difference in individual transmissibility as well. Even the response of any one individual can vary with posture and body tension. The situation may be further complicated by the effects of seats, headrest. gloves, etc., unless great care is taken to measure the vibration level at the exact point of application of the vibration to the body. One more difficulty in the assessment of human response to vibration is in separating it from the response to the high noise levels which are often associated with vibration-causing processes.

EARLY RESEARCH INTO HUMAN RESPONSE : THE REIHER-MEISTER AND THE DIECKMANN SCALES FOR ViBRATION ASSESSMENT

Many schemes have been developed for the assessment of human response to vibration. One of the earliest. published by Reiher and Meister in 1931, covers the frequency range 1-100 Hz and vibration amplitudes, specified as displacements in the range 1-100 m.Using the Reiher-Meister scale it is possible to rate the vibration as belonging to one of six categories ranging from imperceptible to painful. Separate scales are used for vibrations in the vertical and horizontal directions. The threshold of perception corresponds to a velocity amplitude of 0.3 mm/s and the annoyance threshold to 2.5 mm/s.

Dieckmann, in 1955, proposed a similar scheme but extending to lower frequencies (down to 0.1 Hz) and higher amplitudes than Reiher and Meister. The vibration level is quantified in terms of K-values, ranging from 0.1 to 100, which are related to the intensity. The effect of a vibration can be assessed from its K-value:

K = 0 1 - lower limit of perception
K = 1 -allowable in industry for any period of time
K = 10 - allowable only for a short time
K =100 - upper limit of strain allowable for the average man

The K-values may be read off charts of frequency against amplitude, similar to the Reiher-Meister scales, or they may be calculated in terms of displacement amplitude A and frequency f.

BRITISH AND INTERNATIONAL STANDARDS ON HUMAN REPONSE TO VIBRATION

ISO 2631 Evaluation of human exposure to whole-body vibration

The Introduction to the standard states that : "Various methods rating the severity of exposure and defining limits of exposure based on laboratory or field data have been developed in the past for specific applications. None of these methods can be considered applicable in all situations and consequently none has been universally accepted.

In view of the complex factors determining the human response vibrations, and in view of the shortage of consistent quantitative data concerning man’s perception of vibration and his reactions to it, this International Standard has been prepared first, to facilitate the evaluation and comparison of data gained from continuing research in the field; and, second, to give provisional guidance as to acceptable human exposure to whole body vibration."

Part 1 1985 : General requirements

This Part of the standard takes into account frequency (in the range 1-80 Hz), vibration amplitude (acceleration), duration (from 1 minute to 24 hours exposure) and the direction of the vibration relative to the human body. Three different criteria are proposed; working effficiency, health and safety, and comfort. These three criteria give rise to three boundaries or limits; the fatiguedecreased proficiency boundary, the exposure limit (for health and safety),. and the reduced comfort boundary. Fig. shows the limits for the fatiguedecreased proficiency boundary in terms of the amplitude, frequency and duration for a vertical vibration (along the toe-to-head axis). Exposure limits are 6 dB above and reduced comfort values 10 dB below these values, the shape of the contours remaining the same. The human subject is most sensitive to vertical vibrations in the frequency range 4-8 Hz. Above 8 Hz the response contours correspond to constant velocity amplitudes. The ISO standard also allows the effect of broad-band vibrations (i.e. containing many frequencies) to be evaluated .

Parts 2,3 and 4 of ISO 2631 are concerned with the vibration of humans in buildings, at low frequencies, and on board ships.

Part 2 1989 : Human exposure to continuous and shock-induced vibration in buildings (l to 80 Hz).

Part 3 1985 : Evaluation of exposure to whole-body z-axis vertical vibration in the frequency range 0.1 to 0.63 Hz.

Part 4 : Evaluation of crew exposure to vibration on board sea-going ships (1 to 80 Hz}. This part of the standard is at present at the stage of draft.

The subject matter of parts 1,2 and 3 of IS0 2631 are also cover by BS6841 and BS6472. Although there are some similarities there are also some very significant differences between the British and International Standards. One of these is the introduction of the concept of Vibration Dose Value into the British Standards, in order to take into account the effects of impulsive and intermittent vibration.

THE EFFECT OF VIBRATION ON BUILDINGS

It is almost inevitable that high noise and vibration levels experienced by the occupants of a building should give rise to concern about the possible effects that these may have on the building. However, cases in which even minor damage to a building can he attributed directly to the effects of vibration alone are very rare. Usually many other factors are involved as well, such as ground settlement or movement caused by changes of moisture content. It is generally accepted that the vibration levels in a building would become absolutely intolerable to the human occupants long before they reached a level at which there was danger of damage to the building. In cases where minor damage does occur, and in which vibration is alleged to play a part, the most common occurrences are: damage to unsound plaster, cracking of glass, loosening of roof tiles and cracks to masonry. However, it is very likely that existing minor damage may he noticed for the first time by an occupant whose attention and concern has been aroused hy the disturbance caused by a new source of vibration.

Heavy vibrating machinery located at high levels in a building can produce intense vibrations in the horizontal direction, and these are more likely to be damaging than vertical vibration.