TECHNICAL REPORT 3888

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Road vehicles — Test procedure for a severe lane-change manœuvre

Véhicules routiers — Essai de dépassement latéral brusque

Technical Report 3888 was drawn up by Technical Committee ISO/TC 22, *Road vehicles*, and approved by the majority of its members. The reasons which led to the publication of this document in the form of a Technical Report are explained in the Preface.

0 PREFACE

0.1 Introduction

Road-holding ability is one of the most important aspects of active safety. The task of covering and evaluating road-holding ability in a sufficiently objective and reproducible manner is particularly difficult because the physical and biocybernetic factors of influence in the closed control loop "driver-vehicle-environment" are extremely complex (see, for example, R1 and R2)[1]. The first attempts to establish objective test methods go back to the 1930s (see R3)[1]. Despite numerous measuring methods and results of theoretical models, subjective evaluation has remained the best method of evaluating road-holding ability to date. With this method remarkable progress has been made since the beginnings of automobile development.

0.2 Severe lane-change manœuvre as evaluation method for certain aspects of road-holding ability

0.2.1 *Reasons for selection of the test method*

The basic idea in the choice of the severe lane-change manœuvre in the year 1970 was to create a test method for transient road-holding ability with which the closed control loop could be tested in a situation encountered in traffic.

Originally the proposed test seemed to be suitable for that purpose since the driver had not only to observe the given lanes but had to select the vehicle path himself in the areas of changeover.

This process, which could be described as a type of anticipatory control, is of great importance for the behaviour of the system "driver-vehicle" in actual driving situations. Here, the task is nearly always to select the proper path and then to remain there with a certain accuracy depending on the situation.

1) R1 : Bergman; R2 : Limpert; R3 : Olley.
SAE 730492 SAE 7340490 *Road manners of the modern car.* Institution of Automobile Engineers, 1947.

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0.2.2 *Problems of the severe lane-change manœuvre*

In trying to keep the test method as simple as possible, the passing time through the course was first proposed as the sole evaluation criterion. Numerous comparative tests in different countries led to the conclusion that this criterion was insufficient. For this reason, numerous measurements were subsequently made in which the vehicle input values and the relevant responses of the vehicle, together with the subjective evaluation by the drivers, were covered by different criteria.

The evaluation of all tests gave in detail the following results and demonstrated the following problems :

– although the test was developed for testing transverse dynamics, it was found that longitudinal dynamics (usability of the engine power) had a strong influence, which explained the considerable scatter appearing in the results of measurements;

– elimination of longitudinal dynamics did not lead to the desired success in the correlation between individual measured values and subjective evaluation criteria;

– the different paths followed in different tests brought about a considerable scatter in measured results.

The reasons for this could be the following :

– the selection of quantities to be measured is not yet exact enough or is incomplete;

– the method for subjective evaluation for this test is not yet unequivocal;

– the influence of the driver is shown not only in the problems of subjective evaluation but also in the very different steering behaviour of drivers when using the same vehicle.

0.3 Conclusions

At the present state of test experience and for the reasons given above, the severe lane-change manœuvre described in the subsequent test procedure cannot be established as in International Standard.

Research work on transient response tests similar to or derived from the subsequent test procedure is being carried out.

0.4 Interaction between individual test methods and accident avoidance

The quantitative influence which this and other possible test methods have on accident prevention cannot be determined from the presently available data on accidents which have occurred. Before drawing conclusions concerning the influence of handling characteristics on accident prevention, basic research work having the following objectives should therefore be performed :

– improvement of accident recording methods and a better evaluation of accident statistics according to certain types of accident and their frequency, where prevailing conditions such as vehicle speed, road width, curve radii, vehicle type, loading condition and environmental conditions are covered in as much detail as possible;

– exact records of the time profile of the important control operations and vehicle movements in hazard and panic situations; this is only possible with recording systems (for example, a drive recorder);

– on the basis of the two points mentioned above, a weighting of manœuvres which could lead to accidents could be carried out; in particular it could be determined which reactions of the system "driver-vehicle" could have avoided the accident or reduced its consequences; in this way, evaluation criteria for the dynamical processes of driving could be determined;

– parallel to the consideration of possible traffic situations, information on the driver's behaviour in simulated accident situations in a real vehicle or with the aid of a simulator should be established.

1 SCOPE AND FIELD OF APPLICATION

This Technical Report allows evaluation of one of the criteria relating to vehicle dynamics and road-holding properties. It applies to passenger cars regardless of weight, as well as to other motor vehicles derived from passenger cars (except motor-cycles) the total weight of which does not exceed 3,5 tonnes.

2 REFERENCES

ISO 1176, *Road vehicles — Weights — Vocabulary.*

ISO 2416, *Road vehicles — Load distribution for passenger cars.*[1)]

3 DEFINITIONS

3.1 severe lane-change manœuvre (in connection with vehicle dynamics and road-holding properties of automotive vehicles) : A dynamic process consisting in driving a vehicle from its initial lane to another lane parallel to the initial lane as fast as possible, and possibly returning to the initial lane.

3.2 lane-change track : A defined track corresponding to a single or multiple lane-change, the vehicle to be tested having to be driven through this track. This Technical Report specifies a track for a double lane-change, as represented in figure 1.

The length of track sections is constant, the width being a function of vehicle width.

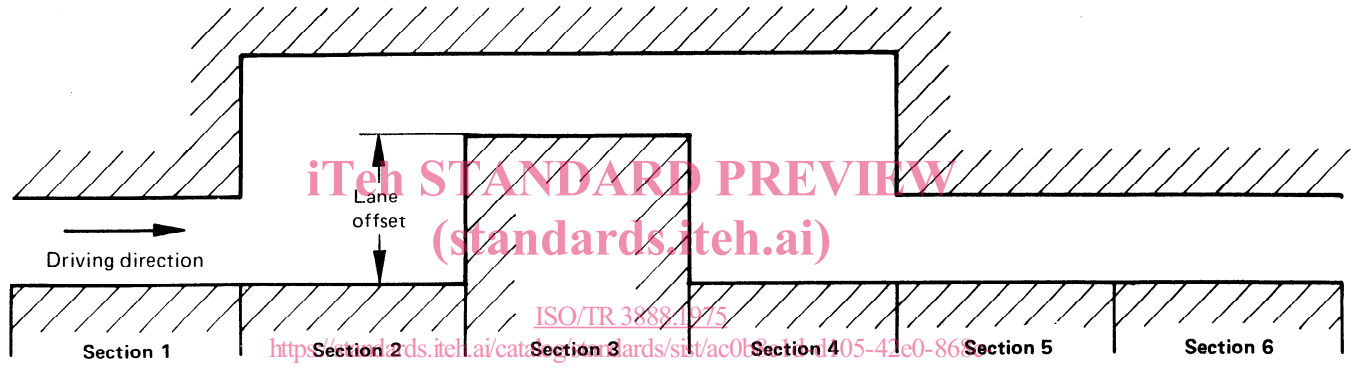

FIGURE 1 — **Lane-change track and designation of sections**

4 PARAMETERS

The following parameters can be determined :

- steering-wheel angle;
- steering-wheel velocity;
- yaw angle;
- yaw angle velocity;
- steering-wheel torque;
- lateral acceleration;
- side-slip angle;
- side-slip velocity;
- roll angle;
- longitudinal acceleration.

The above list is not exhaustive.

1) At present at the stage of draft. (Revision of ISO 2416-1972.)

5 TESTING CONDITIONS

5.1 Lane-change track dimensions

Section 1 : Length = 15 m
Width[1] = 1,1 X vehicle width + 0,25 m

Section 2 : Length = 30 m

Section 3 : Length = 25 m
Width[1] = 1,2 X vehicle width + 0,25 m

Section 4 : Length = 25 m

Section 5 : Length = 15 m
Width[1] = 1,3 X vehicle width + 0,25 m

Section 6 : Length = 15 m
Width[1] = 1,3 X vehicle width + 0,25 m

Lane offset : 3,5 m

5.2 Marking of the lane-change track

The lane-change track shall be marked with cones complying with figure 2, placed at points specified by figure 3. The track limits shall be tangential to the base circles of the cones.

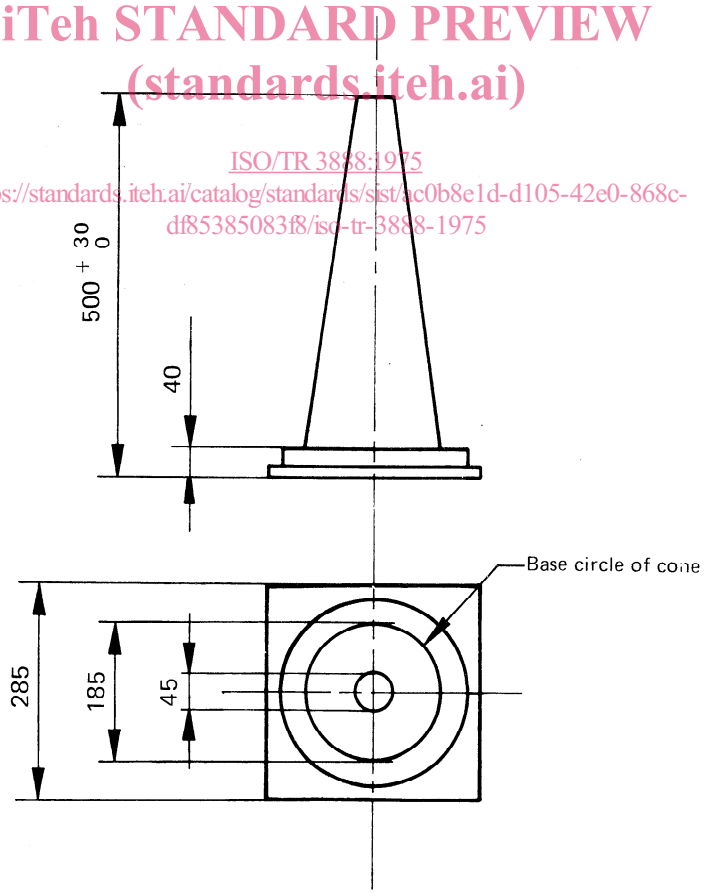

FIGURE 2 – **Cone used for lane-change track delimitation**

1) Width means overall width of the vehicle without rear-view mirrors.

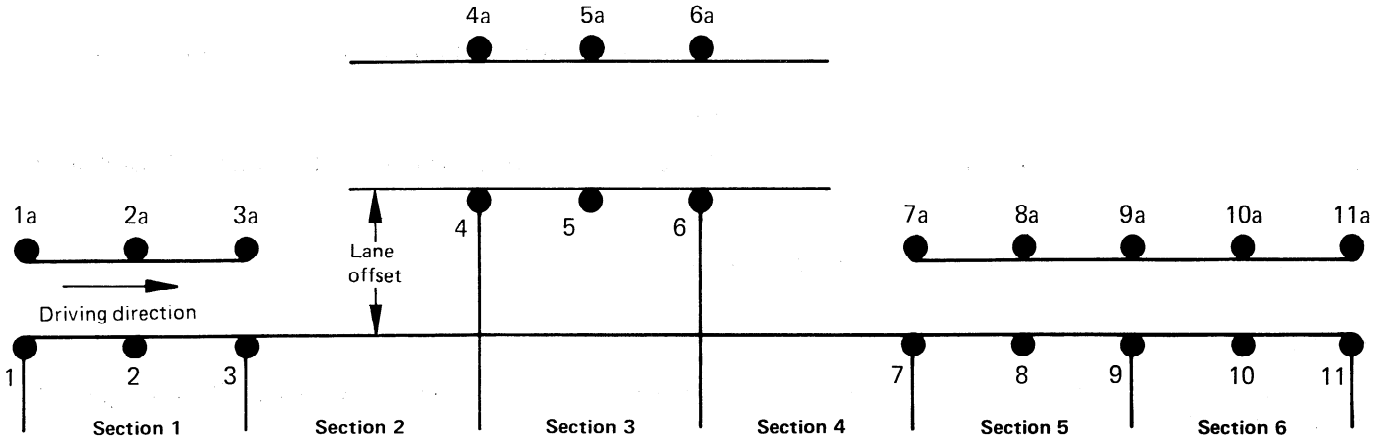

FIGURE 3 – **Placing of cones for marking the lane-change track**

5.3 Measuring distance

The measuring distance starts at the beginning of section 1 and finishes at the end of section 5.

5.4 Track surface

The surface shall be hard and as plane as possible.

The anti-skid property during the test shall correspond to a skid number of at least 70 according to ASTM.

Longitudinal deviation from horizontal shall not be more than 1°.

Transverse deviation from horizontal shall not be more than 2°.

5.5 Ambient conditions

Wind speed shall not be more than 3 m/s.

5.6 Vehicle weight

The test shall be run with two vehicle weights :

5.6.1 *Vehicle weight 1*

Empty weight according to 4.6 of ISO 1176, as a minimum, to which the driver weight is to be added; if parameters other than the average speed are measured, the weight of the measuring apparatus is to be added to the vehicle weight.

In no case must the permissible axle loads be exceeded.

5.6.2 *Vehicle weight 2*

5.6.2.1 VEHICLES USED FOR PASSENGER TRANSPORT

Empty weight according to 4.6 of ISO 1176, as a minimum, plus

- 68 kg X number of seats in passenger compartment, and
- 7 kg X number of seats, regularly distributed over the baggage compartments according to ISO 2416.

Charging of the passenger compartment shall be such that wheel loads obtained correspond to wheel loads obtained by charging each seat with 68 kg at its H point. Weights used for loading may be placed on the passenger compartment floor.

If parameters other than the average speed are measured, the weight of the measuring apparatus is to be added to the vehicle weight.

In no case must the permissible axle loads be exceeded.

Weights must be placed in such a way as not to alter substantially the vehicle's moment of inertia around the vertical axis.

5.6.2.2 VEHICLES USED FOR MERCHANDISE TRANSPORT

Charging shall be done so that the axle loads obtained are the same as those resulting from the following load distribution :

- 75 kg on driver's seat,
- distributed payload up to total permitted weight on loading area.

6 TESTS

The lane-change track shall be passed by skilled drivers. A passage is faultless when none of the cones positioned as specified in 5.2 has been displaced.

6.1 Test No. 1

6.1.1 The speed of entry into section 1 shall be 80 ± 3 km/h. For vehicles unable to attain this speed, the conditions shall be as for test No. 2. In this case the speed shall be mentioned in the test report.

6.1.2 The exit speed shall be stated in the test report.

6.1.3 Over the test course the throttle position shall be held as steady as possible.

6.2 Test No. 2

6.2.1 The speed of entry into section 1 shall be the maximum possible to complete the test course.

6.2.2 Two alternative throttle positions can be considered :

1st alternative

Over the test course the throttle position shall be held as steady as possible. If necessary, the throttle position suitable for this test condition can be determined by preliminary tests.

2nd alternative

Any throttle position can be used during the test.

The alternative chosen shall be stated in the test report.

6.3 Gear position

The gear or selector position engaged during the test shall be stated in the test report.

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