Journal University of Kerbala , Vol. 16 No.1 Scientific . 2018

Analytical Study of Dynamic Shear Strain effect on Shaping tool

دراسة تحليلية لتأثير انفعال القص الديناميكي على عدة القشط

Sabah hatam obaid[1], Alawi Hamada[2], Kamil jawad kadhim[3], Jabbar Abbas Jaber
[1,2,3] Al-Furat Al Awsat Technical university / Musaib technical institute
Email: Sabah_ hatam@ yahoo.com[1], 2016alawi. hamada@gmil.coasm[2],
kamil_jawad35@yahoo.com[3],Jalkafaje@gmail.com[4]

Abstract:

Research papers deals with using the strain gauge technique with equipment of dynamic strain measuring to get of maximum practical readings for "Shaping Tool Strain" which is known there physical and mechanical properties from beginning of cutting process to cutting stroke end .The" Merchant cycle" is using to analysis of cutting forces and measuring of label piece's dimensions that is getting at shear plane by changing cutting depth (2, 3 ,5 mm). The theoretical dynamic strain is determine by knowing mechanical properties of cutting material. The standard deviation (0.00016) and correction factor (0.3) that is referring to the ability of the technique can be using to improve cutting process and increase service life of tool cutting 30% approximately .The process is repeated with using one of lubricant liquid to determine dynamic strain values during lubrication and comparing with the previous one can be predict lubrication coefficient during cutting process that average value is (0.93) .

Key word: dynamic shear strain , shaping tool, strain gauge technique

الخلاصة:

أن الدراسة التحليلية للبحث تم فيها أستخدم تقنية مقياس الانفعال بأستخدام جـــهاز قياس الانفعال الديناميكي للحصول على قراءات عملية عظمى لأنفعال عدة القشـط التنـــقيري المـعروفة خصائصها الفيزيائـية والميكانيكية من بداية عملـــــية القطع الى نهاية شوط القطع وبأستـخدام دائرة ميرشنت لتحليل قوة الـتقطع وقـــياس أبعاد قطع الجذاذة المتحصلة أثناء القطع بتغيير عمق القطع (5,3,2 ملم) تم حســاب أجهاد القـص الديناميكي عند مستوى القص وبـمعرفة مواصـــفات الميـكانيكية للـمادة المـقطوعة". تم أيجـــاد الأنفـــــعال الديـــناميكي النــظري وكان الأنــــحراف المـــعياري(0,00016) ومعامل التصحيح للقراءات النـظرية والعملية (0,3) تدل على أمكـانية أستخدام التقـنية لتحسين عملية القطــع وأطالة عمـر الخدمة للعـدة القاطعة 30% تقريبا"، وتكررت العــملية باستخدام أحـد سـوائل التزيـيت المستخدمة في عمليات القطع المعروفة المواصفات لأيجاد قيم الأنفعال الديناميكي أثناء التزييت ومن المقارنة يمـكن التنبؤ بقيمه، وكذلك بقيم معامل التزييت أثناء عملية القطع أذ أن معدل قيمته (0,93).

الكلمات المفتاحية : انفعال القص الديناميكي ، عدة القشط ، تقنية قياس الانفعال .

1-Introduction:

The researcher [1] deals with in his research to effect of rake angle, tool Geometry ,cutting Knife radius and cutting tool material on cutting forces that produce when machining of mild steel metal and practical side carrying out on shaping machine and the specified mechanism is designed for measurement of cutting force by cells fitting to record readings of cutting force and convert them to computer program (MINITAB15) during test [1]. The researcher [2] deals with the ability to connect a group of cutting process such as (Slotting , Drilling and Shaping) carrying out them once machine by mechanism consist of (Bevel gear and cam) that led to reduce cost production.
The researcher [3] refer to using accelerated strain gage technique to measure cutting force , feeding speed and axial force for turning tool with dynamometer and varying of velocity with different materials such as (Steel , Aluminum and Brass) for work- pieces and the is increase of cutting force combined with increase of cutting speed. The researcher [4] is mention the way to measure cutting force by piez-oelectric and strain gage and at comparison is notice that the results of piezoelectric is a best, low cost, high response ,big mechanical stiffness ,high accuracy in time and has large warily wide . The researchers [5] refer to variables Of cutting process such as

(features of tool) , Working material and machine variables and They are notice effecting there on practical efficiency and specific characteristics and they are investigate about ideal variables values and determine critical areas in cutting process that led to unreasonable outputs ,and they are research in alternative approach to determine Ideal variables to predict of cutting force ,life of tool cutting and surfaces finish in good state**.**

The researchers [6] deals with cutting processes non continue ,hence ,they are need of thermal cutting analysis on workpiece face and this is requirement non continue cutting process analysis to prevent failure of tool cutting there for can be measure of temperature directly to get of practical results and can be putting numeric-al mathematical model to get of theoretical results and then comparison them and using lubricant liquid to get good practical results.

2-Theoretical Side:

From cutting power equation(1) that is limited by machine which is variable of rotating speed and convert it to linear velocity or can be from calculate of cutting stroke ,and using stopping watch to calculate cutting force ,and from merchant cycle equation that are related with cutting processes. The rake and tool angle (α,β) can be measured from tool then calculate shear angle (ø) and from its value can be calculate shear force .The width of cutting tool knife which is preparation in work piece metal can be measured cheap thickness produce from cutting process can be calculate (dynamic shear stress) and with knowing mechanical properties of work piece metal (shear modulus elasticity) can be determine theoretical dynamic strain values at shear plane.

$\zeta = \frac{p_{mechanical}}{p_{Electrical}}$ ………………………………..(1)

$P = F_c * V$ ……………………………………….(2)

$\emptyset = 45 + \frac{\propto}{2} + \frac{\beta}{2}$ ……………………….........….(3)

$\emptyset = Shear\ angle$

$\propto = Rack\ angle$

$\beta = Tool\ angle$

$F_s = F_c\ cos\emptyset - F_t\ \sin\emptyset$ …………………...…. (4)

$\mu = tan\beta$ ……………..……........…………..….(5)

$\mu = \frac{F_t + F_c tan\alpha}{F_c - F_t tan\alpha}$ ……………………..……..……..….(6)

$\tau_{dynamic} = \frac{F_s}{A_0}$……………………..………..….(7)

$A_0 = \frac{w}{t_0}$ (8) …………………………..……..….(8)

$\varepsilon_{dynamic} = \frac{\tau_{dynamic}}{E_{shear}}$ ……………….….……….….(9)

3-Preparation of Specimens and Experimental Procedure:

The research study was used on milling machine, such as (Fig 1) Czech Republic and Slovakia manufacturer Al- musayyib technical institute at workshops, and then change milling head shaped cutting scrape (clicking tools) of metal machines for making shapes, as shown in Fig (1).

Fig.1 Milling machine for pitting shaping,

Then connect shaping tools in holder head tools and connect circular section workpiece on dividing head equipment head ,and the shaping process to be inside circular cavity , then more cavity shaping during rotation head divided for angle suitable and cutting tools stroke of the long the work piece cavity as show Fig 2.

Fig 2. The connection of shaping tool with interface and monitor.

Addition, sensors linked with strain gauge frequency (120 HZ) cutting blade very near with gauge linking to a measure interference to transfer sensor readings according to a computer program that connects the device overlap as shown in Fig. (2). the changes that took into account the practical aspect are the speed and depth of the pieces in the dryer first case, and use lubrication liquid second case. So that, then conducting the cutting process therefore, finds the curves that painted the following values: Fig 3 to Fig 11 detail the relationship for between her. One of the traditional ways to reduce shear force at the plain level, according to the Merchant Circle, is to reduce friction strength with suitable lubrication conditions, which in turn contributes to easy flow of the shearing at the sheer level, which in turn brings down shear force and reduces shear stress that involves several pieces [7]. As the researcher pointed out [8]. The case of lubricant that helps to flow was selected and cooling the cutting area well and improve the functioning of various men and according to the Table1, below shows the proportions of materials used in lubrication and cooling of the cutting process below:

Table 1: illustrates below details of the oil lubricant percentage

Stuff	Office	Contact: (%volume/volume of fixed oil)
Fixed oil	Base oil	%80
Washing soap	Emulsifier	%10
Carbolic acid	Germicide	%5
Sculpture	Extreme	%5

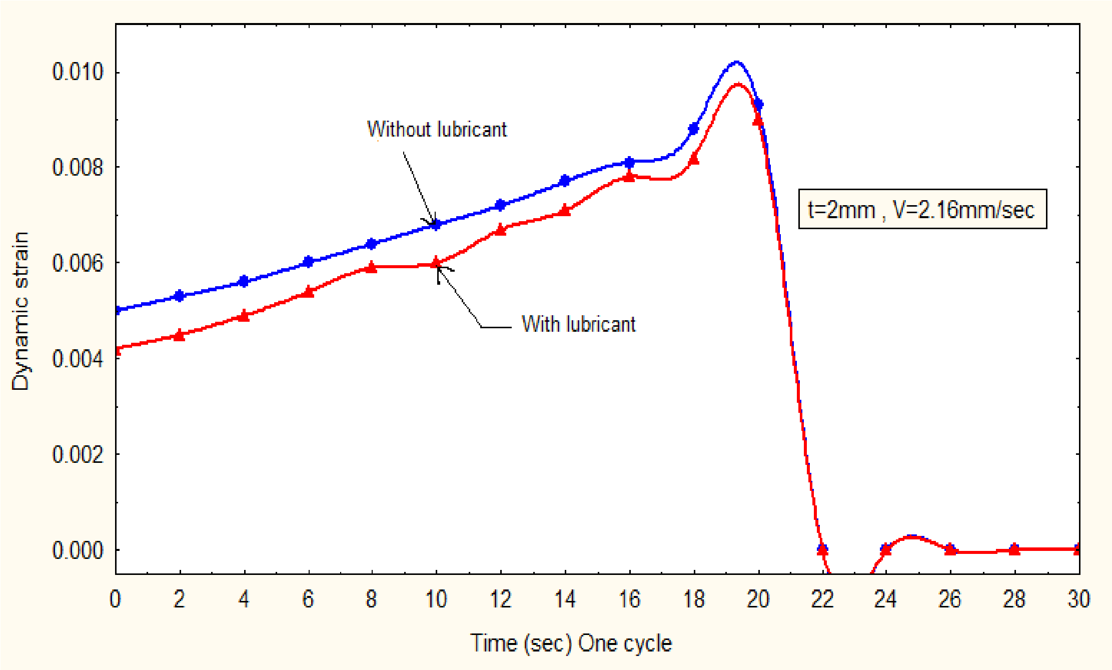

Fig 3:Illustrate practical dynamic strain of cutting tool during one of cutting cycle at 2mm in cutting depth and 2.16mm/sec in cutting velocity

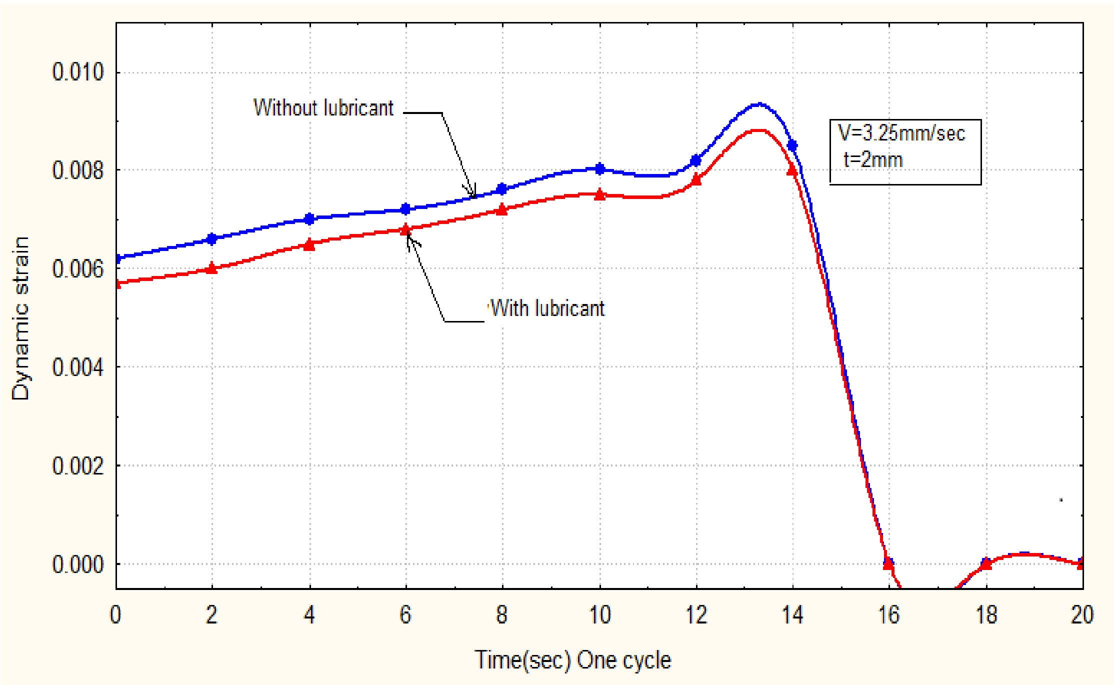

Fig 4: Illustrate practical dynamic strain of cutting tool during one of cutting cycle at 2mm in cutting depth and 3.25mm/sec in cutting velocity

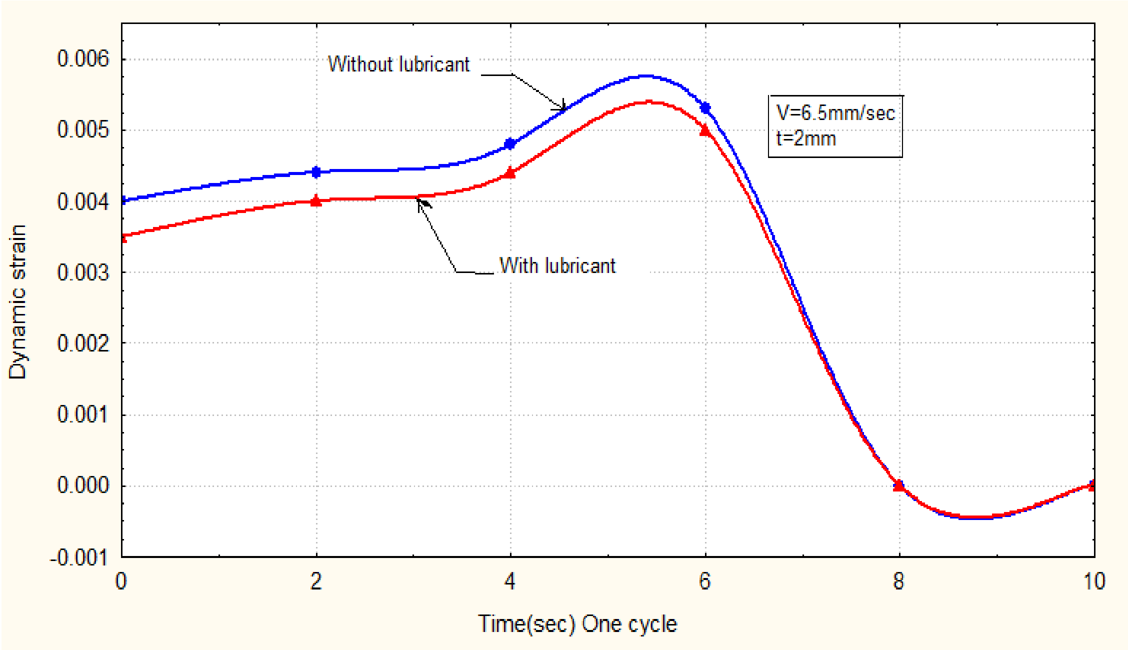

Fig 5:Illustrate practical dynamic strain of cutting tool during one of cutting cycle at 2mm in cutting depth and 6.5mm/sec in cutting velocity

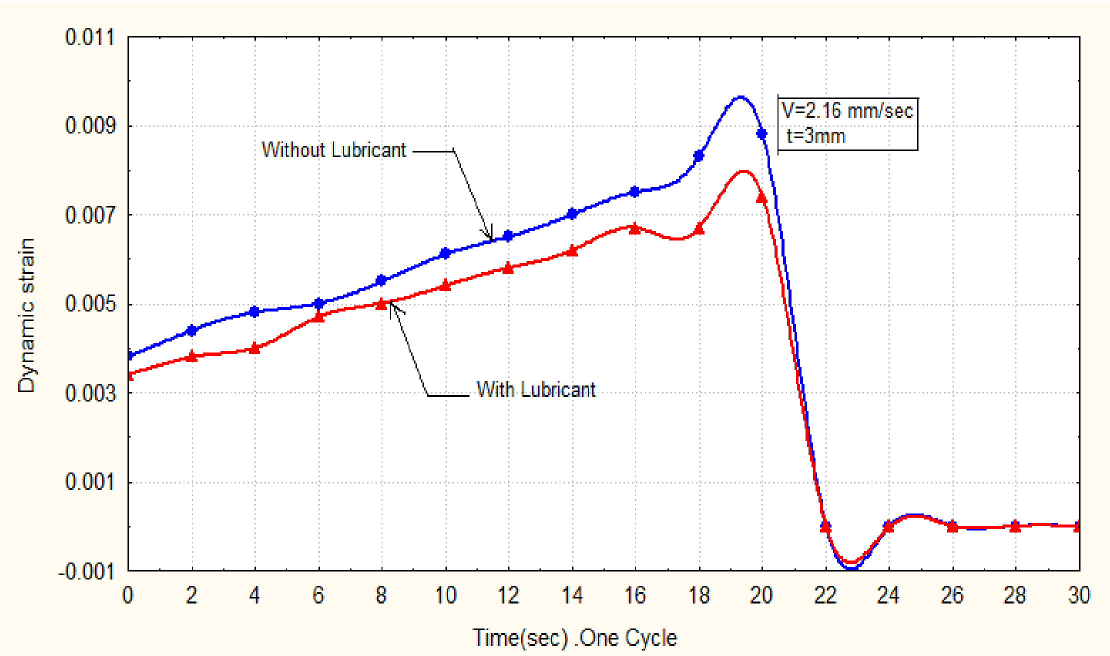

Fig 6:Illustrate practical dynamic strain of cutting tool during one of cutting cycle at 3mm in cutting depth and 2.16mm/sec in cutting velocity

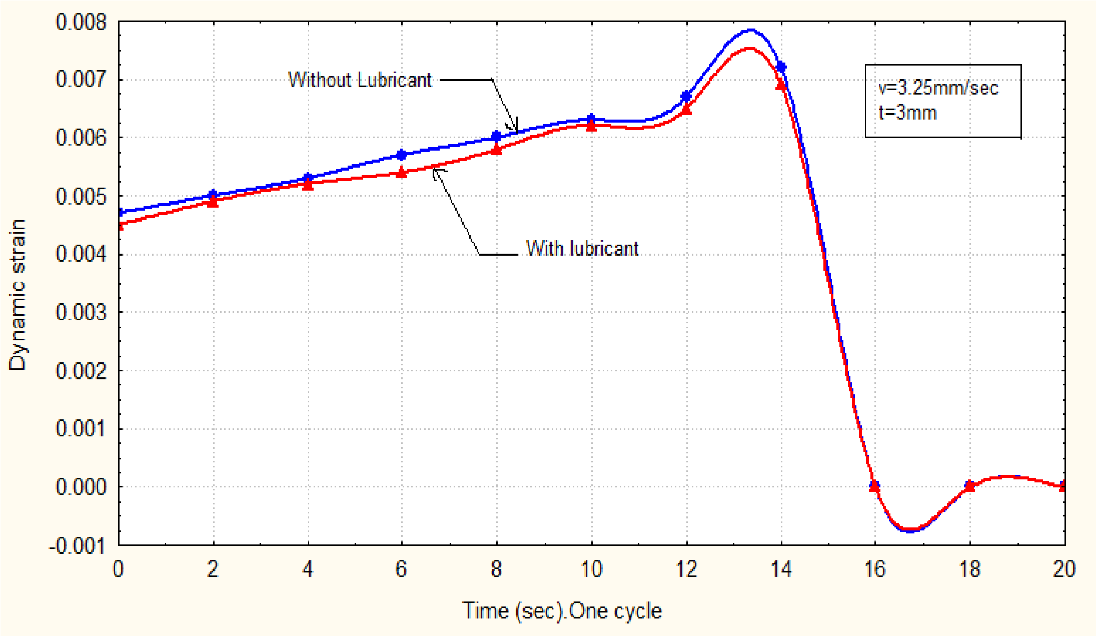

Fig 7:Illustrate practical dynamic strain of cutting tool during one of cutting cycle at 3mm in cutting depth and 3.25mm/sec in cutting velocity

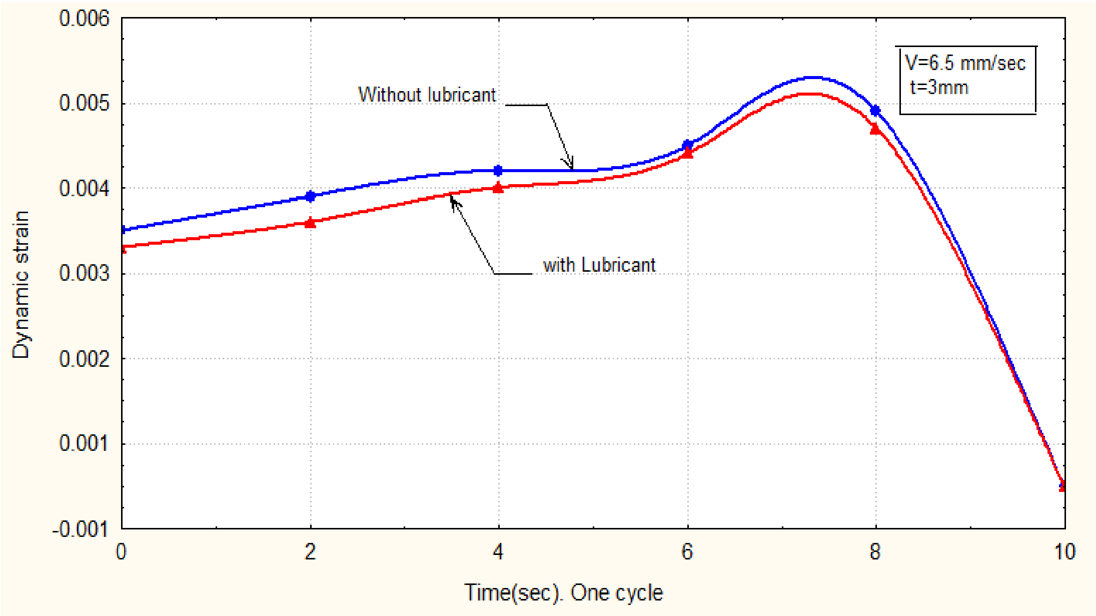

Fig 8:Illustrate practical dynamic strain of cutting tool during one of cutting cycle at 3mm in cutting depth and 6.5mm/sec in cutting velocity

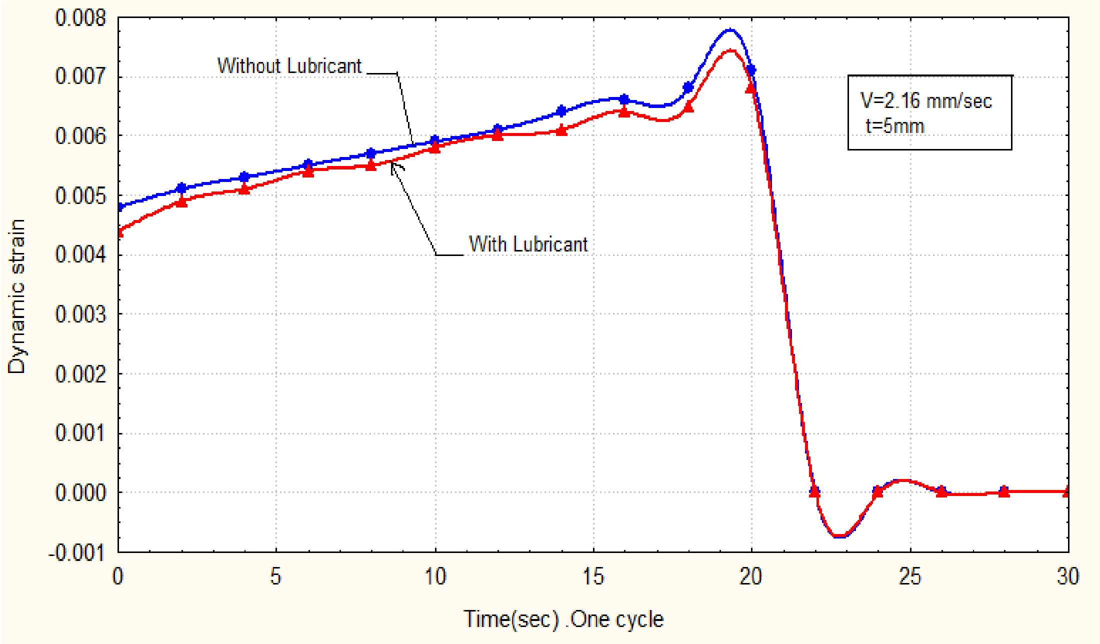

Fig 9: Illustrate practical dynamic strain of cutting tool during one of cutting cycle at 5mm in cutting depth and 2.16mm/sec in cutting velocity

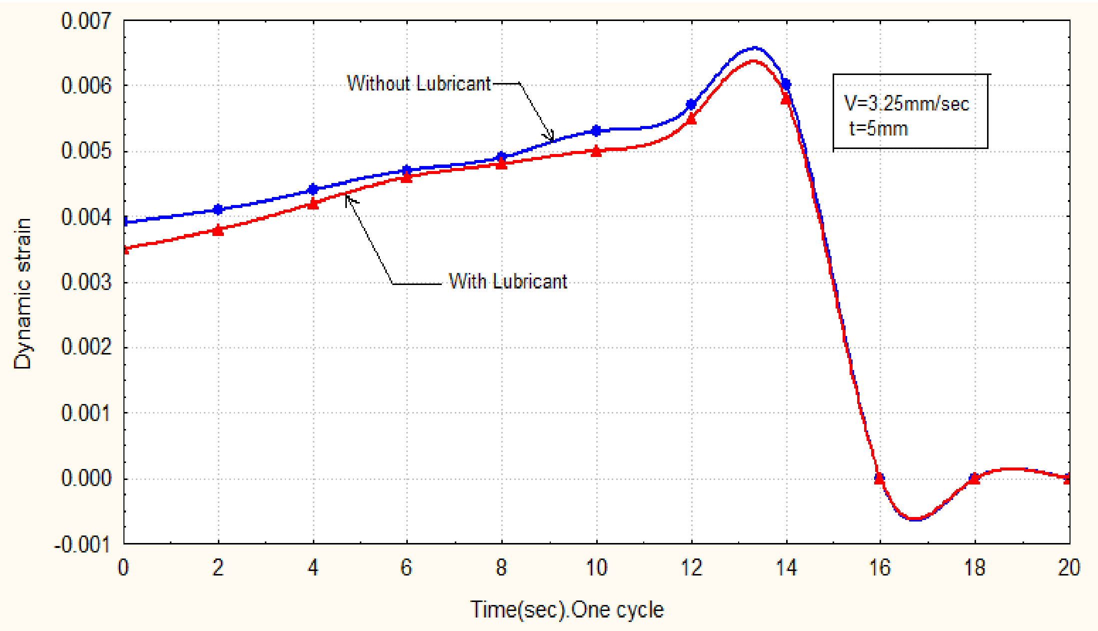

Fig 10: Illustrate practical dynamic strain of cutting tool during one of cutting cycle at 5mm in cutting depth and 3.25mm/sec in cutting velocity

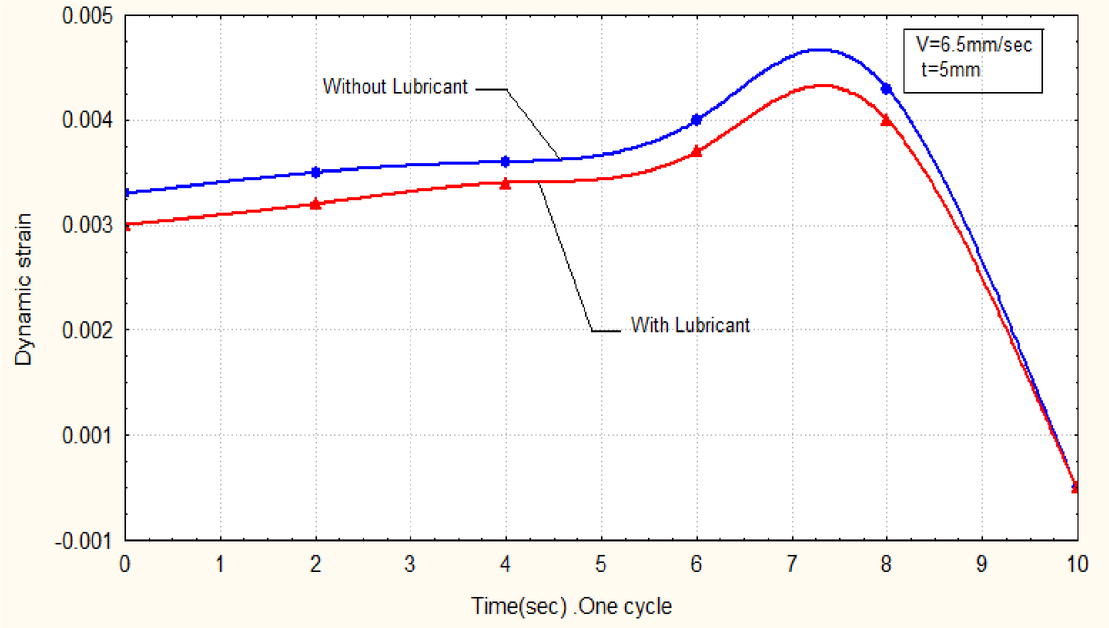

Fig 11:illustrate practical dynamic strain of cutting tool during one of cutting cycle at 5mm in cutting depth and 6.5mm/sec in cutting velocity

4- Results and Discussion:

The outcomes of the analysis were received using a lubricating liquid, which was contrived to dilute the agitation on the various functions and therefore concentrate the tensions leading to the operation. The average lubrication factor was estimated to reduce failure stress and was (0.93) of the practical results and thus possible to be used as stress reduction agents on any number of compositions in different cutting operations. Through a standard deviation equation (S.D) and correction coefficient (R_2) as shown in Table (2).

Table 2. Resulted standard deviation equations (S.D) and correlation coefficient (R_2).

t (mm)	V (m/Sec)	$(\varepsilon_d)_{th}$	$(\varepsilon_d)_{exp.}$	$(\gamma_d)_{exp.}$ With Lub.	FLRS
2	2.16	0.11	0.0093	0.0088	0.96
2	3.25	0.0072	0.0085	0.0079	0.94
2	6.5	0.00365	0.0053	0.0048	0.94
3	2.16	0.0073	0.0088	0.0074	0.84
3	3.25	0.0048	0.0072	0.0069	0.94
3	6.5	0.0024	0.0044	0.0042	0.95
5	2.16	0.00439	0.0071	0.0068	0.95
5	3.25	0.0029	0.006	0.0058	0.96
5	6.5	0.00146	0.0038	0.0035	0.92
Standard deviation = 0.00016					
Correction factor = 0.3					
Average of FLRS = 0.93					

1. Fig. 12: shown the curved in(3D) we note that the relationship between the depth of the pieces and the dynamic emotion is inversely theoretical and the reverse relationship is between the speed and the dynamic soles as illustrated by the shape of the curve Fig 13. The cutter reduces the stress on several pieces and without emotion. Note that the rack angle is greater in the case of increasing speed due to the decrease of the friction force by increasing the speed and reduce the strength of the pieces required to complete the cutting process because the relationship is inverse between them.

2. Fig.(14) in (3D)and in fig.(15)in (2D) shown in curves that the relationship between velocity and dynamic emotion in practice is a linear inverse relationship, granting to the rate of practical readings as the details are scattered from the straight line in certain amounts and for many reasons, including longitudinal and lateral vibrations of the free pieces and decades. Specific to the actual cutting area to keep it from being damaged during the cutting process, the probability of moving the gauge from the place where it is connected during the cutting process, the aging of the milling machine, the cone, which in turn increases the clearance of the cutting mechanism and causes vibration and movement Longitudinal and undesirable.
3. Fig.(13) in(2D) and fig.(14) in (3D) the showing of the curves, observe that the relationship between the cutting depth of the pieces and the dynamic emotion is inversely related. In practice, the shape is a low slope for the two dynamic modes of operation without the coolant and the practical dynamic emotion with the cooling fluid. Previously, the causes led to a discrepancy between the readings mentioned above.
4. The calculations of the rate of lubrication factor to reduce the stresses and emotions generated on several pieces in the shear area (0.93). This indicates that the dynamic stress of the cutoff kits decreases by a small percentage, but allows for an increase in the lifetime of the cutoff limit for a longer period than the actual life of the cutter, which is definitely an economic gain for the cutting process.
5. The standard deviation (0.00016) for the dynamic and theoretical dynamic readings according to the velocity variables and the depth of the pieces indicates that there is a convergence between the readings at a zero rank after .
6. The correction factor (R^2 = 0.3) indicates that there should be a correction between the theoretical and practical readings by 30% between them to reach real convergence. This is in the interest of increasing the useful life of the kit especially in the large quantity production to increase the economic feasibility of the cutting process.

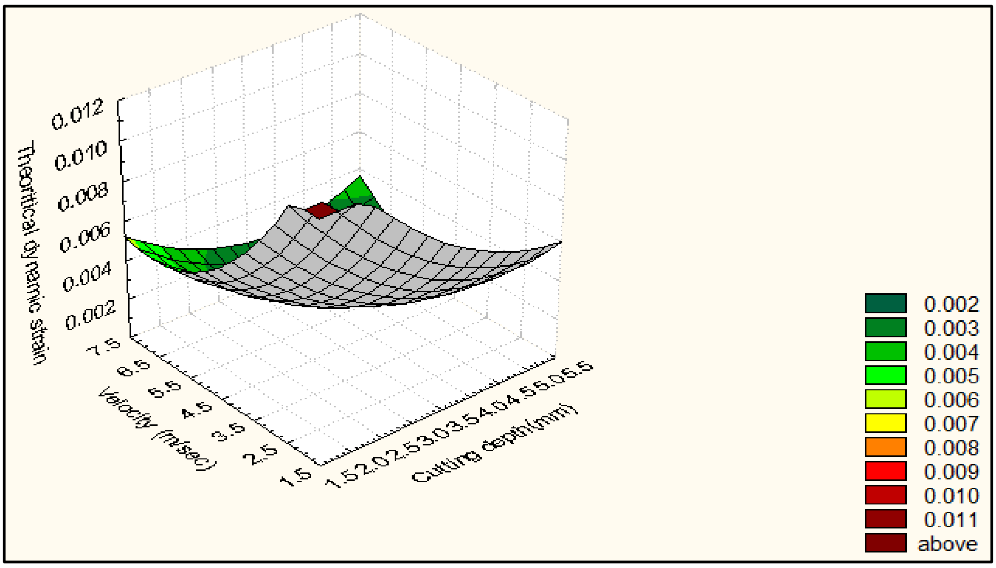

Fig.12 Influence of quadratic function of substrate cutting depth and significant influence of velocity on theoretical dynamic.

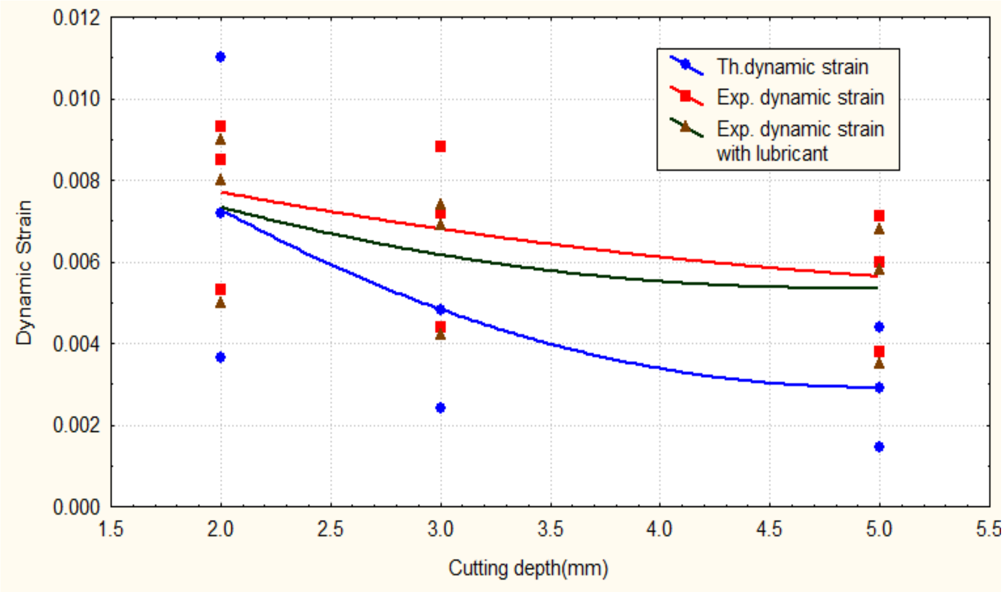

Figure 13: behavior of cutting depth relative to interaction between Exp. dynamic strain and Exp. Dynamic with strain lubricant.

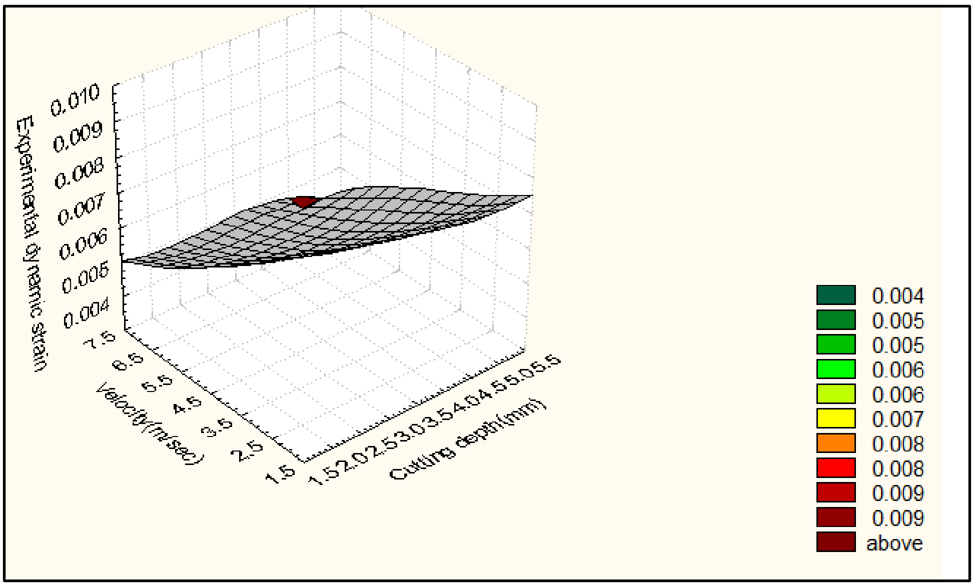

Figure14: Significant influence of a quadratic term of substrate cutting depth while influence Velocity at experimental dynamic strain.

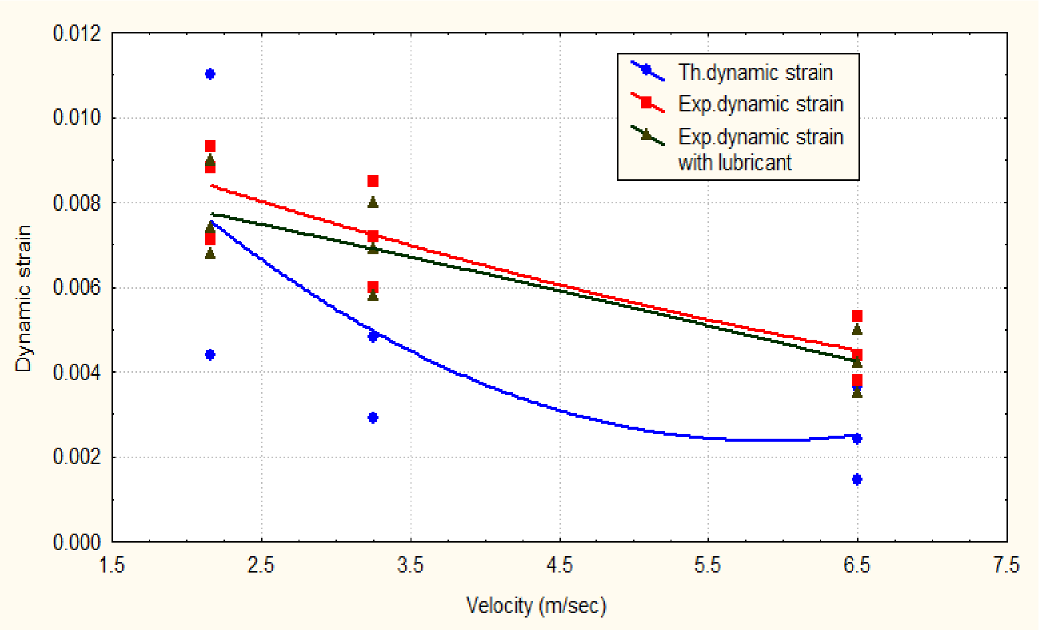

Figure 15: Interaction between the dynamic strain and Exp. dynamic strain with Exp. with dynamic strain lubricant.

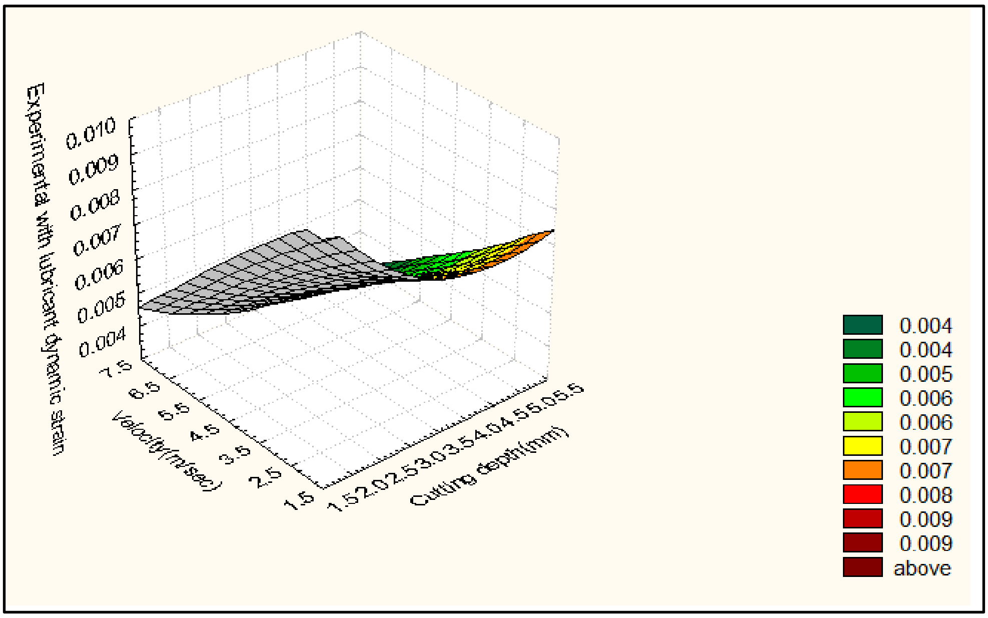

Figure16: Interaction between cutting depth and velocity with Exp. with lubricant dynamic strain

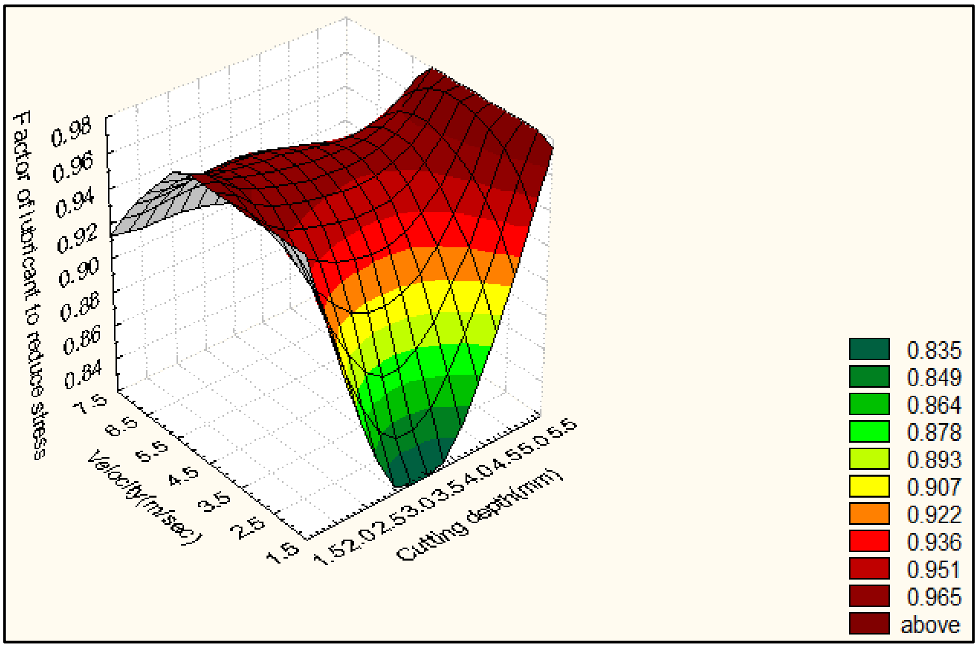

Figure17: Interaction between cutting depth and velocity with a factor of lubricant to reduce stress.

5- Conclusions:

1- Practical results refer to the ability to evaluate the stresses values by reading strains with using technique of strain gauge .
2- Can be reduce the stresses by different ways one of easy them is using lubricant liquid and this is actualize by streaky kinship and there is convergence points for shear cutting strain in normal state and in using lubrication state that cause of being high hardness regions inin metal cutting cause of machine present led to longitudinal vibration in tool cutting.
3- The increasing of cutting speed with cutting depth in constant that is notice reduce of strain values led to reduce of stresses and required cutting force and by reducing cutting depth with increasing of speed that is notice grave reducing in shear stresses values that is cause of easiness of cheap streaming with little cutting depth , high speed and occasion rake angle.
4- The average of lubricant factor to reduce stresses refer to the ability of reduce shear strain On shear plane by simple percentage ratio that is led to long service life of tool.

6- Recommendations:

1- The mechanical milling machine used in the research is practically old. Therefore, the ratio of the clearance in the mechanical parts leads to an error rate in the readings. Whenever the more modern and convergent so that results are accurate with the truth.
2- The longitudinal vibrations of columns or shaft are longitudinal movement that leads to the occurrence of emotions and stresses along the movable column. It is possible to take advantage of Timoshenko's theory for this effect to find the emotions and stresses due to the free and forced longitudinal vibration of the pruning shears.
3- That the technique of the measure of emotion gives accurate results in the case of installation at the point of cutting, and this is not possible for the difficulty of installation and instability, so there is a percentage of error after the small installation distance can be used to install points of distance to find the dimension factor (interpolation) and add the amount for error readings.

7- Reference:

[1] Malik A.K . "Effects on cutting forces in shaping operation". European journal of Advances in engineering &technology,(2015).

[2] Ma GUTEESWARAN.R; "Fabrication of multi process machine" International journal of research in aeronautical and mechanical engineering,(2014).

[3] TULASIRAMARAO. B&DR. SRINIVAS.K "Measuring cutting forces while cutting of different metals with different speeds" International journal of Application or innovation in engineering & management,(2014).

[4] Hidayah. M .T.N & Ghani. J.A."A review of utilization of cutting force analysis in cutting tool condition monitoring" International journal of engineering & technology,(2012).

[5] Roa. C.J, Sreeamulu. D. & Methew.A.T " . Analysis of tool life during turning operation by determining optimal process parameters" www.sciencedivect.com.(2014).

[6] Carou. Drubio.E.M&Dovim.J.P." Discontinuoas cutting: failure mechanisms, tool materials & Temperature" Rev. Adv. Mater.Sci.38,(2014).

[7] Serope Kalpakjian, Steven R. Schmid, "Manufacturing process engineering materials",5th Edition,(2008) .

[8] LAWAL. S.A & ABOLARIN.M.S; " performance evaluation of cutting fluids developed from fixed oils" lawabert 2003 @Yahoo.com,(2003).

[9] Kan Cao, Yang Wang and Yu Wang. "Experimental investigation and modeling of the tension behavior of polycarbonate with temperature effects from low to high strain rates". International Journal of Solids and Structures, Volume 51, Issue 13, Pages 2539–2548,(2014).

[10] LAWAL. S.A & ABOLARIN.M.S; " performance evaluation of cutting fluids developed from fixed oils" lawabert 2003 @Yahoo.com.(2003).

[11] Motorcu A.R. et al." Evaluation of tool life - tool wear in milling of inconel 718 superalloy and the investigation of effects of cutting parameters on surface roughness with taguchi method" .Technical Gazette 20, 5, 765-774,(2013).

[12] Kyung Hee Park. "Tool wear analysis in various machining processes and study of minimum quantity lubrication (mql)" https://etd.lib.msu.edu.(2010).