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GROUND VIBRATION MONITORING FOR SXFEL CONSTRUCTION AT SSRF*

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Abstract

Shanghai X-ray Free Electron Laser test facility (SXFEL) began construction on Dec.30 2014. It is quite important to monitor the ground vibration influenced by the construction at Shanghai Synchrotron Radiation Facility (SSRF), because the SXFEL is just in the north of SSRF and the nearest distance is only 20m. In this paper, the results of ground vibration measurement during the construction period at SSRF experimental hall, tunnel and experimental room near the SXFEL site are shown. Vibrations at different hours, frequency bands and directions are discussed to provide more detailed information on the influence of SXFEL construction to SSRF.

INTRODUCTION

Shanghai X-ray Free Electron Laser test facility (SXFEL) with total length about 300 meters is being built at Zhangjiang campus of Shanghai Institute of Applied Physics (SINAP), where Shanghai Synchrotron Radiation Facility (SSRF) is situated [1]. SXFEL began construction on Dec.30, 2014. It is quite important to monitor the ground vibration influenced by the construction at Shanghai Synchrotron Radiation Facility (SSRF), because the SXFEL is just in the north of SSRF and the nearest distance is only 20m.

METHODOLOGY AND EQUIPMENT

Large-scale pile foundation construction of SXFEL started on Mar. 9, 2015, so a series of vibration measurements were carried out at the SSRF Experimental Hall, Tunnel and Experimental Room since Mar. 2015. The measurement points of A, B, C at SSRF are shown in Fig. 1. Point A locates on the floor of Experimental Hall, with B on the floor of Room 1049 and C in the tunnel. We used a DHDAS5927 data acquisition system and DH610 seismometers from Donghua Testing Technology Co., LTD, China. The test site of A is shown in Fig. 2.

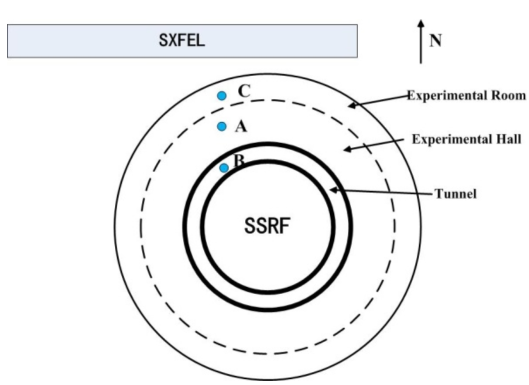

Figure 1: Measurement points at SSRF.

Figure 2: Test site on the floor of Experimental Hall.

The displacement power spectrum density (PSD) and integrated root-mean-square (RMS) displacement are derived based on the data analysis techniques [2].The range of the RMS displacement is between 1 Hz to 100 Hz, which is within the effective frequency band of the DH610 seismometer.

MEASUREMENT RESULTS

Contrast of Vibration with and without Pile Foundation Construction

The contrast of continuous RMS displacements of the measurement point A at SSRF Experimental Hall in vertical direction, west-east (W-E) direction and north-south (N-S) direction every Friday in Mar. 2015 before and after large scale pile foundation construction are shown individually in Figs. 3–5. It can be seen that large scale pile foundation construction affects greatly on ground vibration in the vertical direction while affects less on vibration both in the W-E and N-S directions.

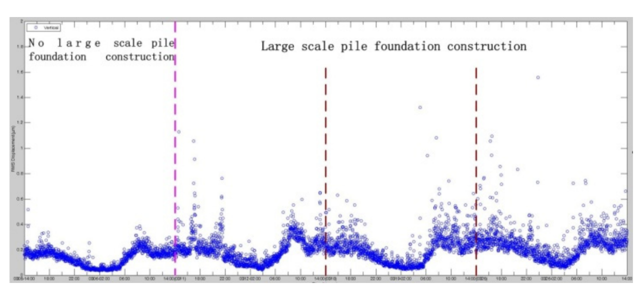

Figure 3: RMS displacement of the point A at SSRF Experimental Hall in vertical direction every Friday in March, 2015.

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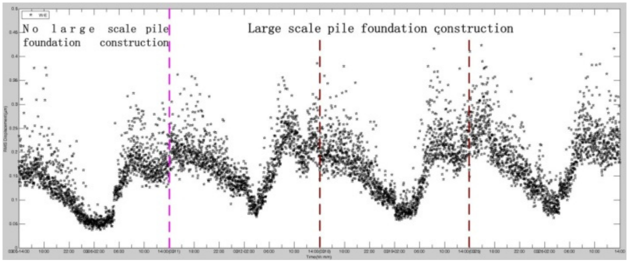

Figure 4: RMS displacements of the point A at SSRF Experimental Hall in west-east direction every Friday in March, 2015.

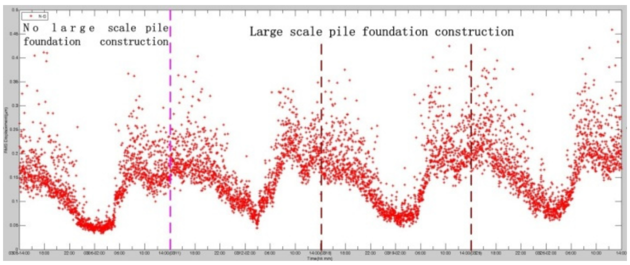

Figure 5: RMS displacements of the point A at SSRF Experimental Hall in north-south direction every Friday in March, 2015.

Contrast of Vibration with and without Surface Construction

Surface foundation construction began on May 6, 2015 and then we studied the effect of surface construction on ground vibration. The contrast of continuous RMS displacements of the point A at SSRF Experimental Hall in vertical direction and N-S direction every Friday in May, 2015 with and without surface construction are shown individually in Figs. 6 and 7.

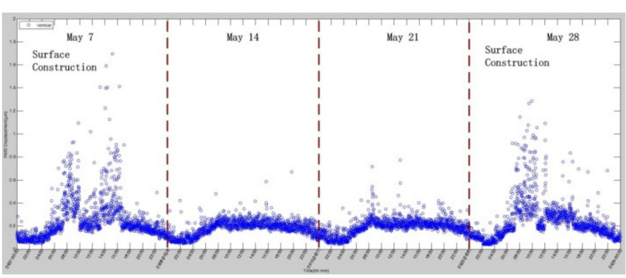

Figure 6: RMS displacement of the point A at SSRF Experimental Hall in vertical direction every Friday in May, 2015.

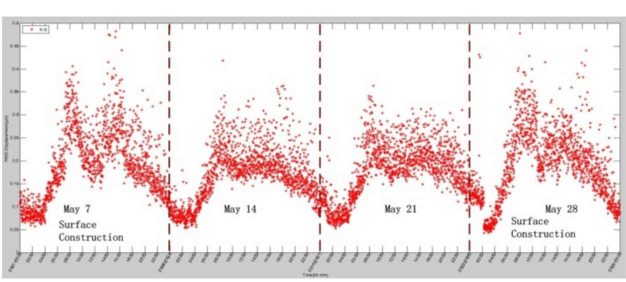

Figure 7: RMS displacements of the point A at SSRF Experimental Hall in N-S direction every Friday in May, 2015.

It can be seen that vibration of Hall floor in the vertical direction increased greatly on May 7 and May 28 because of the vibration of on-site construction vehicles such as excavator, crane, etc. In contrast, vibration of Hall floor in the vertical direction dropped greatly on May 14 and May 21 because the two days are during concrete curing and there was rarely vehicles working on site. The real scenes of SXFEL construction at 9:00 A.M. on May 14 and May 28 are shown individually in Figs. 8 and 9.

Figure 8: SXFEL construction site at 9:00 A.M. on May 14, 2015.

Figure 9: SXFEL construction site at 9:00 A.M. on May 28, 2015.

Contrast of Vibration on Different Floor

In order to study the ground vibration of SXFEL construction on different floor, we placed 3 typical measurement points shown in Fig. 10: Point A located on the floor of Experimental Hall, Point B located on the Tunnel floor, Point C located on the floor of 1049 Room (Experimental Room). Floor of Point A and floor of Point B are the same floor with 1m thickness and 48m-height pile underground, while the floor of Point C is only 0.12 m thick with no pile underground and there is no connection with floor of Point A or Point B.

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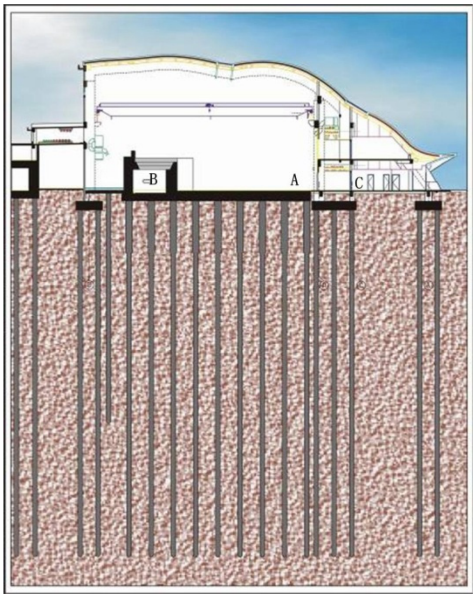

Figure 10: Measurement points at SSRF.

PSD and RMS curves of vibration of Point A (Hall), Point B (C14) and Point C (Room 1049) during noisy and quiet time in vertical direction are shown in Figs. 11-14.

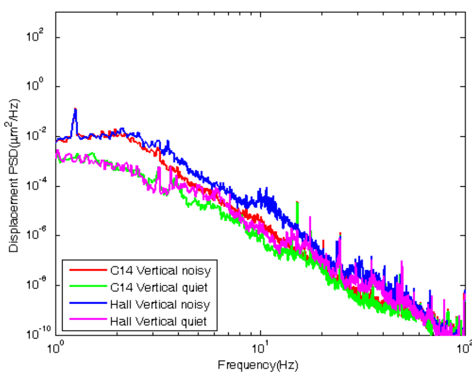

Figure 11: PSD curves of ground vibration of Point A (Hall) and Point B (C14) in noisy and quiet time at SSRF in vertical direction.

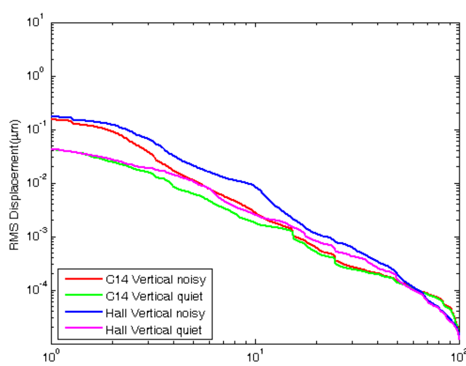

Figure 12: RMS curves of ground vibration of Point A (Hall) and Point B (C14) in noisy and quiet time at SSRF in vertical direction.

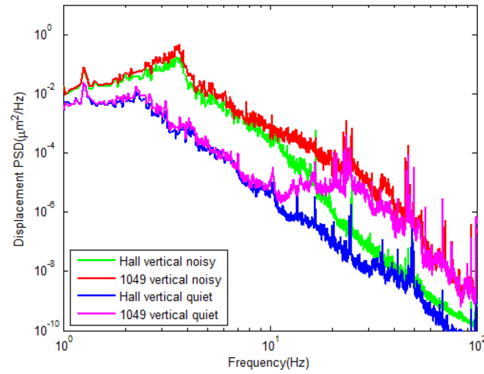

Figure 13: PSD curves of ground vibration of Point A (Hall) and Point C(Room 1049) in noisy and quiet time at SSRF in vertical direction.

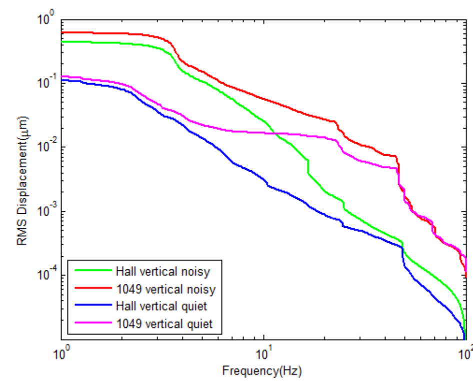

Figure 14: RMS curves of ground vibration of Point A (Hall) and Point C(Room 1049) in noisy and quiet time at SSRF in vertical direction.

RMS values of ground vibration in Tunnel, Experimental Hall and Room 1049 in noisy and quiet time are listed in Table 1 and Table 2.

Table 1: RMS Values of Ground Vibration in Noisy Time

Noisy	**Tunnel**	**Hall**	**Room 1049**
Vertical	420.4 nm	441.8 nm	612.6 nm
N-S	231.2 nm	234.7 nm	239 nm

Table 2: RMS Values of Ground Vibration in Quiet Time

Quiet	**Tunnel**	**Hall**	**Room 1049**
Vertical	107.3 nm	110.9 nm	126 nm
N-S	102.7 nm	105.8 nm	109.7 nm

It can be seen that RMS value of vibration of tunnel between 1 to 100 Hz is a little less than that of Hall. PSD curves of vibration of tunnel and Hall differ little because the floor of tunnel is just the same with the floor of Hall.

The vibration of Hall floor is less than that of floor of Room 1049. What's more, the vibration above 10 Hz on Hall floor is much less than of floor of Room 1049. The floor of Tunnel and Hall has a better damping effect to vibration above 10 Hz.

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Difference between noisy time and quiet time is relatively large whether in the vibration of Tunnel, Hall floor or floor of Room 1049, especially between 1 and 10 Hz.

CONCLUSIONS

SXFEL finished construction of main structure and decoration engineering by Mar. 2016. Ground vibration caused by SXFEL construction at SSRF has been studied in this paper. Continuous tests are performed both during pile foundation construction and surface construction. Conclusions to be drawn are as follows.

(1) SXFEL construction affects greatly on ground vibration in the vertical direction while affects less on vibration in the N-S and W-E direction.

(2) The floor of Tunnel and Hall has a better damping effect to vibration above 10 Hz than that of Experimental room due to different floor structure.

(3) Ground vibration between noisy time and quiet time is relatively large whether on the floor of Tunnel, Hall floor or Room 1049, especially between 1 and 10 Hz.

REFERENCES

[1] Shanghai X-ray FEL Concept Design Report, Shanghai, 2015.

[2] D.B. Li and Q.H. Lu, “Analysis of Experiments in Engineering Vibration”, Beijing, China: Tsinghua University Press, 2011.