INTERNATIONAL ISO

Second edition
2022-03

Mechanical vibration — Laboratory method for evaluating vehicle seat vibration —

Part 2:
Application to railway vehicles

Vibrations mécaniques — Méthode en laboratoire pour l'évaluation des vibrations du siège de véhicules —

Partie 2: Application aux véhicules ferroviaires

Reference number
ISO 10326-2:2022(E)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 4, *Human exposure to mechanical vibration and shock.*

This second edition cancels and replaces the first edition (ISO 10326-2:2001), which has been technically revised.

The main changes are as follows:

— propositions of new excitation signals to measure seat transmissibility: a lower level of narrowband vibration, and measured or reproduced real train stimuli to better consider the non-linearity of the human-seat system;

— propositions to calculate the SEAT “predicted” value from the measured seat transmissibility and real train stimuli.

Annex B gives an example to build an excitation signal for seat testing from a trains’ vibration characteristics.

A list of all parts in the ISO 10326 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Although the vibration felt by passengers in railway vehicles is always of low magnitude, the fact nevertheless remains that acceleration at the seat-buttock and seat-backrest interfaces can sometimes be greater than excitations transmitted by the vehicle frame. Consequently, the aim of laboratory tests to be carried out with railway seats is fundamentally to refine existing knowledge about their overall dynamic behaviour and that of their different components: seat frame, suspension system, linings, coverings, etc. In the long run, the knowledge should provide useful guidance in choosing the optimum components, and for improving passenger comfort further in the process.

Laboratory tests can be performed under clearly defined and reproducible excitation conditions, to complement studies carried out in the field. They consequently represent an essential study method complementary to the investigations performed in the field.

The vibration at the base of railway seats is of the random, broad-band type. The spectra, which are of complex form and non-stationary, depend on the vehicle itself, on its load, on wheel profile conditions, on track geometry and quality, etc. In this document, therefore, it is stipulated to excite the seat, occupied by a test person, by means of various types of excitation (such as pseudo-random; sinusoidal; and realistic, as discussed in Clause 11):

— A broad-band pseudo-random vibration successively in the three directions *X, Y* and *Z*. The vibration spectra are of sufficiently simple form and of sufficient magnitude to cover the majority of actual spectra observed on track, whilst nevertheless remaining quite different from the latter.

— Similar broad-band pseudo-random vibration in the three direction *X, Y* and *Z* simultaneously. It considers the cross-axis responses (response in a direction caused by an excitation in another direction), which represents a more realistic test condition. Also, it shortens the test duration.

— Investigations carried out under the effect of sinusoidal vibration can allow detection of possible non-linearities.

— If the seat vibration exposure is known, specific spectra and phase (either simulated or measured) can be used in the laboratory. This specific excitation can be successively used in the three directions *X, Y* and *Z* on the platform, or used simultaneously if the simulator has the abilities. The advantage of such stimuli is the representability of the actual response of the seat in its environment. As the seat and human are non-linear systems, having the right input excitation provides confidence in the measured output vibration of the seat interfaces.

Calculations, using broad-band pseudo random excitations, are, however, truly valid only on the assumption that the human-seat system considered is sufficiently linear. To check this assumption under laboratory conditions, this document stipulates an extra testing phase during which the seat is excited in a purely sinusoidal, high-amplitude mode at the different frequencies encountered during tests under random excitations, and corresponding to the peaks of the frequency response function. If the system shows non-linearity it is advised to used input spectra and phase representative of the vibration exciting the seat.

As a result, the magnitudes measured at the different response points of the human-seat system during laboratory tests, using broad-band pseudo random excitations, could under no circumstances be used for comparison with limits or acceptable values. By contrast, it is stipulated using the measurements to determine the frequency response function of the human-seat system at seat pan and backrest level in the three directions *X*, *Y* and *Z*. These frequency response functions suffice for characterizing the vibratory behaviour of the seat with its occupant. The directions of excitation, favourable or harmful frequencies, and corresponding gains are thus clearly demonstrated. These inputs are relevant to a comparison of seats with different construction arrangements.

The frequency range relevant to railway conditions is limited to 0,5 Hz to 50 Hz. Railway seats transmit vibration with frequencies lower than 0,5 Hz without amplification. However, vibration with frequencies of over 50 Hz, as sustained by seats in service, is generally of too small a magnitude to be felt by seated passengers. For suspension seats, ISO 10326-1 is recommended.

The discomfort for passengers of railway vehicles can be assessed using ISO 2631-4 or EN 12299.