VILNIAUS GEDIMINAS TECHNICAL UNIVERSITY
FACULTY OF ENVIRONMENTAL ENGINEERING
DEPARTMENT OF ROADS

Gedas Janulis

ROADS FUNCTIONAL ANALYSIS AND RECOMMENDATIONS FOR CLASSIFICATION OF LITHUANIAN STATE ROAD NETWORK

KELIŲ FUNKCINĖ ANALIZĖ IR LIETUVOS VALSTYBINĖS REIKŠMĖS KELIŲ TINKLO KLASIFIKAVIMO REKOMENDACIJOS

Master‘s degree Thesis

Study programme of Innovative Road and Bridge Engineering, state code 628H20001
Road and Bridge specialisation
Study field of Civil Engineering

Vilnius, 2018

VILNIAUS GEDIMINAS TECHNICAL UNIVERSITY
FACULTY OF ENVIRONMENTAL ENGINEERING
DEPARTMENT OF ROADS

APPROVED BY
Head of Department

(Signature)
Virgaudas Puodžiukas
(Name, Surname)
2018 01 04
(Date)

Gedas Janulis

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Supervisor	Doc. Dr. Virgaudas Puodžiukas (Title, Name, Surname)	(Signature)	2018 01 04 (Date)
Consultant	(Title, Name, Surname)	(Signature)	(Date)
Consultant	(Title, Name, Surname)	(Signature)	(Date)

Vilnius, 2018

(the document of Declaration of Authorship in the Final Degree Paper)

VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

Gedas Janulis, 20124198

(Student's given name, family name, certificate number)

Faculty of Environmental Engineering

(Faculty)

Innovative Road and Bridge Engineering, IKTmfu-16

(Study programme, academic group no.)

DECLARATION OF AUTHORSHIP
IN THE FINAL DEGREE PAPER

January 19, 2018

I declare that my Final Degree Paper entitled „Roads Functional Analysis and Recommendations for Classification of Lithuanian State Road Network" is entirely my own work. The title was confirmed on November 14, 2017 by Faculty Dean's order No. 237ap. I have clearly signalled the presence of quoted or paraphrased material and referenced all sources.

I have acknowledged appropriately any assistance I have received by the following professionals/advisers: Assoc Prof Dr Virgaudas Puodžiukas.

The academic supervisor of my Final Degree Paper is Assoc Prof Dr Virgaudas Puodžiukas.

No contribution of any other person was obtained, nor did I buy my Final Degree Paper.

(Signature)

Gedas Janulis

(Given name, family name)

VILNIUS GEDIMINAS TECHNICAL UNIVERSITY
FACULTY OF ENVIRONMENTAL ENGINEERING
DEPARTMENT OF ROADS

APPROVED BY
Head of Department
(Signature)
Kelių katedros vedėjas
doc. dr. Virgaudas Puodžiukas
(Name, Surname)
14 11 2016
(Date)

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OBJECTIVES FOR MASTER THESIS

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KELIŲ FUNKCINĖ ANALYZĖ IR LIETUVOS VALSTYBINĖS REIKŠMĖS KELIŲ TINKLO KLASIFIKAVIMO REKOMENDACIJOS

Approved on 14, November 2016 by Dean's decree No. 219 ap

The Final work has to be completed by 4 January, 2017

THE OBJECTIVES:

To revue the sructure of Lithuanian state road network and functional classification practice. To analyse road network functional classification and functional relationship theory role in the Design Regulations. To formulate the objectives and targets of research paper. To compare functional classification regulations of developed countries like USA, Germany, The Netherlands and current practices in Lithuania. To analyse selected international roads crossing Lithuania (E67 - ViaBaltica and A2 – Vilnius-Panevėžys) how road elements respond theory of fuctionalyti. To analyse traffic volume, accidents and road elements taking attention to the road function, design speed and level of services.

To propose the most favourable international experience for implementation in Lithuania. To delivere general conclusuions and recommendations for a practical application of road functional classification in Lithuania.

.....
Consultants of the Master Thesis: .....
.....
(Title, Name, Surname)

Academic Supervisor .... Assoc Prof Dr Virgaudas Puodžiukas....
(Signature) (Title, Name, Surname)

Objectives accepted as a quidance for my Master Thesis

.....
(Student's signature)
Gedas Janulis
(Student's Name, Surname)
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Antrosios pakopos studijų **Inovatyvios kelių ir tiltų inžinerijos** programos magistro baigiamasis darbas 3 (keliai)

Pavadinimas **Funkcinė kelių analizė ir Lietuvos valstybinės reikšmės kelių tinklo klasifikavimo rekomendacijos**

Autorius **Gedas Janulis**

Vadovas **Virgaudas Puodžiukas**

Kalba: anglų

Anotacija

Baigiamajame magistro darbe analizuojama kelių funkcinė paskirtis Lietuvoje. Darbe taip pat nagrinėjama užsienio literatūra atkreipiant dėmesį į JAV, Vokietijos, Olandijos kelių funkcinio skirstymo patirtį. Literatūros apžvalgoje ypatingas dėmesis skiriamas minėtų šalių kelių projektavimo taisyklėms bei reglamentams apibrėžtiems kelių klasifikavimą. Baigiajame darbe atliekamas tyrimas, kurio metu siekiamą nustatyti ar Lietuvos keliai turi funkcinę paskirtį, taip pat analizuojamas esamas Lietuvos kelių klasifikavimas. Tyrimo metu atliktas vizualinis A2 bei Via Baltica magistralinių kelių tyrimas, taip pat analizuojami kiti valstybinės reikšmės keliai. Tiriant magistralinius kelius siekta išsiaiškinti ar keliai atitinka funkcinią paskirtį, ar jie lengvai atpažįstami visame ruožo ilgyje taip pat ar atitinka saugumo reikalavimus. Išanalizavus literatūrą bei atlikus tyrimą, darbe sudaromos išvados bei nurodomos klasifikavimo rekomendacijos Lietuvos valstybinės reikšmės kelių tinklui.

Darbą sudaro: įvadas, trys skyriai, bendrosios išvados ir rekomendacijos bei priedai. Darbo apimtis – 76 puslapiai teksto be priedų, 17 paveikslų bei 32 lentelių. Rašant darbą remtasi 31 literatūros šaltiniais.

Papildomai pridedami darbo priedai.

Prasminiai žodžiai: Lietuvos kelių tinklas, funkcinis klasifikavimas, Via Baltica, A2, vizualinis tyrimas, apažįstami keliai, kelio funkcija, autoįvykiai, kelių saugumas.

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Master Degree Studies **Innovative Road and Bridge Engineering** study programme Master Graduation Thesis 3 (Roads)

Title **Roads Functional Analysis and Recommendations for Classification of Lithuanian State Road Network**

Author **Gedas Janulis**

Academic supervisor **Virgaudas Puodžiukas**

Thesis language: English

Annotation

Lithuanian road functional classification is analysed in this Master thesis. During this research analysed foreign countries literature like USA, Germany, and Netherlands. During analysis a focused on road design guidelines and standards from mentioned countries. In this master thesis, was completed investigation, which aim was to determinate Lithuanian road having functional classification or not. For data survey were chosen two Lithuanian main roads A2 Vilnius – Panevėžys and Via Baltica (which consists five different road sections), also reviewed other Lithuanian roads. The aim of investigation was to determine roads function, roads safety, also estimate if roads are “self-explaining”. Finally conclusions were submitted and recommendation for Lithuanian state network improvement.

This work consists of: introduction, three chapters, final conclusions and recommendation also annexes. Volume of the work is 76 pages of text without annexes, 17 figures, and 32 tables, 31 references were used while writing this thesis.

Keywords: Lithuanian state network, functional analysis, Via Baltica, A2, visual investigation, self-explaining roads, road functions, road safety, mobility.

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ABBREVIATIONS

AADT – Annual Average Daily Traffic

AASHTO – American Association of State Highway and Transportation Officials

EU – European Union

FGSV – Forschungsgesellschaft für Straßen- und Verkehrswesen. Investigation Association for Road and Transportation

KTTI – Road Transport and investigation institution in Lithuania

KTR – Road technical regulations

LAKD – Lithuania Road Administration

RAA – Richtlinien für die Anlage von Autobahnen. Guideline for the design of motorways

RAL – Richtlinien für die Anlage von Landstraßen. Guideline for the design of rural roads

RASt – Richtlinien für die Anlage von Stadtstraßen. Guideline for the design of urban roads

RIN – Richtlinien für integrierte Netzgestaltung. Guidelines for Integrated Network Design

TEN-T– Trans-European Transport Network

US – United States

WHO – World Health Organization

INTRODUCTION

Road network system is a network which connects places and people inside and outside country borders. Road network system consists of high amount of different roads. They differ in parameters like design speed, length, class, cross–section and other. Road classification means dividing of highways into different operational systems, functional classes, or geometric types. Functional classification is one of most important road classification criteria. Functional classification of roads, defines purpose of each road in road network system. Two major travel needs in classifying highway networks functionality are access from specific locations and travel mobility. Each road type class in road network provides one of access or mobility functions, most of roads provide combination of each.

Road functional classification is another important base for sustainable roads. Mentioned roads consist of “self-explaining” roads and “forgiving” roads. The aim of these roads is different classes of roads should be distinctive, and within in each class features such as width of carriageway, road markings, signing, and use of street lighting would be consistent throughout the route. Drivers would perceive the type of road and "instinctively" know how to behave. During investigation of work a big attention is for self-explaining road definition and how road users have to react on roads.

Many countries successfully use functional road classification in their state road networks. United States, Germany and other Europe countries are as example for Lithuanian. One of the weaknesses in Lithuanian road network is that all national roads are classified by significance. Road categories are determined by using annual average daily traffic. In order to improve Lithuanians road network system in practical were generally used foreign countries experience. Using other more developed countries experience, can be avoided many dangers and created creating efficient classification system for Lithuanian road network.

In the master thesis were analysed two main roads in Lithuania: A2 Panevėžys – Vilnius and Via Baltic which constist other five main roads sections. Both roads are part of European road corridors. During investigation, was analysed annual average daily traffic of last seven years. Also were analysed such road parameters as width, road pavement condition, embankment width. In order to find out more about functional classes, were analysed data about traffic accidents, traffic delays. Roads were compared, applicable Western Europe road classification standards.

The aim of thesis: Determine, if roads have functional classification function. Make and give recommendations for Lithuanian road network to improve or use road functional classification.

Objectives of the work:

1. Compare and analyse road functional classification systems in countries such as United States, Germany and Netherlands;
2. To analyse of selected roads data, parameters, car accidents, travel time delays due to traffic;
3. Make travel speed tests in selected Lithuania roads and determinate travel time delays;
4. Present data of investigation and make analysis of data;
5. To make recommendations and suggestions for Lithuanian road network classification.

1. FUNCTIONAL CLASSIFICIATION

During analysis of literature, it is very important to pay attention to foreign countries. In order to get important experiences in particular field, we should pay attention to more developed countries. For that reason, most of theoretical substantiation would be data from United States, Germany and other foreign countries.

This chapter is about road function classification. The main literature for road functional classification analysis is United States design guidelines also technical specifications, known as Highway capacity manual [10] and A policy of geometric design of Highways and Streets [2,3]. Also these documents are comparing with Europe countries documents and standards.

Also writing this chapter were used many papers from different countries such as Macedonia, United States, Japan, Germany, and Canada. Main papers, which were used writing this master thesis, are:

- Bunevska, J.; Donceva, R.; Malenkovska Torova, M. Role of functional classification of highways in road traffic safety; [8]
- Jasper, J.; Kirk, A.; Stamatiadis, N; Wright, S. A Functional Classification System to Aid Contextual Design; [12]
- Nakamura, H.; Goto, A.; Functionally Hierarchical Road Classification Considering the Area Characteristics for the Performance-oriented Road Planning; [18]
- G. Forbes. Urban Roadway Classification; [11]
- Norman W. Garrick, Tobias Kuhnimhof. Street Design and Community Liveability. [19]

Part of this chapter is about Lithuanian national road network system. Writing about Lithuanian roads were used design guidelines, laws, road standards, papers written in Lithuanian language.

1.1. Literature review

1.1.1. Road classification

The classification of highways into different operational systems, functional classes, or geometric types is necessary for communication among engineers, administrators, and the general public. Different classification schemes have applied for different purposes in different rural and urban regions. [2]

One of the most important road designing documents in United States (A Policy on Geometric Design of Highways and Streets) indicates four most important criteria for road classification:

1) Classification of highways by design types based on the major geometric features (e.g., freeways, conventional streets, and highways) is the most helpful approach for highway location and design procedures.
2) Classification by route numbering (e.g., U.S., State, and County) is the most helpful approach for traffic operations.
3) Administrative classification (e.g., National Highway System or Non-National Highway System) is used to denote the levels of government responsible for and the method of financing highway facilities.
4) Functional classification, the grouping of highways by the character of service they provide, was developed for transportation planning purposes. Comprehensive transportation planning, which is an integral part of total economic and social development, uses functional classification as an important planning tool.

A group of scientists from Macedonia in their article "Role of functional classification of highways in road traffic safety" [8] describes road classification as *various road classification systems are very useful in the process of road network development*. They are based on different criteria, as resulted from several reasons why roads ought to be classified. These divisions are the base for defining the jurisdiction of the road, its geometry, traffic volume, traffic type, origins and destinations it connects.

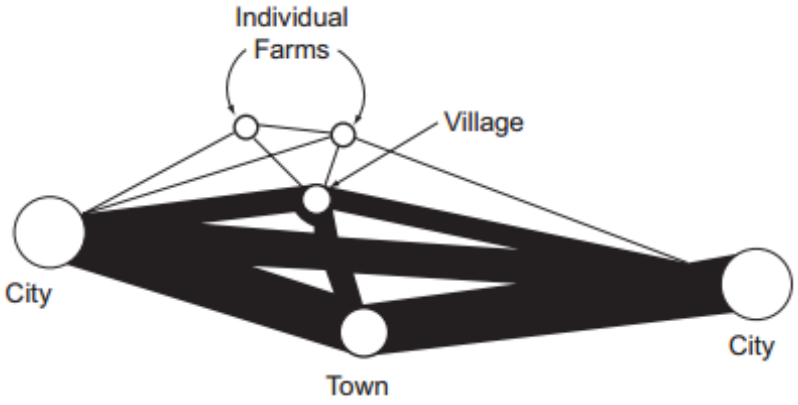
As we assume from several references, the main idea for road classification is determine criteria. Criteria can be based on classification purpose. This classification of roads in mandatory, to make communication between road engineers, designers, users much easier. Basic road scheme is shown in figure 1.1. Analysing basic road scheme we can assume, that all road distance of travel, level of traffic flow and desired speed of travel cannot be the same. For that reason roads must be classified.

1.1.2. Functional Relationships

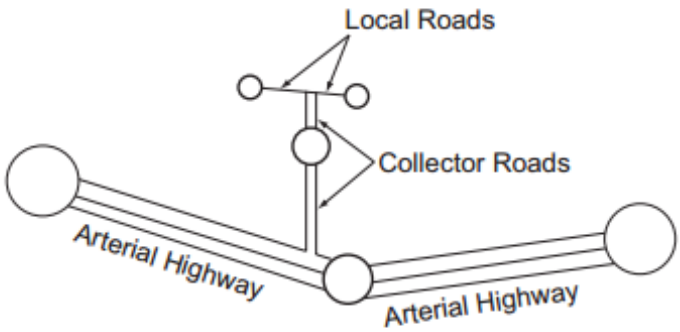
The main idea of function classification is to group streets and highways according to the character of service they are intended to provide. This type of classification identify that individual roads do not serve travel separately. Rather, most travel involves movement through

networks of roads and can be categorized relative to such networks in a logical and efficient manner. Thus, functional classification of roads and streets is also consistent with categorization of travel.

A figure no. 1.1 basically illustrated the idea. In figure 1.1 A, straight lines are connecting trip starting and destination points (in picture shown as circles). The widths of the lines specify the amount of travels on the routes. The diameter of circle shows an interest of travel and traffic generation. In fact, that is impractical and sometimes even impossible to provide direct connection for every desire point, trips should be separated on limited road network, this manned is indicated in figure 1.1 B. Most loaded routes are provided straight to destination points or nearly so, smaller connection are connected into some indirect routes. This action mostly separates and distributes traffic into specific groups. The straight lines or routes are labelled as local roads, collectors, and arterials all that terms describe functional relationships. In this scheme, the functional hierarchy is also seen to be related to the hierarchy of trip distances served by the network.



(A) Desire Lines of Travel



(B) Road Network Provided

Figure 1.1 Basic road scheme

1.1.3. The concept of functional classification in United States

Mainly, function classification means to group streets and highways to the type of service they intended to provide. This type of classification means, that roads and streets do not serve travel independently. Most of travel are going through networks of roads, these networks have logical and efficient manner. All roads in network work as a group and cannot be separated.

Functionally hierarchical road network is the network where individual roads are classified into several levels and operated based on the priority for mobility, access or residential functions. [8]

Functional classification is primarily based on a road function in the frame of a highway network, but also, there are methodologies for roads division having in mind their physical settings. This thesis mostly based on functional classification and aim is to recognise functional classification and determine significance on the road network.

The road is used by many users, bicyclists, pedestrians, and transit users, but the functional classification of highways or streets are primarily based on motor vehicle travel characteristics and the degree of access provided to properties. The six, main recognizable stages are included in most trips:

- Main movement (movement of vehicles in uninterrupted, high-speed flow);
- Transition (comparing with main movement, traveling speed is reduced);
- Distribution (moderate-speed arterials (distributor facilities);
- Collection (collector roads, that penetrate neighbourhoods);
- Access (at this stage vehicle approaches to individual residences);
- Termination (final destination).

Each of the six stages is designed specifically for its function. This hierarchy is based on traffic flow. The reason is the movement hierarchy is based on the total amount of traffic volume, free-way travel is the highest level in the hierarchy in United States, below that is distributor arterial travel, and lowest in the movement hierarchy is travel on collectors and local access routes. Road traffic hierarchy and road network stages are shown in figure 1.2.

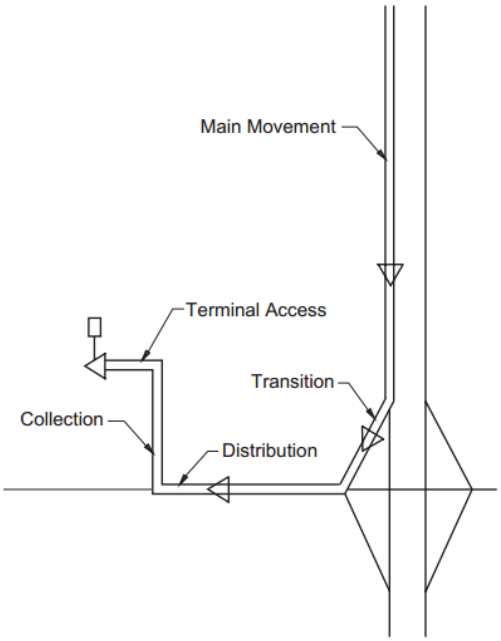


Figure 1.2 Hierarchy of movement

However, no all six stages can be found in each trip. Some of them can be missed, but another stages should be strictly recognized and have visual difference from another. For example commercial driveways which connect directly from high-speed arterial to parking lots, also it can be freeway ramps that connect major shopping malls or stadiums. This hierarchy should correspond to traffic hierarchy, each lower stage; traffic flow should be lower than the higher one.

In general, each element of the functional hierarchy can serve as a collecting facility for the next higher element, but an element should be present only if intermediate collection is needed to satisfy the spacing needs and traffic volume demands of the next higher facility. By estimating or forecasting the spacing needs and traffic volume demands for a system element, it is possible to identify which cases should use the full system and which cases may bypass intermediate elements. [3]

Functional Classification Comprehensive Guide (a guide to Virginia Department of Transportation (VDOT)) [7], determines "functional classification" as a process. *Functional classification is the process by which streets and highways are grouped into classes, or systems, according to the character of service they are intended to provide. Functional classification outlines how travel can be channelized within the network in a logical and efficient manner by defining the part that any particular road or street should play in serving the flow of trips through a highway network.*

1.1.4. The concept of functional classification in Germany

The German guideline RIN (FGSV, 2008) gives lots of insights in this regard. RIN firstly defines several types of centres (central places) according to the necessary daily-life and urban functions, and the target travel time is set for each type of these centres. In this guideline, a hierarchical road classification is established by combining "connection hierarchy" by type of centres' connection and "road category" by roadside environment. However, road category is not uniquely determined and there are two/three options for one connection hierarchy. [20] Category of centres can be:

- Metropolitan centre;
- Upper urban centre;
- Lower urban centre;
- Small centre;
- Community centre.

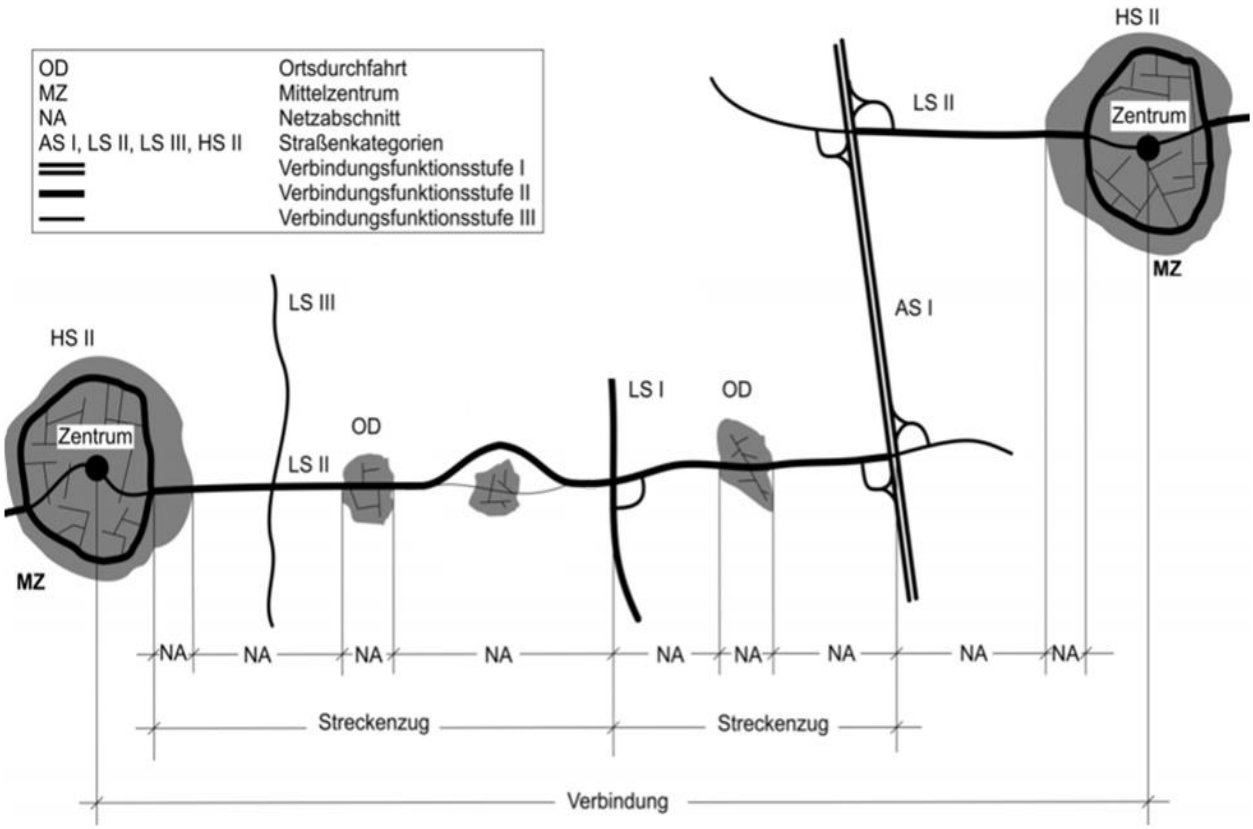


Figure 1.3 Road sections and road network scheme (Germany)

In the scheme (figure 1.3), can be assumed, that basically Germany uses connection method. Two big metropolitan centres are connected by several type of road. Roads are divided in sections (N/A in figure). By using all that sections are created category for whole junction, not

for separated sections. Which road has one function, and each of section has same parameters as whole junction between centres. This is very important in design stage, if junction has one design class; separate road section must look as whole structure.

Germany road network classification system main difference form United States system, that Germans set category for whole junction between centres. United States uses hierarchy system which is based on traffic flow. The reason mobility is based on the total amount of traffic volume. Germany sets one category for different sections; this method allows making one junction entire with same parameters. This strategy is very important for road users – drivers, they whole trip uses same looking road, this do not take additional attention.

1.1.5. Access versus mobility

Two major travel needs in classifying highway networks functionally are access from specific locations and travel mobility. Each road type class in road network provides one of access or mobility functions, most of roads can provide combination of each. Generally it can be understood as mobility function decreases as access increases. At this point we can assume, what mean each of phrases.

Mobility is measured in respect to ability of traffic to pass through a defined area in a reasonable amount of time. Common elements of mobility include:

- Operating speed;
- Level of service;
- Riding comfort.

Accessibility is measured in terms of the road system's capability to provide access to and between land use activities within a defined area.

In general, mobility describes the ability of the road to move traffic and is measured in traffic volumes, vehicle speeds, and trip lengths. Access is the linkage between the road and adjacent properties. The separate functions of mobility and access can be incompatible and conflict with each other.

If we would take a look to road network hierarchy we can assume, those roadways that provide a high level of mobility are called "Arterials"; those that provide a high level of accessibility are called "Locals"; and those that provide a more balanced blend of mobility and access are called "Collectors" as basically showed in figure 1.4.

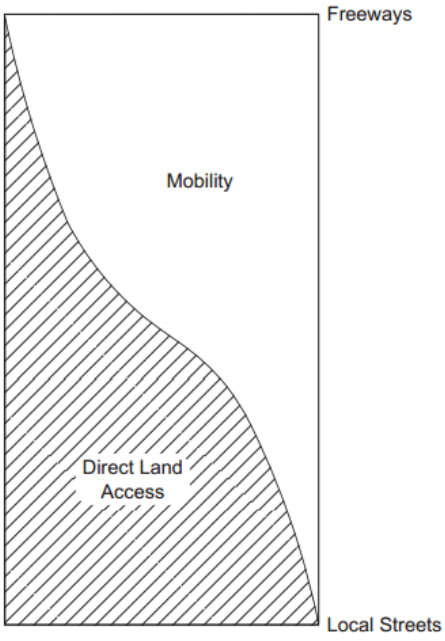


Figure 1.4 Relationship between mobility and land access functions

In general we can assume that:

Mobility function comparing with accessibility provides few possibilities to entry and exit, but creates much faster and longer distance trips. Accessibility function: Provides much more opportunities comparing with mobility function, for entry and exit, which creates potentially higher friction from vehicle access.

The relationship between road function classification and mobility and acess is showed in figure 1.4. This figures out, freeways provides highest level of mobility but lowest level of accessibility. On the other hand local roads provides highest level of access in that case we lose mobility.

Figure 1.4 shows that the concept of traffic categorization leads logically not only to a functional hierarchy of road classes but also to a similar hierarchy of relative travel distances served by these road classes. The hierarchy of travel distances can be related logically to functional specialization in meeting the property access and travel mobility needs. Local rural facilities emphasize the land access function. Arterials for main movement or distribution emphasize the high level of mobility for through movement. Collectors offer approximately balanced service for both functions. [3]

1.1.6. Functional System characteristics in United States

The functional system is different for urban and rural areas. Basically the hierarchy is quite the same for both areas; however, in urban areas there are relatively more arterials with

further functional subdivisions for the arterial category whereas in rural areas there relatively more collectors with further functional subdivisions of the collector category. Consequently, urban and rural functional systems are classified separately. This chapter contains characteristics and definitions of highway networks in rural areas.

As mentioned before urban and rural areas have different characteristics and properties depending on land use, density of street and highway networks and how elements are related. At that point both areas have different classifications.

Urban areas are those places within boundaries set by the responsible state and local officials having a population of 5,000 or more. Urban areas are further subdivided into urbanized areas (population of 50,000 and over) and small urban areas (population between 5,000 and 50,000). For design purposes, the population forecast for the design year should be used. Rural areas are those areas outside the boundaries of urban areas.

1.1.7. Functional Systems for Rural Areas in United States

Mainly roads can be divided into three big categories – Arterials, Collectors and Locals. Based on Federal functional highways division, made by American Association of State Highway & Transportation Officials (AASHTO) [2, 3], specifies these three basic types of roadways in rural, urbanized and small urban areas:

- arterials (principal and major roads);
- collector (major and minor roads);
- local roads.

Main system description and service provided is shown in Table no. 4 Function system comparison. This basically shows main difference between three biggest functional systems.

Most of the travellers would use a combination of arterial, collector, and local roads for trips on classified road network. Each type of road has a specific purpose or function, for example some of roads provide land access to serve each end of the trip. The rest of roads can provide travel mobility at varying levels, which is very important on the first travel stages.

Table 1.1 Function system comparison in United States

Functional System	Service Provided
Arterial	Provides the highest level of service at greatest speed for longest uninterrupted distance, with some degree of access control.
Collector	Provides a less highly developed level of service at a lover speed for shorter distance by collecting traffic from local roads and connecting them with arterials.
Local	Consists of all roads not defined as arterials or collectors; primarily provides access to land little or no through movement.

The rural arterial system, serves the highest degree of through traffic movement and largest proportion of total travel. As used in the functional classification system the Interstate Highway System of United States is considered an arterial network. Arterials generally have one of highest design standards in functional systems. These roadways serve major centres of metropolitan areas, provide a high degree of mobility and can also provide mobility through rural areas. The arterial system includes most of existing rural freeways (motorways). Arterials system roads mostly are divided into two parts: Major Arterials and Principal Arterials.

I. *The rural principal arterial system.* This system consists of network, which have fallowing features:

- Users of road network have opportunities to travel state wide of instate travel; also it can be corridors between different countries;
- Arterials connect urban areas with populations over 50,000, with exception urban areas can be with population over 25,000;
- Generates road traffic without dead-end roads, except international boundary connections or connections to coastal cities.
- This class of roads includes most heavily travelled route
- This system has a highest driving speed limit.

II. *Rural minor arterial system.* This system consists roads, which:

- These roads links cities, larger towns, resort areas, also these roads features long travel distances;
- Interconnect and augment the higher level Arterials;
- Distribute traffic to smaller geographic areas;
- Provide more land access than Principal Arterials;

- Provides intercounty, intercountry and interstate service;
- Trips are much longer comparing with trips served by rural collector or local systems;
- Offer connectivity to the higher Arterial system;
- Provide service for trips of moderate length;
- Serve geographic areas that are smaller than their higher Arterial.

Rural collector road system, the collector street systems provide both land access service and traffic functions, this system is middle between arterials and local roads. One of main difference from arterial road system, collector road system can penetrate in different areas, in that case distributing trips from the arterials. Within the context of functional classification, Collectors are broken down into two categories: Major Collectors and Minor Collectors. Until recently, this division was considered only in the rural environment. Major collectors typically serve higher traffic volumes than minor collectors. Overall, in both urban and rural setting, the total mileage of Major Collectors should be lower than the total mileage of Minor Collectors. To determinate the Collector is a Major or a Minor Collector is frequently one of the biggest challenges in functionally classifying a roadway network.

I. Major Collector Roads:

- Serves land access and traffic circulations between larger towns and other traffic generators (malls, parks, schools, logistics centres and other important areas) which are not connected by arterial road system;
- Provides land access within residential, commercial and industrial areas;
- Collect traffic from lower road systems and channel it to arterial system;
- Links cities or larger towns, can route with higher classification systems roads;
- Can serve intracounty travel corridors;
- Have higher speed limits than minor collectors;
- May have more travel lanes than minor collectors may;
- Major collectors typically serve higher traffic volumes than minor collectors.

II. Minor Collector Roads:

- Serves land access to the remaining smaller town and cities;
- Connects important traffic generators with rural hinterland;
- Creates routes between local roads with developed areas, within reasonable distance;

- Minor collector system has lower speeds and less signalized intersections comparing with major;
- Has opportunity to penetrate residential neighbourhoods, but only for a short distance;
- Minor collectors are spaced at intervals, consistent with population density.

Local road system, locally classified roads account for the largest percentage of all roadways in terms of distance. For rural and urban areas, all public road mileage below the collector system is considered local. They are not intended for use in long distance travel, except at the origin or destination end of the trip, due to their provision of direct access to abutting land. Local roads generally do not carry bus routes and, in many instances, they include various roadway treatments to discourage through traffic. In general, local roadways are often classified by "default". In other words, once all arterial and collector roadways have been identified, all remaining roadways are classified as locals. Basically local road system:

- Serve primarily to provide access to adjacent land;
- Provide service to travel over short distances as compared to higher classification categories;
- Constitute the mileage not classified as part of the Arterial and Collector systems;
- This road system in comparison with another systems provides access to land properties, also provides travel in short distances.

1.1.8. Road functional classification in Germany

Roads classification and design in Germany is indicated in three main road designing documents (RAA, RAL and RASt). Those three main documents divide all roads in three big groups: motorways, rural roads, and other not specified roads and streets. Further in work, will be reviewed two groups: motorways and rural roads. All roads in Germany are classified into six main link function levels. Classification can be found in table 1.2. This functional classification is used by many European countries. Main six levels and description are showed below:

- **Continental** – Roads coincident to accepted European transport corridors, which are mostly based on long travel, with all European countries. These development corridors are distinct from the Trans-European transport networks, which is a European Union project and include all major established routes in the European Union.

- **Sub-continental** – Other roads which coincident to European Union Ten-T or JT roads. That type of roads is marked as "E". Sub-Continental roads link capitals, cultural or other important traffic generators. Most of roads are transit roads which have connecting function.

- **Inter-Regional** – This type of roads mainly used for long distance travel inside in country. These roads connect capital of country with regional centres or national important residential, commercial and industrial areas. Also Inter-regional roads link regional centres with neighbourhood countries if those routes are not important Europe regional scale. Most of roads have transit-connection function.

- **Regional** - These roads links cities, larger towns, resort areas, also these roads connect region centres. Links cities or larger towns, can route with higher classification systems roads. Often these roads have connection function.

- **Sub-Regional** - Creates routes between local roads with developed areas, within reasonable distance. Serves land access to the remaining smaller town and cities. Connects important traffic generators with rural hinterland. Most of roads have connection or distribution function.

- **Local** - They are not intended for use in long distance travel, except at the origin or destination end of the trip, due to their provision of direct access to abutting land. These roads allow reaching higher classification systems roads from small residential areas. This section of roads are most important because generates a lot of traffic from alone road users.

Table 1.2 Road categories and road link function level

Category group / **Link function level**		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

Legend :

AS I	Designation of the category as it occurs
	Problematic
-	Does not occur or is not justifiable

Table 1.2 shows that main five groups in Germany road network is: Motorways, Rural roads, Trunk roads in non built-up areas, Trunk roads in built-up areas and Local Roads. Motorways marked as “AS” and can have up to three link function levels. Rural roads marked as “LS” and can have up to five different function levels. Analysing table 1.2 we can assume that, several category groups can have same function level. It is very important, then choosing designing road category.

Motorways functional classification in Germany, in order to assure, that motorways coincide equivalent network functions, traffic functions motorways are grouped in to three design classes (EKAs), and designed considering it. The properties, which determine the design class mainly, are the position of the motorway in area, road category, designation type and the motorways’ jurisdiction. These main properties take into consideration the significance of the motorway in terms of spatial planning and traffic and also claims originating in the surrounding environment. Motorway’s categories and variables which determine the design class are shown in table 1.3.

Table 1.3 Design classes for motorway roads

Road category	**AS 0/ASI**		**AS II**		
Position in relation to built-up areas	Outside or inside		Outside or inside	Outside	Inside
Jurisdiction	Federal motorway	Non-federal motorway	Federal motorway	Non-federal motorway	All
Designation	Long-distance motorway	Motorway-like road	Inter-regional motorway	Motorway-like road	Urban motorway
Design class	EKA 1A	EKA 2	EKA 1B	EKA2	EKA3

In view of the fact that the traffic functions of a motorway sometimes overlap, it is not always possible to make a clear distinction. The explanation and more detailed cases can be found in RAA technical design documentation.

Motorways that belong to the categories AS 0 and AS I both inside and outside built-up areas (long-distance motorways) and motorways that belong to category AS II outside built-up areas (inter-regional motorways) are designed in accordance with EKA 1. In order to ensure that the significance of the link (link function level) is adequately taken into consideration, EKA 1 is divided up into EKA 1 A (road categories AS 0 and I) and EKA 1 B (AS II). Graded design elements for alignment are allocated to each class. Unless expressly indicated otherwise in the text, the regulations outlined here apply to all EKA 1 motorways.

The motorway-like roads that belong to EKA 2 include all motorways that are not federal motorways and are not urban motorways. These motorways are used for short or medium-distance links and have lower requirements in terms of the travel speeds that can be reached on them. This explains why EKA 2 has lower limiting values for design elements, thereby allowing for a more flexible alignment than is the case with EKA 1. EKA 3 design class includes all motorways in urban territory and mostly in can be any jurisdiction.

1.1.9. Road functional classification in Nederland

Road classification in Nederland mostly described in “sustainable safe road design” guideline. This guideline state [23] *the layout of a road should be appropriate to its function. This is presently explicitly the case for motorways and urban access roads. However, the layouts of roads especially meant to distribute traffic often have too great a diversity. On through roads in rural areas, it is physically possible to drive at high speeds, on distributor roads the speed limit is low (particularly at junctions), and on access roads the speed is even lower. The layout should ‘automatically’ enforce the desired speed.* Rural roads in Netherland divided into three main functional classes:

- Through roads
- Distributor roads
- Rural access roads

Table 1.4 Design parameters for through roads in Nederland

Motorway (freeway)	Motor road (trunk road)
speed limit 100 or 120 km/h	speed limit 100 km/h
design speed 120 km/h	design speed 100 (90) km/h
split level interchanges	split level interchanges
physical separation	physical separation
at least 2x2 lanes	at least 2x1 lanes, maximum of 2x2
emergency lane	emergency bays and/or semi hard shoulder
complete marking	complete marking

The through road is divided in two types, but each type has the essential characteristics of this category (the layout of each type as distinctive as possible):

- Type I: motorway (freeway);
- Type II: motor road (trunk road).

Design and basic through roads parameters are described in table 1.4

The distributor road is also divided in two types and each type has the essential characteristics of this category:

- Type I: dual carriageway
- Type II: single carriageway

Design and basic distributor roads parameters are described in table 1.5.

Table 1.5 Design parameters for distributor roads in Nederland

Dual carriageway	Single carriageway
speed limit 80 km/h;	speed limit 80 km/h;
design speed 80 km/h;	design speed 80 km/h;
physical carriageway separation;	nonphysical driving direction separation;
priority road, 2x2 lanes;	priority road, 1x2 lanes;
closed to (light-) mopeds and bicycles;	closed to (light-) mopeds and bicycles a
a parallel cycle path or service road exists;	parallel cycle path or service road exists;
junctions designed as roundabouts or priority	junctions equipped with speed reducing provisions or designed as roundabout
crossroad with traffic lights	limited number of connections to access
limited number of connections to access roads;	roads;

Rural access roads, the main parameters of this type road are:

- The surfaced width of access roads varies between 2.50 and 6 metres.
- The lane width (in the middle of the carriageway) for motor vehicles is between 2.50 and 3.50 metres.
- The surfaced width is the sum of the widths of the above and the widths of two non-compulsory cycle lanes (discontinuous line; no cycle symbols/pictograms).
- The access road is also divided in two types and each type has the essential characteristics of this category.

Rural access roads are separated into big groups, which main differences are:

- Type I: vehicle lane with separate cycle path(s), priority junctions are possible;
- Type II: single lane for all road users; at level, no-priority crossroads.

The influence of the design and the environment on driver anticipation is important. The Dutch Road Administrations excluded main parameters of the function group, which are:

Through roads:

- physical separation (between opposing traffic directions);
- emergency lane;
- priority road (main road);
- continuous edge lines (0.20 m wide).

Distributor roads:

- nonphysical driving direction separation, two (dis)continuous centre lines;
- priority road;
- discontinuous edge lines.

Access roads:

- no centre line marking;
- separate cycle path, priority junctions if effectiveness can be proven;
- no edge line, if effectiveness can be proven discontinuous line.

Table 1.6 Road functions in Nederland

Road type	Road elements	
	Road link	Junction
Through road	Flow	Flow
Distributor road	Flow	Exchange
Access road	Exchange	Exchange

In order to set up correct function classification for certain roads, "sustainable safe road design" guideline states: [23] *The first step is to categorize the roads, which means that every road must be given a certain function. Thereafter, the proper design should be defined on basis of the design criteria. When giving a function to a road, it is important to build up a logical road network based on the three categories of roads: flow function (through roads), distribution function (distributor roads) and access function (access roads).* Basic road function due to road is showed in table 1.6.

1.1.10. System Continuity

As mentioned before, road network system consists of three main functional systems: Arterial, Collectors and Locals. One of the problems, that users of the road are channelling traffic in both directions from Arterials to Collectors, then to Locals and back again. In general is very important to keep continuity of routes and much more important to recognize classification system. Basically, in road network should be an integrity - a road of a higher classification should not connect to a single road of a lower classification. For example, Arterials should only connect to other Arterials. However, there are exceptions to this example. Arterials can end to very large regional traffic generators. Also they can connect to parallel roads of lower functional classification, which together, can provide the same traffic capacity and same function as an Arterial.

Figure 1.5 presents the Arterials (black lines) only connect to other Arterials. Collectors (shown as red lines) connect only to Arterials or other Collectors. Local roads (represented by the green lines), as lowest hierarchy part can connect to any type of road.

As Sustainable safe road design states [23] *such a step-by-step plan can be considered as an iterative process when not all conditions for one separate step can be fulfilled. In this case it will be necessary to return to a former step. By doing so, the categorized road network is achieved. After establishing an overall picture of the network, choices can be made and brought into practice in the transport plans / designs.*

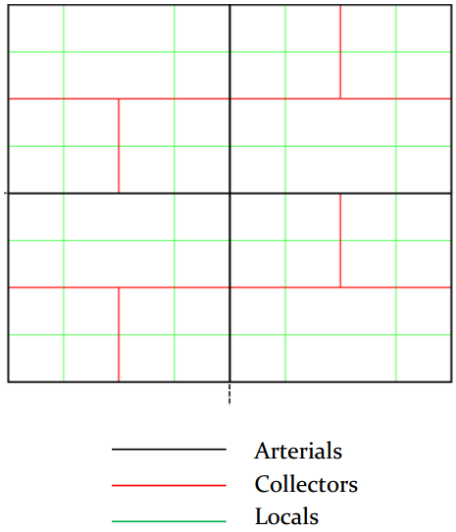


Figure 1.5 Example of road network continuity

At this point we can separate three main functions, which each road network has to fulfil to allow each road user to:

- be able to go from origin to destination (flow function);
- be able to enter and leave an area with multiple destinations (distributor function);
- be able to access properties alongside a road or street (access function).

Can be assumed, that three main road types: Arterials, Collectors and Locals meet three main functions flow, distributor and access.

1.1.11. Travel specifications on Classification systems

The functional classifications for road system were described more qualitative rather than quantitative terms. But for road users is much more important to know, how long each trip takes in each road network system. This factory varies because of geographic conditions (e.g., population densities, spacing between and sizes of cities, and densities and patterns of road networks), criteria on sizes of population centres, trip lengths, traffic volumes, and route spacing's do not apply to all systems in all states.

The values of each functional system extent given in table 1.7 and apply to United States having less extensive total road networks relative to the population density. The network area, and road length mostly depends on the population density, the lower values are applicable. In table the range of percentages of rural collectors represents the total length of both major and minor collector.

Table 1.7 Guidelines on Extent of Rural Functional Systems in United States

Systems	Percentage of Total Rural Road length
Principal arterial	2-4%
Principal arterial plus minor arterial system	6-12%
Collector road	20-25%
Local road system	65-75%

Highly significant roadways connect large activity centres and carry longer-distance travel between and through regions and States. Arterials carry the vast majority of trips that travel through a given State, while Local Roads do not easily facilitate state-wide travel. Table 1.8 summarizes the relationship between the factors previously described and the three main categories of functional classification.

Table 1.8 Relationship between Functional Classification and Travel Characteristics

Functional Classification	Distance Served	Access Points	Speed Limit	Distance between Routes	Usage	Significance	Number of Travel Lines
Arterial	Longest	Few	Highest	Longest	Highest	State-wide	More
Collector	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Local	Shortest	Many	Lowest	Shortest	Lowest	Local	Fewer

1.1.12. The Role of Functional Classification in the Design Process

Designing roads is a high responsibility action, which depends on many factories. The first step in road design process is to determinate the function of road or section of the road. The right selected class would be as the context of whole project. The level of service needed to ensure smooth and safe traffic provides a rational and cost-effective basis on the selection of design speed and geometric criteria within the ranges of values available to the designer. Functional classification carries with it expectations about road design, including its speed, capacity, design controls and criteria, and relationship to existing and future land use development.

The AASHTO Green Book recognizes the relationship between highway functional classification and design criteria. State, county, and city highway design manuals likewise relate design criteria to highway functional classification. The AASHTO Green Book states: *The first step in the design process is to define the function that the facility is to serve. The level of service*

required to fulfil this function for the anticipated volume and composition of traffic provides a rational and cost-effective basis for the selection of design speed and geometric criteria within the range of values available to the designer (for the specified functional classification). [2, 3]

The use of functional classification as a design type should appropriately integrate the highway planning and design process. Once the functional classification of a particular roadway has been established, so has the right range of design speed and also road parameters, such as junction types, road marking and road signs types. With the allowable range of design speed defined, the principal limiting design parameters associated with horizontal and vertical alignment are also defined. Also with design speed, cross–section of the road is defined.

In general, a function class defines all parameters of the road. But most important is design speed, which determines cross-sections and curves types and radiuses. (See figure 1.7)

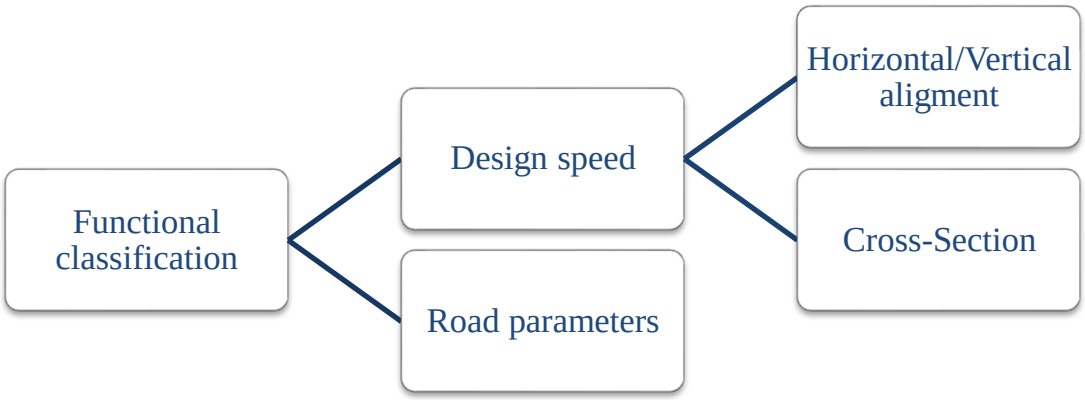


Figure 1.7 Recommended Design levels by Functional Classification

The importance of the functional classification process as it relates to highway design lies in the fact that functional classification decisions are made well before an individual project is selected to move into the design phase. Such systematic reassessments are typically undertaken on a relatively infrequent basis. Thus, the functional classification of a particular section of highway may well represent a decision made 10 or more years ago.

1.1.13. Design classes and design features in Germany

The road category and the design class determine the features as well as the limiting values and guide values for the design and operation elements. This is why motorways and motorway-like roads have different road characteristics. The design class directly determines:

- standard cross-sections;
- limiting and guide values for design elements;

- basic forms of junctions and the distances between them, and where applicable, the application of a speed limit.

Rural roads in Germany are designed according steps provided in guideline RIN. Roads must be designed to be suitable for smooth travel; also it must be considerate about road functional classification, and intended speed. The design speed is determined by evaluating the functional classification of the road. In order to make road friendlier to users, designers are using different design classes (from EKL 1 to EKL 5). Design classes differ from each other by some features:

- cross-sectional profiles;
- plan and profile of the road route;
- marking;
- overtaking and intersection design;
- longitudinal lane/direction road markings;
- separation of directions;
- pavement, irregularity of the surface;
- presence of vehicle breakdown facilities and obstacle-free zones (emergency lane on motorways);
- applied junction types within a road category.

The main difference between design classes is clearly different in appearance. On the other hand, the same design class roads must look as uniform as possible.

In safe traffic system road users know what traffic behaviour is expected related to the road functional class, and what to expect from other road users. Emphasizing the of each category increases predictability. The mechanism that ensures the right level of predictability consists of two steps:

Road users must be able to recognize the road category by a small number of design elements.

Based on education and experience, road users should know which possible traffic situations are associated with the present road category.

Mostly road design classes depend on road category (see table 1.9). This table shows design classes not only for new roads, but also for existing roads. This also applies to existing roads that are connected to the projected road. The Jurisdiction of the road does not affect the

selection of design class. Generally, the road section identifying design class takes to the road category.

Table 1.9 Road design category determination

Road category	Design class
K I	EKL 1
K II	EKL 2
K III	EKL 3
K IV	EKL 4
K V	EKL 5

In the case of high traffic volume, a road design class can be higher than the design class shown in table 1.9. In the case of very low traffic volume in the road section, the design class indicated can be lower than in table 1.6. However, this does not apply to K III category roads. These requirements are ignored if the high or low traffic volume is only in small parts of the road section.

1.2. Lithuanian literature review

1.2.1. Road's law

Road's law is the main law about roads in independent Lithuania this document has been certified in 1995 years. One of the main functions is to define "road" term, also to describe road network expansion, maintenance and use of them. In this document, roads are grouped by significance. Using administration classification, rods can be divided in to national and local roads. Also this document determines road user's rights and responsibilities. Road network classification by this document is:

1. Main roads – This is Lithuanian's main roads which links biggest cities centres also is part of international road network. These roads have biggest road traffic volume.
2. National roads – This is Lithuanian's roads and continuation, where the heavy traffic is taking place between Lithuanian Republic territory administration centres. Also this group of roads serve transit and tourist traffic.
3. Regional roads, this is road which connect cities and town areas with main and national roads.

According to Road's law classification, we can assume that main factory for road classification is road significance. Also from description, one of the problems is that lowest rank roads – National roads can directly connect to heaviest traffic main roads.

1.2.2. Road technical regulations

Road technical regulations know as **(**KTR 1.01:2008.) is main and one road design guideline in Lithuania. In this document roads are classified in two groups: national and local roads. National roads are divided in to main, national, regional, based on significance. To determine road category in Lithuania, main factory is annual daily traffic volume of the road. According to road technical regulations, we can exclude four main road groups by significance:

- **Main** is main Lithuanian roads. This type of road ensures safe and sustainable communication between primary Lithuanians cities. Also these type roads are dedicated to transit traffic. The most important of them, which by the decision of the United Nations Economic Commission for Europe are included into the international road network and are given index E with a corresponding number.
- **National** roads are roads connecting the motorways; link nearby larger towns and cities also centres of administrative units of the territory of the Republic of Lithuania.
- **Regional** roads are roads connecting cities, major rural areas and motorways as well as national roads. Also this type of road connects hinterlands and farms facilities.
- **Local** roads are describe as roads, which connects regional roads, villages, and other roads used for local traffic, included public roads, as: forest roads, national park roads, roads in protected areas, border roads, quarry roads, roads used for hydraulic equipment access, roads in restricted areas, courtyards, and all other roads not classified as public roads.

Each road group by significance in Lithuania has subgroups, depending on road traffic in subgroups. In Lithuanian road network, road subgroups are classified into several categories according to certain parameters, traffic conditions and traffic volumes.

The highest category is AM (motorways), other roads are spread into categories from I to V. Local roads are divided into I_v - III_v categories. Road categories and parameters of each road are defined in KTR 1.01:2008. In this document (see table 1.10), are described all roads of national significance. In this table we can find main parameters of roads like: road category; traffic volume; design speed; lanes of road; cross–section type; junction type.

Table 1.10 Lithuanian road classification traffic volume

Road significance		Road category	Designed average annual per day traffic intensity Cars/per day	Design speed, km/h	Lane number	Cross–section type	Junction type
1	2	3	4	5	6	7	8
National significance roads	Main roads	AM	> 45000	130/110	3+S+3	1	different levels
		AM	12000–55000	130/110	2+S+2	2	
		I	12000–55000	110/100	2+S+2	3	different levels
		II	Up to 15000 (20000)	90	2	5	one level
		IIa	Up to 18000 (23000)	100	2+1	6	
		III	Up to 15000 (20000)	90	2	7	
	National Roads	Ia	12000–30000	90	2+S+2	4	one (different) level
		IIa	Up to 18000 (23000)	90	2+1	6	
		III	Up to 15000 (20000)	90	2	7	
		(IV)	Up to 10000 (12000)	90	2	8	
	Regional Roads	IV	Up to 10000 (12000)	90	2	8	one level
		V	Up to 3000, Up to 1000[1)]	70	2	9, 10	
		Va	Up to 1500	70/50	1	11	
Local significance roads		I_v	1000–2000	50/40	2	12, 13	one level
		II_v	500–1000	40/30	1	14, 15	one level
		III_v	Up to 500	30/20	1	16	one level

Each road group by significance in Lithuania has subgroups, depending on road traffic in subgroups. In Lithuanian road network, road subgroups are classified into several categories according to certain parameters, traffic conditions and traffic volumes.

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AM category motorways are highest speed driving roads, having intersections with grade – separated junctions with other roads and railways, bicycle and pedestrian traffic are

forbidden in the same level with road. These roads connects biggest cities of Lithuanian, also provides one of highest traffic volume. The roads have traffic line separated by traffic barriers central reserves. At intersections the traffic flows of the entering and existing vehicles have different lanes also should not intersect on the same level as minor road. Also this type of roads has biggest inspections and road service level. This road category belongs to Main roads.

Other Main road category is – 1. These roads are designed for intensive traffic, but the service and comfort on these roads are lower that on motorways, also design speed is lower. Opposite traffic is divided by traffic safety measures. On this type of roads pedestrians and bicycle traffic is allowed in one level, but intersections can be in grade – separated or same grade as well. This type of roads is suitable for very high traffic volume.

Road of category II and III also belong to main roads. These roads main differs from first category that opposite traffic is not separated, also has lower driving speed (90 km/h for urban areas). These roads may have grade – separated intersections, but is not mandatory. The traffic volume of is lower as the first road category. Roads of category III form the network of national and main roads.

Usually National roads consist of III and (IV) categories. These categories roads have similarities to the Main road categories. Main difference is traffic volume which can be managed. Category Ia and Iia specifications are the same as Main road categories I and II, main difference is driving speed, which is 90 km/h for all Regional roads. The intersections are in the same grade with as minor road. Also these roads rarely have opposite traffic separation.

Regional roads consist of IV, V and Va road categories. The speed on regional roads can vary form 50 km/h to 90 km/h. All intersections are one level, also opposite traffic is separated only by traffic lines. In exceptional cases, these roads can have only one driving lane. Often regional roads have gravel pavement.

Roads of category Iv, connect the roads of national significance and rural areas, objects of infrastructure. Roads of category IIv connect villages; interconnect with each other or with roads of higher categories. Roads of category IIIv are local roads; they interconnect with each other or with roads of higher categories; These roads often have only one driving lane, and even natural pavement. Low traffic volume is one of parameter Local roads. Road categories description has been argued in KTR 1.01:2008.

1.2.3. Lithuanian State road network

According to the data of the Lithuanian Road Administration under the Ministry of Transport and Communications due to 2016-01-01 the length of the road network of national is

21,249.339 kilometres, 69% (14,573,502 kilometres) of which are regional roads, 23% (4,926.123 kilometres) are national roads, and 8% or 1,749.704 kilometres are main roads. Table 1.11 shows the distribution of road length by road group in Lithuania.

Table 1.11 National rural roads distribution in Lithuania by group

Road group	Percentage of Total Rural Road length
Motorways	2,70%
All Main	8,20%
National	23,20%
Region	68,60%

For comparison, table 1.12 shows United States road network distribution by road system. Percentage can be varying due to State, but main intervals are given in the table. As, we can see Lithuanian roads by density are in quite the same intervals as United States roads. For this reason, is proper to compare our road network to United States road network system.

Table 1.12 Rural roads distribution in United States by system

Systems	Percentage of Total Rural Road length
Principal arterial	2-4%
Principal arterial plus minor arterial system	6-12%
Collector road	20-25%
Local road system	65-75%

1.3. Conclusions

1. The main idea of function classification is to group streets and highways according to the character of service they are intended to provide. This type of classification identify that individual roads do not serve travel separately.

2. United States road design guideline AASHTO "A policy on geometric design of highways and streets" specifies these three basic types of roadways in rural, urbanized and small urban areas: arterials (principal and minor roads); collector (major and minor roads); local roads. This classification is based on function, which road has to provide.

3. Two major travel needs in classifying highway networks functionally are access from specific locations and travel mobility. In general, mobility describes the ability of the road to move traffic and is measured in traffic volumes, vehicle speeds, and trip lengths. Access is the linkage between the road and adjacent properties.

4. Roads classification and design in Germany is indicated in three main road designing documents (RAA, RAL and RASt). Those three main documents divide all roads by function classification; a lot of European countries use Germany classification.

5. Functionally hierarchical road network is the network where individual roads are classified into several levels and operated based on the priority for mobility, access or residential functions.

6. The AASHTO "A policy on geometric design of highways and streets" recognizes the relationship between highway functional classification and design criteria. State, county, and city highway design manuals likewise relate design criteria to highway functional classification.

7. Lithuanian road network are classified in two groups by road significance: national and local roads. National roads are divided in to main, national, regional. National roads are under state jurisdiction.

8. Main documentation about road design, parameters of the roads is KTR 1.01:2008, this documentation is one of nowadays design problems. Lithuania has only one of road design guideline (KTR 1.01:2008); this guideline do not classified roads using functional classifications. Lithuanian roads are classified by significance. Road categories are determined by using annual average daily traffic.

9. The main problem and disadvantages for Lithuanian road network, that road design categories depend on annual daily traffic volume, not on function classification. For that reason lots of Lithuanian roads are unsafe, hardly recognized for users. Most of roads do not look homogenous in whole road length.

2. INVESTIGATION PART OF SELECTED LITHUANIAN MAIN ROADS

During preparation of Master thesis “Roads functional analysis and recommendations for classification of Lithuanian state road network” an investigation was done. The aim of investigation is to determine the situation of Lithuanian road network. Main task was to establish if Lithuanian roads have functional classification function. From all roads, was chosen two roads, which contains six main roads and by Lithuanian technical documentation:

Main roads:

1. A2 Vilnius–Panevėžys;

2. Via Baltica (A5 Kaunas–Marijampolė–Suvalkai; section of A1 Vilnius–Kaunas–Klaipėda; A8 Panevėžys–Aristava–Sitkūnai; A17 Panevėžio bypass; A10 Panevėžys–Pasvalys–Bauskė).

The main road for investigation is “Via Baltica” this road is most dangerous in Lithuanian road network, in this road happen a lot of car accidents, also a huge amount of heavy truck traffic fixed on this road. A2 road is selected for comparison and data analysis.

The aim of investigation: To determine, if selected roads meet requirements for self-explaining and forgiving roads. A part of investigation is to find out selected road meets specific road function.

Objectives of the work:

1. Analyse data of roads, parameters;
2. Make travel speed tests selected Lithuania roads;
3. Present survey of investigation;
4. Analyse data of survey;
5. Formulate recommendations and suggestions for Lithuanian road network.

2.1. The structure of Lithuanian state road network

Using information from Lithuanian Ministry of Transport and Communications, we can assume that according to their traffic volume, social and economic significance, all the roads in Lithuania are divided into: National and Local. The total length of the road network is equal to 84000 km. National roads are divided in to highways, national and regional roads. National roads on the basis of exclusive property rights belong to the Country. Roads of national significance take over the responsibility of the Lithuanian Road Administration under the Ministry of Transport and Communications are 21.3 thousand kilometres long.

The road network of national significance consists of 19 main roads, 132 national roads and 1632 regional roads. There are 1 state-owned company which take care of servicing all Lithuanian road networks.

Figure 2.1 Lithuania main roads network

International E-road network**,** during the conference of European Transport Ministers that took place in 1994 in Crete the following two corridors of Trans-European Transport

Network (TEN-T) were identified crossing Lithuania: I and IX corridors. I extend in the north-south direction which consists of motorway VIA BALTICA and railway RAIL BALTICA. IX corridor crosses country in the east-west direction. All corridors and their location in Lithuania are showed in Figure 2.2. Right now, the territory of Lithuania is crossed by 6 European motorways:

- **E67**, known as "VIA BALTICA" (Helsinki – Talin – Riga – Panevėžys – Kaunas – Warsaw – Wroclav – Prague);
- **E28** (Berlin – Gdansk – Konigsberg (Kaliningrad) – Marijampolė – Prienai – Vilnius – Minsk);
- **E77** (Pskov – Ryga – Šiauliai – Konigsberg(Kaliningrad) – Warsaw – Krakow – Budapest);
- **E85** (Klaipėda – Kaunas – Vilnius – Lyda – Chernivtsi – Bukarest – Aleksandropolis);
- **E262** (Kaunas – Utena – Daugavpils – Rezekne – Ostrava);
- **E272** (Vilnius – Panevėžys – Šiauliai – Palanga – Klaipėda).

Figure 2.2 Situation of international E-road network in Lithuania

2.2. Objectives of investigation

For investigation were chosen couple main roads of Lithuanian road network. It was done for several reasons. Firstly, Main roads in Lithuanian have highest class by significance; they can be compared with arterials roads in United States or with motorways in Germany. Other reason, that easiest to determinate functional classification. In this case, main road should provide access function as Arterial roads by functional classification in United States. In order to

do investigation, first part is to analyse roads, second is to compare our functional class how much is equivalent to United States or Germany road guidelines. This is road, which was selected for investigation:

A2 Vilnius – Panevėžys was selected because:

- This Main road has the highest category according Lithuanian road design guideline KTR;
- This road has the highest driving speed in Lithuania;
- A2 road connects a capital of country and one of the biggest city in central Lithuania;
- Multilane divided with physical obstacle;
- Comparing with other main roads has biggest annual average daily traffic;
- Part of E272 European corridor.

Via Baltica road was selected because:

- This transport corridor is very important Lithuanian arterial road north-south direction;
- A biggest number of car accidents in Lithuania;
- Comparing with other main roads some of sections has one of the biggest annual average daily traffic in Lithuanian road network;
- This road consists of five more main roads sections:
    - A5 Kaunas – Marijampolė – Suvalkai;
    - section of A1 Vilnius – Kaunas – Klaipėda;
    - A8 Panevėžys – Aristava – Sitkūnai;
    - A17 Panevėžio bypass;
    - A10 Panevėžys – Pasvalys – Bauskė.
- This road consists of several sections, whose sections have different parameters, driving speed, cross-section.
- Via Baltica crosses Lithuania from one side to another, road which directly connects two countries – Latvia and Poland;
- Some of sections have multilane divided with physical obstacle;
- For reason, that this road consists of several different sections, this example is great for analysing functional classification function and homogeneity of the road.

2.2.1. **Main road A2 Vilnius – Panevėžys**

A2 Vilnius – Panevėžys is one of two main roads in Lithuania, which has highest speed limit. During summer season speed limit is 130 km/h, another time speed is 110 km/h for car and motorcycles. Heavy traffic speed limit is 90 km/h. This road links capital of Lithuania – Vilnius with another two cities Panevėžys and Ukmergė. This road crosses administrations of Vilnius, Širvintai, Ukmergė and Panevėžys cities. Figure 2.3 shows a cities and a route of A2 road.

This road length is 135, 92 kilometres. Also, this road is part of European road corridors (E272 Vilnius – Panevėžys – Šiauliai – Palanga – Klaipėda). A2 road has junction with other main roads (A6, A8 and A17). Comparing with other main roads in Lithuania, this A2 road has a big annual average daily traffic. As mentioned before main speed on this road is 130 km/h, however in this road exist six spots, where speed limit is lowered to 110 km/h. The reason for lower speed is turning to left side in one level junctions.

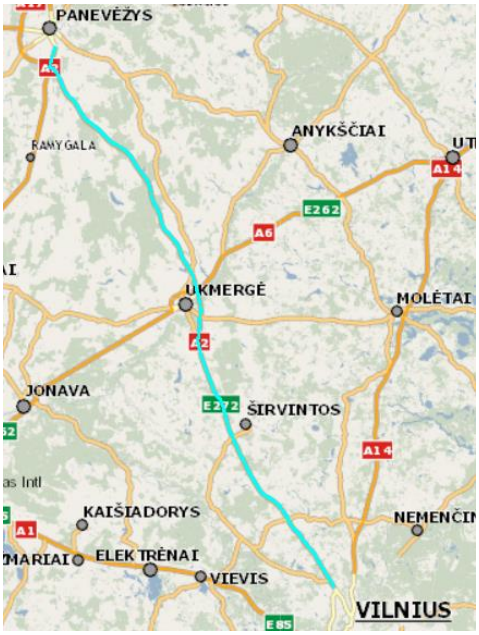

Figure 2.3 Location of A2 Panevėžys – Vilnius road

Using information from KTTI (road and transport investigation institute), A2 road pavement width from 11,5 till 11,8 meters, each direction. This means that road has two lines each way separated with physical obstacle, in this case is green lawn. The main width of the lane is 3,75 meters, pavement type – asphalt. The A2 dominate width of embankments about 35 meters. Road category by KTR is AM 1. Cross–section parameters are shown in table 2.1

Table 2.1 Road A2 cross–section parameters

Road	Widths, m			
	Traffic lane	Roadside	Embankment	Dividing line
A2 Vilnius – Panevėžys	11,5 – 11,8	1,5-1,7	35-38,5	7,0-10,0

Talking about last year annual average daily traffic on A2 road is 10910 cars/per day, involving 1230 of heavy vehicles. As we can see from graph annual average daily traffic is increasing last seven years. The biggest annual traffic was stated 2016 year; maximum of heavy vehicles traffic was fixed 2014. Traffic range last 7 years is between 8507 and 10910 cars/per day. Comparing last 7 years traffic of heavy transport is quite the same and no big exception can be recognized. The change of annual average daily traffic of last seven years on A2 road is shown in figure 2.4.

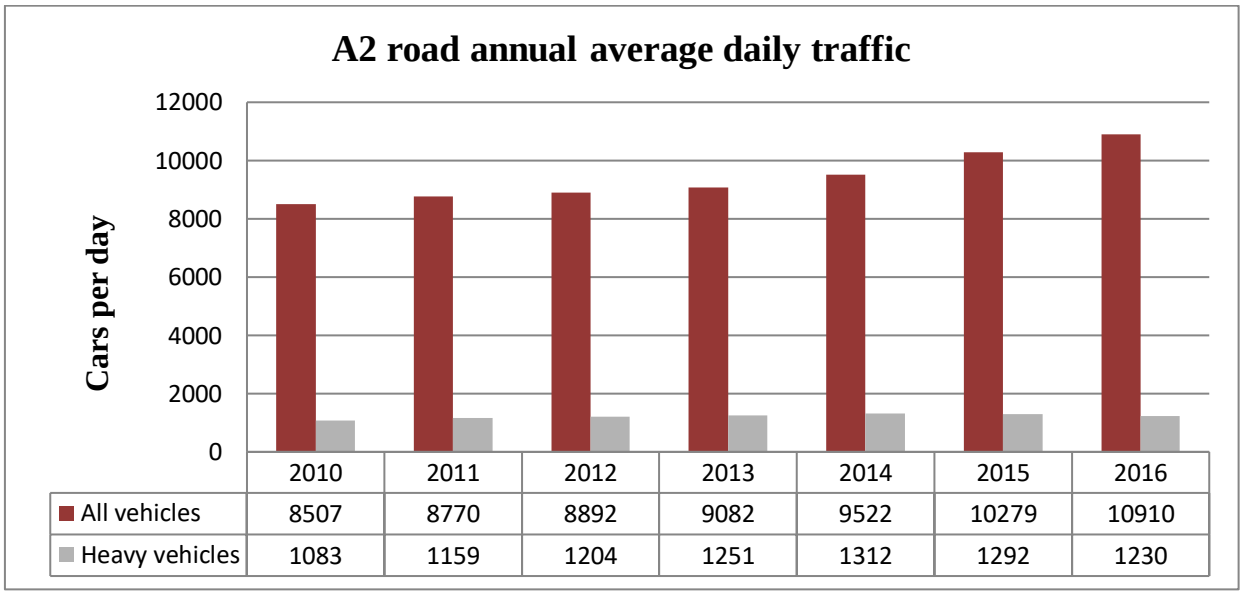

Figure 2.4 Annual Average Daily Traffic of A2 road

Figure 2.5 Via Baltica route in Europe

2.2.2. Via Baltica E67

I Transport corridor ("Via Baltica") is the most important Lithuanian arterial road north-south direction. European route E 67 is an E-road running from Prague in the Czech Republic to Helsinki in Finland by way of Poland, Lithuania, Latvia, and Estonia. It goes via Prague, Wrocław, Warsaw, Kaunas, Panevėžys, Riga, Tallinn and Helsinki. This route is very important transit road for whole Europe, because it

links north Europe with south-west Europe. In general, figure 2.5 shows location, which countries in Europe “Via Baltica” cross.

International “Via Baltica” transport corridor in Lithuania territory consists of five Lithuanian main roads sections, which roads are used intensive every day. “Via Baltica” form these roads:

- A5 Kaunas–Marijampolė–Suvalkai from 0 to 95,84 km;
- A1 Vilnius–Kaunas–Klaipėda from 102 to 114,5 km;
- A8 Panevėžys–Aristava–Sitkūnai from 7,5 to 87,86 km;
- A17 Panevėžio bypass from 0 to 22,25 km;
- A10 Panevėžys–Pasvalys–Riga from 9,17 to 66,09 km.

Whole length of “Via Baltica” in Lithuanian territory is 274 kilometres. To find out more about “Via Baltica”, sections of the road would be analysed separately. After that, would be made a comparison about all sections. It is normal to think, that route E67 starts from border with Poland, first main road is A5 Kaunas–Marijampolė–Suvalkai.

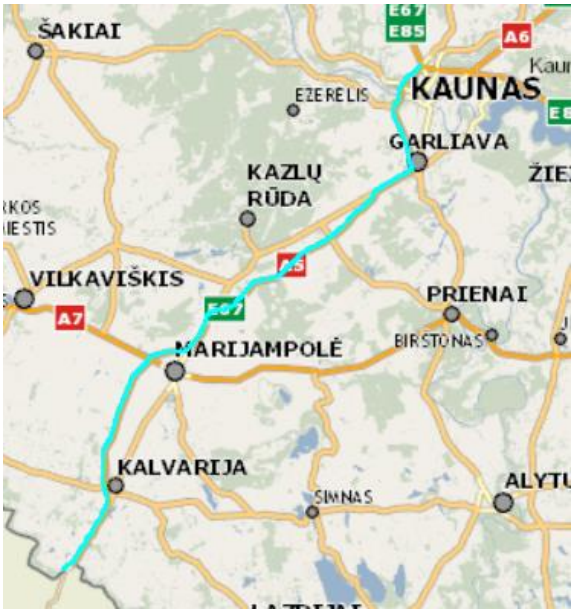

Figure 2.6 Location of A5 road

A5 as start of “Via Baltica” in Lithuania runs from Poland border toward to Kaunas city. The length of the road is 97.86 km. A section of the A5 highway - western bypass of Kaunas, has been reconstructed to a modern dual carriageway without same level junctions or U-turns. Main cities near A5 are Kaunas, Garliava, Marijampolė and Kalvarija. A5 main road have only one junction with other main roads - A7 main road. The figure 2.6 shows the location of A5

road, near cities, and junctions along the route. Annual average daily traffic is 15078 cars/ per day, involving 5280 of heavy vehicles. Detailed data about traffic can be found in figures 2.11 and 2.12.

Using information from KTTI (road and transport investigation institute), A5 road pavement width is from 10,0 to 12,0 each driving direction. This means that road has two lines each way separated with physical obstacle, in this case is green lawn. Other parts of A5 road pavement width is around 10,0 and traffic lanes is not separated by physical obstacle. The main width of the lane various from 3,50 till 3,75 meters. The A5 dominate width of embankment from 12,0 till 36,0 meters. Road category by KTR is AM 1 and part of road is KI. At the end of road A5, "Via Baltica" flow in A1 main road. Cross–section parameters of A5 road are shown in table 2.2.

Table 2.2 Road A5 cross–section parameters

Road	Widths, m			
	Traffic lane	Roadside	Embankment	Dividing line
A5 Kaunas–Marijampolė–Suvalkai	10,0 – 12,0	0,75-1,5	12,0-36,5	3,0

A1 is biggest annual average daily traffic having road in Lithuania. This road connects capital Vilnius with one and only existing sea port in Lithuania - Klaipėda. However to "Via Baltica" belongs only a short section of A1. This section of A1 has two junctions, at start with road A5 and at the end of route with road A8. In this section A1 links one the biggest city in Lithuania, Kaunas with small town Sutkūnai. Figure 2.7 shows a part of "Via Baltica" road – A1 section.

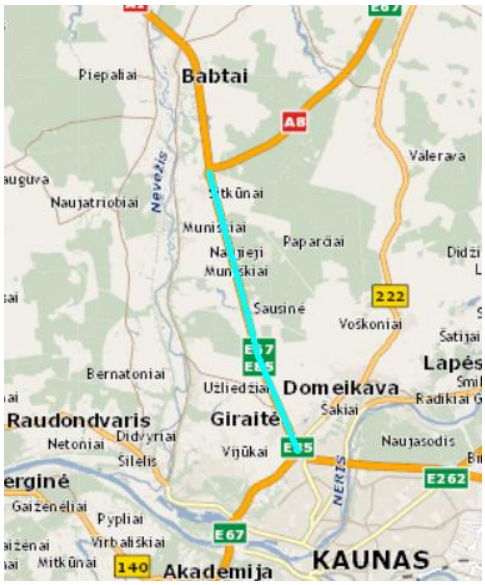

Figure 2.7 Location of A1 road's section

Table 2.3 Road A1 cross–section parameters

Road	Widths, m			
	Traffic lane	Roadside	Embankment	Dividing line
A1 Vilnius – Kaunas – Klaipėda	11,5 – 13,0	0,75	35,0-37,5	7,5-9,5

A1 road section pavement width is 11,50 and 13,00 meters. This means that road has two lines each way separated with physical obstacle, in this case is green lawn and metal safety barriers. The main width of the lane is 3,75 meters, pavement type – asphalt. The A1 dominate width of embankment is about 36,0 meters. Table 2.3 shows A1 road cross–section parameters. Road category by KTR is AM 0, and this is highest category of roads in Lithuanian road network system. Annual average daily traffic is 30519 cars/per day, involving 5928 of heavy vehicles. Detailed data about traffic can be found in figures 2.11 and 2.12.

A8 road Panevėžys–Aristava–Sitkūnai starts after A1 road section. It ruins from interchange Sitkūnai trough Kėdainiai bypass to the Panevėžys. The length of the road is 87.86 km. The speed limit along most of the road length is 90 km/h. This road links Panevėžys city with Kėdainiai and Sitkūnai town. The figure 2.8 shows the location of A8 road, near cities, and junctions along the route. Cross–section parameters of A5 road are presented in table 2.4.

Table 2.4 Road A8 cross–section parameters

Road	Widths, m			
	Traffic lane	Roadside	Embankment	Dividing line
A8 Panevėžys–Aristava – Sitkūnai	9,0 - 13,5	0,75 - 2,25	11,0 - 33,5	0

A8 road pavement width is from 9,0 to 13,5 meters. This road consists of two traffic lines. Each line goes different way; traffic is separated by road horizontal marking. The main width of the lane is 3,75 meters, pavement type – asphalt. The A8 dominate width of embankments from 11,0 m till 33,5 meters. Road A8 cross–section parameters are presented in table 2.4. Road category by KTR is AM 1. This part of "Via Baltica" ends to Panevėžys bypass road A17. Annual average daily traffic is 7038 cars/per day, involving 2504 of heavy vehicles. Detailed data about traffic can be found in figures 2.11 and 2.12.

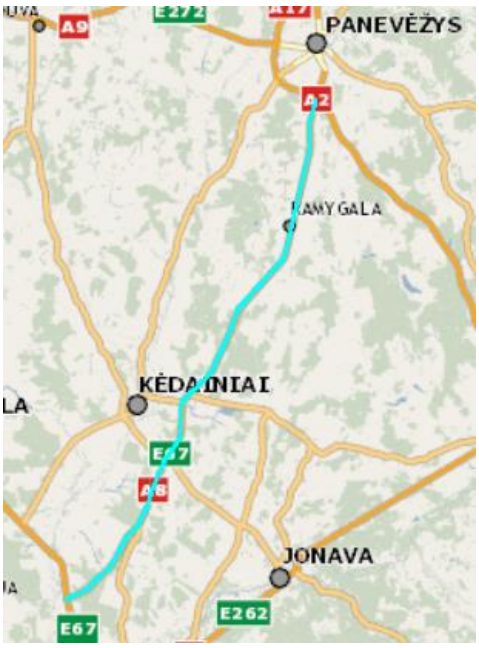

Figure 2.8 Location of A8 road

A17 – Lithuanian main road, also this road is Panevėžys city bypass. This road length – 22,28 kilometers. This road starts with several levels junction with roads A2 Vilnius – Panevėžys and A8 road Panevėžys – Aristava – Sitkūnai. This road rounds Panevėžys city from west side. This road ends with A10 road Panevėžys – Pasvalys – Bauskė. In General this bypass connects A2, A8, A9 and A10 main roads. Situation of A17 road can be seen in figure 2.8.

Table 2.5 Road A17 cross–section parameters

Road	Widths, m			
	Traffic lane	Roadside	Embankment	Dividing line
A17 Panevėžys bypass	7,5 – 14,0	0,50 - 2,50	12,0 – 39,0	0

A17 road pavement width is from 7,5 to 14,0 meters. This road consists of two traffic lines. Each line goes different way; traffic is separated by traffic line. The main width of the lane is 3,75 meters, pavement type – asphalt. The A17 dominate width of embankment is about 37,0 meters. Road category by KTR is AM 1. Road A17 cross–section parameters are shown in table 2.5. Annual average daily traffic is 7753 cars/per day, involving 2566 of heavy vehicles. Detailed data about traffic can be found in figures 2.11 and 2.12.

Figure 2.9 Location of A17 Panevėžys city bypass

Last section of "Via Baltica" road is A10 road. The A10 main road runs from Panevėžys city bypassing Pasvalys town and ends at the Latvian border. From there, the road continues to Riga. The length of the road is 66.10 km. The speed limit for most of the road length is 90 km/h. This road links Panevėžys city with Latvia capital Riga.

Table 2.6 Road A10 cross–section parameters

Road	Widths, m			
	Traffic lane	Roadside	Embankment	Dividing line
A10 Panevėžys – Pasvalys – Bauskė	7,0 – 11,5	0,75 - 2,50	13,0 – 26,8	0

A10 road pavement width vary from 7,0 to 11,5 meters. This road consists of two traffic lines. Each line goes different way; traffic is separated by horizontal road marking. The main width of the lane is 3,25 – 3,50 meters, pavement type – asphalt. The A17 dominate width of embankment is about 13,00 meters. Road category by KTR is AM 1. Annual average daily traffic is 7753 cars/per day, involving 2566 of heavy vehicles. Detailed data about traffic can be found in figures 2.11 and 2.12.

Figure 2.10 Location of A10 Panevėžys – Pasvalys – Riga

Via Baltica road consists of five main roads sections. Most intensive section is A1 main road. In 2016 year annual average daily traffic was fixed 30519 vehicles including 5628 heavy vehicles. As we can see second most intensive road is A5, which have only a half of A1 annual traffic that is about 15078 vehicles per day. Other three roads have quite the same traffic, what is about seven thousands vehicles per day. Lowest traffic is generating A8 road with 7038 vehicles per day including 2504 heavy vehicles. A5, A8, A17 and A10 all vehicle traffic consist of 35% heavy traffic. A1 have lover percentage, it is about 18%.

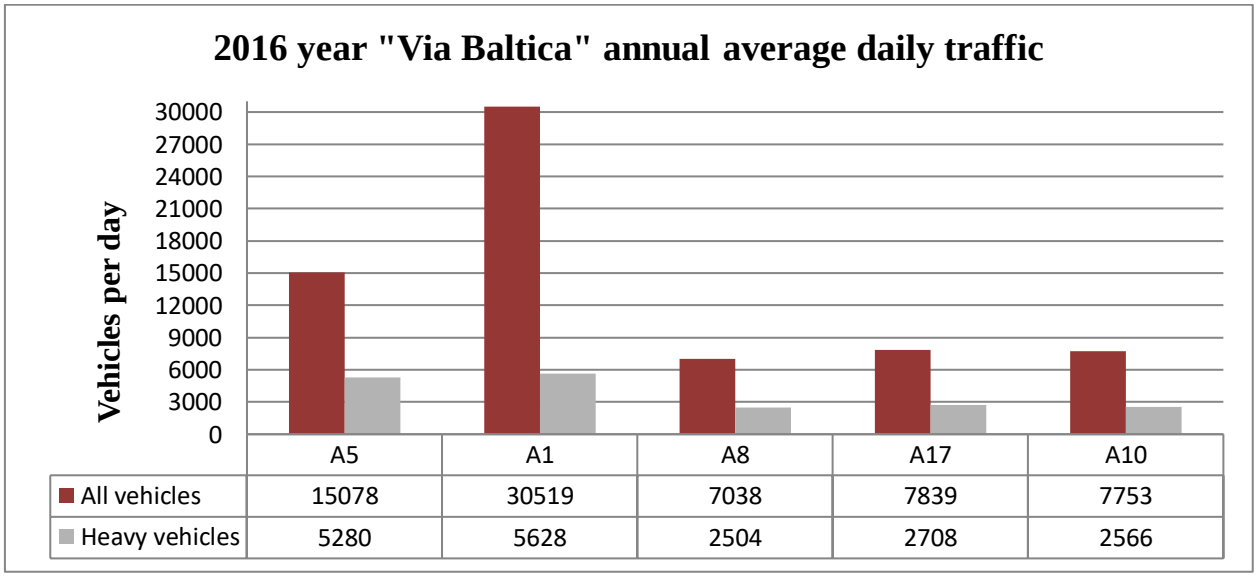

Figure 2.11 2016 year "Via Baltica" annual average daily traffic

Figure 2.12 shows 2010 – 2016 annual average daily traffic in whole Via Baltica route. As we can see traffic volume increases from 2010 till 2016. Highest traffic was fixed in 2016 year and it was 11229 vehicles per day including 3673 heavy vehicles. Comparing whole Via Baltica route, all vehicle traffic volume consists of about 32% of heavy traffic. Heavy traffic is slowly growing through years and average is 3500 heavy vehicles per day.

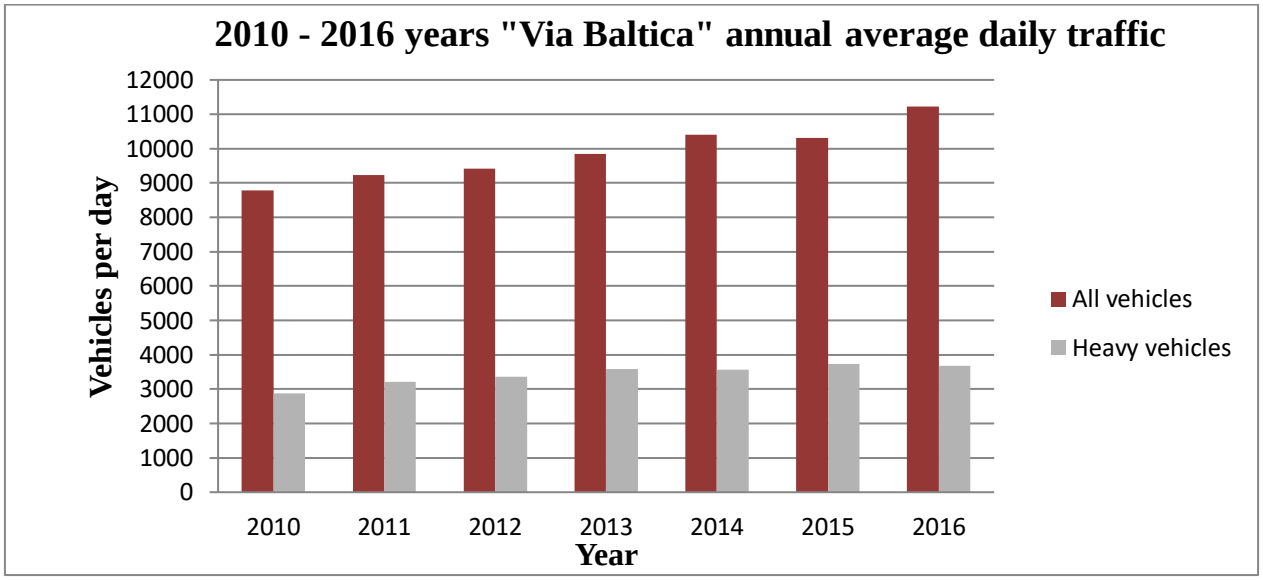

Figure 2.12 2010-2016 years "Via Baltica" annual average daily traffic

2.2. Traffic safety

Road traffic crashes are one of the world's largest public health and injury prevention problems. The problem is all the more acute because the victims are overwhelmingly healthy before their crashes. According to the World Health Organization (WHO), more than 1 million people are killed on the world's roads each year.A part of traffic functional classification is traffic safety. Accidents in roads indirectly show us how safe road is. It is important to analyze traffic accidents, and why they happened.

In order to find out about casualties in Lithuanian traffic, in work would be analyzed data from KTTI institution. "Via Baltica" road is divided in to sections to get more exact information. Data is between 2007 and 2016 years, this data contains about traffic accidents which have injured or killed people during traffic accidents. Accidents and casualties amount are showed in table 2.7.

Table 2.7 Roads accidents and casualties amount between 2007 and 2016 years

Road number	Accident amount	Accident amount per 1 km	Killed people	Injured people	Killed people per 10 km	Injured people per 1 km
A2	128	0,97	28	167	2,11	12,61
"Via Baltica"						
A5	297	3,58	90	406	9,33	45,49
A1	45	3,53	8	58	6,27	23,17
A8	129	1,62	45	184	5,67	27,21
A17	50	2,27	18	60	8,16	30,09
A10	124	2,19	46	170	8,14	32,86
Total	645	2,41	207	878	7,74	32,86

The accident amount is presented for whole section distance. This number is not showing a real rate of collisions. For example, A1 section is about 12,75 kilometers, like A5 road is 96,50 kilometers long. Obviously, that longer road section would have more accidents, for this case we determine accident rate, which shows accident number per 1 kilometer long of distance. As we can the biggest amount of accidents happened in A5 road, also this road has biggest rate of accident amount per 1 kilometer it is 3,58 accidents. For comparison lowest rate is in road A2 0,97 which shows.

Most dangerous roads in "Via Baltica" is A1 and A5. They have a biggest amount of accidents. However accidents in A1 are not so fatally as in other roads like A5 or A17, A10. Most people in Via Baltica road are killed in A5 road. In this road almost half of whole Via Baltica road death is determined. Also in this road A5 the biggest amount of accident happened 297 comparing in whole "Via Baltica" – 645 accidents.

Table 2.8 Roads accidents amount between 2007 and 2016 years caused by pedestrians

Road number	Accident amount	Part of all accidents	Killed people	Injured people	Killed people per 10 km	Injured people per 1 km
A2	19	15%	10	11	2,11	12,61
"Via Baltica"						
A5	40	13,46%	21	20	9,33	45,49
A1	0	0,00%	0	0	0	0
A8	20	15,50%	9	12	5,67	27,21
A17	2	4,00%	1	1	8,16	30,09
A10	25	20,16%	12	11	8,14	32,86
Total	96	15,88%	43	44	7,74	32,86

Another important table no. 2.8 shows us accidents caused by pedestrians. Main idea for this table is, most of foreign countries in motorways such as main roads in Lithuania, pedestrian traffic is forbidden. Now we can see that about 15 % of all accidents are caused by pedestrians. The one A1 main roads do not have accidents with pedestrians; the reason is that whole A1 main road is covered by fence which blocks to get in to A1 road. As before the most accidents caused by pedestrians are in A5 road, more than 20 people was killed last ten years. Almost half of accidents end with fatality; this is caused by high driving speed in main roads.

2.3. Investigation method

A valuable investigation should realize all set tasks. The tasks, aim of investigation are written in chapter 2. In order to get better understand of driving and using roads, author has driven via investigation objects – A2 and Via Baltica roads. During a ride, roads were photographed and recorded using cameras. Also a visual inspection was done, by evaluating pavement, road parameters, and evenness of road. All needed data for investigation like annual daily traffic volume, traffic accidents, road geometrical parameters, general information about roads and stream of users are discussed in chapters 2.1, 2.2 and 2.3. This information would be used to evaluate road functional classification.

Visual inspection aim – driving via roads, which are used for investigation, during ride analysing parameters of roads, conditions of roads. Objectives of visual inspection:

- Evaluate condition of main roads;
- Determinate time, which needed to pass each road;
- Determinate all junctions, and type of junctions;
- Establish how many time design speed changes;
- Establish how many times road crosses town or city.

Trips via roads were done in November month 2017 year. To do visual inspection was used this type measures:

- Car;
- A couple of cameras;
- Tape-measure;
- Notes.

Roads lengths presented in table 2.9.

Table 2.9 Lengths of selected roads

Road		Road length, km
A2 Vilnius – Panevėžys		135,92
Via Baltica	A5 Kaunas–Marijampolė–Suvalkai	95,84
	section of A1 Vilnius–Kaunas–Klaipėda	12,5
	A8 Panevėžys–Aristava–Sitkūnai	80,36
	A17 Panevėžio bypass	22,25
	A10 Panevėžys–Pasvalys–Bauskė	56,92

The selected roads were crossed couple times. One of the time, was calculated real time to cross selected road. During trip, was trying to get as equal driving speed to speed limit. In this case, was determining how much time needed to cross road in real. The real and theoretical times are showed in table 2.10. This time shows the difference, this can be caused by several factors:

- Safety measures;
- Road traffic volume;
- Driving manner of road users;
- Weather conditions;
- Roads works.

Via Baltica road was measured by sections. As whole investigation before, Via Baltica road is under consideration by sections. During second drive, road was measured, taken photos also evaluation of pavement quality.

Table 2.10 Travel time delay comparison

Road		Real trip time, min	Theoretical trip time, min	Difference, min
A2 Vilnius – Panevėžys		77	75	2
Via Baltica	A5 Kaunas–Marijampolė–Suvalkai	75	64	11
	Section of A1 Vilnius–Kaunas–Klaipėda	7	7	0
	A8 Panevėžys–Aristava–Sitkūnai	62	54	8
	A17 Panevėžio bypass	35	15	20
	A10 Panevėžys–Pasvalys–Bauskė	48	38	10

Theoretical time was calculated using these speeds: 90 km/h in main roads and 110 km/h in A2 and A1 because it was November and speed limits were as written. As we can see real time trips takes much longer than theoretical time. Biggest time difference is noticed A17

road. This difference was caused by road works, a ten kilometres distance is reconstructing during investigation. Also in another roads difference are noticed by safety measures, a lot of one level junction also of possibility U turns.

As mention in first chapter, main road the first priority is mobility. During investigation, noticed that a lot car of safety measures, roundabouts have to slow down even to stop. Roundabouts makes main road unequivocal as lower class roads. In this type junctions most of traffic has to stop before crossing junction. Main roads should provide most mobility for drivers and least access functions. To determine how much access provides each main road, during investigation was calculated all junctions, evaluated type of them. Investigation's road junctions, number and crossing roads provided in table 2.11. Some data for this table is taken from "Functional analysis of Lithuanian main roads and recommendations for their development" master thesis.

Table 2.11 Types of junction

Road		Number of Junction with					Places with left turn	Length of road, km
		Main road	National road	Regional road	Local road	Street		
A2		1	5	12	16	4	6	135,92
Via Baltica	A5	1	8	15	19	0	31	95,84
	A1	1	1	1	2	0	1	12,5
	A8	3	4	12	42	3	61	80,36
	A17	3	1	4	14	0	17	22,25
	A10	1	2	12	37	10	68	56,92

Ideology of functional classification states, that road should connect hierarchy with other roads. Figure 1.5 presents the continuity of road network, as showed in figure higher classifications roads connect with same or one level lower class, not with lower as in Lithuanian road network. As we can see from table 2.11 main roads in Lithuania connects with all type of roads: national, regional, local or even with streets. For example in A2 situation is not so bad, because mostly of junctions are several levels, and this type do not impact transport movement via A2. In other roads, mainly junctions are one level, and this makes traffic really slow, and sometime dangerous.

Talking about traffic safety in Main roads a big influence is one level junction, with left turn or U turns. For example we have A2 road which has highest road category in Lithuania road network, highest speed limit of all roads. In this road we can find 6 junctions with left turns at the same level with main road. For example, vehicle's speed is 130 km/h and drive have to stop

vehicle, because in front of it another driver making U turn. This cannot be compare with mobility and high traffic safety. Most of left turn junctions were noticed in roads A10 and A8. Just one of left turn place was found in A1, but need to remember, that this section shortest (12,5 km).

This table 2.8 mostly shows Lithuanian road do not have any continuity. This means that cannot be found any system, at junctions or connections between roads. In United States roads connect in hierarchy systems, from biggest traffic volume to lower. However in Lithuania roads connect randomly, which cause mess in network. This cannot ensure, smooth and most important mobility function. Also in this case drivers lose concentration, because have to look cars from side roads, also a lot of attention is paid to junctions, specially one level.

2.4. Functional class determination

The aim of this investigation is to determinate if each road has road functional class. In this case main roads in Lithuania, have to provide access function as Arterial roads in United States road network. In order to establish, what functional classification each road provides, all collected data would be compared with theoretical information and analysis would be done.

2.4.1. Via Baltica

Road A5 is the first road of Via Baltica in Lithuanian section. This road presents for drivers which enters country from Poland, the start of Via Baltica. However, this road is not as good in functional way as wanted. For example road lane width changes from 10 to 18 meters. Also this road is not homogeneous, in some sections we can approach control reserve, which are not the same in whole A5 road. Maximum driving speed in this road is 90km/h, most of junctions are same grade and some of junctions are grade separated.

This road is not self-explaining, main reason is cross–section changes so many times, that driver get lost and do not know which road he is driving. A several section, are really different between each other, that means road is not sustainable and unsafe for drivers especially first time using this road. A5 road has heaviest traffic in Lithuania also have one of the biggest heavy vehicle traffic volumes. Also this road is most unsafe because a lot of car accidents happen every year.

A5 road do not keep up functional class, one of the reason this road are not self-explaining. Also comparing with another road, this road had biggest time travel needs. Many of junctions are with all type of the roads, but it should be only with the main roads. Main parameters of A5 road are showed in table 2.12.

Table 2.12 Road A5 parameters

Parameters	Values	
Junctions with	Main road	1
	National road	8
	Regional road	15
	Local road	19
	Street	1
Travel time delay	Real trip time, min	62
	Theoretical trip time, min	54
	Difference, min	8
Road cross–section parameters	Road lane, m	10,0 – 18,0
	Roadside, m	0,75 – 1,5
	Road bed	12,0 – 36,5
	Dividing line	0
Annual average daily traffic during 2016 year	All vehicles	15078
	Heavy vehicles	5280

A1 road is shortest section of all Via Baltica roads, for this reason just a short review would be done about this road. This road is Kaunas city overpass, A1 road has highest category – AM which mean highest driving speed – 130 km/h. This road has two traffic lanes, each is 3,75 meters width. Along whole section in Via Baltica, this road has central reserve, green grass, separated with metal barrier. This road as A2 road has bigger signs and green color which make ease to understand that this is motorway. However this road has bus stations and pedestrians can easily walk on roadside, which makes road quite hard to understand.

A1 road looks like most similar to road which has functional classification. Time travel delay during investigation was fixed only one minute. However this road has one grade junctions, and lower class road links to it. Still this road looks like most of all road self-explaining and the easiest to recognize it.

The next road is A8; this road is almost longest in Via Baltica. These road cross–section parameters are not homogenous and changes during a trip. Traffic lane changes from 9 to 13,5 meters, most of road do not have any central reserve. Just in part of road we can find metal barrier in the central with green grass. Maximum driving speed is 90 km/h, part of road which crosses town speed limit is lower to 50km/h. Due to a lot of same grade junctions speed limit is 70km/h. Also along A8 road we can find a lot of bus stops, which generates a pedestrian traffic crossing this road. This makes road a really unsafe. Main parameters of A8 road can be found in table 2.13.

Due to town, which driver have lower speed to even 50 km/h or one grade junction (the biggest number along the road), driver get confused. A big number of spots, in which driver must lower speed, makes this road hard to understand for drivers. Another problem is that road has too many one grade junctions. This cause misunderstanding of which type road it is traveling. Main road as A8 must have as lower junction number as possible, now this road have junction with even local roads. In many places road marking forbids to overtake car even visibility is really good and no obstacles.

Travel time delay in this road – 8 minutes. Most of time delay is due to towns and one level junction. This road have most of same grade junction, just couple is grade – separated junctions. In most of length road is not self-explaining and hard recognize in which class road you are traveling.

Table 2.13 Road A8 parameters

Parameters	**Values**	
Junctions with	Main road	3
	National road	4
	Regional road	12
	Local road	42
	Street	4
Travel time delay	Real trip time, min	62
	Theoretical trip time, min	54
	Difference, min	8
Road cross–section parameters	Road lane, m	9,0 – 13,5
	Roadside, m	0,75 – 2,25
	Road bed	11,0 – 33,5
	Dividing line	0
Annual average daily traffic during 2016 year	All vehicles	7038
	Heavy vehicles	2504

A17 during investigation is capital reconstructing, so not many parameters can be recognized and fixed. Right now road would be 2+1 lanes, with roundabout junction. Road will not have any central reserve; also the cross–section of road is variable. Speed limit is 90 km/h, most of junctions are one graded. The road signs are not different from other main roads.

For drivers is hard to understand at what point A17 road starts, bet still during whole trip road is the same looking. Right now is hard to determine road functional class because of road works. Travel time is really high, but main reason for that is road works. This road after

reconstruction would be more self-explaining. The one worst problem is one grade junction in road especially roundabout.

Table 2.14 Road A10 parameters

Parameters	Values	
Junctions with	Main road	1
	National road	2
	Regional road	12
	Local road	37
	Street	10
Travel time delay	Real trip time, min	48
	Theoretical trip time, min	38
	Difference, min	10
Road cross–section parameters	Road lane, m	7,0 – 11,5
	Roadside, m	0,75 - 2,50
	Road bed	13,0 – 26,8
	Dividing line	0
Annual average daily traffic during 2016 year	All vehicles	7753
	Heavy vehicles	2566

A10 road is the last section, in Via Baltica road in Lithuania territory. This road ends at Lithuanian-Latvian border. This road traffic lane width changes from 7 to 11,5 meters. About 2 kilometers of road have central reserve with metal barrier and green grass. Other sections of A10 do not have any central reserve. Road side changes from minimum 0,75 to 2,5 meters width. Whole road parameters are showed in table 2.14.

Driving speed limit in road is 90 km/h. All junction in road are one grade, some of them are roundabouts. Due to one grade junction, speed limit is lowered to 70 km/h or in some spots even to 50km/h.

Time travel delay was around 10 minutes. Main reason for it, is one level junctions and lower speed limits due to towns. This road has biggest number of junctions with other type roads. This road is not self-explaining in most of sections, due to wide traffic lanes and roadsides.

Via Baltica – is road which consists of five different road sections. Each road has different road cross–section parameters, different speed limits, and different road categories. As being one of most intensive roads in Lithuania, this road supposed to be homogenies as possible.

Each of roads visual looks differently what makes this Via Baltica road hard to be self-explaining.

Different road marking, different types of signs mess much more. Also, main speed limits various from 130 km/h to 90 km/h even to 50 km/h at some points. In Via Baltica road can be found various junctions like same grade, roundabouts and some grade separated junctions.

The main problem for this road, this road is not self-explaining and has too many changes of parameters. This mess driver, in this case whole length of road has to be same looking with same speed limit, cross-sections. Even traffic volume is different between roads, Via Baltica has to look as integrity as possible. Travel time delay for whole road is 49 minutes; main reason for this is one grade junctions, speed limit lowering due to towns and pedestrians traffic. Also junction with all type roads makes travel time much longer as it should be.

2.4.2. A2 Vilnius – Panevėžys

A2 Vilnius – Panevėžys is one of two main roads in Lithuania, which has highest speed limit. During summer season speed limit is 130 km/h, another time speed is 110 km/h for car and motorcycles. Due to one of highest speed limit, this road more close to mobility functions. Talking about speed limit in six spots due to one level junction speed limit is lower. Expect six places, there any reason to stop for vehicle driver or to slow down.

Talking about road cross – section, whole road has separate traffic with physical obstacle – green grass. Often road on sides has metal barrier for safety reasons. The number of traffic lane, except acceleration and slowing lanes are same for whole length – two for each traffic direction. In whole road roadsides are asphalt pavement and width is quite the same for whole road. Traffic lane width for the first lane is 3,75 meters and for second is 3,50, these numbers are constant and do not vary in whole length of road.

Road marking is good quality and can be recognized in whole road. Also all signs are green color, which more allow to recognize this road. All signs are bigger that in other roads.

Total number of junctions is 38; most of junctions are one level. A2 road, which category is main road connects with all type roads. Junctions are one biggest problem in A2 road. All of junctions have to be two levels and also due to system continuity main road have to link with main and nation roads. Due to incorrect type of junctions during travel time delay, this road had delay 2 minutes. All road parameters are presented in table 2.15.

Table 2.15 Road A2 Vilnius – Panevėžys parameters

Parameters	Values	
Junctions with	Main road	1
	National road	5
	Regional road	12
	Local road	16
	Street	4
Travel time delay	Real trip time, min	77
	Theoretical trip time, min	75
	Difference, min	2
Road cross–section parameters	Road lane, m	11,5 – 11,8
	Roadside, m	1,5-1,7
	Road bed	35-38,5
	Dividing line	7,0-10,0
Annual average daily traffic during 2016 year	All vehicles	10910
	Heavy vehicles	1230

Road marking is good quality and can be recognized in whole road. Also all signs are green color, which more allow to recognize this road. All signs are bigger that in other roads.

Total number of junctions is 38; most of junctions are one level. A2 road, which category is main road connects with all type roads. Junctions are one biggest problem in A2 road. All of junctions have to be two levels and also due to system continuity main road have to link with main and nation roads. Due to incorrect type of junctions during travel time delay, this road had delay 2 minutes. All road parameters are presented in table 2.15.

Comparing all data, and visual looking of road can be stated, that A2 in most cases correspond to mobility function road. As most factories for access function is travel speed and trip time delay. This road has highest speed limit in Lithuanian road network, during investigation fixed that trip delay two minutes. Biggest problem for this road is junctions and junctions' types; they have to be at least several levels instead of one level.

2.5. CONCLUSIONS

1. During data survey were compared two main roads in Lithuania: A2 Vilnius – Panevėžys and Via Baltic, which consists of five diffrent roads sections. During data survey were comparated annualy daily traffic volume, road crossection properties, traffic safety, travel time delays. Data were analysed and roads were compared to each other.

2. A2 road Vilnius – Panevėžys, in most cases meets requirements to mobility function road. Bassically this road has lowest trip time delay, also road safety is quite high comparing with annualy daily traffic volume. The crosssection and lane number of road are constant for whole length, which makes this road more „self-explaining".

3. Road Via Baltica tottally are different comparing with A2, this road sections in most cases do not serve mobility functions. In some of roads trip time delays are really high, a lot of accidents in roads, which makes them unsafe for all road users. Also this road have a lot of different cross-sections and missleading surroundings.

4. Lowest travel time delay was fixed in road A1 (section of Via Baltica road) – 0 minutes, highest in A17 road (also section of Via Baltica road) – 20 minutes. For comparinson in A2 road was fixed only 2 minutes travel time delay, which guarantees great mobility of the road.

5. Most dangerous road is A5 (section of Via Baltica road), during last ten years in this road happened 297 accidents, killed 90 and injured 406 people. Comparing lenght of the road and amount of accidents most safest road is – A2, during last 10 years, only 2,11 people killed per 10 kilometres road lentgh.

6. Main problem for both roads are junctions. As being Main roads and have to meet mobility function, most of junctions are one grade. This mean, that traffic on the main road have to slow down before junctions. Also one grade junctions do not meet safety requirements due to high speed on main roads.

3. ECONOMIC EVALUATON OF INVESTIGATION

Every project, investigation should bring economy efficient as well as scientific. In this chapter would be evaluated and calculated economical efficient of changing road functional classification in Lithuania. Economical evaluation would be rated by two criteria: fatalities in road, and time consumption in roads. Lithuania has released document about both criteria, it is called “Car road investment guide”. Using data from previous chapters, and using “Car road investment guide”, would be calculated both criteria.

This chapter aim – to evaluated economic benefits of changing Lithuanian road network functional classification.

3.1. Economic evaluation time consumption of travel time

Time consumption is calculated using 2.4 chapter data. A difference between real and theoretical travel time would be used as time consumption. Using Lithuanian document “Car road investment guide”, determine how much one hour cost for each vehicle class. Trip time expenditure rates are presented in table 2.16. This table provide rates for cars, and all types of heavy vehicles. Rates vary from 8,66 to 93,94 euros per hour. Calculating trip time expenditures stated all vehicles driving as same speed, as investigation author car.

Table 2.16 Trip time expenditure rates

Vehicle class	One hour cost (euros)
Car	8,66
Heavy vehicles:	
2 axles	8,91
3 axles	11,34
4 axles	16,00
5 axles or more	20,00
Small bus (up to 20 passengers)	29,25
Big bus (over 20 passengers)	93,94

In order to calculate trip expenditures using equation from “Functional analysis of Lithuanian main roads and recommendations for their development” master thesis. Also to calculate trip time expenditures rate need annual average daily traffic for cars, heavy vehicles and busses. All data is taken from road and transport investigation institute. In economic investigation are taken data 2016 years. Equation for trip expenditures calculation:

$$TE = AADT_i \cdot OHC_i \cdot t \cdot 365 + AADT_i \cdot OHC_i \cdot t \cdot 365 + AADT_i \cdot OHC_i \cdot t \cdot 365\ , here:$$

TE = time expenditures;

$AADT_i$ = annual average daily traffic (cars, heavy traffic and busses);

OHC_i = one hour cost (euros);

t = travel time (real or theoretical).

Calculating trip time expenditures cost using data from table 2.16. Difference of times using to calculate time expenditures. Trip time expenditures are based on several factories: time delay, annual average daily traffic and price for one hour. Calculating expenditures are involved all listed factories. All calculation data is presented in table 2.17.

Table 2.17 Trip time expenditures

Road		**Delay, min**	**Expenditures, millions euros**			
			Cars	**Heavy vehicles**	**Buses**	**Total**
A2 Vilnius – Panevėžys		2,00	1,02	0,21	0,03	1,26
Via Baltica	A5 Kaunas – Marijampolė – Suvalkai	11,0	5,68	4,97	2,71	13,36
	Section of A1 Vilnius – Kaunas – Klaipėda	1,00	1,31	0,48	0,09	1,88
	A8 Panevėžys – Aristava – Sitkūnai	8,00	1,91	1,71	0,60	4,23
	A17 Panevėžio bypass	20,0	5,41	4,63	1,56	11,60
	A10 Panevėžys – Pasvalys – Bauskė	10,0	2,73	2,20	0,69	5,61

Based on calculations, biggest expenditures stated in A5 roads, this consists about 13,36 million euros per year. A17 road by expenditures are near A5 road, this big delay time was capture due to road reconstruction. This road in investigation would be ignored, because this delay and expenditures are not normal state of road. Smallest trip time expenditures are calculated in A2 road, which mean a little more than one million euros. We can predict, if road would be classified in right way, expenditures can be low as A2 road. This road has quite big length, but expenditures are lowest. During one-year period, government and road users due to bad road classification loses a million of euros, which can be assign for road improvement or other spheres.

3.2. Economic evaluation of road safety

Comparing with worldwide in Lithuania road traffic accident rate is quite in low positions. Looking in Europe, we have one of highest death rate per 100,000 people in car accidents. For comparison in Lithuania rate is – 8,34 deaths per 100,000 people, Germany has only 3,94 is more than two times smaller rate. Deaths and injuries during car accidents are enormous big expenditures not only in economical side. In this chapter using Lithuanian documentation, would be calculated economic evaluation of car accidents, also would be compared with Germany.

Lithuanian guideline "Car road investment guide", provides rate for traffic accidents in which people died or injured. Rates are showed in table 2.18. One people death are worth almost 600,000 euros, one injured people about 54,000 euros. Using these rates, would be calculated accidents in investigation objects - A2 and Via Baltica roads.

Table 2.18 Car accident expenditure rates

Car accident expenditure rate (euros)	Car accident with death	Car accident with injured people	Technical accident without victim
	596899	54201	1720

Data for economic evaluation is taken from table 2.18. Deaths and injuries are from 2007 till 2016 years. Using data and car accident expenditure rates are calculating all expenses from car accidents. Calculations are showed in table 2.19.

Table 2.19 Car accident expenditures from 2007 till 2016 year

Road number	**Year**	**Killed people**	**Injured people**	**Expenditures, millions euros**		
				Killed people	**Injured people**	**Total**
A2	2007-2016	28	167	16,71	9,05	25,76
Via Baltica						
A5	2007-2016	90	406	53,72	22,01	75,73
A1	2007-2016	8	58	4,78	3,14	7,92
A8	2007-2016	45	184	26,86	9,97	36,83
A17	2007-2016	18	60	10,74	3,25	14,00
A10	2007-2016	46	170	27,46	9,21	36,67
			Total	140,27	56,64	196,91

Comparing data from table, most dangerous road is A5, in this road biggest amount of casualties fixed, also this road cost biggest amount of money. A10 and A8 road looks quite

similar and both have expenditures about 36 million euros. A1 road has smallest amount of killed and injured people, this number guarantee lowest expenditures of all roads. The average expenditures for each road is about 37 million euros. Of course these numbers just approximately shows how much government have expenditures due to car accidents.

Using data from 2.3 chapter “traffic accidents”, we can assume a lot of accidents are due to pedestrians. However, in most of countries where have functional classification it is strictly forbidden to cross or even enter to highest classifications roads. Approximately 15% of all accidents are happens due to pedestrians walking or crossing road lanes. In this case about 26 million euros would be saved if road in Lithuania strictly forbidden pedestrian traffic in main roads.

As talked before, Lithuania country has highest death rate per 100,000 people in car accidents. Countries, which have very well developed functional classifications and strong design guidelines, have lower sometimes even couple times death rate. In this case, Lithuania would be compared with Germany, which functional classification is mostly properly for our country. Will be calculated expenditures with lower rates and made comparison. Data related with comparison is showed in table 2.20.

Looking in Europe, we have one of highest death rate per 100,000 people in car accidents. For comparison in Lithuania rate is – 8,34 deaths per 100,000 people, Germany has only 3,94 is more than two times smaller rate.

Table 2.20 Car accident expenditures 2016 year and comparison with Germany

Road number	Year	Killed people	Injured people	Expenditures, millions of euros			Expected expenditures, millions of euros		
				Killed people	Injured people	Total	Killed people	Injured people	Total
A2	2016	2	18	1,19	0,98	2,17	0,56	0,46	1,03
A5	2016	5	21	2,98	1,14	4,12	1,41	0,54	1,95
A1	2016	0	0	0,00	0,00	0,00	0,00	0,00	0,00
A8	2016	1	10	0,60	0,54	1,14	0,28	0,26	0,54
A17	2016	1	6	0,60	0,33	0,92	0,28	0,15	0,44
A10	2016	6	25	3,58	1,36	4,94	1,69	0,64	2,33
			Total	8.95	4,34	13,29	4,23	2,05	6,28

Most accidents happened in A10 and A5 roads, what created biggest expenditures. In 2016, total accidents in Via Baltica road were 45, comparing in A2 road happen only 16 accidents. Most number of deaths was fixed in A5 and A10 roads. In table 2.20 presented, that total expenditures per 2016 year approximately is 13 million euros. That mean, only in two road

Lithuanian government loses a huge amount of money. Comparing death rates with Germany we can assume that it is possible to lower all accident rates about two times. Which mean less expenditure, less casualties. This can be reached due to functional classification development in Lithuania.

3.3. Conclusions

1. Highest expenditures due to traffic delay are caused by passenger's cars are: 1,02 million euros in A2 road and 17,04 million euros in Via Baltica road. Total in A2 road expenditures cause by all types of vehicles are 1,26 million euro. In Via Baltica by all vehicles caused expenditures are 36,68.

2. Government and road users in Lithuania due to Traffic delay loses significant amounts of money, which can be allocated to road upgrading or other spheres. Traffic delays are caused same level pedestrian crossings, traffic safety measurements, and invalid types of junctions, pass through cities, and not right chosen speed limits.

3. Death rate on Lithuanian roads is one of highest in Europe, which creates a high amount of expenditures due to car accidents. On the main road about 15% car accidents are caused by pedestrians.

4. On A2 road total expenditures due to car accidents per 2016 year is 2,17 million euros. In Via Baltica road on the same year was 11,12 million euros. Long time period expenditures, from 2007 till 2016 year are for A2 road – 25,76 million euros and for the same period on the Via Baltica – 171,15 million euros.

5. Due to highly developed road functional classification, Germany has two times lower accident rate on roads. If Lithuania successfully improves functional classification, can expect lower casualties and expenditures lower two times or more.

GENERAL CONCLUSIONS

1. During analysis of literature, noted that many countries use a functional road classification. The main idea of functional classification is to group streets and highways according to the character of service they are intended to provide. This type of classification identify that sections of road do not serve travel separately.

2. Main documentation about road design, parameters of the roads in Lithuania is KTR 1.01:2008, this document is only one for designing roads in Lithuania. This guideline do not classified roads using functional classifications, Lithuanian roads are classified by significance. Road categories are determined by using annual average daily traffic.

3. During data survey were analysed two main roads: A2 Vilnius – Panevėžys and Via Baltica, which consists of five different roads sections. During data survey were comparated annualy daily traffic volume, road crossection properties, traffic safety, travel time delays. Data were analysed and roads were compared to each other.

4. A2 road Vilnius – Panevėžys, in most cases meets requirements to mobility function road. Bassically this road has lowest trip time delay, also road safety is quite high comparing with annualy daily traffic volume. Road Via Baltica tottally are different comparing with A2, this road sections in most cases do not serve mobility functions. In some of roads trip time delays are really high, a lot of accidents in roads, which makes them unsafe for all road users.

5. Lowest travel time delay was fixed in road A1 (section of Via Baltica road) – 0 minutes, highest in A17 road (also section of Via Baltica road) – 20 minutes. For comparinson in A2 road was fixed only 2 minutes travel time delay, which guarantees great mobility of the road.

6. Biggest problem for both main roads are junctions. As being Main roads and have to meet mobility function, most of junctions are inappropriate. Biggest number of junctions are one grade, which cause that traffic on the main road have to slow down before junctions. Also one grade junctions do not meet safety requirements due to high speed on main roads.

7. Highest expenditures due to traffic delay are caused by passenger's cars are: 1,02 million euros in A2 road and 1,26 million euro by all types of vehicles. For comparison in Via Baltica road expenditures due to traffic delay are 17,04 million euros by passengers cars and by all vehicles caused expenditures are 36,68.

8. Death rate on Lithuanian roads is one of highest in Europe, which creates a high amount of expenditures due to car accidents. On the selected main road about 15% car accidents are caused by vulnerable road users. On A2 road total expenditures due to car accidents per 2016 year is 2,17 million euros. In Via Baltica road on the same year was 11,12 million euros. Long

time period expenditures, from 2007 till 2016 year are for A2 road – 25,76 million euros and for the same period on the Via Baltica – 171,15 million euros.

Reccomendations for Lithuanian road networks:

1. First of all we need to classifield road by functional clasisication, not by significance orannual average daily traffic. Also need to determine functional class for each road in Lithuanian road network. These classies have to describe a function, which road have to provide.
2. During road design step, need to analyse functional class and be sure, that section have required parameters for that class. It is very important to keep integrity of road, and all section of road have to be with same parameters and visual looking, design road as possible as „self explaining".
3. Based on Germany design guidelines RAA and RAL, AASHTO „A policy on geometric design of highways and streets" V. Puodžiukas scientific report theme „Automobilių kelių tinklo elementų paskirties analizės ir plėtros schemos parengimo", United States and Nederland road functional classification experience, I have prepared road functional classes and classification in Lithuania. Recommendations can be found in first annex "road functional classification recommendations for Lithuania".
4. By these recommendations in Lithuania roads would have three main functions – mobility, distributor and access functions. Mobility function roads include two road categories – three motorways and two rural roads. Distributor roads have three road categories, which consist from rural categories and access function is determined for two categories of local roads. This divides roads into ten different road class. These classes are divided in to three main road categories – motorways, rural roads and local roads. Motorways have three classes – MT 0, MT I, MT II. Rural roads have five classes – R I, R II, R III, R IV, R V and local roads have two classes L I and L II. In this distribution, design speed and road purpose are stated as well.
5. In general this road distribution states new road categories, each category have fixed function. First annex "Road functional classification recommendations for Lithuania" also provides existing road category, which makes easier to determine road class for existing Lithunian road network. Basically, these recomendations do not state design parameters, and road cross sections. For this reason, should be prepared design classes and new design guidelines for new road functional classification.

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ANNEX

1 Annex. Road functional classification recommendations for Lithuania”

2 Annex. Road functional classification. Paper. Vilnius, 2017.

1 Annex. Road functional classification recommendations for Lithuania”

Category			Design speed	Road purpose	Existing road category in Lithuania	Road function
Motorways	**Rural roads**	**Local roads**				
MT 0			130	Continental	Main	Mobility
MT I	R I		110	Sub-Continental		
MT II	R II		100	Inter-regional		
	R III		90	Regional	National	Junction
	R IV		90	Sub-Regional		
	R V		70	Local	Regional	
		LI	50	Local	Local	Access
		LII	30	Local		

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ROADS FUNCTIONAL CLASSIFICATION

Gedas Janulis

Dept of Roads, Environmental Engineering Faculty, Vilnius Gediminas Technical University,
Saulėtekio al. 11, LT-10223 Vilnius, Lithuania
E-mail: gedas.janulis@stud.vgtu.lt
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Abstract. The paper provides an analysis of road functional classification. In this article are compared different road functional classification. Main attention paid on the United States functional classification, and this used as a base. Also, have been discussed general road functions assess their part to traffic safety. To provide wder and more deeply analysis, mobility and access influence on setting road functional classification discussed in the report. In report have been compared Europe countries functional classification to the United States classification model. Functional class is one of the factories to provide safety traffic, create road friendlier for all users. One of the main conclusions of paper is that determining the correct functional class for the road is of particular importance for designers, administrators of the road, also for the user of the road.

Keywords: roads, functional, classification, mobility, access, Europe, United States, design.

1. Introduction

The road is civil structure, which is intended for transportation, pedestrians, and cyclists' traffic. Roadway system is a vast network that connecting places and people within and across national borders. Road quality and road network size directly show country or state economic level. Traditionally, economic and social considerations bases on the planning of the rural road network. During the last decades, traffic volumes showed a considerable growth, despite an extension of the road networks. Meanwhile, some harmful effects of these networks and their traffic flow appeared. Traffic unsafely, emissions and noise affect local people, flora, and fauna (Jaarsma 1997). Over the years, functional classification has come to assume additional significance beyond its purpose as a framework for identifying the particular role of a roadway in moving vehicles through a network of highways.

2. Road classification

The classification of highways into different operational systems, functional classes or geometric types is necessary for communication among engineers, administrators, and the public. Different purposes in various rural and urban regions applied various classification (A Policy… 2001).

Various road classification systems are advantageous in the process of road net development. Several reasons why roads ought to be classified bases on different criteria. These divisions are the basis for defining the jurisdiction of the road, its geometry, traffic volume, traffic type, origins and destinations it connects. By the relevant literature, there are several basic road classification areas:

- *Functional,* express a road's functional importance in the whole network;
- *Administrative,* bases under the jurisdiction of individual administrations on various roads;
- *Traffic,* volume, type;
- *Environmental,* heavy vehicles, transport harmful impact on the environment.

Different classifications of roads have the significant influence on traffic safety so that they determinate the safety-related task ought to undertake to provide an acceptable level of security. It means that it is impossible to prevent traffic accidents altogether. It is possible to alleviate the consequences of a collision to make roads and vehicles safer, and drivers become more careful. Moreover, the greater insight into the impact of various roads classifications reduces the risk, first, functional classification on road safety (LR… 2015).

3. General road functions

Every road has a general function, which depends on its function and purpose. The function can be as many as needed, to simpler the situation, three basic road functions are:

Traffic flow function − Roads with traffic flow function may ensure long-distance traffic efficiently. Inter-urban motorways and highways and sometimes-urban arterial streets have the flow function. On such roads, strictly separates other forms of transport and vulnerable road users on such roads. The number of access and exit points is limited, and the distance between crossings is considerable.

Traffic distribution function − Roads with traffic distribution function provide an opportunity for the road users to access and exit from any urban and rural territory in the whole length of the road. On this function, the road is more crossings, and all types of manoeuvres in crossings are allowed. Different types of public transport also use such roads.

Traffic destination or access function − Roads with access function allow actual access to properties in the whole length of the road or street. Both crossings and interchanges ensure traffic exchange. To ensure appropriate low speed may engineering measures are necessary.

Presently, roads and streets often have more than one traffic function, creating unsafe conditions. The concept of sustainable, safe road transport comes down to the removal of all function combinations by making the road mono-functional, for example, by creating categories of roads: *pure through roads*, *pure distributor roads*, and *pure access roads*. Multi-functionality leads to different design requirements, and to higher accident risks. Together, the three road categories make up a road network. Switching traffic from one road to another road traffic intends junctions.

Traffic flow designs by road links. An exception to this is the road link in access roads, where stopping and turning are allowed. Through roads should not have junctions but split level interchanges to guarantee a continuous flow function (Kelių... 2008).

4. Functional classification

Functional classification carries with it expectations about roadway design, including its speed, capacity, and relationship to existing and future land use development (Jaarsma 1997). Functional classification is the process by which classes, or systems groups streets and highways, according to the character of traffic service that they are intended to provide (Guidance… 2012).

Functional classification thus groups streets and highways according to the nature of service they aim to provide. The classification recognizes that private roads and streets do not serve travel alone. Rather, such networks in a logical and efficient manner categorize most travel, which involves movement through networks of roads. Thus, functional classification of roads and streets is also consistent with the categorization of the journey (Flexibility… 2001).

Most travel occurs through a network of interdependent roadways, with each roadway segment moving traffic through the system towards destinations. The 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. Planners and engineers use this hierarchy of roadways to channel transportation movements through a highway network efficiently and cost-effectively (Highway… 2013).

The roads making up the functional systems differ for urban and rural areas. The hierarchy of technical systems consists of principal arterials (for the main movement), minor arterials (distributors), collectors, and local roads and streets. However, in urban areas are relatively more arterials with further functional subdivisions of the arterial category whereas in the countryside there are relatively more collectors with further functional subdivisions of the collector category (Todorova *et al. 2009*).

5. Mobility versus access

The two principal considerations in classifying highway and street networks are functionally access and mobility. The conflict between serving through movement and providing access to a dispersed pattern of trip origins and destinations necessitates the differences and gradations in the various functional types. On arterials, to enhances their primary function of mobility needs regulated limitation of access (A Policy… 2001).

Mobility describes the ability of the road to move traffic and is measured in traffic volumes, vehicle speeds, and trip length. Access is the linkage between the road, and adjacent land uses. The separate functions of mobility and access can be incompatible and conflict with each other especially when through traffic inappropriately mixes with local transport. Roads fail from congestion or safety standpoint because of the conflict and inverse relationship between mobility and access. Figure 1 characterizes the overall relationship between road classification and mobility and access. On one end of the scale, expressways provide maximum mobility but only limited access, thus, the term-limited access expressway (Aichele *et al.* 2004).

6. Examples of road function classifications

A properly functioning road network is dependent on the appropriate accommodation of mobility, access and the interconnection of all the roads in the network. To reach the proper mix of mobility and access to the diversity of classes uses road function classification tool (Aichele *et al.* 2004). Figure 2 shows areas of uncertainty.

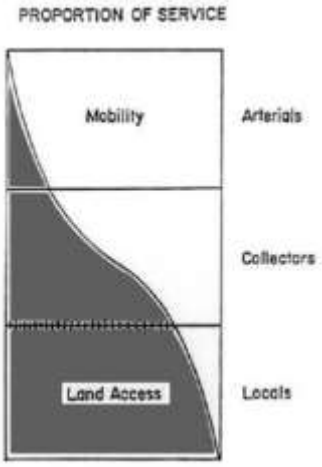

Fig. 1. Proportion of service

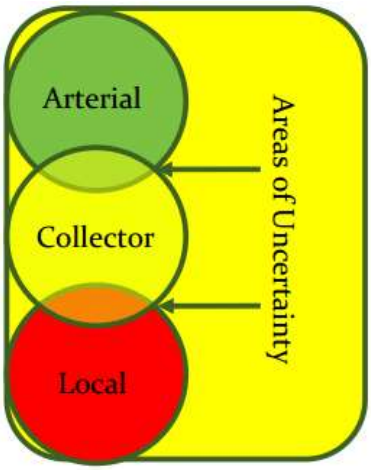

Fig. 2. Areas of uncertainty

6.1. Road functional classification in the United States

Road classification in the United States is main classification form in the world.

In this paper, it holds most of the attention, because this classification bases on most of Europe countries

Functional classification is the process by which streets and highways are grouped into classes, or systems, according to the character of traffic service that they are intended to provide. There are three highway functional classifications: arterial, collector, and local roads. All streets and highways are grouped into one of these classes, depending on the character of the traffic (for example, local or long distance) and the degree of land access that they allow (Flexibility… 2001). Table 1 describes these classifications.

Table 1. Parameters of functional classification

Functional System	Service provided
Arterial	Provides the highest level of service at the greatest speed for the longest constant distance, with some degree of access control.
Collector	Provides a less highly developed level of service at a lower speed for shorter distances by collecting traffic from local roads and connecting them with arterials.
Local	Consists of all roads not defined as arterials of collectors; primarily provides access to land with little or no through movement

As seen categories situated in hierarchy form. The collector connects to the biggest class which is arterial, arterials are longest roads and has the highest speed limit. Also, arterials have just few access points and most of the travel lanes. Arterials are the biggest category, which has highest parameters. Collector connects arterial and local roads. Medium parameters have a middle of categories. This type of road is the connecting type. The local road has smallest parameters but connects most of the access points. This category is main in urban areas, with the lowest speed limit. Table 2 shows the main difference and parameters of categories.

Table 2. Parameters of functional classification

Functional Classification	Distance Served	Access Points	Speed Limit	Distance between Routes	Usage	Significance	Number of Travel Lines
Arterial	Longest	Few	Highest	Longest	Highest	State wide	More
Collector	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Local	Shortest	Many	Lowest	Shortest	Lowest	Local	Fewer

6.2. Road functional classification in the United Kingdom

All UK roads (excluding motorways) fall into the following four categories:

- A roads – major roads intended to provide large-scale transport links within or between areas.
- B roads – roads designed to connect different areas, and to feed traffic between A roads and smaller roads on the network.
- Classified unnumbered – smaller roads designed to connect unclassified roads with A and B roads, and often linking a housing estate or a village to the rest of the network. Similar to 'minor roads' on an Ordnance Survey map and sometimes known unofficially as C roads.
- Unclassified – local roads intended for local traffic. The vast majority (60%) of roads in the UK fall into this category.

As originally conceived, these four classes form a hierarchy. Large volumes of traffic and traffic travelling long distances should be using higher classes of the road; smaller amounts of traffic are travelling at lower speeds over shorter distances should be using lower classes of road. England and Wales by the Department for Transport centrally administers road classification uses a common system of route numbering (Guidance... 2012).

6.3. Road functional classification in Lithuania

Roads in Lithuania have three main categories: motorways, national, and regional roads. Road categories bases on transport volume, not a function class. In another word, these classes are determined by calculating transport volume. In Lithuania standards and directives, we do not have function classification and that function setting. Table 3 shows Road categories and definition about them (LR… 2015).

Table 3. Road classification in Lithuania

Road value	Road description
Motorway	Main roads, connecting biggest cities, on which is highest traffic volume. These roads also provide the highest speed and the longest constant distance. They also classified as Europeans roads.
National	These roads create the biggest part of the road network in Lithuania. They connect smaller cities and tourist objects.
Regional	This group of roads providing traffic links between local small urban areas; These roads relate to national road network as well.

6.4. Road functional classification in Germany

While the American guides suggest three different categories, the German guide defines twenty-two highway classifications. Many of the highway types in the German guide are quite similar to those in the AASHTO. For example, AI in the German guide would be equivalent to AASHTO's rural arterial. However, AASHTO does not explicitly consider many of the German roadway types. For example, a public meeting place and excludes vehicular traffic commonly designs; the German E VI is a roadway. In general, the German system includes community friendly streets as part of the conventional design scheme. Accepted design standard considers an exception to such roads in the USA (Garrick, Kuhnimhof 2000). Table 4 shows the final matrix of classification groups in Germany.

Table 4. Road classification groups in Germany

Level of Mobility	Functional Category				
	Outside built-up areas		Within built-up areas		
	Not surrounded by buildings		Surrounded by buildings		
	Mobility			Access	Public Realm
	A	B	C	D	E
I	A I	B I	C I	−	−
II	A II	B II	C II	D II	−
III	A III	B III	C III	D III	E III
IV	A IV	B IV	C IV	D IV	E IV
V	A V	−	−	D V	E V
VI	A VI	−	−	−	E VI

7. Conclusions

1. Functional classification is the process by which roads are grouped into classes, according to the character of traffic service that they are intended to provide.

2. The two principal considerations in classifying road networks are functionally access and mobility.

3. Every road has a general road function, which main three are: Traffic flow, Traffic distribution function, Traffic destination or access function.

3. Road functional classification in every country is different, but all have hierarchy system bases on the United States functional classification.

4. Determining correct functional class for the road is of particular importance for designers, administrators of the road, also for the user of the road.

5. To provide fluent car traffic paramount to set right functional class, which compliance with road purpose.

6. Functional class is one of the factories to provide safety traffic, create road friendlier for all users.

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