iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 Issue: VII Month of publication: July 2020

DOI: https://doi.org/10.22214/ijraset.2020.30396

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VII July 2020- Available at www.ijraset.com

Design of Pipe Notching Machine

Yogesh Borse[1], Yashraj Darekar[2], Mayur Wable[3], Shivani Sarode[4], Rohit Patil[5]
[1]Assistant Professor, [2,3,4,5]U. G. Scholar, Mechanical Engineering, K.K.W.I.E.E.R, Nashik,

Abstract: Special Purpose machine are designed to perform some specific applications which cannot be carried out using conventional machines. Conceptualization of the system design understanding the need of the system with a collaborative approach and develop the machine. Existing now pipe notching is done on manual hand grinder where people stick Notch profile print from CATIA file on pipe and manually grind it to perfect shape on hand grinder and then the joint is done with the help of welding process. The main focus of project is to study different parameter of SPM and solving the problem related to production rate and design machine to overcome odds of the conventional process. The different software's such as ANSYS, CATIA etc. will be used for analysis and designing purpose. To study about various parameters such as the Material selection for the machine, parts required for manufacturing of machine, Machine feasibility for manufacturing depending on final cost of machine & various design parameter of the SPM. Main aim of the project is to improve accuracy and production rate of the pipe notch.

Keywords: Special purpose machine, Notching, Notch, grinding , Rapid feed rate, Higher accuracy.

I. INTRODUCTION

An engineer is always focused towards challenge of bringing ideas and concepts to life. Therefore, machines and modern techniques have to be constantly developed and implemented for economical manufacturing of products. At same time, we should take care that there has been no compromise made with quality of design and accuracy. In the era of automation of machine are becoming an integral part of human being. By using of automation of machine prove itself that it gives high production rate than manual production rate. In completive market everyone wants to increase their production & make their machine multipurpose. The engineer is constantly conformed to the challenge of bringing ideas, innovation and design into reality. New machines and techniques are under development continuously to manufacture various products at cheaper rates and high quality.

So, we are going to make a machine for 'Pipe Industries& fabrication industries and make it multipurpose & should be used to cut pipe at different angle to improve the joint preparation for welding . The machine is easy to maintain, easy to operate. Hence, we tried our hands on "pipe notching machine". This machine is one of the principal machines in pipe industry& used for notching metals pipes end for welding. It is mainly used as the name indicates for Notching.

K.K.Wagh college of engineering participates in the sae efficycle, sae baja where the frames for these vehicles are typically fabricated from sections of thin-walled steel tubing that are TIG welded together. Tube ends must be notched prior to welding to insure Proper joint and high weld strength.

II. DESIGN

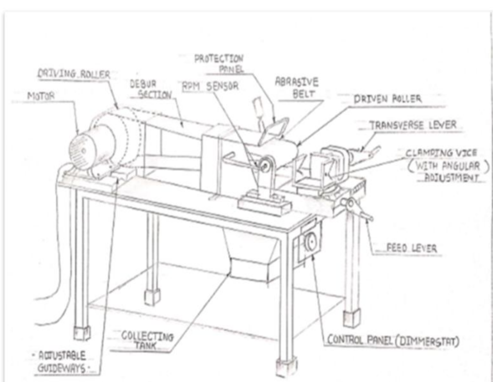


Fig.1 Construction Diagram

A. Construction

1) Motor (Prime mover)
2) Belt.
3) Driving pulley
4) Driven pulley
5) Adjustable Base.
6) Shaft.
7) PedestalBearings.
8) Foundation Bolt.
9) Lead screw
10) Grinding Sand Papers.
11) Foundation support frame.
12) Pipe Vice
13) X-Y Cross slide

B. Working

As the motor is prime mover of entire setup which mounted on to the bed. Motor is mounted with guideways in order to give sliding motion which is adjustable. After the motor the rollers are the main components in driving system. Two rollers are used, one is driving and another is driven. Driving roller is connected to motor through belt drive. Driven roller is connected to abrasive belt. Both rollers are mounted on frame by using pedestal bearings. There are four bearings are used for supports of two rollers. The end of rollers are fixed in internal bore of pedestal bearings which are clamp by using bolts whereas pedestals bearing are supported by using clamping bolts.

Abrasive belt runs over the rollers for grinding purpose. Always while designing any machine as we are using various components for the purpose so there is a need of using the sturdier support so we had used bed to support the various components. As shown in fig.1 additional X-Y cross slides are use with pipe vice which can move vice by using power screw & handle.

When prime mover i.e motor starts rotating it cause the rollers to rotate with it. Motor drives the roller whereas driven roller is rotated by means of the grinding belt. As the material that is pipe, is pressed against the roller which is of the diameter equal to the pipe diameter. As soon as the roller starts rotating there is a relative motion between bearing and rollers shaft which is constrained in the bore of pedestal bearing. Due to this material starts removing from pipe if pipe is perpendicular to the axis of the roller then 90° angle notch is form on pipe. We can change the angle of the pipe according to the groove or notch geometry. We can adjust it by using adjustable vice (angular position adjustment).

C. Mechanical Design

Mechanical design of components are listed down and stored on the basis of their procurement in two categories.

1) Design parts
2) Parts to be purchased.

For the designed parts detailed design is done and dimensions there obtained are compared to next dimensions which are already available in market. This simplifies the assembly as well as the post production and maintenance work. The various tolerances on work are specified. The process charts are prepared and passed on to manufacturing stage. The parts to be purchased directly are selected using various catalogues and are specified so as to have case of procurement. In mechanical design at the first stage selection of right material for the part to be designed for specific application is done. This selection is based on standard catalogues or data.

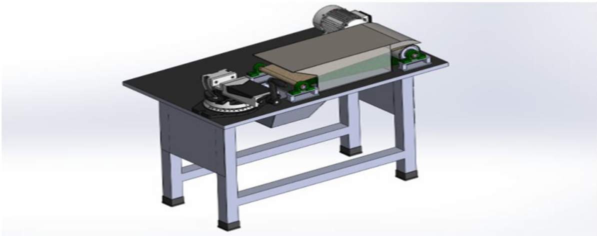


Fig.2 cad model

D. Motor Selection

Motor is a Single-phase AC motor, Power 50 watt; Speed is continuously variable from 0 to 8600 rpm. The speed of motor is variation by means of an electronic speed variation. Motor is a accumulator motor i.e., the current to motor is supplied to motor by means of carbon brushes. The power input to motor is varied by changing the current supply to these brushes by the electronic speed variation; thereby the speed is also is changes. Motor is mounted on foot and is bolted to the motor base plate welded to the base frame of the indexer table.

Fig.3 Motor

Motor Torque

$$P = \frac{2 \Pi N T}{60}$$

$$T = \frac{60 \times 50}{2 \Pi \times 8600}$$

T = 0.055 N-m

Note: All Calculations are taking at full speed of motor.

Power is transmitted from the motor shaft to the input wire brush bundle shaft by means of an open belt drive,

Torque at IPrear shaft = 2 x 0.055= 0.11 Nm

Speed of IP _ wire brush bundle shaft pulley = 8600/2 =4300rpm

Motor pulley diameter d = 30 mm

IP _ shaft pulley diameter D = 60 mm

Reduction ratio = 2

Coefficient of friction = 0.23

Center distance c= 200

Let,

t= Thickness of belt= 5 mm

b= Width of belt=6mm

Velocity of belt is given by;

$$V=\frac{\Pi(d+t)n}{60 \, X \, 1000}$$

$$V=\frac{\Pi(30+5) \times 8600}{60 \, X \, 1000}$$

V=15.76 m/s Linear velocity of open belt drive – 1

To find out tension in the belt is;

$$P= \frac{(F1-F2)V}{1000}$$

$$50 \, X \, 10^{-3}= \frac{(F1-F2) \, X \, 15.76}{1000}$$

F1 – F2 = 3.172 N (1)

Center distance between two pullies of motor &pullies of wire brush bundle C=200mm.

$$\alpha = \sin^{-1}\frac{D-d}{2\,C}$$

$$\alpha = \sin^{-1}\frac{(60-30)}{2 \, X \, 200}$$

$\alpha = 4.30^0$ (In Degrees)

α =4.30 X (Π /180)

α =0.075^c (In Radians)

θ = Angle of lap of belt.

$\theta = \Pi - 2\,\alpha$

$= \Pi - [2 \times 0.075]$

$\theta = 2.99^{c}$ (In Radians)

$\theta = 171.40^{O}$ (In Degrees)

Now,

$\frac{F1}{F2} = e^{\mu\theta}$

$= e^{0.23 \times 2.99}$

$\frac{F1}{F2} = 1.989$ (2)

F1= 1.989 F2 (3)

Put Eq. (3) inEq. (1)

F1- F2 = 3.179

1.989 F2 - F2 = 3.179

0.989 F2 = 3.179

F2 = 3.207 N

Put in Eq. (3)

F1 = 6.379 N

Mass of belt per unit length is given as

$m = \frac{\rho\ x\ b\ x\ t\ x\ 1}{10\text{^}6}$

ρ= density of belt material = 950 kg/m^3

$m = \frac{950\ x\ 6\ x\ 5\ x\ 1}{10\text{^}6}$

m= 0.0285 kg/m

Centrifugal force in belt is given by,

$Fc = mV^2$

$=0.0285 \times (15.76)^2$

Fc = 7.078 N

E. Shaft Design (ASME Code)

Since the loads on the most of the shafts in connected to machinery are not constant, it is necessary to make proper allowance for reduce the harmful effects of load fluctuations According to ASME code permissible values of shear stress is calculated from various relations.

Fig.4.Shaft

For commercial steel shaft,Actual shear stress $\tau_{act} = 55 N/mm^2$

$T = \Pi/16 x \tau_{act} x d^3$

$\tau_{act} = \frac{16 \text{ x T}}{\Pi \text{ x } d^3}$

$0.11 x 10^3 = \frac{16 \text{ x } 55}{\Pi \text{ x } d^3}$

d^3=393.83

d=7.33mm

d=20mm(Select) Ref: - PSG Design data book.

F. *Selection of Bearing*

In the selection procedure of ball bearing the main governing factor is the system design of the drive i.e.; the size of the ball bearing is of major importance; hence we shall first select an appropriate ball bearing. Taking into consideration convenience of mounting of ball bearing. As shaft diameter is 20 mm so we have welded a supporter of shaft 20mm to it &selected a pedestal ball bearing having shaft outer dia-20mm ball bearing to support the shaft of 20mm.

Total radial load on bearings are =Weight of belt+ weight of roller shaft.

Total radial load on bearings = Assume = 6kg = 60 N

Radial load on each bearings Fr = 60/4

= 15 N.

Equivalent dynamic load

Pe = V.Fr.Ka

= 1 X 15 X 1.5

Pe = 22.5 N

bearing life is,

$L^{10} = \frac{Lh10 \text{ X } 60 \text{ X } n}{10^6}$

L_{h10} from graph 4.6 PSG Design data book for 16000 rpm maximum speed of ball bearing is 315000 Hours.

$L^{10} = \frac{31500 \text{ X } 60 \text{ X } 4300}{10^6}$

L^{10} = 8127 millions of revolutions.

$L^{10} = (\frac{C}{Pe})^{(\frac{10}{3})}$

$C = (L10)^{(\frac{10}{3})}$ X Pe

$C = (8127)^{(0.3)}$ X 22.5

C = 335.09 kN.

PSG Design data book P.No. 4.13.

G. *Design of Lead Screw.*

For screw material C40 yield stress σy= 330 N/mm^2

Ultimate shear stresses = 0.5 σy=165 N/mm^2

Operating load F= 15kg =150 N.

Distance from which power is transmitted to screw (handle length) R =75mm.

We know that T = F X R

= 150 X 75

= 11250N.mm

= 11. 250N.m

Tensional shear stress $T = \Pi/16 \text{ x } \tau \text{ x} d^3$

$11.25 \text{ x } 10^3 = \Pi/16 \text{ x } 165 \text{ x} d^3$

dc =7.02 mm select dc=7 mm.

Nominal dia. d= 10mm.

Core dia. dc=7mm.

Pitch p = 3mm.

Operating load W= 150 N.

Coeff. Of friction μ = 0.11 (For steel lubricated screw)

Coeff. Of friction μc = 0.125 (Forcoller)

$\lambda = \tan^{-1}\frac{L}{\Pi \text{ x dc}} = \frac{Nt \text{ x } p}{\Pi \text{ x dc}}$ $(N_t = 1)$

$\lambda = \tan^{-1}\frac{1 \text{ x } 3}{\Pi \text{ x } 7}$

$\lambda = 7.7682^0$ (For single start)

$\mu_1 = \frac{\mu}{Cos\beta}$

$= \frac{0.11}{\text{Cos } 14.5}$

$\mu_1 = 0.1136$

$\Phi_1 = \tan^{-1}\mu_1$

$= \tan^{-1} 0.1136$

$\Phi_1 = 6.4820^0$

Efficiency for screw

$\eta = \frac{\tan\lambda}{\tan(\Phi 1 + \lambda)}$

$= \frac{\tan\ 7.7682}{\tan(6.4820 + 7.7682)}$

$\eta_s = 0.5371$

$\eta_s = 53.71\%$

Overall Efficiency for screw

$\eta = \frac{W\,L}{2\Pi T} = \frac{W\ P}{2\Pi T}$

$= \frac{150 \text{ X } 3}{2\Pi \text{ X } 7.96}$

$\eta = 9\%$

H. Selection of the Material

The machine is basically made up of mild steel because of following Reasons:

1) Mild steel is readily available in market.
2) It is economical to use.
3) It is available in standard sizes.
4) It has good mechanical properties i.e. it is easily machinable.
5) It is having moderate FOS , because factor of safety results in unnecessary wastage of material and heavy selection.
6) Lower factor of safety results into unnecessary risk of failure.
7) It has high tensile strength.
8) Low co-efficient of thermal expansion.

I. Properties of Mild Steel

M.S. has carbon content from 0.15% to 0.30%. It is easily wieldable thus can be hardened only. They are similar to wrought iron in properties. Both ultimate tensile strength and compressive strength of these steel increases with increasing carbon content. They can be easily gas welded or electric welded or arc welded. With increase in the carbon percentage weldability decreases. Mild steel serve the need and was hence was selected because of the above purpose.

III. RESULT

CAE analysis of roller and pulley assembly: Power is provided to the rollers from motor through belt drive. This belt drive includes pulleys, one pulley is mounted on motor and other one is connected with roller. Roller which is coupled with pulley is also the main working roller or simply it is also subjected to transverse loading due to feeding of the job for grinding. So, this entire assembly is subjected to bending as well as torsion. To determine the material and cross-section of the parts which will give optimum strength and weight. Analysis of the forces acting on it has to be done.

Assumptions and consideration:

Main assumption is about the transverse force which is acting due to feeding of material so by references we had come to know that its value should be 15-20kg (1300N-1900N). torque value can be easily find out from motor and diameter ratio of pulleys.

A. Values of Various Boundary Conditions

Transverse force due to feeding:

As per the assumption it should be 1300-1900N. so taking its maximum value i.e. 1900N.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VII July 2020- Available at www.ijraset.com

Torque on pulley:
Torque provided by motor – 0.065N.m
Service factor – 4.5
Starting torque - 0.065*4 = 360N.mm
Diameter ratio of pulleys = D1/D2
= 3
So, torque on pulley = 1100N.mm
Geometry in ansys :

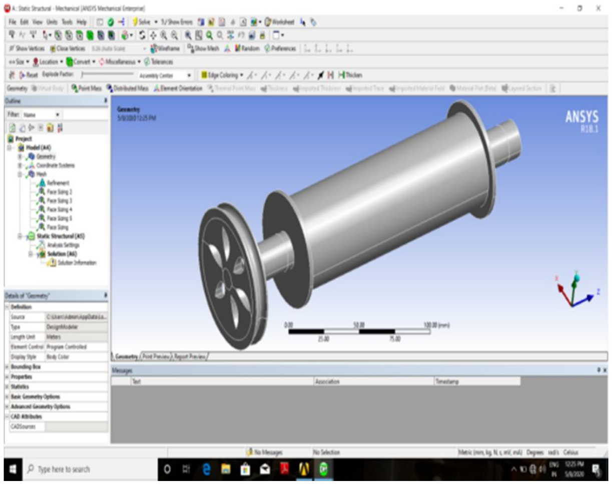


Fig.5 Geometry

A combine geometry of roller and pulley is imported in Ansys design modeler. Modeling have done in solidworks, then it was imported in Ansys for further simulation i.e. analysis.

B. Meshing or Discretization

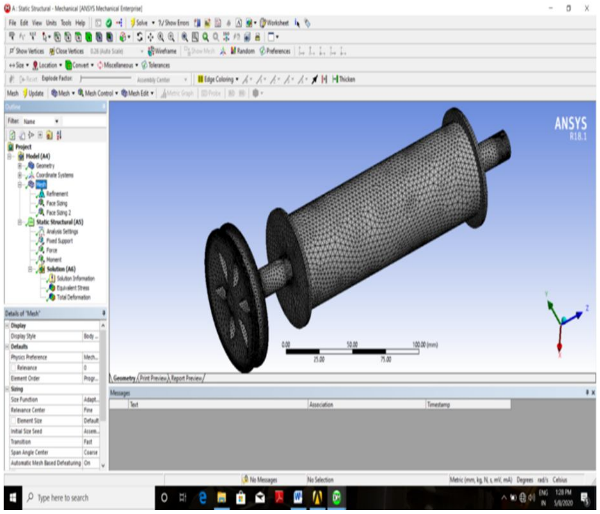


Fig.6 Meshing

FEA always needs discretization of body, so after importing geometry in ansys meshing is must. entire geometry is divided into small elements.

Details of meshing: type of elements Tetrahedrons ,number of Elements-40267,
number of Nodes - 8075

C. Boundary Conditions

Three main boundary conditions are taken into consideration:

1) Fixed supports – pedestal bearing
2) Transverse load due to feeding of material – on roller
3) Torque/twisting force – on pulley

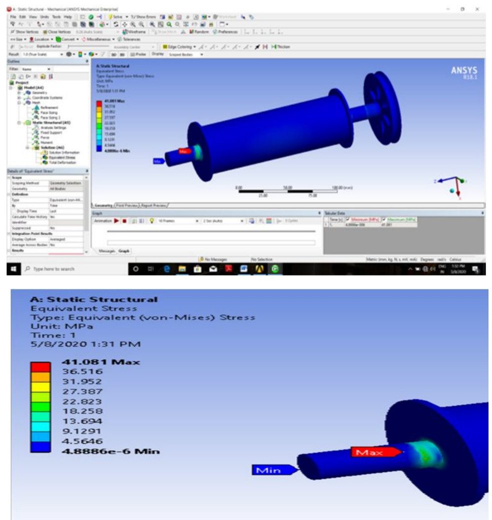


Fig.7 Boundary condition

D. Analysis Results

Static structural analysis has been done on body so to check, whether design is safe or not it is necessary to calculate equivalent (von-mises) stress & deformation.

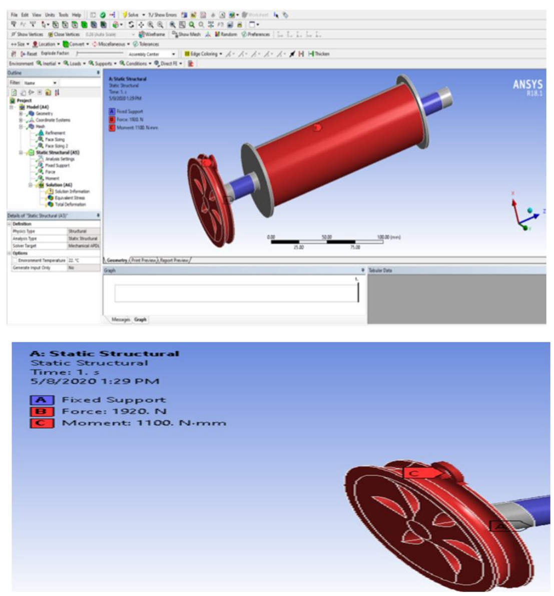


Fig.8 Equivalent stress

Maximum stress is acting near supports (pedestal bearings). Maximum value of stress is 41.081Mpa which is very less as compare to UTS of material. Factor of safety is more than 5 so design is safe.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VII July 2020- Available at www.ijraset.com

E. Total Deformation

As the maximum value of total deformation is 0.002mm so, there is no effect of it on assembly during working. So, design is safe by considering total deformation

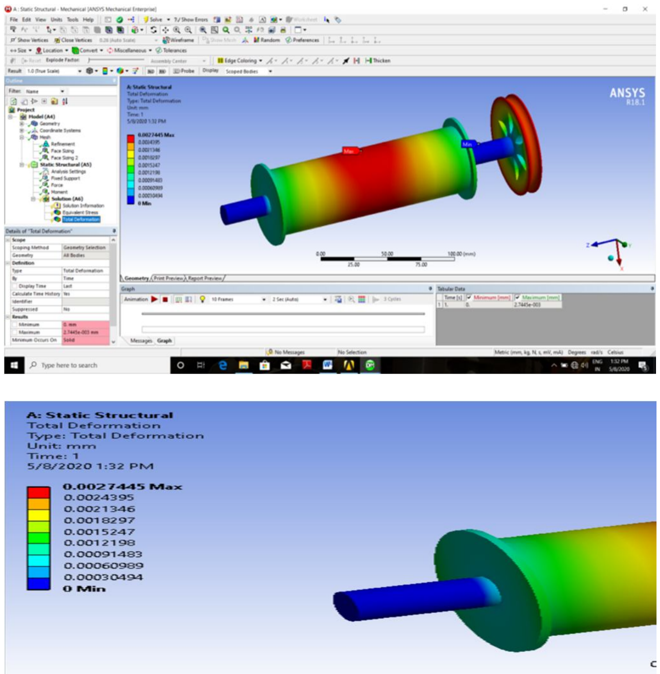


Fig.9 Total Deformation

So, the material selected for the parts is Mild steel Properties of mild steel:

F. Physical Properties

Density	7.87 g/cc	0.284 lb/in^3

G. Mechanical Properties

Hardness, Brinell	126	126
Hardness, Knoop (Converted from Brinell hardness)	145	145
Hardness, Rockwell B (Converted from Brinell hardness)	71	71
Hardness, Vickers (Converted from Brinell hardness)	131	131
Tensile Strength, Ultimate	420MPa	63800 psi
Tensile Strength, Yield	370 MPa	53700 psi
Elongation at Break (In 50 mm)	15.0 %	15.0 %
Reduction of Area	40.0 %	40.0 %
Modulus of Elasticity (Typical for steel)	205 GPa	29700 psi
Bulk Modulus (Typical for steel)	140 GPa	20300 psi
Poissons Ratio (Typical For Steel)		

	0.290	0.290
Machinability (Based on AISI 1212 steel. as 100% machinability)	70 %	70 %
Shear Modulus (Typical for steel)	80.0 GPa	11600 psi

IV. CONCLUSION

In this way we conclude that our project “pipe grinding & notching machine “is useful for institute to understand the actual operation in grinding & notching of pipes before work. The project work & testing shows that this machine solves some problems arrases from manually grinding & notching from various types of pipes by exhibiting a good integrated result. This machine can be fixed in less place, low maintenance, does not require skilled labor, has high rate of action, has longer span of time, require less capital investment, has low running cost, hence can be implemented in the industry to help to lower down the product cost. The older method of pipe notching is very complicated as time consuming. And also pipe grooves are not accurate. By designing Special purpose machine for notching, the grooving of complex profile grooving made easily by abrasive belts. Also, accuracy of pipes grooves is improving and time required for grooving also reduces. Thus, SPM machine improves the productivity. As the process of grooving is safely hence it improves the safety for operators. From the above it is concluded the methodology for the designing of the special purpose machine. This machine can be developed by us is a pilot scale model, by giving some modification of this machine gives a unique advantage of interfacing in rust grinding & notching of pipes industry unit. For more fast production rate & unique ability this system.

V. ACKNOWLEDGEMENT

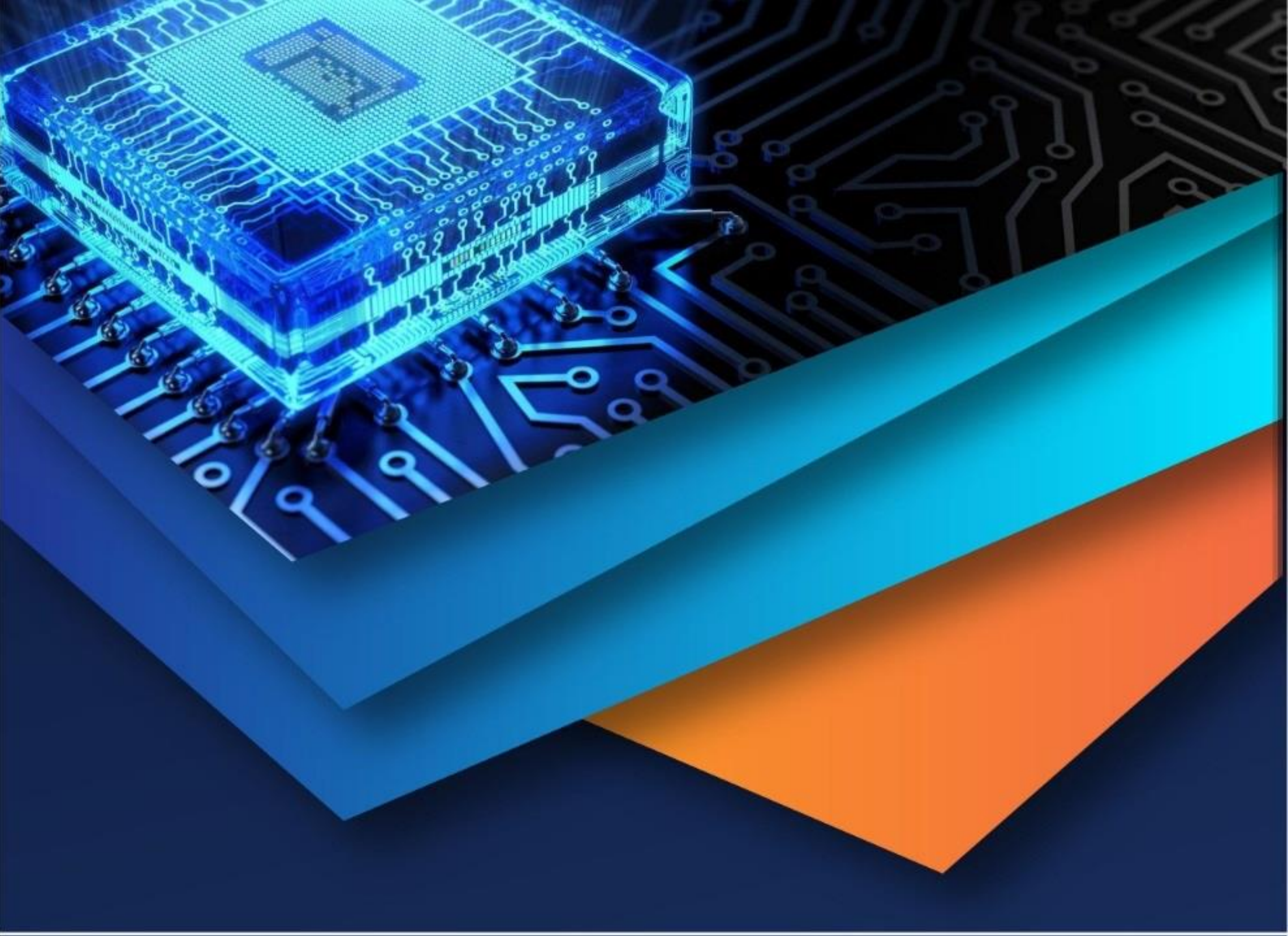
We cannot express enough thanks to our Institution and Department for their continued support and encouragement: Prof. M. Murugkar Sir, Head of the Department; Prof. Y. V. Borse, Guide; Prof. R. D. Rakhade, Project Co-coordinator. We offer my sincere appreciation for the learning opportunities provided by our faculties.Our completion of this Project and Research Article could not have been accomplished without the support of all.
Thank you for allowing us time away from you to research and write.

REFERENCE PAPERS

[1] Bartosz Zieli ´ nski , Wojciech Kapłonek , Marzena Sutowska and Krzysztof Nadolny, Analysis of a Feasibility Study of a PrecisionGrinding Process for Industrial Blades Used in theCutting of Soft Tissues by a Prototype 5-Axis CNCGrinding Machine, Appl. Sci. 2019, 9, 3883; doi:10.3390/app9183883,pp.1-20.
[2] Ing. Lukas Rudolf, Design Of Grinding Machine Spindle, MAPE 2018, volume 1, issue 1, pp. 69-76.
[3] Automation of In Feed Centerless Grinding MachinePiyusha P. Jadhav, Sachin V. Lomte, Sudhir Surve, International Journal Of Engineering Sciences & ResearchTechnology, April, 2017, pp. 718-726.
[4] Pushpendrakumar,Sunatyakumar & Dipender Kumar Dev,Grinding Processes, A Review, International Journal of Engineering Technology, Management and Applied Sciences www.ijetmas.com September 2016, Volume 4, Issue 9, ISSN 2349-4476,pp.68-72.
[5] Shrikant B. Pawar&Swapnil K. Koli, Design And Fabrication Of Bar Polishing Machine, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 06
[6] Jayanti Das & Barbara Linke, Effect of Manual Grinding Operations on Surface Integrity, ScienceDirect,3rd CIRP Conference on Surface Integrity (CIRP CSI), Procedia CIRP 45 (2016) pp.95 – 98.
[7] Mr.K.Sathish,Mr.G.Phaneendrakumar&Mr.Rambabu Dara, Design And Fabrication Of Grinding Wheel Attachment On Lathe Machine, International Journal of Engineering Inventions e-ISSN: 2278-7461, p-ISSN: 2319-6491 Volume 4, Issue 9 [May. 2015] PP: 57-63.
[8] R. Vairamuthu, M Brij Bhushan, R. Srikanth, N. Ramesh Babu, Performance Analysis of Cylindrical Grinding Processwith a Portable Diagnostic Tool, 5th International & 26th All India Manufacturing Technology, Design and Research Conference (AIMTDR 2014) December 12th–14th, 2014, pp.1-5.

REFERENCE BOOKS

[9] PSGdesign data ,Coimbatore, first edition Kalaikaikathir Achchagam,2003
[10] Khurmi R. S.,Gupta J.K., Atextbook of machine design, first edition, S. Chand Publication,1979.
[11] Thomas Bevan, The Theory of Machines,Third edition, CBS publishers,2005.
[12] Ballany P. L.,Thory of machines &mechanisms,Twentyforth edition, Khanna publishers,2005.
[13] Bhandari V.B.,Design of machine elements,eighteenth edition, MC graw-hill companies,2003.
[14] Joseph E. Shigley, Mechanical engineering design, sixth edition, Tata Mcgraw hill ,2005.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY