

COMPARISON BETWEEN GEOMETRIC DESIGN RULES IN THE REPUBLIC OF MOLDOVA AND SPAIN

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SUMMARY

Every country has its own legislation about road design. When projecting a new highway, laws and recommendations about the parameters that must be applied in road geometry vary from one country to another, but normally, they use and share approximate values in main characteristics. The aim of this paper is to compare the specifications about road geometry in the Republic of Moldova and in Spain. Fundamental parameters such as design speed, radius of horizontal curves, longitudinal grades and width of transversal section elements are discussed and compared between these two countries of Europe.

1. Introduction

Almost all the countries have their own regulations about road geometric design. Some of the most used and followed recommendations are defined in the USA, like the worldwide known “*A policy on Geometric Design of Highways and Streets*”, commonly referred as “*The Green Book*”, published by the AASHTO [1]. The last edition is the sixth and it was finished in 2011. Other important rules concerning road geometry are the British “*Design Manual for Roads and Bridges*” [2], the French “*Aménagement des routes principales. Recommandation techniques pour la conception générale et la géométrie de la route*” [3] and the German “*Richtlinien für die Anlage von Landstraßen (RAL)*” [4].

The present regulation in Moldova about road characteristics is in the document *NCM D.02.01:2015 Proiectarea drumurilor publice*, from Ministry of Regional Development and Construction [5]. In Spain, although there were rules about roads since the XVIII century [6], the first rule about road geometry was published officially in 1939 [7]. Since 1999, Spanish regulation was “*Norma 3.1-IC Trazado de la Instrucción de Carreteras*” [8] until March 2016, when a new version has become official, “*Norma 3.1-IC Trazado (2016)*” [9].

In section 2, road classifications and design speed in both countries are presented. Section 3 contains the details about the horizontal alignment, and section 4 about vertical alignment. A comparison between established transversal sections is provided in section 5. Finally, conclusions are exposed in section 6.

2. Road classification and design speed

The road classification in the Republic of Moldova is established taking into account the average annual daily traffic (ADDT) of the highway. There are 5 technical categories, but the first one, I, the most important one is divided in two; I-a and I-b. They are shown in Table 1. So as to count the different vehicles in a road, some equivalence coefficients are defined in the regulation.

Table 1. Technical Categories of Public Roads in Moldova

Technical category	Functional destination of the road	ADDT	Recommended road
I-a	National roads with highly intense traffic, designed exclusively for auto-vehicles circulation, including international traffic	over 16000	Freeways
I-b	National roads with intense traffic, designed for republican and international traffic	8001–16000	Express roads
II	National roads with medium traffic, opened for international traffic	3501–8000	Two lane roads
III	National roads with reduced traffic	751–3500	Two lane roads
IV	Local and commune roads with very low traffic	200-750	Two lane roads
V	Commune secondary roads	under 200	Two lane roads

In Moldova, the design speed of the road is related to the technical category of the road and to the relief in the area of design, as shown in Table 2. The level lands are composed of actual lowlands, highlands and floodplains. In rolling areas, hills and valley slopes with an inclination between 20° and 25° are included. In mountainous areas slopes exceeded 25° and include instable grounds.

Table 2. Design speed depending on road category and relieve in Moldova.

Technical road category	Design speed (km/h) depending on the relieve		
	Level	Rolling	Mountainous
I-a	140	120	100
I-b	120	100	80
II	120	100	80
III	100	80	60
IV	80	60	40
V	60	40	30

In Spain roads are not classified by traffic volume. Roads are ranked according to their importance by the Administrations that are in charge of the road network, normally considering the traffic volume, but without fixed values. The Spanish Central Government only supervises and controls the main roads of Spain, whereas the Regional Governments of the 17 autonomous regions of Spain have the competence to manage the road network in their area. According to the

law of roads [10], there are 4 types of roads: 2 types of freeways (with the difference that the most important one is exclusively for motor vehicles), multilane highways and two lane highways. Each administration chooses the type of road and establishes the design speed. There are 3 road groups according to road type and design speed, as exposed in Table 3.

Table 3. Road types and classification in Spain

Group	Road type	Denomination
1	Freeways	A-140, A-130
2	Freeways Multilane highways / Highways	A-120, A-110, A-100 C-100
3	Multilane highways / Highways	C-90, C-80, C-70, C-60, C-50, C-40

Note: The number in the denominations indicates the design speed.

3. Horizontal alignment

Horizontal alignment is composed by tangent, horizontal curves and transition curves. The main elements of a curve are the radius of the circumference, R (m), the rate of roadway superelevation, e (%), and side friction (demand) factor, f (dimensionless). They are related to design speed, V (km/h) by means of Eq 1, which is employed in Moldova and in Spain.

$$R = \frac{V^2}{127 \cdot (f \pm e)} \quad (1)$$

The regulations of each country established the minimum radii for horizontal curves according to the design speed. The values are shown in Fig. 1.

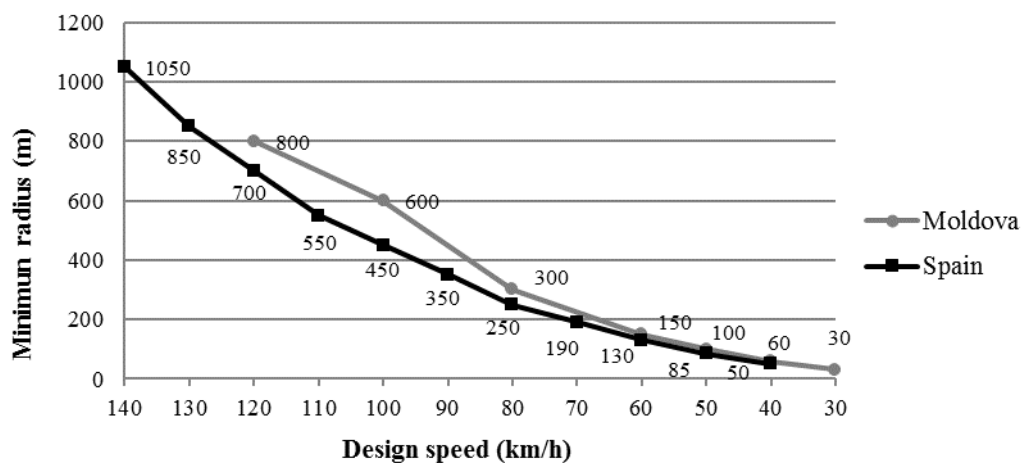


Figure 1. Minimum radius for horizontal curves depending on design speed

As observed, Spanish design rules indicates lower values for radii.

Proposed values for side friction factor are also lower in Spain, as shown in Fig. 2.

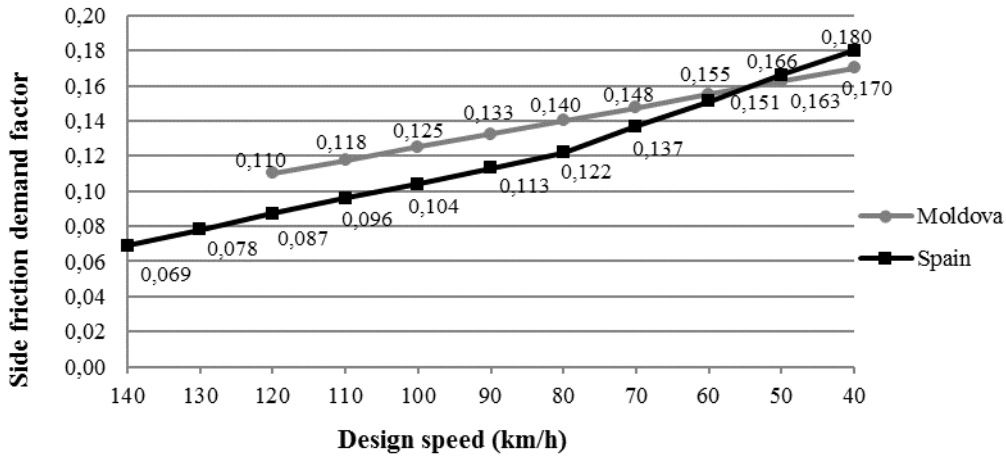


Figure 2. Maximum side friction demand factor values in Moldova and Spain

The higher values for radii in horizontal curves in Moldova are due to the lower superelevation values that are allowed, 5 %, while in Spain, it is possible to project superelevations until 8 % (depending on the design speed). Hence, same speed can be achieved with a lower radius if the superelevation rate is increased.

4. Vertical alignment

Grades and vertical curves compose the vertical alignment. Maximum and exceptional longitudinal grade values allowed in Spain and in Moldova are compared in Table 4, depending on design speed.

Table 4. Maximum longitudinal slopes in Moldova and in Spain

Design speed	Maximum longitudinal grade				
	Moldova		Spain		
	Maximum (%)	Except. (%)	Separated carriageways (%)	Maximum (%)	Except. (%)
120	4	-	4		
100	5	-	4	4	5
80	6	-	5	5	7
60	6,5	-		6	8
50	7	-		7	10
40	7,5	9		7	10
30	8	10			

The minimum longitudinal grade is 0,5 % in Spain, being allowed 0,2 % as long as the grade in the in any point of the carriageway is not under 0,5 %. The minimum value in any point of the carriageway in Moldova is 0,4 %.

5. Transversal section

The characteristics of the transversal section elements of roads in Moldova are presented in Table 5, and in Spain are shown in Table 6.

Table 5. Width of transversal section elements in Moldovan Roads

Transversal section element	Transverse profile parameters depending on road category					
	I-a	I-b	II	III	IV	V
Road lanes	$n \geq 4$	$n \geq 4$	2 (3)	2 (3)	2	2 (1)
Width lane (m)	3,75	3,75	3,5	3,5	3,0	2,75 (4,5)
Carriageway width (m)	$3,75 * n$	$3,75 * n$	7 (10,5)	7 (10,5)	6	5,5 (4,5)
Shoulder width (m)	3,75	3,0	3,0	2	1,5	1,00
The minimum width of the median zone.	2 + s	2 + s	-	-	-	-

Note: s: barrier in the median zone.

Table 6. Width of transversal section elements in Spanish Roads

Transversal section element	Freeways	Multilane highway		Highways		
Design speed (km/h)	140 - 80	100 - 60	50 - 40	100	90 - 60	50 - 40
Road lanes	≥ 4	≥ 4	≥ 4	2	2	2
Width lane (m)	3,5	3,5	3,25	3,5	3,5	3,50-3,00
Interior/right shoulder (m)	1,50 - 1,00	1,50-0,50	2,50-1,50	2,5	1,50-1,00	1,00-0,50
Exterior/right shoulder (m)	2,5	1,00-0,50	1,50-1,00			

As observed, road lanes in Moldovan freeways are wider than in Spain. However, the standard width for lanes, 3,50 m is maintained in Spain in all roads, and only in two lanes highways with low design speed ($V = 40$ km/h) and low traffic ($AADT < 300$ veh./day) can be reduced to 3,00 m, the absolute minimum. On the contrary, road lanes in technical category IV in Moldova are 3,00 m width, and in category V, the width is reduced to 2,75 m.

6. Conclusions

Generally, every country employs its own rules about road geometry design. In Moldova the last regulations is the *NCM D.02.01:2015 Proiectarea drumurilor publice*, published in 2015, and in Spain, the present rule, *Norma 3.1 IC Trazado* became official in March 2016.

Roads in Moldova are classified according to the Average Annual Daily Traffic in 6 technical categories, and different types of roads are proposed for each category. The design speed is obtained from the combination of the technical category and the emplacement relief. On the contrary, there are four types of road in Spain, according to its properties, 2 types of freeways, multilane highways and two-lane highways. The type and the design speed of the projected road are established by the administration (Central Government or Regional Government)

in charge of the road.

Spanish rules allows smaller radii for horizontal curves than the Moldovan one, even with lower values of side friction demand factors because higher superelevations, until 8 % are permitted, whereas in Moldova superelevations are more restricted. Similar values for longitudinal grades were observed in both countries. Freeways lanes in Moldova (3,75 m) are wider than in Spain (3,50 m). However, Spain maintains the European standard of 3,50 m in all roads, onland it can be reduced to 3,00 m in low speed two lane highways with low traffic. In Moldova, roads in technical category IV have 3,00 m lanes and in category V, only 2,75 m.

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