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Road vehicles — Heavy commercial vehicles and buses — Calculation method for steady-state rollover threshold

Véhicules routiers — Véhicules utilitaires lourds et bus — Méthode de calcul du seuil de renversement en régime permanent

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Foreword

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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 33, *Vehicle dynamics and chassis components*.

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

The dynamic behaviour of a road vehicle is a most important aspect of active vehicle safety. Any given vehicle, together with its driver and the prevailing environment constitutes a closed-loop system which is unique. The task of evaluating the dynamic behaviour is therefore very difficult, since the significant interaction of these driver-vehicle road elements are each complex in themselves. A complete and accurate description of the behaviour of the road vehicle inevitably involves information obtained from a number of different tests.

Moreover, insufficient knowledge is available to correlate overall vehicle dynamic properties with accident prevention. A substantial amount of work is necessary to acquire sufficient and reliable data on the correlation between accident prevention and vehicle dynamic properties in general.

Road vehicles — Heavy commercial vehicles and buses — Calculation method for steady-state rollover threshold

1 Scope

This document describes a method for calculating steady-state rollover threshold of heavy commercial vehicles and buses, not considering the effects of active control systems. The calculation method considers the main factors that influence the rollover threshold, namely the height of centre of gravity, the track, the tyre lateral stiffness, and all factors that affect the vehicle roll stiffness. The considered compliances (e.g. tyre deformation) have a considerable influence on the effective track, and consequently on the steady-state rollover threshold.

NOTE As an alternative to the described calculation method standard, the steady-state rollover threshold can be measured on a test track or with a tilt-table test as described in ISO 16333.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 8855, *Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in in ISO 8855 and the following shall apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
steady-state rollover threshold
a_{srt}
maximum lateral acceleration that the vehicle can sustain in a steady state turn without rolling over

3.2
first lift-off lateral acceleration
a_{yf}
lateral acceleration, at which the first wheel lift-off occurs

3.3
total lift-off lateral acceleration
a_{yt}
lateral acceleration, at which theoretically all axles lift from the ground

3.4
track
b
distance between the contact centres on a single wheel axle, measured parallel to the *Y* axis, with the vehicle at rest on a horizontal surface

Note 1 to entry: For dual wheel axles, it is the distance between the points centrally located between the contact centres of the inner and outer dual wheels.

3.5
equivalent track
b_e
track (3.4) for a dual wheel axle

Note 1 to entry: For single wheel axles, equivalent track is equal to the track.

3.6
kingpin representative track
b_k
representative *track* (3.4) for the kingpin of a semitrailer, used for calculation of *vehicle effective track* (3.7)

3.7
vehicle effective track
b_v
average of the axles' *equivalent tracks* (3.5) normalized by the *axle normal forces* (3.21)

3.8
tyre lateral stiffness
C_{yt}
first derivative of tyre lateral force with respect to tyre lateral deformation, calculated for all tyres on each side of an axle

3.9
vehicle effective tyre lateral stiffness
C_{yv}
sum of *tyre lateral stiffnesses* (3.8) at all axles of the vehicle

3.10
tyre normal stiffness
C_{zt}
first derivative of the tyre normal force with respect to the change in loaded radius, calculated for all tyres on each side of an axle

3.11
roll stiffness distribution
$D_{k\varphi}$
distribution of the *vehicle roll stiffness* (3.20) between the individual axles expressed as a percentage of the vehicle roll stiffness

3.12
centre of gravity height
H_{cg}
height of complete vehicle's centre of gravity above the ground plane

3.13
roll centre height
H_{rc}
height of suspension roll centre above the ground plane

3.14
sprung mass centre of gravity height
H_{sm}
height of centre of gravity of the sprung mass of the vehicle above the ground plane

3.15
axle roll stiffness
$K_{\varphi a}$
rate of change of the restoring couple exerted by an axle on the sprung mass with respect to the angular change about the X_V axis of a line joining the contact centres of the axle

3.16
suspension roll stiffness
$K_{\varphi s}$
rate of change of the restoring couple exerted by an axle suspension on the sprung mass with respect to the suspension roll angle of the axle

3.17
equivalent suspension roll stiffness
$K_{\varphi e}$
rate of change of the restoring couple exerted by an axle suspension on the sprung mass with respect to the angular change about the X_V axis of a line joining the contact centres of the axle

3.18
kingpin representative roll stiffness
$K_{\varphi k}$
representative roll stiffness for the kingpin of a semitrailer, used for calculation of *vehicle roll stiffness* (3.20)

3.19
tyre-induced roll stiffness
$K_{\varphi t}$
contribution of *tyre normal stiffness* (3.10) to rate of change of the restoring couple exerted by an axle on the sprung mass with respect to the angular change about the X_V axis of a line joining the contact centres of the axle

3.20
vehicle roll stiffness
$K_{\varphi v}$
sum of the individual *axle roll stiffnesses* (3.15)

3.21
axle normal force
N_a
normal force exerted on an axle

3.22
kingpin normal force
N_k
normal force exerted on the kingpin

3.23
total normal force
N_t
sum of normal forces exerted on all axles

3.24
dual wheel spacing
S_d
distance between the contact centres of the inner and outer dual wheels

3.25
unsprung mass weight
W_{um}
weight of the vehicle's unsprung mass

4 Properties

4.1 Vehicle properties used for calculation

For the calculation of the steady-state rollover threshold, the following variables are utilized:

— b_{ei}, where i is the axle number;

— b_i, where i is the axle number;

— b_k;

— b_v;

— C_{yti}, where i is the axle number;

— C_{yv};

— C_{zti}, where i is the axle number;

— $D_{k\varphi i}$, where i is the axle number;

— H_{cg};

— H_{rci}, where i is the axle number;

— H_{sm};

— $K_{\varphi ei}$, where i is the axle number;

— $K_{\varphi k}$;

— $K_{\varphi si}$, where i is the axle number;

— $K_{\varphi ti}$, where i is the axle number;

— $K_{\varphi v}$;

— N_{ai}, where i is the axle number;

— N_k;

— N_t;

— S_d;

— W_{um}.

NOTE For the vehicle dimensions see Figure 1.