NORDIC

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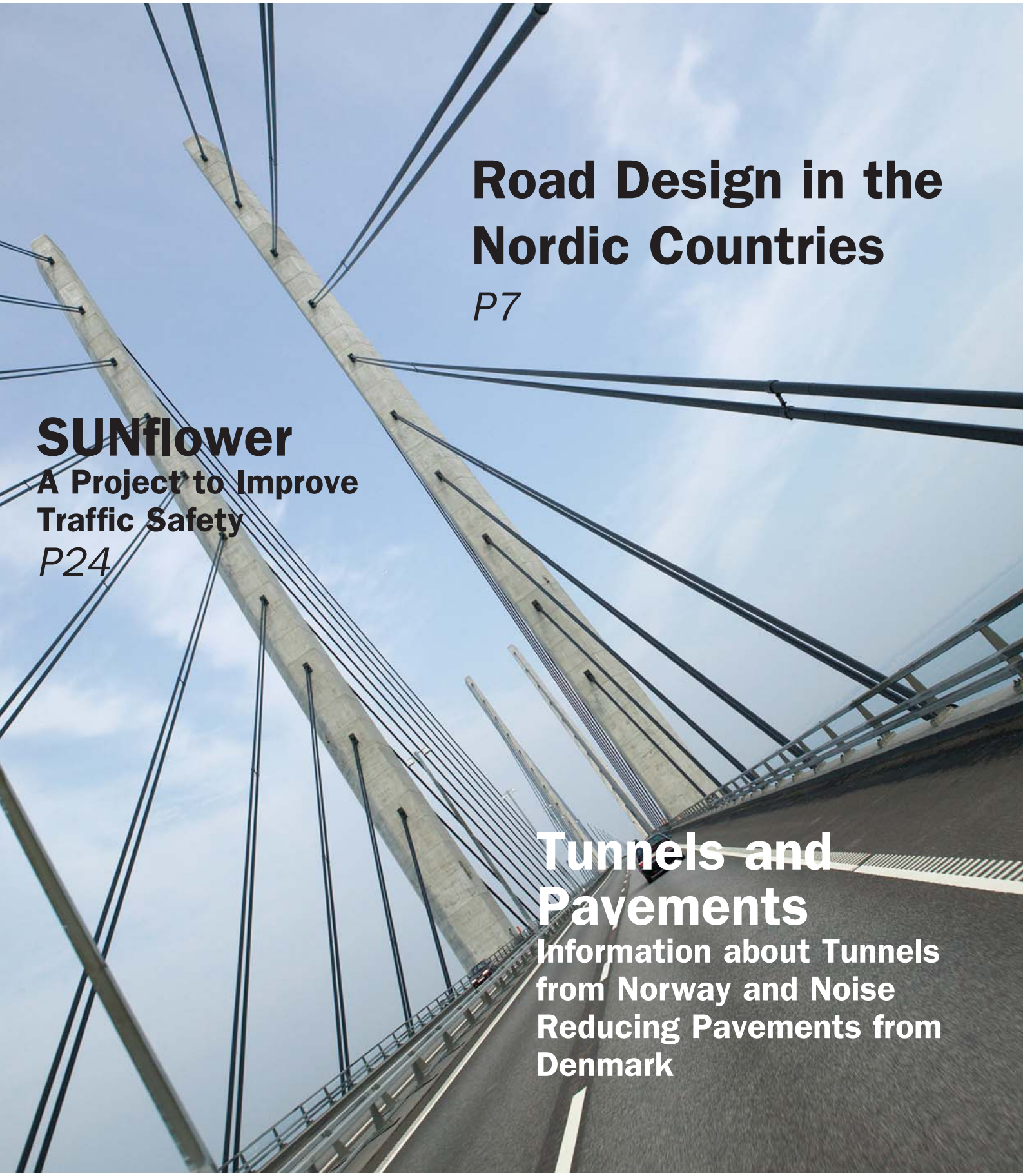

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News from

VTI, Sweden

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 & Energy, 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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Addresses: see back cover.

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PHOTO: PHOTOS.COM

The Transport Sector is Counteracting Terrorism

A terrorist attack against vital infrastructures such as transport and energy may have extensive regional, national and international impacts on society and the economy. This problem has received a lot of attention in the EU, and through the project COUNTERACT, Cluster of User Networks in Transport and Energy Relating to anti-terrorist ACTivities, security in the transport and energy sectors will be strengthened. VTI is contributing rail and public transport expertise to the project.

The transport sector is not immune from terrorism. EU is now taking measures to evaluate and recommend solutions in order to increase security in vital parts of the transport sector, infrastructure, public transport, railways and freight transport.

COUNTERACT will make its contribution by improving knowledge and understanding of the terrorism threats that exist and the way these are related to the transport sector. It is also the intention to establish good cooperation between the sector and the police, security firms and rescue services. The project will act as a platform for European expertise of researchers, consultants, operators and authorities.

The most recent terrorist attacks, 11 September, the attacks against the London underground and the regional trains in Madrid, show that security is of the greatest importance for transport.

The project extends over three years and will deliver reports on the present situation with regard to risks, threats and terrorist acts, a review of the present position concerning the need of e.g. training, policy measures and further research. A number of targeted studies will also be made, and several conferences and workshops will be arranged.

PHOTO: PHOTOS.COM

Metro-like Bus Service Attracts Passengers in the Helsinki Region

Helsinki Metropolitan Area Council (YTV), the body responsible for public transport planning and procurement in the Helsinki Metropolitan Area, believes in the appeal of high-quality bus services. A new cross-town bus service known as the Jokeri Line began operating between Helsinki and its neighbouring city Espoo in August. The service links several district centres, employment clusters and residential areas, covering a total of 27 km with 36 stops. Transfer connections to other bus and rail services are excellent, because Jokeri stops are located close to railway stations and other transport nodes. Special attention has been paid to passenger information as well as comfortable and environmentally friendly buses.

This line, which follows a ring road, was originally planned as a rail link but the bus service was chosen as a more economical alternative to speed up the project's implementation. Implementation of the bus service also required the construction of a number of tunnels and bridges, as well as a public transport street for fluent progress and to avoid traffic jams. The Jokeri Line features metro-like service frequency. During weekday rush hours the buses run at 5-minute intervals. On Saturdays and Sundays the service is less frequent but

runs until late evening. The Jokeri Line has a distinctive visual image using blue and green colour scheme for its vehicles, both outside and interiors, bus stops and all passenger information.

Public transport signal priorities help buses run on time. The driver's ticket unit informs drivers on how close they are to their schedule. Key stops, 25 in all, have real-time displays showing the arrival time of the next bus. The system is based on the GPS satellite system in use on bus and tram lines operating in downtown Helsinki.

The Jokeri Line vehicles are brand-new city buses. The high standard includes consideration of the environment; the buses' exhaust emissions conform to the Euro 5 standard.

According to YTV's estimates, passenger numbers on the Jokeri Line are expected to reach 18,000 during the initial stage. Should the line turn out to be a success, YTV plans to increase the circular cross-town transport.

VTT's role as a consultant in the development of the Jokeri line touches on several areas, notably increasing punctuality and reducing fuel consumption.

TRA – New Arena for Transport Research

"Greener, Safer and Smarter Road Transport for Europe" was the heading for TRA 2006, a new European conference on research into road transport.

TRA 2006 (Transport Research Arena) was held during four days in the middle of June at the Swedish Fair in Göteborg. This conference is the first of its kind and size in Europe that has the aim of implementing a common research area (European Research Area – ERA) for road transport. This research area shall comprise components such as vehicles, roads and humans seen from a system perspective. The conference shall be a platform to support the coordination of the needs for, the performance and implementation of research and development in the field of road transport. It is expected to contribute to a sustainable, effective and safe road transport system by helping, in its turn, to stimulate and reinforce the European networks within and between the world of research, authorities and industry.

This introductory conference in Sweden attracted around one thousand visitors who could hear presentations and exchange experiences concerning the latest research findings relating to road transport. The idea is that the conference shall be repeated every second year in different European countries; the next one is planned for Slovenia in 2008.

The programme included both joint plenary sessions and parallel thematic special sessions. They covered most aspects and issues concerning the road transport sector and the way it should be changed to meet future challenges. Some of the subjects dealt with in the plenary sessions were the Seventh EU Framework Programme for R&D and the contribution of road transport to a sustainable society and global competitiveness. VTI contributed with ten papers, concerning, inter alia, intelligent roads and VTI's HVS, an equipment for the simulation of heavy traffic.

PHOTO: MAGDALENA GREEN, VTI

A commercial exhibition with around forty exhibitors was held in conjunction with the conference. Here, VTI had the opportunity to present its subject areas and to meet its customers and cooperation partners.

The Swedish Road Administration and VINNOVA were the organisers of the conference on behalf of three principals, CEDR (Conference of European Directors of Roads), ERTRAC (European Research Advisory Council) and the EU Commission.

Norwegian – Czech Cooperation

TØI recently signed an agreement of cooperation with its Czech sister institute Centrum Dopravního Výzkumu (CDV). The ceremony took place at the Czech Republic's embassy in Oslo.

The good relationship between the two institutes has developed over time through collaboration in research projects and in international research policy fora. With the new strategic alliance the two institutes aim to develop this cooperation further.

Director of CDV, Josef Mikulík and Managing Director of TØI, Lasse Fridstrøm sign the agreement.

A break during the Decision Makers' Seminar

Joint Interest for Noise Abatement in the Road Sector

A Dutch-Danish seminar for executives and senior researchers was held in Copenhagen in June, 2006.

The purpose of the invited seminar was to bring together senior researchers, executives and program managers from the national road and environmental administrations. The discussion topics were on the level of combining the perception from research with strategic items in relation to national noise abatement objectives. Interesting subjects were:

- Understanding of the "political playing field" (national road and environmental authorities, industry, European and international regulations)
- Understanding of the "technical working field" of the noise measures (road surfaces, tires, noise barriers)
- Differences in assessments of the measures (costs and benefits)
- Needs for future initiatives.

From the discussions it was concluded that technical terms should be translated into social financial costs. Focus should be on the process rather than the technical issues and it should be considered to hitchhike noise considerations into air pollution considerations in the definition of environmental zones in larger cities. In Stockholm, environmentally friendly vehicles pay no tax for entering the city zone and parking is free. This has created a market for environmentally friendly cars (20 % of the total market in the region). Environmental labelling of tires and noise labelling in motor vehicle registers connected to car taxes could effectively promote low noise vehicles. It was noted that the responsibility for noise abatement is shared between three parties: Car manufactures, tire manufactures and road authorities and that noise should be regarded as a global problem and solved in EU rather than by local authorities individually.

The Road Safety Conference 2005 was a Great Success

During a period of nearly twenty years, starting in Göteborg, Sweden, in 1987, an international road safety conference has been organised by the Swedish National Road and Transport Research Institute (VTI). In October 2005 this series of conferences were organised with the 13th "Road Safety on Four Continents" in Warsaw, Poland. The Road Safety Conference 2005 was a great success and attracted the international research community, national safety experts, decision makers, practitioners and other delegates with an interest in road safety development. In total more than 250 delegates from 55 countries and 6 continents participated in the three day event.

The next conference planned for late 2007, probably November, will be a 20-year anniversary. The venue for the next conference is proposed to be Bangkok, Thailand. A "Call for papers" and other information about the next conference will be presented at the website www.vti.se/RS4C.

EU Cooperation for an Index of Road Safety

The European Transport Safety Council (ETSC), together with Toyota Motor Europe and the Swedish Road Administration, has launched a new programme for comparing traffic safety in the EU. VTI will be one of the Swedish representatives in this programme, and Urban Karlström, the Director General of VTI, is a member of the steering group of the programme.

The new programme will produce a Road Safety Performance Index, PIN, which will take account of the increasing gap between countries that are good at traffic safety and others that have not yet done as well. The index will be based on ten key areas associated with training, legislation, engineering and evaluation.

The overarching objective is to create a stronger political leadership in the field of traffic safety by noting how well the member countries of the EU are doing in the areas of the greatest importance for traffic safety.

National research organisations, industry and independent researchers from 25 EU countries are taking part in the programme and will ensure that evaluation is performed on scientific grounds. A steering group will have an active role in designing the evaluation and reporting process, one feature of which will be an annual programme evaluation. The panel will consist of traffic safety experts from all the EU member countries.

Autumn Brings Darker Conditions

PHOTO: PHOTOS.COM

Good road lighting not only reduces fear of violence and criminality but also cuts the number of accidents to pedestrians and cyclists. Road lighting helps pedestrians detect hazards, identify local landmarks and recognise other pedestrians, and makes them feel safer.

The principal aim of road lighting is to create a safe journey for car drivers and passengers, to help pedestrians detect hazards, identify local landmarks, make them feel safer and promote the appearance of the surroundings in the dark. Several studies that have been made all over the world point out that many accidents involving cyclists and pedestrians occur at dusk, dawn or darkness.

Good lighting is an art

Visibility and thus the ability to detect an object depends on several factors, such as the contrast between the object and the background, the adaptation of the eye, glare and the visual acuity of the driver. Many factors must be taken into account in choosing lighting fittings, such as shape, distribution of luminous intensity in relation to the surroundings, type of fitting and the height of the fitting.

For the illumination of footpaths and cycleways, fittings placed at a low level with a dim natural light that spreads light to the sides have many safety advantages, such as reduced shadow formation and enhanced identification capacity. The drawbacks are the risk of vandalism, the risk of glare and inferior lighting of the road layout.

Since dark areas discourage many people from cycling or walking because they are afraid of being attacked, road lighting must be provided and it must be continuous.

Environmental problems

Road lighting has not only positive effects but may also have a negative effect on the environment and energy use. Light pollution is artificial light that shines in an undesirable direction. One example is badly shielded road lighting that lights up open landscape or shines upwards. One way to save energy and reduce light pollution is to reduce the level of illumination.

There are also other problems with road lighting. One concerns lighting columns that are exposed to corrosion attacks both above and below ground.

Magdalena Green, VTI, Sweden

Title: Road Lighting – A literature review, R535
Contact: Sara Nygårdhs, sara.nygardhs@vti.se

New Manual for Road and Street Design

In the near future Norway will get a new manual for road and street design. The existing manual was published in 1993.

The reason for the revision of the existing manual is, among other factors, Vision Zero – a vision of a future situation where nobody is killed or seriously injured in road accidents and the need for more self-explanatory and forgiving roads (i.e. if a traffic accident takes place, it shall not result in death or serious injuries). In Norway approximately 300 persons are killed and 1,200 are seriously injured in road accidents per year.

The new manual distinguishes clearly between roads and streets. Streets are being formed by the town structure, available area and the wish for low speed. Consequently the streets will get completely different shape and dimensions than the roads.

There are three main parts in the new guidelines: street design (new streets), road design (new roads) and improvement of existing roads. Input parameters for selecting different road or street types, which are the bases for the design requirements, are the area connected to the road/street, speed limit and average annual traffic. The design guidelines give instruction to providing solutions for several road user groups: Cars, heavy vehicles/goods delivery, buses, pedestrians and cyclists.

PHOTO: BÅRD ASLE NORDBØ.

Street design - street enhancement (Drøbak).

What Is New?

Some important changes in the new road and street guidelines:

1. High-traffic roads will be provided with a better standard due to the Vision Zero.
2. Low-traffic roads (i.e. AADT 0-4,000) will have a poorer standard because resources will be used to improve the existing roads.
3. Roads with an AADT more than 4,000 will be given the same standard are primaryroads or other main roads.
4. For AADT 4-8,000 and speed limit 80 km/h a road width of 10 m with 1 m of rumble strips in the middle is recommended.
5. More use of median barriers and four-lane roads are based on the gain in traffic safety. This however will increase the measures dramatically in some projects.
6. The demands on horizontal and vertical curvature will be adjusted to make it easier to adapt the road to the landscape.
7. Open up for more use of roundabouts where traffic is moderate.
8. The principles in The Norwegian Bicycle Guideline (published 2002) are integrated in Hb 017. Among other factors construction of cycle tracks has turned out to be a good measure with regard to traffic safety.
9. The public transport topic is updated on the bases of new knowledge from public projects. In the future there will be more focus on public transport network, public transport priority and universal design.
10. In the manual updated knowledge will be given on water pollution, vegetation,

The topography, among other factors, makes it challenging to plan roads in Norway.

PHOTO: BÅRD ASLE NORDBØ.

game protection fences and noise. The environmental topics are relatively shortly described, but there are references to guidelines.

11. The new 017 manual will result in reduced level of light on roads with motorized traffic only. On other roads the level of light will also be reduced, but the light level will increase in areas of conflict such as cross-over areas and crossing points for cyclists and pedestrians.

Road Manuals in Norway

In Norway The Road Directorate in The Public Roads Administration is responsible for issuing a series road manuals and guidelines to shape of and design the public roads. Preparation of the road manuals requires high professional skill, and the work is normally organized as a project with a steering committee and work groups. New standards go through an extensive hearing by the road authorities, by various technical authorities and by a number of interest groups.

Road manuals are used on all road levels. The choice of road standard is often a political issue. Norway has good connections with standardization agencies in other countries, in particular the other Nordic countries. The coordination of the efforts in the Nordic countries and the cooperation through CEN will be even more important in the future based on the fact that the contractors are operating more internationally than before.

More information:
http://vegvesen.no/horinger/hb_017/hb017_w.pdf
(Temporarily only in Norwegian)
Contact: Randi Eggen.
E-mail: randi.eggen@vegvesen.no

Harmonisation of Road Signs and Markings

Part of the EU project IMPROVER studied the possibilities of improving traffic safety on the Trans-European Road Network (TERN) through harmonisation of fixed traffic signs and road markings in EU countries. VTT coordinated this subproject with six partners.

The continuing increase in vehicular traffic in the EU, together with greater movement of freight across Europe, has resulted in the need to have dedicated road networks within the EU. The White Paper of 1993 identified serious imbalances in Europe's transport system. In order to correct these imbalances the common transport policy seeks, and needs, to pursue seven objectives among which they recommend the establishment of Trans-European Networks. This network will enable citizens to travel and businesses to deliver their goods without hindrance or risk from one end of the Union to the other.

The increased importance of the TERN is one reason for the EC to demand better safety standards in road traffic. Fixed, vertical traffic signs and road markings make an important contribution to traffic safety. Deployment of traffic signs is a national duty, but road signing systems on European roads vary between countries. This variation may have a significant impact on traffic safety.

Differences in road signing systems as a starting point

An important milestone for traffic safety is the year 2010, by which time the EU aims to have halved the number of people killed in road traffic. This study aimed to show what role the harmonisation of fixed traffic signs and road markings among EU countries on the TERN could play in achieving that target, and also looked beyond it.

Figure 1. Examples of different practices in the use of road numbers as destinations

The study first focused on differences in legal and technical instructions for road signing systems between the European countries, then assessed the effect of these differences on traffic safety from the viewpoint of costs and benefits. Thereafter, the work developed four harmonisation scenarios to eliminate significant differences in road signing. Finally, institutional analysis was undertaken to elucidate the implementation steps and EU actions for harmonisation.

The total number of fatal accidents on the TERN was estimated to be almost 5,000 per annum and the length of the TERN approximately 70,000 km. The harmonisation of road signs and markings among EU countries could prevent many road deaths on the TERN by means of the following scenarios, actions and recommendations:

Scenario 1. Should be harmonised in the short term

The first scenario showed harmonisation of relatively low-cost measures that could be realised in the short term. The first estimation of the measures showed that the safety benefits should exceed the costs within one year. An efficient way to improve traffic safety on the TERN involving road signing could be to harmonise the use of:

i. Exit lane countdown marker signs to all motorway exits and intersections,
ii. Retro-reflective road markings on the whole of the TERN, and to supply:
iii. Better pre-trip information on the World Wide Web about the existence and meaning of various road signs and road markings for motorists in Europe.

The recommendation is that the European Commission should start the implementation of these measures as soon as possible, since the means to carry them out are fairly clear-cut. The necessary steps in this scenario would be to draft a document resulting in a Decision that would allow implementation of the Scenario 1 measures immediately, and completion of a detailed list of roads (or road sections) belonging to the TERN in order to make it more easily identified and better known in every EU country.

Scenario 2. Should be harmonised in the short term if the means are available

The second scenario consisted of urgent harmonisation needs, but the exact means for harmonisation will not be known until further work and research are undertaken. The task of driving safely on the TERN

PHOTO TIMO UNHOLA

would be supported by the harmonised use of:

i. E-road numbers (only on E-roads which cross at least one border and only at their intersections)
ii. Exit numbers on motorways.

Based on initial estimates, a quick way to improve matters would be to modify existing signs by means of adding 'patches' with E-road and exit numbers. However, national direction-signing systems are different, therefore solutions on how and where numbers should be added may vary from country to country. Before the value of these measures can be fully assessed, a concept for realisation must be developed. Costs then have to be derived reliably from the concept. Since a safety benefit is hard to quantify, the number of accidents that the measure could have an effect on must be determined, to gain an impression of the maximum number of accidents that could be prevented.

Further research to determine the best practice should be done in the following areas:

iii. Direction sign positions at intersections,
iv. Maximum number of destinations and letter size in direction signs,
v. Road numbers as destinations.

Harmonisation of the above is expected to produce considerable benefits in road safety. These harmonisation measures first require further clarification of, and research on, drivers' information-processing capabilities in relation to input from the road. Nevertheless, the costs of these analyses are estimated to be minimal compared to the potential safety benefits after implementation. However, the costs of implementation cannot yet be predicted as the needed measures for harmonisation depend on results from studies.

For a swift implementation of Scenario 2, the EC should launch the following initiatives: A joint committee with UNECE should be set up to formulate European norm plans for typical intersections. Similarly, a joint committee should be formed to initiate dialogue on optimal definitions and background research; an agreement with the Vienna Convention would be one way to produce new guidelines on road signs. Finally, UNECE would have to produce another agreement specifying the minimum parameters for road marking performance over time, while (under CEN) the European Norm ENV 13459-3 could be modified to assist in this process. Accordingly, the performance of fixed, vertical traffic signs (initial performance and performance in use) should be defined and harmonised for sign types.

Scenario 3. Should be harmonised in the long term

The third scenario involved long-term measures, as the costs of harmonisation exceed the estimated safety benefits likely to be obtained in a single year. However, the harmonisation need is high-priority and safety would improve through:

i. Extending the use of profiled road markings
ii. Improving night-time visibility of road markings.

Both should be applied on road sections with high accident rates (only accident types on which road markings might have an effect need be considered) in the first instance.

Scenario 3 required the relevant national institutions in the field of road safety to identify road sections with high accident rates. The EC should then issue a Decision stating where road markings should be improved. This scenario could then be implemented within the scheme of regular maintenance.

Scenario 4. Could be harmonised in the long term

The fourth scenario comprised a variety of details (14 aspects in total) in road signing differences among EU countries. Their safety effects were not assessed to be high separately, but together they demonstrated the clutter and inconsistency that foreign drivers have to face on the TERN. Thus, the combined effect of harmonisation may be substantial as it meets the general demand for continuity and uniformity of road signing on the TERN in the long term. After making an initial assessment, the Commission should further develop particular issues by launching additional research into the measures suggested in this scenario.

Contact: Mikko Räsänen, mikko.rasanen@vtt.fi

Rumble Strips Make Rural Roads Safer

A study from VTI shows that milled rumble strips in the centre of a two-lane road are probably an excellent measure to reduce the number of head-on collisions that occur because tired and inattentive drivers inadvertently leave their own lanes. One alternative to rumble strips in the carriageway is to simulate them in the car, for instance through a vibrating driver's seat.

PHOTO: VTI

A study shows that one of the effects of milled rumble strips in the centre of the road is to make car drivers lower their speed and keep at a larger distance from the centre of the road. Milled rumble strips have been found to work well on Swedish rural roads that are not wide enough for a centre barrier such as a wire rope barrier. No effects can however be found as regards changes in the behaviour of the drivers of heavy vehicles.

– Milled strips help the driver both through the sound they create and through the vibrations they set up in the vehicle, in the seat and the wheel. These signals can stop the driver from inadvertently wandering over the centre line because he/she is tired or inattentive, says Anna Anund, researcher at VTI.

Results from the study:

- According to the drivers, the greatest benefit of the strips is that they warn drivers that they are about to drive across the centre line (94%)
- At all sites of measurement, car drivers significantly, by an average 1.8 km/h, reduced their speed
- On average, car drivers drove about 5 cm nearer the edge of the road when the road had rumble strips than when it had none
- 76% of drivers answered that they would feel safer if there were rumble strips in the centre of the road
- 83% said they that would feel more certain they would not inadvertently drive over into the wrong lane
- 88% thought that rumble strips at the centre are a good way of improving traffic safety.

The strips may also improve driver behaviour by making the driver consciously avoid crossing the centre line on sections where this would be unsafe. This may, in turn, have the result that the number of overtaking and curve cutting manoeuvres is reduced.

The rumble strips chosen for the study were milled at 1.2 m centres. They are 35 cm wide, 15 cm long and about 1.0 cm deep. The experimental section is 14 km long. The strips were evaluated by means of traffic counts, roadside interviews and observations.

One alternative to rumble strips is to simulate these in the car through a vibrating driver's seat. Citroen has such a veer-off alarm in models C4 and C5. The great difference between these support systems and actual rumble strips is that these vibrations are of much lower intensity and that false alarms often occur.

Title: Milled rumble strips on the centre line on a two-lane road
Contact: Anna Annund, anna.annund@vti.se

Improved Road Safety in Kungsbacka Town Centre

Through knowledge and the correct measures, the traffic situation for vulnerable road users can be markedly improved in towns. VTI has monitored the road safety situation in Kungsbacka town centre in Sweden. It is found that, as the result of the comprehensive measures, vehicular traffic in the town centre has decreased, speeds have been reduced and there has been a marked reduction in the risk run by vulnerable road users of being injured or killed.

VTI has studied the road safety situation in Kungsbacka town centre. The investigation has focused on the road safety situation of vulnerable road users and an evaluation has been made of the safety effect of the physical measures that had been taken.

– We are very pleased with the results we have achieved, all the measures we have taken have been found to improve the road safety situation in the town centre, says Lars Björkman, traffic manager in Kungsbacka. Our cooperation with VTI has worked very well, and we feel that we have had a very good return for the money spent.

PHOTO: VTI

Physical measures

As long ago as 1991, VTI made a situation assessment and analysis of the traffic and trafic safety situation in the central areas of Kungsbacka. This investigation was arranged as a preliminary study that could be used as the basis for a future follow-up. After the investigation, extensive measures were taken in the town centre to improve road safety. One street was closed to reduce through traffic in the town centre, a pedestrian and cycle tunnel was constructed, roundabouts were built, intersections and pedestrian and cycle crossings were raised, and the whole town centre was made a 30 km/h area.

Good results

VTI has now followed up the road safety situation in Kungsbacka, with the focus on studying the interaction between vulnerable road users and motor vehicles.

– We have focused on vulnerable road users, which has irritated some drivers who think that they now have to drive too slowly through the town centre, says Lars Björkman. But it is good to be able to show how the number of accidents has dropped in recent years when we get this type of complaint.

Closing a junction from a street carrying a lot of traffic redistributed traffic and thus reduced traffic volume in the town centre. A large proportion of the reduction was due to heavy traffic. Speeds also dropped owing to the physical measures. Mean speed decreased from 34 km/h to 24 km/h. Another important measure was separating vulnerable road users from vehicular traffic to the greatest possible extent.

To sum up, the measures taken may be said to have reduced the risk of pedestrians and cyclists being hit by motor vehicles. The risk of being killed has decreased by 75% and the risk of being injured by 44%.

Magdalena Green, VTI, Sweden

Contact: Hans Thulin, hans.thulin@vti.se
Alexander Obrenovic, alexander.obrenovic@vti.se

Traffic Safety on Wind-exposed Roads in

Iceland's windy climate poses a notable threat to road users. On the most severely exposed road sections, as many as one third of all road traffic accidents may have strong wind as a contributing, or as a primary factor. An ongoing study funded by the ICERA Research Department reflects on influencing factors such as local topography, road surface condition, vehicle characteristics, driving speed, road weather information and traffic control etc.

PHOTO: J. TH. SNÆBJÖRNSSON

Windy road environment

The study was conducted by ORION Consulting Engineers and the Engineering Research Institute, University of Iceland. It focuses on two exposed road sections, on either side of the Hvalfjordur submarine road tunnel near Reykjavik. The two road sections (Kjalarnes, ADT 6400 and Hafnarfjall, ADT 3400, year 2005 figures) play a significant role in the national transport system of goods and people. Both sites are adjacent to mountains (approx. 800 metres above sea level) that during specific weather conditions are prone to magnifying the wind effects, causing extremely hazardous conditions on the road. At Kjalarnes the chances that the 10 minute mean wind speed exceeds 15 m/s in a single day during the winter is 47%. The highest wind gust can be as high as 2,5 times higher than the mean wind speed, frequently caching drivers off-guard. At least one third of the road traffic accidents may have strong wind as a contributing factor.

The objective of the study is to enhance the knowledge of the road users and the road authorities on the different parameters influencing road traffic safety in windy environments. The main goal is to reduce the accident rate in windy road environments.

Method

A variety of tools has been adopted by the researchers and different data sources were utilized. Thanks to the ICERA Road Service Department's ambitious information policy, data from road weather stations is available to supplement the road traffic accident database, as well as data from subpavement sensors determining vehicle speed and size.

In order to map the distribution of strong winds in the exposed areas, computerized wind simulations have been done as well as wind measurements with a vehicle-mounted device. Also, the project funds have in part supported the development of a probabilistic model for the assessment of road vehicle safety in windy environment.

Key findings

Existing road weather stations enable real-time monitoring of wind conditions and early warning possibilities. Besides that, historical time series from the stations are important for accident statistics. Comparison of the road traffic accident database and measurements from the weather stations indicate that strong winds and the combined effects of the wind and road surface condition are in many cases not adequately reported. In other words, analysis omitting the cross linking with weather measurements would underestimate the influence of winds on traffic safety.

Accident category

Frontal collisions of meeting vehicles and single vehicle driving off the road are the accidents types most often resulting in personal injury according to the database. The mean wind speed is higher than 10 m/s for two thirds of the frontal collisions, and one third of the driving off the road incidents. The road condition related to these accidents is most often wet and not icy or snowy. The only accident type solely happening on a dry road surface is trailer rollover on the road.

Road surface condition

In theory, less tire friction means that lower wind speed is needed to cause the vehicle to slip. The study confirms that during windy conditions, a higher number of accidents occur when the road friction is lower than usual, due to water or ice. A wet road surface seems to be equally hazardous as icy or snowy road surface. A possible explanation is that drivers seldom experience the reduced friction caused by a wet road surface and are thus not prepared for the combined effects of wind gust and reduced road friction, while on the contrary an icy road triggers an "automatic reflex" in most drivers.

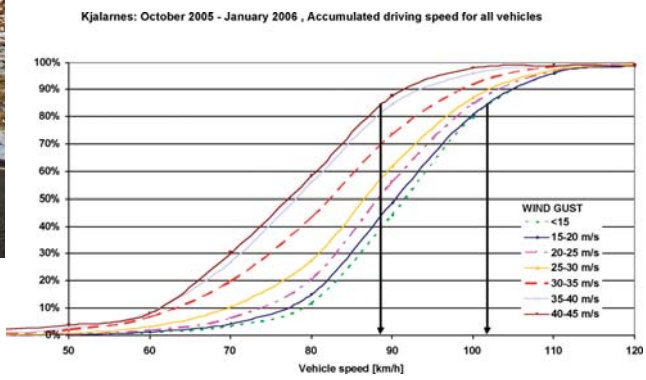
Vehicle category

The aerodynamic properties of vehicles are important to the stability on a windy day. On exposed sites, cross winds acting laterally on the side of the vehicle are commonly as strong as the vehicle velocity induced airspeed, the air pressure acting sideways can

Iceland

Minivan with a mobile wind measuring device attached to the roof, at the Hafnarfjall study site. The vehicle is here parked in the curve close to the weather station on the following map.

Hafnarfjall study site. Red cross indicates the road weather station in the area.



The relationship between driving speed and wind gust for all vehicles at the Kjalarnes study site. The arrows define V85 under normal and under extremely high wind gusts respectively.

thus be high as the drag force in the driving direction. The appearance of the different vehicle categories in the data confirms the theory. Once an accident has happened, the chances that the recorded mean wind speed is 10 m/s or more, are double for high-sided vehicles such as trucks and trailers, than for passenger cars. With respect to this it should be mentioned here that some national insurance companies in Iceland discourage commercial traffic during adverse weather conditions, declaring a limited responsibility when the wind speed exceeds a certain limit

Wind direction, wind speed

In the Kjalarnes area, when the recorded wind direction is 40° north-east, most accidents happen at the Esjuberg black-spot, and wind gusts on the order of 1,5 to 2,5 times the mean wind speed can be expected. On the other hand, when the weather station records 80° east, the Dalsmynni black spot (a few kilometres away) is the most common location of wind induced accidents. Anyhow, regardless of the incident wind direction being 40° or 80°, the whole Kjalarnes area of almost 12 kilometres is dangerous in either case.

Driving Speed

A higher driving speed can increase the overall aerodynamic forces on the vehicle. By reducing the driving speed during extremely windy conditions, drivers not only reduce the risk of accidents taking place but also increase their chances of correcting the course in time should the vehicle come out of control. Last but not least will they reduce their risk of injury if the driving speed is moderate. In the accident database, the vehicle speed at the time of accident is recorded according to the driver's own assessment. In accidents happening at mean wind speeds lower than 10 m/s at Kjalarnes, 85% of the drivers state that their driving speed was 89 km/h or lower (V85 = 89 km/h). When the mean wind speed is higher than 10 m/s, V85 is reduced to 78 km/h.

Thanks to the sub-pavement sensors, V85 is easily calculated and sorted according to the recorded wind speed in a nearby weather station. For last October till January, on Kjalarnes, this exercise reveals that V85 is close to 103 km/h when the wind gust is lower than 15 m/s (equalling mean wind speed lower than approx. 10 m/s). When the wind gust is 40 m/s (78 knots or 144 km/h !), V85 is only reduced to 90km/h.

Concluding on this fact it sounds reasonable to say that drivers only slightly moderate their driving speed according to wind speed, and are probably not paying the deserved respect to the wind. And obviously, driver's own assessment of the driving speed once the accident has happened gives a biased picture!

Future tasks

The researchers believe that the risk of wind induced accidents can be heavily reduced by driver education, early warning, traffic control and possibly local sheltering measures on exposed sections or road class improvements. However, due to Iceland's harsh climate and sparse vegetation, the risk of wind induced traffic accidents will always be there. Even though wind induced accidents are most common during the winter, August is also a risky month, when the autumn is approaching and lots of holiday makers are still out on the roads with their caravans, which have proved to be the wind's own favourites!

FACTS:

Thordarson & Snæbjörnsson, 2004, 2006. Traffic accidents and wind conditions. Reports for RannUm, part I & II. The Icelandic Board for Road Traffic Safety Research. (In Icelandic).

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Contact: Skuli Thordarson, PhD. Civ. Eng.
Iceland
skulit@simnet.is

Designing the Urban Motorring 3

All phases of the project of the extension of the Motorring 3 – from idea to the completed road – is carried out in close co-operation with architects. The purpose is to construct an urban motorway which is safe and which lives up to the requirements for quality and aesthetics set by the Danish Road Directorate, the road users, and the neighbours of the road.

Facts on M3

With almost 125,000 cars per day the M3 is the most important ring road of Copenhagen, Denmark. The 17 km motorway connects the Danish capital to the rest of Denmark and Europe through five motorways and a motorway to Sweden. The need for more capacity has been urgent for several years. The project widens the M3 by one extra lane in each direction plus an emergency lane in both directions. The work started March 2005 and will be finished by the end of 2008. Total cost is 255 million Euro.

The M3 surrounds the Danish capital Copenhagen for a length of 17 km, going from North to South. It is the most important ring road of the region. To design an urban motorway, such as the Motorring 3 (M3) requires necessary aesthetic decisions as regards elements such as bridges, lighting, noise barriers, crash barriers, plants, etc. In brief, everything, which is part of a heavily trafficked road. If the aim is to give road users and neighbours a beautiful, safe and high quality impression within the framework of the project, all elements must be considered to give a comprehensive picture.

Aims

The aim of the Danish Road Directorate has been to create a modern urban motorway within the economic framework of the project for the extension of the M3. A modern urban motorway should be created which corresponds to the expectations of the surroundings and the road users. The architects have therefore been in close dialogue with the Danish Road Directorate and have been involved in all phases of the project from idea to completion.

The completed road (illustration).

Comprehensive picture of the project

Claus Bjarrum Arkitekter has designed the M3 seen from several points of view and considerations. Some basic questions have been asked which form the basis for the design of the motorway. How can a high capacity road be designed where traffic safety has the highest importance? How can the redesigned road contribute to the creation of higher quality and identity in those urban areas through which the road passes? How can the barrier effect of the road be reduced? How are the elements of the road experienced by the road users, who drives on the road at high speed? And maybe the most important questions of all for the neighbours of the road – how will the new road appear in relation to the closest surroundings?

Surroundings

By analysing the surroundings and the urban conditions it has been possible to establish those characteristics which form the basis for the aesthetics for M3. The M3 is fused by its many ramps and bridges to the landscape and urban areas it passes. A road user, driving at approximately 100 km/h passes an interchange approximately every 90 seconds. The road is situated above, below and on level with the surrounding level and gives a varying experience, when the road user drives from one end of the road to the other.

The basic plan was produced by urban developers back in 1947. This plan, known as "Finger Plan" has had great influence on the development of the area and landscape in Greater Copenhagen. The provincial towns are today situated along the radial roads of Copenhagen and are a part of the characteristic star formation of the Finger Plan. Between the fingers or arms of the stars are rural areas which spread far into the urban areas.

The radial roads crossing the M3 are clean crossings of the infrastructure and are therefore a natural starting point for aesthetic thoughts. At the interchanges various different trees are planted, which thus give each place an individual identity.

Cross section (illustration).

The neighbour

The neighbours to the M3 have considerable nuisance from noise, coming from the road. Thus a 3-4 meter high noise barrier will be constructed for the total length of 18 km. The noise barrier is slanted at 10° towards the centre of the motorway, partly to achieve the greatest possible effect of the noise absorbing capacity of the noise barrier, but also to soften the experience of the barrier as seen from the side of the neighbour. In order for the noise barriers to look harmonious - and for them to have a good design - the barrier on the neighbour's side is covered with trelliswork to allow climbing plants to grow there.

On some stretches the M3 is situated some 4-5 meters over the surrounding terrain. On the major part of these kind of stretches supporting walls are established in order to minimise the expropriations necessary. The four meter high noise barrier is placed on top of the supporting wall. In total, the height of wall and noise barrier can become up to nine meters. As a neighbour, this is an overwhelming barrier. Here also, climbing plants will be planted so in some years' time, this will appear to be a green, coherent surface.

The character of the road

M3 passes a varied environment. It can be divided into two types:

- The open countryside: Along some of the way, the road passes a stretch of wooded area.
- The urban part lies very close to housing areas. This part of the M3 will have noise barriers of up to four meters in height and in places where the road is above or below the normal level, supporting walls will be constructed.

On the northern side, the noise barriers will form a smooth course. The road user moves through an environment which is calm and the traffic can largely flow without hindrances. At the different interchanges one sees vertical tress which catch one's attention and which is in agreement with the fact that it is important to be aware of other road users, who come into or leave the M3. On the southern part, the motorway construction expands and catches the road user's attention through the surroundings and the most important landscape.

The motorway with noise barrier, light and gantry for intelligent traffic management systems.

It is a positive development in these years that there is so much focus on improvement of the physical environment. Hopefully, the ongoing design work on M3 will be considered a practical example of a careful and integrated effort to create quality improvements and a new identity for infrastructure and town development.

Article specially written for Nordic Road & Transport Research by Jesper Krilov Sørensen, architect MAA, Claus Bjarrum Arkitekter A/S

More information: www.trafikken.dk/m3.
Contact: tel. +4533413700, Email: m3@vd.dk

Using Clean Clay as Cap Material:

Environmental Aspects of the Bjoervika Project in Oslo

The Bjoervika Project is not a typical road project, but part of a city development plan in an old harbour area.

PHOTO: NPRA/PROSJEKTFOTO AS AND BÅRD GUDIM

The E18 motorway passes through Oslo's (Norway) city centre with an annual average daily traffic volume of 95,000 vehicles. The Bjoervika Project will realign the motorway from the surface to under the harbour area by means of an immersed tunnel. The new alignment will cross two small bays: Bjoervika and Bispevika, and release valuable land sites for city development Figure 1. Construction work started in the summer of 2005 and construction work in the water will be going on until the end of 2008. The whole project will be finished during spring 2011.

Particular attention has been given to environmental aspects of the road project both during construction and for the completed road system. This includes finding acceptable solutions for mass disposal, maintaining fresh and salt water environments, polluted sediments and sea-bottom, excavation and transportation of soil material, vegetation, air pollution, and noise.

PHOTO: NPRA/PROSJEKTFOTO AS AND BÅRD GUDIM

A overwiew of the new alignment crossing Bjoervika and Bispervika.

After removing a minor layer of contaminated marine sediment, approximately 380,000 m³ of clean clay will be dredged to make space for the prefabricated tunnel elements. An additional 180,000 m³ of clean clay will also be excavated from land approach areas.

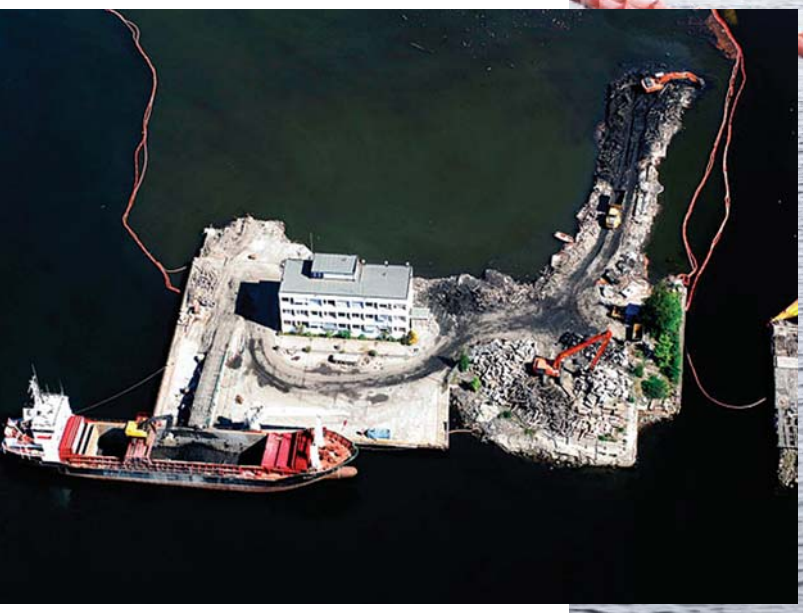
The clay is very soft and not suitable for construction work. Transportation and disposal of 560,000 m³ clay on land would generate traffic and air pollution, plus extra costs if the clay is defined as waste. The plan is therefore to use this non-contaminated clay to cap areas of the sea bed in the Inner Oslo fjord that are heavily contaminated. This will establish a physical barrier between the contaminated seabed and sea life.

The Pilot Project

To test the feasibility and effectiveness of this concept, a pilot project was carried out in the autumn of 2004. The results (2005) showed that the pilot project was a success. Clay slurry of suitable consistency was produced and seems to provide a valuable cap on contaminated sea bed. The negative reaction of the media has been hard to understand. It is possible that they are sceptical to capping contaminated seabed in itself.

Challenges Related to the Marine Environment

In the sea area the tunnel will mostly be lower than the present seabed level. Therefor during the time of the building project, a deep canal down to about contour line -20 has to be excavated belov the bottom of the sea. This will be laying open until the prefabricated elements of the immersed tunnel are installed and the masses filled back to cover the tunnel elements. The construction site will also cross the outlet of a river (Akerselva) and unless necessary measurements are carried out, migrating fish could be negatively affected by particles, pollution and noise. The masses from the excavation consist of different types of material of which some fractions have a high concentration of heavy metals and organic environmental poison which have to be handled in a way that prevent spreading of pollution.



Construction works for the immersed tunnel which also will cross The Bjoervika pier.

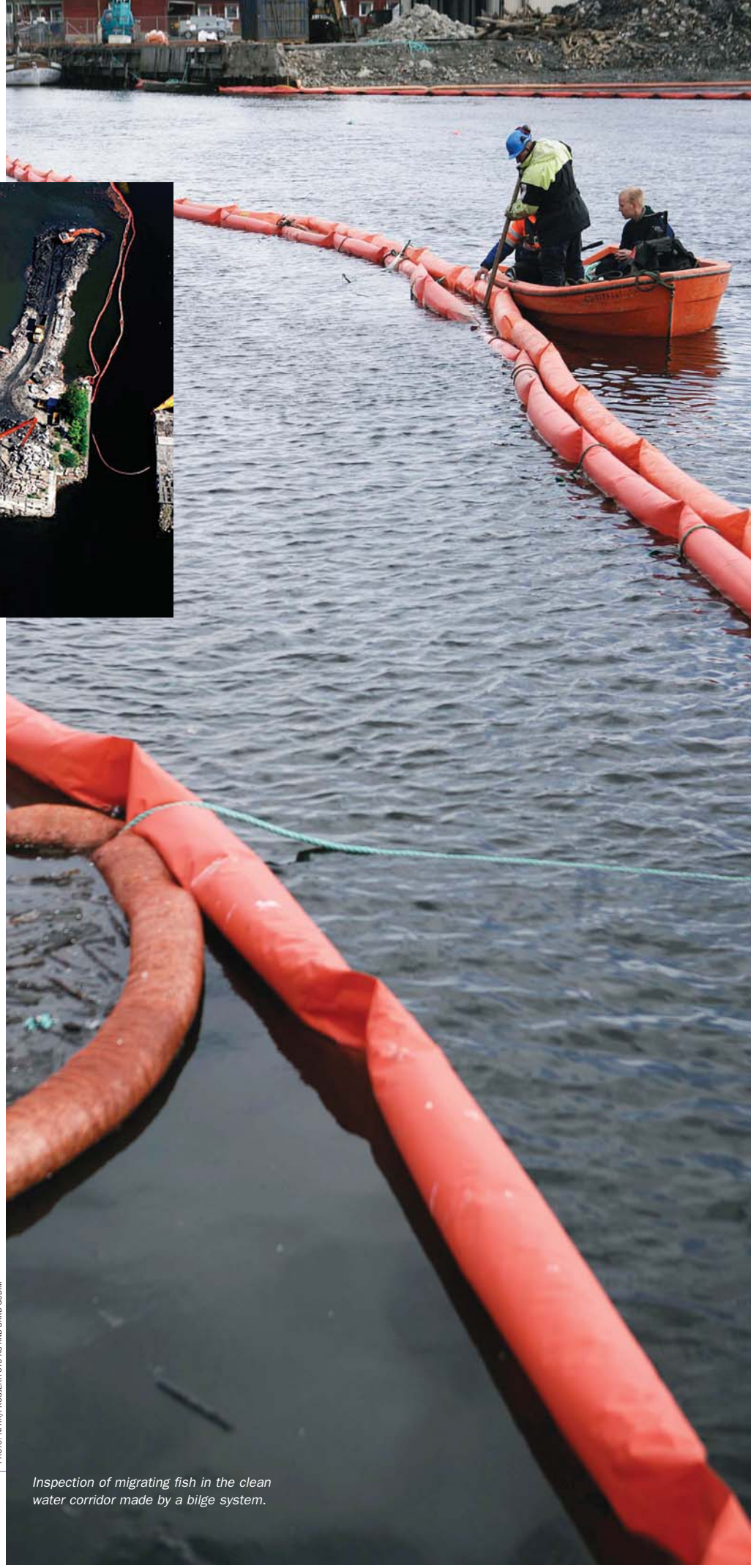
Analysis have shown that spawning fish and fry should manage to pass through the construction site during the construction period and be secured from negative exposure of particles, pollution and noise if appropriate measures are taken. In addition the bottom contour line and the river bed of the Akerselva will be restored so that the river mouth remains as it is today.

Status by August 2006

The construction work on the alignment of the immersed tunnel has begun. Contaminated clay has been disposed, and clean clay is now being excavated. When the excavation for the alignment is over, this clean clay will be used as cap material on the immersed tunnel. The alignment is 110 m wide and the excavation will last for about a year and a half. The first two 112.5 m long elements of the immersed tunnel manufactured in Bergen, Western Norway, are also tugged into the construction site.

More information:
http://vegvesen.no/region_ost/prosjekter/bjorvika/english.stm
Contact: Turid Winther-Larsen, turiwl@vegvesen.no

PHOTO: NPRA/PROSJEKTFOTO AS AND BÅRD GUDIM



Inspection of migrating fish in the clean water corridor made by a bilge system.

2005 Norwegian Travel Survey

The 2005 Norwegian National Travel Survey (NTS) is the fifth national survey of travel behaviour conducted in Norway, and marks 20 years of NTS surveys in Norway. This article summarises some key findings of the survey.

NTS records personal travel of all types, including short trips taken on a daily basis and longer journeys undertaken less frequently, and all modes of transport including walking. The Norwegian NTS is comparable with most European and the American Passenger Travel Surveys. A total of 17,514 persons aged 12 and above were interviewed in the 2005 NTS. The figure includes a representative sample of the entire country of around 10,000 and supplementary, regional samples.

Increased car access

Car access is one of the most important factors affecting mode choice. In 2005, 87 per cent of the population belonged to a household with at least one car, one third had two cars and seven percent had three or more cars. 68 per cent said that they always had access to a car; an increase of four percentage points from 2001.

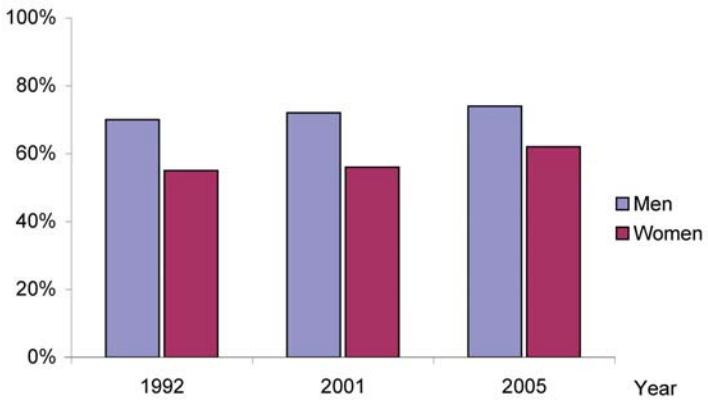


Figure 1: Proportion of men and women who can always access a car in 1992, 2001 and 2005

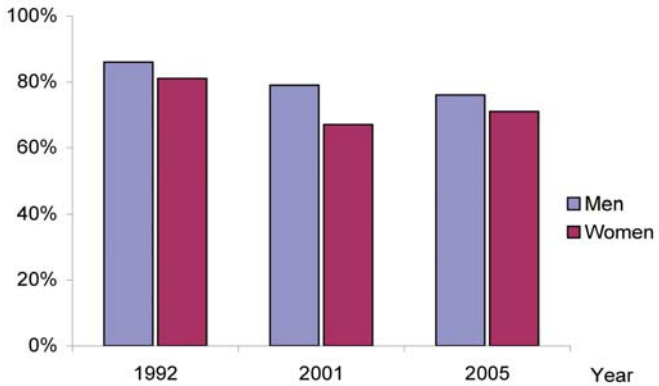


Figure 2: Proportion driver licence holders among women and men aged 18-24 in 1992, 2001 and 2005

Access to a car varies considerably. Men continue to have better car access than women. Other characteristics of those with good access to a car are high income, higher education, couples with children, and age group 45-54. There are considerable geographical differences in car access. People living in the capital, Oslo, have the lowest car access rates; whereas those living in smaller towns and in sparsely populated areas have highest access. People living in areas surrounding the big cities have good access to cars, too.

During the 1990s, the proportion of young people aged 18-24 with driving licence fell. In 2005, the relatively low proportion of driving licence holders in this group remained at the same level as 2001, 73 per cent. Among young people, the primary reasons for not having a driving licence are that they do not need one and that they cannot afford it.

The quality of public transport, measured in terms of the distance to the bus or tram stop and in terms of service frequency, varies extremely between different areas. The quality is clearly best for people living in Oslo. Also those living in the cities of Bergen, Trondheim and Stavanger enjoy relatively good levels of service, whereas service levels in areas surrounding the large cities are considerably poorer.

24 percent of the sample reported that

Car access is one of the most important factors affecting mode choice.

PHOTO: PHOTOS.COM

very good public transport services were available to them, 46 per cent good or fairly good services and 30 per cent stated poor or very poor public transport services. This is an improvement compared with 2001, when 38 per cent reported poor or very poor public transport.

A large proportion of the population owns a bicycle, 76 per cent. This figure remains stable over time.

More trips and more car use

The average trip length is 11.1 km, a slight reduction from 2001, and takes 20 minutes. The total length travelled per day for each person is 37.4 km, a slight increase from 2001. Men, those in employment, people with high income and education, and those living in the Oslo region travel the longest distances.

In 2005 the population made an average of 3.3 trips per day. This is a slight increase from the 2001 average of 3.1 trips and is mainly caused by an increase in car travel. The number of trips by other modes of travel is stable. In 2005, 54 per cent of all trips were made by car drivers. When we add trips made as a car passenger, the car represents two thirds of all trips being made. One trip in five is a walking trip, and in total one out of four trips is non-motorised. Public transport trips constitute eight percent of all trips.

Trip purpose

Commuting constitutes 19 per cent of all individual trips, but is often connected with trips for other purposes, such as shopping, taking children to activities etc. Nearly 30 per cent of daily trips are related to shopping. This a slight increase from 2001. More than half of these shopping trips involve grocery purchases. Accompanying children to activities and trips for other care purposes constitute 10 per cent of daily trips. Separate leisure trips are 17 per cent of daily trips, and travel related to private visits 13 per cent.

More long trips

On average Norwegians made 1.6 long trips per month, defined as trips longer than 100 km (62 miles) and trips abroad. This is a clear increase since 2001. More than half of the population made a long trip in 2005.

Holiday and leisure travel dominate long trips. Every third trip takes place in the context of a holiday, with visits coming in addition. Altogether these two purposes constitute 56 per cent of long trips. Work-related trips represent 18 per cent.

For domestic long trips, the car is the dominant mode with a 71 percent modal share. Aviation accounts for 13 percent, as do train and coach together. There is an increase in car use since 2001. For holiday and leisure trips abroad, travel by air is the dominant mode of transport.

Title: 2005 Norwegian Travel Survey - key results
Authors: Jon Martin Denstadli, Øystein Engebretsen, Randi Hjorthol and Liva Vågane
TØI report no 844/2006
All TØI reports are available on www.toi.no

Under-sea Tunnels: New World Record

Graphic design: Graphic centre, NPRA

A new world record for deepest under-sea tunnel was set in Norway on the 31st of May this year when, under construction of the new Eiksund tunnel in the north-western part of the country, a depth of 266 m under mean sea level was reached. The record is expected to increase to 287.32 m this autumn and experts believe this record will not be broken in many years.

Never before have road builders reached as far below the ocean surface as the builders of Eiksund tunnel. The old record of 264 m below sea level, which belongs to Hitra tunnel in Sør-Trøndelag, is now history. The new record was reached after constructing 3.940 m tunnel starting from Steinnesstranda in Ørsta district.

The Eiksund tunnel, which runs from Eika under Yksenøysund and Yksen island, and further under Vartdalsfjord to Berknes peninsula will be 7.765 meter long. The tunnelling goes deeper and deeper and the lowest point of 287.32 m will be reached in the autumn. Breakthrough in Eiksund tunnel is expected at the end of December this year depending on the quality of the rock in the remaining 2.300 meters.

The Eiksund tunnel will have three lanes (climbing lane) from the lowest point up to Eika where the slope is 9.6%. The exit to Steinnesstranda where the slope is lower (7.6%) and the view is better, will have two lanes.

The total cost of the project including supporting roads, two tunnels and a new bridge is about 100 million Euros (2003). The cost of the Eiksund tunnel itself is about 47 million Euros (2003).

When the Eiksund link on the national road 653 becomes completed in 2007, the island districts of Hareid, Herøy, Sande, and Ulstein with their 22,000 inhabitants will get ferry-free road connection to the main land. The Eiksund link will also connect Ørsta and Volda on the main land side to the island districts to form a region with over 40,000 inhabitants, who will get better communication and access to:

- diverse schools
- wider and diverse job market
- physician and hospital services
- Wider and better trading opportunities.
- Wider offer in public and private services.
- Attractive recreational areas in the mountains and near the sea.
- An active and well developed industrial environment in ship building and mechanical industries.
- Fishing activities

The tunnel builders were praised very much during celebration of the new world record. The good teamwork that was conducted by all those involved in the project and the fact that the work was conducted without any injury was highly appreciated. In addition it was noted that the project is on the right track with regard to progress, quality and economy.

The Eiksund link. Graphic design: Wiggo Kanck/Graphic centre, NPRA

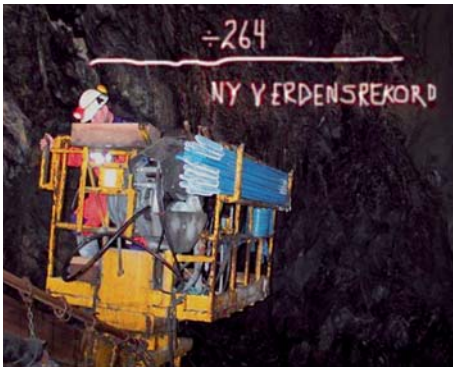


PHOTO: WIGGO KANCK

Never before have road builders reached as far below the ocean surface as the builders of Eiksund tunnel.

More information (only in Norwegian): http://www.vegvesen.no/region_midt/prosjekter/eiksundsambandet/index.stm

Fire in Tunnels:

The Runehamar Test Tunnel

Åndalsnes is located 500 km from Oslo. The Runehammer test site is located 5 km from the town centre of Åndalsnes.

Fires in road tunnels have happened more frequently over the last decade. To be able to prevent such fires, there is a need for understanding the specific elements related to fires and tunnels and how these matters influence each other. Laboratory testing has been usual, full scale testing is rarer. The Norwegian contribution is an abandoned tunnel, The Runehamar Tunnel, upgraded with equipment to execute full scale fire tests.

The Tunnel Fire Test Site

The Runehamar test site is located 5 km from the town centre of Åndalsnes in the north western part of Norway. Åndalsnes is located 500 km from Oslo and 40 km from Molde. The Runehamar test site has three road tunnels closed down for ordinary traffic, where two can be used for fire testing. The Old Runehamar tunnel has previously been used for fire testing of various tunnel insulation materials. All tunnels at the site are easy to access by road. They are located about 1 km from road E136. The entrance has a key closed gate entering into a short tunnel, which leads to the site. The road is in good condition with asphalt paving.

The Runehamar Test Tunnel

The Runehamar tunnel is made of hard Gneiss type rock. It is about 1.650 m long and the cross section is about 50 m². The tunnel has a small slope (1%-3%) downwards (going west) and a slight curve going north. The tunnel was constructed in the early sixties.

The site of the tunnel, length and shaping make the Runehamar Tunnel ideal as a tunnel for research and development of tunnel safety technology. The benefit of such a test tunnel will be related to the fact that every research activity conducted in this tunnel will be in full scale. Previous laboratory tests can be evaluated in realistic conditions and environment compared to real life:

- Large scale fire tests
- Size of fires influencing accept criteria
- Size of fires and structural response
- Accept criteria for evacuation in tunnel smoke
- Tests of insulation materials
- Mitigation measures.

Large Scale Fire Tests in the Runehamar Tunnel

In the frame of Swedish national and European research programs on tunnel safety, comprehensive large scale fire tests have been conducted in September 2003 in the Runehamar road tunnel. Especially semi-trailer fires similar to the size of the fires in Mont Blanc Tunnel (France/Italy) and St. Gotthard Tunnel (Switzerland) were used. The Swedish National Testing and Research Institute (SP) have carried out the tests in collaboration with our UPTUN partners from TNO Building and Construction Research in the Netherlands and the Norwegian Fire Research Laboratory (SINTEF/NBL). Total four large-scale tests with different semi-trailer fire loads where carried out. The world's highest peak heat release rate ever measured in a tunnel fire test was registered. It was higher than 200 MW and the gas temperatures in the vicinity of the fire were registered above 1.350 °C.

Why Testing?

The purpose of the fire tests was to measure the rate of growth of various types of semi-trailer cargoes and to investigate the heat exposure to the tunnel linings. The purpose was also to obtain information to assist a new approach to fighting fires in tunnels. The information will be used to develop design scenarios for road tunnels and guidelines for protection of such tunnels. Variation of loads is infinite, but we shall attempt to restrict the number to those most commonly encountered.

During 2005 two full scale tests were conducted in the tunnel:

- Test of tunnel membrane used for water protection. A total length of 30 m of membrane was installed and the test fire was approximately 25 – 30 MW with a time-temperature curve similar to HC. The test confirmed that the given demands for such a membrane were fulfilled.
- A full scale mitigation test was conducted at the end of the year. For the results of this test the "Ministerie van Verkeer en Waterstaat" in the Netherlands has to be contacted: http://www.rws.nl/rws/bwd/home/www/cgi-bin/index.cgi?site=3

For 2006 The Norwegian Public Roads Administration is planning for three different full scale fire tests of materials related to water-frost insulation and protected with 80 mm sprayed concrete with polypropylene fibres. The fire growth, caused by pool fire, of these tests are decides to be of a size around 50 MW for at least 90 minutes.

More information about the tests and the results can be found at the website: www.uptun.net, www.sp.se and http://vegvesen.no/servlet/Satellite?cid=1156250661871&pagename=vegvesen%2FPage%2FSVVsubSideInnholdMal&c=Page

Contact: Harald Buvik, harald.buvik@vegvesen.no

PHOTO: PHOTOS. COM

– Developments in Traffic Safety in Sweden, the UK and the Netherlands

By commission of the EU, the project SUNflower, a comparison of traffic safety in Sweden, the United Kingdom and the Netherlands, was carried out in 2002. The aim was to find information that several countries could use and in this way improve their traffic safety. The project was extended since these countries acted as models for many other countries. Two other groups of three countries in Europe have also performed projects of very much the same type as that in the original SUN countries.

Sweden, the UK and the Netherlands are countries which have the highest traffic safety measured in terms of the number killed in traffic per head of population and the number killed in traffic in relation to the total mileage driven by vehicles on the road network in the country. A comparison of countries requires information concerning different groups of roads, age groups of road users or drivers, and so on. The more detailed the information on road accidents or traffic, the better and more reliably road safety can be described. In the end, the comparisons are limited by the fact that one or more countries do not have the necessary information or that the information is too imperfect to be used.

The method used is formulated as a pyramid where the objective is to describe the "costs" of society for road safety. The level below this contains the number killed and injured in traffic. Below this level there is information concerning the road network, traffic and traffic user behaviour. The two lowest levels comprise the road safety measures of society and the structure of society and the traffic system. The description of these levels requires annual reporting and registration routines, and preferably the same routines in all countries. Sweden, the UK and the Netherlands satisfy these requirements for comparisons to a very high degree. The years used as the basis for the work have been those between 2000 and 2003. The total number of road fatalities is largely unchanged between 2000 and 2003, but the population and the traffic have increased, which means that the total risks have decreased. From 2003 to 2004, the number of road fatalities was drastically reduced in these three countries. At the same time, the situation was largely the same in the whole of Europe.

There are nine areas that have received particular study, pedestrians, cyclists, moped riders, motorcyclists, young drivers, heavy vehicles, speed limit systems, surveillance and sanctions, and traffic safety measures such as 30 km/h limits in urban areas, speed cameras and the use of cycle helmets. Every country was responsible for three of these areas; Sweden was represented by VTI.

Some results concerning traffic safety in Sweden, the UK and the Netherlands:

- in relation to the population, the num-

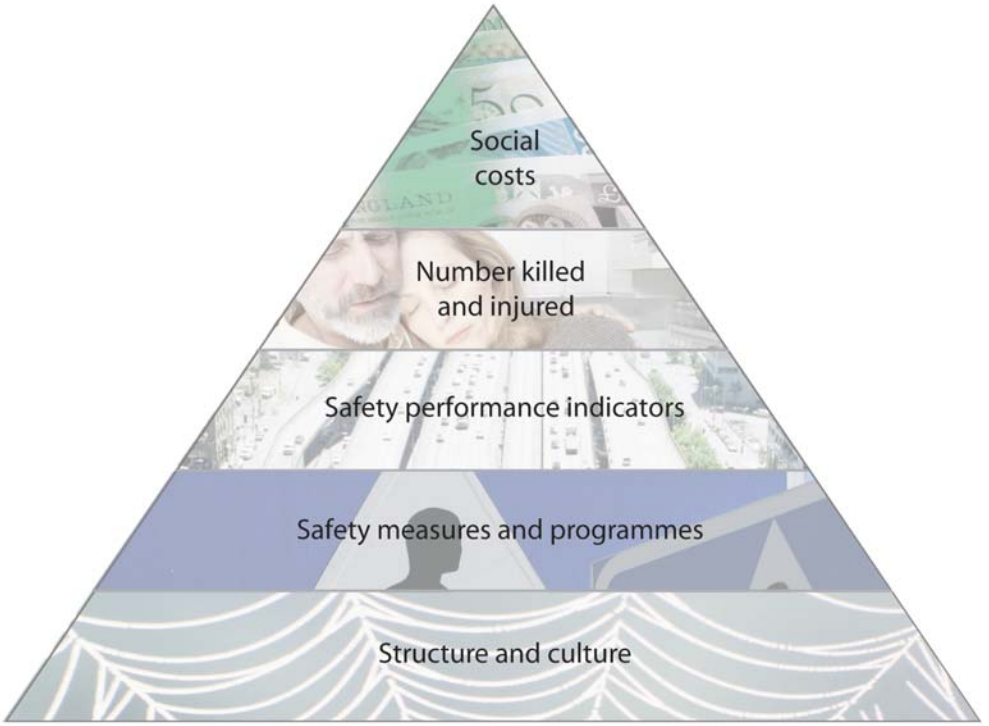


ILLUSTRATION: MAGDALENA GREEN, VTI

ber of pedestrians killed is twice as high in the UK as in the Netherlands and Sweden. The greatest problem in Sweden relates to elderly pedestrians.

- in relation to cycling, the risk of being killed per cycle km in the UK is twice as high as in the Netherlands and Sweden. Cyclists have been given their own space to a greater extent in the Netherlands and Sweden, and need not, in general, mix with vehicular traffic to such an extent as in the UK.
- the risk run by moped riders of being killed is twice as high in the Netherlands as in Sweden and the UK. The majority of those involved are younger than 20. Generally, mopeds do not conform to the traffic system and/or are used by a less responsible age group, often for purposes other than transport.
- the number killed in motorcycle accidents in relation to the number of motorcycle km is twice as high in the UK as in Sweden. What is surprising is that motorcycles are now less common in the "motorcycle country" UK than in Sweden and the Netherlands.
- the risks run by young car drivers in the three countries are about the same when consideration is given to the number of km driven. There has been a trend for risks to increase in recent years, primarily in Sweden. The risks are 4-5 times higher than for those aged 30-59. There is largely the same difference between young men and young women as car drivers, which indicates that this is mainly a male problem. The combination young man and car driver is in many ways an unfortunate one.
- the speed limit systems in the three countries are different, but the thinking behind the systems is the same. Because of the limited surveillance and the performace of the cars, car drivers have adapted to a greater extent to the "limits" of surveillance. A large proportion of car drivers drive within the limits that are accepted by the police, and/or that the likelihood of a reasonable fine can be accepted.
- as regards police resources, the UK and the Netherlands have about 270 police per 100,000 population against 180 in Sweden. Police in the Netherlands issue fines in traffic much more often (at least 10 times as often) than in Sweden and the UK. In Sweden, the action taken by police in traffic is only about one half of that in the UK. What is perhaps most striking is that in the UK and the Netherlands more car drivers want to have greater surveillance and higher fines for speeding than in Sweden.
- three measures have been treated with regard to their introduction and the attitudes of the countries to these measures. These are 30 km/h limits in urban areas which are most common in the Netherlands, speed cameras that are relatively rare in Sweden, and the use of cycle helmets that is most common in Sweden.

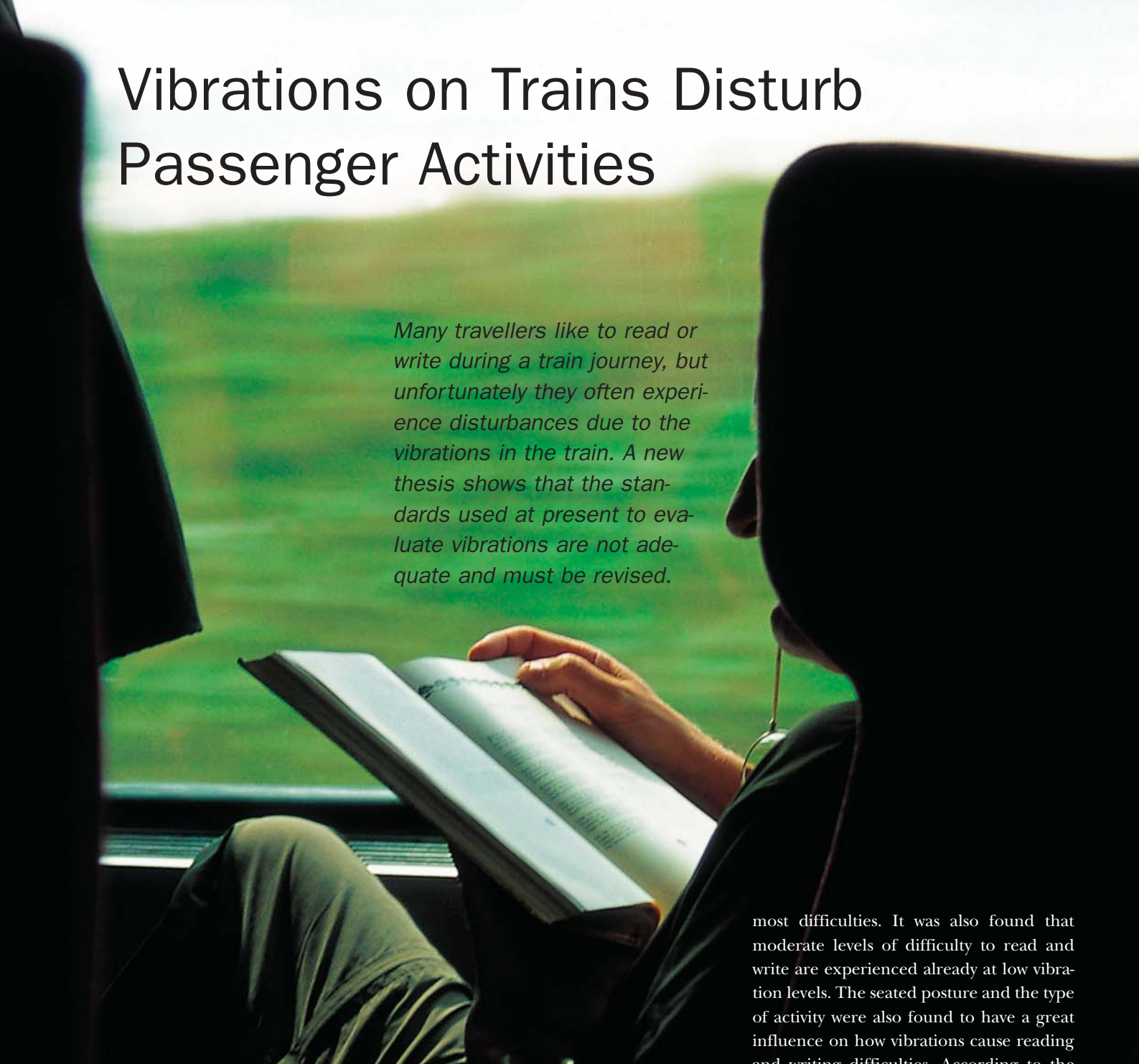
Magdalena Greeen, VTI, Sweden

FACTS

As mentioned above, the project comprised two other groups of three countries, Portugal, Spain and Greece, and Czech Republic, Slovenia and Hungary; these are described in separate reports. The project has thus given rise to five reports:

"An extended study of the development of road safety in Sweden, the United Kingdom and the Netherlands"
"A comparative study of the development of road safety in the Czech Republic, Hungary and Slovenia"
"A comparative study of the development of road safety in Greece, Portugal, Spain and Catalonia"
"Development and application of a footprint methodology for the SUNflower+6 countries"
"A comparative study of the development of road safety in the SUNflower+6 countries"
You can find the reports on www.transguide.se

Vibrations on Trains Disturb Passenger Activities



Many travellers like to read or write during a train journey, but unfortunately they often experience disturbances due to the vibrations in the train. A new thesis shows that the standards used at present to evaluate vibrations are not adequate and must be revised.

A large number of people who use the train for their daily travel read and write during the journey. Many of them are disturbed in their activities due to vibrations onboard the train. At present there are international and european standards for evaluating the vibrations in the train, but a doctoral thesis from VTI researcher Jerker Sundström shows that these should be revised. According to the standards, in the simplest case only vibrations at floor level are measured. The thesis demonstrates however that vibrations at the seat and table are often higher. In the thesis, one field study and two laboratory studies were made to investigate how vibrations affect train travellers ability to read and write. In the field study onboard three types of trains in normal traffic, 80% of travellers stated that they read at some time during their journey, 25% wrote by hand and 14% worked on portable computers. The travellers applied a number of different seated postures for their activities. In the laboratory studies, the vibration frequency and amplitude were found to have a great influence on the perceived difficulty in reading and writing. The vibration spectra in the actual train also appear travellers to coincide with the frequencies that causes the most difficulties. It was also found that moderate levels of difficulty to read and write are experienced already at low vibration levels. The seated posture and the type of activity were also found to have a great influence on how vibrations cause reading and writing difficulties. According to the standardised vibration measurements, even the trains that travelled on poor tracks were shown to have acceptable vibrations levels. On the same trains 60% of passengers said that they were disturbed by noise and vibrations when they performed a simple writing test.

Title:
Difficulties to Read and Write Under Lateral Vibration Exposure. Contextual studies of train passengers' ride comfort.
Contact:
Jerker Sundström, jerker.sundstrom@vti.se

Motorring 10 and Noise Reducing Pavements

The Danish Road Institute/Road Directorate (DRI) and Road and Hydraulic Engineering Institute in the Netherlands (DWW) is cooperating on the DRI-DWW noise abatement programme that includes a project on Thin Layer Pavements. An important part of this project is to carry out a full scale test of different types of noise reducing thin layers on a highway in Denmark with speed limits of 110 km/h for passenger cars and 85 km/h for heavy vehicles. The test site is located on highway M10 at Køge Bugt Motorvejen near Solrød. The purpose of this experiment is to document the noise reducing effect, and on a long term the acoustical and the structural lifetime of the thin layers.

In the summer of 2004, five different pavements including a reference pavement were constructed. In the last part of 2004 (year 0) when the mentioned pavements were a few months of age, the DRI performed a series of detailed noise measurements. A sixth pavement was constructed in August 2005. A new series of measurements was conducted in December 2005 (year 1) in order to monitor the development of the noise emission of these pavements. The measurements were performed according to the international standard ISO 11819-1 characterizing road surface influence on traffic noise, the so-called "SPB" method (Statistical Pass By method). Furthermore, a series of CPX (Close Proximity) measurements were performed in year 0, as a part of the project on acoustical characteristics in the DRI-DWW noise abatement program. To describe the surface texture of the pavements on the five sections, the DRI has performed detailed texture measurements by using laser equipment also in year 0. And finally, friction has been measured by DRI.

The completed SPB measurements are used to evaluate the noise reduction of the tested pavements relative to the reference pavement. When the actual distribution of the traffic is used as it was in the noise mapping of the M10 at Solrød with 90 % passenger cars, 5 % dual-axle trucks and 5 % multiaxle trucks, then the results, the modified SPB index ($SPBI_{M10}$) for each tested pavement is as shown in the table below. The total uncertainty on the $SPBI_{M10}$ is around 0.4 dB.

Modified SPB indices for each pavement and difference re reference pavement, when the actual traffic distribution was used ($SPBI_{M10}$ dB re 20µPa). Year 0/ 1.

There was an increase in the noise emission of 0 to 1.3 dB from year 0 to year 1. At the dense reference pavement there was no increase in the noise emission. This is the main reason that the year 1 measurements showed a less effective noise reduction compared to year 0 noise reductions.

It can be seen that relative to the reference pavement there was a reduction in the modified SPB index for the tested pavements of between 0 and 3 dB in year 0 and year 1 with a trend for lower noise reduction in year 1. The noise reduction was around 1.5 dB at the SMA6+ pavement for both years, while the initial noise reduction at the two thin layers (TP8c and AC8o) was 2-3 dB, in year 1 this was reduced to 1-2 dB. AC8o and TP8c have the biggest built in air voids of 15.3 % and 14.4 %, respectively. At the SMA8+ the measured noise reduction was of 2.4 dB. in year 0. The marginal noise reduction at the SMA8 pavement was of no significance.

The AC8o and the SMA8+ pavements had the best noise reduction performance; the same could be said about the TP8c pavement in year 0, whereas it seemed in year 1 that the traffic noise at this pavement had increased.

A 1/3-octave-band frequency analyses has been made for the $SPBI_{M10}$ indices. In the frequency spectra below 800 Hz the noise from vibrations in the tyres (and engine noise) is dominating. Below 800 Hz in year 0 the spectra were very similar for both the reference and the thin layer pavements. This indicates that there was no significant reduction in the noise generated from tyre vibrations. Above 1000 Hz the noise from the air pumping effect is dominating. The noise reduction relative to the reference pavement AC11d takes place at the high frequencies above 1000 Hz. This indicates that the air pumping noise was reduced by the thin layers. This must be caused by the open surface structure of these pavements.

CPX measurements have also been made. The two indices (SPB and CPX) for passenger cars and passenger tyres showed the same tendency but there was no unique linear relation.

The surface texture measurements yielded the Medium Profile Depth (MPD). The MPD value for the layers SMA8, AC8o and TP8c was around 0.9 mm, and this was a significantly higher MPD value than that of the reference pavement and SMA6+ which was 0.4 to 0.5 mm. All pavements fulfilled the requirements for the friction as stated in the highway standards. The thin layer pavements had better friction than the reference pavement. Both the texture and the friction values were homogenous in the longitudinal direction for all pavements.

	AC11d		SMA8		AC8o		TP8c		SMA6+		SMA8+ [1]	
Year 0 Year 1	0	1	0	1	0	1	0	1	0	1	0	1
$SPBI_{M10}$	84.0	84.1	83.2	84.1	81.2	81.8	81.8	83.1	82.6	82.6	81.6	-
Difference re. AC11d [dB]	0	0	-0.8	0.0	-2.8	-2.3	-2.2	-1.0	-1.4	-1.5	-2.4	-

[1] Due to intense traffic only 38 light vehicles were measured, whereas at least 100 light vehicles were included in the other measurements.

Noise Reducing Pavements – Internationally!

The latest international experiences are presented. Good noise reduction and durability as well as good friction have been achieved in Europe.

PHOTO: HANS BENDTSEN

There is an increasing focus in Denmark on the possibilities of using thin layer pavements, which have been optimised to reduce noise. The Danish Road Directorate/ Danish Road Institute (DRI) has published two new reports about international experiences with noise reducing thin layer pavements based on literature studies and visits to France and USA. The purpose was to obtain the latest international knowledge, which can form the background for a continued development and optimisation of noise reducing properties and durability of thin layer pavements in Holland and Denmark.

The work has been carried out within the framework of the co-operation on research and development, which DRI is carrying out with Road and Hydraulic Engineering Institute (DWW) in the Netherlands in the period from 2004 – 2007, called the "DRI-DWW noise abatement programme" [1].

Thin layer pavements were introduced in the early 1990s and have since been used in France and other European countries on a large scale. The purpose was to obtain good friction at a relatively low price. In the late 1990s, work was started to modify these pavements to also obtain noise reductions. France also has worked on optimising the pavements to obtain noise-reducing qualities, not only on urban roads, but also on rural roads and motorways. This work has changed existing mix designs, which can have consequences on the durability, friction and other relevant properties.

Use of thin layer pavements is not new in Denmark either, but the new aspect is that the pavements are being optimised in order to obtain better noise reducing properties.

There are two important mechanisms which influence the amount of tyre-road surface noise:

- Noise from the vibration of tyres is generated by the contact between the rubber blocks on the surface of the tyre and the surface of the road. These vibrations start moving the air surrounding the

Microphone on roadside to measure noise.

PHOTO: HANS BENDTSEN

tyre, which then creates noise. This noise is in the frequency area less than 1000 Hz. The more even the road pavement, the less noise.

- Noise from air pumping occurs when a tyre goes over a pavement. As the rubber blocks of the tyre hit the road surface, they are compressed, and thus the air between the rubber blocks is pushed out. When the rubber blocks are released from the road surface, air is sucked in again. These quick movements in the air result in high frequency noise over 1000 Hz. If the road pavement has an open structure the air will to a greater extent be pressed into the pavement and be sucked up again, which reduces the level of noise produced.

When comparing noise levels, it is always necessary to have a reference pavement against which the noise level can be compared.

The layer thickness has in fact no direct influence on the noise level from noise reducing pavements. But as mentioned above, there is an indirect effect by using a little maximum aggregate size of 6 or 8 mm. Since as a rule of thumb, pavements usually are constructed three times the size of the aggregate in thickness, noise reducing pavements with an open structure will usually have a small layer thickness of typically 15-25 mm. This can give a noise reducing effect. However, not all thin pavements are noise-reducing.

Noise reduction

In France, researchers and asphalt producers have worked for a number of years to develop noise reducing thin layer pavements. Thin pavements are divided into two classes depending on the voids in the pavement mix. They have a thickness of 20-30 mm. Also a type of ultra thin pavement is being considered with a thickness of 15-20 mm. In order to obtain an efficient sealing, an emulsion layer is usually put underneath the thin pavement. Modified bitumen is used in places where there is a risk of shear forces. According to the French Road Research Laboratory, LCPC, thin pavements are resistant to rutting, they reduce splashing from rain and have a high friction. It would seem that pavements with 6 mm aggregate have a better friction than pavements with 10 mm aggregate.

Noise reductions were measured in France in relation to a dense asphalt concrete with 10 mm maximum aggregate size, which basically corresponds to the Danish reference pavement. Noise is measured at 80 km/h and 90 km/h. In general, noise reductions are measured on thin layer pavements of 2-4 dB, which is less than can obtained on a drainage asphalt, which is 4-6 dB. It can be seen that the best noise reduction can be obtained on pavements with the smallest aggregate and for Class 2 pavements with the largest possible voids. The noise reduction is in general somewhat greater for cars than lorries.

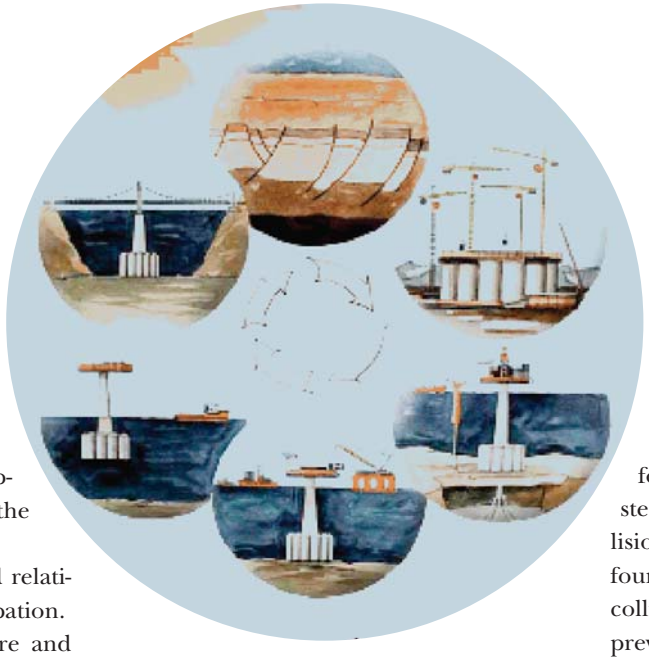
Hans Bendtsen

Literature:
1. The DRI-DWW Noise Abatement Programme — Project description. Technical Note 24, 2005. Danish Road Directorate, Danish Road Institute
2. International experiences with thin layer pavements. Technical Note 29, 2005. Danish Road Directorate, Danish Road institute
3. French experience on noise reducing thin layer. Technical Note 28, 2005. Danish Road Directorate, Danish Road Institute

Article specially written for Nordic Road & Transport Research by Senior Researcher Hans Bendtsen, Road Directorate Danish Road Institute hbe@vd.dk.

Recycling of Oil Installation

In our millennium the petroleum activities have provided an economic and technological basis for innovation and opportunities for large and bold projects. Concrete substructures with technology that keeps pushing the limits are some of the boldest structures in more recent times.



Norwegian oil and gas production has passed through various production phases during the last three decades.

- The 1970s are known for being the infancy of the Oil Age with American expertise and development of the first oilfields on the Norwegian and British sides.
- The 1980s for large projects and relatively extensive Norwegian participation.
- The 1990s for increased pressure and injection into the reservoirs to extend the lifetime and improve recovery from the fields.
- The 2000s for field cessations, deep water technologies and increased international focus.

The 1990s phase with focus on prolonged lifetime initiated research within several fields. In addition to reservoir technology, studies were carried out on maintenance and exact lifetime calculations for facilities. The studies concluded that the concrete quality and technology far exceeded the other marine structures we are familiar with in quay facilities and bridge structures.

A platform or installation on the open seas represent a limited environmental problem. A large number of platforms and fields scattered across large areas of open sea represent a major environmental and safety problem for the North Sea. What is the best way to handle this issue? International and national authorities work diligently, but there are still many unresolved issues. What is done to remove gravity base concrete structures?

Over the last 4-5 years an idea based on reuse of concrete substructures from the North Sea for bridge foundations have come up among several professionals. Also reuse of steel constructions is relevant.

The proposal is as follows:

- By using one or more concrete substructures as "islets" in a fjord, the bridge span may be halved compared with traditional bridge constructions. This will allow for greatly reducing the necessary steel and concrete volumes. Visible collision buffers are built between the foundation and the tower to avoid boat collisions with the bridge tower. This will prevent accidents.
- By bringing steel platforms to land, these may be used for several smaller transportation projects across Norway. Flare stacks, gangways, platform decks, etc. can be scrapped for reuse.

Title: R&D: Reuse of concrete and steel sub structures from the petroleum industry
Author: Bjørn Martin Alsaker
Language: English
Contact: bjorn.alsaker@vegvesen.no

Drugs Cause High Accident Risk in Road Traffic

Title: The prevalence and relative risk of drink and drug driving in Norway
Author: Terje Assum
TØI report no: 805/2005
Language: English
Available on www.toi.no

The relative risk of road trauma associated with psychoactive substance use was determined by comparing the prevalence of seven substances between a sample of killed and seriously injured drivers and a sample of the general driver population. Due to data collection problems both samples obtained were smaller than planned, a fact which limits the conclusions of the study. Nevertheless, the prevalence of five of the seven drugs studied is higher among the killed and injured drivers than among the general drivers. 32 per cent of the killed or injured drivers had taken at least one of the seven drugs studied, whereas only one per cent of the general drivers had taken one or more of these drugs. This is an indication that these drugs cause high accident risk in road traffic.

Bicycle Injuries and the Risk of Cycling

Title: Bicycle injuries, risk of cycling and the tool for cost-benefit analysis of measures towards cycling
Authors: Knut Veisten, Kjartan Sælensminde, Karl-Erik Hagen
TØI report no: 816/2005
Language: Norwegian with summary in English
Available on www.toi.no

This report provides an estimate of the total extent of cyclist injuries in Norway. By means of hospital data, the non-recorded accidents are split according to injury severity. Approximately 13 per cent are police recorded out of a total annual injury number of slightly less than 6,000. In discussing the risk of cycling, we show how important it is to distinguish between pure section risk and pure crossing risk. Construction of cycle paths reduces the section risk, but the combined section and crossing risk may increase if crossing measures are not brought about simultaneously. Finally the report indicates how to include non-recorded accidents and the issue of section risk/crossing risk into a tool for cost-benefit analysis of measures towards cycling.

PHOTO: PHOTOS.COM

Cycling Against Red Light - Extent and Causes

Title: Cycling against red light - extent and causes
Authors: Torkel Bjørnskau
TØI report no: 821/2006
Language: Norwegian
Available on www.toi.no

On average, bicyclists ride against red lights in one out of three cases. Men do so more often than women, but there are no differences between age groups. The probability of riding against red increases (i) at right hand turns; (ii) when signals are located at the bottom of a downhill trajectory; (iii) when signals are slow to change to green; and (iv) when others walk or ride against red. The probability of stopping increases (i) when one rides together with children; (ii) when children wait for green light; (iii) at left hand turns; and (iv) when the crossing road has more than two lanes. A majority think that those who ride against red lights are law abiding in other areas and that the best countermeasure is to better arrange for bicycling in general.

Norwegian Air Travel Survey

Title: 2005 Norwegian Air Travel Survey
Authors: Jon Martin Denstadli, Arne Rideng, Jon Inge Lian
TØI report no: 828/2006
Language: Norwegian with summary in English
Available on www.toi.no

This report presents results from the 2005 Norwegian Air Travel Survey (ATS). Information from 91,581 passengers travelling on scheduled international and domestic flights have been collected and analyzed. During recent years the number of international passengers travelling to and from Norwegian airports has increased substantially. Results from the ATS show that approximately 1.4 million Norwegians made one or more international flight in 2005, an increase by 300,000 in two years. The growth has primarily taken place within the leisure market. Leisure travel constitutes 60 per cent of the market, compared to 56 per cent in 2003. Increased competition and fare reductions are important factors behind these changes. Passengers travelling on domestic flights have also experienced price reductions during recent years, in particular within the business segment.

PHOTO: PHOTOS.COM

Deliberate Offences in Traffic

Title: Traffic violations – a review of the literature
Author: Sonja Forward and Catharina Lewin
Series: R534
Contact: Sonja Forward, sonja.forward@vti.se
Catharina Lewin, catharina.lewin@vti.se

Traffic safety research previously focused on describing the cause of accidents with reference to various types of shortcomings of the driver, which has resulted in attempts to improve driving ability and to change the traffic environment. In recent years, researchers have begun to understand that the solution to the problem does not always lie in what the driver can or cannot do, but in what he/she actually intends to do.

Human errors are of three types:

- deliberate offences such as speeding, drink driving
- mistakes such as erroneous assessment of their own or others' speed, and defective sight conditions
- routine offences that are due to carelessness or forgetfulness.

As regards traffic accidents, it has been found that it is deliberate offences which are the principal cause, rather than mistakes or routine offences. Deliberate offences have been described as a deliberate departure from routines which, in the usual case, can protect the individual from danger. Research has shown that people who commit deliberate offences often think that they are better drivers than others, which means that they feel traffic rules need not apply to them.

The following are the typical characteristics of a person who deliberately takes risks in traffic:

- has an overweening belief in his/her capacity as a driver and believes that he/she can handle the car even in a difficult situation
- overestimates the advantages and underestimates the risks
- has difficulty in controlling his/her behaviour
- believes that his/her nearest accept his/her behaviour
- overestimates the inclination of other drivers to commit deliberate offences
- does not feel that his/her behaviour is anything be ashamed of.

Increased knowledge of what induces a driver to commit deliberate offences may form the basis for various measures that aim to change his/her behaviour. The longest lasting effect is achieved when the internal motivation is modified, i.e. the individual's assessment of his/her behaviour is changed.

Measures addressed to target groups are preferable, but campaigns directed at all citizens have also had good effect. It is possible to change people's behaviour, but this requires good knowledge of the target group, which, in turn, is also a help in formulating the message. This work demands well thought-out methods and patience. A behaviour that has taken years to form cannot be changed in one day.

Respirable Particles in Railway Environments

Title: Inhalable particles in railroad environments
Author: Mats Gustafsson, Göran Blomqvist, Andreas Dahl, Anders Gudmundsson, Erik Swietlicki
Series: R538
Contact: Mats Gustafsson, mats.gustafsson@vti.se
Göran Blomqvist, goran.blomqvist@vti.se

The environmental quality standard for respirable particles (PM^{10}) came into effect in January 2005. This standard has increased interest also in particulates in railway environments.

Particulate pollutants from rail traffic have been noted as an air pollution problem, especially in underground railway environments. In many underground railways all round the world, emissions from brakes and high particulate contents have drawn attention to the sources of these particles and to the ways in which the problems can be tackled. But the problem has also been noted above ground.


PHOTO: PHOTOS.COM

Over a period, VTI has made measurements of particulate contents at several places both above and below ground. The results show that, during the periods of measurement, particulate contents in railway environments above ground do not exceed the environmental quality standard. On the other hand, the average 24-hour concentration on the platforms of the underground stations is considerably higher than the limit value. However, underground railway environments are exempt from the environmental quality standard at present.

The measurements in the underground environments also give some interesting results associated with measures against particulates. It was found, for instance, that flushing the tunnels had no effect at all on the particulate contents, which was rather unexpected.

The results of the studies show that trains give rise to high concentrations of iron-containing respirable particles, especially in underground railway environments. In station environments above ground, which are mostly of a very open character, the emissions are ventilated away quite effectively, and therefore high concentrations persist for only short periods. During journeys by rail, particulate concentrations are

generally low but rise when the train stops at stations and, most of all, when the train drives into the investigated tunnels.

The sources of PM^{10} from the railway are probably the wheels, tracks and brakes, but an allocation to various sources could not be made in this project. The concentrations of both PM^{10} and ultrafine particles vary greatly for different trains. The ultrafine particles, in particular, appear to be associated with certain trains, but it has not been possible to determine their source. For the construction and operation of existing and future railway and underground railway tunnels and for their traffic, it is important to investigate the significance of the sources, the health hazard posed by the particles and the measures that can be taken to reduce their concentrations.

Speed is Governed by the Traffic Environment

Title: Car drivers' spontaneous speed choice in urban areas
Author: Jan Törnros, Sven Dahlstedt and Gabriel Helmers
Series:N9-2006
Contact: Jan Törnros, jan.tornros@vti.se

Drivers do not bother too much about speed limits; it is the traffic environment that determines speed.

VTI has performed a test in which some twenty drivers drove along roads with 30, 50 and 70 km/h speed limits in a town in Sweden, with the speedometer covered. The test group consisted of experienced drivers; one group had at least five years' experience of driving in this town, while the other group had little experience of driving in this town. This experiment was used in comparing the drivers' spontaneous choice of speed in an urban environment with the signed speed limits.

The measured speed was found to vary greatly between the traffic environments. On some sections, the test subjects drove faster, and on other sections more slowly, than the signed speed limit. The drivers who were unfamiliar with the traffic environment drove faster on some sections than those who were familiar with the environment. The variation in speed between the traffic environments can to the greatest extent be explained by the variation in traffic environments and, to a considerably lesser extent, by the variation between drivers. Factors that influenced the speed chosen by drivers were road width, visibility and the amount of traffic.

The results of the study are relevant for, and bring to the fore, the issue of more flexible speed limits in towns.

Riihimäki Inland Port

Further information: reijo.lehtinen@prorautatie.net or antti.permala@vtt.fi

The growth of unitised transport and the construction of a new unit port in Helsinki have given rise to several feeder terminal planning projects. This study looks at intermodal terminal planning in Riihimäki. The biggest container ports in Finland are Helsinki and Kotka, representing a volume of 400,000 TEUs each.

The aim was to draw up a general plan for an intermodal terminal. The potential and possibilities of the new terminal were evaluated in the light of operational concepts, viewpoints of potential operators and financial and operations models.

Figure 1. Illustration of the planned terminal. Source: Pöyry Infra

Terminal facilities include offices, flow-through terminals, warehouses (palette places) and enlargement capacity. Operations include the handling of parcel goods, storing, crossdocking, and value-added services. Three possibilities of operation were identified for the Riihimäki terminal:

1. Terminal for combined transport, e.g. intermodal terminal, serving mainly rail transport
2. Nationwide distribution centre serving both truck and rail transport
3. Local terminals serving the logistics of local enterprises.

Based on the study the Riihimäki terminal appears to have good potential. Because the new Helsinki Port will not cater for loading or unloading of containers, this must be done elsewhere. The location of Riihimäki (70 km North of Helsinki on the main railroad line) is excellent from the viewpoint of road and rail transport to and from all the other main ports in southern Finland, and it has a good central location for nationwide distribution.

The driving force in the Riihimäki–Hyvinkää area is the combination of different terminals, including intermodal traffic to and from ports, container loading/unloading, transport connections to Russia, and an otherwise optimal location. The main challenge is to find the first operators and end customers for the terminal. The terminal will need marketing and dissemination of information, not only in Finland but elsewhere in Europe and Russia as well.

Public Authorities as Providers of Traffic Management Services

Title: Public authorities as providers of traffic management services
Authors: Risto Öörni, Risto Kulmala
Series: Finnra Reports 18/2006
(http://alk.tiehallinto.fi/julkaisut/pdf/4000515-v-viranom_liikent_hall_palv_toteut.pdf)
Language: Finnish with English abstract

The main objective of the study was to identify what services should be provided by public authorities, and why. The work was carried out as an international literature and interview study for the Finnish Road Administration (Finnra).

Efficient markets do not exist for traffic management and information services in Finland. The markets are biased, service demand is quite low, and there are few service providers.

Factors favouring outsourcing and privatisation include:

- Legal responsibilities can be considered with specific contracts and regulations
- Service provision is more efficient and service quality is better in competitive markets
- Authorities are under less pressure to make developments
- With privatisation, public sector budget needs are reduced unless there are increased resources for regulation. With outsourcing, budget needs diminish unless the supplier has an actual monopoly.
- Authorities are averse to risk taking

Factors favouring authority-provided services include:

- Service provision requires public authority responsibility
- Authority responsibility is evident and easily verified
- Equality and non-discrimination is more easily achieved
- Ensuring sufficient quality and effects are the primary objectives of the service provider
- Maximum service effects with as many end users as possible
- Private service provision can not be expected to occur
- Costs of service provision can probably not be reduced via outsourcing
- It is easier to maintain the trust of users and other players
- Expertise is better maintained in the long term
- It is difficult to create the required regulation framework for private players.

The obvious conclusion from a non-increasing budget and the necessity of quality for service benefits is that the authorities should focus on providing only services of good quality. National legislation already indicates which services necessarily have to be taken care of by the public sector. For Finnra, these are:

- Traffic control,
- Authority co-operation in incident management,
- Authority alerts of safety hazards on the road network,
- Real-time overseeing of winter and road maintenance contractors,
- Monitoring and information systems required by the activities above.

Cost-benefit Analysis on Noise-reducing Pavements

Title: Cost-benefit analysis on noise-reducing pavements
Author: Lars Elleberg Larsen
Series: VI report 146
(http://www.vejdirektoratet.dk/publikationer/VIrap146/index.htm)
Language: English

This report presents the Danish results of the project on cost-benefit analysis under the DRI-DWW noise abatement program. This program is a co-operation between the Danish (DRI) and Dutch (DWW) road institutes and is a part of the large Dutch Noise Innovation Programme, also called the IPG research programme. The Road

PHOTO: PHOTOS.COM

Directorate has a long tradition for developing and using cost-benefit evaluation methods, which include external costs such as noise, and recently the Ministry of Transport has published guidelines on how to carry out such evaluations. These methods and guidelines are presented as a basis for presenting actual assessments. In 2003 a working group with members from six ministries published a suggestion for a strategy to reduce road traffic noise, which focuses on the cost-effectiveness of various means of noise abatement. These means include barriers, various types of pavements, less noisy vehicles and planning initiatives such as reduced speed. In 2004 the Danish Road Institute did a technical and socioeconomic evaluation of using various pavements - including noise reducing pavements - on a widening of the Motorring 3 in Copenhagen.

Noise Reducing Pavements in Japan

Title: Noise reducing pavements in Japan
Authors: Carsten B. Nielsen, Hans Bendtsen, Bent Andersen, Hans Jørgen Ertman Larsen
Series: Technical Note 31 (http://www.vejdirektoratet.dk/publikationer/VInot031/pdf/not31vi.pdf)
Language: English

A Dutch/Danish delegation visited Japan 14-18 November 2005 to analyse the recent Japanese developments in the field of Durable Silent Roads. It is aimed that this analysis will help the Dutch Noise Innovation Program in implementing silent roads. The goal of the scanning tour was to obtain the latest Japanese experiences with the use and maintenance of porous pavements as well as new concepts and ideas in the field of noise abatement. The focus was on the following topics related to porous pavements:

- Improvements in the structural durability
- Improvements in the acoustic durability
- The paving of two layer porous pavements in one application
- Performance based contracts including tire/pavement noise

The current situation in Japan on these topics is summarized in the report including the prospective for the use in Japan and the possible implementation in Europe.

Traffic Noise Measurement

Title: Trafikstøjmåling Tesdorpfsvej (Traffic noise measurement, Tesdorpfsvej)
Authors: Jørgen Kragh, Sigurd N. Thomsen
Series: Technical Note 34 (http://www.vejdirektoratet.dk/publikationer/VInot034/index.htm)
Language: Danish

In the EU research project (SILVIA) about noise reducing pavements, experiments have been carried out at Tesdorpfsvej in Frederiksberg (Copenhagen). Two noise reducing thin layer pavements, TP6c and SMA6, and a reference AC8d were included in the experiment. Noise measurements were carried out according to the international standardized SPB (Statistical PassBy method) measurement method. Noise measurements were also carried out on the old pavement (AC11d/HRA). A comparison between the results of the reference and the AC11d/HRA pavement, and the reference pavements at Kongelundsvej and Søren Frichs Vej were also carried out. The references at Kongelundsvej and Søren Frichs Vej were the same as the reference at Tesdorpfsvej.

Compared to the reference pavement, an insignificant noise reduction of 0.1 dB was measured on the SMA6 pavement, and 0.3 dB on the TP6c pavement. The noise levels measured on the reference pavements at Kongelundsvej and Søren Frichs Vej were respectively 0.8 dB and 0.6 dB higher compared to the noise level measured on the reference pavement on Tesdorpfsvej.

The noise level measured on the old pavement was about 6 dB higher compared to the noise level on the reference pavement.

Test of Thin Layers on Highway

Title: Test of thin layers on highway, Year 1 measurement report
Authors: Sigurd N. Thomsen, Hans Bendtsen, Jørgen Kragh
Series: Techical note 35 (http://www.vejdirektoratet.dk/publikationer/VInot035/index.htm)
Language: English

The aim of this project is to investigate the noise reducing effect, and on a long term basis, the acoustical and structural lifetime of thin layers. Five different pavements including a reference pavement were tested. Noise measurements were performed according to ISO 11819-1 (Statistical Pass By, SPB-method), characterizing road surface influence on traffic noise. Results showed an increase in noise emission of between 0 to 1.3 dB from year 0 to year 1. Relative to the reference pavement, there was a noise reduction of between 0 and 3 dB in year 0 and year 1, with a trend for lower noise reduction in year 1. The noise reduction of one of the tested pavements turned out to be of no significance. The total expanded uncertainty of the results is around ±0.4 dB. 1/3-octave frequency analyses were also performed which showed a significant increase in noise at one pavement in the frequency region 400 to 1000 Hz. Additional Close Proximity (CPX) measurement results in year 0 showed the same tendency as results by using the SPB-method. The Medium Profile Depth (MPD) was around 0.9 mm, except for the reference layer and one of the tested layers which was around 0.4 to 0.5 mm. All pavements fulfilled the requirements for the friction stated in the highway standards.

Noise Reducing Thin Layers – Promising Concepts

Title: Noise reducing thin layers, Promising concepts
Authors: Hans Bendtsen. Erik Nielsen
Series: Technical note 36 (http://www.vejdirektoratet.dk/publikationer/VInot036/index.htm)
Language: English

On the background of the latest international knowledge, suggestions for optimized noise reducing thin layers are developed in this technical report. In 2006, the Danish Road Directorate will construct a test road north of Herning in Jutland where around 8-10 thin layer pavements will be tested on a highway under real traffic conditions. This report is also a project description of the full scale testing project in Herning. This is a part of the DRI-DWW noise abatement program.

NORDIC

SWEDEN

VTI
Magdalena Green
SE-581 95 Linköping
Phone +46 13 20 42 26
Fax +46 13 14 14 36
Orderphone +46 13 20 42 69
Email magdalena.green@vti.se
Web www.vti.se

DENMARK

Danish Road Institute
Helen Hasz-Singh
Guldalderen 12
2640 Hedehusene
Phone +45 46 30 70 00
Fax +45 46 30 71 05
Email hhz@vd.dk
Web www.roaddirectorate.dk

FINLAND

VTT Technical Research Centre of Finland
Kari Mäkelä
P.O.Box 1000
FI-02044 VTT
Phone +358 20 722 4586
Fax +358 20 722 7056
Email kari.makela@vtt.fi
Web www.vtt.fi

ICELAND

Icelandic Road Administration
Hreinn Haraldsson
Borgartún 7
IS-105 Reykjavik
Phone +354 522 1000
Fax +354 522 1009
Email hrh@vegagerdin.is
Web www.vegagerdin.is

NORWAY

Institute of Transport Economics
Nils Fearnley
Pb. 6110 Etterstad
NO-0602 Oslo, Norway
Visiting address: Grensesvingen 7, Oslo.
Phone +47 22 57 38 00
Fax +47 22 57 02 90
Email toi@toi.no
Web www.toi.no

NORWAY

Norwegian Public Roads Administration
Thorbjørn Chr. Risan
P.O. Box 8142 Dep
N-0033 Oslo
Phone +47 22 07 35 00
Fax +47 22 07 37 68
Email thorbjorn.risan@vegvesen.no
Web www.vegvesen.no

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