



COST 351

WATMOVE

Water Movements in Road Pavements and Embankments

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Executive summary

The brief report gives an overview of the activities of the COST 351 Action on “Water Movements in Road Pavements and Embankments”. The Action’s team includes representatives of 18 countries, an increase from 14 which started the Action in late 2003. The Management Committee comprises experts from a wide range of disciplines and representing a diverse cross-section of the stakeholders of the topic.

The team are addressing the following issues:

- Water and seepage in the lower pavement layers and the upper part of the subgrade, in the zone of influence of traffic loading, extending to the water table where contaminant seepage is of concern,
- The production of a textbook that will be the principal final output, suitable for practising engineers,
- The collection of in-situ performance data whenever possible, particularly on best-practice,
- Run-off water as well as seepage water as regards contaminant movement, and
- Heat-flow so as to be able to understand water flow driven by freezing or thawing.

The Management Committee has met twice in 2005, in Paris and Madrid, with the Working Groups meeting sequentially with the Management Committee as well as alone on one other occasion in Bruxelles. The working groups have defined in considerable depth the topic matter to be presented by the Action and have already drafted approximately 50% of the text, although progressed has been slowed due to inadequate funding being available for all activities. In parallel, some continuing questionnaire work on best-practice has been performed. The web-site is now well established for members and some public information is available. The short-term scientific mission programme was curtailed due to the funding difficulties. Special emphasis was given to a “Water in Pavements” international workshop held in Madrid in October as a means of informing external members of the work of the Action and in attracting input to our tasks from external experts.

In 2006 the principal tasks to be addressed are:

- Remaining drafting of the text book.
- Assimilation of the replies to questionnaires.
- Outstanding Short-Term Scientific Missions
- Issuing a further copy of our Newsletter.

One or two more Management Committees (with Working Group meetings) and two or three other sets of Working Group meetings are envisaged, dependent on funding.

1 Introduction

COST Action number 351 held its first Management Committee on December 19th 2003 in Bruxelles. Since then the members have met four further times as a Management Committee, have elaborated the details of the tasks that need to be addressed and have made substantial progress in those tasks. In addition, working groups of the Action have met on up to seven occasions, usually in conjunction with the Management Committee meetings and sometimes separately. This report summarises the progress that has been made against the objectives, particularly in the second year of the programme. Details of progress in the first year can be found in the 1st Annual Report, dated 1st December 2004.

2 Membership

The Action entered into force on the 12th June 2003 but, due to fiscal constraints, did not commence active work until the first meeting of the Management Committee on December 19th 2003, despite the Memorandum of Understanding (MoU) having been accepted by the COST organisation in 2002. At the time of commencement the Action had six signatories. A further 12 countries have joined since the start with one (Romania) completing signature since the date of the first Annual Report. The Action is currently due to end on the 18th of December, 2006. Table 1 list the signatory countries and the date of joining the Action.

Table 2.1 Membership of COST351

Country	Date of Signature of MoU
Belgium	11/06/2003
Croatia	12/06/2003
Czech Republic	21/04/2004
Denmark	29/01/2004
Finland	11/06/2003
France	11/06/2003
Greece	02/06/2004
Iceland	01/07/2004
Norway	29/01/2004
Poland	29/01/2004
Portugal	31/03/2004
Romania	15/12/2004
Serbia and Montenegro	21/04/2004
Slovenia	11/06/2003
Spain	08/10/2004
Sweden	29/01/2004
Switzerland	10/09/2003
United Kingdom	29/01/2004

3 Management Committee

Most of the member countries send two delegates to the Management Committee (MC). In the case of a few countries three delegates are identified, two of them being present at the MC meetings. This allows for illness or for other commitments. The current list of members is shown in Table 3.1.

Table 3.1 List of Management Committee Meeting Members

Name	Institution	Country
Jostein Aksnes	Norwegian Road Administration	Norway
Radu Andrei	Technical University "Gh. Asachi", Iași	Romania
Torleif Baekken	NIVA (Water Institute)	Norway
José Baena	CEDEX (Road Institute)	Spain
Susanne Baltzer	Danish Road Institute	Denmark
Gunnar Bjarnason	Icelandic Road Administration	Iceland
Virgil Breaban	"Ovidius" University of Constanta	Romania
Mihael Brenčič	Geological Survey of Slovenia	Slovenia
Cane Cekerevac	Ecole Polytechnique Fédéral de Lausanne	Switzerland
Robert Charlier	University of Liège	Belgium
Cyrille Chazallon	University of Limoges	France
Andrew Dawson	University of Nottingham	UK
Sigurdur Erlingsson	University of Iceland	Iceland
José Santinho Faisca	Estradas de Portugal, EPE (Portuguese Road Agency)	Portugal
Lennart Folkesson	KTH (Royal Institute of Technology)	Sweden
Denis François	LCPC (Road Institute)	France
Beata Gajewska	IBDIM (Road and Bridge Research Institute)	Poland
Åke Hermansson	VTI (Road & Traffic Institute)	Sweden
Pierre Hornych	LCPC (Road Institute)	France
Matti Huhtala	Retired (formerly VTT)	Finland
Antonios Kaltsounis	University of Athens	Greece
Aleksandar Kostadinovic	IMS (National Civil Engineering Institute)	Serbia & Montenegro
Cezary Kraszewski	IBDIM (Road and Bridge Research Institute)	Poland
Petra Kurimska	CDV (Transport Research Centre)	Czech Republic

Rainer Laaksonen	VTT (Road Research Institute)	Finland
Lyesse Laloui	Ecole Polytechnique Fédéral de Lausanne	Switzerland
Teresa Leitão	LNEC (National Civil Engineering Laboratory)	Portugal
Roman Licbinsky	CDV (Transport Research Centre)	Czech Republic
Wyn Lloyd	Highways Agency	UK
Nikolaos Michas	Greek Road Federation	Greece
Goran Mladenovic	University of Belgrade	Serbia + M.
Antero Nousiainen	Tieliikelaitos (Road Operator)	Finland
Primož Pavšič	ZAG (Civil Engineering Institute)	Slovenia
Paulică Răileanu	Technical University "Gh. Asachi", Iași	Romania
Mate Sršen	IGH (University/ Civil Eng. Institute)	Croatia

The Action's team has a wide spread of disciplines represented - Geology, Water Resources, Highway Owners & Operators, Materials Engineers and Pavement Designers. This is a strength of the Action. Also, there is a good mix of academic, policy and research institute membership.

Mr Andrew Dawson, Associate Professor in the Nottingham Centre for Pavement Engineering (UK) has continued as chairman throughout the year. Prof. Charlier is vice-chair and Ms Susanne Baltzer, Prof. Siggurdur Erlingsson, Dr. Mihael Brenčič and Prof. Charlier are the chairmen of Working Groups (WG) 1, 2, 3 and 4, respectively. Ms Baltzer had been working on questionnaire matters independently of formally establishing a WG. For this reason, WG 1 acts in an ad hoc manner receiving requests for data from the MC and other WGs. Ms Baltzer seeks assistance from others to complete WG1 tasks as required. No permanent membership, except Ms Baltzer, exists.

4 Progress in 2005

4.1 Review MoU's of the Technical Annex

The issues concerning the relationship between the MoU's Technical Annex and the desirable outputs of the Action, discussed in more detail in the first Annual Report, have not entirely been finalised. There is an inherent tension between defining the state-of-the-art for researchers at the front of their fields of study and providing a best-practice guide to lead engineers, more generally, into applying scientific and technological advances in their own businesses and duties. Nevertheless, the work programme has been largely fixed and few topics have been identified during the year as needing our attention that were not already identified 12 months ago.

4.2 Management Committee

The Management Committee (MC) met in full session on 28th October in Madrid. Due to the reduced funding available, it was not possible to invite 2 members from every country to attend the other MC meeting in Paris on April 15th. The MC asked Kevin Gardner to address them at the Paris meeting on contaminant movement in the near pavement environment.

4.3 Progress of Working Groups

Working Groups 2, 3 and 4 have each met 3 times in 2005. The first meetings were in Bruxelles on 3rd-4th April, the second on 14th April in Paris, the third in Madrid on October 26th. The last meetings two of these were contiguous with MC meetings. A further set of WG meetings had been planned for September, but insufficient funding led to these being cancelled.

The Technical Annex envisages the work of WGs 2, 3 and 4 continuing until mid 2006. Given this timetable the work of these Groups is on-schedule.

Working Groups 2, 3 and 4 have identified and revised, more than once, the syllabus to be covered by the textbook. Many of the chapters have been divided up between drafting persons and drafting panels and writing has commenced on most parts with some sections now in an advanced draft. An outline of the Contents is given in Annex 2. It has changed only in detail from that given in an Annex to the 2004 Annual Report. Overall it is estimated that work has begun on drafting approximately 70% of the final output.

Ms Baltzer, for Working Group 1, has issued a revised questionnaire jointly on behalf of the other three WGs and has completed initial summarisation of the responses.

The chairman's panel has acted as a de-facto Working Group 5 (Dissemination & Reporting) rather than as a stand-alone WG as envisaged by the Technical Annex. Given the limited funding, it was felt that formally starting a further WG when there was insufficient to fund the existing WGs would be unwise. Nevertheless significant dissemination activity has occurred (see Section 4.5 of this report).

4.4 Short-term Scientific Missions (STSMs)

Due to lack of funding, it was not possible to arrange any STSMs in 2005, despite requests from 3 applicants. Of particular concern was the inability to address the goal set by the MoU of evaluating computational modelling of water flow.

4.5 Dissemination

4.5.1 Web-sites

The internal web-site for the Action members has been established by the chairman and has been well used to exchange documents, to log reference materials, to distribute committee papers, etc. A simple to remember web-site address (www.watmove.org) has been operative for almost all of 2005. It enables access to both the private material just mentioned, but also, as importantly, to the public web-site which has been widely advertised (see next sub-section). Visitors to the site can now access information on the Action, published reports (like this one) and other materials. They can also register their ongoing interest in the Action so that they can be placed on a circulation list for subsequent announcements.

4.5.2 Newsletter

The first copy of a 4 page, full colour, newsletter was prepared by Åke Hermansson. 350 copies were printed. A little over 200 were distributed to registrants of the “Bearing Capacity of Roads, Railways and Airfields” conference in Trondheim in late June. Approximately 60 were distributed to Action members for distribution in their own countries along with copies supplied to the COST office in Bruxelles. The remainder were distributed to attendees to the Action’s workshop (see below).

4.5.3 Workshop

A highlight of the year was a workshop hosted by CEDEX in Madrid on 27th October. Special thanks are due to José Baena for making all the arrangements. The workshop attracted speakers from Europe and N. America. Approximately 75 persons attended, about half of these from Spain and 12 papers were presented (see Annex 1). A selection of the papers will be edited and supplemented, then published as a special issue of the International Journal of Road materials and Pavement Design (published by Hermes). The workshop provided a powerful “shop-window” for some of the work being undertaken by Action members, allowed some of the collaborative efforts to be publicised and allowed the Action members to engage with some of the key participants in the field.

4.5.4 Final reporting

The decision to produce a text-book style output as the principal deliverable of the Action was taken in 2004. In 2005 it was decided to seek a commercial publisher for this book and the chairman approached around 7 different publishers in several of the COST member countries. At the October MC meeting he presented the results of these initial negotiations to the MC who decided that Springer was the preferred publisher. Springer was then informed and a draft contract has been received for discussion between the chairman, the COST office and the proposed publisher. This discussion is ongoing at the time of writing.

4.5.5 Other disseminations

Individual members of the Action have also been announcing the Actions' work, directly or indirectly, in their own countries and within their specialist fields of interest.

4.6 Budget

The budget for 2005 has been inadequate for the tasks required by the MoU. Furthermore, the substantial reduction of the budget indicated in the Autumn of 2004, led to severe planning difficulties and inefficiencies in the work of the Action. The level of difficulty can be best appreciated when it is considered that the original budget was €68 000 with 14 member countries, was agreed as requiring €88 000 with the COST office for a full year, was budgeted for 2005 at €70 908 Euro and then reduced to €68 000 in February of 2005. As a consequence, one of the MC meetings had a reduced invitee list, one set of WG meetings was cancelled and no STSMs were held.

5 Plan for 2006

5.1 Budget

The budget for meeting in 2006 has been further reduced from that in 2005 (to around €65 000) and, therefore, is likely to make a timely completion of the work of the Action impossible. The TCT has already been appraised of this situation. To seek to minimise the impact it was decided only to have one MC meeting in 2006 and to concentrate on several small WG meetings at which drafting of the final book would be the main activity. No specific dissemination activities are planned except a further copy of the Newsletter, subject to finding the small funds available. A small amount of the overall budget has been “earmarked” for STSMs by the COST office (see below). It is as a consequence of this that the meeting budget is further reduced.

5.2 Tasks

The chief tasks for 2005 are as follows:

- to continue with the drafting of the chapters for the text book.
- to assimilate the results of the questionnaire into the book.
- to finalise the contractual arrangements with the publishers of the text-book (Springer).
- to seek to arrange a final presentation/course for Spring 2007 (partly to promote the work of the Action and partly to get its findings into practice).
- to prepare and issue a second Newsletter in time for several conferences in the Spring / Summer of 2006.
- to maximise the work that can be achieved while keeping to the 2006 budget.

5.3 Meeting Schedule

Our planned meeting schedule was as follows (with suggested venues), but there is uncertainty with this given the further reduction of the meeting budget in 2006 from 2005 and the recent announcement of rules concerning the venues for meetings:

- Feb/March, WGs – probably at different venues to suit reduced membership.
- 20th/21st April 2006, WGs – Brno or Praha.
- June? WGs – probably at different venues to suit reduced membership.
- 14th Sept 2006, WGs/15th MC – Constantza.
- Late November / early December WG5 – editorial meeting for book – venue not yet fixed.

5.4 Short-term Scientific Missions (STSMs)

A total of five STSM's had been requested during 2004 or 2005 for which funds had not been available. With the “earmarking” of STSM funds in 2006, two of these are envisaged for 2006. A young researcher at the University of Liège (BE) will travel to

EPFL (CH) to engage in implementation of coupled mechanical-moisture movement-chemical models in analytical simulations. A young researcher from the University of Ljubljana (SI) will travel to Sweden (KTH and VTI) to study environmental pollution control strategies.

5.5 Final conference/course

We are currently investigating the possibility of holding a conference or course soon after the end of the Action. We will need to plan this in 2006. The decision will, of course, be heavily dependent on budgetary matters.

5.6 Web-site

The www.watmove.org web-site is now a major means of communication amongst the team and, increasingly to provide information about the Action. The Annual reports are mounted there, for example.

6 Conclusions

2005 has been a mixed year. It has been successful in so far as a team of dedicated engineers, scientists and administrators have engaged in steps towards the production of a state-of-the-art book recording the best practice in the area of Water Movements in Road Pavements and Embankments. It was also very successful in regards to the “WIP 05” workshop held in Madrid in October. The Newsletter has also made the Action more widely known. However, it also a frustrating year in so far as budget restrictions and changes necessitated no STSMs, a reduced participation by our enthusiastic team and a reduction in working group meetings. This latter difficulty has had the effect of reducing the progress of the Action as the WGs are, in effect, the engines driving the Action forward.

In the conclusions to the 2005 report it was said that successful delivery of work that meets the aims of the Action, depends on two things: an enthusiastic team and a realistic budget. Experience confirms the existence of the first but gives rise to concern about the second.


ANNEX 1


WATER IN PAVEMENTS WORKSHOP - Programme


Session 1

PERFORMANCE RELATED PROPERTIES OF THE PAVEMENT AND SUBGRADE MATERIAL

KEYNOTE: *Incorporation of environmental effects in pavement design* - M.W. Witczak, W.N. Houston, C.E. Zapata & D. Andrei, USA

 *Chemistry, suction and temperature - a unified constitutive mechanical model* - F. Collin, L. Laloui & R. Charlier, SWITZERLAND


 *Prediction of permanent deformations of unbound granular materials, in relation with the moisture content* - P. Hornych, C. Chazallon, A. Elabd & A. Fatima, FRANCE


 *Influence of moisture changes in subgrade performance* - J. Baena & R. Romero, SPAIN


Session 2


MODELLING AND MONITORING OF WATER FLOW AND MOISTURE WITHIN PAVEMENTS AND SUBGRADES

KEYNOTE: *Design, construction & maintenance of subsurface drainage systems: a Spanish perspective* - A. Parrilla, SPAIN

 *Predicting moisture movement under pavement systems* - Y.Y. Perera, C.E. Zapata, W. N. Houston, USA

 *Hydraulic aspects of block pavements: development of a hydraulic model for the water and particle movement in street layer course under pavements* - P. Ampe, J. De Corte & G. Delepeleire, BELGIUM


 *Measuring, predicting and specifying moisture in granular pavements with thin surface seals* - B. Vuong, AUSTRALIA


 *Drainage in reality - a survey of practising engineers in the UK* - A. Dawson & P. Boothroyd, UK

Session 3

ENVIROMENTAL ASPECTS

KEYNOTE: *Contribution of fluxes within the pavement and embankment to the overall road enviromental pollution* - Michel Legret, FRANCE

 *Modeling hydrology and reactive transport in roads: the effect of cracks, the edge, and contaminant properties* - D. Apul, K. Gardner & T. Eighmy, USA

 *Effects of Average Daily Traffic, Overlay Date, and Pavement Conditions on Highway Runoff Metal Concentrations* - L.E. Miller, D. Apul, USA

ANNEX 2

Draft Table of Contents

1. Introduction
2. Relationship between water & roads
3. Water flow theory in saturated and unsaturated soils
4. Heat transfer in soils
5. Measurements techniques for water flow
6. Computer modelling for water movement and heat transfer in pavements
7. Contamination of water and soil
8. Measurement techniques for contamination detection & evaluation
9. The mechanical effects of water in pavement and its control / theoretical aspects / mechanical constitutive modelling.
10. Mechanical behaviour: experimental investigation, dependency on water and moisture
11. Coupled hydro - mechanical modelling of pavement materials
12. Applications: water influence on bearing capacity and pavement performance
13. Advice on control of pavement water
14. Advice on pollution mitigation
15. Remedial methods for pollutant leaching
16. Conclusions and Recommendations