

BASICS OF PAVEMENT PRESERVATION IN A CHANGING WORLD

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ABSTRACT

The choice of road maintenance techniques has long been the preserve of the consultants acting on behalf of the owners. At the same time, the road industry has developed its own technical skills so that to offer more elaborate solutions.

In the middle of the 1970's, and even more in the 2000's, economic constraints have forced the road owners to optimize technical solutions. To a certain extent, the goal was to do more for less. New tools such as life cycle analysis were developed: an expensive solution may be highly cost-effective over the life span of the infrastructure.

The requirements of sustainable development, often initiated by associations and staves by Governments have then added an important parameter in the criteria of selection of technical solutions, and, more broadly, in maintenance strategies.

In some countries, the Road Authorities have started to focus on their management role, outsourcing the actions of specification. New ways of contracting appeared, with performance based contracts, BOTs, concessions, public - private partnerships.

In recent years, the public came into the debate. On one side, the users of the infrastructure request that the funds generated by the use of road infrastructure are more equitably allocated to road maintenance. On the other side, the inhabitants in cities ask for solutions that create minimal inconveniences, especially in respect of noise emission.

Finally, new information and communication technologies, changing the way infrastructure are used, create new needs and new opportunities too.

New business models have been developed so that to meet these long term changes. Technologies are also changing but the basics remain the same.

INTRODUCTION

Roads networks are primary assets of nations. They provide greater connectivity that allows people to get to work, to access needed goods and services, and connect with their family and friends. Road networks are also important economically as they provide critical connections between businesses and intermodal facilities such as ports and railways. They also provide lower cost goods to the consumer as there are few alternatives to get goods to market without them. In order to ensure social progress and advance economic prosperity, maintaining our road networks needs to be a priority.

However, it appears in many countries that the backlog of outstanding road maintenance has caused irreversible deterioration of the road network. In other words, delaying road maintenance is false economy.

The shortfall in investment in maintenance generates higher risks of accidents, problems of congestion, increased noise and a reduced service to society. In this way, road maintenance should be seen as a whole, involving many stakeholders: road users, politicians, road owners, road industry.

BACKGROUND

The choice of road maintenance techniques has long been the preserve of the consultants acting on behalf of the owners: traditionally, infrastructure works financed by public organizations are procured according to a standard procurement pattern which means that the local “Contracting Authority” engages a Consultant to assist the Contracting Authority in developing comprehensive specifications and documentation to be included in the tender dossier. The bidders then review the documentation and submit their proposed price. The usual standard method of awarding works contracts provides that the successful tenderer is the one submitting the least expensive bid classified as technically compliant during the technical evaluation.

In the middle of the 1970’s, and even more in the 2000’s, economic constraints have forced the road owners to optimize technical solutions. To a certain extent, the goal was to do more for less. The 2008 crisis have severely impacted public road expenditure. It has been a global trend even if the magnitude of this impact differs from a country to another.

Scarcity of funds has lead road agencies to make the best use of the moneys available, identifying priorities and selecting the most appropriate technical solutions. Tools have been developed such as Pavement Management Systems that make such optimization workable. Being challenged by a fast changing context, the industry has developed systems that are meant to be closer and closer to their customers’ needs. Beyond systems, the industry aims at offering more and more elaborate solutions.

Scarcity of funds has also led the road owners as well as the road industry to be watchful in order to raise the full awareness of the road users and politicians about the value of pavement preservation.

NEW REQUIREMENTS AND TRENDS

Evolution of the Mobility

Since roads have existed, they have always been used by ... road users driving their vehicles. Nowadays, roads become inclusive involving all the stakeholders and communities.

Moreover, the global automotive industry may be on the verge of a fundamental transformation giving rise to a new mobility ecosystem. These changes could have far reaching implications for how we move from point A to point B, and for stakeholders far beyond the auto industry, including gas companies, retailers, insurers, emergency rooms, advertisers, and government regulators.

We might be forgiven for thinking these shifts will materialize only in the distant future, making strategic changes today premature. But the future of mobility is already impacting how businesses operate in an array of industries. As of November 2015, Google self-driving cars have completed more than 1.3 million miles of autonomous driving on public streets.

The changes are being driven by a series of trends—some technological, some social—that collectively may be poised to fundamentally transform how people and goods move about.

Environmental Concerns

Health Safety and Environment requirements have become new incentives for updating the panel of existing techniques and develop Research & Development works for innovative solutions.

Such trends are not limited to a few countries: they apply on a worldwide scale, encouraging communication and beyond, such as through technology transfers.

The requirements of sustainable development, often initiated by associations and staves by Governments have then added a growing parameter in the criteria of selection of technical solutions, and, more broadly, in maintenance strategies.

Focus on Performance: Less Rowing, More Steering

In recent years, the public came into the debate. On one side, the users of the infrastructure request that the funds generated by the use of road infrastructure are more equitably allocated to road maintenance. On the other side, the inhabitants in cities ask for solutions that create minimal inconveniences, especially in respect of noise emission. As a matter fact, both populations want more (performance) for less (money / tax).

In some countries, Road Authorities have started to focus on their management role (steering), outsourcing the actions of specification and control (rowing). New ways of contracting appeared, with performance based contracts.

In traditional contracts, the road agency specifies techniques, materials and quantities of materials to be used, together with the period during which the works should be executed. In performance-based contracts, the client specifies performance indicators (or results).

Development and Maintenance of the Road Network at Constant Cost

Globally, the road industry has been facing a double challenge: costs increases (e.g. bitumen price have more than tripled on a 10 year period) and shrinking markets due to public budgets restrictions.

Expansion of road networks implies increasing maintenance needs while public budgets do not follow such expansion. Road owners together with the road industry have to cooperate in order to identify and select the most cost effective solutions so that to deal with such a challenge.

However, such goal is not always reachable and it often appears that maintenance is delayed at the detriment of the future of economy and mobility. Delaying road maintenance is false economy.

DEVELOPMENTS

New Procurement Systems

Existing rules for public procurement to date have proved, to a certain extent, to be a barrier to the uptake of new products and innovative techniques that are both greener and more durable. Despite improvements in recent years, the vast majority of public tenders for road related services have been based on the principle of the ‘cheapest initial price’, failing to provide an appro-

appropriate framework for the holistic assessment of solutions based on their environmental performance and their durability.

New sets of rules need to be developed in order to modernize the whole framework for public procurement so that to allow governments to adapt their tendering processes to current needs to facilitate acquisition of greener and more innovative products and services.

By encouraging public authorities to modify the philosophy of the purchasing approach, it provides at the same time incentives to industry to invest in research and innovation. The combination of these two elements will benefit the whole of society by optimizing public resources and delivering to citizens better and more durable roads.

Road Asset Management

Determining the most cost-effective option is a process that takes into account the condition of the existing pavement as well as its future use. On a large scale, i.e. a full integrated road network, it is a strategic operation known as road asset management (RAM).

The PIARC has defined RAM as “a systematic process of maintaining, upgrading and operating assets, combining engineering principles with sound business practice and economic rationale, and providing tools to facilitate a more organized and flexible approach to making the decisions necessary to achieve the public’s expectations.”

Basic common RAM requirements are:

- Establish a complete inventory of all road network with all its elements
- Provide a clear picture of the current condition/performance of the road network
- Estimate the value of the asset
- Predict future demand of traffic and service needs
- Estimate maintenance needs and costs
- Prioritize objectives related to the desired quality and performance of the road network
- Set up funding scenarios for the regular and timely maintenance and upgrade of the road asset
- Define a strategy (RAM Plan)
- Implement the RAM Plan

Life Cycle Analysis

Within the frame of RAM, life-cycle cost analysis (LCCA) is a tool to determine the most cost-effective option among different competing alternatives to purchase, own, operate, maintain (and, finally, dispose of) an object or process, when each is equally appropriate to be implemented on technical grounds.

For road pavement maintenance, LCCA takes into account all the user costs, (e.g., reduced capacity at work zones), and agency costs related to future activities, including future periodic maintenance and rehabilitation. All the costs are usually discounted and total to a present-day value known as net present value (NPV).

One of the main difficulties of such an exercise is to forecast the future costs. As an example, the bitumen cost has increased by 13.5% per annum, from year 2003 to 2013. Who could have anticipated that such a cost would have fallen by 2/3 in early 2015?

Use of NTIC and Big Data Associating the Road Users

So far, data acquisition has been made using specific machines, operated by specialized and professional teams.

NTIC and big data have now started to enlarge to tool panel and embark the road users themselves: experimentations have already started using cars as data acquisition means.

As an example, chips connected to GPS systems constantly send information to a central data center, which helps to analyze traffic flows and speed, allowing road agencies to better understand the needs of the road users and improve the way the infrastructure is tailored to these needs.

Another example deals with the use of accelerometers in smartphones carried in moving vehicles. This system automatically evaluates the roughness of road surfaces and identifies major damage, such as potholes.

The crowdsourced data is analyzed to extract information, particularly on the condition of road surfaces users travel over, providing the road agencies with comprehensive and frequent information on road surface condition over wide areas.

This enables them to prioritize maintenance operations, and to assess road surfaces before and after maintenance work. By promoting citizen engagement and enabling road agencies to respond more effectively to users' concerns, this approach also enhances government accountability.

CASE STUDY: BITUMEN EMULSIONS

Cost Effective Solutions

Bitumen emulsion techniques are probably the most ancient and, for that reason, the most reliable maintenance techniques. Invented and developed in the 1920's, bitumen emulsion has for long found its share amongst a wide panel of maintenance techniques. Nowadays, emulsions account for 8% of the asphalt binders used Worldwide (Source: International Bitumen Emulsion Federation). This ratio is an average and can be as high as 30 or 35% in countries such as France and Mexico.

The first reason of this success is of course the economic factor, but this must be understood with the long-term in mind: upon the lifetime of a pavement – 20 to 20 years - emulsion based maintenance techniques have proven their efficiency and reliability.

In the United States, the land of pragmatism, the Federal Highway Administration (FHWA), in the wake of strict budget cuts, launched a genuine “think & action tank” called the Emulsion Task Force (ETF), designed to draft out performance-based specifications for bitumen emulsion. Some twenty years after Strategic Highway Research Program (SHRP), which led to the Superpave system for hot mixes, the ETF aims at setting the same targets for bitumen emulsion.

In terms of development, a number of practical accomplishments can be put to the credit of emulsion-based techniques, e.g., a study by the Ohio Department Of Transportation whose findings showed that surface dressings could help lengthen service life by 7 years depending on the initial condition of the pavement.

Examples are numerous, such as the experience of the Versailles district road department (France), which claims that between 2009 and 2012, the maintenance budget of road maintenance has decreased by 24%, while keeping the level of service. Such achievement has been met in changing and diversifying the maintenance techniques. Until 2009, 90% of the wearing courses were based on the use of asphalt overlays (25 to 35 mm thick). From 2010, and for low to medium traffic roads, emulsion based surface treatments have been extensively used, mainly surface dressing and micro surfacing. The cost of such techniques is 3 to 7 times lower than the cost of conventional hot mixes.

Environmentally Friendly Solutions

Bitumen emulsions techniques are well known for their limited impact on the environment.

As far as spray seals are concerned, we may refer to two examples from the USA:

The motivations for replacing cutback with emulsion are numerous. The primary reason for placing restrictions is environmental, specifically Air Pollution Act of 1990. In many areas of the United States cut-back asphalt has been banned because of Volatile Organic Compounds (VOC's). The restriction on VOC's is intended to reduce "Ground Level Ozone" (smog) formation.

In the state of Texas, the Texas Natural Resource Conservation Commission (TNRCC) has established strict guidelines and/or prohibited the use of cut-back asphalt for most applications between April 16th and September 15th of any year. This regulation states "Cut-back cannot be used, applied, sold, or offered for sale in the counties named" (Cut-back asphalt is defined by the TNRCC as "Any asphaltic cement that has been liquefied by blending with petroleum solvents)

For mixes, cold manufacturing techniques generate very few potential nuisances. There is no smoke and little or no dust, which explains why cold mobile plants usually do not require any special permits for operation.

Beyond Environment, Health and Safety also benefit from the advantages of the emulsion techniques. As long emulsions are used at ambient temperature, hazards for storage, transportation and use are minimum.

The Future of Emulsion Techniques

With the increased focus on preserving asphalt pavements, emulsions play a growing role. The introduction of PG technology to selecting, specifying and evaluating emulsion performance offers significant promise to improving emulsion tests to a "performance graded" (PG) system.

In this changing environment, bitumen emulsion techniques as well as engineered bitumen techniques, such as polymer modified bitumen, find their place more than ever, at the service of the quality of the infrastructures and their users.

Together with road owners, the emulsion industry is still continuing to develop and propose new systems, in order to extend the use of emulsions on roads bearing higher and higher traffic, such as:

Use of fibers

- Modification of the binders (modified emulsion of emulsion of modified bitumen)
- New systems such as Cape Seal
- Semi warm mixes aiming at replacing hot and warm mixes (Semi warm: temperature < 100°C).

Beside these typical maintenance systems, some developments are in progress, especially for tack coats. This is especially the case for trackless tack coats, which are meant to improve the bonding of the asphalt concrete placed on top, improving the integrity of the whole pavement and contributing to an extended lifespan of the later.

CONCLUSIONS

Our societies are constantly evolving, whether it is the behavior of individuals or the way the economy operates. These changes are often, but not always, initiated by the evolution of technologies. To these new behaviors are added the constraints and opportunities linked to the requirements of sustainable development.

In any case, individuals and the economy must rely on quality road networks.

Road networks have mostly been built in the last decades or so and need to be maintained. However, the growing maintenance needs linked to the development of human activities are not always covered by public finances. Road owners jointly with the industry must therefore develop and propose new solutions to meet the challenge “more for less”.

Meeting this challenge is twofold:

- On one side, operators develop new products, processes and systems by evolving their own technology.
- On the other side, solutions become inclusive, and use the best of new technologies, especially those of information and communication, and big data.

In this context, the most ancient technologies are also evolving, based on a solid background, from which they are improved in deliver the best service to the community. Bitumen emulsion technologies are part of them and have a great future.