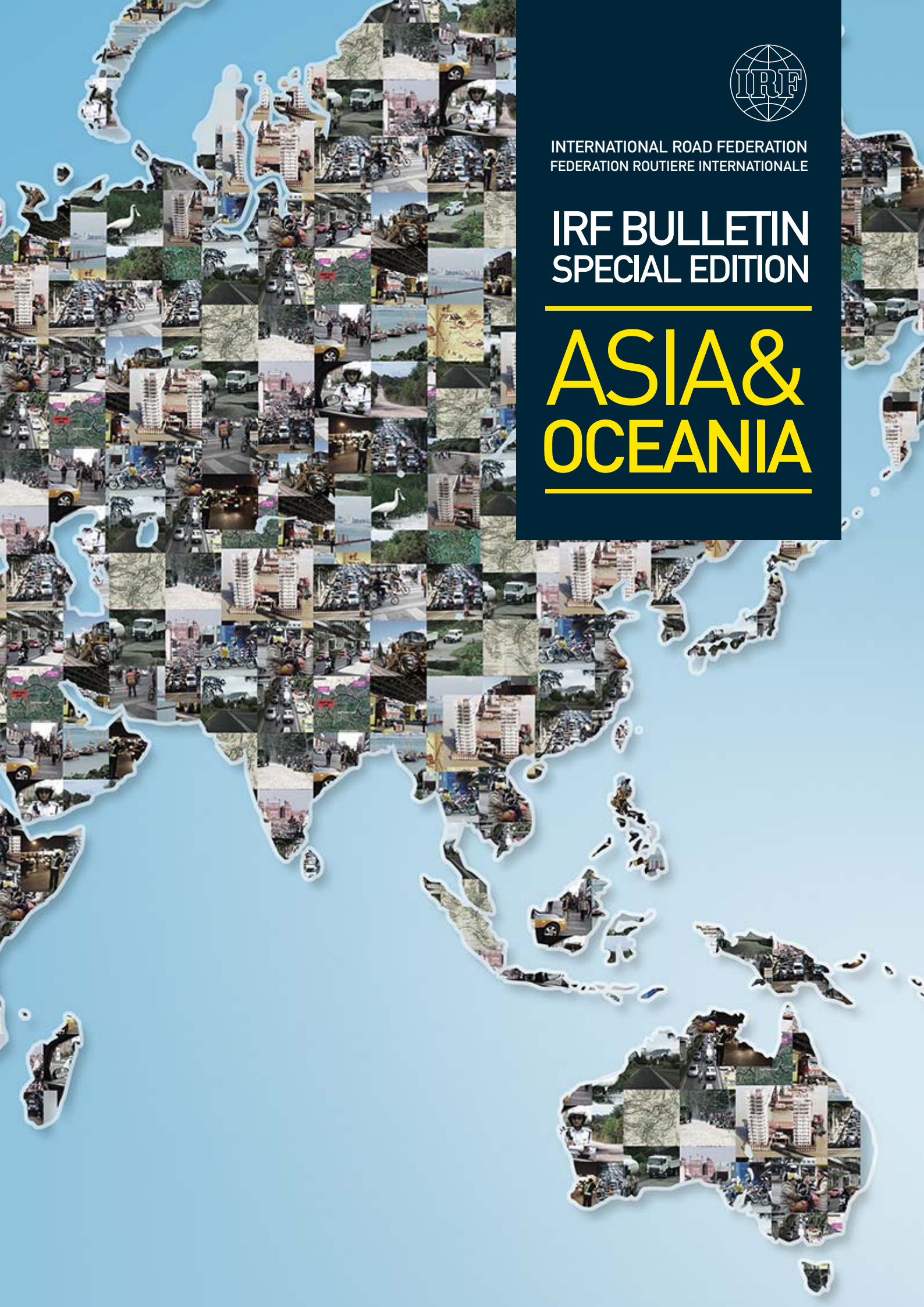


INTERNATIONAL ROAD FEDERATION
FEDERATION ROUTIERE INTERNATIONALE

IRF BULLETIN
SPECIAL EDITION

ASIA& OCEANIA



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INTERNATIONAL ROAD FEDERATION
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Senior Road Executive Course
11-23 May 2009

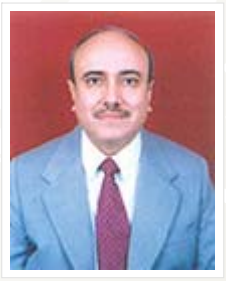
- **Road Financing & Road Fund Management** (11th May – 13th May 2009)
- **Restructuring Road Management** (14th May – 16th May 2009)
- **Road Maintenance Management** (18th May – 20th May 2009)
- **Road Infrastructure Safety** (21st May – 23rd May 2009)

Background
The road sector is going though an unprecedented period of restructuring. Countries are improving management of their road networks, introducing private sector finance, setting up new style road funds and changing the way they set spending priorities and manage their roads. Furthermore, road safety has become a major issue, with it being a recognised by the world community as an unprecedented endemic.

Who should attend
Road executives, members of roads boards, government officials dealing with the road sector, staff from international donor organisations, and consultants working on the road sector, staff from private sector such as construction companies.

2-week courses (4 modules of 3 days)
The two-week courses consists of 4 modules of 3 days, involving presentations, discussions, group exercises and site visits. The courses facilitate an international exchange of ideas and common experiences, and provide a forum for the dissemination of emerging good practice.

Course recognised by:
- The World Bank
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- International Road Federation



EDITORIAL

There is no region of the world where disparities of infrastructure development and wealth distribution are as evident as in the Asia and Pacific region. From the hyper technological metropolis to remote and inaccessible villages, this vast region is a real challenge for transport planners and operators and certainly requires innovative and imaginative thinking.

The opening and on-going rapid growth of China, India and other Asian economies have created new chances and challenges. The revival of the Silk Road is now a matter of economic necessity. Road transport is very often the only possibility to carry vital foreign trade between Asian states, particularly those that are land-locked.

The urgency for infrastructure development is as evident in Central Asia as it is in New Delhi or Papua New Guinea. It is crucial to the economic development and the quality of life of every single citizen.

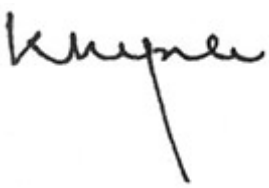
Road safety is still the missing protagonist in the growing demand for mobility that this region is experiencing. If you think that India alone accounts for 10% of the 1.2 million deaths caused by road accidents, you can easily understand the size of the problem.

Investment in road infrastructure has been worldwide identified as one of the major tools for reversing the recession trend in the economy. Substantial financing is certainly needed to secure infrastructure, but we should not forget that this is only part of the solution. Global processes require global responses. Framework instruments like the ones developed by the United Nations are essential to address major challenges, such as harmonization of border crossing procedures or road safety issues. But these instruments must be adjusted to local experiences in order to be effective and to translate vision into reality.

In this spirit, the International Road Federation has just inaugurated an IRF India Chapter in New Delhi, of which I have the honour to be the Chairman. The IRF has helped with the years to raise awareness on the specific needs of this region of the world and encouraged governments to intensify efforts to improve the sustainability of their transport systems.

At the same time it has been instrumental in building the relationship between local authorities and international and regional organizations. With this new office, the IRF wishes to reinforce and broaden its presence in the region and ensure that recommendations are translated into practicable action at the earliest.

A famous maxim from Lao Tzu says that a thousand mile journey starts with a single step. This Bulletin will accompany you in a tour around this promising region



Kiran K. Kapila
Vice Chairman IRF Geneva
Chairman of IRF India Office

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Financing roads from tolls has become a "mature" industry in itself. But, for various reasons, tolls alone cannot replace publicly funded road development and the tolling industry must make itself more attractive to potential finance. The Asian Development Bank is finding new ways to address old problems in countries such as Papua New Guinea.

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Improving road safety depends on both the strategic efforts of national governments and the tactical efforts of local authorities and communities. But increasingly, there is a third element - the personal engagement of local professionals and communities based on their own cultural and economic circumstances and competencies. It is a step-by-step process of raising public awareness and securing political commitment. "See and be seen" is a slogan for adoption at every level.

25 **Sustainable Roads**

It is a happy coincidence that many of the roads in Asia which are necessary and being laid down for the first time have the benefit of the latest perceptions of long-term ecological viability. And, concepts such as pavement recycling have a very large potential in the undertaking of major road reconstruction.

TRANS-NATIONAL HIGHWAYS AND NATIONAL PROGRAMMES

The revival of the old "silk roads" is not a matter of romance but of economic necessity; the new silk roads have enormous potential for the entire Eurasian continent and especially for the countries of greater Central Asia. Countries such as India have upgraded their own major highways to complement and enhance such east-west links. Australia is upgrading its road infrastructure to the level its economy demands.

Boosting trade between Europe and Asia: The Silk Road

Susanna Zammataro
Deputy Director General, IRF GPC

In the 14th century it would take a caravan up to a year to make the 6,000 km Silk Road trip, or 10,000 km if one included the back roads and side trips. Silk was the main commodity moving from east to west. From the opposite direction came wool, ivory, glass and precious metals.

Similarly now, most of the traffic along the Silk Roads travels relatively short distances, and international traffic is less than one in ten of all vehicles. International transit is, however, increasing and is forecast to become a dominant factor in the future. Most of the international road traffic is carried on a core network of around 20,000 km of mainly two lane roads.

Almost half the world's cargo traffic consists of goods transported between Europe and Asia. Currently, the international trade of the Central Asian countries is some USD 50 billion, of which 5 billion is trade between the Central Asian republics themselves. Freight operations on the Silk Roads create annual revenue of over USD 1 billion for transport companies and transit countries.



Over time all manner of goods were carried along these roads, from the most expensive cloth to the most mundane. But few, if any, individuals made the entire trip. Instead, goods were passed along through an intricate network of middlemen who rarely travelled outside their own region.

In the 1990s Turkey, he Caucasian and Central Asia States agreed to re-establish the Silk Road railways, filling in the missing links between Mashad, Iran and Turkmenistan, and between Kars, Turkey and Tiblisi, Georgia. The "new Silk Roads" have enormous potential for the entire Eurasian continent, and especially for the countries of

greater Central Asia, which they must traverse. Many states, notably China and Japan, have embraced the expansion of free trade across the emerging Eurasian continent as an effective engine for development, an efficient means of creating jobs, and a reliable method of generating government income on a continent-wide basis. Today, the volume of trade between Europe and the Far East exceeds USD 300 billion and the volume of goods transported exceeds 40 million tonnes. The revival of the Silk Road will reduce transportation costs by 50%.

Over the last decade the IRF has supported the redevelopment of the ancient Silk Roads with a series of conferences focusing on the practical aspects of the rehabilitation of these roads. The last of these conferences was held in 2007 in Istanbul.



Senior delegations from all countries of the Black Sea region and the countries along the Silk Roads exchanged views with international organisations, international financial institutions, governmental organisations, non-governmental organisations, and a very large number of companies and private sector organisations. The conference underlined that the provision of good quality land links between Europe and Asia requires investment to bring existing infrastructure up to standard and to build missing links, chiefly in border areas. The limited resources available and the need to ensure good coordination between projects entail the development of a planning process on an international scale and a selection of projects after an in-depth review of their suitability.

Infrastructure bottlenecks are undoubtedly part of the problem but institutional reforms should not be neglected. Delays at borders counteract the effects of upgraded highways. We need, urgently, simplified and standardised border control procedures; development of cross country co-operation among customs administrations with their immediate neighbours as well as among other countries along the corridor both at the political and custom station level.

NEW EURASIAN LAND TRANSPORT INITIATIVE
NELTI

To this end, the IRU NELTI project is the practical implementation of tasks and principles articulated by governments of the Eurasian region. However, it has required the implementation of UN Facilitation Agreements and Conventions, including the TIR Convention, to facilitate border-crossing and to harmonise customs procedures. More efficient traffic flows between Europe and Asia will stimulate trade, investment, tourism and employment and will thereby contribute to strengthened prosperity and peace in all countries along the Great Silk Road. To achieve this goal, it is imperative that development of transport infrastructure across the region are considered as a coherent network, not simply a collection of national projects.



(c) IRU

Developing Euro-Asian Transport Links

Michalis P. Adamantiadis
Chief, Transport Facilitation & Economics Section, Transport Division, United Nations Economic Commission for Europe (UNECE)

Globalisation has led to significant increases in trade and transport between Asia and Europe. Most of the cargo traffic has chosen increasingly congested - but still the least costly - maritime routes, pointing to the need to further develop and promote inland Euro-Asian transport links. These routes, once established, could provide credible and competitive transport options for traders and shippers. They could also become an effective tool for stimulating economic development and integration of the Euro-Asian region, including landlocked countries of Central Asia.

But, for historical and economic reasons, transport links in many countries along the traditional Silk Road are insufficiently developed. The persistence of non-physical bottlenecks, such as cumbersome, costly and time-consuming border crossing procedures, excessive documentation requirements, unofficial payments, and unexpected closures of borders, together with inadequate transport infrastructure, discourage transport operators from using Euro-Asian inland transport routes.[1]

The UNECE started in 1995 to address this issue. In 2000 and 2002 the UNECE road and rail infrastructure agreements were extended, to incorporate the Caucasus and Central Asian links. It also developed, together with ESCAP, a common strategic vision for the development of Euro-Asian links.

The greatest progress has been achieved since 2003, when UNECE and UNESCAP began to promote cooperation among the countries directly concerned. All East-European ECE countries that were not EU members at that time, Caucasus and Central Asian member countries, and other interested ESCAP members, including China, were invited to participate.

In four Expert Group meetings (from 2003 to 2007) organized under Phase I of the Euro-Asian Transport Linkages (EATL) Project, Government representatives from the countries concerned identified the main Euro-Asian road and rail routes to be considered for priority development as well as the main transhipment points and ports along them



In this project, 230 investment opportunities worth USD 43 billion, have been evaluated and prioritized, using a methodology similar to that of the Trans-European Motorway (TEM) and Trans-European Railway (TER) Projects' Master Plan. Around half the projects have secured financing and are likely to be implemented in the medium term.

Non-physical obstacles, which constitute a major barrier to Euro-Asian transport, have also been addressed in the context of this project. Capacity-building workshops on the facilitation of international transport along Euro-Asian transport links were organized in Azerbaijan, Belarus, Georgia, Kyrgyzstan, Moldova and Ukraine.

The first phase of the United Nations EATL project culminated in February 2008 with the ministerial meeting in Geneva. During that meeting, transport ministers and

high-level officials from countries across the Euro-Asian region, Western European high-level officials and representatives from international institutions confirmed their support to the UNECE-UNESCAP EATL project and its continuation. Ministers and high level representatives of 19 countries involved with the project endorsed the identified Euro-Asian routes and their priority development and signed a joint statement on future development of Euro-Asian transport links calling for continuation of the EATL project.

EATL Phase II (2008-2010) is already building upon the successfully implemented Phase I. For more information on the project: **www.unece.org/trans/main/eatl.html**

The Asian highways network - genesis and initiatives taken to develop the routes in India

Shri Nirmal Jit Singh, Shri A. N. Dhodapkar and Shri Sudip Chaudhury
Department of Road Transport & Highways, Government of India

The Asian Highway Network Project was started in 1959 by the Economic and Social Commission for Asia and the Pacific of the United Nations (UNESCAP) to promote the development of international road transport in Asia and to facilitate international trade and tourism. It is intended to provide connectivity between (i) capitals of member countries, (ii) main industrial and agricultural centres, (iii) major sea and river ports, (iv) major container terminals and depots, and (v) places of major tourist attraction.

In 2002 UNESCAP established the Working Group on the Asian Highway to develop a regional inter-governmental agreement to formalise the network. The fourth session of UNESCAP's Committee on Transport, Communications, Tourism and Infrastructural Development then recommended the convening of an inter-governmental meeting to consider and adopt the agreement. UNESCAP conducted seminars in 2003 in different sub-regions, to brief member countries. The seminar for the SAARC sub-region was held at New Delhi on 16-17 October 2003. In November 2003, an inter-ministerial meeting was held at New Delhi. The inter-governmental agreement was signed at Shanghai in April, 2004. The objectives of the Agreement are:

- Formalisation of the Asian Highway Network.
- Coordinated development of Asian Highways to a minimum prescribed standard.
- Review mechanism for the routes, design standards and signs.

The Asian Highways Network: at present, the Asian Highways Network extends to 32 countries. Its total length is more than 141,000 km. Two Asian Highways, namely AH-1 (from Tokyo (Japan) to the border of Bulgaria) and AH-2 [from Denpasar (Indonesia) upto Khosarary (Iran)] pass through India. AH-1 connects India with Pakistan, Bangladesh and Mynamar; AH-2 connects India with Nepal and Bangladesh. In addition, there are six sub regional routes in India. Of these, three have connections with Nepal, Sri Lanka and Bhutan. The remaining three are entirely within India. There are eight Asian Highway Routes in India including AH-48. The total length of the Asian Highways in India is about 11,458 km, comprising 11,432 km of National Highways and 26 km of State roads.



Source: *Transport and Tourism Division, UNESCAP, Bangkok*

The Inter-Governmental Agreement on the Asian Highway Network laid down the Asian Highway Classification and Design Standards for the following four classes:

- Primary - access controlled highways (asphalt or cement concrete) - 90 km
- Class I - highways having 4 or more lanes (asphalt or cement concrete) - 3,787 km



- Class II - highways having 2 lanes (asphalt or cement concrete) - 1,962 km
- Class III - highways having 2 lanes (double bituminous treatment) - 5,690 km

Their geometric standards have also been specified.

Initiatives taken by India: India signed the Inter-Governmental Agreement on the Asian Highways Network in April, 2004; the Agreement came into force from 2005. India has participated actively in the programme since its inception. The standards of the portions of Asian Highways in India are generally at least to the prescribed minimum standards of the Asian Highway; development of Asian Highway routes is within the framework of the national programme, in conformity with the Agreement. The road signs showing the Asian Highway Routes in India will all be in place within 5 years from the date of entry into the Agreement.

About 1,500 kms of NHs in India coinciding with the Asian Highways Network have been categorized under Class II only because they do not meet the stipulated standards for right-of-way and median widths for Class I. Similarly, about 5,000 kms of NHs on the Asian Highways Network in India are of Class III category mainly because their actual available right-of-way and shoulder widths are less than the standards stipulated for AH Class II category.

Out of 11,432 km of Indian NH roads on Asian Highways routes, about 5,200 have been developed to 4-lane standard under the National Highways Development Project (NHDP); development of 4-lanes of about 1,400 km is underway and about 2,500 km of National Highways have been earmarked under various phases of NHDP, about 150 km of National Highways have been identified for development to four lane under SARDP-NE. Thus, about 9,250 km of Indian NH roads along Asian Highways are either already developed to 4-lane standards or programmed to be developed. The development of the Asian Highways Network in India, as well as in SAARC and ASEAN countries, will facilitate increased trade, transport, tourism and economic development.

Asian Highway Route AH-48 is presently passing through Thimphu-Phuentsholling in Bhutan and extends to the Indian border. In March 2008 India proposed to UN-ESCAP an extension of AH-48 from Thimphu-Phuentsholling - Jaigaon (in India, on the India - Bhutan Border) to connect to AH-2 at Phulbari via Hashimara and Jalpaiguri. Incorporation of India's proposal would greatly improve trade and tourism for India, Bangladesh, Nepal and Bhutan.

Conclusion: India recognizes the importance of strengthening road transport infrastructure for overall development of trade, the economy, of regional balance and international co-operation. India remains committed to assigning due priority for development of internationally significant road infrastructure within the framework of national priorities. The work and initiatives described are manifestations of this commitment.

Australia renews its focus on infrastructure needs

Ray Fisher
President, Roads Australia and IRF WEB Member

IRF's local representative member, Roads Australia (RA), is the peak body of road industry stakeholders, with members drawn from across the public and private sectors. 2009 shapes as a big year for roads in Australia, with the promise of significant Federal Government investment in infrastructure. This comes on top of the already substantial spending commitments by state governments.

The Australian road industry has been buoyed by the Federal Government's proactive approach to the challenge of bringing the nation's infrastructure into the 21st century. In its first 12 months in office, the Government has created a new statutory independent body, known as Infrastructure Australia (IA), charged with prioritising and overseeing the task of modernising the nation's transport, water, energy and communication assets.

In December 2008, Infrastructure Australia delivered a preliminary audit of the nation's key infrastructure assets and a list of projects for further analysis and prioritisation. From that initial list a final Priority List is due to be handed to the Government in the first quarter of this year. The Government has already committed AUD12.6 billion to fund transport and communications infrastructure, with the promise of more to come.

The big question remains: how much funding will be earmarked for road infrastructure, and how much private sector investment will be brought to the table given the economic uncertainty associated with the global financial crisis.



Australia's Federal Infrastructure Minister, Anthony Albanese (left), with Roads Australia President, Ray Fisher

The Federal Government's renewed focus on infrastructure represents a significant injection to the already substantial road budgets managed by the states. State governments, particularly those of the most populous states-Queensland, NSW and Victoria-are planning for and spending record amounts out of their own budgets on road infrastructure and road safety. All levels of government are recognising the economic and social importance of an efficient, safe, modern road network.

Among the key road projects included in Infrastructure Australia's initial list for further analysis are the Pacific and Bruce highways, the major eastern seaboard road corridors linking Sydney and Brisbane, and Brisbane and Cairns, respectively. Along with the Hume Highway between Sydney and Melbourne, these highways are the backbone of Australia's national road freight network and have received significant Federal and state government funding over the last decade.

Also on the list are key metropolitan road and rail works across all capital cities aimed at addressing the problems of urban congestion and freight movement. Congestion is a major problem in all Australia's major cities and governments are under enormous pressure to do something. While there is a clear need for new transport infrastructure, including new roads, one of the greatest challenges is to get more out of our existing urban road networks. That is a challenge the various state road authorities recognise and are tackling head-on.

The promise of new and renewed infrastructure will invariably open the door to private investment opportunities and a variety of public-private funding models. Federal Infrastructure Minister Anthony Albanese has publicly stated his Government will assess the funding of projects put forward by IA on their relative merits, considering either public provision, private provision or a combination of both. And, to underline the importance of keeping private investors onside and interested, the Government-again through IA-has recently developed a new, nationally consistent set of guidelines for Public Private Partnerships (PPPs).

On the flip side, the private sector is looking to governments around Australia to provide not just the vision but firm planning commitments for new infrastructure. We are seeking governments-both Federal and state-to take a more coordinated approach to project planning and timetabling so the construction sector can marshal its resources efficiently and effectively to undertake the work.

For this, the advent of Infrastructure Australia is a step in the right direction. So too is the long-term planning work done by various state governments such as Queensland with its South-East Queensland Infrastructure Plan (SEQUIP) and, more recently, Victoria with its 10-year Transport Plan.

Despite the current economic gloom, the long-term prospects for the road industry in Australia look good. There is an identifiable need for new and improved road infrastructure, a willingness by governments to commit to it, and an efficient and capable private sector ready to deliver it. But we also face significant challenges. Because of the size and extent of Australia's road network, road maintenance and renewal is a huge and costly issue. On this, we are falling behind - and finding funding solutions to adequately address the backlog is a major challenge for all governments.

MATERIALS FOR ASIAN ROADS

There are historical reasons for the use of pure bitumen, rather than emulsions, on Asian roads. But things are changing and emulsions are coming into their own. Part of the change will involve the use of waste products from other industries.

Bitumen emulsions in India: past, present and future

Étienne le Bouteiller
Technical & Development International Manager, Colas SA

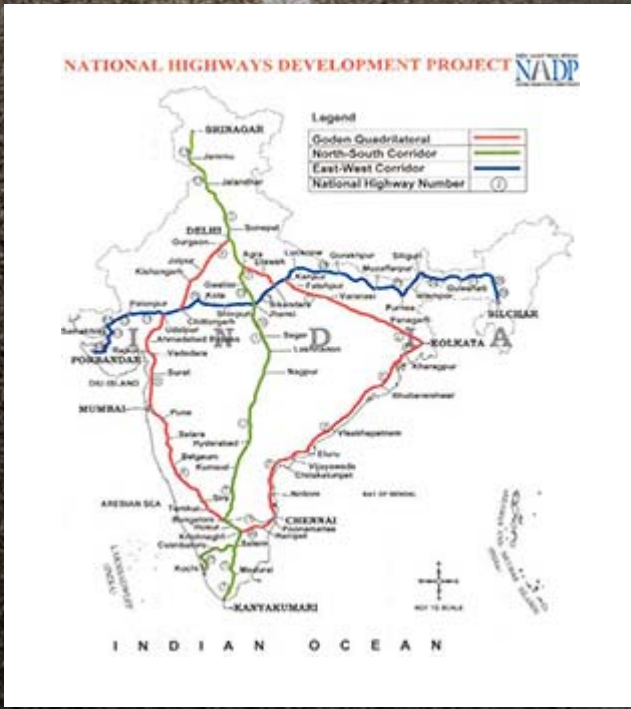
A short history: bitumen emulsion is not a new technique in India. Some uses that date to the 1930s have even been reported. However, the technique could not attain the position it should have had, from that time onwards. The competition of hot bitumen associated with traditional uses has been predominant for a long time.

At the beginning of the 1990s, reported annual volumes were in the range of 10 to 20,000 tonnes, produced by several small plants that could not afford to acquire the real knowledge that could have helped to update the technique. For that reason, bitumen emulsion suffered from a poor reputation.

With the development of the internal market boosted by the authorities' willingness to improve road infrastructure, some big players started reconsidering developments using the technique. In this respect, Indian Oil Corporation and Hindustan Petroleum Corporation Ltd started up emulsion factories close to the main markets, such as Delhi, Mumbai and Chennai.

Along with such new developments, technologies from abroad were introduced and the standards were updated in such a way that the technique could be implemented within a suitable and accepted framework.

Current use: for the past 10 years, the development of bitumen emulsions has been the result of three factors: the introduction of modern techniques by the local and powerful oil industry, supported by international players; the development of the road network, and especially the "Golden Quadrilateral", followed by the North-South and East-West corridors; acceptance and support by pre-



eminent bodies such as the Indian Roads Congress, Central Road Research Institute and the National Highway Authority of India.

All this has boosted the emulsion consumption in India from only 15,000 tons in 1993 to more than 170,000 in 2007. The main uses for bitumen emulsions are tack coats and prime coats. Other uses are emerging, such as surface rejuvenation, cold mixes and micro surfacing. Surface dressing is not used to a large extent. Bitumen emulsions are governed by the IS 8887-95 standard. This standard is regularly revised, in order to extend the use of emulsions.

The future: in 2007, the volume ratio of emulsion to bitumen was 3.6%. As the average worldwide value of this index is 9%, one can expect a tremendous increase in emulsion consumption in the years to come-of up to more than 400,000 tons. In fact, such a volume may be seen as a minimum, especially when considering the existing Indian road network, and especially the rural roads, that account for 2.7 million kilometres.



The road authorities are now progressively shifting from pure bitumen to emulsion. As an example, there was a national seminar on hill roads organised by the government of Arunachal Pradesh and the National Rural Roads Development agency under the Ministry of Rural Development in Tawang in November 2008. One of the strong recommendations of that seminar was wider use of emulsions in both construction and maintenance in hilly areas.

Other agencies, such as the Border Roads Organisation, are willing to develop the use of bitumen emulsion in remote areas of this vast country with limited resources. Moreover, the HSE requirements will grow in the future. In this context, bitumen emulsion techniques will find their full justification. The success of this development will be based on reliable techniques and players. Confidence in the bitumen emulsion technique, patiently growing during the past 15 years, will remain a key element of its development.

From Fertilizer Plant to Bituminous Roads: Waste Chalk becomes Valuable

Dr. N.K.S. Pundhir
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Central Road Research Institute, New Delhi

Precipitated calcium carbonate-chalk-is a waste product formed during the preparation of Ammonium Nitro-phosphate fertilizer. The waste material, produced as chalk powder, has disposal and environment problems - and it causes health hazards and degradation of the environment. In order to manage the solid wastes, Central Road Research Institute undertook a laboratory study for the suitability of chalk as filler material for bituminous mixes of flexible pavements. Based on the results obtained, it was found that 3-7% chalk can be used in bituminous concrete (BC) mixes. The use of chalk not only increases the strength of the mix but also increases its retained stability, indicating reduced water-induced damage to bituminous pavements. Similarly, the incorporation of 5.5% impure chalk in semi-dense bituminous concrete (SDBC) mixes increases the strength of the mix and a higher retained stability, in comparison to an SDBC mix without chalk as filler.

Solid waste management has become a serious issue in India, since the nation seeks to minimize health and environmental hazards. The disposal of tons of chalk causes health hazards and degrades the environment. In order to manage the solid waste produced in Rashtriya Chemical Fertilizer Plant, a laboratory study was undertaken to test if waste materials can be used in bulk. The complex fertilizer 20:20:0 is produced in an Ammonium Nitro-phosphate Plant (ANP). In an ANP, rock is acidulated with Nitric acid to produce Calcium Nitrate and Phosphoric acid. The resultant Calcium Nitrate-Phosphoric acid slurry is crystallized to remove the part of calcium nitrate formed in the reaction and rest of the slurry is carried out further in ANP preparation. Calcium nitrate solution is taken in another reactor where is carbo-ammoniated and produces calcium carbonate (chalk) and ammonium nitrate solution. The solution is filtered on a vacuum bed filter. Ammonium nitrate solution filtrate, collected from the bottom, is partly recycled in the system for preparing complex fertilizer and part is taken for further concentration, which is sold as Ammonium Nitrate melt.

Most research and practical knowledge on the effect of the filler in bituminous mixtures are mainly based on engineering properties of the filler; gradation, filler content, weight-volume relationships, and so forth. Previously, the Asphalt Institute studies examined a large number of mineral fillers and it was found that different fillers affect the properties of bituminous mixes differently. It was concluded that such changes in test properties can be associated with change in viscosity of filler-bitumen binder containing different fillers. Five mineral fillers: limestone dust, kaolin clay, hydrated lime, short fibered asbestos and fullers earth were studied. The chalk contains some salts which can be used as fillers like kaolin clay and fullers earth.

Design of bituminous mixes: bituminous concrete (BC) and semi-dense bituminous concrete (SDBC) are two major types of wearing courses used in the construction of flexible pavement. The Marshall method of mix design always begins with acceptance tests performed on aggregates and bitumen proposed to be used prior to undertaking the design. Different sizes of aggregates are blended to obtain aggregates of specified gradation. Marshall samples were prepared by varying the binder contents and tested for their volumetric properties. Bitumen holds the aggregates in position and the load is taken by the aggregates mass through the contact points. If all the voids are filled by bitumen, the load is transmitted by hydrostatic pressure through bitumen, and the strength of the mix, therefore, reduces. That is why the stability of mix reduces when bitumen content is increased beyond a certain value. Also at high temperatures during the summer season, bitumen melts and occupies the void space between aggregates. When the void space is not available, it causes bleeding. Thus, some amount of void is necessary in a bituminous mix, even after the final stage of compaction. For determination of optimum binder content (OBC), the values of bulk density, stability, air voids and voids filled with binder (VFB) are plotted against the binder contents.

Bituminous concrete mix with impure chalk as filler: Marshall specimens were prepared with 3% impure chalk as filler. The mechanical properties of BC mixes with 3% impure chalk were determined. The binder contents, plotted against other properties of mix to obtain the optimum binder content (OBC) are presented in Figures 2a and 2b.

It was observed that the optimum binder content is 5.75% by the weight of aggregates and 5.45% by the

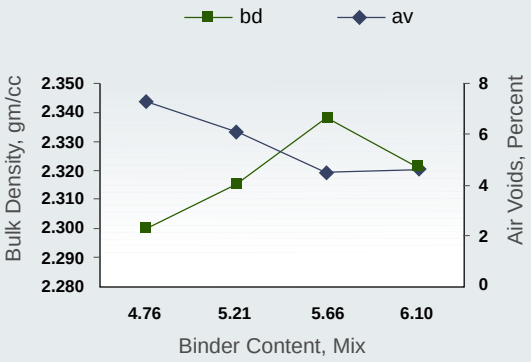


Fig. 2a: Property of BC Mix at 3% Chalk.

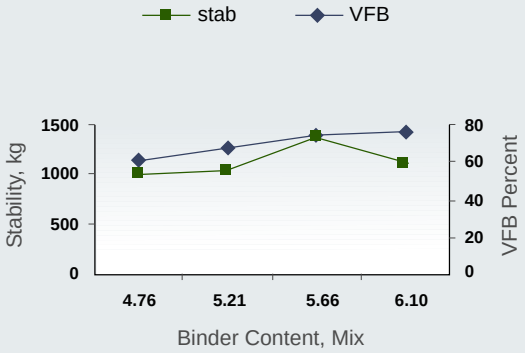


Fig. 2b: Property of BC Mix at 3% Chalk.

weight of mix. The retained stability after 24 hours was found to be1078 kg. The stability of BC mix at OBC was found to be 1144 kg. The retained stability was found to be 94%.

SDBC with chalk as filler: a mix design of SDBC with 60/70 penetration grade bitumen was carried out as per the procedure given in AASHTO T-245 or ASTM: D-1559. Marshall specimens were prepared with varying bitumen contents of (4.5, 5.0, 5.5 and 6%). Bitumen and aggregates were heated thoroughly at about 160oC and 150oC respectively and mixed together until the aggregate particles were coated. The aggregates and bitumen mixture was placed in a Marshall mould and each side compacted with 75 blows of Marshall hammer as per the procedure given in AASHTO T-245 or ASTM: D-1559. The bulk density was determined at ambient temperature. The stability and flow value of Marshall specimens were determined at 60oC. The binder content, plotted against other properties to obtain the optimum binder content (OBC) is shown in figures 4a & 4b.

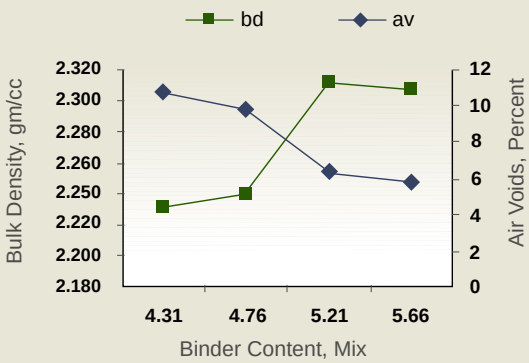


Fig. 4a: Property of SDBC Mix at 5.5% Chalk.

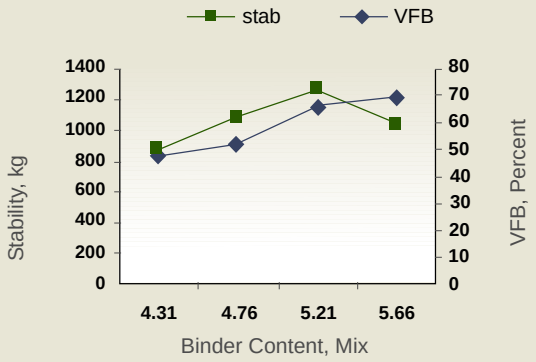


Fig. 4b: Property of SDBC Mix at 5.5% Chalk.

It was observed that the optimum binder content is 5.5% by the weight of aggregates or 4.76% by the weight of mix of SDBC mix with 5.5% chalk as filler.

General results: the fillers, as one of the bituminous mixture ingredients, play a major role in determining the properties and the behaviour of the moisture. Generally, the filler sieves as an inerratic material for filling the voids between coarser aggregate particles in the mixture. Conversely, because of its fineness and surface characteristics, the filler also sieves as an active material. The activity of the filler is expressed in the physico chemical properties at the interface between the filler and the bitumen.

The chalk powder passing the 200-mesh sieve in the bituminous mixture can perform several functions. One function is that of filling voids in coarser aggregates, which increases the density, stability and toughness of a conventional bituminous paving mixes. Another is the creation of filler-asphalt mastic in which the particles of dust either may be individually coated with asphalt (bitumen) or are incorporated into the asphalt in mechanical and colloidal suspension. These forms of mastic are produced by special processes, such as cooking, atomized asphalt and foamed asphalt. In paving mixtures the mastic serves as the cementing agent.

There is, however, a limit to the beneficial effects of increasing filler content. As filler content increases, the brittleness and tendency of the mix to dry out and crack in sieve also increases. That is why smaller quantity of chalk 3 to 7 percent has been used in different mixes. The filler utilizes the share of asphalt first, leaving the remainder to coat the coarse aggregate particles. In the later stages of mixing, through the action of mixer and temperature of aggregates, the asphalt (bitumen) is more uniformly distributed and coarse particles become coated.

The feasibility of using bituminous concrete mixes, impure chalk as filler in BC mixes was evaluated in the laboratory by incorporating 7% and 3% chalk contents by weight of aggregates. The stability of bituminous concrete with 7% impure chalk with OBC at 6.0 % by weight of aggregate or 5.66% by weight of mix was found to be 1453 kg at and 2mm respectively which is in accordance with MOSRTH Specification. The Stability of BC mix with 3% impure chalk was found to be 1364 kg .and 1.8mm respectively. It is also observed that the stability increases with increase in chalk content. Though the excess quantity of filler increases stability, it also tends to brittleness and cracking. Hence, chalk as filler cannot be taken at higher dosage. The properties of BC mixes at 7% and 3% chalk content meet the required specification. The retained stability at 7% and 3% chalk was found to be 94% content, while with sand as filler it was 89%. This indicates that water damage to B.C. mix gets reduced by incorporating impure chalk. The stability, flow, optimum binder content, air voids and VFB of BC which prepared with impure chalk as filler are found to be within the specified limits of MOSRTH.

Conclusions: chalk, a low value product from fertiliser plants can be suitably used in bituminous mixes for road construction and would mitigate the solid waste disposable problem. A content of 3-7% of impure chalk as filler can be used in bituminous concrete mixes. The impure chalk can also be used in semi-dense bituminous concrete (SDBC) mixes. A content of 5.5 % impure chalk in SDBC mixes increases the strength of mix with higher retained stability in comparison to SDBC without chalk. The stability, flow, optimum binder content, air voids and VFB of BC and SDBC mixes, with impure chalk as filler, meet the specified limits of MOSRTH - the Ministry of Shipping, Road Transport & Highways.

INNOVATIVE FINANCING AND CONTRACTING FOR ROAD NETWORKS

Financing roads from tolls has become a "mature" industry in itself. But, for various reasons, tolls alone cannot replace publicly funded road development and the tolling industry must make itself more attractive to potential finance. The Asian Development Bank is finding new ways to address old problems in countries such as Papua New Guinea.

New perspectives for augmenting toll finance

Amitava Basu, Executive Director
Intercontinental Consultants and Technocrats Private Limited, New Delhi, India

Traditionally, governments have financed roads through budgetary allocations. However, government budgets are constrained-and new approaches have been explored to fund new roads, additional lanes on existing roads and new or expanded interchanges. Tolling provides a stable and dedicated source of finance that can support construction and maintenance for a particular road. Today, toll roads have become common.

Worldwide experience of toll roads: toll road users have discretion over their travel route. Sensitivity of toll rate to their incomes and the costs compared to the benefits received, drive the success or failure of these projects. Toll road investors are not properly aware of all the risks inherent in the setting and administration of toll rates-and this tends to drive away commercial lenders. High level public sector leadership is necessary to set the terms of a project: the legal, regulatory, and developmental framework for managing and financing toll roads.
Toll roads in developing countries of Asia face roadblocks due to:

- Absence of a structure for identification and analysis of proposed private-sector projects, resulting in plans announced by Government Highway agencies losing credibility with developers and the financial community.
- Inaccurate traffic and revenue projections, leaving developers and lenders with large unanticipated cash flow deficiencies.
- Lack of traffic density - not justifying four-lane highway construction.
- Public resistance to toll revenues, compounded by political opposition to tolling.

Countries have adopted different approaches to overcome these difficulties. For example, the Highways Agency in the U.K. introduced shadow tolls for Design, Build, Finance, Operate (DBFO) concession contracts, that involves payment by the Highways Agency to the concessionaire for each vehicle using the project road and no toll is paid by the road users. Several countries have set up "Roads Fund" to collect money from fuel levies, transit charges, vehicle overloading fees and other sources - and use the funds specifically for development, modernisation and maintenance of the road network.

The following approaches can further augment toll road financing:

- Toll road projects may be grouped with connecting roads, to access a transportation network and activity centres, to enhance the project viability - as different road corridors grouped in a single project can enable cross-subsidisation.
- To offset the impact on the investor's return resulting from low traffic levels and toll rates, a government can contribute parcels of land at the interchanges of the toll road, or near activity centres, for later development by the concessionaire.



- As part of an integrated infrastructure development, markets, warehousing, tourism, educational projects and the like, built along or near the project road, can be dovetailed with the toll road to promote activity centres and increase traffic volumes, to enhance the project viability.
- Sponsored advertising at toll plazas, telecom service providers' advertisements at help-line kiosks, income from film shoots, corporate sponsorship for toll tickets, etc. - all can supplement the toll revenue.
- The toll rate can be made more publicly acceptable through suitable modifications in the toll structure - such as variations by time of the day or day of the week, tolling by area, etc.
- Land values along the toll roads increase due to better accessibility, through construction of new roads or expansion of existing roads. Development fees can be levied on these lands and the fees used to partially support the toll road project.



Conclusion: There is no single toll financing mechanism. Projects differ and country situations vary. Depending on the project and country characteristics, a suitable toll financing model has to be developed. Necessity is the mother of invention.

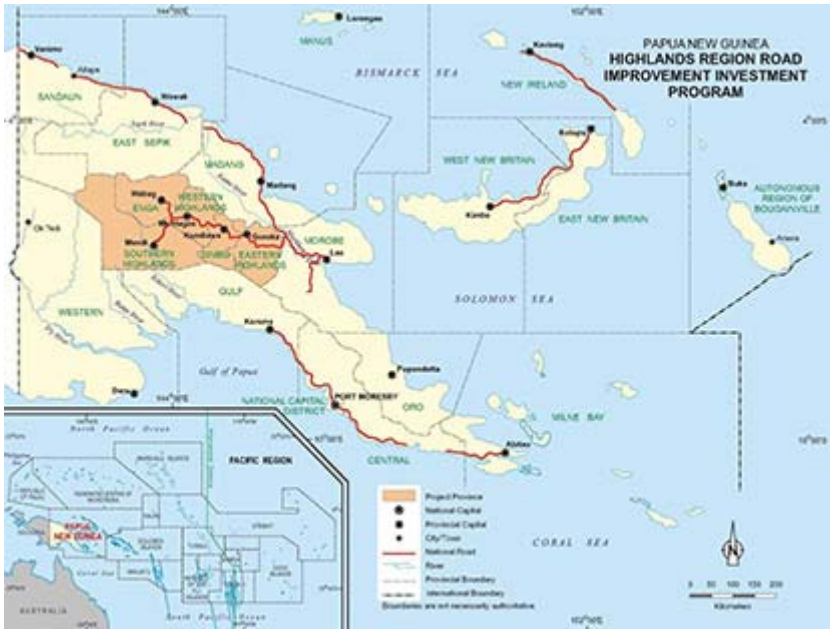
Asian Development Bank (ADB) supports USD 750 million programme to improve roads in Papua New Guinea's Highlands region

Hasan Masood
Head, Project Administration Unit, Pacific Operations Division, ADB

Papua New Guinea (PNG) comprises the eastern half of the island of New Guinea, together with five island provinces and some 600 associated islands. Only a small proportion of the total land area of 460,000 square kilometres is inhabited, by a population of over 6 million. Roads provide the main means of access for most of the mainland population. For the island provinces without land connections, domestic aviation and coastal shipping play important roles.

The five provinces of the mountainous Highlands region are home to over a third of the population and are the country's primary source of national income and export earnings. The region contributes over 80% of the exports - from minerals, oil and gas production, and agricultural commodities, including coffee. Amid rugged terrain that includes mountain ranges, valleys and fast-flowing rivers, the road network provides a lifeline for exports as well as for supplies, to the resource enclaves and the general population. The Highlands Highway links the Highlands provinces with the main port at Lae. High rainfall, seismic activities, fragile geological conditions and a highly dispersed population make the road network difficult to develop and sustain.

The Asian Development Bank (ADB) and other development partners are supporting the Government of PNG in improving and managing the road network in the Highlands. But lack of regular maintenance causes rapid deterioration of the road infrastructure, resulting in longer journey times, higher vehicle operating costs, and isolation of rural communities. This leads to significant loss of the income from mineral and agricultural exports and contributes to worsening social conditions, exacerbating unrest and lack of security.



The reasons for the failure to maintain roads are both financial and institutional. The Department of Works (DOW) that is responsible for roads receives far less funds than its estimates for routine and periodic maintenance. The result is that emergency repairs take up a large proportion of the funds, undermining the DOW's ability to institute a planned maintenance program.

The Government's 10-year National Transport Development Plan (2001-2010) places the responsibility for maintaining national roads on the National Roads Authority (NRA), created in 2004. A road fund, financed through user charges, provides sustainable resources for road maintenance. An autonomous Board with predominantly private-sector and road user representatives oversees the functions of NRA and use of the road fund.

Taking a holistic view of the maintenance issue, the ADB approved financing of USD 400 million on 16 December 2008 for the USD 750 million investment programme to improve roads in the Highlands region. ADB financing will be provided in four or more tranches over 10 years through its Multi-tranche Financing Facility. The Government will provide USD 200 million and other development partners will provide co-financing of USD 150 million.

Relying on the existing policy and institutional framework, the investment programme identifies the core road system of 2,500 km in the Highlands, finances the rehabilitation and upgrading of 1,400 km, and assists the NRA in gradually taking over maintenance responsibility for all core roads. It also strengthens the capacity of the DOW and NRA to develop and manage road assets.

Through ten-year performance-based contracts, it is envisaged that all 2,500 km of the Highlands core road network will be regularly maintained by the end of the investment programme in 2018. These contracts will have provision to engage local communities for some maintenance activities, providing a sustainable livelihood and creating a sense of participation and ownership which will help mitigate security concerns.



The investment programme will benefit the entire population of the Highlands region. For communities living around the road network, a grant-financed project is being prepared to increase their benefits from improved roads. In addition, a piggy-backed technical assistance will help the Government prepare a National Transport Development Plan for 2011-2020.

ROAD SAFETY

Improving road safety depends on both the strategic efforts of national governments and the tactical efforts of local authorities and communities. But increasingly, there is a third element - the personal engagement of local professionals and communities based on their own cultural and economic circumstances and competencies. It is a step-by-step process of raising public awareness and securing political commitment. "See and be seen" is a slogan for adoption at every level.

Building safety "step-by-step" to meet the driving demands of Asia's growth

Pinjaroenpun "Jan" Buaboun and Malcolm Lucard
GRSP coordinator for Lao PDR, Cambodia, Indonesia, Vietnam, Thailand and Malaysia

Lao Tzu once said that the journey of 1,000 miles begins with a single step. But to get a sense of how quickly people in Asia might cover that distance these days, all you have to do is walk across a busy intersection in Bangkok, Beijing or Phnom Penh. Streets already filled with taxis, bicycles, rickshaws, pushcarts and trucks are even more choked with fast-moving cars and motorcycles. More and more, the first step people take for any journey is into a car - or onto a motorcycle, the fastest growing mode of transport in Asia.

Economic growth in Asia is spurring rapid motorization and, correspondingly, a spike in casualties for the six main countries I work with. With assistance from GRSP and its partners, countries have responded with an array of legislation, partnerships, road safety action plans, professional development, improved infrastructure and programmes aimed at building the local capacity to manage road safety. By partnering with local governments, NGOs, p rivate business, volunteers and



others, GRSP's team is helping these countries build sustainable long-term capacity, based on their own cultural, political and economic circumstances.

Signs of Progress: there are many signs of progress. A number of countries - especially those that were lacking legislation or road safety policy or action - are starting to pick up on the importance of the issue. Countries such as Lao PDR, Cambodia, Indonesia, Vietnam and Thailand have all enacted important road-safety legislation in recent years while GRSP is engaged with a wide range of players in a host of capacity-building activities around the region. Last year, for example, GRSP received a USD 850,000 grant from the Japan Social Development Fund to enable a programme that encourages young people in north eastern Thailand to wear motorcycle helmets. The grant supports public awareness, subsidises helmets, helps enforcement and first aid training and allows local communities to set road safety priorities.

In Cambodia, GRSP is working with Handicap International on various road-safety programmes, including helmet wearing compliance and development of helmet standards. Handicap International began working in the region to prevent casualties from land mines, but has since begun working to prevent road crash injuries. A similar partnership has begun in Lao PDR. Meanwhile, Malaysia, which began partnering with GRSP in 2007 is emerging as a road safety leader in the ASEAN region. The government has even elevated the Road Safety Department to the director-general level, the second highest civil service rank.

Despite progress, Asian countries have a long way to go. For example, the 2008 Beijing Olympics served as a visible reminder of China's growing place in the world economy. Developments for the Olympics led to several road and public transport improvements. But even GRSP programmes there are just the beginning of a long process. It has taken "safe" countries such as Sweden and Australia over 40 years to get to today's level. It is possible that China has to go through that process, as well. Ann Yuan, GRSI China (see first article in this section), who works with partners on a variety of initiatives, from drinking and driving, to speed management on China's highways, to intersection improvements in Beijing, refers to a "step-by-step" process. Each project starts with careful study, design, implementation, then re-assessment - and serves as a model for future endeavours. "We are trying to plant some seeds here, to raise public awareness and also to get more political commitment," she says.

Around Asia, that awareness is clearly growing. There is a greater sophistication in the media on road safety issues, and a growing awareness of GRSP among transport agencies and local governments as the go-to experts. In countries such as Malaysia, there are signs that local officials are making GRSP strategies very much their own. Malaysia's national newspaper The Star, recently carried an exhortation to "traffic cops to be more gentle," and including words that were the focus of GRSP workshops in Malaysia, according to GRSP consultant Gayle Di Pietro; she says it's also exciting to see less-developed countries such as Cambodia engaging in partnerships to tackle tough issues such as helmet wearing, helmet standards, speed management and strategic traffic policing.

GRSP has given police training sessions in Cambodia and research assistance to help identify problem areas. Di Pietro refers to "building their capacity - help them in building their ideas, in their context." Malaysian police officers who had earlier attended a GRSP pilot programme on professional development told Di Pietro that they felt valued, as a result. "They had some input into the way that they work. The professional development gave some recognition of the skills they knew they had."



Challenges ahead: there are still many big challenges and potential potholes ahead - political instability, the unwillingness of some government agencies to work together, an over-emphasis on road improvements in lieu of changing behaviour, poor quality roads and traffic enforcement, and a lack of resources to implement key regional initiatives are just some of the key challenges, according to GRSP coordinators in the area.

In Cambodia, the government has accepted our national helmet wearing plan, but they do not have the budget to support the activities. That's when GRSP comes in to assist, to facilitate and support a number of projects. Other challenges lie outside what is traditionally thought of as the road-safety sector. In the rural regions of Cambodia and Thailand, for example, emergency services and hospitals are often few and far between. Where I am from, in northeast Thailand, there is only one hospital that can operate on your brain. For 19 provinces, for 10,000 districts. Can you imagine that?

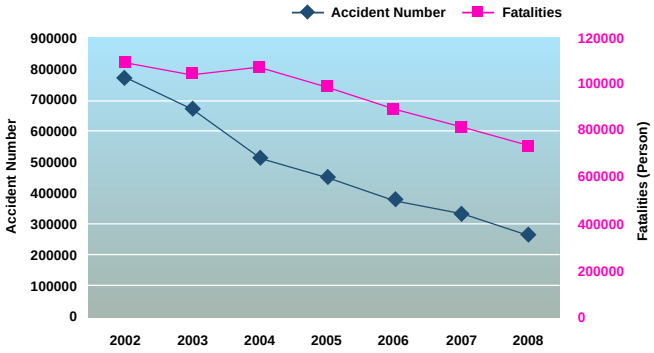
"While the challenges are huge, it's clear that the partnership approach is working, with Asia's diverse range of experiences and programmes now serving as a model for other regions," notes Rob Klein, GRSP's regional coordinator for Asia. The region's relatively long track record, and steady funding levels via GRSI, he notes, has led to the creation and field-testing of numerous initiatives. "The knowledge gained on the street here is now spreading to other areas just now making their first steps toward road safety."

Progress for road safety in China

ZHANG Gaoqiang
Research Institute of Highways, MOC, CHINA

Continuous efforts: on 4 January 2009, the Ministry of Public Security (MPS) of the People's Republic of China published the data of road traffic accidents for 2008. According to official figures, 73,484 persons were killed and 304,919 persons were injured in 265,204 traffic accidents throughout the Republic in 2008. All accidents and fatalities represent human tragedy and economic loss. But, compared with the data of 2007 and other recent years, those figures also represent good progress.

2008 is the 5th year of continuous decrease in road traffic accidents and fatalities in China - the result of road safety actions in recent years. The dramatic improvement is shown in the figure below.



China's Road Traffic Accidents and Fatalities in Recent Years: from the end of the 1980s until 2006, due to increased Chinese urbanization and sharply rising vehicle populations, the traffic safety problem deteriorated. During this period the number of fatalities caused by road traffic accidents in China was always the highest in the world. To improve the situation, the Chinese government adopted a series of measures and actions in road safety fields. In 2003, approved by the China State Council, a Multi-Ministry Joint Board on National Road Safety was established, which determined the responsibilities in related Ministries, such as SAWS (State Administration of Work Safety),MPS, MOC (Ministry of Communications, now changed to Ministry of Transport), and so on. Its main functions are as follows: to control the national road safety status, to analyze the road safety posture and policies, to establish the medium and long-term tactical plans, to guide and supervise the road safety jobs of local governments, to establish the long-term systems to prevent and reduce traffic accidents, and to accelerate the cooperation of other relevant departments.





Another section of G109 after HSEP

On 1st May 2004, the "Law on Road Traffic Safety" was promulgated (and revised in 2007); road traffic behaviour could then be regulated by law. At the beginning of 2004, to comprehensively enhance the service level of China's highway facilities and to improve traffic safety, reduce the accident rate, and strengthen research and development capabilities, the Ministry of Communications decided to launch "Highway Safety Enhancement Projects" (**HSEP**) themed at "Eliminate Potential Danger, and Cherish Life" for national and provincial highways. The main tasks are focused on the comprehensive treatment of sharp curves, **HSEP Countermeasures on one section of G109** steep slopes, roads with poor forward visibility and those with dangerous sides.

The National Guideline on medium-and long-term programme for Science and Technology Development (2006-2020), published by the State Council on 9th Feb. 2006, said that science and technology innovation must play a very important role in reducing very severe traffic accidents with multiple fatalities and injuries, to guarantee traffic safety and construct a harmonious travel environment.

On 18th Feb, 2008, The Ministries of **Science and Technology, Public Security, and Communications** signed an agreement to develop a National Science and Technology Plan for Road Traffic Safety, in a bid to reduce the death toll in traffic accidents year by year and reduce the death rate per million vehicles to the level of medium advanced countries, within a few years. The main studies and pilot engineering projects include studies of the influence of technology on traffic participants' behaviour,



Signing ceremony for three ministries

vehicle organisation technology on safe transportation, the safety enhancement technology on road infrastructure and traffic management safety technology.

Technology Support: the Research Institute of Highways (RIOH) is the only institute directly under MOC in the highway traffic field. RIOH has devoted itself to road safety research for several decades. In 2003, RIOH was appointed as the responsible unit to guide, supervise and mange the project by MOC. The project obtained the 2006 IRF European Road Safety 2nd Prize Award. In 2008, RIOH finished an important project, the Study on Applied Technology for Highway Safety (SATHS). MOC commissioned the project in 2004 and paid 30 million RMB (USD 4.5 million) for it. The achievements and techniques of the project are now widely used in China highway construction and operations. Through such initiatives, China aims to make its highway road safety record comparable to the record of the safest nations.

GRSP/GRSI in China

Ann Yuan
GRSI Coordinator for China, with Malcolm Lucard

Implemented by GRSP, there are 4 road safety projects going on in China under the umbrella of Global Road Safety Initiatives (GRSI). The following are two of them, which show the progress made in China.

Safer Beijing Intersection

Beijing University of Technology's Transportation Research Centre has released a "before and after" study that shows dramatic safety improvements at city intersections. The study was a Vulnerable Road Users (VRU) project undertaken in Beijing in close cooperation with the Global Road Safety Partnership (GRSP) as part of the Global Road Safety Initiative (GRSI).



The three-year project selected six busy, high-risk downtown Beijing intersections and roundabouts for study, then made design recommendations and improvements. Some of them are black spots; a lot of crashes occurred already at these intersections, or they have a lot of conflict.

The first phase included careful case studying and design of potential improvements. Implementation of those improvements started in Phase II. The third phase involves studying the intersections to see if the improvements made a significant difference.

Low engineering cost countermeasures were used to improve VRU safety at all of the selected intersections. Instead of building underground path or flyover bridge, we use channelisations, barriers to separate motor vehicles, non-motor vehicles and pedestrians; use road sign and barriers to guide road users to use the existing safety facilities; use pedestrian islands for people to cross a road by stages. Some of these roads are wide - up to 80 metres across, with six lanes in each direction. They are very dangerous to cross at one time.

The before and after data analysis of the study shows a reduction in traffic conflicts at all selected intersections. For example, more pedestrians use underground paths and more left turn bikers are stopping at the waiting line for the 2nd stage crossing. At south entry of a selected 4 leg intersection, rate of left turn bikers stopping went from 21 percent (before) to about 80 percent (after); and at the north entry, 77 percent now stop, compared to 13 percent prior to the improvements. Similar statistics are reflected in the other directions.

Speed Management Pilot Project in China

Together with China's Research Institute of Highways and the Ministry of Communications, GRSP launched the Chinese version of the global good practice manual on Speed Management and introduced a speed management pilot project in China.

The Ministry of Communications (MOC) is a key Chinese partner of the project, which is financially supported by Global Road Safety Initiative (GRSI). The press conference launching the manual and the pilot project was chaired by Dr. Gao Hailong, Deputy Director of Road Safety Research Center of MOC. About 50 people attended the event, which include the relevant stakeholders and media.

Dr. Gao Hailong introduced the two-year pilot project on speed management in China which is being carried out by the MOC and GRSP, and which will take place in two-phases. Phase I is a case study on 3 selected road sections: one express highway (Guangxi-Nanyou Express Highway); one class II national highway (road section of Luzai-Pingle on 323 national highway in Guangxi); and one urban road in Beijing. To date, the project team has almost completed the study in Guangxi; the study in Beijing started in November, 2008.

The case study on the selected road sections includes collection of existing data (crash data, condition of road surface and roadside, type of safety facility, type of road users); spot survey (mean speeds, V85 speed on different road conditions and speed limits); and interviews with road users (drivers, pedestrians and residents in the villages nearby).

Road traffic crashes are a major cause of death and injury in China. Official statistics reported over 81,000 deaths and 380,000 injuries on China's roads in 2007. Speeding was seen as the number one killer.



The Global Road Safety Partnership (GRSP) brings together governments, the private sector and civil society organizations to prevent road crashes and road trauma in low and middle income countries. GRSP was established in 1999 as part of the World Bank's Business Partners for Development Programme and is hosted by the International Federation of the Red Cross and Red Crescent Societies at its secretariat in Geneva. For more information on GRSP, please visit our website at www.grsproadsafety.org

"See & Be Seen": A Visible Way To Improved Road Safety

Rik Nuyttens
Traffic Safety Systems, 3M Europe, Brussels

The WHO reports that road fatalities are still on the rise in most Asian countries. If no serious actions are taken by the various governments, road accidents will move from the 7th to the 4th leading cause of death. Various road safety experts have concluded that improved visibility is one of the "quick wins" to reduce accidents, as some countries count up to 60% of their total road casualties during night time hours. Improved visibility is an especially important component of needed infrastructure improvements-particularly for rural situations, where vulnerable users include vehicle drivers. Adherence to international conventions and standards is critical.

Improved night time visibility is a low cost safety measure with a proven record. For many years 3M has been contributing to a range of solutions based on retro-reflective technology:

- School wear for children and professional work wear.
- Attached or incorporated components for bicycles and motorcycles
- Retro-reflective license plates.
- Conspicuity markings for vehicles
- Delineation of road infrastructure.
- Road markings with optics performing during rainy weather.
- Road signs with improved brightness to all vehicles and age groups.

Safe Road Infrastructure: investments have proven to provide an immediate return on investment. And traditional road infrastructure will continue to play a dominant role. Mr Niemann, US Federal Highway administrator, said during a recent congressional hearing: "If we cannot always physically protect the motorist from hazards, we must give him enough information to protect himself." As effective signs and road markings continue to play a role from the remedial as well as from the preventive point of view, 3M has continued to perform research in this domain. Due to the severity of night time accidents road infrastructure features-and especially signs and road markings-should be visible 24 hours a day and during all weather conditions.

Dr Rune Elvik, a road safety specialist of the Norwegian Institute of Transport Economics, teaches that an effective road sign should not only be "visible" but also attract the attention of the driver by being "conspicuous." Fluorescent colours provide this daytime feature for the sign. The message or symbol ("UNECE Vienna Convention 1968") on the sign should also be simple and understandable by all drivers, including foreigners.

In order for a driver to clearly see and read a sign, the light emitted by car head lights should be reflected back to the eyes of the driver. This means we do not want perfect retro-reflection. The reflected light, rather than return straight to the headlamp, should travel upwards to the driver under a slightly different angle than the angle at which it has entered the sign. This angle deviation is the observation angle. The higher the driver is sitting above the car headlights and the closer the car is moving towards the sign, the higher will be this observation angle. The longer the driver can stay in the cone of light reflected by the sign, the longer the driver will have to read the sign. Next to observation angle, a wide range of entrance angle performance is another key parameter for sign sheeting. Entrance angles will vary between 0° and 40° or more, depending on the position of the sign beside or above the road-and will generally further increase when the car is travelling towards a sign next to the road.

Standardization institutes like **ASTM** and **CEN** developed test and performance criteria in order to classify the different materials. The **ASTM 4596-01 type IX** and the proposed **Type XI** specify retro-reflective sheetings that offer the optimum luminance at the critical reading distances to the sign (150 m and less). Also **CEN EN 12899-1** is currently under revision to allow specifications adjusted to modern traffic needs.



High performance retro-reflective materials for motor cycle safety



Truck conspicuity - contour marking from Turkey

Effective signs and road markings provide a low cost measure with immediate return on accident reduction. The use of fluorescent signs have shown to be specifically effective regarding black spot eradication, construction work zones and school safety zones.

Protect the vulnerable road users: Asia counts many casualties amongst **motorcycle** drivers, as the heavier goods vehicles are increasing exponentially and infrastructure can not separate these road users. Brazil, coping with the same problem, has issued regulations aiming to protect these vulnerable road users. Both helmet and the rear of the motorcycle need to carry reflective material. The addition of fluorescent colours would increase *daylight* visibility.

Truck Conspicuity: crash investigations generally show that nearly 5% of severe truck accidents can be traced back to poor conspicuity of the truck or its trailer at night. These accidents can be characterised by the fact that car drivers often fail to recognise trucks or truck combinations driving ahead of them. In most cases trucks are in slow motion, are entering the road or are turning off the road. Trucks can be rendered much more conspicuous by marking their sides and rear using retro reflective marking tape. The truck is therefore made visible to other road users thereby reducing accidents, specifically rear and side impacts into large vehicles. UNECE Regulation 104 sets out an international specification for retro-reflective marking tape. Another

UNECE regulation (R48) sets out requirements for the installation of lighting and light signaling devices on vehicles. This regulation currently mandates the installation of conspicuity markings for new type approvals and will later expand to all new registrations.

Many countries, such as UAE (Abu Dhabi), South Africa, Italy, Romania and the US, already mandate these markings for *all trucks and trailers on the road*. The **US**

NHTSA report (2001) concluded that related accidents have reduced by about 29%-with 44% less fatalities-since implementation of these regulations on large trucks in the 80's. The Abu Dhabi authorities specified the need for fluorescent colours, with will provide the conspicuity effect during daylight.

Trains and rail road crossings: a train traveling at 80 km/hr needs 2 km to stop. One is 30 times more likely to die in a crash with a train than in a crash with another motor vehicle. Derailment can result and, if a freight train is involved, there is a possibility that hazardous material on the train could endanger an entire community. Beside the human tragedy, the economic cost could be extremely high. Several countries consider rail road crossings as black spots and have considered special, often fluorescent, signs to announce these intersections. Other countries like South Africa have implemented special regulations to make trains and wagons more visible.



Fluorescent retro-reflective signing to better inform drivers of road works, in daylight conditions - yellow sign on left is non-fluorescent.

SUSTAINABLE ROADS

It is a happy coincidence that many of the roads in Asia which are necessary and being laid down for the first time have the benefit of the latest perceptions of long-term ecological viability. And, concepts such as pavement recycling have a very large potential in the undertaking of major road reconstruction.

Engineering a highway through sensitive ecology: Shenzhen Bay Bridge

Tony Marshall
Highways Business Leader
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Background: Hong Kong-Shenzhen Western Corridor (HK-SWC) is the fourth vehicular boundary crossing between Hong Kong and Shenzhen, a city in the southern part of mainland China. As a dual three-lane highway across Deep Bay, the waters between Shenzhen and the north-western coast of Hong Kong, the HK-SWC is a joint project between the governments of Hong Kong Special Administrative Region (HKSAR) and Shenzhen, with each side responsible for the design and construction of the portion of HK-SWC within its own territory. Ove Arup & Partners was appointed by Highways Department of the HKSAR Government to undertake the investigation consultancy (including planning and environmental impact assessment) and the detailed-design & construction-supervision consultancy for the Hong Kong portion of HK-SWC.

A key feature of the project is that it is located at the environmentally important but sensitive ecosystem of Deep Bay, which is right on the main East Asia migration route for tens of thousands of birds, serving as their 're-fuelling stop', wintering ground and breeding ground. Amongst them is the endangered species of Black-faced Spoonbill. There were in fact several challenges:

Sedimentation rate and water quality impacts on Deep Bay: to minimize impacts to the sedimentation rate and water quality in Deep Bay, the project team has taken substantial efforts to obtain agreement by Shenzhen side to increase the typical span length of the HK-SWC bridge from the originally planned 50m to 75m, thereby reducing the pier numbers from 106 pairs to 70 pairs. Also, the piers were designed with streamlined shape and the pile caps of the bridge piers were designed to be embedded below the seabed in order to reduce obstruction to the tidal flow. To mitigate the potential impact on Deep Bay during construction, coffer dams and silt curtains have been provided for marine sediment dredging work.



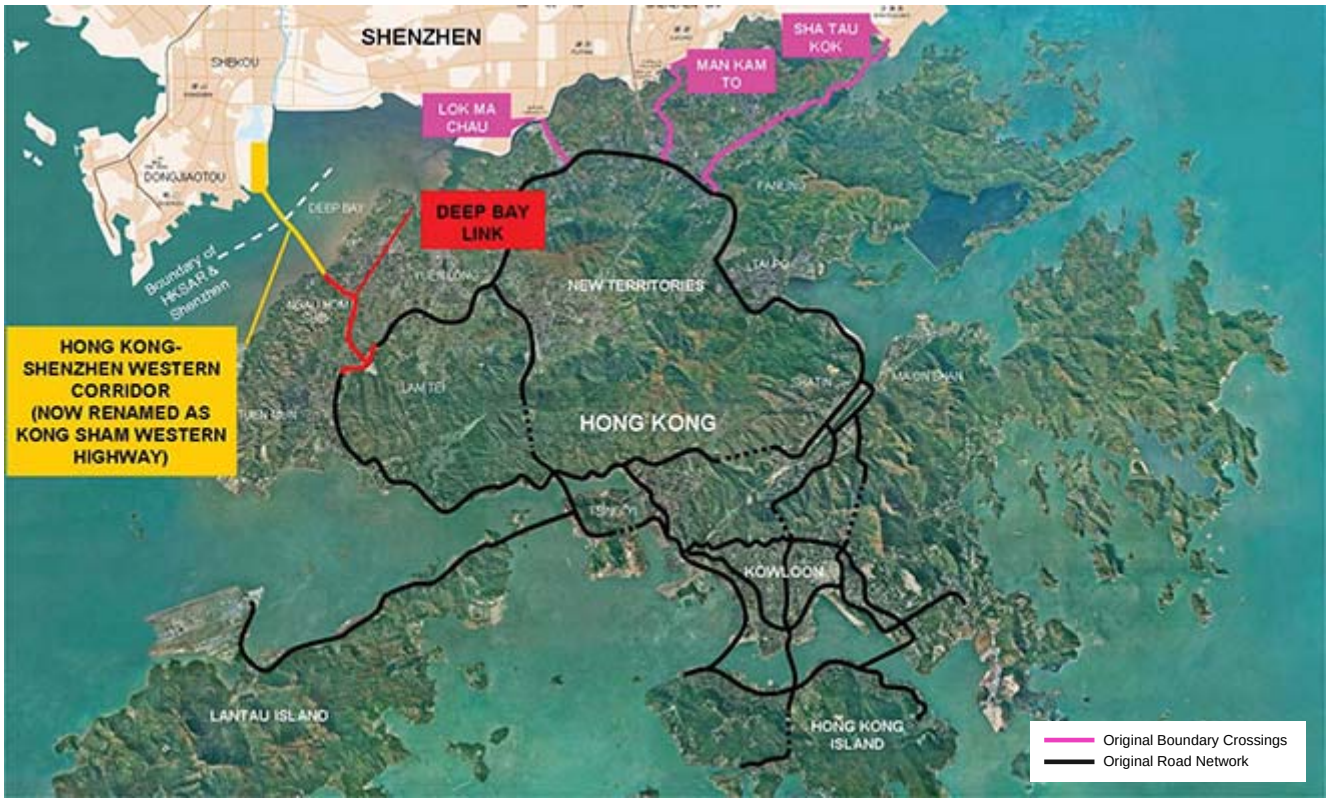
Accidental Chemical Spillage from Dangerous Goods Vehicles (DGV): to address the risk of accidental chemical spillage of DGVs, an Emergency Response Framework was prepared and presented in the EIA to consolidate relevant existing emergency response plans and to recommend operational guidelines to minimize the potential water quality and ecological impacts associated with a spillage incident. With prompt response and good co-ordination amongst relevant government departments, it is expected that the consequence of any chemical spillage incidents on the bridge would be suitably controlled, to minimize impacts on Deep Bay.

Bird collisions with man-made structures: the project team reviewed over 1,500 publications on bird collisions. The potential hazard of bird collisions to the bridge structures was assessed to be unlikely, because: the maximum height of the bridge structures is less than 150 m; it is located in Deep Bay without any prominent topographic feature in the vicinity; the cable-stayed portion of bridges are not isolated, but attached to the rest of the bridge; precautionary measures were incorporated in the architectural lighting design, so that flood lights would be switched off during foggy weather; and unlike the power lines, the cables of the cable-stayed bridge are about 300 mm in diameter and readily visible to birds.

Loss of mudflats: to minimize unnecessary disturbance to the mudflats caused by the operation of machinery, a temporary access bridge was built to accommodate the construction plant and to provide a gateway for delivery of material to the deeper waters, thus lessening the impacts of construction activities to the mudflat and easing the traffic of marine-based vessels in the deeper waters. Its construction was based on the modular concept, making up of standard size steel decks supported on free standing steel pipe piles.

Special environmental mitigation measures during the construction stage: special methods were developed to minimize disturbance to the habitats during the construction of the permanent foundation works. Many of these methods were unique to the project. For example, a Y-shaped funnel was mounted over piling casing to intercept spillage of wastewater and spoil material during the grabbing activity of bored pile construction, and an oversized casing was fitted over individual temporary piling casing as a double protection against the leakage of contaminated water during piling excavation.

To minimize the impact to water quality, the excavation of marine sediment for the construction of buried pile caps





was carried out within a coffer dam, made up of inter-locking sheet-piles. The coffer dam was further enclosed by silt curtain outside.

Whenever possible, wastewater generated from construction activities was recycled or re-circulated by circulation tanks for use in other operations. Steps were also taken to install additional drip trays on all major piling plant and equipment including the crawler crane, reverse circulation drill, power pack and generator, to control spillage of lubricants and fuels from the machinery.

Conclusion: the works involved in the project were successfully completed, with the mitigation measures thoroughly implemented. No significant adverse environmental impact has been caused. The highway was eventually opened to traffic on 1st July 2007 at the 10th anniversary of the return of Hong Kong to Chinese sovereignty. After opening, the HK-SWC was renamed as Shenzhen Bay Bridge, to form part of the Kong Sham Western Highway. The HK-SWC project demonstrated the successful implementation of a major highway through an ecologically sensitive area.

Environmentally friendly premix carpet (PMC) and SDBC, laid with emulsions-based cold mix technology, in different climates of India

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Central Road Research Institute, New Delhi

To develop environmental and eco-friendly cold mix technology for open-graded Premix carpet (PMC) and semi dense bituminous concrete (SDBC) with bitumen emulsion, field trials were conducted covering various operating conditions viz. Jammu-Srinagar Highway (NH-1A) near Patnitop (J&K) under snow bound; Jowai - Badarpur Road (NH-44) near Silchar (Assam) under heavy rainfall; and H-S Road near Hanumangarh (Rajasthan) under desert climate. The specifications adopted for laying test sections were 20mm thick premix carpet (PMC) and 25mm thick semi dense bituminous concrete (SDBC) for laying test sections with bitumen emulsion and control sections with 80/100 penetration grade paving bitumen. Cold mix design for SDBC with bitumen emulsion was developed using Marshall methods and Marshall specimens were tested at 250C for stability and flow values. Post construction performance evaluation has been carried out periodically after every six-month intervals for a period of about 5-6 years. The characteristics of binder recovered from bituminous mix of the laid surface were determined and it was found that ageing in the residual bitumen from test section was less as compared to the control section with paving bitumen. From the results obtained through field studies, it was inferred that the performance of SDBC with bitumen emulsion is comparable with that of paving grade bitumen. PMC with bitumen emulsion performed better in snow bound area and high rainfall areas, while its performance comparable with conventional paving grade bitumen in desert climate. The use of emulsion in bituminous mix also retards reflective cracking on overlays due to less ageing and low viscosity in cold mixes which helped in the sealing of cracks during tack coating.

A higher temperature range for bituminous binder is required for different applications in road construction with hot mixes. Therefore, bituminous roads construction

with conventional paving grade bitumen is sometimes not feasible or even not desirable in high rainfall areas due to intermittent rains throughout the year which affect the production and laying of hot mixes. At high altitude or in snow-bound areas, hot bitumen gets solidified quickly and looses its binding property, when it comes in contact with existing pavement surface. Cutback bitumen is, therefore, specified to overcome such problems in these environments which requires little heating but is accompanied by emission of solvents used as cutter stock, which create environmental problems.

The use of bitumen emulsion eliminates the heating of the binder and aggregate and thus prevents degradation of the environment and conserves energy. **Despite being a versatile material with several advantages, use of bitumen emulsion in India is only about 2.7% of total consumption as compared to 43% in Switzerland, France and other European countries.** This is probably due to inexperience in use of this technology, non-availability of proper plants and machinery and inadequate quality of bitumen emulsions.

Central Road Research Institute, R & D Centre of Indian Oil Corporation Ltd. and Border Roads jointly undertook field trials for the first time in India to study the techno-economic viability/feasibility of use of cold mix technology using bitumen emulsion with an objective of promoting the technology in the country through the development of guidelines and specifications. In this paper the design and construction, problems faced and experience gained during preparation and laying of cold mixes, and performance of test sections with bitumen emulsion under different climatic conditions are described. The conclusions are drawn from the study.

Extract from results: The performance of PMC with emulsion and PMC with bitumen is plotted against the pavement's service life (see figure below). As can be seen, the performance of PMC with emulsion is better in comparison to PMC with bitumen. The performance evaluation shows that the service life of PMC with emulsion is about 6 years while it is about 4 years for PMC with bitumen at the limiting value of 50 percent marks.

The performance of SDBC with emulsion and SDBC with bitumen was almost similar and comparable after 3 years of service, since the marks obtained were 75% and 76% respectively. The performance of the test section and control sections after 5 years of service was also found to

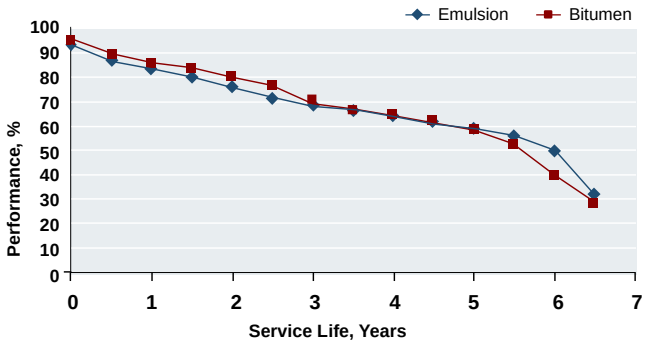
Fig-1: Performance of PMC on NH-1A



be not much different since the marks obtained were 55% and 65% respectively. A graph between the performance v/s pavements service life over a period of time is give in the figure below which shows comparable performance/ life of test section and control section.

Extract of conclusions: a premix carpet (PMC) with bitumen emulsion provides better performance than with neat bitumen. This result applies across climatic areas. The service life of PMC with emulsion was 6 years while PMC with bitumen was 4 years in a snow bound area. The service life of PMC with emulsion was 5 years while PMC with bitumen was 4 years in a high rainfall area. The service life of PMC with emulsion was 4 years while PMC with bitumen was 5 years in a desert climate.

Fig-1: Performance of SDBC on NH-1A



A liquid seal coat on premix carpet with bitumen emulsion provides better performance. Sand seal coat is problematic as mixing emulsion with sand leads to ball formation. The quantity of bitumen emulsion provided for PMC in the tentative specification IRC: 97-1987 was observed towards the higher side. The code of PMC with emulsion has been revised, with recommendation of a lower quantity of bitumen emulsion than specified in the tentative specification.

Caterpillar champions pavement recycling in China

Caterpillar Asia

In rural China few road contractors have the resources to undertake major road reconstruction. As a consequence, when rural roads deteriorate, the government has often had no option but to apply a "quick fix" asphalt overlay on top of whatever is underneath. The life of many new surfaces is short. However, Caterpillar's Project Century programme is turning things around and allowing many of China's rural roads to be fully and economically rejuvenated through in-place pavement recycling. The aim of Project Century is to have 100 road recycling projects completed in China before the end of 2009. The end of 2008 had already completed around 25 sites.



The campaign is being driven through the extensive network of Caterpillar dealers in China and managed by four main dealers: Lei Shing Hong Machinery in Kunshan, Jiangsu province; WesTrac China in Beijing; ECI-Metro in Chengdu, Sichuan province and China Engineering Limited in Hong Kong. Contractors are offered training in road recycling technology and, through China's Cat Rental Store network, attractive hire rates are available on pavement recycling equipment such as rotary mixers, motor graders and compactors. Attractive financing arrangements are also offered through these channels. The four main dealers have been involved with Project Century since its inception in 2006 and have made a commitment to the programme's long-term goals.

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In the latest project of the campaign, a 20km section of road in the city of Dong Yang in eastern China provided a measure of the cost savings associated with in-place recycling. The city highway bureau's project supervisor Li Jinxiu said the **final cost of the rehabilitation was about half that of removing the whole pavement, discarding it and bringing in new material for a new pavement.** A Cat RM300 rotary mixer was used at Dong Yang to pulverize the surface and mix in an appropriate percentage of cement. As the RM300 moved along, a Cat 140H motor grader followed immediately behind, reshaping the pavement, before a Cat CS583E compactor brought the material to the required density. At a speed of more than 500m per day, **the recycling process took less than one third of the time of full reconstruction - minimising disruption to traffic.**

The savings achieved in cost and time on many similar projects will allow many more roads to be rehabilitated within existing budgets - improving regional transport networks and ultimately **improving the socio economic status of many country villages.** At the same time, Project Century is encouraging local contractors and road owners to embrace recycling technology, to adopt new and more efficient work practices and to use machinery that will do the job better, faster and more economically. As the Project Century campaign gets into full swing, the full extent of the socio-economic benefits it delivers to China's rural communities will be huge. Many of those benefits will not be fully recognised for several years. However the benefits the campaign brings to the environment are much more immediate.

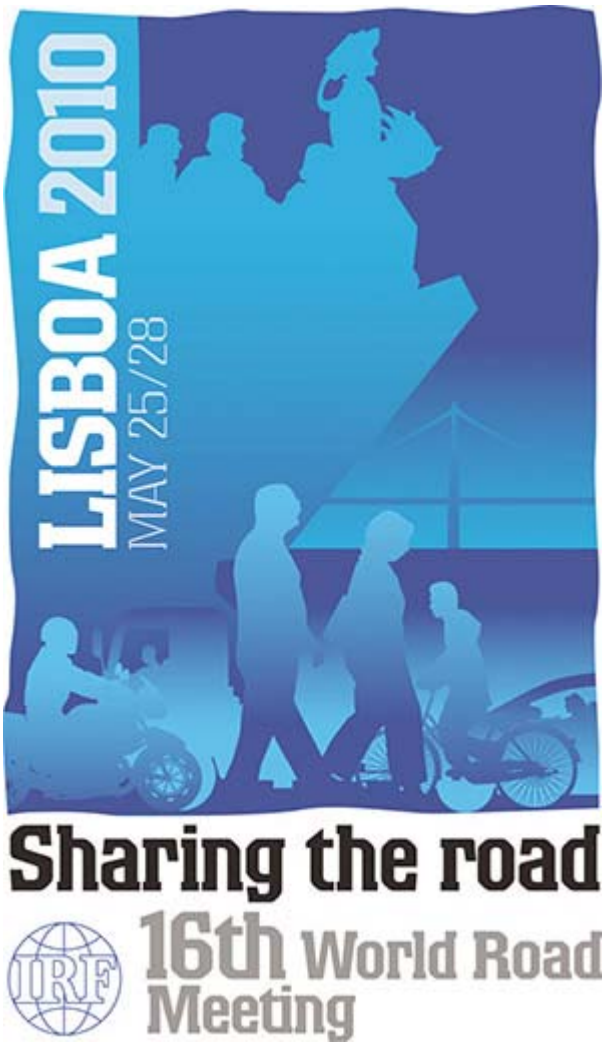
By recycling pavements in-place, the **consumption of virgin raw materials is dramatically reduced**, leaving them available for more vital, future needs. Recycling also leads to **reductions in the costs, energy consumption and green house emissions** normally



associated with: drilling, blasting, crushing, handling and transporting the virgin materials to site; and removing, transporting and disposing of the original pavement materials. At the same time, old pavement materials are retained in the road and no longer need to go into landfills, where potential always exists for bituminous products to later pollute the environment.

Caterpillar's initiative with Project Century reaffirms the corporation's commitment to helping bring about a more sustainable world. Caterpillar's stated goals in this regard include helping customers to (relative to 2006 base figures): **reduce greenhouse emissions by 20% by 2020; increase energy efficiency by 20% by 2020; and, increase material efficiency by 20% by 2020.**

As Project Century gains momentum Caterpillar plans to extend the scope of the campaign to include China's state roads and roads in other Asian countries where the economies and environmental benefits of in-place recycling can be best exploited.

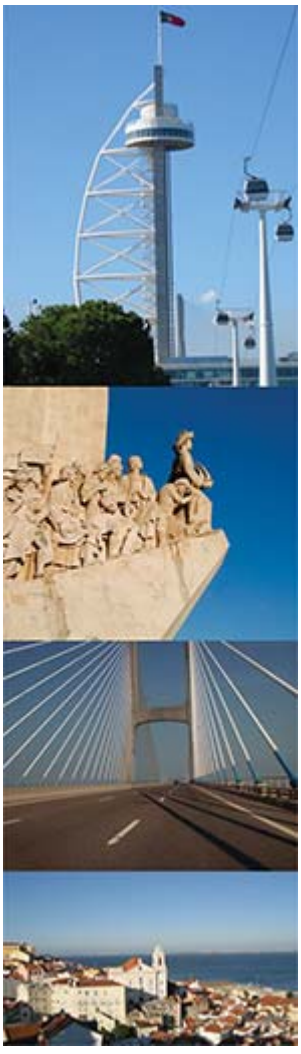


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