Causes and Cures for Washboarding in Bandsaws

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Background

The guidelines contained in this document were developed as a result of a collaborative research study between the University of British Columbia and Forintek Canada Corp. funded by the National Science and Research Council of Canada, the Canadian Forest Service, and Forintek Canada Corp. Although much valuable data have been obtained during this study, more research is required in order to obtain a complete understanding of washboarding. The recommendations given in this document were found to be effective for a 1.5m bandmill running 16, 17 and 18 ga. blades, but can be expected to be helpful for other sized mill also.

Introduction

Washboarding is a result of excessive tooth vibrations that occur at a natural frequency of the blade. The most important characteristic of the phenomenon is the relationship between the tooth passing frequency and the excited natural frequency. The tooth passing frequency is the number of times per second that a new tooth impacts the wood (its value equals the number of teeth on the blade multiplied by the number of times the band rotates in a second). The determination of the natural frequency of the blade is extremely difficult because it is effected by the gullet shape, the blade width and thickness, the length of cutting span, the tension, the strain, and the blade speed. However not all these variables effect the washboarding equally, and in some cases it may be that a given variable has no effect on the washboarding.

In the laboratory testing two distinct washboarding patterns were obtained. They are labeled as Type I and Type II. Type I washboarding is the one usually found in a mill with the washboarding pattern at about 45 degrees. Type II washboarding is usually associated with small bites and the pattern is almost vertical.

The variables that have been found to affect the washboarding include: tooth profile, plate thickness, bite, depth of cut, wheel rotation speed and strain. The effect of these variables will be discussed and guidelines for the elimination of washboarding given.

Effects of Primary Variables

In this section, the effects of primary variables on the washboarding extent, severity and region will be discussed. Washboarding extent is described by the percentage of the board that has washboarding. Washboarding severity is graded in words: Faint, Light, Medium and Heavy. A washboarding region refers to a wheel rotation speed range in which washboarding occurs. In the middle of a washboarding region, the washboarding extent is
usually high and the pattern is most pronounced. On the lower and upper bounds of the region, washboarding extent is low and the pattern is faint.

**Tooth Profile**

Cutting tests conducted with blades of different tooth profiles demonstrate that washboarding becomes more pronounced with an increase of the gullet depth or the hook length. As shown in Figure 1, there is no washboarding for the original 16 ga. blade. Faint washboarding (5~25%) occurs in a very small speed region after the gullet is ground by 1.5mm, i.e. $g = 1.5\text{mm (1/16")}$. Faint to medium washboarding (25~50%) is induced in a wider speed region after the hook is ground by 1.5mm, i.e. $h = 1.5\text{mm (1/16")}$. More pronounced washboarding (50~80%) occurs with further grinding. Finally, heavy washboarding (>80%) and wide washboarding regions are induced when both the gullet and the hook are ground by 3mm(1/8") from the original profile. It is seen that the washboarding region and the maximum-washboarding-extent increase with increasing gullet depth and hook line length. As one might expect, the rotation speed, defined as the wheel rotation speed at which the heaviest washboarding is induced, decreases as increased values of ‘g’ and ‘h’ weaken the teeth.

![Figure 1 Variation of washboarding extent with speed for a 16 ga. blade with different modifications (Strain = 63kN, Bite=0.11mm, Depth of Cut =.28m)](image)

*Plate Thickness and Width*

Experimental results for the cutting tests with the 16, 17 and 18 ga. blades demonstrate that a thinner blade is more likely to experience washboarding and this washboarding occurs in a lower speed region.
Bite

Figure 2 shows the variation of Type I washboarding extent with bite for the modified 16 ga. blades at the given wheel rotation speeds and the given depth of cut (.28m). It is seen that the washboarding increases with the bite if the bite is small and decreases with the bite if the bite is large enough.

![Figure 2 Variation of washboarding extent with bite for a 16 ga. blade with three gullet modifications (Strain=63kN kN)](image)

Depth of Cut

Figure 3 shows the washboarding extent and speed region for the 16 ga. blade with the depth of cut ranging from .15m to .31m. If the depth of cut is less than a certain value, there is no washboarding for the blade. The washboarding extent and the washboarding region both increase with the depth of cut. The speed corresponding to the maximum washboarding extent for different depths of cut does not change.

Wheel Rotation Speed

The washboarding extent varies with the wheel rotation speed, or the tooth passing frequency, for given bite and depth of cut. Figures 1, 3 and 4 show the variation of Type I washboarding extent for the 16 ga. blades with the wheel rotation speed for the given strain of 63kNlbs. In these cases, the washboarding extent has a maximum value at a certain speed and it decreases with either an increase or a decrease of this speed.

Strain

Figure 4 shows that the variation of Type I washboarding extent for a modified 16 ga. blade (g = 3.0mm (1/8"), h = 1.5mm (1/16")) with wheel rotation speed for a given bite of 1.1mm and three different strains (45, 63 and 81kN). The washboarding region extends to higher wheel rotation speeds as the strain increases.
Figure 3 Variation of washboarding extent with speed for different depths of cut

Figure 4 Variation of washboarding extent with speed for different strains
Suggested Modifications

Based on the previous results, the following suggestions are made to help minimize the effect of washboarding in bandsaws.

Change of Strain

If light washboarding is induced, the operating speed may be close to the bounds of a washboarding region. The washboarding may be reduced or eliminated by increasing or decreasing the strain by 18 ~22 kN. On the other hand, if this action does not work, or the washboarding is medium or heavy, it means that the operating speed is in the middle of a washboarding region. Under these conditions, it may be hard to get rid of the washboarding by changing the strain.

Change of Plate Thickness

For a given bite and a given depth of cut, a thinner blade is more likely to give rise to washboarding. Thus a thicker blade may reduce the washboarding. If the tooth profiles (the hook and the depth of gullet) of the two blades are similar and the thicker blade runs with a bigger bite, the washboarding may not be reduced.

Modification of Gullet Profile

Compared with changes to the wheel rotation speed, and the bite, modifying the tooth profile is the most effective method for reducing washboarding. If light washboarding occurs, the hook length and the gullet depth should be reduced by 1.5mm (1/16”). If the washboarding is heavy, the hook length and the gullet depth should be decreased by 3.0mm (1/8”). It is noted that the modifications of the tooth profiles do not greatly reduce the gullet area. The modified blade can therefore run at the same feed speed or the same bite.

Change of Bite

Type I washboarding may be reduced by decreasing the bite if the bite is small, but this is not likely to be a practical solution. Type II washboarding may be eliminated by increasing the bite.

Change of Blade Speed

It has been found that washboarding usually occurs in a specific wheel rotation speed region. If faint or light washboarding occurs, the washboarding may be eliminated by a 5~8% increase or decrease of the operating speed. Unfortunately, it cannot be predicted beforehand if an increase or a decrease will work. If heavy washboarding is encountered, the speed may need to be varied by 10%.