Gantry Melting 3D Printer

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Abstract

3D printing technology is a new manufacturing technology with industrial revolution. It is gradually integrated into R&D, design and production. It is a high degree of integration and innovation of material science, manufacturing process and information technology.At present, 3D printing technology has begun to play a role in many fields such as military, medical, equipment manufacturing, consumer electronics, architecture and so on, and the industry has shown rapid growth momentum. First of all, according to the comprehensive consideration of function and space location, the framework of 3D printer is determined to be Longmen type 3D printer, and the 3 dimensional modeling software is used to design the 3D printer for 3 dimensional modeling. Static analysis of the designed 3D printer frame is carried out by using the finite element analysis software, and the static pressure of the print nozzle part on the two transverse optical axis is studied. The stress, strain and total deformation of the optical axis are analyzed.

Keywords

3D printing technology, 3 dimensional modeling, Finite element analysis.

1. Introduction

3D printing (3D printing) is a rapid prototyping technology based on a digital model that uses an adhesive material such as powdered metal or plastic to construct an object by layer-by-layer printing. Due to its innovation in manufacturing process, it is considered to be the 'important production tool of the third industrial revolution'. The 3D printer was first born in the mid-1980s and was invented by American scientists. However, due to the high price and the immature technology, the early rise has not been popularized. After more than 20 years of development, the technology has become more sophisticated, accurate, and at a lower price.

At present, 3D printing has become a trend. 3D printing technology has been applied to many scientific fields. Surgeons use 3D to create organ models to help plan complex surgical procedures. Archaeologists and museum technicians use 3D printing to create precious artifacts. Replica, and carry out research on this basis, especially in the field of industrial design, digital product opening and other fields; can complete the printing of a mold in a few hours, saving a lot of product development time to the market. A 3D printer requires neither paper nor ink. Instead, a series of techniques, such as electronic mapping, laser scanning, and material melting, melt specific materials and refold them in layers according to the instructions of the electronic model diagram, eventually turning the electronic model into a real object.

2. 3D Printer Mechanical Structure Analysis

This design uses the gantry melt-squeezing 3D printer. The overall frame is composed of 2020 profiles. The dimensions are: 385=X285=X370 o The X-axis uses two optical axes with a length of 340mm as the beam to support the beam. The print head portion is moved by the conveyor belt in the X direction. The Y-axis uses two 340mm optical axes to support the hot bed and guide, and the conveyor moves the hot bed in the Y-axis direction. The two arms of the Z-axis are supported and guided by two 384mm optical axes, and two 300mm screw drives.

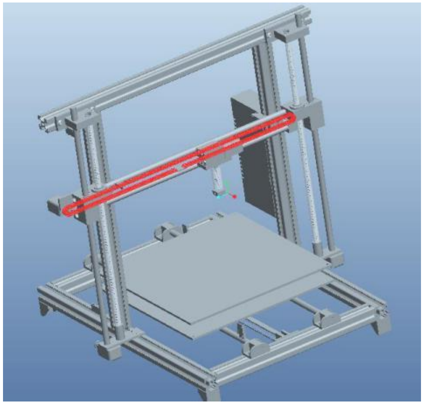

Fig 1. 3D printer overall framework

This printer uses 20A, 110/220V dual voltage, 47-63Hz power supply. 42 stepping motors, respectively, control the movement of X, Y, Z, extruder, motor single-phase current is 1. 2A power supply voltage is 12-36V, step angle is 1. 8, moment of inertia is 38g.cm *2, the motor weight is 0. 23kg / PC.

3. 3D Printer Design Options

The advantages and disadvantages of the 5 types of 3D printers are as follows:

This chapter introduces five design schemes from the principle and technical aspects of 3D printers. Each scheme technology has its own advantages and disadvantages. From the aspects of material selection and utilization, cost, development speed, etc., the solution is melt-squeezed FDM.

4. Static Mechanical Analysis of Printer Mechanical Structure

4.1 Analysis of the Beam Using ANSYS Workbench

4.1.1 Adjustment of 3D Printer Model

For the 3D printer designed this time, the parts are too scattered, and there are too many threads and screw holes. It is too troublesome to import the model and mesh, and the computer requirements are relatively high. Therefore, it is necessary to delete some unnecessary parts, such as the entire hot bed and the upper spring, the bottom 4 supports, the two timing belts and the synchronous wheel coupled with the timing belt, the thread of the motor and the screw also need to be replaced by the optical axis. In this way, under the stress condition of the 3D printer without affecting the ansys analysis, the part shape and the number of parts of the 3D printer are simplified as much as possible, and the requirement for the computer is also reduced.

4.1.2 Establish An Analysis Project

Open the workbench and create an analysis project in Project Schematic with the Anslysis Systems->Static Structural option in the main interface Toolbox.

4.1.3 Import Creation Geometry

Right-click on A3 Geometry, select the import Geometry->Browse command in the shortcut menu that pops up, and save the model saved in stp or igs format. After this, the A3Geometry becomes a checkmark, indicating that the solid model already exists. . Double-click A3 Geometry in Project A. At this point, click the Generate button on the left and the imported model will appear.

4.1.4 Add Material Library

Double-click the A2 Engineering Data item in item A to enter the material parameter setting interface. Right-click in the blank space of the interface and select Enigineering Data Sources in the menu bar. Select A3 column General Materials in the table, then select A4 column Aluminum Alloy in the Outline of Favorites table to add, the material will be added successfully in the C5 column. You can also return to the original interface. You can modify the properties of the material in the Properties of Outline Row5: Aluminum Alloy table.

Tab.1

Type Advantages and disadvantages	Advantages	Disadvantages
Melt extrusion(FDM)	1. Wide range of raw materials 2. Low manufacturing and maintenance costs 3. Open source project support, relevant information is easy to get 4. The raw material of the printing process does not undergo chemical reaction 5. High raw material utilization rate 6. Can be used for investment casting	1. There are obvious step stripes, and the overall precision is low. 2. Printed objects have low strength 3. Z-axis material strength is weak, not suitable for printing large objects 4. Slow printing speed and long printing time
Lamination molding(LOM)	1. Fast forming speed 2. High model accuracy 3. Good hardness and good mechanical properties 4. No need to design and manufacture support 5. Raw materials are cheaper	1. The tensile strength and strength of the molded parts are not good. 2. Organic light loss during printing, high maintenance costs 3. Cannot be used directly after printing, need to remove waste materials 4. Post-processing complex 5. Stepped texture with relatively low precision
Inkjet powder(3DP)	1. Printing speed is fast. No need to add support 2. The printing principle is the same as the traditional process, and can draw on two-dimensional printing technology. 3. Can print full color prototypes	1. The molded part has low strength and can only be used as a concept prototype, which is difficult to use for functional testing.
Laser sintering(SLS)	1. High production strength, excellent material properties 2. More raw materials available 3. Short build time of parts and high printing accuracy 4. No need to design and construct support components	1 High loss of key parts, Special laboratory environment should be required 2. Printing process requires stable temperature control 3. Higher raw material prices 4. Unable to print fully enclosed hollow design
Light curing(SLA)	1. Long time and high technical maturity 2. Fast printing speed and short production cycle 3. High print accuracy, printable traditional production cannot be made 4. The PC software is fully functional	1. Sla equipment is generally expensive and has high maintenance costs 2. Need to operate the venom accurately, and the working environment is demanding 3. Limited by materials, limited performance of finished products 4. Core technology is monopolized

4.1.5 Add Model Material Properties

Double-click the Model item in the project A3 column of the main interface project management area to enter the Mechanical interface.

The interface can be divided, analyzed, and observed in the interface. Select A1-AFO under the Geometry option in the Outline on the left side of the Mechanical interface, and you can add material to the model in the Details of "A1-AFO".

Material, the design ansys analysis is mainly to analyze the static analysis of the print head to the beam, so you only need to select the material of the beam is stainless steel, the other does not need to be modified.

4.1.6Dividing the Grid

Select the Mesh option in the Outline of on the left side of the Mechanical interface. In this case, you can modify the mesh parameters in the Details "Mesh", set it to 0. 005 in the Element Size in Sizing, and use the default settings.

Right-click on the Mesh option in the Outline and select the Generate Mesh command from the pop-up shortcut menu. A progress bar will pop up, indicating that the grid is being divided. When the mesh is divided, the progress bar will disappear automatically. The final mesh effect will be eliminated. as the picture shows.

4.1.7Applying Loads and Constraints

Select the Static Structural option in the Outline on the left side of the Mechanical interface and the Environment toolbar will appear.

Select Environmen and the Support->Fixed Support command in the toolbar. At this time, the Fixed Support option will appear in the analysis tree. Select Fixed Support and select the surface to which the fixed constraint needs to be applied. The selected surface is the two circular cross sections of the beam. Click the apply button under the Geoetry option in the Details of "Static Structural" to select the fixed constraint on the selected surface, and set the following settings in the Detail of "Force" panel:

1: Under the Geometry option, make sure that the surface to which the force is applied is selected and click the Apply button. At this point, 1Face is displayed in the Geometry column, indicating that a face has been selected.

2: Select the Component option in the Define By column to indicate the value by coordinate;

3 In the Z Component field, enter 1.96N (the mass of the motor is 0. 23kg, the mass of the other printed parts is 0. 17, the average distribution is on the two beams, and the force of the single beam is 1.96N). Load values are displayed in the Graph and Tabular Data areas respectively, keeping other options default;

Right-click on the Static Structural option in the Outlines and select the Solve command. The progress display will pop up, indicating that the solution is being solved. The progress bar will disappear automatically when the solution is completed.

4.1.8 Post-Processing

Select the Solution option in the Outline on the left side of the Mechanical interface and the toolbar as shown will appear.

Select the Stress->Equivalent (von-Mises) command in the Solution toolbar and the equivalent stress option will appear in the analysis tree. Select the Strain->Equivalent(von-Mises) command in the Solution toolbar and the equivalent strain option will appear in the analysis tree. Select the Deformation>Total command in the Solution toolbar and the Total Deformation option will appear in the analysis tree. Right-click on the Solution option in the Outline and click on the Equivalent All Results command. A progress bar will pop up indicating that the solution is being solved. The progress bar will disappear automatically when the solution is automatically completed. Select the Equivalent Stress option under Solution in the Outline, and the stress analysis cloud image as shown below will appear.

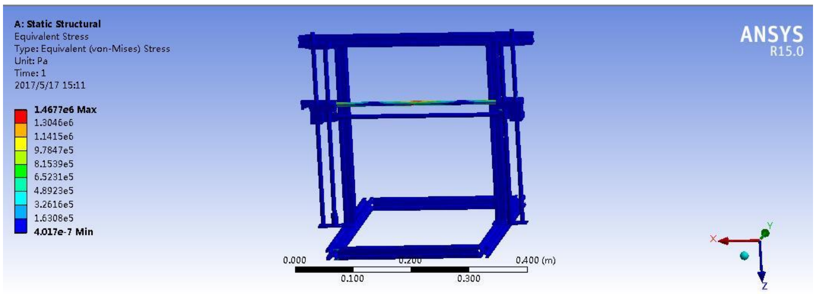

Fig 2. Stress analysis cloud

Select the Equivalent Elastic Strain option under Solution in the Outline, and the strain analysis cloud as shown in the figure will appear;

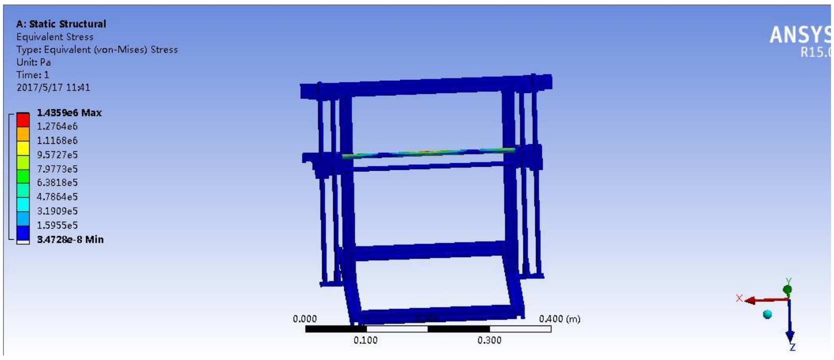

Fig 3. Strain analysis cloud

Selecting Total Deformation under Solution in Outline will now display the total deformation analysis cloud as shown.

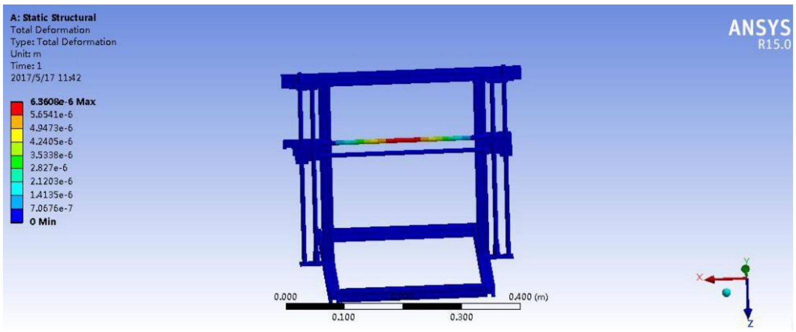

Fig 4. Total deformation analysis cloud

4.2 Analysis of the Overall Framework Using ANSYS Workbench

The 3D printer designed in this paper uses the ansys workbench to analyze the beam and the whole frame in the same way, but does not constrain the two circular sections of the beam when constraining the whole, but constrains the bottom support of the frame. After the ansys analysis of the above process on the overall framework, the analysis image of the following 3 graphs is obtained.

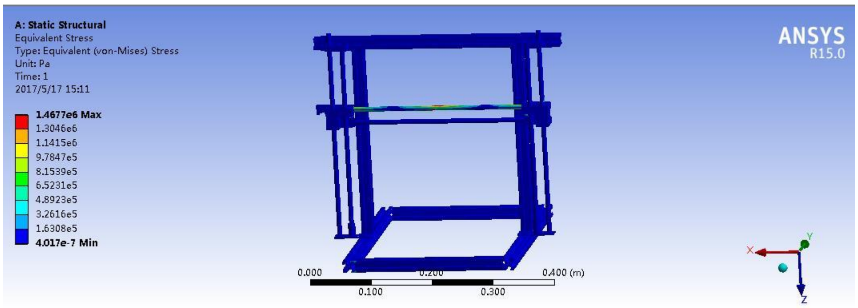

Fig 5. Stress analysis cloud

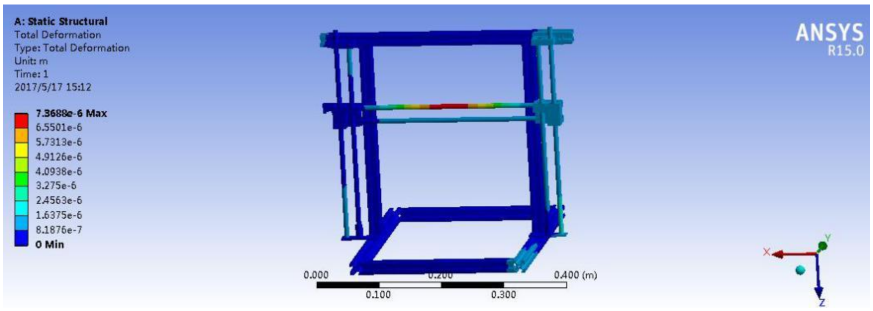

Fig 6. Strain analysis cloud

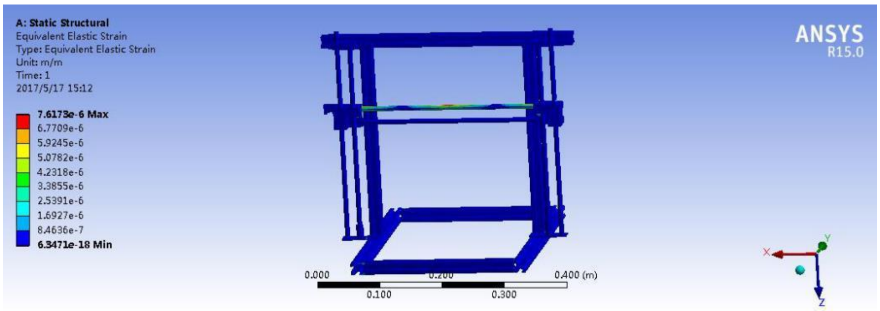

Fig 7. Total deformation analysis cloud

5. Conclusion

With the continuous advancement of modern industry, 3D printing technology has played a leading role in military, medical, equipment manufacturing, consumer electronics, construction and other fields, and the industry has shown rapid growth. Especially in the field of consumer goods, medical and equipment manufacturing, the 3D printer market has great potential and good development prospects. The design analysis of this paper has a certain effect on the research of gantry-type molten 3D printer.

This paper introduces the design process and precautions of the gantry-type molten 3D printer. From the preliminary selection of the design of the gantry 3D printer, the design of the mechanical part and the selection of the mechanical structure and the use of finite element software for the gantry-type molten 3D printer beam The overall framework is used for structural static analysis. The results and conclusions obtained through the above design process are as follows:

(1) According to the working mode of the gantry type 3D printer, 5 design schemes were selected. According to the working principle, advantages and disadvantages of each design scheme, the design scheme of the gantry-type molten 3D printer was finally selected according to the working mode of the printer.

(2) Using finite element analysis software to design 3D

The printer frame performs static analysis to study the static pressure of the print head part on the two transverse optical axes, and analyze the stress, strain and total deformation of the optical axis. The results show that the optical axis is subjected to a maximum stress of 1.44MP, a maximum strain of 7.44e-6, and a total deformation of 6.36e-6m. The optical axis is subjected to stress, strain, and total deformation occurring within the allowable range.

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