ARKEditions

OPEN ACCESS

Engineering >> Mechanical Engineering

Structural Design of Linear Sliding Platform

Bin Zhao*[1]
Junrong Xu[2]

[1]School of Science, Hubei University of Technology, Wuhan, Hubei, China.
[2]School of Science, Hubei University of Technology, Wuhan, Hubei, China.

Abstract

Modular single axis linear CNC sliding table is a fundamental component of many large electromechanical devices. Modular single axis linear CNC rolling sliding table usually includes guide rail seat, mobile slider, workpiece, ball screw nut pair, servo motor and other components. The screw slide table plays an irreplaceable role in industrial production, so it is of great significance to design and study it. This article mainly provides a calculation method for the design of a linear sliding table, explaining the transmission scheme, rail and screw nut calculations, and introducing lubrication methods and pointing out precautions.

Keywords

PMI, Ball screw, Electromechanical device.

Introduction and Research Status

A linear sliding platform refers to a mechanical component used by a system to operate, support, and guide the movement of a sliding table, performing a reciprocating linear sliding motion according to a given parallel direction of an axis. According to the different characteristics of linear friction motion, the guide rails for linear friction motion can be roughly divided into several main types, including sliding linear friction motion guide rails, rolling linear friction motion guide rails, elastic linear friction motion guide rails, and fluid linear friction motion guide rails. Linear bearings are widely used in various fully automated processing machinery. German companies import linear machine tools, bending machines, laser machines, welding machines, and so on. Of course, this type of linear bearing is also used in conjunction with other linear bearings. The main design purpose of this linear guide module is to be directly used on fixed mechanical moving structures that require high cost for movement accuracy. The connection position of the linear guide can eliminate the need for intermediate connection media between the moving control components and the fixed moving components, and directly use rolling control steel balls. Famous manufacturers of rolling linear guides in the world include IKO Bearing Company and THK Company from Japan Nsk and Rexroth from Germany Companies such as INAand Schneerberger from Switzerland.The manufacturing products of these companies represent the highest level of products in the world. Foreign products of the same type require meticulous workmanship in manufac-

Article Information

Article Type: Review Article
Bunch/Area: Engineering/Mechanical Engineering
Volume: 1
Issue: 1
Publisher: ARKEditions
Received Date: 19th February 2025
Accepted Date: 28th February 2025
Published Date: 15th March 2025

*Corresponding author

Bin Zhao

School of Science, Hubei University of Technology, Wuhan, Hubei, China,
E-mail: zhaobin835@nwsuaf.edu.cn

Citation

Bin Zhao, Junrong Xu. Structural Design of Linear Sliding Platform. ARK Editions. 2025 March; 1(1): 13-15.

turing This product has a flexible structure, high acceleration speed during the acceleration process, strict design, high precision, heavy load, and multiple properties that can be replaced with each other in manufacturing. The production technology of rolling linear ball tracks in China has been around for 26 years. Currently, the good track machine tool technology widely used on the spindle rollers of large industrial CNC machine tools is developing rapidly in the industry. Major industrial machine tool manufacturers are continuously investing a large amount of human resources to vigorously develop slide rail technology, and have successfully promoted their products to enter machine tool batch production mode and batch production.

Overall scheme design

Based on the introduction of the linear sliding table in the previous section, the transmission scheme is to choose a servo motor to drive the synchronous wheel in class, and to drive the screw rod to rotate through the synchronous belt. The screw rod is fixed with a slider, which is fixed above the guide rail and moves back and forth through the guide rail. The screw nut pair must have both achievable pulse equivalent and high-precision positioning capability. Under such double standards, it is difficult for sliding screw pairs to meet the requirements, so generally only ball screw pairs can be considered. The ball screw pair has reached a very high standard in terms of transmission accuracy, and its operation is relatively stable, with a long service life and high efficiency. It can effectively eliminate recoil after pre tightening, and the ball screw has been serialized. Therefore, the ball screw pair we have chosen not only fully meets the requirements, but also is convenient and efficient.

Design and calculation methods for main components

Guide rail slider

The maximum vertical workload is:

In this formula, G represents the total weight of the moving parts, F represents the external load, and its value should be determined according to the working requirements of the designed sliding table. After determining the maximum load, the rated maximum dynamic load and rated static load should be consulted based on the guide rail model.And it should meet the following requirements:

C represents dynamic load rating, a C a C 0 C0 represents rated static load.

According to the above load calculation method, the guide rail model can be selected, but the guide rail length cannot be selected.The length of the guide rail directly affects the operational efficiency and performance of mechanical equipment. If the length of the guide rail is too short, it will limit the range of movement of the mechanical equipment, affecting operational efficiency and accuracy. If the length of the guide rail is too long, it will increase the weight and cost of the mechanical equipment itself, as well as the difficulty and cost of maintaining and replacing the guide rail. In addition to length, the quality and craftsmanship of guide rails also directly affect the performance and service life of mechanical equipment. Therefore, when selecting and installing guide rails, it is necessary to comprehensively consider factors such as the length, material, and manufacturing process of the guide rails based on the situation and usage requirements of the mechanical equipment, in order to ensure the normal operation and stability of the mechanical equipment.

Usually, the length of the guide rail has a series of national regulations. In addition to considering the above factors, the selection of the guiderail lengthshouldat least meet the travel requirements and the installation requirements of the motor.

After completing the selection of guide rails, the distance life should be verified to ensure that it meets the life requirements.

Distance life span

Represents the hardness coefficient. T f represents temperature coefficient. C f represents the contact coefficient. R f represents the accuracy coefficient. The above coefficients can be found in the "Mechanical Manufacturing Process Manual". The load factor is usually determined based on usage conditions

	Work situation	Value range
1	No external impact or vibration.	1~1.5
2	Low speed occasions.	
1	No significant impact or oscillation.	1.5~2
2	Medium speed occasions.	
1	There is external impact or vibration.	2~3.5
2	High speed occasions..	

Screw nut

The maximum working load of guide rails is an important parameter in the design and production of mechanical equipment, which has a direct impact on the performance and service life of the equipment. Manufacturers need to conduct comprehensive quality testing and certification of guide rails to ensure that their rated dynamic load meets the requirements of mechanical equipment. It also plays an important reference role in nut selection.

There are significant differences in the calculation method of maximum working load for guide rails of different shapes.

For rectangular guide rail:

For dovetail rails:

For triangular guide rails:

F_x, F_y, F_z represents the feed direction load, lateral load, and vertical load of the slide table. There are also differ-

ences in the value of K and G for slide tables of different shapes.For rectangular guide rail, the value of K is 1.1, and is 0.5.For dovetail rails,the value of K is 1.4, and is 0.2.For triangular guide rails, the value of K is 1.15, and is 0.15~0.8.

Maximum dynamic load FQ:

After determining FW and FQ,the screw nut can be selected according to the "Mechanical Manufacturing Process Manual", and the selection should meet the principle of rated dynamic load greater than FQ.

Lubrication System

Lubrication is mainly used to add a certain amount of chemical lubricant between the surfaces of various moving mechanical equipment and high-speed moving objects, effectively reducing their frictional resistance., How to reasonably and correctly design lubrication and material selection based on the actual use of various equipment lubrication machinery, the main materials and lubrication devices for lubrication, and how to ensure that various equipment lubrication machinery can have good equipment lubrication working conditions, stable equipment lubrication performance, have very important technical guidance significance.

During the operation of the linear sliding table, a large amount of friction is generated between the guide rail and the guide rail slider, as well as between the screw and the guide rail slider, due to long-term sliding, which generates a large amount of heat and friction on the parts, causing wear and tear on the contact surfaces. After wear and tear, the appearance and surface quality of the parts are slowly and continuously impacted and damaged, resulting in a continuous decrease in the efficiency and accuracy of the machine's work, and serious loss of part damage. In order to control the movement and wear of the entire mechanism, improve its mechanical efficiency, reduce power and energy loss, and ensure the reliability of the entire machine during normal operation, lubrication is one of the most effective measures. For the East China guide rail that performs linear reciprocating sliding, oil lubrication is often used. The lubrication method requires the operator to regularly inject lubricating oil into the oil cup, and the lubricating oil enters the upper and lower surfaces of the sliding guide rail through the oil delivery pipe to achieve the purpose of lubrication.

Discussion and Conclusion

The linear CNC slide table system is a fundamental component of many electromechanical equipment. Modular single axis linear CNC rolling slide tables typically include guide rail seats, servo motors, moving sliders, workpieces, and ball screw nut pairs.

This article mainly elaborates on the guide rail and screw nut parts of the linear sliding table, explaining how to choose the guide rail model under different working conditions, and providing methods for life verification. In the screw nut section, it is explained how to choose the screw nut based on the maximum working load. Finally, the relevant precautions in the lubrication system were elaborated.

Overall, the application of linear sliding tables varies greatly in different situations and cannot be generalized. This article still has many shortcomings, such as further improvement in the selection of sliding table motors. The research on linear sliding tables still has great research significance and needs to be further deepened.

References

1. Zhang P.Cross slide assembly measurement technology[J]. Mechanical Engineering and Automation, 2015, 26 (04): 217-218.
2. Li Q, Ding J, Liu Q, Huang H&Zhang Y.Development and Application of Cross Sliding Table Based on Skill Training[J]. Mechanical and Electrical Engineering Technology, 2021, 43(05), 178-180.
3. Ci Y, Cheng J, Wang P,et al.Discuss the influence of slide table construction and installation methods on the natural frequency of fixtures[J]. Environmental Technology, 2024, 42 (12): 231-236.
4. Yao Y.Design and simulation verification of mechanical sliding table based on PLC control[J]. Motor Technology, 2024, 29(06): 14-18.
5. Yang S, Wang X, Liang J, et al.Development of a calibration device for automotive side slip inspection[J]. Agricultural Equipment and Vehicle Engineering, 2024, 62 (12): 70-74.
6. Shi J Meng F, Zhang S, et al. Design of a four axis sliding table teaching aid robot based on ROS[J]. Heilongjiang Science, 2024, 15 (20): 38-41.
7. Bai Z, Wang B, Fei J, et al. Design and Application of Passenger Body Pressure Collection System for Sliding Platform Test[J]. Journal of Hunan University (Natural Science Edition), 2024, 51 (10): 1-10.
8. Qiu Q.Installation and positioning structure of Z-direction sliding table for gantry machine tool[J]. Metal Processing (Cold Processing), 2024, 32(10): 39-42.
9. Jiang X.Design and Simulation of Hydraulic Power Sliding Platform System for Combination Machine Tool[J]. Hydraulic Pneumatic and Sealing, 2024, 44 (09): 45-49.
10. Liu Q, Geng , Yang Z, et al. Design of a Cross Sliding Platform Multi dimensional Non collapsing Rod Autonomous Correction Experimental Device[J].Experimental Technology and Management, 2024, 41 (09): 138-145.
11. Liu S.Design of Packaging Sliding Platform System Based on PLC and Servo Motor[J]. Shanghai Packaging, 2024, 43(05): 3-5.
12. Zhang Y.Research on Multi Objective Topology Optimization and Weight Reduction Design of Precision Sliding Platform Base Structure Based on Variable Density Method[D]. Hunan University of Technology, 2024.