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QUALITY OF ROAD INFRASTRUCTURE

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ABSTRACT

With a density of the public road network (including streets) of 0.84 km/km^2, with a highway network of only 322 km and about 43 % dirt and stone public roads (including streets), Romania owns a road infrastructure incompatible with the European social and economical requirements. Nevertheless, Romanian specialists make continuous and important efforts to adapt the technical design, construction and maintenance conditions to those existent worldwide, and respectively to render the road administrations and the political decision makers more interested in intensifying their efforts to improve the present technical condition of public roads.

The report presents some of the studies realized lately both to improve the management methods of the road network, and to modernize the calculation methods for resistance structures in roads.

It is worth noticing the fact that Romania disposes of verified management models for the public road network (HDM 4) and of modern and highly performing tools to determine the technical condition indices of pavements. Unfortunately, the large application of management models is slowed down by the reserve shown by decision factors, as well as by the limited funding required for the periodic determination of the technical condition of the entire road network.

We shall present the research realized in the field of resistance structures in collaboration with engineers from other European countries to design new road pavements. It is especially worth mentioning the use of the accelerated test track Romania owns to verify the theoretical calculations.

According to the new analytical calculation methods for road pavements, we mentioned the preoccupations of Romanian specialists for diversifying the realization technologies for the capping layer, by using certain industrial by-products or pozzolanic binders in order to reduce the dosages of classical binders.

1. INTRODUCTION

In Romania public roads are classified, depending on their use and administration, in the following categories:

- public roads of republican interest (highways, express roads, European national roads, trunk national roads and secondary national roads), that have a total length of 16,503 km and are managed by bodies of the central state administration;
- public roads of departmental interest (county roads), with a total length of 35,048 km, that are managed by departmental administrations;
- public roads of local interest (communal roads, to which rural and urban streets are added), that are managed by communal or urban administrations. The total length of the communal roads is of 30,162 km, and that of the urban and rural streets is of about 120,000 km.

The analysis of the Romanian public roads technical condition shows its precarious state, with a high share of stone or dirt roads (about 43 %) and with only 29 % modernized pavements (Figure 1.a). In the case of county and communal roads, the situation is even worse, with a mere 13 % modernized pavements and about 33 % bituminous roads, the rest being stone or dirt pavements (Figure 1.b).

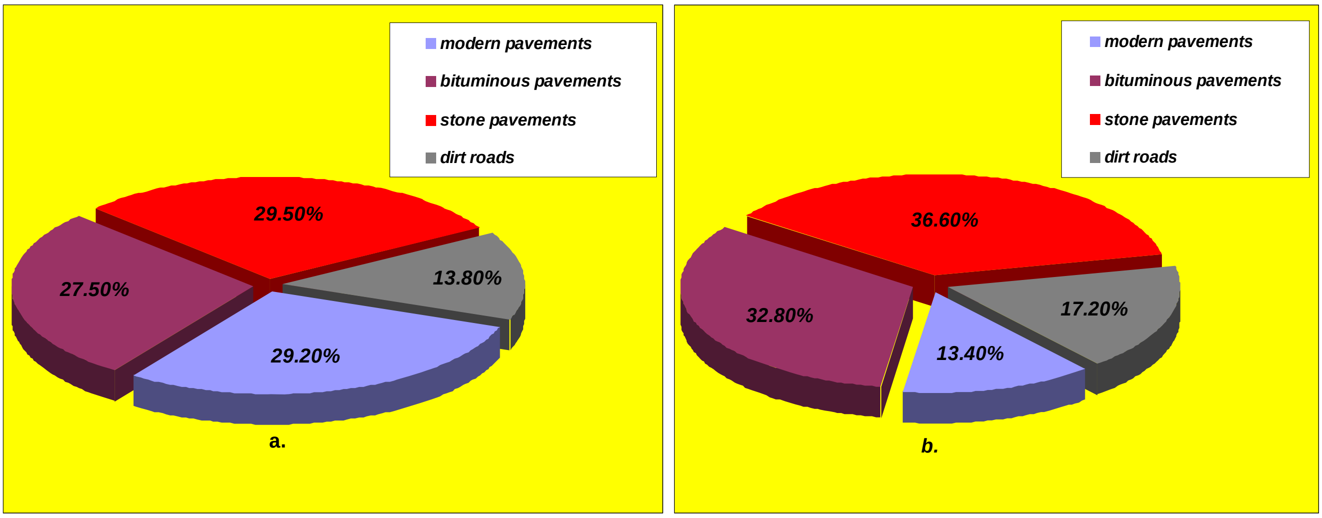

Figure 1 – The technical condition of public roads in Romania.

The organization presented above results in difficulties concerning the implementation of a complete road management system. Even in the case of the national roads we cannot speak of a specialized operational management system yet. The process of implementing a management system is especially slowed down by:

- the lack of a road technical data bank at the level of the managing bodies responsible for the different categories of public roads;
- the difficulties encountered in bringing up to date the data concerning the technical condition of roads, due both to the lack of funding required by the periodical updating of data, and to the caution showed by the decision makers in promoting the necessary investigations;
- the political influence in adopting several administrative decisions concerning the management of roads;
- the budgetary restrictions concerning road works, which do not allow the application of different risk criteria;
- the orientation of most of the available financial resources towards large road projects (highways, express roads) with the implied diminution of the budgets required by maintenance works;
- the integration of certain elements of the road management system (PMS and BMS) is hindered by the lack of general economic parameters;
- the difficulties met in explaining to the decision makers the importance and usefulness of applying technically supported means in the process of taking decisions.

On the other hand, the technical standards to be observed in building and maintaining road infrastructures are identical for all the categories of public roads.

Continuous efforts are made for the correlation of national standards to the European ones, for the development of research in the road field, for improving and verifying the road structure calculation methods, for a better adaptation of the resistance structures to the ever more aggressive stress from road traffic, for the application of the management principles to road assets respectively.

The following chapters will present some of the concerns of the Romanian specialists and the results obtained in the field of improving the quality of road infrastructures.

2. ASSET MANAGEMENT

Even if at the level of the road administrations there is no operational management system for road assets, there is interest for the implementation of such models at the level of the national road administration, as well as at the level of certain county road administrations. The model taken into consideration is HDM 4, aiming at prioritizing the works within a determined budget.

As an example, we present the research realized by a county road administration in the North-Western area of Romania (Salaj County), considering a number of 24 county roads 431 km in length (254 km modernized roads with bituminous or cement concrete pavements, 142 km stone pavements, 4 km paving roads and 31 km dirt roads). The technical condition of the analyzed roads is bad and very bad on 297 km (68.6 %), and the number of homogenous sections which divide the respective roads is 124 (113 homogenous sections with bad and very bad technical condition, respectively 11 homogenous sections with good or poor technical condition).

The rehabilitation needs are determined based on the bearing capacity and the technical class of the road, according to the technical specifications in force. The analysis for the determination of the maintenance priorities is realized with the help of the HDM 4 program, by using the notion "life span analysis", for two discount factors of 5 % and 10 %, the analyzed period being of 20 years. The prioritization is treated from the economic point of view. To this purpose, a data base has been created completed with data concerning the technical condition of roads, culverts, water draining devices and the inventory of the road containing files concerning:

- roads (general road data, technical road data, type of pavement, the built-up area, water collection devices, parapets, cross sections, degradation condition, bearing capacity, evenness, traffic data, conclusions and recommendations for roads);
- bridges (technical condition for bridges, conclusions and recommendations) and
- culverts and engineering structures technical condition culverts, technical condition engineering structures),
- respectively reporting (roads, culverts, engineering structures and bridges).

The data base is realized in MS Acces2007, as a monopost working environment to minimize the expenses and to be able to work independently without a server.

The menus were designed with a simple presentation without graphical loading and an optimization of the menu sites was attempted to make them easy to use (as intuitive as possible), a tree-type menu has been chosen to make the access easy. Thus, the base has four important branches: roads, bridges, engineering structures and culverts. In the main, the data base can be divided into the four distinctive bases shown above.

The definition of the project details lays in specifying the traffic data for each of the homogenous sections (annual average daily traffic, MZA, at the level of the most recent general traffic census realized in 2005, traffic composition on types of vehicles at the beginning of the program, evolution of the traffic during the period 2009-2025 on the analyzed county roads).

The details of the alternatives were stated starting from the previously determined field data (degradation, type of road pavement and assessed traffic), for each and every homogenous section, taking into account the technical solutions for strengthening the existing road pavements. The benefits obtained by the users are estimated starting from a real basis that represents the case when no investment or improvement is made, thus defining a “without design” or “minimum to realize” scenario.

The “without design” scenario (in HDM 4 – Base Alternative) establishes that the roads are not to be rehabilitated and only minimal maintenance works are to be performed.
The “with design” scenario (in HDM 4 – works) consists of:

- strengthening on sections with bituminous or cement concrete pavement or bituminous surfacing;
- reshaping the stone pavement, addition of 12.0 cm crushed stone and bituminous pavement in two layers of bituminous surfacing;
- realization of a new pavement on the dirt sections;
- stipulation of maintenance works after modernization (realization of planned surface dressing and a 4.0 cm bituminous surfacing) with application year 2014 (surface dressing) and 2019 (bituminous surfacing) for the roads less than 15 km long, and for those over 15 km in length, 2015 (surface dressing) and 2010 (bituminous surfacing). For each year, ordinary maintenance works, including pavement repairing, ditch cleaning and snow clearing works, are stipulated.

For each section taken into consideration a single investment variant has been planned. The analysis was realized with the help of the HDM 4 program on the 124 homogenous sections, by using the “life cycle analysis” notion, for the two discount factors of 5 % and 10 %, the analyzed period being 20 years. In order to ensure the conditions required by the prioritization, all sections were considered to be subjected to rehabilitation during the first two years. HDM considers these years to be 2009 and 2010.

It has been determined that the Benefit/Cost selection index offers the best method of prioritization for roads within a predefined network. This method implies to choose from several investment options based on the value of NPV/Cost, respectively the highest NPV/Cost. The economic indices NPV, RIR are not recommended as prioritization criteria in the analysis of the program. It is specified that for the 5 % discount factor the list includes only 113 out of the 124 sections, and for the 10 % discount factor the list includes only 82 out of the 124 sections since the rest (11 sections, respectively 42 sections) mark negative results (negative RIR) or less than 5 %, respectively 10 %.

Following budgetary restraints (budget available for the period 2009-2011 = 15.0384 million Euros – covering VAT), the analysis resulted in distributing works on 12 of the analyzed homogenous sections.

We can estimate that the larger application of the HDM 4 model for the public road network would contribute to a better justification of the financing demands to access structural funds (chapter where Romania is still showing a deficit).

In the case when the access of structural funds is required, the documents are drawn up to obtain the financing. The access to financing resources (Structural Funds, World Bank, European Investment Bank, European Reconstruction and Development Bank) requires to follow certain stages and to cover certain steps as demanded by the financing body. Irrespective of the financing body, the justification of the financing demand, the analysis of opportunities and the economic analysis by applying the HDM model, will lead to a better understanding and marking of the project.

3. CHARACTERISTICS OF THE ROAD SURFACE

In Romania the technical condition assessment methodology is part of optimized management system for modern pavements. The technical condition is determined in order to set out periodic maintenance works and ordinary works respectively, works that aim at permanently adapting resistance structures to road traffic requirements.

The technical condition of modern pavements is assessed based on the evenness of the road surface, roughness of the pavement, bearing capacity of the road complex and degradation. The measurement of the above mentioned characteristics is realized on the entire length of the road network, on homogenous road sections characterized by the same parameters, namely: traffic characteristics, type of road pavement, year of the modernization or of the most recent ordinary maintenance or repair work.

The evenness is a functional characteristic of the pavement expressed by the roughness index IRI. The evenness is determined at national level with the following equipment: longitudinal section analyzer APL 72 (1 equipment), BUMP Integrator (2 equipments), HAWKEYE 2000 (1 equipment), Road Surface Profiler RSP (1 equipment).

The measurements taken periodically allowed the classification of the road network depending on the roughness and also the percentage distribution on variation intervals of the evenness index IRI, as shown in Table 1.

Table 1 – Classification of roads according to the evenness index IRI

Rating	Class of national roads		
	European	Trunk	Secondary
GOOD	< 3.5 (38 %)	< 4.0 (32 %)	< 4.5 (33 %)
MEDIUM	3.5 – 5.5 (42 %)	4.0 – 6.0 (38 %)	4.5 – 6.5 (37 %)
BAD	> 5.5 (20 %)	> 6.0 (30 %)	> 6.5 (30 %)

For example, the situation of the European roads is shown in Figure 2.

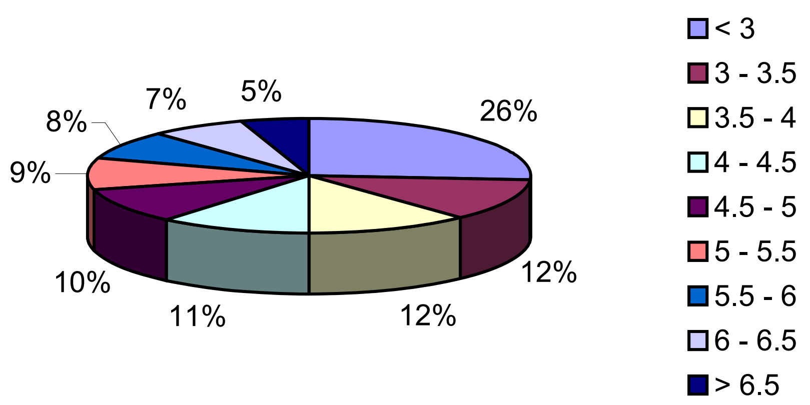

Figure 2 – Percentage distribution of the evenness index IRI on the European roads

The evenness of the road pavement surface is a functional characteristic of the road and it is characterized by the SRT values (Skid Resistance Tester) and the HS (Hauteur Sable) values. The roughness of the surface of the road pavement is measured with the help of the following equipments: Griptester (1 equipment), HAWKEYE 2000 (1 equipment), HAWKEYE 1000 (1 equipment). The values admitted in Romania are shown in Table 2.

Table 2 – Classification of roads according to roughness

Rating	Roughness	
	SRT	HS
BAD	<55	<0.2
POOR	55...70	0.2...0.6
GOOD	70...80	0.6...0.7
VERY GOOD	>80	>0.7

The bearing capacity of the road complex is presently determined on national roads with Phonix MLY 10000 type and Dynatest 8000 FWD type dynamic loading deflectometers (5 equipments). The measurements performed periodically allowed the classification of the national roads according to the bearing capacity and the percentage distribution of deflections on variation intervals (Table 3).

Table 3 – Classification of roads according to deflection values

Rating	Class of road		
	European	Trunk	Secondary
GOOD	< 65 (49 %)	< 75 (50 %)	< 75 (50 %)
MEDIUM	65 – 80 (22 %)	75 – 80 (10 %)	75 – 100 (20 %)
BAD	> 80 (29 %)	> 85 (40 %)	> 100 (30 %)

For example, for the European rods, the distribution of the measured deflections is shown in Figure 3.

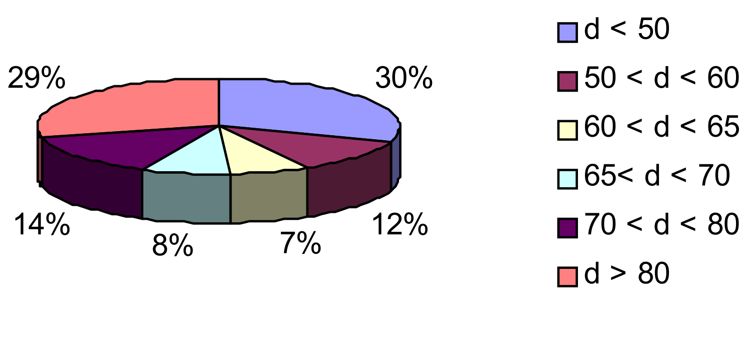

Figure 3 – Percentage distribution of measured deflections on European roads

The degradation condition is a structural characteristic determined by the visual inspection of the road surface. The assessment of the damage found on the road (qualitative and quantitative) is realized by determining certain global indices of the deterioration condition (the global deterioration index IG or the deterioration index ID can be determined).

In order to have the image of the technical condition on the national roads, the decision makers can visualize on theme maps the distribution of sections with the same parameters or the same technical condition rating. For example, the extension of cracking is visualized as in Figure 4.

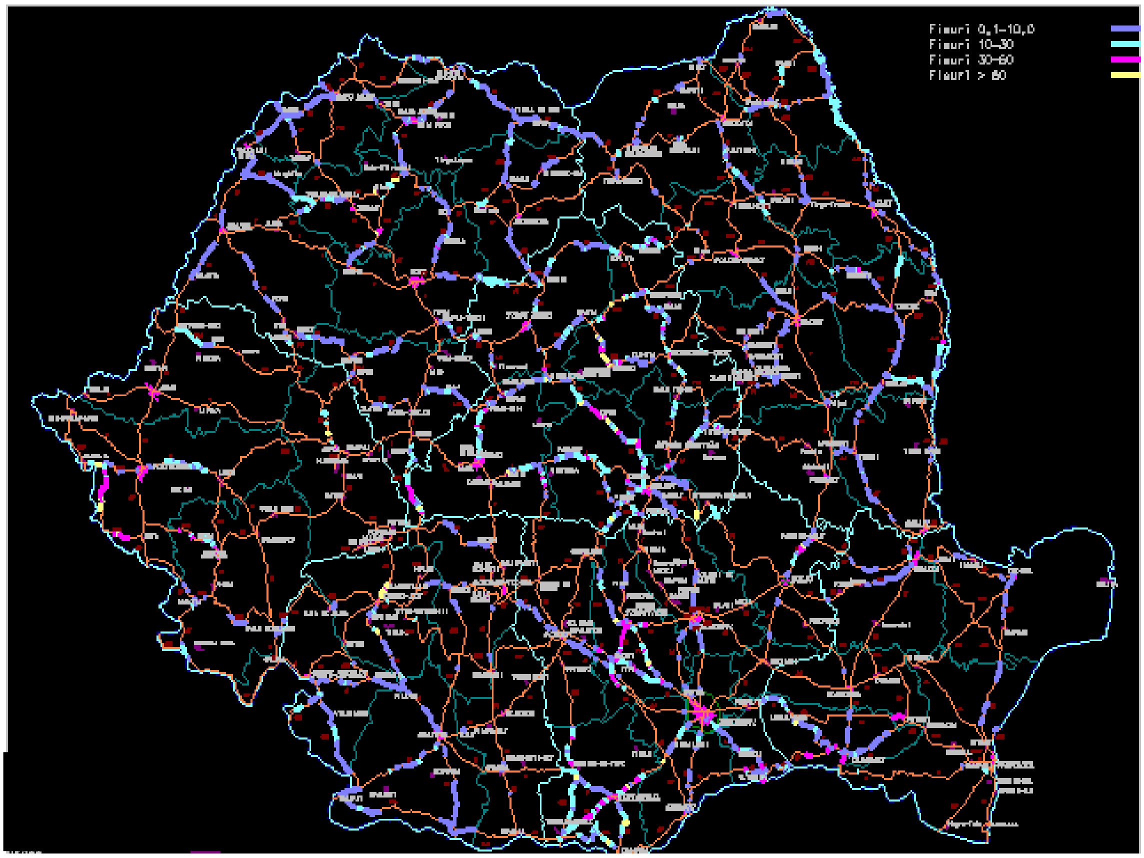

Figure 4 – Extension of cracking on homogenous sections (national roads)

The technical condition of a homogenous road section is determined by concomitantly analyzing the ratings obtained for the four previously mentioned characteristics. The technical condition can be ranged in one of the five classes stipulated by the Romanian standards (very good, good, poor, bad and very bad).

Based on the rating granted to the technical condition, the beneficiary of the road can take decisions concerning the category of works required, starting from the specifications of the standards in force.

4. ROAD PAVEMENTS

Romania has lately adopted new dimensioning methods for flexible and semi-rigid road pavements as well as for rigid pavements.

According to these models, the design traffic represents the number of standard axles with 115 kN loading which is to circulate on the traffic lane the most solicited on the entire life span taken into consideration (by calculating the equivalent to real vehicles). There have been defined six traffic classes: from the very light $T_1 \leq 0.03$ million standard axles (msa), to the exceptional $T_6 > 3.00$ million standard axles (msa). The distribution of the traffic on the homogenous sections within the national roads is shown in Figure 5.

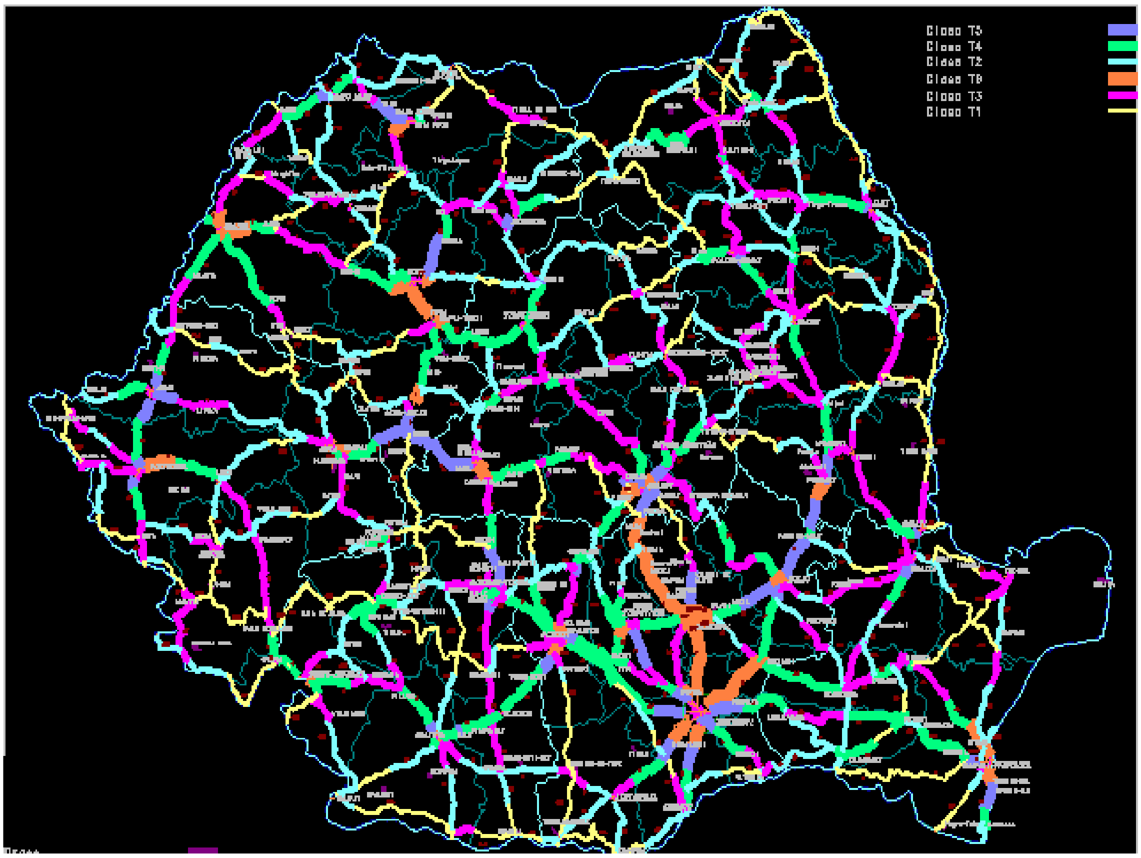

Figure 5 – Distribution of traffic on the national road network

The method of calculation for flexible and semi-rigid pavements is based on the pattern-making of the resistance structure together with the foundation ground forming a massif of maximum five layers, followed by the calculation of tensions and specific deformations under a 57.5 kN standard semi-axle. The analytical solution is found with the help of the Burmister pattern, the layers taken into consideration are characterized by perfect links at the interfaces, and the utilized calculation program is called CALDEROM 2000.

The dimensioning criteria are as follows:

- admissible specific tensile deformation at the bottom of the bituminous layers;
- admissible specific compression deformation at the level of the road formation level
- admissible tensile stress at the bottom of the layers in natural aggregates stabilized with hydraulic or pozzolanic binders (only for semi-rigid pavements).

The dimensioning of the rigid road pavements is based on the criterion of the admissible flexural tensile stress in the cement concrete (Γ_{adm}). The calculation chart within the method is the pattern with finite element realized by the multi-layer procedure, made up of the concrete slab and the layer equivalent to the real layers by which the slab is supported.

The main research in the field aims at calibrating the above mentioned calculation methods, starting from the acquired experience. To this purpose, starting from the hypotheses of the CALDEROM 2000 pattern, it is worth mentioning the research concerning the impact of the adherence to the road layer interface upon the results offered by the dimensioning method. The research used the calculation programs ALIZE, ELMOD and ABAQUE as well as the equipment Dynatest 8000 FWD to measure the strain condition of the investigated pavements. The conclusions of the results are as follows:

- the lack of adherence between layers determines deflection increase, more so when the sliding interface is closer to the road surface;

- the lack of adherence between all the layers of the road complex leads to a 36…69 % increase of deflections, but also to an unfavorable stress condition within road layers;
- the lack of adherence between the bituminous layers and the unbound layers determines an important increase of the specific tensile deformation at the bottom of the bituminous layers;
- the stress at the foundation ground level diminishes in the case when the pavement slides on the formation level to 38…63 % of the one calculated for the adherence variant;
- in the lack of adherence between layers variant the admissible traffic is 15…30 times diminished.

This shows that the Romanian model may lead to the under-dimensioning of the resistance structures in the case when the adherence between the pavement layers is not realized.

On the other hand, the research realized on the accelerating loading test track of the University "Gheorghe Asachi" Iasi is worth mentioning.

4.1. Research & development of the Long Lasting Rigid Pavement (LLRP)

The research work for the conception and development of long lasting rigid pavements was part of the EU collaboration project EcoLanes funded under the priority thematic area of Sustainable Surface Transport in the 6th Framework Program of the European Community. The main objective of this project was the development of pavement infrastructure for surface transport using conventional and roller compaction technology in combination with concrete mixes reinforced with steel fibers, recovered from post-consumed tires, seeking significant benefits expressed in terms of reduction of time, costs and energy consumption in road construction. In parallel with Accelerating Loading Test, ALT, performed in the ALT-LIRA facility existing at Technical University "Gheorghe Asachi" Iasi (see Figure 1) some demonstration projects have been carried out in various European regions.


Figure 6 – The loading system

Two types of steel fiber reinforced concrete have been used for the ALT experiment in the frame of the EcoLanes project:

- (SFRC) steel fiber reinforced concrete, compacted by vibration;
- (SFRCC) steel fiber roller compacted concrete, compacted by rolling.

In order to assess the effect of fibers on the concrete pavements compacted by vibration, a number of four types of pavement structures have been proposed to be constructed on the ALT facility, in relation with Figure 7, as follows:

- sector 1 – non-reinforced concrete BcR 4.5, d_{max}=25 mm, L=6 m;
- sector 2 - SFRC, with 3 % of SRSF fibers (ADRIA type), d_{max}=16 mm, L=6 m;
- sector 3 - SFRC, with 3 % of SRSF fibers (ADRIA type), d_{max}=16 mm, L=8 m;
- sector 4 - SFRC, with 3 % of SRSF fibers (ADRIA type), d_{max}=16 mm, L=10.5 m.

As shown in Figure 7, all these sectors are provided with 20 cm thick concrete slabs, placed on a sub-base made of cement stabilized ballast (h = 15 cm) laid over a ballast foundation layer having the same thickness. Thus, it will be possible to make the comparison of performance between the non-reinforced slab (sector1) and the SFRC one, as well as between the SFRC sectors having slabs of different lengths (6 m, 8 m & 10.5 m), by studying the stresses developing in the slabs, using periodical measurements realized with specific transducers placed at the bottom of the slabs.

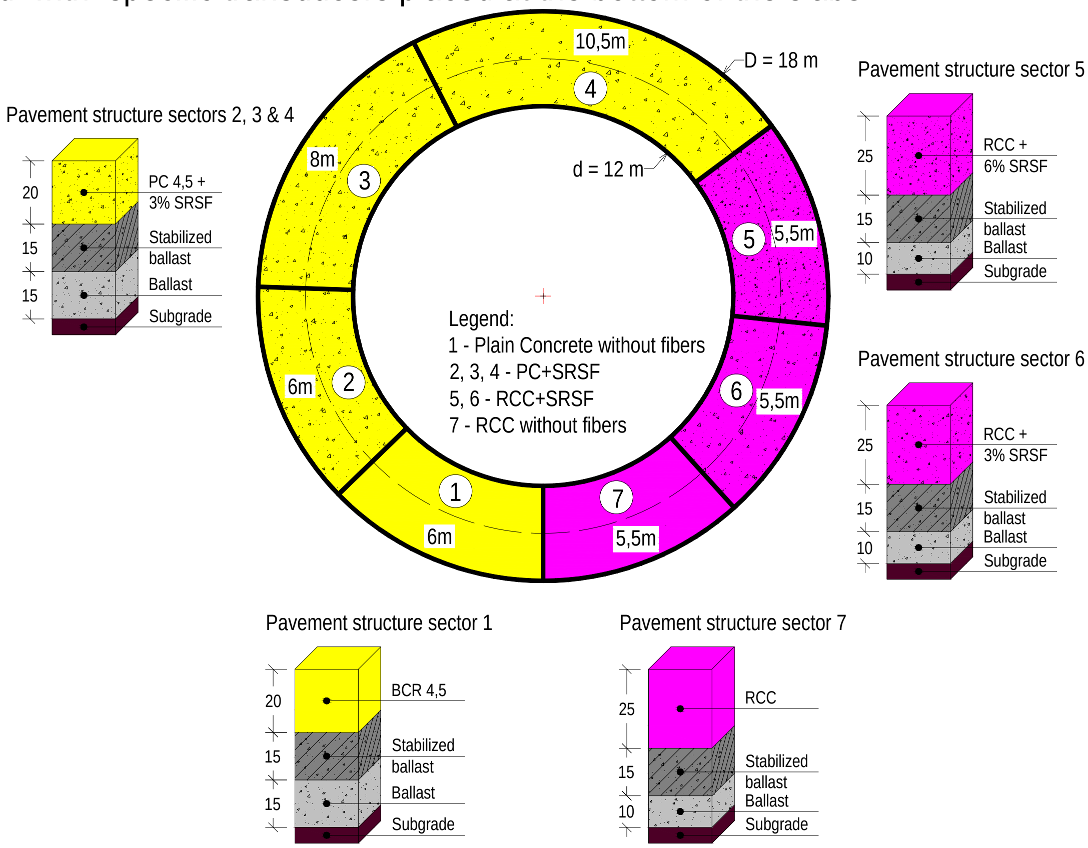

Figure 7 - Experimental sectors constructed on the circular ALT facility and their pavement structures

Thus, in relation with Figure 7, there have been constructed three sectors (sectors 5, 6 & 7) having the same length of 5.5 m, but realized with concrete prepared with different percentages of fibers (6 % of fibers, 3 % of fibers & without fibers). Also, being envisaged that traffic loads will apply directly on the surface of the RCC, in order to keep for the riding surface the same level on the whole ALT circular track, the initial thickness of RCC slabs of 20 cm has been increased to 25 cm. The RCC slabs are placed on a sub-base made of cement stabilized ballast (h = 15 cm), supported by a ballast foundation (h = 10 cm), the total thickness of pavement structures on the ALT track being the same (50 cm).

All these sectors have been subjected to a total of 1.5 million passes of 115 kN standard axles (msa), deformation and stresses at various levels in pavement structures being monitored by specific stress and strain transducers placed as shown in Figure 8.

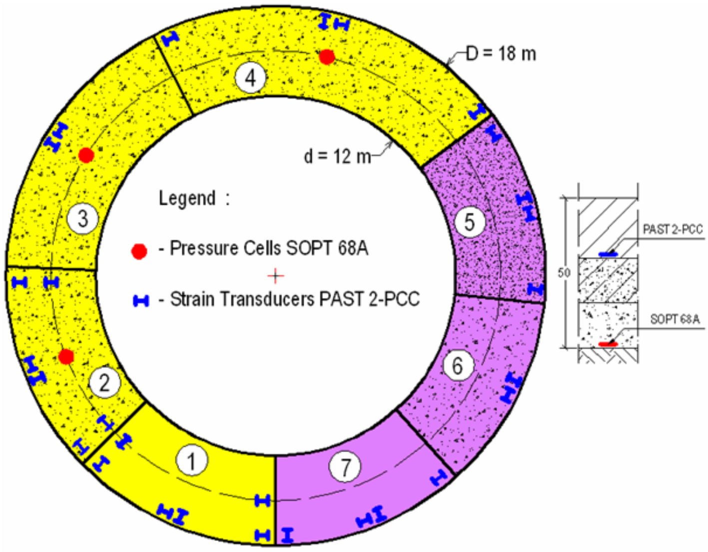

Figure 8 - Placement of the transducers on the experimental sectors

Full scale demonstration projects have been carried out during and after completion of the project, in order to validate and to implement the research results in four different European climates and economies in the following countries: Cyprus, Romania, Turkey and United Kingdom.

The final synthetic results of the concrete slab thicknesses designed for the demonstration sectors investigated are presented in Table 4, below.

Table 4 - Thickness of slabs, for various demonstration projects

	Romania	Cyprus	Turkey
Design traffic (msa)	20.43	1.35	14.93
Climate type	III	II	II
Modulus of subgrade reaction K_0	42	46	46
Modulus of subbase reaction K	58	58	65
Strength of the concrete at 28 days R^k_{inc}	5.0	4.0	4.5
Flexural strength σ_{tadm}	3.48	3.05	3.17
Thickness of the concrete slab	22	24	23

According to these results it was concluded that despite the variability observed in traffic and climatic conditions for various demonstration projects, the thickness of the slabs are very similar, but their behaviors are expected to be different taking into consideration the significant differences in environmental and traffic conditions. The monitoring of all these demonstration projects will continue for a period of 10 to 15 years in order to evaluate their performances.

4.2. Research & development of the Long Lasting Flexible Pavement (LLFP)

The actual flexible pavements designed according to the existing norms are usually leading to overdesigned structures because of the lower values for the elastic module of the asphalt materials specified in the existing norms. The total thickness of classical pavement structures, currently used for important motorway projects in this country, is currently reaching significant values ranging from 80 to100 cm. In comparison with these traditional practices the long lasting flexible pavements LLFP, conceived on new principles and involving the use of high quality materials such as stone mastic asphalt SMA are leading to thinner and in the same time more durable pavements. Here follow some typical examples of LLFP structures envisaged to be studied on the Accelerating Testing Facility ALT-LIRA existing in the frame of the Technical University “Gheorghe Asachi” Iasi (see Figure 9).

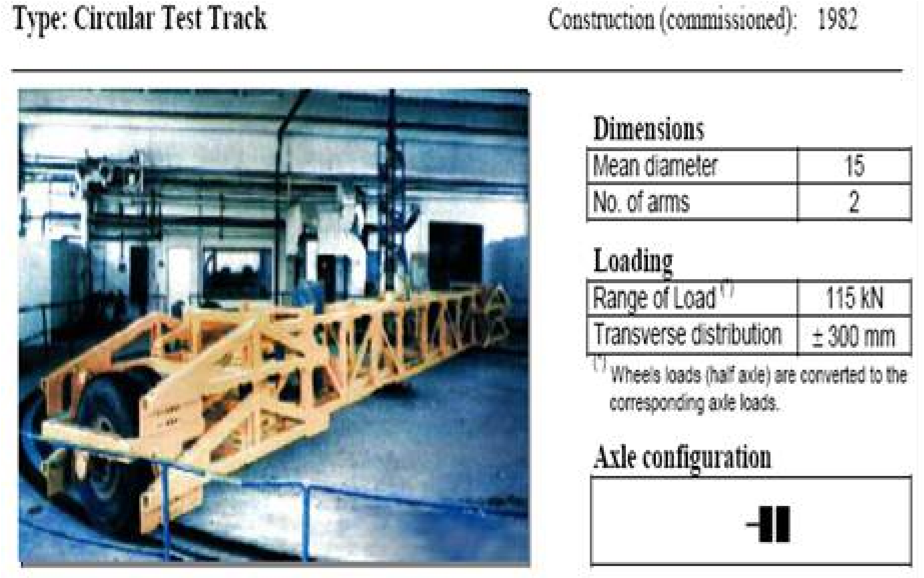

Figure 9 - The ALT circular track facility of the Technical University “Gheorghe Asachi” Iasi

In order to evaluate the performance of these new long lasting flexible pavements, in comparison with the classical ones, the following experiment (see Figure 10) involving the accelerating testing of a set of six distinct pavement sectors, including three witness classical ones (sector No. 1, No. 3 & No. 5) and other three LLFP sectors (No. 2, No. 4 & No. 6) constructed in accordance with the new LLFP concept which is envisaged to be realized in the near future on the ALT-LIRA facility. Traffic of 10, 20, 30, 60 and 120 million standard axle loads of 115 kN has been considered in the design of the new LLFP and also of the witness sector No. 1, with the difference that the design life of the LLFP structures was considered two times higher than that of a traditional structure.

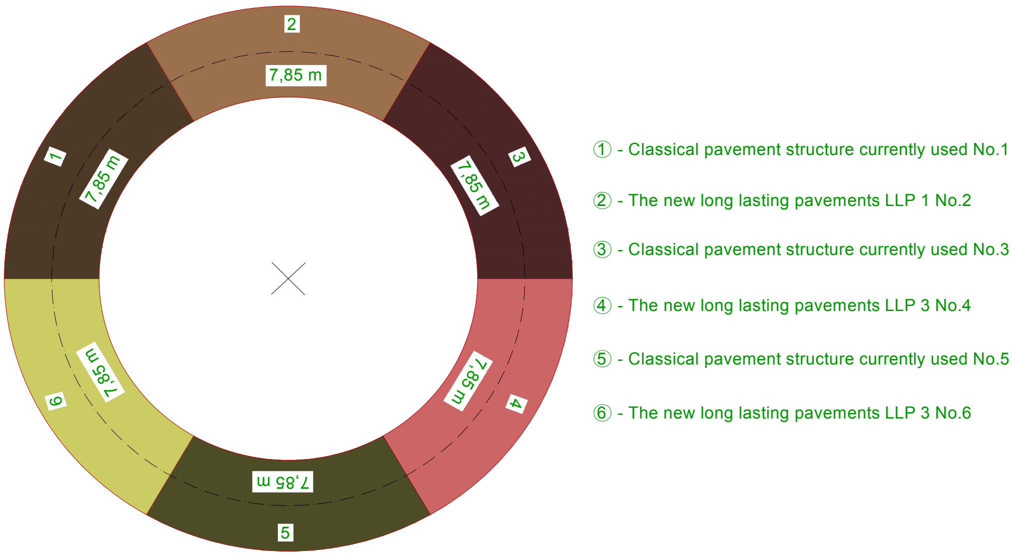

Figure 10 - Experimental sectors envisaged to be tested on the ALT circular track facility

For long lasting pavements to be viable, they must perform from the perspectives of both engineering and economic points of view. Designing against structural defects, proper materials selection, good construction practices, and scheduling resurfacing activities to maintain the functionality of the pavement are the primary engineering concerns for performance. Efficient design, low maintenance rehabilitation costs, and long pavement life will ensure the economy of the pavement.

Final synthetic results of the comparative study of both classical and LLFP pavements are presented in Table 5 and lead to the following conclusions:

Table 5 - The final synthetic results of the comparative study of both Classical and LLFP pavements

Classical pavement structure				Long lasting pavement structure			
Layer	Design Traffic			Layer	Design Traffic		
	10 msa	30 msa	60 msa		20 msa	60 msa	120 msa
Wearing course (MASF 16/SMA)	4	5	5	Upper (Wearing) course (MASF 16/SMA)	5	5	5
Binder course (B.A.D. 25)	6	10	10	Medium Compression Resistance course (Asphalt Macadam)	25	30	30
Bituminous base - AB2	15	15	15	Lower Tensile Resistance course (MASF 8/SMA)	5	5	5
Ballast stabilized with cement	20	20	30	Ballast Subbase	25	30	45
Foundation	25	35	35	Subgrade/Soil Type P5	∞	∞	∞
Subgrade P5	∞	∞	∞				
Total thickness (cm)	70	75	95	Total thickness (cm)	60	70	85

1. By using asphalt materials with higher elasticity modulus value (e.g. E = 6000…7000 MPa), and disposing them according to the LLFP concept, it is possible to construct flexible pavement structures with the total thicknesses lower than those of classical/witness ones, but capable to support considerable higher design traffics.
2. These new structures proved also to be frost resistant when checked according to the Romanian standards.
3. This research exercise will be extended in the near future, by considering a parallel design approach using the actual Romanian standard and the new methods, especially developed in the frame of the Asphalt Pavement Alliance and also some other modern structural design methods, like Mechanistic-Empiric Pavement Design Guide – ME-PDG or the actual UK Highway Agency method.

Based on existing knowledge and latest developments in this field future work will continue with the construction of the envisaged experimental sectors on the circular track of the ALT facility of the Technical University of Iasi, parallel with the construction of similar experimental sectors, selected on the existing public road network, followed by monitoring their performances in time and the drafting of specific technical recommendations for the design and constructions of LLFP.

5. GEOTECHNICS AND UNPAVED ROADS

One of the main concerns of Romanian specialists in this field is referring to the realization of the capping layer. According to the calculation methods for pavements, the realization of the capping layer is compulsory in all cases when the dynamic elastic modulus of the foundation ground is less than 80 MPa.

To notice that the research continues also in the field of the need to realize the capping layer. Results exist, based on the calculation with the help of the Romanian standard method, to argue that the realization of a 10…50 cm thick capping layer leads to an important increase of the admissible traffic in the case of flexible pavements as well as the semi-rigid ones.

The technologies used to realize capping layers are based on in situ stabilization of the soil in the formation level with classic binders or with certain industrial by-products, such as:

- the largely used stabilization with calcium hydroxide from industrial wastes having a high $Ca(OH)_2$ content (waste from the manufacturing of acetylene – Linde Gaz Romania), or from lime, is based on the ionic exchange of H^+, Na^+, K^+, Li^+ with ions of Ca^+, procedure through which the calcium hydroxide in water solution is homogenized with the soil to stabilize with the help of recycling equipments;
- stabilization with precipitate calcium carbonate, a by-product from the soda or sugar industry; being partially water soluble, it liberates ions of Ca^{2+} with similar effects but with more heterogeneous results concerning quality;
- stabilization with fly ash and calcium hydroxide allows the correction of the particle grading as well as the stabilization of the reaction of the two components in water solution;
- stabilization with granulated blast furnace slag and calcium hydroxide represents an alternative to the stabilization of soils with fly ash where the ash source is not to be found on an economical area from the transportation point of view. The advantage is the more reduced quantity of calcium hydroxide which needs to be brought to the system in order to activate the slag, due to the higher CaO content in the blast furnace slag as compared to the fly ash;
- stabilization with granulated slag or fly ash, phosphor-gypsum and calcium hydroxide represents a mixed stabilization, which besides the advantage of basically activation with $Ca(OH)_2$, puts into value the sulphatic activation of the calcium sulphate type;
- stabilization with calcium chlorate has the following two aspects: the content of Cl^- and Ca^+ facilitates the ionic exchange in the clay complex of soils and maintains the cohesion of soils during the dry and hot season.

Another recent concern is the use of chemical substances to improve the viability condition of dirt roads. To this purpose, experimental sections have been realized by using different chemical substances (T-RRP, NanoSTAB, GEMSTONE, EARTHZIME, SISTEM TERRA, BASE STABILIZER), and certain technologies have been developed.

A longtime preoccupation of the Romanian specialists concerns the promotion of efficient technical solutions to maintain dirt and stone roads. Unfortunately, the local road administrations are not always open to the promotion of such solutions, choosing solutions which are either economically expensive or not correctively adapted to the site conditions.

To bear in mind the fact that lately, based on the dimensioning method adopted in Romania, catalogs have been proposed with types of pavements both for communal roads and for urban or rural streets.

Especially for local roads with light and low traffic, which do not dispose of public utility networks, it is recommended to realize pavements in penetrated macadam waterproofed with a single surface dressing, respectively in macadam protected with a double surface dressing.

6. CONCLUSIONS

The research pointed out, more or less in detail, is not exclusive and it is worth noting the fact that Romania managed lately to modernize the material endowment of the research or quality control laboratories, especially within the national roads administrations, but also within certain private companies.

In principle, Romania owns the entire range of modern equipments and devices to analyze the quality of road materials and respectively to determine with high efficiency the indices of the road technical condition.

We nevertheless face a certain lagging behind with respect to the promotion of the results obtained and the periodical up-dating of the investigations concerning the technical condition of roads. This leads to the acceleration in applying management patterns that Romania has knowledge about (HDM 4), but which are still little used in decision making.

The calculation methods for pavements have been up-dated, turning to analytical models. It is worth mentioning the interest for the research aiming at calibrating the proposed methods, respectively those following the designing of pavements adapted to intense and heavy traffic.

In the field of geotechnics and unpaved roads the main tendencies refer to justifying the need to realize, in well determined conditions, the capping layer and to perform highly efficient maintenance works on stone or dirt roads. The Romanian scientists propose technical solutions using mainly local materials or industrial by-products for the realization of capping layers as well as to create pavements adapted to light and low traffic.

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