Chip Flow and Shape Generated in Milling of Wood-Based Materials by Helical Cutting Tools

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A. INTRODUCTION

The conventional cutting tool (straight edge configuration) generates an extreme flight speed of the formed chips which causes dust emission. A helical cutting tool has been developed to improve the performance of conventional cutting tool, however the previous researches were limited to the helix angles between 0° and 45°. Therefore, an extreme helix angle of cutting tool edge has been developed and their performance in reducing dust emission was tested in this research. Though the theoretical principle of helical cutting tool has a great promising to reduce dust emission for cutting metal and solid wood, however investigations and tests should be performed for better description of the performance in cutting wood-based materials, and to prove the potential of the developed new helix angle of cutting tool in the near future.

B. OBJECTIVE

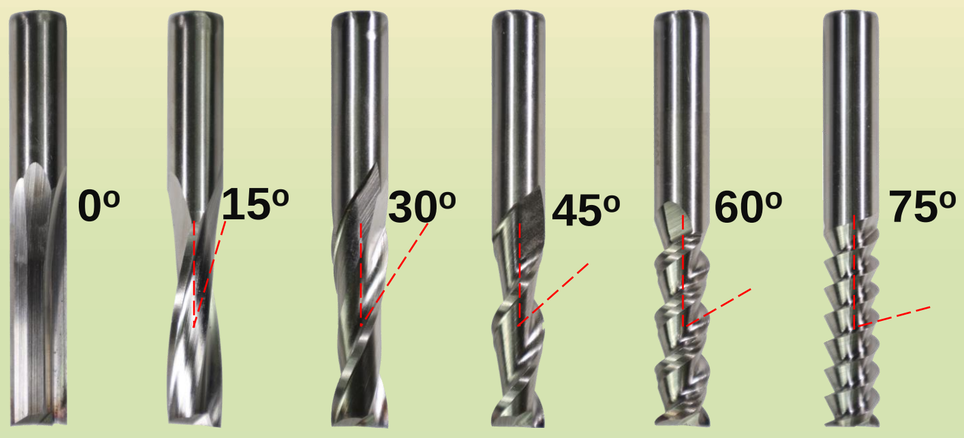
The purpose of this research was to investigate chip flow and shape generated in milling wood-based materials (wood plastic composite/WPC, laminated veneer lumber/LVL, and oriented strand board/OSB) using helical edge cutting tools.

3. Milling Test Condition

Adjusted parameters	Condition
Milling process	Up-milling, down-milling
Cutting speed (m/s)	12.6
Spindle speed (rev/min)	20000
Feed speed (m/min)	2, 3, 4
Cutting width (mm)	1
Cutting depth (mm)	20
Total cutting length (mm)	600

C. MATERIALS AND METHODS

1. Cutting Tools Tested



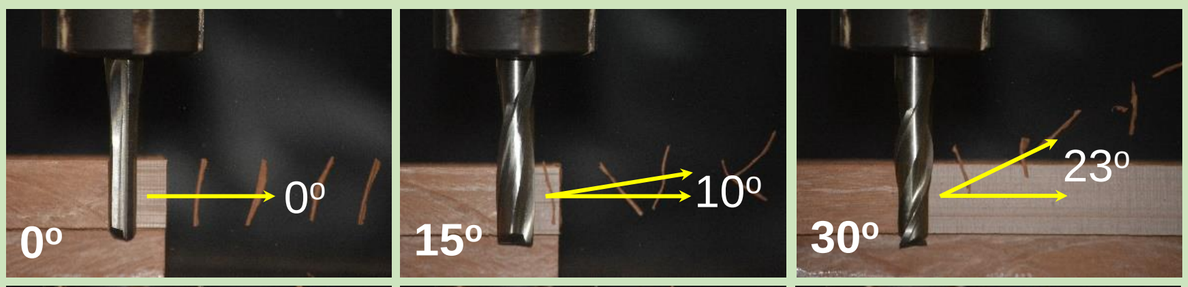
2. Cutting Tools Specifications

Cutting tool material	M2 high-speed steel
Hardness	640 HV
Cutting circle diameter	12 mm
Shank diameter	12 mm
Number of cutting edges	2
Total length of router bit	80 mm
Geometry of the edges	
Helix angle	0°, 15°, 30°, 45°, 60°, 75°
Rake angle	22°
Clearance angle	15°

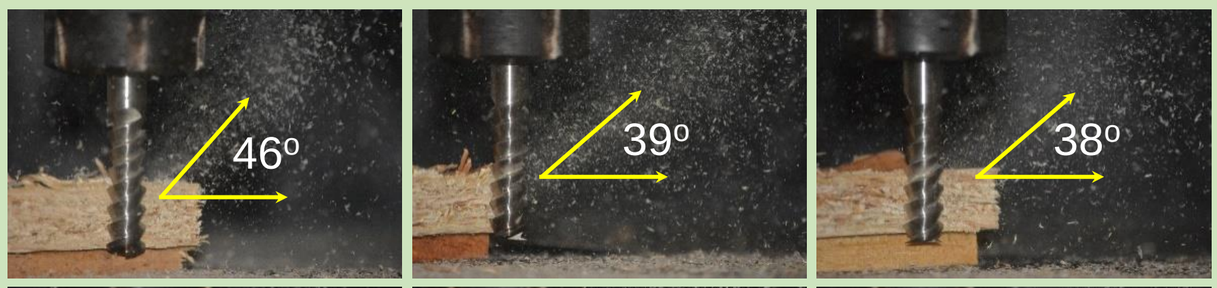
4. Workpiece Specifications

Wood-based materials	MC (%)	Density (kg m^{-3})	MOR (MPa)	Hardness (N m^{-2})	Silica content (%)
WPC	2.1	135	28	3.64	5.09
LVL	10.4	83	80	5.23	0.73
OSB	11.2	59	20	1.41	0.01

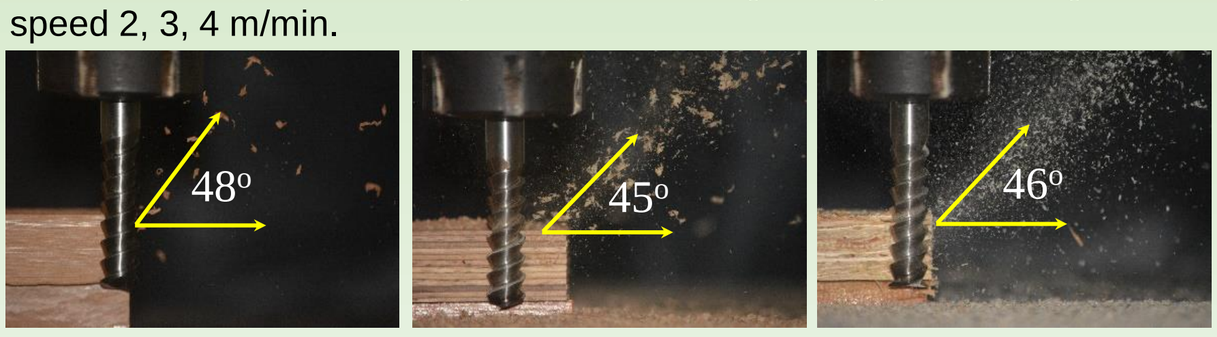
D. RESULTS



With increasing the helix angle, the chip flow angle to the tangential direction became larger, the sector area of the chip flow became smaller, and the speed of flow was observed to be lower



The flow area in up-milling (upper) was larger than in down-milling (lower). Increasing of feed speed resulted in a larger area of flow and was observerd to produce a higher speed during cutting. Left to right: feed speed 2, 3, 4 m/min.



The flow area was different among the wood-based materials due to the difference in their structures. Left to right: WPC, LVL, OSB. Feed speed 3 m/min, 75° helix angle.

The chip shapes generated in cutting WPC (1), LVL (2), and OSB (3) were classified as continuous chip (a), flow chip (b), spiral chip (c), thin chip (d), granule/powder chip (e), and splinter chip (f).

E. CONCLUSIONS

The helical edge compared to the conventional edge cutting tool provides smaller chip flow area with nearly axial direction and lower flight speed, leading to easier handling for suction system. The down-milling is better than up-milling in producing smaller area of chip flow. The chip flow and shape phenomenon are almost similar among the feed speeds. The structure of the wood-based materials could take an important role in determining the chip flow and shape. The cutting tool edge of 75° helix angle due to its low in dust emission should be proposed for milling of the wood-based materials.

F. ACKNOWLEDGMENT

Thanks to Directorate of Higher Education (DIKTI), Ministry of Research, Technology, and Higher Education of the Republic of Indonesia for its financial support under grant number 1/E1/KP.PTNBH/2020.

G. DISCLOSURE STATEMENT

No potential conflict of interest on the presented poster