A PROJECT REPORT

ON

ROLL BENDING MACHINE WITH RATCHET MECHANISM

Submitted by

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In partial fulfillment for the award of the Degree

Of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

UNDER THE GUIDANCE

Of

Prof. ATUL MESHRAM

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL,

NAVI MUMBAI – 410206

UNIVERSITY OF MUMBAI

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ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL

(Approved by AICTE, recg. By Maharashtra Govt. DTE,

Affiliated to Mumbai University)

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CERTIFICATE

This is to certify that the project entitled

"ROLL BENDING MACHINE WITH RATCHET MECHANISM"

Submitted by

TALHA MEMON	**(16ME44)**
GRAHAM MIRANDA	**(16ME46)**
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HRITHIK SALIAN	**(16ME58)**

To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

Internal Examiner | **External Examiner**

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Prof. ZAKIR ANSARI | **Dr. ABDUL RAZZAK HOUNTAGI**

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APPROVAL OF DISSERTATION

This is to certify that the thesis entitled

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Internal Examiner **External Examiner**

Prof. ATUL MESHRAM **Prof.**

Date: __________

ACKNOWLEDGEMENT

After the completion of this work, we would like to give our sincere thanks to all those who helped us to reach our goal. It's a great pleasure and moment of immense satisfaction for us to express my profound gratitude to our guide **Prof. ATUL MESHRAM** whose constant encouragement enabled us to work enthusiastically. His perpetual motivation, patience and excellent expertise in discussion during progress of the project work have benefited us to an extent, which is beyond expression.

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ABSRTACT

Metal forming can be defined as a process in which the desired size and shapes are obtained through plastic deformation of a material without any significance loss of material. Bending is a metal forming process in which straight length is transformed into a curved length. Roller forming is a continuous bending operation in which a long strip of metal is passed through consecutive sets of rollers, until the desired cross sectional profile is obtained. The roller bending process usually produces larger parts of cylindrical or conical cross sections in large quantity. This project is to design and construct a portable roller bending machine. This machine is used to bend metal strips into curve and the other curvature shapes. The size of machine is very convenient for portable work. It is fully made by steel. Moreover, it is easy to be transported and use at any time and any place. It reduces human effort and also required less skill to operate this machine. We are designing manually operated roller bending machine with use of rollers, chain sprockets and support (frame). The roller bending machine is manually operated. Therefore, our objective is to increase accuracy at low prize without affecting the bending productivity. This machine works on simple kinematic system instead of complicated design. Due to its portability it can be used by small workshop or fabrication shop. In the three roller bending machine, the three rollers rotate. Bending can be done in both sheet metal and bars of metal. For designing a three roller bending machine, it is required to calculate the exact force for bending. Based on this force, the machine parameters and motor power are decided. Various factors that should be considered while calculating this force are material properties, width, and thickness, number of passes, bending radius, force developing mechanism and link.

LIST OF ILLUSTRATIONS

CHAPTER 1 :-

INTRODUCTION

As students we have learned that machine makes the work easier. Keeping the same motive in our minds we are building this machine. Best machinery equipment’s comes with great expense, high power consumption, requirement of skilled workers & regularly high maintenance. To overcome & counter these points we have come with a new & less complicated model which is very efficient, mostly useful in small scale industries & economical for enough producing good work. Due to increasing business around the world & to cope up with the present models it is very important to provide flexibility in our model along with reliability & the best aspects.

Roll bender is a machine having three rollers & is used to bend a metal bar or sheet into a circular arc. Rollers freely rotate about their parallel axis, which are arranged uniformly as required. Workpiece is assumed to have a uniform cross section & is suspended between the rollers. Two outer rollers hold the bottom of the workpiece & gently help to crawl while the middle roller presses the topside of the workpiece.

A ratchet spanner uses a mechanism which allows an open-ended, socket to turn a fastener in one direction but not the other while remaining fitted to the fastener head. Ratchet spanners are useful because they don’t need to be removed from the head and relocated every time the limit of the turning arc is reached, like non-ratcheted spanners. They are turned back and forth repeatedly but the nut is only turned in one direction. This saves time, reduces the effort and hence we will be using it in our model to provide the necessary turning action required on the main shaft.

Coming to our model "The roll bending machine with ratchet mechanism" simply performs all the functions of a regular bending machine & in addition to that provides multiple operations that is metal bar bending and sheet metal bending. It also provides a variation in the horizontal & vertical axis to obtain different bend radius. It is designed in such a way which makes it easy to use & is light weight which means it is portable.

The machine is divided into multiple components which are as follows

1. Frame :-

   Frame is designed in a way to provide different radius of bend by doing certain adjustment along the horizontal & vertical axis. Frame is further divided into 3 parts :

   Horizontal frame is responsible for horizontal adjustments.

   Vertical frame is responsible for vertical adjustments.

   Base frame acts as a support.

2. Shafts :-

   Shafts are designed to carry the required load under the specific range of our project.

3. Shaft Holders :-

Shaft holders are used to provide complete support & protection to the shaft.

4. Hydraulic Bottle Jack :-

   Vertical movement is possible due to the hydraulic bottle jack. It carries the load of the machine.

5. Ratchet Spanner :-

   Ratchet mechanism provides the necessary rolling action on the main shaft.

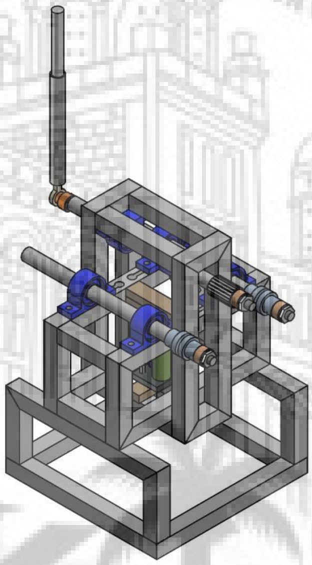


Fig :- Final Assembly

The machine is completely manual & skilled workers are not required. Metal bar is to be placed in front of the machine & sheet metal is placed in between the horizontal frame where the slot is provided. The machine guarantees the complete safety of the workers & the product obtained is totally reliable.

1.1 Motivation behind the project :-

Motivation seems to be a simple function of management in books but in practice it is more challenging & in order to complete this challenge & acquire the outcome, is what keeps us motivated. Completion with an improved model along with the desired output is the overall challenge to us.

Growth of manufacturing machinery output, & technology improvement in the machinery are the main drivers of the economic growth. Manufacturing has been the path to development & to walk along this path we are developing our own model which is very efficient, reliable & can stand out of the crowd.

1.2 Scope of the project :-

Scope describes to us what is to be delivered to the customer as a result of the project initiative. Keeping the customer satisfaction as the primary goal we have developed our own model of bending machine.

1. It is complete manual & unskilled workers can work on it easily.
2. No power consumption that is electricity is not required.
3. It is light in weight which makes it easy to transport.
4. We have done a lot of cost cutting to make it economical enough.
5. However it could more frequently be used in small scale industries.

CHAPTER 2 :-

LITERATURE SURVEY

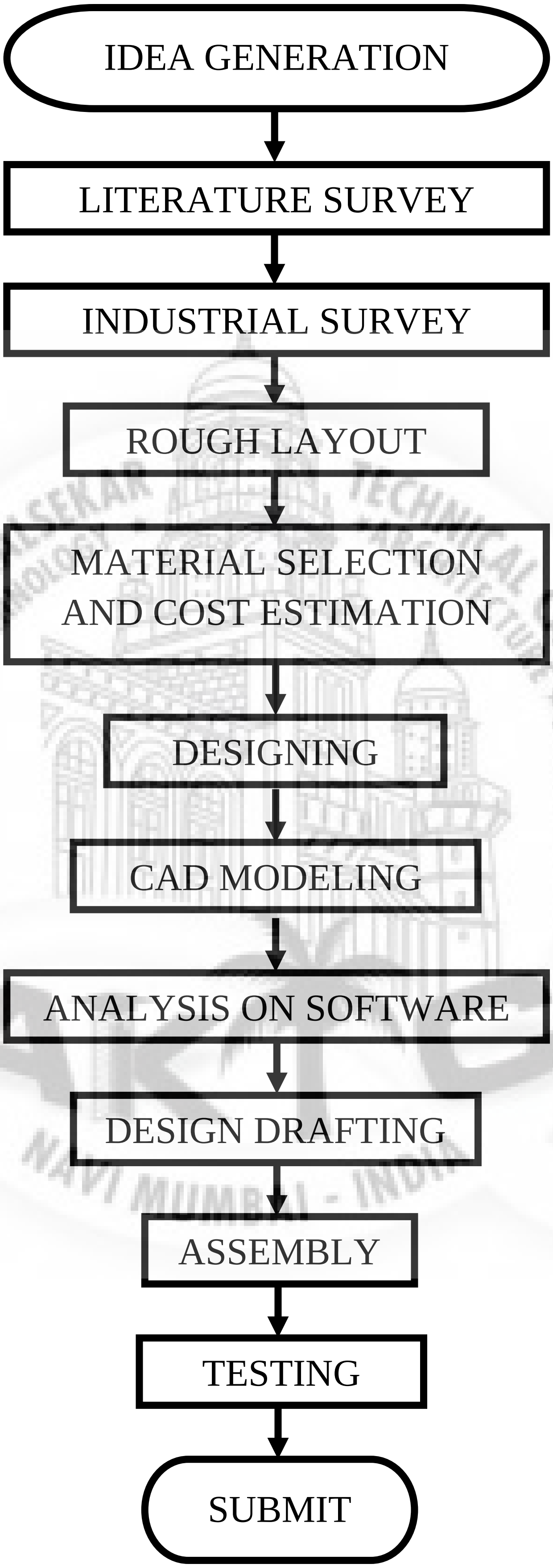
- In april,2013 Prof. Nilesh Nirwan and Prof. A.K. Mahalle, of , Department of Mechanical Engineering, G.H. Raisoni college of engineering Nagpur had found a PORTABLE ROLLING PIPE BENDING MACHINE that was used for reliability, easy convey and good quality purpose. But there were some difficulties like it could not be used for mass production and slow process due to hand operated device.
- In April 2015, Prof Dhaval T. Suthar, Prof Kiran R. Malvi, Prof Deneesh K. Patel, of Dept. of Mechanical, Bhagwan Mahavir College of Engg. and Tech., Surat, Gujarat, INDIA had found FINALWORKING OF ROLLING PIPE BENDING MACHINE it was used for Automobiles & Industrial. process. It reduces human effort and also required low less skill to operate that machine. They designed automatic pipe bending machine with use of pulley, motor, gear& support (frame).
- In December 2014, Prof Mohan Krishna S. A., of Department of Mechanical Engineering, Vidyavardhaka College of Engineering, Mysore, Karnataka INDIA, developed PORTABLE HYDRAULIC PIPE BENDING MACHINE. Hydraulic bending machine was portable, flexible and less expensive, hence it was better to replace conventional machines by hydraulic pipe bending machine. That operated bending machine required no maintenance and power consumption. During mass production it could be converted into automated or electrically operated jack so

that the rate of production could be increased. Applications of bending machines are found to be in production industries, petroleum, chemical, automobile etc.

- In august 2015, Prof Mahesh Gadekar, Prof Mr. Amol, of Dept. of Mechanical Engineering, Abha Gaikawad Patil Engineering College, Nagpur, Maharashtra, India found THREE ROLLER SHEET BENDING. In three roller sheet bending machine sheet is bend with the help of load acting on upper roller, which is movable. 3 roller sheet bending machine mainly consist of following parts: 3 rollers (upper roller and 2 bottom rollers), motors, gears, power screw, and frame. Bending operation is done by applying load (force) with the help of upper roller, which is movable. It can be moved by adjusting the power screw manually. Two bottom rollers are fixed which acts as a support for holding the metal sheet. Motor is used in sheet bending machine for providing power transmission. Gear drives are used for minimize the rpm transferred from motor to the assembly (machine). Spur gears are used in 3 roller sheet bending machine. Spur gears used are made up of cast iron. Square threaded power screw is used to change the position of upper roller. This operation is totally manual. Frame is a fixed rigid support used for supporting the assembly and also prevent machine from vibration.

CHAPTER 3 :-

METHODOLOGY


IDEA GENERATION
LITERATURE SURVEY
INDUSTRIAL SURVEY
ROUGH LAYOUT
MATERIAL SELECTION AND COST ESTIMATION
DESIGNING
CAD MODELING
ANALYSIS ON SOFTWARE
DESIGN DRAFTING
ASSEMBLY
TESTING
SUBMIT

IDEA GENERATION :- Thinking about some ideas about any problems that we encounter and their remedies.

LITERATURE SURVEY :- Studying the past work that has been done on the machine or idea that we have selected.

INDUSTRIAL SURVEY :- Survey of the market for addition of comfort or variations to the machine according to requirement of the industry.

ROUGH LAYOUT :- Sketching the rough ides of different parts of the machine.

MATERIAL SELECTION AND COST ESTIMATION :- The material is selected acc. to requirement and its cost.

DESIGNING :- constructing detailed diagrams of each and every parts and their assemblies.

CAD MODELING :- 3D modeling the parts according to parts designed.

ANALYSIS ON SOFTWARE :- Analyzing the cad model and checking the parts for various loads.

DESIGN DRAFTING :- Drafting the machine according to the design.

ASSEMBLY :- Assembling the parts.

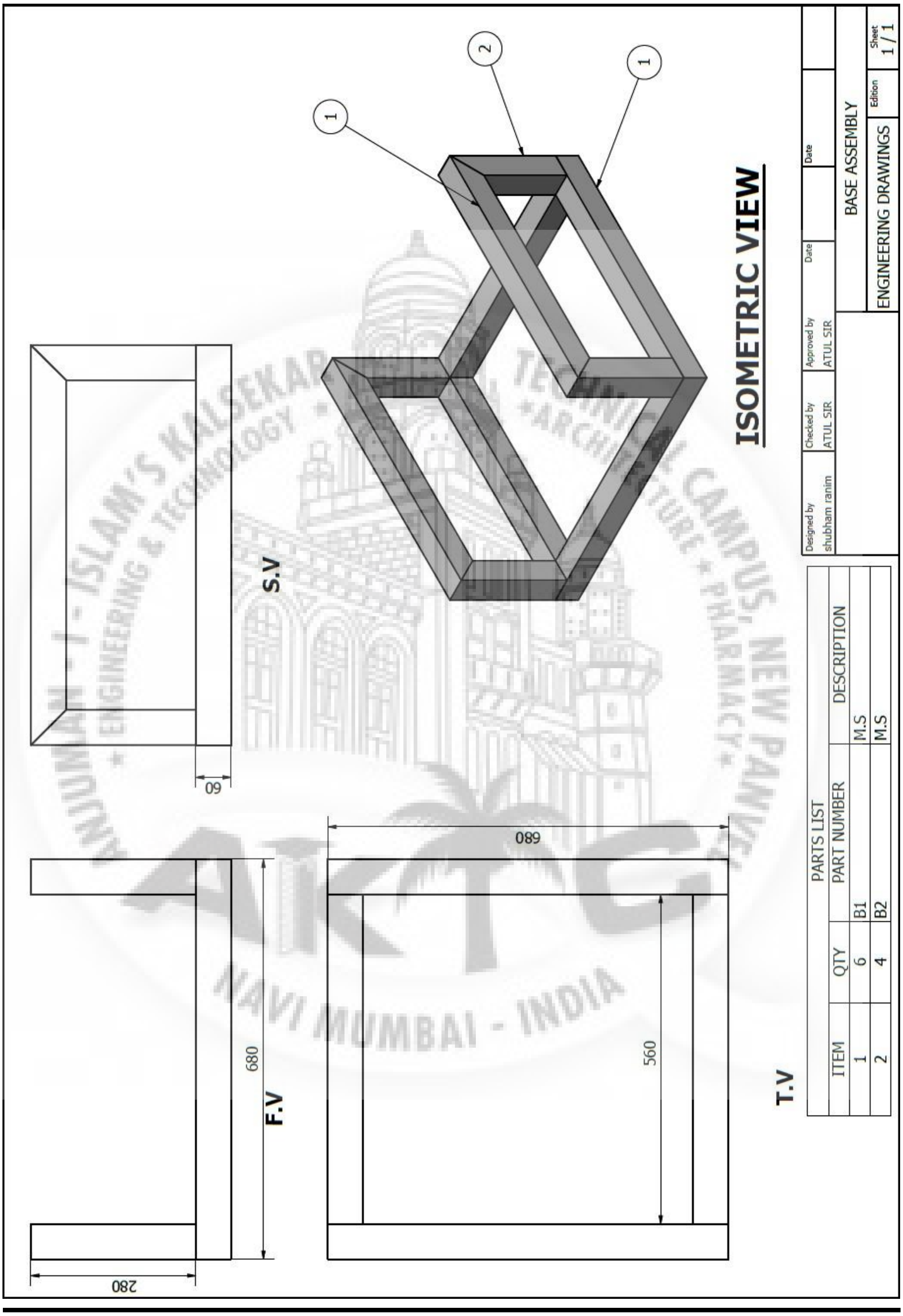
TESTING :- Testing the machine.

SUBMIT :- Submit the final machine.

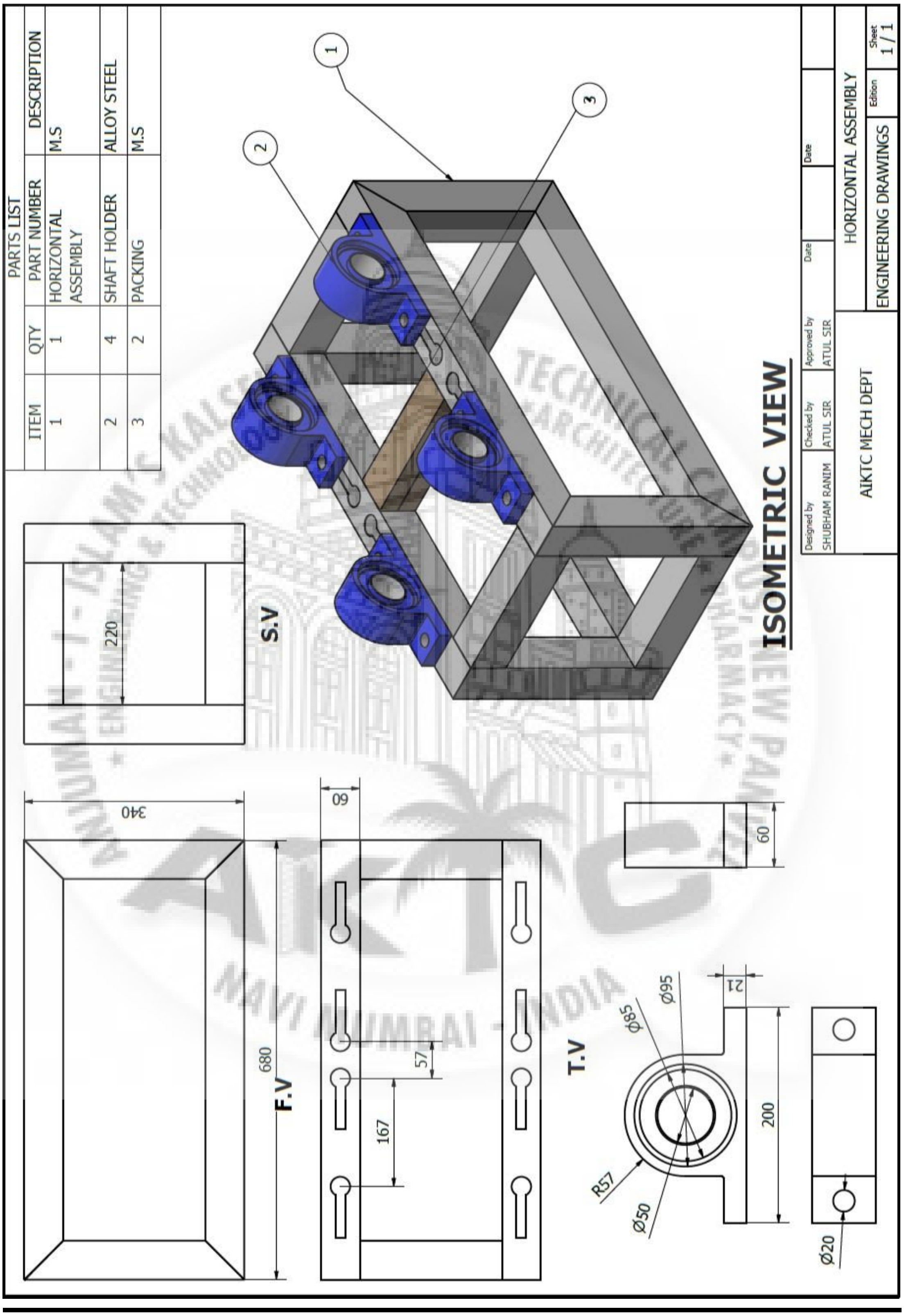
CHAPTER 4 :-

ENGINEERING DRAWINGS

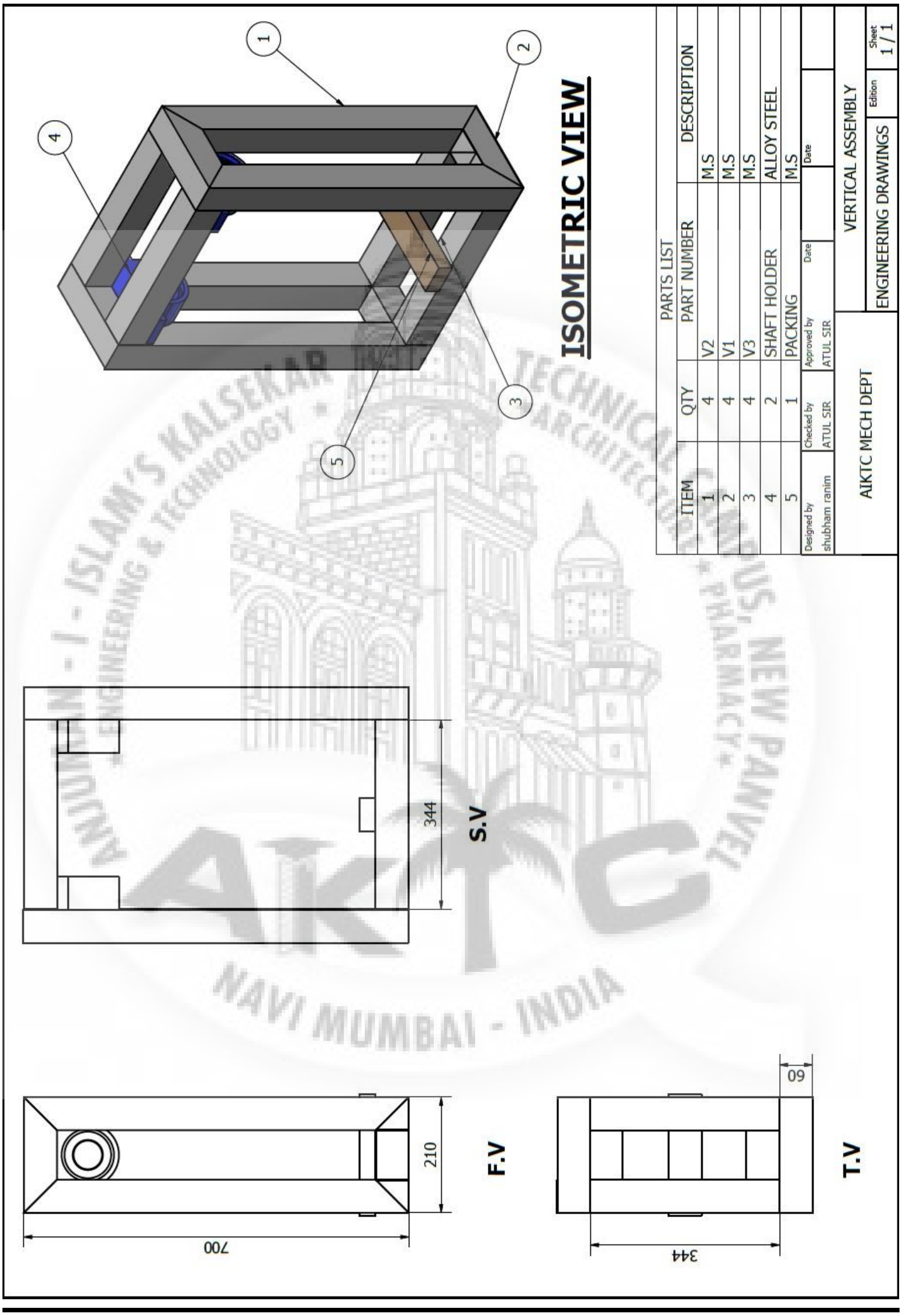
4.1. BASE ASSEMBLY :-



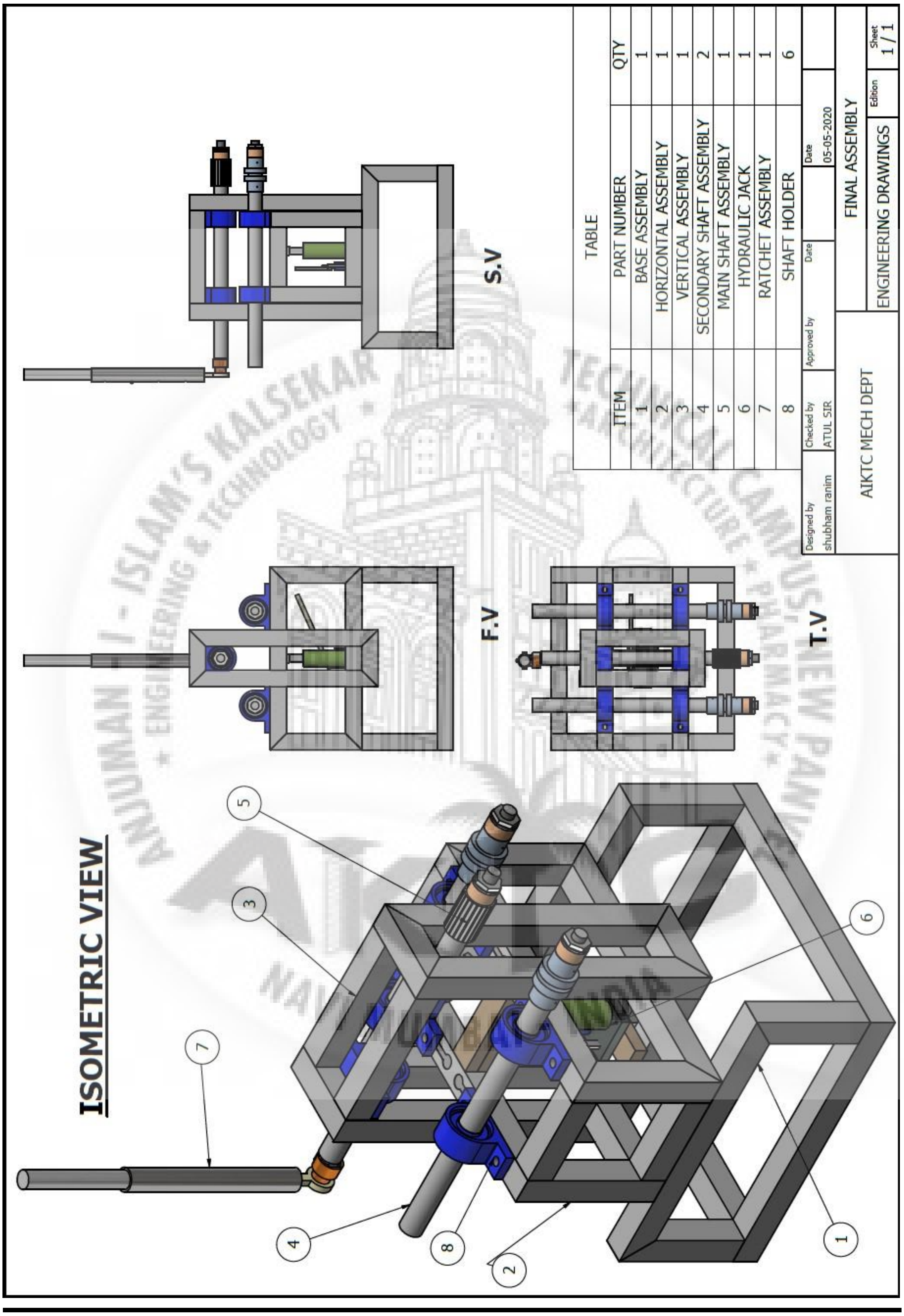
4.2. HORIZONTAL ASSEMBLY :-



4.3. VERTICAL ASSEMBLY :-



4.4. FINAL ASSEMBLY :-



CHAPTER 5 :-

DESIGN COMPONENTS

5.1. SQUARE HOLLOW BEAM :-

The sole idea behind selecting a square or cuboidal shape frame was to provide stability and reduce weight of the frame. Beams of different shape are available in the market the, and they are selected according to the load coming on structure and the weight of the machinery.

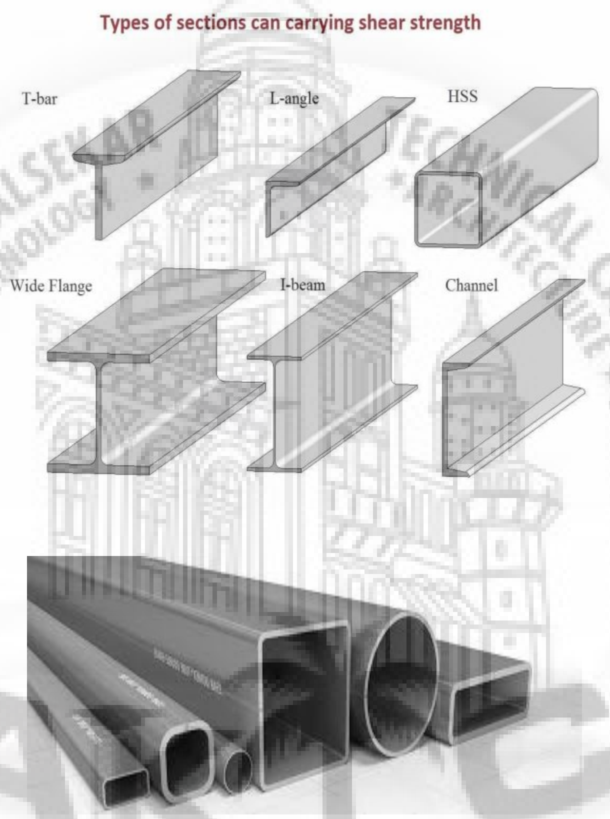


Fig:- Different types of hollow beams

Technical Details :-

Material : M.S

Cross section Area : 60*60*2 MM

Total Hollow Rod Length : 14906MM or 49.08FEET

Cost For 6000MM : 1170RS

Final Cost : 3510RS

Weight : Approx. 55KG

Frame is designed into 3 parts :

1. Horizontal Frame
2. Vertical Frame
3. Base Frame

Element	Content
Carbon, C	0.14 - 0.20 %
Iron, Fe	98.81 - 99.26 % (as remainder)
Manganese, Mn	0.60 - 0.90 %
Phosphorous, P	≤ 0.040 %
Sulfur, S	≤ 0.050 %

Fig :- Cuboidal Hollow Beam

M.S is one of the most common material used in any industrial applications. 1018 steel is a common type of mild steel used. Mild steel is very strong due to the low amount of carbon it contains. Mild steel, as opposed to higher carbon steels, is quite malleable, even when cold. This means it has high tensile and impact strength. M.S can be easily machined compared to harder steel. Easy machinability was among the main criteria for selecting the cuboidal hollow frame.

5.2. SHAFT :-

The material of shaft should be such that it should sustain both the turning i.e. the torque as well as the compressive forces. It should contain some amount of malleability so that it does no break on application of force. So accordingly to the requirements EN24 is the material of the shaft that we have used in our roll bending machine. This grade is a nickel chromium molybdenum specification usually supplied hardened and tempered as EN24T or EN24U. EN24T steel is readily machinable and combines a good high tensile steel strength with shock resistance, ductility and wear resistance. It is a widely used engineering steel with a tensile strength of 850/1000 N/mm². It has reasonably good impact properties at low temperatures, whilst it is also suitable for a variety of elevated temperature applications. Flame or induction hardening of EN24T can give a case hardness of 50 HRc or higher.

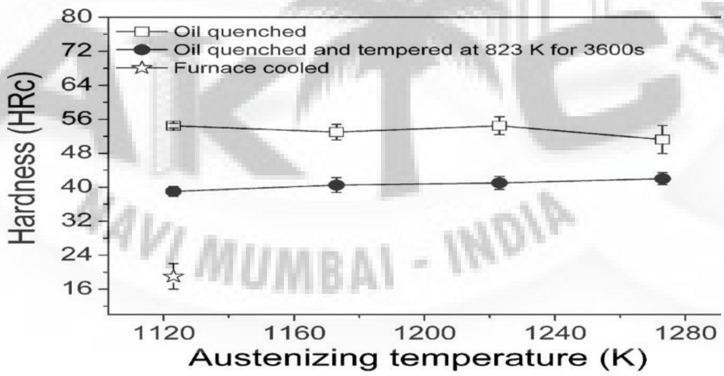


Fig :- Tempering chart of EN24T

EN24 was originally introduced for use in the motor vehicle and machine tool industries for gears, pinions, shafts, spindles. Later its applications became much more extended. Suitable to produce parts for such as locomotives, cranes, rolling mills, coal cutting machinery etc. with good strength and fatigue resistance. Other applications for EN24 and EN24T are found in die casting and hot metal working, such as die bolsters, racks and pinions, angle pins for pressure die casting, hot stamping dies for aluminium stamping, die beds for steel stamping, lower temperature nut, bolt and rivet heading dies, large section drop forging dies. It is widely used in the plastic and rubber moulding industries for moulds. For moulds EN24 is normally supplies hardened and tempered to 'T' condition. If a higher hardness is desired EN24T should be annealed and then heat treated to the required hardness.

Analysis:

Carbon 0.35-0.45%, Silicon 0.10-0.35%, Nickel 1.30-1.80%, Manganese 0.45-0.70%, Chromium 0.90-1.40% , Phosphorous 0.05% max, Molybdenum 0.20-0.35%, Sulphur 0.05% max.

Technical Details :-

Shaft Length : 840MM

Shaft Diameter : 50MM

No. Of Shafts : 3

Material : EN24 (Alloy Steel)

Cost : 3600 RS

Weight : 39 KG

Distance variation Between the Shaft : (Refer the Diagram)

Maximum Horizontal distance between the center of Shafts : 375 MM

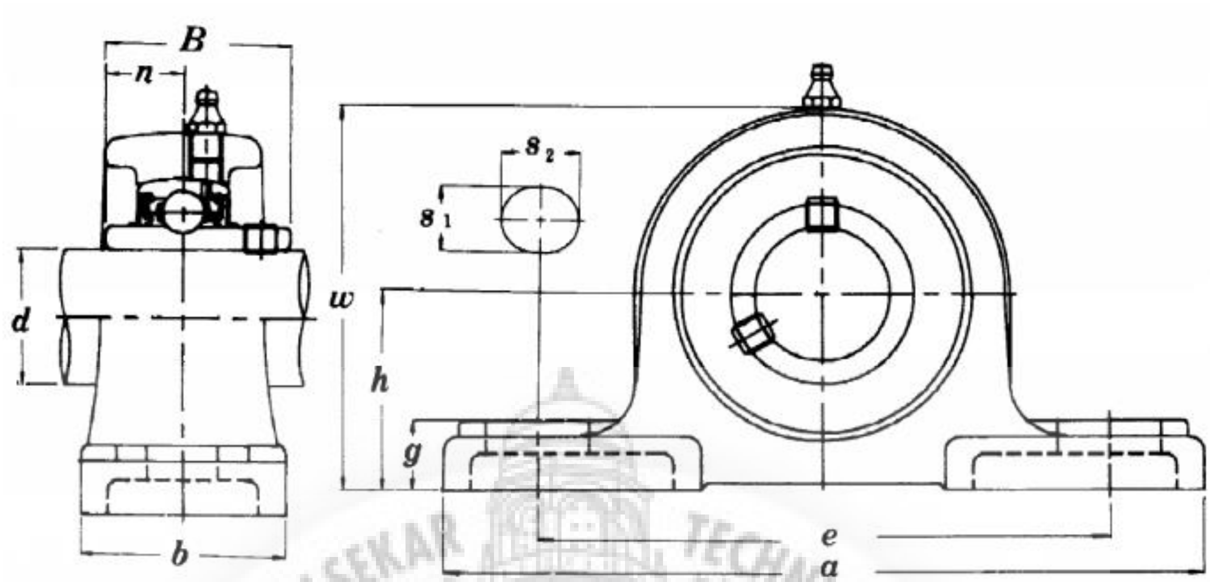
Minimum Horizontal distance between the center of Shafts : 220 MM

Maximum Vertical distance between the center of Shafts :125.6 MM

Minimum Vertical distance between the center of Shafts : <0 MM.

5.3. PILLOW BLOCK :-

A pillow block usually refers to a housing with an included anti-friction bearing. A pillow block may contain a bearing with one of several types of rolling elements, including ball, cylindrical roller, spherical roller, tapered roller, or metallic or synthetic bushing. The fundamental application is to mount a bearing safely enabling its outer ring to be stationary while allowing rotation of the inner ring. The housing is bolted to a foundation through the holes in the base. Bearing housings may be either split type or solid type. Bearing housings are usually made of grey cast iron. However, various grades of metals can be used to manufacture the same, including ductile iron, steel, stainless steel. The bearing element may be manufactured from 52100 chromium steel alloy or bushing materials such as SAE660 cast bronze, or SAE841 oil impregnated sintered bronze, or synthetic materials. A Shaft holder is selected according the shaft requirements. There are some specifications according to ISO.



Unit No.	Dimensions mm												Bearing No.	Housing No.	Weight (kg)
	d	h	a	e	b	s1	s2	g	w	t	B	n			
UCP201	12	30.2	127	95	38	13	19	14	62	44.5	31	12.7	UC201	P203	0.69
UCP202	15	30.2	127	95	38	13	19	14	62	44.5	31	12.7	UC202	P203	0.69
UCP203	17	30.2	127	95	38	13	19	14	62	44.5	31	12.7	UC203	P203	0.68
UCP204	20	33.3	127	95	38	13	19	15	71	48	34.1	14.3	UC204	P204	0.66
UCP205	25	36.5	140	105	38	13	19	15	71	48	34.1	14.3	UC205	P205	0.81
UCP206	30	42.9	165	121	48	17	20	17	84	53	38.1	15.9	UC206	P206	1.24
UCP207	35	47.6	167	127	48	17	20	18	93	59.5	42.9	17.5	UC207	P207	1.58
UCP208	40	49.2	184	137	54	17	20	18	100	69	49.2	19	UC208	P208	1.89
UCP209	45	54.0	190	146	54	17	20	20	106	69	49.2	19	UC209	P209	2.14
UCP210	50	57.2	200	159	60	20	23	21	113	74.5	51.6	19	UC210	P210	2.66

Fig :- Specification of Pillow Block

Fig :- Pillow Block

Technical Details :-

Selecting Shaft Holder for Shaft Diameter 50MM

Bearing No. : UC210

Weight : 2.66KG

No. of Shaft Holders required : 6

Cost : 1000RS/PIECE

Material : Stainless Steel

For Complete Dimensions details refer the Chart

Bolt for Screwing the Shaft Holder to the Frame

Bolt Size : M12

No. of Bolts Required : 6

Cost : 1000 RS

Material : Stainless Steel

M.S. **RATCHET :-**

A ratchet is one of the most important part the whole assembly. It one of the sole component that plays a vital role in the working of the machine. We got this idea when we how a simple spanner easily turns a heavily tightened bolt with so much ease. A **ratchet** is a mechanical device that allows continuous linear or rotary motion in only one direction while preventing motion in the opposite direction. A rachet consists of a round gear or a linear rack with teeth, and a pivoting, spring-loaded finger called a pawl that engages the teeth. When the teeth move in the opposite (backward) direction, the pawl will catch against the steeply sloped edge of the first tooth it encounters, thereby locking it against the tooth and preventing any further motion in that direction.

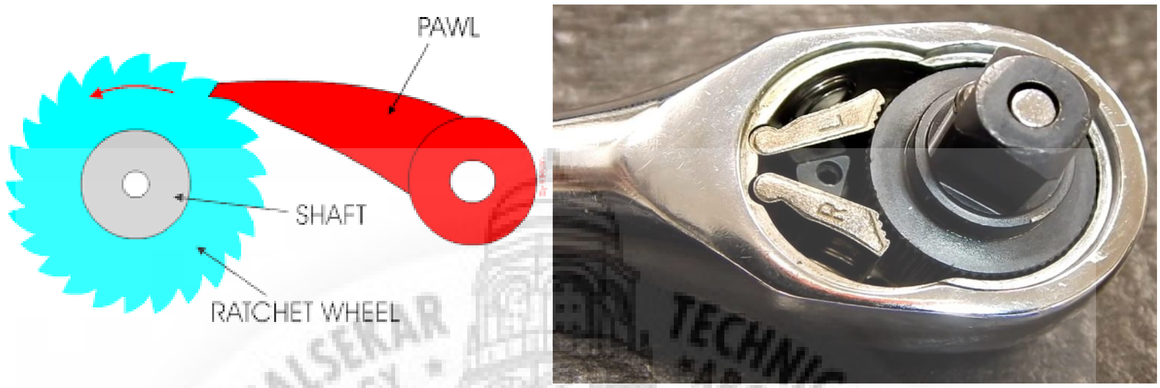


Fig :- Ratchet Mechanism and Ratchet Spanner Assembly

In our machine we have used the application of this mechanism in the form of ratchet spanner. A ratchet spanner uses a mechanism which allows an open-ended, flare or ring head to turn a fastener in one direction but not the other while remaining fitted to the fastener head. Ratchet spanners are useful because they don't need to be removed from the head and relocated every time the limit of the turning arc is reached. They are turned back and forth repeatedly but the nut is only turned in one direction. This saves time. Using this same idea of the spanner we have applied it to our machine so that bending can be done easily.

Content	Percentage
Iron (Fe)	96.7 to 97.7%
Chromium (Cr)	0.8 to 1.1%
Vanadium (V)	0.18 to 0.3%
Manganese (Mn)	0.7 to 0.9%
Carbon (C)	0.50 to 0.53%
Sulfur (S)	0 to 0.040%
Silicon (Si)	0.15 to 0.35%
Phosphorous (P)	0 to 0.035%

Fig :- Composition of Chromium Vanadium Steel

Technical Details :-

Size : 41MM

Cost : 1450RS

Material : Chromium Vanadium steel

Purchase Reference :

Price Estimation from A.A.A Traders

5.5. HYDRAULIC JACK :-

A **jack** is a mechanical lifting device used to apply great forces or lift heavy loads. A mechanical jack employs a screw thread for lifting heavy equipment. A hydraulic jack uses hydraulic power. Jacks are usually rated for a maximum lifting capacity (for example, 1.5 tons or 3 tons). A hydraulic jack uses a liquid, which is incompressible, that is forced into a cylinder by a pump plunger. When the plunger pulls back, it draws oil out of the reservoir through a suction check valve into the pump chamber. When the plunger moves forward, it pushes the oil through a discharge check valve into the cylinder. At this point the suction ball within the chamber is forced shut and oil pressure builds in the cylinder. And the object is lifted up. In our project the jack supports the vertical assembly and helps the vertical assembly to carry the load that is applied to the shaft. It also acts as linking mechanism that attaches the vertical assembly to the horizontal assembly.

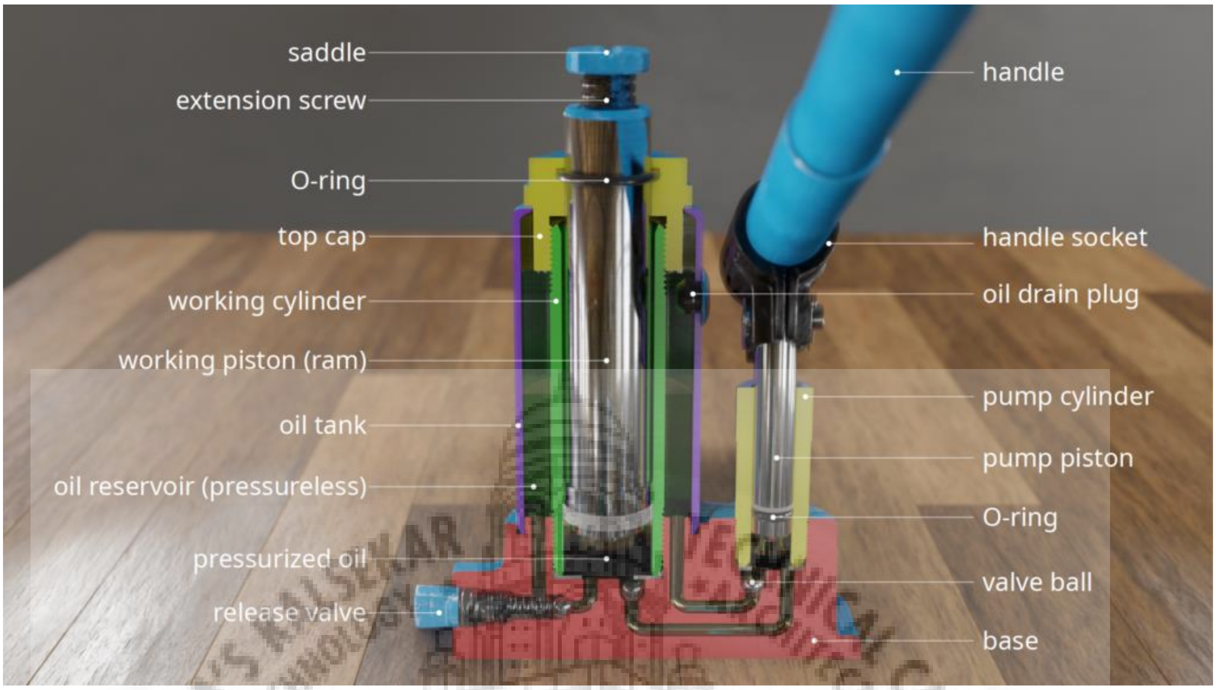


Fig :- Hydraulic Jack Parts

Technical Details :-

Capacity : 3TON

Maximum Height : 350

Minimum Height : 180

Cost : Approx. 1000RS

5.6. MANDREL :-

A flanged or tapered or threaded bar that grips a workpiece to be machined in a lathe. A flanged mandrel is a parallel bar of a specific diameter with an integral flange towards one end, and threaded at the opposite end. A tapered mandrel (often called a plain mandrel) has a taper of approximately 0.005 inches per foot and is designed to hold work by being driven into an accurate hole on the work. On a lathe, mandrels are commonly mounted between centers and driven by a lathe dog, but may also be gripped in a chuck, typically the threaded mandrels, where the outer face of work is to be machined. Threaded mandrels may also be mounted between centers. Exhaust pipes for automobiles are frequently bent using a mandrel during manufacture. The mandrel allows the exhaust pipes to be bent into smooth curves without undesirable creasing, kinking, or collapsing. Molten glass may be shaped in this way as well.

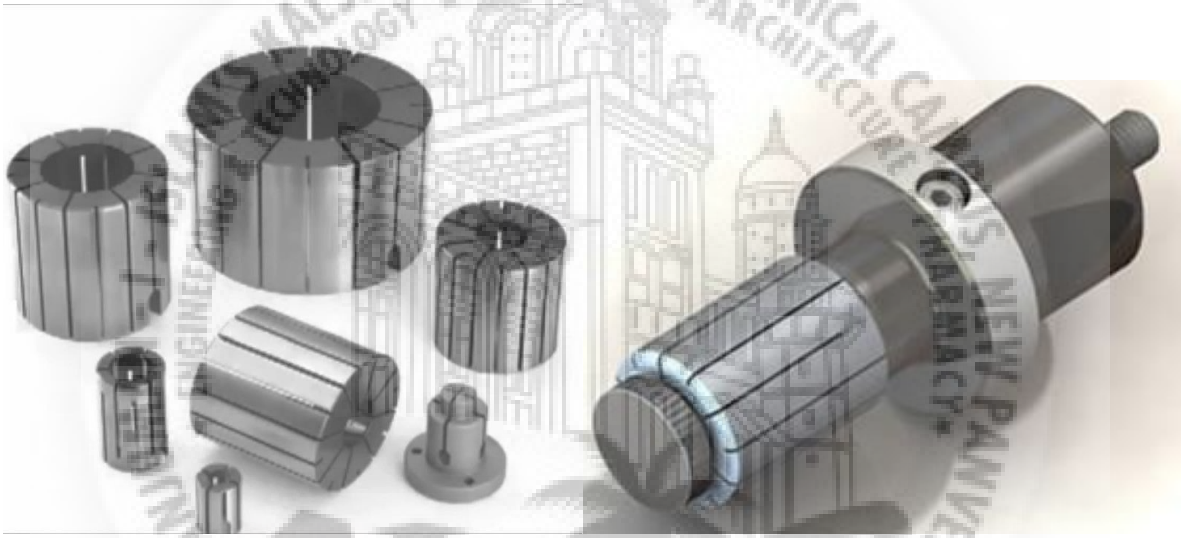


Fig :- Mandrel mounted on a Shaft

5.7. ADJUSTABLE HANDLE :-

The idea behind using an adjustable handle was to improve the working of the machine. As we all know the simple concept that when we apply some amount of force at one point of a rod the force that's transferred on the other point it always some more in amount. This addition of force depends on the length of the shaft, more the length of the shaft more the addition of force takes place. So we applied this simple concept and came up with the idea of adjustable handle. The material of this type of handle is generally made of Chromium and vanadium. Chrome vanadium is formed by combining chemicals in different proportions. The percentage of each component will vary as per the desired characteristics of the finished product. Typically, Chrome vanadium contains a high amount of chromium, between 0.80 and 1.10 percent, and the vanadium content is approximately 0.18 percent, along with 0.70 to 0.90 percent of manganese. Other substances include 0.50 percent carbon, 0.30 percent silicon, and trace amounts of other metals.

Fig :- Push Button used to lock the Handle

A push button is generally used in the locking mechanism. A spring-loaded button on one pole segment locks into one of several holes on the other segment. When the Ratchet handle is set at the correct height, tighten the anti-rattle collar by turning it clockwise. Same mechanism of Height Adjustable Walking stick used by old aged people is implemented in our Ratchet key locking mechanism.

Technical Details :-

Length Variation Including Ratchet lever 450 MM, 500 MM, 600 MM, 700 MM & 800 MM.

5.8. SLEEVE :-

Sleeve is the element that holds the rod in portion while working on the material. They are made up of M.S. It is keyed to the shaft.

Fig :- Sleeves made of M.S

Technical Details :-

Pulley Outer Diameter : 70MM

Pulley Inner Diameter : 50MM

Step Outer Diameter : 60MM

Step Inner Diameter : 50MM

Pulley & Shafts are connected with Keys.

5.9. WASHERS, NUTS AND BOLTS :-

Washers are used as a packing elements in our machine. They serve the main function of preventing the sliding of pulleys away from the workpiece. A **washer** is a thin plate with a hole that is normally used to distribute the load of a threaded fastener, such as a bolt or nut. High-quality bolted joints require hardened steel washers to prevent the loss of pre-load due to brinelling after the torque is applied.

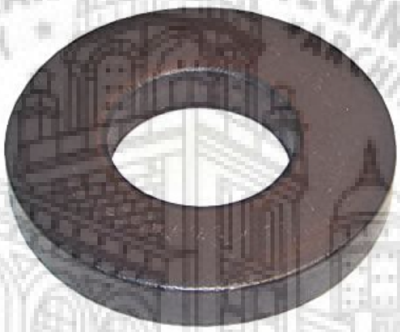
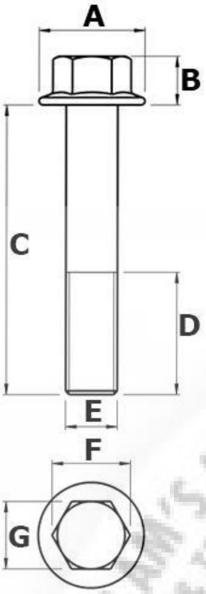


Fig :- Washer

A **bolt** is a form of threaded fastener with an external male thread. Bolts are often used to make a bolted joint. This is a combination of the nut applying an axial clamping force. For this reason, many bolts have a plain unthreaded shank (called the grip length). The unthreaded grip length should be chosen carefully, to be around the same length as the thickness of the material and washers through which the bolt passes. An overly long unthreaded length prevents the nut from being tightened down correctly.

A **nut** is a type of fastener with a threaded hole. Nuts are almost always used in conjunction with a mating bolt to fasten multiple parts together. The most common shape today is hexagonal, for similar reasons as the bolt head: six sides give a good granularity of angles for a tool to approach from.



Dimensions (mm)

	M12x30	M12x35	M12x40	M12x50	M12x60	M12x70	M12x80	M12x90
A	20	20	20	20	20	20	20	20
B	10	10	10	10	10	10	10	10
C	30	35	40	50	60	70	80	90
D	25	25	25	25	25	25	25	25
E	12	12	12	12	12	12	12	12
F	16	16	16	16	16	16	16	16
G	14	14	14	14	14	14	14	14

Fig :- Specification of nut and bolts

Fasteners used in automotive, engineering, and industrial applications usually need to be tightened to a specific torque setting, using a torque wrench.

Technical Details :-

Bolt for Screwing the Shaft Holder to the Frame

Bolt Size : M12

No. of Bolts Required : 6

Cost : 500 RS

Material : Stainless Steel

CHAPTER 6 :-

CAD MODELING

FRAME ASSEMBLY :-

Frame defines the structure of our model. It is the most Integral part of our assembly. Frame supports every component of the machine. The frame is designed so as to resist deformation & to withstand the forces that are acting on it during the operation. The material used is MS which possesses great strength & has a high resistance to breakage. Also it is easily available in the market & can be safely welded. Square sections hollow rod of dimension 60*60*2MM is used in the frame.

The Frame is designed in 3 parts :

6.1. BASE ASSEMBLY :-

The base assembly carries the complete weight of the machine. It provides the necessary height required for the vertical assembly to slide down. It holds the machine in one place & maintains the balance of the machine components during the operation.

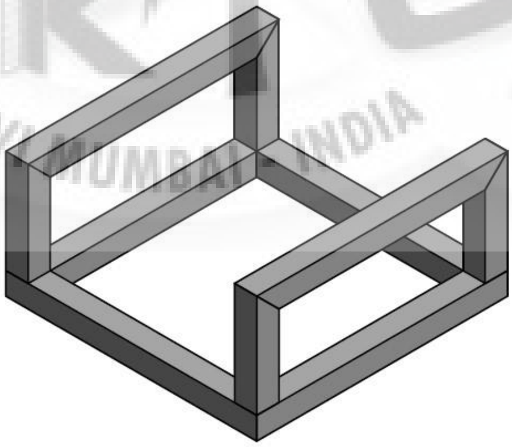


Fig :- Base Frame Assembly

Technical Details :-

Cut Pieces for Base Frame : (Length*No of pieces)

1.680*4MM

2.340*4MM

3.560*2MM

Total Length of Hollow Square Rod for Base Frame : 5200MM

Area of Hollow Rod for Base Frame : [A(Outer square) – A(Inner Square)]*Length of Hollow Square Rod

= [(60*60) – (56*56)] * 5200

= 2412800MM^2

Dimensions of Base Frame :

Length, Breadth & Height are 680,340&680 respectively.

Weight of Base Frame : Approx. 19KG

6.2. HORIZONTAL ASSEMBLY :-

The horizontal assembly consists of 2 shaft holders with shafts inserted in them on which the workpiece is supported. Holes are drilled on it to screw the shaft holders. Slots are provided in extension to these holes for sliding the shaft holders & obtaining different distances between the shafts. Due to these variation in the distance different bending angles is obtained.

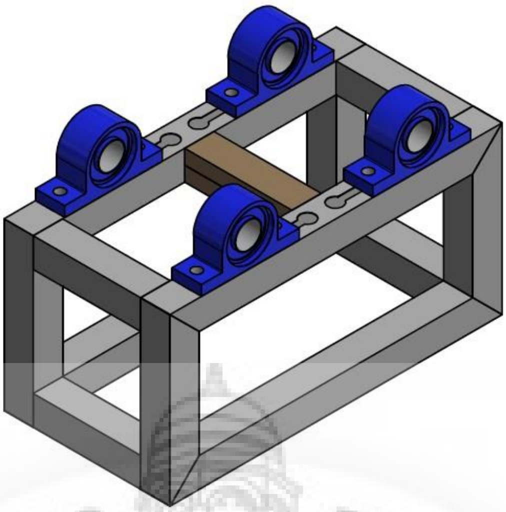


Fig :- Horizontal Frame Assembly

Technical Details :-

Cut Pieces for Horizontal Frame : (Length*No of pieces)

1.680*4MM

2.340*4MM

3.220*4MM

Total Length of Hollow Square Rod for Horizontal Frame : 4960MM

Area of Hollow Rod for Horizontal Frame : [A(Outer square) – A(Inner Square)]*Length of Hollow Square Rod

= [(60*60) – (56*56)] * 4960

= 2301440MM^2

Dimensions of Horizontal Frame :

Length, Breadth & width are 680,340&340 respectively.

Weight of Horizontal Frame : Approx. 18.2KG

Frame Construction : (Refer the diagram)

For 680MM length cut the ends at 45Degree angle

For 340MM length cut the ends at 45Degree angle

For 220MM do straight cuts

Weld all parts according to the diagram.

Drill Holes for inserting the shaft holder.

Considering extreme left & bottom form top view as co-ordinates (0,0).

Drill 8 Holes of 21.1MM at co-ordinates (X-axis, Y-axis)

(152.5,30)

(311.5,30)

(368.5,30)

(527.5,30)

(152.5,310)

(311.5,310)

(368.5,310)

(527.5,310)

Drill 4 Slots of 12MM from co-ordinates (X-axis, Y-axis) to (X-axis, Y-axis)

(73,30) to (142.5,30)

(378.5,30) to (448,30)

(73,310) to (142.5,310)

(378.5,310) to (448,310)

6.3. VERTICAL ASSEMBLY :-

Vertical assembly is designed to apply the required force on the workpiece to obtain the desired bend. The shaft holder is screwed in the center of the top bottom of the workpiece. It is designed to allow the vertical movement which is done by the hydraulic bottle jack, connected & supported at the bottom of the vertical assembly.

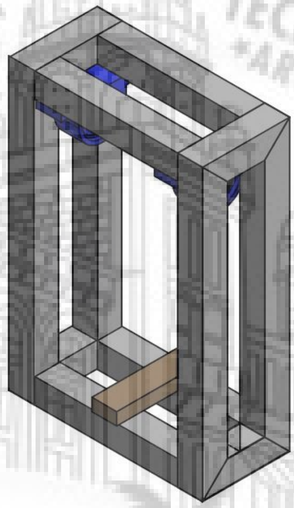


Fig :- Vertical Frame Assembly

Technical Details :-

Cut Pieces for Vertical Frame : (Length*No of pieces)

1.700*4MM

2.210*4MM

3.344*4MM

Total Length of Hollow Square Rod for Vertical Frame : 5016MM

Area of Hollow Rod for Vertical Frame : [A(Outer square) – A(Inner Square)]*Length of Hollow Square Rod

= [(60*60) – (56*56)] * 5016

= 2327424MM^2

Dimensions of Vertical Frame :

Length, Breadth & width are 210,700&344 respectively.

Weight of Vertical Frame : Approx. 18.4KG

Frame Construction : (Refer the diagram)

For 210MM length cut the ends at 45Degree angle

For 700MM length cut the ends at 45Degree angle

For 344MM do straight cuts

Weld all parts according to the diagram.

Drill Holes for inserting the shaft holder.

Considering extreme left & bottom form top view as co-ordinates (0,0).

Drill 4 Holes of 21.1MM at the Bottom of the top frame at co-ordinates (X-axis, Y-axis)

(25.5,90)

(184.5,90)

(25.5,372)

(184.5,372)

SHAFT ASSEMBLY :-

Shaft is a common & important rotating component of the machine. It is solid & has a circular cross section. Shafts are supported on the bearing placed in the shaft holders. The shafts are generally acted upon by bending moment, torsion and axial force. Shafts are made of EN24

(Alloy steel) material. EN24 is very well known for its high strength & wear resistance properties. Shafts rolling action causes the workpiece to bend in a circular arc

6.4. SECONDARY SHAFT ASSEMBLY :-

The secondary shafts are the support shafts that support the workpiece and slide them to the front. Sleeves are used to support the workpiece & avoid the workpiece to slip under loading conditions.

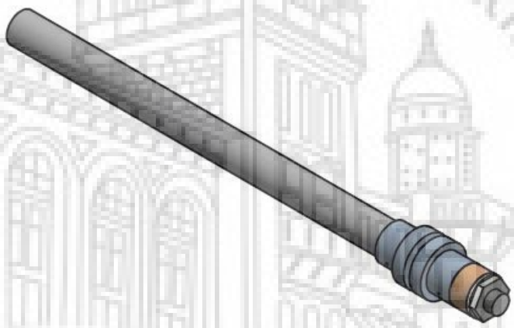


Fig :- Secondary Shaft Assembly

Sleeves are used to fill up the empty spaces on the shaft. The front of the shaft is reduced in diameter and threaded for inserting a nut to hold the components assembled on the shaft. It plays the role of acting as a support for the workpiece while working.

6.5. RATCHET ASSEMBLY :-

Ratchet assembly is the main mechanism that provides the main torque or force required to apply the bend on the workpiece. Ratchet Lever will be forged pressed into the Rod. Screw Holes are Drilled in both these rods for achieving variable lengths.

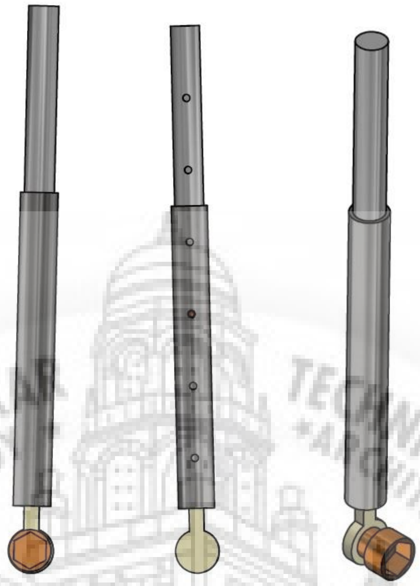


Fig :- Ratchet Assembly

Technical Details :-

Extension Rod Design : (Refer Diagram)

1.Slot Rod

Material : Chromium Vanadium steel

Length : 420MM

Diameter : 50MM

Rectangular Slot of Dimension 15*20MM From 0 to 50MM.

Circular Slot of Diameter 40MM From 70MM to 420MM.

2.Solid Rod

Material : Chromium Vanadium steel

Length : 420MM

Diameter : 40MM

6.6. MAIN SHAFT ASSEMBLY :-

The Main shaft applies force on the workpiece. A silver mandrel is positioned on the shaft at the point of contact with the workpiece. Sleeves are used to fill up the empty spaces on the shaft. The rachet assembly and adjustable handle assembly is attached to this shaft. And the turning moment is provided from this shaft. It is the main rotating and force applying member in the machine.

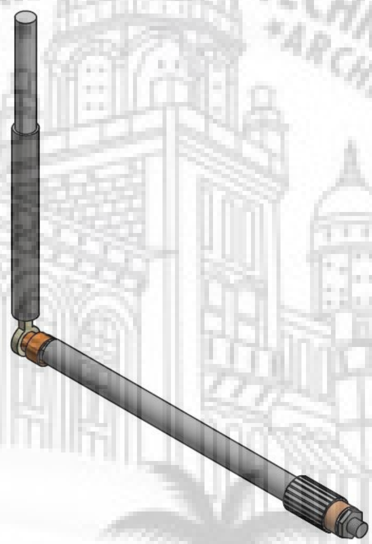


Fig :- Main Shaft Assembly

The front of the shaft is reduced in diameter and threaded for inserting a nut to hold the components assembled on the shaft. The back side of the shaft is given hexagon shape to insert the ratchet socket. Ratchet Lever will be forged pressed into the Rod. Screw Holes are Drilled in both these rods for achieving variable lengths.

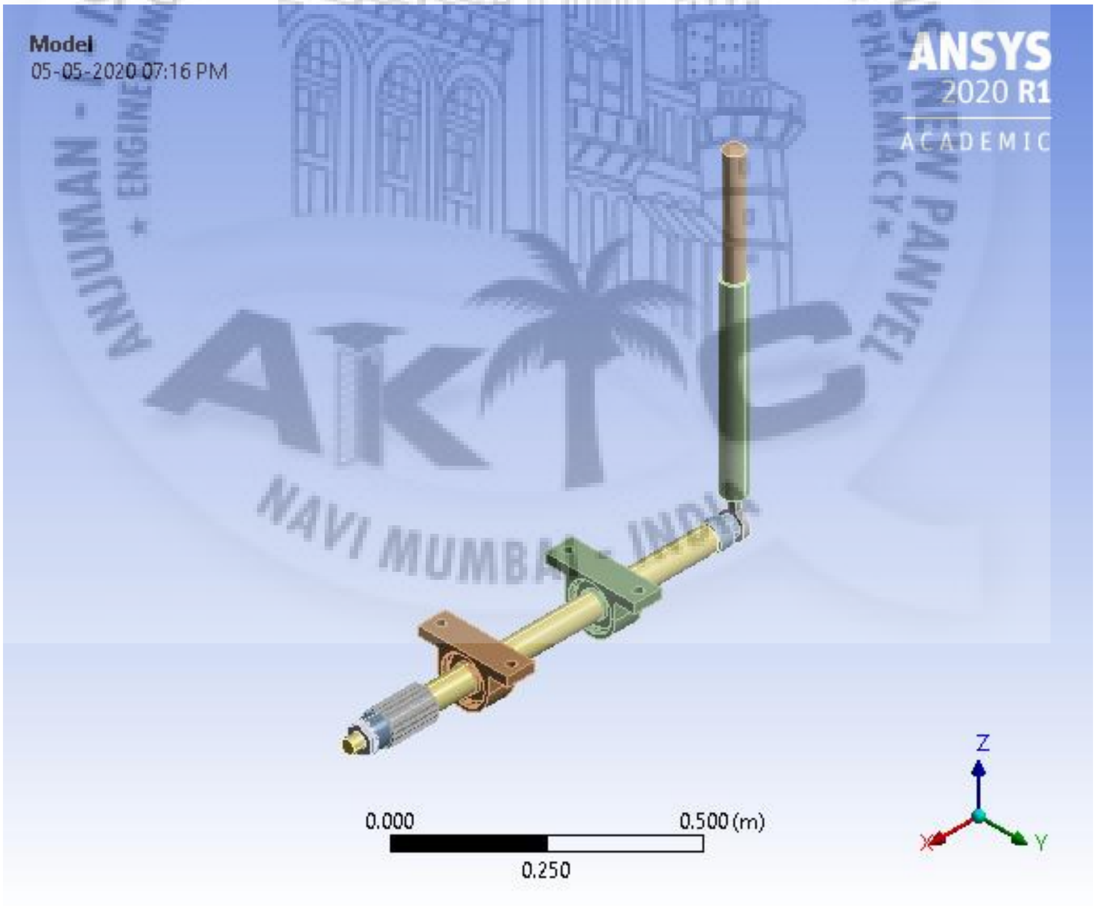
CHAPTER 7 :-

VALIDATION

7.1. MAIN SHAFT ANALYSIS :-

Project*

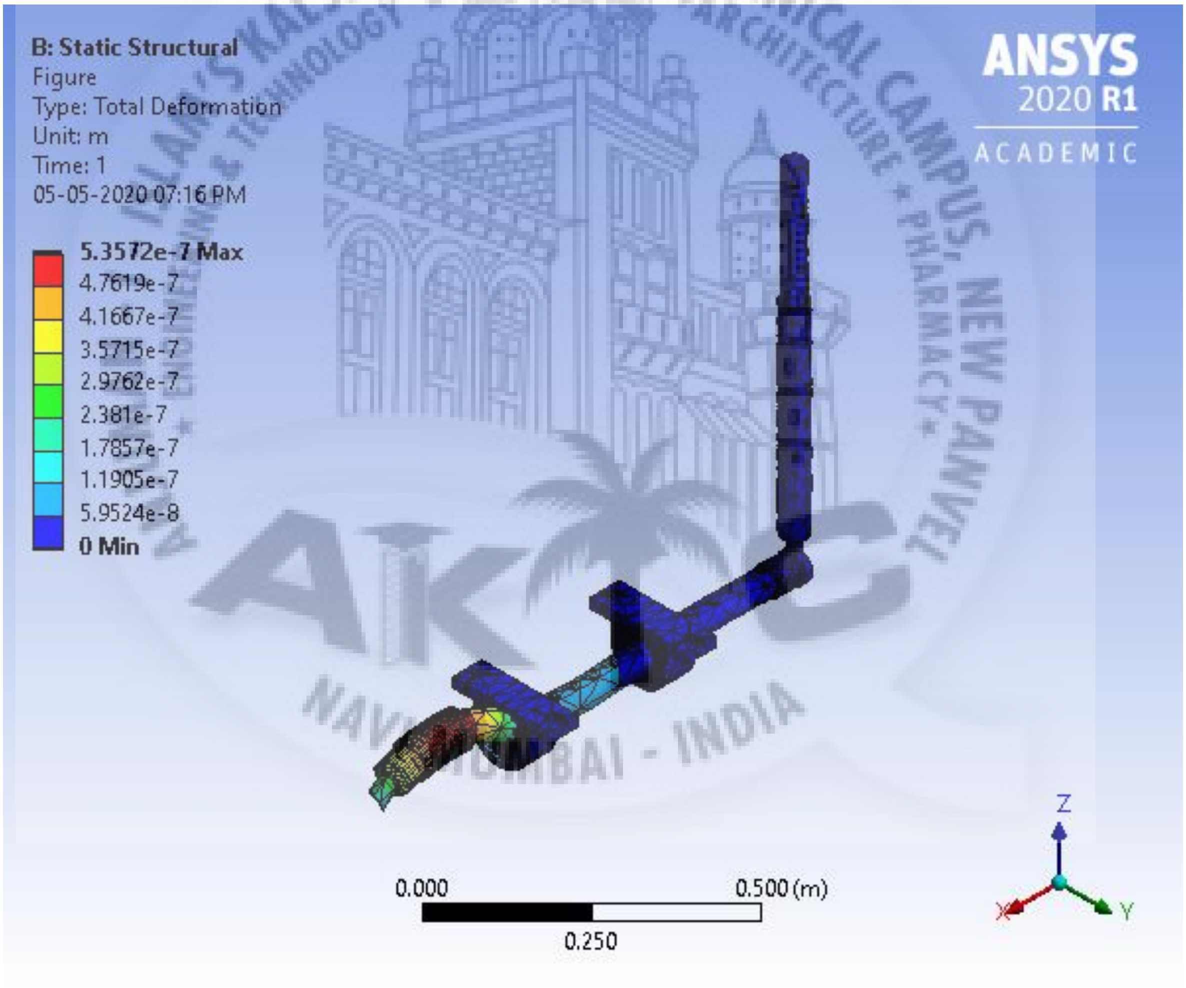
First Saved	Tuesday, May 5, 2020
Last Saved	Tuesday, May 5, 2020
Product Version	2020 R1
Save Project Before Solution	No
Save Project After Solution	No



Model (B4) > Static Structural (B5) > Solution (B6) > Total Deformation

Time [s]	Minimum [m]	Maximum [m]	Average [m]
1.	0.	5.3572e-007	1.443e-007

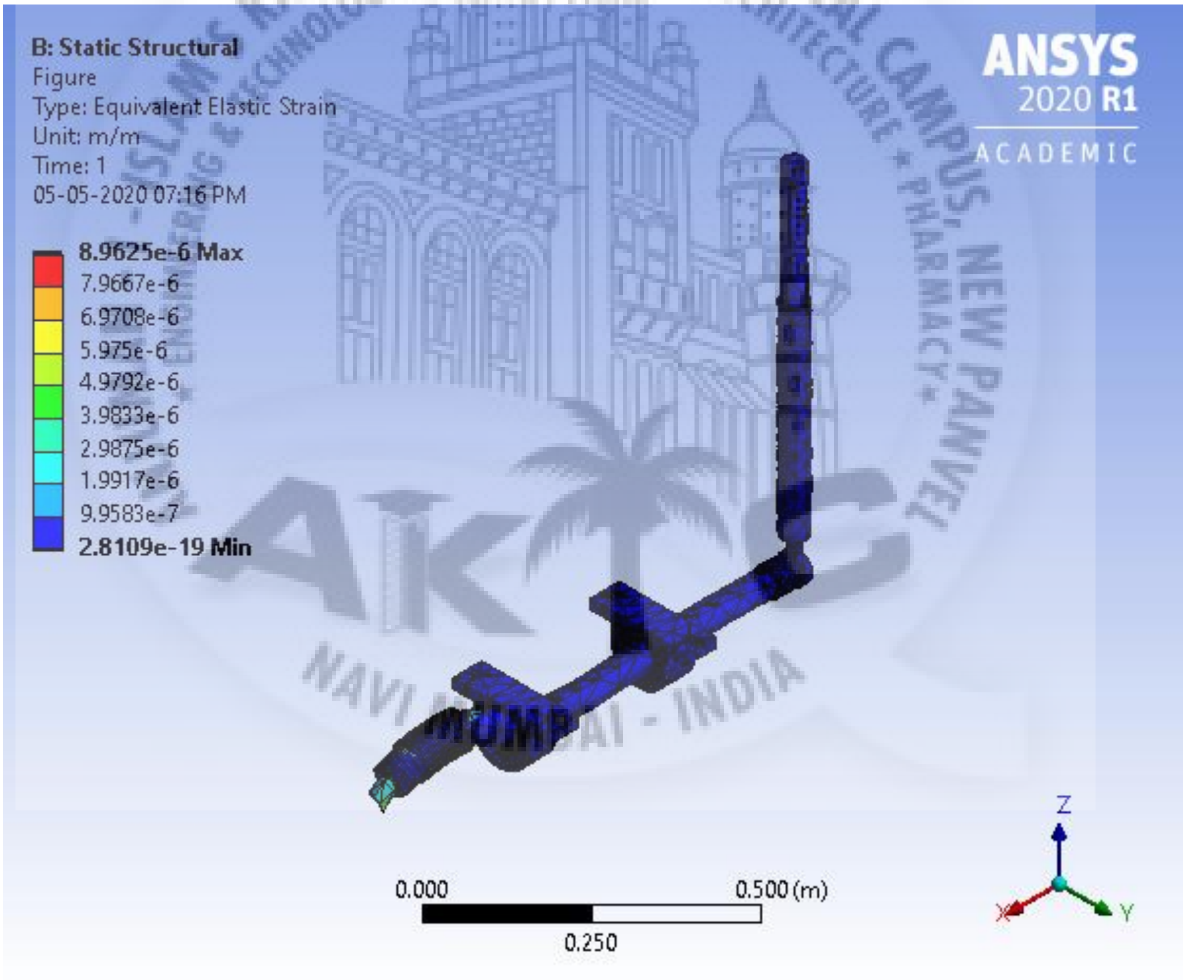
Model (B4) > Static Structural (B5) > Solution (B6) > Total Deformation > Figure



Model (B4) > Static Structural (B5) > Solution (B6) > Equivalent Elastic Strain

Time [s]	Minimum [m/m]	Maximum [m/m]	Average [m/m]
1.	2.8109e-019	8.9625e-006	2.3904e-007

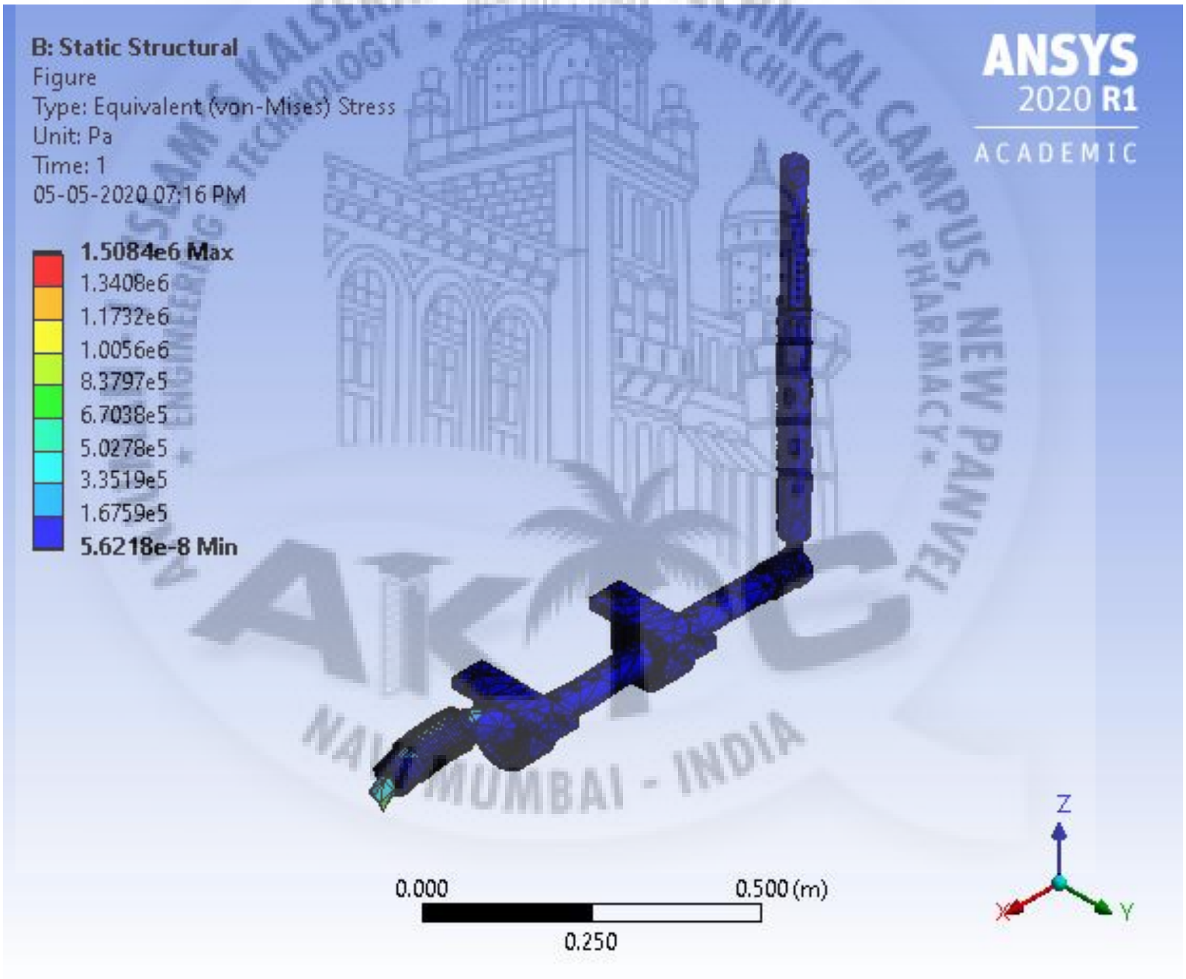
Model (B4) > Static Structural (B5) > Solution (B6) > Equivalent Elastic Strain > Figure



Model (B4) > Static Structural (B5) > Solution (B6) > Equivalent Stress

Time [s]	Minimum [Pa]	Maximum [Pa]	Average [Pa]
1.	5.6218e-008	1.5084e+006	43006

Model (B4) > Static Structural (B5) > Solution (B6) > Equivalent Stress > Figure



Material Data

Alloy Steel

Alloy Steel > Constants

Density	7850 kg m^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	434 J kg^-1 C^-1
Thermal Conductivity	60.5 W m^-1 C^-1
Resistivity	1.7e-007 ohm m

Alloy Steel > Colour

Red	Green	Blue
132	139	179

Alloy Steel > Compressive Ultimate Strength

Compressive Ultimate Strength Pa
0

Alloy Steel > Compressive Yield Strength

Compressive Yield Strength Pa
2.5e+008

Alloy Steel > Tensile Yield Strength

Tensile Yield Strength Pa
2.5e+008

Alloy Steel > Tensile Ultimate Strength

Tensile Ultimate Strength Pa
4.6e+008

Alloy Steel > Isotropic Secant Coefficient of Thermal Expansion

Zero-Thermal-Strain Reference Temperature C
22

Alloy Steel > S-N Curve

Alternating Stress Pa	Cycles	Mean Stress Pa
3.999e+009	10	0
2.827e+009	20	0
1.896e+009	50	0
1.413e+009	100	0
1.069e+009	200	0
4.41e+008	2000	0
2.62e+008	10000	0
2.14e+008	20000	0
1.38e+008	1.e+005	0

1.14e+008	2.e+005	0
8.62e+007	1.e+006	0

Alloy Steel > Strain-Life Parameters

Strength Coefficient Pa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient Pa	Cyclic Strain Hardening Exponent
9.2e+008	-0.106	0.213	-0.47	1.e+009	0.2

Alloy Steel > Isotropic Elasticity

Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa	Temperature C
2.e+011	0.3	1.6667e+011	7.6923e+010	

TABLE 31

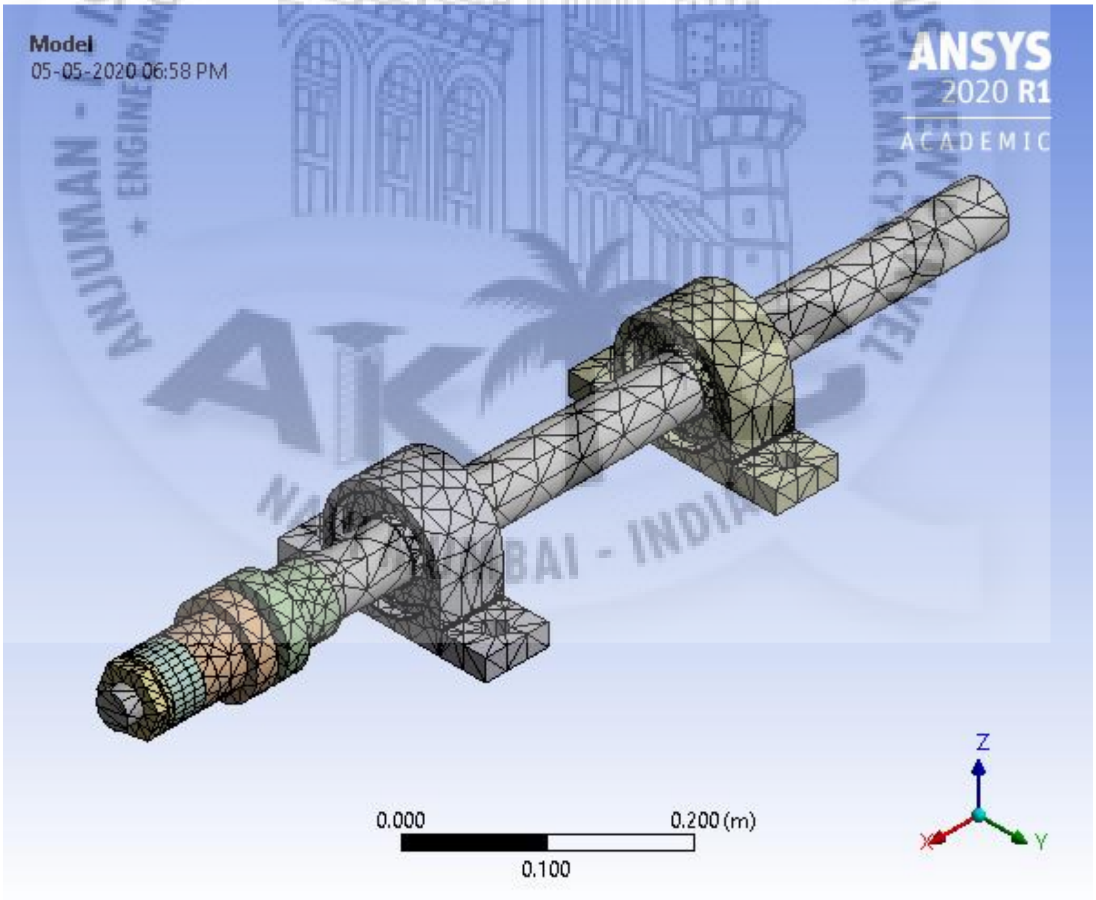
Alloy Steel > Isotropic Relative Permeability

Relative Permeability
10000

7.2. SECONDARY SHAFT ANALYSIS :-

Project*

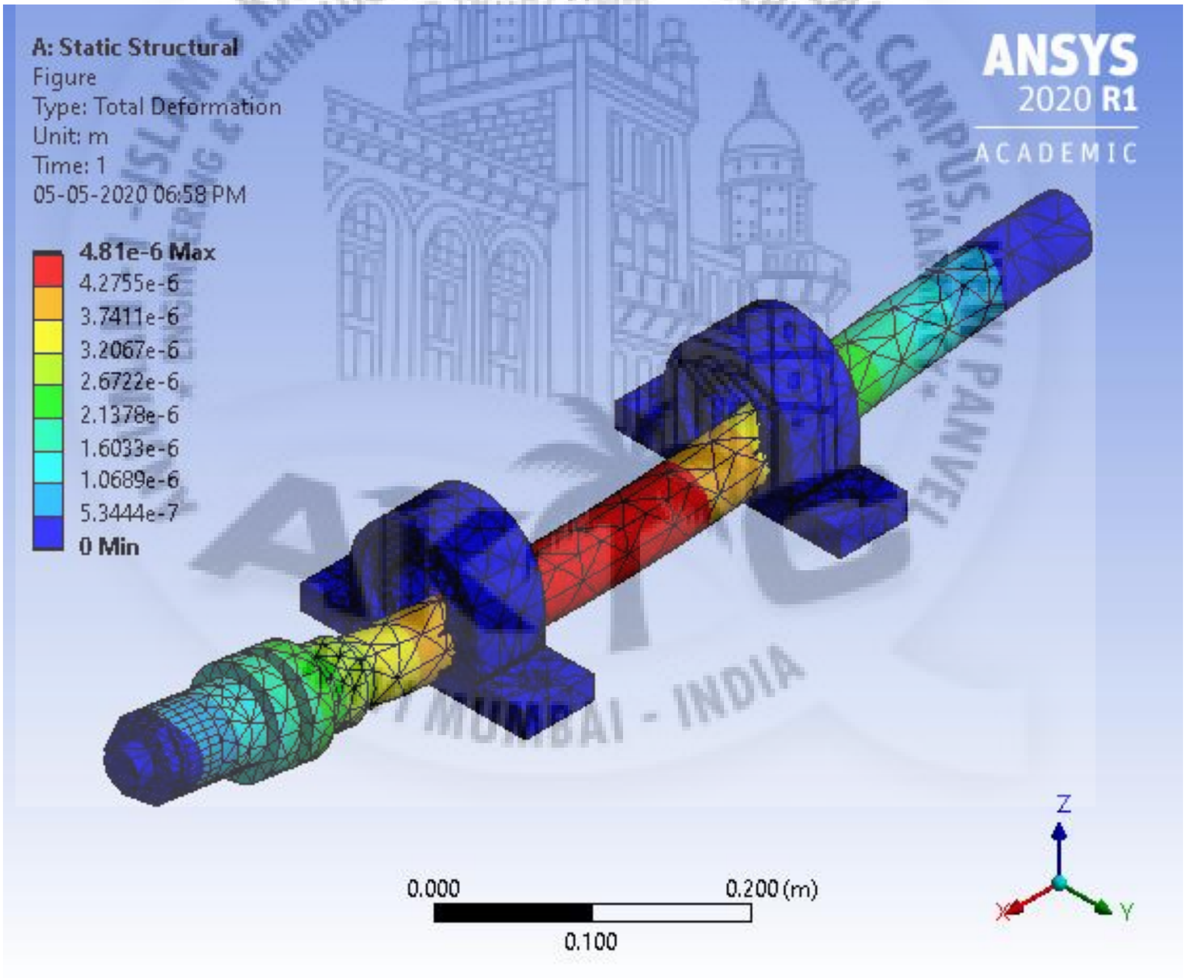
First Saved	Tuesday, May 5, 2020
Last Saved	Tuesday, May 5, 2020
Product Version	2020 R1
Save Project Before Solution	No
Save Project After Solution	No



Model (A4) > Static Structural (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [m]	Maximum [m]	Average [m]
1.	0.	4.81e-006	5.7029e-007

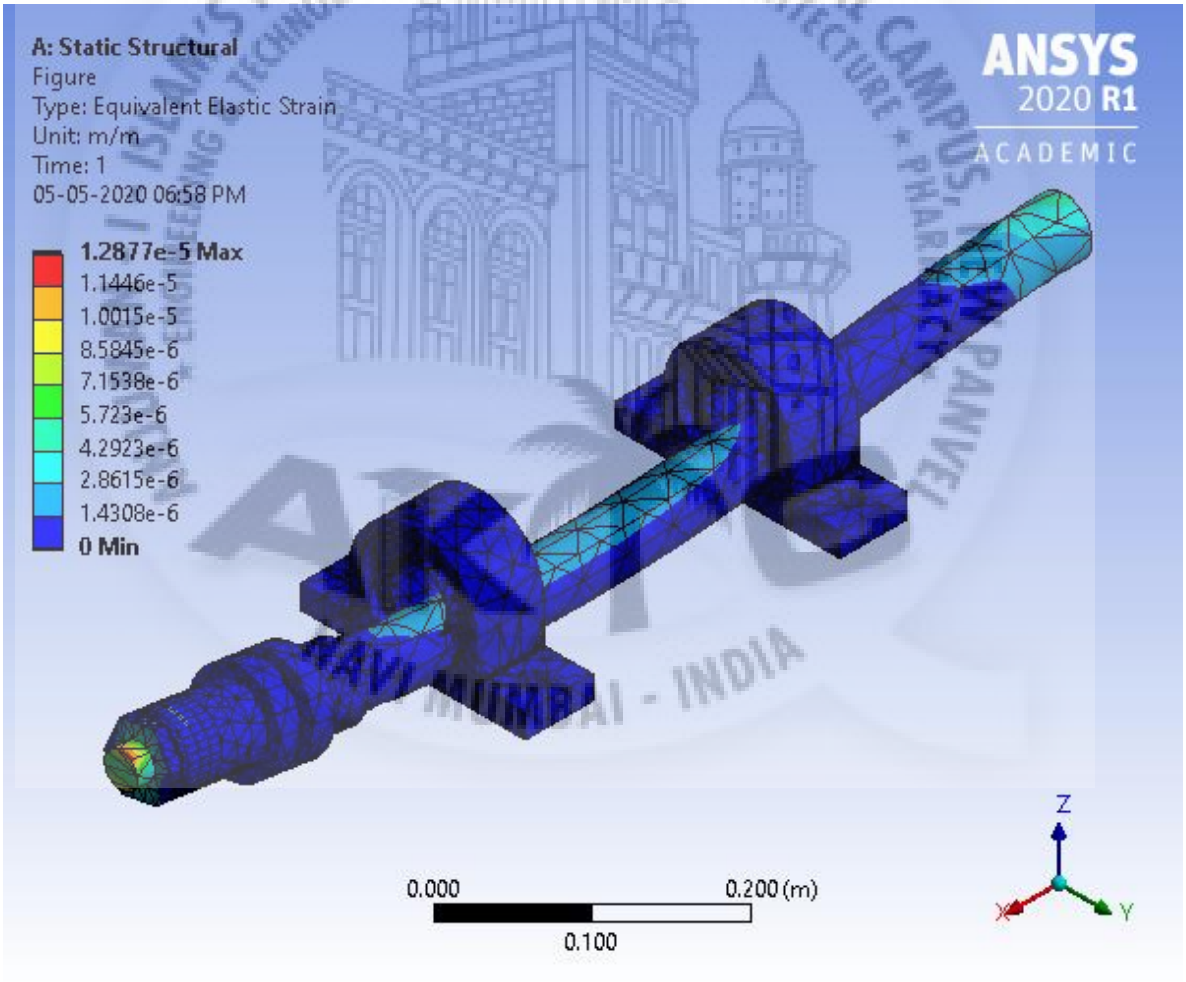
Model (A4) > Static Structural (A5) > Solution (A6) > Total Deformation > Figure



Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Elastic Strain

Time [s]	Minimum [m/m]	Maximum [m/m]	Average [m/m]
1.	0.	1.2877e-005	2.1793e-007

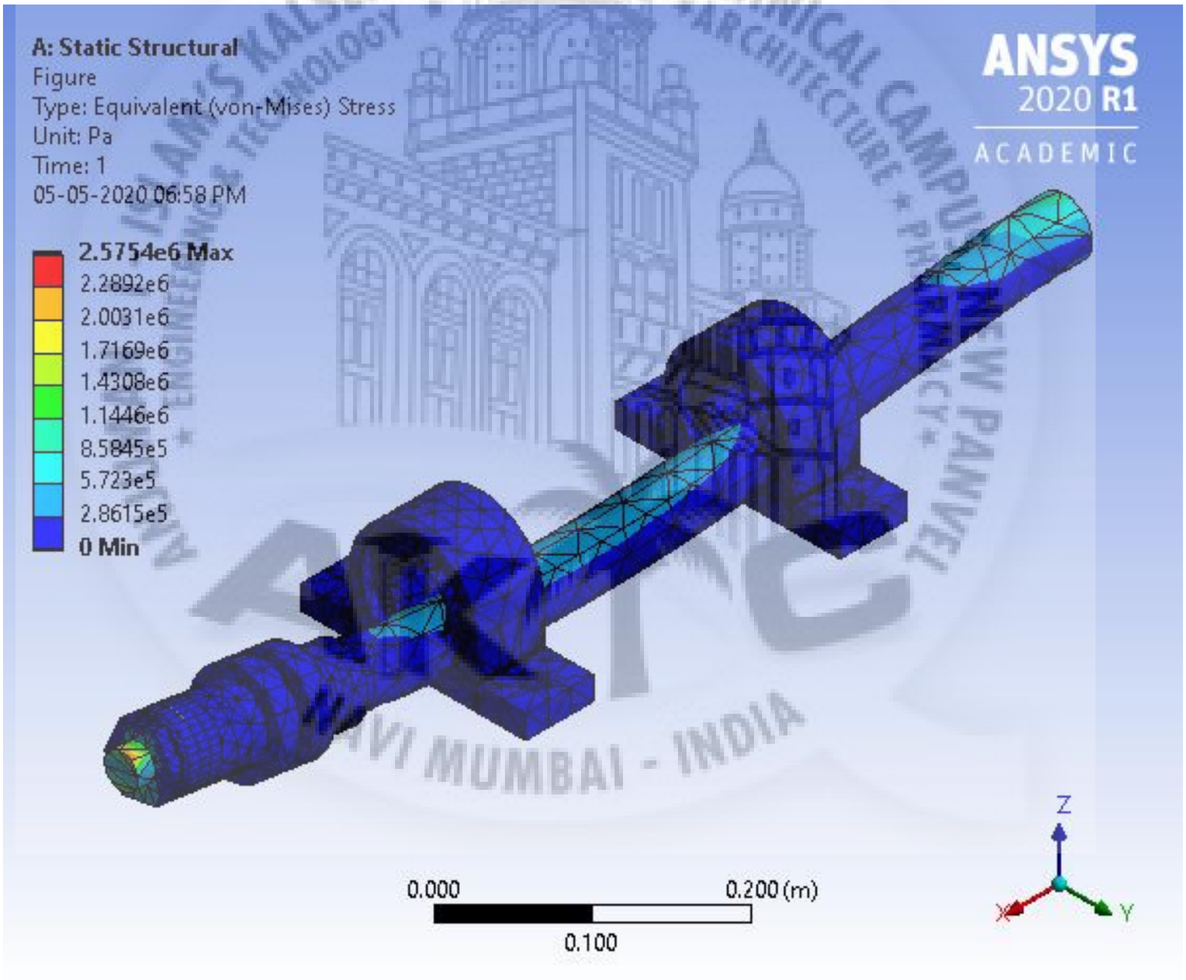
Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Elastic Strain > Figure



Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Stress

Time [s]	Minimum [Pa]	Maximum [Pa]	Average [Pa]
1.	0.	2.5754e+006	37666

Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Stress > Figure



Material Data

Alloy Steel

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Specific Heat	434 J kg^-1 C^-1
Thermal Conductivity	60.5 W m^-1 C^-1
Resistivity	1.7e-007 ohm m

Alloy Steel > Colour

Red	Green	Blue
132	139	179

Alloy Steel > Compressive Ultimate Strength

Compressive Ultimate Strength Pa
0

Alloy Steel > Compressive Yield Strength

Compressive Yield Strength Pa
2.5e+008

Alloy Steel > Tensile Yield Strength

Tensile Yield Strength Pa
2.5e+008

Alloy Steel > Tensile Ultimate Strength

Tensile Ultimate Strength Pa
4.6e+008

Alloy Steel > Isotropic Secant Coefficient of Thermal Expansion

Zero-Thermal-Strain Reference Temperature C
22

Alloy Steel > S-N Curve

Alternating Stress Pa	Cycles	Mean Stress Pa
3.999e+009	10	0
2.827e+009	20	0
1.896e+009	50	0
1.413e+009	100	0
1.069e+009	200	0
4.41e+008	2000	0
2.62e+008	10000	0

2.14e+008	20000	0
1.38e+008	1.e+005	0
1.14e+008	2.e+005	0
8.62e+007	1.e+006	0

Alloy Steel > Strain-Life Parameters

Strength Coefficient Pa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient Pa	Cyclic Strain Hardening Exponent
9.2e+008	-0.106	0.213	-0.47	1.e+009	0.2

Alloy Steel > Isotropic Elasticity

Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa	Temperature C
2.e+011	0.3	1.6667e+011	7.6923e+010	

Alloy Steel > Isotropic Relative Permeability

Relative Permeability
10000

CHAPTER 8 :-

CALCULATION

8.1. WORKPIECE CALCULATIONS :-

Calculations of force applied on Workpiece :-

Calculations:-

Material:-C15

Tensile strength:-340 N/mm^2

F.O.S:-1

Bending strength :- 1.2*340 = 408 N/mm^2

Diameter of Workpiece :- 10mm

M = $\frac{\pi}{32} \times \sigma_b \times d^3$

Where,

M = Bending Moment.

σ_b = Allowable Bending Stress.

D = Diameter of workpiece.

M= $\frac{\pi}{32} \times 408 \times 10^3$

M = $40055.30\ Nmm$

M_d = 1.2×M M_d = Design Moment.

M_d =1.2×40055.30

M_d = 48066.36 Nmm.

$M_d = F_a \times L_l$

Where,

M_d = Design Moment

F_a = Applied Force

L_l =Length of Lever

Here length of lever is not fixed and can be varied from 450,500,600,700 and 800mm.

Where L_l = 450mm

$48066.36 = F_a \times 450$

F_a = 107 N

Where L_l = 500mm

F_a = 96 N

Where L_l = 600mm

F_a = 80 N

Where L_l = 700mm

F_a = 69 N

Where L_l = 800mm

F_a = 60 N

Material :- C10

Tensile strength :- 500 N/mm^2

F.O.S :- 1

Bending strength :- 1.2*500=600 N/mm^2

Diameter of Workpiece :- 10mm

M = $\frac{\pi}{32} \times \sigma_b \times d^3$

Where,

M = Bending Moment.

σ_b = Allowable Bending Stress.

D = Diameter of workpiece.

M = $\frac{\pi}{32} \times 600 \times 10^3$

M = $58904.86\ Nmm$

M_d = 1.2×M, M_d =Design Moment.

M_d = 1.2×58904.86

M_d = 70685.83 Nmm.

$M_d = F_a \times L_l$

Where,

M_d = Design Moment

F_a = Applied Force

L_l = Length of Lever

Here length of lever is not fixed and can be varied from 450,500,600,700 and 800mm.

Where L_l = 600mm

F_a = 118 N

Where L_l = 700mm

F_a = 101 N

Where L_l = 800mm

F_a = 88 N

Material :- C45

Tensile strength :- 620 N/mm^2

F.O.S :- 1

Bending strength :- 1.2*620=744 N/mm^2

Diameter of Workpiece :- 10mm

M = $\frac{\pi}{32} \times \sigma_b \times d^3$

Where,

M = Bending Moment.

σ_b = Allowable Bending Stress.

D = Diameter of workpiece.

M = $\frac{\pi}{32} \times 744 \times 10^3$

M= $73042.02\ Nmm$

$M_d = 1.2 \times M$, M_d = Design Moment.

$M_d = 1.2 \times 73042.02$

M_d = 87650.43 Nmm.

$M_d = F_a \times L_l$

Where,

M_d=Design Moment

F_a=Applied Force

L_l=Length of Lever

Here length of lever is not fixed and can be varied from 450,500,600,700 and 800mm.

Where L_l = 700mm

F_a = 125 N

Where L_l = 800mm

F_a = 110 N

Material :- C20

Tensile strength :- 580 N/mm^2

F.O.S :- 1

Bending strength :- 1.2*580=696 N/mm^2

Diameter of Workpiece :- 10mm

M = $\frac{\pi}{32} \times \sigma_b \times d^3$

Where,

M = Bending Moment.

σ_b = Allowable Bending Stress.

D = Diameter of workpiece.

M = $\frac{\pi}{32} \times 696 \times 10^3$

M $= 68329.60\ Nmm$

$M_d = 1.2 \times M$, M_d = Design Moment.

$M_d = 1.2 \times 68329.60$

M_d = 81995.56 Nmm.

$M_d = F_a \times L_l$

Where,

M_d = Design Moment

F_a = Applied Force

L_l = Length of Lever

Here length of lever is not fixed and can be varied from 450,500,600,700 and 800mm.

Where L_l = 700mm

F_a = 117 N

Where L_l = 800mm

F_a = 103 N

Material :- Al6082 Aluminium bar

Tensile strength :- 295 N/mm^2

F.O.S :- 1

Bending strength :- 1.2*295=354 N/mm^2

Diameter of Workpiece :- 10mm

$$M = \frac{\pi}{32} \times \sigma_b \times d^3$$

Where,

M = Bending Moment.

σ_b = Allowable Bending Stress.

D = Diameter of workpiece.

$$M = \frac{\pi}{32} \times 354 \times 10^3$$

$M = 34753.868\ Nmm$

$M_d = 1.2\times M$, M_d =Design Moment.

$M_d = 1.2\times 34753.868$

$M_d = 41704.642$ Nmm.

$M_d = F_a \times L_l$

Where,

M_d = Design Moment

F_a = Applied Force

L_l = Length of Lever

Here length of lever is not fixed and can be varied from 450,500,600,700 and 800mm.

Where L_l = 450mm

41704.642 = $F_a \times 450$

F_a = 93 N

Where L_l = 500mm

F_a = 83 N

Where L_l = 600mm

F_a = 69.5 N

Where L_l = 700mm

F_a = 60 N

Where L_l = 800mm

F_a = 52 N

For Diameter of Workpiece :- 12mm

$$M = \frac{\pi}{32} \times \sigma_b \times d^3$$

$$M = \frac{\pi}{32} \times 354 \times 12^3$$

$M = 60054.68\ Nmm$

$M_d = 1.2 \times M$, M_d = Design Moment.

$M_d = 1.2 \times 60054.68$

$M_d = 72065.62$ Nmm.

$M_d = F_a \times L_l$

Where $L_l = 600$mm

$72065.62 = F_a \times 600$

$F_a = 120$ N

Where $L_l = 700$mm

$F_a = 103$ N

Where $L_l = 800$mm

$F_a = 90$ N

An average human can apply a maximum force of 130N.

8.2. SHAFT CALCULATIONS :-

MATERIAL:-

Taking Material For Shaft As EN24 Alloy Steel.

Ultimate Tensile Strength:- 850 N/mm^2.

Factor Of Safety :- 6.

Tensile Stress :- 141.66 N/mm^2.

Shear stress :- 70.83 N/mm^2.

In designing shafts on the basis of strength, the following cases may be considered :-

1. Shaft subjected to Bending moment.
2. Shaft subjected to Torque.
3. Shaft subjected to combination of torque and bending moment.

Calculations:-

1. Shaft subjected to Bending moment.

$F_a = 130$ N

$L_s = 840$ mm

$M = F_a \times L_s$

M :- Bending Moment

F_a :- Applied Force

L_s :- Length of Shaft

M = 130 x 840

$M = 109200$ Nmm

$M = \frac{WL_s}{4}$, where W Is load on shaft

$109200 = W x 840/4$

$W = 520$ N

$M = \frac{\pi}{32} \times \sigma_b \times d^3$

σ_b :- Bending Stress

d :- diameter of shaft

$109200 = \pi/32 \times \sigma_b \times 50^3$

$\sigma_b = 8.89$ N/mm^2 $< \sigma_t$, Design is Safe

2. Shaft subjected to Torque.

$\tau = \frac{16T}{\pi d^3}$

T :- Twisting moment acting upon the shaft

d :- Diameter of shaft

$T = F_a \times L_L$

F_a :- Applied force=130 N

L_L :- length of lever=800 mm

$T = 130\times 800$

$T = 104000$ Nmm.

$\tau = \frac{16\times104000}{\pi\times50^3}$=4.237 N/$mm^2 < \tau_{allowable}$,Design is Safe.

3. Shaft subjected to combination of torque and bending moment.

By using Maximum Shear Stress Theory

$T_{eq} = \sqrt{M^2 + T^2}$

M :- Bending moment.

T :- Torque Acting on shaft.

$T_{eq} = \sqrt{(109200)^2 + (104000)^2}$

$T_{eq} = 150800$ Nmm.

$\tau_{max} = \frac{T_{eq}\times r}{\frac{\pi}{32}\times d^4}$

$\tau_{max} = \frac{150800\times25}{\frac{\pi}{32}50^4}$

τ_{max} = 6.1441 N/mm$^2 < \pi_{allowable}$, design is safe.

By using maximum principal stress theory

$\sigma = \frac{16}{\pi d^3}\times M_{eq}$

M_{eq} = Equivalent Moment.

$M_{eq} = M + \sqrt{M^2 + T^2}$

$M_{eq} =$ 260000 Nmm

$$\sigma = \frac{16}{\pi \times 50^3} \times (260000)$$

$\sigma = 10.59$ N/mm^2 $< \sigma_t$, Design is safe.

A.S.M.E. Code:-

As there is dynamic loading occurring on the shaft as the applied force is not constant so the shaft will be subjected to shock and fatigue, so the bending and twisting moment is to be multiplied by factors K_b and K_t, equivalent torque and equivalent moment will become,

(where $K_b = 1.5$ and $K_t = 1$ are the service factors for gradually applied load)

Where, T_e = Equivalent Torque , M_e = Equivalent Moment.

$$T_e = \sqrt{K_b M^2 + K_t T^2}$$

$$T_e = \sqrt{1.5(109200)^2 + 1(104000)^2}$$

$$T_e = 1.6941 \times 10^5\ Nmm.$$

$$M_e = \left[K_b M + \sqrt{K_b M^2 + K_t T^2}\right]$$

$$M_e = [1.5 \times 109200 + 1.6941 \times 10^5]$$

$$M_e = 3.3321 \times 10^5\ Nmm.$$

CHAPTER 9 :-

COST ESTIMATION

SR NO	DESCRIPTION	QUANTITY IN PEICE	UNIT PRICE	TOTAL PRICE
1.	M.S. Frame	3	1170	3510
2.	Shaft	1	3600	3600
3.	Shaft Holder	6	1000	6000
4.	Hydraulic Bottle Jack.	1	1000	1000
5.	Ratchet	1	1450	1450
6.	Adjustable Handle	1	2500	2500
7.	Nuts And Bolts	20	-	200
8.	Washer And Fittings	20	-	200
9.	Sleeve	2	60	120
10.	Mandrel	1	-	1000
11.	Others	-	-	2000

CHAPTER 10 :-

CONCLUSION

Our Model “The roll bending machine with ratchet mechanism” is very much acceptable. We brought about every possible replacement & carried out every calculation required for proving our model perfect. The components of the machine are of the best quality with the use of suitable materials. Ratchet spanner is used to cause the turning action of the main shaft. Hydraulic bottle jack carries the load of the machine & allows the vertical movement. Shaft holders provide proper support to the shaft. Proper dimensions are used to design the model. Design is developed into a 3D model & analyzed using 3D software’s (Inventor & Ansys). Force is calculated, that is to be applied by an average human on the ratchet lever to turn the shaft & bend the workpiece. Failure checking is done for, when the shaft is subjected to bending moment, torque & combination of torque & bending moment ensuring no damage to the shaft during the operation. The model is completely reliable & safety is guaranteed.

While the world runs on electricity we designed a model free from electricity, efficient enough for producing quality work at low cost. The machine is completely manual, easy to use & very well structured. It is capable of fulfilling every requirement of any present model of bending machine with its amazing performance & simplified design, giving us an edge to compete in the marketing world.

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GLOSSARY

- ISO STANDARD :- The International Organization for Standardization (ISO) is an international standard-setting body composed of representatives from various national standards organizations.
- EN24T :- EN24T steel is a popular grade of through-hardening alloy steel due to its excellent machinability in the "T" condition. EN24T is used in components such as gears, shafts, studs and bolts, its hardness is in the range 248/302 HB.
- ASTM STANDARD :- ASTM International, formerly known as American Society for Testing and Materials, is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.
- SAE SANTADARD :- SAE International, previously known as the Society of Automotive Engineers, is a U.S.-based, globally active professional association and standards developing organization for engineering professionals in various industries.
- HYDRAULIC JACK :- A hydraulic jack is a device that is used to lift heavy loads by applying a force via a hydraulic cylinder. Hydraulic jacks lift loads using the force created by the pressure in the cylinder chamber.
- RATCHET SPANNER :- A ratchet spanner uses a mechanism which allows an open-ended, flare or ring head to turn a fastener

in one direction but not the other while remaining fitted to the fastener head.

- FASTENERS :- A fastener or fastening is a hardware device that mechanically joins or affixes two or more objects together. In general, fasteners are used to create non-permanent joints.
- BEAMS :- Beams are metal bars shaped to minimize sectional area and maximize load. They are mostly used to support structures in civil engineering, construction, heavy machinery, truck construction, and general heavy duty applications.

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