

Error factors in vertical positioning system

Hyun-Gwang Cho, Wan-Seok Yang, Su-Jin Kim, Jeong-Seok Oh, Chun-Hong Park

Abstract—Machine tools are improved capacity remarkably during the 20th century. Improving the precision of machine tools are related with precision of products and accurate processing is always associated with the subject of interest.

There are a lot of the elements that determine the precision of the machine, as guides, motors, structure, control, etc. In this paper we focused on the phenomenon that vertical movement system has worse precision than horizontal movement system even they were made up with same components. The vertical movement system needs to be studied differently from the horizontal movement system to develop its precision. The vertical movement system has load on its transfer direction and it makes the movement system weak in precision than the horizontal one. Some machines have mechanical counter balance, hydraulic or pneumatic counter balance to compensate the weight of the machine head. And there is several type of compensating the weight. It can push the machine head and also can use chain or wire rope to transfer the compensating force from counter balance to machine head. According to the type of compensating, there could be error from friction, pressure error of hydraulic or pressure control error. Also according to what to use for transferring the compensating force, transfer error of compensating force could be occur.

Keywords— Chain chordal action, Counter balance, Setup error, Vertical positioning system.

I. VERTICAL MOVEMENT SYSTEM

The vertical movement system has load on its transfer direction than the horizontal one.

The gravity force which effects on the horizontal movement system does not affect at thrust force directly, but load at ball screw of vertical movement system are different when it moves upper side and down side [1],[2].

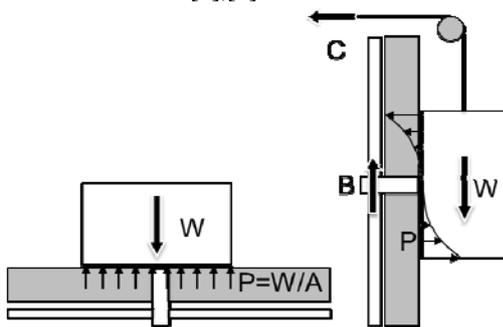


Fig. 1 Horizontal and vertical movement system

Hyun-Gwang Cho and Wan-Seok Yang are with the Department of Mechanical Engineering, Gyeongsang National University, 900 Gajwa, Jinju, 660-701, Korea (e-mail: elgar328@naver.com).

Su-Jin Kim is with the Department of Mechanical Engineering, Gyeongsang National University, 900 Gajwa, Jinju, 660-701, Korea (e-mail: sujinkim@gnu.ac.kr).

Jeong-Seok Oh and Chun-Hong Park are with the Korea Institute of Machinery & Materials, Daejeon, South Korea, 305-343 (e-mail: pch657@kimm.re.kr).

The counter balance to compensate the weight of vertical table is used in heavy machine tools. There are mechanical counter weight and hydraulic counter weight. The advantage of counter weight is reducing the weight and moment of vertical table and the disadvantage of it is the poor dynamic characteristic. And the chain connecting vertical table and counter weight causes counter force transmission error [3].

Vertical table is supported by guide such as slide guide, rolling guide and hydro static guide. The traction force moving vertical table up and down is made by ball screw or linear motor. If the table is too heavy to be sustained by motor, counter balance is used to compensate the weight of the table. The mechanical counter weight is indirectly connected by chain that transmits counter force [4].

II. FORCE & MOMENT IN VERTICAL GUIDE

Fig. 3 shows guide, ball screw, machine head, counter balance and force, moment that works on it.

Machine tool has setup error of it and also has assembly errors in it. So the gravity force direction of vertical table is not always same to counter force direction.

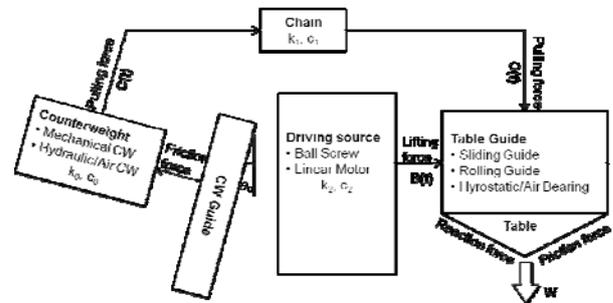


Fig. 2 Compensation system in vertical table

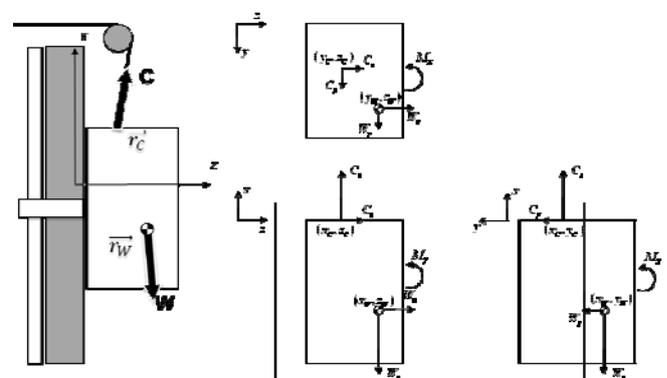


Fig. 3 Force & moment in vertical guide

If we define the moving direction x and normal direction y