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Railway applications - Suspension components - Hydraulic dampers

Applications ferroviaires - Eléments de suspension - Amortisseurs hydrauliques

Bahnanwendungen - Federungselemente - Hydraulische Dämpfer

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Contents

Foreword

This document (EN 13802:2004) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2005, and conflicting national standards shall be withdrawn at the latest by February 2005.

The European Standard has been prepared under a mandate (M/024) given to CEN by the Commission of the European Communities and the European Free Trade Association, and supports essential requirements of the following EC Directives:

— Council Directive 96/48/EEC of 23 July 1996 on interoperability of the trans-European high-speed rail system[1];

— Council Directive 93/38/EEC of 14 June 1993 co-ordinating the procurement procedures of entities operating in the water, energy, transport and telecommunications sectors[2];

— Council Directive 91/440/EEC of 29 July 1991 on the development of the Community’s railways[3].

This document includes a Bibliography.

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1) Official Journal of the European Communities N° L 235 of 17.09.96.

2) Official Journal of the European Communities N° L 199 of 09.08.93.

3) Official Journal of the European Communities N° L 199 of 09.08.93.

1 Scope

This document applies to hydraulic dampers (excluding end mountings) used on rail vehicles. The dampers covered in this standard include:

- dampers that control the dynamic behaviour of vehicle:
  - suspension dampers, (e.g. primary vertical dampers, secondary vertical dampers and secondary lateral dampers),
  - yaw dampers,
  - roll dampers,
  - inter-vehicle dampers,
- dampers that control the dynamic behaviour of mechanical systems:
  - pantograph dampers,
  - etc.

All relevant terminology which is specific to the subject is defined in this document.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

prEN 14363, *Railway applications — Testing for the acceptance of running characteristics of railway vehicles — Testing of running behaviour and stationary tests.*

EN 61373, *Railway applications — Rolling stock equipment — Shock and vibration tests (IEC 61373:1999).*

EN ISO 2813, *Paints and varnishes - Determination of specular gloss of non-metallic paint films at 20°, 60° and 85° (ISO 2813:1994, including Technical Corrigendum 1:1997).*

EN ISO 9000, *Quality management systems — Fundamentals and vocabulary (ISO 9000:2000).*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests.*

3 Terms, definitions and symbols

For the purposes of this document, the following terms, definitions and symbols apply.

NOTE 1 Decimal multiple and sub-multiple units defined in this clause may be used.

NOTE 2 In this document, the spatial characteristics of the damper are defined with reference to its axis (see Figure 1). Axial characteristics are defined along the x-axis. Extension of the damper is defined as positive and compression is negative. Transverse characteristics are defined in the y–z plane. Rotations are defined as positive in a clockwise direction.

3.1 Terms and definitions

3.1.1
damper
hydraulic damper without end mountings

3.1.2
hydraulic damper
device with a fluid as the damping medium

3.1.3
damper characteristic
relationship (assuming that there is no force–velocity phase shift) between damper force and damper velocity established at a damper displacement of large amplitude and low frequency to discount the dynamic influence of the damper structure and fluid stiffness

3.1.4
damper displacement
displacement
stroke

relative axial displacement of the damper ends

3.1.5
damper fluid
damping medium (usually oil)

3.1.6
damper performance description
document used to define the performance requirements and capabilities of a damper, (see Annex A)

3.1.7
dynamic damper characteristic
damper characteristic (see 3.1.3), but including the phase shift effect, and thus including influence of damper structure and fluid stiffness

3.1.8
end mounting
generally elastomer based component, fitted at both ends of the damper

NOTE Mountings are not specified in detail in this document.

3.1.9
friction type characteristic damper
damper that has a force–velocity characteristic that closely imitates the effect of friction

3.1.10
leakage
visible evidence of accumulation of fluid, which has originated from within the damper

3.1.11
priming
operation allowing the removal of temporary imperfection to the damper characteristic caused by entrapment of gas (usually air) in the damper pressure chamber

3.1.12
service interval
minimum continuous time or distance travelled in which a damper remains in service use, with only periodic visual inspections and no maintenance attention

3.1.13
symmetrical damper characteristic
damper characteristic (see 3.1.3) having the same compression and extension force–velocity characteristic throughout the operating range (see Figure 5)

3.1.14
asymmetric damper characteristic
damper characteristic (see 3.1.3) not having the same compression and extension force-velocity characteristic throughout the operating range (see Figure 6)

3.2 Symbols

c_d N/m/s dynamic damping rate, this includes the effect of phase shift

NOTE 1 Unless specified otherwise, the dynamic damping rate is the rate of the damper including effects of the damper structure and fluid stiffness.

The dynamic damping rate is given by:

$$c_d = \frac{k_d}{2\pi f \tan \Phi}$$

This definition is based on a mathematical model with a linear viscous damper of dynamic damping rate c_d in series with a linear spring stiffness k_d, subjected to a sinusoidal motion with excitation frequency f, displacement amplitude d_0 and force amplitude F_o. This is termed the Maxwell model. It does not therefore refer to force amplitude divided by velocity amplitude.

d_c m compression margin, the part of damper compression travel never reached by the piston during operation in the given mechanical system

NOTE 2 $d_c = L_{u,\min} - L_{\min}$

d_e m extension margin, the part of damper extension travel never reached by the piston during operation in the given mechanical system

NOTE 3 $d_e - L_{\max} - L_{u,\max}$

d_n m nominal travel, the travel over which the damper meets the operational requirements established by the damper performance description

NOTE 4 The nominal travel is indicative of the operating travel of the damper in the given mechanical system.

d_w m working stroke

NOTE 5 $d_w = L_{u,\max} - L_{u,\min}$

d_o m damper displacement amplitude at sinusoidal motion

$D_{\max}$ m diameter of an envelope cylinder in which the main body of the damper shall be contained (dust guard included) (see Figures 2 and 3)

D_{res} m diameter of damper reservoir envelope (see Figure 3)

f	Hz	excitation frequency
F	N	damper force, the axial force of the damper
$F_{c,\max}$	N	damper compression force at maximum velocity
$F_{c,n}$	N	nominal damper compression force NOTE 6 Force at nominal velocity.
$F_{e,\max}$	N	damper extension force at maximum velocity
$F_{e,n}$	N	nominal damper extension force NOTE 7 Force at nominal velocity.
F_0	N	damper force amplitude at sinusoidal motion
H_{res}	m	height of damper reservoir (to damper centreline) (see Figure 3)
k_d	N/m	damper stiffness NOTE 8 $k_d = \frac{F_0}{d_0}\sqrt{1+\tan^2\Phi}$ (Maxwell model) NOTE 9 Unless otherwise noted, stiffness of the damper structure and fluid. It does not therefore refer to force amplitude divided by displacement amplitude.
L	m	damper length (see Figure 4)
L_{del}	m	damper length at delivery NOTE 10 The length of the damper to permit mounting it on a vehicle at rest on straight, horizontal track (except for particular cases, for example pantograph dampers).
L_i	m	length of the damper installed NOTE 11 Length when the damper is mounted on a vehicle at rest on straight, horizontal track.
$L_{\max}$	m	damper length when the damper is fully extended
$L_{\min}$	m	damper length when the damper is fully compressed
L_n	m	nominal damper length NOTE 12 Generally, $L_n = L_i$. NOTE 13 The reference length used to determine the characteristics of the damper.

$L_{u,\max}$	m	maximum utilization length of the damper NOTE 14 The maximum length of the damper during operation.
$L_{u,\min}$	m	minimum utilization length of the damper NOTE 15 The minimum length of the damper during operation.
$T_{ae,\max}$	°C	maximum ambient temperature (i.e. temperature of the air surrounding the damper) in extreme situations
$T_{ae,\min}$	°C	minimum ambient temperature (i.e. temperature of the air surrounding the damper) in extreme situations
$T_{ao,\max}$	°C	maximum ambient temperature for normal vehicle operation
$T_{ao,\min}$	°C	minimum ambient temperature for normal vehicle operation
$T_{s,\max}$	°C	maximum transportation or storage temperature to be experienced by the damper
$T_{s,\min}$	°C	minimum transportation or storage temperature to be experienced by the damper
v	m/s	damper velocity, piston velocity that is the relative axial velocity of the damper
$v_{\max}$	m/s	maximum damper velocity NOTE 16 Highest velocity to be encountered during operation by the damper for the application specified and considered in the design of the damper. The value of this velocity is part of the technical specification of the damper.
v_n	m/s	nominal damper velocity NOTE 17 Upper velocity to be encountered during operation by the damper for the application specified. The value of this is part of the technical specification of the damper.
v_0	m/s	the damper velocity amplitude at sinusoidal motion
Φ	rad	force–displacement phase shift at sinusoidal motion (see the definition for c_d and k_d)
ω	rad/s	angular velocity of excitation