10th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2006, Barcelona-Lloret de Mar, Spain, 11-15 September, 2006

INFLUENCE OF DRILL GEOMETRY ON RESULTING PARAMETERS OF DRILLING PROCESS DURING MACHINING COMPOSITE MATERIALS

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ABSTRACT
The following errors are present during the drilling of composite materials: delamination, fuzzing, edge chipping, spalling, surface roughness, roundness and dimensional errors. Cutting tool geometry and shape of cutting edge have significant impact on integrity of machined area and errors. With correct choice of cutting regimes and cutting tool geometry it is possible to ensure required quality of the drilled holes in the most difficult parts of the composite materials construction. Sharpening angle of the drill and geometry of cutting edge significantly influence on all parameters defining functional quality of the tool. This paper gives research results of drilling composite materials by constant load method.
Keywords: composite materials, drill geometry, quality of drilling

1. INTRODUCTION

Composite materials are more and more used in demanding constructions, due to their hardness to weight and stiffness to weight ratios. Parts made out of composite materials are joined and connected by elements for joining into complex construction sections and subsections. For this purpose, it is necessary to fabricated numerous holes with different dimensions. In composite material drilling the following occurs: increased tool wear, machined hole surface damage, hole dimension deviation, cracking, peripheral hole zone damage and dust generation. These occurrences are undesirable so they must be removed or minimized. These problems were investigated by several authors [1, 2, 3], that devised methods and means for fabricating hole of increased quality. With correct selection of cutting regimes and cutting tool geometry it is possible to ensure required quality of the drilled holes in the most difficult parts of the composite materials construction. Sharpening angle of the drill and geometry of cutting edge has significant influence on all parameters defining functional quality of the tool. Optimal tool geometry defining by wear method is usually long and expensive. In cooperation of Engineering Institute and IAT Trebinje research installation was designed. In designing research installation insuring constant load was accepted as essential, and penetration (drilling) time was monitored. Penetration time becomes a measure for: machinability grade, geometric shape advantages, sharpening types, cutting geometry, wear intensity, coolant quality, scavanging and lubrification. Goal function becomes minimal penetration time, in respect to other machining limitations. This paper gives research results of drilling composite materials by constant load method.

2. EXPERIMENTAL WORK AND RESULTS OF INVESTIGATION

In experimental study, HSS drills 8 mm in diameter were used to generate holes. Different drill bits geometry shown in Fig. 1. Apart from standard drill, two drills modificated geometry were used in this experimental work. Drilling processes were conducted on unidirectional carbon fibre reinforced composite, thickness 9 mm. Experimental work also were done on aramid fibre reinforced composite material, KEVLAR®, thickness 5 mm, [4].

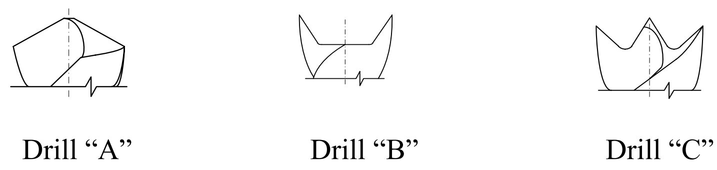


Figure 1. Different drill bits geometry

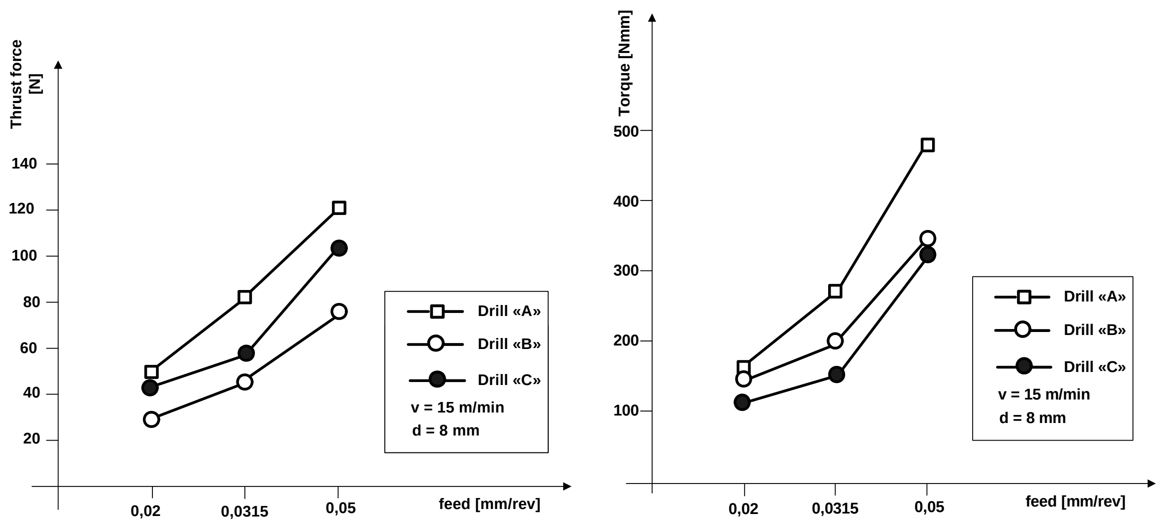


Figure 2. Thrust force and torque

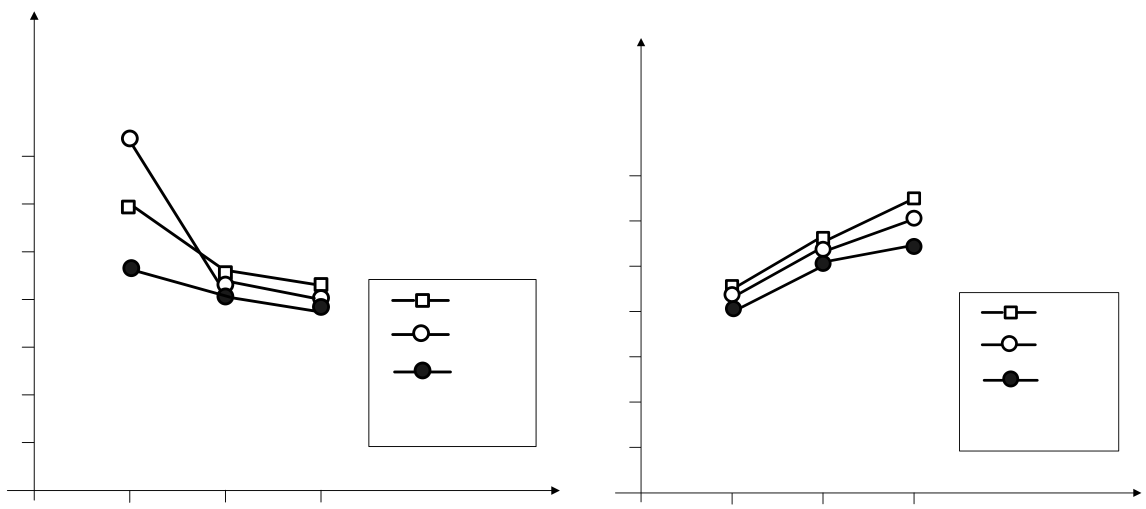


Figure 3. R_a in correlation to feed and cutting speed

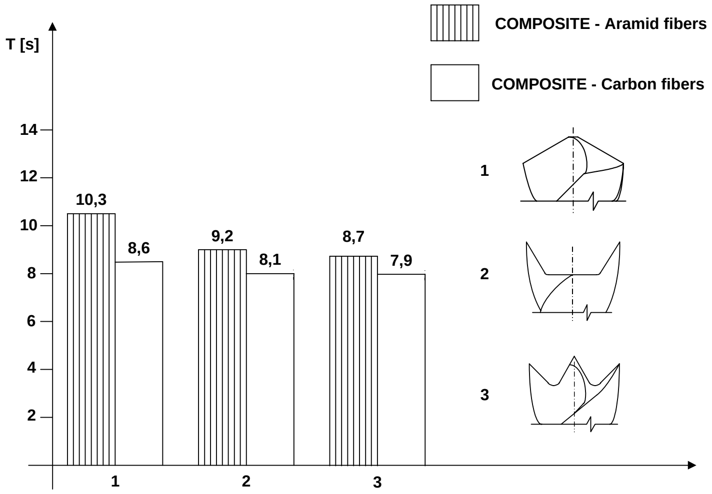
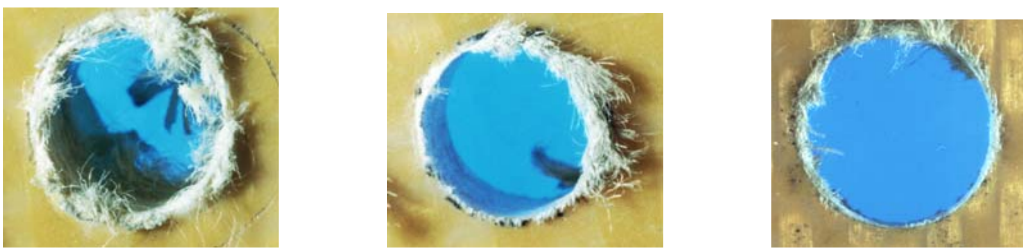


Figure 4. Compared time diagram of spiral drill penetration in correlation to material type and geometric tool shape

v = 17,60 m/min	v = 14,13 m/min	v = 21,98 m/min
f =0,05 mm/o	f = 0,02 mm/o	f = 0,02 mm/o
Drill "A"	Drill "B"	Drill "C"

Figure 5. Drilled holes in carbon fibre reinforced composite materials



v = 11,3 m/min	v = 14,13 m/min	v = 17,6 m/min
s = 0,05 mm/o	s = 0,0315 mm/o	s = 0,02 mm/o
Drill "A"	Drill "B"	Drill "C"

Figure 6. Drilled holes in aramid fibre reinforced composite materials (KEVLAR®)

3. CONCLUSION

Based on above stated, following conclusions are made:

- Thrust force and torque depend on cutting speed, feed rate, tool geometry and tool wear.
- Chisel edge has significant impact on increase thrust force. Reducing chisel edge length, thrust force may be considerably reduced.
- Feed rate significantly contribute to drilled hole quality.
- Drilling aramid fibre composite material with standard drill geometry has as its consequence errors development, like fuzzing, and therefore composite material reinforced with aramide fibre, is requiring special (optimal) tool geometry.
- Application of constant load method for defining functional quality has a considerable practical meaning because it gives a quick and correct answer.
- Errors that occur during machining of fibre composites are in functional dependence with cutting tool and conditions of machining, cutting tool geometry and cutting tool wear.
- For efficient manufacture of composite material parts, it is essential to continue research of machining process and optimise it by choosing means and machining regimes. Special consideration must be taken in choosing material and tool geometry.

4. REFERENCES

[1] Konig W., Wulf C., Grass P., Willerscheid H.: Machining of fibre reinforced plastics, Manuf. Technol., Annals of CIRP, 34 (2), 536–548, 1985.

[2] Ho-Cheng H., Dharan C. K. H.: Delamination during drilling in composite laminates, Journal of Engineering Industry, Vol. 112, pp. 236–239, 1990.

[3] Bhattacharya D., Horrigan D., P., W.: A study o hole drilling in Kevlar composites, Composites Science and Technology 58, pp. 267–283, 1998.

[4] Koboević N.: Metode i načini osiguranja kvalitete pri izradi otvora bušenjem u kompozitnim materijalima, Magistarski rad, Sveučilište u Mostaru, Fakultet strojarstva i računarstva, Mostar, 2003.

[5] Koboević N., Mišković A.: Ensuring hole fabrication quality in composite material as prerequisite for implementation in industry, Proceedings of the 3rd International Conference on Revitalization and Modernization of Production, RIM 2001, pp. 277–284, Bihać, Bosnia and Herzegovina, 2001.

[6] Koboević N., Mišković, A.: Parameters for defining machining quality of composite materials components, Proceedings of the 6th International Scientific Conference on Production Engineering CIM 2000, pp. I-119–I-126, Lumbarda, Croatia, 2000.