diameter and curvature

The tip of the hammer shall be spherical with a radius of curvature of 500 ±100 mm. The diameter of the hammer heads shall be 30 ±0,2 mm.

The curvature measurements are carried out using a surface roughness instrument at the department for dimensional metrology at SP. The curvature is measured along two perpendicular lines through the centre point of the hammer tip. The curvature radius is determined using the least square method.

The results of the curvature radius measurements of the six tapping machines are given in figure 3.

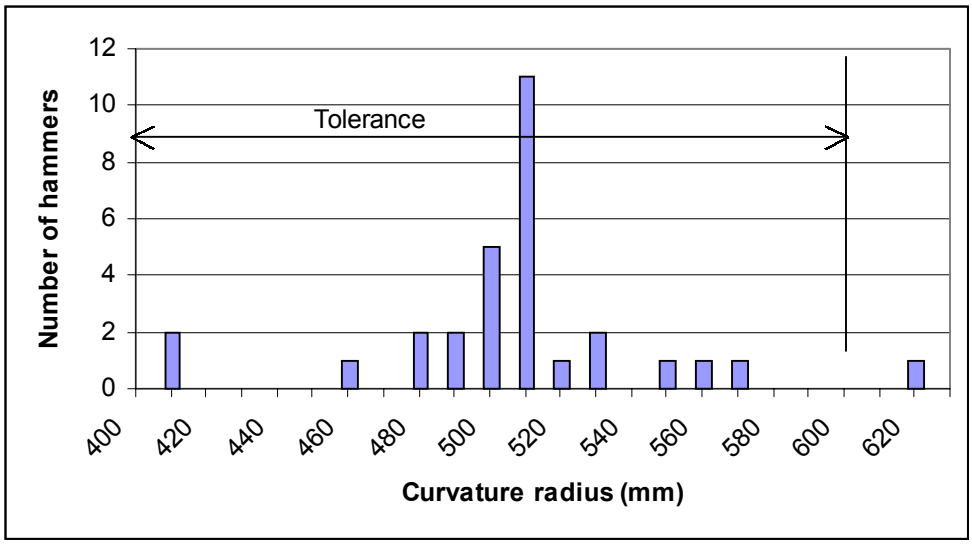


Figure 3. *Results of hammer tip curvature measurements.*

The diameter of the hammer heads are measured using a micrometer.

The results of the hammer head diameter measurements of the six tapping machines are given in figure 4. The hammer outside the tolerance had visual damages close to the rim.

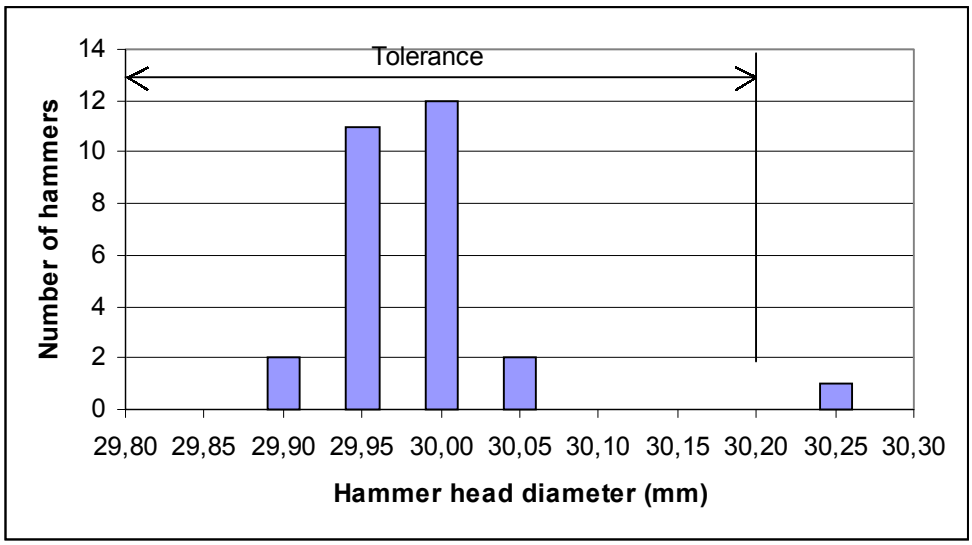


Figure 4. *Results of hammer head diameter measurements.*

2.5. Falling direction

The falling direction of the hammers shall be perpendicular to the test surface to within ±0,5°. The method used means that the blade of an angle meter is aligned to the vertical envelope surface of the hammer. To give space for the angle meter the tapping machine is placed on distance cylinders.

All six tested tapping machines had falling directions within the required tolerance.

Picture 2. *Measurement of falling direction.*

3. CONCLUSIONS

The high ratio of tapping machines, five of six tested, found not to fulfil the requirements of ISO 140 any more points out the need for regular verification. Checking the falling height with the supplied height adjustment rod is not always sufficient due to increased friction of the hammer guidance. The verification interval needed is dependent on the time and environment of use but should not be more than three years.

4. REFERENCES

[1] ISO 140 Acoustics – Measurements of sound insulation in buildings and of building elements, part 6-8, Annex A.