

(IWG MU) R117 rolling sound emission - C1 temperature correction proposal

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Annex 3

2.1. Test site

The test site shall consist of a central section surrounded by a substantially flat test area. The measuring section shall be level; the test surface shall be dry and clean for all measurements. The test surface shall not be artificially cooled during or prior the testing.

The test track shall be such that the conditions of a free sound field between the sound source and the microphone are attained to within 1 dB(A). These conditions shall be deemed to be met if there is no large sound reflecting objects, such as fences, rocks, bridges or building within 50 m of the centre of the measuring section. The surface of the test track and the dimensions of the test site shall be in accordance with ISO 10844:2014. ~~Until the end of the period indicated in paragraph 12.8. of this Regulation the specifications for the test site may be in accordance with Annex 4 to this Regulation.~~

A central part of at least 10 m radius shall be free of powdery snow, tall grass, loose soil, cinders or the like. There shall be no obstacle, which could affect the sound field within the vicinity of the microphone and no persons shall stand between the microphone and the sound source. The operator carrying out the measurements and any observers attending the measurements shall position themselves so as not to affect the readings of the measuring instruments.

4.2. Temperature correction

For class C1 and class C2 tyres, the rolling sound levels $L_i(\vartheta_i)$ obtained at the test surface temperature ϑ_i (where i denotes the number of the single measurement) shall be normalized to a test surface reference temperature ϑ_{ref} by applying a temperature correction, according to the following ~~formula~~ **formulae**:

For class C1 tyres,

$$L_i(\vartheta_{\text{ref}}) = L_i(\vartheta_i) + K(\vartheta_{\text{ref}} - \vartheta_i)$$

$$L_i(\vartheta_{\text{ref}}) = L_i(\vartheta_i) - K_1 \cdot \lg\left(\frac{\vartheta_{\text{ref}} + K_2}{\vartheta_i + K_2}\right)$$

where:

$$\vartheta_{\text{ref}} = 20 \text{ }^\circ\text{C},$$

For class C1 tyres, the coefficient K is:

— $-0.03 \text{ dB(A)/}^\circ\text{C}$ when $\vartheta_i > \vartheta_{\text{ref}}$ and

— $-0.06 \text{ dB(A)/}^\circ\text{C}$ when $\vartheta_i < \vartheta_{\text{ref}}$.

and the coefficients K_1 and K_2 are given in the table below:

<i>Category of use</i>	K_1 ($^\circ\text{C}$)	K_2 ($^\circ\text{C}$)
Normal tyre	2.18	0
Snow tyre	2.18	0
Snow tyre for use in severe snow conditions	1.35	2.29
Special use tyre	2.18	0
Special use tyre for use in severe snow conditions	1.35	2.29

For class C2 tyres, the coefficient K is $-0.02 \text{ dB(A)/}^\circ\text{C}$.

$$L_i(\vartheta_{\text{ref}}) = L_i(\vartheta_i) + K(\vartheta_{\text{ref}} - \vartheta_i)$$

where:

$$\vartheta_{\text{ref}} = 20 \text{ }^\circ\text{C},$$

and the coefficient K is $-0.02 \text{ dB(A)/}^\circ\text{C}$.

Notwithstanding the above procedure, the temperature correction may be made only on the final reported tyre rolling sound level L_R , utilizing the arithmetic mean value of the measured temperatures, if the measured test surface temperature does not change more than $5 \text{ }^\circ\text{C}$ within all measurements necessary for the determination of the sound level of one set of tyres. In this case the regression analysis below shall be based on the uncorrected rolling sound levels $L_i(\vartheta_i)$.

There will be no temperature correction for class C3 tyres.

Annex 4

~~Reserved Specifications for the test site¹~~

~~1. Introduction~~

~~This annex describes the specifications relating to the physical characteristics and the laying of the test track. These specifications based on a special standard² describe the required physical characteristics as well as the test methods for these characteristics.~~

~~2. Required characteristics of the surface~~

~~A surface is considered to conform to this standard provided that the texture and voids content or sound absorption coefficient have been measured and found to fulfil all the requirements of paragraphs 2.1. to 2.4. below and provided that the design requirements (paragraph 3.2. below) have been met.~~

~~2.1. Residual voids content~~

~~The residual Voids Content (VC) of the test track paving mixture shall not exceed 8 per cent. For the measurement procedure, see paragraph 4.1. of this Annex.~~

~~2.2. Sound absorption coefficient~~

~~If the surface fails to comply with the residual voids content requirement, the surface is acceptable only if its sound absorption coefficient is $\alpha \leq 0.10$. For the measurement procedure, see paragraph 4.2. below. The requirements of this paragraph 2.1. above are met also if only sound absorption has been measured and found to be $\alpha \leq 0.10$.~~

~~*Note:* The most relevant characteristic is the sound absorption, although the residual voids content is more familiar among road constructors. However, sound absorption needs to be measured only if the surface fails to comply with the voids requirement. This is motivated because the latter is connected with relatively large uncertainties in terms of both measurements and relevance and some surfaces therefore erroneously may be rejected when based only on the voids measurement.~~

~~2.3. Texture depth~~

~~The Texture Depth (TD) measured according to the volumetric method (see paragraph 4.3. below) shall be:~~

$$\text{TD} \geq 0.4 \text{ mm}$$

¹ The specifications for the test site reproduced in this annex are valid until the end of the period indicated in paragraph 12.8. of this Regulation.

² ISO 10844:2014.

2.4. Homogeneity of the surface

Every practical effort shall be taken to ensure that the surface is made to be as homogeneous as possible within the test area. This includes the texture and voids content, but it should also be observed that if the rolling process results in more effective rolling at some places than others, the texture may be different and unevenness causing bumps may also occur.

2.5. Period of testing

In order to check whether the surface continues to conform to the texture and voids content or sound absorption requirements stipulated in this standard, periodic testing of the surface shall be done at the following intervals:

(a) For residual VC or sound absorption (α):

When the surface is new:

If the surface meets the requirements when new, no further periodical testing is required. If it does not meet the requirement when it is new, it may do so later because surfaces tend to become clogged and compacted with time;

(b) For TD:

When the surface is new:

When the noise testing starts (*Note*: Not before four weeks after laying);

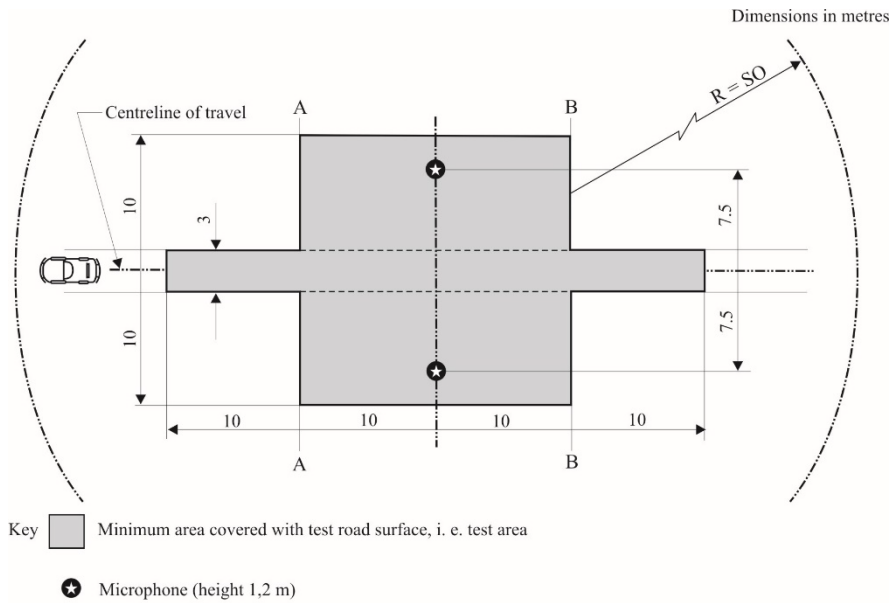
Then every twelve months.

3. Test surface design

3.1. Area

When designing the test track layout it is important to ensure that, as a minimum requirement, the area traversed by the vehicles running through the test strip is covered with the specified test material with suitable margins for safe and practical driving. This will require that the width of the track is at least 3 m and the length of the track extends beyond lines AA and BB by at least 10 m at either end. Figure 1 shows a plan of a suitable test site and indicates the minimum area which shall be machine laid and machine compacted with the specified test surface material. According to Annex 3, paragraph 3.2., measurements have to be made on each side of the vehicle. This can be made either by measuring with two microphone locations (one on each side of the track) and driving in one direction, or measuring with a microphone only on one side of the track but driving the vehicle in two directions. If the latter method is used, then there are no surface requirements on that side of the track where there is no microphone.

Figure 1
 Minimum requirements for test surface area. The shaded part is called "Test area"



NOTE - There shall be no large acoustically reflective objects within this radius.

3.2. Design and preparation of the surface

3.2.1. Basic design requirements

The test surface shall meet four design requirements:

3.2.1.1. It shall be a dense asphaltic concrete.

3.2.1.2. The maximum chipping size shall be 8 mm (tolerances allow from 6.3 mm to 10 mm).

3.2.1.3. The thickness of the wearing course shall be ≥ 30 mm.

3.2.1.4. The binder shall be a straight penetration grade bitumen without modification.

3.2.2. Design guidelines

As a guide to the surface constructor, an aggregate grading curve which will give desired characteristics is shown in Figure 2. In addition, Table 1 gives some guidelines in order to obtain the desired texture and durability. The grading curve fits the following formula:

$$P(\% \text{ passing}) = 100 - (d/d_{\max})^{1/2}$$

Where:

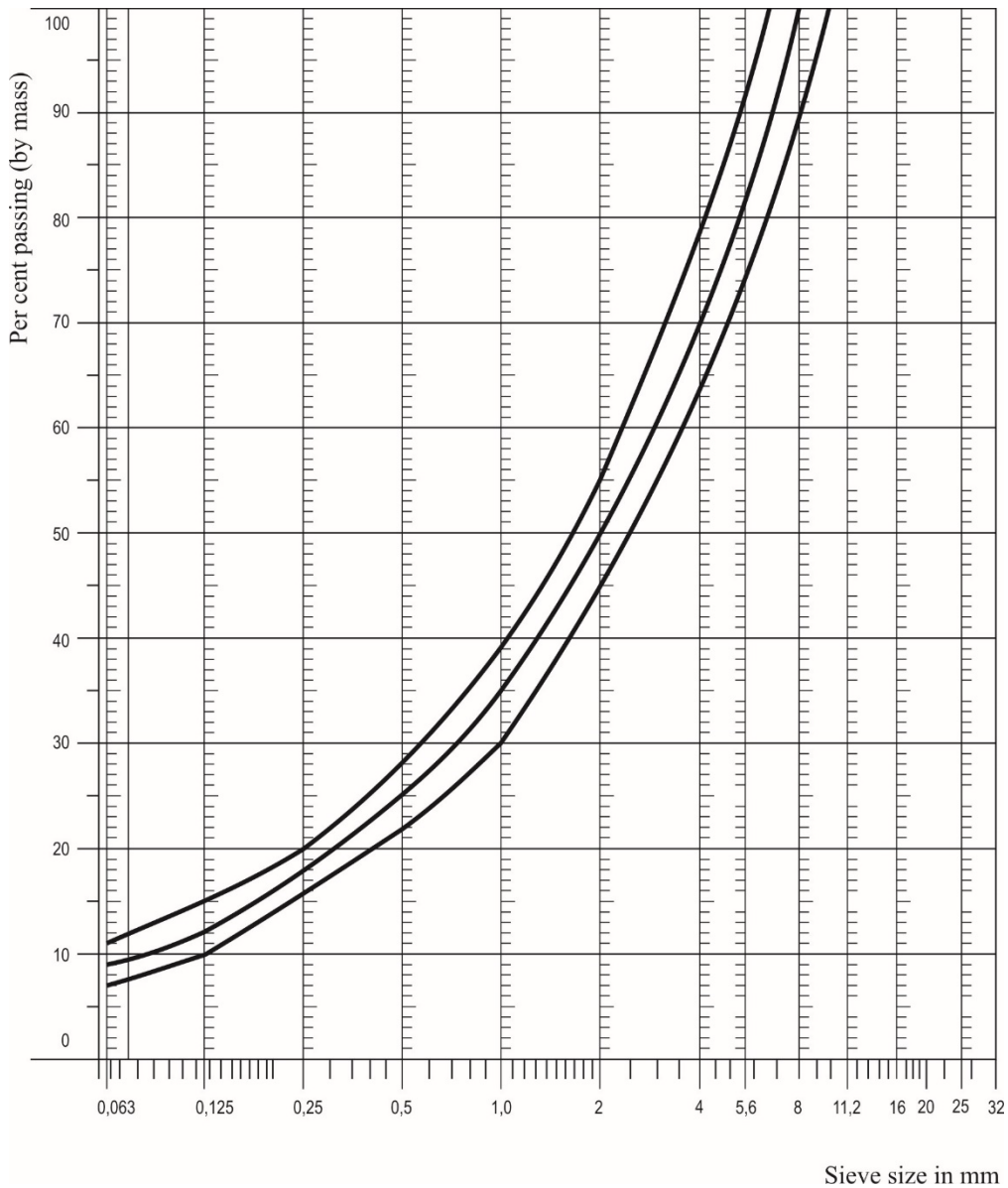
d = square mesh sieve size, in mm

d_{\max} = 8 mm for the mean curve

= 10 mm for the lower tolerance curve

= 6.3 mm for the upper tolerance curve

Figure 2
Grading curve of the aggregate in the asphaltic mix with tolerances



In addition to the above, the following recommendations are given:

- (a) The sand fraction (0.063 mm < square mesh sieve size < 2 mm) shall include no more than 55 per cent natural sand and at least 45 per cent crushed sand;
- (b) The base and sub base shall ensure a good stability and evenness, according to best road construction practice;
- (c) The chippings shall be crushed (100 per cent crushed faces) and of a material with a high resistance to crushing;

- ~~(d) The chippings used in the mix shall be washed;~~
- ~~(e) No extra chippings shall be added onto the surface;~~
- ~~(f) The binder hardness expressed as PEN value shall be 40–60, 60–80 or even 80–100 depending on the climatic conditions of the country. The rule is that as hard a binder as possible shall be used, provided this is consistent with common practice;~~
- ~~(g) The temperature of the mix before rolling shall be chosen so as to achieve by subsequent rolling the required voids content. In order to increase the probability of satisfying the specifications of paragraphs 2.1. to 2.4. above, the compactness shall be studied not only by an appropriate choice of mixing temperature, but also by an appropriate number of passings and by the choice of compacting vehicle.~~

Table 1
Design guidelines

	<i>Target values</i>		<i>Tolerances</i>
	<i>By total mass of mix</i>	<i>By mass of the aggregate</i>	
Mass of stones, square mesh sieve (SM) > 2 mm	47.6 %	50.5 %	±5 %
Mass of sand 0.063 < SM < 2 mm	38.0 %	40.2 %	±5 %
Mass of filler SM < 0.063 mm	8.8 %	9.3 %	±5 %
Mass of binder (bitumen)	5.8 %	N.A.	±0.5 %
Max. chipping size	8 mm		6.3–10 mm
Binder hardness	(see paragraph 3.2.2. (f))		
Polished Stone Value (PSV)	> 50		
Compactness, relative to Marshall Compactness	98 %		

4. ~~Test method~~

4.1. ~~Measurement of the residual voids content~~

~~For the purpose of this measurement, cores have to be taken from the track in at least four different positions, which are equally distributed in the test area between lines AA and BB (see Figure 1). In order to avoid inhomogeneity and unevenness in the wheel tracks, cores should not be taken in wheel tracks themselves, but close to them. Two cores (minimum) should be taken close to the wheel tracks and one core (minimum) should be taken approximately midway between the wheel tracks and each microphone location.~~

~~If there is a suspicion that the condition of homogeneity is not met (see paragraph 2.4. above), cores shall be taken from more locations within the test area.~~

~~The residual voids content has to be determined for each core, then the average value from all cores shall be calculated and compared with the requirement of paragraph 2.1. of this Annex. In addition, no single core shall have a voids value, which is higher than 10 per cent.~~

~~The test surface constructor is reminded of the problem, which may arise when the test area is heated by pipes or electrical wires and cores shall be taken from this area. Such installations shall be carefully planned with respect to future core drilling locations. It is recommended to leave a few locations of size approximately 200 mm x 300 mm where there are no wires/pipes or where the latter are located deep enough in order not to be damaged by cores taken from the surface layer.~~

4.2. ~~Sound absorption coefficient~~

~~The sound absorption coefficient (normal incidence) shall be measured by the impedance tube method using the procedure specified in ISO 10534 1:1996 or ISO 10534 2:1998.~~

~~Regarding test specimens, the same requirements shall be followed as regarding the residual voids content (see paragraph 4.1. above). The sound absorption shall be measured in the range between 400 Hz and 800 Hz and in the range between 800 Hz and 1,600 Hz (at least at the centre frequencies of third octave bands) and the maximum values shall be identified for both of these frequency ranges. Then these values, for all test scores, shall be averaged to constitute the final result.~~

4.3. ~~Volumetric macro texture measurement~~

~~For the purpose of this standard, texture depth measurements shall be made on at least 10 positions evenly spaced along the wheel tracks of the test strip and the average value taken to compare with the specified minimum texture depth. See Standard ISO 10844:2014 for description of the procedure.~~

5. ~~Stability in time and maintenance~~

5.1. ~~Age influence~~

~~In common with any other surfaces, it is expected that the tyre rolling sound level measured on the test surface may increase slightly during the first 6-12 months after construction.~~

~~The surface will achieve its required characteristics not earlier than four weeks after construction. The influence of age on the noise from trucks is generally less than that from cars.~~

~~The stability over time is determined mainly by the polishing and compaction by vehicles driving on the surface. It shall be periodically checked as stated in paragraph 2.5. above.~~

5.2. ~~Maintenance of the surface~~

~~Loose debris or dust, which could significantly reduce the effective texture depth shall be removed from the surface. In countries with winter climates, salt is sometimes used for de-icing. Salt may alter the surface temporarily or even permanently in such a way as to increase noise and is therefore not recommended.~~

~~5.3. Repaving the test area~~

~~If it is necessary to repave the test track, it is usually unnecessary to repave more than the test strip (of 3 m width in Figure 1) where vehicles are driving, provided the test area outside the strip met the requirement of residual voids content or sound absorption when it was measured.~~

~~6. Documentation of the test surface and of tests performed on it~~

~~6.1. Documentation of the test surface~~

~~The following data shall be given in a document describing the test surface:~~

~~6.1.1. The location of the test track;~~

~~6.1.2. Type of binder, binder hardness, type of aggregate, maximum theoretical density of the concrete (DR), thickness of the wearing course and grading curve determined from cores from the test track;~~

~~6.1.3. Method of compaction (e.g. type of roller, roller mass, number of passes);~~

~~6.1.4. Temperature of the mix, temperature of the ambient air and wind speed during laying of the surface;~~

~~6.1.5. Date when the surface was laid and contractor;~~

~~6.1.6. All or at least the latest test result, including:~~

~~6.1.6.1. The residual voids content of each core;~~

~~6.1.6.2. The locations in the test area from where the cores for voids measurements have been taken;~~

~~6.1.6.3. The sound absorption coefficient of each core (if measured). Specify the results both for each core and each frequency range as well as the overall average;~~

~~6.1.6.4. The locations in the test area from where the cores for absorption measurement have been taken;~~

~~6.1.6.5. Texture depth, including the number of tests and standard deviation;~~

~~6.1.6.6. The institution responsible for tests according to paragraphs 6.1.6.1. and 6.1.6.2. above and the type of equipment used;~~

~~6.1.6.7. Date of the test(s) and date when the cores were taken from the test track.~~

~~6.2. Documentation of vehicle noise tests conducted on the surface~~

~~In the document describing the vehicle noise test(s) it shall be stated whether all the requirements of this standard were fulfilled or not. Reference shall be given to a document according to paragraph 6.1. above describing the results which verify this.~~