Response analysis of inertia mass under dynamic load

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Abstract. In the fields of civil engineering, aerospace and mechanical manufacturing, inertia mass is a very common form of load. The research on the response of inertia mass under dynamic load can provide a strong basis for the research in the above fields. In this paper, in order to study the response of inertia mass under dynamic load, a high-speed dynamic actuator is used to carry out sinusoidal loading and impact loading on an inertia mass, and its response under dynamic load is studied, which can provide a basic basis for the follow-up study of inertia mass. It can be concluded from the response analysis of inertia mass that the motion of inertia mass satisfies the basic laws of kinematics and dynamics.

1. Introduction

In the fields of civil engineering, aerospace and mechanical manufacturing, inertia mass is a very common form of load [1-6]. The effects of inertial mass of electromagnetic damper on vibration insulation performance of vehicle regenerative suspension were studied by Pu et al [1]. Inertial load control method of pneumatic rollers was studied by Wang et al [4]. The seismic control performance of vertical irregular structure with weak story using inertia mass damper was researched by Zhang et al [5]. Therefore, the research on the response of inertia mass under dynamic load can provide a strong basis for the research in the above fields. In this paper, in order to study the response of inertia mass under dynamic load, a high-speed dynamic actuator is used to carry out sinusoidal loading and impact loading on an inertia mass, and its response under dynamic load is studied, which can provide a basic basis for the follow-up study of inertia mass. It can be concluded from the response analysis of inertia mass that the motion of inertia mass satisfies the basic laws of kinematics and dynamics.

2. Experiment design

The experiment devices are shown in Figure 1, including Bosch Rexroth electro hydraulic servo dynamic actuator, ball screw, rectilinear orbit and inertia mass. The measuring sensors include displacement sensor, force sensor and acceleration sensor. The composition of the dynamic actuator is shown in Figure 2.
3. Experimental phenomena and results

3.1. Loading program
In this experiment, the displacement loading is used, and the dynamic actuator is controlled by displacement control method. During the experiment, two kinds of loading are carried out, the one is standard sinusoidal loading mode of frequency 2.0Hz and displacement amplitude is 15.0mm; the other is impact loading and the displacement amplitude is 47.0mm. The loading program are shown in the Figure 3 and Figure 4, respectively.

3.2. Displacement response
The good tracking effect of the system is obtained by adjusting the PID parameters and acceleration feedback parameters of the system. In addition, the comparison of displacement command and displacement feedback of the two tests are shown in Figure 5 and Figure 6, respectively. The results show that the system has good displacement tracking effect and the system is stable.
3.3. Acceleration response
The acceleration response of inertia mass under the sinusoidal loading and the impact loading can be obtained by the acceleration sensor installed on the front articular hinge of the dynamic actuator, as shown in Figure 7 and Figure 8, respectively. According to the basic laws of kinematics and dynamics, the acceleration phase is consistent with the displacement phase, but the direction is opposite.

3.4. Force response
The inertia force of inertia mass (including the dynamic actuator front articular hinge, loading platform and counterweight) under sinusoidal loading and impact loading can be obtained by force sensor installed on the behind of dynamic actuator spherical hinge, as shown in Figure 8 and Figure 9, respectively. For force sensors, the tension is negative and the pressure is positive. According to the basic laws of kinematics and dynamics, the force response phase is consistent with the displacement phase, and the direction is same.

3.5. Result analysis
In this test system, the weight of the front articular hinge of the dynamic actuator, loading platform, and counterweight are 427 kg, 162kg and 368kg, respectively. Therefore, the sum of the inertia masses is 962kg. The peaks of the acceleration response and force response of sinusoidal loading and impact loading can be obtained from Figure 7, Figure 8, Figure 9 and Figure 10, respectively. Hence, the peak accelerations of the sinusoidal loading and impact loading are 0.242g and -5.48g, respectively; and the peak inertia force of the sinusoidal loading and impact loading are -2.277kN and 52.23kN, respectively. According to the Newton's second law, the weight of the inertia mass of sinusoidal loading and impact loading can be deduced respectively, and the weight of the inertia mass of sinusoidal loading and impact loading are 960.01kg and 972.55kg, respectively. From the above results, it can be seen that the measured value and the calculated value of the inertia mass weight of sinusoidal loading and impact loading have good consistency.
4. Conclusions
In this paper, in order to study the response of inertia mass under dynamic load, a high-speed dynamic actuator is used to carry out sinusoidal loading and impact loading on an inertia mass, and its response under dynamic load is studied, which can provide a basic basis for the follow-up study of inertia mass. The measured value and the calculated value based on the Newton's second law of sinusoidal loading and impact loading of inertia mass weight have good consistency, and the maximum relative error is 1.10%. In summary, it can be concluded from the response analysis of inertia mass under dynamic load that the motion of inertia mass satisfies the basic laws of kinematics and dynamics.

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