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Performance Test Research of New Viscous Damper

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Abstract. With the progress of engineering, technology viscous damper are widely used in the field of engineering structures. Its principle is that when the external normal disturbance on the structure, the viscous damper will not generate damping force on the structure; when there is a strong external disturbance (strong earthquake, strong wind), The dampers can produce a reaction force, which can reduce the damage of the structure and improve its seismic capability. In this paper, the new viscous damper has been experimentally tested, including: 1. Test for maximum damping force; 2. Test for damping coefficient, damping exponent; 3. hysteresis curve. By analyzing the experimental data, the actual performance parameters of the new viscous damper are obtained, which provides certain support for future mass production and use of the product.

1.Introduction

Earthquake is a kind of common natural disaster in human society[1], which has the characteristics of large destruction intensity and undeterminable occurrence time. Usually high magnitude shallow earthquakes can cause a large number of casualties and significant economic losses. It is also one of the most threatening natural disasters. In recent years, viscous dampers have been widely used in seismic field due to their excellent damping effect[2]-[5]. In this paper, the new viscous damper has been experimentally tested, including: 1. Test for maximum damping force; 2. Test for damping coefficient, damping exponent; 3. hysteresis curve. The results show that the new viscous damper has good performance and meets the experimental expectation.

2.Experiment

2.1.loading equipment

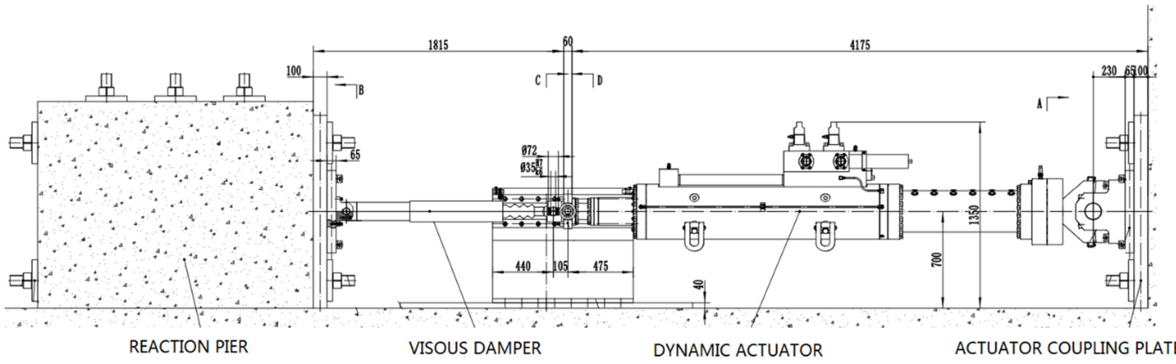


Figure 1. The layout of loading and measuring devices.

as shown in the figure 1. A dynamic actuator with a maximum output of 50t and a stroke of ±500mm was used in this test. The viscous damper is fixed between the reaction pier and the dynamic actuator.

2.2.test purpose

In this paper a new type of viscous damper has been experimentally tested. It includes its maximum damping force, damping coefficient, damping exponent and hysteresis curve. Its type for this test is VFD-NL×200×±180, and its technical parameters are shown in Table 1

Table 1. Viscous damper specifications.

Damper type	Maximum damping force（kN）	Maximum speed（mm/s）	Limit range（mm）
VFD-NL×200×±180	200	1500	±180

2.3.Loading method

2.3.1.Maximum damping force.

In this experiment, first of all, under the circumstances of 120mm amplitude, 2Hz frequency and 1500mm/s, the specimen is loaded and recycled with sinusoidal wave 5 times. Secondly, The damping force and displacement hysteretic curves are recorded. Lastly, The maximum damping force corresponding to the third cycle is taken as the measured value. during the whole process, the maximum measured damping force of viscous dampers should be within ±15% of 200kN(170kN-230kN). At the same time, There is no structural damage, yield, damage, permanent deformation or leakage.

2.3.2.Measurement of damping coefficient, damping exponent and hysteresis curve.

In this experiment, first of all, the viscous damper is loaded five times respectively (u0=±120mm, 2Hz and u0=±27.66mm, 1.72Hz). Secondly, the damping force and displacement hysteretic curves are recorded. Lastly, the damping coefficient and damping exponent to the third cycle are measured values. throughout the process, the difference in force output between the first cycle and the fifth cycle is no more than ±15%. The damping curve should be smooth, without mutation, and the rate of change of envelope area should not be more than ±15%. In each test, there is no structural damage, yield, damage, permanent deformation or leakage.

3. experimental results

3.1.Maximum damping force test

We tested it at a loading rate of 2Hz, Horizontal displacement of ±120mm, Horizontal velocity of a 1500mm/s, and loaded five cycles. The testing results look as following.

Table 2. Viscous damper measuring parameter

Testing displacement （mm）	Testing speed （mm/s）	Damping force（kN）		
		Design value （kN）	Measured value （kN）	Deviation ratio
±120	1500	200	172	-14%

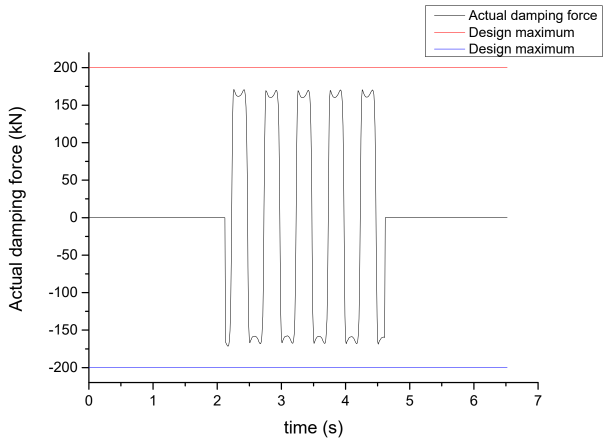


Figure 2. Maximum damping force

As shown in figure 2, the damping force is 172kN, which meets the requirements of 85%-115% (170kN~230kN) of the maximum design damping force of 200kN. The difference between the measured value and the design value is 14 percent, which is in line with the expectation.

3.2.Measurement of damping coefficient, damping exponent and hysteresis curve

In this paper, the damping coefficient and damping exponent are determined by the test of two working conditions (one is u0=±120mm, 2Hz and the second is u0=±27.66mm, 1.72Hz).

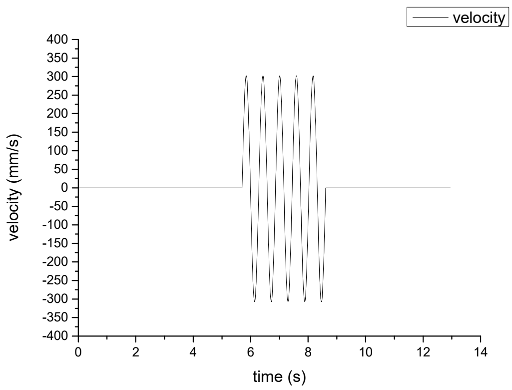


Figure 3. Maximum speed of 1.72 Hz

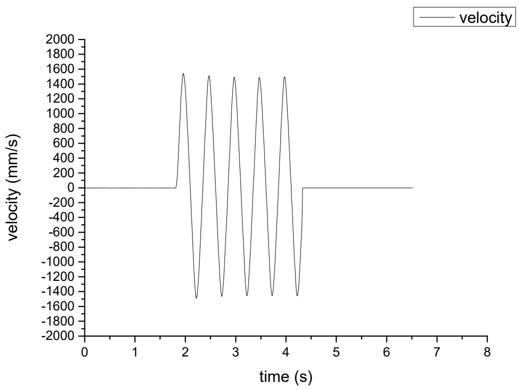
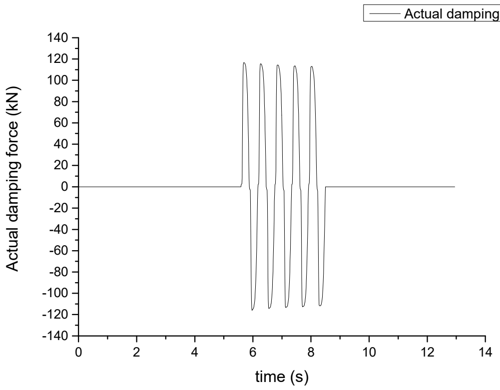


Figure 4. Maximum speed of 2 Hz



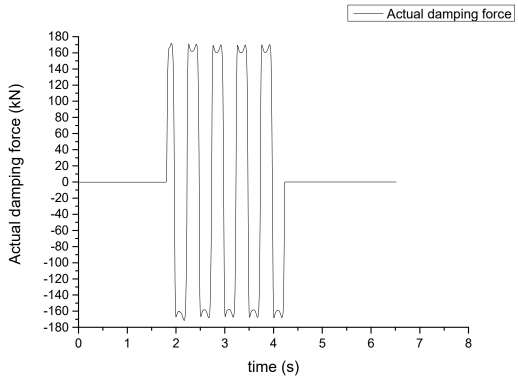


Figure 5. Maximum damping force of 1.72 Hz

Figure 6. Maximum damping force of 2 Hz

As shown in figure 3 and figure 5 in working condition one, when the working condition is 1.72 Hz, the maximum velocity is 302.3mm/s and the maximum force is 116.7kN. In the second condition shown in figure 4 and figure 6. when the working condition is 2 Hz, the maximum velocity is 1543.7mm/s and the maximum force is 171.6kN. In both cases the difference in force output between the first cycle and the fifth cycle is no more than ±15%, which was in line with experimental expectations.

According to the values of damping force and viscous damper velocity in the test results, the damping coefficient and damping exponent can be calculated as 155198.9N*(s/m) and 0.2364 respectively.

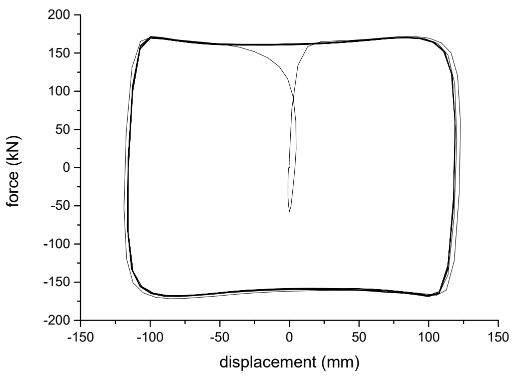


Figure 7. Test hysteresis curve

Figure 8. Photo of device

As can be seen from the figure 7. The hysteretic curve is smooth without abrupt change, which was in line with the experimental expectation. During the whole experiment there are no structural damage, yield, damage, permanent deformation or leakage occurred.

4. Conclusions

In this paper, a new viscous damper has been tested and analyzed, and the conclusions are as follows:

1. The test speed is required to be 1500mm/s, and the damping force is 172kN, which meets the requirements of 85%-115% (170kN~230kN) of the maximum design damping force of 200kN.
2. The difference in force output between the first cycle and the fifth cycle is no more than ±15%.
3. Damping coefficient is155198.93 N*(s/m), And damping exponent is 0.2364.
4. The damping curve is smooth without mutation and the rate of change of envelope area is no more than ±15%.
5. In each test, there is no structural damage, yield, permanent deformation or leakage.

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