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Design, Analysis & Fabrication of Drilling and Tapping Machine

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Abstarct :-

This paper presents the design and analysis of an automatic drilling and tapping machine aimed at enhancing efficiency and precision in machining operations. The study focuses on the conceptualization and development of a comprehensive machine model that integrates drilling and tapping functionalities within a single automated system. Key design parameters, including spindle speed, feed rate, tool dimensions, and material compatibility, are analyzed to ensure optimal performance and reliability. A detailed CAD model is developed, followed by structural and functional analysis to validate the machine's design.

The design data for the model includes specifications for the motor, spindle, and feed mechanisms, along with material properties and operational constraints. These data points were used to optimize the system's performance and ensure the machine's suitability for a wide range of machining tasks.

Key Words :- Drilling, Tapping, Design, Measurement , Automation

1. Introduction:- The topic "Design & fabrication of Drilling and Tapping Machine" is about creating a machine that can drill holes and cut threads (tapping) in one setup. The design process involves creating the machine's structure, including the spindle, base, and tool holders, ensuring they can handle the forces during drilling and tapping. Key design factors include material selection for durability, optimizing the geometry to reduce weight while maintaining strength, and ensuring smooth tool alignment for precision. Advanced CAD software is used for 3D modelling.

1.1 Drilling Process:- The drilling process is a systematic method used to create holes in materials by removing material using a rotating cutting tool. It involves stages such as selecting the appropriate drill bit, aligning the workpiece, and applying controlled force and speed to achieve precise and efficient results.

1.2 Tapping Process:- The tapping process is a machining operation used to create internal threads within a pre-drilled hole using a tool called a tap. It involves precise alignment of the tap with the hole, controlled rotation, and to ensure accurate threading and avoid damage to the tool or workpiece.

2. Design of Components :- The design data for an automatic drilling and tapping machine includes critical parameters such as spindle speed, feed rate, motor power, tool dimensions, and material specifications. These data points serve as the foundation for optimizing the machine's performance, ensuring precision, durability, and suitability for specific industrial applications.

I. Motor: It is a 3 Phase 0.5 H.P. Motor and runs at 720 rpm & is mounted on the bracket.

II. Table: The Table (90 MM X 130 MM) is mounted on the column and is provided with ‘T’ bolts for clamping the work directly on its face. The table is made as a rectangular in shape. It is made of Cast Iron.

III. Base: The Base is that part of the machine on which the vertical column is mounted. The Base is made of Cast Iron.

IV. Column: The column is the vertical member (500 mm X ⌀45mm) of the machine, which supports the table and the head containing all the driving mechanism.

V. Cone Housing: The cone housing is made up of mild steel. Initially a square bar of 80mm x 80mm of length 280mm is machined. A drill of 45mm is made on one side for a depth of 75mm. A cylindrical bar of dia 80mm and length 100mm is welded to the square bar at a distance of 64mm from the top.

VI. Worm and worm gear : It consist of Worm with 4 teeth and Worm gear with 30 teeth. Diameter of gear = 90mm , Diameter of worm = 50mm.

VII. Table Housing: The table housing is made up of mild steel. A collar of inner dia 45mm wnr outer 55mm is machined and it is cut on one side alone the axis and two flats are welded. The Table Housing slides over the Column of the Machine.

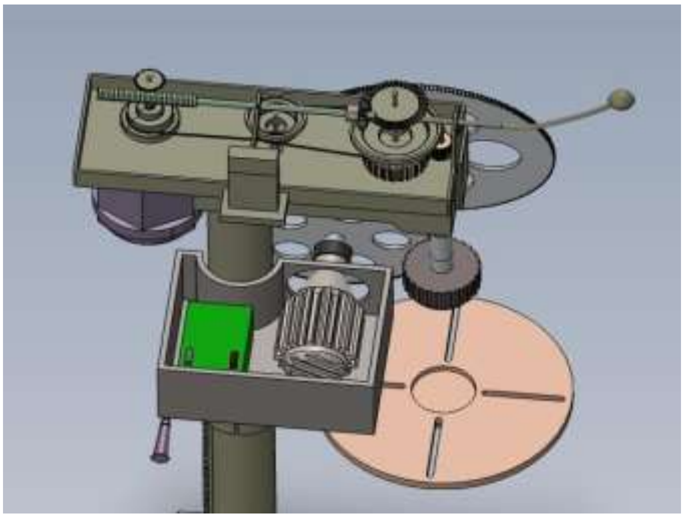
VIII. Main Vertical Spindle: The Spindle is mounted vertically (220 mm X ⌀22mm) held between bushes and its carries two M. S. Cones one end of the spindle is attached to the drill Chuck to hold the tool. The spindle rotates in the either direction according to the engagement of Cones.

IX. Drill Chuck: The self-cantering 3 jaw chuck is particularly adapted for holding tools having straight shanks. The chuck is tightened and loosened by rotating a bevel key meshed with bevel teeth of the sleeve.

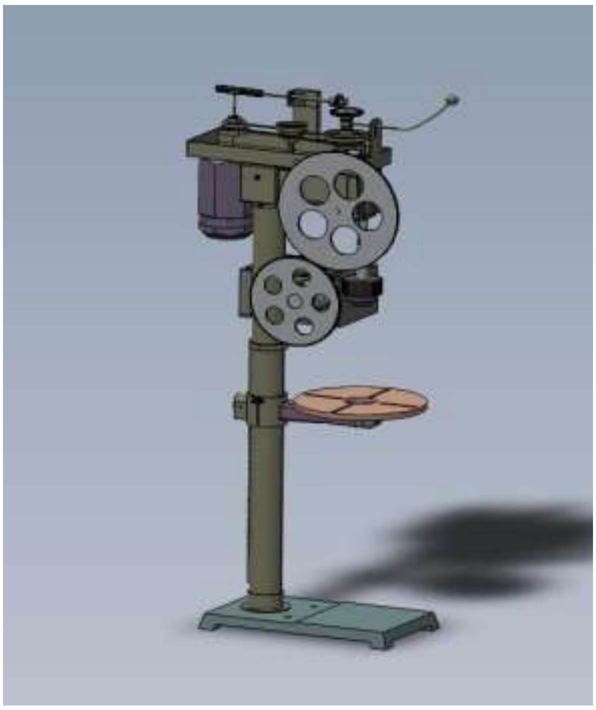
X. Bolts & Nuts: It is used to fix the motor with Base, to fix the column support to the base. The Grub screw to fasten the M.S. Cones to the vertical Spindle.

XI. Pulleys: The pulleys are made up of Cast Iron (3.5" & 4.5"). There are two similar step cone pulleys of which one is attached to motor and other is attached to the main Drive Shaft. Diameter of Larger pulley = 114.35 mm, Diameter of smaller pulley = 63.53 mm.

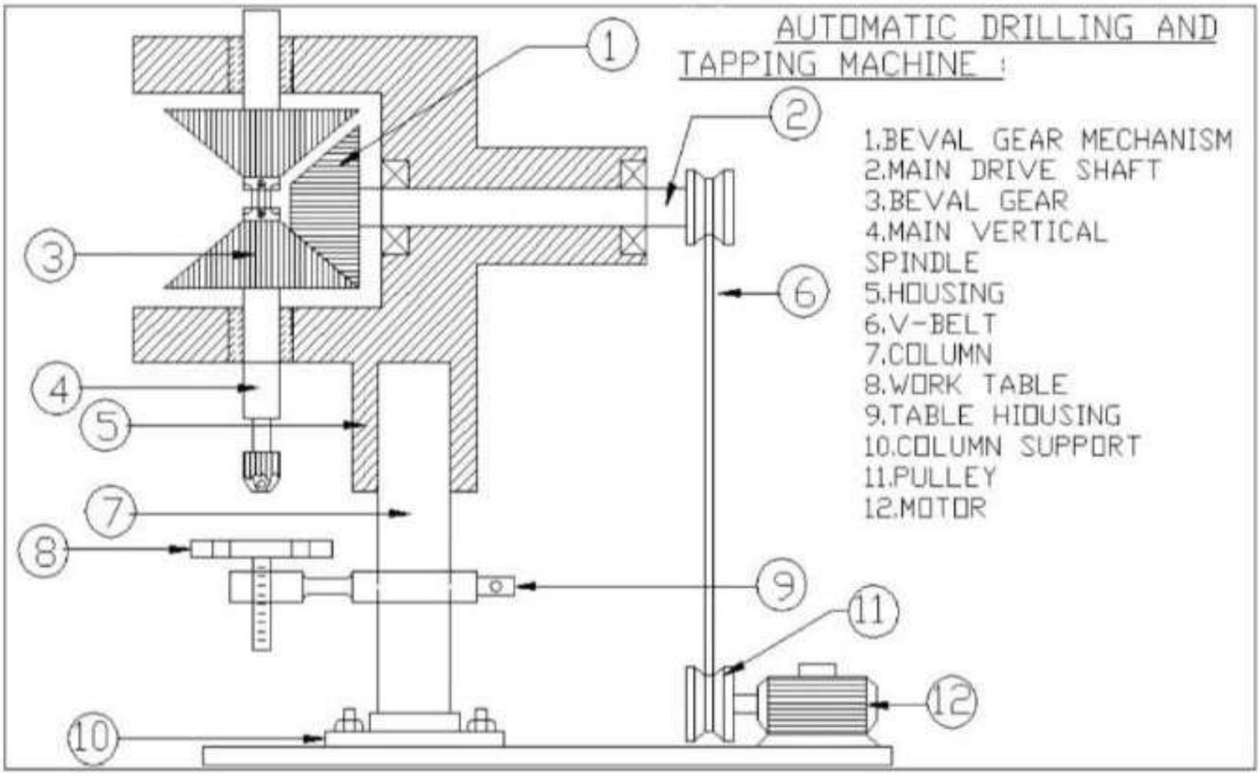
3. CAD Design :-



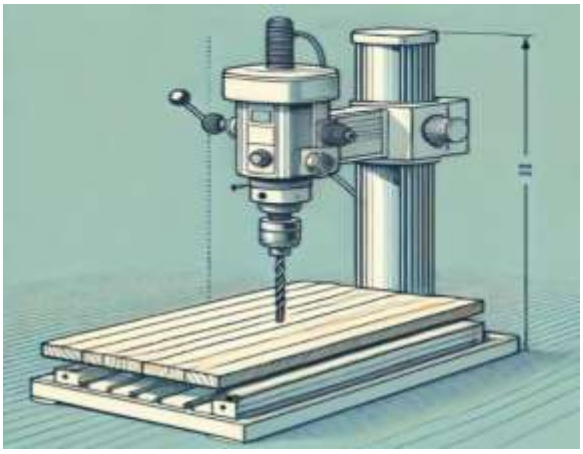
1.1 CAD Model 1

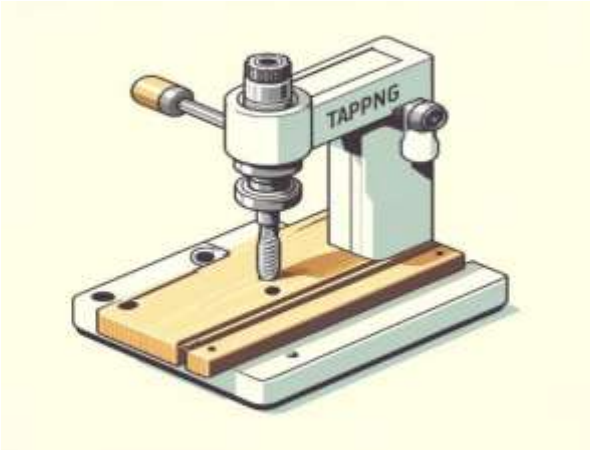


1.2 CAD Model 2



1.3 Assembly of Model





1.4 Drilling Process

1.5 Tapping Process

4. Design analysis :-

1. for selection of motor

Cutting Speed (V) for wood = 300 m/min Feed Rate (f) = 0.2 mm/rev
Spindle Speed (N):
N= 1000×V
π× d Substituting:
N= 1000×300 = 300000 = 9550rpm
π×10 31.4159
Spindle Speed N ≈ 9550 rpm

Thrust Force (F):
For wood, thrust force is much lower. KfK_fKf = 20 N/mm
F = Kf×d

Substituting:
= 20×10 = 200 N

Axial Force F ≈ 200 N

Torque (T):

T = F×d
2
Substituting:
T = 200×10 = 1000 N-mm = 1 N-m
2
Torque T ≈ 1 N-m

Power Required (P): P = 2π×N×T
60×1000
Substituting:
P=2π×9550×1 ≈ 1.0 kWP 60000
Power Required ≈ 1.0 kW

Selecting Motor:
Add 30% safety margin:
Final Power=1.0×1.3=1.3 kW
Closest standard motor = **1.5 kW Motor**

2. for selection of Belt:

We know,
$D = d \times (n_1/n_2) \times \eta$
D - Diameter of Larger pulley = 114.35 mm d - Diameter of smaller pulley = 63.53
n_1 - Speed of smaller pulley = 720 RPM η - Efficiency = 0.98
Speed of larger pulley (n_2) = 63.53 x (720/114.35) x 0.98
= 392 RPM
Nominal pitch length of belt (L) = 2C + Π/2 (D+d) + {(D-d) ²/4C}
= (2 x 500) + Π/2 (114.35+63.53) +

{(114.35-65.53) ²/ (4 x 500)}
= 1280 mm
For 1280 mm, the belt selected is "A" type.
Centre distance for the given belt length(C) = A + √A² - B Where,
A = (L/4) – {Π(D+d)/8}
= (1280/4) – {Π(114.35-63.53)/8}
= 250.14 mm
B = {(D-d) ²/8} = {(114.35-63.53) ²/8}
= 322.83 mm
∴C = 499.6 mm ≈ 500 mm
Formula for transmitting capacities: -
Kw = (0.45 S ⁰⁰⁹ - 19.62 – 0.765 x 10⁻⁴S²) S
S-Speed of the belt = (Πdn₁/60) x 1000 in m/s de-Equivalent Pitch dia. = dp x Fb
dp-Pitch dia. Of smaller pulley. S = (Π x 63.53 x 720/60) x 1000
S = 2.39 m/sec
de = 125 mm, Fb = 1.12
According to D/d = 1.79, dp = 111.6 mm Kw = 0.62 Kw
Are of contact angle = 180º - 60º (D-d/C)
= 180º - 60º (114.35-63.53/500)
= 173.9º ≈ 174≈º
Number of Belts = {(P x Fa)/ (Kw x Fe x Fd) } Where,
Fa = Correction factor for industrial service = 1.2 Fe = Correction factor for Nominal length = 0.93
Fd = Correction factor for Arc of Contact angle = 0.76
∴ Number of Belt = 1.09 ≈ 1 Belt

3. Calculation For Worm And Worm Gear

- Motor input = 1320 rpm
- Assume tapping =170 rpm
- Velocity Ratio $VR = \frac{Nw}{Ng}$ $VR = \frac{1320}{170} = 7.8$

If V.R. is in between 6-12 then teeth on the worm (No. of start) = n= 4 n = $\frac{Tg}{VR}$ 4 = $\frac{Tg}{170}$
Tg = 31.2, Say 30 as per std worm gear.

II. Gear ratio = $\frac{30}{04}$
So, we finalized the No. of teeth on worm and worm gear for tapping. Tw=04 Tg= 30
PCD of gear Dg=m xTg=30m
Velocity Vp= π Dg Ng/60 x 100 = π x 30m x170/ 60 x 1000 = 0.267 m/sec
III. Design power, Pd= Pr* Kl (Kl=1.75)
=450 x 1.75 =787.5 Watt
IV. Tooth load (Ft), Ft=Pd/Vp
=787.5/0.267 =2.94 x 10^3
V. Beam strength, FB=So.Cv.b.Y.m
So=84 Mpa
Cv= 0.75 (Trial value)
b= 2.38 Pc+6.25 =2.38 (π x m) +6.25 = 7.47m+6.25
VI. Lead angle =λ=tan⁻¹(Ng/Nw) ⅓=26.79º VII Pressure angle= Φn=25º
VIII. Modified Lewis Factor,
Y=0.314+0.0151(Φn-14.5) =.314+0.0151(25-14.5) =0.472 Fb=84*0.75*(7.47m+6.25) *0.472*m=222.56 m²+186.06m
Now, Fb = Ft
222.56 m²+186.06m=2949.44/m

IX. module (m)=2.11≈ 3 mm Dia.of gear= 30 x m=30 x 3
Dg=90mm
Dia.of worm=2.4 x Pc+27.5
=2.4 x π m+27.5
Dw= 50mm

4 Calculation of Pinion Shaft (Horizontal) Shaft For Bevel Gear

Torque acting on pinion T= Px60/2x π x170
=25.27 x10^3 Nm
XI. Tangential force acting at mean radius on pinion. Wt= T/Rm
=25.27 x 3 / 30
=842.33N
XII. Axial and Radial forces.
Axial force WRH = Wt x Tan ф x sin Ѳp1
= Tan -1 = (Tp/Tg) But we have, Tp = Tg Ѳp1= tan -1 (1)
=45˚
Ѳp2 = tan-1 (Tg/Tp) Ѳp2= 45˚
XIII. Face angle (ф)= Pitch angle + Addendum angle (α)
= Ѳp1 + (α)
Let (α)= 25˚
(ф)= 45+25 =70 ˚
WRH=842.33x10*3 x Tan 70 x sin 45
= 1636.44 N
XIV. Radial forces (WRV)= Wt x tan фx cos45
= 842.33 x tan 70 x cos 45
=1636.44 N
XV. Bending moment due to (WRV) and (WRH) M 1= WRV x overhang- WRH x Rm
Let overhang = 40
=1636.44x10^3-1636.44x30
=16.36x10^3
M 2= Wt x overhang
=842.33x40
=33.6x10^3
XVI. Resultant M = 37.45x10^3 Equivalent Twisting moment= 45.18x10^3 Te= π/16 x Fs x Dp^3
= 45.18 x10^3= π/16 x 22.87 x Dp^3
Consider: - for shaft
Live load …. material SAE 1030 carbon steel for shaft FOS=8 sys= 183/8= 22.87 N/mm^2
Dp=22 mm therefore Dp=25 mm as per standard

1. CAD Model Geometry Summary

Estimated Volume 21,165 cm^3 Surface Area 29,309 cm^2
Bounding Box 368 × 1868 × 860 mm
Mesh Faces 213,096

2. Material Properties

Material Mild Steel / Cast Iron Density 7850 kg/m^3
Young's Modulus 200 GPa Poisson's Ratio 0.3
Yield Strength 250 MPa (typical)

3. Structural Loading Assumptions

- Fixed Support: Base of the machine frame
- Applied Load: 500 N vertically downward at the spindle head
- This simulates typical axial force during drilling.

4. Estimated Stress and Deformation Max Stress ~120 MPa
Max Deformation ~0.6 mm (at spindle head) Safety Factor ~2.0 (Acceptable)
5. Design Evaluation Strength
The design shows acceptable stress levels under typical loading. Safety Factor ~2.0 indicates durability and margin for unforeseen loads.

Stiffness & Deflection
Deformation of ~0.6 mm is minimal and unlikely to affect drilling/tapping precision. Material Optimization

- Mild steel provides good strength but increases weight.
- Consider aluminum for non-load-bearing parts to reduce weight.

Manufacturability

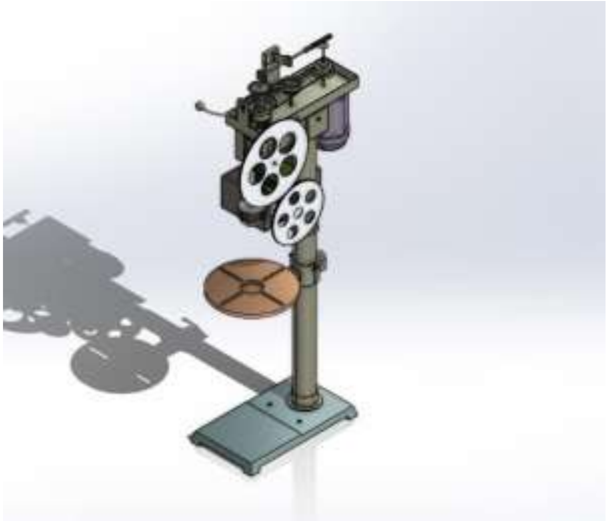
- The design is suitable for machining and welding.
- Parts should be toleranced properly for accurate assembly.

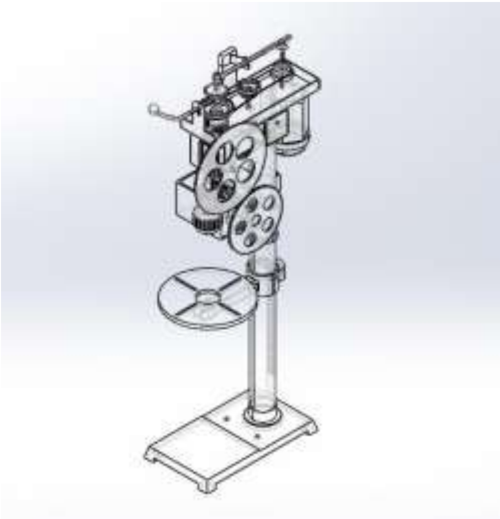
5. MODELING & ANALYSIS

1. **Software Modelling**

1.6 Front view of model

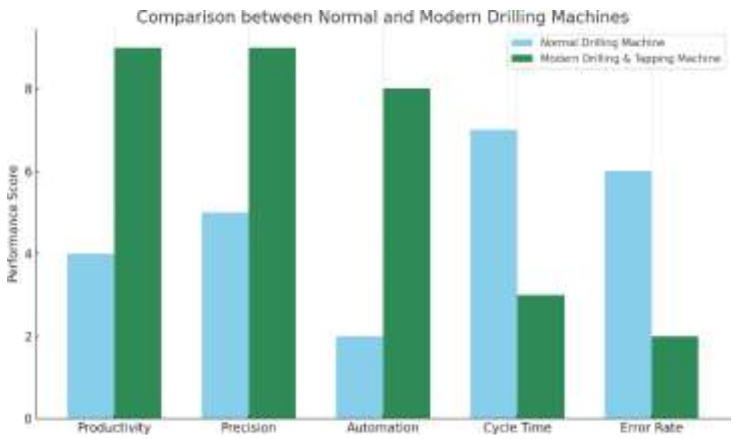
1.7 Side view of model



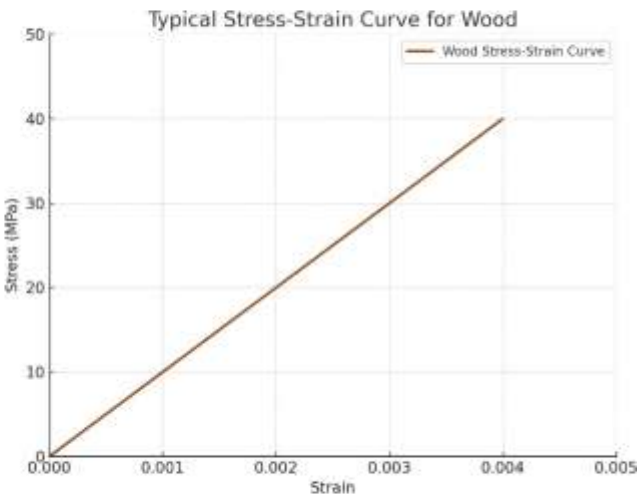


1.8 3D view of model 1.9 3D mesh view of model

2. FEM analysis :-



Comparison of model drilling and tapping machine with regular drilling machine



Stress – strain curve for wood material drilling and tapping

6. Estimation of Cost:-

S. No.	Description	Qty	Amount (RS)
1.	BASE	1	300
2.	COLUMN	1	500
3.	CONE HOUSING	1	450
4.	CONE	2	250
5.	CONE	1	350
6.	TABLE HOUSING	1	500
7.	TABLE	1	250
8.	RACK & PINION	1	450
9.	MAIN DRIVE SHAFT	1	5,000
10.	VERTICAL SPINDLE	1	3,500
11.	LINEAR BUSH	1	400
12.	3 JAW SELF CENTERING CHUCK (0-12MM)	1	3,000
13.	TAPPER ROLLER BEARING	2	250
14.	MOTOR (0.5 HP)	2	3,000
15.	BOLTS	3	400
16.	C.S. SCREW	3	400
17.	GRUB SCREW	3	600
18.	V-BELT	1	200
19.	PULLEYS (2.5”, 3.5” & 4.5”)	2	200
20.	FABRICATION COST	-	1,000
21.	TOTAL		21,000

7. Advantages :-

1. Improved repeatability and accuracy
2. Minimization of production cost.
3. Noiseless & smooth operation
4. Improved Design
5. Less Power Consumption
6. Stable Formation

8. Conclusion:-

This paper presents and approach which could be used for designing automatic drilling & tapping machine and our attempt is small in the whole of the Engineering world, but it can do better than any other machine for the same purpose with less cost, high accuracy and precession. This design is simple and compact in size. Therefore, it is affordable by the small- scale industries.

9. References:-

1. N.U. Kakade1, Piyush Bhake2,Sumit Dandekar3 ,Rohan Kolte4 , Sumit Selokar5 **"FABRICATION OF COMBINE DRILLING AND TAPPING MACHINE "** International Research Journal of Engineering and Technology, Volume: 04 Issue: 03 | Mar - 2017

2. V. B. Vaidya1, Akshay Dukhi2, Chirag Meshram3, Hemant Chaudhray4, Mayank Gurve5, Sahil Rangari6 **"Design parameter of Automatic Drilling & Tapping Machine"** International Journal for Research in Applied Science & Engineering Technology, *Volume 11 Issue IV Apr 2023*

3. Keval Malaviya1, Jay Bhatt2 **"Design and Development of Flexible Drilling and Tapping Machine"** International Research Journal of Engineering and Technology, Volume: 08 Issue: 03 | Mar 2021

4. N.VENKATESH1, G.THULASIMANI2, S.NAVEENKUMAR3, S.K.MALATHI4, S.PALANISAMY5, M.KARTHIKEYAN6 **"Combined Drilling and Tapping Machine by using Cone Mechanism"** International Journal of Scientific & Engineering Research, Volume 7, Issue 5, May-2016

5. G. Niranjan1, A. Chandini2, P. Mamatha3, **"Automated Drilling Machine with Depth Controllability,"** International Journal of Science and Engineering Applications, Volume 2, Issue. 4, Aug-2013

6. Mohammad Nasir Khan1 **"Fabrication and Automation of Drilling Machine by Using Arduino"** IOP Conference Series: Materials Science and Engineering, **DOI** 10.1088/1757- 899X/1224/1/012007

7. Nikhil G Lokhande[1], Vyankatesh B Emche[2], Vikas M Khanke[3] Pravin B Raut[4] Pramod N Jagtap[5] **" FABRICATION OF DRILLING CUM TAPPING MACHINE"** International Journal of Creative Research Thoughts Volume 5, Issue 4 October 2017

8. Prof. P.R. Sawant[1], Mr. R. A. Barawade[2] **"DESIGN AND DEVELOPMENT OF SPM- A CASE STUDY IN MULTI DRILLING AND TAPPING MACHINE"** International Journal of Advanced Engineering Research and Studies E-ISSN2249-8974

9. Akshay R Mahendrakar **"AUTOMATION OF DRILLING PROCESS USING ELECTRO -PNEUMATICS SYSTEM"** International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Impact Factor (2012): 3.358

10. Keval Malaviya[1], Jay Bhatt[2] **"DESIGN AND DEVELOPMENT OF FLEXIBLE DRILLING AND TAPPING MACHINE "** International Research Journal of Engineering and Technology Volume: 08 Issue: 03 | Mar 2021

11 Yousef M. Abueejela[1] , A. Albagul[2] , Ibrahim A. Mansour[3] Obida M. Abdallah[4] "**Automated Drilling Machine Based on PLC**" IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 3, March 2015

12 Pisit Phokharatkul[1] , Supachai Phaiboon[2], Sanchaiya Phasomkusolsil[3] , Nathum Koetsam- ang[4] Chom Kimpan[5] **"SEMI-AUTOMATIC TAPPING MACHINE CONTROL USING MICROCONTROLLER"** Kasem Bundit Engineering Journal Vol.10 No.2 May-August 2020

13. S. Kamalakkannan[1], J. Lavanya[2] "**Automatic Drilling and Tapping Machine Monitoring using NodeMcu**" Research Article Vol 2 Iss 1 Year 2020

14 A.S.Udgave[1] ,Prof.V.J.Khot[2] "**Design & Development Of Multi Spindle Drilling Head (Msdh)**" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278- 1684, PP: 60-69

15. P.G. Mehar, A.V. Vanalkar, S.S. Khandare , **"Formulation of Mathematical Model, Design of Experimentation, Optimization and Investigation of Parameters for Integrated Bamboo Processing Machine",** IJETT 3 (2).

16 PG Mehar, DAV/DSS Khandare , **“Formulation of Mathematical Model and Investigation of Parameters for Integrated Bamboo Processing Machine”** International Journal of New Technologies in Science and Engineering 2.

17 PG Mehar, AV Vanalkar, **“Design of Experimentation, Artificial Neural Network Simulation and Optimization for Integrated Bamboo Processing Machine”** International Journal of Engineering Research and Applications 5 (11), 23–29.

18 PG Mehar, L Misal, S Donadkar, A Sukhadev, S Tonge, S Gotmare, **“Design and Fabrication of MultiPurpose Cutting Machine for Agricultural Uses.”**

19 PG Mehar, L Misal, S Donadkar, A Sukhadev, S Tonge, S Gotmare, **“A Review on Design of Multipurpose Cutting Machine for Agricultural Uses.”**

20 PG Mehar, VD Dhopte, **“Experimentations and Productivity Analysis of Power Operated Sheet Bending Machine.”**