Deformation Analysis of Rotating Linear Guide

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Abstract. Rotating linear guide movement precision because of its flexible realization of two-dimensional space, and the advantages of compact structure, easy to install and debug, in more and more application in the industry and precision instruments, not only its application technology and rapid development in different areas, rotating linear guide itself material, structure and control technology have been rapidly increasing. Rotating linear guide application according to the use of the environment and the demand is different, have different requirements, but to control its deformation is the key to ensure the good operation to solve common technical problems. Rotating linear guide deformation is mainly composed of the weight of the structure itself and structure stiffness, support and fundamental cause, among them, the support (including support and support) and vehicle (including the distribution of vehicle quality, vehicle quality and vehicle movement way and the state) is a key factor, the deformation of the straight line guide rail and the trend of change over time, is crucial, especially in the condition of rotating linear guide. This paper focuses on the potential of several support state set of rotating linear guide bearing conditions of stress and deformation analysis, study its change trend, compared several different support condition state of linear guide.

1. Introduction
Linear guide is also called line rail, slide rail, linear guide, linear slide rail, often used to need to do a straight line reciprocating movement, which can realize higher bearing capacity than the straight line bearing, can absorb a certain amount of torque at the same time, but in the case of high load to ensure high precision linear motion. Practical applications, the linear guide is mainly used to support and guide the moving parts, in a specific position according to the given direction do reciprocating linear motion, a guide rail sliding friction, rolling friction guide rail, elastic friction guide, fluid friction guide several types, such as linear guide many with chromium bearing steel materials, such as common GCr15, also can consider to carburizing bearing steel, such as G20CrMo, to reduce the cracking and deformation, guarantee the stability and accuracy[1].

Usually in order to get good stability and greater carrying capacity, linear guide, generally with groups, the most common way of sliding table for four groups, in according to the requirement to choose the appropriate linear guide, precision of the composite guide mainly decided by the layout structure, installation and adjustment, the combination of the rotating guide due to the effect of gravity, layout structure, installation and calibration and the conventional fixed state, which affect the largest is the arrangement of structure, as shown in the diagram below a transverse vertical shaft adopt linear guide, different arrangement of structure, stress, deformation and the trend of the change over time. This article mainly discuss the layout structure of rotating linear guide pair of stress and deformation,
the influence of the transverse structure of similar to figure 1 can rotate, and through the analysis of several kinds of condition of different performance to study the change trend.

![Figure 1 combined linear guide rail pair](image1)

2. The layout structure comprehensive analysis

The combination of rotating linear guide vice layout structure includes three aspects: supporting form, rotation and bearing structure. Rotating state against doing straight line reciprocating movement load in the design process are usually as far as possible to reduce the lightest, and center of gravity is as far as possible near the center of linear guide rail pair, high to low as far as possible, after more than do these points, can play when bearing structure design and optimization of little space, so here don't do too much to discuss, in several rotation would focus on state support types influence on the combination of linear guide rail pair loading and deformation [2].

Combination according to the practical application of linear guide rail pair spin state change between horizontal and 60 ° inclined, choose levels, 30 ° inclined and 60 ° inclined three states are analyzed [3]. Combination among the support linear guide rail pair has, at both ends, and three forms "Π" type, figure 1 horizontal axis is the intermediate support way, on both ends of the support in short distance travel guide."Π" type and its extension type "is often used in long distance guide, select 2800 mm long linear guide rail pair experiment analysis, choose the middle support, support on both ends and the "Π" type a third support three ways. Below is for the three rotating state and three kinds of support way, carry out specific analysis on nine kinds of state, assumes that the load bearing 1000 g, at 1.6 m, guide installed on 2800 mm long, 160 mm wide and 100 mm high hollow stent.

2.1 level + middle support

In accordance with the above preconditions, in horizontal state adopts middle support method, the stress and deformation was carried out on the linear guide rail pair is analyzed, the following figure 2: + middle support horizontal deformation analysis diagram shows, the linear guide rail pair deformation mainly produce at both ends.

![Figure 2 middle level + support deformation analysis diagram](image2)
2.2 level + support at both ends
In accordance with the above preconditions, in horizontal state adopts two-terminal bracing method, the stress and deformation was carried out on the linear guide rail pair is analyzed, the following figure 3: level + on both ends of the support deformation analysis diagram shows, the linear guide rail pair deformation mainly produce in the middle position.

![Figure 3 horizontal deformation analysis diagram + supported on both ends](image)

2.3 level + 1/3 "∏" type support
In accordance with the above preconditions, in horizontal state adopts "∏" type a third support method, the stress and deformation was carried out on the linear guide rail pair is analyzed, the following figure 4:1/3 +" ∏" type support horizontal deformation analysis diagram shows, the linear guide rail pair deformation mainly produce in the middle position.

![Figure 4 horizontal 1/3 + “∏” type support deformation analysis diagram](image)

Through the analysis of the level in the state of three kinds of support way, found that the first way deformation approximately twice the second way, the second mode of deformation is about twice that of the third way, that in the condition of static level, "∏" type a third support better. When the linear guide rail pair tilts, stress state and deformation state whether there will be different, the following is to analyze in 30 ° inclined and 60 ° inclination of two kinds of condition.

2.4 30 ° inclined + middle support
In accordance with the above preconditions, under 30 ° inclined state adopts middle support method, the stress and deformation was carried out on the linear guide rail pair is analyzed, the following figure 5:30 ° inclined + middle support deformation analysis diagram shows, the linear guide rail pair deformation is mainly produced at both ends, and low deformation is bigger.
In accordance with the above preconditions, under 30 ° inclined state adopts two-terminal bracing method, the stress and deformation was carried out on the linear guide rail pair is analyzed, the following figure 6: 30 ° inclined + on both ends of the support deformation analysis diagram shows, the linear guide rail pair deformation mainly produce in the middle position.

2.6 30 ° inclined + 1/3 "∏" type support
In accordance with the above preconditions, under 30 ° inclined state adopts "∏" type a third support method, the stress and deformation was carried out on the linear guide rail pair is analyzed, the following figure 7: 30 ° inclined + "∏" "type a third support deformation analysis diagram shows, the linear guide rail pair deformation is mainly produced at both ends.
Through the analysis of three kinds of support under 30° inclined state, found that the first way deformation is significantly higher than the second and the third way, the second mode of deformation is about 1.5 times that of the third way under the static state of 30° inclined, "∏" type a third support is better. Horizontal combination of the above three ways of data comparison, found that in the condition of 30° inclined, three ways of deformation is less than level condition, but the middle support way difference to be markedly less than the other two ways[4].

2.7 60° inclined + middle support

In accordance with the above preconditions, in 60° inclined state adopts middle support method, the stress and deformation was carried out on the linear guide rail pair is analyzed, the following figure 8:60° inclined + middle support deformation analysis diagram shows, the linear guide rail pair deformation is mainly produced at both ends, and low deformation is bigger.

![Figure 8. 60° inclined + middle support deformation analysis diagram](image)

2.8 60° inclined + support at both ends

In accordance with the above preconditions, in 60° inclined state adopts two-terminal bracing method, the stress and deformation was carried out on the linear guide rail pair is analyzed, the following figure 9:60° inclined + on both ends of the support deformation analysis diagram shows, the linear guide rail pair deformation mainly produce in the middle position.

![Figure 9. 60° inclined + support deformation analysis diagram on both ends](image)

2.9 60° inclined + 1/3 "∏ type support

In accordance with the above preconditions, in 60° inclined state adopts "∏ type a third support method, the stress and deformation was carried out on the linear guide rail pair is analyzed, the
following figure 10: 60° inclined + "∏ type a third support deformation analysis diagram shows, the linear guide rail pair deformation is mainly produced at both ends, and low deformation is bigger.

![Figure 10. 60° inclined + 1/3 "∏ type support deformation analysis diagram](image)

The above nine state maximum deformation comprehensive analysis and comparison, see Figure 11: the biggest deformation analysis table, can be seen from the table, "∏ type a third support" means in the same state minimum deformation, this is consistent with the traditional theory of the strut, with the increase of Angle, three kinds of support way cause deformation decrease gradually [5].

| Angle   | The middle support level | On both ends of the support | "∏ type support by one-third |
|---------|--------------------------|-----------------------------|-----------------------------|
| 30°     | 9.377e-002               | 4.059 e-002                 | 2.656 e-002                 |
| 60°     | 8.342 e-002              | 3.617 e-002                 | 2.367 e-002                 |

![Figure 11. the biggest deformation analysis table](image)

3. Conclusion
In the process of using rotating linear guide rail pair, in the case of position structure allows, give priority to "∏ type support way, specific pivot location determined comprehensively combined with bearing and linear guide rail pair[6]; At the same time, through the above analysis that the smaller the Angle, the greater the deformation, as far as possible when in use and stop the linear guide rail pair in a bigger perspective, is conducive to guarantee the stability and precision of the linear guide rail pair.

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