The scale **Journal Website:** https://thescalejournal.com.ng/
An Interdisciplinary Journal of
The ACADEMIC STAFF UNION OF POLYTECHNICS - ZONE D
ISSN: 2992-3727 Published 30th November, 2025

EFFECT OF THERMAL ENERGY VARIATION ON RESIDUAL STRESS IN MILD STEEL FACE MILLING

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Abstract
This research used heat flux and atom oscillation to determine energy build up due to chip formation. This condition affects mild steel ductility and reliability in harsh weather condition. Internal stresses were monitored by discrete photon generated due to change in intermolecular bonds. It was discovered when temperature increase by decrease in coolant films. Tensile stress is concentrated more towards kinetic energy from the edges and less at the mild steel pivot support. Plasticity is favored by compressive stress at 15^0c coolant set point when amplitude decreases.
Keywords: Thermal, Residual, Stress, Steel, Milling.

Introduction

To attain precision in measuring heat flux requires specific principles with an uninterrupted cutting pattern. Face milling is a process of cutting material on flat surface with rotary motion. The motion of the cutter are often in x, y and z axes which requires consistent cutting force. Surface roughness in complex shapes with huge chip trap affect thermal energy through regression analysis (Lela et al.,2009; Simunovic et al., 2015). This often creates uneven temperature which causes more heat dissipation, inaccurate dimension with poor surface finishing. Residual stress causes internal heat transfer which settle within short interval. Difference in temperature excites mild steel crystal lattice accompanied by increment in tool wear (Prime & Dewald, 2013). Since metals respond differently based on thermal conductivity. It is interesting to calibrate thermal energy set point with depth of cut and feed rate (Frerichs & Lubben, 2020).

In conventional cutting in lathes the task is differ due to limited adaptive responses to decode a command. This indirectly affect homogeneity by increasing fatigue and decrease corrosion in resistance. Existing studies uses bulk stress to measure residual which is complex during modeling. An experiment conducted using alloy material (7050-T7451) shows that cooling reduces micro cracking (Zhang et al., 2014). When a cutter overheats the elastic modulus shift in from its critical temperature causing decrease in sampling frequency. (Masoudi et al., 2015; Chighizola et al., 2021). Asymmetric behavior has to be adjusted to retain surface thermal loading within multi axis motion within cutting angles (Bagci & Aykut, 2014). Thermal energy flow gets higher when cutting fluid cannot spread so easily in contact with cutter (Kaiser et al., 2018). This has some critical problem with vibration and cutting time with plasticity threshold (Reo et al., 2025).

Material and Method

Material used for this research consist of mild steel with dimension 10mm by 2mm by 1mm.The tool has diameter built up edge distance of 2.5m as it rotates on the cement workpiece surface. Roughness of the mild steel was measured with profilometer, temperature by infra-red sensor and X-ray diffraction instrument for crystalline structure and material phase shift in atomic level. The initial cutting speed was set at 20 m/sec with depth of cut 0.2m. The maximum critical speed was at 71m/s for every 10 seconds to adjust the cutter orientation. At 5 seconds a blended oil-based coolant is released to compensate uneven internal stresses. The control loop was recalibrated at each edge to optimized surface roughness and coefficient of friction. In table 1.0 below, reduction in stress on the beam has

negative values indicating compressive stresses causing buckling. When the mild steel was positioned in close range to observe expansion and cutting forces at each test performed. As the coolant set point and cutting zone increases it creates residual stress instability. Each layer of the mild steel has varied response when atom is preferentially discharged in electro-chemical series. The energy level increases when the wavelength of beams decreases at each end of cutting task.

Result And Discussion

The cutting speed parameter that was selected rely on boundary response to cooling and heating tolerance. The data were run on three level analysis of variance (ANOVA) to forecast the mild steel smoothness in height profile (SIHP). It was detected that micro crack was more at end span than at the pivot point. It shows that residual stress in table 1.10 below affects mild steel within the range of 0.40 coefficient of friction having arithmetic roughness of 4.32 µm. When the cutting speed increases from 245.73 m/s there was unstable arithmetic roughness less than 0.05. In table 1.0 below tensile stresses was optimal from 35Mpa to 60 Mpa with an increase in cutting zone temperature from 22.71 ^{0}c to 40.70^{0}c. To some extent it obeys rate Maxwellians theory.

Table 1.0 Contouring Internal Residual Stress Distribution

Coolant Set Point (^{0}c)	Cutting Zone Temperature (^{0}c)	Residual Stress (Mpa)
7	11.00	-10
15	22.71	+35
39	18.30	-48
47	36.11	+15
50	40.70	+60
25	65.02	+27

As the coolant temperature increases, residual stress forms unstable strain at each mild steel ends. This is triggered by thermal energy when coefficient of friction in table 1.10 below increases at 0.70 and decreases to 0.33. Using these theories, we found that mild steel is more affected by compressive stress at (-12.02 Mpa) and less to tensile stress close to zero intercept in figure 1.10 below.

Table 1.10 Buckling Control by Spot Detection

Arithmetic Roughness(µm)	Coefficient of friction	Cutting Speed (m/s)
2.30	1.00	71.00
2.76	1.50	103.40
4.83	2.50	174.60
4.32	0.40	245.73
6.00	0.70	316.30
3.64	0.33	387.40

In table 1.10 above, coefficient of friction from 2.50 to 1.00 slightly shows destructive interference of internal stresses response as the kinetic energy increases.This is possible as the cutter deflects within an angle of twist ranging from 30^0 and 45^0 rotations.

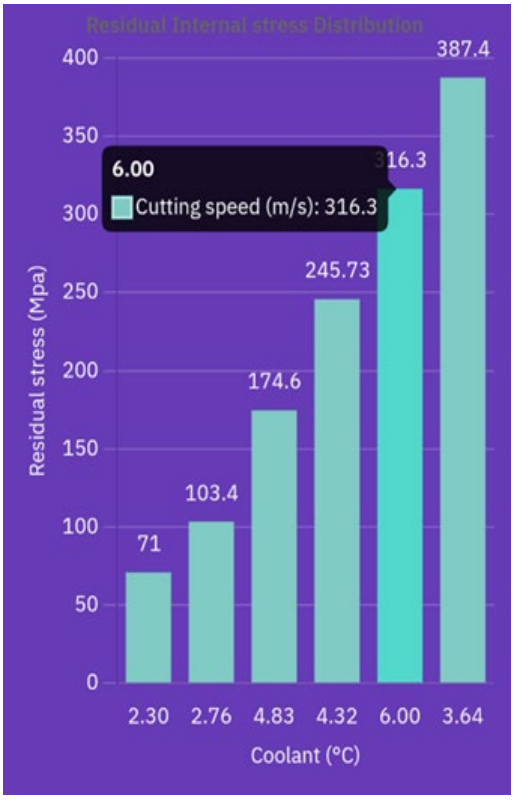


Figure 1.0: plastic Deformation Responses

The vertical axes with residual stress have a cryogenic effect within 316.3 m/s cutting equilibrium yield strength. This parameter was previously in static condition with coefficient of friction 0.70 and arithmetic roughness of 6.00 µm above in both figure 1.0 and table 1.10 above. This has a great impact when calibrating isothermal controller shown in figure 1.0 above when relative humidity decreases with half decrease in coolant volume concentration.

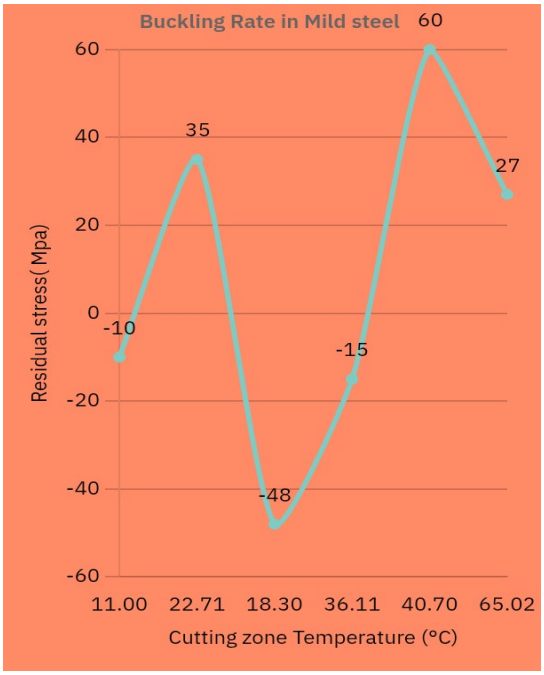


Figure 1.10 Residual stress versus Cutting Temperature Correlation

Axial load produced on the mild steel surface causes scattering of x-rays beams. At -60 Mpa compressive stress becomes intense and combines to form hydrate pellets. When hydrogen is replaced cutting zone temperature become inconsistent with induced internal stress at -10 ^{0}c to form oxide biofilm illustrated above in figure 1.10.

Conclusion

This research tends to develop an embedded system that will promptly forecast stresses at 2.3m wavelength. This will seize the atomic weight of mild steel material with tendency to resist stress corrosion cracking.

Recommendation

Detection of stresses and vibration should be prioritized with feedback speed modulation. This will enhance control of temperature within the mild steel surface at vary coefficient of friction.

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