DESIGN AND ANALYSIS OF BASE STRUCTURE OF CNC ROUTER

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Abstract* – *CNC router is used to make a cavity on wooden and it is widely used in industry. Other processes for producing holes are punching and various advanced machining processes. The cost of holes and cavity making is one of the highest machining costs. There are several types of wooden cutting which is different tool or cutter.

The three mechanical subsystems will consist of the framing system, the guide system, and the mechanical drive system. The guide and mechanical drive systems have several choices of material and structure type, and each of these choices will be evaluated based on cost and precision. The drive subsystem will be analyzed for efficiency and cost tradeoffs.

The electrical subsystem consists of the communications and the motor drive electronics subsystems.

The software subsystem will be evaluated and selected based upon the number and types of drawing files with which it can be used, without requiring intermediate programs to translate the files.

The cost of structure is estimated, which is a significant saving over current machines currently available on the market with the proposed features.

Index Terms* – *CNC Router, Wood, Marking, Analysis, Mechanical Drive

I. INTRODUCTION

This paragraph illustrates different router configurations and discusses each configuration, its advantages and disadvantages.

X-Y TABLES

This is machine style that is seldom used anymore. They can usually be found on smaller machine or in special applications such as for chair legs or for making templates. In this configuration, a table that moves both right to left and front to back is mounted under a spindle that moves up and down. The first of these machines was actually a pin router with an X-Y table mounted to it.

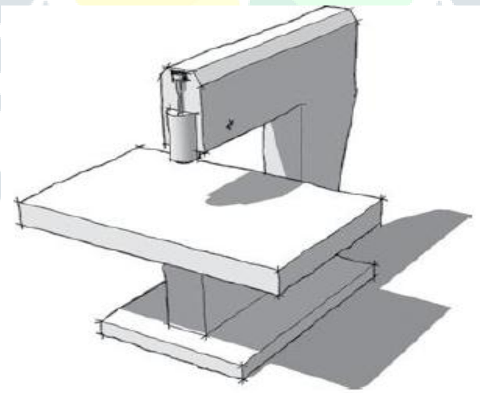

Figure 1 X-Y tables have evolved from pin routers

It is quite to get a very rigid machine in this manner. However, from a practical standpoint it is limited to rather small table sizes. The spindle must be attached to the machine base by an upright column. The distance from the column to the spindle defines the maximum table width and this distance cannot be too large without making the overall machine structure impractical.

CANTILEVERED

These are usually referred to in the industry as point-to-point machine although only very old machine actually qualify as such anymore.

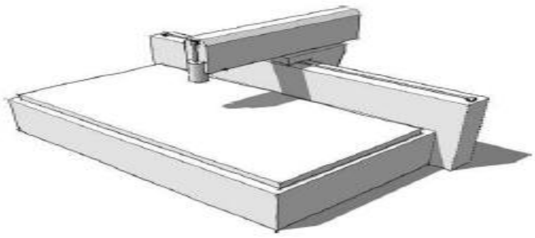

Figure 2 Cantilevered Arm Router

This configuration has one major advantage. It is easy to load and unload. The table is suspended in front of the operator and all of the operating mechanism is located behind the table. Every part of the table can be easily reached.
Since the arm structure is suspended from only one side, developing a structure that remains rigid becomes quite difficult.

MOVING TABLE

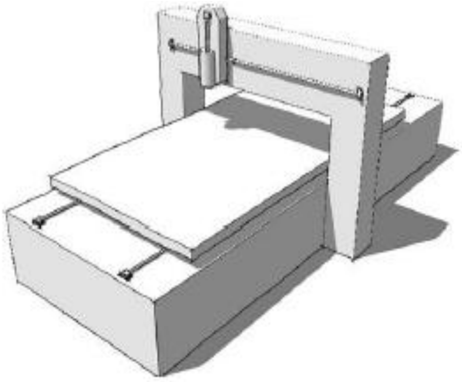

Figure 3 Moving Table Router

The moving table and the moving gantry designs are the most common in industry today.
The moving table machine is more popular than the moving gantry machine, not because it is inherently more stable but because of a control system limitation. A moving table machine has a single lead screw moving the head back and forth on the gantry and a single s crew moving the table front to back.

CNC ROUTER TECHNICAL SPECIFICATION

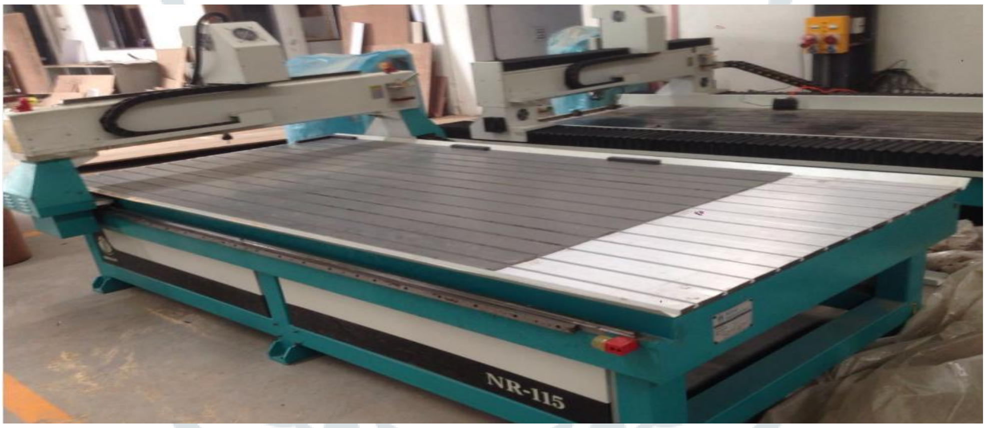

Figure 4 Photograph of NR-115

TECHNICAL DATA

Table 1 Technical Data

Description	**NR-115**
X-Y-Z Axis Movement	1300 x 2500 x 200m
Reposition Accuracy	0.01mm
X-Y Movement	Taiwan Rack & Pinion Transmission
Z Movement	German Ball Screw
Table Size	1440 x 3040 mm
Max Idling Speed	35 m/min
Max Cutting Speed	25 m/min
Working Voltage	3ϕ / 380V/ 50Hz
Spindle Power	6 HP (HSD ITALIAN Air Cooled)/ 6 HP (Water Cooled)
Spindle Rotating Speed	0-18000 RPM/ 0-24000 RPM
Drive Motor	Stepper/Servo
Command	G code
Computer Interface	USB
Controls	DSP (Digital Signal Processor)
Collet Size	6mm, 8mm, 12mm
Working Holding	Manual T-Slot Clamping / Vacuum Holding

Dust Collecting Arrangement	Yes

II. CAD MODELING AND FEA ANALYSIS OF CNC ROUTER STRUCTURE

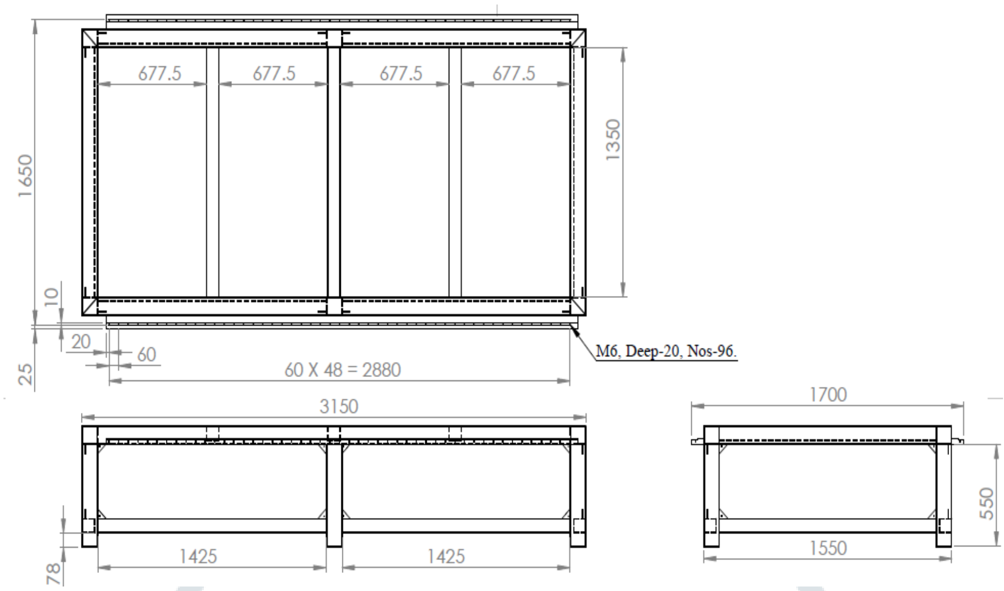

Figure 5 Detail view drawing CNC Router Structure

STRUCTURAL ANALYSIS OF NR-115 BASE STRUCTURE

BASIC STEPS OF FEA ANALYSIS FOR NR-115 BASE STRUCTURE

(1) Preprocessing: defining the problem

The major steps in preprocessing are define key points/lines/areas/volumes,

I. define element type and material/geometric properties,

II. Mesh lines/areas/ volumes as required. The amount of detail required will depend on the dimensionality of the analysis, i.e., 1D, 2D, axsymmetric, and 3D.

(2) Solution: assigning loads, constraints, and solving

Here, it is necessary to specify the loads (point or pressure), constraints (translational and rotational), and finally solve the resulting set of equations.

(3) Post processing: further processing and viewing of the results

In this stage one may wish to see lists of nodal displacements,

I. element forces and moments,

II. deflection plots, and

III. stress contour diagrams or temperature maps.

Step-1 Pre-processing

First Prepare Assembly in Solidworks 2015.

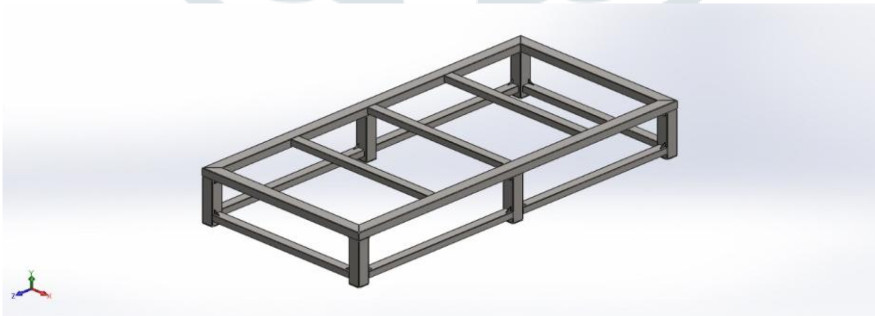

Figure 6 Geometry of NR-115 Base Structure using static analysis

2) Check the Geometry for Meshing.

3) Apply Material for Each Component.

Table 1 1080 Mild Steel Material Properties

Structure	Material used	Young Modulus (Gpa)	Yield Strength (Mpa)	Poisions Ratio	Density (Kg/m3)
NR-115 Base Structure	1080 Mild Steel	210	550	0.266	7860

4) Create mesh.

Solid mesh (Jacobian Point : 4 Point) which is programme generated.
Fine Meshing is apply
No. of Nodes:- 88097
No. of Elements:-44793

Figure 7 Meshing of NR-115 Base Structure using static analysis

5) Define Boundry condition

Apply Fixed Support at bottom edge of base structure. In fixed support boundary condition, bottom face of structure having not movement along X,Y & Z and also rotation same axis.

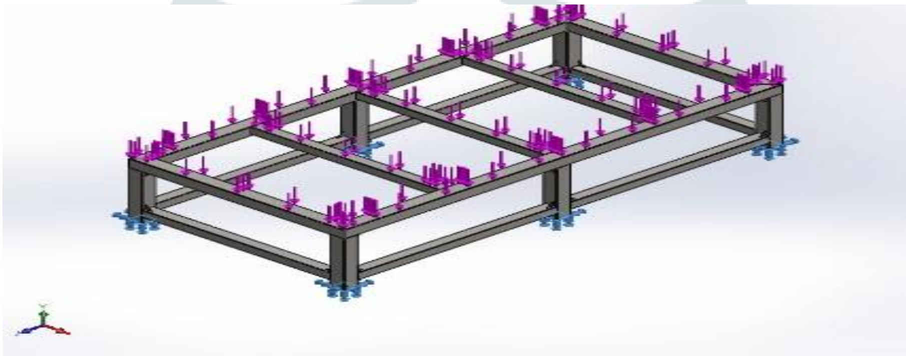

Figure 8 Boundary condition of NR-115 Base Structure using static analysis

Apply Force

Force magnitude on Y-axis is 4000N.
(Weight on Y-axis =400kg , FY =400 x 9.81 = 4000)

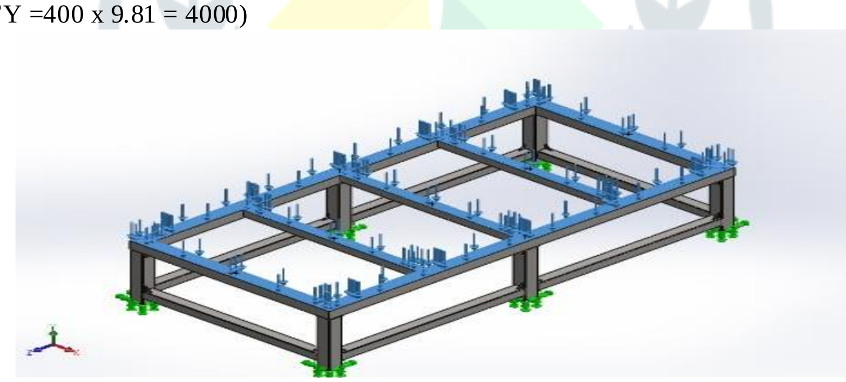

Figure 9 Force applying NR-115 Base Structure

Results of Analysis

Equivalent Stress for static analysis

Name	Type	Min	Max
Stress1	VON: von Mises Stress	8027.45 N/m^2 Node: 80451	4.50689e+007 N/m^2 Node: 11318
FS1325-10-00-Static 1-Stress-Stress1			

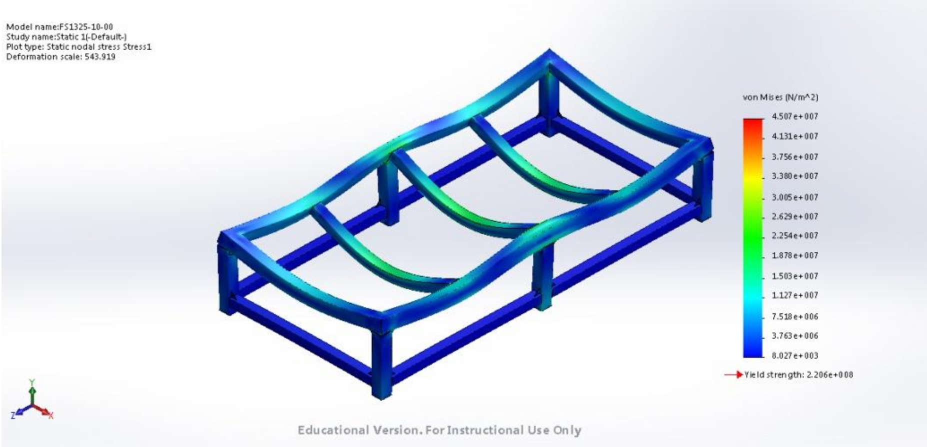

Figure 10 Equivalent Stress analysis of NR-115 Base Structure

Displacement

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 80026	0.579132 mm Node: 72554
FS1325-10-00-Static 1-Displacement-Displacement1			

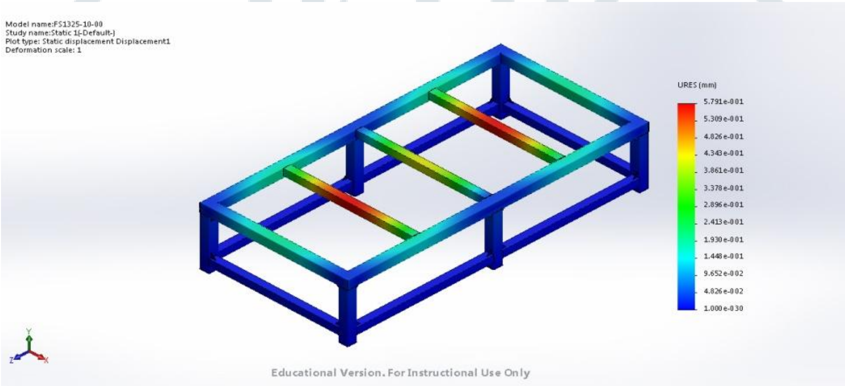

Figure 11 Displacement of NR-115 Base Structure

Equivalent Strain

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	5.81393e-008 Element: 40646	0.000159671 Element: 14984
FS1325-10-00-Static 1-Strain-Strain1			

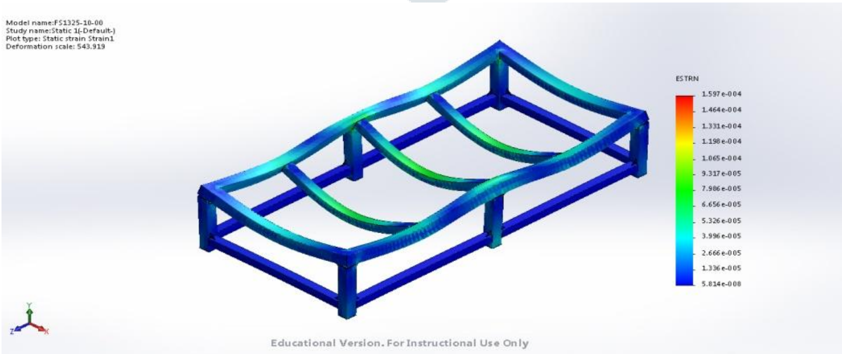

Figure 12 Equivalent Stress analysis of NR-115 Base Structure

Table 2 Result

Material	Von mises stress (MPa)	Strain	Displacement (mm)
1080 Mild Steel	45.06	0.000159671	0.5791

III. ACKNOWLEDGMENT

It is indeed a great pleasure for me to express my sincere gratitude to those who have always helped me for this dissertation work. I am extremely thankful to my thesis guide Asst. Prof. Piyush S. Surani, Asst. professor in Mechanical Engineering Department Indus Institute of technology, Rancharda, Ahmedabad andExternal Guide Asst. Prof. Dhaval P Patel, Asst. professor in Mechanical Engineering Department, Gandhinagar Institute of Technology, Moti Bhoyan. I had a valuable guidance, motivation, cooperation, constant support with encouraging attitude at all stages of my work. I am highly obliged to them for their constructive criticism and valuable suggestions, which helped me to present the scientific results in an efficient and effective manner in this research.

IV. CONCLUSION

By using practical data of CNC Router structure, prepared 3D CAD model for Finite Element Analysis in Solid Works 2015. From analysis result find value of von mises stress, strain and displacement (deflection) for optimize structure in strength and cost.

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