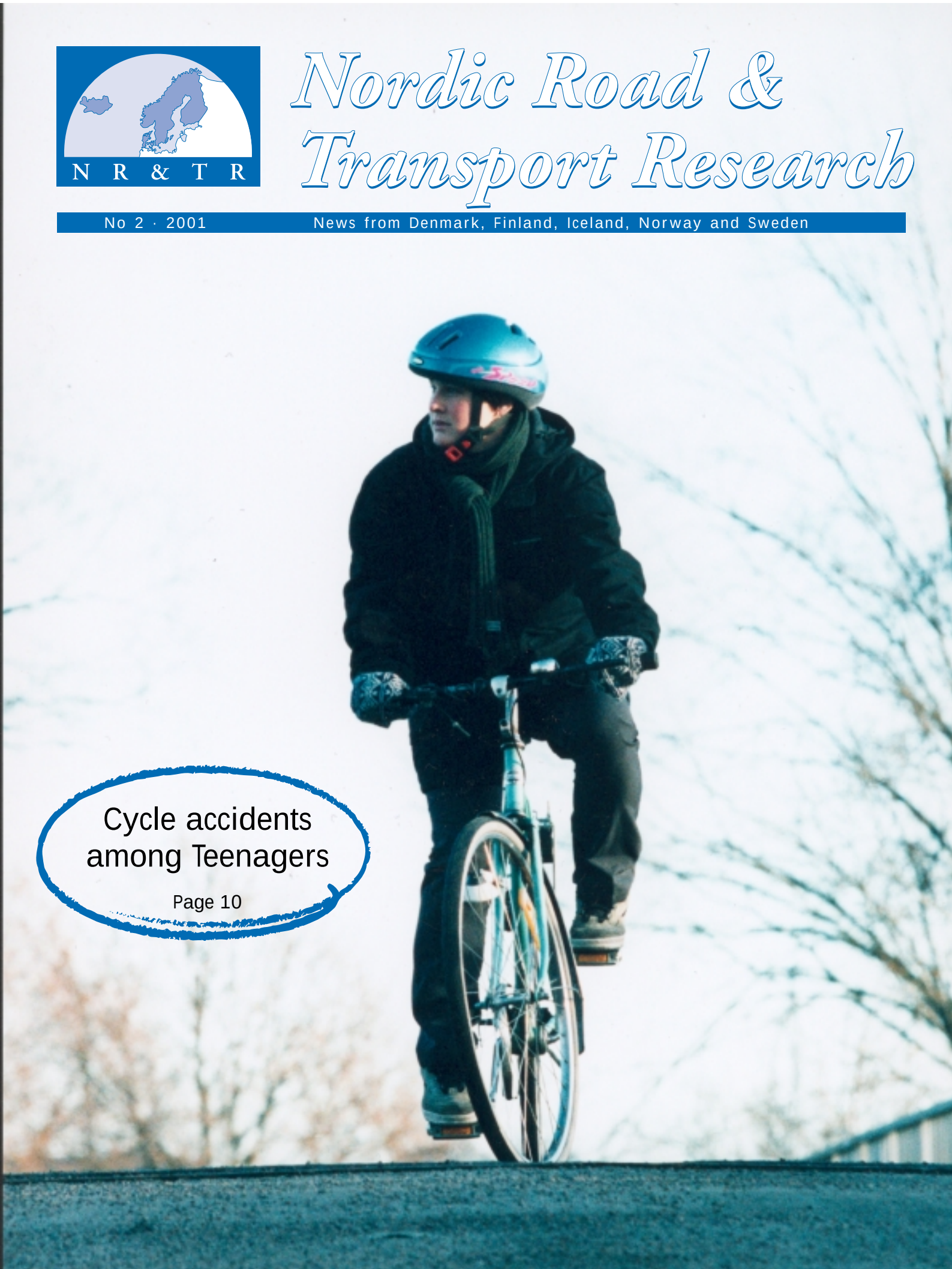
N R & T R

Nordic Road & Transport Research

No 2 · 2001 News from Denmark, Finland, Iceland, Norway and Sweden



Cycle accidents among Teenagers

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Editorial notes

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

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Nordic Road & Transport Research

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Danish Road Directorate (DRD)

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

Road Directorate

Technical Research Centre of Finland (VTT), Building and Transport

VTT Building and Transport, employing a staff of 530, is one of the eight research units of the Technical Research Centre of Finland (VTT), with a total staff of 3,000. VTT Building and Transport covers all fields of transport and road engineering. The unit is active in international research and has a prominent role on the national level.

VTT

Public Roads Administration (PRA), Iceland

The duty of PRA is to provide society with a road system according to its needs and to offer service aiming at safe, unobstructed traffic. The number of employees is about 340. Applied research concerning road construction, maintenance and traffic and safety is to some extent performed or directed by the PRA. The authority with its Research and Development division is responsible for road research in Iceland.

VEGAGERÐIN

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 application of R&D products.

Norwegian Public Roads Administration

Institute of Transport Economics (TØI)

The Institute of Transport Economics is the national institution for transport research and development in Norway. The main objectives of the Institute are to carry out applied 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.

Institute of Transport Economics
Norwegian Centre for Transport Research

The Swedish National Road and Transport Research Institute (VTI)

is responsible for research and development in road construction, maintenance, road traffic and transport, railroads, rail transport, vehicles, road user behaviour, traffic safety and the environment. The Institute is state-owned and has a total of 180 employees.

Swedish National Road and Transport Research Institute

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ANNOTATED REPORTS

New Sanding Methods in Norway

Recognizing that more knowledge is needed of all types of friction measures, the Norwegian Public Roads Administration started a research program in 1997 focusing on winter management. The Winter Friction Project deals with practical, technical and financial problems that arise when providing good friction conditions on winter roads. The final report is scheduled for 2002.

One of the main activities throughout the whole project period is to carry out a testing program (scientific studies) to document the performance of different friction improvement methods. The goal is to draw up a recommendation as to what is the best method under different conditions.

Aside from studying different salting methods, the project has dealt with different ways of applying abrasives. Both traditional and new sanding methods have been tested:

– traditional methods: dry sand and sand with salt
– new method: warm wetted sand.

Description of the warm wetted sand method

The warm wetted sand method is based on adding hot water to the sand. Scientific studies conducted as part of the Winter Friction Project in Norway has revealed that measures carried out with the new method have considerably longer effect than traditional sanding methods. Under favourable road and weather conditions, satisfactory friction values have been found to be maintained for up to one week on roads with AADT 1 500–2 000 using the new method.

The first truck based on the warm wetted sand principle in Norway was called Friction Maker. This equipment, which was tested for the first time in the 1998/99 winter season, was a re-constructed semi-trailer spreader with a dropside body, see figure 1.

Figure 1. Swedish prototype for warm wetted sand.

Figure 2. Typical pattern on the road when using warm wetted sand and a roller distributor.

Figure 3. Typical pattern on the road when using warm wetted sand and a spinner.

A water tank containing 2.5 m^3 and a heater with a water pump is fitted onto the lorry's body. The equipment has a spreader mounted behind the dropside body. The method is based on adding hot water to the sand and covering the sand particles with a film of water. When the sand that has been sprinkled with water leaves the spreader and lands on the roadway, the film of water has a short melting effect and then the mixture of sand and water freezes to the surface. This gives the roadway a kind of sandpaper texture, see figure 2.

The most significant factors in this method are the amount of water, the spreading speed and the water temperature. Hot water means a temperature of 90–95°C. The amount of water in the mixture of sand and water is approximately 30 weight percentage, and the normal dosage of sand used is equivalent to 200 grams/m^2 as an average.

During the 1999/2000 winter season, two new Norwegian prototypes were constructed on the basis of experience from the first winter test with a Swedish prototype. The spreader and the heater system were further developed and refined during the 2000/01 winter season. Norwegian

trucks have shown very good performance both with a roller distributor and with a spinner. The warm wetted sand method is recommended for use on a larger scale for daily gritting operations as an alternative to traditional sanding methods.

Tests during the 1999/2000 winter season showed that the method used in combination with a spinner type spreader, gives almost as good results as the system combined with a roller distributor, even though the spreader pictures are quite different, see figure 2 and 3.

Development of new spreaders

During the last two winter seasons, the project has concentrated on developing new spreaders and continuing tests with the warm wetted sand method to study the performance of the trucks and effects gained by different types of spreaders.

There has been a great change in the spreader concept and heater system during the project period. The Swedish prototype used in the 1998/99 winter season tests was based on placing a unit combining the water tank and heater system on the dropside body and using a roller distributor, see figure 1. This truck can only be used for spreading sand. The 1999/2000 winter season was an intermediate season and development has continued over the 2000/01 winter season. In the latest concept, the heater system and water tanks are separated, see figure 4. The new spreader type in combination with a spinner can be used for spreading both sand and salt, with or without adding liquid.

Figure 4. New concept for warm wetted sand. The truck to the left can also be used for spreading salt.

There is still a long way to go, but continued tests this winter have confirmed the results from the previous winter seasons. Consequently, there are three equipment manufacturers now offering units for the new sanding method in Norway.

Evaluation of new spreaders

The 2000/01 winter season has focused on testing new spreaders and gaining experience with the new method in daily operations. However, there has been some delay in the delivery of the spreaders, which has allowed less time to try the new spreaders in full scale in the daily operations.

To evaluate the performance of the different spreaders, a thermo camera was used in two of the scientific tests. The camera is an Inframetrics SC1000 that operates in temperatures from –10 to +2000°C. Its sensitivity is 0.1°C. For picture analysis, the emissivity for a mixture of sand and water is set to 0.94.

Figures 5 and 6 show pictures taken with the thermo camera of the two spreaders shown in figure 4. Figure 5 is the new

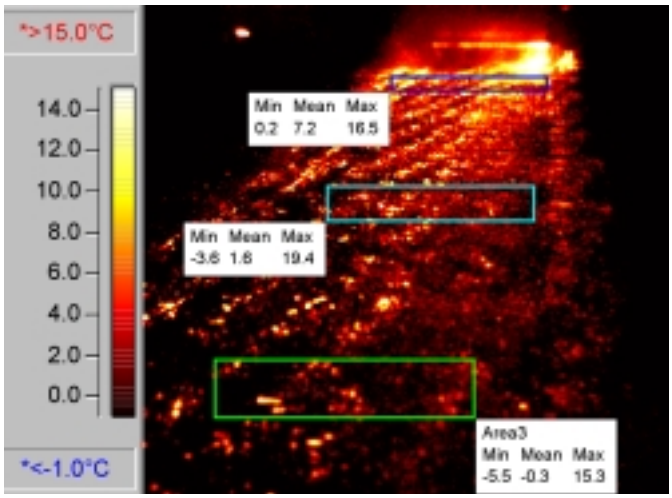


Figure 5. Warm wetted sand. New spreader with roller distributor. Picture taken with thermo camera on 13th February 2001. Air: –2.8°C, road surface: –3.5°C.

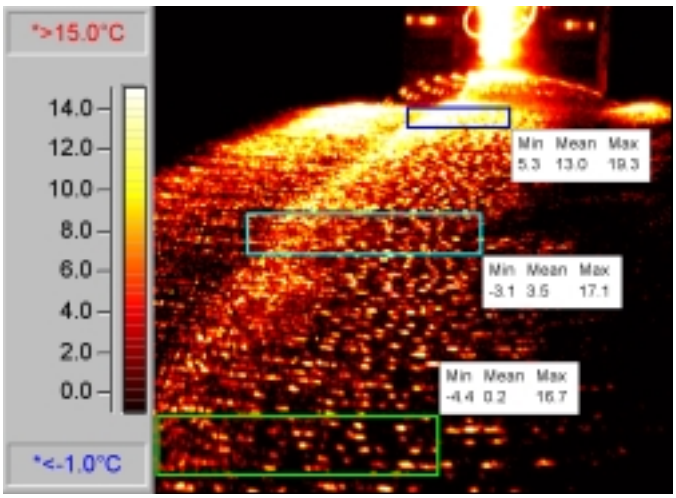


Figure 6. Using a spinner. Picture taken with thermo camera on 13th February 2001. Air: –2.8°C, road surface: –3.5°C.

spreader based on using a roller distributor. Figure 6 shows the temperature using the spinner. Comparing the spinner with the roller distributor, the difference between the roller distributor and the spinner seems to have diminished. There are only small differences in the distribution of the heat.

Figure 7 shows the results from one of the trials on road E136 with different methods. The second last friction measurement was made 5 days after sanding. Even if much of the sand is worn away (see figure 8) there is still enough sand on the surface to raise the friction above the background level.

Figure 9 show, the results from testing the new spreaders against the Norwegian prototype developed in 1999/2000. There are only small variations between the different trucks. There is no significant difference between trucks with roller distributor and trucks with a spinner when it comes to the rise in the friction level.

Implementation of the new sanding method

In Norway, 88 per cent of public roads, i.e. 47,300 km, are operated using the so-called white winter road strategy. Large quantities of sand are spread to improve friction on ice and snow. The limitations of this method are well known: the friction improvement is modest, and the effect of gritting is rapidly reduced by the traffic. For both practical and economical reasons it is not always possible to comply with the required standards.

The introduction of wet gritting means

Figure 8. Test field strewn with warm wetted sand on 18th January 2001. Picture taken on 22nd January.

substantial improvement, both with regard to friction and the time of effect. The new method is expected to have a marked impact on winter road operations.

The field tests carried out during the 2000/2001 winter season confirm the results from last season. Good results were achieved with the new trucks. From the experiments carried out, it is concluded that the wet-sand method in particular has a broad range of applications, and can therefore be recommended as a supplement to existing sanding methods. It is important to emphasize that the wet-sand method can be used under conditions where traditional methods have little or no effect. This new method also makes it possible to maintain the friction standard under conditions where it is normal to spread sand less frequently than necessary in order to maintain the friction standard.

The normal practice in Norway is to organize the national road network into operational sections of 40–60 km both for snow plowing and sanding and salting. The road length is adapted to the standard requirements. For sanding, which is used on roads with winter road strategy, the standard says that when the friction falls below 0.25, sanding should be done within 2 hours. At a driving speed of 25 km per hour, this means that one truck can cover 50 km if the sand is spread in only one direction.

The problem, however, is that this sand is gone after only a few vehicles have passed. In many cases it will be difficult to maintain the friction standard using traditional sanding methods because it is not possible, in a practical sense, to use the resources necessary to maintain the standard. From the available documentation, it is known that, on a road with AADT 2 000, approximately 12–40 measures of dry sand will be needed in a 24-hour period to meet the friction requirements as opposed to only one measure of warm wetted sand. It is obvious that this is beyond the available resources to accomplish with the level of measures required for traditional methods. During a day with difficult driving conditions 3–4 measures might be needed.

The introduction of wet gritting means substantial improvement, both with regard to friction and the time of effect. During the 2000/2001 winter season the following counties have started using the new method in daily gritting operations:

– Oppland
– Hedmark
– Sør-Trøndelag
– Møre and Romsdal.

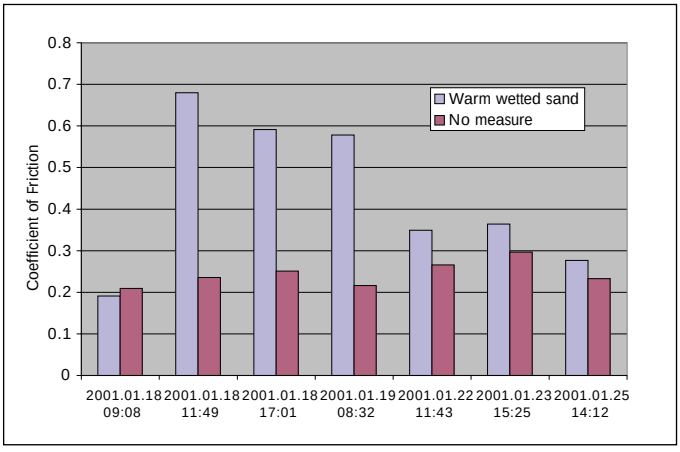


Figure 7. Results from field test with warm wetted sand.

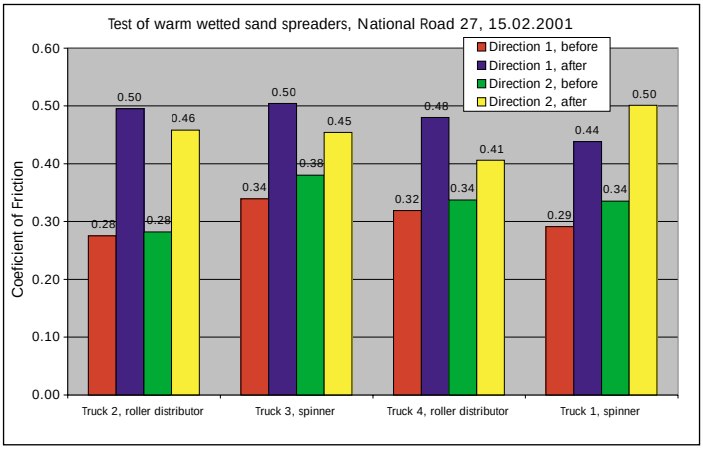


Figure 9. Field trial on road NR 29 in February 2001. Friction improvement immediately following the measure.

This is less than expected, but is still an important step towards a wider use of the method. It is expected that the organisation of the sanding operations will see significant changes in the next 2–3 years.

Both controlled tests and reports from the counties confirm the effectiveness by the new method. Under normal and stable conditions without precipitation, the effect of a measure of warm wetted sand will last 10–20 times as long as dry sand with the same traffic volume.

The method is now so well documented that it can be recommended as an alternative to traditional dry sand. With fine gradation the water and sand slurry stick evenly to bare pavement if the surface temperature is below 0C°.

In addition to a better and more lasting effect, the warm wetted sand method will also have an environmental impact by reducing the quantity of sand used. Preliminary calculations indicate that it is possible to reduce sand consumption by between 40 and 50 per cent.

The new method is expected to have a marked impact on winter road operations:

1) The capacity of each spreading truck will be markedly increased, making it possible to improve the organization of the entire spreading services.
2) Spreading can, under certain conditions, be carried out as a preventive measure, implying that the work can be planned ahead and, to a large extent, be completed during regular working hours, thus reducing labor costs.
3) The improvement in friction must be evaluated in relation to the required standards.

We are in the initial phase of implementing wet spreading. The current challenge is to move from the experimental phase into large-scale production. During the 2000/2001 season we have provided several spreading trucks with wet spreading equipment. As yet, the manufacturers of the equipment are at somewhat different stages of development. We would like to gain some experience for use in the future organization of spreading services. One hypothesis might be that one wet spreader unit will replace 3–5 ordinary spreading trucks.

Advantages of implementing the new method:
– one truck can cover a greater road length
– less sand consumption
– easier to meet standard requirements
– preventive sanding.

Article specially written for NR&TR by Roar Støtterud, Senior Engineer, Norwegian Public Roads Administration, Jon Dahlen, Senior Engineer, Norwegian Public Roads Administration and Torgeir Vaa, Senior Research Scientist, SINTEF Civil and Environmental Engineering

The Scandinavian Transport Planning Experience

Since the Scandinavian countries started long term strategic transport planning in the 1960's, the focus has changed from projects to strategies. However, there are still differences between the three countries, according to a study carried out at the Institute of Transport Economics (TØI) in Norway.

The transport planning concepts in the Scandinavian countries (Denmark, Norway and Sweden) are fairly advanced and well designed.

Current comprehensive and cross-sectoral strategic transport planning has its conceptual roots in the national long term planning of transport infrastructure projects, which started in the 1960's. However, the planning concept has changed dramatically over the last three decades and it is possible to identify three generations of national transport planning approach. In brief, the changes involve a shift of focus from project to strategies.

The main features of the planning system currently applied in Scandinavia are the inclusion of all transport modes in the planning process, the prioritisation of measures across sectors and the use of alternative strategies to demonstrate the latitude for decision-making. Ideally, the measures considered should include not only investment projects but also others found relevant, such as pricing and regulatory measures.

Objectives and strategies

The planning concept is based on the assumption that politicians are responsible for defining objectives and at the end of the process decide on a strategy. It implies that the planners, who include the national transport agencies for air, railway, road and sea transport, develop alternative strategies based on a combination of measures from all sectors and assess the impacts of each alternative in respect to the various objectives defined. This provides the input for the politicians' decisions on strategy. When the strategy is defined, the national transport agencies start planning for its implementation, usually through ten-year action plans where the implementation of the individual measures is prioritised in time and where the programmes for the first four years are usually more detailed.

The table on the next page summarises the description of the planning concepts and the different types of methodology currently applied in Denmark, Norway and Sweden for national strategic transport planning.

The table shows the similarities between the planning and evaluation systems in Norway and Sweden, and the somewhat different situation in Denmark. If we had included ex post evaluation, the differences would have been even greater.

Currently, ex post evaluation studies are applied systematically for learning by experience in Norway and Sweden, but not in Denmark. The results of the studies contribute to more systematic improvements of the planning system and the evaluation methodologies. There are two main types, one evaluating the planning process and the other investigating the various evaluation methods and their use. As a result of these studies, Scandinavian experience also contributes to the picture of how planning processes and planning tools perform in the real world.

The political process

It is difficult at this stage to assess the relevance of the current strategic planning process in respect to the subsequent political decision-making process in Parliament. However, it is only when the technical planning process can be seen in the light of the political process that we obtain full feedback on the appropriateness of the technical process.

A study of the Parliamentary discussion of the Norwegian Road and Road Traffic

The Norwegian National Transport Plan 2002–11 is, as in the other Scandinavian countries, based on a planning concept where the politicians are responsible for defining objectives and at the end of the process decide on a strategy.

Plan for the previous planning period casts some light on the matter. The study concluded that very few politicians seriously considered and used the information on alternative strategies. Therefore, it is not clear at this point in time whether the strategic transport planning processes currently applied really provide the most relevant decision information for the politicians. An ongoing study of the political process concerning the National Transport Plan in Norway is, however, looking further into the matter.

The planning and methodological approach

Generally, the current approach is well in line with the requirements of the conceptual framework. There are, however, certain matters of concern.

One is the objectives that guide the planning process. There are cases where discrepancies exist between the objectives and the measures available to the planning agencies. A key conclusion is that policy objectives should be realistic and achievable within a reasonable time perspective compared to the range of measures available to the strategic transport planners. If the objectives are more ambitious and broadly defined, planners should also be allowed to use a wider set of measures, but that may shift the focus away from the measures they control themselves.

Another concern is the strategy concept applied in Norway and Sweden. The plan-

ning agencies are requested to develop alternative strategies that include different combinations of actions and measures. The basic idea behind the strategy concept is that politicians should discuss strategies rather than projects and, finally, select a strategy which then will provide the framework for more detailed planning and implementation. Experience from ex post evaluation shows that there are good reasons for discussing whether the above approach to strategy-orientation is the best. It appears that the strategies developed by the planning agencies are not necessarily significantly different in respect to the projects and measures included. Furthermore, the little we know at this stage about the political process does not indicate that politicians find the strategies particularly useful in their decision-making process. The strategies may, however, be useful for other parties, such as the Ministry of Transport.

Level	Item	Denmark	Norway	Sweden
1) Planning concept	Objective-oriented	x	x	x
	Strategy-oriented		x	x
	Project-oriented	x		
	Cross-sectoral	x	x	
2) Approach	Process-oriented	(x)	x	x
	System analysis		x	x
3) Methods & supporting tools	Cost-benefit analysis	x	x	x
	Multi-criteria analysis	(x)	x	(x)
	Impact analysis	x	x	x
	National transport demand models		x	x
	Regional transport demand models			x
	Other demand models	x		

Table 1. Overview of planning concept features, evaluation approaches and methods for national strategic transport planning in Scandinavia.

Cross-sectoral prioritisation

The evaluation studies revealed serious problems in respect to cross-sectoral prioritisation in both Norway and Sweden. It is, therefore, an open question as to what extent these problems were due to insufficient knowledge or to a lack of tools, which normally would be the conclusion of planners, or to what extent the professional level of ambition for such planning is realistic. It seems, however, that the planning approach and the ambitious processes were more to blame than the various evaluation methods and planning tools applied.

It appears that the planning approach could be improved by re-organising the process. A division into an initial phase of clarification of general policy principles through a set of analyses of strategic issues and a second phase of developing alternative strategies may be a better approach. Furthermore, there are reasons for believing that the regional level should play a bigger role in the national planning process. A two-phase approach would facilitate involvement from the regional level at an appropriate time in the initial phase of the process.

Experience from Norway and Sweden shows that the inherent institutional characteristics of the planning agencies are key factors in the process. The road agencies and the rail agencies played the most important roles, whereas the civil aviation agencies, which are financed through user charges, kept a low profile. It may, therefore, be worthwhile to consider whether the process can be organised differently with a clearer distinction between efforts that must be carried out jointly and matters that do not necessarily involve all agencies.

The need for further development of evaluation methods

Ex post evaluations of planning methods in Sweden addressed the methods for cost-benefit analysis. The general conclusion was that the methods as such appear to be sound and sufficient for the purpose. The questions raised concerned primarily current practises. A more serious question, however, concerned the quality of input data, in particular traffic data. It may, therefore, at this stage be more important to improve traffic data and to introduce a reliable system for documentation of such data than to improve the methods for cost-benefit analysis. A previous evaluation study raised some doubt about application of the methods and asked whether they had been adapted to the desired results.

The evaluation of the Norwegian strategic planning process showed that the agencies were not able to evaluate impacts across sectors in a comparable way. The coastal agency and the civil aviation agency were hardly able to assess the impact of their own measures at all. In addition, the agencies faced problems in handling intermodal transport in a satisfactory way. There is consequently a need for developing compatible methods for all sectors.

There were shortcomings in respect of better methods for analyses of the specific strategic areas, which formed a new and important element of the Swedish strategic analysis. This applied not least to the analysis of maintenance needs. It is therefore important to improve methods for analysis of strategic issues.

There is obviously a need for further development of the evaluation methods and in particular some of the supporting tools such as the national and regional transport demand models. Current practises may to some extent be a greater problem than the methods per se and it appears that it is highly important to ensure that input data are of sufficient quality and documented properly. Development of the specific evaluation methods must be done in such a way that they fit into the overall evaluation approach.

Report title: Strategic Transport Planning and Evaluation. The Scandinavian Experience
Author: Henning Lauridsen
Series: TØI Working Report 1177/2000
Language: English

Cycle Accidents among Teenagers

Knowledge of traffic rules does not contribute to reducing the accident risk or injury risk among young cyclists, according to a new report from the Institute of Transport Economics.

Traffic rules are generally of little importance for the accident and injury risk among young cyclists.

New traffic regulations were introduced in Norway on May 1, 1998. The new regulations primarily concerned the bicycle and cyclists were now obliged to give way to others when leaving the sidewalk. In addition, a number of minor changes were made in the text concerning cycling on the sidewalk.

The Norwegian road authorities launched a campaign to inform cyclists and car drivers about the new rules.

In order to evaluate the campaign, a questionnaire was distributed to school pupils in junior and senior high schools in 16 of the 19 counties in Norway. A total of 5 619 pupils answered the questionnaire.

In addition to questions regarding knowledge of the traffic rules and the campaign, there were questions concerning cycling and accidents and questions concerning lifestyle, sensation-seeking, etc.

The results show that knowledge of traffic rules does not contribute to reducing the accident risk or injury risk among young cyclists. However, road user behaviour contributes significantly to the accident and injury risk. Running red lights and cycling in the wrong direction in one-way traffic increases the accident and injury risk. Keeping to cycle paths and using reflecting materials when cycling in the dark reduces the accident and injury risk.

In addition to these behavioural factors, other factors that increase the risk of accidents and injuries are lifestyle factors such as smoking, being allowed to stay out late, etc. and sensation-seeking, as measured by two questions on bungee jumping. In addition, teenagers who are active in sports are more at risk than those who are inactive, contrary to what was expected.

One especially interesting result is that cyclists who say they always dismount from their cycles when crossing the street at pedestrian crossings appear in the statistical analysis to be significantly more at risk than those who do so more seldom. The reason for this seems to be that some cyclists have had accidents in such situations, which in turn has made them more cautious.

One side-effect of the change in the traffic rules may be that car drivers have become more conscious of their right of way, giving rise to more collisions between cars and cycles when cyclists leave the pavement, for example at pedestrian crossings. Census data from Statistics Norway show a significant increase in injuries from cycle accidents in such situations after the change in the rules.

The results show that knowledge of the traffic rules generally does not have much importance for the accident and injury risk among young cyclists. Cyclists are notorious for breaking traffic rules. Increasing the number of situations when they are obliged to give way may give rise to more accidents when car drivers are informed of the changes and become aware that they have the right of way in these situations.

Report title: Bicycle accidents among teenagers
Author: Torkel Bjørnskau
Series: TØI report 504/2001
Language: Norwegian

Achievements of the Finnish R&D Programme on ITS Infrastructures

In Finland, development of the ITS infrastructure was initiated as a programme managed by the Ministry of Transport and Communications. The programme concentrated on a number of priority areas for public sector action to build up the ITS information infrastructure, as well as on national expertise and product development. The programme met most of the objectives set, and many of the results have already led to concrete development and implementation. New ITS services have not yet, however, been created as a result of the programme.

In Finland, population and vehicle volumes do not offer very good possibilities for the private sector to build up ITS services on its own. The role of the public sector in Finland is to invest actively in the provision of optimal platforms for the private sector to develop ITS products, systems and services while ensuring that the society benefits from these systems and services. The Ministry of Transport and Communications initiated a three-year (1998–2001) national programme called TETRA for the development of ITS infrastructures. The programme aimed at promoting the production of interoperable ITS systems covering all transport modes by developing the required basic ITS infrastructure and information systems. The private sector can utilise the information infrastructure being developed by producing new ITS services and systems in co-operation with the public sector. The objective of the programme was also to promote national expertise and industrial innovation in the area.

The programme was funded by the Ministry of Transport and Communications and the transport mode specific central administrations linked to it, the Technology Development Centre and the Finnish municipalities implementing ITS systems. The total costs of the programme were estimated at 75 million FIM or 12.5 millions ECU. Co-ordination with European actions is ensured via links to the Euroregional VIKING project supported by the TEN-T funding of the European Commission.

Achievements in priority areas

The contents of the programme were set on the basis of a comprehensive analysis of the future transport system and its vision, as well as the role of ITS in the future transport system in Finland. The analysis identified key areas in which the public sector must act in order to build up a sufficient platform for ITS service and product industry. Areas requiring the most urgent action were included in the programme as its project areas. The achievements in each project area are briefly summarised below.

– Development of traffic and environmental monitoring systems: This project area developed methods and systems, as well as the integration of these systems, for the real-time monitoring of traffic and environmental conditions (e.g. traffic, road weather, road surface condition, air quality and parking data) for Finnish conditions. The probe vehicle concept for continuous monitoring and transmission of friction, road surface condition, traffic status and video footage to traffic centres was developed into an operational system.
– Development of port operations management systems: This area developed tracking and tracing systems for goods transport, systems integrating goods units and their associated data, and the real time management of information at ports. The management of the terminal, land transport, port and sea transport phases of port operations were developed within a number of pilot trials. The major achievement was the development of a national maritime transport information system, Port@net, which contains real-time data on port operations, freight, vessel traffic control, and pilot and icebreaking actions and services. The Internet based solution interacts with other systems via XML.
– Intelligent signal priorities: The objective was to develop and harmonise the planning of and technical solutions for the real-time traffic signal priorities for public transport, so that the same in-vehicle equipment can be utilised throughout the country. The area included pilot systems for traffic signal priorities applying SPOT or fuzzy control, as well as the development of national design guidelines for the traffic signal priorities of public transport. Long loop detectors proved to be an affordable solution for setting up bus priorities.
– Development of ITS for small and medium-sized road haulage companies: This area defined ITS systems based on the needs of small and medium-sized road haulage companies.

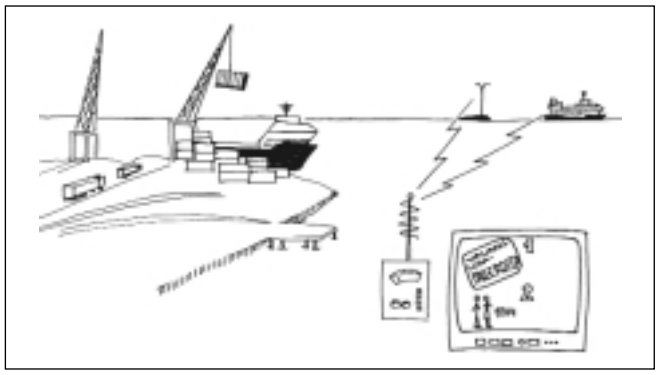
Road surface condition monitoring.

Internet applications were piloted for an electronic operations diary, haulage event monitoring system and transport exchange system.

– Evaluation of ITS systems: This area studied the transport, socio-economical and other essential impacts in the pilot trials of the new ITS systems, applications and services in a reliable and consistent way, so that the full-scale implementation of the systems can be decided upon from an objective basis. The evaluations were based on common guidelines for the evaluation of ITS systems and projects.
– Development of traffic management systems: This area concentrated on the development of information management systems and operations of traffic centres run by the road authority. Co-operation between emergency centres, police and traffic centres was a major concern.
– Transport information system covering all modes: Co-operation between the different modes of transport and the implementation of inter modal services associated with the different phases of the trip/logistics chain was developed by setting up an information exchange library and the KALKATI.net platform, and via a number of pilots. The pilots included ITS systems in Tampere, data exchange between authorities, bus passenger information, bus and train transport scheduling and routing, regional public transport information centres, Helsinki centre public transport information, and an integrated lighting and traffic management system.
– The national digital street and road data base DIGIROAD was specified and piloted in the programme. A separate project specified digitised data on public transport stops and terminals. The full-scale implementation of DIGIROAD has already begun.

ITS system architecture: This programme area produced the common, open national system architecture for ITS called TelemArk. It specifies the 11 most important passenger transport related ITS processes and their actors.

– Co-ordination of system architecture and standardisation procedures: Extensive and determined system architecture and standardisation procedures are in progress internationally. For the full utilisation of international activities, a group of main ITS actors in Finland was set up to co-ordinate the national system architecture and standardisation procedures. A user-friendly service on standardisation was set up on the Internet.



Port operations management.

Programme evaluation

In the first half of 2000, the Ministry of Transport and Communications commissioned an independent mid-term evaluation of the programme. This evaluation was finalised in the summer of 2000. The evaluators concluded, among other things, that the overall programme structure, the umbrella principle, the programme area level preplanning, project selection procedures, programme area choices and monitoring activities were all appropriate. Problems were identified relating to co-operation between projects, private sector exploitation of results and information dissemination.

Conclusions

The basic concept of building up the ITS infrastructure as a public sector initiative and programme was a success in Finland. The programme produced valuable results through studies and specifications, but also as a concrete deployment of ITS infrastructures and service pilots.

Organisation of the programme into largely independent programme areas has ensured the commitment of key actors in each area, but has caused problems in co-operation between projects.

The approach has also been successful in promoting ITS. New actors have participated in the programme. Some public sector actors, however, are still not wholly committed to building up the ITS infrastructure. Easy access to public sector data has also not been realised, which is an impediment to ITS service providers.

The final success of the programme, however, still hangs in the balance. We cannot treat the programme as a success unless we can foresee in the near future the emergence of new ITS services on the ITS infrastructure platform produced by the TETRA programme. To promote this development, the Ministry of Transport and Communications has initiated a follow-up R&D programme which emphasises the ITS services and their promotion. The programme, called FITS (Finnish R&D Programme on ITS Infrastructures and Services), was launched in March 2001.

Article specially written for NR&TR by Risto Kulmala, VTT Building and Transport.

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FITS web site www.vtt.fi/rte/projects/fits

TETRA web site www.vtt.fi/rte/projects/tetra

Pavement Technology Project (PTP) in Thailand

Over the last few decades there has been a strong swell of international research interest and movement in many countries towards partial and full implementation of analytical (also known as mechanistic-empirical) procedures for determining the existing strength (bearing capacity) of road pavements, for analysing and designing the pavements of new roads and for the rehabilitation of existing road pavements.

This article briefly presents the Pavement Technology Project (PTP) in Thailand, which is a three-year research project begun in 1999 and undertaken jointly by the Department of Highways (DOH) and the Danish Road Directorate (DRD). The project has the overall objective of reducing the maintenance costs on the Thai national road network by implementing Falling Weight Deflectometer technology and developing and implementing analytical pavement analysis and design methods in Thailand, based on pavement performance and determination of the structural properties of the road pavement materials in existing road pavements and in laboratory investigations.

Falling Weight Deflectometer

Over the last fifteen years, Falling Weight Deflectometers (FWD) and the measurements made using this type of non-destructive testing equipment have gained their own place in pavement management. Originally developed for scientific research, the technology has now become a fully developed tool used for general pavement evaluation and subsequently in pavement management systems. FWDs are now used to test the bearing capacity of roads as part of the routine evaluation of the road networks in many countries.

Failure of road pavements is often indicated by cracking of the asphaltic surfacing due to excessive stresses induced by traffic loading that may not be accompanied by permanent deformation or loss of shape. An indication of the stresses developed in road pavement layers may therefore be obtained from the curvature and the elastic deflections of the road surface beneath the loaded dual wheels of a truck or under dynamic applied loads that closely simulate truck tyre loading. Two common field-testing procedures employed for measuring these curvatures and deflections are the Benkelman Beam (BB) test and the FWD test. Benkelman Beam surveys have been carried out over a number of years in Thailand; however, it is the implementation of FWD technology and the introduction of analytical pavement analysis and design methods that are the primary technological objectives of this Project.

Bearing capacity evaluation of road pavements using FWDs is an analytically based method. The advantages compared with more empirical methods are that FWD analyses may be used on any type of material and structure, and under all climatic conditions, whereas empirical methods should only be used under those conditions for which the empirical relationships were developed.

With FWDs, a falling mass induces, via a buffer system, a load on a circular loading plate placed on the road surface. The falling mass, the drop height, and the buffer system, are selected to simulate the stresses produced in a pavement structure similar to that of a heavy truck travelling at 60 km/h. The peak impact force and the surface deflections at the load centre and up to eight radial distances from the load centre are recorded. These measurements, combined with information on material characteristics, layer thicknesses, and test temperatures, enable computer calculation of the stresses and strains within the pavement that would be induced in the layers from a standard axleload of, for example, 80 kN (8.2 tonne) at the specified design conditions.

The analytical method of calculating strengthening design is based on the concept that a pavement is composed of several more-or-less linear-elastic layers. The stress and strain distributions under a wheel load in an infinite half-space of

isotropic materials are defined by the equations developed by J. Boussinesq in the 1870s. The software program, ELMOD, developed by Dynatest, calculates the stresses and strains in each layer and relates them to the critical stress and strain values that are specific for the pavement materials. Based on a specified design period and the estimated traffic volume for the design period, the program will calculate the residual structural lifetime and, if required, the necessary overlay thickness at each measurement point.

Calibration to Thai conditions

Before introducing a new technology, the method must be adjusted / calibrated to local conditions. Calibration is necessary because the pavement materials used, the uniformity of the pavements, the climatic conditions, and the subgrade, are very different from one country to another. These are issues that need to be clarified through a project such as the PTP at the DOH, before routine testing of the bearing capacity of Thai highways is commenced.

Implementation

The PTP is the DRD's biggest export assignment at present. The project includes field and laboratory research and training for the implementation of FWD technology and analytical pavement analysis and design in Thailand.

A Contract Agreement for the "Implementation of Falling Weight Deflectometer Technology and Development of Analytical Pavement Design Project" was signed between the DOH, Thailand, and the DRD on 30th October 1998. The project is funded through a Danish Mixed Credits Loan for the total cost of the project. The project is ongoing and will be completed by the end of 2001.

The overall objective of the project is to reduce maintenance costs for the Thai national road network by implementing FWD technology and developing and implementing analytical (also known internationally as mechanistic-empirical) pavement analysis and design methods in Thailand, based on pavement performance and elastic modulus evaluation. To meet this objective, five FWDs and towing vehicles (which are also the command centres for operation of the FWDs) have been supplied by Dynatest A/S (Denmark) and introduced in Thailand by the DRD (the first FWD + towing vehicle unit was supplied in 1994 followed by four more in 2000). Extensive technical assistance and training has also been carried out both in Denmark and in Thailand.

It has been estimated that the project can reduce pavement maintenance costs by as much as 20 per cent due to improvements in the calculation methods that will be implemented for new pavement and overlay design and because the number of staff involved in the measurements can be reduced to approximately 50 per cent of the current level of staffing. Furthermore, by introducing FWDs as pavement evaluation and testing equipment to replace Benkelman Beam (BB) procedures, the efficiency of bearing capacity measurement will be increased by a minimum factor of 2–3 and FWD crew safety during field operations will also be significantly increased.

By introducing this advanced pavement technology to the road sector in Thailand, the research engineers of the DOH will also be able to carry out more advanced research in the fields of road pavement analysis and road construction materials.

The overall objectives of the project are to:

- increase the efficiency of pavement evaluation measurements
- extend pavement evaluation measurements to highways with high volumes of heavy traffic
- reduce pavement maintenance costs
- reduce the manpower required for pavement evaluation measurements
- improve the safety of the technical staff in the field measurement teams
- develop an analytical pavement design method for overlays and new roads
- monitor the development of longitudinal roughness
- bring advanced modern technologies into practical use in the road sector in Thailand.

Research topics

At a meeting between DOH and DRD held in 1999, the research topics listed below were identified. These should be undertaken during the course of the project to achieve a comparison of the BB and FWD measurements, so that future FWD and historic BB measurement records can be interrelated and used in existing Pavement Maintenance and Management Systems (PMMS) and in the future development of such systems. In addition, the methods and procedures will be documented for the ongoing and continuing monitoring of the road network of Thailand under the responsibility of the DOH. Historic and ongoing BB field surveying information will thereby complement backcalculated FWD test data that will be collected in an extensive field program during the project period. The data will be input into the re-engineered and updated database that will contain the pavement structure, construction and maintenance records that will be set up using modern relational database software such as Microsoft Access. This database will potentially become the core of Thailand's future PMMS.

Identification of the research activities to be undertaken during the project period is therefore very important. It is anticipated that the benefits listed below will be

achieved through the joint research activities that will be carried out by DOH and DRD:

– formation and training of a study group that will be provided with relevant information and literature concerning research into pavement materials, pavement analysis and design methods, and information about the production and laying of road construction materials and road maintenance, in order to establish a uniform level of knowledge of analytical road pavement analysis and design procedures and an understanding of some of the practical aspects of road construction;
– FWD testing to determine the relationships between temperatures and the E-moduli of asphaltic materials will be conducted on selected flexible road test sections of the Thai road network;
– research into the evaluation of the bearing capacity of jointed concrete pavements using FWD technology;
– assembly and calibration of the SERVOPAC Gyratory Compactor and UTM-5P equipment manufactured and supplied by IPC of Australia. Initiating a research project into the evaluation of the E-moduli of Asphalt Concrete (AC) in accordance with the DOH specifications. Evaluation of cored specimens from selected road sections of different ages and levels of damage in order to determine E-moduli and Poisson's ratios for the main types of asphaltic (bituminous) surfacing and bound and unbound granular materials used in Thailand;
– initiation and development of analytical road pavement analysis and design methods for Thai road conditions;
– discussions with road maintenance officers to develop an efficient and practical means of classification, ranking and costing of road defects and criteria for road rehabilitation and maintenance works using visual road condition descriptions;
– planning and organisation of a number of workshops and seminars for sharing the results and experience from the road pavement research in Thailand, nationally and internationally.

Article specially written by Robin Macdonald.

TransPortalen

– A Subject Gateway for Researchers, Academics and Students within the Area of Traffic and Transport

Denmark's Electronic Research Library has begun a project – the DEF project (Danmarks Elektroniske Forskningsbibliotek) – that is the result of a co-operative effort by the Ministry of Culture, Ministry of Research and Ministry of Education. The basis for the project is to be found in the government's IT-political action plan "The Information Society for All - the Danish Model" from 1996. The initial preparations for the project were made in 1996–1997, and when the national budget for 1998 was approved, DEF came into being with a budget of 200 million DKK distributed over a period stretching from 1998 until 2002.

The DEF project has been launched to encourage co-operation between libraries and to pool valuable experience and financing in an effort to gain maximum benefit for the users. The libraries will be given a lift both in financial and in technical terms to pave the way towards their future role as competent, hybrid users.

The organisation

The Liaison Committee sets out the framework for DEF and consists of representatives from the three Ministries and the Danish National Library Authority, and the chairman of the Steering Committee.

The Steering Committee consists of ten representatives from relevant user groups. They have the overall responsibility for realising the project.

The Danish National Library Authority acts as secretariat to the Steering Committee and is responsible for the day-to-day running of the project.

The players

Denmark's 12 largest and 44 medium-sized research libraries, the 16 county libraries and the Danish National Library Authority are the primary forces in the DEF project. In due course, however, more than 200 small research libraries and the country's other information providers will become a part of DEF.

TransPortalen

Taking the above information into consideration, it has now become possible to create subject gateways.

In the spring of 2001, two of the seven established subject gateways have come into being. They are

- **http://www.bizigate.dk/**
  – erhvervs-økonomisk fagportal
  (a business economic subject gateway)
- **http://www.def-musikportal.dk/**
  – Det virtuelle musikbibliotek
  (a subject gateway for people interested in music).

Other subject gateways will be created in the following areas: Energy, Clinical information, Food, Art and Transportation.

The subject gateway to be opened in the area of transportation will be known as TransPortalen.

Article specially written by Lilian Olling.

PHOTO: CHRISTER TONSTRÖM, MEDIABILD

Research on Track Geometry for High-speed Trains

During the last 15 years, train speeds for conventional (non-tilting) trains have been increased from 130 km/h to 160 km/h, tilting trains with a maximum commercial speed of 200 km/h have been put into service, and on the Stockholm–Arlanda airport railway, non-tilting EMUs have been put into service with a maximum speed of 200 km/h.

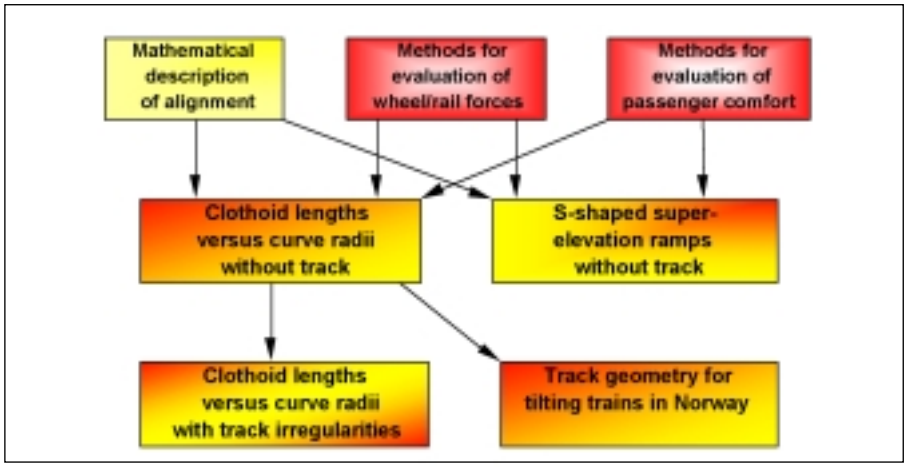

Figure 1. The structure of the present project.

The efforts to increase train speeds on existing lines and the programme for building new lines formed the starting point for a research project on track geometry conducted by the VTI in co-operation with the Royal Institute of Technology (KTH) in Stockholm.

The article covers the choice of cant for a predefined horizontal alignment, the choice of transition lengths when clothoids are used in predefined terrain corridors and a comparison of different types of transition curves and superelevation ramps.

According to report C172 Rp 1 issued by ERRI (ORE), the research organisation formerly owned by the International Railway Organisation, UIC, alignment and cant, together with other track aspects such as gauge widening, rail inclination, rail profiles, track irregularities, rail lubrication, track stiffness and damping, have not been studied as closely as vehicle aspects in the area of track/vehicle interaction.

Consequently, VTI and KTH conducted a Ph.D. project with the aim of establishing methods for the optimisation of track geometry.

The structure of the project is shown in Figure 1. The approach is inter-disciplinary and involves permanent way, vehicle engineering, track/vehicle interaction and comfort evaluation.

Terrain corridors

Various concepts have been used to identify and describe relations between the horizontal alignment and obstacles along the route. One example of curvature and slew diagrams is shown are Figure 2, where curvature (k) and slew values (differences

in lateral position) are plotted against distance along the track (s).

In Figure 2, alignment alternative A0 consists of short transition curves and the radius is assumed to be maximised, so that there is no margin to the boundaries or the terrain corridor at least at one point along the curve.

Alignment alternatives A1-A4 have double the transition lengths of A0. Alternative A1 has the same radius as the reference alternative A0. Hence, the track is shifted inwards along the entire curve, passing the boundary for the terrain corridor, at least at the critical section. If the critical section is located in the middle of the curve, alignment A2 requires the smallest adjustment to the radius to remain within the terrain corridor. If the critical condition is to have the same length of tangent track (due to turnouts or crossings), alignment A4 has the smallest adjustment of radius.

The concept (of the terrain corridors) has been used in evaluating different clothoid lengths in different terrain corridors, where the possible combinations of radius and transition lengths depend on the characteristics of the corridor.

The concept (of the terrain corridors) has also been used when evaluating S-shaped superelevation ramps and corresponding types of transition curves. In this evaluation, S-shaped ramps have lengths that either give the same lateral position of the circular curve, or the same lengths of the adjacent tangent tracks as linear ramps.

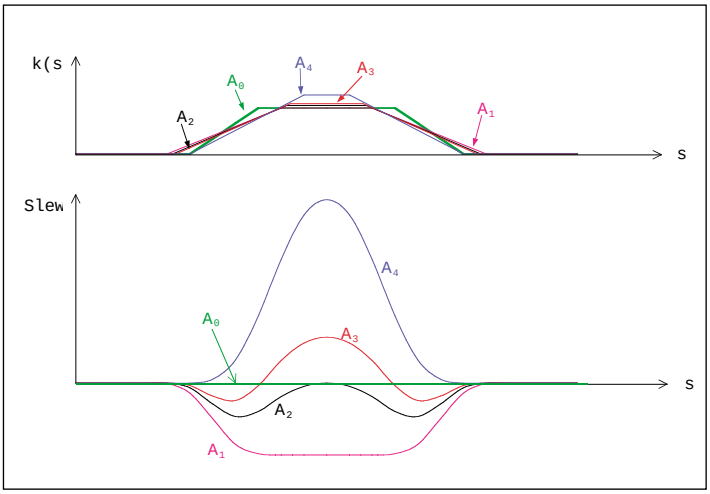

Figure 2. Comparisons in a slew diagram.

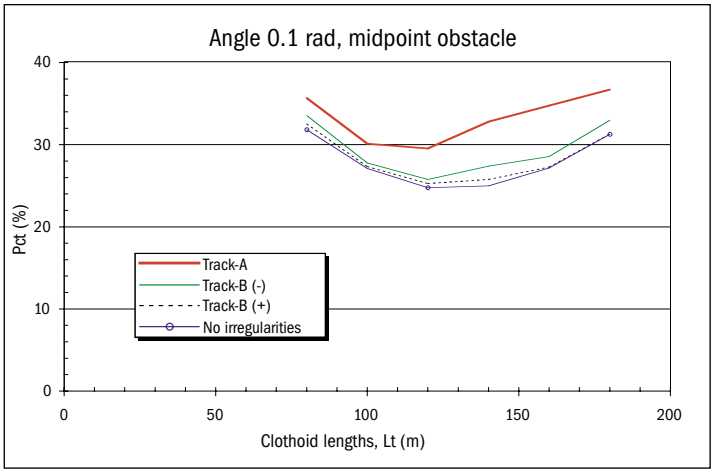

Figure 3. P_{CT} (standing passengers) for two vehicles when passing within one of the evaluated terrain corridors.

Vehicle response

Wheel/rail forces and climbing ratios have been evaluated according to recent draft standards from CEN (1999b) and UIC (1999). These standards refer to the evaluation, tests and approval of vehicles with respect to track/vehicle interaction, but have been found useful also when evaluating alignment alternatives. Maximum vertical wheel/rail forces (Q), track shift forces (ΣY), and climbing ratios (Y/Q) have been evaluated and compared with their limits according to these standards.

An investigation by Björn Kufver (1997) showed that when passenger comfort was evaluated in alignment design, the P_{CT} functions (derived from field tests by British Rail Research) were the most suitable object functions. Using statistical analysis, it was found that the percentage of disturbed passengers was dependent on the lateral acceleration, lateral jerk (rate of change of acceleration) and roll velocities of the vehicle body.

The P_{CT} functions are now incorporated in a draft CEN standard (CEN 1999a).

Simulations

The vehicle response is estimated through simulations instead of measurements in full-scale tests. Such tests are expensive, and it is also very difficult to control background variables such as vehicle speed, friction in wheel/rail contact, track stiffness and track irregularities.

The simulations have been conducted with the GENSYS multibody code. This code is used in a wide range of applications concerning track/vehicle interaction.

The vehicles have been modelled with seven rigid bodies (a vehicle body, two bogies and four wheel sets), each having six degrees of freedom (three translational and three rotational directions). Vehicle data correspond to the non-tilting Eurofima coach, the tilting SJ UA2 coach and the SJ X2 power car, representing a modern, high speed locomotive.

Choice of cant

The amount of cant on a circular curve affects passenger comfort in terms of P_{CT} in three ways. Compared with low cant (high cant deficiency) high cant (low cant deficiency) results in low lateral acceleration, low lateral jerk but high roll velocity. It has been shown how optimal cant can be calculated in order to minimise the total comfort disturbances when running into curves. The optimal cant depends not only on curve radius and train speed, but also on lengths of transition curves and vehicle characteristics.

S-shaped superelevation ramps

In the present study S-shaped superelevation ramps have been evaluated with respect to dynamic vehicle response. The ramps have been combined either with a transition curve with an S-shaped pattern for the curvature, or with traditional clothoids (transition curves with a linear change of curvature). The simulations are performed with the nominal track geometry (i.e. no track irregularities have been used).

Where the inward shift is binding, P_{CT} is approximately the same for different alternatives. Where lengths are binding, linear ramps generate the lowest P_{CT} values. The differences in wheel/rail forces and climbing ratios between the different layouts are small. Hence, the general conclusion when evaluating S-shaped ramps according to the criteria in CEN (1999a & 1999b) and UIC (1999) is that no substantial advantages have been found with the S-shaped ramps.

Curve radius and linear ramps

The main issue in the present project has been to investigate the effects of different lengths of transition curves (of the clothoid type). The investigations have focused on cases where curve radius and transition curves are close to the limits according to the track standards.

Figure 3 shows vehicle response in terms of P_{CT} for one set of alignment alternatives within a terrain corridor. The simulations are conducted both with and without different levels of track irregularities, measured with a Swedish track recording coach. Track A is a track for operation at 130 km/h (tilting trains 165 km/h), while Track B (+/-) are tracks for 160 km/h (tilting trains 190 km/h). The irregularities are relatively rough and lie on the maintenance limits (according to Swedish standards).

The clothoid lengths that minimise P_{CT} are different for tilting and non-tilting trains. They were also found to be different for the evaluated terrain corridors. The larger the angle between the two tangent tracks, and the nearer the middle of the curve the binding obstacle is located, the longer will be the optimal transition curves.

Most often, vertical wheel/rail-forces (Q), track shift forces ($\sum$Y), and climbing ratios (Y/Q) do not exceed the limits according to CEN (1999b) and UIC (1999). However, at cant deficiencies of about 270 mm for Track A and 300 mm for Track B, the track shift forces for the SJ UA2 coach reach their limits.

Discussion

The present studies have focused on the most basic problems in curve design: the types of superelevation ramps and transition curves, and the lengths of transition curves and curve radii.

Comprehensive computer models have been used to simulate the vehicle response on curves. The response has been evaluated according to draft standards from CEN (1999a & 1999b) and UIC (1999). The comfort evaluation in CEN (1999a) will be revised by the UIC Comfort Group, which will conduct full-scale tests in Italy. Participants in the UIC Comfort Group are UIC, AEA Technology, DB, JBV and VTI. If the P_{CT} formulas are modified, the present study will be revised, although its methods may continue to be used. Further research on motion sickness may also yield useful explanatory models for use in track design.

Other aspects of curves to investigate are minimum lengths of track (tangent track, circular curve) between two transition curves, and curvature patterns on crossovers.

Article specially written for Nordic Road & Transport Research by Björn Kufver, Senior Researcher at VTI. It is based on a presentation at Railway Engineering-2001, held in London on 30th April. The full paper won the Innovation Award – to the best paper on Innovations in Railway Industry – and may be found on CD-ROM ISBN 0-947644-45-8 from Engineering Technics Press Publications, Edinburgh.

ACKNOWLEDGEMENTS

The project has been conducted in cooperation with Professor Evert Andersson at the Division of Railway Technology, Royal Institute of Technology (KTH), Stockholm, Sweden. The research was financed by Adtranz Sweden, Banverket, SJ, Vinnova (previously KFB) and VTI. The applied study on Norwegian tilting trains was financed by Jernbaneverket.

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Seat Belts in Trains

In 1999, the Finnish Rail Administration started an experiment in which seat belts were installed in three railway carriages (a total of 271 seat belts). Two seat belt types were tested – a manually adjustable lap belt (as in aircraft) and an automatically adjusted lap belt. The railway carriages were used in daily traffic in three different railway connections over a total period of one year.

The aim of the study was to investigate usage of the seat belts, the factors affecting usage and travellers' opinions about the advantages and necessity of the belts. Usage of the seat belts was recorded by an observer. Travellers' opinions about the seat belts were collected by a questionnaire provided by the observer. The questionnaire was given both to potential belt users and travellers in a railway carriage with no seat belts.

A total of 1,532 completed questionnaires were collected. The main results showed that the usage rate was only 1.4 percent, with a higher rate for the manually adjustable belt. This might be due to the fact that this type of belt was also detected more frequently (61%) than the automatically adjusted belt (46%). The most frequently given reasons for not wearing the belt (if detected) was "it is uncomfortable to use" (32 %), followed by "I forgot to fasten the belt" (22 %). Only eight percent indicated that the seat belt is unnecessary. Although only a few travellers used the seat belts, most of them (68 %) thought that more railway carriages should be equipped with them. Only 10 percent of the travellers indicated that the use of seat belts should be mandatory in trains.

Authors: Virpi Anttila and Juha Luoma
Series: VTT Research Notes 2106
Language: Finnish with English abstract

Comparison of Daily Mobility in 1986–98 According to the National Travel Surveys

In Finland nation-wide travel surveys have been conducted at six-year intervals since 1974. Data from the three latest surveys (1986, 1992 and 1998/99) are available.

The aim of the study was to determine both permanent and variable features of weekday daily travel by people between 18 and 64 years of age during the research period 1986–98.

The "3-storey model" formed the framework for the study. It divides up persons into three traveller groups: persons not making any trips (zero-travellers), persons spending a maximum of three hours travelling daily and persons spending more than three hours travelling daily. People were further divided up into subgroups by gender and daily access to a car (car always, sometimes or never available for daily trips). A classification into eight groups according to the region of residence and type of municipality was also used in the analysis. Only domestic travel was considered.

During the study period, accessibility to a car has increased considerably, especially among women. In 1998, 76 per cent of men and 43 percent of women had a car at their disposal, whereas twelve years earlier the proportions were 58 per cent and 19 per cent.

The number of zero-travellers in nearly all age and car-user groups has declined to 10 per cent of the population for both men and women. In the earlier studies the share of zero-travellers used to be on this level only for groups of persons who always had a car at their disposal. However, there were differences in the surveys in reaching all groups of persons equally.

The survey method was formerly a postal questionnaire, but for the latest survey informed telephone interviews were used. For the largest group (83 % in 1998), travelling a maximum of three hours, the average daily travel distance per person has increased by 8 per cent, from 33.7 km in 1986 to 36.4 km in 1998. The share of trips by car has remained at 75 per cent of the total weekday kilometrage. For travellers making daily journeys exceeding three hours, both the average daily travel time and distance have decreased somewhat; in 1998 the distance travelled daily was 229 km. The approximately 7 per cent minority of persons travelling over three hours per day are still responsible for over a third of the total weekday kilometrage.

Authors: Tuuli Järvi-Nykänen, Veli Himanen, Ari Sirkiä
Series: Ministry of Transport and Communications
Language: Finnish with English abstract

Night Time Visibility of Wet Road Markings

The poor visibility of road markings in the dark and wet is a well-known problem. In rainy weather, a reflective water surface often forms on the surface of road markings, with the result that the light from the vehicle is reflected away from it instead of towards it. This is the reason why conventional flat road markings can hardly be seen in the dark when it rains.

In a European project (COST 331) it is stated that longitudinal road markings should be visible not less than 45 m in front of the vehicle on a road subject to a 90 km/h limit if driving is to be safe and comfortable. In wet conditions, a flat marking has a considerably shorter visibility distance and cannot be considered to satisfy the requirements for safety and comfort that road users can make. Could these requirements be met using road markings specially designed to have good visibility in dark and wet conditions?

In order to answer this question a number of firms were invited to apply road markings, visible in the wet, on two test sections. No limits were imposed on the type of road marking, although the function was to focus on good visibility in the dark and wet.

The road markings were laid on the test sections in August 1998 and physical measurements of retroreflective properties (dry and wet), luminance coefficient and friction were made on four occasions up to May 2000. Further measurements of retroreflective properties were also made on ten occasions.

Measurements on wet road markings showed that they can be so designed that retroreflection initially exceeds 200 mcd/m2/lux. The function deteriorates over time; for most materials it drops to about half this value after two winters. These results must be regarded as very good and can be compared with the requirements specified in the Nordic countries, i.e. 25–35 mcd/m2/lux.

A comparison with the results from COST 331, Chapter 5, shows that visibility in the dark and wet would initially have been approximately 70 m for the best materials if they had been made as "ordinary" Swedish edge markings, i.e. intermittent with a width of 0.10 m. Visibility deteriorated over a two year period to 55–60 m. This implies that they would satisfy the requirements for the absolutely shortest preview time according to COST 331. Whether they meet the requirements for the desired comfort is more doubtful. In this respect, Chapter 6 of COST 331 states that 55 m is far too short a visibility distance for a speed limit of 90 km/h.

The results can thus be summarised as follows:

– it is technically possible to manufacture road markings that have considerably better retroreflective properties in the wet than those currently available
– even if these road markings, visible in the wet, are laid, it is doubtful if the requirement concerning comfort for the conventional Swedish intermittent edge marking is satisfied.

If a visibility distance greater than 55 m is to be achieved in the wet, the edge marking must have a greater aggregate area, i.e. it has to be wider or have closer spacing or be continuous.

Authors: Sven-Olof Lundkvist and Sofi Åström
Title: Night time visibility of wet road markings – final report on test road 1998–2000
Series: VTI rapport 465
Language: Swedish with English summary
The report is also available as a pdf file on www.vti.se under Reports

The Use of Winter Tyres on Heavy Vehicles

A comparative accident investigation into heavy vehicles' use of winter and summer tyres, respectively, in different combinations did not give support for the hypothesis that the use of winter tyres would decrease the accident risk. A possible explanation for the result may be that the improvement in gripping power is not enough. Another possible explanation may be that hauliers and bus companies adapt their tyre selection to suit the environment the respective vehicle is travelling in. It may also be due to the fact that the drivers of heavy vehicles drive faster more frequently with winter tyres than the improved level of gripping power allows, or that they drive more slowly with summer tyres than the difference in gripping power is commensurate with.

Comparative studies of friction showed that winter tyres give better gripping power than summer tyres on ice, but still appreciably inferior to that of a passenger car fitted with good quality studded tyres. In tests carried out with different combinations of studded and unstudded tyres on trucks with trailers, the combination with new studded tyres on all wheels delivered far greater braking capacity than new unstudded tyres on all wheels, which however delivered somewhat greater braking capacity than half worn summer tyres. There was, though, no significant difference between the tyre alternatives as regards swerving lateral evasive manoeuvres.

Authors: Gudrun Öberg, Olle Nordström, Carl-Gustav Wallman, Mats Wiklund and Peter Wretling
Title: Tunga fordons däckanvändning. Effekter vid is/snöväglag
Series: VTI meddelande 884
Language: Swedish with English summary
The report is also available as a pdf file on www.vti.se under Reports

Speed Behaviour Before and After Installation of Camera Boxes

On behalf of the Central Directorate of National Road Administration, VTI has described the speed profile between Iggesund and Hudiksvall before and after the installation of seven camera boxes for automatic speed enforcement. The boxes can be equipped with cameras, which take a front photo if the approaching car is driven at a speed exceeding the speed limit by 10 km/h.

The measurement method means that about 30 randomly selected cars have been followed in each direction by an instrumented car from VTI. The instrument in the car continuously registered the distance to the followed car and the speed of the instrumented car. The speed profile of the followed car is thus obtained for the road section. For every 50 metres of the road section the mean value for all cars followed is calculated and an aggregated speed profile obtained.

The speed measurements, after the installation of the boxes 1998, verify that the mean speed on the experimental section decreased by between 6 and 7 km/h from June 1998 to June 1999. From June 1998 to June 2000 the mean speed decreased by between 4 and 5 km/h, while at the same time the speed variation decreased.

Authors: Henrik Kronberg and Göran Nilsson
Title: Automatic speed enforcement. Speed behaviour before and after installation of camera boxes on E4 between Iggesund and Hudiksvall
Series: VTI meddelande 906
Language: Swedish with English summary
The report is also available as a pdf file on www.vti.se under Reports

PHOTO: VÄGVERKET

Flat Slopes, Coherent Safety Fences and Safety Barriers Protect in Run-off-road Accidents

Flat slopes, safety fences with as few end terminals as possible, and central barriers on motorways in the traffic environment, contribute greatly to traffic safety in connection with run-off-road accidents. Safety fences are safer than the general roadside area of today. It has not been possible to determine how flat a slope must be to be as safe as a safety fence.

Colliding with the end terminal of a fence is much more dangerous than colliding with other parts of the fence. However, this is no major problem since only approximately 5 per cent of collisions with safety fences occur at the ends. No significant difference could be shown between rigid end terminals and terminals which sloped to underground anchorages.

Over the last 10 years, run-off-road accidents on state maintained roads constituted 17 per cent of all accidents (including accidents involving wild animals). The severity of injury in such an accident largely depends on the roadside area. In this study, the roadside area has been studied through analyses and a review of the literature. The roadside variables studied are the gradients of slopes, embankments, earth cuttings, safety fences and their terminations, and central reserves on motorways.

Author: Li Ljungblad
Title: The road side area and safety fences
Series: VTI rapport 453
Language: Swedish with English summary
The report is also available as a pdf file on www.vti.se under Reports

PHOTO: STAFFAN GUSTAVSSON, REDAKTA

Municipalities' Action Plans for Road Safety

The Danish Road Directorate desired an independent evaluation of the 42 local traffic safety plans which had been prepared in December 1999 with financial support from the Traffic Pool. The work was initiated to make local traffic safety work more effective.

The evaluation included the importance of the traffic safety plans in local traffic safety work:

- create a basis for decisions and setting priorities
- create conditions for co-operation across traditional demarcations
- include local interest groups, inhabitants and road users
- stimulate local debate and awareness on traffic safety problems
- increase local contribution by means of concrete projects.

The local traffic plans were evaluated using a combination of literature analyses, analyses of accident data, questionnaires and interviews.

The general evaluation of the local administrations' traffic safety planning is:

- that the Traffic Pool has markedly increased the number of traffic safety efforts in smaller administrations
- that the planning has led to a high level of political awareness and involvement in local traffic safety
- that most local authorities' planning has led to productive local debates
- that local authorities' planning has led to more activities in the area of traffic safety
- that it has not been possible to include other administrative offices and break down traditional demarcations
- that many places lack a clear connection between working areas, aims, means and projects
- that not all plans include a concrete action plan
- that there is no clarification of the meaning of insecurity in traffic safety.

A number of recommendations have been drawn up in the report on the basis of the above findings, intended for local administrations with and without traffic safety plans, counties and the Road Directorate.

Title: Municipalities' action plans for road safety
Report: 221
Language: Danish

Economic and Equity Effects of Marginal Cost Transport Pricing

Marginal cost transport pricing – if implemented in European cities – may give rise to substantial welfare benefits for urban populations, according to a new report produced by the Institute of Transport Economics in Norway and the Government Institute for Economic Research (VATT) in Finland. The study forms a part of the larger EU-financed project called AFFORD.

Depending on the local conditions and the policy instruments used, annual welfare gains may typically amount to 100-400 Euros per capita, as measured by the willingness-to-pay-within the affected urban population.

These welfare gains have been estimated by means of transport models applied to the cities of Edinburgh, Helsinki and Oslo. Real-world instruments considered include cordon toll rates, parking charges, fuel tax, vehicle tax, distance based charges, and public transport fares and level-of-service.

Not all of these instruments are currently available to local urban authorities – some belong to the national level of government. Thus the study distinguishes between second-best policies "under current institutions", and those which are practicable only "after institutional reform".

In the latter variant, it is assumed that the local authorities are allowed access to certain instruments that are not presently at their disposal, or that national authorities agree to tuning the level of certain instruments so as to maximise the welfare of the urban population.

Report title: Economic and equity effects of marginal cost pricing in transport. Case studies from three European cities
Authors: Lasse Fridstrøm, Harald Minken, Paavo Molanen, Simon Shepherd and Arild Vold
ISBN: 951-561-353-1
Language: English

Limited Effect of Lowered Age Limit for Driving Practice

In 1994, the age limit for private driving practice in Norway was lowered from 17 to 16 years of age. This change had only a limited effect on the amount of training.

In the evaluation study, self-reported data on crashes and exposure were collected from 10 300 drivers, who had held a licence between 2 and 18 months and had passed the driving test between April, 1998 and March, 1999. These drivers were legally able to drive with a private instructor from the age of 16, since the age limit was lowered from 17 years in 1994 (the licensing age was kept at 18). These drivers' post-licensing risk did not differ significantly from that of drivers who obtained their licence before or immediately after the age limit was lowered. The lowered limit had only a limited effect on the amount of training. A recent tendency to increased involvement of 18-year-old drivers in police-reported injury crashes is probably explainable by regional differences regarding changes in exposure and a decrease in licensing among young people. Against this background, the amount of pre-licence driving must probably be increased considerably in order to achieve measurable effects on post-licensing crash risk.

Report title: Novice drivers' crash risk before and after the age limit for driver training in Norway was lowered from 17 to 16 years
Author: Fridulv Sagberg
Series: TØI report 498/2000
Language: Norwegian with summary in English

The amount of pre-licence driving probably needs to be increased considerably if it is to have measurable effects on post-licensing crash risk, according to the conclusions in this report.

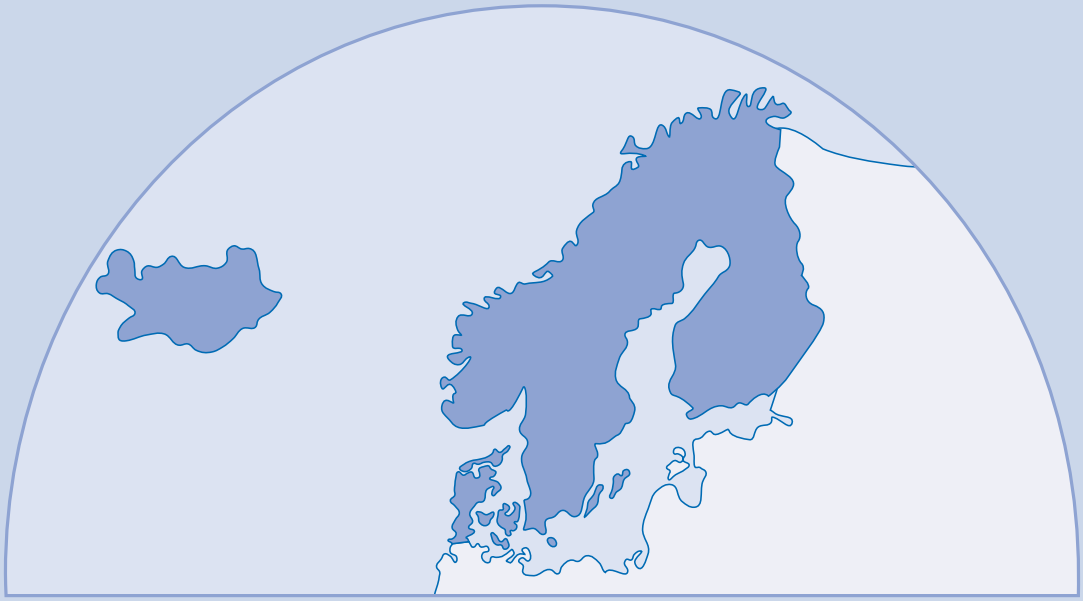
Road Pricing Strategies for Oslo

Road pricing can produce substantial efficiency gains, but high and low income groups will be affected differently. This is one main conclusion in a study carried out at the Institute of Transport Economics.

The report describes the construction and application of a modelling framework to analyse both efficiency and equity impacts of selected first and second best road pricing strategies in the Greater Oslo area of Norway, and report results. The strategies considered differ with respect to the road pricing measures that are available (traditional vs link-based measures), whether only short-term or both short-term and medium-term effects are considered, and with respect to redistribution and use of the revenue. In conclusion, there are trade-offs between the three aspects of road pricing – efficiency in the transport sector, efficiency of the tax system and equity. For a successful implementation of road pricing, these tradeoffs must be studied carefully in each particular instance.

Report title: Road pricing strategies for the Greater Oslo area
Authors: Arild Vold, Harald Minken and Lasse Fridstrøm
Series: TØI report 507/2001
Language: Norwegian with summary in English

The present toll ring in Oslo.



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