

New Approach to the Lithuanian Road Classification Based on Worldwide Experience

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Abstract. Road classification and road hierarchy are essential steps making sure that roads are designed and used properly. Road classification is an approach, to sort them into a small number of groups or classes, and then assigns the roads in a network to one or more of these groups. There are many ways to classify roads. One of them is regarding road hierarchy (or more specifically, functional road hierarchy). The efficiency and effectiveness of the road network directly impact economic growth and societal development. Economically, it is important through classification of roads to represent every road function, as it can enhance the delivery of goods efficient and effective. Arterial roads of a higher class significantly influence economic development by providing the main route of freight transportation and services, as well as significantly influence societal development as it provides a safe, effective and efficient route to travel on. At the same time, the high volume of traffic-related accidents calls for a road network that is safe for all road-users. It is known that the physical road network affects traffic and driver behaviour, and this in turn directly influences energy consumption and the environmental impacts associated with the emissions thereof. In this article review at road classification and road hierarchy of worldwide. It concludes with some comments on the current Lithuanian situation. It can be achieved in Lithuania to make influences to road safety, speed regulation, driver behaviour, traffic studies and accessibility to services.

Keywords: road classification, road hierarchy, road function, road network.

Conference topic: Roads and railways.

Introduction

Imperative sustainable development of all economic sectors is emphasized in the strategic planning documents of the European Union and the Republic of Lithuania. Therefore, a modern transport system policy is based on a long-term integrated approach to creating a safe, cost-effective and environmentally-friendly transport system. The *Road Maintenance and Development Programme of 2015–2020 years* in Lithuania provides for the development of sustainable national road network, taking into account aspects of social justice, economic development, and environment protection. One of these aspects provides access to road, socially oriented of all members of the public access road infrastructure, taking into account the needs and economic benefits.

- to increase the mobility of goods and passengers, by maintenance, modernisation, and development of national significance road network and to ensure functional properties of this network;
- to increase traffic safety on national roads;
- to preserve, protect and improve the quality of the environment and public health.

The rapid development process takes place in areas near the main cities and highways. Residential, commercial, industrial and other objects of the territory develop. Territorial urbanization process takes place partly chaotic. Individual land usage and changing and planning of the uses do not take place according to the essential principles of a sustainable transport system. Therefore, transport infrastructure develops by solving created problems of developed areas rather than to establish conditions under which the sustainable transportation is guaranteed. Problems occur through restrictions on the development of state roads in rapid development processes of individual areas near national roads. The transit purpose of highways is converted into access, i.e. local and transit routes are closely intertwined, appear factors of differences in operating speeds, directions of movement, and vehicle masses, which causing accidents; come into play traffic safety problems and the negative environmental impact of transport. There is a commitment to ensuring the long-term traffic conditions for the improvement of transit and local transport through the development and modernization of transport corridors, which are partly financed by European Union funds. That is why it is of particular importance to implementing solutions that ensure a harmonious interaction between state roads to the cities and territories with the boundaries of the local roads.

There are many ways to classify roads. Road hierarchy, or more specifically functional road hierarchy, is one of them. Hierarchy of roads and road classification are essential steps in making sure that roads are designed and used properly.

Bergman (2009) thorough discussion about Future European Road Network (FERN) notes that today there are two main international road network systems in Europe with partly different and partly unclear international aims and national commitments.

Eppell *et al.* (2001) specify that a road hierarchy is a means of defining each roadway regarding its function such that appropriate objectives for that roadway can be set and appropriate design criteria can be implemented. These objectives and design criteria are aimed at achieving an efficient road system whereby conflicts between the roadway and the adjacent land use are minimised, and the appropriate level of interaction between the roadway and land use is permitted. The road hierarchy can then form the basis for ongoing planning and system management aimed at reducing the mixing of incompatible functions.

Vorobjovas (2010) indicates the experience of European countries by sustainable traffic safety concept. Thereby, the implementation of preventive road safety strategy, starting with the road network and road design to the audit, it is necessary to examine and analyse the Lithuanian roads by road function and design elements.

This paper provides world experience and Lithuanian approach in forming the national road network and analyses the experience of EU countries, USA and Australia.

Road classification by country

In Matena *et al.* (2006) today’s practice of road categorisation in Europe was investigated. The results showed that the way how road categories are defined is quite similar in most European countries. Usually, it is a combination of road function and road hierarchy that leads to a certain number of possible road categories which are characterized by more or less strict design rules. The objective of this paper is to review the road classification systems around the world by comparison. This document looks at road classification and road hierarchy in these countries: Germany, Austria, Poland, Denmark, Greece, Norway, Portugal, USA, and Australia.

Germany has some advanced ideas on road networks. The traffic research organisation *Forschungsgesellschaft für Straßen- und Verkehrswesen e. V. (FGSV)* introduces *Guidelines for Integrated Network Design (in German Richtlinien für Integrierte Netzgestaltung (RIN 2008))*. According to RIN (2008), German roads are classified into five groups and five categories depending on function (Table 1). The road functional level determines road category and according to the road mobility and accessibility, are fixed driving speed on the road, the requirements to the route, cross-section, and other parameters.

Table 1. Road categories according to their functional levels in Germany

Link function level \ Category group	No.	Motorways	Rural roads	Trunk roads in non-built-up areas	Trunk roads in built-up areas	Local roads
		AS	LS	VS	HS	ES
Continental	0	AS 0		–	–	–
Sub-Continental	I	AS I	LS I		–	–
Inter-Regional	II	AS II	LS II	VS II		–
Regional	III	–	LS III	VS III	HS III	
Sub-Regional	IV	–	LS IV	–	HS IV	ES IV
Local	V	–	LS V	–	–	ES V

Note: AS I Designation of the category as it occurs; Problematic; – Does not occur or is not justifiable

Roads are divided up into road design classes and designed accordingly to ensure the uniformity of roads with similar network functions and traffic significance. The variables that determine the design class are the road category, the position of the road about built-up areas, and the jurisdiction of the road. These variables take into consideration the significance of the road regarding spatial planning and traffic and also claims to originate in the surrounding environment. Each road has different road characteristics because the road category and the design class of the road determine the features as well as the limiting values and guide values for the design and operation elements of the road. The design class directly determines:

- standard cross-sections,
- limiting and guide values for design elements,
- basic forms of junctions and the distances among them, and
- where applicable, the application of a speed limit.

Austrian roads are classified in hierarchical principal according to significant and function of the road, and there are five types of roads (Table 2).

Table 2. Road classification in Austria

Road category	Syntax category	Administrative subordination	Sub classes
Motorway	A	National	1–14, 21–26
Fast traffic road	S	National	–
Provincial road with priority	LB	Bundesland	3
Provincial road without priority	L	Bundesland	1–/2–/3–d/4–d
Private road	P	Bundesland	–

Poland has several road classifications, which relate to an international, a national or a local level. The Central Statistical Office of Poland (2016) classifies roads in three ways (Table 3).

Table 3. Road classification by the Central Statistical Office of Poland (2016)

No.	Road classification
1	Urban (roads within administration borders of cities)
	Non-urban (roads outside administrative borders of cities)
2	National roads – motorways, expressways, etc.
	Regional roads – defined as “roads other than those presented above, which are links between cities, have a great significance for the voivodship, and roads with a military significance not included among state roads”
	District roads – defined as “roads other than those mentioned above, which link powiat capital cities with gmina capital cities and gmina capital cities with other such cities”
	Communal roads
3	Hard surfaced roads
	Unsurfaced roads

The Polish road design guidelines published by the General Directorate for Public Roads refer to seven technical classes of roads (Table 4) (Generalna Dyrekcja Dróg Publicznych 1995).

Table 4. Road classification by the General Directorate for Public Roads in Poland

Road category	Technical class	Syntax category
Highways	I	A
Expressways	II	S
Speeded up roads	III	GP
Main roads	IV	G
Collector roads	V	Z
Local roads	VI	L
Access roads	VII	D

Danish roads are divided into three groups according to function. However, due to local conditions, many roads perform more than one function, i.e. mobility and accessibility (Kjemtrup 2005). The Danish road design rules distinguish six road classes according to design speed (Table 5) (Danish Road Directorate 2015).

Table 5. Road classification in Denmark

Road class according to design speed	Design speed	Functional classification		
		Through roads	Distributor roads	Local roads
Very high +	120–130 km/h	X	–	–
Very high	90–110 km/h	X	–	–
High +	80 km/h	X	X	(X)
High	60–70 km/h	X	X	X
Medium	50 km/h	–	X	X
Low	30–40 km/h	–	–	X

Note: X – applicable, (X) – designation of the category as it occurs.

Greece roads are classified by function (Marshall 2002). The road network is characterized by the road category, which is characterized by five groups of roads (A, B, C, D, and E), and six functional levels of roads (I, II, III, IV, V, and VI). Speed limits are set according to the road category (Table 6).

Table 6. Road classification in Greece

Road groupe	Level of Road function					
	I	II	III	IV	V	VI
A	Speed, km/h					
B	90–120	90–110	80–90	80		
C	100	90	70	60		
D			50	50	50	
E				50	30	30

Norwegian roads are classified into three groups by the road function (Marshall 2002). Country roads are divided into four classes according to the road function and category (Table 7). The geometry of the road cross-section is selected based on the traffic volume.

Table 7. Road classification in Norway

Functional classification \ Category group	Design speed, km/h			
	Highway	Other roads	County roads	Municipal roads
Through roads	90–100	50–90	–	–
Distributor roads	–	–	80	–
Local roads	–	–	–	80

The Portugal has a National Roadway Plan, which is split into a fundamental network and a complementary network (Maia Seco *et al.* 2008). Motorways in Portugal form a “motorway network”; the motorway links are part of either the fundamental or the complementary network. Table 8 presents the classes of roads and road networks in Portugal.

Table 8. Road network classification in Portugal

Network	Road class	Portuguese code
fundamental network	principal routes	IP
complementary network	complementary routes	IC
	national roads	EN
regional network	regional roads	ER
municipal network	municipal roads	EM
	municipal ways	CM
	neighbourhood ways	CV
motorway network		

Portugal road network is divided into a number of sub-classes. Appropriate speeds are suggested for each class:

- inter-urban motorway (140, 120 km/h);
- inter-urban motorway in difficult terrain (80 km/h);
- suburban motorway (100 km/h);
- urban motorway (80 km/h);
- collector roads (>80 km/h);
- main distributor roads (50–80 km/h);
- local distributor roads (30–40 km/h);
- access roads (20–30 km/h);
- Pedestrian streets (50–80 km/h).

USA road concept of functional classification defines the role that a particular roadway segment plays in serving this flow of traffic through the network. Roadways are assigned to one of the several possible functional classifications within a hierarchy according to the character of travel service each roadway provides (FHA 2013). Figure 1 shows the basic hierarchy of the Highway Functional Classification System in the USA by rural and urban setting. The classes are defined by certain characteristics as well as the level of access and the type of travel mobility the roads provide. The three roadway classes are arterials, collectors, and local. Arterials provide mobility, locals provide land access, and collectors strike a balance between arterials and locals. Context sensitivity and livability form the environment through which mobility and access should be considered. While most roadways offer both “access to property” and “travel mobility” services, it is the primary purpose of roadways that defines the classification category to which a given roadway belongs. A basic tenet of the functional classification network is continuity – a roadway of a higher classification should not connect to a single roadway of a lower classification. However, there are exceptions. Arterials can end or link to large regional traffic generators or can connect to multiple parallel roads of lower functional classification that, together, provide the same function and capacity as an arterial.

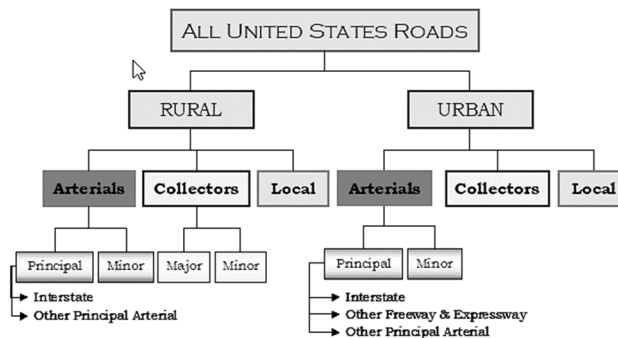


Fig. 1. Highway functional classification system in the USA

Australian roads consistent with various road classification theories and are “Road Function”, “Through Traffic and Local Traffic”, and “Road Purpose” (Government of South Australia and LGA of South Australia 2008.).

Australian roads have some functions that grouped: movement function (traffic) and access function (abutting land use). The general notion is that arterial roads primarily provide for the movement function and local roads primarily provide for the access function. All roads, however, (with the possible exceptions of a freeway and urban cul-de-sac) provide for a mixture of movement and access functions.

The Australian State Government has developed a means of determining the hierarchy of its arterial roads by the formation of “Role and Function” maps. These maps assist in the general future planning of the arterial road network and detail the following: strategic routes; primary and secondary freight routes, commuter routes, tourism routes, regional bus routes, public transport routes, cycle routes, and pedestrian zones.

This role and function designation do not directly influence or form the basis for road classification. It is simply a means of defining the hierarchy of roads within the state for planning purposes. Figure 2 presents road classification system in the State of Western Australia (MRWA 2011).

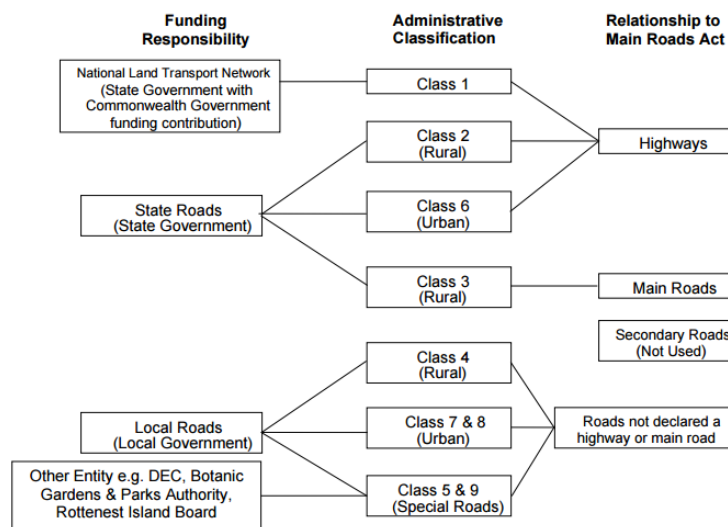


Fig. 2. Road classifications in the State of Western Australia

In 2007 Australia's National Transport Commission (National Transport Commission 2007) report was presented detailed a performance-based method of classifying roads for heavy vehicles. The classification is related to access for vehicles of larger and larger size:

- Level 1 access – passenger cars to single articulated;
- Level 2 access;
- Level 3 access;
- Level 4 access – triple road train (type II).

Discussion and approach to the Lithuanian Road Classification

Road classification practice in the European countries and the United States and Australia showed that there is no common road classification system. In many countries road classification based on the road function and it is the only goal to divide roads, but the road cross-section and the type of junction are assigned a certain road category only in some countries. The road classification of many countries used attributes, features, property, and relationships among roads and their geometric parameters.

Paraphantakul (2014) specify that to compare the road classification together, establish eight key classification criteria themes:

- *Access Control* considers whether the road has any form of access mechanism such as road access, vehicle access, building frontage access, tolled, and non-tolled roads;
- *Road Surface* defines the physical allocation of road section and roadside;
- *Usage* classifies roads by their usage performance indicators such as traffic speed and traffic volume;
- *Administration* differentiates the bodies that are responsible for road management;
- *Link Role* identifies roads based on the role, the importance of connected settlements, trip length, and their purposes in network and policy viewpoints;
- *Place Status* indicates the type of places the roads located;
- *Transport mode* distinguishes roads by the types of user served, the priority of road users, or the road infrastructure that provide for them;
- *Function* classifies the roads based on their function indicators, which are mainly circulation or mobility, accessibility, and connectivity.

Paraphantakul (2014) specify that are four groups of classification themes as shown in Figure 3.

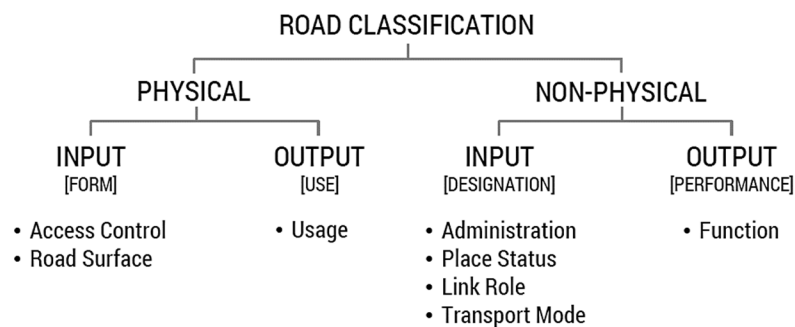


Fig. 3. Road classification relationship (Paraphantakul 2014)

We used these a structured classification themes highlighting the similarities among the road classification world-wide. Table 9 presents a summary of road classification based on applicable classification criteria in each country.

Table 9 shows that all the countries (except Lithuania) classify roads according to their *Function* and *Link Role*. *Road Surface* and *Transport Mode*, on the other hand, is the least used themes.

Road design based on *Highway Capacity Manual* (HCM 2010) and *A Policy on Geometric Design of Highways and Streets* (AASHTO 2011) in particular EU countries. It is appropriate to adopt the best practices of old EU countries for Lithuania, as an EU member state. Currently, Lithuania makes reference to the German model, i.e. Guidelines for Integrated Network Design (RIN 2008) because such grouping roads based on their functional purpose and is adopted in many European countries.

Understanding the classification around the world helps to learn some important aspects. Learning the differences contributes to compare the benefits and shortcoming, which are useful to make better road standards, proper designs, and sustainable roads. Furthermore, a collection of global road classification system helps to find the similarities of road systems in the neighborhood and to see the way to join the road network together, which resulting in creating a synergic relationship in trades and communications among countries.

Table 9. Analysis of road classification

Country	Road classification criteria themes							
	Access Control	Road Surface	Usage	Administration	Link Role	Place Status	Transport Mode	Function
Germany					+	+		+
Austria				+	+			+
Poland				+	+			+
Denmark			+		+	+		+
Greece	+		+		+			+
Norway			+		+			+
Portugal	+		+		+		+	+
USA	+		+		+	+		+
Australia	+		+	+	+	+		+
Lithuanian		+	+	+	+	+		

The entire Lithuanian state road network consists of three different uses of the roads under the Road Technical Regulations KTR 1.01:2008 Motor Roads (hereafter Regulations):

- arterial roads are designed to drive over a long distance, quickly and without any delays;
- collector-distributor roads are designed to drive in the medium distance; they are connections between adjacent areas and zones (linkages of arterial and access roads);
- access roads are designed to drive up to the yards, fields, parks and other areas nearby to the road.

One way only one function is the objective in the planning and designing roads under Regulations. It should be noted that the technical characteristics of the road determine the Level of Service (LOS) on the route. According to the Regulations, the LOS are directly related to the road function:

- the highest LOS is provided on arterial routes;
- the moderate LOS is provided on collector-distributor routes;
- the minimum LOS is provided on access routes.

This hierarchy of roads leads the principle that access roads from arterial roads and vice versa are accessed only through a suitable intermediate chain, i.e. distribution roads. Theoretically, Lithuanian state road network for these three functions is divided as follows:

- arterial routes are main roads;
- collector-distributor routes are national roads;
- access routes are regional roads.

In practice, elements of road network very often carry out not only one function and provided LOS is not ensured on each road. However, it is important to create presumptions for improving the situation. Therefore, it is necessary to develop a methodology of Lithuanian road classification into categories according to the road function, based on the common practice of road network classification in the world. The Concept of Self-Explaining Roads, uniform and proper operating speed and LOS should be implemented in Lithuanian state road network as well. This approach allows preparing sustainable development of Lithuanian state road network and harmonious interaction between state road network and areas with the boundaries of the local roads. The sustainable development of state road network allows to achieve a high LOS and traffic safety on main and national roads and to ensure the development of internal connections and growth of surrounding areas in a different format.

Conclusions

1. Summary of various road classification shows that there is no common road classification system. The different countries classify their roads in various terms, and types, but *Link Role* and *Function* criteria are common for all (except Lithuania).
2. Lithuanian Road Technical Regulations *KTR 1.01:2008 Motor Roads* classify roads up to classification criteria: *Administration*, *Link Role*, *Usage*, *Road Surface* and *Place Status*.
3. A suggestion is to reduce the number of criteria and develop an advanced classification of Lithuanian roads based on *Link Role* and *Function*.
4. A proposal is to use the *Link Role* criteria (European, Euro Regional, National, Regional, District and Local) and the *Function* criteria (Mobility, Connectivity, and Accessibility) for the Lithuanian state road network system.

5. For a selection of traffic lanes, access, and intersection type it is suggested to use the methodology of *Highway Capacity Manual HCM2010* to determine the Level of Service by the road function.

References

- AASHTO. 2011. *A Policy on Geometric Design Highways and Streets*. American Association of State Highway and Transportation Officials (AASHTO), USA, 2011.
- Bergman, L. 2009. *Future European Road Network (FERN)*. Conference of European Directors of Roads, 7 May 2009. CEDR's Secretariat General. 31 p. [online], [cited 10 September 2016]. Available from Internet: http://www.cedr.fr/home/fileadmin/user_upload/Publications/2009/e_Future_road_networks_FERN.pdf.
- Central Statistical Office of Poland. 2016. *CSO – Statistics, Road Transport in Poland in the Years 2012, 2013*. [online], [cited 28 September 2016]. Available from Internet: <http://stat.gov.pl/en/topics/transport-and-communications/transport/road-transport-in-poland-in-the-years-2012-2013,5,3.html?pdf=1>.
- Danish Road Directorate. 2015. *Forslag til vejregler for geometrisk udformning af veje og stier I åbent land 2012–2013*. [online], [cited 5 January 2015]. Available from Internet: www.vejregler.dk (in Danish).
- Eppell, V.A.T.; Bunker, J. M.; McClurg, B. A. 2001. A four level road hierarchy for network planning and management, in *Proc. of the 20th ARRB Conference*, 19–21 March 2001, Melbourne [online], [cited 10 September 2016]. Available from Internet: <http://eprints.qut.edu.au/2349/1/2349.pdf>.
- FHA. 2013. *Highway functional classification concepts, criteria and procedures*. Federal Highway Administration, U.S. Department of Transportation.
- Generalna Dyrekcja Dróg Publicznych. 1995. *Wytuczne projektowania dróg WPD1*. Warszawa.
- Government of South Australia and LGA of South Australia. 2008. *Road classification guidelines in South Australia*.
- HCM. 2010. *Highway capacity manual HCM2010*. Transportation Research Board of the National Academies, USA, 2010.
- Kjemtrup, K. 2005. Status report, Denmark 2005, in *Proc. of the 3rd International Symposium on Highway Geometric Design*, 29 June – 1 July 2005, Chicago, Washington DC, USA [CD-ROM].
- KTR 1.01:2008. *Automobilių keliai*. Kelių techninis reglamentas. Vilnius, 2008. (in Lithuanian).
- Maia Seco, A. J.; Antunes, A. J. P.; Costa, A. H. P.; Silva, A. M. B. 2008. *Princípios básicos de organização de redes viárias*. Manual do planeamento de acessibilidades e transportes. Comissão de Coordenação e Desenvolvimento Regional do Norte. 72 p. [online], [cited 15 September 2016]. Available from Internet: http://www.estgv.ipv.pt/PaginasPessoais/vasconcelos/Documentos/ManualdeAcessibilidades/ManuaisCCDRNmiolo_AF/04PrinciBasicos_AF.pdf (in Portuguese).
- Marshall, S. 2002. *A First Theoretical Approach to Classification of Arterial Streets*. ARTISTS: Arterial Streets towards Sustainability 2002. 116 p. [online], [cited 15 March 2016]. Available from Internet: http://www.academia.edu/5488882/A_First_Theoretical_Approach_to_Classification_of_Arterial_Streets_ARTISTS_Report_D1.1.
- Matena, S.; Weber, R.; Louwse, R.; Drolenga, H.; Vaneerdewegh, P.; Pokorny, P.; Gaitanidou, L.; Hollo, P.; Moksari, T.; Elvik, R.; Cardoso, J. 2006. *Road categorisation and the design of self-explaining roads*. European Commission, Directorate-General for Transport and Energy (TREN), Brussels. 133 p.
- MRWA. 2011. *Guidelines for determining and assigning responsibility for roads in Western Australia. Part 1: Policy for classification, proclamation and transfer of Western Australian roads*. Main Roads Western Australia (MRWA).
- National Transport Commission. 2007. *Performance-based standards scheme – Network classification guidelines*. 52 p. [online], [cited 10 September 2016]. Available from Internet: <https://www.nhvr.gov.au/files/resources/0018-pbsnetwrkclassglines.pdf>.
- Paraphantakul, C. 2014. Review of worldwide road classification systems, in *National Transportation Conference*, 2014, Bangkok, Thailand, Vol. 9.
- RIN. 2008. *Forschungsgesellschaft für Straßen- und Verkehrswesen e. V. Richtlinien für Integrierte Netzgestaltung (RIN)*, Köln. (in German).
- Vorobjovas, V. 2010. *Assurance of the function of low-volume roads for the improvement of driving conditions*: Summary of doctoral dissertation. Vilnius Gediminas Technical University. Vilnius: Technika. 24 p.