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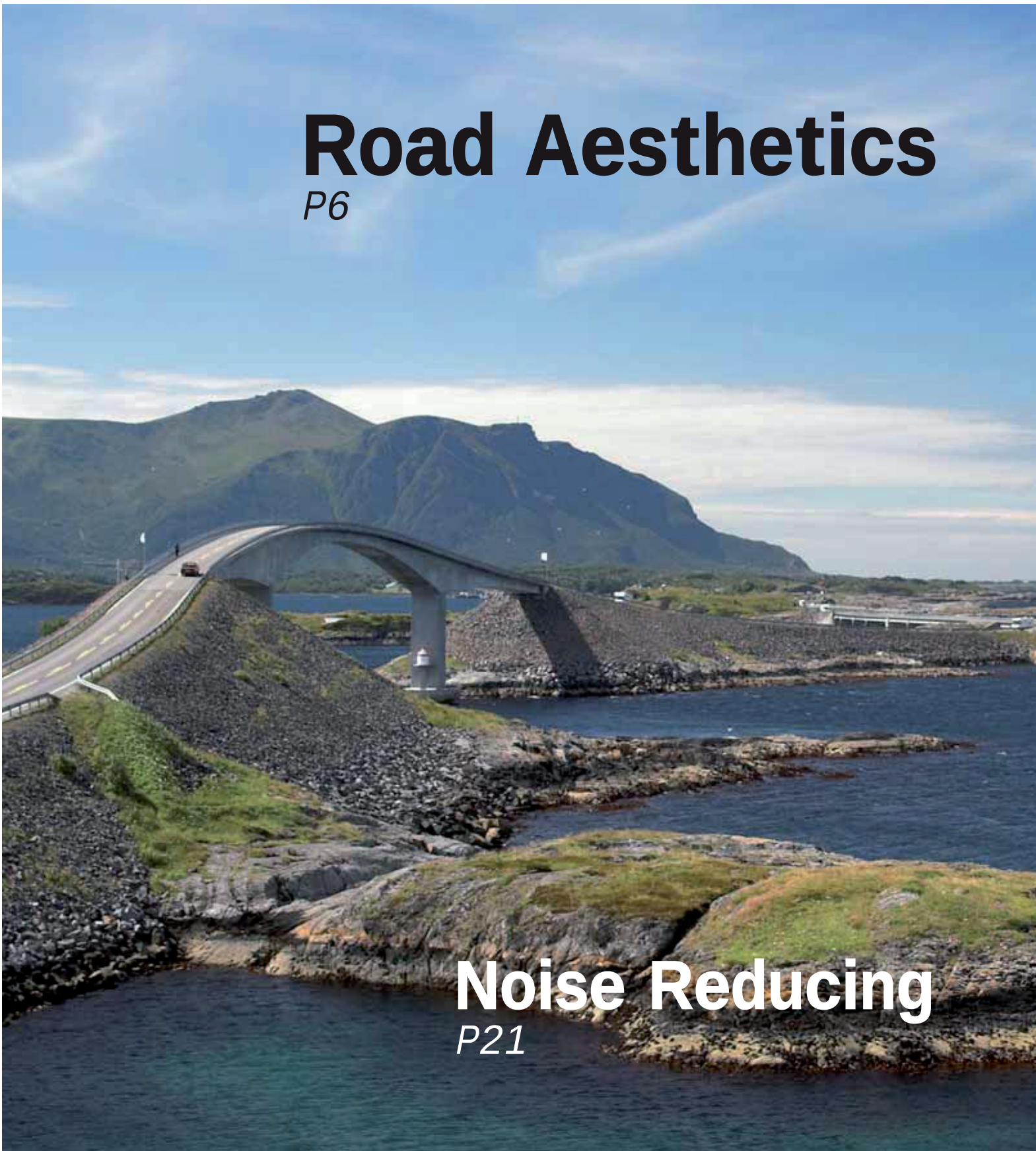

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News from

Swedish National Road and Transport Research Institute (VTI)

VTI is an independent, internationally established research institute which is engaged in the transport sector. Our work covers all modes, and our core competence is in the fields of safety, economy, environment, traffic and transport analysis, public transport, behaviour and the man-vehicle-transport system interaction, and in road design, operation and maintenance. VTI is a world leader in several areas, for instance in simulator technology.

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.

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 development of transportation, logistics and road structures. The work is carried out in five research groups employing a staff of 60.

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 340. 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.

Norwegian Public Roads Administration (NPRA)

The Norwegian Public Roads Administration is one of the administrative agencies under the Ministry of Transport and Communications in Norway. The 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), Norway

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 research and promote the application and use of results through consultative assistance to public authorities, the transport industry and others. The Institute 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.

Nordic Road & Transport Research is published three times a year. It is regularly sent out, free of charge, to recipients selected by the six joint publishers. Free sample copies are also sent out on special request.

Correspondence about the contents of the publication:

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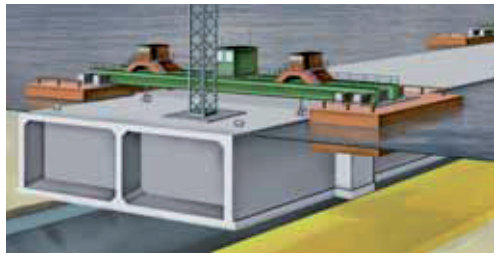
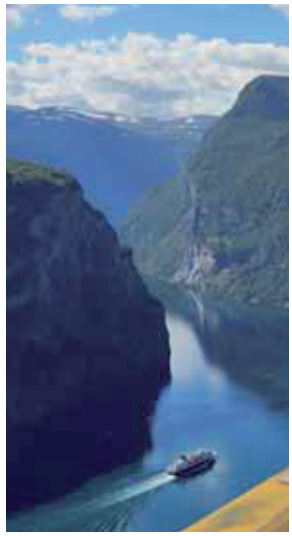

PHOTO: PHOTOS.COM

300 Years of Tunnel Experience Gathered

In early November, 30 employees from The Norwegian Public Roads Administration (NPRA) were gathered outside Oslo to take part in the new internal training program called The Tunnel School. The participant weren't just new beginners. All together they have more than 300 years of experience with tunnel design, construction and management.

The participants come from different places of work all over Norway and have educational background in several of the special fields within the tunneling profession.

– The main intention with the Tunnel School is to gather all of those who plan, construct and maintain tunnels in such a way that they can learn more from each other's subject areas. In particular it is important to give professionals who plan and construct tunnels better knowledge about problems with operation and maintenance to avoid building of solutions which are difficult to operate and maintain in a good manner, says Ruth Gunnlaug Haug, "Headmaster" of the Tunnel School.

PHOTO: TOE SOLBERG, NPRA

General manager of NPRA, Terje Moe Gustavsen, at the opening ceremony of The Tunnel School.

The gathering was the first one of four planned gatherings; the last one will take place in April 2009. Main subject was operation and maintenance of tunnels. Then planning and construction of tunnels will follow on the next gatherings. The final gathering will be a session for summing up and exchange of experience.

Beside operation and maintenance, also the theme management and communication is given great attention. In addition, the participants get input about expectations from the tunnels users; The Norwegian Haulier's Association (NLF) and Norwegian Automobile Federation (NAF), among others. The Norwegian National Rail Administration (Jernbaneverket) will also share their experience

PHOTO: THORBJØRN CHR. RISAN, NPRA

Project Manager and "Headmaster" of The Tunnel School, Ruth Gunlaug Haug, was giving the participants a smiling welcome.

with tunnels with the students of the Tunnel School.

The Tunnel School constitutes a part of NPRA's research and development project called Modern Road Tunnels.

Norway has the second largest total tunnel length in the world. There are nearly 950 road tunnels with a total length of ca. 840 km on the national and county roads in Norway. Annual tunnel construction is 20 – 30 km. So far 24 sub sea tunnels are constructed and several more are planned. The world's longest road tunnel, Lærdalstunnelen – 24.5 km, and the world's deepest tunnel, Eiksundtunnelen – 287 metres below sea level are both located in Norway.

The majority of tunnels in Norway are built in solid rock type and the most common tunnel construction method has been drilling and blasting. Tunnel boring machine has to a lesser extent been used in Norway.

Today more stringent requirements for designing tunnels, both when it comes to safety and aesthetics are new challenges that NPRA has to face. Water- and frost protection, electro-technical equipment, maintainability and safety on all levels are objectives of these new requirements.

The Tunnel School contributes to meeting those new challenges.

More information:
vegvesen.no/fag/teknologi/tunnelteknikk/tunnelutvikling (some in English)

Lightweight hybrid bus, a successful solution for energy efficiency

Kabus Oy, a Finnish bus manufacturer, is part of the Koiviston Auto Corporation, which is the largest bus operator in Finland. Kabus' goal is to produce high quality, energy efficient buses and coaches exclusively for its parent corporation.

Lightweight, engine downsizing and improved aerodynamics have already cut the fuel consumption of Kabus buses and coaches by 20%. The next step towards even more energy efficient Kabus buses was to exploit regenerative braking and the hybrid propulsion system.

In 2005, together with VTT Kabus started to develop a concept of a diesel electric city bus. Simulations early in the project were promising, showing that up to 30% savings in fuel consumption are achievable. Building the first prototype required several partners specialised in electronics, most of which were Finnish. The leading idea was to use ultra capacitors as energy storage, since in city traffic regenerative braking energy can be stored in short-term energy storage, and for that purpose the modern capacitors seem to be more suitable than batteries. The first parallel hybrid Kabus TC-4A4 city bus was ready for test-driving in November 2007. Testing has proved that the idea of a parallel hybrid bus with ultra capacitors works, and fuel savings are nearly 30% already for the first prototype.

Kabus plans to continue with hybrid bus development in order to have it in serial production around 2010-2011.

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TRAFFIC SAFETY 2025 – Research Program

At the beginning of 2008, VTT Technical Research Centre of Finland launched a research program in traffic safety. In the program, applied and customer-oriented research is conducted that will contribute to the advancement of overall traffic safety goals and the participating organizations. The research program involves multidisciplinary traffic safety research in the areas of road traffic and rail traffic, with a main focus on technical countermeasures and applications. However, other types of countermeasures are not excluded. The aim is to collect an extensive consortium of customers including private companies and public authorities. These members annually provide current and challenging traffic safety issues that need scientific research to be solved. The following organizations and companies have committed to the first 3-year period of the program: the Finnish Rail Administration, the Finnish Rail Agency, the Finnish Road Administration, Michelin Nordic AB, the Ministry of Transport and Communications Finland, Neste Oil Corporation, and VR-Group. New members are also welcome once the program has started. In 2008, the program focused on seven topics: paradigms and approaches of national road safety work, advanced illustration of accident data, road safety in various plans, tire issues in crashes, assessment of driver's own road safety, security in rail transport, and driver behavior at grade crossings.

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Read more: http://www.vtt.fi/proj/tl2025/

The Motorway in Denmark

The classic motorway is thought of as a means of transportation in open country – planned with a rhythmic sequence, where the purpose is a balance between monotony and experience. The ideal is a sequence, which is sufficiently varied to catch the driver's attention while driving, but which at the same time presents the landscape around the motorway in a beautiful – almost film-like way.

Ulla Egebjerg, VD,
Denmark

The classic motorway is very vulnerable to the changes which occur in a dynamic society. The surroundings near bigger urban communities change very fast, in an almost explosive manner. Industrial areas grow quickly and almost in a random way, suburbs creep along the motorways with flags and signposts, the towns are growing close by with demands for noise barriers at the same time as the limits of the motorway and areas near it, become overgrown. This puts big demands on the main architectural principle and challenges the total architectural treatment in a wider space. This applies both for the experience which the traveller has of the road – but also the surrounding landscape of the motorway and its contact with industrial areas and especially the meeting with the town.

When driving through the country, the experience of the countryside depends on many different factors. For example, driving speed plays a big role. High speed requires greater concentration, both on the way one drives and the road itself. Thus there is less concentration on the landscape alongside the road.

Today we experience nature and the open countryside as well as the changes in the countryside in the different parts of the country through car windows, when driving on the motorways. The motorway network is one of the biggest construction projects in newer times. It represents the present architectural and engineering expertise and reflects at the same time the time period when it was constructed. To form the course of a motorway through the landscape is a discipline which puts demands on safety, technical road construction, architectural safety and a sense of feeling. The Danish Road Directorate has a tradition of taking the harmony in the forming into consideration and this is done for the safety of the road user, but also to take the landscape into account through which the road passes.

Thus the alignment of a motorway must be seen from two sides. The landscape is seen from the road, but the placing of the road in the landscape is of great importance seen from the point of view of the neighbours of a road. There are a number of Road Standards which deal with the construction of motorways in open countryside. The cross profile of the motorway is also of importance in how the landscape is perceived. A wide cross profile through a landscape in big scale will underline the open character of the landscape and provides good possibilities of orientation for the road users, whereas a narrow and more closed cross profile gives the impression of a corridor with a limited field of vision. The character of the landscape will decide whether the motorway will be placed in a cutting, filling or terrain and this is of great importance for the experience of the landscape through which the road passes. Furthermore this has great influence on the conditions of the flora and fauna.

It is unavoidable that the landscape looks different when a motorway is constructed; in some places soil disappears and in other places soil is added and thus lakes, valleys and hills appear. Surplus soil can also be used to create landscape sculp-

The motorway is situated in the landscape with the wide central reserve as a part of the construction.

Motorway in cutting in the open landscape:

Motorway in open landscape

Motorway in a town

Motorway entering a large city

PHOTOGRAPHER: FINN LARSEN

turing, as f.x. the large sculptures made by Professor Steen A.B. Høyer near Esbjerg, which are made of surplus soil when the motorway Esbjerg-Kolding was constructed.

Visions and challenges

The big challenge in the future will be how the needs of modern society for passability can be provided in a positive interaction between the road and the town, so that a cohesive and systemic planning is achieved. This applies particularly to extensions of the existing motorway network projects. In future we must ensure that the interplay between town, road and landscape do not become a conflict ridden area but an exciting part, which reflects it.

Contact: Ulla Egebjerg, ue@vd.dk

The Landscape Has an Effect on Driving

A group of researchers at VTI have investigated whether drivers are affected by the landscape they are driving past. In our driving simulator, test subjects drove through forest, mixed and open landscapes. An assessment was then made to see whether, and if so how, a certain landscape affected the drivers – both how they were driving and how they themselves regarded the journey.

Magdalena Green
VTI, Sweden

Simulator runs showed that the surroundings affected both the driving style and safety margins of the drivers. Distance to oncoming traffic was greatest in an open landscape. On the other side the drivers kept slightly higher speed here.

The results of the VTI research on how the landscape affects us as drivers are set out in a data sheet which is published by the research program INCLUDE, Integration of ecological and cultural dimensions in the transport infrastructure. The sheet is the first in a series of data sheets on how roads and railways affect natural and cultural values.

Include is part of TransportMistra, the principal aim of which is to develop strategies, models and tools in support of decisions concerning sustainable mobility.

Read more: www.includemistra.org
Contact: Mats Wiklund, mats.wiklund@vti.se

The surroundings affected both the driving style and safety margins of the drivers.

Planting in Connection with Road Constructions

An avenue is a typical type of road - it created shade for the "walking" traveller.

An area planted along a motorway

Plants play an important part in a road's architectural expression, near noise barriers, in roundabouts and on motorways

FOTOGRAF: FINN LARSEN

The change in seasons can be seen in the plants along the roads

Ulla Egebjerg, VD, Denmark

It is important to plan which plants to put when constructing new roads and this should be an integral part of the general planning of a road construction. They can be used to mark various changes in a road construction. Such changes are for example marked by special plants near a junction on a motorway, or to mark special points where plants are used as a surprising element. They are a part of the living element of a road. Thus it is important to create good growing conditions, so plants can thrive. Plants can be used to underline the existing flora. By planning the plants carefully, an entirely new landscape can be created in connection with a road construction. Think of the classical boulevards or an open field with a single tree.

New plant types in the road

When a tree is planted in an open landscape, it must be planted at greater distance from the road than is necessary for a row of trees in a town. It is, however, necessary in a town to make sure that the trees are planted in such a way that there is space for the development of the roots of the trees. Rows of trees are also used to enforce some of the conditions of the landscape at a particular place. It is important to prepare a planting plan from the start of a road construction project, where one tries to enforce the existing plants at the place or on the other hand completely frees a stretch from any plants.

Alternatively, a new type of plants can be planted to create a special look. This has been done on the motorway to Holbæk near Taastrup and on the Ring Road 3. On the motorway to Holbæk, big rows of high poplars have been planted and along the Ring Road 3 various plants have been planned at junctions. When special plants are required, these can be high or low; also special grasses are used, particularly in roundabouts.

Plants along roads are exposed to the effects of road salt, so it is important that the plants chosen can withstand the harsh traffic environment. It is of great importance to choose plants which are easy to take care of. The plants should be clearly visible with big, simple elements and they should not have fine details which decay and start looking ugly. Grasses which do not need mowing and robust types of trees such as poplar, mountain ash from the island of Bornholm and oaks are particularly well suited in road environments. In towns, plane trees as we know from southern Europe are frequently seen.

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National Tourist Routes – the World's Most Beautiful Drives

Nasjonale turistveger
National Tourist Routes in Norway

According to a German proverb, he who travels has something to tell. In Norway, a journey on the National Tourist Routes gives tourists some excellent stories to tell about the most beautiful drives in the world.

Per Kolstad, NPRA
Norway

Not unexpectedly it was in the home of the car, the USA, that Scenic Byways were first launched. These are drives through scenic landscape as an alternative to the press and rush of the freeway. In Germany tourists can enjoy the cultural delights of Romantische Strasse and Burgenstrasse. Scotland has its Malt Whiskey Trail. France offers the Chemin de Baroque and Route de Vin. In Denmark you can take a detour along the Margarittroads.

After almost 20 years of planning, development and building, Norway's National Tourist Routes will be marketed as a combined attraction from 2012. At their heart is a unique driving experience in unique natural surroundings. Tourists will realise their expectations of finding the true experience of mountain, fjord, moorland and coast along the way. As well as a taste of our own time, in the form of modern architecture and increasingly also contemporary art.

Tourism is one of the world's fastest growing industries. In Norway, tourism is the third largest industry after fish and oil. But Norway is losing ground in the international competition for tourists. One element of the Norwegian Government's tourism policy is the development of the National Tourist Routes. The aim is to attract more tourists to stay longer and thus help strengthen industry and habitation in rural districts.

Quality

The vital prerequisite for the National Tourist Route project is quality, not just in the form of pure, undisturbed natural surroundings, but in buildings and facilities as well. Driving the tourist routes should provide an alternative to the main roads, with activities and attractions to increase the experience. It should also provide a good service.

The quality of buildings and facilities is assured by employing skilled professionals at every stage from first sketch to laying the final stone. Architects both young and experienced have been involved in working out the best solutions as part of a professional team. An architectural council was set up to refine and develop the ideas into a final result with the emphasis on quality.

The Norwegian Public Roads Administration put together an architectural council of experienced consultants in the fields of architecture, landscape architecture and art. This kind of dedicated architectural council has previously been used for other major national projects such as the main Oslo Airport at Gardermoen and the winter Olympics in Lillehammer. In encouraging young architects and developing the architectural council, the Norwegian Public Roads Administration, the National Tourist Routes are making an important contribution to the renewal and development of Norwegian architecture.

From trial project to determined effort

The Norwegian Public Roads Administration started work on the National Tourist Routes in the early 1990s. To begin with, this was a trial project with four stretches of road. In 1998 the Storting and the Ministry of Transport decided to recommend increased commitment, which has been followed up since in the annual budgets, national transport plans and the Government's tourism strategy.

The Public Roads Administration invited input from all quarters on potential Norwegian tourist routes. 52 proposals came in, covering 8,500 kilometres of road. After several rounds of discussion, these were honed down to 18 stretches of road totalling 1,660 kilometres that displayed suitable uniqueness and identity. Up until 2011 the National Tourist Route project will be developing unique stopping points on these roads, as well as tourist information all along the eighteen routes. The aim is to be able to market the tourist routes as a distinct national tourist attraction from 2012, with its own exclusive logo. The tourist routes will continue to be developed until 2015, so that they represent a clear and attractive tourist product of world class.

PHOTO: JARLE WÆHLER, NPRA

PHOTO: JØRN HAGEN, NPRA

Signs of our times

The Norwegian Public Roads Administration is using the National Tourist Routes as a mean of leaving a mark of our own times. The project has entered a productive phase with many spectacular and award winning pieces of construction. The tourist routes have given a real boost to Norwegian architecture.

The combination of the best of Norwegian architecture and the most beautiful of Norwegian nature has attracted a great deal of attention in Norway, and indeed internationally. In partnership with the design organisation Norsk Form and the Ministry of Foreign Affairs, the Norwegian Public Roads Administration has sent a travelling exhibition called Detour around Europe and further afield. Since it began in Berlin in autumn 2007, the exhibition has visited Nice, Caen / Normandy, Paris, Brussels, Stockholm, London, Bologna and Bratislava. In the new year the exhibition will visit the National Building Museum in Washington DC.

Finance

The National Tourist Routes are largely being financed by the Government, through the transport budget. The Norwegian Public Roads Administration plans to use NOK 1,260 milliard up to 2015. The strong national input will release synergies and value creation out in the rural districts worth NOK 630 million. Support from other official bodies is estimated at NOK 410 million. In total, the National Tourist Route project involves investment of NOK 2.3 milliard. The Public Roads Administration has high ambitions for the National Tourist Routes. Without financial support from other public and private sources it would not be possible to achieve these ambitions.

In general terms, the division of responsibilities and activities means that the Norwegian Public Roads Administration is planning and building the various stopping points where travellers can stop and enjoy their natural surroundings. The National Tourist Routes project is also responsible for information and visual improvement along the roads, as well as profiling and information about the project on the Internet. Other parties will offer tourists natural and cultural attractions, establish accommodation and food and beverage outlets and assist with marketing and information. It is also important that there should be ongoing work at local level to make visual improvements both indoors and out and to raise service levels for tourists at every stage. A specific agreement with Innovation Norway and the Norwegian Hospitality Association will contribute to the quality of the overall product, as well as making the National Tourist Routes better known as a tourist attraction among potential Norwegian and foreign visitors.

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More information: www.turistveg.no

Beautiful Roads Award

The Road Director's "Beautiful Roads Award" was established in 1988 in order to encourage high quality road architecture. The prize is now awarded every 2nd year.

VAKRE VEGER
Vegdirektørens Pris

Thorbjørn Chr. Risan,
NPRA, Norway

The winner is selected by a jury which, in addition to The Road Director, consists of five external members appointed by Tekna – (The Norwegian Society of Graduate Technical and Scientific Professionals), The Norwegian Association of Landscape Architects (NLA), The National Association of Norwegian Architects (NAL), Central Office of Historic Monuments and Norwegian Public Building Ornamentation Fund. The right to nominate is open.

The award is a prize of honour to road projects with good aesthetic qualities adapted to the surroundings. A road project can consist of roads, streets, bridges, tunnels or sites and equipment belonging to these areas. The project must be a part of the public road network and the prize can be awarded both to a complete project and a part of or an element of it. The award consists of a plaque with inscription, which is intended for a central placing at the site, and a diploma to the award winner. Additionally a scholarship, which should be used for a study tour, can be linked to the award.

Norway has signed The European Landscape Convention, which involves a special responsibility to take landscape values into consideration when it comes to strategic planning, feasibility studies, detailed planning and management of the roads. The ambition is to design all new roads without adversely affecting important landscape features and, if possible, add beauty to the surroundings.

Aesthetic values, residential environments, biological diversity and cultural monuments are all aspects that need to be incorporated into road planning. Roads are aligned and designed in accordance with two main principles; either as a positive contrast to the environment or adapted to and anchored in it. For most roads the principle of adaptation will be the natural choice. The Norwegian landscape constitutes a significant challenge to road planners and engineers and demands a multi-disciplinary approach in planning, construction and maintenance of roads.

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Here are some examples of previous winners of the Beautiful Roads Award:

PHOTO: BØRN IJELL, NPRA

Strynefjellsvegen

The first Beautiful Roads Award was established in 1988 and the first prize winner was section Langevatn-Breidablikk on the Strynefjellsvegen (the road crossing the Stryn Mountain).
The jury stated: The possibilities in a beautiful landscape are in a fine way utilized to form a beautiful road. The slope design and adjustment of the terrain provide good adaptation to the landscape. The road is placed lightly in the terrain.

PHOTO: SYNNØVE LIEN, NPRA

Vettrlidsalmenningen

In 1993 the prize was awarded to the street Vetrlidsalmenningen in the city of Bergen.
From the jury statement: The Vetrlidsalmenningen is an extraordinary good example of street upgrading in harmony with the city's distinctive stamp and history. Kerbstone and fences with artistic design bear witness to creativity and care. The furnishing appears as a visual unit and gives the street identity.

PHOTO: GEIR BREKKE, NPRA

Mannheller ferjekai

The photo showing one of two winners in 1997, The Ferry Quay of Mannheller, on national road Rv 5 in the county of Sogn og Fjordane, Western Norway. The Ferry Quay of Mannheller is part of the road section Kaupang – Lærdal. At the end of a 3 km long tunnel the road divides into 5 lanes and 200 meters of the tunnel is also a car park connected to the ferry service.
In this project the jury wanted to stress the main arrangement, technical implementation of a complex project and the paramount use of materials where a vigorous building project is located together with the preservation of the inshore zone in one of Norway's most beautiful fjords.

PHOTO: NPRA

The Sphere i Bragernestunnelen

The winner 2004: In the city of Drammen – Nedre Strandgate – Elveparken – The Bragernes Tunnel. The photo shows the sculpture "The Sphere" central in a roundabout inside the tunnel.
The jury made this statement: A worn-down road site is transformed into a functional and attractive area which creates identity to the place. It is deeply professional rooted in aesthetic sense, fantasy and creative zest.

Aesthetic Roads – Road Architecture

In 1995, the Danish Road Directorate prepared a "Strategy for aesthetic roads" which includes architectural and visual sides in connection with planting along roads.

Ulla Egebjerg, VD, Denmark

The strategy describes a number of quality intentions for old and new roads as regards planning, quality assurance and maintenance so as to obtain well balanced road designs. All road constructions are today exposed to critical attention on many aspects and it is therefore relevant to respect and work with architectural considerations in the same way as with other aspects of road construction.

The Road Prize

When the Danish Road Directorate set up the Road Prize in 1994 its purpose was to reward initiatives which contributed to raise the aesthetic and architectural standards in road projects throughout the country. The prize contributes to draw attention to quality in the public space and shows that it is useful to integrate architecture in road construction.

What is road architecture?

Architecture is not only experienced in connection with buildings, but also with landscapes. The placing of roads in the landscape and in connection with towns is also experienced as architecture.

Bridges – and good cooperation between architects and engineers

In Denmark, we have a tradition of constructing bridges. Our big bridges are designed by engineers in cooperation with architects; they are regarded as architectural structures and are visible proof of the good results which can be created by the two groups put together. In order to be able to create good road architecture both in the open country and in towns, a good cooperation between architects and engineers must be established. Focus must be placed on the entity and the precise detail. Experience from the projects completed in recent years has shown that when this cooperation works well, it results in durable, beautiful and economically good solutions.

The five factors for good road architecture

The factors, which are of importance to create a good result, are:

- Good cooperation between the two professional groups
- Attention to quality and functionality
- A feeling for the interactions between

architecture and traffic safety

- A realisation that architectural consideration does not have to disrupt economic considerations
- Good dialogue between many interested parties

Architecture in connection with road construction must be planned and incorporated right from the start and there should therefore be an overriding architectural idea right from the outset of the project. It is of course presupposed that all technical conditions and demands are included in each project. The cooperation between the architects and engineers is very important for the final results, since the architectural quality in road projects is created by an interaction between functionality, technology and creativity.

Contact: Ulla Egebjerg, ue@vd.dk

Noise Barriers and Embankments

The increasing road and train traffic means that there nowadays only are very few areas which are free from traffic noise. Thus, a large need for noise barriers has arisen.

Ulla Egebjerg, VD,
Denmark

Various solutions and designs appear at great speed in the country. It is therefore important that the correct choices are made as regards appearance of the noise barriers. It is obvious that noise barriers should lower the noise level, but it is necessary also to think of the design, placing and choice of materials, so that both technical and architecturally correct solutions are chosen.

Noise embankments

In the open country, noise barriers can be made as earth embankments and here it is important to adjust the embankment to the shape of the landscape and the natural types of growth.

Noise barriers

Noise barriers are very visible and this puts a great demand on their design. It should be a positive experience both for the neighbour and the road user. A noise barrier has two sides - one towards the road and the other towards the neighbour. It often has two expressions, the side towards the road is experienced at great speed, whereas the other side can be a part of the neighbour's garden or the open space near housing areas. Details, incorporation and placing are therefore of great importance in relation to the various conditions of the neighbours. The placing of the noise barrier is crucial for its relation to the surroundings. The noise barrier can emphasize the alignment of the road and underline the spacious course of the road. The placing in the spacial road can contribute to the optical appearance of the road, but also frequently gives the best noise-reducing effect.

Towns include a large number of different elements: bridges, tunnels, crash barriers, roadside equipment etc. This makes special demands on the design of the noise barrier. Cramped space conditions in towns can be the reason why noise barrier elements are preferred. The placing and design of the elements should be coordinated with the surroundings, so that a technical and architectural unity is achieved. The height of the barrier is decisive for the experience. A high barrier will reduce the noise best, but for aesthetic reasons a height of three meters is usually preferred.

The barriers can be designed as bigger identical areas and divided areas with a horizontal or vertical division. The ends of the barriers are important and should often be made as special elements, which can be cut off at an angle.

Materials and architectural expression

A good design is an expression of quality and there should not be a number of different noise barriers near each other as if they were an exhibition, but rather a harmonious expression should be achieved. Choice of transparent barriers is often made so that a view can be obtained from

the road or the neighbour or to get light in southerly gardens. Transparent barriers are also used on bridges due to the road underneath. The material should be chosen with thought about how it ages and also about the durability and look. All noise barriers must be maintained. This is continuing process and must be a part of the planning of every noise barrier project, if one wishes to ensure a long lifetime of the barrier. Transparent barriers are easy to maintain, since they only need to be hosed down or washed. The problem of broken glass arises however. For that reason transparent sheets of man-made material are used which are more robust, if vandalism occurs.

Barriers with plants require maintenance and care. Frequent supervision becomes necessary as well as replacement of plants. Graffiti is also a big problem, but effective means for prevention and removal have been developed. Wooden barriers are generally not used, since they age quickly; pressure-creosoted wood cannot decay and it is more difficult to clean of graffiti. Barriers of hard wood are generally expensive to use; there are however some good examples of barriers made of hard wood, which have long durability and age beautifully. A noise barrier is a foreign element and the art is to integrate it naturally into the landscape. When reconstructing motorways, bigger demands are made to the use of noise barriers which fit well into the open countryside. They can be made of wood, stones, planted elements or other materials, which are a part of nature. Natural materials patinate often nicer than metal and plastic. Noise barriers should become part of the landscape in the same manner as for example snow fences.

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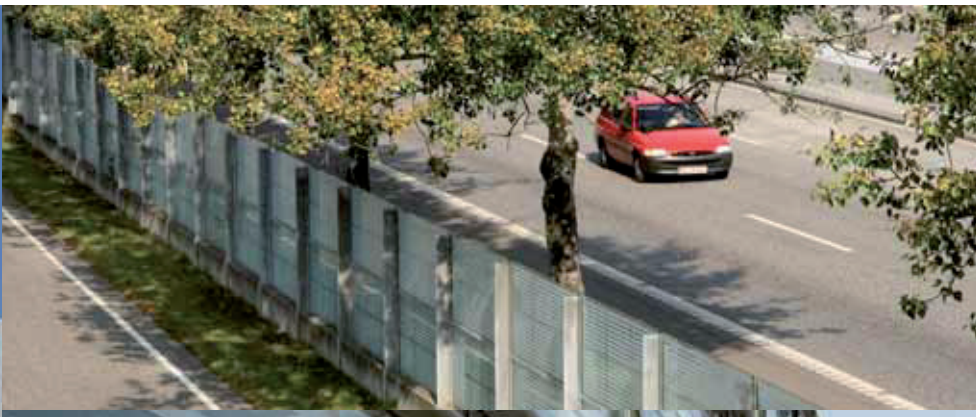

Norway: Beautiful Roads Award
The Winners 2008

The Slemmestad Road through the community of Asker south-west of Oslo and the Risøy Bridge in the city of Haugesund is rewarded The Beautiful Roads Award of 2008.

VAKRE VEGER
Vegdirektørens Pris

Thorbjørn Chr. Risan,
NPRA, Norway

In addition The National Tourist Roads project was awarded a price for its ground-breaking activities. (See article about The National Tourist Roads on page 10.) Further two road sites are honourably mentioned: The Canal of Spangereid at Lindesnes at the southernmost part of Norway and The Open Landscape in the county of Sogn and Fjordane, Western Norway.

The Road Director's Beautiful Roads Award, which is the official name of the prize, is a prestigious prize of honour awarded to road sites with outstanding aesthetic qualities adapted to its surroundings. Presented for the first time this year is an award to a site that distinguishes itself with regards to operation and maintenance. The prize is handed out by The Director General of the NPRA.

Slemmestadvegen i Asker.

The photo shows one of the two winners in 2008, Slemmestadveien, National Road Rv 165, at Vollen in the community of Asker.

The jury states the following reasons: From being a small community with a heavy traffic flow, one has with professional background, aesthetic appreciation and respect for the environment and history, managed to recreate an idyllic place at the shore of the Oslo fjord. Simplicity and purity characterizes the road, both in design and use of materials. The road is now following the original alignment from the 18th century and still appears as a road and not a street, which seems quite correct for a place like Vollen. The elegancy of the alignment is being illustrated by the beautiful ashlar walls. The use of vegetation is controlled and is based on a long tradition of gardening. Care for different needs for all kinds of users makes this a valuable site. The winning project is an ideal example of how a road with heavy traffic can be planned and built on the areas premises, and how one has been able to take into consideration the environment, traffic safety and mobility for all road users.

The other winner in 2008 is the Risøy Bridge in Haugesund. The jury states the following: The rehabilitation of the Risøy Bridge in Haugesund preserves this bridge for the future. It is a construction which is an outstanding engineering feat and an element for creating identity. The bridge swings with an elegant form and rises high above the strait Smedasundet before it reaches the island Risøya. It is an impressive construction, which also is in contrast to the city situated under it - still they emphasize each other in a way that enhances the experience of both bridge and town. The rehabilitation has in a respectful and humble way taken the original design into consideration down to the smallest detail.

Risøy Bridge in Haugesund.

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The Preservation of 40 Bridges

The Norwegian Directorate for Cultural Heritage has preserved 40 of the NPRA's bridges this year. These bridges have national value as technical cultural monuments and should be preserved for the future to reflect the Norwegian road history.

Thorbjørn Chr. Risan,
NPRA, Norway

16700 bridges on the main and county roads bind the country together to one kingdom. Bridges made of concrete and wood, stone and steel, bridges that hang and bridges that tilt, bridges with struts over and bridges with trolls under. 40 of these bridges are now being preserved. The traffic will continue as usual, but there are restrictions when it comes to making changes on one of the bridge.

The purpose of preserving bridges is to show the development in road history from around 1537 until today. Not only long and spectacular bridges are being preserved. It is also taken into consideration variation in design, material and construction. Some bridge environments are also chosen because they show the social changes over a long period of time.

The bridges are preserved according to The Norwegian Cultural Heritage Act, and from 2008 the Norwegian Directorate for Cultural Heritage is therefore responsible for managing the development of these bridges.

May Do Preventive Measures

The value of the bridge shall be kept like it is on the time of preservation. But to preserve a bridge doesn't necessarily mean to "freeze" it. A bridge can for instance be preserved due to it's placing in the landscape. In that case one can still widen the road or put up safety barriers, but the alignment can not be changed. On another bridge the main construction may be conserved, but besides that changes can be made.

Old and New

Both old and new bridges are preserved. The new Minnesund Bridge (80 km north of Oslo) is among the most famous preserved bridges. It is part of an environment with several bridges and in the area it has been boat, train and road traffic for a long time. As a contrast to this modern bridge we have the corduroy road at Terland (Egersund, Western Norway) from the 18th century, a traditional preserved bridge. An example of a preserved bridge in the period between is the Canal Bridge in Tønsberg which is a rear bascule bridge constructed in a functionalist style in 1957.

PHOTO: NPRA

The Skarnsund Bridge (Mid Norway) is a modern bridge that has been preserved for the future.

Management Plan

For every preserved bridge the NPRA has made a management plan locally anchored which has to be recommended by the Norwegian Directorate for Cultural Heritage. In the plan there are close specifications of what is allowed and not. These plans are not stricter than necessary, but shall contribute to planned development of the bridge which unites use and preservation. The 40 bridges are a random sample from a series of local suggestions. Also the county and the local municipality have participated in the process.

Instructed to Preserve

The Government has imposed all sectors to prepare management plans as a part of the sector responsibility for the environment. Also a representative selection of Norway's technical cultural monuments should be preserved for the future. In 2002 the NPRA proposed a management plan for a selection of its roads, bridges and road related cultural monuments reflecting road history from the Reformation and up till our time. 19 of the NPRA's buildings were preserved in 2007. This year 40 bridges are preserved and in 2009 approximately 70 road sites and road sections will be preserved.

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Tourist Routes Important for the Economy

Tourist routes benefit the local economy. At least this is the view of a number of businessmen near one of the tourist routes in Sweden, who were interviewed by VTI and TØI.

Sandra Johansson,
VTI, Sweden

When the importance of the road network for economic development is discussed, the focus is often on the transport of goods and services. But tourist traffic can also be seen as part of the many kinds of transport in the economy, i.e. the transport of customers to the sites of production or consumption. However, we have no comprehensive knowledge of the relationship between Swedish tourist routes and the interests of the travellers and the economy. The point of reference for this project has therefore been to give the Swedish Road Administration further information on the interests and views of car tourists and the tourist industry, so that the road transport system may be developed for tourism regarded as an industry. The project has given rise to two reports.

It has not been possible to show clearly that signposting a tourist route with brown signs has resulted in an increase in traffic. It is therefore remarkable that the businessmen themselves consider that their activities have benefited from the local tourist route. This indicates that it is a more distinct and purposeful group of travellers who make use of the route. Aspects to do with the economy should therefore always be included in the deliberations concerning the provision of brown signs.

PHOTO: PHOTOS.COM

The Gränna-Ödeshög-Rök tourist route, together with the Kullaberg tourist route in Skåne County, have also been compared with a Norwegian tourist route, Turistväg Sognefjell. The travelling tourists in Sweden, in their responses to a questionnaire, accord cultural attractions a high value, while a beautiful view is given a lower ranking in comparison with the study of the Norwegian tourist route. The differences are presumably associated with the nature of the landscape and the regions, but it is also possible that tourists of different nationalities have different views regarding the landscape. Improvements which travellers want to see mostly relate to service facilities which were considered too few in number. The shortage of toilet facilities figured particularly high, but there was also a wish to have more stopping areas at interesting views, more parking places, more overnighting facilities and better and more comprehensive information signs.

Tourist routes in Sweden are marked with brown signs.

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The Way to a Quieter Surfacing

Noise is one of the many environmental problems that our traffic gives rise to. The problem can be tackled in many ways, one of which is to use noise barriers. But a very effective way is to deal with the problem right at the source, by using a road surfacing on which less traffic noise is generated.

Magdalena Green
VTI, Sweden

Noise reducing road surfaces as a cost effective measure against traffic noise is a field VTI has been working on for many years. Now there is a good chance that a project can be started which will develop a road surface that not only protects the environment from noise but also re-uses old tyres. VTI has carried out research in the subject since 1999, and the knowledge acquired on the subject matter will be one of the cornerstones of the desired new project.

Within road technology, it has been known for a long time that a porous surface of the right texture gives lower traffic noise levels than traditional asphalt due to the air voids in the asphalt layer. Another important parameter in relation to noise reducing road surfaces is elasticity. A soft elastic surface damps the vibrations of tyres, which results in less noise. Investigations show that, for a substantial effect, elasticity should be almost as high as that of the tyre, which explains why asphalt mixes with a relatively small proportion of rubber have not produced as high an effect as had been hoped for.

The optimum solution combining the effect of air voids and elasticity is, therefore, a fully rubber-based porous surface. This technology, called PERS, Poroelastic Road Surface, has been found in tests in Japan and Sweden to reduce tyre/road noise levels by around 10 dB.

PHOTO: PHOTOS.COM

However, we will not see PERS used on our roads the next few years. The concept and the material must be further developed. One property that must be improved is its adhesion to the underlying material. The result should be a durable surface which is cost-effective compared to noise barriers, that substantially reduces noise levels; preferably on low- and medium-speed roads where porous asphalt surfaces are less effective. One great environmental bonus in the work is the recycling of old tyres which gives the raw material for the PERS. In Europe, the major part of the material in post-consumer tyres is reused. The principal means of reuse of the rubber is as an energy source in cement kilns and power plants. A more sustainable strategy is to use the technical qualities of the recovered rubber in engineering applications, before it is finally used as a fuel.

An application for a research project concerning PERS has received a favourable response from the EU Commission, and it is expected that the project can start next year. The project is coordinated by BRRC, VTI's counterpart in Belgium. If the project is approved, VTI will work on the composition of the material, construction of test surfaces, measurements on the roads and dissemination of information.

VTI is hoping to produce a durable surface which is cost-effective and visually much more favourable compared to noise barriers, and which substantially reduces noise levels on roads where noise exposure is a serious concern and porous asphalt is insufficient.

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Good Governance Regarding Noise Management

Noise is an important factor to be considered when it comes to developing, upgrading and maintaining national road networks in Europe. In some EU member states, significant financial resources are used to incorporate noise abatement measures in developing or upgrading national roads.

Hans Bendtsen,
VD, Denmark

The Conference of European Directors of Roads (CEDR) had in the CEDR Strategic Plan 2005–2007 defined a task "to reduce road traffic noise". One of the main objectives of the CEDR noise group was to facilitate knowledge sharing on noise management and abatement issues among the European National Road Administrations (NRAs). In order to undertake these objectives, a comprehensive questionnaire survey was carried out on how noise issues are treated in NRAs around Europe. A report has been prepared summarizing the results of the survey which was responded to by 20 CEDR member states. The report will shortly be available on the CEDR homepage.

For a more extensive version of the results obtained, please see: www.nordicroads.com.

Recommendations on good governance regarding noise

On the background of the information received from the NRAs in addition to the fruitful discussions of the CEDR noise group, the following fourteen recommendations for good governance regarding noise management and abatement are proposed:

1. In Europe, the main noise problems occur along the existing road network and the order of magnitude of the problems is increasing with increasing traffic volume. Therefore, noise abatement along these roads is crucial in order to start a process where the noise exposure over the long term is reduced.
2. It is important to include noise issues at the early planning stage for new road developments. In adopting such an approach, future noise problems may be avoided. The basis for such an approach will normally be the national noise guidelines.
3. Noise should be included as an important parameter in projects where existing roads are widened and improved to accommodate increasing traffic volumes. This can improve the noise environment for people living in close proximity to the upgraded road.
4. When planning to incorporate noise abatement measures on new, existing and reconstructed roads, it is important to adopt a time horizon of 20 to 30 years, when predicting future noise from increasing traffic volumes and planning noise measures. This will enhance the robustness of specific noise projects.
5. When road construction work is carried out in close proximity to residential areas, it is relevant to consider construction noise when planning and realizing such works. Residents close to the construction site should get sufficient information.
6. In projects where noise abatement measures are planned and designed, it is recommended to establish a good communication strategy to ensure a two way communication process with the public. In this way, residents may take ownership of the project and their expectations to what noise mitigation may deliver in terms of noise reductions may be more realistic.
7. Noise barriers erected on roads have not only visual impacts for the residents living in close proximity to the road but also the drivers and their passengers. It is therefore, important to use barrier designs that are appropriate to the specific locations where they are erected.
8. The use of noise reducing pavements should be considered when selecting noise mitigation measures because such pavements are purported to provide a cost effective tool in noise abatement. In upgrading existing roads, the use of noise reducing pavements is often a low cost measure of noise abatement.
9. Integration of noise as an active component in Pavement Management Systems can increase the optimal use of

noise reducing pavements in the ongoing road pavement renewal process.

10. To enhance the current market for noise reducing pavements the development and use of a noise labelling system in member states should be considered.
11. In order to reduce noise emissions from individual vehicles, it would be invaluable if individual NRAs lobby at EU level to promote tighter noise limits for the EU type approval of new vehicles and tyres.
12. Like all elements of infrastructure, noise abatement measures such as pavements, barriers, facades, etc. need to be maintained on a regular basis.
13. There is a need for further research and development in improved and long time durable measures of noise abatement like optimized noise reducing pavements, tyres, vehicles etc.
14. A continuation of international cooperation on noise abatement and management between the NRAs is value adding and fruitful. In the coming years issues like noise mapping and noise action plans in relation to European Noise Directive (END) seems highly relevant.

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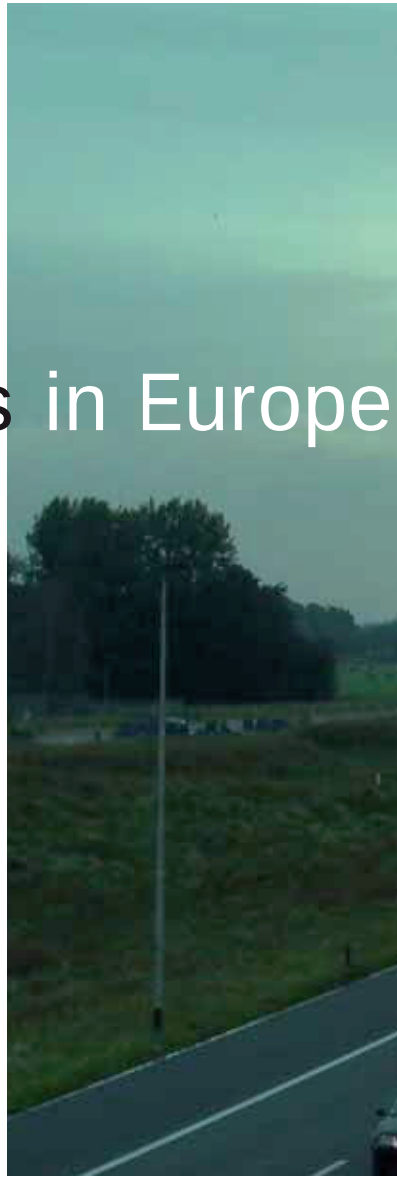
Noise Reducing Pavements in Europe



There is increasing focus in Europe on applying noise reducing pavements on the road networks as cost effective noise abatement. California Department of Transportation (Caltrans) contracted the Danish Road Institute to prepare an overview of the current state of the art in this field.

Hans Bendtsen,
VD, Denmark

Only a few countries have an explicit policy for the use of noise reducing pavements, even though they are increasingly becoming part of the "toolbox" for consideration in noise abatement.

The Netherlands apply porous asphalt on their entire main road network following an increase, in 1987, of the permitted vehicle speed from 100 km / h to 120 km / h. This policy is very efficient from a noise abatement point of view.

In Denmark, noise reducing pavements are also frequently used on new roads or when significant changes are made on existing roads. The municipality of Copenhagen has decided to apply noise reducing surfacings in its maintenance of streets with an ADT exceeding 2000 vehicles. The introduction of the Danish noise labeling system for noise reducing pavement products on the market facilitates tendering such pavements. The process whereby road administrations and the pavement industry developed the noise labeling system in consensus with consultants gave wide acceptance and has brought knowledge of the system to many users.

Noise reducing pavements can be used in conjunction with other measures, but noise reducing pavements should always be the first choice because they attack the problem at source (tire-road-noise) and it is often the most cost-effective measure of noise abatement. In the Netherlands, noise reducing pavements combined with noise barriers are used frequently. There is a legal demand on road administrations to reduce the increasing noise and this can be done by either by increasing the height of existing noise barriers or by building new barriers, both very expensive solutions, or by using noise reducing porous pavement or thin layer surfacings, which are much more cost-effective.

Noise reduction is evaluated in relation to a reference pavement. The reference pavement(s) in different countries are typically chosen from what would have been the most probable alternative used for high capacity roads prior to the focus of noise reducing pavements. In Denmark, the reference is a worn (approx. 8 years old) surface of a dense graded asphalt concrete with 11 mm as nominal maximum aggregate size. The Netherlands use a reference pavement based on a population of measured surfaces all of which were probably less than two years old at the time of noise measurement. Sweden uses a Stone Mastic Asphalt 16 mm (or dense graded Asphalt Concrete 16 mm) at the age of one year primarily based on CPX-measurements.

Some noise monitoring over time on noise reducing pavements is done in the Netherlands, France and Germany to gain "overall experience"; but not all individual pavement works are monitored. In Denmark, several test sections have been monitored every year by SPB measurements and now this is supplemented with CPX measurements. Texture measurement by means of laser equipment will be added soon. This has generated valuable lifetime noise reduction time histories.

Usually, it is the road owner who pays either in a project for constructing a new road or in the ongoing process of pavement renewal on existing roads. In Denmark, it has been discussed at the Municipality of Copenhagen that a developer of a new residential area should pay for a noise reducing pavement on a nearby road in order to be given permission to build the new dwellings.

Warranty periods for noise reducing pavements in Denmark are the same as for standard pavements (legally 5 years), but there is no established practice yet as to how the warranty covers the acoustical performance. When more experience is gathered with respect to the durability of the individual mix types it is assumed that durability (acoustical as well as structural) will be important in the competition between products /contractors like it is on standard asphalt materials.

Some new developments can be seen on the horizon:

a. The ongoing development and testing of noise reducing thin layers seems to provide low cost noise reduction.
b. In Germany, there is a trend to replace Portland Cement Concrete (PCC) with Stone Mastic Asphalt which has a lot of application advantages in the rehabilitation and maintenance situation on a heavily congested road network. Some Portland Cement Concrete test sections have been built which show reasonable noise levels, but they are presently few and at a purely experimental stage, so no substantial information on PCC solutions is available.
c. Two-layer porous pavement optimized for long-term noise reduction and durability for roads with speeds above 70 km/h might be an option for testing in order to achieve high noise reduction.
d. Poro-elastic surfacing might be an option. There are plans for European research and development of such an idea.

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Read more: www.vejdirektoratet.dk/publikationer/VInot069/index.htm

METRONOME
A Methodology for Evaluation of Project Impacts in the Field of Transport

More than 800 transport research projects have been financed in the recent Framework Programmes of the European Commission. In order to evaluate the contribution of these projects to the current key themes of the European Policies: Industrial Competitiveness, Sustainable Development, and Improving Community and Public Policies, the Commission has launched the METRONOME project.

Anu Tuominen, VTT, Finland

Transport research under the European Research and Technological Development Framework Pro-grammes (FPs) aims to produce new knowledge and innovation for different stakeholders within the transport sector, thereby helping them contribute to the achievement of the goals and objectives of the European Policy Statements regarding e.g. sustainability issues, European competitiveness, European governance practices and the European research area.

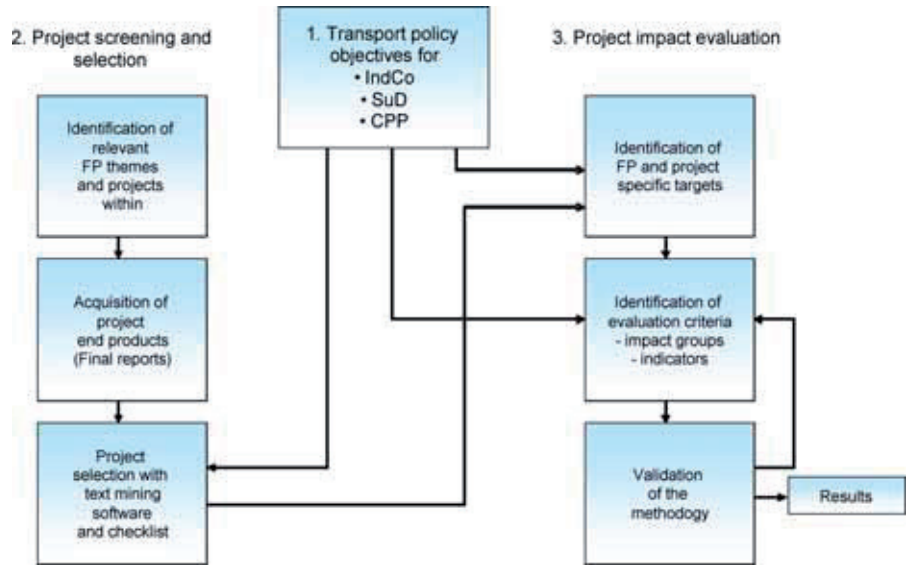
A lot of transport-related research knowledge on sustainability and competitiveness of the transport system has been produced in recent FPs. Policy support projects have also aimed to contribute to improving community and public policies. Currently, however, there is no systematic methodology for evaluating the achievements of the research projects towards often very broad policy goals or even research programme objectives. Further, there is the question of how to use the project results in defining future objectives for EU-funded transport research.

The METRONOME project, as part of FP7, will contribute to solving the above dilemma by devel-oping a methodology for evaluation of European Commission RTD Framework Programmes (FP) 5 and 6 transport projects, from the perspectives of industrial competitiveness, sustainability concerns and uptake of research results in European policy developments.

The project is set to continue until July 2009, but a preliminary screening, selection and evaluation framework has been developed with the following three phases (Figure 1):

1. Identification of European transport research and policy objectives for the three thematic fields of the METRONOME project
2. Project screening and selection
3. Project impact evaluation

In the first phase, European transport research and policy objectives for Industrial Competitiveness, Sustainable



Development, and improving Community and Public Policies were identified from the European Policy documents relevant to these fields.

In the second phase, around 60 'most relevant' projects from the group of 400 FP5 and FP6 projects were selected for detailed evaluation. The project selection was carried out with text mining software (RapidMiner), the main idea being to identify projects relating most to the identified transport policy objectives for Industrial Competitiveness, Sustainable Development, and Improving Community and Public Policies.

In the third phase, the key questions in the methodological development were as follows:

- What kind of impacts can research projects have on the three main themes of the European Poli-cies?
- What kind of indicators could be used to describe these impacts?

In conclusion we propose the following four indicator groups:

a. *Scientific impact indicators.* These indicators will reflect the quality and validity of research projects versus the project's own and FP theme targets. Examples of indicators:

- Number of publications, number of patents
- Fit between framework and data
- Efficiency of the research - results versus resources used
- Effectiveness of the research - outputs versus set FP targets
- The power to address previously unsolved questions

b. *Customer/ End user impact indicators.* These impact indicators will reflect the (short-term) benefit of the research results to their actual end users (e.g. EC, industry, national govern-ments, ministries, research organisations, etc.). Examples of indicators:

- Public-policy initiatives
- Long-term product or service development
- Advantage and stability of the research results

c. *Societal impact indicators* will reflect the more long-term impacts (outcomes) of the re-search on the society at large (e.g. on the transport system end-users: individuals, logistic companies, industry, etc.). Examples of indicators:

- Implementation of research output by policy field, industry or other societal stakeholders
- (Active) use of implemented research output by societal groups
- Contribution of priority setting, e.g. future research goals
- Contribution to strategy processes of public and private organisations
- Norms, standards, regulation

d. *Impact indicators on management and coordination* will reflect the 'enabling factors' or 'tools' for complementing the impacts measured in the other three groups above. Examples of indicators:

- Improved networks, new networks with public/ private organisations
- Networks with global/EU/national partners
- Systematic dialogue with policymakers
- Customer orientation: customer involvement in project planning

Also considered very important is the evaluation of the role and success of different funding in-struments, as well as the impact of various project partners (SMEs, universities, research organisa-tions, NGOs, others) on the project results. These issues will be covered in the forthcoming tasks of the project.

The methodology under development will hopefully provide one tool for mid-term review of the EC FP7 transport projects.

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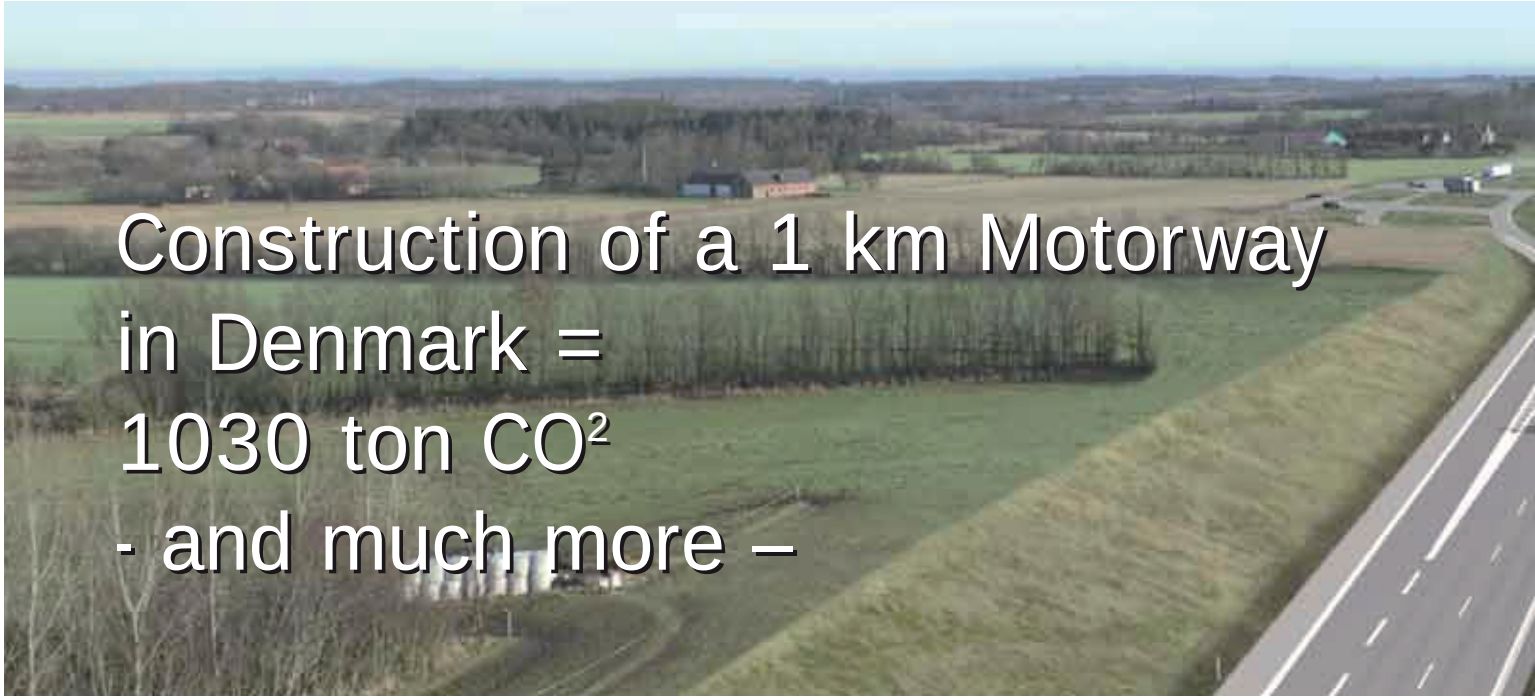

Construction of a 1 km Motorway in Denmark = 1030 ton CO^2 - and much more –

Life cycle assessment (LCA) is an important tool to assess the use of resources and environmental impacts related to the entire life cycle of a product, system or service. LCA has been tested by the Danish Road Directorate in relation to an 11 km motorway project in Jutland. Five different options for the choice of road materials for the construction were assessed. The results provide the Danish Road Directorate with information regarding the use of resources and environmental impacts related to the whole life cycle of a motorway project - and whether the choice of materials makes a difference for the environmental impacts of the project. In this article, one of the environmental impacts assessed in the LCA is presented: The global warming potential.

Harpa Birgisdóttir, Knud A. Pihl

Recently, the Danish Road Directorate has finalized a project where LCA was performed on an 11 km traditional motorway project in Jutland with asphalt wearing course and base to evaluate the environmental impacts and use of resources at different stages during the life cycle of the motorway. Four alternative options for the choice of materials were compared to the traditional one:

- Traditional Danish asphalt pavement with asphalt wearing course and asphalt base course on top of a granular road base.
- Thin asphalt on asphalt base course and granular road base.
- Thin asphalt with cement stabilized base and granular road base.
- Asphalt wearing course on macadam (stone) base and granular road base.
- Cement concrete on cement stabilized base and granular road base.

The functional unit for the assessment is construction of 11 km motorway operated and maintained for 100 years. The road consists of four lanes, two hard shoulders, two soft shoulders and a central reserve.

What is assessed in the LCA?

LCA includes inputs of energy and resources as well as outputs of waste and emissions to air, water and soil for all materials and processes related to the entire life cycle. In this project, a Danish model for LCA on road materials (ROAD-RES) is used, where eight environmental impact categories and seven resource categories are assessed.

Global warming potential of a traditional motorway

The results of the LCA project show that the total contribution to the global warming potential for this 11 km traditional motorway construction during 100 years is 29.000 tons CO^2-equivalents or 2.670 tons CO^2-equivalents pr km. Approximately 40% of the total impact is related to the construction phase and 60% is related to the operation and maintenance during the 100 years. The construction of 1 km of this particular traditional motorway construction therefore emits 1.030 ton CO^2-equivalents and the operation and maintenance during 100 years emits 1.640 tons CO^2-equivalents.

How much is that? Results in LCA are often normalized and calculated into person equivalents (PE).This means that the results are illustrated as the fraction of the

contribution to the impact deriving from the average person in the affected area, which in this case is Europe. So 1 PE equals the impact that one person in Europe contributes within one year with all his activities. The contribution for the entire life cycle of the 11 km motorway during 100 years equals 3.380 PE or 307 PE pr. km. Since the construction phase accounts for 40% of the total impact, the construction of a 1 km motorway contributes 119 PE and operation and maintenance contributes 188 PE during the 100 years.

Does the choice of materials make a difference for global warming?

As shown in table 1, the results show that the potential contribution to global warming is lowest for the scenario with thin asphalt, followed by the scenarios with asphalt and macadam base and cement stabilized base. The global warming potential for the traditional construction of a motorway is approximately 9% higher than for the solution with lowest impact. The global warming potential is considerably higher for the road with concrete wearing course, or approximately 40% higher than the solution with thin asphalt. When potential CO^2 uptake of concrete is taken into account, the concrete scenario still ends up having the largest impact on global warming, or approximately 17% higher than the solution with thin asphalt.

Why LCA in the Danish Road Directorate?

Technical, qualitative and economical parameters are the fundamental parameters used in decision making when considering dimensioning and maintenance of road construction. LCA provides the opportunity to add sustainability as an additional dimension into the decision making process. By gaining more knowledge of LCA, the Danish Road Directorate can consider how strategies and requirements regarding sustainability can be a part of construction, extension and operation of the road system. This may include procurement policies including strategies for choice of materials, operation of roads, requirements in tender for contractors and etc.

In Nordic Road & Transport Research 3/2006, an article on this LCA project can be found under the title "Life Cycle Assessment of Road Materials in the Danish Road Directorate" which explains the basic premises of the LCA study.

A more detailed version of the present article, as well as the article mentioned above, can be found on the internet under www.nordicroads.com. A DRD report (no. 164) will be available on DRD's homepage (www.roadinstitute.dk) under Publications by the end of 2008.

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		ton CO^2-equiv.	PE	Difference
1	Asphalt – thin asphalt	26.909	3.093	
2	Asphalt – on macadam (stone) base	27.666	3.180	+3 %
3	Asphalt – with cement stabilized base	28.136	3.234	+5 %
4	Asphalt – traditional	29.354	3.374	+9 %
5	Concrete – with cement stabilized base	37.366	4.295	+39 %
5*	Concrete – with cement stabilized base and calculations of potential uptake of CO^2 in concrete during the life time of the construction and after demolition	31.450	3.615	+17%

Table 1: Ranking of the scenarios according to global warming potential.

New EU Countries Need Better Roads

Road standards vary considerably in the EU member countries. Generally speaking, the roads in the new member countries have a lower standard, but in spite of this they already have heavy goods traffic on their roads, and this poses acute demands for a sustainable infrastructure.

Magdalena Green
VTI, Sweden

The objective of the EU project SPENS, Sustainable Pavements for European New Member States, is to develop a sustainable pavement structure to increase the standard of the road network in the new member countries in East and Central Europe. The aim is to develop appropriate tools and methods for rapid and cost effective recovery and maintenance of the road infrastructure, so that it complies with the EU standard requirements.

Work in the project focuses on developing methods to produce and apply materials for road construction which take into consideration the traditions, available materials and construction techniques of the country concerned, and the character of the existing roads in the country. This will be achieved through the different technology packages of the project, such as optimisation of appraisal methods for roads, improvement of pavements and evaluation of materials for higher road standards and minimisation of the environmental impact.

VTI technology is an important component

Within SPENS, experiments on accelerated testing of strengthening measures have been made for the first time. The VTI mobile heavy vehicle simulator has been an important tool in this work (more information on HVS in the box to the right).

In the spring of 2008 the simulator was in Slovenia and Poland to test types of strengthening on four test roads.

- The aim is to clarify the effect of various options on different types of road and thus be able to choose the option that provides the best performance in relation to its cost. Experience from these experiments will be useful in e.g. performance contracting and the choice of the strengthening measure, says Leif G. Wiman who is responsible for the equipment at VTI.
- The results of the runs will not be ready

until 2009, but we can already see differences in wheeltracking on the different surfacings, says Leif.

Tests were also made on the use of alternative materials in the surfacings. Use of slag in the wearing course, for instance, has provided greater knowledge of how alternative materials can be used in surfacings. Alternative materials give rise to a recycling approach in road management which increases the opportunities for long term sustainable use of natural resources.

Quality versus cost

In another part of the project, test methods for assessing the performance of bitumen and polymer modified binders are evaluated. Prior to upgrading or strengthening a road pavement, it is necessary to be able to estimate what gains in terms of greater durability can be made by choosing binders of high performance, and to consider these gains in relation to the higher cost of construction. For such an estimate it is essential to have test methods that are clearly correlated to the functional properties of bitumen.

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HVS, Heavy Vehicle Simulator
The HVS of VTI is a mobile equipment for test loading and accelerated testing of road pavements at full scale. Using HVS, real loads from heavy vehicles can be simulated and a study made of how different types of pavement stand up to heavy traffic. Its capacity for two-way loading is ca 24,000 loads per day, which means that one year's heavy traffic can in many cases be simulated in only one week. Load, speed, temperature, tyre pressure, lateral position and load direction can be controlled. Load is transmitted via an ordinary lorry wheel, either as twin wheels or a single wheel. Wheel load can be varied from 3 to 11 tonnes, which is equivalent to an axle load of 6-22 tonnes. The equipment is mobile which means that it can be used both in special test installations and out on existing roads. Over short distances it can move under its own power, but over long distances it is coupled to a tractor as a semitrailer. Through testing and evaluating how traffic degrades different materials and constructions, knowledge of road pavements and road maintenance measures is improved. It is also possible to estimate the service life of different types of maintenance and strengthening measures. HVS is made in South Africa and was purchased jointly by Finland and Sweden in 1997. In Sweden its cost was financed by the Swedish Road Administration, but VTI was appointed as its owner in Sweden. From 2005, VTI has been the sole owner of the simulator through a partnership agreement with Finland. HVS is the only equipment of its kind in Europe, and VTI regards it as a "common" European facility that can be used jointly by contractors, material manufacturers and researchers in one or more countries.
Read more: www.vti.se/hvs

Re-road Improves Asphalt Recycling

The objective of the Re-road project is that all asphalt should be recyclable and that the material should retain its functional properties. This is a development that will have positive effects for both the environment and the economy.

Magdalena Green
VTI, Sweden

Re-road is a project that is coordinated by VTI. Its aim is to improve the methods for the recycling of asphalt.

– We want to improve the functional properties of asphalt which wholly or partially consists of recycled asphalt and at the same time we strive to improve the energy efficiency in recycling so that emission of greenhouse gases is reduced, says Björn Kalman who is coordinator for the project.

Retention of properties

At present, recycling of asphalt often involves a certain downgrading of the material. High quality wearing course is recycled for the production of bound or unbound layers that are used lower down in the road pavements. In future, we want to be able to utilise more of the good properties of the recycled asphalt in new high quality surfacings such as wearing courses and basecourses.

Recycled asphalt can have a highly variable properties, and at present there are certain problems that make it difficult to use the material in an optimum manner. Work in Re-road aims to produce knowledge and to develop techniques for improved recycling strategies for asphalt in order to reduce material losses. The ultimate objective is that all asphalt should be recyclable and that it should be possible to use the material without downcycling and with minimum addition of new material.

Reduced environmental impact

Owing to improved strategies for recycling asphalt material and methods that use less energy, i.e. energy efficiency that reduces emission of greenhouse gases, the use of resources and energy at European level will decrease. In the project, various strategies and scenarios will be evaluated with regard to environmental impact and cost effectiveness.

Re-road incorporates an approach which also includes methods and strategies for scarifying asphalt, characterisation of the recycled material, handling and storing of the material, and procedures for the addition of the recycled material to the mixing plant.

Contact: Björn Kalman, bjorn.kalman@vti.se

Progress Report from Bjørvika

The sixth and final tunnel element in the Bjørvika Tunnel project in Oslo was immersed on the 27th of October this year.

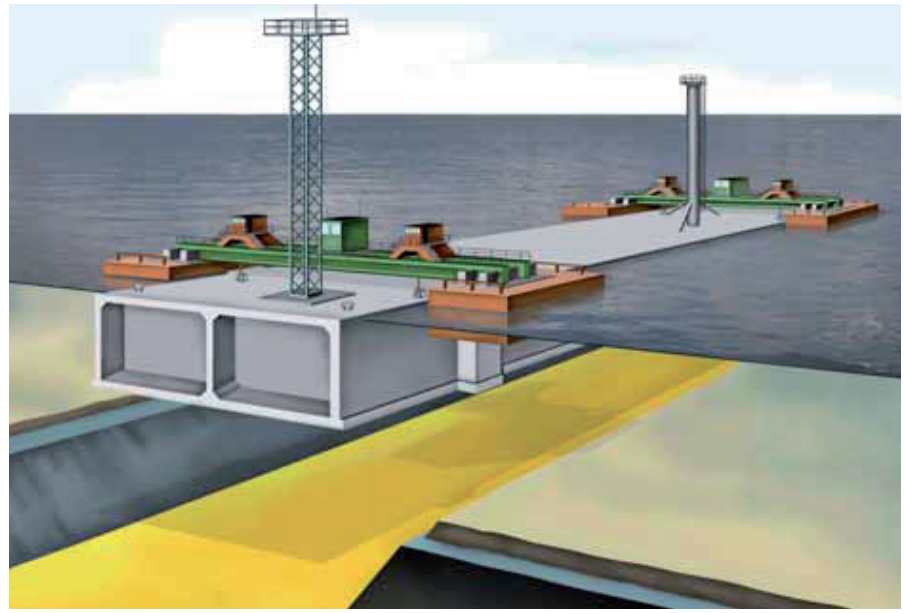
Johanne Solheim, NPRA, Norway

The 112 meter long, 35 000 tonne, bulk headed element was manoeuvred into place between the immersed tunnel and the key edge with about 2 metres of space to spare. It was tight. A system of land-based winches was used to move the element into place. Its path resembled that of a parallel parking car.

Before immersion of each element, a fibre cloth was laid out in the carefully dredged trench. Onto this, a 160 cm gravel bed (with a tolerance of +- 30 mm) was laid out. The element was then manoeuvred into place and fastened with winches to two catamarans. Ballast tanks inside the tunnel elements were partially filled with water, and the element could then be lowered into place. A rubber gasket between the elements secured water tightness. After immersion, gravel was filled along the sides of the element, and seabed and rocks covered the tunnel completely. Gradually, the ballast water is replaced with ballast-concrete.

As the final element is immersed, a two-metre gap between the immersed tunnel and the key edge at Sørenga remains. The last two metres of the tunnel will be cast using watertight shuttering. First, a wedge is placed between the final element and the key edge. The wedge will keep the six tunnel elements in place, taking up the forces occurring when water-pressure is removed. Steel plates with gaskets are then placed around the gap and secured. Water is pumped out of the space, reinforcement is installed, and the concrete can then be cast.

As work on the raw construction nears an end, the next phases of the tunnel-project begin. Fire-safety panels are to be installed, asphalt to be laid out, signs, cameras, emergency phones and other technical equipment will then follow. A lot of work is yet to be done. The Bjørvika tunnel will open for traffic in 2010.



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More information: www.vegvesen.no/bjorvika/
Click: In English

Assessment of traffic-induced vibrations in buildings

Title: Assessment of traffic-induced vibrations in buildings
Authors: Talja, Asko, Vepsä, Ari, Kurkela, Juha & Halonen, Matti
Series: VTT Research Notes 2425
Language: Finnish with 15 page English summary
Available at: www.nordicroads.com/publications
Name: Assessment of traffic-induced

In regard to traffic-induced vibrations, clay areas with surrounding rocky or gravelly hills are especially problematic in Finland. The thickness of the soft layer is often less than 10 metres. Vibrations spread effectively through such layers and are difficult to evaluate. Often, horizontal vibrations of the ground can be greater than the vertical component, and frequencies under 10 Hz with a very narrow band dominate. The areas are problematic especially for detached houses, because natural frequencies below 10 Hz are typical of the building frame and resonance vibration may occur. Because lightweight floors and short-span concrete floors usually have natural frequencies above 10 Hz, resonance of floors does not usually appear in soft clay areas but is possible in harder soils where higher frequencies dominate. The resonance phenomenon is not very common, but when it does appear it poses a real problem.

A method for the vibration design of the frame and floor of a building is presented that takes into account the direction and frequency content of the soil. The design is based on measured ground vibrations. The evaluation has two approaches: one considers the uniform magnification of the vibration and the other the magnification in the resonance. The resonance design of the frame is based on the horizontal, and the resonance design of the floor on the vertical, vibration of the ground. In resonance design only the 1/3 octave band that coincides with the fundamental frequency is studied.

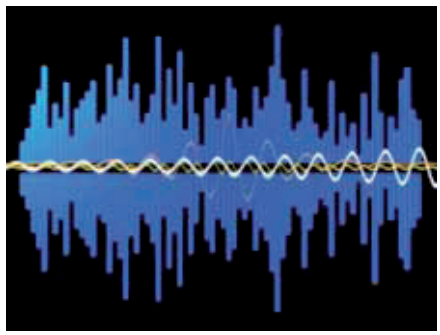

PHOTO: PHOTOS.COM

The design method is based on the vibration measurements of buildings, on FE calculations and on a literature study. Altogether 36 buildings were measured. Seven of them are at least three-storey houses and the other 29 are one- or two-storey low-rise houses. All the high-rise buildings are in clay areas. Seven of the low-rise buildings are in sand or gravel areas and the others in clay areas. The vibration is induced by railway traffic in 22 houses and by street traffic in 14 houses. FE analysis of the frame is based on a simple two- to three-storey plane model and the examination of the floor on a simply supported beam model. The FE study was based both on the statistical resonance study and on the measured vibration signals.

Greenbox-vehicle platform for safe and sustainable transport

Title: Greenbox. Vehicle platform for safe and sustainable transport
Authors: Risto Kulmala, Risto Öörni (VTT), Heli Mattila, Jari Oinas, Kristian Appel (Traficon), and Tuomo Roivainen (Semel Oy)
Series: Ministry of Transport and Communications, AINO publications 48/2007
Language: Finnish with English abstract
Available at: www.nordicroads.com/publications
Name: Greenbox

The objective of the Greenbox project was to demonstrate how existing in-vehicle systems installed in taxis can be used to collect, at low cost, a high volume of data on the fluency of traffic. The project was funded by the Research and Development Programme on Real-Time Transport Information (AINO), the Ministry of Transport and Communications, The Finnish Road Administration, Semel Oy, and Helsingin Ympäristön Taksikeskus Oy (Lähitaksi).

PHOTO: PHOTOS.COM

Services piloted during the Greenbox project were based on taxi dispatching, control and payment systems produced by Semel and related solutions for data communications. The second and third chapter describe these systems and the potential ITS services to be implemented with them.

Three ITS services were piloted in the project: production of real-time traffic information as floating car data, road user charging, and anonymous monitoring of travel speed. A full-scale trial was organised in the Helsinki region involving around 1,100 taxis. Piloted services and the way the full-scale trial was realised are documented in the report.

The evaluation of ITS services included in the Greenbox concept focused on the production of real-time traffic information and road user charging. The Greenbox system was able to produce reliable information on traffic conditions in the Helsinki region. Travel time information produced by Greenbox was compared with that produced by the Finnra travel time information system, which is based on automatic number plate reading and cameras installed at several points along the road network. The medians of travel times produced by different systems were within 20% of

each other on all links chosen for comparison. The number of vehicles equipped with the Greenbox system was not always adequate to generate up-to-date information on all links. Even with a small number of observations of travel time, the uniform speed behaviour of taxis allowed the detection of congestion. Bus lanes used by taxis were found to have no major impact on the reliability of floating car data on the road links chosen for comparison.

The system was found to be reliable with regard to positioning required by road user charging. Only some of the vehicles involved in the test experienced any problems with satellite positioning. The distance travelled without functioning satellite positioning was usually a small fraction of the whole distance the vehicle covered during the test.

Finally, lessons learned during the project as well as the technical feasibility of services piloted in the project are briefly reviewed. The report ends with future views of the technology used and the services piloted in the Greenbox project.

Optimized thin layers – urban roads

Title: Optimized thin layers - urban roads-The Kastrupvej experiment
Series: Technical Report 66
Author: Sigurd N. Thomsen, Hans Bendtsen, Bent Andersen
Language: English
Available at: www.nordicroads.com/publications
Name: Optimized thin layers

The Kastrupvej experiment

The objective of the SILENCE Working Package WP F.2 (New production technologies for surfaces on urban main roads), is to develop and test concepts for new noise re-ducing thin pavements for urban roads, focussing especially on SMA pavements. Alto-gether 8 different test sections have been constructed on Kastrupvej in Copenhagen. Samples of 4 SMA pavements

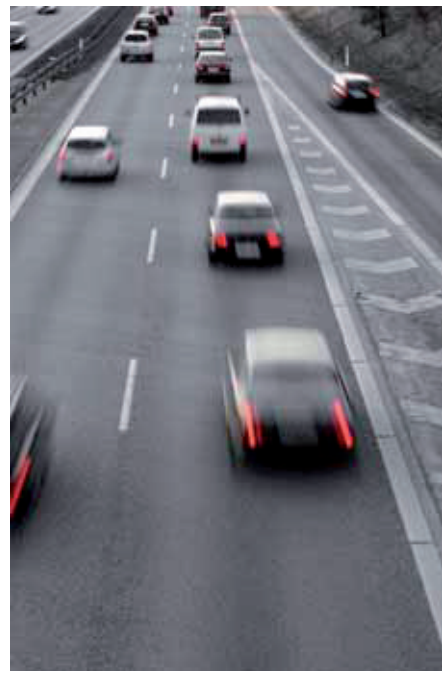

PHOTO: PHOTOS.COM

were also acoustically tested at BASt. Full scale acous-tical testing was carried out in compliance with the SPB and the CPX methods, respec-tively. Initial noise reduction measured by the SPB method was in the range of 0.9 to 4.3 dB relative to the reference surface DAC 0/11 for passenger cars at 50 km/h at 20 °C.

Use of noise reducing pavements

Title: Use of noise reducing pavements – European experience
Series: Technical report 69
Author: Hans Bendtsen, Jørgen Kragh, Erik Nielsen
Language: English
Available at: www.nordicroads.com/publications
Name: Noise reducing pavements

European experience

In this report the latest European experience on the practical use of noise reducing pavements are presented. The work has been carried out in the framework of the Administrative Agreement on "Road Infrastructure Technologies and Quieter Pavements between California Department of Transportation (Caltrans) and Danish Ministry of Transport, Road Directorate, Danish Road Institute A collection and analysis of European practice on the use of noise reducing pavements have been performed. Subjects like policy and praxis for the use of noise reducing pavements, noise labelling and Conformity of Production procedures are included. To cover a variety of European countries Denmark, Germany, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom have been selected.

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