World Scientific Research Journal (WSRJ) ISSN: 2472-3703
www.wsr-j.org

Vibration Characteristic Test of Turbine-generator Spring Vibration Isolating Foundation

An Dong

School of Civil Engineering, North China University of Technology, Beijing, China

hadesloveln@163.com

Abstract: The spring vibration isolation foundation is more and more used in the large capacity generator units. On the basis of the study on spring vibration isolating foundation of full-speed turbine-generator, the following research is carried out in this paper. The natural frequency of the turbine-generator foundation plate is obtained by hammer modal test. It is shown in the studies, the first-order frequency of the spring vibration isolating foundation can be kept below 3Hz, and the natural frequency is densely distributed between 0 and 30 Hz, avoiding the disturbance frequency generated by the turbine-generator operating.
Keywords: spring vibration isolated foundation, natural frequency, hammer test

---

1. INTRODUCTION

In recent years, with the development of China's economy, large capacity turbine-generator units have gradually replaced small capacity units in power plant production. In order to reduce the vibration caused by the increase of the unit power, the spring vibration isolation foundation is more and more favored by the power plant construction. Spring vibration isolation device is arranged between the plate and the upright column of the turbine foundation, and rigid connection of the original frame is changed into flexible, which is called spring vibration isolating foundation. The vibration isolation spring enables the plate and the column to detach from the dynamic coupling and reduce the horizontal stiffness of the foundation. The utility of isolation spring can effectively absorb the vibration generated in the operation of the unit, and prevent the vibration energy from transmitting to the substructure [1], such as column and equipment piping, thereby reducing the influence of vibration on the foundation.

Compared with the rigid foundation, the spring vibration isolation foundation can reduce the size of the column and save space for equipment. Since the introduction of the spring vibration isolation foundation in the last century, a large number of model tests have been carried out in China [2-5].

In order to comprehensively and accurately study the vibration characteristics of spring vibration isolation foundation, the spring vibration isolating foundation of full-speed turbo-generator is tested in the field.

2. VIBRATION CHARACTERISTIC TEST

2.1 Layout of Measuring Points

When the construction of the foundation structure and the power plant is completed, the installation and setup of the equipment are shown in Fig. 1. After the spring vibration isolator is released to the working state, the vibration characteristics of the foundation plate are tested. The measuring points are arranged evenly and evenly to each position of the whole plate, and arranged at the important bearing seats. The measuring points are symmetrically distributed on the longitudinal axis of the turbine-generator, which are shown in Fig. 2. Only the operating plate is tested, not the columns and the middle plate in the vibration characteristic test.

Fig. 1 Photo of foundation operating plate

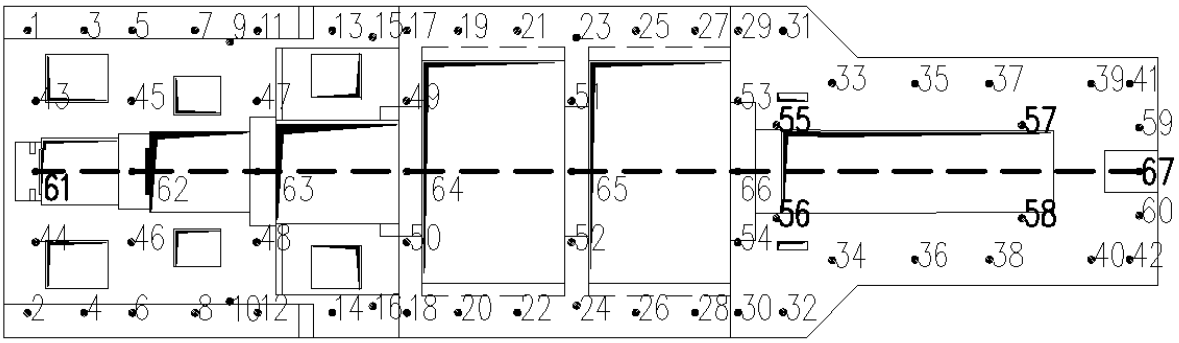

Fig. 2 Layout of measuring points

2.2 Test method

In this paper, the size of the foundation plate is 55.886m×16.0m, and the excitation method and the pulse method are difficult to realize the excitation of the whole structure. The modal test uses the hammer method which is easy to detect exciting signals and has high modal identification rate. The frequency of the civil structure is lower, and the natural frequency of the turbine-generator with spring isolation is lower than that of the rigid foundation. Therefore, a rubber hammer which can excite low frequency is used in the hammer test. Single-point, single-direction hammer and multi-point space measurement are used in the tests. The hammer and acceleration sensor are shown in Figure 3. The three hammer points and directions are horizontal transverse (X)-No.25, horizontal longitudinal(Y)-No.43 and vertical (Z)-No.14.The setting of the three hammer points ensures that the energy excited by hammer is distributed evenly across the plate. To improve the test accuracy and reduce the environmental vibration effect, the average function is used to obtain the transfer function (FRF).

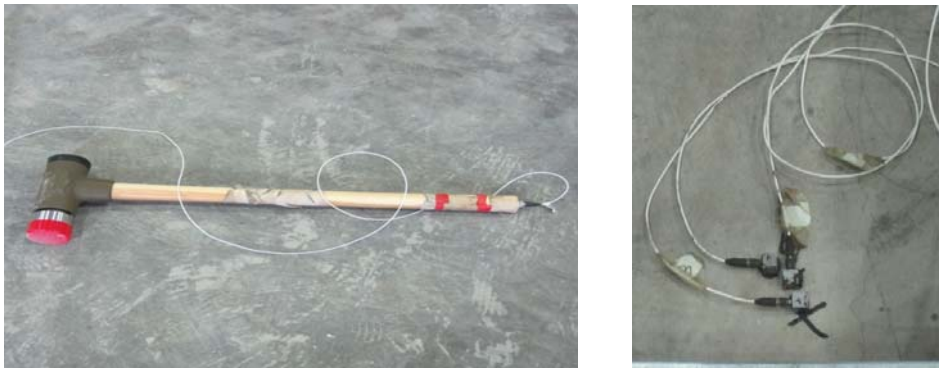

Fig. 3 Force hammer and acceleration sensor used in vibration characteristics test

2.3 Test results

The natural frequencies of the foundation operating plate are obtained by the series of tests, as shown in Table 1. The natural frequency distribution is shown in Fig. 4. The analysis results from the model test, the first-order natural frequency of direction X, Y and Z were 0.99Hz, 1.56Hz, 2.76Hz, compared to the general frame of rigid foundation is much smaller, and far less than the normal working frequency of turbine-generator. Through the analysis of natural frequency distribution, it can be found that frequency is more intensive in the range of 0-30Hz and sparse around about 50Hz. By setting the spring vibration isolator, the natural frequency of the foundation can effectively avoid the working frequency of turbine-generator.

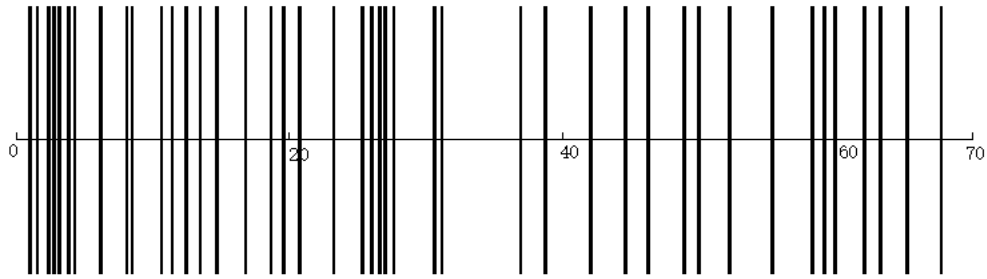

Fig. 4 Natural frequency distribution of foundation

TABLE 1. Natural frequency value of foundation

Order	Transverse (X)		Longitudinal (Y)		Vertical (Z)	
	Frequency (Hz)	Damping ratio (%)	Frequency (Hz)	Damping ratio (%)	Frequency (Hz)	Damping ratio (%)
1	1.56	12.73	0.99	18.3	2.76	9.37
2	8.50	2.80	1.04	9.78	3.17	6.07
3	12.44	1.00	2.37	2.31	3.83	1.50
4	13.46	0.78	6.23	1.67	4.28	12.11
5	18.63	1.23	11.44	0.88	6.12	4.28
6	27.21	0.97	14.69	0.59	8.08	1.85
7	30.63	2.08	26.01	0.44	10.66	3.05
8	46.73	0.57	27.64	0.71	19.58	1.10
9	52.27	0.20	31.17	0.35	25.35	0.40
10	58.31	0.32	38.78	0.95	27.00	1.11

3. CONCLUSION

In the paper, natural frequency of spring turbine-generator vibration isolation foundation is obtained according to the hammer modal test. The spring vibration isolation device reduces the natural frequency of the foundation and causes most of the natural frequency of the plate away from the normal operation frequency of the turbine-generator.

ACKNOWLEDGEMENTS

This paper was supported by the Youth Talent Support Program of North China University of Technology (XN018034). The authors' deeply express sincerely appreciation to them.

REFERENCES

[1] G. Sh. Luo, J. X. Fang, and J. Wang, “Aseismic performance of spring supported turbo-generator foundation”, Engineering Journal of Wuhan University, 2009, Vol.42 (S1), p436-442.

[2] X. Y. Shao, J. Z. Zhou, and X. J. Yin, “Research of model test of spring vibration isolated turbine generator foundation-pseudo dynamic earthquake test”, Engineering Journal of Wuhan University, 2011, Vol.44 (S1), p389-392

[3] Q. H. Li, “Study on spring isolated frame foundation model of turbine generators of a nuclear power plant”. Harbin: Harbin Institute of Technology, 2013.

[4] M. M. Zan, “Research on the horizontal seismic behavior of the vertical vibration damping spring structure”. Beijing: North China University of Technology, 2015.

[5] X. Y. Wang, “Research on the seismic performance of spring vibration isolation foundation of steam-turbine generator considering gravity effect”. Beijing: North China University of Technology, 2016.

[6] Y. Li, Y. Luo, C. X. Sha, “Inquisition into Foundation Vibration Criteria of “Linear Displacement” or “RMS Velocity””, Electric Power Construction, 2004, Vol.25 (4), p39-41.