Design of Multi-Layer Glue Dispensing Gantry System

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ABSTRACT

This paper deals with the methodology of designing of a glue dispensing gantry system. The linear motion guideways, ballscrew, rack and pinion and stepper motor is selected. The static loads of the system are calculated. Verification of load and deflection is done using Ansys. The cad designs are made using Autocad and Solidworks.

Keywords*: Linear motion guideways, ballscrew, rack and pinion, Autocad, Solidworks.*

1. INTRODUCTION

The project involves designing of a glue dispensing gantry, based on the specifications provided by the company. The system is used for application of glue uniformly on metal sheets, membranes etc., that are required to be adhered together. Glue dispensing gantry system is preferred over the manual application of glue due to its uniform application, reliability on intricate shapes too, better accuracy in localized application of glue.

The project includes design, manufacturing, testing and trials of the system. The gantry size specified is 800 x 500 x 1200 (mm). The approximate weight of the machine is 100kg. Furthermore, the component loading height is specified as 800mm. The system has 3 axis travel along X-axis, Y-axis, Z-axis. The driving system comprises of ball screw and LM guide, servo motor and drive. The servo motor has replaced the hydraulic/pneumatic driving system due to its sophisticated controlling options.

1.1 Objectives

Understand the function of the filtration candle in the filtering of water.
Designing the base and work bench of the gantry system based on the company specifications.
Study of the drive system catalogues and selecting appropriate ball screw and LM guide ways.
Selection of stepper motor.
Design of the glue gun.
Manufacturing of the components.
Testing of the system.

1.1 Scope:

Stepper motor:
The hydraulic and pneumatic system was replaced by stepper motor overtime. The latter provided better localised positioning of the gun along with desirable speed. Furthermore, using the stepper motor made the system lighter and more convenient as it eliminated storing of hydraulic oil and leakage issues.

Automated glue dispensing gun:

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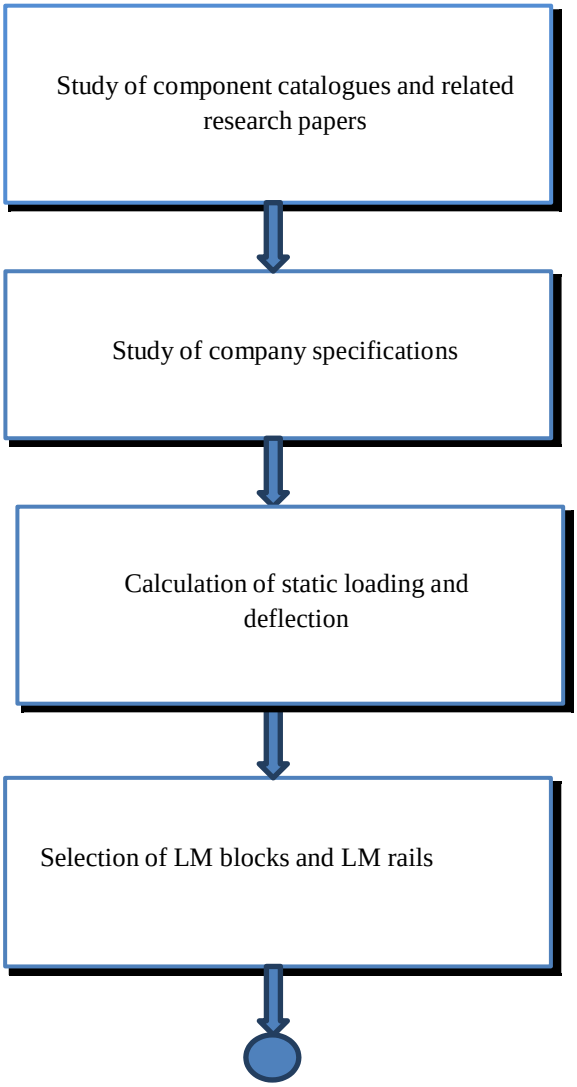
969 – 974

This gun is designed with a provision of mixing of the two solutions within the gun. This eliminates the wastage of glue. The design ensures only a required amount of solutions to be mixed accurately. This directly aides in increasing the production rate.

1.2 Work Flow



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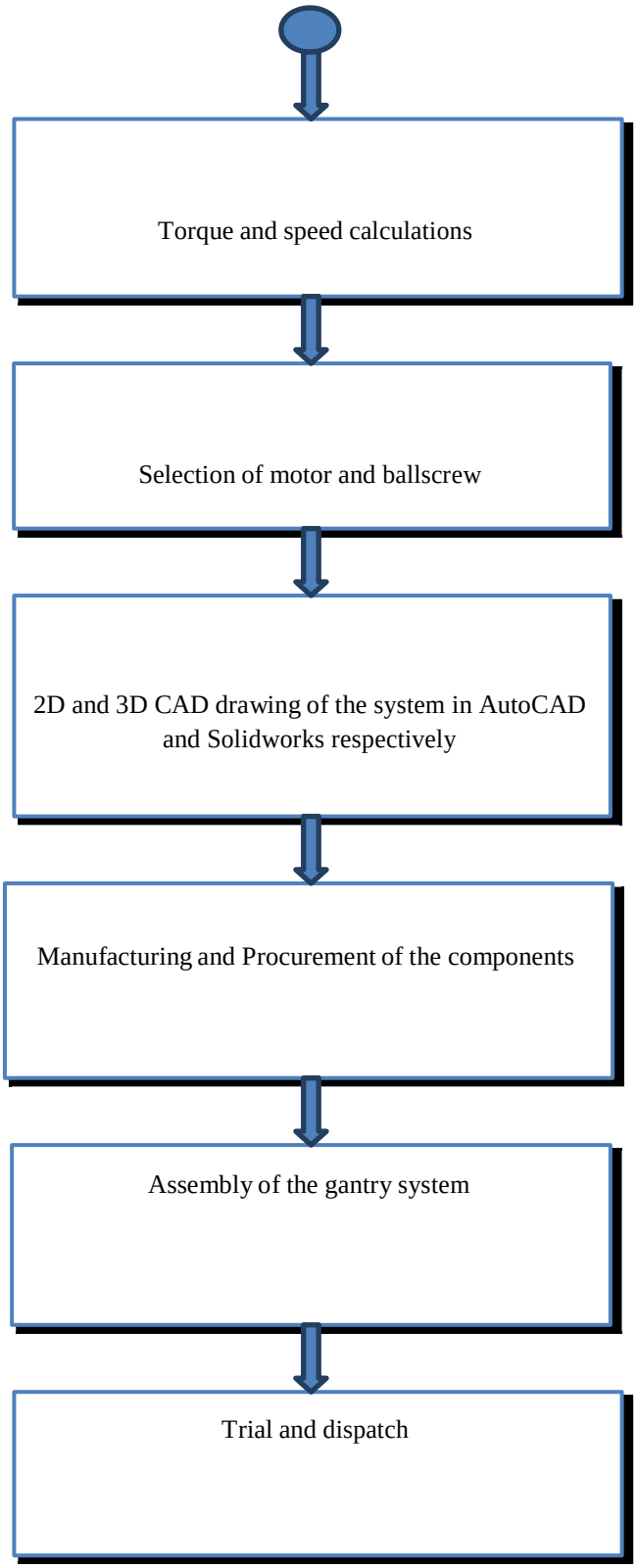

2. Calculation for selection of components

2.1 Distance between the LM blocks

The system is to be designed as per the specifications provided by the company. Firstly the weight on each axis is decided. This weight is to be carried by the slide plate of the LM guide. This slide plate is mounted on four LM blocks. It is thus essential to find the optimum distance between the LM blocks to sustain the weight without any deflection of slide plate. The formula for the force on each block is as follows,

$w/4 + F/4 + F*k/2d = P_a$

where ,w = weight on the slide plate (N)
F = dynamic force (N)
k = offset of the CG from the geometrical centre of the slideplate (mm)
d = distance between the blocks (mm)
P_a = force acting on each block (N)

In our case value of k is considered to be zero. The value of P_a thus found is the theoretical which is later verified by using Ansys. A number of permutations were run on Ansys by changing the distance between the blocks. The optimum value was selected on the basis of almost equal force distribution on all the four blocks. The arrangement of the blocks obtained was a square arrangement, with each block placed at the vertex of the square.

2.2 Ball Screw Calculations

Referring to V.B. Bhandari for power screws we calculated the diameter of ballscrew. For the Z axis slide plate the mass of the glue gun is considered as the axial load. The referred formula is as follows

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Where = Compressive strength (N/mm^2)

P = Axial load (N)
d = Diameter of ballscrew(mm)

However the calculated diameter was found to be of a very small value. It was therefore decided to go for the minimum standard diameter of the ballscrew from the HIWIN catalogue.

2.3 Motor Calculations

The standard pitch for ballscrew available in the HIWIN catalogue for our required diameter are 5 mm and 10 mm. The selection of the required pitch is then done by considering the speed which is to be achieved. The motor pulses are also taken into account in order to decide the required pitch.

The value of torque required is an important parameter in selection of motor. The torque is calculated by using the following formula

= ( )

$F = + mg (sin +)$

Where = Load torque (Nm)
F = Force in the moving direction (N)
= Ballscrew lead (m/rev)
= Internal friction coefficient of preload nut (0.1 - 0.3)
= Preload (N)
= Efficiency (0.85 – 0.95)
i = Gear ratio
= External force (N)
= Tilt angle (degree) In our case

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969 – 974

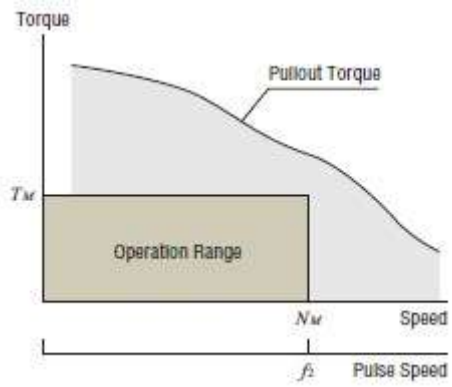

Fig 2.3.1 Torquevs Speed motor characteristics

3. 2D and 3D diagrams

The next step after slection of components is designing of the auxiliary components required for the assembly of the gantry system. The auxiliary components include the slide plate, the base plate, couplings, bearings and ballscrew nut mounting. The size of these auxiliary components is decided after the relative placements of LM guides, LM blocks, ballscrew, ballscrew nut and motor. The 2D drawings help in finding the relative positions and placements of various components. The following 2D drawing is done by using Autocad.

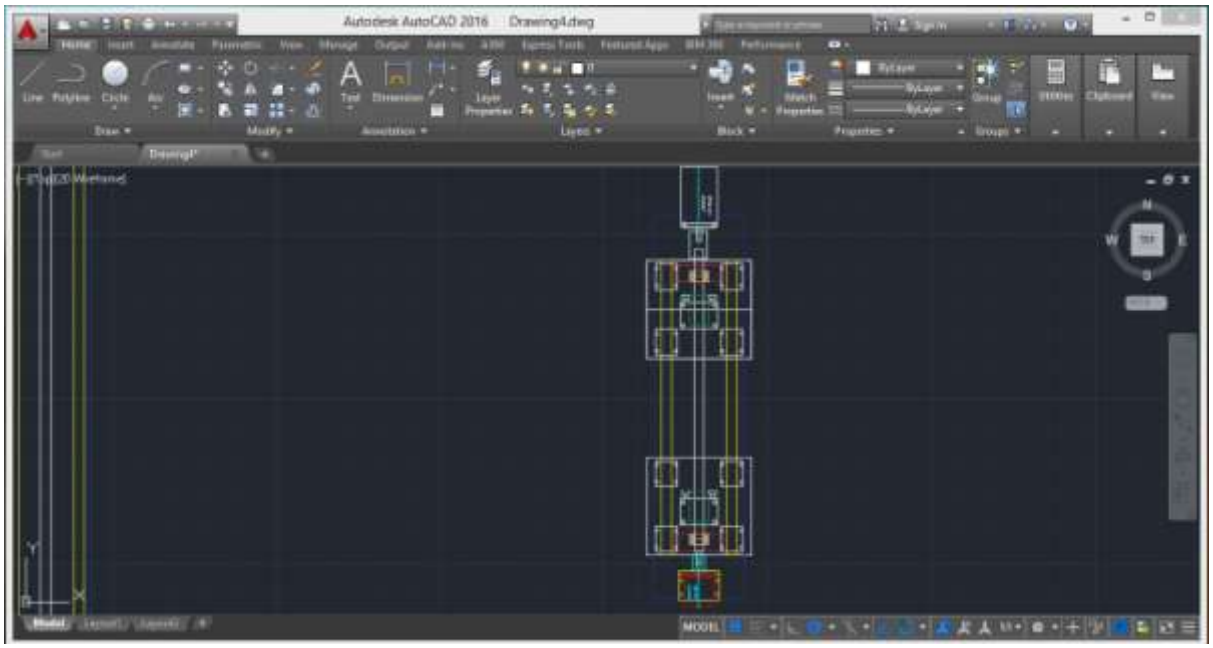

Fig 3.1 2D drawing of Z axis

Using the 2D drawing from autocad the following 3D drawing was made.

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969 – 974

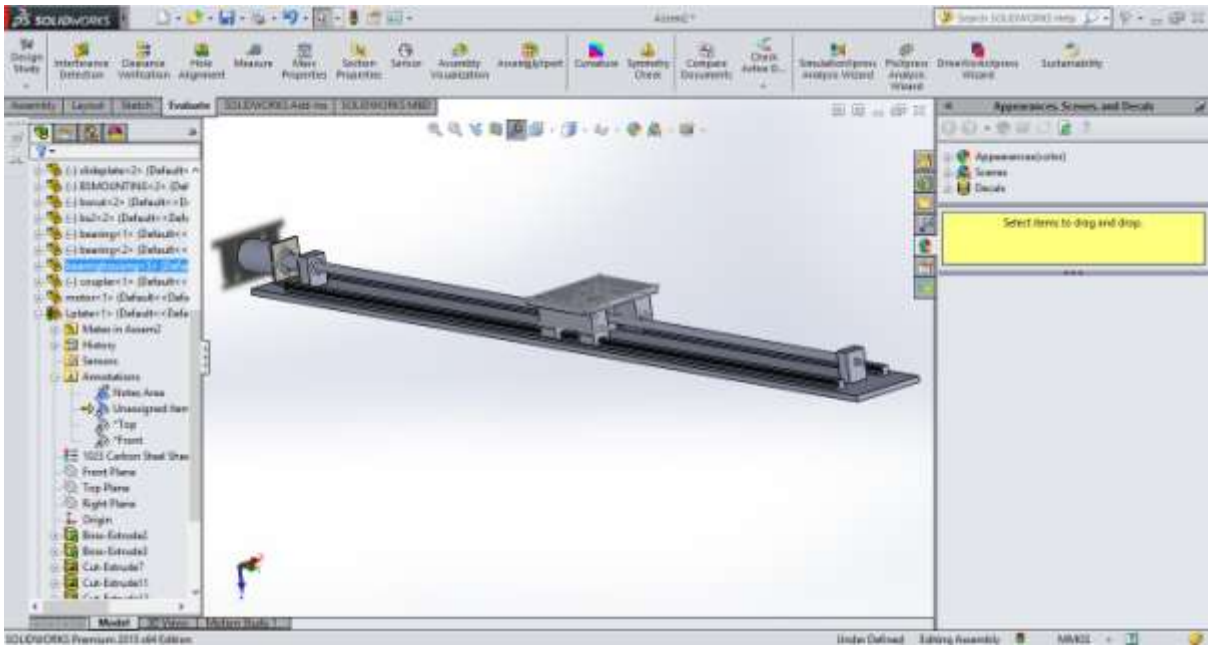

Fig 3.2 3D drawing of Z axis

Conclusion

The design is validated by manufacturing the component without affecting the component's function. The motion of the gun is observed, its positional accuracy, glue dispensing volume and its efficiency. The design and the final system will be checked for its accuracy and if found any defects it would be rectified.

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