Chip Breakability in Turning of 7075 Aluminium Alloy with a High-Pressure Coolant Supply

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Journal of Physics: Conference Series 1510 (2020) 012009, IOP Publishing, doi:10.1088/1742-6596/1510/1/012009, pp. 1-8.
(Proceedings of 2019 The 10th Asia Conference on Mechanical and Aerospace Engineering, Chulalongkorn University, Bangkok, Thailand, December 26-28, 2019)

INTRODUCTION

Because of its extremely high strength to weight ratio [1], 7075 aluminum alloy is used for highly stressed structural parts including aircraft fittings, gears and shafts and various other commercial aircraft, aerospace and transportation equipment [2]. The machinability of metals is estimated by the cutting force, tool life, surface finish and chip shape. Due to the strength and hardness of aluminum alloys, the cutting force and tool life are relatively unproblematic, and the chip breakability is the most important feature to ensure reliable operation in automated machining [3].

One improvement in chip cracking is the use of free-cutting alloys. Conventionally, Pb is added to aluminum alloys to improve the chip breakability. However, due to the negative impact on the environment, the addition of Pb has been banned in many countries. The addition of Si improves chip breaking performance [4]-[6], but when turning Si-added aluminum alloys with high speed steel tools, tool wear increases with the increase of Si contents [4]-[5], [7]-[8].

On the other hand, supplying coolant to the cutting area at high pressure improves chip breakability performance [9]-[11], and supplying high-pressure coolant to the cutting edge lowers the cutting temperature and reduces flank wear [12]. This method is also effective in reducing tool wear [9]-[11], [13]. Therefore, many studies on high-pressure coolant supply cutting of hard-to-cut materials such as hardened steel [14], titanium alloy [15]-[19], Inconel [12], [20], cemented carbide [21] have been conducted. However, there have been no reports on the effect of the coolant pressure on the chip breakability performance when aluminum alloys are turned with a high-pressure coolant supplied.

In this study, in turning of 7075 aluminum alloy with a high-pressure coolant supply, the chip configurations, the mass and thickness of chip were experimentally investigated.

CONCLUSIONS

In this study, in turning of 7075 aluminum alloy with a high-pressure coolant supply, the chip configurations, the mass of chip and the thickness of chip were experimentally investigated.

The following results were obtained:

(1) In the case of a cutting speed of 5.0 m/s, a feed rate from 0.05 mm/rev to 0.50 mm/rev and a depth of cut from 0.1 mm to 3.0 mm, chips were not broken at a feed rate of 0.15 mm/rev or less in the conventional coolant supply.
In the high-pressure coolant supply, the combination area of feed rate and depth of cut that can be broken chip was wider than in the conventional coolant supply. In the high-pressure coolant supply at a coolant pressure of 7 MPa, there is a combination area of feed rate and depth of cut that can be not broken chip. However, chips were broken in all areas at a coolant pressure of 20 MPa.

(2) In the case of both the high-pressure coolant supply, which has a coolant pressure of 7, 14 or 20 MPa, and the conventional coolant supply, the thickness of chip increased with the increase of the depth of cut. And, the thickness of chip did not change depending on the cutting method, namely the high-pressure coolant supply cutting method and the conventional coolant supply cutting method.

(3) In the case of both the conventional and the high-pressure coolant supply, the thickness of chip decreased with the increase of the cutting speed.

ACKNOWLEDGMENTS

We would like to thank TOKUPI Corporation for their support in the turning test, which enabled this work to be conducted. We would also like to express our gratitude to KYOCERA Corporation for supplying the indexable insert for turning and the external tool holder.

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