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

Experimental Study on Vibration Response of Turbine-generator Spring Vibration Isolating Foundation

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Abstract: In this paper, the vibration response of spring vibration isolating foundation of full-speed turbine-generator is studied. The vibration line displacement of the bearing seat under different working conditions when commissioning is obtained. It is shown in the studies, the velocity RMS value and the vibration displacement response of the bearing seat on the plate are in accordance with the relevant specification when the turbine-generator unit is commissioning. When the turbine-generator unit is load-down, speed-down and vacuum-breaking, the displacement response curve of the bearing seat indicates that the shafting of the unit is not deformed and the design meets the requirements.
Keywords: spring vibration isolated foundation, vibration response, line displacement, velocity RMS, displacement response

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1. INTRODUCTION

The spring vibration isolation is more and more applied in the turbine-generator foundation by the power plant construction. 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. However, each unit is different, spring isolation devices need to be individually designed. It is necessary to study the vibration response of turbine-generator foundation with spring isolation separately. 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 response of spring vibration isolation foundation, meanwhile, study vibration displacement of bearing seat under different working conditions, the spring vibration isolating foundation of full-speed turbo-generator is tested in the field.

2. VIBRATION RESPONSE IN FULL-LOAD OPERATION

2.1 Layout of Measuring Points

When turbine-generator full-load operating, the vibration response of the foundation plate is tested under the steady running condition of the turbine-generator unit. The velocity RMS value and vibration displacement can be obtained under the stable running state to determine whether the vibration of foundation plate meets the vibration control standard when the unit is running. The bearing seat is the position that the foundation plate directly receives the disturbing action caused by the operation of the turbine-generator unit, and its vibration response is very important to the safe operation of the unit. Therefore, this research mainly contains the vibration response of the bearing seat. When the unit is in operation, the measuring points of No.62-No.66 are in the high, medium and low pressure cylinder, and cannot be tested. In this paper, No.55, No.56, No.57 and No.58 located on generator side, No.61 located on ultra-high pressure cylinder and No.67 on exciter are taken as the final measuring points, which are shown in Fig. 1.

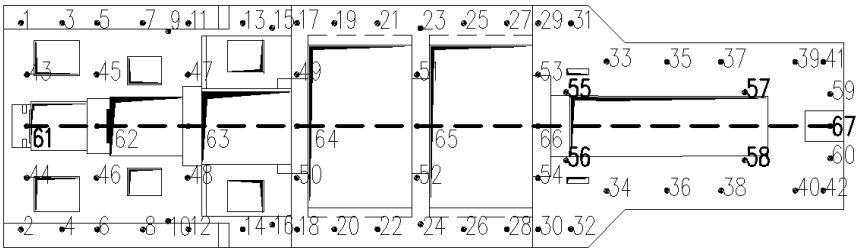


Fig. 1 Layout of measuring points

2.2 Test method

At present, the vibration evaluation of large turbine-generator foundation is based on the root mean square velocity (RMS) value or the vibration line displacement as the vibration parameter [6]. In order to test the vibration response of foundation plate when full-load operation, the velocity response is collected by velocity sensor of each measuring point, using LMS software to change speed signal to the displacement signal, so as to obtain the velocity RMS value and line displacement value.

Fig. 2 Speed sensor used in vibration response test

2.3 Measuring Results

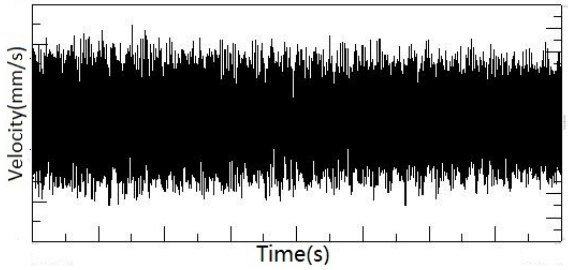
The maximum values of root mean square velocity and line displacement at the bearing seat are shown in Table 1.The maximum value of velocity RMS at the bearing seat is 0.99mm/s and the value of vibration line displacement is 9.44μm. The design of the spring vibration isolation foundation meets the control standard of vibration: the vibration RMS velocity value is less than 2.8mm/s, the vibration linear displacement value is less than 25.2μm [7-8].

Table 1 Vibration response of bearing seat

Measuring Point	Velocity RMS Value(mm/s)			Line Displacement (μm)		
	Transverse (X)	Longitudinal (Y)	Vertical (Z)	Transverse (X)	Longitudinal (Y)	Vertical (Z)
55	0.63	0.62	0.98	7.18	3.45	5.05
56	0.23	0.14	0.20	5.30	2.71	3.52
57	0.30	0.14	0.30	4.92	2.94	8.26
58	0.99	0.37	0.10	6.39	2.81	5.86
61	0.38	0.87	0.04	9.44	7.18	0.90
67	0.30	0.32	0.39	6.74	3.25	5.55

Vibration of foundation plate is not caused by a single source, each frequency component and the frequency distribution of the spectrum range, in the dynamic signal can be obtained from spectrum analysis. In this analysis, amplitude and energy distribution of each frequency component can be computed so as to get the main frequency value and its amplitude with energy distribution. The velocity response of each measuring point is obtained by setting the speed sensor on the plate, and the frequency response spectrum of the velocity response is measured by the FFT, so that the amplitudes corresponding to different frequency can be analyzed. Fig. 3 and Fig. 4 are velocity time domain curve and spectra of No.61. It can be seen from Figure 4, in addition to running force corresponding to the 50Hz frequency, the low

frequency section of the velocity spectrum has large amplitude, illustrate that there is a low frequency vibration source in the environment of unit operation. The low-frequency vibration source has influence on the vibration of the plate.



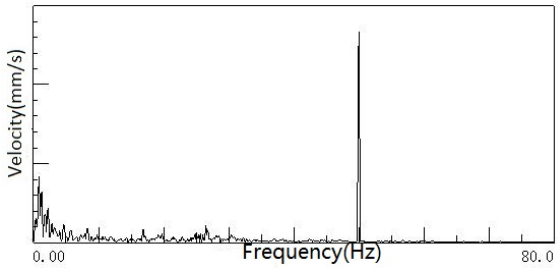


Fig.3 Velocity response in time-domain Fig.4 Velocity response Fourier spectrum

3. VIBRATION DISPLACEMENT OF BEARING SEAT UNDER DIFFERENT WORKING CONDITIONS

3.1 Test Method

There will be a series of setup process before the operation of the turbine unit. The shafts of the unit will be affected by a variety of working conditions. The vibration line displacement of the plate bearing seat can reflect the bearing load. Measuring points are arranged at each bearing seat of the foundation plate, and the vibration displacement of the bearing seat under different working conditions is collected, so as to obtain the vibration displacement response of the bearing seat under different working conditions.

3.2 Test Results

The setup and commissioning process of the unit mainly includes the stage of load-down, speed-down and vacuum-breaking. In this paper, the vibration displacement curve of each bearing seat is tested at different stages, as shown in Figure 5.

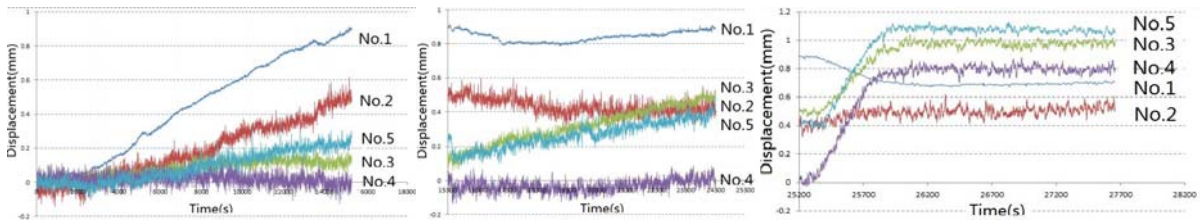


Fig.5 Displacement response of load-down, speed-down and vacuum-breaking

4. CONCLUSION

In the paper, the vibration response of foundation plate under turbine operating is studied; the vibration line displacement under different working conditions of bearing seat is obtained and compared. The vibration response of the foundation plate during the normal operation of the turbine is studied. The analysis of the velocity spectrum shows that the vibration energy corresponding to the low frequency section is more obvious, and the vibration caused by the low frequency vibration source of the foundation cannot be neglected. The vibration displacement of the bearing seat under different working conditions is compared, and the influence of vacuum-breaking on the vibration line displacement is large.

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.

[7] Mechanical Vibration-Evaluation of Machine Vibration By Measurements on Non-rotating Parts-Part 2: Land-based Steam turbines and generators in excess of 50MW with normal operating speeds of 1500r/min, 1800r/min, 3000r/min and 3600r/min (GB/T 6075.2-2007/ISO10816-2:2001), Standard Press of China, Beijing, 2001.

[8] Code for Design of Dynamic Mechanic Machine (GB50040-96), China Planning Press, Beijing, 1997.