TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 67, Issue Special I, February, 2024

THE INFLUENCE OF CHIP TRANSPORT DIRECTION ON THREAD TAPPING OF PEHD1000 AND M980 PLASTIC MATERIALS

Sandor RAVAI-NAGY, Alina Bianca POP, Ioan PAȘCA

Abstract: *This study delves into the influence of chip transport direction on the cutting torque and feed force during thread tapping of PEHD1000 and Sika Block M980 material, shedding light on critical machining parameters. Our primary objective was to compare and analyze the cutting torque and feed force variations between two distinct chip transport directions – forward in the feed direction and opposite to it – while threading with M8 taps. The findings reveal that chip transport direction significantly impacts the cutting torque, with forward transport resulting in higher torque values. Additionally, it is observed varying degrees of burrs and thread quality, offering insights for tap selection. This research underscores the importance of considering chip flow direction in machining processes.*

Key words: *Thread tapping, Chip transport direction, Cutting torque, Feed force, Burrs, Thread quality.*

1. INTRODUCTION

The current state of research in materials processing, particularly in the context of thread tapping, has brought to light a crucial aspect— the influence of chip transport direction on cutting parameters such as cutting torque and feed force. These factors are of paramount importance in ensuring the quality of machining processes and the final products.

The motivation for this research lies in identifying significant gaps in the existing body of literature. These gaps have necessitated a comprehensive investigation into this area of study. To date, there are limited studies that have focused on the influence of chip transport direction in the thread tapping process, especially in plastics such as PEHD1000 and Sika Block M980. This research gap drives us to plan and conduct this study to shed light on the essential aspects of this influence and address this knowledge deficit in the field.

The primary novelty of this research lies in our approach to understanding the impact of chip transport direction on cutting torque and feed force in the threading of plastic materials, particularly PEHD1000 and Sika Block M980. This study will provide empirical data and relevant observations that can be applied in the industry for process optimization and the appropriate selection of taps based on chip transport direction.

The main objectives of this research include the analysis and comparison of cutting torque and feed force variations based on chip transport direction, as well as the evaluation of thread quality. This will contribute to a deeper understanding of thread tapping processes and provide valuable guidance for the industry.

The paper's structure is outlined as follows: The subsequent section will provide a brief literature review, followed by a detailed description of the equipment and methods utilized in the experiment. In the Results section, the findings will be presented, accompanied by their analysis. The Discussion section will interpret the results and discuss their implications before drawing conclusions in the dedicated section.

2. LITERATURE REVIEW

Building upon the introduction's emphasis on the significance of investigating the influence of chip transport direction on material processing, we now proceed to a comprehensive literature review. The aim of this review is to assess the current state of research and identify the key gaps that have motivated this study.

The paper [1] reviews drilling experiments on Carbon Fiber Reinforced Plastic / Al (CFRP/Al) composite laminates, highlighting the influence of drill parameters on machining efficiency. It addresses the need for optimizing parameters in aerospace applications.

The study [2,3] introduces a system for measuring feed forces and cutting torques in drilling processes, emphasizing its relevance for research and education. It outlines the system's components, functions, and presents demonstrative tests.

Investigating CFRP/Ti6Al4V stacks, the research [4] explores the impact of minimum quantity lubrication (MQL) on machining behavior. MQL reduces drilling torque, cutting energy, and improves surface quality.

For CFRP/Al stacks, a self-adaptive drilling method based on impedance analysis is proposed in [5], enabling online interface recognition and parameter modification. The method demonstrates good recognition accuracy.

A mathematical model for cutting force in Aluminum matrix reinforced with silicon carbide particles (SiCp/Al) composites is established in [6] using response surface methodology. It quantifies the effects of cutting parameters on cutting forces.

The paper [7] reviews the machinability of Fibre-Reinforced Polymer (FRP) composites using minimum quantity lubrication (MQL). It discusses tool wear, feed force, hole diameter, burr height, and chip formation.

The study [8] investigates chip formation during hard milling using experimental and finite element analysis. It examines serrated chip formation and micro-cracks, enhancing understanding and control.

This study [9] optimizes drilling parameters for AISI 430 ferritic stainless steel, focusing on reducing burr height, feed force, and surface roughness. The study emphasizes the importance of cutting speed and feed rate.

Using deep neural networks, the research [10] predicts cutting forces in ball end milling processes, offering a data-driven approach to optimizing machining parameters.

The paper [11] reviews cutting force models for CFRP composites, discussing mechanistic, macro-mechanical, micro-mechanical, and numerical models. It suggests future trends in model development.

The research [12] analyzes cutting forces in milling CFRP, considering cutting and edge effects. It quantifies net cutting, pressing, and friction forces and their relation to machining damage.

The study [13] optimizes turning parameters for Al7075/SiC/Gr composites (Al7075/Silicon Carbide /Graphite), enhancing surface finish, tool wear, and cutting force reduction.

Evaluating drill-induced defects in recycled CFRP, the research [14] finds reduced burr formation in recycled composites compared to virgin CFRP, supporting recycling efforts.

The paper [15] explores the drilling quality of woven CFRP, modeling delamination and feed force based on cutting parameters and tool geometry.

The research [16] reviews machining processes for hard tissues, focusing on cutting forces, thermal and mechanical damage, and solutions to minimize tissue damage during surgery.

The paper [17] reviews advances in CFRP machining, emphasizing the need for optimal parameters, monitoring systems, and AI-based diagnostics in composites machining.

Building upon the comprehensive overview of the current state of research in the field provided by the literature review, the specifics of the equipment and methods employed in the experiment will now be explored.

3. THE EQUIPMENT AND METHODS USED IN THE EXPERIMENT

This experiment aims to elucidate the impact of chip transport direction on cutting torque during thread tapping. The experimentation takes place on a universal drilling machine, utilizing a previously introduced measurement system placed on its table. Two M8 taps will be employed, both designed for internal threads with a precision rating of 6H:

- M8x1.25 6H tap (HSSE-GLT-1 REKORD 1 B-MULTI, manufactured by EMUGE) – featuring chip transport in the forward feed direction, recommended for through holes;

- M8x1.25 6H tap (HSS-E TCB804366, manufactured by YG1) - with chip transport directed opposite to the feed direction, suitable for blind holes;

The machining process involves a spindle speed of 63 *rotations per minute* and a feed rate of 1.25 *mm/rotation*, aligning with the M8 thread pitch. The taps are securely affixed using "Quick change tapping chucks with length compensation on compression and expansion" with the assistance of "Quick change adaptors with safety clutch," selected according to the specific M8 tap utilized. The workpiece materials under investigation are PEHD 1000 and Sika Block M980. Throughout the experiment, meticulous tracking of the fluctuations in cutting torque associated with each tap will be conducted. The various phases of the experimental procedure are detailed below.

3.1. Phase 1. Aligning the equipment with the machine tool spindle

The measurement apparatus 4 is situated on the drilling machine's 1 table, and the axis of the torque module is meticulously aligned with the main spindle of the drilling machine. This alignment holds significant importance as any deviations from coaxially could adversely impact the precision of the measured cutting torque values.

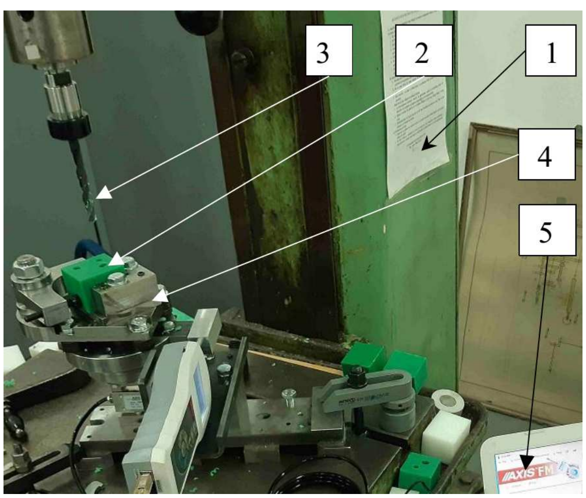


Fig. 1. Alignment of equipment according to the axis of the machine tool

In figure 1 are presented the drilling machine 1 (Type: G40, manufactured by Infratirea Oradea Romania, 1972), the specimen 2, the cutting tool 3, measurement equipment 4 and laptop whit data acquisition software 5.

To achieve this precise alignment, a specialized centering device is affixed within the drilling machine spindle, preferably equipped with a dial gauge. The gauge's probe contacts the bore in the fixture device of the test item. It is worth noting that from the assembly phase onwards, the concentricity and coaxially between the bore in the tool holder and the bore of the torque module are ensured. Subsequently, the device is securely fastened to the drilling machine's table using clamps. The dynamometers are then connected to the USB ports of a computer or laptop, where the experimental data will be recorded and saved for subsequent processing. The Axis FM data acquisition software is launched individually for each dynamometer (figure 1).

3.2. Phase 2. Equipment calibration.

In this phase, a series of critical steps are undertaken to ensure the precise functioning of the dynamometers and establish the correction coefficient for the measured cutting torque. Additionally, the dynamometer is calibrated to accurately measure the feed force, which involves the following steps:

- Reset the dynamometer to zero by pressing the resolute "0" button on the dynamometer itself or via the interface displayed on the computer monitor (refer to Figure 14). This action effectively eliminates the influence of the torque module's mass, the test item fixture device's mass, and the mass of the test item;
- Apply weights of known mass to the test item fixture device and compare the mass of these weights with the values indicated by the dynamometer;
- Calculate the correction coefficient for the measured torque. This calculation follows the procedure detailed in the section titled "Establishing the Correction Coefficient of the Cutting Torque."

Practically, after the meticulous alignment of the torque module and the cutting tool axes, a test item is securely affixed within the tool holder, where an internal thread is machined. Subsequently, a screw is inserted into this thread, and known torques are precisely applied using a torque screwdriver. Concurrently, the values of the forces at the end of the torque module's arm are meticulously recorded. The correction coefficient for the cutting torque is determined based on the data recorded by dynamometer A. It is imperative to note that for every setup of the measuring system on a machine tool, phases 1, "Aligning the Equipment with the Machine Tool Spindle," and 2, "Equipment Calibration," must be rigorously performed to ensure measurement accuracy and acquire precise data.

3.3. Phase 3. Conducting the experiment

The test item is securely positioned within the fixture device, and all the necessary holes required for subsequent threading operations are drilled. After each hole is completed, the test item is extracted from the device, rotated 90 degrees, reinserted into the fixture device, and securely fixed in place. A total of four holes are processed within each test item.

For the drilling phase, an HSS-R DIN 338 twist drill with a 6.8 *mm* diameter was utilized, in accordance with DIN 336 specifications. This drill is recommended for hole preparation prior to threading with the M8 tap, aligning with the specified hole diameter.

Subsequently, replace the drill together with its respective fixture device, and insert the tap fixture device into the main spindle of the drilling machine. Begin the threading process using the first specified tap: M8x1.25 6H tap.

Ensure that the chip transport direction is oriented forward, following the feed direction downward. During this threading process, capture data pertaining to the cutting torque was also conducted.

After completing this thread, proceed to change the tap. Now, perform the threading operation using the M8x1.25 6H tap (HSS-E TCB804366, manufactured by YG1), ensuring that the chip transport direction is opposite to the feed direction, directed upward. Simultaneously, continue to collect data regarding the cutting torque during this threading operation.

3.4. Phase 4. Data processing

The experimental data is accessed within the Excel file, and a new "sheet" is created specifically for calculating the cutting torque. This calculation involves utilizing the measured force, the arm length of the torque module, and the correction coefficient, as described further.

About the necessity of the correction coefficient for the measuring system, during the design phase, considerations were made regarding the frictional forces within the bearings. However, it was acknowledged that these forces could vary due to factors such as bearing manufacturers and their respective mounting conditions. Consequently, a practical approach was adopted, involving the experimental determination of a correction coefficient. This coefficient is subsequently applied to the calculated cutting torque using the following formula: The force measured by dynamometer A multiplied by the length of the arm of the torque module.

Therefore, it is recommended a diligent procedure of verifying and measuring the correction coefficient before each installation of the equipment and its placement onto the machine tool where the experiments are to be conducted. It is important to note that each piece of equipment must be individually calibrated with its specific correction coefficient.

The determination of the correction coefficient involves the use of a torque screwdriver. Specifically, a Proxxon MicroClick Mc5 torque screwdriver with a measuring range of 1-5 *N·m* was employed for this purpose. This instrument boasts a measurement error of 0.03 *N·m* and an uncertainty level of 0.13, as certified according to relevant standards.

To ascertain the correction coefficient, a resolute technological assembly, illustrated in figure 2, was utilized.

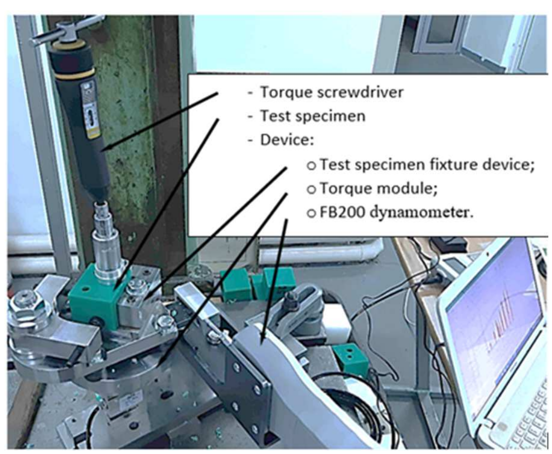


Fig. 2. Determination of the correction coefficient

The torque screwdriver was systematically adjusted to each specified value of known torque, as documented in the "Certification of Conformity." Subsequently, the test item element was engaged to activate the torque screwdriver, causing the dynamometer to record the force component of the torque. Figure 3 illustrates the measured force component values corresponding to the torque applied using the torque screwdriver.

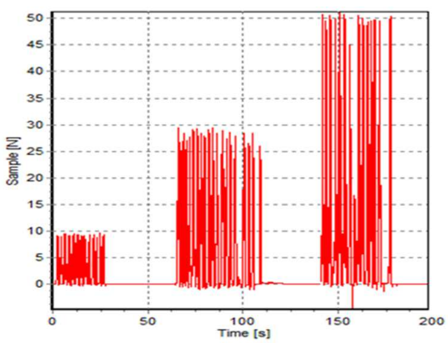


Fig. 3. Variation of forces on dynamometer one during performance of the measuring device calibration

The correction coefficient, denoted as "k" and defined by equation 1, is calculated as the ratio between the applied test torque (the torque setting on the torque screwdriver), and the torque ascertained through the developed equipment (derived from the force measurement conducted by the dynamometer and the arm's length).

$$k = \frac{a}{b} \qquad (1),$$

where:

a - torque adjusted on the torque screwdriver;

b - torque determined with de developed equipment (force x arm).

Table 1

The measured data and the calculated coefficients.

Torque screwdriver MC5	Developed equipment			Correction coefficient	
Adjusted torque	Measured force	Arm of force (constructive)	Determined torque		average
a			b	ki	k
[1]	[2]	[3]	[4] = [2x3]	[5] = [1 / 4]	[6]
N·m	N	m	N·m		
1.01	9.65	0.1	0.965	1.046632	1.05
3.1	29.45	0.1	2.945	1.052631	
5.28	50.25	0.1	5.025	1.050746269	

Table 1 serves as a central repository for both the measured data and the calculated coefficients.

The values listed in column [1] represent torque values officially certified by the metrological bulletin.

The coefficient "k" is derived as the arithmetic mean of the coefficients determined in column.

Figure 4 provides a graphical representation of how the coefficient varies concerning the torque settings on the torque screwdriver.

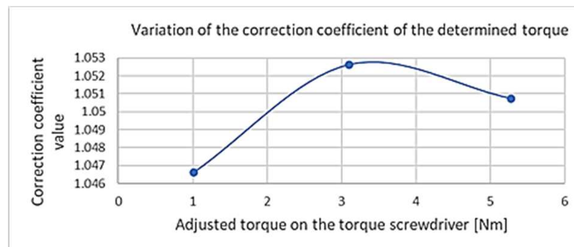
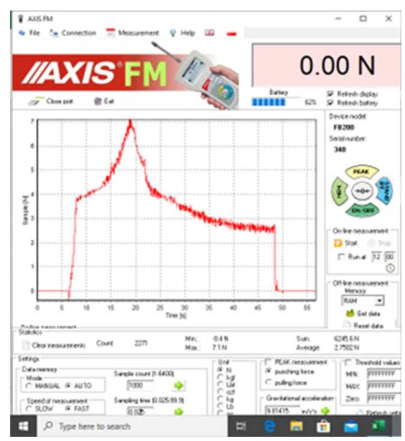
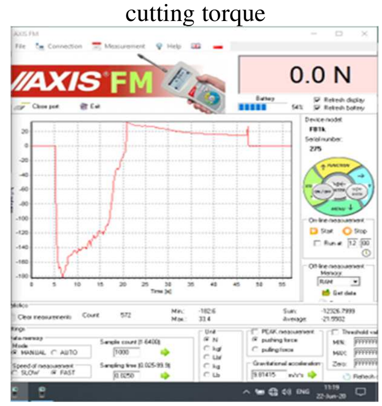


Fig. 4. Variation of the torque correction coefficient



a) force component, measured, which results from the cutting torque



b) feed force

Fig. 5. Data acquisition of the dynamometers

Based on the empirical data depicted in figures 3 and 4 and table 1, a correction coefficient of 1.05 will be applied in the context of experiments conducted using the proposed system. If the arm length L2=200 *mm* of the torque module is utilized, the determination of the correction coefficient follows a similar methodology.

If deemed necessary, this "sheet" can also incorporate data related to the feed force and calculated cutting torque based on the "sampling time."

The data presentation within this sheet (figure 5) is organized as follows: the time axis is represented along the X-axis, while two separate axes are used for the Y-axis, with one representing the force measurements and the other displaying the cutting torque values. Now, the concurrent representation of feed force and cutting torque within the same graph does not appear to yield additional insights, thus suggesting the use of two distinct graphs.

In alignment with the research's objectives, the subsequent stages of data processing and interpretation will be diligently pursued.

4. RESULTS

The last phase consists of the results analysis.

After analyzing the data concerning cutting torque and thread quality, the following observations can be made:

- Regarding cutting torque, it was observed that tapping with a chip transport direction forward in the feed direction (downwards) results in higher torque, measuring 1.25 *N·m*, in contrast to 0.755 *N·m* measured for the tap with chip transport direction opposite to the feed direction (upwards).

- In the context of burr formation, specifically for PEHD1000 material processing, the following findings are noteworthy (figure 6a):

- Tap with chip transport direction upwards (M8x1.25 6H, HSS-E TCB804366, manufactured by YG1):
  - Significant burrs observed on the tap entrance side;
  - Insignificant burrs are present on the tap exit side.
- Tap with chip transport direction downwards (M8x1.25 6H, HSSE-GLT-1 REKORD 1 B-MULTI):
  - No noticeable burrs on the tap entrance side;
  - Minimal burrs on the tap exit side.
- In the case of Sika Block M980 material, there are no noticeable burrs (figure 6b).

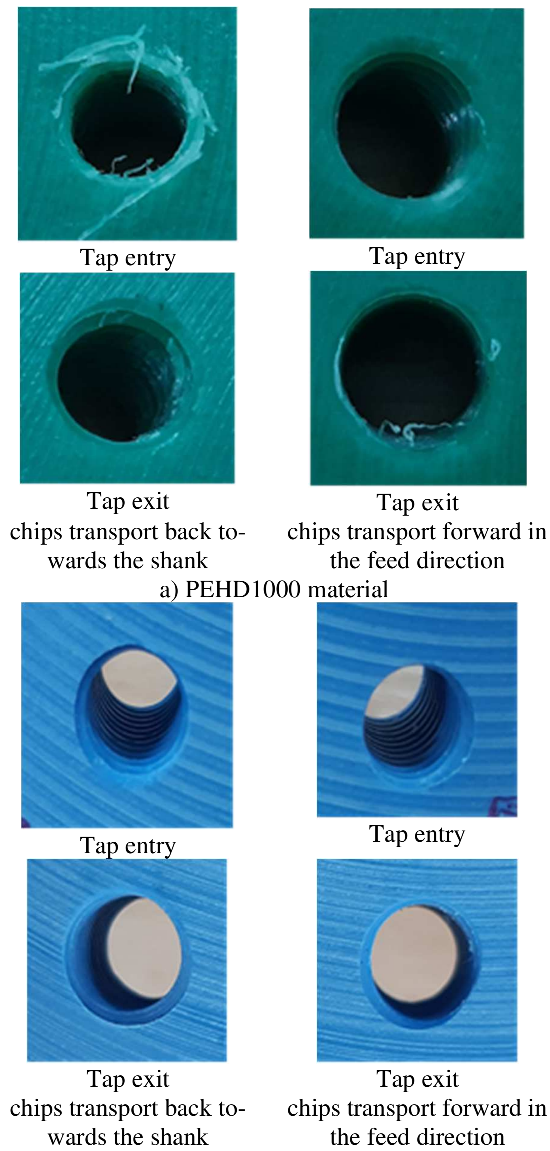


Fig. 6. Burrs occurred as result of thread processing.

- Examining the thread flank quality for PEHD1000 material (figures 8 and 9):
  - The thread flank exhibits a finer surface without micro-burrs when processed with a tap having a chip transport direction

downwards (M8x1.25 6H, HSSE-GLT-1 REKORD 1 B-MULTI);

- Conversely, the thread flank surface is rougher and contains micro-burrs when processed with a tap having a chip transport direction upwards (M8x1.25 6H, HSS-E TCB804366, manufactured by YG1).

chips transport back towards the shank

chips transport forward in the feed direction

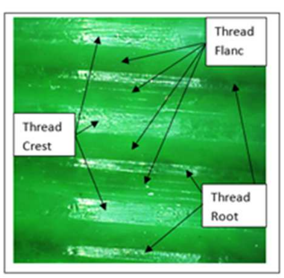
a) PEHD1000

chips transport back towards the shank

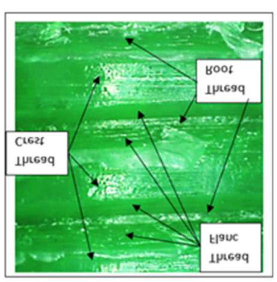
chips transport forward in the feed direction

b) SikaBlock M980

Fig. 8. Burrs occurred as result of thread processing.



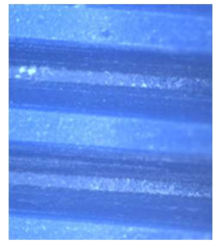
a) Chips transport forward in the feed direction



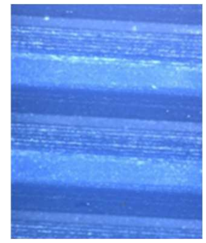
b) Chips transport back towards the shank

Fig. 9.1. The quality of the thread flank depends on the tap used. (Processed material PEHD1000)

- It is worth noting that with each tap, there is a 0.2 $N{\cdot}m$ torque attributed to tightening the workpiece material onto the tap, as illustrated in figure 10.

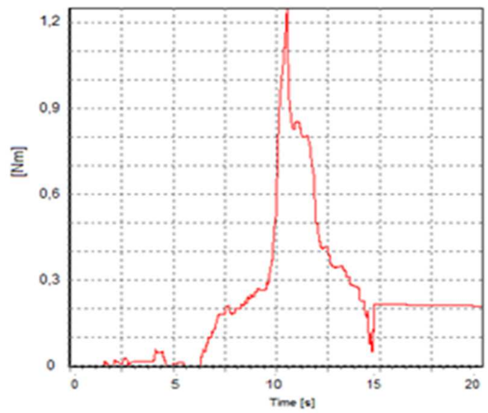


a) Chips transport forward in the feed direction

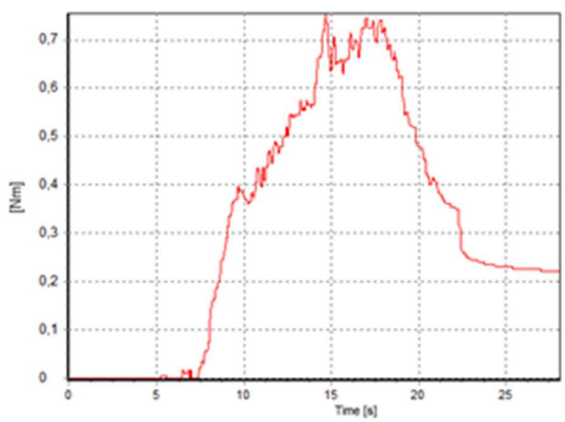


b) Chips transport back towards the shank

Fig. 9.2. The quality of the thread flank depends on the tap used. (Processed material Sika Block M980)



a) Chip discharge direction forward in feed direction (downward)



b) Chip discharge direction opposite to the feed direction (upwards)

Fig. 10. The variation of the cutting torque during thread processing, in the case of PEHD1000 material.

The experimental tests conducted to validate the functionality of the proposed equipment revealed aspects that have not been extensively explored in plastic drilling and tapping. For future research, the following suggestions are proposed:

- Simultaneous monitoring of the feed force alongside the cutting torque to determine the minimum feed force required for tap engagement. This information can aid in understanding the impact of spring force in threading devices, particularly in relation to the processed material;

- Conducting focused studies on the resulting threads and burrs to establish criteria for tap selection. Investigating the influence of chip discharge direction by the tap on thread quality, especially in relation to the processed material;
- Determining the influence of thread quality (e.g., burrs, material tearing) on the pullout resistance of the thread.

5. DISCUSSIONS

In this section, a comprehensive discussion is undertaken regarding the experimental findings, their implications, and the broader context of the study. The results of the experiments concerning cutting torque, burr formation, and thread quality are thoroughly analyzed.

5.1. Cutting Torque Analysis

The cutting torque measurements revealed distinct differences between the two tested scenarios: chip transport direction forward in the feed direction (downwards) and chip transport direction opposite to the feed direction (upwards).

The higher cutting torque observed during downward chip transport (1.25 $N{\cdot}m$) compared to upward transport (0.755 $N{\cdot}m$) is a significant finding. This discrepancy can be attributed to the mechanics of chip evacuation. When chips are transported downwards, they tend to accumulate in the flutes of the tap, resulting in increased resistance during the threading process.

Conversely, when the chip transport direction is upwards, chips are effectively removed from the cutting zone, leading to lower torque requirements. Understanding this relationship between chip transport direction and torque is vital for optimizing tapping processes.

5.2. Burr Formation and Thread Quality

Burr formation, a common concern in machining processes, was examined in detail for two distinct materials: PEHD1000 and Sika Block M980. For PEHD1000 material, the experiments revealed that tapping with chip transport direction upwards (using the M8x1.25 6H tap, HSS-E TCB804366) resulted in significant burrs on the tap's entrance side and minor burrs on the exit side. In contrast, tapping with chip transport direction downwards (M8x1.25 6H tap, HSSE-GLT-1 REKORD 1 B-MULTI) exhibited no noticeable burrs on the entrance side and minimal burrs on the exit side.

These findings highlight the direct correlation between chip transport direction and burr formation. The removal of chips from the cutting zone (upwards transport) reduces the likelihood of burr formation. This insight is crucial for industries where burr-free threads are essential for product quality and safety. In the case of Sika Block M980 material, burr formation was not observed. This suggests that material properties play a role in the extent of burr formation during tapping. Further research into the relationship between material characteristics and burr formation is warranted.

5.3. Thread Quality and Surface Finish

Examining the quality of the thread flank surface revealed interesting disparities. For PEHD1000 material, threads processed with the tap having chip transport direction downwards (HSSE-GLT-1 REKORD 1 B-MULTI) displayed a finer and smoother surface without micro-burrs. Conversely, threads produced with the tap featuring chip transport direction upwards (HSS-E TCB804366) exhibited a rougher surface with micro-burrs. This difference in surface finish demonstrates the importance of chip transport direction not only on cutting torque but also on thread quality. A smoother thread surface is often desired for better functionality and aesthetics.

5.4. Practical Implications and Future Research

The findings of this study have several practical implications:

Process Optimization: Manufacturers can use this knowledge to optimize their tapping processes by selecting taps with appropriate chip transport directions based on material and quality requirements.

Quality Assurance: Industries where thread quality is critical, such as automotive and aerospace, can benefit from understanding the impact of chip transport on thread surface finish.

Material Selection: Material properties play a role in burr formation. Future research can explore how varied materials react to various chip transport directions.

Pullout Resistance: Investigating the influence of thread quality, including burrs and surface finish, on pullout resistance is a potential avenue for further study.

In conclusion, this study provides valuable insights into the influence of chip transport direction on cutting torque, burr formation, and thread quality during tapping processes. These findings contribute to the broader understanding of machine processes and offer practical guidance for industries seeking to enhance the quality and efficiency of their tapping operations.

6. CONCLUSIONS

This research makes several noteworthy contributions to both the theoretical and practical aspects of machining and threading processes:

Theoretical Contributions:

- Understanding Chip Transport Effects: Theoretical understanding regarding how the chip transport direction significantly impacts cutting torque has been advanced, addressing an area previously underexplored in the field.
- Burr Formation Mechanisms: Our study contributes to the theoretical knowledge of burr formation, highlighting the role of material properties and chip transport direction.
- Thread Quality Correlation: A strong correlation between chip transport direction and the surface quality of threaded components has been established, offering theoretical insights into enhancing thread quality.

Practical Contributions:

- Optimized Tapping Processes: Industries involved in threading operations can leverage our findings to optimize their processes by selecting the most suitable chip transport direction, thus improving efficiency and product quality.
- Quality Assurance: Manufacturers in sectors requiring high-precision threading, such as automotive and aerospace, can apply our research outcomes to enhance thread quality assurance protocols.
- Material Selection: Material selection for machining operations can be informed by our study, helping industries choose materials that minimize burr formation and optimize machining efficiency.

7. REFERENCES

[1] Koyyagura, L. K., & Karanam, P. R. *Influence of cutting conditions in drilling of CFRP / Al stacked composites*. Indian J Eng Mater Sci, April 2021.

[2] Ravai-Nagy, S. *Method and System for Measuring the Cutting Torque and Feed Force used for Hole Processing*. Acta Polytechnica Hungarica, 20(6), 2023.

[3] Ravai-Nagy, S., Pop, A.B., Titu, A.M. *Determination of Processing Precision of Hole in Industrial Plastic Materials*, Polymers, 15, 347, 2023.

[4] Xu, J., Ji, M., Chen, M., & El Mansori, M. *Experimental investigation on drilling machinability and hole quality of CFRP/Ti6Al4V stacks under different cooling conditions*. The International Journal of Advanced Manufacturing Technology, 109, 1527-1539, 2020.

[5] Xu, J., Ji, M., Davim, J. P., Chen, M., El Mansori, M., & Krishnaraj, V. *Comparative study of minimum quantity lubrication and dry drilling of CFRP/titanium stacks using TiAlN and diamond coated drills*. Composite Structures, 234, 111727, 2020.

[6] Laghari, R. A., Li, J., & Mia, M. *Effects of turning parameters and parametric optimization of the cutting forces in machining SiCp/Al 45 wt% composite*. Metals, 10(6), 840, 2020.

[7] Ghoshal, A., Khan, A., Zahid, M., Pervaiz, S., & Kannan, S. *Reviewing Machinability of Fibre-Reinforced Polymer (FRP)/Metallic Stacks Using MQL*. In ASME International Mechanical Engineering Congress and Exposition (Vol. 59377, p. V02AT02A014), 2019, American Society of Mechanical Engineers.

[8] Li, B., Zhang, S., Zhang, Q., & Li, L. *Simulated and experimental analysis on serrated chip formation for hard milling process*. Journal of Manufacturing Processes, 44, 337-348, 2019.

[9] Günay, M., & Meral, T. *Modelling and multiresponse optimization for minimizing burr height, thrust force and surface roughness in drilling of ferritic stainless steel*. Sādhanā, 45(1), 273, 2020.

[10] Balasubramanian, A. N., Yadav, N., & Tiwari, A. *Analysis of cutting forces in helical ball end milling process using machine learning*. Materials Today: Proceedings, 46, 9275-9280, 2021.

[11] Song, Y., Cao, H., Zheng, W., Qu, D., Liu, L., & Yan, C. *Cutting force modeling of machining carbon fiber reinforced polymer (CFRP) composites: A review*. Composite Structures, 116096, 2022.

[12] He, Y., Sheikh-Ahmad, J., Zhu, S., & Zhao, C. *Cutting force analysis considering edge effects in the milling of carbon fiber reinforced polymer composite*. Journal of Materials Processing Technology, 279, 116541, 2020.

[13] Kannan, A., Mohan, R., Viswanathan, R., & Sivashankar, N. *Experimental investigation on surface roughness, tool wear and cutting force in turning of hybrid (Al7075+ SiC+ Gr) metal matrix composites*. Journal of Materials Research and Technology, 9(6), 16529-16540, 2020.

[14] Geier, N., Poór, D. I., Pereszlai, C., & Tamás-Bényei, P. *Drilling of recycled carbon fibre–reinforced polymer (rCFRP) composites: analysis of burrs and microstructure*. The International Journal of Advanced Manufacturing Technology, 120(3-4), 1677-1693, 2022.

[15] Mahdi, A., Makhfi, S., Habak, M., Turki, Y., & Bouaziz, Z. *Analysis and optimisation of machining parameters in drilling woven carbon fiber reinforced polymer CFRP*. Materials Today Communications, 105885, 2023.

[16] Zhang, Y., Robles-Linares, J. A., Chen, L., Liao, Z., Shih, A. J., & Wang, C. *Advances in machining of hard tissues–from material removal mechanisms to tooling solutions*. International Journal of Machine Tools and Manufacture, 172, 103838, 2022.

[17] Seo, J., Kim, D. Y., Kim, D. C., & Park, H. W. *Recent developments and challenges on machining of carbon fiber reinforced polymer composite laminates*. International Journal of Precision Engineering and Manufacturing, 1-18, 2021.

INFLUENȚA DIRECȚIEI DE EVACUARE A AȘCHIILOR ÎN FILETAREA MATERIALULUI PEHD1000

Rezumat: Această cercetare explorează influența direcției de evacuare a așchiilor asupra momentului așchietor și a forței de avans în timpul filetării unor epruvete din materialele PEHD1000 și SikaBlock M980, evidențiind parametrii critici ai prelucrării. Scopul nostru principal a fost să comparăm și să analizăm variațiile momentului așchietor și ale forței de avans între cele două moduri de evacuare a așchiilor - în direcția de avans și opusă acesteia - în timpul filetării cu tarozi M8. Concluziile scot în evidență că direcția de evacuare a așchiilor influențează semnificativ atât calitatea flancului filetului, cât și mărimile momentelor așchietoare. Identificăm valori ale momentului așchietor mai mari în cazul evacuării așchiilor în direcția de avans. Pe baza observațiilor, formulăm recomandări privind alegerea tarozilor. Această cercetare subliniază importanța luării în considerare a direcției de evacuare a așchiilor în procesele de prelucrare.

Sandor RAVAI-NAGY, Lecturer, Technical University of Cluj-Napoca, 62A Victor Babeș Street, 430083, Baia Mare, Romania, E-mail: sandor.ravai@imtech.utcluj.ro, Institute of Technical and Agricultural Sciences, University of Nyíregyháza, 31/b, Sóstói Street, 4400 Nyíregyháza, Hungary. E-mail: nagy.sandor@nye.hu

Alina Bianca POP, Lecturer, Technical University of Cluj-Napoca, 62A Victor Babeș Street, 430083, Baia Mare, Romania, E-mail: bianca.bontiu@gmail.com

Ioan PAȘCA, Phd., Eng., S.C. Electro Sistem SRL, 8 Martie Str. 4B, 430406 Baia Mare, Romania, pascaing@yahoo.com