ROUTES/ROADS

World Road Association
www.piarc.org

n°375 - 4th quarter 2017

FEATURES

XVth International Winter Road Congress

WORLD ROAD ASSOCIATION
MONDIALE DE LA ROUTE
AIPCR PIARC

English Version

MIEUX PROTÉGER LA PLANÈTE

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Diffusion : GIS (France)

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ISSN : 0004-556 X

CONTENTS

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Background: Fotolia © Dfikar
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EDiTORIAL

Wojciech Kowalewski
Director General, General Directorate for Roads and Motorways (GDDKiA), First Delegate of the Republic of Poland

Welcome to Gdańsk!
Witamy w Gdańsku!

Severe weather conditions and winter's unpredictability always pose a challenge for road administrations to keep the national road network safe and serviceable. Crucial elements to a successful winter road management lie within establishing effective communication, proper crises management procedures, flexibility and coordination. Along with this, road administrators need to take care of snow removal and hauling, dumping sites and contractors' monitoring. All actions, whether within city limits or rural areas, need to take into consideration the environmental aspect and the impact of climate change.

Having in mind the importance of road users' safety, particularly during winter time, I am more than sure that all of you will be able to find answers and solutions to those and many more issues on winter maintenance at the XVth International Winter Congress in Gdańsk on February 20-23, 2018.

> *"… Collecting data on road and weather conditions is a way forward to a better communicated and consolidated product for all parties involved such as road users, road managers and industry…"*

The Congress will be structured in 8 thematic blocks, each addressing the main theme *"Providing a safe and sustainable winter road service"*. The relevant Technical Committees of the World Road Association carefully selected 170 papers, presenting the latest developments, research and experiences on road management in winter time. Experts, university professors, road managers and politicians will engage in a sizzling debate on how to implement ambitious plans of road maintenance at the highest standards, in line with sustainability.

Poland, 6th biggest country in the European Union, has a road network of 420,000 kilometres with 36,000 bridges and tunnels. Winters last up to 6 months and implt constant attention and monitoring of the weather conditions. That's why the General Directorate for National Roads partnered with the Institute of Meteorology and Water Management to prepare a report and set a standard book for winter maintenance. The plan involves different standards for maintenance depending on road category.

Intensive snow fall may cause road network closing and paralyze local economy as well as endanger lives. It is essential to constantly improve winter service, its effectivity and efficiency. Research show that focus point should be on predicting extreme weather conditions, careful and long-term maintenance planning together with prevention actions. Collecting data on road and weather conditions is a way forward to a better communicated and consolidated product for all parties involved such as road users, road managers and industry.

Thus, the Congress will examine the best practices in using road weather information including: increasing user acceptance and public support, dissemination of weather, traffic and operations information, use of real-time information. Collected data on road, weather or traffic condition open up a great field for new services. Poland, as one of the founder of Crocodile system, created a single point of access for data collecting. Bringing together all information and exporting is as one consolidated and reliable product saves time, energy and money for the end users.

The Congress will deliver insight into numerous areas of expertise on winter maintenance, attracting top level executives, academic and business professionals, all eager to share their knowledge and exchange their needs. On top of those discussion the Congress will host a ministerial session, where top transport and infrastructure politicians will debate on strategic goals in providing sustainable and efficient winter road services.

I sincerely invite you to get involved, observe, listen and actively participate in technical sessions as well as enjoy the technical tours during Gdańsk Congress.#

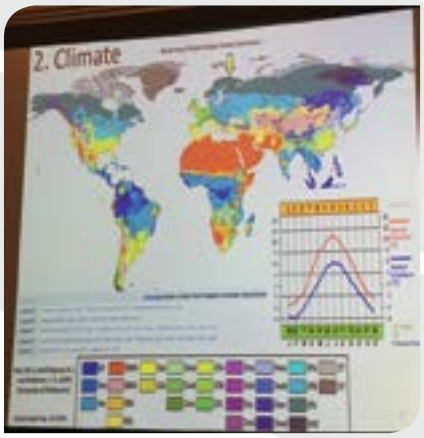
Update on the World Road Association's actions

GREAT SUCCESS FOR THE HDM-4 INTERNATIONAL CONFERENCE IN CHILE

Santiago (Chile), 26 - 29 September 2017

The Technical Committee D.1 *Asset Management* of the World Road Association (PIARC), the HDMGlobal consortium and the Cement and Concrete Institute of Chile (ICH) jointly organized the «*International Conference on HDM-4: A meeting point for road infrastructure managers*». This event took place in the city of Santiago, Chile, from 26 to 29 September 2017.

https://www.piarc.org/en/2017-10-17,success-HDM-4-International-Conference-Chile-2017.htm



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All news available at:
https://www.piarc.org/en/All-News/

A SEMINAR ON TUNNELS IN SOUTH AFRICA

Cape Town (South Africa), 18-20 October 2017

The Huguenot Tunnel was the main topic of discussion at the seminar on tunnels in low and middle income countries held from 18 to 20 October 2017 in Cape Town, organized by SANRAL and the World Road Association Technical Committee D.5 *Road Tunnel Operations.* This seminar provided an opportunity for speakers to address both technical and management issues such as:

- Safety standards for tunnel operations;
- Incident detection mechanisms;
- Hazard and dangerous goods in tunnel;
- Optimizing operating costs;
- Funding options for low and medium income countries.

***

THE WORLD ROAD ASSOCIATION AT THE ITS WORLD CONGRESS 2017 IN MONTRÉAL

Montreal (Canada), 29 October - 2 November 2017

ITS WORLD CONGRESS 2017
Montréal | OCTOBER 29 - NOVEMBER 2

In line with its strategy of wide dissemination of its results, the World Road Association (PIARC) took an active part in the Intelligent Transport Systems World Congress 2017 which took place in Montréal (Canada) from 29 October to 2 November, by organizing there two sessions: «*Autonomous vehicles: road authorities and network managers' perspective*», and «*Low cost ITS and Big data: a new approach of road network operations?*».

https://www.piarc.org/en/2017-08-31,PIARC-ITS-World-Congress-Montreal-2017.htm

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PIARC gathered international experts on climate change adaptation and risk management for road organizations in Cuba

La Havana (Cuba), 8 - 10 November 2017

The World Road Association (PIARC)'s Technical Committees A.3 *Risk management*, E.1 *Adaptation/Resiliency Strategies* and E.3 *Disaster Management*, in coordination with the Ministry of Construction of Cuba, organized an International Seminar on *«Climate change adaptation, risk and disaster management for roads and road organizations»* in Havana (Cuba).

https://www.piarc.org/en/2017-08-28,PIARC-seminar-climat-change-risk-management-Cuba-November-2017.htm

PIARC announces its online manual on Road Asset Management

PIARC has released its new online manual on road asset management. This tool is intended for national and international decision-makers in road-related fields, whatever their level of expertise in the subject.

The manual is available in English, and will shortly be published in French and Spanish. It contains 15 chapters organised in 4 themes: Management, Data and modelling, Planning, Application.

https://road-asset.piarc.org/en

THE WORLD ROAD ASSOCIATION HELD ITS ANNUAL STATUTORY MEETINGS FROM 23 TO 28 OCTOBER IN BONN

Bonn (Germany), 23 - 28 October 2017

The city of Bonn (Germany) hosted the 2017 statutory meetings of the World Road Association from 23 to 28 October. The meetings were an opportunity to discuss the progress of work in view of achieving the objectives set by the Association for the period 2017-2020.

Two new special projects were approved, one concerning *«electric roads»* and the other related to the contribution of road transport to economic development. They will provide insight on these topical subjects from next year. A morning was dedicated to a very rich debate on autonomous vehicles, with presentations given by various countries.

https://www.piarc.org/en/2017-11-09,PIARC-statutory-meetings-october-Bonn-2017.htm

The Winter Road Congress 2022 to be held in Calgary

The Council of the Association selected the city of Calgary (Canada) to host the XVIth International Winter Road Congress in 2022.

http://aipcrgdansk2018.org/2022-international-winter-road-congress-in-calgary/

Three new honorary members

The Council 2017 conferred honorary membership upon Jean-François Corté (France) *(1)*, General Secretary of PIARC between 2002 and 2016, Jeffrey Paniati (United States) *(2)*, Chairman of the Strategic Planning Commission between 2013 and 2016 and lastly Yves Robichon (France) *(3)*, twice Chairman of the French National Committee and member of several PIARC technical committees#

(1)

(2)

(3)

France

Good Governance Practiced by Public Agencies and Private Firms in the Transportation Sector

Michel Demarre, Director General of the French International Contractors Association (SEFI), France
French-speaking Secretary of the World Road Association Technical Committee A.1 *Performance of Transport Administrations*

Over the past few years, the topic of good governance in administrative agencies and private firms has received much greater attention. For the transportation sector, the focus on good governance has risen to the fore as both public and private actors face a situation of needing to closely collaborate during the phases of infrastructure design, construction and operations.

WHAT IS THE EXTENT OF GOVERNANCE?

The term as used herein refers to the set of rules, procedures and practices implemented during the aforementioned phases, i.e. infrastructure design, construction and operations. Without intending to be exhaustive, governance encompasses the following items:

- the decision-making process dedicated to infrastructure building (clearly defined process-centric responsibilities exclusively targeting urban transportation; objectives set, specifications and functionalities; process transparency; quality of both project evaluation and preparation; recourse available to contest the decision, etc.);
- works contract awards (procedural clarity, precision and transparency; equal treatment of bidders; removal of corruptive influences, etc.);
- execution of works (compliance with: best practices, environmental preservation measures, labor protections, occupational hygiene and safety guidelines, etc.).

This set of rules, procedures and practices is embodied in the overall concepts of corporate social responsibility, specifically for companies, and responsible conduct (Responsible Business Conduct for firms and Responsible Government Conduct for agencies) applicable to both companies and public authorities.

Several reasons help explain the growing level of interest shown in this topic:

- the widespread reduction, prevalent across all countries, in public financing available for infrastructure has led to search for alternative financing; to attract investors, a number of attributes are essential, namely: the quality of project evaluation and preparation, the transparency of procedures and assurances of their proper application, the analysis and mitigation (to the greatest extent possible) of all types of risks inherent in the process. It is well known that: *"Financing isn't the problem, it's the lack of good projects"*;
- the transportation sector is particularly sensitive to governance issues, given that:
  * projects are becoming more complex, in being subject to the influence of new regulations adopted (and legitimately so) on behalf for example of the environment; the *"prototype"* aspect of each project complicates the automatic replication of past successes, instead each project and the ancillary communication actions are to be *"infused with intelligence"*;
  * civil society and NGOs are becoming more readily aware and informed of transportation projects, which often have a high profile when up and running; moreover, they have come to expect (completely legitimately) exemplary behavior on the part of both public and private sector actors throughout the deployment process;
  * let's not overlook that in 2011, the World Bank issued a report on fraud, collusion and corruption in the roads sector, recalling that according to a Transparency International survey, the construction sector is the most heavily exposed to corruption.

A MORE HIGHLY FOCUSED BODY OF LEGISLATIVE TEXTS

Both internationally and nationally, a greater number of *"hard line"* legislative mandates have made their way onto the books, in the aim of rendering public service more ethical, overcoming conflicts

of interest and corruption, and nurturing a culture of transparency and responsibility.

Many international organizations have recently compiled a body of legislative texts or recommendations relative to good governance; below is a non-exhaustive list of the primary sources:

- **United Nations (UN)**:
  The United Nations Convention Against Corruption (UNCAC: United Nations Convention Against Corruption) is an international treaty adopted by resolution of the UN General Assembly in October 2003. To date, a total of 182 countries have ratified this accord.
- **OECD**:
  * 2011 update of the Guidelines addressed to multinational corporations *(OECD Guidelines for Multinational Enterprises)*;
  * Recommendation on the mission to prevent bid rigging in the public procurement arena *(Recommendation On Fighting Bid Rigging in Public Procurement)*, 2012.
- **G20**:
  The Group of Twenty (G20) is composed of the European Union plus 19 nations, namely: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the United Kingdom, and the United States. It has met annually since 1999 and places heavy emphasis on fighting corruption. The statement issued by the most recent (2017) meeting that gathered in Hamburg underscores the adoption of *"High-level principles on corporate responsibility to fight corruption"*, and *"High-level principles on organizing against corruption"*. These principles are applicable to the public, as well as the private, sector.
- **ISO**:
  In October 2016, the International Standardization Organization published Standard ISO37001 regarding anti-corruption management systems. Here again, this certification standard is applicable to both public and private bodies.
- **Multilateral development banks**:
  These banks, spearheaded by the World Bank, are reshaping their social and environmental protection policies. Moreover, for many years now, these entities have rolled out procedures aimed at upholding moral integrity in the projects they elect to finance.

At the national scale, many countries have adopted more restrictive legislation in these areas (e.g. France's so-called *"Sapin II"* Law to impose vigilance on parent companies and contractors with respect to their entire subcontracting chain).

IMPACT OF NEW LAWS AND RECOMMENDATIONS

It would be a mistake to believe that the scope of these recommendations is possibly limited to just a few countries (e.g. OECD members) or just a handful of multinationals.

As an illustration, the OECD Convention on Combating Bribery of Foreign Public Officials in International Business Transactions was signed by, in addition to the 35 OECD member nations, six non-members: Argentina, Brazil, Bulgaria, Colombia, Russia, and South Africa.

The OECD's definition of *"multinationals"* lacks precision, and the Organization's Member States are free to introduce legislation or regulations that carry the same impact relative to their national corporations. Also, these recommendations help prompt multinationals to conduct risk analyses focusing on their supply chain and local-level subcontractors, to the extent that such entities are indirectly affected by the provisions contained therein.

Moreover, as indicated above, the search for investors to finance infrastructure increasingly forces the beneficiary countries to comply with good governance rules, with these investors themselves displaying a more ethical behavior. Along these lines, the *"Equator principles"* (***www.equator-principles.com***), now more widely adopted among French actors, do warrant special recognition.

It goes without saying that these expected changes will only come about very gradually and in certain fields, though it does appear that the trend underway is now here to stay.

The MEDEF Employers' Federation delegation at the 2017 G20 meeting © Author

PIARC'S ROLE

Within the scope of preparing for the 2017 G20 meeting mentioned above under German leadership, the B20 (bridging the business communities of the twenty member nations) voiced support for the proposals sponsored by professional building organizations, with CICA (Confederation of International Contractors' Associations) chief among them. These organizations have lobbied hard for improved quality of the project preparation processes (particularly through use of the SOURCE platform[1]) and have promoted the benefits of dialoguing more openly between public and private actors, as exemplified by PIARC's approach to issues surrounding good governance.

Dating back to 2008, PIARC has been addressing governance-related topics among its agenda items, with an emphasis on anti-corruption efforts. More recently, at the time of inaugurating the next cycle (2016-19), this topic was wisely expanded to encompass development of a culture of transparency and responsibility, thereby meshing well with the notions of good governance outlined above.

PIARC's role thus becomes even more critical knowing that the various legislative texts (laws, recommendations, etc.) cited earlier are very often being drafted by representatives of Ministries like Finance, Foreign Affairs or Justice, with practically zero input from the more technical ministries, which in reality are the most highly concerned. In addition, the documents and *"toolboxes"* produced by PIARC are entirely consistent with the procedures introduced in the newly adopted texts.

It is therefore essential for the dialogue initiated between PIARC members stemming from both the public and private sectors be brought to fruition, through the progress achieved by Technical Committee A.1 *Performance of Transport Administrations*.#

1 See: ***https://public.sif-source.org/*** PIARC's Executive Committee has been kept regularly apprised by CICA of the development of this platform, which had formerly been designated under the acronym IISS.

United Kingdom

England Set to Map Out a New Major Road Network

Phil Carey, Rees Jeffreys Road Fund (United Kingdom)

Illustrations © Author

Illustration 1 - A35 Dorset © David Quarmby

Big changes are ahead in how England's road network is run, with the Government now working up proposals for a new category of Major Road Network: what's this all about?

One of the more fundamental challenges in roads administration is what level of public authority - national, regional or local – is best suited to running which roads. Most traffic is essentially local, and most of the impacts of a road are very localised, but the local commune may not be the most effective manager of that road. Most countries, recognising in particular the longer distances covered by freight, the most economically important type of traffic, determine a national network of 'strategic' roads which central Government owns, plans, funds and operates.

But different road administrations take different approaches to what proportion of the main routes should form that national network. And the balance between national and more local responsibility is not necessarily aligned with the degree of centralisation in the country as a whole. England is in general unusually centralised, with relatively few powers held at local authority level, yet the Strategic Road Network (SRN) owned by the Secretary of State for Transport constitutes only 2% of all roads in England - roughly split between motorways and major *'trunk'* roads ('A'-class in the UK classification system). Two-thirds of all traffic is on so-called *'local roads'*; the remaining 98% of miles are the responsibility of 153 Local Highway Authorities (LHAs). These vary greatly in size[1] and capability.

There has been increasing concern about the relative neglect of these LHA roads, particularly now that the Government's own SRN – the motorways and trunk roads – is benefitting from a major upturn in funding as part of an overdue programme of *'Roads Reform'*. In 2015 a new publicly-owned company, Highways England, was set up to run the SRN at arms-length from Government, with guaranteed funding on a five-yearly cycle, sufficient to deliver a new Roads Investment Strategy, determined by Government to support economic growth. And from 2020, Highways England's funding will come from ring-fencing all vehicle ownership tax receipts collected in England, through a new National Roads Fund – a game-changing move towards roads being funded directly by users.

But is that focus on the SRN enough? The Rees Jeffreys Road Fund carried out a comprehensive study into what England needs from its major roads and came to the view that, even though the 4,200 miles of SRN *(illustration 2)* is critically important for the nation, it does not comprise all the roads that drive England's economy at the national and regional level. The output from the study was published in October 2016 as '*A Major Road Network for England*' – proposing a fresh approach to the roads that matter most.

The report focuses attention beyond the SRN on those major 'A'-class roads left to local authorities which also play a crucial role in meeting the needs of business at both national and regional level. Based on objective criteria, the report identified 3,800 miles of these roads *(illustration 3)*, as with the SRN carrying a high proportion of commercial traffic, and providing essential connectivity by filling the gaps in the SRN. Together, these constitute an 8,000-mile Major Road Network (MRN), carrying 43% of all traffic in England on 4% of its roads.

The whole of this MRN needs to be managed and funded in a consistent way – so that it really can underpin economic growth through providing the effective service that users need. Consistency does not mean uniformity, though: *illustration 4, next page* shows how the MRN really comprises three distinct tiers of road, reflecting the diversity of the network, and *table 1, next page* sets out some key statistics for our indicative MRN.

Several sections of this expanded MRN had in fact been part of the SRN until responsibility for them was transferred from central Government to local authorities over the last couple of decades – a programme of *'de-trunking'*. But this is not now just a matter of reversing that move; we have not proposed any changes in the current split

1 Ranging from large 'counties' (sub-regions) such as Kent, in the south-east, with some 5,000 miles, to small urban councils with only a hundred or so miles of road.

Illustration 2 - England's Strategic Road Network (background shading represents population density of district)

Illustration 3 - The indicative Major Road Network proposed by Rees Jeffreys Road Fund (comprising the SRN in blue and LHA roads in green)

of responsibilities between central and local government, because it's worth retaining the local accountability which these LHA roads enjoy. Furthermore, local authorities are in the best position to align what they do on roads with their approach to land use planning and supporting the local economy. But success with the MRN absolutely needs a high degree of collaboration between these highway authorities; the core aim, working together, is to ensure that this 8,000-mile network is '*fit for purpose*', so it can deliver its potential for all its users, and also for the communities it serves and passes through.

The report specifies six components of fitness for purpose:

1. setting and meeting reasonable service expectations for users;
2. mitigating the impacts on towns and villages and on the natural environment;
3. providing effective regimes for safety management and optimising network capacity;
4. applying an effective asset management regime;
5. fitting in to the more complex transport policy requirements of larger urban areas; and
6. working within a fit-for-purpose planning regime, well integrated with spatial and economic planning.

Increasingly, with devolution of power in England gathering momentum, that last will be a task for new regional transport bodies, such as Transport for the North; these *'Sub-national Transport Bodies'* (STBs) are now being tasked with injecting a strategic, cross-modal, view of network need in their region.

It is unreasonable to expect all this to be delivered without more effective funding for the MRN. The Rees Jeffreys report highlights the large and growing gap between the resources available for the SRN and for 'A'-class roads run by local highway authorities *(table 2, next page)*; unlike Highways England, local authorities are largely subject to annual budget-setting, and a complex patchwork of funding sources. There is a pressing need to avoid focusing the Government's investment in roads too narrowly: the planned National Roads Fund earmarked for the SRN should be applied to local major roads too.

We are pleased to report that in July 2017, ten months after taking delivery of our report, the Government decided to do exactly that. In its new Transport Investment Strategy, it has accepted the case for special recognition of the busiest and most strategically important LHA roads and will shortly be consulting on how exactly a new Major Road Network should be defined and governed. It envisages a key role for the new STBs in running this network at the regional level and crucially, Government proposes applying the National Roads Fund to those most important LHA roads too – providing new funding on top of what is planned through existing channels.

Rees Jeffreys hopes that the MRN that emerges from this consultation resembles as closely as possible the concept set out in its report. We're encouraged that it seems likely to

TABLE 1 - SUMMARY STATISTICS FOR COMPOSITION AND TRAFFIC FLOW ON THE MAJOR ROAD NETWORK

	By SRN / local road MRN			By tier			
				Tier 1		Tier 2	Tier 3
	MRN total	SRN	Local MRN	Non-urban	Tier 1A		
Approximate length in miles	8,000	4,200	3,800	2,900	800	3,300	1,000
Percentage of total	100	53	47	36	10	41	13
Average daily flow (all vehicles)	50,032	76,068	32,439	78,613	89,576	29,913	38,804
Average % HGVs	6.4	9.4	4.4	9.5	7.5	6	4.1
Average % vans	14.1	14.3	14.1	14.0	14.0	14.5	13.9
Indicative total traffic (billion vehicle-miles)	113	86	27	58	19	26	10

Illustration 4 - Indicative breakdown of the Major Road Network by tier

TABLE 2 - SUMMARISED COMPARISON OF RELATIVE SPEND ON THE SRN AND ON LOCAL HIGHWAY AUTHORITY 'A' ROADS

('*per vehicle miles*' figures are for maintenance spend only; see Supporting Document 1 to the main report).

Total spend in 2015/2016	£'000 per route-mile	£'000 per lane-mile	£'000 per million vehicle-miles*
Strategic Road Network	643	146	16
Local authority 'A' roads	117	51	12
Forecast spend in 2019/20			
Strategic Road Network	911	207	16
Local authority 'A' roads	108	47	11

* per vehicle-miles are for maintenance spend only

pick up around the same length of LHA road as we had proposed; but we believe that the MRN must incorporate the existing SRN, rather than be a separate set of roads (not in itself a coherent network) that is added to it. Ownership and management of the enlarged network can indeed sensibly be split between Highways England and the local authorities – but the whole 8,000 miles or so of MRN must be perceived by users as a single coherent concept.

Ultimately, a country's road network is a service, an essential one, that has to meet a myriad of different user needs, all to a high standard. All countries with a well-established road network should review from time to time whether the governance arrangements in place for roads, and the split between central and local responsibilities and funding, is keeping pace with the evolving nature of the economy and how roads are used.

The Rees Jeffreys Road Fund, an independent charity, has, since its inception in 1950, provided support for education and research in all forms of transport in Great Britain, with a particular focus on England. It helps to fund projects that improve safety, the roadside environment and rest facilities for motorists and other road users.

For further information, please see ***www.reesjeffreys.co.uk***. The full report, and a Report Summary, can be found at ***www.reesjeffreys.co.uk/transport-reports***.

England is not alone in facing increasing pressures and expectations from its road network, nor in striving to see how new technologies can form part of the solution rather than just complicate the task. Those challenges are now being recognised here. By adopting the core principle of the MRN that the report sets out, England is now on track to be better equipped to manage its extensive network of roads better. The new focus on the Major Road Network should match more closely the needs of users, businesses and communities across the country.#

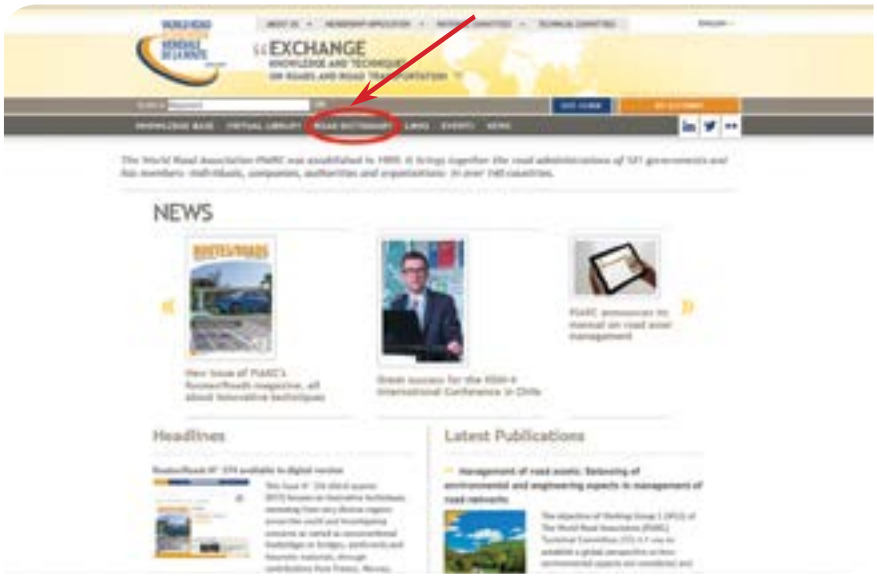
The World Road Association's New Road Dictionary online

A Powerful Tool with a Huge Potential

Daniël Verfaillie, Chairman of the World Road Association Committee on Terminology, Belgium
Annelies Glander, English–speaking Secretary of the World Road Association Committee on Terminology, Austria

Illustrations © Authors

In past years, you were informed on activities and developments of the Committee on Terminology (CTERM) in e.g. Routes/Roads No. 363, page 10-13. This article will focus on the new features implemented and/or envisaged.



DEVELOPMENTS SINCE SEPTEMBER 2014

The new "PIARC Road Dictionary" …

… or "Dictionnaire routier de l'AIPCR" (in French) and "Diccionario vial de PIARC" (in Spanish), as agreed during the kick-off meeting in Paris (February 2016), is a merger of all nine dictionaries formerly contained in the PIARC Terminology database into a single one, while removing the many multiple and sometimes conflicting entries and adding the terms and definitions resulting from contacts with PIARC Technical Committees during the work cycle 2012-2015. This merger was completed in the spring of 2016, without any loss of existing data or disruption of service to the users.

Software

The Dictionary section is directly accessible on the home page of the PIARC website ***www.piarc.org***, under the tab "ROAD DICTIONARY". It is introduced by a welcome page available in English, French and Spanish, explaining the history and presenting the contents of the Dictionary, with due reference to CTERM´s responsibility.

The help files (in English and in French, and translated into Spanish) for users of the Dictionary were updated (to account for the "unified" single PIARC Road Dictionary).

THE FUTURE

App for smartphones and tablets

As part of the pending renewal of its website, CTERM has been encouraging PIARC to have an app developed for the use of the PIARC Road Dictionary on smartphones and tablets. This app will have to be user-friendly and suitable for use both on-line and off-line (downloadable). It will have to be readily updatable and not too memory-consuming.

Downloading specific parts of the Dictionary

Also being considered is the possibility of allowing users to download specific chapters (or only subchapters or sub-subchapters) in specific languages for printing, while avoiding abuse for commercial purposes.

CTERM'S RESPONSIBILITY

CTERM is responsible for updating and upgrading the PIARC Road Dictionary, but cannot meet this request satisfactorily without inputs from the experts in the Technical Committees and with the help of National Committees and member countries for translations into other languages than English and French.

That is why we are launching an urgent call
… upon PIARC Technical Committees

Input for whatever revision of the PIARC Road Dictionary in English and French must come from PIARC´s Technical Committees, since the Dictionary should portray their linguistic reference work. It should be in their personal and professional interest to revise terminology

and transmit specialized vocabulary in their specific areas of expertise to CTERM.

Technicians and engineers give their best to achieve optimum results. The best way to transmit this conscientiously acquired knowledge to other experts and a curious and grateful public is to offer it by means of a reliable terminology. A convincing argument for systematically co-operating with CTERM will be the *"collateral profit"* of having one´s expert terms and definitions documented, widespread and available on-line, plus a fair chance of competing successfully with totally inadequate but still popular Google translations.

As striking examples for most welcome developments CTERM, assisted by IFSTTAR, is currently processing a long list of proposals received from the Technical Committee on Road Bridges towards the end of the previous work cycle (2012-2015) and has been receiving regular contributions from the Technical Committee on Road Tunnel Operations.

Unfortunately though, it is the experience of CTERM that the response of the Technical Committees to calls for proposals has been rather poor.

The *"terminology correspondents"* appointed within the Technical Committees are, therefore, challenged to have the chapters of the Dictionary (sent to them at the beginning of the work cycle!) speedily reviewed.

In addition, they are reminded of their engagement to send CTERM the terminology sections to be included (according to the Blue Guide) in specialized technical reports.

Also, they are recommended to attend at least one CTERM meeting during the 2016-2019 work cycle, to see how CTERM and the web-based PIARC Road Dictionary operate and become familiar with what is expected from them.

… but also upon PIARC member countries

The list of languages (35) currently represented in the database is still sadly incomplete, and numerous language versions have become outdated in the absence of further revisions before and after the merging process described above.

Since September 2014, national language editors have been working on the translation of the PIARC Road Dictionary into Dutch, Estonian, German, Hungarian, Italian, Persian, Polish, Romanian, Spanish and Turkish. An editor has been appointed for Catalan and projects are being prepared for translations into Latvian and Lithuanian. An agreement signed with the Nordic Road Association (NVF) has made it possible to include a number of terms in the field of intelligent transport systems, in the Nordic languages (Danish, Finnish, Icelandic, Norwegian and Swedish). Inputs have been received from the Technical Committee on Road Tunnel Operations for the various languages represented in that Committee.

In spite of all these efforts, CTERM's small team of engineers and linguists, as enthusiastic as they may be, cannot be expected to be competent in all the languages spoken in the currently 121 member countries of PIARC. Only newly appointed full or corresponding CTERM members could provide dearly missing translations into their respective languages.

In view of the next PIARC World Road Congress being held in Abu Dhabi in 2019, an appeal is sent to all Arab-speaking members to develop a revised and complete version in standard Arabic, possibly upgraded with specific variants or synonyms from individual countries.

… and even upon users

Users of the Dictionary are strongly encouraged to enter requests, remarks or suggestions by clicking the button *"Submit your remarks on this term"* at the bottom of a sheet showing the result of a term search. By doing so, they help us to keep the Dictionary as complete and up-to-date as possible.#

The Polish Road Congress: Back to Where We Belong

Illustrations © Polish National Committee

Ninety-two years after it was established, the Polish Road Congress (PKD) is coming back to the world's road family and its prominent representation, the World Road Association. It has just been officially recognized as the Polish PIARC National Committee in Bonn, in October 2017. If history develops in the form of circles, it has just completed the full turn. We are part of the world road community as much as the founding fathers of our organization were in the mid 1920's.

OUR ORIGINS

Our history traces back to 1925, when the 8th Congress of Road Engineers in Warsaw put forward the idea of establishing a Polish Road Congress. Why 'Congress' in its name? The answer is simple: from the very beginning it was meant to refer to the World Road Congress. Polish road engineers were familiar with its operations right from the start, although the country did not exist on the political map of Europe until 1918.

Illustration 2 - Opening ceremony of the 5th (and first post-war) Polish Road Congress, October 2006 Warsaw © PKD

Illustration 1 – The First Polish Road Congress in January 1928, Warsaw © Road Industry Museum in Szczucin, Poland

The overall state of roads at the time of regained independence of the nation left much to be desired. *"In Poland, the road industry is more neglected than any other area of economic life, and Polish roads are suffering from difficult and pressing problems. There is an urgent need for improvements and reorganization. They are issues of economic, technical or financial nature and not political."*

These words were spoken by Eng. Melchior Władysław Nestorowicz at the opening ceremony of the Polish Road Congress in January 1928. The roadmakers were keen to make a contribution to the modernization of the country. Those were the main subjects of the first Polish Road Congress and the three that were to follow until the outbreak of the Second World War.

2005 – THE POLISH ROAD CONGRESS ACTIVE AGAIN

The tradition described above was well known in Polish road circles at the dawn of the new century. 2005 was a special moment again for Poland. Just a few months after becoming a member state of the European Union, the nation was on the verge of civilization leap.

Mr Nestorowicz's words quoted above became an inspiration for a dozen of prominent representatives of the Polish road industry, who in April 2005 initiated to the registration of the Polish Road Congress. Conditions were different, but priorities remained. The most important thing was the radical modernization of the Polish road network.

Today's Polish Road Congress is a broad, non-political platform for cooperation of people willing to ensure highest possible and uniform standards to Polish roads. The organization operates

Illustration 3 – PKD President Zbigniew Kotlarek addressing the 3rd Road Forum of Małopolska Region, January 2017, Zakopane © Tomasz Orłowski, PKD

Illustration 4 – PKD is also about integration through sport; participants of the cycling tour of Świętokrzyskie region, June 2017 © Tomasz Orłowski, PKD

on a non-profit basis, in the legal form of an association. It gathers more than 150 individual members and 35 supporting companies.

When PKD was re-established, it mirrored the structure of the World Road Association. It had Technical Committees dealing with specific groups of technological issues of road construction and maintenance. Recently, the structure has been reviewed and six new Working Groups established: on Bitumen Pavements, Concrete Pavements, Road Safety, Design Works and Bridges, the latest addition being the Working Group (another term for Technical Committee) on Road Asset Management.

ROADS UNDER CONSTRUCTION

The primary task of the re-established Polish Road Congress was to become part of the great modernization effort of the nation's infrastructure. According to recent reports, construction companies directly generate 7.4% of GDP, but indirect effects generate an additional 9.3%. The construction sector directly accounts for 6% of jobs in the economy, and with indirect effects - a total of 15%. Those figures show how important for the nation's economy is the infrastructure investment and financial means provided by the EU's Cohesion Fund and the European Regional Development Fund.

Before the accession to the European Union, Polish roads presented standards significantly worse than those in the countries of the *"old fifteen"*. First of all, we had no roads of high capacity. At the end of 2002, the total length of Polish motorways was about 410 km.

2007-2013 was the first full financial framework of the European Union from which Poland could benefit. The total value of the money allocated in the EU budget for the Polish transport sector was 24 billion Euros, of which road transport accounted for 15 billion, including 10 billion for the construction of national roads (the rest for the regional roads and in major cities and for transport).

PKD committed itself into monitoring the process of preparation and execution of road investment. In a series of conferences and seminars, we pointed out what we called *"barriers"* which hampered the process of road constructiuon. Those problems included regulations on obtaining land for construction of new roads, new rules related to environment protection, and practical consequences of the public procurement law. And yet, with so many problems identified above, Poland has reached an unquestionable success. In mid 2017 the Polish network of high speed roads (motorways and expressways) counts 3,249 km, including 1,627 km of motorways and 1,622 km of expressways.

NEW APPROACH AND NEW HOPES

It still remains more than twice as much to construct. According to government regulation of the prospect network of motorways and expressways, the whole network has to count a total of approximately 7,560 km, of which 2,000 km are motorways and 5,560 km expressways.

Things are different in road construction in Poland now. The government installed in 2015, together with the industry representatives, has sought ways to optimize the processes of road construction. Working Groups, consisting of representatives of the Ministry, of the General Directorate for National Roads and Motorways (GDDKiA) and local investors, and organizations representing road

industry sector were created to discuss proposals. The work is now continued in the 28 people-strong Expert Council to the Minister for Infrastructure and Construction. PKD has two delegates to that Council.

GOALS FOR 2025

A lot of work remains for the Polish Road Congress. The annual meeting of the association in June 2017 adopted the *"Congress 2025"* strategy which sets the goals for the 100th anniversary of Poland's Road Congress in 2025.

The strategy assumes that PKD will be an internationally recognized principal representative of the Polish road circles. It will serve as an intermediary in the flow of knowledge between the international level and the Polish road research and practice. The leading program of activities organized by Congress will be of international format. PKD will be an opinion-making representative of the road industry as a whole, especially in the field of technology. We want to remain an important partner of the political authorities in matters related to road administration. The year 2019 marks the 200th anniversary of the road administration (GDDKiA) in Poland. PKD will propose a new public roads act to be voted by Parliament by that time. The present law, adopted in 1985, is outdated and no longer complies with modern road management.#

Illustration 5 - The Grzegorz Stech Bridge in the town of Dobczyce in southern Poland, named after the vice president of PKD who died in 2013
© Marek Medon, ZDW Kraków

Illustration 6 - S7 road near Gdańsk © Maciej Bejm, GDDKiA

CIMBETON,
CENTRE D'INFORMATION SUR LE CIMENT ET SES APPLICATIONS

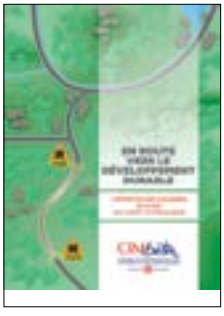
Organisme professionnel de l'industrie cimentière, CIMBETON a pour mission de promouvoir les techniques à base de ciments, de liants hydrauliques routiers et de bétons dans tous les secteurs de la construction : Bâtiments, Routes & Terrassements et Génie Civil.

Pour atteindre cet objectif, CIMBETON développe une écoute efficace pour collecter l'information et remplir sa mission :

- En étudiant les besoins et les aspirations de tous les acteurs de la construction,
- En participant à la formulation de réponses techniques aux préoccupations de chaque intervenant,
- En communiquant les solutions et en appuyant leurs développements.

En outre, CIMBETON consacre une partie importante de son activité à initier, organiser, animer et faire fructifier des partenariats actifs entre les acteurs de la construction. Cette volonté d'ouverture permet de faire réaliser des études, des recherches appliquées et des essais pour motiver un développement de produits et de techniques, pour faire évoluer la règlementation et soutenir les initiatives de promotion des nouvelles technologies.

Enfin, CIMBETON est un organisme qui initie, centralise et coordonne l'élaboration de l'information technique sur les ciments, les liants hydrauliques routiers, les bétons et leurs applications et qui assure sa diffusion aux professionnels, maîtres d'ouvrage, maîtres d'œuvre, bureaux d'études, entreprises mais aussi aux enseignants et étudiants et le grand public.



CIMBETON, la Collection Technique

Pour mieux faire connaître les ciments, les liants hydrauliques routiers, les bétons et leurs applications, CIMBETON édite différents types de documents constituant la collection Technique CIMBETON. Celle-ci rassemble les ouvrages techniques, les revues spécialisées et le multimédia. Tous ces ouvrages sont disponibles gratuitement sur simple demande.

- **Les ouvrages techniques**

Les fiches techniques, les brochures d'information, les guides techniques et les documents pratiques.

- **Les revues spécialisées**

o Construction Moderne : revue trimestrielle d'architecture qui montre les utilisations du béton dans l'art de bâtir et apporte aux constructeurs références et témoignages.

o Routes : revue trimestrielle d'actualité consacrée aux réalisations routières qui présente à travers des reportages et des monographies, la réalisation des projets et les raisons des choix techniques, économiques et environnementaux.

- **Le multimédia**

o www.infociments.fr: site général sur le ciment et ses applications dans tous les domaines de la construction.

o www.lhr.cimbeton.net : site spécialisé dans les techniques de valorisation des matériaux routiers en place aux ciments et aux liants hydrauliques routiers. Il s'agit d'une alternative économique et environnementale à l'utilisation des matériaux nobles dans la construction et l'entretien des infrastructures de transport. On distingue deux grandes filières de valorisation :

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SPOTLIGHT ON YOUNG PROFESSIONALS

34-year old **Aleksandra Cybulska** is the head of the International Relations Unit of the Polish General Directorate for National Roads and Motorways (GDDKiA); she is member of the Council of the World Road Association and the linchpin of the preparation of the XVth International Winter Road Congress in Gdańsk

What studies led you to take a job in the road sector?

When I graduated from the Faculty of International Relations at Nicolaus Copernicus University in my home town Toruń, Poland, and got postgraduate studies at College of Europe with the same expertise, I had never imagined that my career would be strongly related to the road sector but now I know that roads connect people much more than traditional diplomacy does.

But when I started my professional career, Poland had already become a member of the European Union. We witnessed great changes of quality on Polish roads, as they reached the position of main UE funds' beneficent. International relations became therefore crucial for the road sector. I felt that this would be a position allowing me to cramp great relations with the European Commission regarding funds but also to renew bilateral relations aiming to attract knowledge from more experienced countries.

According to you what makes your job interesting?

Processes and activities that we carry on are never stopping, it is rolling cooperation which brings every year new issues and new possibilities. Meeting people from all over the world, being ambassador of Poland and presenting growth of our country make me satisfied. My job is real adventure and never makes me demotivated. I appreciate the diversity of the tasks I have to manage. There is nothing more interesting that having influence and take part in big projects dedicated to the development of road infrastructure in Poland. I feel being part of this challenge. I am working to serve Poland and its development, which makes this job meaningful.

What has been your best work experience so far in your career?

The best work experience so far is the preparation of XVth International Winter Road Congress in Gdańsk, Poland. This event will take place on 20-23 of February 2018. We are in the last steps of a project which started from scratch ideas back in 2013. My dream was to bring this kind of event to Poland; we managed to convince PIARC and became host country. I am the General Coordinator of this event and this role requires lot of travels, meetings and many puzzling, challenging tasks. The best reward will be a successful congress which cannot be rolled without participants. For that reason, I would like to invite you all to come to Gdańsk.

How could your organization address the challenges facing the road sector?

In Poland, road infrastructure has been currently very intensely developed. Since 2007 we have constructed more than 3,000 kilometres of high-speed roads. Nevertheless we are not focused only on construction. We are open to new projects in ITS sector, road maintenance or asset management.

Our cooperation with road private sector as well as with other partners as research institutes and technical universities give us broad scope of knowledge on current trends and challenges, not forgetting international cooperation.

What do you hope to achieve in the future?

I hope that my expertise in international relations within road sector will be useful and utilized in coming transport branch projects. I look for the future not only with confidence, but also with curiosity what it can bring.

In your view, what could your organization do to attract a greater number of young professionals?

I believe that public sector in Poland is becoming more and more popular and attractive. It is important to present it not only as a stable and reliable employer but also as a place which offers opportunities for personal development and career. We are attracting more and more young engineers which are choosing public sector instead of private. That makes our organization stronger.#

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The 15th International Winter Road Congress in Gdańsk: A sneak preview of paper content

Didier Giloppé, Expert in Winter Road Service, CEREMA, France
Chairman of the World Road Association Technical Committee B.2 *Winter service*

Illustration Fotolia © Pictures news

Every four years, the culmination of activity sponsored by the World Road Association Technical Committee B.2 *Winter service* is showcased on the stage of an international Congress, with the next one scheduled for February 20th through 23rd in Gdańsk (Poland). According to the Association's 2016-2019 Strategic Plan, this Committee is tasked with spearheading Congress preparation activities, in particular by defining its scientific and technical program, evaluating abstracts and full papers, and lastly organizing and coordinating technically synchronized sessions, while not overlooking production of the Snow and Ice Data Book.

Many countries are not presently focusing on road network expansion or densification, but instead on resource optimization and use of existing networks. Such a shift in approach requires constantly improving both organizations and practices. The provision of winter road services is highly dependent on the organizations already in place given that such services cannot be easily scheduled in advance. These considerations become more pressing as climate change results in extremely volatile winters or winter weather patterns, between heavy snowfall and, in contrast, a complete absence of any road-related weather event.

Winter road service affects a large number of activities and practices; the field is relatively complex and the topics requiring attention, when assembling a Winter Road Congress, are in no short supply. The scientific program adopted for the Gdańsk gathering is aimed at responding to the ever-increasing concerns exposed above. The overarching Congress theme, namely *"Providing a Safe and Sustainable Winter Road Service"*, seeks to address this complexity in light of the need to reconcile promoting economic development, heeding society's demands and protecting the environment.

The road remains a pivotal economic driver, and the demand for mobility is continuously rising; should the resources allocated be extended even further to satisfy these needs or, on the other hand, should answers be sought through developing multimodal approaches? How about altering our modes of consumption and pursuing lifestyles that generate fewer trips and rely less on transportation services? How should extreme conditions and climate change be handled? What's the best way to assimilate and better utilize the vast quantity of information at our disposal? Which facilities and products are best suited to the various contexts encountered? What is an appropriate response to issues surrounding the urban setting and road safety? Lastly, which directions will the management and planning of future winter road service take?

Such are the underlying questions that to a large extent will permeate and trigger discussion at all Congress technical sessions. The numerous papers received will, at least in part, offer leads on how best to move forward.

Nearly 300 abstracts originating from across the world have been submitted to the World Road Association's 2018 International Winter Road Congress (15th edition), targeting the eight topic areas. Among these submissions, the some 150 papers accepted specifically address the proposed themes. As a sneak preview, this issue of Routes/Roads is pleased to provide you with a few *"selected highlights"* extracted from longer articles.

We hope that these initial presentations will spark great interest; we hope you will enjoy reading these excerpts and wish you a productive Congress!#

Managing the Risk of Avalanches on the Road

Andrés Olloqui, Director of the Aragnouet-Bielsa Tunnel Consortium (Spain)

Illustrations © Author

Andrés Olloqui

Illustration 1 - View of the Aragnouet-Bielsa Highway

THE ARAGNOUET-BIELSA TUNNEL CONSORTIUM AND FACILITY ACCESS

The Franco-Spanish consortium responsible for the Aragnouet-Bielsa Tunnel was created on June 2nd, 2008, as enshrined in the Bayonne Treaty signed between the Aragon Government (Spain) and France's Upper Pyrenées Department. This entity conforms to a unified binational policy dictating maintenance and winter service on a cross-border itinerary through the heart of the Pyrenées range, at a maximum elevation of 1,880 m, hence exposed to the risks typical of high mountain roads. This highway connection, including the tunnel and all access routes, is managed under an operations and maintenance agreement signed with the contractor Ferroser in November 2012.

The Consortium's geographic coverage spans the Aragnouet-Bielsa Tunnel (3,070 m long, split 1,710 m on the French side and 1,360 m in Spain), plus its access routes: 4.5 km of Spanish Highway A-138 (peaking at 1,664 m), and 6.1 km of French Highway RD-173 (reaching 1,821 m). As a high mountain road, this connection is subject to heavy snowfall in winter *(illustration 1)*.

For example, between the winters of 2014-15 and 2016-17, this section of road was the scene of up to 88 avalanches, 24 of which were triggered preemptively by GAZEX (27%), in conjunction with road closures, 50 fell onto a road already closed due to avalanche risks (57%), 12 fell while the road was still open to traffic (14%), and 2 unexpected avalanches forced road closures (2%).

LOCALIZED PREDICTION OF THE AVALANCHE RISK

Basic information

For a number of years, the French company RTM (acronym for the Restoration of Mountainous Terrain) conducted monitoring campaigns focusing on tunnel access, in the aim of **defining the avalanche-prone slopes**, as well as to determine the history of avalanche slides and produce a Localized Prediction of the Avalanche Risk (known as PLRA).

This mapping exercise, *illustration 2,* is performed between November 1st and April 30th by snow removal teams, who inform the Road Maintenance Manager of any observed snowpack movement, in indicating the approximate size and applicable slope number. The manager also combs the Consortium zone at least 4 times a day, using a monocular to survey the load carried on avalanche-prone slopes and any formation of snowdrifts. This information is then relayed to the Head of Operations, the Consortium Director and to the snow expert tasked with overseeing PLRA risk prediction.

This expert's role is to permanently collect information uploaded to the Internet by the Consortium, i.e.:

- information from two weather stations installed along access routes on both sides of the tunnel;
- information from Météo France's *"Nivôse Aiguillettes"* station (part of the agency's *"Nivôse"* mountain network), located at an altitude of 2,130 m on the northern tunnel entrance;
- information delivered from the «*Nivexc*» weather masts, placed on slope 17 (French side) and slope 15 (Spanish side);
- forecast output by Météo France Agency's *"Prévi-expert"* service;
- the Météo-Group forecast and descriptive weather bulletin.

Snow coring and PLRA weather bulletins

Every Friday during the winter period, this snow expert visits the «*Nivôse Aiguillettes*» weather station (on the French side) and the base of slope 15 (Spanish side) to p**erform snow coring** *(illustration 3)* and **collect field observations**, prior to stating an opinion on the risk of an avalanche falling onto the road.

Sharing of PLRA prediction results and road closure decision

The snow expert is responsible for submitting periodic PLRA bulletins to the Consortium Director, as well as to the Head

Illustration 2 - Mapping of avalanche-prone slopes on both the Spanish and French sides

of Operations for Ferroser and the Aragnouet Mayor's Office (France). With the French side being more heavily exposed to snowfall, thus exposed to a higher risk level, the Aragnouet City Hall issues the order to close Highway RD173 so as to guarantee the safety of travelers and goods. The Upper Pyrenées Prefect may act on the Mayor's behalf to order facility closure. Once such an order has been announced by the Mayor, the road will only reopen upon consensus reached at a meeting convening the Mayor, the Consortium Director, the snow expert and the High Mountain Gendarmerie Office. On the Spanish side, the Consortium Director alone is responsible for closure with an elevated risk of an avalanche falling onto the road.

Illustration 3 - Snow coring performed by the snow expert

THE PIDA PLAN: EMERGENCY RESPONSE AND AVALANCHE TRIGGERING

PIDA plan activation on France's Highway RD173

The Aragnouet Mayor's Office has implemented an emergency response plan that calls for triggering avalanches (labeled «*PIDA*»), with backing by the Consortium.

This PIDA Plan imposes closure of the French road once snowfall accumulation exceeds 30 cm at the Nivôse Aiguillettes station, enabling initiation of a procedure called GAZEX (oxygen and propane exploding through stationary guns), *illustration 4,* as soon as RD173 has been cleared of all vehicles. The Road Maintenance Manager then authorizes the Head of Operations to launch the 7 GAZEX installations on French slope no. 17, which is the most mobile.

Upon each blast, the Head of Operations uses a **land telescope** to verify the state of the snowpack; these observations are instantaneously relayed to both the Consortium Director and snow expert.

Based on the expert's recommendation, the Aragnouet City Hall may elect to proceed with a grenade launch from a helicopter in order to clear the most prone slopes along the RD173 of their accumulated snow. The municipality is responsible for the explosives and launching service, while the Consortium handles the requisite helicopter rental. It should be noted that this procedure is not authorized on the Spanish side.

The Spanish PIDA Plan in effect on Highway A138

Under typical conditions, the **avalanche risk is initially detected north of the tunnel**, in the more heavily exposed French territory, and Spanish authorities simply follow the protocol dictated upon PIDA activation by the Aragnouet City Hall. However, during strong thunderstorm activity originating from the south, this risk might arise first on Spain's A138 Highway.

In such a case, the **PIDA stipulates that**:

- the Head of Operations may unilaterally make the decision to close the road should the avalanche risk

Illustration 4 - A GAZEX gun and analysis of the results

Illustration 5 - The Daisybell and helicopter deployed

Illustration 6 - A variable-message sign installed on the French side

seem particularly high, while awaiting validation by the Consortium Director (or, otherwise, deferred to the Aragon Regional Roads Director);

- weather permitting, a flyover in a helicopter equipped with a Daisybell system (and an onboard Gazex gun) allows conducting blasts on the Spanish slopes, in the aim of removing the snow load and artificially producing an avalanche on the road.

For the time being, the Consortium is leasing the Daisybell, *illustration 5,* to carry out this procedure, but a system purchase has been anticipated within the scope of the European project SECURUS 2 (dedicated to highway protection against natural hazards) for improved responsiveness. Use of the acquired Daisybell would be overseen by Aragnouet's PIDA Plan.

USER INFORMATION

Information dissemination is fundamental to any plan intended to prevent traffic disruptions due to avalanches. Included herein is an entire sequence of systems, encompassing: variable-message signs all along the tunnel approach route, *illustration 6*, information campaigns stressing video surveillance, vigilance regarding engine temperature during the summer, and radar speed controls. This panoply is naturally complemented by a website ***(www.bielsa-aragnouet.org)***, providing users with real-time updates and forecasted road conditions, plus a Twitter presence ***(@BielsaAragnouet)*** and access to phone or radio messages while in the tunnel.

MANAGING SNOW REMOVAL CREWS

Planning work shifts around weather forecasts

The work schedules for snow removal crews are set 48 hours ahead of time in accordance with weather forecasts posted by both Météo-France and Météo-Group specially for the Consortium. This weather-based scheduling allows us to generate considerable savings on winter maintenance costs since the concessionaire Ferroser is only paid for the actual amount of time removal crews and snow plows are operating. If the announced snowstorm fails to materialize, the Consortium still pays the cost of labor (reassigned to other road maintenance tasks) but not the hourly snow plow rate.

Safety systems in place for snow removal crews

Snow removal crews can find themselves in vulnerable situations, particularly when the risk of an avalanche falling reaches at least 3 (on a 5-point scale) or when clearing a road at the time of a closure. Both equipment quality and level of training must ensure mitigation of any potentially fatal hazard. All personnel are thus fitted with an avalanche beacon, while snow plow cabs contain air recirculation systems, *illustration 7,* offering a 60-minute air supply inside the plow while awaiting rescue.

Training

The Consortium Director, Facilities Manager and Road Maintenance Manager all receive basic training for working in a snowy environment, *illustration 8, next page,* in order to better understand avalanche dynamics as well as the measurements and observations produced by the snow expert and removal crews. Moreover, all Consortium and Ferroser personnel are trained in emergency response, use of the semi-automated defibrillator and mountain rescues, assisted by the High Mountain Gendarmerie Squad from the Upper Pyrenées Department.

Illustration 7 - Air recirculation systems

Illustration 8 - Emergency response training in the high mountains

Illustration 9 - An avalanche falling onto the road pavement

Road operations during closures

Once an access highway has been closed by order of either the Aragnouet Mayor's Office (French side) or the Consortium Director (Spanish side) due to an avalanche risk, no vehicle is allowed to travel within the Consortium's jurisdiction, covering highways A138 (5-km stretch) and RD173 (6 km), except for the Consortium's special snow removal units.

To increase crew member safety, road cleaning operations will only start up 24 to hours after closure, providing a sufficient lapse of time for the avalanche to slide naturally, *illustration 9*.

Snow removal begins on the **Spanish side**, *illustration 10,* where snowfall is less intense and the avalanche risk smaller. The Road Maintenance Manager, accompanied by the Consortium Director, is behind the wheel of the lead snow plow so as to **assess the state of the avalanche-prone slopes,** in relying on land telescopes and their knowledge of snow conditions. Their observations are shared with the expert to better evaluate the risk level.

Illustration 10 - Snow removal on the southern side

Up to 4 plows can be deployed along with a charger at any one time; such resources are normally adequate to clear the road before reopening, once the risk has returned to an acceptable level.

CONCLUSION

The Aragnouet-Bielsa Tunnel Consortium's jurisdiction comprises high mountain roads subject to heavy snowfall, giving rise to a distinct risk of an avalanche falling onto the road. Consequently, the safety measures adopted must be commensurate with the natural risks threatening road users and winter maintenance personnel.

A number of specific work procedures were thus required, namely:

- instituting a Localized Prediction of the Avalanche Risk (PLRA) function, based on observations logged by winter maintenance crews and a staff snow expert;
- establishing plans for Emergency Response and Avalanche Triggering (PIDA) that assign responsibilities for road closure and action levels depending on circumstances and risk present;
- informing users by various means of road conditions and the status of closures;
- training snow removal crews in emergency response and the basics of mountain rescue;
- scheduling snow removal work shifts in accordance with weather forecasts;
- evaluating the existing protections in place against avalanches and setting up a protection works program, featuring both active and passive measures, to target avalanche-prone slopes.

In conclusion, the science of snow behavior is inexact yet has made tremendous strides over the past few years. While a risk-free environment can never exist, still the measures introduced above do reduce this risk for both users and road maintenance personnel.#

Use of the Pikalert® System in the Wyoming Department of Transportation Connected Vehicle Pilot Deployment

Amanda Siems-Anderson, **Gerry Wiener**, **Thomas Brummet**, **Seth Linden**, **William Petzke**, **Padhrig McCarthy**, Research Applications Laboratory, National Center for Atmospheric Research, Boulder, Colorado,
Vince Garcia, **Ali Ragan**, Wyoming Department of Transportation, Cheyenne, Wyoming,
Tony English, Trihydro Corporation, Fort Collins, Colorado,
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WYOMING AND THE CONNECTED VEHICLE PILOT DEPLOYMENT

Weather Challenges in Wyoming

Rural Wyoming is strongly impacted by hazardous weather along its road network. Interstate 80 (I-80) is a major highway that runs west to east along the southern part of the state, which is located in the Northern Rocky Mountain area of the U.S. *illustration 1*. The entirety of I-80 in Wyoming is over 1,800 meters in elevation, with a maximum of 2,633 meters. This elevation and Wyoming's continental, northerly climate lead to extreme weather along I-80 throughout the year.

The location of I-80 in Wyoming means this corridor is a major throughway for freight traffic and travelers, as it connects the West Coast of the U.S. to the eastern regions of the country. Many drivers are not local and are unfamiliar with the typical weather in Wyoming, leading to weather-related crashes. These crashes can be large and high profile, such as a 65-vehicle pileup crash on I-80 on 16 April 2015. The majority of vehicles involved in this crash were commercial trucks (lorries).

Many areas of the U.S. receive significant snowfall, but Wyoming's terrain lends it to high speed winds that result in severe cases of blowing snow and vehicle blow overs. The Wyoming Department of Transportation (WYDOT) has already taken significant steps to address these conditions and keep the roads in their state safe and open. Some of them may be solved by filling in the gaps between the Road Weather Information System (RWIS) stations and snowplow operator reports and improving the latency of receiving and transmitting hazard information to drivers en route on I-80. This is where the WYDOT Connected Vehicle (CV) Pilot Deployment fits in.

Illustration 1 – Location of the State of Wyoming (blue) in North America

The Connected Vehicle Pilot Deployment

In 2015, the U.S. Department of Transportation (USDOT) awarded grants to three sites (New York, Tampa, and Wyoming) to apply the years' worth of CV research into their operations. The Wyoming site uniquely focuses on freight vehicles and the impact of weather on traffic along I-80. Through developing applications using Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) technology, the WYDOT CV Pilot will integrate with existing traffic management centers (TMC) operations to support several services such as advisories, roadside alerts, and travel guidance.

The WYDOT CV Pilot consists of three levels of vehicle integration. About 100 of the participating vehicles will be fully equipped with an On-Board Unit (OBU) for communication and an external sensor package for weather observations. These vehicles are mostly snowplows, though may include other WYDOT-owned vehicles. The OBU will be able to send and receive Basic Safety Messages (BSM) to/from the Road Side Unit (RSU), of which about 75 will be installed along I-80. The less-integrated system will compose of about 150 commercial trucks that heavily use I-80. These vehicles will be equipped with an OBU for sending/receiving BSMs, but will not have additional instruments for sensing weather. The most basic system, consisting of another 100 to 150 vehicles, will be able to receive traffic

information messages (TIMs) that have been enhanced by CV data through a satellite connection.

THE PIKALERT® SYSTEM

The Pikalert System is a collection of modules designed to ingest and quality check vehicle-based observations, and to assess, forecast, and disseminate road weather hazards and warnings. By melding vehicle observations with traditional ancillary observations (e.g., weather radar, RWIS stations), Pikalert uses CV to fill in the gaps between RWIS stations and other ground observations to assess hazardous weather at a fine temporal and spatial scale.

The Vehicle Data Translator

At Pikalert's core is the Vehicle Data Translator (VDT), which ingests and quality checks CV data. These data may include typical weather observations such as air and road temperature or relative humidity, but may also include vehicle-specific relevant data like wiper blade speed and Anti-lock Braking System (ABS) status. Some elements (e.g., air temperature or wiper blade speed) are native to the vehicle and may be accessed via the Controller Area Network (CAN)-bus port. Others (e.g., relative humidity or road temperature) may be measured by external sensor packages. Once these data sets are ingested by the system, they are assigned to user-configured road segments based on Global Positioning System (GPS) location and timestamp. Ancillary weather observations are also assigned to the road segments by location and timestamp.

The Road Weather Hazard Module

The road segment statistics, along with the results of the quality checking algorithms, are output and may be used in any user application. The road segment statistics may also be passed into the Road Weather Hazard module (RWH). The RWH consists of four major algorithms (precipitation, pavement condition, visibility, and blow over) that meld the CV observations and ancillary weather data to determine current and forecast road weather conditions.

Current Condition Hazard Assessment Algorithms

The precipitation algorithm, consisting of precipitation type and precipitation intensity, evaluates current precipitation conditions. The current air temperature (either CV-reported or from a nearby surface station/background model) and hydrometeor identification from dual-polarization radar are used to assess precipitation type. Based on that type, radar reflectivity, nearby station weather, and dewpoint depression are used to determine intensity. Once an initial intensity is assigned, CV data are used to refine the assessment using wiper blade speed, headlight status, and vehicle speed relative to the speed limit. Precipitation type outputs are no precipitation, snow, rain, or icy mix, and precipitation intensity outputs are no precipitation, light, moderate, heavy, or road splash.

The pavement algorithm uses the output from the precipitation algorithm along with road surface temperature (either CV- or surface station-based) and RWIS station-observed road condition to determine whether the road surface has been impacted or is dry. A separate algorithm using fuzzy logic calculates whether or not the pavement is slick using ABS/traction control/stability control status, yaw rate, and the pavement condition previously assessed. The outputs are dry, wet, snowy, icy, or hydroplaning risk and a yes/no slickness flag.

Visibility is assessed in two parts. First, the output from the precipitation algorithm is used to determine if precipitation is negatively impacting visibility. Heavy rain, heavy snow, and blowing snow are possible outputs. If no precipitation is affecting visibility, then a fuzzy logic algorithm using relative humidity, headlight status, nearby surface station visibility and weather, and vehicle speed relative to the speed limit determines whether or not fog is occurring. If no hazards are identified, the output is *"normal visibility"*.

Specific to the WYDOT CV Pilot, a blow over risk algorithm was developed. The algorithm consists of three sets of fuzzy logic weights and functions using nearby station-observed wind gusts, sustained wind speed, orientation of the wind direction to the roadway, and whether or not the pavement algorithm analyzed slickness for three different vehicle types (high profile heavy, high profile light, regular passenger). The output is an interest value between 0 and 1, where 0 is no chance of a blow over and 1 is high risk of a blow over. If the interest value is above 0.6, the algorithm assesses a blow over risk for the given vehicle type.

Forecast Hazard Assessment Algorithms

The Road Weather Forecast System is used within Pikalert to provide road weather-specific forecasts for the RWH as well as other Pikalert modules. The RWFS is a point-based consensus forecasting system that may be run at the midpoint of each Pikalert road segment. It works by ingesting forecasts from multiple Numerical Weather Prediction (NWP) models, then producing a consensus via a series of weights. The weights are determined by verification of each NWP model against previous observations of the past week, giving more weight to better performing models. The result is a point forecast with a higher accuracy than any individual NWP model that fed into it.

The Road Weather Alert Module

While the RWH provides weather assessments and forecasts, many of the weather output types (e.g., light rain) are not particularly hazardous and may not be of interest to the user. The Road Weather Alert (RWA) module converts the RWH output into alerts of various intensity (clear, advisory, warning) and provides messaging to accompany the hazard. *Illustration 3* is an example RWA alert via a phone application and the accompanying configuration.

Pikalert Applications: Enhanced Maintenance Decision Support System and the Motorist Advisory and Warning System

The VDT, RWH, and RWA make up the core of the Pikalert system and are the main modules to be used as part of the WYDOT CV Pilot. Two additional applications that include web-based displays: the Enhanced Maintenance Decision Support System (EMDSS) and the Motorist Advisory and Warning System (MAW), will be discussed briefly. The MAW functionality via RWA output and internal use of the EMDSS display are part of the WYDOT CV Pilot.

EMDSS

The MDSS combines the RWFS and the Model of the Environment and Temperature of Roads (METRo) to produce both forecasts of road weather conditions and winter maintenance treatment recommendations. These recommendations aid maintenance managers and other personnel in decisions including treatment type, timing, location, and rate of application.

The EMDSS builds on the traditional MDSS by filling in the gaps between RWIS stations. By using CV data and Pikalert segment-based forecasts, the EMDSS provides high resolution forecasts and treatment recommendations that benefit from the incorporation of CV data.

MAW

The MAW provides a link between the RWA and the end user by providing Pikalert output via a web-based display and a phone application. Via the web-based display, the user may check current and forecast travel hazards along their route during their period of travel. While on the road, the phone application compares the user's GPS location to Pikalert road segments, and an automated voice alerts the driver if they are approaching a hazardous stretch of road.

Illustration 2 – Interstate 80 (I-80), Wyoming

Web Display

Pikalert output is available for use in existing user display applications. The main Wyoming display is shown in *illustration 4*. The display includes options in the upper left to choose current (Obs) or three forecast windows of hazards, which appear in increasing order of severity as green, yellow, and red shading on Pikalert segments. A radar mosaic is overlaid to provide situational awareness and may be looped. RWIS stations locations are shown as triangles and also have hazard assessments through 72 hours.

Clicking on a road segment on the main map in *illustration 6, next page,* will allow a user to view the 72 hour RWFS forecast for that segment. The forecast variables displayed are snow accumulation on the roadway, probability of precipitation and type (rain, snow, or ice), road, air, and dewpoint temperature, and wind speed and direction. An alert summary at the top shows the level of hazards expected for the segment.

Illustration 3 – An example application of the RWA

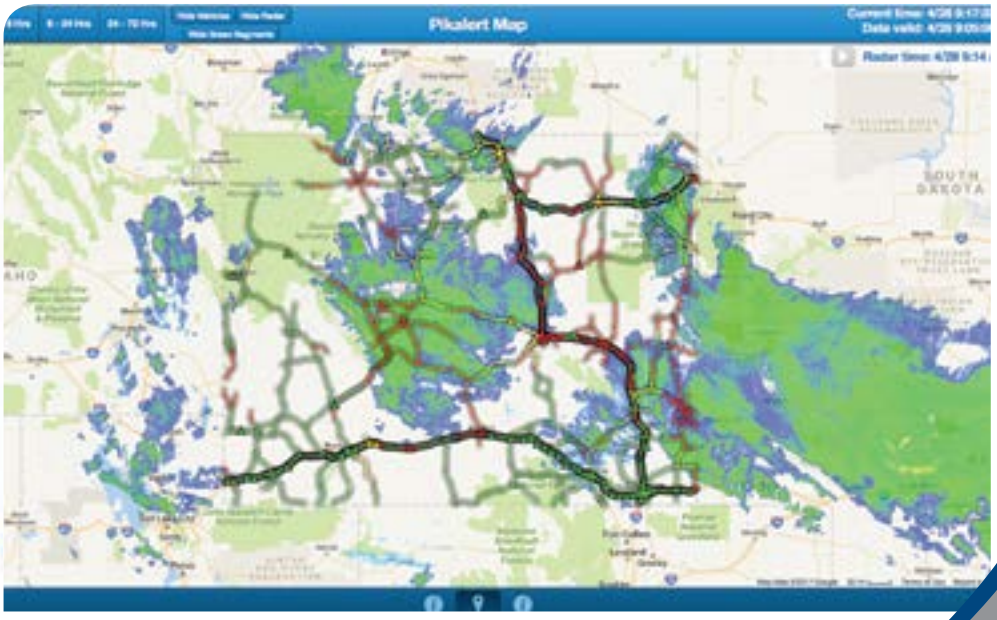

Illustration 4 – Main Pikalert web-based display for Wyoming

Illustration 5– Interstate 80 (I-80), Wyoming

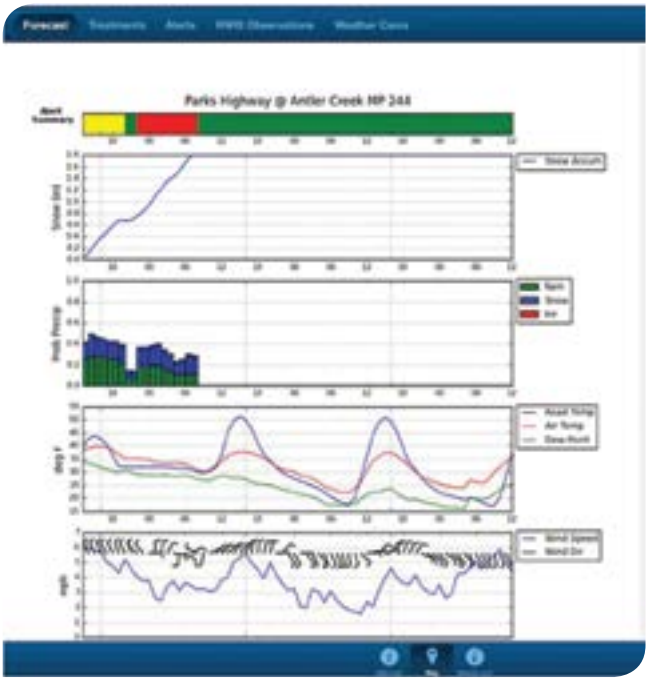

Illustration 6 – Example forecast display

PIKALERT IN WYOMING AND BEYOND

Pikalert will serve as the main engine for ingesting and quality checking CV data, then translating that CV data into relevant hazards and actionable messages for the WYDOT CV Pilot. Along with inclusion in specific pilot applications (i.e., a Spot Weather Impact Warning application) that will feed hazard information directly to a user, the wider WYDOT system will benefit from Pikalert through its high-resolution hazard assessments and forecasts. Pikalert will help inform the setting of VSL zones, development of TIMs in the TMC, and population of WYDOT's transportation weather and hazard web page. Meteorologists in the TMC may also use the Pikalert output to auto-populate their forecast software, then use their expertise to adjust the forecasts as required before dissemination.

Pikalert is an open-source application that is currently available on the USDOT's Open Source Application Development Portal (OSADP; ***http://www.itsforge.net***). All code developed as part of the WYDOT CV Pilot, including the blow over algorithm, will be open source and available through the OSADP as well. Information about downloading, installing, and using the Pikalert software may also be obtained by contacting the author.#

Climate Change and Adaptation Needs for Road Infrastructure in Indian Himalayan Region

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Illustrations © Authors


Indranil Bose


Aditi Paul

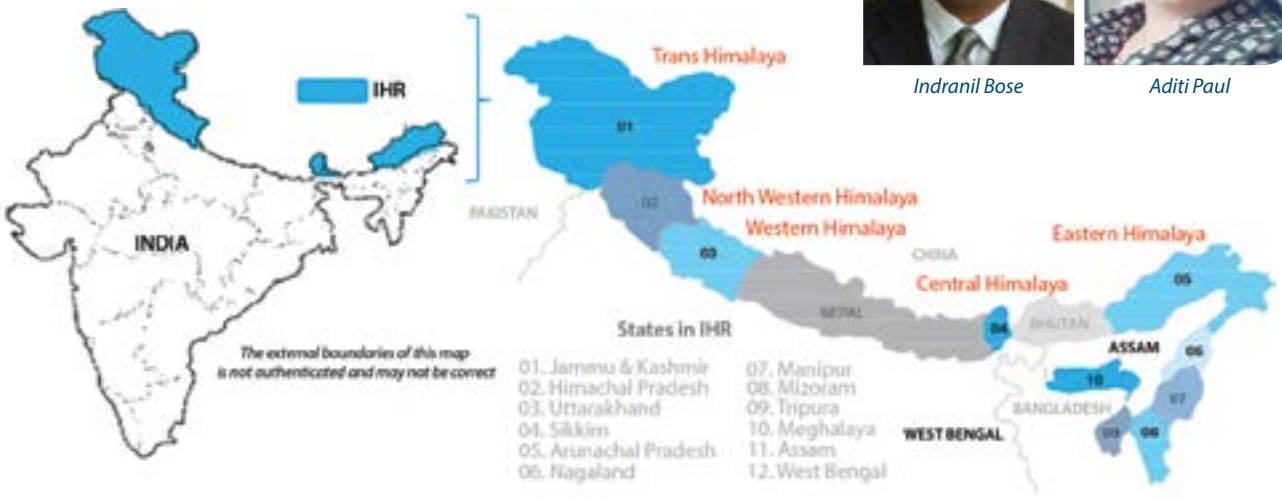

Illustration 1 - Indian Himalayan Region (IHR)

Heavy snowfall in several parts of Indian Himalayan Region (IHR) during current winter throws normal life out of gear with roads and residential utility services getting mostly affected. The challenges of winter commuting for the people living in IHR is even more acute owing to its terrain, lack of adequate winter maintenance infrastructure and early-warning system leading to limited social and economic development. Several of the mountain passes, access roads to high-altitude villages, pilgrimage sites remain closed to car traffic during winters. In this context, climate proofing of the road infrastructure in terms of planning, designing and road asset management with advanced road weather information system has become essential.

The Himalayan mountain ranges—extending 2,400 km through six nations (India, Pakistan, Afghanistan, China, Bhutan, and Nepal)—make up the largest cryosphere region and fresh water sources outside the poles.

IHR has a very large area experiencing seasonal snow cover and permanent snow-bed mainly at higher altitudes (anything above 4,000-4,800 m), exposure to snow-related hazards and traffic challenges are mainly reported from Western Himalaya (WH) of IHR, since three large States located there are frequented by a floating population for both eco-tourism and pilgrimage attraction. As roads run through high altitudes ranging between 2,400 m to 6,000 m, steep terrains, snow belts experiencing extreme climates and avalanche prone slopes, they normally remain closed during winter season for five to six months (November to April) due to heavy snowfall.

The national government has launched all-weather-road connectivity programmes in this region, supporting safe pilgrimage, enhancing tourism and thus economic developments of the hills. With a substantial number of large multi-million invested road projects being launched in the region, an essential question remains whether these projects are entirely climate compatible and will be able to provide safe travels.

GEOGRAPHICAL, TERRAIN AND SOCIO-ECONOMIC SETTINGS OF WESTERN HIMALAYA

The area falling under WH extends from 31°N to 36°N latitudes, 73°E to 80°E longitudes and between altitudes of 2,000 m to 7,000 m, as shown in *table 1, next page*.

Lower Himalaya is a zone of warm temperature, higher precipitation and short winter periods of three months. The precipitation is generally concentrated between December to March with periods before and after experiencing wet snow precipitation and rains. The avalanche activity in this region is quite high with peak winter avalanches being moist slab avalanches and late winter avalanches being spring thaw avalanches containing snow, mud and stones. Middle Himalaya is characterized by high mountain peaks and numerous glaciers. Severe avalanche activity is reported in this zone from drift loaded slopes. This zone is sparsely populated for being rugged, cold and mostly glaciated.

The third upper climatic zone comprises Zanskar, Ladhak and Karakoram ranges, housing some of the longest glaciers of the world. The snow is dry and bonds poorly with glaciated surface and old snow and this generally results in avalanches with 30-40 cm of fresh snow. This part of Himalaya is very thinly populated with climatic conditions at some places in winter close to polar conditions.

ROAD CONNECTIVITY IN IHR & INSTITUTIONAL ARRANGEMENTS

Currently, two national government-owned organizations play a vital role in providing road connectivity in the entire

TABLE 1 - TERRAIN AND METEOROLOGY OF WESTERN HIMALAYAS

Factors	Lower Himalayan	Middle Himalayan	Upper Himalayan
Terrain			
Altitude	3,200 - 4,100 m (76%)	3,500 - 5,300 m (100%)	5,000 - 5,600 m (100%)
Slope	30 - 38 (64%)	32 - 40 (100%)	28 - 32 (100%)
Ground	Tall grassy cover	Scree and boulders	Rocky scree and glacial
Meteorology			
Snowfall	20 - 80 cm (56%)	20 - 80 cm (81%)	10 - 20 (51%)
Average Yearly Snowfall	15 - 18 m	12 - 15 m	7 - 8 m
Temperatures (°C)			
Highest Max	20.2 °C	14.5 °C	9 °C
Mean Max	6.8 °C	0.96 °C	-8.1 °C
Mean Min	-1.6 °C	-11.3 °C	-27.7 °C
Lowest Min	-12 °C	-25.4 °C	-41 °C

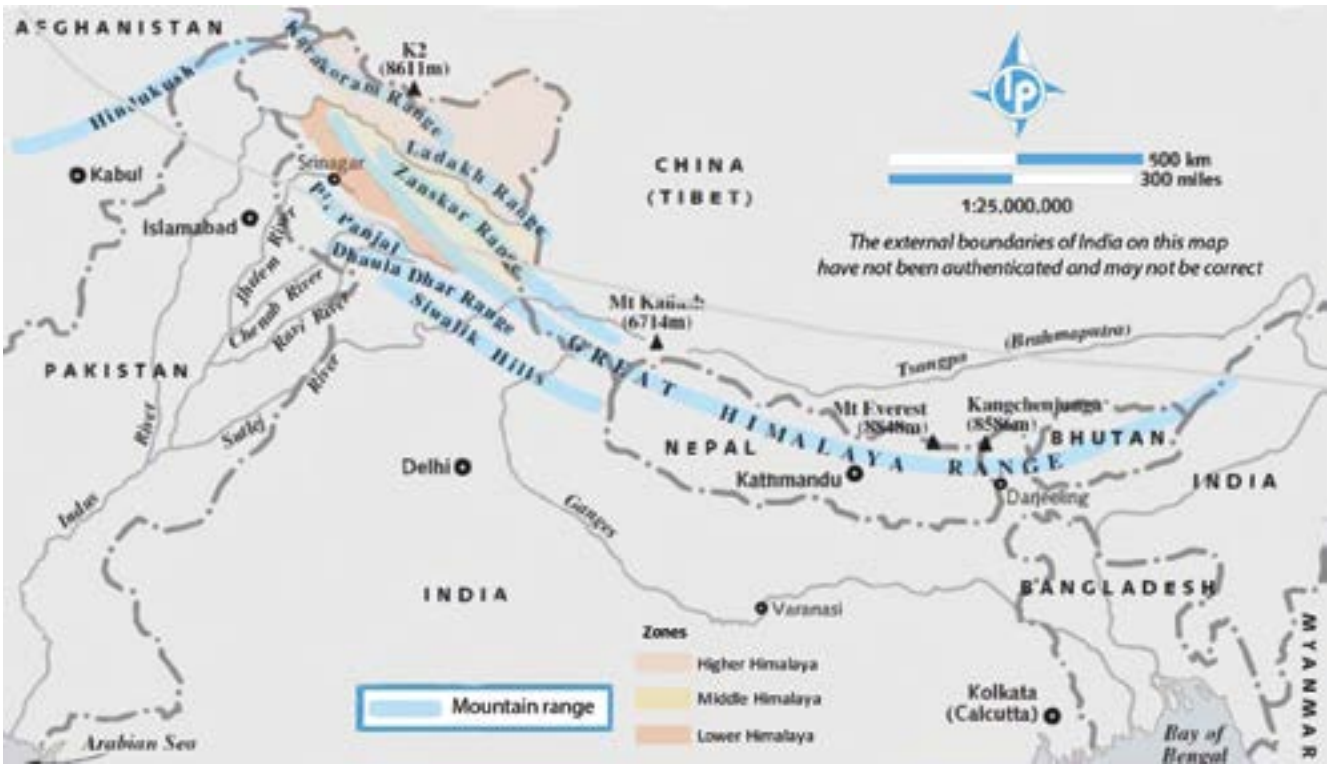

Illustration 2 - Mountain range and Himalayan Regions
© Lonely Planet Guide and secondary research

Illustration 3 - State-wise km of roads in IHR under BRO
© BRO Website (Statistics as on 31st December 2016)

IHR, i.e. Border Roads Organization (BRO) and National Highways and Infrastructure Development Corporation Ltd. (NHIDCL) and both of these agencies primarily manage National Highways. The state and rural roads are managed by respective States.

Border Roads Organization

BRO, under the Ministry of Defence, was established in 1960 to secure India's borders and develop infrastructure in remote areas of the North and North-Eastern states of India. It manages more than 30,000 km of road network out of which 23,400 km lie in the IHR.

While all national highways and strategic roads sharing international boundaries were developed and maintained by the BRO, currently maintenance of such roads with no defence importance are being entrusted upon NHIDCL.

National Highway and Infrastructure Development Corporation (NHIDCL)

NHIDCL is a fully owned company of the Ministry of Road Transport & Highways (MoRTH), set up in 2014 to improve connectivity in the north-east region and border areas. As of July 2017, NHIDCL is entrusted with more than 10,945 km of road projects of which 8,796 km of the network are in IHR.

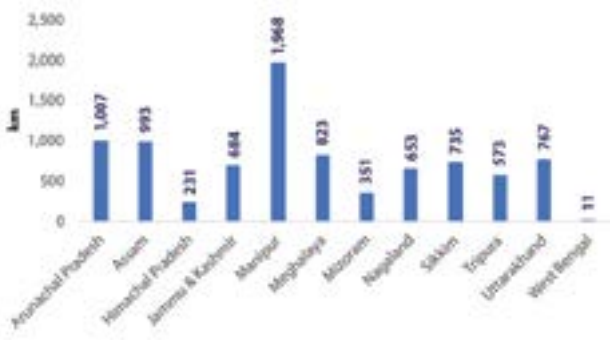

Illustration 4 - State-wise km of roads under construction in IHR by NHIDCL
© NHIDCL Website (Statistics as on 31st July 2017)

State Road Agencies

Besides the two national organizations, State road agencies - Public Works Department (PWD) or Roads & Buildings Department at sub-national level are responsible for development and management of state, other categories and rural road networks. Rural connectivity in India is also covered under the national programme Pradhan Mantri Gram Sadak Yojana (PMGSY) launched in 2000 aimed for providing all-weather-roads to every rural habitation of population 500 or more located in plains and 250 plus at the hilly states, tribal districts and desert areas.

WINTER ROAD MANAGEMENT- CURRENT SCENARIO

Roads in altitudes above 2,400 m

A large part of the road network in IHR track at altitudes ranging between 2,400 m to 6,000 m. Most of these roads are above the tree line. The soils in these areas are mostly of glacial origin and consist of metamorphosed, stratified and schistose rock formation which disintegrates under extreme weather conditions. Many of these routes go through high mountain passes with altitudes over 3000 m, having snow 8-10 months and risk of avalanche generally triggered during winters and thawing season during spring. Passes in Western and Eastern Himalayas remain mostly closed during the winter season (November to April) while few are kept open for defence supplies, but closed for civilian purposes.

Roads in Altitude below 2,400 m

Most of the population in the IHR lives in altitudes below 2,400 m; this region falls

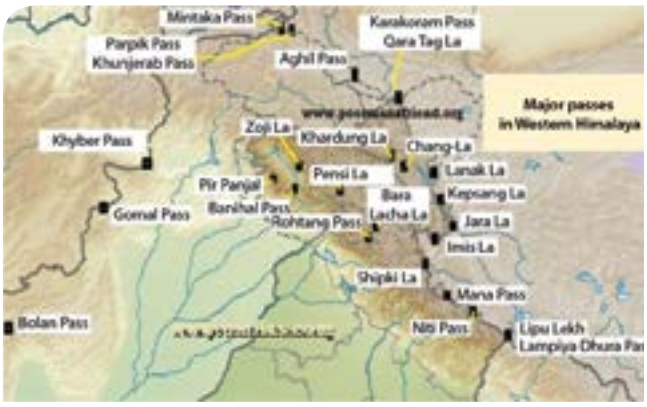

Illustration 5 - Major passes in Western Himalaya

Illustration 6 - Major passes in Eastern Himalaya

within the treeline and is all-weather accessible. The seasonal snowfall is primarily witnessed in this region during the winter months from January to March. During the winter season, there are instances of heavy intensity of snowfall spread over a couple of days, snow sleets, rainfalls which trigger natural hazards like snow accumulation on road pavement before it could be cleared, slippery roads from melting snow freezing on road surface during night from sub-zero temperature and events like landslides. The State Road Agencies like PWDs are primarily responsible for operation and maintenance of the state highways and other lower categories road; they are required to make advance planning for winter road management and provision of budget for the same.

With the climate change, winters in lower Himalayas do register snows as well as high intensity rainfall. Such rainfalls also trigger natural hazards like landslides, which are already a regular feature along these roads on many of the perennial landslide zones, during monsoon months (July to September) with huge socio-economic impact.

WINTER ROAD MANAGEMENT IN IHR: KEY ISSUES, CHALLENGES AND LIKELY SOLUTIONS

Policy

There is a lack of comprehensive winter road management policy in India that could bind all high-altitude roads, demanding year-long connectivity to be maintained and managed applying best practices of road-safety and environmental protection. There is no such guiding policy for national and or State highways. While programmes like PMGSY takes a holistic view of the need to provide all-weather road connectivity to civilians, this programme focuses on rural/ village roads whose yearlong connectivity at elevation above 3000 m will always remain a challenge.

Regulations

The major challenges of winter operations at high-altitude road network is ensuring traffic safety. Unlike various European nations, India currently doesn't have regulation/ legislation that mandates use of safety measures such as winter tyres at high altitudes during snow season. Besides, Western Hymalaya (WH) being a popular tourist zone, vehicles moving from plains with inadequate preparation is likely to cause traffic disturbances unless mandated/ certified for training for all drivers driving in these terrains. IHR being an eco-sensitive region, use of excessive salt, brine, and other anti-icing/de-icing chemical agents for winter operations also needs careful consideration. Use of sand and ballast for anti-icing seems to be cheapest solution at this stage, however such materials are required to be recycled to the extent possible for resource efficiency which on the hind-side makes it a costlier affair.

Institutional

Historically, the Border Road Organization (BRO) has been the key central agency responsible for managing snow bound roads in IHR. The institutional knowledge of winter road management in IHR thus remains with BRO. Recently, responsibilities for managing civilian roads and defence roads have been bifurcated between NHIDCL and BRO respectively. NHIDCL being a new incorporated body is less likely to have historical learning of managing winter roads. Further, there are institutional gaps in communicating extreme weather conditions. As these roads have been traditionally operated and maintained under defence requirement, such communication channels are well established within defence bodies. The same needs to be inculcated with new bodies like NHIDCL as well as State administration and Police.

Financing

There is significant cost involved in restoration of roads damaged whether by snow accumulation, snowmelt-runoff/thawing, avalanches, landslides and mudslides, thus there is a definite case for climate resilient road

building and maintenance while applying appropriate landslide and avalanche protection engineering measures. However, building climate-resilient roads implies additional capital cost, requiring adequate budget provisions for road infrastructure in IHR and annual budget for winter road management.

Technical

In India, Hill Road Manual IRC SP 48:1998 is the primary guidance document for planning and designing roads in hilly and mountainous terrain. However, there is a case for an indigenous and applied research and simulation based use of design practices, technology for construction and operations of roads in IHR. Design of road structures, landslide and avalanche control measures therefore requires special design considerations considering the seismicity of IHR. The alternative cycle of thawing and freezing is one of the major causes of damage to the pavement. Research in High Modulus Flexible Pavement and high friction pavement surfaces may be required (some activities are already in place through academic institutes like IITs). Certain bioengineering solutions like vetiver grass plantations for slope protections/stability above the treeline are also available as research shows that it can grow in such temperature also. Use of local materials/recycling of pavement and use of construction/ demolition waste, solid wastes may also need active considerations from environmental sustainability of IHR.

Climate Change and Weather forecast

Currently, there is a lack of micro-data and information related to impacts of climate change on the major roads covering WH. The number of weather stations operated by both Indian Meteorological Department, Govt. of India and Snow & Avalanche Study Establishment, under Defence Research and Development Organization (DRDO) is not enough to provide accurate prediction of snowfall and occurrence of avalanches. The Doppler Weather Radar network currently operates at 145 locations including some Himalayan states. But most of the time they are non-functional due to effective channel of communication, high accuracy data and information will not be useful for operating the roads during extreme weather conditions.

Information and Communication Technology

Some information on hill road opening/closure status are available on the internet. However, information systems are rudimentary and are not available on a real-time basis to the road users. Real time information would be key to winter road management. The machineries deployed for road maintenance and surveillance vehicles should be GPS controlled and fitted with two-way communication devices for real time information based on site data collected which can be passed onto the users through central system.

Illustration 7 - Route 1 (Manali to Leh), North side of Rohtang Pass BRO Snow clearance operations in mid-April 2017

Illustration 8 - Route 1 (Manali to Leh) first light traffic on Manali-Keylong, end of April 2017

Illustration 9 - Route 2 (Srinagar Leh Highway) between Sonmarg and Drass, end April 2017

CONCLUSIONS

It can be safely concluded that all weather road connectivity in the Upper Western Himalayas of IHR above the treeline is a challenging task. Although some of these roads are important for strategic /defence reasons and may remain partially open during winter, most of them are non-operational during winters and closed to civilian traffic. Prior to 2014, BRO was principally in charge of upkeeping these roads. Now, with recently formed NHIDCL for civilian roads, private sector participation is also explored for road asset building, operation and management in IHR. It would need a well-articulated policy retrofitted to environmental and social requirements; regulations in terms of driver licensing for IHR, winter tyres; systematic planning and adequate annual budgeting for winter road management; institutional capacity building for road agencies and private contractors; deployment of modern winter road management equipment and ICT based road user information backed by accurate weather forecast and early warning systems for avalanches and landslides. Ensuring safe traffic operations in difficult terrains, extreme winter climatic conditions and long tunnels need to be evolved and mainstreamed with best and next practices, indigenous specific applied research funded by Government and structured information and knowledge sharing practices across road agencies and contractors.#

A Winter Maintenance Manual for the Finnish Transportation Agency

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Juha Äijö


Jarkko Pirinen

WINTER MAINTENANCE AND THE FINNISH TRANSPORTATION AGENCY (FTA)

In 2016, the Finnish Road Administration (FTA) initiated a project to describe the best current practices and winter maintenance methods entitled the *"Winter Maintenance Manual"*. The target group for the manual is winter service professionals, contractors, subcontractors, quality assurance personnel and FTA contract managers without previous experience in maintenance works. The manual also gives an overall understanding of how maintenance contracts are designed and what knowledge is expected from the contractors.

The Finnish Transportation Agency (FTA) is responsible for over 90 000 km of public roadway network. All routine maintenance activities have been outsourced since the 1990's to about 80 local and regional maintenance contracts. The length of these contracts are five to seven years. Although the contractor is quite free to choose equipment, materials and winter maintenance methods to meet the contract requirements, the FTA does provide guidance and an online reporting system for contractors to understand the best alternatives and to produce the required quality economically, as well as be able to report the conducted works.

The Finnish winter climate is described as subarctic and humid continental. The average winter temperature (south/north) is -4 / -13°C and the number of frost days is 110 – 190 days.

Winter maintenance policies in Finland are based on maintenance classes created by FTA according to average daily traffic, safety, mobility, economics, environmental concerns and other factors. The maintenance classes for winter maintenance in Finland are defined as follows:

- **1se** - covers 807 km, 23% of all traffic, 19 % of all heavy traffic. Roads are maintained preventively.
- **1s** - covers 2,772 km, 24 % of traffic, 27% of heavy traffic. Roads are maintained preventively. No snow on traffic lanes; during long cold periods, packed snow is allowed in Central and Northern Finland. Preventive anti-icing.
- **1** - covers 4,896 km, 19% of traffic, 22% of heavy traffic. Most of the time no snow on traffic lanes; some packed snow is allowed outside the wheel paths. Preventive anti-icing.
- **1b** - covers 11,257 km, 19% of traffic, 19% of heavy traffic. High quality winter maintenance without salt. Snow is ploughed and treated, usually also packed snow on the road. The road surface is kept smooth with levelling.
- **T1b** - some urban city roads. Low speed limit, deeper ruts allowed, otherwise like 1b.
- **2** - covers 18,895 km, 11% of traffic, 10% of heavy traffic. Most of the time packed snow; good grip in normal weather conditions especially in intersections, steep hills and curves. The road surface is kept smooth with levelling. Road users should be cautious during poor weather conditions.
- **3** - covers 39,361 km, 5% of traffic, 4% of heavy traffic. Most of the time packed snow on the road, quality requirements according to class 2 but the allowed action period is longer that in class 2. Road condition may remain poor for several hours during bad weather.

MAINTENANCE CONTRACTS

The FTA manages its private contractors with integrated contracts for regular maintenance of multiple assets (regular maintenance includes both summer and winter regular maintenance works covering all asset types under FTA's purview). Integrated contracts include labour time and materials. The payment mechanism is a hybrid of lump-sum based services and activities based on unit prices with a pre-defined payment schedule.

Performance specifications are intervention- and service-related with general winter maintenance quality standards as well as quality assurance methods defined by FTA. The general quality requirements are *(table 1)*:

- de-icing (salting and sanding, minimum skid value and action period time (h);
- removal of snow and slush (action period time (h) and depth (cm) during snowfall and after the end of snowfall);
- levelling (maximum unevenness for surface (cm).

The tender evaluation is performed in a phased manner based on a ratio of quality and price, in that order. Price evaluation is conducted only for those contractors who meet the minimum quality demands. Budget predictability is good (when there is no need for additional works), price level is low due to intense price competition.

Integrated contracts allow the authority the possibility to share the work load with the contractor and benefit from the contractor's full expertise. Contract costs have been low due to existing market competition. The standard of quality provided meets specifications. Integrated contracts for winter maintenance offer good overall quality. Future contract structures emphasize automatic quality measurements and implementing new technologies. This type of contract is very important for stakeholders. Risk allocation is defined by the authority. Long contract periods balance risks (e.g. winter maintenance). Due to short warranty periods, it is essential that quality control measures are properly followed during the contract period.

Over time, contractors' operations models have changed, and the tendency for a prime contractor to hire many sub-contractors requires a different management process than the traditional, single-contractor relationship.

OPERATIVE QUALIFICATIONS FOR CONTRACTORS

Planning

The contractor is responsible for fulfilment of the contract specifications. Their ability is evaluated during the tendering process. The main documents used are Action and Quality plans.
Dimensioning is dependent on the defined maintenance area and its characteristics. The main focus is on snow removal and ice control. The action periods and required quality, especially on high volume roads, proves to be a challenging task for route and resource planning.

The use of an underbody plough is common as it significantly reduces the need for levelling. Also, preventative anti-icing is a key tool to meet the requirements. It is also important that the contractor has enough resources for other winter maintenance works, such as the tidying up of crosswalks etc., signs, culverts and traffic control tasks.

Organization

The personnel and sub-contractor qualifications need to be vetted to ensure their understanding of how to meet the requirements in terms of quality, safety, efficiency and service. Technical and relational competencies are both needed to provide the necessary co-operation and trust with the road agency.

The contractor must assure his readiness to provide service 24/7 during the winter period. Also, real-time implementation of weather information centers is a common solution in maintenance contracts.

FTA personnel monitoring the contract and contractor have a contact person for fast decision making in case of emergencies. FTA maintains a nationwide Road User Service center which delivers the winter maintenance-related messages to the appropriate contractors.

Information management

Online and real-time data are currently the key component for communication between FTA and contractors. All vehicles are connected and contractors provide the required information to FTA IT system (called *"HARJA"*) in real-time. Data interface details are included in the tender documents; this method diminishes and automates many reporting requirements for providing necessary documentation to the project meetings.

TABLE 1 - FTA'S QUALITY REQUIREMENTS FOR WINTER MAINTENANCE CLASSES

		Winter maintenance class					
		1se	1s	1	1b&T1b	2	3
Anti-icing	Friction	0,3	0,3	0,28			
	Action period (h)	0	2	2	3/4	6	8
Snow removal	Max. snow depth during snowfall (cm)	4	4	4	4	8	10
	Action period (h)	2,5	2,5	3	3	4	6

TABLE 2 - USE OF SNOWPLOUGHS IN FTA WINTER MAINTENANCE

Base machine	High-volume roads	Low-volume roads	Pedestrian ways	Cities
Truck	x	x		x
Light Trick			x	x
Tractor		x	x	x
Grader				x

FTA and organisations share a common understanding of how to develop the communication towards mutual usage of the maintenance contract-related data.

HARJA IT system includes e.g. the following data items: Map-based Situation, Real-time Conditions Tracking, Road- and Activity-based Updates, Operator Information, Traffic Control Center Notifications and Contractor's Total Cost Tracking. *Illustration 1* shows the mobile user interface for the HARJA IT system.

Weather management

Knowledge about the driving conditions within the maintenance area directs maintenance activities. Contractors have their company-specific Maintenance Decision Support Practices and Systems. Every contractor uses weather information systems combined with local observations and quality measurement from their own supervisors. FTA provides access to the national weather information as well as satellite and street images.

Quality management

The contractor is responsible for Quality Assurance (QA) and FTA follows up on reporting by performing its own random spot checks. Quality criteria and quality assurance methods are commonly accepted and well known to all parties.

The contractor's Quality Plan is the key document for QA and it is updated continuously. Road inspections conducted by the contractor's supervisors are essential. Daily activities are reported online to the FTA in accordance with the demands of the contract diary.

SAFETY AND ENVIRONMENTAL REQUIREMENTS

Safety

Public and operator safety is an important factor in winter maintenance. Many legislative acts and codes of conduct guide the activities. The contractor reviews the safety documentation on a continuous basis and safety deviations are reported and assessed regularly. *Illustration 2* presents the required visibility add-ons for side ploughs.

Operators have a great responsibility during ploughing and de-icing works. Increased visibility of machines and being alert about other drivers' behaviour are essential factors during winter maintenance operations, which are usually performed during poor visibility and weather conditions.

Environment

FTA has focused on decreasing the usage of salt over the last decades and the total volumes have dropped

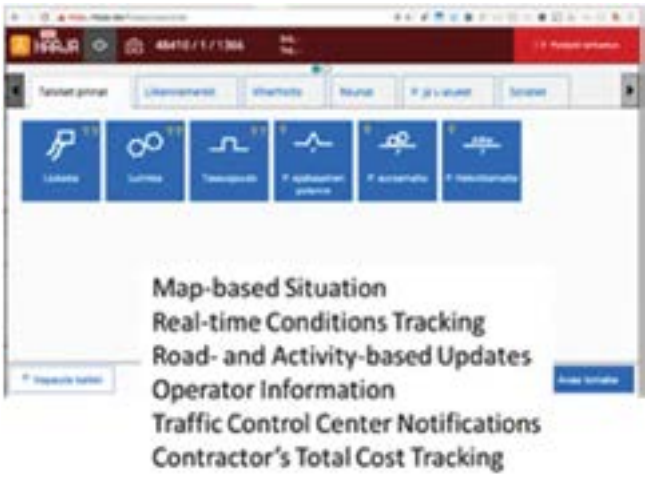

Illustration 1 – HARJA user interface for mobile devices

Illustration 2 - Increased visibility for side plough

significantly. Still, there are restrictions on ground water areas and maintenance bases with de-icing chemical storages are regulated with environmental audits and permit proceedings.

Other focus areas are energy efficiency and CO_2 emissions from maintenance machinery. Noise and dust management are also important issues in contracting.

WINTER MAINTENANCE EQUIPMENT

Base equipment

The contractor is free to choose the machinery and the current practice is presented in *table 2*.

Add-ons

A large variety of add-ons to the base equipment exists and the development of, for example, automation is fast. There are several providers for ploughs, cutting edges and pin blades for snow, slush and ice *(illustrations 4 and 5, next page)*.

Illustration 3 - Heavy, high-speed truck (A) and small multitask loader for bicycle paths (B)

Another category is ice-control devices for solid and liquid materials. Automation has been implemented on all heavy-duty vehicles and at the same time old mechanical equipment is used on minor and private roads. The most common spreader is the spinner, usually combined with salt dispenser *(illustration 6)*.

Granular materials (sand, gravel, etc.) are used according to the weather conditions and on low-volume roads. Tractors are used for anti-skid protection *(illustration 7)*.

Material usage volumes are monitored and reported continuously. Minimizing the amount of anti-icing chemicals used has been one important efficiency target for FTA since the 1990's.

WINTER MAINTENANCE METHODOLOGIES

Winter maintenance methodologies can be categorised as works before and during the winter period. Preparing for winter operations is essential to be able to conduct the time-critical winter operations. These activities include equipment inspections, calibration, and training of personnel. Snow poles and snow fences are also installed on that occasion to ease winter works.

Snow and slush removal

Snow and slush removal activities are fully outsourced to contractors, although FTA guides the outcome with several definitions, restrictions and requirements. The interest to use best knowledge and practices is common to all parties, but the fast development and generation shift in maintenance personnel is a challenge for the entire practice.

The manual provides guidance for multiple cases of snow removal on:

- normal, single carriageway roads;
- high-volume, dual carriageway roads;
- extra lanes/shoulders;
- ramps;
- intersections;
- roads with extra-wide lanes;
- bus stops and parking lots;
- bridges at intersections/interchanges;
- railroad crossings;
- urban areas;
- pedestrian facilities.

On high-quality roads with a bare road policy, levelling is not needed if the anti-icing and snow removal works are done in time and successfully.

Ice removal

The most used anti-icing method is liquid salt (NaCl or $CaCl_2$) or diluted NaCl (brine). Both calcium and sodium formats are also used in some special cases.

Anti-icing is performed with liquid salt based on weather predictions. The liquid amount and salt concentration is

Illustration 4 - Tractor with front plough and back plate

Illustration 5 - Heavy winter maintenance unit, truck with side, underbody and front plough and rear spreader automat

Illustration 6 - Spinner with salt dispenser and separate containers for different materials

Illustration 7 - V-box with belt feeder for gravel/sand

planned before the anti-icing operation for the vehicle automation. De-icing with prewetted salt is also done via automation in an effort to minimize the use of chemicals *(illustration 8, next page)*.

On low-volume roads (winter maintenance classes 2 & 3), the policy is to create a snow packed surface where the friction goal is maintained by spreading granular and mechanically roughening the snowpack surface.

Other winter maintenance works

The manual also presents other winter maintenance work methods such as:

- sign cleaning,
- removal of snow and ice from structures,

- protecting infrastructure from the damages of melting snow,
- ice roads,
- tunnels,
- work zones.

In the Eastern and Northern Finland archipelago, public ice roads provide better connectivity for people living on islands *(illustration 9)*.

Illustration 8 - Steering unit for the salt dispenser

Illustration 9 – Hailuoto-Oulu ice road (Finland)

CONCLUSIONS

Co-operation between FTA and contractors has resulted in productive routines and methodologies to economically meet quality requirements. Fast-paced development with equipment, automation, information services and change of personnel is nonetheless challenging all parties in the current working environment. The interest to use best knowledge and winter maintenance methods is common to all parties and this manual is one way to provide the basic information from the current contracts.

The main reason to update the FTA's manual is that the contracting practice has changed. The main contractor has multiple subcontractors and the number of actors have increased. Also winter maintenance equipments have developed and automatized significantly. Markets are providing a wide range of new add-ons and vehicles.

The importance of both worker and road user safety, limited economic resources, and environmental issues must be taken into account during all phases of the winter maintenance process. The FTA's maintenance contract requires many capabilities of the contractor, like action and quality planning, organising duties through the winter period, online information management, and weather management. Also, the contractor must fulfil several requirements in terms of safety, environment and outcomes. On the other hand, the contractor is free to choose subcontractors, equipment, add-ons, materials and methodology.

Knowledge of good winter maintenance methodologies combined with careful timing will result in the right level of service for all road users.#

Measuring Sustainability in Winter Service Operations

Wilfrid A. Nixon, Salt Institute, Naples, Florida, USA
Richard Mark DeVries, Vaisala Inc., Louisville, Colorado, USA

Illustration 1 - Maintaining the balance between safety, mobility and good environmental stewardship is at the heart of safe and sustainable snowfighting

Sustainability has been an area of growing importance in the transportation field over the past two decades. In the United States, the Federal Highway Administration (FHWA) now provides an online tool that allows agencies to assess their performance in transportation design and operations, and include examples of how agencies have made use of the checklist based tool that the FHWA provides. The challenge for agencies charged with winter maintenance is that tools such as provided by FHWA are very general in nature. Winter service operations are only one area (comprising four items) among many covered by the FHWA tool. For an agency wishing to conduct an in-depth investigation of the sustainability of their winter service operation, the FHWA tool is too coarse. This is not a criticism of this tool but rather an acknowledgement of the scale of use for which it is intended. This means that to conduct an in-depth investigation of winter service operations and their sustainability, an agency must to some extent revert to first principles of sustainability. Such first principles might be expressed as: *"Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs."*

This is an excellent aspirational or inspirational statement, but it is not particularly applicable to winter service operations. In creating a tool to measure the sustainability of winter service operations, some *"flesh"* must be put onto the *"bones"* of this definition.

We can adjust this statement to the field of winter service operations. Some guidance for such a statement could be found, for example, in the NCHRP Report 577 *"Guidelines for Selecting Snow and Ice Control Materials to Mitigate Environmental Impacts."* Such a statement might be something like:

Sustainable winter service operations use the most appropriate snow and ice control equipment, processes and materials for the unique objectives and conditions that each agency encounters in a manner that does not compromise the ability of future generations to do likewise.

As a guiding statement, this has more promise in that it provides specific areas (equipment, processes, materials) in which actions may be considered for their sustainability. However, the issue of how to determine the sustainability of a given action remains rather vague. Some clarity can be gained by considering what is termed the "triple bottom line" of sustainability, which can be expressed as the intersection of three overlapping circles, with the circles representing economic concerns, societal interests, and environmental protections. This approach formed a basis for the ranking scheme outlined in the GreenRoads web site ***(https://www.greenroads.org/)*** which provides a ranking system for new road projects.

A variety of efforts conducted by the AASHTO (American Association of State Highway and Transportation Officials) Winter Maintenance Technical Services Program over the past decade, have demonstrated that a number of knowledge gaps exist among practitioners of winter maintenance, including significant gaps in the general area of sustainable practices. In an effort to advance the application of the principles of sustainability in the field of winter maintenance, the AASHTO Winter Maintenance Technical Services Program Committee decided to draft a checklist that could be used by agencies (at the state, county, and municipal levels) to ascertain the degree to which sustainable principles have been incorporated into their winter maintenance practices.

Checklists are particularly useful and pertinent in the field of winter maintenance. Checklists are used regularly in this field, for example in pre-trip truck inspections. Therefore, there is a high level of familiarity with them and as such there will be one less barrier to usage that must be overcome if sustainability is presented in the form of a checklist. It is nonetheless clear that while the checklist may represent a good starting point for advancing the application of the principles of sustainability in the field of winter maintenance, it is by no means a sufficient tool on its own.

One disadvantage of the checklist approach is that it does not provide a tool for an agency to evaluate how sustainable a potential change in practice would be. For example, some agencies have found that blending agriculturally based by-products with the salt brine that they use in their winter service operations provide significant operational benefits (especially with regard to the persistence of the applied chemicals on the road surface). How should another agency, that is not yet blending, determine whether or not it would be sustainable for them to begin using blended products? Further, how could they determine whether using blended products is more sustainable for their agency than not using them? The answer will, and should, vary according to location and the local societal needs, but at present, tools do not exist to allow agencies to make such decisions. In particular, checklists do not provide a method to answer these sorts of questions.

Another challenge with the checklist approach is that it is *"expert driven"* in that the items on the checklist are selected by *"experts"* who cannot consider the local factors that impact each and every agency. Sustainability is supposed to provide local empowerment, but a checklist inevitably cannot do this.

Notwithstanding the drawbacks of the checklist approach, it is clear that it has specific benefits as well. It does provide a quick and simple method for agencies to review their activities and determine areas where change would be beneficial. And by using such checklist tools, agencies can demonstrate a commitment to the application of sustainable practices in their winter service operations.

TABLE 1 - SUSTAINABILITY CHECKLIST AREAS	
1	Levels of Safety and Service (8 items)
2	Materials Usage (6 items)
3	Equipment Selection and Operation (9 items)
4	Performance Measurement and Continuous Improvement (4 items)
5	Strategic (annual) Operations (14 items)
6	Tactical (per storm) Operations (6 items)
7	Storage and Safety (9 items)
8	Housekeeping (6 items)
9	Environmental (9 items)

TABLE 2 – ITEMS IN PERFORMANCE MEASUREMENT AND CONTINUOUS IMPROVEMENT AREA
Performance Measurement and Continuous Improvement Items
Do you have a post-storm review process that is used after each storm?
Do you have a formal system to measure whether and when the required level of safety and service has been achieved on each road segment?
Is your storm severity measurement quantitative?
Do you have a system that actively seeks out ways to improve your winter safety and service activities?

Illustration 2 - Strategies such as anti-icing prevent the formation of a bond between the snow and the pavement

CHECKLIST DEVELOPMENT

The checklist is divided into 9 different areas, listed in *table 1*. Within each area, there are a number of items (between 4 and 14 items) which cover various practices within that area. Each item requires a straight *"yes or no"* response. *Table 2* lists the items within the area of Performance Measurement and Continuous Improvement, by way of an example.

Identification of areas and items

The checklist was developed in two parts. First, the AASHTO Winter Maintenance Technical Services Program identified a number of areas of excellence and good practice in winter services, and these were compiled into part of the list. The second part of the checklist was derived from the Salt Institute program for Safe and Sustainable Salt Storage, which has been an award program offered by the Salt Institute in North America for a number of decades.

The exploration of the key areas in winter service in North America has been ongoing for some years now. It has included a special National Cooperative Highway Research Program task force that identified the Grand Challenges in the field of winter maintenance in 2010. Additionally, the American Public Works Association (APWA) has at their annual North American Snow Conference held sessions discussion on the top ten issues in winter maintenance in 2014 –2016.

More recently, the Clear Roads consortium (an AASHTO Pooled Fund research program) conducted a study into best practices in salt procurement, storage, and use in winter maintenance. The study produced a report and a guide book that detailed best practices in these areas. There is a welcome degree of overlap between the sustainability checklist and the best practices found in this study.

While, as noted above, a weakness of the checklist approach is that it is *"expert driven"* in this case a broad range of input was obtained and used to create the checklist, so insofar as possible the *"expert driven"* approach reflects the perceived wisdom of the winter service community in North America.

Encouraging use of the checklist

Merely having a checklist type of tool does not guarantee that the tool will be used by the targeted agencies. In this case, the target is any agency that provides winter maintenance services for the traveling public. In the United States, such service is typically provided at three levels of government. The State Department of Transportation provides all winter services on state roads (which includes any roads in the Interstate system and the National Highway system). Of the 50 State Departments of Transportation (or equivalent – not all such departments have the same name) 48 provide winter services in at least part of their state.

The situation becomes rather more complex at the next two levels of government – the county and the city levels. County roads are typically more rural, and in parts of the US many of them are unpaved. The US has 3,144 counties (or equivalent) but obviously not all of these provide winter services since their climate does not make this necessary. A first order estimate conducted by the authors suggests about 2,400 counties provide winter services.

Cities are even more difficult to categorize, in part because they are not as well defined historically and politically as counties. With the exception of Washington DC, every location in the US is in a county. Clearly not everywhere is in a city. The US Geological Survey estimates there are 35,301 cities and towns in the US, but their definition of a city or town is that it has a permanent population and buildings – it does not have to have any political status (which is acquired in the US by the process of incorporation). Other measures of urban populations indicate that there are 3,035 cities with populations greater than 10,000 and 16,470 cities (or towns or villages – but they must be incorporated) with populations of less than 10,000.

Assuming that approximately 75% of the cities in the US are in parts of the US where winter services will be provided by city authorities, this suggests that there are about 17,000 agencies in the US alone that provide winter services on their road systems. Each of these agencies can set their own levels of service and will determine for themselves their approach to providing those services, subject of course to appropriate political oversight.

Unlike in Canada where some national standards for winter service exist, there are no such standards in the US so the use of the sustainability checklist can only be voluntary for agencies. The challenge is therefore how to make a voluntary activity attractive to an agency, or more specifically to the winter service management of that agency, who are typically rather busy people. The method that has been chosen is to modify an award program to encourage participation. Details of the award program are provided below.

THE SAFE AND SUSTAINABLE SNOWFIGHTING AWARD PROGRAM

Since it started its Sensible Salting Program in 1972, the Salt Institute has encouraged environmentally responsible storage and use of road salt. As part of that, it used to offer an Excellence in Storage Award which honoured those agencies that used good practices in salt storage. In 2012, it transitioned the Excellence in Storage Award into the Safe

Illustration 3 - Rural roads do not need to be bare and dry at all times

and Sustainable Snowfighting Award and the application form uses the sustainability checklist described herein. Applications are reviewed by an evaluation committee and, in some cases, an on-site facility visit is conducted.

This award program provides some recognition, and thus encouragement, for an agency that opts to go through the self-evaluative process that is captured by the checklist. As noted above, this is an entirely voluntary process. If an agency is approved for the award, then they receive a certificate, and are recognized in a press release.

Since its transition to the Safe and Sustainable Snowfighting Award in 2012, the award has been given to between 64 and 90 recipients annually. The low year (2014) followed a particularly severe winter, and it is reasonable to assume that some agencies were too busy to complete the application that year.

Obviously, 90 award winning agencies out of approximately 17,000 candidate agencies is not a high percentage, but should be viewed as just a start. It is hoped that more agencies will come to find this process of value and undertake the sustainability self-assessment annually.

CONCLUSIONS

A checklist based approach has been developed that allows winter service agencies to conduct a self-evaluation of their practices within the context of safe and sustainable snowfighting. The checklist, while limited in ways common to all such checklist like approaches, is based upon a wide ranging evaluation of the key practices in North American winter service operations. In order to encourage agencies to conduct this sustainability self-evaluation, the checklist has been incorporated into the Salt Institute Safe and Sustainable Snowfighting Award program, which is run on an annual basis.#

Lombardi

Damage Risk Assessment Copenhagen Cityringen

The Copenhagen Metro City Ring is expected to be operational in 2018 and will consist in two single tracks in a twin tunnel, each approximately 16 km long. The City Ring includes 17 underground stations (many of them located in the historical centre of the city) with island platforms, 4 cross-over facilities and 3 construction and ventilation shafts and will be transporting up to 234,000 passengers on an average working day.

In the framework of Damage Risk Assessment for the buildings neighbouring the excavation sites, the effects of subsidence induced by the construction of deep underground stations were evaluated for the following sites:

- Københavns Hovedbanegård
- Frederiksberg
- Nørrebro
- Skjolds Plads
- Poul Henningsen Plads
- Gammel Strand
- Rådhuspladsen

The effect of tunnel-induced settlements was analyses at Frederiksberg, Rådhuspladsen and Kongens Nytorv for selected important constructions. Most of the structures to be assessed were in fact masonry buildings positioned at short distance from retaining walls and/or located directly above the tunnel alignment.

The excavation processes were modelled by means of finite elements analyses. In general, the soil-structure interaction was taken into account when calculating expected damage to the structures. In order to properly model the soil behaviour, advanced constitutive laws were adopted.

In some cases, mitigation measures were advised in order to comply with the very strict limitations imposed by the Copenhagen municipality on the tolerated damage.

Client
Copenhagen Metro Team (CMT)

Project
Damage Risk Assessment for Buildings Subject to Settlement in the Copenhagen Cityringen metro line, Danmark

Construction period
2012–2018

Construction costs
Approx. Euro 2.1 billions

Service provided *
- Damage risk assessment for structures neighbouring deep excavations and tunnels
- Advice on the design of mitigation measures

Period of services
2012–ongoing

Reference person
Mr. S. Notarianni
Technical Director CMT

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A Technical Description of LARS and Lumi: Two Apparatus for Studying Tire-Pavement Interactions

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All three at the Department of Civil and Transport Engineering, University of Norwegian Science and Technology, Trondheim
and **Katja-Pauliina Rekilä**, Engineer, Norwegian Public Road Administration, Oslo, Norway


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Mathis Dahl Fenre


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The controllability of a vehicle equipped with tires decreases under certain circumstances. One of these circumstances is in winter, where snow and ice affect tire-pavement interaction and thus friction. In such conditions, the control of the vehicle might be lost, which results in longer braking distances or unsafe steering. The presence of snow, ice, water, sand or chemicals makes the interaction between tire and pavement extremely complex. As interfacial property, the frictional phenomenon, depends on both the tire and the underlying pavement. Therefore, friction on ice and snow depends both on the material (snow/ice) in itself and on the system which it belongs to. In pavement engineering, the typical system composed by tire, pavement, interfacial medium such as snow/ice, and environment is defined as tribosystem. Several outdoor and indoor tests are performed during winter time to increase the knowledge of this system in snowy and icy conditions. Nevertheless, outdoor testing is challenging due to the unpredictability of the weather conditions and test area. On the other hand, indoor tests allow the understanding of the whole system in controlled conditions. Several known indoor facilities investigate tire pavement interaction and thus the frictional phenomenon. However, most of them lack the linear testing of a real tire moving at high testing speed, especially for underlying pavement surface such as snow or salted snow. The Linear Analyser of Road Surface conditions (LARS) at our research center aim to fill this gap. LARS and a snow producing machine (Lumi) forms the core of this laboratory. The object of this paper is to provide a detailed description of our facilities.

THE LINEAR TEST APPARATUS: LARS

LARS is a linear test track with a length of 8.8 meters. LARS allows linear tests of a freely rolling tire within a maximum speed of 10 m/s in a cold laboratory within test temperatures controlled from -25 °C up to + 25 °C. *Illustration 1* describes the components of the linear test track.

The system design

The beam (1) is LARSs *"spine"*. An electrical motor (2) is mounted on the left side of the beam. A sprocket wheel (3) is mounted to the electrical motor and another sprocket wheel (4) is mounted at the end of the beam. An encoder, placed on the motor counts the revolutions of the sprocket wheel. A tensioned belt (5) is mounted around the sprocket wheels and the tension wheel (6) Underneath the beam, a sledge (7) displaces transversally for the whole length of the beam. A desired testing tire (8) is attached to the beam with an aluminium arm, and rolls over a desired pavement, for example asphalt concrete (9). The beam can be raised or lowered to allow wheels of different diameter. The test tire is pressed on the pavement within a maximum applied normal force of 1500 N. An air bellow in pressure (10) controls the applied normal force on the tire. In the current set-up, the braking torque, rotational speed and acceleration of the tire are measured. The whole facility is fitted into an aluminium frame (11).

Test procedure

A specifically designed LabView software enables the control of LARS. When activated, the motor transfers energy to the sprocket

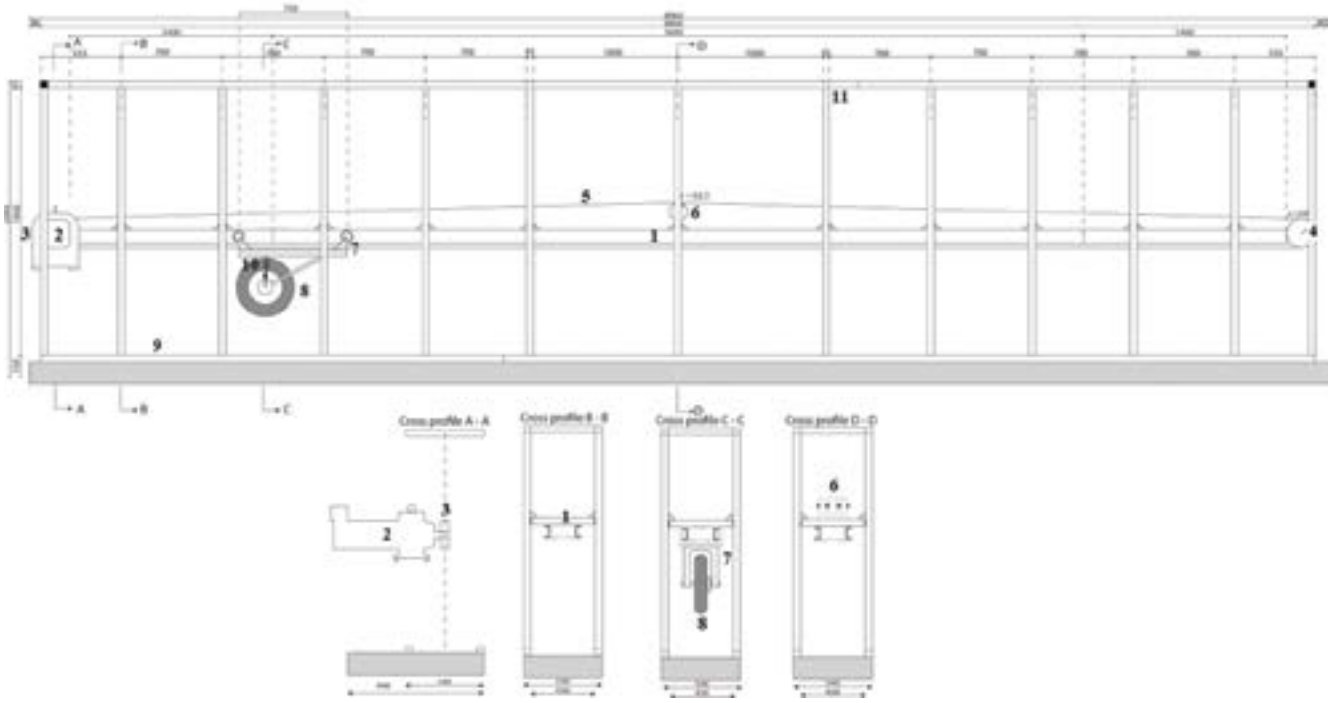

Illustration 1 - LARS linear track apparatus © [12]

Illustration 2 - Tire Pavement Interaction in water and snow condition

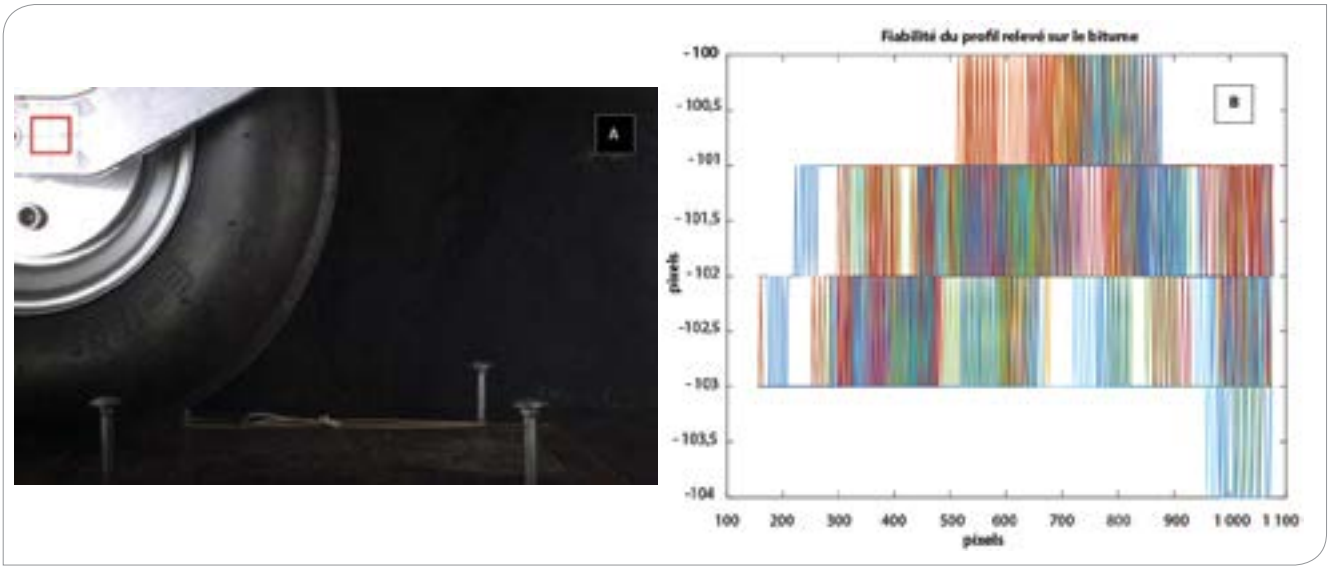

Illustration 3 - Tracking Reference Point (A), Reliability measurements of tracking point (B)

wheel, which further induces transversal movement of the sledge through the belt. This enables free rolling of the tire. During a test run a rolling tire is accelerated up to maximum 10 m/s within the first 3 meters of the track. Over the next two meters at the centre of the track, the tire is rolling at constant desired speed. Finally, the tire begins to brake reaching the final position with a speed of 0 m/s. After the test, the tire can be returned to the start point. Hence, the test can be repeated.

Video documentation

Lars is equipped with a Phantom VEO 410L, digital high-speed camera. The camera captures the tire motion within a maximum of 6,100 frames per second with 1,280 x 800 pixel resolution. The recorded video is processed and analysed with the Vision Research software. *Illustration 2* shows the effect of a free rolling tire on water *(illustration 2 A)* and snow *(illustration 2 B)*.

From the documented video it is possible to extract measurements. To test the reliability of the camera measurements, a reference point has been tracked over 50 test runs. The reference point, marked in red in *illustration 3A*, has been placed on the arm connecting the tire and the sledge. The testing tire was running with 2 [m/s], a wheel load of 85 [kg] and an inflation pressure of 2 [bar] on bare asphalt and the reference point was tracked for the whole tire motion captured within 2,000 fps. *Illustration 3B* shows the results of the test runs.

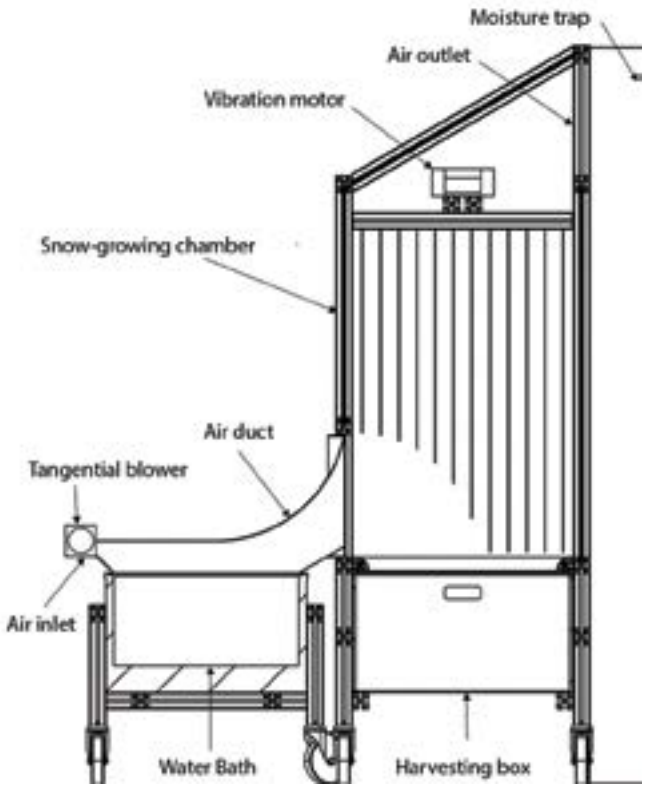

Illustration 4 – Design of Lumi apparatus

For each test run, the reference points pixels coordinate was tracked from the first frame until the last one. With a total of 50 test runs, 47 tests show a variation of +/- 1 pixel, in y-coordinate, for the whole captured motion of the reference point. 3 tests show a variation of +/- 2 pixels.

THE SNOW MACHINE: LUMI

Natural snow comes in a variety of shapes, sizes and densities. This makes testing on natural snow very difficult and test results tend to be largely scattered. Storing natural snow over time is difficult as the snow changes important properties such as grain shape and size over time. Our snow machine Lumi ("snow" in Finnish) reduces these problems by producing artificial new snow under controlled conditions. Lumi operates in a cold room laboratory with controlled temperatures down to -25 °C. Temperatures are controlled with an accuracy of +/-0.5 °C. Illustration 4 shows Lumi and its components.

Lumi snow procedure

Two tangential blowers blow the cold laboratory air into an air duct and over the water baths. Two water baths are heating water to a desired temperature, typically within a range from + 30 °C to +40 °C. The warm water provides the water vapour that humidifies the air. The cold, humid air continues through the air duct and into the snow-growing chamber. Snow crystals start growing on a polymer coated steel grid. At set intervals, a motor induces vibrations to the steel lattice, allowing the snow to fall down into a harvesting box. An aluminium frame covered in a fine masked fabric following the snow-growing chamber traps most excess air moisture. Illustration 5a and 5b shows the snow formation in the snow-growing chamber.

The system design

Two water baths, Julabo TW-20, 500x300x180 mm^3 provide PID controlled water heating up to 90°C with a temperature stability of +/- 0.2°C. Running in a temperature range between +30 and +40°C, conditions are ideal for legionella bacteria formation. To avoid formation of legionella, each water bath is equipped with an Aqua Medic Helix Max 5W UV filter.

Two EBM-Papst QLZ06/2400-2212 24VDC tangential blowers allow cold laboratory air to get into Lumi. Maximum air flux is 220 m^3/h. Jtron DC motor PWM controller controls the blowers to operate at around 110 m^3/h to lower the amount of excess humid air flowing in the laboratory.

The stainless steel air ducts leading cold laboratory air over the water baths and into the snow-growing chamber are custom made. In order to obtain an evenly distributed snow-growth, the air ducts half funnel-like design help spread the

airflow as much as possible when entering the snow-growing chamber. The plates are welded together and the welds are sealed. A foam tape on the edge between the water baths and the air ducts and two ratchet tie-downs provides a watertight connection between air blowers, water baths and the snow-growing chamber.

An aluminium profile, Bosch-Rexroth, frame 1,955 x 973 x 695 mm^3 with styrene-acrylonitrile (SAN) plastic windows make up the snow-growing chamber. Inside, hangs an aluminium frame with eleven plastic covered steel grids, forming the snow-growing lattice.

The motor regularly inducing vibrations to the lattice is a three-phase Venanzetti Vibrazioni Micro VV002N/2 vibration motor. The motor exerts a centrifugal force up to 0.44 kN. A Siemens SINAMICS G110 converter controls the frequency of the motor by slowly ramping up from 0 Hz to 50 Hz and down again. A digital time clock relay initiates the vibrations every two hours. By slowly changing the frequency, different parts of the steel lattice with different stiffness (and different natural frequencies) will experience heavy vibrations, hence making as much snow as possible fall down into a harvesting box, placed underneath the snow-growing chamber.

The combined use of the linear test apparatus LARS, the snow maker Lumi and the phantom VEO 410L provide the tools for accurate studies and documentation of tire-snow interaction. The focus at our research center is the investigation of the interfacial medium behaviour when tire and pavement are boundaries of the system. Tests on tire-pavement interaction in presence of loose dendritic snow aim to reproduce tire traction during snowfalls. *Illustration 6* shows the ice crystals created with different gradient temperature between the water chambers and the cold room temperature.

Illustration 6A and 6B show ice crystals created with water chamber temperature of + 30°C and cold room temperature of -20°C. *Illustration 6C* shows ice crystal

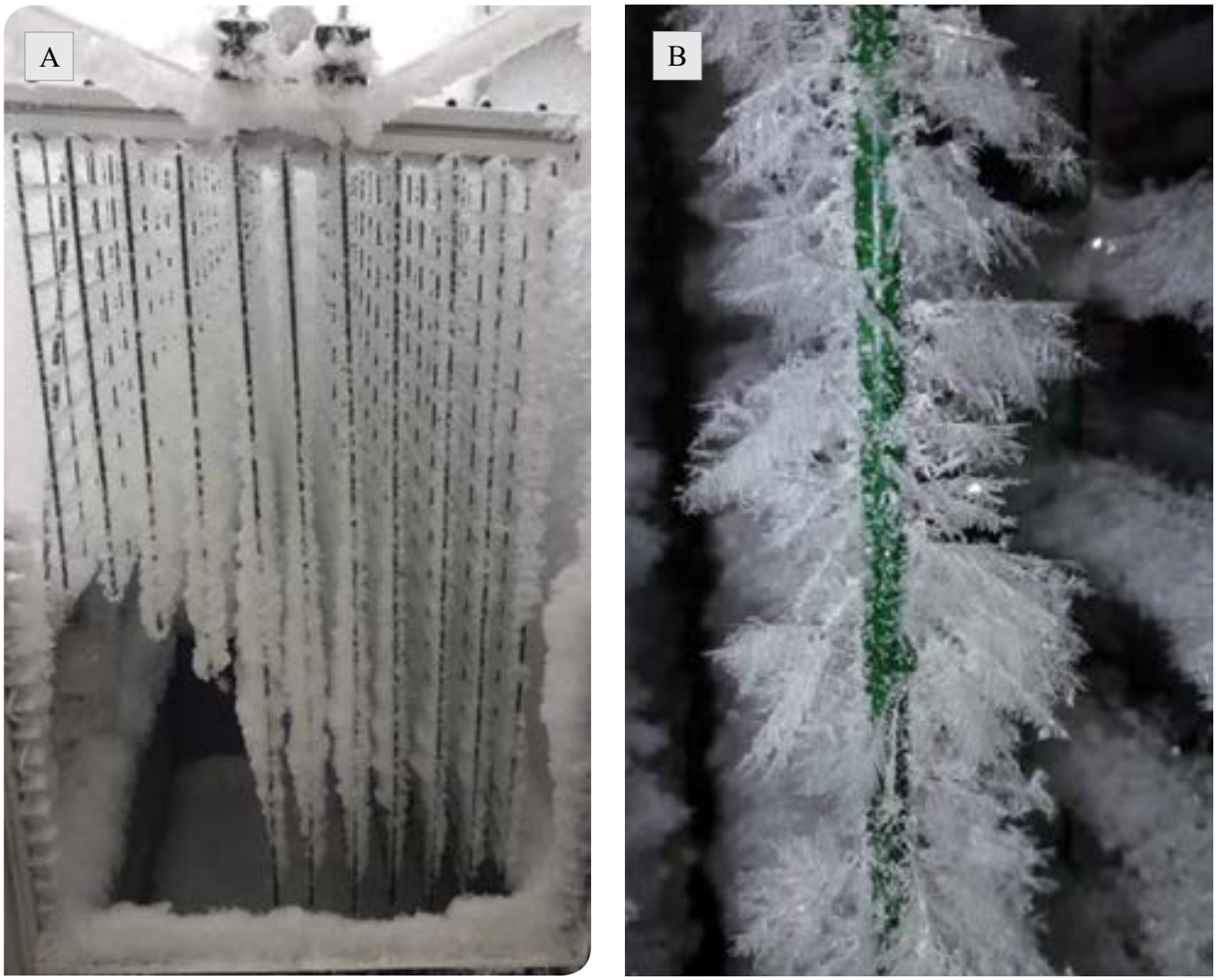

Illustration 5 - Artificial loose dendritic snow produced by Lumi

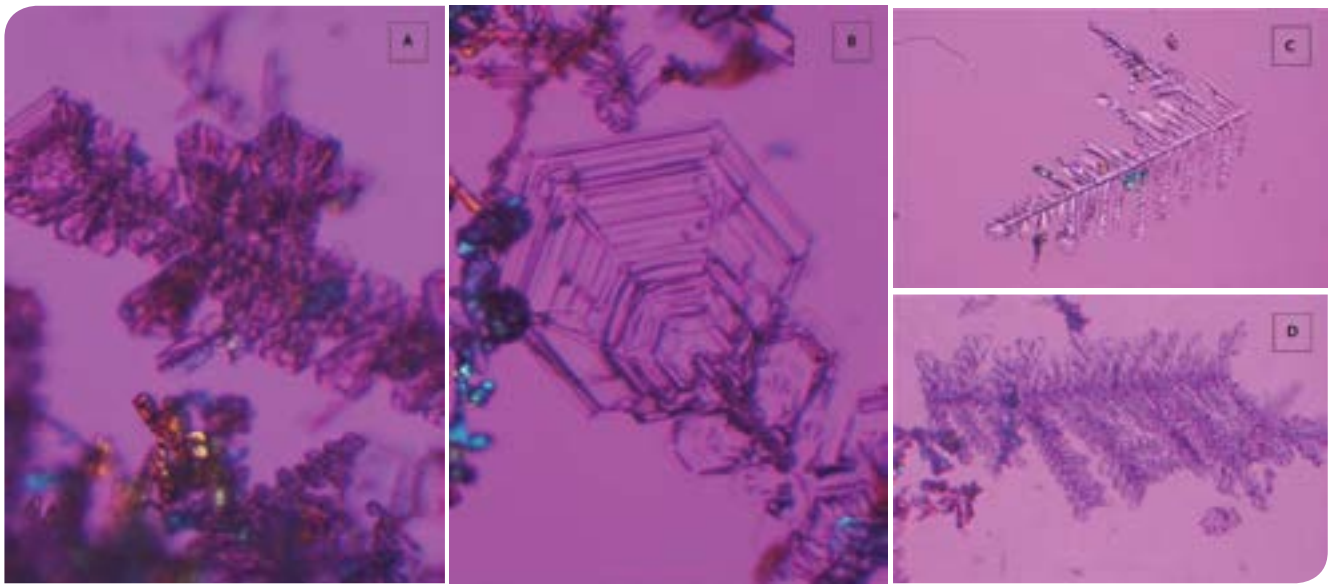

Illustration 6 - Lumis ice crystals observed with a polarized microscope

formation at water chamber temperature of +40°C and cold room temperature of -20°C. *Illustration 6D* shows ice crystal formation at water chamber temperature of +35°C and cold room temperature of -20°C. The density of the produced snow is comprehended within a range from 30 to 80 [g/L], based on the chosen gradient of temperature.

The LARS apparatus offers different possibilities for tire testing. In that case, test runs can be performed with different tire geometry (i.e. car/bicycle), composition (studded tires and frictionless tires) and with different treads and rubber compound. Finally, LARS also allows testing of different pavement surfaces.

CURRENT USE OF THE FACILITIES

LARS apparatus is currently in use for investigating the effect of a free rolling tire on salted snow.

Laboratory grown-snow, classified as DFdc (loose dendritic snow) according to the international classification of seasonal snow on the ground was produced at a temperature of -20°C. *Illustration 6C and 6D* shows the typical test crystals shape. Test snow is mixed with different amount of sodium chloride solution at -2°C. Over a smooth asphalt specimen, classified as AB11 according to [14], a smooth friction testing tire is free rolling on the top of the unconfined testing snow with a speed of 2 m/s, wheel load of 85 kg, and an inflation pressure of 2 bar. Final density and hardness of the salty snow after the tire rolls over it are analysed and discussed.

CONCLUSION

A technical description of LARS and Lumi has been presented as well as preliminary test results. The indoor apparatus offers a realistic tire pavement interaction in icy and snowy conditions. In such conditions, the importance of the artificial snow maker Lumi is explained. Tire-pavement interaction in real test scale is documented with a high-speed quality camera. The development of a test set-up is in progress to enable control of slip ratio and friction measurements for any testing tire in any condition. However, due to the high reliability and reproducibility of its test, the apparatus is currently used for several research purposes. The research carried on wishes to explore the effect of a rolling tire on salted snow and possible optimization of salt uses. Improved understanding about tire traction in snowy conditions will be useful to increase the efficiency of winter maintenance without compromising road traffic safety.#

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A Short History of Polish Roads From Amber to Enlightenment

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General Directorate for National Roads and Motorways – GDDKiA (Poland)

This article and the one to follow in Routes/Roads 376 will take you on a journey through centuries of history, showing the good and challenging times of road building, and conclude our story in modern times, thus encouraging you to visit Poland and come to Szczucin, which hosts the Road Building History Team of GDDKiA.

In distant times, when most of the European continent was covered with dense forests, sea and rivers provided convenient and fairly safe routes. Roads were created to satisfy the need for movement, not only from the desire to discover the world, but for trade. Paths were used and maintained, natural barriers were removed, smoothed out or reinforced; and so began the planned and conscious construction of roads, although a long time had to pass for them to become dedicated thoroughfares. Starting from areas close to the Baltic Sea, warehouses were established, serving as starting points for inland journeys to create subsequent storage places, usually well hidden.

Poland, unlike ancient civilisations, developed its statehood quite late. It was only in the 10th century that the tribes accepted the authority of one of the dukes, Mieszko I (922 – 992), and the baptism of 966 legitimised the existence of the country. Life centred around settlements of various sizes, with poorly developed transportation systems. Trade routes created by outside visitors crossed Polish lands inhabited by Slavic and Prussian tribes. The most famous and longest-functioning of these is the Amber Road, used for transport and trade from the Baltic Sea to the Adriatic Sea and further on, but other ones supplied also tin, silk, salt, gold and spices. They were not roads, but travel directions defined by stopovers, usually up to 25 kilometres apart – this is how far one could traverse on foot with pack animals. It is where the location of many cities originates from – which exist to this day, e.g. Cracow, Wrocław, Kalisz, Gdańsk. Later, roads were built between them and connected into road networks. Polish lands, covered with dense woodlands, were difficult to build roads and routes on, but attempts were made to clear forests and prevent vegetation from overgrowing. Marshy sections were reinforced with levees, timber, and branches. Archaeological studies also found vertically driven wooden piles with planks laid on joists, forming thoroughfares up to 3 metres wide. The needs and demands of man grew along with the development of society and the organisation of state life, which over time made roads become an instrument of economic policy. Rulers introduced numerous duties for merchants, and privileges for towns by adopting the so-called «*staple*», forcing foreign merchants to put a part of or all their merchandise for sale for a certain period, and the road coercion, a duty to follow a staple route, which required merchants to stop at designated locations.

The first road signs appeared. In 1151, a stone pillar – which exists to this day – with a Latin inscription marking half the distance between two towns on the Amber Trail was placed in Konin, and 30 years later the first statute regulating matters concerning roads was written down.

The 11th and 12th century in Poland were a time of intensive economic development and important social transformations. The country was fragmented into provinces, and the administration system was changed. Rural self-governments were formed, along with a general set of feudal rules. Wars were waged, some Polish territories became dependent on neighbouring states, and only in 1320 power returned to the hands of one man. The road situation was treated differently depending on the ruler, but nowhere was it satisfactory.

Illustration 1 - A well from the 14th-15th centuries at the crossroads of Via Regia with the trade route from Germany to Russia through Wroclaw - Krakow in Lwówek Śląski. Photograph taken in 1980

Historical sources include descriptions of the first bridges created from floating rafts joined together. These were quite uncomfortable and unstable, and there were attempts to

replace them with more durable structures. The first bridge on the Oder River in Szczecin, erected in the 13th century, allowed boats to sail freely underneath. By the end of the 14th century, there were 10 bridges and 9 ferry crossings on this river. This type of construction developed significantly during the Teutonic wars, when the concentration of military forces and the need to cross rivers quickly required bridges. The best description from those times pertains to a bridge crossing following the 1409 decision made by kings Vytautas and Władysław II Jagiełło. Elements of a boat bridge were floated to Czerwińsk and assembled, allowing the entire western group of troops to cross to the eastern bank of the Vistula River on June 30, 1410 and march on towards Grunwald, the site of the largest battle with the Teutonic Order of that time. This light boat bridge was dismantled and assembled again near Ciechocinek, allowing the returning army to cross the river.

In the 14th and 15th centuries, the municipal councils of wealthy Polish cities, such as Cracow, Toruń, or Lwów, were responsible for building streets and roadways – often paved with cobblestones. Tolls were introduced, such a:

- *cespitaticum* – for destroying roadside grass collected also from merchants travelling by foot,
- *ripaticum* – concerning waterways, for destroying riverbanks, also collected from ships passing harbours.
- *pontaticum* – for crossing a bridge, even a ford, including on ice.

The purpose of collecting duty and tolls was to maintain roads, but only a small percentage was devoted to that goal. We have no knowledge about the amount of traffic on roads. Travellers at the time used modern harnesses, shoed horses, used horse collars, saddles, stirrups and spurs, but there were quite many wayfarers. The technical condition of roads was not the most important matter; the width, order and throughput, along with the good condition of dykes and bridges were all regulated in legal documents. It is worth noting that written accounts of that time state that a dyke was defined as an embankment in marshy and boggy areas. Roads were not marked, and guides were hired for longer journeys.

Illustration 2 - A pontoon bridge over the Dnieper River during Orsza battle
Unknown painter, 1525-1530 © National Museum, Warsaw

The 16th century was called the Golden Age. There were three categories of transport routes:

- *iter* – road for those travelling by foot and on horseback, probably approximately 1 metre wide
- *actus* – road for carts leading in a single direction with a width of up to 3 metres
- *via* – public road for traffic in both directions and all vehicles, up to 6 metres wide.

Poland had a significant position among the political powers of Europe, which translated to other areas of life. The problem with the Teutonic Order was ultimately solved in 1525, when the eradication of the Teutonic State was signed, the Grand Master became a Lutheran and established the Duchy of Prussia, a Polish fief. Culture developed along with blossoming agriculture, mining, and steel industries. Travelling became fashionable, necessary for Poles of various estates undertaking education (nobility, townsmen, and peasants) at the universities in Western Europe. Roads became essential, and gaining knowledge resulted in newer technical solutions for constructing bridges. They were constructed at the expense of the owners of adjacent lands.

During the Russian campaign, a new type of boat bridge was built in 1514 on the Dnieper River near Orsha, where tight barrels fastened to each other with ropes were used instead of boats. It was a huge achievement, since it allowed transporting cannons up to 1 ton in weight.

The first permanent bridge over the Vistula River was built in Toruń in 1500. It was the longest wooden bridge in Europe. The beam bridge supported on vertical posts remained operational until 1835. Keeping up with world innovations, in 1573, through the effort of King Sigismund II Augustus (1520-1572), the construction of a bridge in Warsaw began, headed by the Italian Erasmus of Zakroczym. Based on technically innovative plans, this was a 500-metre-long and 6-metre-wide bridge with a truss bearing system with 18 fixed spans erected on oak piles mounted on rafts. Five floating spans were used to allow river sailing. The construction was secured with strong ice-breaking piers. In later years, due to fires that often ravaged wooden bridges, a brick tower was also built. However, the bridge was destroyed by piling ice floes. The next monarch, Stephen Báthory, rebuilt this technological wonder. For the purpose of crossing this bridge, regulations were created that may

Illustration 3 - The oldest bridge of Toruń from 1500. Copperplate Alt- und neues Preussen, Christoph Hartknoch, 1684

Illustration 4 - Szarwark works Photo from album around 1920

Illustration 5 - "Prince's Inn" in Jarkowice from 1783 (Picture dated 1980)

Illustration 6 - Inn from the 18th Century in Uniemyśl (Picture dated 1980)

be regarded as the archetype of a highway code.

Other wooden bridges were not permanent, since each time the waters rose, the river destroyed the structure, and therefore boat bridges disassembled for winter became popular.

It should be noted that several hundred years since the baptism of the first Polish ruler, the State was developed not only in terms of industry, but also agriculture and administration. As in any civilized country, prosperity requires efficient transportation to exercise authority effectively. During the reign of King Sigismund I the Old (1467-1548), major communication arteries were placed under the authority of district governor (official administrators of crown lands), who – together with selected members of the nobility – constructed and maintained roads using the residents subjected to them. The custom was called *szarwark* (from German Scharwerk; Schar – crowd, group, werk – act, work).

It consisted in compulsory, unpaid engagement of the local rural population equipped with primitive agricultural tools in improving, maintaining, and building roads, bridges, and crossings in their areas. Along with the consolidation of the states, these responsibilities were taken over by the central administration and cities, but the rural populace was still required to maintain rural roads and access roads to fields. Over time, this obligation changed into the obligation to work for free for the court or rural assembly *(gromada)* for approximately 32 days per year, which was officially enforced. The number of days and scope of work changed over the years, but it was only in the 19th century that buying one's way out of szarwark became possible. Money obtained this way was spent on maintaining local roads. Szarwark was abolished in 1958.

Inns and roadhouses were also located next to roads. They did not enjoy a good reputation. They were a meeting place for all social estates and served for entertainment, dancing, drinking, and gambling. Inns and roadhouses were not prepared for travellers, which resulted from traditions prevailing in Poland. The nobility stayed in courts, while merchants stayed the night in towns. Not having one's own horses and the need to replace them was «*humiliating*» and shameful. The lack of accommodation and board was incomprehensible to foreigners and often criticised, especially when it came to unpalatable meals seasoned with angelica, considered a miracle cure for all ailments.

It was a long time until public means of communication and connectivity appeared. Exchange of information – mail – carried out by messengers was organised privately by individual cities, rulers, feudal lords, religious orders, and universities. Differences in organising this task were enormous, but travel on foot was usually the common denominator.

Wanting to gain the sympathy of the magnates, State authorities often handed out privileges, and the situation reached its apex in the 17th century. Due to a climate of impunity, it became fashionable to rob passing merchants and dignitaries, and organise raids on the manors and estates of neighbours among the nobility. Regular groups or gangs were involved in these activities, and they were often fighting with each other. It was especially true for the southern part of the country. It became obvious that high tolls, duties, and robberies did not impact the condition of the road network positively. Poland's situation changed dramatically when, from the mid-17th century, the country became involved in wars, Turkish, Russian, and Swedish invasions, internal disputes and rebellions – which halted development and placed it on a downward spiral.#

To be continued in Routes/Roads 376, March 2018

ÉVÈNEMENT

CONGRÈS PPRS Nice 2018

26-28 MARS 2017
UN RENDEZ-VOUS INCONTOURNABLE

Le monde change rapidement, la mobilité impactée par les révolutions énergétiques et numériques change tout aussi rapidement : de nouveaux services et de nouveaux usages apparaissent comme l'auto-partage, le covoiturage ou les circulations douces et bientôt les véhicules autonomes.
Mais dans ces évolutions permanentes il y a une constante : **la route reste toujours le support essentiel de la mobilité** et singulièrement de ces nouvelles mobilités qui bouleversent notre quotidien.

Jacques TAVERNIER
Président du Congrès PPRS Nice 2018

Partout dans le monde la route assure plus de 80 % des déplacements de personnes et plus de 80 % des transports de marchandises !
Le réseau routier, routes et voiries urbaines, est donc un patrimoine public précieux, indispensable à la vie économique et sociale de l'humanité. C'est aussi un patrimoine coûteux, fruit des efforts d'investissement des générations passées, et malheureusement un patrimoine qui vieillit et se dégrade sous l'effet du trafic et des conditions météorologiques.

Ce patrimoine il est donc impératif de l'entretenir, de le préserver, de le moderniser et de l'adapter aux besoins et aux contraintes de notre temps, notamment environnementales.
C'est un enjeu crucial pour tous les pays, un enjeu difficile compte-tenu des contraintes budgétaires, des contraintes d'organisation territoriale, des contraintes de gestion et des contraintes techniques.

Le congrès PPRS (Pavement Preservation Recycling Summit) de Nice 2018 a précisément pour objectif de confronter les approches et les réponses de tous les acteurs concernés par cet enjeu : pouvoirs publics décideurs et techniciens, entreprises, ingénierie, usagers etc.

Le premier PPRS organisé à Paris en 2015 a réuni plus de 1 000 participants et a mis en évidence une réelle prise de conscience politique des enjeux de l'entretien et de la modernisation des réseaux routiers et des voiries urbaines. Il a mis en évidence aussi le dynamisme des professionnels de la route et leur capacité d'innovation.
Le PPRS de Nice vise à présenter des solutions concrètes expérimentées partout dans le monde et à offrir aux décideurs politiques et techniques un éventail de bonnes pratiques.
Quinze sessions traiteront notamment de l'organisation de la gestion du patrimoine routier, du financement, de l'économie circulaire, des innovations techniques et contractuelles, des attentes des usagers et des conséquences de la mobilité intelligente sur les infrastructures routières.

Organisé par de grandes institutions françaises et internationales (IBEF, USIRF, IDRRIM), soutenu par l'AIPCR, ce congrès sera le grand rendez-vous des professionnels de la route en 2018 et leur apportera un panorama complet des tendances et des innovations dans le domaine de l'entretien et de la modernisation de nos routes et de nos rues.

Au plaisir de vous rencontrer à Nice en mars 2018.

Jacques TAVERNIER
Président du Congrès PPRS NICE 2018

BIOGRAPHIE

Jacques Tavernier est Président de l'Ecole des Ponts Paris Tech, Président du Conseil d'Administration de l'IFSTTAR, Président du comité scientifique et technique de l'IDRRIM, ancien Président de l'USIRF (2014 – Juin 2017) et Président d'Honneur d'Eurovia.

Né en 1950, ancien élève de l'Ecole Polytechnique, il est ingénieur des Ponts et Chaussées. Au ministère de l'Equipement, où il a débuté sa carrière, Jacques Tavernier a notamment été directeur général de l'établissement public d'aménagement de la ville nouvelle de Sénart et directeur départemental de l'Equipement des Hauts-de-Seine.

Il a rejoint le groupe ASF en qualité de directeur général en 1998.
Jacques Tavernier était, depuis 2006, directeur général de VINCI Concessions et président-directeur général d'ASF.

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PUBLICATIONS

http://www.piarc.org/en/publications/technical-reports

TECHNICAL COMMITTEE 2.2

IMPROVED MOBILITY IN URBAN AREAS

Key issues for improving mobility strategies in large urban areas

2016R27EN, 978-2-84060-427-3, 101 pages

During the period 2012 - 2015, Technical Committee 2.2 *Improved Mobility in Urban Areas* collected and evaluated case studies on urban mobility from numerous large and medium-sized cities from all over the world. Three issues were evaluated in these case studies:

- a comparison of strategies for sustainable urban mobility, at a mobility plan level;
- design of transport infrastructure for multimodality in urban areas;
- promotion of walking and cycling.

In regard to the first issue, the objective was to find out how policies regarding transportation strategies, methods, and operations are decided and implemented by the authorities in an effort to solve current transportation challenges such as traffic congestion, ever changing population demographics, and environmental impacts. In order to benchmark system performance, mobility data at a metropolitan level was collected and analysed.

In regard to the second issue, the objective was to investigate the sustainability and efficiency of the increasing trend to dedicate travel lanes on existing road networks for use by buses, (bus rapid transit (BRT) systems) or carpooling (high occupancy vehicle (HOV)/high occupancy toll (HOT) systems)) to increase person throughput. The aim was to highlight and better understand the different practices observed among countries. We had also the objective to investigate the increasing motorcycle or scooter evolution, including its advantages and its drawbacks with regard to safety and road management.#

TECHNICAL COMMITTEE 2.4

WINTER SERVICE

Advanced technology for data collection and infomation to users and operator

2016R30EN, 978-2-84060-434-1, 50 pages

The study that is the subject of this report was defined in the PIARC Strategic Plan 2012-2015 approved by the Council of the World Road Association.The report provides brief summaries of projects from around the world, presented in the form of use cases that are representative of innovative ways of collecting, distributing, and making use of mobile data to assist transportation officials in their winter maintenance operations and to provide information to the traveling public.The use cases or case studies were selected because it is the belief of the authors that, when deployed, any of the technologies described will have a positive impact on transportation safety, mobility, the environment, and/or more efficient use of human and material resources needed to carry out their winter maintenance duties. As an added bonus, these use cases generally result in the traveling public being better informed, allowing users to make better travel choices and being more receptive to the technologies.#

PUBLICATIONS

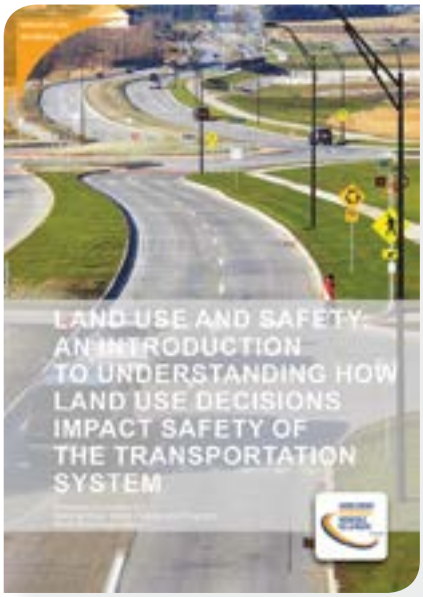
http://www.piarc.org/en/publications/technical-reports

TECHNICAL COMMITTEE 3.1

NATIONAL ROAD SAFETY POLICIES AND PROGRAMS

Land use and safety: An introduction to understanding how land use decisions impact safety of the transportation system

2016R32EN, 978-2-84060-440-2, 44 pages



Unplanned communities create hazards for road users of all types generating unsafe conditions for motorists on the roadway and significant dangers for pedestrians, bicyclists and residents alongside or adjacent to the road. While the World Road Association continues to investigate options and recommendations for communities that already exist in these environments, Technical Committee 3.1 generates this report to explain the relationship between land use and transport planning and the need for determined, thoughtful planning processes to prevent unsafe road conditions from developing. This report is not a design guide, but rather an attempt to inform the reader about the impact of fundamental land use and transportation decisions on the character and safe operations of the transportation system. Information in this report comes from contributions of the Technical Committee members and a literature review of international land use and transport planning research.

This report provides an introduction to land use planning concepts for non-experts and reviews the impacts that fundamental land use decisions (density, use, mix) and fundamental transportation decisions (functional classification of roads, transit availability, speed, access) can have on safety outcomes.

It begins with a discussion of the three main highway functional classifications - arterial, collector, and local roads - and the relationship between functional classification and land access. Arterials provide a high level of mobility and a greater degree of access control, while local facilities provide a high level of access to adjacent properties but a low level of mobility. Collector roadways provide a balance between mobility and land access.

This report also provides examples of where and how land use and transportation decisions are made in various government structures since the decision-making authority can vary in different countries. Lastly, it briefly explores several tools and techniques to improve safety in transportation and land use interactions.#

TECHNICAL COMMITTEE 2.5

RURAL ROAD SYSTEMS AND ACCESSIBILITY TO RURAL AREAS

Rural roads maintenance and improvement management

2016R33, only in French and Spanish

The work program of Technical Committee 2.5 for the 2012-2015 cycle included suggesting common policy directions for our countries and developing a maintenance management model for rural roads, with parameters that best respond to the actual needs of communities, by involving them throughout the whole process, and utilize everyone's input.

The issue was to promote public policies that aim at ensuring rural road service through a type of management that guarantees an adequate level maintenance and design. The aim is also to implement favorable conditions to a comprehensive development of rural populations.

It is in this context that three strategic lines were developed, including one related to rural roads maintenance and improvement management, which is analyzed in detail in this report.#

http://www.piarc.org/en/publications/technical-reports

TECHNICAL COMMITTEE 3.2
DESIGN AND OPERATION OF SAFER ROAD INFRASTRUCTURE

Vulnerable road users: diagnosis of design and operational safety problems and potential countermeasures

2016R34EN, 978-2-84060-442-6, 26 pages and appendices

Following the World Health Organisation, nearly half of those dying on the world's roads are vulnerable road users (VRU). This proportion is much greater in low- and middle-income countries, because of the greater variety and intensity of traffic mix and the lack of separation from other road users, than in high-income countries. Compared to other road users the vulnerable user group is particularly exposed to injury as they are not protected by a vehicle shell.

For years, pedestrians, cyclists, moped riders, etc. have been considered in the PIARC guidelines on road safety. However, considering that worldwide the total number of vulnerable road users deaths and injuries remains unacceptably high the PIARC 2012-2015 technical committee «*Design and Operation of Safer Road Infrastructure*» decided to review and update its guidelines, checklists and manuals emphasizing on the safety of this group of users.

As a first step a PIARC common agreed definition of VRUs has been proposed. This definition focuses on road users who are at great risk because of insufficient physical protection or because of relative high speed difference with potential conflicting modes. Through this definition a specific attention is given to four main categories of road users; i.e. pedestrians, cyclists, riders of powered two-wheelers, light duty farm vehicles or animal drawn vehicles. In a second stage the working group worked on listing infrastructure safety treatment solutions to mitigate risks for VRU sub-groups along urban and interurban roads.

In parallel the road safety audit (RSA) and inspection (RSI) checklists have been amended to account for the newly adopted definition. Checklists have been made more consistent to address safety issues related to pedestrians, cyclists, powered two-wheelers and other VRU subgroups.#

TECHNICAL COMMITTEE 3.3
ROAD TUNNEL OPERATIONS

Road tunnel operations: First steps towards a sustainable approach

2017R02EN, 978-2-84060-470-9, 69 pages

In terms of sustainable development, the current situation in the field of infrastructure varies greatly from one country to another. Certain countries have laid down regulations; a few have set objectives to be achieved, while others have no regulations at all. So far, the World Road Association has not issued any recommendations for road tunnels which reflect the current 'State of the Art' in various countries. This document has therefore been produced as an initial means of making up for this shortfall.

The main focus of the report is on tunnels already in use. However, as the options available for the operation of a tunnel are closely linked to the design and construction stages, the scope has been extended to all phases in the tunnel life. New tunnels are taken into account, with a range of economic, social and environmental aspects that could be considered when appraising schemes. Therefore, the construction phase and, most importantly, the design phase have been included in the reflections.

The report defines the concept of sustainable development and its relevance to road tunnels. It then examines existing regulations across the world, focusing particular attention on regulatory texts and requirements applying to road tunnels. Given the constant and rapid changes in this area, we cannot strive to be exhaustive.

Special attention is then paid to initiatives undertaken in the field of road tunnels, with both traditional cost-reduction actions and actions that encompass a more sustainable development approach. The report ends with recommendations and, to conclude, avenues for future studies in the field of sustainable development.#

PUBLICATIONS

http://www.piarc.org/en/publications/technical-reports

COMITÉ TECHNIQUE 3.3
ROAD TUNNEL OPERATIONS

Experience with significant incidents in road tunnels

2016R35EN, 978-2-84060-444-0, 67 pages

Approximately ten to fifteen years ago, many countries introduced tunnel safety management systems and started paying attention to tunnel safety in a more structured way. PIARC report 2007/R07 recommended an integrated approach to tunnel safety. As a result of this, many countries have gained experience with the application of various tools for tunnel safety management. Experience with tunnel incidents and methods for incident evaluation and risk analysis have led to developments in organisation and management and to improvements in the systems in use. In this report several contributing countries share information on lessons learned from incidents and developments in safety management and risk analysis and conclusions are drawn on topics of general interest.

As documented in chapter 2 of this report, the collection of data on significant incidents in road tunnels is carried out in a systematic manner in many countries. It has been noted that in practice, collecting all necessary data for a good evaluation leading to improving safety procedures or to produce incident statistics that can be used in risk analysis, is not easy and can be very time consuming. It is therefore important that the required data is clearly identified and that it is determined which data shall be collected by each party involved and at what time (immediately after incident or at a later stage).

In chapter 3 collision rates for several countries are presented. In general, collision rates represent average values for a certain set of tunnels investigated. It has been determined in several studies that collision rates are influenced by many parameters. In the report a list of the most influencing parameters is given., e.g. tunnel length, traffic volume, horizontal alignment, lane width, tunnel cross section, quality of tunnel lighting, traffic composition, driving speed, and - last but not least - national driving habits and the technical standard of the vehicles in use. All these influencing factors make it difficult to compare collision rates on a statistical level. The report provides a comprehensive list of all relevant data concerning collisions, which should be collected in order to improve the quality of information.

In chapter 4, new information on fires rates has been compiled, based on tunnel fire statistics from 12 countries around the world. However, the scatter of the rates from tunnel to tunnel may be very significant as a number of factors may influence the recorded fire rates. The fire rates should be used with care, and the assessment of the applicability and the modification of the basic rates required for an application for a given tunnel should be done by experts with experience in tunnel safety.

Chapter 5 focusses on real incidents at the level of an individual tunnel. It provides a realistic idea of incidents happening in road tunnels as well as examples of conclusions and improvements that can be identified for specific incidents and tunnel systems.

Practical experience with risk assessments is described in chapter 6. Several countries shared their experiences with risk assessment in the past decade. From these contributions it can be noted that there are some differences between countries in methodology they use. Typical applications for risk assessments are: to demonstrate that the tunnel is safe enough; as a decision-making tool to compare various alternatives or to decide on risk; to determine performance and/or reliability requirements of safety systems; to provide insight into the residual risk; for the classification of the tunnel with respect to transport of dangerous goods.

In all countries risk analysis is applied as an additional tool complementary to prescriptive guidelines and regulations. Experiences in the past decade and input from real incident data and statistics have been used to improve risk analysis methods. Vice versa, risk analysis methods are used to improve prescriptive guidelines.

Based on the information in this report we can conclude that use of an integrated approach to tunnel safety is becoming practised more and more in several countries. Experience with this approach and lessons from real incident data are used for further improvements in tunnel safety. This report can be used as a reference to further improve the integrated approach to tunnel safety, especially the requirements and key aspects to data collection and risk assessment in this approach.#

CEREMA

LES PRÉMISSES D'UNE SIGNALISATION ROUTIÈRE EN TRANSITION

La signalisation routière évolue régulièrement, nombre de ces évolutions sont liées aux changements de comportement. Ceux-ci sont à considerer dans les champs de l'urbain et de l'interurbain où ils n'ont pas les mêmes caractéristiques. Entretien avec Georges Tempez, directeur de la Direction Technique Infrastructures de Transports et Matériaux du Cerema.

Georges Tempez, Directeur technique Infrastructures de Transports et Matériaux

Quels sont les nouveaux besoins de la société et des usagers de la route?

Dans le champ de l'urbain, les principales évolutions sont liées au partage de la voirie avec l'accroissement des modes actifs (vélo, piétons, etc..) et la multiplication des risques de conflits, notamment en entrée et en sortie des zones de partage. On peut également souligner la problématique particulière des piétons de plus en plus distraits par leurs smartphones par exemple. Ces nouveaux besoins nécessitent des signalisations qui guident les usagers en sécurité, pour eux-mêmes et pour leur environnement.

Dans le champ de l'interurbain, on est davantage dans la recherche d'une meilleure productivité de l'infrastructure (moins de congestion, plus de fluidité des debits, etc...); les usagers souhaitent aujourd'hui être informés le plus directement et le plus rapidement possible.

Comment les nouvelles règles de droit intègrent-elles les besoins en question?

Parler de règle de droit reste complexe. Le partage de voirie en urbain pose par exemple la question de la priorisation entre les différents usagers et modes de transport. Aujourd'hui, la règle prévoit de favoriser le plus vulnérable. Cependant, lorsque les modes vulnérables sont de plus en plus rapides, des questions de conflits entre usagers vulnérables se posent.

Quand il s'agit d'améliorer le rendement de la route, une des difficultés pour rendre la route plus productive est de faire varier par palier les vitesses qu'on peut y pratiquer, de réguler les accès etc. Il faut alors s'assurer que les usagers aient bien pris connaissance de la règle, et parallèlement, par exemple, adapter les radars automatiques. Comment garantir qu'à cet instant T telle vitesse est en vigueur? : nous devons mettre en place des systèmes opposables, auditables et traçables.

Par ailleurs, l'apparition du véhicule autonome va remettre largement en question la hiérarchie du droit; c'est un des problemes majeurs pour les assurances.

Quels sont aujourd'hui les nouveaux supports de signalisation?

Les nouveaux supports apparaissent notamment là où il s'agit d'améliorer le rendement de l'infrastructure. On passe d'un support de signalisation unitaire à un "support systémique" composé de tout un réseau de capteurs, d'informations dans les véhicules eux-mêmes, en bord de route et qui vont constituer la signalisation. Au bout du compte la signalisation reste concrète mais avec une partie virtuelle.

Le nouveau support que l'on voit apparaître, pour tous les types de transport, est le véhicule lui-même: la signalisation elle-même n'est plus uniquement en bord de route mais également dans le véhicule. Cela nous renvoie aux problèmes de droit: comment s'assurer, comment garantir que l'information reçue par l'usager dans (ou sur) son véhicule est réglementairement la bonne?.

Comment garantir finalement le maximum de sécurité et de fluidité?

C'est un enjeu complexe là aussi. Quelque soit le problème considéré, on est toujours ramené aux sujets de la maîtrise de la vitesse et de la distance (distance aux autres véhicules, distance aux obstacles,....). Tous les systèmes devront permettre de garantir d'une part une vitesse adaptée au contexte (type de route, densité de trafic,...) et d'autre part de gérer les distances (distance d'arrêt liée à la vitesse, distances latérales aux autres usagers et aux obstacles,...). L'enjeu principal est alors de pouvoir donner, gérer et redistribuer les informations.

Pour ce qui est des modes actifs en zone urbaine, le sujet de la vitesse est également important (avec l'augmentation du mombre de vélos électriques par exemple..) mais on a également besoin, par exemple, de trouver le bon vecteur d'information pour les piétons distraits (flash lumineux ou sonores,....). Sur ces sujets des recherches ont lieu aujourd'hui au niveau international pour trouver des solutions gérables techniquement et financièrement et qui puissent être mises en place sans trop de difficultés.

La France prend-elle exemple sur d'autres pays pour faire évoluer ses règles?

On regarde ce qui se passe dans les autres pays pour réfléchir à ce qu'il est opportun à mettre en place chez nous. Les sujets renvoient souvent à ceux de la sécurité routière. Le couple est très fort entre signalisation et sécurité routière. Dans le cadre même de l'AIPCR il y a des comités techniques qui parlent sécurité et qui donc parlent signalisation. La France a également une série de coopérations bilatérales dans lesquelles des groupes traitent de sécurité routière, de signalisation etc. Au niveau du Cerema, nous entretenons des relations annuelles avec nos collègues suisses de la VSS et, par exemple, à la fin de notre dernière session, nous avons échangé sur le problème de partage de voirie avec les vélos dans les villes et les impacts sur la signalisation et les problèmes à traiter.

■

Deutsch

Im Abstand von vier Jahren stellt der Weltstraßenverband PIARC die von seinem Technischen Komitee für den Winterdienst (B.2) unterstützten Arbeiten im Rahmen eines internationalen Kongresses vor. Die nächste Tagung wird vom 20. bis 23. Februar in Danzig (Polen) stattfinden. Gemäß dem Strategischen Plan 2016-2019 des Verbandes leitet das Komitee auch die Vorbereitungen für den Kongress. Hierzu zählen insbesondere die Ausarbeitung des wissenschaftlichen und technischen Programms, die Auswertung der Abstracts und vollständigen Fachbeiträge sowie die Organisation und Koordination von technisch synchronisierten Sitzungen. Und das alles, ohne die Produktion des Snow and Ice Data Book aus dem Blick zu verlieren.

Viele Länder legen derzeit den Schwerpunkt nicht auf den Ausbau oder die Verdichtung ihres Straßennetzes, sondern auf die Ressourcenoptimierung und Nutzung bestehender Netze. Diese Verlagerung erfordert eine ständige Verbesserung sowohl der Organisationen als auch der Praktiken. Bei der Erbringung von Straßenwinterdiensten ist man stark auf die bereits bestehenden Organisationen angewiesen, da solche Dienste nicht ohne weiteres im Voraus geplant werden können. Diese Überlegungen werden zunehmend dringlicher, da der Klimawandel zu extrem unbeständigen Wintern oder winterlichen Witterungsschwankungen führt – von heftigen Schneefällen bis hin zum völligen Fehlen winterlicher Straßenverhältnisse.

Der Winterdienst betrifft eine Vielzahl von Aktivitäten und Praktiken. Dieses Thema ist relativ komplex. Gleichzeitig gibt es viele Themen, die bei der Ausrichtung eines Winterkongresses berücksichtigt werden sollten. Das für den Danziger Kongress vorgesehene wissenschaftliche Programm zielt auf die oben dargelegten zunehmenden besorgniserregenden Ereignisse ab. Das übergreifende Kongressthema „Providing a Safe and Sustainable Winter Road Service“ (sicherer und nachhaltiger Winterdienst im Straßenverkehr) soll dieser Komplexität angesichts der Notwendigkeit Rechnung tragen, die Förderung der wirtschaftlichen Entwicklung mit den gesellschaftlichen Anforderungen und dem Umweltschutz in Einklang zu bringen.

Rund 300 Abstracts aus aller Welt wurden für den 15. Internationalen Winter Road Congress 2018 der PIARC in den acht Themenbereichen eingereicht. Unter diesen Einreichungen befassen sich die rund 150 angenommenen Arbeiten konkret mit den vorgeschlagenen Themen. Als kleine Vorschau stellen wir Ihnen in dieser Ausgabe von Routes/Roads einige „ausgewählte Highlights“ aus längeren Beiträgen vor.#

Português

A cada quatro anos, o culminar da atividade desenvolvida no âmbito do Comité Técnico da AIPCR dedicado à Viabilidade Invernal (i.e., Comité B.2) é demonstrada no palco de um Congresso Internacional, estando o próximo agendado para 20 a 23 de fevereiro de 2018, em Gdansk (Polónia). De acordo com o Plano Estratégico 2016-2019 da Associação, foi cometida a esse Comité a missão de conduzir as atividades de preparação do Congresso, em particular definindo o seu programa científico e técnico, avaliando resumos e artigos, e por último organizando e coordenando as sessões técnicas, sem deixar de estar encarregue da produção do Data Book Neve e Gelo.

Em muitos países, o foco neste momento não está na expansão e densificação da sua rede rodoviária, mas na utilização e otimização dos recursos da rede existente. Essa mudança de abordagem requer uma melhoria constante de organização e de práticas. A prestação de serviços no âmbito da viabilidade invernal está altamente dependente de organizações já instaladas, uma vez que se trata de serviços que não podem ser agendados com antecipação. Estes considerandos são tanto mais importantes quanto as mudanças climáticas resultam em invernos, ou padrões climatéricos invernais, mais voláteis, que variam entre nevões agressivos e, em contraste, a completa ausência de qualquer evento climatérico digno de nota para efeitos rodoviários.

Os services relacionados com a Viabilidade Invernal afetam um número significativo de atividades e práticas: esta matéria é relativamente complexa e os tópicos que requerem atenção, no âmbito da realização de um Congresso de Estradas de Inverno, não são poucos. O programa científico adotado para o Congresso de Gdansk pretende dar resposta às preocupações crescentes acima referidas. O tema fundamental do Congresso, “Assegurar uma Viabilidade Invernal Segura e Sustentável”, pretende endereçar essa complexidade, à luz da necessidade de compatibilizar o desenvolvimento económico, as necessidades da sociedade e a proteção do ambiente.

Praticamente 300 resumos vindos de todo o mundo foram submetidos ao XV Congresso Internacional da Estrada – Inverno de 2018, cobrindo os oito tópicos. De entre essas submissões, as cerca de 150 comunicações aceites abordam especificamente os temas propostos. Este número da Routes/Roads, procurando dar a conhecer uma breve antevisão desse manancial, tem o prazer de lhe apresentar alguns destaques selecionados, extraídos das comunicações mais longas.

GDAŃSK
Poland 2018

XVth International Winter Road Congress

" Providing Safe and Sustainable Winter Road Service "

Gdańsk (Poland), 20-23 February 2018

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