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Reaction of passengers in commercial vehicles to the vibrational environment.

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1. Introduction

At the present time a number of teams in the United Kingdom are working on various aspects of the problem of man's reaction to vibration, particularly to whole body vibration. A national working group has been established in an attempt to coordinate the various aspects being studied. The main aim of the working group as it was originally established was to ensure that such information as may be obtained by the various investigators be applied as soon as possible to provide design data for transport vehicle designers.

One of the main problems in any such scheme of work is the application of results obtained from relatively simple laboratory experiments to the relatively complex practical situation in actual vehicles. This problem is particularly acute when vibration or oscillation is the physical phenomenon being studied because of the number of degrees of freedom involved when an actual vehicle be studied, and because there is no generally acceptable vibration parameter to be measured - although here it must be admitted that in any field studies acceleration is undoubtedly the easiest parameter to measure directly.

The problems involved in the correlation of laboratory experiments with field trials become particularly acute when one is considering the comfort of fare paying passengers in commercially operated vehicles. The crews of such vehicles are usually limited to a particular range of age, physical type and even mental type, whilst the criteria to be used can be defined by the setting of some task criteria . Passengers, on the other hand, may be very young or very old, fit or ill, and the problem of assessing a standard against which to measure 'comfort' is one which has been exercising agile minds for a long time.

Accordingly it was felt that it was vitally necessary that laboratory studies being carried out at the University College of Swansea should be parallelled with a preliminary investigation into the problems likely to be met in attempting to relate laboratory results to actual vehicular situations.

A subsidiary aim which has emerged has been to define, as closely as possible, the physical features of the vehicular environment so as to ensure that an adequate range of conditions be tested in laboratory work.

2. Preliminary questionnaire studies

The primary aim of the first questionnaire studies was to try to establish a reliable channel of communication between non-technical passengers and the investigators. One of the major problems to be faced when attempting to get non-technical people to talk about vibration is the fact that there are no generally accepted terms which describe sensations induced by vibration which do not also include such motions as 'comfort' or 'tolerance'. For example, it is possible to talk about the 'loudness' or noisiness' of a sound, or the 'brightness' of a light and to be understood in a way which does not prejudge whether or not a sensation of comfort or discomfort is involved. The authors would welcome suggestions for words to describe subjective effects of vibration in the same way.

By using open ended questions, and by doing some instructured interviews, some words have been obtained which seem to mean much the same to about one quarter of the population tested. However, the words chosen differ considerably between one vehicle type and another - primarily, no doubt, because of the differences in the type of vibration involved. Thus, words such as 'bounce','bump' and 'lurch' appear in responses of passengers on hovercraft, whilst 'swing' and 'sway' appear on helicopter passenger replies.

Further attempts are being made to try to pin down words which describe particular aspects of the motion. This is proving difficult since there is a marked tendency on the part of a proportion of passengers to confuse airborne noise with tactile vibration, and even, to some extent, with the lower frequency vibrations.

3. Current studies

Two further objects are being pursued in questionnaires being used at the moment.

The first is to try to gain information on the relative importance of different environmental parameters such as noise, heating, ventilation and lighting as well as vibration or motion. All the evidence obtained so far indicate unmistakeably that vibration is at least as important as any of the others. This, in itself, is justification for fairly intensive work on this particular aspect of the vehicle environment.

The second is to discover whether it is possible to get reliable numerical values for subjective response in the field situation, and which is the easiest means to use to do this.

4. Field measurements

Up to the present moment, no suitable equipment is available for measuring the motion parameters either as overall vehicle motion effects or as localised structural vibrations. Some crude measures can be obtained, but these are of limited use. Equipment has been designed, and is being built, to enable six channels of vibration data to be recorded simultaneously for future analysis. The big problem has been to obtain equipment which is portable (less than 25lb. weight in total), self contained and independent of any external power supplies, and small enough to be used in confined gangways.

Other environmental parameters such as noise level, temperature, humidity and lighting level have been measured, and will continue to be measured.