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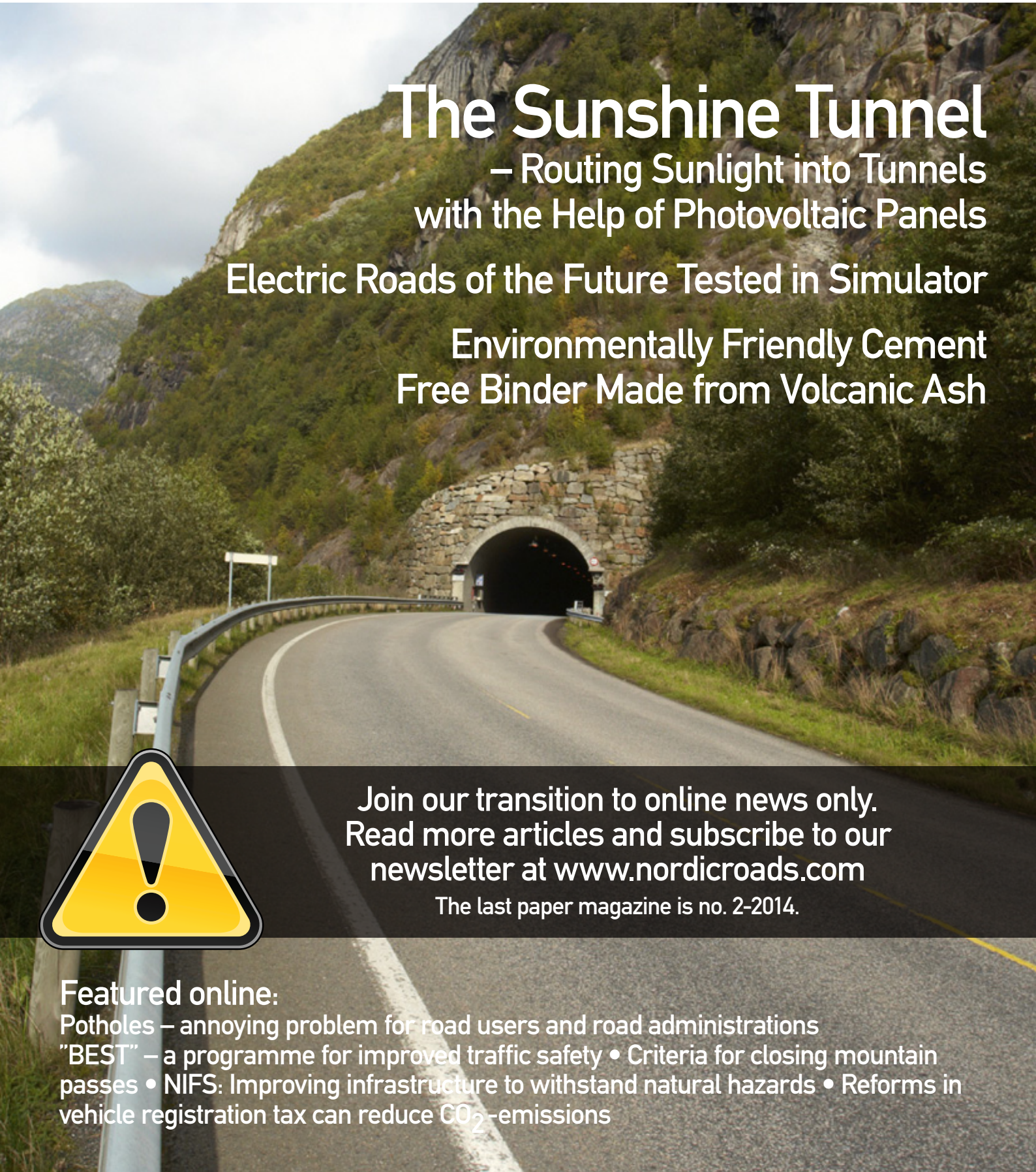

The Sunshine Tunnel
– Routing Sunlight into Tunnels with the Help of Photovoltaic Panels

Electric Roads of the Future Tested in Simulator

Environmentally Friendly Cement Free Binder Made from Volcanic Ash

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Featured online:

Potholes – annoying problem for road users and road administrations • "BEST" – a programme for improved traffic safety • Criteria for closing mountain passes • NIFS: Improving infrastructure to withstand natural hazards • Reforms in vehicle registration tax can reduce CO_2-emissions

Illustration: Trafikverket

Electric Roads of the Future Tested in Simulator

Transport that depends on fossil fuels is to be minimised by the year 2030. One conceivable alternative is for future cars to be powered by electricity supplied via the roadway. Working together with the Swedish Transport Administration and Viktoria Swedish ICT, VTI is launching a comprehensive research project to test electrified roads in a driving simulator.

The environmental goals of the Swedish parliament will entail a major overhaul of the transport sector, and so research initiatives are needed in many areas. With the help of its advanced driving simulators, VTI can generate additional knowledge for research into the electrification of roads, which is poised to pick up speed in Sweden and other European countries. The Swedish Energy Agency has granted just over MSEK 7 in research funding.

Simulator offers perfect test environment

There are three main proposals for transferring electricity to a vehicle in transit: via overhead lines, via lines in the roadway or via magnetic fields in the road (inductive transfer). These alternatives have different advantages and disadvantages in terms of factors such as capacity, safety and aesthetics. Using a driving simulator, it is possible to model different technical solutions and study the interactions between infrastructure, vehicle and driver.

"Simulators are perfect for studying systems and environments that are not yet available, as they are flexible, safe and cost-effective. In this project, we will create models for electrified roads, electric vehicles, payment systems and driver support systems," says VTI project manager and researcher Arne Nåbo.

Focus on the user

When carrying out such a major overhaul, it is important to take the users into account to ensure that the systems will be user-friendly and widely accepted.

"In the initial phase, we will create a virtual demonstration environment. The simulator will allow test subjects to experience what it is like to drive on electrified roads, and allow us to study driver behaviour," says Nåbo.

The user studies will test the ability of the driver to maintain a good position on the road, which is important if the transfer of electricity is to function correctly. The research group will also study the driver's experience and acceptance of electrification. Another important element is to study how road electrification can be realised in the road environment, and what it will look like.

Demonstrations in 2014

The simulator can be used throughout the full process from concept to market introduction. Proposed concepts for products and services, such as driver support systems for energy-efficient driving, will be tested and demonstrated. In this way, use of the simulator will stimulate development and cooperation surrounding the electrification of vehicles and roads, allowing the early introduction of high-quality systems.

"Simulator demonstrations are a great way of marketing new transport solutions. In the second project phase, we will run demonstrations for financiers, actors, stakeholders and the media, so that concepts and knowledge can be experienced and disseminated," says Nåbo.

The project is being conducted as part of the Swedish Energy Agency's demonstration programme for electric vehicles. The results will be provided to organisations including the group within the Forum for Innovation in the Transport Sector that is working on the roadmap for the electrification of transport. The project will run until January 2015.

Text: Eva Åström

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Level Crossings – Can Road Users Detect Them in Time?

Safe traversing of a road-railway level crossing requires that road users can detect it early enough to stop their vehicle in time if needed. We studied whether actual detection distances at passive level crossings are adequate from the viewpoint of existing regulations and safety.

Photo: Tapio Ahonen

1 048 approaches to passive Finnish level crossings on main railway lines were studied to find out if car drivers could detect the crossing early enough. The distance at which an approaching driver could first detect level crossing was estimated from photos and video recordings collected in earlier studies.

The current regulations – that concern only new and improved level crossings – correspond roughly to the sum of the distance the vehicle travels during the reaction time of 1.7 seconds, and the distance needed to stop the vehicle when braking at constant deceleration of 3 m/s^2. From a safety point of view the reaction time used in the calculation should rather be 2 seconds and the deceleration during braking 2 m/s^2. The approach speed of the road vehicle should not exceed 50 km/h. At that speed the minimal detection distance according to current regulations would be 55 m, and for a speed of 30 km/h it would be 26 m. Using a reaction time of 2 s and deceleration of 2 m/s^2 would result in an increase of detection distance requirements by approximately one third. It was estimated that the detection distance of passive level crossings was not long enough for safety in 11–17% of cases. A number of recommendations were made for improved detection of level crossings.

This study was part of the Traffic Safety 2025 research program: https://bitly.com/trafficsafety2025

Text: Veli-Pekka Kallberg

Full report (English abstract): http://bit.ly/vtt123

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Management of Safety and Reliability in Road Transport Companies

The bigger the company is, the more likely it is to exploit existing practices and policies to manage the relevant sub-branches of safety. The recommendation is that the practices and policies employed by larger companies be put to use also in small and medium sized companies.

Photo: Shutterstock

The aim of this study was to identify (1) the practices and policies used by road transport companies to manage various sub-branches of safety, (2) how widely road transport companies exploit existing standards and guidelines to manage their safety, quality and environmental issues, and (3) the benefits and challenges experienced by the companies when using these standards and guidelines. The information was collected via a web survey, which was completed by 562 road transport companies.

The main reasons for using standards and guidelines to manage safety, quality and environmental issues are related to greater reliability, the company's image and marketing edge, and the need for systematic improvement of these issues.

Based on the results of this study, we recommend that the practices and policies employed by larger companies be put to use also in small and medium sized companies. This can be done e.g. via transport contracts and related audits. The other alternative is to include the specific practices and policies in the tendering process, which means that the companies taking part in the tendering process will pledge to use the recommended or required practices.

This study was part of the Traffic Safety 2025 research program: https://bitly.com/trafficsafety2025

Text: Anne Silla

Full report (English abstract): http://bit.ly/vtt149

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Photo: Jørgen Wanvik

The Sunshine Tunnel

Most tunnels rely on a complex web of power cables feeding electricity from distant energy sources to power light fixtures mounted in the ceiling. At the same time the tunnels are surrounded by daylight. A new pilot project at the Norwegian Public Roads Administration (NPRA) aims to challenge this rather counterintuitive way of lighting our tunnels by routing the outside sunlight into the tunnel.

This is to be done by way of photovoltaic panels mounted discretely at the tunnel entrance. Once the electricity has passed through inverters and cables the LED fixtures will essentially reverse the photovoltaic process and reemit the light down to the tunnel surfaces.

This pilot project is part of a collaboration between the R&D program Lower Energy Use in the Norwegian Road Administration (LEIV), and students at the Norwegian university of science and technology (NTNU). As part of my master thesis, I aim to design a photovoltaic plant to power a short tunnel in the western county of Rogaland. As of date, the tunnel is pitch black and a hazard for road users. The road is categorized as a Norwegian tourist road and is currently located outside the energy grid. This means that there are high costs associated with connecting the tunnel to grid electricity. This provided an opportunity for the NPRA to experiment with solar power.

Advantages

The price of solar power is declining. Deutsche Bank says that in January 2014 more than 19 countries are under grid parity. The world's biggest markets, China, India, the U.S and Germany are expected to experience a second gold rush of photovoltaic investments. This will inevitably lead to a market for solar power also in Norway. It is therefore of importance for large contractors to gain some experience with the use of PV.

The actual cost of powering the tunnel will dramatically decrease, and the NPRA will have a large photovoltaic plant to use for research.

Testing of new concepts and technology

The tunnel, Kjøladalstunnelen, will be the location for the testing of several new technologies. The tunnel will have traffic controlled lighting, meaning that a radar will detect vehicles and activate the light sources as they approach the tunnel.

Guiding lights are also to be installed to see if it improves the visibility of cyclists and pedestrians.

In addition to normal lighting according to today's standards, a new concept of illuminating short tunnels will be tested. The technique of using a band of light in the middle of the tunnel. This will reduce the energy consumption. Both the visual and economical effects of the reduced light will be studied.

The Photovoltaic plant

To meet the energy demand of the tunnel during the winter months the photovoltaic plant must be supplemented by for example a conventional gasoline generator. The cost of storing the PV energy in batteries for use in the low producing months of December and January would be much too high. Still, the PV plant will supply about 90 % of the annual energy. 50 photovoltaic modules with a combined peak production of 13 kW are to be installed with a 24 unit battery storage. The 85 m^2 of panels will deliver 5.75 MWh annually.

Text: Jørgen Wanvik

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Environmentally Friendly Cement Free Binder Made from Volcanic Ash

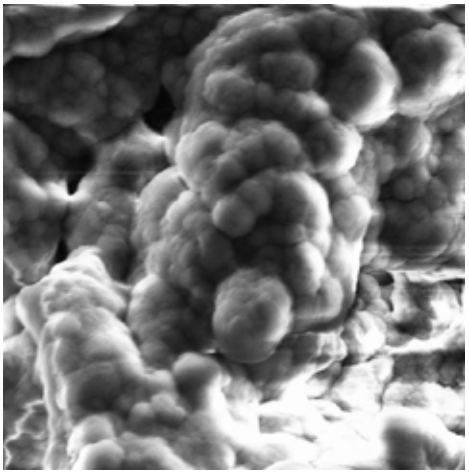
Concrete is the most produced material in the world to date, with around 23 billion metric tons being produced annually. Although concrete itself does not have a large carbon footprint per unit volume, this massive production means that it is a huge contributor to the total carbon emissions due to human activity. Nowadays around 10 % of all anthropogenic greenhouse gas emissions are due to concrete production and thereof around 6–8 % can be attributed directly to the production of cement, where large amounts of CO_2 are emitted because of the decalcination of limestone and the burning of fossil fuels in cement kilns.

At the Innovation Center Iceland (ICI), investigations regarding environmental solutions for the concrete and the building industry have been going on for several years. One of these solutions is the development of a cement free binder using waste materials in Iceland. The project initially started as a response to the eruption of Eyjafjallajökull in 2010, with the aim of using some of the vast amounts of volcanic ash as a source material for a geopolymer binder.

Geopolymers or alkali activated binders are inorganic aluminosilicate polymers, synthesized from predominantly silicon and aluminium materials of geological origin (like rocks, clay, mud, etc.) or by-product materials such as fly ash, silica fume or slag. In fact it can be said that any kind of silica or alumina source that easily dissolves in basic solution, can act as a precursor for a geopolymer cement free binder and take part in a geopolymerisation process. The material selection for geopolymers depends on aspects such as source availability, type of application, cost and specific requirements of the end users.

The project started off by exploring how volcanic ash could be activated. Once this was successfully achieved, other waste materials from Iceland were investigated. Geothermal silica (from run-off water from geothermal power plants) was incorporated into the mix with positive results. The addition of diatomite, the fossilized remains of aquatic single celled algea that is common in the northeast of Iceland, has also been investigated. Alongside these investigations, the addition of supplementary cementitious materials (silica fume, fly ash and slag) was examined, as well as waste products from the aluminium industry.

Eyjafjallajökull eruption in 2010.



Scanning Electron Microscope (SEM) image showing the gel like microstructure of the binder.

Photo: Brynjar Gauti Sveinsson, David Karná

Dr. Kristján Friðrik Alexandersson and Sunna Ólafsdottír Wallevik are both part of the project.

The work has led to mix designs of very environmentally friendly binders, as well as the creation of a substantial knowledge database of how a number of Icelandic waste materials can be alkali activated and/or how they can be used to compliment such an activation. For example, the research work has identified how volcanic ash based mix design can be altered to enable much more practical curing conditions.

The future applications of these environmentally friendly binders are similar to those of conventional concrete, although initially they are expected to be used in more restricted projects. The use of these binders will also depend on the utilization of performance based concrete specifications rather than prescriptive based specifications. The positive characteristics of these environmentally friendly binders have already attracted attention from outside the construction industry and variations on these binders may go into production this year.

The research work has received generous funding from the Icelandic road directory and the author would like to extend her thanks for the support.

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Norway Number One Electric Vehicle Country

A long lasting broad interaction between private enterprises, public authorities and non-government organizations, have resulted in Norway being home to the largest per capita Electric vehicle market in the world.

Photo: Michael W J Sørensen, TØI

The Electric vehicle market in Norway is expected to continue to grow as more models are coming on the market.

The Electric vehicle share of the total vehicle market was around 3 per cent in the first half of 2013 and the share of the fleet reached 0.5 per cent. At the end of 2013 sales increased so that total market share for 2013 reached 5.6 per cent and the share of the fleet 0.8 per cent.

Electrification of vehicles is an important measure to reduce environmental impacts and climate gas emissions from transport. Electric propulsion is energy efficient, does not cause local emissions and reduces noise. The main challenges with electric propulsion is related to range, price and the production of batteries.

From the 1990s Electric vehicles have been high on the political agenda in resulting in the introduction of incentives necessary to meet market challenges, and encourage the early adopters to test the new technology. Economic incentives such as exemption from vehicles taxes (registration tax, VAT) have secured the potential to sell Electric vehicles competitively. Reductions in the annual circulation tax on vehicle ownership and exemptions from toll road charges, reduce the owner costs compared to conventional vehicles.

The public investment support for charging infrastructure reduces the range issue in daily transport activities. The access to bus lanes has only been available for the Electric vehicle owners. The combined effect of these and other incentives, has made Electric vehicles popular with increasingly larger shares of car buyers.

The Electric vehicle market in Norway is expected to continue to grow as more models are coming on the market, and given the government decision to extend the economic incentives through 2017. Further into the future the market will depend on future incentives, market- and technology developments, and the competitiveness of Electric vehicles compared to other technologies.

Text: Erik Figenbaum

Report (in English) : Electromobility in Norway - experiences and opportunities with Electric vehicles. TØI report 1281/2013 Authors: Erik Figenbaum and Marika Kolbenstvedt. http://bit.ly/1281-2013

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Scrappage Premium Unfavorable for Climate

A temporay car scrappage premium as implemented in Norway in 2015 will hardly affect the life-cycle climate footprint of the Norwegian passenger car fleet. In fact, the impact is more likely than not to go in an unfavorable direction.

From 2020 onwards, the emission volume is higher in the scrappage premium scenarios than in the corresponding reference paths. This is so because the mean annual distance driven per car is projected to increase under the fleet renewal scenarios. Newer cars are nicer and represent a more competitive travel mode. Also, the car scrappage premium tends to affect low value cars more than the more expensive ones, leading to a disproportionately large outflow of smaller, petrol driven cars. These cars are not the worst culprits in terms of fuel consumption and CO_2 emission. To the extent that they are replaced by newer, but larger cars, the gain in terms of carbon footprint is limited.

Text: Lasse Fridstrøm

Report (English summary): Car scrappage premium – a GHG abatement measure? TØI Report 1292/2013. Authors: Lasse Fridstrøm, Vegard Østli and Kjell Werner Johansen. http://bit.ly/1292-2013

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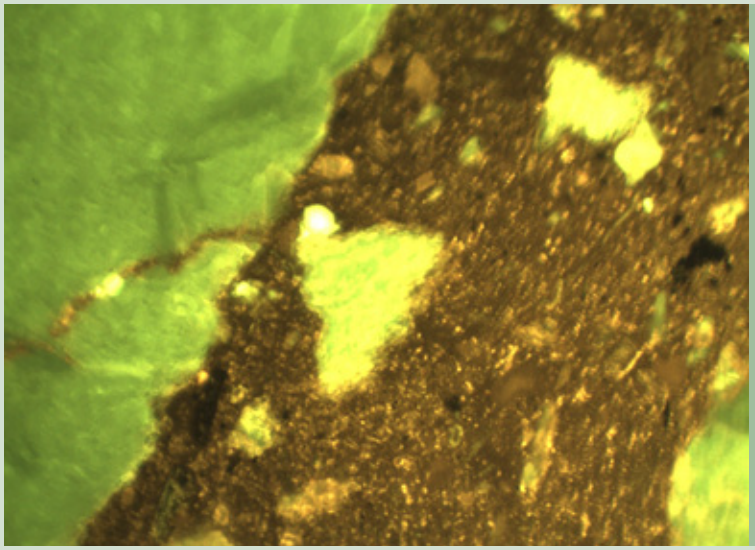
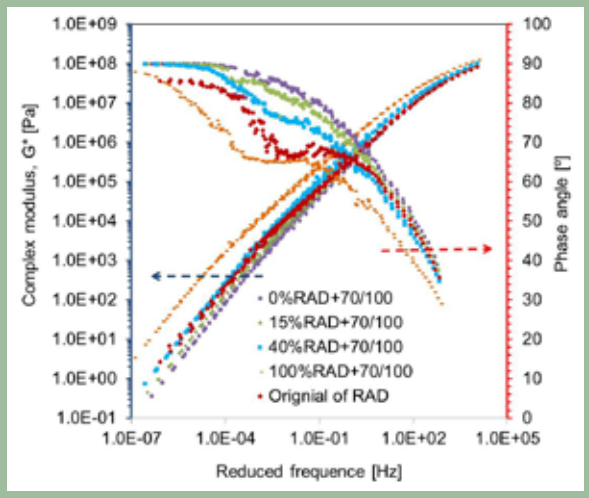


Photo: Annette Neidel

Microscopy analysis of SMA containing 40 % polymer modified reclaimed asphalt. In UV-light tiny bright yellow spots reveal presence of SBS polymer in the mortar phase between aggregate grains.



DSR mastercurves of blends between polymer modified reclaimed binder (RAD) and bitumen 70/100

Polymer Modified Reclaimed Asphalt – Revealing the Potential

In 2011 ERANET Road issued a call for research projects under the theme Design: Rapid and Durable Maintenance Methods and Techniques. A project proposal RECYPMA was granted funding in a cross-border joint research programme from October 2011 to September 2013. The acronym is an abbreviation for the long project heading "Possibilities for High Quality Recycling of Polymer Modified Asphalt".

Polymer modified bitumen and asphalt have now been in use for more than two decades many places in Europe. This means than we now are approaching a situation where increasing amount of polymer modified reclaimed asphalt (PMRA) is "harvested" in maintenance of roads due to milling and otherwise. The RECYPMA project has been engineered to study the possibilities and conditions for exploring the potential of the polymer modified reclaimed asphalt as part of a new premium binder.

A consortium of four partners was established with TNO (the Netherlands) as project coordinator. The other participants were

- The Technical University Delft (TUD), the Netherlands
- The University of Zilina (UNIZA), Slovakia and
- Vejdirektoratet (DRD), the national road administration, Denmark

The objective of the project gave special focus to the conditions for the polymer SBS (Styrene-Butadiene-Styrene) due to its dominating position for road applications with bituminous binders. Each of the three countries provided a representative variation of PMRA containing SBS modified bitumen: Stone Mastic Asphalt (SMA11, 22 years old), dense graded Asphalt Concrete (AC11, 15 years old) and Porous Asphalt (PA4/8, 7 years old).

In order to optimize extraction of a representative binder from the reclaimed asphalt a literature review combined with a questionnaire issued to leading laboratories and research facilities was performed. The conclusion was that extraction method (EN 12697-1 and -3) with dichloromethane as solvent is acceptable as long as the reclaimed binder has not aged excessively.

The three binder were extracted and their potential as contribution to new premium binder was characterized and evaluated with traditional and advanced techniques - penetration, softening point, viscosities, rheology (DSR master curves), chemical and physical by FTIR and GPC. Mixing laws with virgin polymer modified bitumen was established.

The next step was recycling the reclaimed asphalt into new asphalt mixes of similar type as the origin using either standard paving grade bitumen or polymer modified bitumen as virgin bitumen. The level of reclaimed asphalt material in the new mix was chosen to be 15% and 40%; reflecting PMRA introduction in asphalt plant as cold feed or preheated PMRA. Five combinations of each asphalt type were tested for their performance and microscopy was used to verify the mixing quality and distribution of virgin and reclaimed SBS in the mixes.

A Life Cycle Analysis was performed based on the findings to illustrate the environmental and economic benefits of a focused recycling targeted to utilize the potential in the old polymer modified asphalts.

The conclusion is – in short – that it is important to utilize the potential of the polymer in polymer modified reclaimed asphalt. Therefore it is equally important that the potential high quality of PMRA is not lost by "diluting" the polymer content with ordinary RA below an effective level.

Text: Erik Nielsen

Reports from the project can be downloaded from the ERANET Road website.
Direct link: http://bit.ly/recypma

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NORDIC

ROAD AND TRANSPORT RESEARCH

A joint publication with the latest research findings of six public road and transport research organisations in Denmark, Finland, Iceland, Norway and Sweden.

SWEDEN

SWEDISH NATIONAL ROAD AND TRANSPORT RESEARCH INSTITUTE (VTI)

VTI is an independent and internationally prominent research institute in the transport sector. Its principal task is to conduct research and development relating to infra-structure, traffic and transport and its operations include all modes of transport. VTI has a total of some 200 employees. VTI's head office is in Linköping, with branch offices in Stockholm, Gothenburg, Borlänge and Lund.

DENMARK

DANISH ROAD DIRECTORATE (DRD)
DANISH ROAD INSTITUTE (DRI)

The Road Directorate, which is a part of The Ministry of Transport, Denmark, is responsible for development and management of the national highways and for servicing and facilitating traffic on the network. As part of this responsibility, the Directorate conducts R&D, the aim of which is to contribute to efficient road management and to the safe use of the network. The materials research component is carried out by the Danish Road Institute.

FINLAND

TECHNICAL RESEARCH CENTRE OF FINLAND (VTT)

VTT Technical Research Centre of Finland is a contract research organisation with a staff of 2,800. In this joint publication, the VTT expertise areas cover research and develop-ment of transportation, logistics and road structures. The work is carried out in five research groups employing a staff of 60.

ICELAND

ICELANDIC ROAD ADMINISTRATION (ICERA)

The ICERA's mission is to provide the Icelandic society with a road system in accordance with its needs and to provide a service with the aim of smooth and safe traffic. The number of employees is about 290. Applied research and development and to some extent also basic research concerning road construction, maintenance, traffic and safety is performed or directed by the ICERA. Development division is responsible for road research in Iceland.

NORWAY

NORWEGIAN PUBLIC ROADS ADMINISTRATION (NPRA)

The Norwegian Public Roads Administration is one of the administrative agencies under the Ministry of Transport and Com-munications in Norway. NPRA is responsible for the development and management of public roads and road traffic, as well as the Vehicle Department. This responsibility includes research and development of all areas related to road transport and the implementation of R&D results.

INSTITUTE OF TRANSPORT ECONOMICS (TØI)

The Institute of Transport Economics is the national institution for transport research and development in Norway. The main objectives of the Institute are to carry out applied re-search and promote the application and use of results through consultative assistance to public authorities, the transport industry and others. TØI is an independent research foundation employing about one hundred persons.

Editorial Notes

Nordic Road & Transport Research is a joint publication of six public road and transport research organisations in the Nordic countries Denmark, Finland, Iceland, Norway, and Sweden. The main objective of the publication is to disseminate research results and news from the institutions, especially to researchers and decision makers. Each institution is responsible for the selection and presentation of the material from its own scope of activities.

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