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Vibration Reduction Evaluation of an Isolated EDG Model

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1. Introduction

A vibration and noise are among one of the well known problems of a rotational machine. An Emergency Diesel Generator (EDG) is one of the safety related equipments of a Nuclear Power Plant. The EDG system also has a vibration problem. Kim, et al [1,2] studied the operating vibration problem of the EDG system in Yonggwang 5, Ulchin 2 and 3 unit. Foundation systems of the Yongwang 5, Ulchin 2 and 3 unit EDG systems are an anchor bolt, coil spring with a seismic mass and a coil spring & viscous damper system, respectively. But in these cases it is impossible to evaluate the vibration reduction effect according to the spring system. So, in this study, a small scale EDG model and a spring-damper system were developed and a vibration was measured. For a producing a sine wave vibration, a vibration generator was produced. As a result, at least 80% of a vibration was decreased by using the coil spring and viscous damper system.

2. Test Model

The target EDG system is the 16PC2-5V400 manufactured by the SEMT Pielstick Corporation. This EDG generates 7000kW of electricity and the velocity is 541 RPM. The EDG operates for 1 hour every one month. These types of EDG are one of the most widely used in Korea. One of these EDG systems which is located in the Yonggwang 5 unit NPP is shown in Figure 1(a) and the scaled model is shown in Figure 1(b).

(a) Target EDG System (b) Scaled Test Model
Fig. 1 Emergency Diesel Generator

For the design of an isolation system, the static and dynamic stability were considered. The drawing and the produced isolation systems are shown in Figure 2. The mechanical properties are summarized in Table 1.

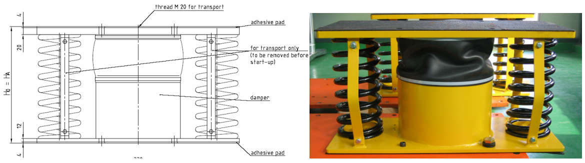


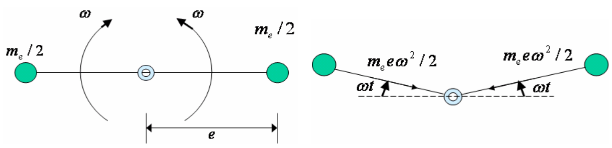
Fig. 2 The Isolation System for Test Model of EDG System

Table 1 The Properties of Isolation System

Item	Properties	
Load Capacity	15 kN	
Stiffness	Vertical	0.144 kN/mm
	Horizontal	0.04 kN/mm
Damping Coefficient	Vertical	3.5 kNs/m
	Horizontal	4.0 kNs/m
Height	410mm	

3. Vibration Generator

For the produce of a harmonic vibration like an operational EDG, a vibration generator is manufactured. This type of vibration generator is based on a very simple theory about eccentricity. The two counter-rotating masses, $m_e/2$, are shown schematically in Figure 3 as lumped masses with an eccentricity=e; their locations at t=0 are shown in (a) and at time t in (b). The x-components of the inertia forces of the rotating masses are cancelled out, and the y-components combine to produce a force



(a) (b)
Figure 3. Schematic Drawing of Vibration Generator

$$p(t) = (m_e e\omega^2)\sin\omega t \qquad (1)$$

By bolting the vibration generator to the structure to be excited, this force can be transmitted to the structure. The amplitude of this harmonic force is proportional to the square of the excitation frequency ω. Therefore, it is difficult to generate a force at low frequencies and impractical to obtain the static response of a structure. The drawing of the vibration generator is shown in figure 4.

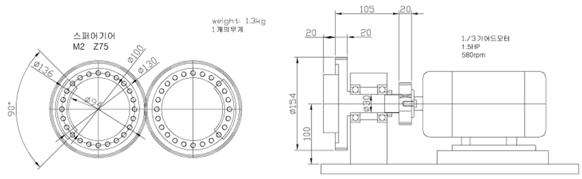
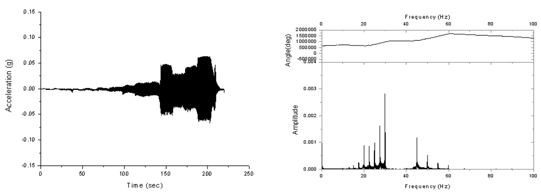


Figure 4. The Drawing of Vibration Generator

4. Vibration Reduction Test

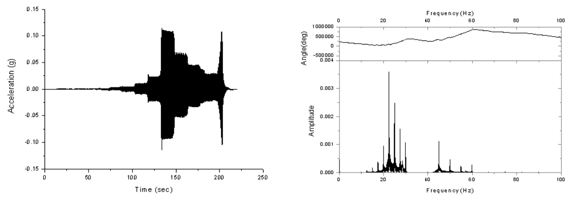
For the vibration reduction effect according to the foundation type, the vibration measurements were performed for two cases, isolation and non-isolation cases. The vibration frequencies are varied from 2.5Hz to 30Hz. The increment is 2.5Hz and a total of 12 steps were measured.

The non-isolation cases responses are shown in the Figure 5 and 6. The results are presented in the time and frequency domain. Figure 5 shows the response of the body of the EDG model and Figure 6 shows that of the floor. In this case, the responses of over 30Hz are the reflection waves. As shown in the figure, the responses are magnified till 25Hz, but at over the 25Hz vibrations the responses are decreased. The range of the operational frequencies of the EDG systems is below 10Hz, so the fixed type foundation systems are not appropriate for the EDG system.



(a) Time Domain (b)Frequency Domain

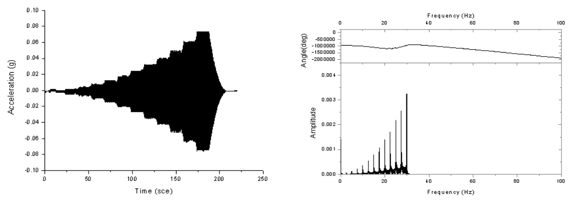
Figure 5. Acceleration Response of EDG Body (Non-isolation Cases)



(a) Time Domain (b)Frequency Domain

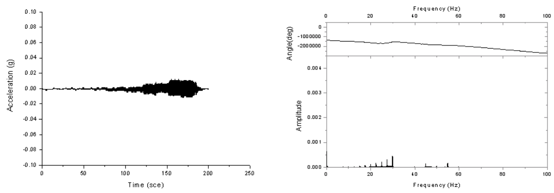
Figure 6. Acceleration Response of the Floor (Non-isolation Case)

The isolation cases responses of the EDG model and the isolated floor are shown in Figure 7 and 8, respectively. As shown in the figures, the vibrations are dramatically decreased for all the frequency regions. The vibration reductions are about 50% for the low frequency range and 85% for the high frequency range. But, the vibration responses of the floor position, the peak acceleration of the isolation cases are 10% that of the non-isolation cases. So, it can be said from the isolation systems which are used in this study, that the vibration reduction effects are almost 90%.



(a) Time Domain (b)Frequency Domain

Figure 7. Acceleration Response of EDG Body (Isolation Cases)



(a) Time Domain (b)Frequency Domain

Figure 8. Acceleration Response of the Floor (Isolation Case)

5. Conclusion

In this study, an experimental study was performed for an evaluation of a vibration reduction effect of a coil spring and viscous damper system on a scaled EDG model. As a result, the coil spring and viscous damper system can reduce the operation vibration of an EDG by at least 50% and at a maximum it can decrease it by about 90%.

ACKNOWLEDGEMENT

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[2] Kim, Min Kyu, Choun, Young Sun, Kwon, Hyoung Oh, Seo, Jeong Moon, Evaluation of a Spring-Viscous Damper Vibration Isolation System by Measuring the Vibration of the Emergency Diesel Generator, Proceeding of the Korean Nuclear Society Spring Meeting, Jeju, Korea, May, 2005.