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VIBRATION IN EARTH MOVING VEHICLES

G.J. McNulty, D. Douglas, N.C. Hilyard and P. Collier

Sheffield City Polytechnic, Pond Street, Sheffield S1 1WB

INTRODUCTION

There is little published work on the discomfort of drivers of earth moving vehicles due to vibration. This vibration at the driver's seat is the result of excitation forces from several stimuli, notably the rough terrain and the loading on the vehicle due to dynamic forces of the bucket.

The aim of this work is to report on the measurement of the vibration through an earth moving vehicle on repeatable surfaces to datumise actual site conditions.

Four contrasting concrete surfaces of some 40 m long by 3 m wide were used in the test situation. These surfaces are described as Quarry Floor, Wave motion, regular kerb, and random d kerb. The depth of the indulations varied from 50 mm to 100 mm. This provides a severe test on the vibrational activity of the earth moving vehicle under test.

MEASURING TECHNIQUES

The dynamic performance of the cab, to axle, seat to axle among several tests were achieved by mounting a tri-axle B and K 4321 accelerometer at the appropriate positions in the vehicle, in the cab and on the seat. In order to monitor this whilst the vehicle was moving, another car housing the recording equipment was driven alongside the test vehicle and the leads suspended between the two vehicles. Some work on a pilot study using a Land Rover and explaining the calibration has already been published, McNulty and Douglas [1]. Tests were carried out on two different machines, a new Earth Moving vehicle and a not-new machine. The not-new machine correlates with contractors' vehicles on-site.

RESULTS

Measurements were carried out along three co-ordinate axes, X, Y and Z. The Z axis is that vertical axis through the body, X axis is the movement front-to-back and Y axis is the side-to-side movement. An overall spectrum map of seat amplifications for all road conditions and all co-ordinated axes is shown in Figure 1. It is shown that frequencies at which attenuation does not occur and the dots in the appropriate spaces indicate the frequencies at which the seat is not attenuating the movement activity of the cab.

The main activity is exhibited by the Y and Z axes. The seat always displays an energetic movement in the Y axis compared to the other two. However, the majority of the actual vehicle vibration is on the Z axis. The only case of ISO regulation being infringed is on the Z axis using random kerb and with the old machine. In the X axis there is evidence of a high level of seat vibration but insufficient to infringe ISO regulations.

Figure 2 shows the spectrum levels for dynamic movements between several sources in the vehicle. Figures (a) to (c) describe the amplification and attenuation of any two vibrating sources. For example Figure (a) shows the cab vibration/axle vibration amplitudes. At the 1 Hz block the cab is attenuating the axle and between 6.3 to 20 Hz there is a large amplification of axle vibration due to the cab suspension. A similar spectral history is given in Figure (b) to (c) where a salient feature is that between 1 and 6.3 Hz the seat amplifies the cab movement and thereafter up to 63 Hz there is diminution in the seat's activity resulting in attenuation of the cab.

Figure (c) shows the resulting activity of figures (a) and (b) exhibiting the feature of energy flow into the seat from the axle.

Figure (d) shows the ISO curves for an 8 hour maximum exposure limits. It should be noted for the tests performed that the specification is infringed between 1 to 6.3 Hz where there is a decided and high level of vibration above the eight hour curve dominant at 2 Hz.

CONCLUSION

This work shows that for the vibration of earth moving vehicles certain critical areas result in the ISO regulations being infringed. A comprehensive survey on the vibrational aspects of the salient points in two vehicles have been completed and it is shown that potential serious discomfort according to ISO regulations will be felt by the driver's at frequencies below 6.3 Hz.

REFERENCE

[1] G.J. McNulty and D. Douglas, "The comfort of drivers of earth moving vehicles. PROC Fourth Brit.Conf V and N Sheffield City Polytechnic July 1982 pp 283-287.

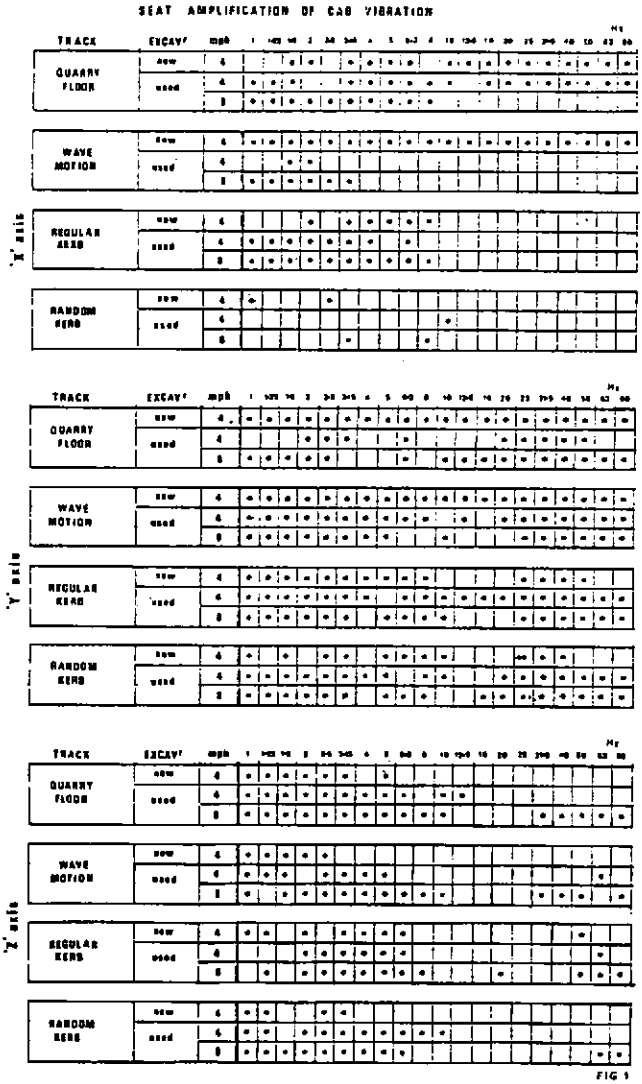
SEAT AMPLIFICATION OF CAB VIBRATION
TRACK
EXCAV'
mph
Hz
QUARRY FLOOR
WAVE MOTION
REGULAR KERB
RANDOM KERB
new
used
'X' axis
'Y' axis
'Z' axis

FIG 5

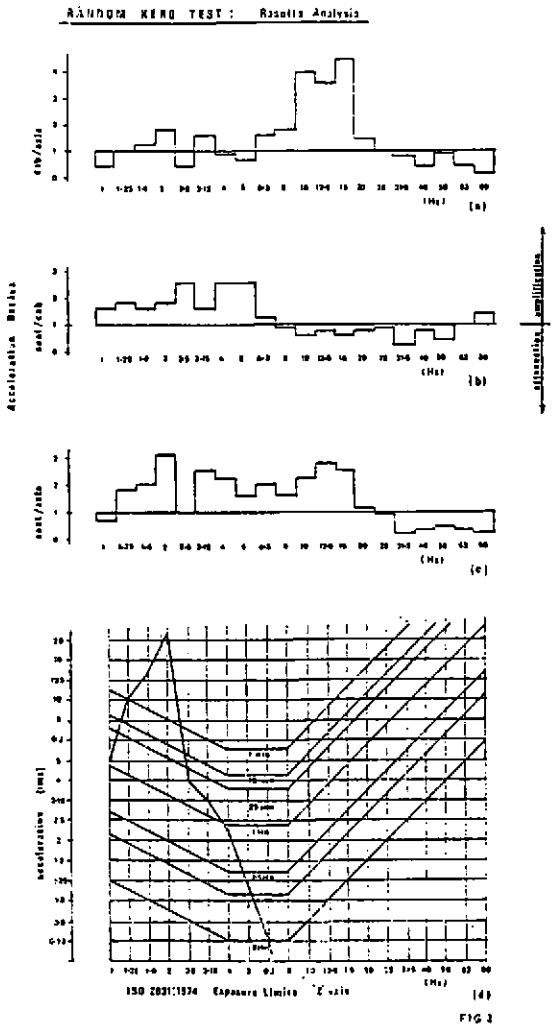
RANDOM HERQ TEST : Results Analysis
(a)
(b)
(c)
(d)
(Hz)
ISO 2631:1974 Exposure Limits 'Z' axis

FIG 3