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Construction Work under Low-Frequency Horizontal Motions

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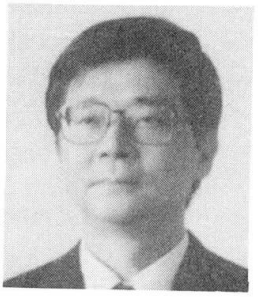

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Summary

According to an investigation of construction sites in Japan, approximately 40% of construction workers on high-rise structures experienced excessive low-frequency horizontal vibration due to wind. In this study, critical limits of continuous tasks such as welding works and straight line drawings were experimentally investigated. From the results obtained, it was found that the critical acceleration for experimental tasks of straight line drawings and simulated tasks of welding works increased in proportion to frequency between 0.5 and 2.0 Hz. However, under the level of 0.5 Hz, inverse proportion was shown. The experimental results differ from the international standards of ISO 6897.

1. Introduction

In the construction of tall structures such as bridge pylons and buildings, weather has a strong influence on work efficiency and safety. The influence of weather on the construction of 14 tall bridge pylons and buildings sites in Japan was investigated by questionnaires to workers. One result from the questionnaires, shown in fig. 1, reveals about 40% of the workers experienced excessive low-frequency horizontal vibration during work, with bridge construction being especially demanding due to wind-induced sways. Bridge pylons under construction are likely to vibrate at wind speeds less than 10 m/s, which is a widely used criterion for suspension of construction work in Japan. In fact, on one construction site, the welding workers felt it difficult to work due to wind-induced sways. Even with these problems, no criteria or standards on limits of construction work under low-frequency horizontal motions have been made.

2. Methods

Critical task limits of construction work under horizontal motions were experimentally investigated by an original device which generates sway, vibration or linear acceleration, and is shown in fig. 2. Low-frequency sine-formed vibrations were given to each subject by the device, and the critical acceleration of straight line drawing tasks, simulated welding tasks or holding limits of human standing posture was investigated. A total of 15 young males, 15 females, and 5 welding workers participated in the series of experiments.

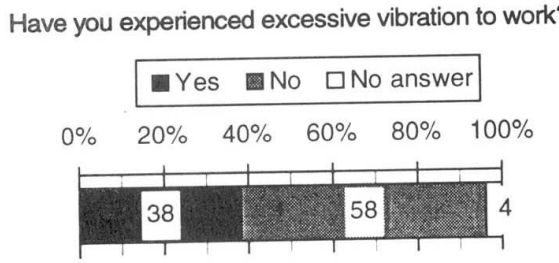

Fig. 1 : Result from questionnaires concerning vibration due to wind

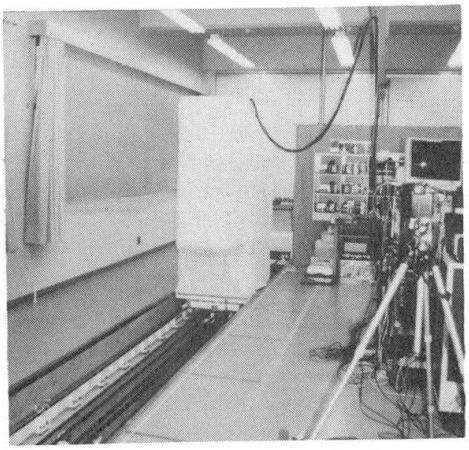

Fig. 2 : Experimental device which generates horizontal motions or vibrations

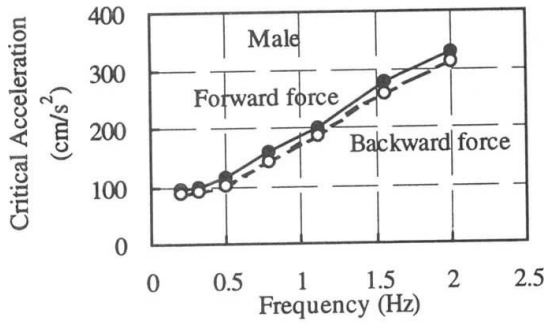

Fig. 3 : Limits for holding human standing posture for males

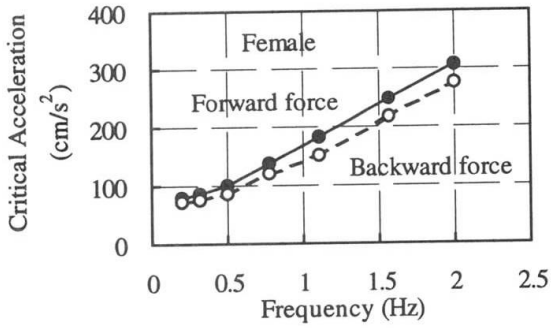

Fig. 4 : Limits for holding human standing posture for females

3. Results

3.1 Critical limits for holding human standing posture

Fig. 3 and fig. 4 show experimental results of critical acceleration for holding human standing posture. It was found that the values for male subjects were larger than the values for female subjects. Considering critical values for holding human standing posture, subjects were likely to lose balance under backward forces. The critical acceleration increased in proportion to frequency, which ranged from 0.5 to 2.0 Hz. However, under 0.5 Hz the critical values tended to keep constant.

3.2 Critical limits of welding tasks

Fig. 5 shows the critical acceleration of straight line drawing tasks performed by male subjects. Limits of welding tasks were verified by five welding workers, as shown in fig. 5. It was found that the relation between the values for straight line drawing tasks and for welding tasks showed similar tendencies and these values were at similar levels. Both critical accelerations increased in proportion to frequency between 0.5 and 2.0 Hz. However, they were in inverse proportion to the frequency under 0.5 Hz. These results show different tendencies from the international standards of ISO 6897 of the guidelines to evaluate the response of occupants of off-shore structures to low-frequency horizontal motion, as shown in fig. 5.

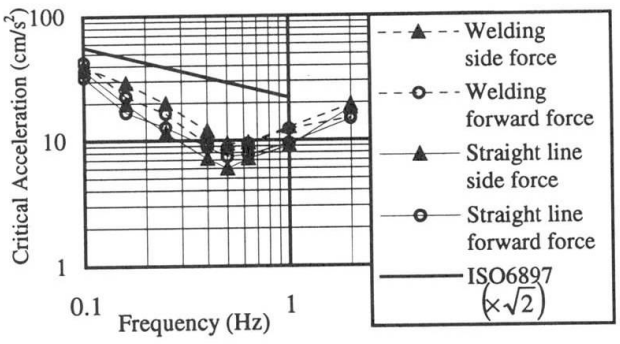

Fig. 5 : Limits of straight line drawing or welding tasks