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www.watmove.org

is a *portal* to the web sites of the COST Action 351 in Europe. Keep up-to-date about our Action by checking this site from time-to-time. It's the first place that our reports will appear.

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WATMOVE DRAINS AWAY!

Chairman Andrew Dawson, University of Nottingham, UK

When the WATMOVE "Water Movements in Roads and Embankments" project started in late 2003, I thought that it would be difficult for a European group to spend three or more years studying the movement of water in road layers and in the adjacent earthworks. Now, three and a half years later, I realise that we have hardly started! Like many other subjects, once you begin to investigate "how", "why" and "where", you find that there are many aspects that are little understood and that no-one has ever tried to answer some of these questions. I can-not say that we've succeeded in every task we set ourselves, but we have tried to bring together engineering theory, geological constraints, and best-practice into a book that covers scientific aspects, engineering principles and design solutions. We've also widened the initial scope so that we can explain seepage flow, temperature induced water movements, flow and quality monitoring, geo-environmental aspects and highway sub-surface water control.



Late in 2006 the US President, George Bush, was overheard to say "And truth of the matter is, a lot of reports in Washington are never read by anybody. To show you how important this one is, I read it, and our guest read it". Our ambition for the WATMOVE report is that it will be read by more than 2 people (even if Mr Bush isn't one of them!) so, early on in the project, the research team decided to deliver its main output in the form of a textbook (see page 3). That way, we aim to get the findings of our study out to as many readers as we can.



Example of an asphalt pavement distressed by being under water during the wet seasons.

To produce such a book has required a huge amount of effort. So my welcome to this, the last WAT-MOVES newsletter, must end with a very big "thankyou" to everyone who's co-operated during the life of the project. My colleagues, past and present, on the Management Committee and its working groups have given a great deal of time, energy and, above all, enthusiasm to the task. It has been a real pleasure to work with you and to act as your chairman. I also need to acknowledge our debt to the COST office in Brussels and to the dedicated team of scientific and administrative officers who've helped us in so many ways, not least in funding our meetings. Thanks too, to our publisher, Springer. But final thanks are reserved (in anticipation) for you - we will know that we did a good job when you start using our findings to increase your knowledge and to build better roads!

Best wishes,

Mr. Andrew Dawson

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Short lifetime due to water intrusion

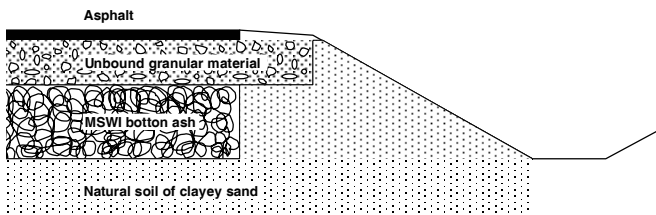
By Susanne Baltzer,
Danish Road Institute, Denmark

Case Study: An 1100 m road section in western Denmark was reconstructed and opened in the summer 2002. Unfortunately only 1½ year later the road showed severe cracking.



The reason for the distress was insufficient bearing capacity, partly due to design, but **accelerated due to an inefficient drainage system**. Water had intruded along the shoulders and was not drained efficiently off the construction, resulting in cracks along the edges of the road.

The road was constructed of a thin asphalt-concrete layer, 200 mm of unbound granular material and 400 mm Municipal Solid Waste Incinerator (MSWI) bottom ash on top of the natural subsoil, as the cross section below shows. The layer thicknesses were slightly under-designed for the traffic, but should have been able to last considerably longer than 1½ years. But the bottom ash used has a higher fines-content than recommended by the guidelines, which makes it less efficient as drainage layer and as capillary brake. And this was not taken into account by other means in the construction.



The road has drains in both sides. On some sections they consist of open ditches, on other sections of subsurface drains. Both types of drain systems were not well-maintained. Shoulders were not profiled so that water could run to the ditches, and in some places the vegetation stopped water from running to the drains – see photos below.



Blast Furnace Slags should not be used below water table

By Andrew Dawson,
University of Nottingham, UK



Case Study: This case was selected in order to assess the long-term risks from the use of Blast Furnace Slag (BFS) as an alternative aggregate to traditional ones. The main A66 road through the beautiful English “Lake District” in Cumbria was constructed in 1975. Part of the route took the road over an acidic marshy area. So the natural soil was removed and the area was back-filled with approximately 300,000 tonnes of BFS – a locally available industrial by-product. At some sites the slag was used below the water table.

There were large contamination problems early in the life of the road, which were most likely due to the leaching of contaminants from the slag. This leaching was at its greatest for the first 1 to 2 years in the life of the road. The reasons for this initially large increase in concentrations of leachates were probably two-fold: firstly, initial contaminant wash-off from rain on the slag resulted in high concentrations in the wash-off; and secondly due to the drought of 1976 less available rain resulted in water remaining in contact with the slag for longer than normal, leading to highly contaminated water when it did drain from the road.

One of the main problems with the construction of the road was that it was constructed on an area of peat bog, much of which lay below the water table, resulting in eventual drainage becoming highly contaminated. Recent recommendations by the Building Research Establishment of UK are that “*unbound BFS should not be used below the water table or in waterlogged or poorly drained areas*”. In the case of the A66 the BFS was used below the water table, because there were no such recommendations in place at the time of construction. Although the highest concentrations of contaminants occurred within the early life of the A66, data obtained in 2001 shows that continuing leaching of contaminants is an on-going process, although at a much reduced rate.

However, if BFS were to be used in construction nowadays as an alternative to traditional aggregate above the water table in its unbound form, leaching of contaminants would probably be far below the levels that occurred in the case of the A66 in Cumbria. In such a situation any leachate could only reach high concentrations of contaminants if surface cracking deteriorated to a state that allowed a large infiltration of rainfall.

WATMOVE to produce a book - "Water in Roads"

In the Watmove team, we are well advanced in producing a book to contain the major outputs of our work. It aims at covering all aspects of water and water movement IN roads and their immediate surroundings. We would have liked to cover road surface drainage as well, but that would have more than doubled our work, so we've decided to limit ourselves to water inside the road. Of course, a lot of that water comes from infiltrating run-off, so we cover some aspects of run-off, too.

The book looks at the effects of moisture on performance, how water moves in the pavement and its surroundings, how it can be controlled, sub-pavement drainage design and the environmental issues associated with the protection of ground and surface water due to seepage of water from run-off or from leaching construction material. It has been our aim to produce a book that both contain chapters that explain the theory, and also chapters that can be used by practicing engineers.

The book will be published in the winter 2007/08 by the international publishers Springer Science. We hope that this will ensure the book's wide availability.

For more information – or to **sign up for a note** when the book is released, please contact our chairman:

Andrew Dawson at andrew.dawson@nottingham.ac.uk

Conference Announcements

Int'l. Conf. Advanced Characterization of Pavement & Soil Eng'g Materials, 20-22 June 2007, Athens, Greece, www.3dfem.org.

PIARC 23rd World Road Congress, 17-21 September 2007, Paris, France, www.piacr.org/en/paris2007

NR2C Final Workshop, 16 November 2007, Brussels, Belgium, www.fehrl.org/index.php?m=32&mode=download&id_file=1392

3rd European Asphalt Technology Association (EATA) Conference, 14-15 April 2008, Lyon, France, http://www.lcpc.fr/en/actualites/manifstation_detail.dml?id=158

TRA – Transport Research Arena Europe, 21-25 April 2008, Ljubljana, Slovenia, www.TRA2008.si

Int'l. Symp. Asphalt Pavements & Environment, 18-20 August, 2008, Zürich, Switzerland, www.empa.ch/isap2008/

1st International Conference on Transportation Geotechnics, (Int'l. Soc. Soil Mech. & Geotech. Eng.) AND The 7th International Symposium on Unbound Aggregates in Roads (UNBAR7), 25-27 August 2008, Nottingham, UK, <http://www.nottingham.ac.uk/ngc/course/ISSMGE-2008-flyer1.pdf>

Special issue of the International Journal of Road Materials and Pavement Design

A special issue of the Road Materials and Pavement Design journal will be published in the summer 2007. It contains a selection of invited, full-length, peer-reviewed manuscripts from the international workshop "Water in Pavements WIP'05", held in Madrid, Spain on 27th October 2005. The papers presented in this special issue give a complete picture of the recent developments in the area of mechanical and environmental aspects of the water in pavements. In particular, they address performance-related properties, modelling and the monitoring of water flow and moisture within pavements and subgrades.

This special issue is a part of the dissemination activities of the COST 351 WATMOVE action. It constitutes a suitable overview of the most innovative research on water in pavements, and it is to be associated with the soon-to-be published book by the WATMOVE team at Springer Science.

Lyette Laloui and Jose Miguel Baena are guest editors of the special issue. Papers in the special issue are:

"Incorporation of environmental effects in pavement design"
by C.E. Zapata, D. Andrei, M.W. Witzczak, W.N. Houston

"The quality of infiltrated water through porous and conventional asphalt pavements"
by M. Legret, V. Colandini, C. Pagotto, A. Jullien

"Prediction of permanent deformations of unbound granular materials"
by P. Hornych, C. Chazallon, F. Allou, A. El Abd

"State-of-practice in prevention of water-born pollution from pavements"
by A. Dawson, S. Baltzer

"Unified stress framework for modelling unsaturated subsoil behaviour"
by M. Nuth, L. Laloui

Another five papers are still in the review process and will, hopefully, also appear in the special issue.

For more information, please contact:
Lyette Laloui at Lyette.Laloui@epfl.ch



Water in Pavements - WIP'06 & WIP'07

2006 in Constanta, Romania

Our first dissemination seminar took place in 2005 in Madrid. Last year we gave an overview of the results of the COST351-action in Constantza, Romania on September 12th. 4 presentations summarised important chapters in the final book to be published (read more page 3). In a fifth presentation, Professor Radu Andrei of Technical University " Gh. Asachi" of Iasi, related the COST351 work to the Romanian situation, and gave examples of where the results could be applied. It was the first seminar given in Romania by any COST Action from the Transport and Urban Development domain. You can down-load the presentations from the WATMOVE homepage www.watmove.org. Their titles and subjects are:

- Water Flow - Theory, Measurement and Application to Highway Engineering
- Water Impact on Pavement Granular Materials' Behaviour
- Contaminants in the Highway Sub-surface - Principles, Experience and Monitoring
- Practical Highway Design – Drainage
- Adapting the COST 351 research results to the Romanian conditions.

During the meeting in Romania, the COST351-group had the pleasure of a field trip to a motorway construction site. On the way we visited the beautiful Cernavoda bridge over River Danube (pictured below). The Cernavoda bridge is a national monument, designed and constructed by the Romanian engineer Anghel Saligni. The WATMOVE-project would like to thank Professor Virgil Breaban of the Ovidius University of Constantza for hosting this excellent meeting and seminar.



The COST 351 team in front of the Cernavoda bridge

2007 in Athens, Greece

Our final seminar is being held as part of the International Conference on Advanced Characterization of Pavement and Soil Engineering Materials from 20-22nd June. We're really thankful to the conference organisers (especially Prof. Andreas Loizos) for allowing us to present as part of the conference. The WATMOVE "strand" will be held on the afternoon of June 20th and looks like this:



Session 1 – 14:00 – 16 :05

1. *Introduction on COST 351 action*, A. Dawson
2. *Technical overview of road deterioration due to water, and about the contaminants in the road environment*, by S. Baltzer and A. Dawson
3. *Transport of moisture in temperate and cold regions*, by A. Hermansson, S. Erlingsson et al.
4. *Water influence on mechanical behaviour of pavements: numerical and constitutive models vs. experimental evidence*, by R. Charlier, L. Laloui, C. Cekerevac et al
5. Paper IJRMPD: *Prediction of permanent deformations of unbound granular materials*, by Pierre Hornych, Cyrille Chazallon, Fatima Allou, Absamad El Abd. Laboratoire Central des Ponts et Chaussées, France

Session 2 – 16:20 – 18:25

6. *Roads as a source of water contamination*, by M. Brencic, T. Leitao, L. Folkeson et al.
7. *How to control water in and around roads, a review of good European practices*, by S. Baltzer, J. Santinho Faisca, A. Dawson et al
8. Paper IJRMPD: *State-of-practice in prevention of water-born pollution from pavements*, by Andrew Dawson et Susanne Baltzer
9. Paper IJRMPD: *Unified stress framework for modelling unsaturated subsoil behaviour*, by M. Nuth, L. Laloui,
10. *Panel discussion*
11. *Conclusions* by A. Dawson