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TRAFFIC INDUCED VIBRATIONS IN BUILDINGS

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Introduction

A survey carried out in 1972 to determine the environmental effects of road traffic on people in and around their homes indicated that about eight per cent of the population were considerably bothered by vibration from road traffic[1].

Building vibrations induced by road traffic may be caused either by ground vibrations originating in the road surface and coupled into the structure via the foundations and floor supporting walls or by low frequency sound emitted from vehicles and coupled into the structure via the windows and doors[2].

Ground vibrations from traffic

Ground-borne vibrations are generated by the variation in contact forces between the wheels of a vehicle and the road surface. Most roads conform to the Specifications for Road and Bridge Works as regards surface finish, and in these situations moving vehicles do not generate vibrations large enough to be perceived by people. Ground vibrations are unlikely therefore, to cause perceptible structural vibrations in buildings located near to a well maintained road.

Air-borne vibrations from traffic

Air-borne low frequency sound in the frequency region below 100 Hz can induce building vibration. Acoustic coupling can excite the window pane and the contents of the room into vibration. The occupants of buildings exposed to high levels of low frequency sound may detect vibration by direct perception in the body, by indirect perception of the responses of the window and room contents or by a combined response involving both direct and indirect perception.

Low frequency traffic noise and building vibration

Measurements of low frequency sound and building vibration were carried out at four sites[3]. The aims of this study were to:

(a) determine the level of floor vibrations occurring at sites subjected to relatively high levels of low frequency sound and where a high degree of bother with vibration had either been demonstrated or was expected, and

(b) examine possible physical measures of vibration and low frequency sound which could be used to predict the disturbance caused by traffic vibration.

The road surface at each of the sites was smooth, and there were no discontinuities present which could have given rise to ground-borne vibrations. Consequently it was expected that any traffic-induced building vibrations would be caused by low frequency sound generated by the traffic.

The results confirmed that at all sites low frequency acoustic excitation was responsible for floor vibrations. The floor vibrations were generated in two frequency ranges. These were at 63 to 125 Hz which corresponded with the excitation frequencies of exhaust emissions, and at 10 to 25 Hz which corresponded with the natural frequencies of the upper freely-suspended floors at the sites.

The magnitudes of the floor vibrations were compared with the perception threshold, proposed in a draft International Standard[4]. It was found that the floor vibrations exceeded the perception threshold for only one per cent of the time and at only two of the sites. At the other two sites the perception threshold was not exceeded at the one per cent fractile level. At three of the sites social surveys had been carried out in which it had been shown that between 30 and 65 per cent of the population interviewed claimed to be either 'quite a lot' or 'very much' bothered by vibration from traffic. It was concluded from this investigation that either comparing the ISO draft perception thresholds with the floor vibrations was inappropriate as a guide to determining possible vibration disturbance caused by road traffic or vibration disturbance was not primarily caused by structural vibration.

Conclusions

1. At four sites where social surveys had shown that there was a high degree of bother with traffic vibrations, air-borne low frequency noise was responsible for floor vibrations in buildings.

2. Since the floor vibrations were above the ISO vibration perception thresholds for only one per cent of the time at only two of the four sites, the floor vibration level is not a suitable measure of vibration bother.

3. It is suggested that the physical parameters used to relate vibration level with vibration bother should be based on measurements of low frequency traffic noise in situations where there are no road surface discontinuities present which could give rise to ground-borne vibrations.

References

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