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FABRICATION AND TESTING OF ELECTROMAGNETIC CRANE WITH FIVE MECHANISMS

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ABSTRACT:

Most of the fabrication / manufacturing industries like Heat Exchangers, Railway coach building, material handling and heavy machinery uses overhead cranes to handle different metallic objects/ materials like shells, boxes, larger diameter pipes, thick plates etc. These cranes require additional man power and time for slinging operation.

Apart from shells, pipes and boxes, handling of thick large metallic plate is one of the most difficult activities as it needs to be lifted manually from one end for tying with crane slings and hooking to overhead crane.

Metallic objects / are to be transported to various places in the factory for processing them to make final product, lifting and tying of metallic objects with crane slings has to be performed many times during manufacturing process, which is one of the time consuming/risky process.

The fabrication and testing of an electromagnetic overhead crane are carried out with following mechanisms.

1. Long Travel
2. Short Travel
3. Column Rotation
4. Lifting
5. Grab and Electro Magnet.

1. INTRODUCTION:

An overhead crane, commonly called a bridge crane, is a type of crane found in industrial environments. An overhead crane consists of parallel runways with a traveling bridge spanning the gap. A hoist, the lifting component of a crane, travels along the bridge. If the bridge is rigidly supported on two or more legs running on a fixed rail at ground level, the crane is called a gantry crane (USA, ASME B30 series) or a Goliath crane (UK, BS466).

Unlike mobile or construction cranes, overhead cranes are typically used for either manufacturing or maintenance applications, where efficiency or downtime are critical factors.

Most of the fabrication/manufacturing industries like Heat Exchangers, Railway coach building, material handling and heavy machinery uses overhead cranes to handle different metallic objects/materials like shells, boxes, larger diameter pipes, thick plates etc. These cranes require additional man power and time for slinging operation.

Electromagnetic overhead crane will have mechanisms namely long travel, short travel, column rotation, lifting grab and electromagnet so that it can easily lift all magnetic like mild steel plates, pipes and boxes. This crane also requires very less man power and time.

2. LITERATURE REVIEW

CRANE:

A Crane is a type of machine, generally equipped with a hoist rope, wire ropes or chains, and sheaves, that can be used both to lift and lower materials and to move them horizontally. It is mainly used for lifting heavy things and transporting them to other places. The device uses one or more simple machines to create mechanical advantage and thus move loads beyond the normal capability of a human. Cranes are commonly employing in the transport industry for the loading and unloading of freight, in the construction industry for the movement of materials, and in the manufacturing industry for the assembling of heavy equipment.

The first known crane machine was the Shadouf, a water-lifting device that was invented in ancient Mesopotamia (modern iraq) and then appeared in the ancient Egyptian technology. Construction cranes later appeared in ancient Greece, where they were powered by men or animals (such as donkeys), and used for the construction of buildings. Larger cranes were later developed in the Roman Empire, employing the use of human tread-wheels, permitting the lifting of heavier weights. In the high middle ages, harbor cranes were introduced to load and unload ships and assist with their construction- some were built into stone towers for extra strength and stability. The earliest cranes were constructed from wood, but cast iron, iron and steel took over with the coming of the Industrial Revolution.

3. OBJECTIVES:

3.1 -Time required for holding and un holding the metallic objects should be very less.

3.2 -The crane should require only one person to operate it.

3.3- Metallic Objects like plates, shells, boxes and pipes should be easily handled.

4. MATERIALS USED:

4.1-ANGLE ROD:

Angle bar,also known as “L-Bar”,” L-Bracket” or “Angle iron” is a metal in the form of a right angle. Steel angle bar is the most widely used structural steel by the construction industry because of its very economical cost. Structural steel angels are manufactured by rolling pre-heated blooms to form an angle shape. We make sure our angle bars are produced under strict quality controls conforming to ASTM A36 specification. We offer equal and unequal angle steels according to the depth of legs and depending on the customer’s requirement. Steel angle bars are necessary for building power tower, trusses for roofing, communication tower, engineering projects, billboards and other steel structure buildings.

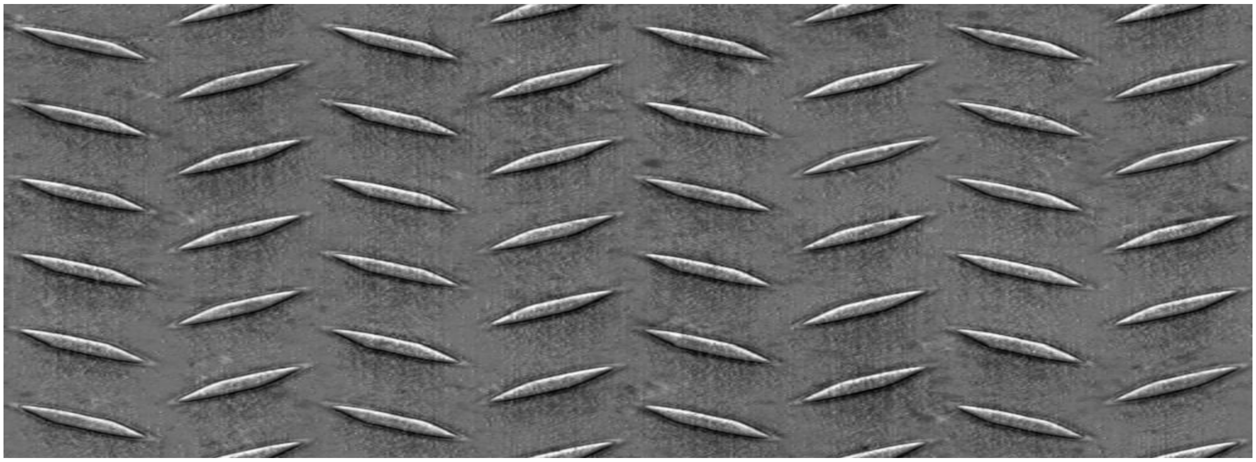
Steel angle bars could also be found in our everyday life like industrial shelves, classical coffee table, chairs, sheds and son on, apart from industrial and engineering applications. An angle bar is a steel material which is an angle shape with inside radius corners that is ideal for all structural applications.an angle bar is also used to turn the web when feeding from the side, or to bypass the former folder. Angle bar is also used on ribbon folders.

4.2-SQUARE ROD:

Made from High grade mild steel, our square shaped rods are appreciated for their excellent finish, optimum strength, and high corrosion resistance.

Square rod made of mild steel square rods in different lengths and thickness.

4.3-PLATES:



Metal plates are thick slabs of metal that are normally used for structural purposes. Available from continental steel in a number of different materials, plates are usually cut as their size makes them difficult to shape or bend.

Mild steel plate is a structural quality steel plate used for a large variety of general construction and industrial applications.

5. PROPERTIES OF MATERIALS:

Steel is made up of carbon and iron,with much more iron than carbon .infact ,at the most, steel can have about 2.1 percent. Mild steel is one of the most commonly used construction materials. It is very strong and can be made from readily available natural materials. It is known as mild steel because of its relatively low carbon content. Chemistry: Mild steel usually contains 40 points of carbon at most. One carbon point is .01 per cent of carbon in the steel. This means that it has at most .4 per cent carbon. Most steels have other alloying elements other than carbon to give them certain desirable mechanical properties. 1018 steel, a common type of mild steel, contains approximately .6 per cent to .9 per cent manganese, up to .04 per cent phosphorus, and up to .05 per cent sulphur. Varying these chemicals affects properties such as corrosion resistance and strength. Physical Properties: Strength Mild steel is very strong due to the low amount of carbon it contains. In materials science, strength is a complicated term. Mild steel has a high resistance to breakage. Mild steel, as opposed to higher carbon steels, is quite malleable, even when cold. This means it has high tensile and impact strength. Higher carbon steels usually shatter or crack under stress, while mild steel bends or deforms.

6. MECHANISMS OF CRANE:

Crane is a mechanism that uses a simple set of lifting and lowering objects the machine and to move in the horizontal direction. They are always equipped with at least one winding; cables, ropes or chains; and pulleys. Both pulleys and winder are a form of a pulley.

6.1-LIFTING

Cranes may use a combination of simple, to get the advantage and lifting machines, mechanical objects. A first lever which is used in the balance-style crane. Girder overhead crane is balanced on a fulcrum that allows you to lift heavy objects with fewer forces. The second style jib crane, which uses pulleys to achieve a mechanical advantage (but note that all cranes use pulleys - in this case, the pulleys are the main source of mechanical advantage). A third method of the crane can lift the objects by a hydraulic cylinder, either directly or by feeding or balance the antenna.

6.2-HORIZONTAL MOVEMENT:

The horizontal movement of the crane can be done one of two ways. First, to install all the device on a rotating axis, and a swing arm or around a supporting beam. This is very common in mobile cranes and derricks used in some building. The second method is to roll the load back and forth on rails along the pen itself. This is very common in stationary cranes in ports and railway stations.

6.3-STABILITY:

A final consideration in the operation of cranes is stability. The crane is stable when the sum of all movements on the basis of zero. In practice this means that the size of the nominal load the tap must be less than what would be necessary to tilt the valve. In the United States, the mobile crane can pick up only 85 per cent of what it would take to tip the crane bowl. This stock should take into account the potential of the mobile crane happens to sit instability.

6.4-MOTORS:

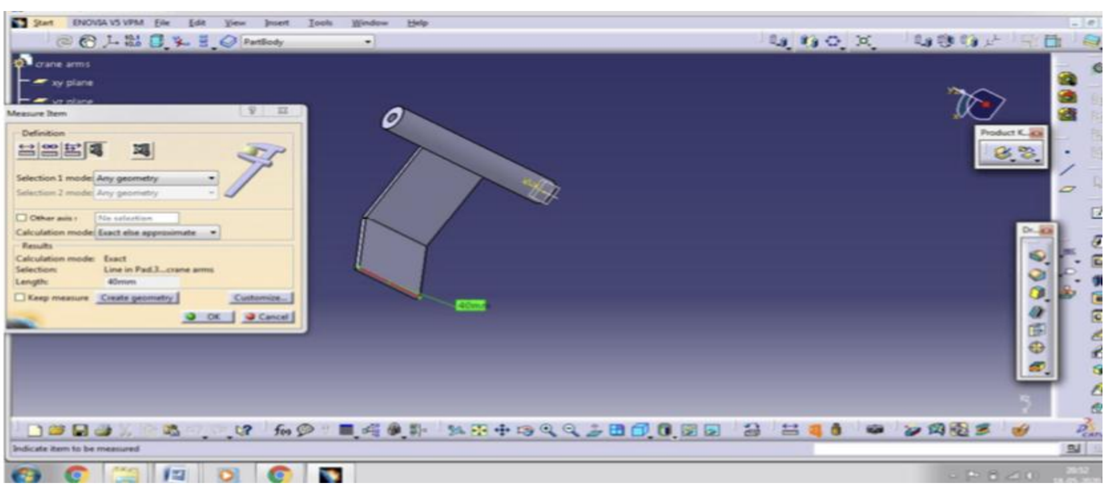
An electric motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque applied on the motor's shaft. Electric motors can be powered by direct current (DC) sources, such as from batteries, motor vehicles or rectifiers, or by alternating current (AC) sources, such as a power grid, inverters or electrical generators. An electric generator is mechanically identical to an electric motor, but operates with a reversed flow of power, converting mechanical energy into electrical energy. Electric motors may be classified by considerations such as power source type, internal construction, application and type of motion output. In addition to AC versus DC types, motors may be brushed or brushless, may be of various phase (see singlephase, two-phase, or three-phase), and may be either air-cooled or liquid-cooled. General-purpose motors with standard dimensions and characteristics provide convenient mechanical power for industrial use. The largest electric motors are used for ship propulsion, pipeline compression and pumped-storage applications with ratings reaching 100 megawatts. Electric motors are found in industrial fans, blowers and pumps, machine tools, household appliances, power tools and disk drives. Small motors may be found in electric watches. In certain applications, such as in regenerative braking with traction motors, electric motors can be used in reverse as generators to recover energy that might otherwise be lost as heat and friction. Electric motors produce linear or rotary force (torque) intended to propel some external mechanism, such as a fan or an elevator. An electric motor is generally designed for continuous rotation, or for linear movement over a significant distance compared to its size. Magnetic solenoids produce significant mechanical force, but over an operating distance comparable to their size. Transducers such as loudspeakers and microphones convert between electrical current and mechanical force to reproduce signals such as speech. When compared with common internal combustion engines (ICEs), electric motors are lightweight, physically smaller, provide more power output, are mechanically simpler and cheaper to build, while providing instant and consistent torque at any speed, with more responsiveness, higher overall efficiency and lower heat generation. However, electric motors are not as convenient or common as ICEs in mobile applications (i.e. cars and buses) as they require a large and expensive battery, while ICEs require a relatively small fuel tank.

6.5-ELECTROMAGNETISM:

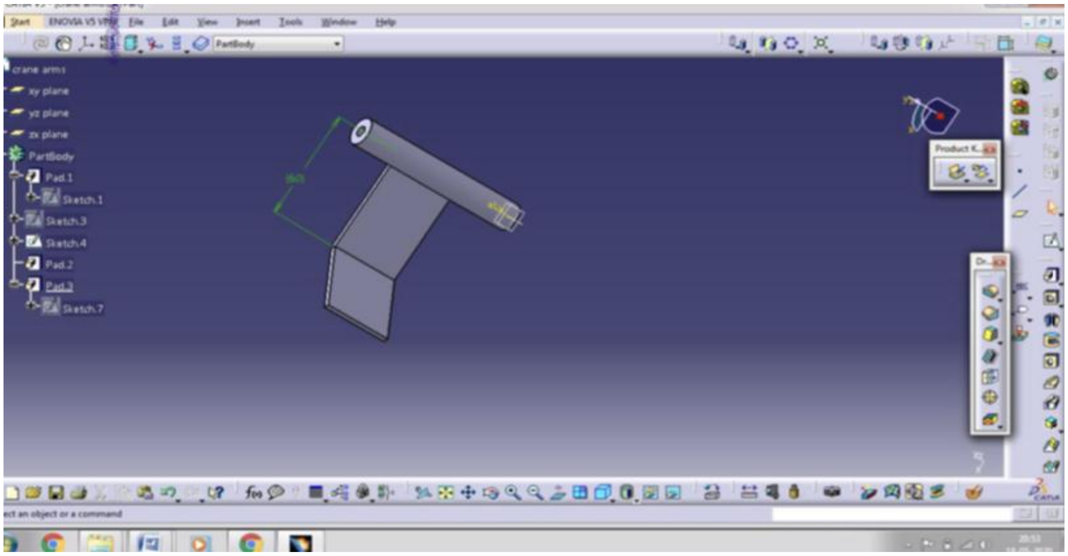
Electromagnetism is a branch of physics involving the study of the electromagnetic force, a type of physical interaction that occurs between electrically charged particles. The electromagnetic force is carried by electromagnetic fields composed of electric fields and magnetic fields, and it is responsible for electromagnetic radiation such as light. It is one of the four fundamental interactions (commonly called forces) in nature, together with the strong interaction, the weak interaction, and gravitation. At high energy the weak force and electromagnetic force are unified as a single electroweak force. Electromagnetic phenomena are defined in terms of the electromagnetic force, sometimes called the Lorentz force, which includes both electricity and magnetism as different manifestations of the same phenomenon. The electromagnetic force plays a major role in determining the internal properties of most objects encountered in daily life. The electromagnetic attraction between atomic nuclei and their orbital electrons holds atoms together. Electromagnetic forces are responsible for the chemical bonds between atoms which create molecules, and intermolecular forces. The electromagnetic force governs all chemical processes, which arise from interactions between the electrons of neighboring atoms. There are numerous mathematical descriptions of the electromagnetic field. In classical electrodynamics, electric fields are described as electric potential and electric current. In Faraday's law, magnetic fields are associated with electromagnetic induction and magnetism, and Maxwell's equations describe how electric and magnetic fields are generated and altered by each other and by charges and currents. The theoretical implications of electromagnetism, particularly the establishment of the speed of light based on properties of the "medium" of propagation (permeability and permittivity), led to the development of special relativity by Albert Einstein in 1905.

7. DESIGN:

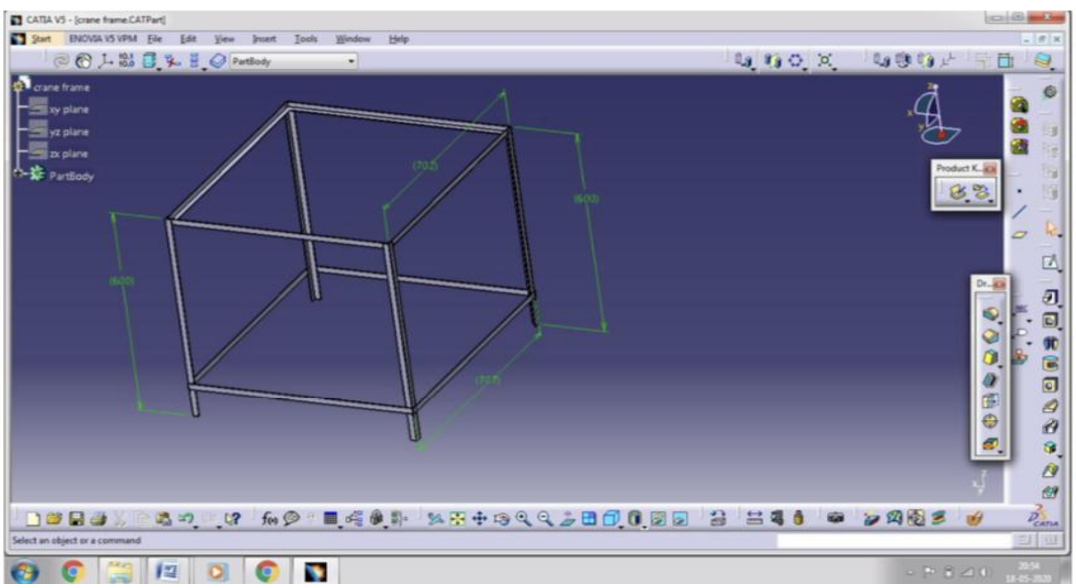
7.1-HOLDING ARM DESIGN-1



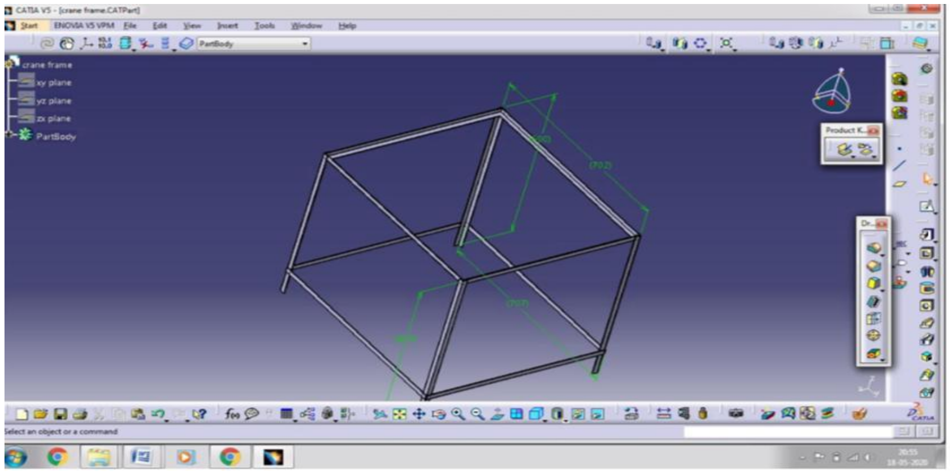
7.2- HOLDING ARM DESIGN –2



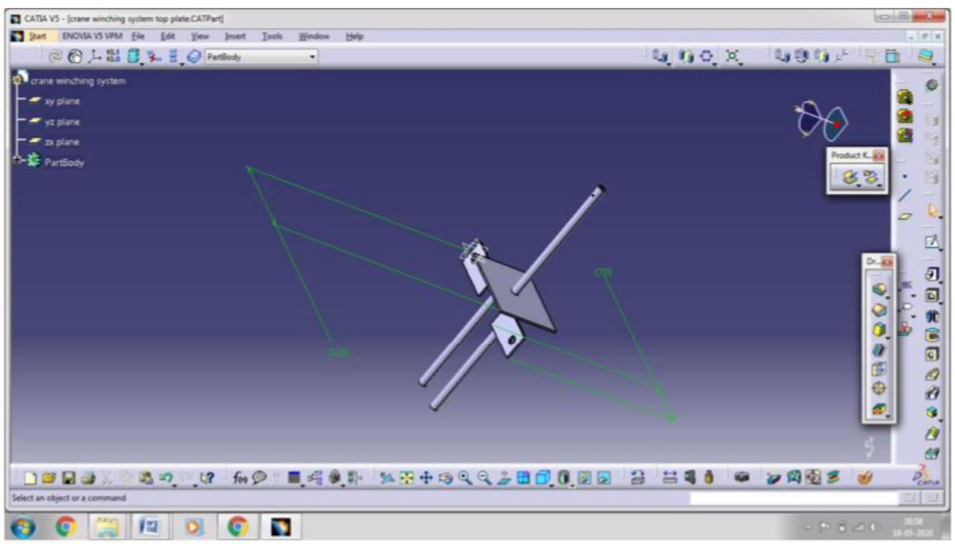
7.3-CRANE FRAME DESIGN –1



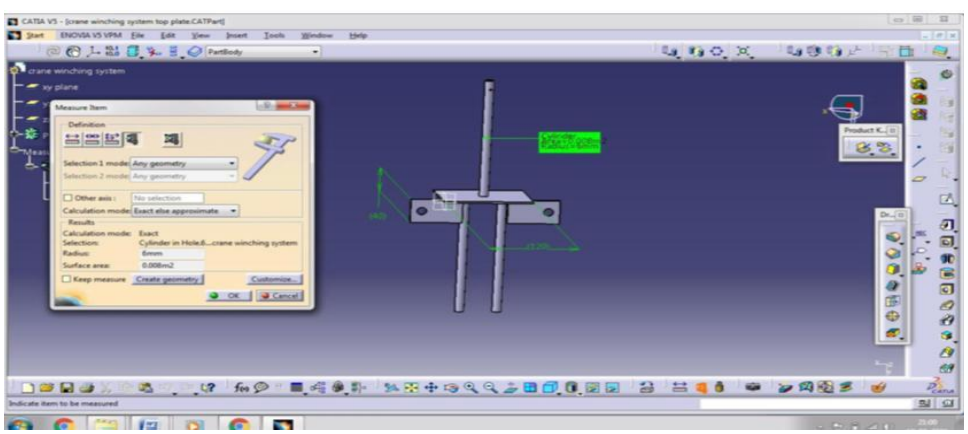
7.4-CRANE FRAME DESIGN –2



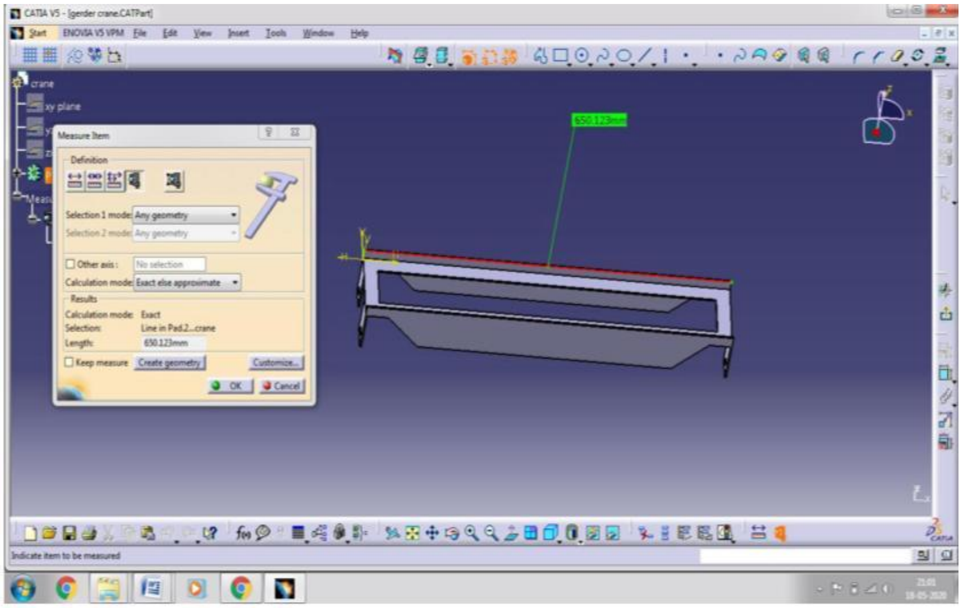
7.5-CRANE WINCH TOP PLATFORM DESIGN –1



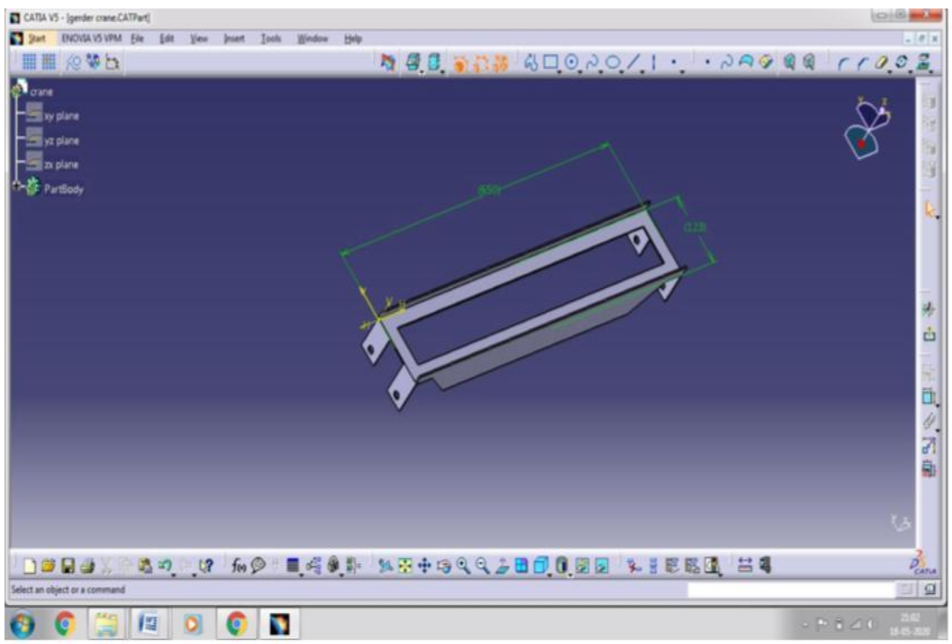
7.6- CARNE WINCH TOP PLATFORM DESIGN-2



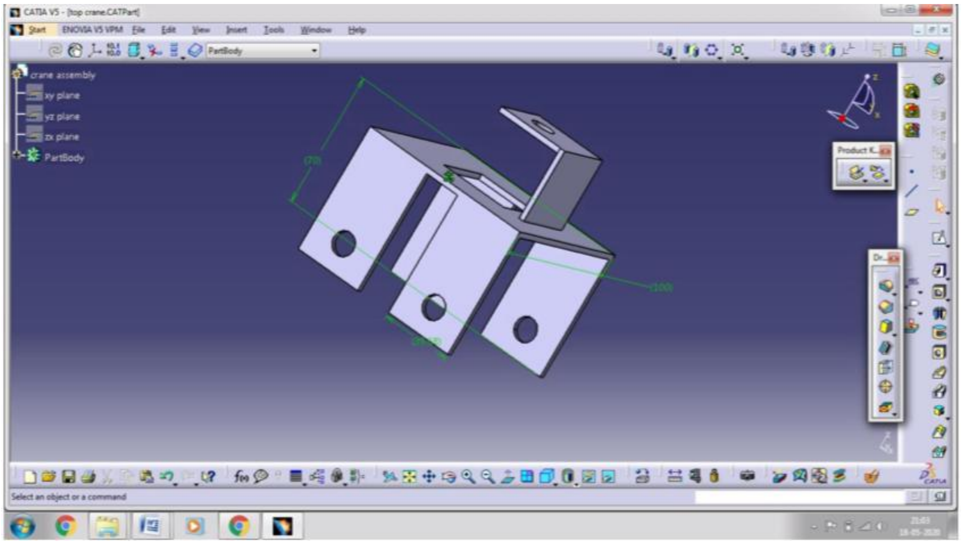
7.7-GIRDER DESIGN-1



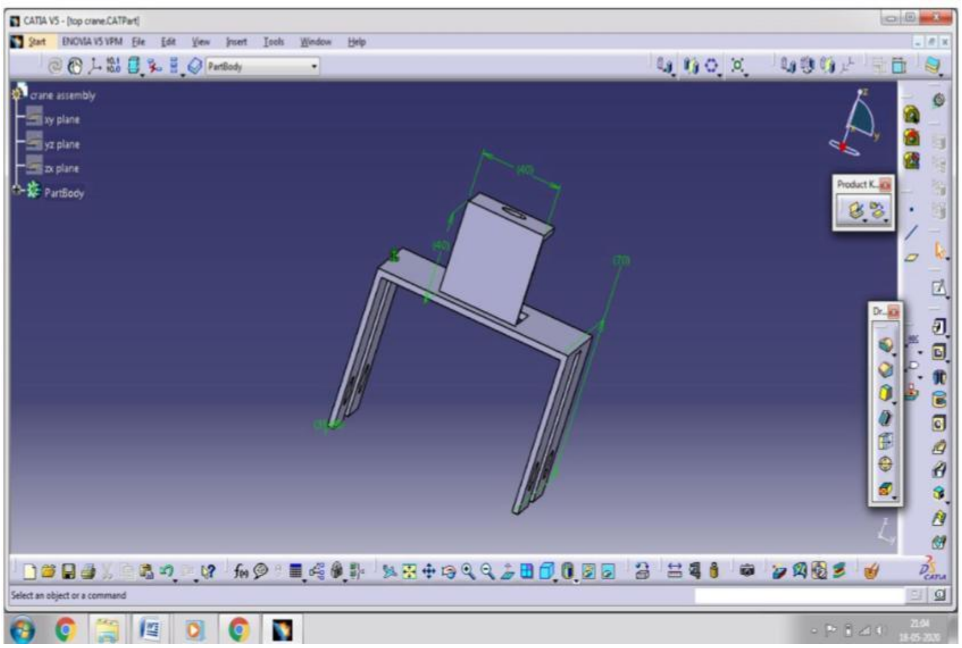
7.8-GIRDER DESIGN-2



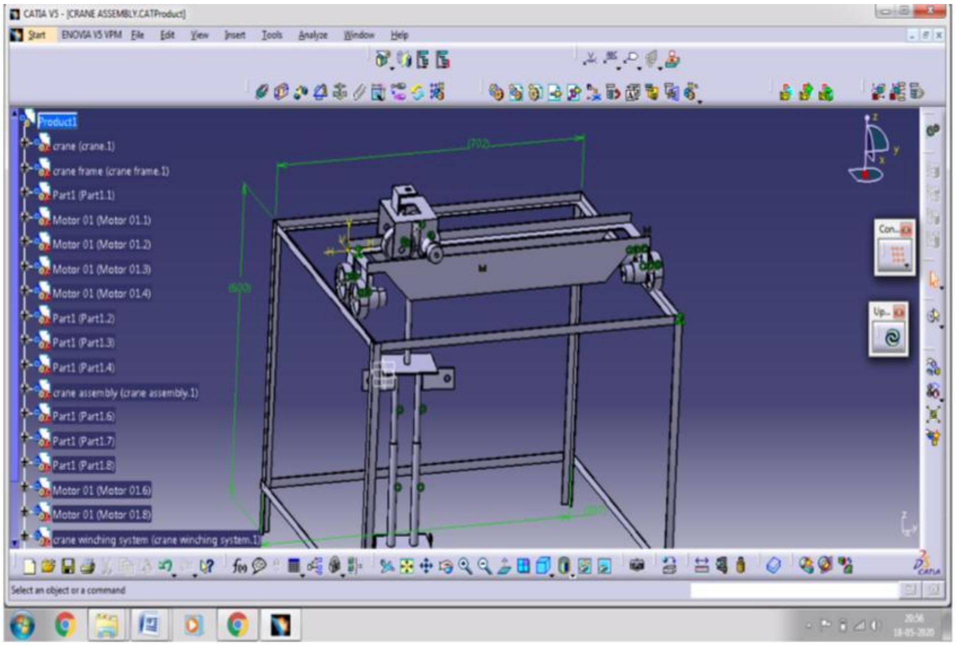
7.9-TROLLEY DESIGN-1



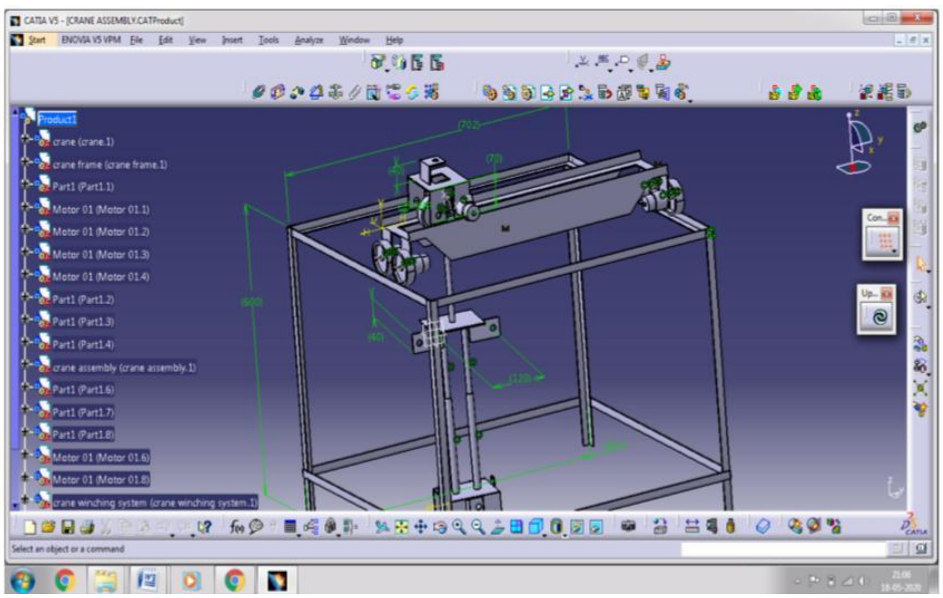
7.10-TROLLEY DESIGN-2



7.11-ASSEMBLY DESIGN-1



7,12-ASSEMBLY DESIGN-2



8. FABRICATION:

For the above design the fabrication is done part wise

.8.1-STAND

Cutting operation and welding operations are carried out for stand.

8.2-WINCH

The top part and bottom part of the carne is made by cutting and drilling operations respectively.

8.3-GIRDER:

Girder is made by the required measurements taken.

8.4-PAINTING:

The girder and stand are painted.

8.5-WIRING AND ASSEMBLY:

The wiring and the other parts of the crane are assembled accordingly.

9. CALCULATIONS OF CRANE:

9.1- GIRDER POWER CALCULATION:

Mass of girder (m) = 5 kg

Gravity (g) = 9.81

Force = 5×9.81 = 49.05 N

Speed of motor N = 10 rpm

Radius of wheel r = 0.035 m

Speed of travelling = (2×3.14×10× 0.035)/60 =0.0366 m/s

Power = F × v = 49.05×0.0366 = 5.39 watts

9.2-TROLLEY POWER CALCULATIONS:

Mass of trolley = 3.9 kg

Gravity g = 9.81

Force F = 3.9 x 9.81 = 38.259 N

Speed of motor N = 10 rpm

Radius of wheel = 0.035

Speed of travelling = 2 x 3.14 x 10 x 0.035/60=0.0366M/S.

Power p = F x v p = 45.07 x 0.0366 p = 1.401 watts.

9.3-LIFTING POWER CALCULATIONS:

Mass to be lifted = 2.5 kg

Radius of pulley/shaft = 0.003 M

Force F = mg = 2.5 x 9.81 = 24.25 N

Torque T = 24.25 X 0.003 = 0.0735 N-M

Speed N = 10 rpm.

Power = 2 x 3.14 x 10 x 0.0735 / 60 = 0.077 Watts

9.4-ROTATING POWER CALCULATIONS:

Mass of Rotating Column = 3.2 kg

Radius motor shaft =3/1000 = 0.003 M

Force F = m x g = 3.2 x 9.81 = 31.392N

Torque T = 0.003 x 31.392 = 0.094N-M

Speed of motor N = 3.5 rpm.

Power P = 2 x 3.14 x 3.5 x 0.094 /60 = 0.0345 W

10. RESULTS AND DISCUSSIONS:

10.1-The maximum weight lifted by Electromagnetic crane was observed to be 1.5kG.

10.2-The load is shifted one from place to another place from the above mentioned five mechanisms.

10.3- The Holding arm is used to hold the load firmly.

10.4- Electromagnet can be replaced by hooks for lifting of non-metallic objects.

11. CONCLUSION:

11.1- Long travel mechanism is successfully working and able to run up to 520mm .

11.2-Cross travel mechanism is successfully working and able to run up to 400mm .

11.3-Lifting and lowering mechanisms are functioning and able to achieve 200mm lifting / lowering .

11.4- Electro Magnetic Crane is able to lift MS Plates weighing 1Kg.

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