Acta of Turin Polytechnic University in Tashkent

Volume 8 | Issue 2 Article 8

1-6-2018

Comparative Analysis of Road Roughness Specifications

Abduvokhid Yunusov
Senior lecturer at the Tashkent Institute of Design, Construction and Maintenance of Automotive Roads,
abduvokhid.yunusov@gmail.com

Narikawa Kazuo
Japan International Cooperation Agency (JICA) Senior volunteer

ACTA TTPU

III. ENGINEERING SCIENCE

COMPARATIVE ANALYSIS OF ROAD ROUGHNESS SPECIFICATIONS

Abduvokhid Yunusov, Narikawa Kazuo[1]

Senior lecturer at the Tashkent Institute of Design, Construction and Maintenance of Automotive Roads,
[1]*Japan International Cooperation Agency (JICA)* Senior volunteer

Abstract

In this paper, it is given that comparative analysis of road pavement roughness specifications between Uzbekistan and Japan. Road roughness measurement methods and acceptance values in construction and maintenance were analyzed. Based on comparative analysis, we developed recommendations about pavement roughness measurement methods for road authority of Uzbekistan.

Key words: Road roughness specifications, standard deviation value, 3 meter straight edge and profilometer, IRI.

Pavement roughness is generally defined as expression of irregularities in the pavement surface that affects the ride quality of the vehicle. According to ASTM E867, pavement roughness can be defined as the "deviation of a surface from a true planar surface with characteristic dimensions that affect vehicle dynamics and ride quality" [1]. Road roughness is the basic items of pavement performance evaluation, which is the management standards for road pavement construction and maintenance. In particular, the importance of measuring road surface profiles is increasing, as well as the indicators of ride comfort from the viewpoint of road users. In many road specifications, road roughness assessed in terms of quality of the pavement and some surface defects. To define reliable road roughness evaluation specification and development recommendations for modernizing existing methods, we have compared road construction and maintenance standards which is using in Uzbekistan and Japan.

Firstly we have analyzed Japanese road roughness specifications. In Japan for measuring and assessing methods of road roughness and standard values given in following standards [2,3,4 and 5]. In October 2016 road roughness evaluation methods newly added to the management standard. IRI is adopted as road roughness evaluation in terms of road users.

In this standards as an evaluation of pavement roughness is determined by the following indicators:

- Standard deviation obtained by measuring height difference every 1.5 m [mm];

- IRI, accumulated suspension stroke divided by traveled distance [mm/m]

Standard deviation value: Individual measurement values (test, inspection, measurement) measured by formulation management standard and quality control standard shall satisfy the standard value. The roughness of the road surface and side pavement road surface immediately measure after construction. Standard deviation σ is 2.4 mm or less. Standard deviation value measured according to the "Technical Standards on Pavement Structure" standards using 3 m profile- meters shown in Fig.1.

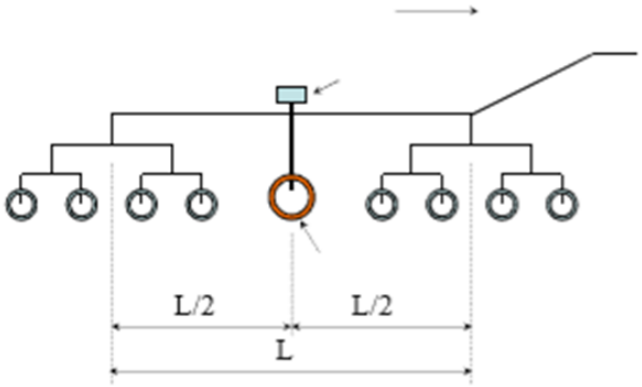

Fig.1 3 m profile- meters

Roughness in the roadway of a paved roads, on a line parallel to the center line 1 m away from the center line as in (Fig.2). Standard deviation value obtained by measuring height difference every 1.5 m and calculates following equation (1).

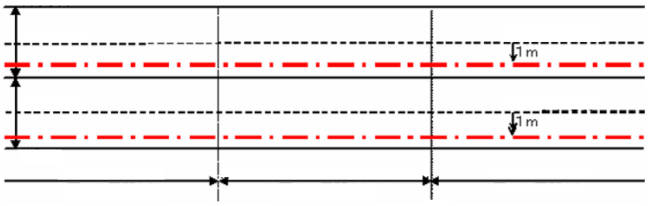

Fig.2 Roughness measurement line

$$\sigma=\sqrt{\{\Sigma d^2-(\Sigma d)^2/n\}/(n-1)} \quad (1)$$

where

σ : Standard Deviation (mm)

d : Measured value of height difference

n : Number of data

Japanese roughness standard value in construction and for repair or maintenance, shows in Table-1.

In Uzbekistan the requirements on the pavement roughness in newly built, major repairs and reconstruction of highways, found their reflection in the standard SHNK 3.06.03-08 “Highways” [6]. In this normative document, an evaluation of pavement roughness is determined by the following indicators:

- clearance between 3 m straightedge and pavement surface [mm];

-amplitude method (algebraic difference) leveling every 5 m interval and determining the relative amplitudes inherent in 5, 10, 20 meter points, at three base points 10, 20 and 40 m [mm]

- the indicator determined by the device RSC-2 at a speed of 30 or by roughometer measurement [cm / km]

3 meter straightedge is used to measure the gap between the straightedge and the pavement surface shown as Fig. 3. Road roughness measuring methods using this device performs by standards GOST 30412-96 [7].

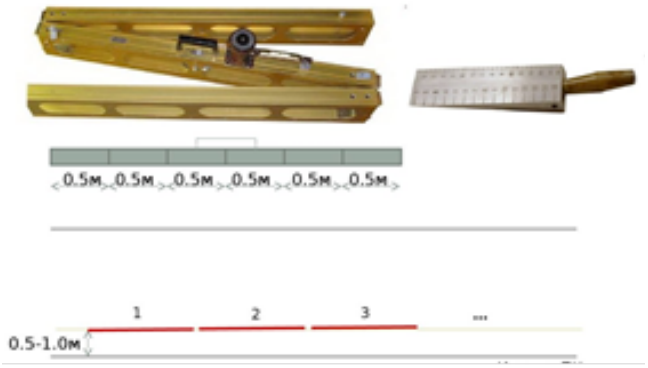

Fig. 3 3m straightedge

Data measured by 3 m straightedge calculate following: the total number of measurements should be taken as 100% and determine the number of gaps under the straightedge that exceed the maximum permissible value established by SHNK 3.06.03-08 and standard value given in Table-2.

This device has many limitations: labor intensive, time consuming, easily tend to miss reading or miss writing, enable to get roughness profile data. The main advantages are simple to measure roughness and low cost.

Table - 1 Japanese Roughness Standard value

Road type, Road Administrator	Roughness		
	Roughness Standard Deviation 3 m profilometer (σ3m) Standard value (mm)	Just after newly constructed	Repair or maintenance
		IRI value (mm/m)	
Expressway Company NEXCO	-	1.6≧IRI	3.5≧IRI
National road MLIT	2.4 ≧σ3m	-	3～8>IRI IRI≧8
Prefectural road	2.4 ≧σ3m	-	-
Municipal road	2.4 ≧σ3m	-	-

Table-2. Standards for pavement roughness assessment in terms of road category and conditions of construction

Road category and condition of construction	Number of measured free distances, %										The relative length of the sections with deviations, determined from the graphical record of the multi-bearing straightedge of RCP-4 or RCP-4m,%					The indicator is determined by the installation of PKRS-2 at a speed of 30 km / h	
	Straightedge with gauge					Two-way Straightedge type PKR-1 or PKR-5											
	up to 2 mm not less than	up to 3 mm not less than	less than 3 mm, not more than	above 5 mm, not more than	greatest	up to 2 mm not less than	up to 3 mm not less than	less than 3 mm, not more than	above 5 mm, not more than	greatest	up to 2 mm not less than	up to 3 mm not less than	less than 3 mm, not more than	above 5 mm, not more than	greatest	Average on site	Maximum
I - III with conventional sets of machines	-	80	-	5	10	-	53	-	11,7	10	-	65	-	5,5	10	130-180	290
The same, with the use of kits with an automatic system to ensure smoothness	90	-	5	-	6	74	-	11	-	6	85	-	5,5	-	6	50-70	100
For other road categories	-	75	-	5	10	-	50	-	12,4	10	-	57	-	5,5	10	160-210	340

In road maintenance period road roughness assessment is important. In Uzbekistan IRI included only road inspection standard. For evaluation IRI many roughometers are using in the operation of roads, (PKRS-2, TKhK-2, TED-2) and to get IRI value by correlation coefficients. The disadvantage of these devices are a certain complexity when it is installed on the car and calibrating, and small mistake made on the installation will significantly affect the degree of accuracy of all measured counts. Standard values of IRI is given in Table-3[8].

Table-3. Requirements for the pavement roughness in the diagnosis of automobile roads

Traffic intensity	Road category	Pavement type	Limits of longitudinal roughness sm/km	IRI limits of longitudinal roughness m/km	Increased amounts of permissible values of clearances under 3-meter straightedge ShNQ 3.06.03-08, %
			In PKRS-2U device		
7000 дан кўп	I	Capital	540	3	6
3000-7000	II		660	3,5	7
1000-3000	III	Capital	860	4	9
		Light	1100	4,5	12
500-1000	IV	Light	1200	5	14
200-500		Transitional	-	5,5	-
200 дан	V	The lowest	-	6	-

Road roughness specifications of Uzbekistan now using 3 m straightedge and an other devices. Straightedge has many limitations and even the same unit of roughness value between both countries but they have different values and measuring method. The important thing is Japanese device can plot true profile. 3 m straightedge is only applicable for selective evaluation and at least 10 % of total measuring data. In Uzbekistan IRI included only road inspection standard, it needs to justify measuring devices, methods and standard values based on road category and construction and maintenance period.

IRI value adopted only for expressway in Japan. Standard value also needed for another roads for example National road and some Prefectural roads. 3 m profilometer is popular method in Japan and so some reliable correlation formula needed to convert data between σ3m and IRI. Directly measurement and assessment of road roughness by IRI is easy but not cost effective for national, prefectural and municipal roads. So we recommend to develop more cost effective and user friendly methods and devices for road roughness assessment in both countries.

References

1. ASTM. (2012), E867 Standard terminology relating to vehicle-pavement systems, American Society for Testing Materials.

2. Civil engineering construction management standards and standard values. March 2017 MLIT (in Japanese)

3. “Technical Standards on Pavement Structure” Ministry of Land, Infrastructure, Transport and Tourism (MLIT) 2001 (in Japanese).

4. Pavement Inspection Procedure . MLIT; Ministry of Land, Infrastructure, Transport and Tourism of Japan. October 2016

5. Nippon Expressway Company Limited (NEXCO). Design Procedure First volume. Pavement construction and maintenance July 2012 (in Japanese).

6. SHNK 3.06.03-08. Automobile roads. Norms of construction. Tashkent., 2007.- 137 p.

7. GOST 30412-96 Automobile roads and aerodromes Uneveness measurement methods for base courses and pavements. Moscow 1997

8. IKN 05-2011. Giedlines of road diagnosys and assessment. Tashkent, 2012. – 129 p.