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Road quality service levels and innovations to meet user expectations

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Summary

The first part of the paper gives a description of the ongoing revision of standards related to roads within the framework of improving the standardisation system, i.e. the conversion of the previous compulsory standards into regulations. In the context of developing a road information database, it describes the process of setting up a road meteorological measuring station network to enhance traffic safety as well as the operation of related continuous traffic survey stations and the use of their data. It presents the new geographic information program system of the road databank containing the sizes and condition of the national road network. It deals with the ongoing upgrading of the digital map-based network registration and positioning system and, in association with it, the application of GPS in the supervision of road management (e.g. in winter road operation).

Then, it presents the findings of skid resistance measurements carried out recently on pavements with a view to reducing the risk of accidents and the related condition rating limits. It describes methods and instruments (radio, Internet) already applied and under development by road operators to ensure a higher quality information supply to road users.

The second part of the report deals with technologies applied to improve the condition of low-trafficked secondary roads, their effectiveness and financing constraints. It presents the findings of observations being made for a decade by the use of a reference section to explore the deterioration process of pavements and the opportunities to use such data. It discusses the ongoing change in the application of a method for allocation of maintenance funds which has the aim of establishing a performance-based allocation of funds. It gives a description of measures taken to date in relation to the adaptation of HDM-4 and PONTIS software in the framework of upgrading the road and bridge management systems as well as of the results achieved.

Finally, the report discusses in brief roadside plant caring which is essential for the protection of health (allergy). It gives a detailed description of the methods developed and applied to ensure safe traffic diversion necessary for the rehabilitation and upgrading of a more than 100 km long section of the M7 Motorway, the oldest Hungarian motorway, while allowing traffic to run over it.

1. Indicators suitable for appraising measures taken to satisfy the needs of road users and reflecting the quality of service

1.1 Development of a new technical regulation system

In the current hierarchy of road engineering regulation, national standards constitute the top level of regulation of a technical specification character other than laws. The 1995 Act XXVIII on Standardisation has abolished the official and public administrative validity of standards and established a single-level national set of standards for voluntary application. In this system the application of standards is regulated by contracts or other laws adopted within a particular jurisdiction.

The replacement of compulsory national standards and the conversion of the related documents into regulations are an ongoing process. The basic document in preparation will consist of the following two main parts:

- the road engineering regulation part which contains generic, essential regulations of public concern to be applied generally and consistently to national public roads, local public roads and private roads open to public traffic; and
- the road engineering specification part which contains technical standards to be applied by road management organisations for the specific conditions of public road management.

To reach a consensus among professionals, the competent professional organisations are also involved in the development of documents.

Between March 1998 and December 2000, all county State Road Management Public Service Companies have their quality assurance system certified by an independent third party in compliance with the requirements of the ISO 9001:1994 standard. A change-over to the ISO 9001:2000 system is now under way.

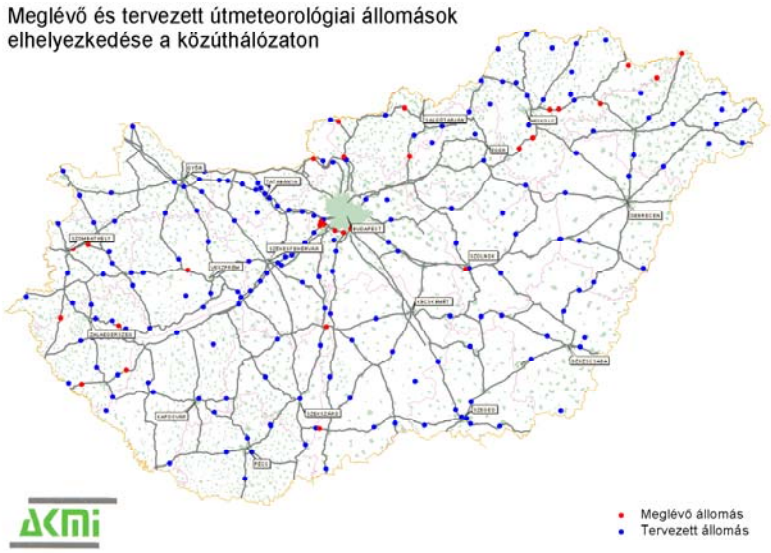
1.2 Setting-up and improvement of information databases

In recent years, a number of road management organisations have set up - by way of experiment - road meteorological measuring stations on roads managed by them. They were established by different manufacturers and the built-in measuring instruments were neither uniform. An advanced measuring station measures the direction and force of wind, the intensity and type of precipitation, the sight distance and the thickness of snow layer on the soil. In the late 90s, the road service operated 61 Road Meteorological Measuring Stations (RMMSs). The RMMSs provide continuously precise data on road and weather conditions, thus considerably reducing vehicle run needed for status survey patrolling as well as the amount of spraying material used.

Based on the favourable experience gained with experimental equipment, the Road Administration issued in 1999 a public procurement tender for the setting-up of a road meteorological information network. The system to be developed covers the entire national road network (30,000 km), comprising 61 measuring points already in operation and 198 measuring points to be established newly.

The users of the new information system will have access to meteorological forecasts issued for 24-hour and 5-day periods, to animated satellite cloud pictures made in the infrared range as well as to animated precipitation intensity pictures supplied by precipitation radar stations.

Location of the existing and proposed
road meteorological stations across the network



Existing station
Proposed station

On average, one measuring station will be set up on every 9 km section of motorways and high-speed roads and on every 60 km section of the about 11 thousand km long other national roads included in the system. During the winter service period (between 1 November and 15 March) the system will alarm the regionally competent road management service on duty in each case 90-120 minutes before the occurrence of an actual emergency situation when from analysing data recorded and registered in the district of individual measuring stations and the momentary weather condition it can be assumed that a situation dangerous to motorists will probably be developed (precipitation of moisture, freezing drizzle, freezing rain, development of hoar-frost and rime). Giving a warning signal allows preventive measures to be taken in due time. According to simplified cost-benefit estimates, the cost of setting up a system will be recovered within 2-3 years.

Using the infrastructure of the road meteorological stations (power supply, data transmission), an on-line traffic counting network (ÚTFORG) consisting of 50 stations has also been established. It provides traffic and speed data, in a breakdown of 8+1 vehicle categories, throughout the day on points of the national road network which are typical and important from the viewpoint of traffic. Traffic counting data covering the total calendar period basis contain initial data for investigating the rules of traffic flow.

Based on the analysis of an annual traffic counting set of data and after determining the threshold levels typical to particular traffic counting places, it is also intended to introduce an event-driven mode of operation. It allows possible congestion to be detected and the real-time data so obtained will be useful for making the activity of the central road information organisation (ÚTINFORM) more effective.

The National Road Databank (OKA) containing data characteristic of the dimensions and condition of the national road network is operating since 1993 in its present form. For its modernisation, a new databank program system (OKA2000) supported by a geographic information system has been developed between 2000 and 2001 and put into operation in 2002.

To present data, OKA2000 uses a digital map-based registration and reference system which can divided into two components:

- DTA-50000 military digital map, and
- Közút-50000 road network digital map.

The DTA-50000 map is a basic map made to a scale of 1:50000 and maintained by the Cartographic Office of the Ministry of Defence which represents public administration boundaries and hydrographic and topographic conditions (the national road network is a special layer).

The Közút-50000 digital map is a map maintained by the State Road Engineering and Information Public Service Company (ÁKMI) in parallel to databank data. The road number and the commencement and termination points (identifiers) of sections serve for the purpose of positioning, thus the map becomes suitable for assigning road network data included in the OKA database as well as for presenting the data and results of sorting and for printing thematic maps.

OKA2000 also allows the application of other "maps" of arbitrary accuracy as a background, thus the integration of digital register books already partially available regarding motorways into a system has also started.

An additional objective is to localise objects (e.g. kilometre poles, guard rails, pedestrian crossings, railways crossings, etc.) registered in OKA databank through absolute positioning using 3D co-ordinates.

1.4 The application of GPS in road management

For the purpose of modernising the road registration system, ÁKMI announced in the autumn of 1998 an open tender for surveying the national road network by the use of GPS technology. The survey is conducted for 5 years between 1999 and 2003. The goal is to record the 3D co-ordinates of the national road network at an average interval of 10 metres.

The absolute accuracy of measurements made in the global positioning system is less than 1 metre horizontally and less than 2 metres vertically. During GPS measurement, video records are made of the surveyed roads with two cameras by the use of which the horizontal position of objects on the carriageway surface and in its environment can be determined with an error of less than 1 metre. For this purpose, measurement is made with differential correction so that the base station is located in the operation and maintenance centres of road management companies.

The measuring system combined with video needs the identification of position also in places where the GPS receiver is not able to measure. This problem has been solved by installing a laser gyroscope-based inertial navigation system.

The GPS road survey provides a passage between various transport sectors: the water, railway and land registrations all operate in this system or change over to this system. It creates the possibility of setting up subsequently an integrated geographic information database for infrastructure. By the use of WGS84 world co-ordinates, the Hungarian position of e.g. a foreign road condition surveying car can also be identified easily.

Another field of GPS application is vehicle tracking which has been introduced gradually by the State Road Management Public Service Company in 5 counties since 1998. The components, accessories and surroundings of roads are checked periodically with a frequency, level of detail and expertise as specified by the National Road Management Regulations. The fact of checking and some of its characteristics and statements must be reported and the reports documented and archived. The vehicle tracking system, the board terminal installed in road control vehicles provides efficient help for coping with tasks.

Trucks operating in winter periods have also been equipped with a board unit. The location of this unit may also be concealed, not allowing the personnel of a truck to intervene in its operation. The vehicle tracking system provides reliable, practical and quick information about the movement and operation of the car, at the same time ensuring the documentation of information.

In case of complaints, the application of the GPS vehicle tracking system for winter road operation may justify decisions since it can be ascertained: whether a machine was present on the site or not; a machine was in operation or not; the performance of work by a road management organisation complies with its commitments or not; a road management organisation bears liability e.g. for a particular accident or not. The system is also suitable for preparing, submitting and further handling road inspection reports. In a particular case, it could be demonstrated that a road management organisation carried out road inspection at the specified intervals on the site of accident, the road inspector corrected the observed defect and the road management organisation is not accountable for the accident occurred.

1.5 Measurement of skid resistance across the network

It is well known that traffic safety on roads can be improved considerably with pavements having a good skid resistance. In Hungary, the skid resistance of roads is rated by a SCRIM (Sideway-force Coefficient Routine Investigation Machine) on the basis of measurements of the sideway-force coefficient (SFC) for a machine travelling at a speed of 50 km/h.

In a study undertaken in 1997, specialists proposed to implement a skid resistance measuring programme on the national road network (21,000 km during 5 years).

Between 1998 and 2001, measurements and their processing have been carried out according to a schedule with measurements scheduled for the last year being under way. In 2000, the measurement of skid resistance by SCRIM on the travelling and overtaking lanes of motorways and dual carriageways has also been carried out.

Based on Hungarian measurements, SCRIM-SFC skid resistance limits for various types of pavement are presented in the table below. The upper limits given in the table apply to condition at the time of construction, whereas lower limits apply to heavily worn road surface.

Type of pavement Character of road section	Limits	Rolled asphalt	Cement concrete	Surface dressing
I	0.8-0.5	0.75-0.5	0.75-0.5	0.9-0.5
II	0.8-0.45	0.7-0.45	0.65-0.45	0.8-0.45
III	0.7-0.4	0.64-0.4	0.64-0.4	0.8-0.4
IV		0.64-0.33	0.64-0.33	0.64-0.33

I. At approaches to road signs, pedestrian crossings and similar dangerous points with a radius less than 100 m on motorways and dual carriageways, on primary and secondary national main roads with a traffic volume over 3,000 pcu per day, and on urban main roads.
II. With the exception of motorways and dual carriageways, at approaches to major junctions on roads with a traffic volume over 3,000 pcu per day, on 5% or steeper slopes or rises, in bends with a radius less than 150 m, at points ahead of signalised railway barrier, on bridges, in cuts, at locations exposed to wind gust, and on road sections with poor drainage or susceptible to precipitation of moisture.
III. On primary and secondary main roads, on any other national roads with a traffic volume over 3,000 pcu per day and on straight sections of urban main roads in bends with a radius greater than 100 m, on rises with a gradient below 5%, and at locations where there is no junction or mixed traffic giving rise to dangerous conditions.
IV. With the exception of motorways, dual carriageways, primary and secondary main roads, on any roads running on flat terrain which have a traffic volume below 3,000 pcu per day.

1.5 Information to road users

Road users can obtain information about matters of high importance to them, like road and traffic conditions, weather conditions, possible emergency situations or accidents, through a number of channels, such as teletext, radios, central road information service (ÚTINFORM) and Internet portal sites.

The 21 state road management organisations now have 11 home pages on different servers. The home pages have different design and diverse colour effect. Their logical structure is also varied but shows some similarity. Home pages are edited at different places. The goal is to develop home pages according to consistent principles. Designing portal sites according to these principles, which also present the image and specific features of county State Road Management Public Service Companies, is now under way by the supervision of an expert board.

The proposed contents of home pages displayed under an Internet portal site on roads include news, phone numbers, general information about companies, operation and maintenance centres, maps, developments, operation and maintenance, winter road operation, traffic engineering, traffic restrictions, links and images.

Organisations interested in the construction, rehabilitation and operation of motorways have recently developed a multi-level common communication programme to provide information for road users. They have allocated communication channels through which they supply preliminary or prompt information intended for road users. Information materials are already available in eight languages at border crossings and customer service offices.

Within the framework of co-operation between six local commercial radio stations broadcasting in the environment of motorways, road users can regularly obtain information from the dispatchers of motorway operation and maintenance centres about the current traffic condition, winter road conditions, contingencies and possible emergency situations. At frequencies shown on boards along motorways, a magazine program containing news about construction, rehabilitation and operation is broadcast every week or month.

On the M7 Motorway, alphanumerical displays provide information in the form of brief messages about possible congestion caused by an accident, the expected increase in driving hours and other factors affecting the travellers or influencing the journey. Messages are controlled by the central dispatcher service on the basis of the latest information received from operation and maintenance centres.

2. Technology and organisation of maintenance works to improve services for road users

2.1 Improving the condition of low-trafficked secondary roads

The planning of maintenance interventions on the secondary roads of the national road network cannot exclusively be based on economic efficiency because there are low-trafficked secondary roads which form an integrated part of the road network and their deterioration has a detrimental effect on the level of service of the whole network.

In many cases, these secondary roads represent the only traffic link for a settlement with the external world, thus maintaining their good condition both from a socio-economic perspective and for the purpose of serving the public transport. On the grounds of social equity, the users of these low-trafficked secondary roads reasonably demand that maintenance works should mostly be financed from central budgetary resources.

To identify the poor condition of secondary roads and determine the technological, costing and scheduling characteristics of an appropriate condition improving programme, the Road Administration prepared in 1997 a decision supporting technical document which was updated in 2001. Then, a technical working committee was entrusted with developing technologies that allow rehabilitation to be carried out economically, using locally available materials. Some experimental road sections were constructed with milling up, mixing and strengthening the existing pavement structure.

In 1998, contracts were awarded following tender procedures conducted by the county State Road Management Public Service Companies to carry out condition improving intervention at a total cost of HUF 548 million. Then, proceeding with the programme was prevented by a lack of central budgetary resources. To complete the most urgently needed condition improving works, a considerable portion of the budgetary maintenance resources, probably HUF 10 billion will be allocated for this purpose between 2003 and 2006.

According to experience gained so far, cheaper surface dressing can be applied on low-trafficked secondary roads only in the case of medium and lower roughness and load-bearing capacity indicators. In case of the combined emergence of more serious roughness and load-bearing capacity problems, complete resurfacing or sometimes the reconstruction of individual road sections is required. Of course, the material of the existing pavement in poor condition can also be used for this purpose.

2.2 The application and continuous calibration of pavement deterioration models

An essential prerequisite for making systematic road management decisions is the availability of reliable estimates about the probable lifetime of road sections with different traffic volume, pavement structure and earthwork. The condition of 60 reference sections (measuring sections) each having a length of 500 m selected from the Hungarian road network according to scientific criteria is monitored since 1991. The surface evenness of road sections, the depth of rutting, the load-bearing capacity of pavement structure and the macro- and micro-roughness of pavement are measured regularly, whereas the surface status of carriageway is characterised visually. For each parameter, an exponential or linear function best fitting to a set of measurement values describes the deterioration process as a function of the time elapsed and the aggregated traffic performed.

The observation of condition being carried out for eleven years has allowed the development of more and more precise network performance models for the condition parameters listed above. The originally designated 20 road categories have been reduced to 14 road categories on the basis of laboratory analyses of core samples taken and as a result of pavement structure strengthening works done in the meantime. The 14 measuring sections have 3 semi-rigid, 5 flexible and 6 recompacting (macadam type) pavement structures.

Following rehabilitation of individual road sections (resurfacing, strengthening, surface dressing), the actual condition improving effect of various technologies and the condition parameters of rehabilitated sections have been measured and compared to those before intervention. In case a reference section has been rehabilitated (construction of a new asphalt layer, surface dressing) during the observation period, the calculation of the time elapsed and the traffic volume performed has been restarted according to the new cycle time.

The deterioration curves for reference sections in specific road categories have been evaluated and compared. To check and verify particular deterioration and performance models, an extensive investigation based on the processing and evaluation of condition change information obtained for some 3,000 km of the national road network was carried out in 1999. The new condition data have been converted into a form required by the EU's PARIS project.

2.3 Preparation for introducing a performance-based allocation of funds

Budgetary funds available for maintenance of the national road network are allocated every year in keeping with the principles developed by an expert committee. The purpose of the currently applied method is to ensure the allocation of funds pro rata to performance, within the limits of central budgetary estimate, for the maintenance and operation activity carried out by county State Road Management Public Service Companies in accordance with the laws. For allocation pro rata to performance, the road management activities have been divided into 4 operation groups and 4 maintenance groups, taking into consideration the relevant technical regulation. The ratio between them is determined on the basis of performance data for the previous years.

Within activity groups, the product of the weight of parameters and their value in a particular band gives the ratio of fund available for a particular group of activity within the total funds. The aggregation of the ratios of activity groups gives the percentage share of a road management company in the total amount of the operation and maintenance cost estimate. During annual activity, tasks required for the road network managed have to be carried out in conformity with laws, therefore individual road management companies may reallocate the allocated funds to a technically justified extent between groups of activity.

Currently, an expert committee is reviewing the principles of allocation of funds. The new method of allocation of funds will probably based on the minimum performance expected by an employer for each of the activities.

2.4 Introduction of advanced management systems (adaptation of HDM-4 and PONTIS)

The Hungarian Road Administration has bought the HDM-4 program with a view to adapting it to the Hungarian conditions. A prerequisite for introduction is the loading of the program with data and coefficients characteristic of the Hungarian conditions.

The HDM-4 software describes deterioration using various equations depending on the characteristics of pavement. The coefficients of these equations ("calibration values") have been determined by the Institute of Transport Science. In the first step, relying on data from the past two decades, the deterioration probabilities for various road parameters have been determined on a statistical basis (so modelling the "trend" of deterioration). Then, some routes with typical (average) parameters have been identified to use them as a basis for setting the calibration values.

Currently, input - typically financial - data required for the basic configuration are being determined. Experimentally, a strategy and program analysis has also been carried out on a selected county set of data where the analysis is based on the actual road conditions, thus allowing the input parameters to be fine-tuned. For making the data input more simple, small data processing programs have been developed. The goal is to create a data input system between the OKA2000 databank and the HDM-4 software.

In 1997, Hungary purchased version 3.2 of the PONTIS American bridge management system. After performance of tasks necessary for its Hungarian adaptation, detailed guidelines have been prepared and specialists have acquired the necessary knowledge for the application of the system on training courses. Specialists conducted the first comprehensive condition survey of some 6,000 bridges existing on the national road network between 1998 and 1999. To supervise on-site investigations, independent experts have rated a total of 100 bridges in 10 counties. The adequacy of condition dispersion has proved to be satisfactory with permissible error occurred in the division into bridge components, whereas major differences have been observed in the recording of the quantity of bridge components.

The results of running the PONTIS bridge management system are also used in the allocation of funds since 2000.

2.5 Plant care to a higher standard in road operation

Among maintenance tasks performed for environmental and health protection purposes, special emphasis has been put between 1998 and 2002 on the removal of ambrosia and weeds growing in areas along the national road network. During this period, the State Road Management Public Service Companies have spent one-fourth of their operation budget on plant care. This activity mostly comprises mowing, accounting for some 60% of the funds spent on plant care within an area of about 300 million m^2.

2.6 Rehabilitation of the M7 Motorway

The 112 km long M7 Motorway is the oldest high-speed road of Hungary, connecting the capital with the Lake Balaton which is of great importance from the viewpoint of tourism and thus performing an extremely heavy traffic particularly during the summer period. The motorway has been rehabilitated between 2001 and 2002. A new, third traffic lane is being constructed on the 48 km long half-carriageway running from Székesfehérvár to Budapest with both carriageways being rehabilitated between Érd and Balatonvilágos on a 78 km section. A second carriageway is constructed between Balatonvilágos and Zamárdi (over a length of 20 km) with the old carriageway being rehabilitated.

Works include the reconstruction of overpasses and underpasses, a correction to the central reservation, and the construction of noise screening walls and protective fence.

Rehabilitation works have made it necessary to develop a particularly strenuous timetable. Traffic had to be kept off the carriageway to be rehabilitated at some intervals. According to traffic investigations, two traffic lanes had to be maintained continuously for vehicles in each direction over the total length of the motorway (except the dual carriageway section). The motorway is rehabilitated at 6-9 km long intervals. When diverting traffic, two narrowed lanes were designated on one of the carriageways. For this purpose, only a 11.0 m wide pavement was available in most cases, therefore lane widths represented the minimum widths permitted by technical specifications, i.e. 3.0 m for external lanes used by trucks and 2.5 m for internal lanes.

A section with traffic diversion is always followed by a so-called "relief" section over approximately the same length which is free from diversion. During a particular period, works were frequently carried out on not less than 5 sections, thus traffic was diverted over a length of about 40 km in most part of the year. Restrictions also caused a significant increase in driving hours since a speed restriction of 60 km/h was introduced at diversions due to the aforementioned lane widths, the lateral obstacle distances, a lack of slowing and accelerating lanes at junctions and the access points of traffic to workplaces.

According to experience, restrictions did not cause themselves any congestion. However, in case of an accident or a failure in a vehicle, rescue works were difficult to carry out and congestion developed within a short time resulting in frequent nose-to-trail driving accidents. Restoration of the traffic order took much more time than on average. In spite of stricter police control, the lack of discipline of vehicle drivers caused serious troubles and the permissible speeds were exceeded significantly in many cases. Rehabilitation works are scheduled for completion in late 2002 when an advanced motorway will be open to motorists.