Issue 1 | August 2009

# SPENS Newsletter

Sustainable Pavements for European New Member States

Inside This Issue



*__SPENS final seminar,__ where the project's results and final outcomes will be presented and discussed, will be held on __August 27th and 28th, 2009 in Ljubljana, Slovenia.__*

## **Introduction** by Mojca Ravnikar Turk, project coordinator

At the initiative of FEHRL, the European Commission has set up a research project named 'Sustainable Pavements for European New Member States' (SPENS). This three year project, which is funded within the EU Sixth Framework Programme, Sustainable Surface Transport priority, will end in August 2009.

The standard of the road infrastructure differs throughout the European Union member states, but the present volume of heavy road transport requires a sustainable road infrastructure immediately. There is a constant need for new resistant pavement materials, which should comply with the EU regulations.

Due to the priority of motorway construction, the standard of maintenance of other roads has lowered, resulting in an increased need for effective road maintenance and improvement over the years to come. The materials and technologies now used in the New Member States differ from those adopted in common practice in the EU-15.

The objective of this Specific Targeted Research Project was to develop appropriate tools and procedures for the optimum and cost-effective rehabilitation and maintenance of roads in the EU New Member States.

The overall objective was to search for materials and technologies for road pavement construction and rehabilitation that would:

- behave satisfactorily in a typical climate,
- have an acceptable environmental impact,
- be easy to incorporate within existing technologies,
- be cost-effective and easy to maintain.

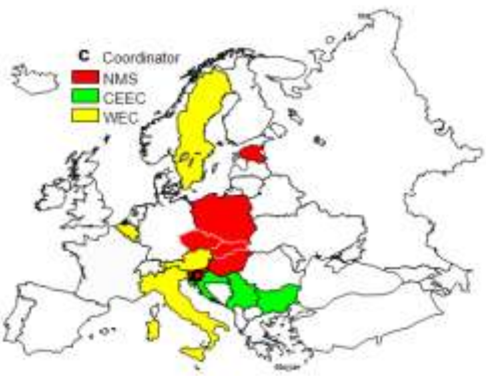
Since September 2006 ten partners together with four institutes under the FEHRL umbrella have been working together doing laboratory and field testing of asphalt materials, as well as evaluating the impact of roads on the environment. The project, with a total budget of 2,5m EUR, has been coordinated by the Slovenian National Building and Civil Engineering Institute (ZAG).

The research work has focused on developing procedures for producing and implementing materials for road construction, using only local materials and taking into account the tradition and existing construction techniques, as well as the specifics of already constructed roads. Laboratory and in-situ tests were performed in several European countries. Field trials and monitoring during the project were used to verify the research results.

The research has been organised into four technical work packages, which deal with

- the optimization of assessment techniques and procedures for roads - WP2, led by László Gáspár
- the improvement of pavement structures - WP3, led by Safwat Said
- evaluation of materials for road upgrading - WP4, led by Marjan Tušar
- evaluation and minimization of the impact of road traffic on the environment - WP5, led by Manfred Haider.

A number of dissemination events have already been organized. Based on the results of the research within the technical work packages, practical guidelines and recommendations have been produced. The dissemination of results is being done through national and international conferences, as well as on the SPENS web site. For more information and final deliverables please visit: [http://spens.fehrl.org](http://spens.fehrl.org)




*The SPENS project encompasses fourteen different languages.*

The consortium mainly consists of experts from the New Member States, in order to ensure that the research is focused on issues relevant to the latter. Within SPENS fourteen different languages are spoken.

This newsletter provides some information on the research results which will be fully presented in the following project deliverables:

| | |
|---|---|
| D8 | Laboratory and field implementation of high modulus asphalt concrete |
| D9 | Long-term performance of reinforced pavements |
| D10 | Practical mix design model for asphalt mixtures |
| D11 | Guidelines of a complex methodology for non-destructive pavement measuring techniques |
| D12 | Recommendations for traffic equivalency factors |
| D13 | Guidelines on a systematic decision-making methodology for the pavement rehabilitation of low volume roads |

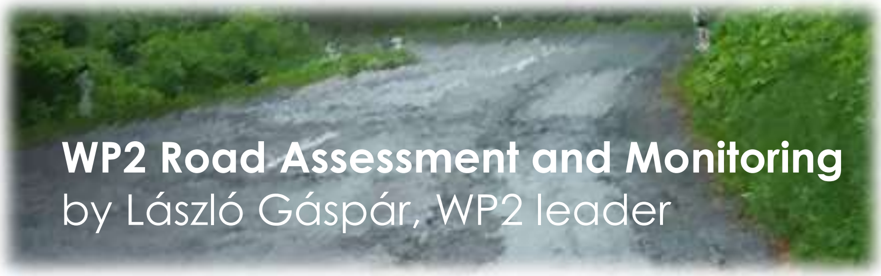
D15 Recommendations for modified binder usage in pavements

D16 Guidelines for the selection of the most convenient upgrading systems based on the results of heavy vehicle simulator tests and cost-benefit analyses of field trials

D17 Guidelines for the environmental assessment of various pavement types including recommendations to road authorities in New Member States

D18 A methodology for testing and implementing selected recycled materials and industrial by-products in road construction

The SPENS final seminar, where the project's results and final outcomes will be presented and discussed, will be held on August 27th and 28th, 2009 in Ljubljana, Slovenia. The program and further information may be **accessed here.**



# WP2 Road Assessment and Monitoring
by László Gáspár, WP2 leader

The main objective of WP2 in the SPENS-project is to contribute to the development of various road assessment and monitoring topics, mainly for the use in New Members States of the European Union.

## WP 2.1 Traffic load equivalency factors

The Work Task deals with the calculation (or at least the estimation) of traffic load equivalency factors for various road pavement structures typical for Central and Eastern Europe. Considering the financial and time constraints, the following methodology was applied:

- use of Heavy Vehicle Simulator (Figure 2.1) for applying different wheel loads on the test pavements under investigation,
- before and after 200,000 load applications of 60 kN, the strain values at the bottom of asphalt layers were recorded under 30, 40, 50, 60 and 80 kN wheel loads for the 6 sections,
- the critical repetition numbers of 50kN wheel loads were determined for each pavement structure using the Slovenian pavement design methodology,
- the critical asphalt strains and the critical repetition numbers were calculated for each wheel load and each trial section investigated,
- the traffic equivalency factors for each section were calculated (values between 1.93 and 3.62 were given).

*Figure 2.1 Heavy Vehicle Simulator*

## WP 2.2 Non-destructive testing of pavement condition

The objective was to carry out and evaluate the results of a harmonisation test covering skid resistance, longitudinal evenness and bearing capacity measuring devices (Figure 2.2).

For skid resistance measuring exercise, six test pavements were selected with various skid resistance. The 9 devices coming from 7 countries run the 100-m long test sections at 30-60-90 km/h measuring speeds. At least 3 runs were performed for each speed. Measurements in the right wheel path were strived for. A water film thickness of 0.5 mm was applied on the pavement surface to be measured. The analysis of the test results was carried out according to CEN/TC 227/WG-5 N202 E Rev. 4.

*Figure 2.2 Bearing capacity measuring devices*

For longitudinal unevenness measuring test, the device Primel in VTI was selected as reference device. Six test pavements were chosen with various unevenness. The 7 devices coming from 6 countries run the 500 m-long test sections at 30-60-90 km/h measuring speeds. At least 3 runs were performed for each speed. The devices measured along the same lines of the sections.

For bearing capacity measuring devices, the methodology developed in COST action 336 for calibration and harmonisation was applied. Seven Falling Weight Deflectometers from 6 countries participated in the exercise. The maximum surface deflection values were compared.

A certificate on the participation in the harmonisation test near Vienna was given to each participant from Austria, Czech Republic, Hungary, Norway, Poland, Slovenia, Slovakia and Sweden.

## WP 2.3 Systematic decision making methodology on pavement rehabilitation and upgrading

The aim of the Work Task was to develop a systematic decision making methodology mainly on the pavement rehabilitation and upgrading of low-volume roads in Central and Eastern European countries.

The flow-chart based methodology was developed on the basis of a Slovenian procedure which was modified by the information coming from Poland, Slovakia, Hungary and Czech Republic.

It covers the following condition parameters: skid resistance, transverse evenness (rut depth), surface defects, longitudinal evenness, bearing capacity. Among the road rehabilitation and upgrading techniques, resurfacing (surface dressing, slurry seal, and thin overlay), overlaying, pavement strengthening (upgrading by asphalt layers, "sandwich systems", recycling) and reconstruction were considered. A questionnaire survey carried out in SPENS-project was also utilized in the methodology proposed.

*Figure 2.3 Deteriorated low volume road*

Several examples (Figure 2-3) were presented in order to demonstrate the use of the flow-chart based methodology developed for the pavement rehabilitation and upgrading of low-volume roads.

# WP3 - Improvement of pavement structures by Safwat Said, WP3 leader

The main objective of this work package was the development and optimisation of methods, materials and technologies for improvement of pavement structures for new and existing flexible road pavements. Its aim is also to study the benefits and limits of waste and by-product materials including recycled materials for road construction.

## WP 3.1 Long term performance of reinforced pavement

Usually roads are rehabilitated by removing one or several layers of pavement that are substituted by new layers or just overlaid by a new layer. The pavement layer can be strengthened with different types of materials and layer thicknesses. The main objective of this task group is to study methods and technologies for improvement of pavement structures for new and existing flexible road pavements. This work focuses on the methodology of pavement performance evaluation of reinforced structures, the modelling of reinforced flexible pavement structures as well as guidelines/instructions for the implementation of reinforcement in road construction:

- It is quite evident that the use of reinforcement gives a clear benefit, if we consider the whole life of the road, based on the estimation of several type of deterioration.
- Almost 100% of steel meshes used in the reinforcement of pavements are manufactured from recycled steel products.
- Best practice and practical guidelines have also been presented in this work.

It is concluded from several performance evaluations that the reinforced structure has prolonged the service life of pavement with more than 20 per cent.

*…crushed concrete can be good and an environmentally acceptable replacement for the natural aggregate for construction of the unbound layers.*

*WP 3.1 Photo*

## WP 3.2 Alternative materials

Rapid industrial growth during recent decades has resulted in the production of a wide variety of waste that imposes severe environmental problems on mankind. Several attempts have been made to increase the reuse of waste materials, with the aim of achieving several goals: (a) reducing the size of landfills, and thus protecting the environment, (b) technical benefit from the use of waste materials in different applications, (c) economical benefit, by reduction in the consumption of natural materials and energy and (d) social-ecological benefit, by following a sustainable development policy.

The most promising waste materials for road construction purposes are crushed building rubble and industrial by-products such as slag. Several test fields, with slag aggregate for the wearing course and surface dressing, and natural aggregate for comparison, were constructed in Slovenia. The purpose of these test fields were to validate the suitability of slag aggregate for use in wearing courses. It was found that no problems had been encountered by the firm carrying out the works, either in the designing of the mix, or in its transport to the asphalt plant, or in the placing of the asphalt in the test fields. It is planned that the test fields be subject to further monitoring in order to detect any long-term changes in skid-resistance.

To validate suitability and long term behaviour of crushed concrete in unbound layers an instrumented test section on section of Slovenian national road Ivančna Gorica – Muljava was constructed. The research shows that crushed concrete exerts lower permanent deformations and lower decrease of modulus of elasticity in same environmental conditions, thus showing better long term behaviour than compared natural aggregate with no negative environmental effects. In all cases, independently of induced pressure, we can observe higher deformations in part with natural aggregate (See Figure 3.2).

On the basis of results of this research we can conclude that crushed concrete can be a good and environmentally acceptable replacement for the natural aggregate for construction of the unbound layers. Of course quality of these materials must be in line with the technical and legislative regulations for intended use.

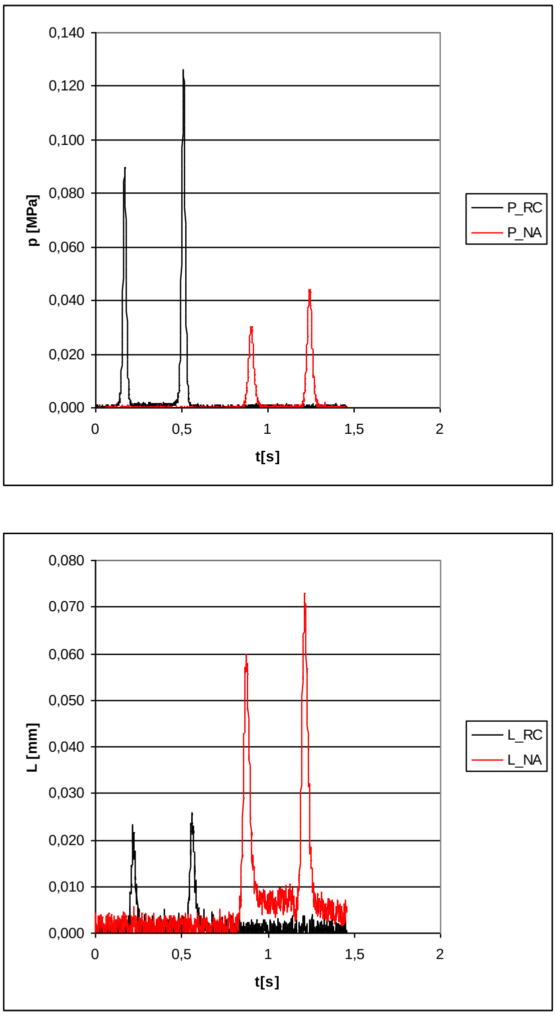



*Figure 3.2 Behavior of Crushed concrete and Natural aggregate*

# WP4 - Evaluation of materials for road upgrading by Marjan Tušar, WP4 Leader

Within WP 4, materials and pavement layers appropriate for road upgrading were evaluated, with consideration of the conditions in New Member States. The New Member States have mainly focused on the construction of new motorways, while less money has been available for the improvement of the existing roads. However at the same time there is a strong need for new, sustainable road pavement materials, with a high bearing capacity, in all of the EU countries. It is anticipated that maintenance costs in the New Member States could be lowered significantly by introducing better techniques and improving the prevailing procedures, which are used to deal with the assessment of road conditions and maintenance planning for road upgrading. Increasing traffic volumes and loads mean that wider roads, with a higher bearing capacity and better pavement durability, are needed.

Chemically-modified bitumen, as asphalt binders, is used more and more in road construction, but not much information is available about the actual performance of these materials. A reliable correlation between the laboratory and in-situ performance of mixtures with modified bitumen has not yet been established. This knowledge is necessary for the evaluation of the behaviour or appropriateness of these materials in different climatic and environmental conditions. Within **Task 4.1** (Investigation of the Performance of the Conventional and Polymer Modified Bitumen) the objective is to find performance based binder criteria founded on correlations between binder tests and critical asphalt performance tests.

**Task 4.2** deals with studies of High Modulus Asphalt Concrete (HMAC) as technical solution providing improved durability of road asphalt pavement with possibility to reduce the pavement thickness and road construction costs.

In **Task 4.3** the effect of different layer thicknesses and strengthening treatments in the pavement structure were evaluated with the HVS-Nordic.

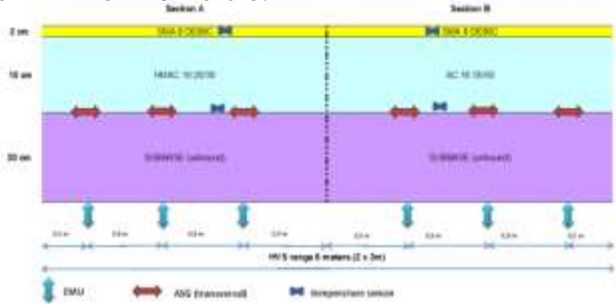


*Figure 4.1. Test sections in Poland (Pruszków).*

## Task 4.1 Investigation of the Performance of the Conventional and Polymer Modified Bitumen

To upgrade roads in NMS to perform better with respect to traffic load, climatic variations, environmental impact and cost efficiency, involves using new or improved materials and construction methods. Polymers and other additives used to modify bitumen are used in many places to improve asphalt mixtures. Formula based construction methods and traditional binder testing methods are not suitable for dealing with the complexity associated with polymer modified bitumen and asphalt mixtures made of these binders. The most obvious performance related properties of asphalt mixtures are wear resistance, stiffness, resistance to plastic deformation, resistance to fatigue and durability (water sensitivity and ageing). All of these properties are to a very large extent influenced by the properties of the binder and the binder aggregate interaction. Binder test methods should guide the pavement engineer in selecting the most efficient binder for a certain type of aggregate and type of asphalt layer. A combination of fundamental binder test methods, e.g. the complex shear modulus measured with DSR and methods characterizing the binder during severe stress have been suggested to be asphalt mixture performance related. The task has focused on selecting the most efficient combinations of binder testing methods for predicting asphalt mixture performance.

## Task 4.2 Material Recommendations and Performance-based Requirements for High Modulus Asphalt Mixtures and Flexible Pavement Design

The aim of this task is to develop a concept of high modulus asphalt mixtures (Format, 2005) for the implementation in the Central and Eastern European countries. It is obvious that the technology transfer has to take into account local climatic conditions as well as the availability of materials and equipment, both for the road construction and for laboratory testing. The following countries were interested in implementation of High Modulus Asphalt Concrete: Poland, Slovenia, Croatia, Serbia, Sweden and Estonia.

The first point of the task is preparation of initial recommendations for High Modulus Asphalt Concrete (HMAC) in different countries. Poland has experience with this type of mix and the test in real scale was therefore performed in Poland. Recommendations for Poland have been already prepared. This was adopted taking into account climate, materials and test methods for countries that are interested in implementation of HMAC (Slovenia, Serbia, Sweden, Croatia, and Estonia). Climate analysis consists of evaluation of effective temperature for fatigue (TEFF) and PG temperatures for different layers.

Test sections were located in Pruszków – near Warsaw and construction works were done by STRABAG in October 2007. The test section was divided into two halves of the same layer thickness, but with two different mixes as the base course: asphalt concrete (AC) and HMAC. It allows direct evaluation of the influence of HMAC on pavement durability.

## Task 4.3 Upgrading of asphalt macadam and light asphalt pavements to the bearing capacity level needed by the EU

For assessing the pavement bearing capacity, deflections of road pavement under a dynamic loading were measured with Dynatest Falling Weight Deflectometer (FWD). Surface unevenness was tested with ZAG-VP (ZAG Longitudinal Profilometer).

Accelerated load test (ALT) were performed on selected field trials with a Heavy Vehicle Simulator, HVS-Nordic. This cost-effective facility is convenient to investigate the effect of different strengthening treatments on existing pavements.

Field trials in Slovenia were prepared by DDC and ZAG. Three test fields were selected as the most proper for SPENS test fields, one of which is Figure 4.3. They are new road construction and not an upgrade of low volume roads, as was planned.

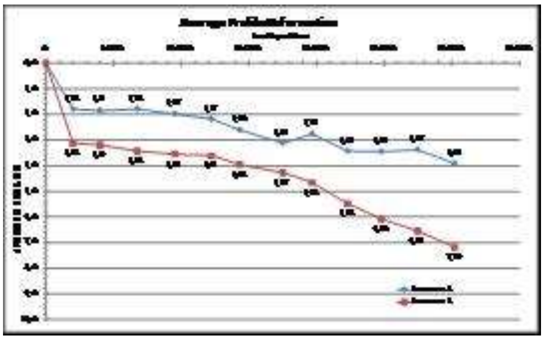


Figure 4.2. Evolution of profile deformation

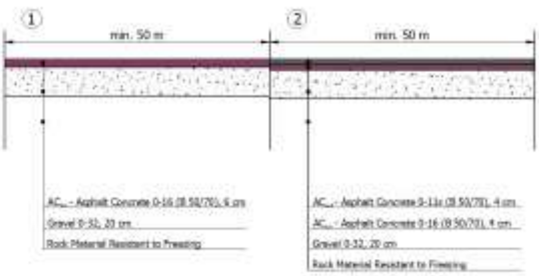



*Figure 4.3. Test fields 1 and 2*

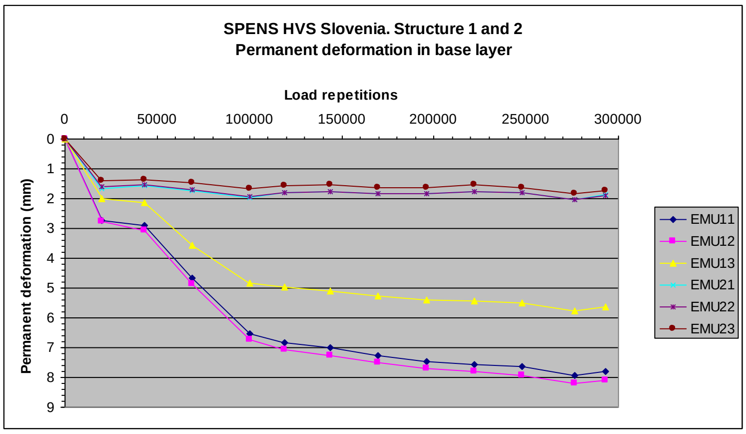



Figure 4.4. Propagation of permanent deflection in unbound gravel layer

# WP5 - Assessment of the impact of roads on the environment by Manfred Haider, WP5 Leader

Work Package 5 was concerned with methods to investigate the impact of pavement choice on the environment especially for European New Member States (NMS). The common goal of partners of old and New Member States alike was to achieve a common understanding of suitable pavements and the associated procedures and methods to assess and manage their environmental properties. Within the broad scope of environmental impacts the WP5 partners selected air pollution by particulate matter and noise emission as their main investigation targets. The partners from NMS provided information on the general legislative situation in their countries, the methods and procedures currently applied concerning the selection of road pavements and on the actual use and distribution of pavement types within their countries. A first insight gained by all partners was that the differences were less present in the pavement types actually used, which would be considered quite standard pavements in the old member states, but more in the procedures and methodologies. The use of advanced low noise pavements like porous asphalts is not likely to be found in NMS, but the same is true for quite a lot of the EU-15 countries.


*Figure 5.1: The VTI circular road simulator Pavements in the road simulator: Czech diorite (top) and Slovenian limestone (bottom)*

The experimental programme of WP 5 focused on investigations of the most common pavement types in the participating NMS partner countries, which were found to be asphalt concrete (AC) and stone mastic asphalt (SMA) varieties. Some of the investigations also included measurements on concrete pavements, as they play a significant role in some motorway networks. The investigation programme contained measurements of the particle emission of typical pavements with hard (Czech Republic) and soft (Slovenia) stone material on the VTI road simulator combined with a chemical analysis of the particles, in-situ dust fall measurements of PM emissions in the Czech republic and Slovakia and SPB (ISO 11819-1) and CPX (ISO/CD 11819-2) measurements in all three NMS partner countries. The experiments showed some interesting results both for the pavements themselves and the applied methodology.

*Figure 5.2: Pavements in the road simulator: Czech diorite (top) and Slovenian limestone (bottom)*

The final recommendations were derived from the experimental results and previous knowledge to help road administrations manage environmental effects influenced by road construction and maintenance. The recommendations for air pollution from tyre-pavement interaction point to the importance of investigating the pavement contribution to PM emissions in road and street environments where the EU PM10 limit values are exceeded.

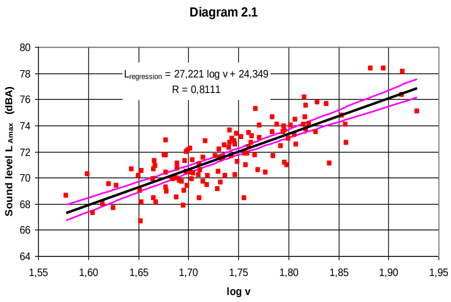



*Figure 5.3: SPB measurement results for SMA 8s in Slovenia (at Domžale)*

If harder stone material is chosen for the pavement, it will generate less overall PM and is more resistant to the applied torque from speed changes. However, a part of the results indicates that harder stone material tends to have a higher emission of small-size particles below 1µm which are more dangerous than the larger particle diameters. Winter tyres will produce more PM than summer tyres no matter which kind of road surface is present. Results from CDV indicate that asphalt concrete pavements are less resistant to abrasion than cement concrete pavements and produce more particulate matter. However, the highest attention should go to the fraction with diameters below 1 µm, as they penetrate very deeply into the lungs. The share of this fraction was found to be high in locations with stone mastic asphalt. The results of dust fall measurements in tunnels are in accordance with measurements of PM in ambient air. In any case it can be stated that the effect of tyre and pavement abrasion on PM present in the air can be very difficult to determine due to the many possible background sources.

*Noise emission from NMS road surfaces is very comparable to that of standard road surfaces in the rest of the EU.*

The recommendations for noise emission show that the noise emission from NMS road surfaces is very comparable to that of standard road surfaces in the rest of the EU. Asphalt concrete and SMA surfaces dominate, and problems are usually due to the use of old types of concrete surfaces or bad maintenance condition. SMA pavements with small chippings sizes of e.g. 8 mm are considered the most silent pavements already in use. The future may see the introduction of more open-graded road surfaces and porous asphalt surfaces to improve the noise emission situation.

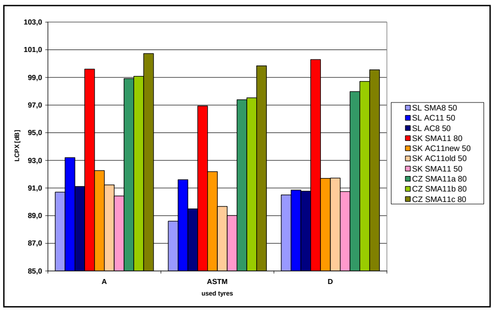



*Figure 5.4: CPX levels for the ten measured sites using tyre A, ASTM and D*

Concerning the methodology, all partners recognized the value of performing SPB and CPX measurements to assess the noise performance of road surfaces. The recommendations are stated in the final deliverable D17.

The results of SPENS WP 5 were presented in a workshop on the 7th of May, 2009, in Bled, Slovenia. They also form the basis of SPENS deliverable D17, which aims at providing recommendations and guidance on the environmental assessment of pavements and on useful and cost-effective techniques and procedures to keep their environmental impact at acceptable levels.

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THANK YOU to all partners, researchers and others who have provided text or input for this newsletter.

A sustainable infrastructure is vital for the economic progress of a country. Especially at a time of economic decline, we must put more effort into the implementation of new knowledge in everyday road construction practice, without delay.

Mojca Ravnikar Turk, SPENS coordinator.

VTI - Sweden
DDC - Slovenia
CDV - Czech Republic
Ferriere Nord - Italy

KTI - Hungary
IBDIM - Poland
ZAG - Slovenia
AIT - Austria

TUZA - Slovakia
IGH - Croatia
IP - Serbia
Tecer - Estonia
CRBL - Bulgaria

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