

# Norms according to international roughness index of road pavements in Republic of Uzbekistan

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**Abstract.** This scientific article presents an analysis of the norms of the roughness of road pavement in foreign countries. Based on the results obtained from the experimental research work on measuring the international roughness index (IRI) of road pavements on many years of various highways by studying their experience, norms on the roughness of road pavements in the Republic of Uzbekistan are recommended.

## 1 Introduction

Roughness is an important pavement characteristic because it affects ride quality, vehicle delay, fuel consumption, and maintenance costs. Roughness measurements are used for dividing the road section into statistically homogeneous units, establishing the preferences for maintenance and rehabilitation, and other pavement surface characterization aspects. Currently, one of the problems of the road industry is to increase the performance of pavements and increase their exploitation life. Road pavement is one of the most important components of the road. In some cases, the cost of its devices reaches 50-70% of the total construction cost. The pavement condition greatly affects traffic speed, safety, and comfort. Road pavement is a complex structure consisting of successively laid layers of road building materials with different strength characteristics. These indicators must be carefully considered so that the road pavement can meet all its requirements and ensure the safe movement of cars at any time of the year at the calculated speed and convenience of car traffic. It is known that the road structure consists of the following elements: pavement, bases, additional base layers, and the active zone (working layer) of the subgrade.

## 2 Methods

In this paper, research is specialized to survey using statistic analysis and rewriting new recommendations by getting correlation. The designed and built pavement should not only be reliable and durable but also even, as well as economical, and should comply with environmental requirements. Roughness, strength, and other pavement indicators must be assigned based on standards.

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### 3 Result and Discussion

Many countries have developed various standards for roughness, strength, and other pavement indicators. In most CIS countries and far abroad, standards have been developed to assess the roughness of the pavement surface. In the countries of the customs union (Russia, Belarus, Kazakhstan, etc.), standards for the equality of roads during the period of construction and overhaul (or reconstruction) on the IRI scale have been developed, which are shown in Table 1 and the standards during the period of road operation are given in Table 2.

**Table 1.**

№	Countries	Category and type of coverage	The number of the international index of equality IRI (m(km) with different estimates			
			Perfectly	Good	satisfactorily	unsatisfactory
1	Russia [1]	I - Category HAC and CC	Till 1.2	1.2-1.7	1.7-2.1	>2.1
		II - Category HAC and CC	Till 1.7	1.7-2.2	2.2-2.6	>2.6
		III- Category HAC and CC				
		III- Category CAC, black rubble and stone materials treated with binders	Till 3.2	3.2-3.7	3.7-4.1	>4.1
2	Kazakhstan [2]	I - Category HAC and CC	Till 2.0	2.0-2.3	2.3-2.4	>2.4
		II- Category HAC and CC	Till 2.5	2.5-2.8	2.8-3	>3.0
		III- Category HAC				
		III- Category CAC, black rubble, and stone materials treated with binders	Till 3.5	3.5-3.8	3.8-4.2	>4.2
3	Belarus[3]	I - Category HAC and CC	-	-	-	>1.5(2.0) <sup>x</sup>
		II- Category HAC and CC	-	-	-	>2.0 <sup>x</sup>
		III- Category HAC and CC				
		III- Category CAC	-	-	-	>2 <sup>xx</sup>

*Note to Table 1:* X - H norm 1.5 for new construction, norm 2.0 after reconstruction or repair; XX-norm only for cold asphalt concrete. HAC hot asphalt concrete - hot asphalt concrete, CC - cement concrete ( cement concrete), CAC (CAC) - Cold asphalt concrete.

**Table 2.**

№	Countries	Category of road and type of coverage	Valid value IRI (m/km)
1	Russia [1]	I-Category HAC and CC	Till 3.4
		II-Category HAC and CC	Till 3.5
		III-Category HAC and CC	Till 4.2
		III- Category CAC	Till 4.9
2	Kazakhstan [2]	I-Category HAC and CC	Till 3.4
		II-Category HAC and CC	Till 3.8
		III-Category HAC and CC	Till 4.1
		III-Category CAC	Till 4.8
3	Belarus [3]	I-Category HAC and CC	Till 4.5
		II-Category HAC and CC	Till 5.5
		III-Category HAC and CC	Till 6.2
		III-Category CAC	Till 6.2

*Note:* HAC-hot asphalt concrete, CC-cement concrete, and CAC-cold asphalt concrete. Data from far abroad standards for equality in Table 3 after construction and during the operation of roads are given in Table 4.

**Table 3.**

№	Countries	The value of the international indicator IRI (m / km) with the following quality characteristics of roughness				
		Great	Fine	satisfies eloquently	dissatisfied eloquently	Very bad
1	Finland[4]	Till 1.7	1.7-1.9	1.9-2.1	> 2.1	>4.2
2	Canada [5]	Till 1.0	1.0-2.0	2.0-3.5	3.5-5.0	> 5.0
3	Brazil The World Bank [6]	Till 1.3	-	-	>3.5	-
4	The IRI roughness Scale [7]	Till 1.3	-	-	>3.5	-

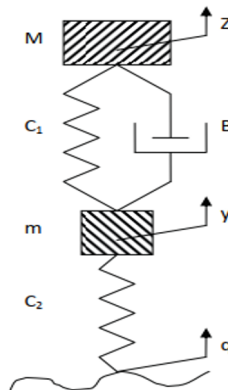
**Table 4.**

№	Countries	Horn categories and coverage type	Allowable IRI value (m/km)
1	Belgium [8-9]	I- Category HAC and CC	Till 2.0
		II - Category HAC and CC	2.0-4.0
		III - Category HAC and CC	4.0-6.0
		III - Category CAC	Till 6.0
2	USA [10-11]	I - Category HAC and CC	Till 2.4
		II- Category HAC and CC	Till 3.2
		III-Category HAC and CC	Till 3.2

**Continuation of table № 4**

3	Sweden [12]	I - Category HAC and CC	Till 1.5
		II- Category	1.5/2.5
		III-Category	2.5/3.5
		III - Category CAC	3.5/4.5
4	Brazil, World Bank [6, 13]	I- Category HAC and CC	4.0
		II- Category	4.0/6.0
		III-Category	6.0/8.5
5	Germany (FILTER PLARC) [14]	I- Category HAC and CC	Till 1.5
		II- Category	Till 1.5
		III-Category	1.5-3.5

In the table above, the international fluency index is IRI (International Roughness Index) assessment used in many countries. For this reason, using the equipment of the mobile "TRASSA" laboratory of the State unitary enterprise "Road Expertise" under the "Uzavtoyol" committee of the Ministry of Transport of the Republic of Uzbekistan, based on the cooperation with them, for many years, joint measurement of traffic flow was carried out on different categories of highways in the Republic of Uzbekistan. International Roughness Index IRI(International Roughness index) represents the ratio of the total displacement of the unsprung mass of the car (this is its wheels) relative to the sprung mass (this is the body of the car) to the length of the road section (m/km or mm/m). It is determined by calculation by modeling the movement along the microprofile of  $\frac{1}{4}$  of the reference car at a speed of 50-80 km/h. When measuring with a profilometer, the IRI index (m/km or mm / m) is calculated using the software included in the measuring equipment. The evenness index IRI is determined by the following algorithm. The movement at a speed of 50-80 km/h of a two-mass model of  $\frac{1}{4}$  of a car part is considered. The well-known model for measurements with a profilometer used in calculating the IRI index is shown in Fig. 1.



**Fig 1.** Two-mass model adopted for the calculation of IRI:

$M$  is sprung mass, kg;  $m$  is unsprung mass, kg;  $C_1$  is suspension stiffness, N / m;  $C_2$  is tire stiffness, N / m;  $B$  is the coefficient of viscous friction of the suspension, N · s/m;  $z$  is vertical displacement of the sprung mass, m;  $y$  is vertical displacements of the unsprung mass, m;  $q$  is vertical disturbance from the surface of the carriageway (microprofile), m.

The equations of motion for the presented model have the form:

$$\begin{cases} Mz + B(z - y) + C_1(z - y) = 0 \\ my - B(z - y) + C_1z + (C_1 + C_2) = C_2q \end{cases}$$

$C_1/M = 63.3 \text{ s}^{-2}$ ;  $C_2/M = 653\text{c}^{-2}$ ;  $B/M = 6\text{c}^{-1}$ ;  $m/M = 0.15$ .

In calculations, it is allowed to take  $M = 1$ .

The IRI indicator is determined by the formula:

$$\text{IRI} = 1/L \cdot \int_0^T |z - y| dt$$

where  $T$  is the travel time on the road section, s;  $L$  is the path (km) traveled in time  $T$  at a model speed of 50 - 80 km/h.

Using the mobile "TRASSA" laboratory shown in Fig. 2, the IRI of various types of car roads was determined.



**Fig. 2.** View of the TRASSA mobile laboratory with measuring instruments

The data collected on the international flow index IRI measured by the portable "TRASSA" laboratory for many years of different categories and with different coatings were analyzed, and the evaluation values based on the international flow index IRI required by the importance, category, and type of coating of highways in Uzbekistan are given in Table 5.

Requirements for assessing evenness according to the International IRI indicator depend on the functional value, road category, and types of surface.

**Table 5.**

№	The value of the road	Road category	Coating type	The value of the international evenness index IRI at its various estimates, (m / km)				
				Great	Very good	Fine	Satisfactory	Unsatisfactory
1	International	I (I a and I b)	Hot asphalt concrete	Till 2.1	2.1-2.5	2.5-3.1	3.1-3.9	Over 3.9
			Cement concrete					
2	State	II	Hot asphalt concrete	Till 2.8	2.8-3.3	3.3-4.0	4.0-4.9	Over 4.9
			Cement concrete					
		III	Hot asphalt concrete	Till 3.2	3.2-3.8	3.8-4.7	4.7-5.8	Over 5.8
			Cold asphalt concrete	Till 3.5	3.5-4.2	4.2-5.1	5.1-6.2	
3	Local	IV	Cold asphalt concrete	Till 4.4	4.4-4.9	4.9-5.6	5.6-6.5	Over 6.5
			Black rubble					
			Stone materials treated with binders	Till 4.7	4.7-5.3	5.3-6.1	6.1-7.2	
		V	black rubble					Over 10.1
			Stone materials treated with binders	Till 6.1	6.1-7.1	7.1-8.5	8.5-10.1	
			Crushed stone or gravel	Till 6.5	6.5-7.6	7.6-8.9	8.9-10.6	

## 4 Conclusion

The following conclusions can be made based on the results of the experiment surveyed through the years to determine the flow of traffic on the highways of the Republic of Uzbekistan:

1. The standard for assessing the roughness of newly constructed road surfaces has been developed, and its results are recommended.
2. As a result of the assessment of the highways in operation based on the recommended norms, it allows carrying out capital repair works.

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