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A Study on Automobile Brake Testing Standards

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Abstract

Automotive brake performance tests include determination of stopping time, distance, and levels of deceleration. Dry terrain, wet terrain, concrete, asphalt and other road surfaces must guarantee the braking performance of the car. and long applications. Various brake test standards are used worldwide to ensure vehicle and pedestrian safety. This article provides methods for testing the automotive service brakes of two-wheeled vehicles. The main contribution of this work lies in the comparative study of three main brake test standards to know.

1. Indian Standard

2. Federal Motor Vehicle Safety Standard

3. European Economic Commission Standard

This study will help policymakers choose the best of these three standards while developing an updated version of the test standard.

Introduction

Vehicle braking performance is very important from a vehicle and pedestrian safety perspective. A vehicle's brakes must be effective on a wide variety of road surfaces. Since brakes operate on the principle of friction, the effect of heat on braking performance must also be addressed. The formation or presence of water affects braking performance. Strict standards involving various types of tests have been developed around the world to ensure the safe application of vehicle brakes. Vehicles must meet the requirements of these standards in order to be on-road eligible

This article introduces commonly used braking methodologies and the theoretical background of brake testing. Vehicle brake performance parameters were calculated. An overview of the different types of brake testing is provided along with the equipment required to assess the rigor involved in the brake test. However, the main contribution of this article is a comparative study among three brake testing standards for two wheelers, namely Indian Standards (IS) 14664:1999, Federal Motor Vehicle Safety Standards (FMVSS) 122 and European Economy Community (ECE) Standards R78.

Brake Performance Testing Parameters

Here are the main parameters used to characterize the braking performance

(a) Stopping time: The time elapsed between the application of the braking force on the pedal and the moment when the vehicle comes to a stop.
(b) Stopping distance: The distance traveled by the vehicle from the time the driver begins to activate the brake control until the time the vehicle comes to a stop.
The mathematical expression of these parameters is given in

Stopping time ¼ Vo=Dx ð1Þ

Stopping distance ¼ V2
o =2Dx ð2Þ

where Vo is the initial speed and Dx is the application of the brake. Assume that the vehicle's final speed is zero (point) and that other forces on the vehicle remain constant while the brakes are applied. Parameters affecting braking performance Vehicle initial speed and deceleration

Various Brake Tests

Brake testing is a procedure for checking that a vehicle's brakes are maintained at the (active) level. Performance that does not endanger people.

According to IS 14664:1999, following are tests

It is carried out to evaluate the braking performance of a vehicle.

(i) Type-P test (dynamic performance)

(ii) Type F test (thermal fade)

(iii) Type W test (water fade)

Type P Test (Dynamic Performance)

Tests are performed at initial speed and load conditions as stated in the standard. the vehicle starts and speeds are recorded slightly above initial tests given speed. When the vehicle approaches the test area, the vehicle speed is slightly above the prescribed initial velocity, the throttle is fully closed, and the drive is released. Clutch or otherwise. For recording equipment Distance, speed and deceleration are not automatic the device will start. when the vehicle slows down Braking within allowable initial speed range control is equally fast, continuous and smooth stop the vehicle. The test is repeated as above. The control force when the wheels do not lock and control force when the wheel locks up to the control force Determines where best performance is achieved Stopped without locking wheels After foundation work correct steering force, test is repeated enough times to get 4 valid readings accessible. Stopper to limit control travel or valve control force helps limit hydraulic pressure be recorded

Type F Test (Heat Fade Test)

This test evaluates the braking force after repeated use, as the braking force decreases due to temperature rise. Initial speed, control force, use of gear and clutch control are maintained as per standard. At each stop, the vehicle quickly accelerates to an initial speed and maintains that speed until the next stop is initiated. The distance between consecutive stops is 1000 m and the throttle must be fully closed while braking. Immediately

after repeating 10 stops, the Type P performance test above is run according to the criteria with the same control force and the stopping distance/average total deceleration is recorded. This test is run only once.

Type W test (water fade)

This test evaluates braking performance on wet road surfaces. The track must be dry during this test, but the brakes to be tested should preferably be moistened with tap water at a temperature not exceeding 30°C. Water is applied using the method described in the standard. The vehicle is driven within 500m of the starting point of the test at an initial speed suitable for the test without applying the brakes to be tested. After the brakes are wet, the vehicle is braked from the initial speed with the control force stated in the standard. The test consists of 15 stops with an interval of 120 seconds between the two stops. An average deceleration value is calculated for each stop. The deceleration achieved at the first stop should not be 60% of the value maintained during the baseline check. At least 90% of the baseline check value should be reached by the end of the 15th stop. If 90% recovery is achieved before the 15th stop, no further recovery stops are required.

Preparations and Instrumentation for Tests

This section provides some general details about the requirements to be fulfilled before the tests and the instrumentation required for the same.

Preparations

Manufacturers must prepare vehicles before submitting for brake testing. The vehicle is run in, and the brakes are properly applied. Lever and pedal free play must be adjusted. The actual weight during the tests must not exceed the specified loaded or unloaded weight by more than 25 kg. The distribution of the masses between the axles must be as close as possible to the values recommended by the manufacturer. Allows a tolerance of ±5% of the specified speed on the start speed. The test must be carried out on a dry class test track with a coefficient of adhesion of at least 0.8. The test is performed when the wind speed in any direction is ≤3m/s. The room temperature is preferably between and 40 C, and the relative humidity should be 75%.

Instrumentation for Tests

A speed measuring system using a non-contact electronic speed and distance measuring instrument (commonly known as "Correvit") or using an additional wheel (commonly known as called fifth wheel), must reach the minimum score and accuracy requirements such as those listed in Table 1

Table 1 Instrumentation least count and accuracy requirement

Parameter	Least count	Accuracy
Speed	0.1 km/h	0.1 km/h
Distance	0.1 m	0.1 m
Time	0.01 s	0.1 km/h

Instrument for Deceleration

It is recommended to properly secure decelerometers for testing vehicles so that they are less likely to be disturbed during testing. It must be mounted as close as possible to the center of gravity of the vehicle in the longitudinal and transverse planes. Before beginning each analysis of the, the instrument manufacturer ensures that the instrument levels are within the limits specified.

Instrument for Speed

When measuring latency, a speedometer can be used. shall be marked on the dial of the speedometer so that the actual speed of the vehicle, when the speed indicated by conforms to the marking, is determined in accordance with the procedure for given in IS 11827, within ± 1 km/ h of the initial speed specified. A suitable notation would be for all the test speeds needed.

Instrument for Control Force

Suitable load cells are to be used for this and the recommended least count and accuracy are 10 N (1 kg) and 20 N (2 kg) respectively.

Brake testing standards

Various automotive braking standards are used worldwide to determine a vehicle's braking performance. Few are American FMVSS, EEC Standard, IS, J 12-61 (Japanese Safety Standard) and Australian Design Rule 33/00. 4044 These have several sections detailing the requirements and 4044 procedures for different types of vehicles, although the methods and 4044 methods are still general. This study covers IS 14664:1999, FMVSS 122 and ECE R78 for comparative studies limited to braking standards for two-wheeled vehicles.

Comparison Among Brake Standards

This section presents the comparison between three brake standards used in two wheelers, namely, IS 14664:1999, FMVSS 122 and ECE R78.

Measurement Parameters

The ECE R78 test method measures braking performance using either deceleration or stopping distance, while FMVSS 122 evaluates performance based solely on stopping distance. IS specifies a delay or stopping distance, as is the case with ECE.

Test surfaces

FMVSS 122 currently requires that the road test be performed on a flat surface 8 feet wide with a slip number of 81. ECE R78 does not specify the coefficient of friction of the test surface, but describes that the test surface must be flat, dry and provide good adhesion. The width of the test track is also specified at 2.5 m (8. ft).

According to IS, the test requires a dry surface test track a coefficient of adhesion not \0.8, which is equivalent to slip number 81

Sequence of tests

The order of the tests is not specified in ECE R78. FMVSS 122 requires that all tests be performed in a specific order, ending with a wet brake test. IS also does not prescribe a series of tests, but for heat and water discoloration tests, the baseline check refers to the level of performance at the time of the dynamic performance test.

Brake Actuation Forces

Table below summarizes the brake actuation forces for these standards

Table 2 Brake actuation forces

Regulation	Foot control F_P (N)	Hand control F_L (N)
FMVSS 122	$25 < F_P < 400$	$10 < F_L < 245$
ECE R78	$F_P < 350$	$F_L < 200$
IS 14664:1999	$F_P < 330$	$F_L < 260$

Brake Temperature Measurement

FMVSS 122 includes specifications for plug-type thermocouples, including detailed diagrams covering their installation on disc or drum brakes. Although ECE R78 requires brake temperature measurement, it does not mention the specific measurement equipment or installation method of. IS does not guarantee temperature

measurement of the during the brake test. thermal fade. ECE R78 states that the IBT (initial brake temperature) must be B100 C (212 F), while FMVSS 122 states that the IBT is between 55 and 65 C (130 F and 150 F).

Burnishing

FMVSS 122 mentions polishing procedures, while ECE R78 does not include any polishing procedures for the brake test. IS also does not require the brake to be polished during testing.

Dry Stop Test

The ECE R78 regulations require a separate evaluation of the braking performance of each brake control, with the motorcycle under load, at a test speed of 40 or 60 km/h, depending on the vehicle class. The main FMVSS performance requirements of the are quite different, the controls are tested under light load conditions with all brakes applied simultaneously. FMVSS also requires testing from 30 mph (48.3 km/h), 60 mph (96.6 km/h) and times at 80 mph (128.8 km/h). The IS specifies testing under loaded and unloaded conditions; brakes alone and together at 30 and 40 km/h or 60% of maximum speed, whichever is lower.

High Speed Test

The ECE R78 test is performed from 160 km/h or 0.8 of the maximum vehicle speed (Vmax), the lowest value being. The FMVSS 122 high speed performance test is a test of speed based on the speed capability of the motorcycle, not exceeding 193.2 km/h (120 mph). When tested at a top speed of 120 mph, the required stopping distance was 861 feet (262.5 m), and the equates to an average deceleration of 5.5 m/s2. IS recommends driving at 30 km/h (single brake) or 40 km/h (two brakes together) or 60% of the maximum speed, whichever is lower.

Wet Brake Test

The ECE is R78 to simulate heavy rain conditions. The test requires a wet brake performance test. This is achieved by spraying water directly onto the brakes under test. ECE R78 wet braking performance the evaluation begins with a basic test where each brake is placed Individually checked and required to brake loaded machinery Motorcycle at a specific price using the terms of dry stop test – single brake control active. The same test is then repeated for comparison, but with a constant splash that wet the brakes. The FMVSS test is based on: Restoring braking performance after motorcycle crossing areas of standing water. In this way, the wetting procedure consists of soaking the front and rear brakes in water separately for 2 minutes each. Evaluate performance under all braking conditions Wet brake regenerative performance at the same time based on 5th stop after brake dip. According to IS regulations, wetting equipment is used in manufacturing Brakes to get wet. The test consisted of 15 breaks; The delay achieved at the first stop is \60% of the value maintained during the baseline check. At the end of the 15th keystroke, Baseline check must be achieved.

CONCLUSION

This article provides an overview of commonly used methodologies for automotive brake testing. Along with the type of braking test. Provides details on general requirements and required instrumentation. The presented comparative study should help gain insight into the three brake test criteria. IS, ECE, FMVSS. The authors believe that this comparative study will help policy makers and industry professionals to develop revised brake testing standards. Two main points should be considered in future revisions: braking test sequencing and temperature measurement in thermal fade tests. Brake performance testing of polished brakes as in FMVSS can also be considered to ensure minimum acceptable performance of worn brakes. A similar study of brake test standards relevant to various vehicle categories may provide useful insights for future revisions

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