Challenges of pavement rehabilitation in Central and Eastern Europe region

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Introduction

International cooperation and globalisation of the economy requires efficient and sustainable development of intermodal transport systems. Roads play significant if not the major role in the creation of free market economy in Europe. It may be quoted after Mrs. Wanda Debauche of PIARC Technical Committee on Freight Transport C19 [1]: "Freedom of movement of people, goods and capital is one of the major founding principles of the European Union. An efficient transport system is a necessary condition for the proper functioning of a market economy. Regional accessibility, whether for person flows or goods flows, is particularly important because it is a prerequisite for trade and therefore economic development". This quotation should became the specific motto for activity of the politicians in the Central and Eastern European countries. This paper discusses mainly the experience in Poland but to the great extent it reflects the situation in other countries of the region.

The political and economical transition in the beginning of 1990-ties brought significant changes in the economy and transport circumstances in the Central and Eastern European countries. New market ruled economy turned the organisation of the industry from the heavy centrally governed enterprises into small and medium ones. The significant shift of the goods transporting from rails onto roads was one of the unexpected results.

Unfortunately, the economy transition did not allow for realisation of the above mentioned thoughts and creation of the effective transportation systems by now.

Specific challenges in Central and Eastern Europe

Each country and region in the world and in Europe is unique and unrepeatable. So is the area of Central and Eastern Europe. This is particularly valid with regard to the factors affecting road construction and rehabilitation. At least three topics should be take into account to understand this exceptional situation:

- climate
- traffic loading
- existing pavements.

Climate

Climatic conditions in Poland and other countries of the area are one of the most severe for road construction. The region is under influence of the continental climate generating both temperature extremes: low in the winter and high in the summer. The lowest and the highest 7-days average temperature in the 30-years period of time in the surface asphalt layer of the road pavement was determined according to SHRP Superpave methodology. Binder grades for this temperature range recommended are PG 58-28 or 58-34 for high speed low volume traffic (Fig. 1). But for low speed high volume traffic grades should be shifted to PG 70-28 or PG 70-34 (or even higher).

Climatic conditions are one of the most important factors influencing the durability of the engineering structures and road pavements. They determine the choice of materials and the construction costs, as well. It should be bear in mind that climatic conditions of the region create the most severe material requirements to meet the durability demand, independently from the type of the pavement. For instance, we experienced hot summer 1994 which brought specifically severe rutting of the bituminous

pavements, but the cold winter 2001 reminded the opposite extreme and caused severe low temperature and frost deterioration of the pavements.

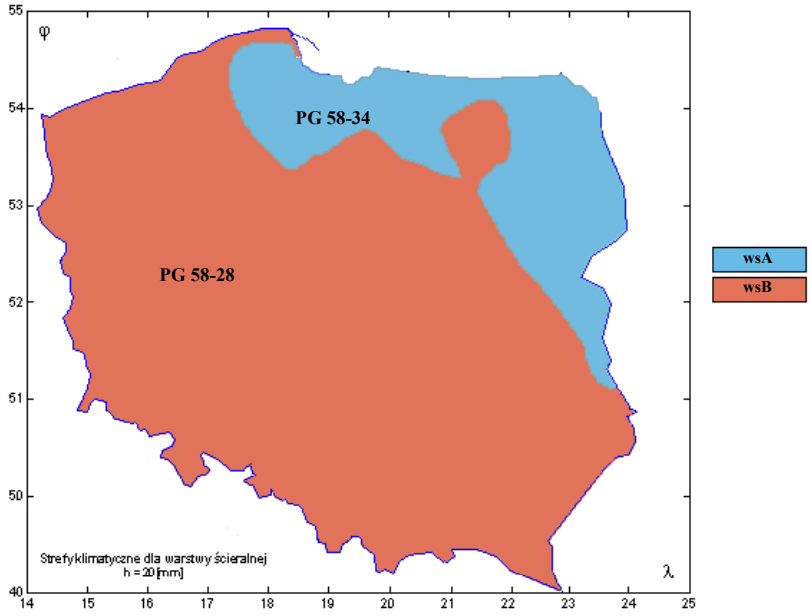

Fig. 1. SHRP Superpave binder grades for wearing course in Poland (high speed and low volume traffic)

Both experiences proved that the pavements constructed in the past were not suitable for the new combined conditions of loading and climate. The conclusion is the only one: **the road pavement must be reconstructed.**

Traffic loading

In the period 1990-1995 the average traffic volume on the national roads in Poland increased by 40%. It was hoped that it was exceptionally for this transition period, but the newly performed traffic measurements in 2000 proved that the traffic growth was steady at the same level in the next 5 year period: 1995-2000. Traffic data and growth factors on national roads in Poland are given on Fig. 2-5. Important conclusions are that:

- the growth is steady in the period 1990-2000
- the most aggressive vehicle category of articulated trucks (including Super Singles) exhibits the highest growth in this period – the number of these vehicles almost doubled.

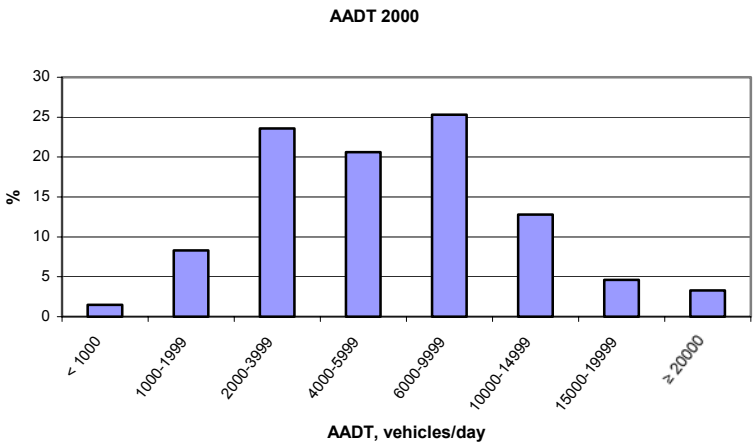

Fig. 2. AADT on Polish national roads in 2000

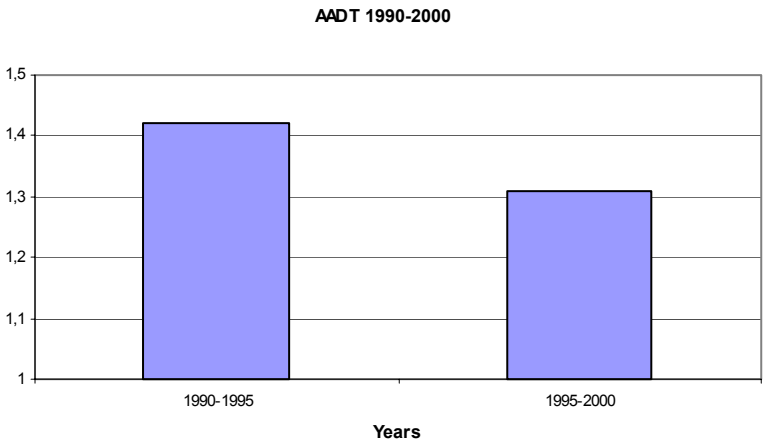

Fig. 3. Growth factor of AADT in years 1990-1995 and 1995-2000

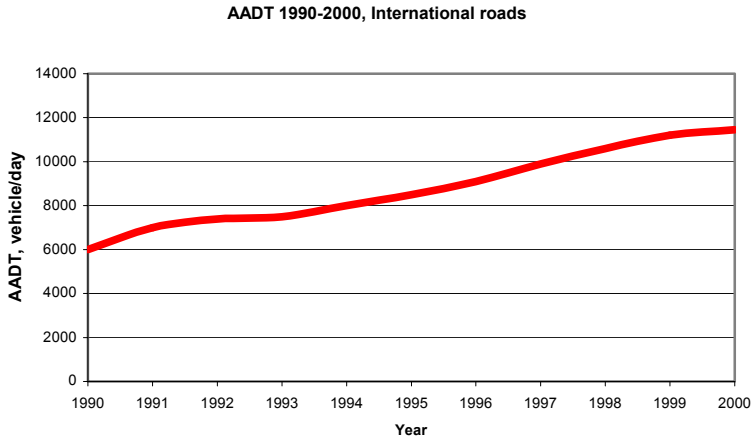

Fig. 4. Growth of AADT on international roads in Poland

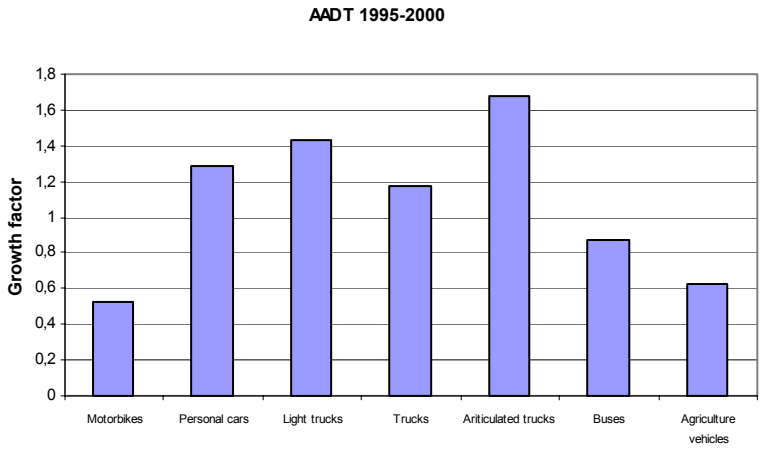

Fig. 5. Growth factors of AADT of vehicle categories

Traffic volume growth was associated with the growth of axle loading. The axle load limit in Poland is still 100 kN but some of national roads do not fulfil even this bearing capacity criterion. Secondary roads were constructed in the past for 80 kN loading. It must also be taken into consideration that up to 20% (or even more) of trucks are loaded beyond 100 kN limit. Further, new type of trucks with Super Single wheel axles became even more popular which causes additional severe loading on the pavement. Growing traffic loading combined with severe climatic conditions, low winter and high summer temperatures, generated a lot of deterioration of the road network.

Overloading of the trucks became one of the main problem for Polish road administration. In the expertise prepared for Polish General Directory of Public Roads by our Road and Bridge Research

Institute, it was estimated that truck overloading causes additional deterioration of road pavements which is accounted equal to the budget of national road administration.

Existing pavements

Majority of existing road pavements were constructed in 1960-ties or 1970-ties. The pavements were maintained and rehabilitated in the meantime with use of materials and techniques available at that time in Poland. The pavement design, choice of material and construction was sufficient for these times but do not meet demands of the traffic in combination with climatic conditions of nowadays. Existing pavements and materials deposited in them often create specific problems in the course of rehabilitation. The decision of the range and technique of rehabilitation must be preceded by the detailed investigation and acceptance or rejection of materials in the existing pavement. Firstly, because of their quality and secondly, because of their potentially harmful influence on the environment.

The quality of materials used for road construction was very often poor in our contemporary understanding. Road structure frequently needs deep rehabilitation including strengthening of the subgrade or subbase, or at least replacement of asphalt layers. Frequently, asphalt layer overlay alone is not sufficient because of the weakness of lower layers as it is shown on Figure 6 - the very significant proportion of the overall rut that is predicted to come from bottom layers. This observation is of considerable importance when only surface pavement recycling is carried out, without any remedial treatment to the lower layers [2]. It is supported by Figure 7 presenting the thickness of existing asphalt layers and their creep stiffness modulus. Insufficient rutting resistance is evident. Unfortunately, this pavement was subjected to hot recycling in place and it proved to be inefficient in only a few moths [3].

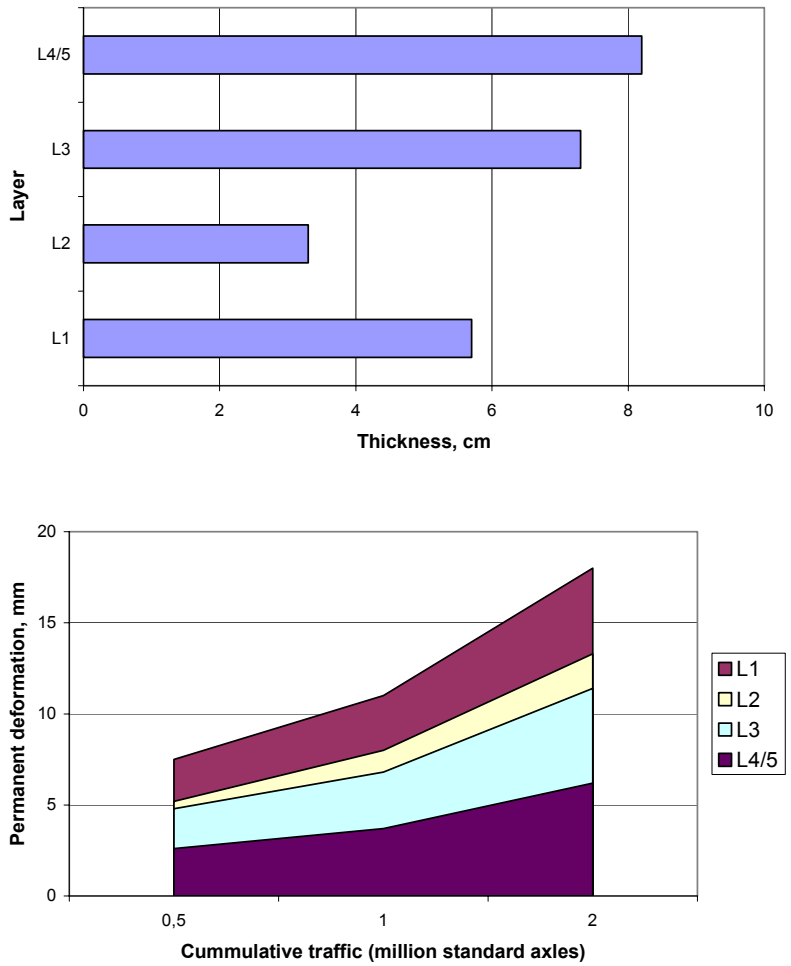

Fig. 6. Asphalt layers' thickness and prediction of permanent deformation based on repetitive creep test (after Elliot [2])

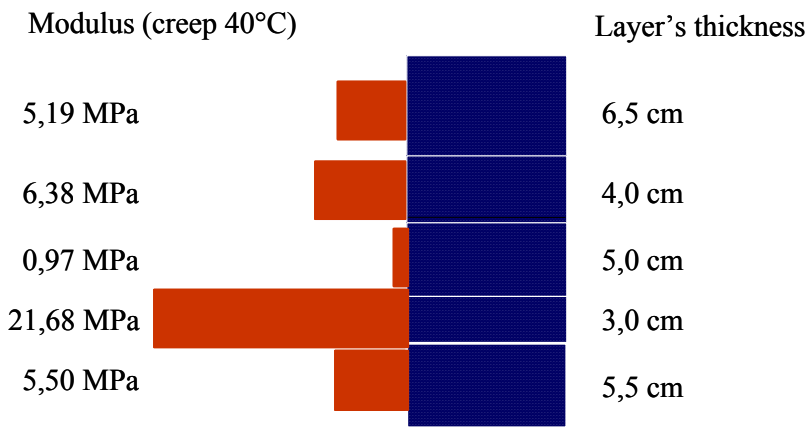

Fig. 7. Asphalt layers' thickness and creep stiffness modulus (after Sybilski, Mechowski [3])

Road tar was frequently used for road pavement construction in Poland in the past. It's use ceased in 1980-ties but the binder is present in many existing pavements. It's the potential source of environmental problems during rehabilitation. The procedures for tar detection and choice of a relevant safe rehabilitation process must be developed and implemented. Cold in-place recycling seems to be the most appropriate solution for our region's conditions from both environmental and financial point of view.

Need for pavement strengthening

At least the main national road network carrying the most heavy and international traffic need to be strengthen to allow for the free access and mobility. The survey of pavement conditions shows decreasing the service level of the main roads in Poland and the need for strengthening and deep rehabilitation (Fig. 8).

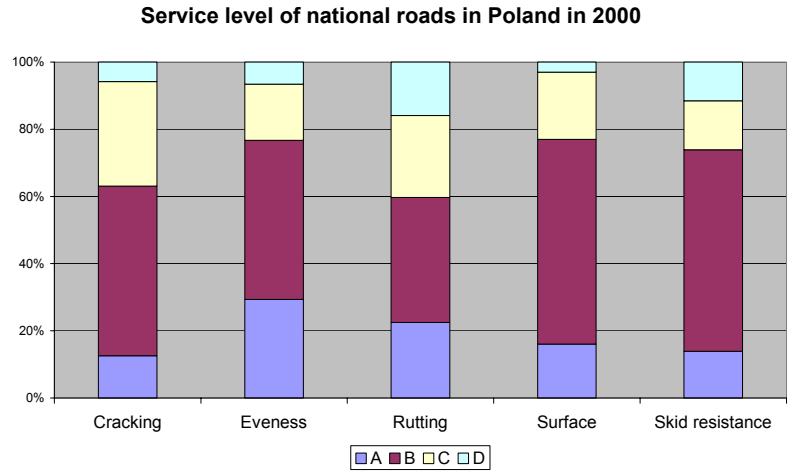

Fig. 8. Service level of national roads pavements in Poland

In Poland, the General Directorate of National Roads and Motorways developed the program for upgrading the main national road network to the European Union standards. The TINA road network (Transport Infrastructure Needs Assessment) consists of nearly 4800 km (30% of national roads). The aim of the strengthening program is to obtain bearing capacity of roads allowing for the vehicle loading according to EU Directive, i.e. to maximum axle load 115 kN. By now, only 1% of Polish road network meets the requirements of EU Directive. It is scheduled that by 2015 the whole TINA network will be reconstructed and strengthen, including 1525 km of motorways and 1618 km expressways (Fig. 9).

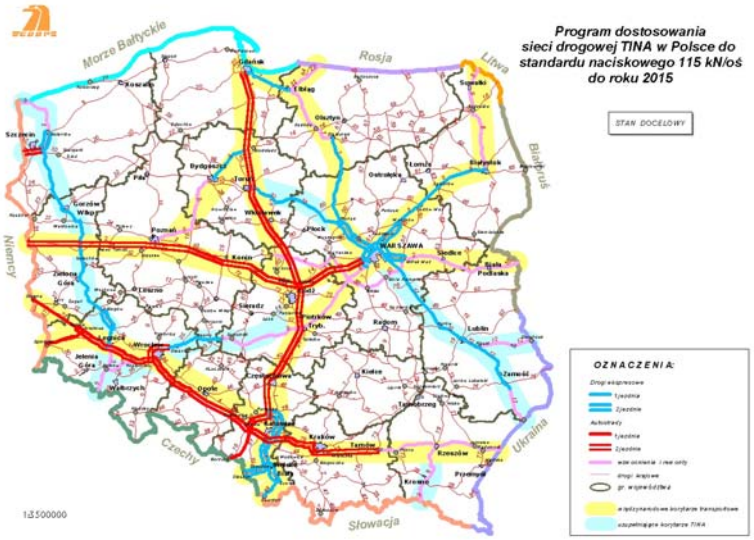

Fig. 9. Program of upgrading main Polish road network to EU standard load 115 kN by 2015

New materials and techniques

Growing demands of the road users and the whole society on road infrastructure require the use of more durable materials which may meet more tough requirements. On the other hand more open economy and accessibility of the market causes that great variability of new products from abroad appears in our countries every year. It creates certain difficulties for the road administrators, investors, designers, contractors. Such novel products and technologies are in the majority mostly welcomed as a technical development and improvement replacing the old out-dated solutions. It must however be bear in mind that the climatic conditions determine certain requirements. Quite often good solution applied in other area of the world does not pass the examination in our region.

From the legal point of view these new products can not be applied not meeting the national specifications. In Poland the system of Technical Approvals was developed to enable the application of non-standardised products. This measure was earlier successfully proven in other European countries, i.e. France, Great Britain, Germany. Several industrial research institutions were appointed by respective ministries for evaluation of the novel, non-standardised products, and among them, Road and Bridge Research Institute in the area of road and bridge construction industry. The special independent body - Technical Approvals Commission - representing the whole administration and industry was founded at the Institute for this purpose. Starting from the year 1998 until today, the total number of 1350 of Technical Approvals has been issued by the Commission.

The system proved to be effective allowing for the relatively safe and controlled implementation of the new products, providing the minimum safety for the contractor and road administrator. The system of Technical Approvals does not however solve all the problems of road design and material choice. Further, Technical Approval is not a quality certificate of the product. It does not also eliminate the need for proper choice of material for certain technical design and service conditions. It does not take the responsibility from the partners of the investor-designer-contractor chain.

A specific problem appeared due to the fact that a great number of new products and technologies was introduced in the relatively short time of several years. Sometime it created certain confusion and misunderstanding.

For certain, the last years brought a significant development in Polish road construction with use of new materials as well as new maintenance and construction techniques. The list is very long but just to mention the most important: Stone Mastic Asphalt SMA, gap graded asphalt mixtures (BBTM), thin asphalt layers, high stiffness asphalt mixtures, polymer-modified binders, geosynthetics, hot and cold recycling.

The most important task seems to be development and implementation a pavement construction technique providing long life durability in Polish climatic conditions (to combat high temperature permanent deformation, and low temperature cracking as well as to provide proper bearing capacity and fatigue life). Unfortunately, up today experience shows that stiffer asphalt mixtures providing rutting resistance exhibit to low fatigue life. New projects to implement high stiffness asphalt mixtures give the chance to solve the complexity of the problem. Three test sections were constructed by now: in 1999, 2001 and the last one 2002 (the latter in cooperation with LCPC, France). The results are very positive and optimistic. The main disadvantage of this solution is higher construction cost.

Pavement design, modeling and material testing

New tolls for pavement design, pavement modeling and material testing are available. Use of mechanistic pavement design supported with the performance related laboratory material testing enable to design a durable road pavement for the specific traffic and climatic conditions. More advanced visco-elastic-plastic modeling of the asphalt pavement allows for precise calculation of strains and stresses in the structure with recognition of new types of distress such as fatigue surface cracking generated at the pavement surface and propagated from top to bottom. It is important tool for evaluation of a long life asphalt pavement.

A series of performance related laboratory tests were implemented in Poland (or are in the phase of implementation) for asphalt mixture evaluation, such as: wheel tracking test (both small and large), static creep test, fatigue test (4 Point Bending), low temperature TSRST, water and frost resistance.

Main problem consists in the certain conservatism of investors, designers and contractors and their reservation for practical application of these tools. On the other hand, the ambitious road network rehabilitation and strengthening program requires application of the best available techniques and materials to provide long life durability of rehabilitated and newly constructed pavements.

Conclusions

The region of Central and Eastern Europe make up an area of expected potential great development of economy and transport infrastructure. There is a serious demand for rehabilitation of existing and construction of new roads. Certain specific conditions should be taken into consideration: climate influence, traffic growth and existing pavements' careful evaluation. The best available techniques and materials should be applied, even at higher costs but providing longer life and meeting the technical requirements and demands of the society. Recycling of asphalt pavements is a set of important techniques for rehabilitation of the roads in the region. The most appropriate technique should be always chosen for the specific pavement conditions.

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1 Debauche W.: The Road: Key to Mobility and the Economy, Routes/Roads, No. 314, April 2002

2 Elliot R.: The use of performance related materials testing to control rutting on Poland's roads. II International Conference: Durable and Safe Road Pavements. Kielce, 15-16 May 1996

3 Sybilski D., Mechowski T.: Czy stosować w Polsce recykling na gorąco na drodze nawierzchni bitumicznych? Część 1: Badania odcinków nawierzchni. Część 2: Ocena skuteczności technologii. Drogownictwo 10, 1996, 51, s.298-304, 11, 1996, 51, s.320-324