ROAD PAVEMENTS

Tuesday 21 October 2003 (1.30 – 5.00 p.m.)

Session Agenda & Introductory Report

22.78.E

SESSION AGENDA

1. **Opening Remarks and session introduction**

Mr. Nelson RIOUX (C7/8 Committee Chairperson/CANADA-QUEBEC)

2. **Selection of pavement types**

Mr. Paul T. TENG (C7/8 member/USA)

3. **Recycling and retreatment of pavements**

Mr. Jan T. VAN DER ZWAN (C7/8 member/THE NETHERLANDS)

4. **Design of innovative pavements**

Mr. Jean-Pierre CHRISTORY (C7/8 Committee French-speaking Secretary/FRANCE)

5. **Questions and Discussion**

6. **Specifications of performance**

Mr. John WILLIAMS (C7/8 member/UK)

7. **Discussion: "Specifications of performance and Innovation": How to obtain and improve the performance of pavements**

8. **Future direction of Road Pavements**

9. **Conclusion and closing**

Mr. Nelson RIOUX (C7/8 Committee Chairperson/CANADA-QUEBEC)

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SUMMARY OF ISSUES

Road administrations are increasingly seeking to develop partnerships and make use of the expertise available in all its forms, both within the client units and externally in the public and private sectors. This expertise is at the heart of developments in terms of innovation and new contractual approaches that will guarantee the performance sought for pavements and even push back the current frontiers to achieve better performance in the future.

The introduction of performance specifications in road building contracts, while relatively new, is consistent with this objective. This new type of specifications offers many advantages for the client and for contractors, but its implementation runs into obstacles that nonetheless can be overcome. Adopting such specifications requires their testing and the gradual expansion of the field of application to make the most of these experiments. However, their implementation requires a profound change in roles and responsibilities and a new sharing of risks between the client and the contractor, who must trust each other.

Performance specifications stimulate entrepreneurial innovation. However, contractors are not alone in possessing the potential for innovation. It is essential to continue to support and stimulate the innovation efforts originating from the public sector and from other organizations in the private domain. The potential for innovation is complementary and each player remains dependent on the other to guarantee the successful development and implementation of innovation. Innovation does not only materialize in products and techniques but also in the programs and structures set up to help it flourish.

The purpose of this introductory report is to stimulate discussion and enrich reflection on the means of improving pavement performance. Special attention is addressed to performance specifications and the need to innovate to improve pavement performance.

CONTRIBUTION TO THE REPORT

The following persons from the C7/8 Committee on Road Pavements participated in writing this introductory report:

Mr. Nelson Rioux, Chairman of the C7/8 Committee of PIARC, Canada-Quebec
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Mr. Paul Teng, Subgroup leader for " Selection of Pavement Type", United States
Mr. Jean-Pierre Christory, French Secretary, subgroup leader for "Innovative Pavement Design", France
Mr. John Williams, Subgroup leader for "Performance Specifications", United Kingdom
Mr. Jacques Aunis, Subgroup leader for "Rehabilitation and Strengthening of Pavements", France
Mr. Jan van der Zwan, Subgroup leader for "Pavement Recycling", The Netherlands

INTRODUCTION

For the current cycle 2000-03, the work of the current Committee on Road Pavements (C7/8) began in spring 2000 and focused on the following five main themes:

1. Criteria and processes for selecting pavement types;
2. Pavement rehabilitation and strengthening: inventory of techniques;
3. Technical recommendations on pavement recycling and retreatment;
4. Innovative pavement design;
5. Functional specifications of new and recycled materials: towards performance-based technical specifications.

These five major themes are or will be the object of reports and guides published by the PIARC. Several issues accompanied by questions on these themes are related to the main topic of this introductory report, i.e. what is the current status of the use of performance specifications and what means are being considered to improve this performance through innovation?

In fact, any client road organization is able to define its performance objectives. The main difficulty resides in converting this expected performance into contractual obligations and specifications. Performance specifications can serve as a stimulus for innovation, but always with a predetermined performance level as the target. It therefore remains necessary to innovate, not only to obtain the specified performance, but also to push the envelope of this performance to higher levels.

The issues and questions in terms of obtaining the expected performance and the needs for innovation to improve performance are summarized below. A discussion will follow on the obstacles to overcome, the benefits envisioned and the necessity of innovating along with performance specifications.

1. EXAMPLES OF NEEDS IN INNOVATION AND IMPROVEMENTS OF PAVEMENT PERFORMANCE

1.1 Pavement rehabilitation and strengthening techniques

Use of these techniques, with their advantages and limits, requires the ability to adapt them to the specific context of each country and each project. The engineering dimension is fundamental to balance the limits of use, costs and expected performance. Since needs are evolving, innovation may consist in developing a completely new technique or adapting an existing technique to new conditions of use in a given country.

The condition of existing structures and the materials already present on the site before intervention will have significant consequences for subsequent performance. The field of application of the techniques should be well known before it is possible to consider translating rehabilitation and strengthening objectives into performance specifications.

1.2 Pavement recycling and retreatment

Recycling raises great interest in many fields of human activity, including road building and maintenance. Recycling continues to be necessary as a means of ensuring sustainable development by reducing the necessity to scrap old materials or extract new ones. However, recycling must result in performance levels at least equivalent to or better than the traditional processes, at the same cost or less over the life of the pavement. Recycling must remain competitive, taking into account both processing costs and environmental costs.

Recycling is not always a simple technique. Often no standards exist. What is relatively well mastered in one country becomes an innovation in another. Clients are sometimes reluctant to apply these techniques, even though they have been used successfully under various circumstances and according to well-documented processes in several developed countries. Nonetheless, these techniques are perceived as an attractive alternative for countries in transition because they allow a gain in structural capacity at less cost.

Knowledge of long-term performance of pavements built with recycled materials has not been mastered in most countries. A few countries have more than two decades of experience with recycled materials and recycling techniques, although for other countries this is a new phenomenon. Nevertheless, recycling can still be considered as relatively innovative. However, the gains resulting from recycling are so great that using recycled materials remains an option that inevitably must be examined.

Performance in terms of quality and total cost continues to be a key factor to ensure the long-term viability of recycling techniques. Equitable risk sharing between the partners to stimulate development and use of recycling processes in a market to be created or consolidated is also very important. These concepts are also present in the development of performance specifications.

1.3 Selecting pavement types

Once the responsible authorities have decided to build a new road section or perform work on an existing road link, it is necessary to select an adequate service level. This choice is reflected in terms of expected performance and has repercussions, not only for the pavement's functional qualities perceived by the users and adjacent landowners, but also on the structural requirements and the future intervention strategies that will ensure that these functional qualities are maintained in the long term.

Determining the most appropriate pavement type is not an exact science but a matter of judgment. This process is based on the examination of many factors such as traffic conditions, climate constraints, properties of materials, special drainage features, road building methods, the impact of the work on the users, safety imperatives, budgets and environmental issues, such as noise and emission reduction. One or more of these factors may dominate the others to the extent of dictating the decision.

However, no predetermined and universal formula exists for selecting pavement types. The facts affecting the decision vary from country to country and from one project to another, depending on the context. To establish an equitable comparison among the various options, the costs estimated by applying whole life cycle costing can then serve as a basis of comparison. Anticipated performance plays an essential role in this decision.

In fact, pavement selection decisions always involve several questions that are inseparable from the very nature of an investment justified on the basis of future performance and cost projections:

- How can specific short-term needs be reconciled with desired long-term performance?
- What is the certainty of obtaining this long-term performance and predicting the costs over the life cycle for periods of 40 to 50 years?
- How will the quality of materials and road building work, user expectations and road needs evolve in the future? What impact will road innovations and traffic have on maintenance, performance and costs?

Despite these unknowns, a decision nonetheless must be rendered on the type of pavement to be built. Structured approaches, as rigorous as possible, are the only way to reduce the risks associated with the decision. To improve the results of these analyses and reduce uncertainties, performance levels and the associated costs must be clearly defined. Performance specifications are one of the appropriate ways to define them but they should be employed with a sound knowledge of the implications of the risk transfer involved.

2. INNOVATIVE PAVEMENT DESIGN

All partners associated with building and operation of road infrastructures today agree that innovation is a primary necessary to deliver structures that will meet tomorrow's performance requirements. In fact, it is still difficult to promote active cooperation and value the most promising concepts and techniques.

How is it possible to prepare today to respond to the major concerns of tomorrow's users? Society demands less nuisance impacts, less risks, more mobility for everyone, more sustainable development. It is also increasingly impatient to satisfy its expectations. There is increasing pressure to implement "best practices" from other countries before they are fully understood home. The innovative approach should not only provide good answers but endeavor to reconcile the agendas between the expression of a need and speedy delivery of the solution.

There is no standard organizational chart or miracle formula that guarantees development and fruitful implementation of innovations. It is necessary to show creativity not only in techniques and products but in relation to the strategic plans and means implemented within organizations to support innovations. Here are a few concerns in this regard.

The city's concerns: a wealth of ideas for road innovation

"A street is not a road" is now the maxim of most cities. The culture of multifunctional planning prevails in cities, while the function of mobility for automobiles is specific to roads. However, there are still many points in common, even though the performance objectives may differ. The urban environment, which encompasses 85% of users living in cities in the industrialized countries, is particularly promising in terms of innovation needs that can then benefit the entire road community.

Innovation and developing countries

The methodologies of development and implementation of innovations are mainly based on the concerns and contexts of the industrialized countries. For the developing countries, it is interesting to note that Innovation and Technology Transfer are closely interlinked. Applying to developed country model to development and implementation of innovations is worth debating.

Innovation inseparable from evaluation procedures

Innovation means taking risks, measured risks if possible. To guarantee the success of innovation, the risk necessarily should be shared to obtain an equitable return between the client and the promoter of the innovation. This is why evaluation of innovation and the evaluation procedures have considerable importance.

In some cases, the definition of a new evaluation procedure is an act of innovation in itself. Reconsidering conventional standards for judging the quality of pavement materials and structures is difficult but may turn out to be indispensable to avoid swamping the innovation. The application of performance specifications is a specific case where the client should reconsider traditional means in order to stimulate new ideas and adequately judge contractors' proposals.

Innovation and standardization – Reintroducing the art of engineering

Standardization is often cited as a hindrance to innovation. This idea should be fought and it is worth debating how to change this view. If we follow the logic of product life cycle, we can say that standardization is a logical consequence of innovation, or that innovation feeds the progress of standardization.

How can the art of engineering be restored to road building and how can controlled creativity be expressed? How can we avoid situations where the necessary development of all kinds of standards, technical manuals, catalogues and directives transforms the technical services of public authorities into technical "notaries" who base their opinions too exclusively on a meticulous knowledge of these texts? Innovations in recycling and retreatment are specific examples of the value of this rediscovered art of engineering as opposed to catalogue solutions. The introduction of performance specifications also opens up new avenues for contractors that are thus able to amend the catalogue solutions.

Risks and innovation – Equitable risk sharing between partners

Better contractual methods to satisfy the philosophy of equitable risk sharing is now a necessity. Performance contracts are appropriate tools to specify the commitments of each party regarding the duration and allocation of risks. This type of contract is discussed in more detail in Chapter 5.

3. PERFORMANCE-BASED TECHNICAL SPECIFICATIONS

Client organizations are trying to introduce new contract structures, moving from a traditional approach where the client assumes responsibility for the performance of road structures, to a partnership with the industry that leads to greater risk sharing. There is a growing interest in testing performance specifications to develop sustainable pavements and benefit from recent technological innovations.

End-result specifications have evolved into performance specifications. The main distinction between the two is that end-result specifications concern delivered products subject to control of a set of characteristics that are presumed to influence performance whereas, for performance specifications, the direct relationship with performance is greatly amplified. Performance specifications thus are based on properties used to predict performance directly, or simply direct measurement of performance over time based on functional specifications.

Functional specifications are not new. It is their translation into contractual obligations that represents a significant change in itself. The use of these different types of specifications has inevitably altered the contractual relationship, transferring more responsibilities from the client to the contractors to benefit more from their potential for building performing road pavements at an acceptable cost.

It is nonetheless important to bear in mind that risks associated with this new sharing of responsibilities exist for both parties. This type of contract does not eliminate the necessity to define the characteristics of raw materials and the way they are laid on the site. This latter obligation simply is transferred to the contractors instead of being defined by the client, which then concentrates on clearly specifying the functional requirements. If the contractor deviates from known models and materials to install pavement, this increases the risk that should be borne by the contractor with an adequate warranty period.

A few basic conditions are necessary before using the performance specifications:

- The existing conditions that may affect performance should be well known and shared with the contractors during the call for tenders: nature and properties of soil, condition of existing pavements, existing and anticipated traffic, any other factors with a potential influence on design and performance.
- Sharing of risks and responsibilities should be clearly defined.
- The competencies and knowledge of the two parties, contractor and client, should be adequate.
- Healthy competition should prevail among contractors.

- The size of individual contracts and the market as a whole should be sufficient to give contractors an incentive to invest in such contracts.
- The requirements for test and performance measurement methods and the frequency of testing and performance measurement should be clear and precise.

Major issues

Three major issues will have to be addressed in the future:

1. Harmonization of definitions of performance specifications;
2. Profitability of the investment associated with their implementation;
3. Advantages and disadvantages of the different warranty formulas required.

Harmonization of definitions is essential. What is performance? Does it apply to a material produced at the plant or laid on site, depending on the expected properties? Or does it apply exclusively to the functional qualities of the structure as a whole once it is delivered? This harmonization of definitions would allow better sharing of information and clarification of the fields of application, requirements and test protocols.

The profitability of the investment associated with implementation of performance specifications seems interesting, at first glance, but it is still difficult to demonstrate it clearly, given their relative novelty. The whole life costing analysis for pavements are not all conducted in the same way from one country to another and do not include all the same costs. The way risks are transferred to the other partners will largely influence the results. There are higher probabilities that the initial costs will be greater before the long-term benefits are recovered. Since the specifications and characteristics required regarding materials and road building methods are evolving, it may be difficult to gather coherent data from which sure conclusions can be derived.

The way contracts are awarded also has a strong influence on the type of specification and on the warranties. These warranties protect the client against defects in design and construction (materials and implementation). Warranty periods of 2 to 5 years are the most popular but are not equivalent to the whole life of the pavement.

Other warranty periods cover 26 to 50 years. In some Design-Build-Finance-Operate (DBFO) contracts, no warranty is mentioned. The risks over long periods are greater and predictions regarding performance are very difficult to fulfill.

Here is a summary of the advantages associated with performance specifications, the very nature of which depends on trust between the parties.

Advantages

- The emphasis is placed on performance.
- Risk sharing: the risks are reduced for the client with a transfer of responsibilities from the client to the contractors. The contractors are more aware of the engineering excellence required and are even more sensitive to quality.
- Greater flexibility is allowed to contractors in the selection of materials and means, which encourages a better choice of constituents, reduces scrap material and optimizes site organization.
- The actual total cost of obtaining pavement that performs well is more certain. Depending on how risks are transferred to contractors, this total cost may be reduced, considering the synergy created by the design, building and maintenance package entrusted to the contractors. This work is carried out in an environment where design solutions and road building methods are also in competition. Based on appropriate assessment of bids, it may result in either lower costs or higher quality initially. In any case, the client seeks to obtain lower whole life costs.

- Optional solutions can be developed in accordance with the specifications and may even exceed the performance targets.
- Less contract disputes arise although the scope of claims and disputes might evolve over time, as conditions affecting pavement performance change and as contractors acquire more legal experience.

- The responsibilities and risks will also eventually be passed on to the suppliers.

- The risks of budget overruns for the client are reduced and it can then reserve its own resources for other purposes.

On the other hand, some risks still exist.

Risks

- It is not clear that the client is currently capable of defining all the characteristics associated with performance.
- There is a risk of loss of client competencies which could translate into a reduced ability to judge bids, insufficient knowledge to audit work and difficulties in taking over road sections in the event that a contractor cannot meet its contractual commitments.

- Few contractors are large enough, diversified enough, or well financed enough to be able to bid on this type of contract, thus limiting competition.

- The client cannot intervene on the means so as not to interfere with the warranties. The client may have difficulty guarding against poor performance once the warranties have expired.

- Risk allocation is clearly different with such specifications, which results in a probable increase in costs for companies, because they cannot spread their risk over a limited number of kilometers, as opposed to the client, which has an entire network to amortize its risks.
- Several changes in road operating conditions may occur during the term of the contract and limit the application of contractual obligations.

- The tests and performance measurement methods can become obsolete if the warranty is long. They may also be contested, since other types of tests and other measurement methods than those selected may allow validation of compliance with the performance specifications. Testing equipment and method vary from one country to another and the experts have different opinions on the subject.

- Road sections designed with performance specifications may vary significantly from each other in terms of materials used and the type of maintenance work required, thus resulting in a more heterogeneous network compared to the current situation.

Regarding innovation potential

- Performance specifications are an incentive for contractors to innovate in road building techniques and methods. These specifications favour faster implementation of contractors' products and solutions.
- With new materials, less experience is available, performance is more difficult to predict and therefore more risks are involved. Recycling is one example. Safety factors must then be added to offset the greater risks.

4. DISCUSSION

Performance specifications are a logical outcome of the evolution of specifications. By directly targeting the pavement's expected performance, we focus our attention on the real objective. Despite the undeniable advantages they provide, however, implementation of performance specifications is slow.

Since the client considers that it has the ability to judge performance, why aren't such functional specifications used more extensively? What technical and contractual obstacles have to be overcome? Can uncertainties be reduced regarding the obtaining of this performance and the associated costs so that we can have more confidence in our choices of pavement types? Can the risks be reduced from the client's point of view and in general for both partners?

In fact, we are still at the learning stage, both for the client and for contractors. This does not only mean technical learning but a gradual change in attitudes and a climate of partnership needs to be developed with new roles and new responsibilities.

It is first necessary to define the expected performance. The longer the period over which contractual obligations are extended, the more difficult it is to formulate the warranty and the performance specifications attached to it.

We can question how far pavement performance specifications should go. Figure 1, produced in the Netherlands, illustrates the different specification level. This figure is taken from the document produced by the C7/8 Committee of the PIARC, entitled « A fact finding review of performance specifications in 2002».

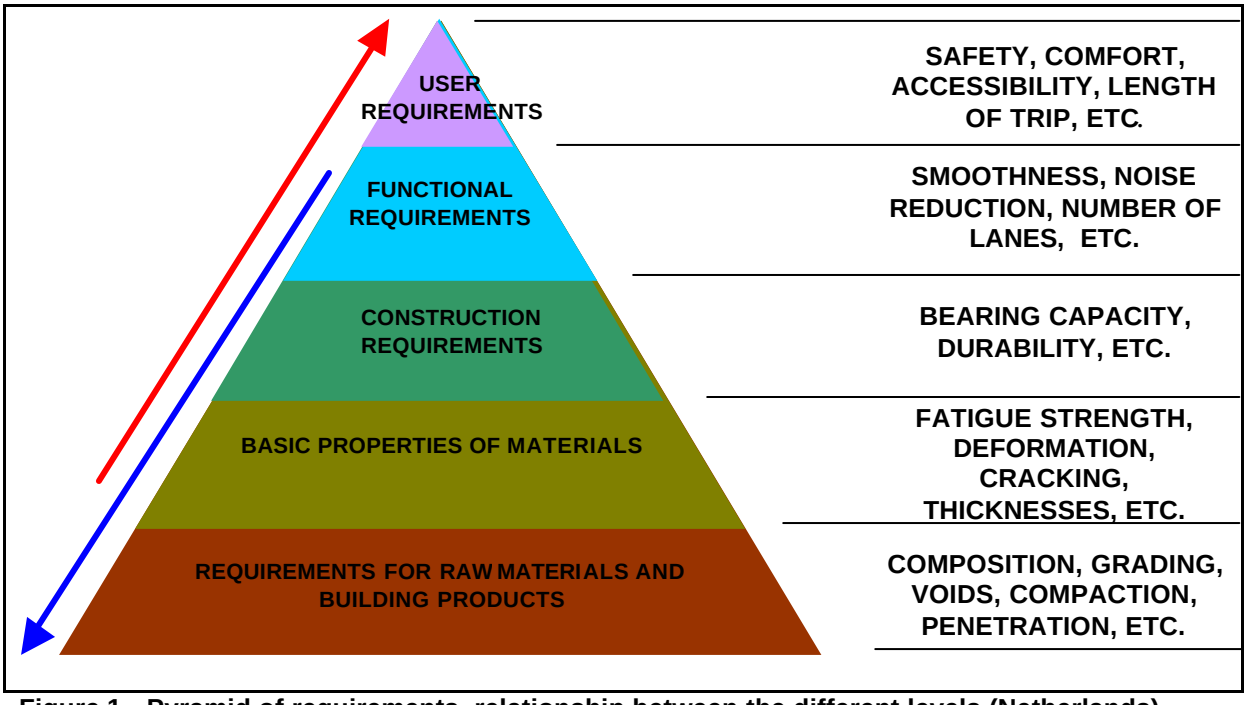

Figure 1 - Pyramid of requirements, relationship between the different levels (Netherlands)

As illustrated in Figure 1, these different performance-related levels can be established from properties of materials to the functionalities of the pavement once delivered, the chosen level based on which the performance specifications are formulated depends on the objectives pursued by the client and the context of its organization and its partners.

This pyramid is valid for any roadwork. In fact, the performance specifications can start at any level. They will not be expressed in the same way for a highway as they would in an urban environment, the closer the level is to the top of the pyramid. The level of responsibilities that could be transferred to the private sector in a specific country is another subject for discussion.

All parties to a performance contract should be competent in designing and building roads. Learning these competencies should begin very early in the process, before the introduction of performance specifications. Even before scrutinizing the potential technological know-how and design knowledge, contractors should already have the competencies to prove the compliance of the materials and processes they are going to use. They must therefore master the quality assurance process for materials and the production and site implementation processes. In fact, the efforts made by the various partners to achieve total quality allow faster and more confident progress towards warranty systems more consistent with the life cycle and expected performance of the pavement.

So what are the difficulties of implementing performance specifications:

- It is necessary to have a market for this type of contract and the commitment of the client organizations at both the political and technical levels is essential. The size and number of contracts should be sufficient to generate and maintain interest while allowing contractors to amortize their investment.
- Is there enough competition to design original solutions and support warranties on several contracts of this type in the same country? It is essential to have a pool of technically competent and financially sound companies that can meet their contractual obligations and ensure competition in terms of prices and the diversity of solutions.
- Formulating specifications and measuring their compliance are two different things. The specifications should be clear, measurable, acceptable, realistic and appropriate to the term of the warranties. Is it possible to have some certainty that in 5, 10 or 20 years the performance specified will still be appropriate? Will the measuring equipment still be valid and available? Are the tests repeatable and reproducible enough for the results of the measurements to be recognized by both parties?

In any case, the client must take risks when it has to design its own solutions. Why couldn't this risk be shared with the contractors? The difference is mainly due to the fact that these performance measurements are contractual and that it is necessary to ensure that they are not invalidated before the end of the contract. A focus on risk sharing is very important.

- When the specifications pertain to a property or properties of materials, are the tests reproducible and repeatable enough? Is their direct relationship to performance proven sufficiently? Is too much emphasis placed on these properties alone to the detriment of other properties that are just as important but not included or difficult to account for in the specifications? Once again, what the client is already doing can be shared with the contractors.

- Is this transferable to pavement types other than road pavements, such as urban pavements and airport pavements? The tests so far seem to be limited to road pavements, but in principle nothing prevents this.

- The risks should be clearly shared and known to all parties involved without being excessive for the contractor. In a learning period, there is little knowledge of these risks but this will change as experience is acquired by each party.
- The client and the contractor should become accustomed to playing a new role. The client's interventions would be limited to inspections and audits of critical points to avoid any interference with the company's contractual obligations. A breach of contractual obligations therefore is likely to be perceptible late in the process and the client cannot react preventively as it did with end-result specifications. This risk has to be taken to benefit from the advantages. However, the client should preserve the level of expertise required to audit the quality of the work so that it can respond in an emergency and take over the work if the contractor is eventually unable to fulfill its obligations.

In contracts with performance specifications based on the properties sought (fatigue, rigidity): where the client can predict acceptable performance on the basis of these same properties, why wouldn't a contractor be able to do the same thing by using the same prediction models?

The client cannot require a contractor to know what effect a change in a property or a performance requirement may have on other properties or other performance requirements, which the current models cannot predict. The properties used in the performance prediction models are not the only properties associated with performance. Moreover, these models try to predict reality with a good measure of empiricism and should stay within their field of application. They are not necessarily the truth. Thus, a contractor can do no better than to increase productivity and apply the known formulas with variants for materials.

The term of the warranties also raises other questions. How is it possible to define the quality of the structure and its residual value at the end of a long contract period when the structure is turned over to the client? What performance requirements then apply to rehabilitation and maintenance interventions, requirements that are more difficult to define since the state of the existing pavement, with its multiple variants, influences future performance?

To date, for contracts with short-term warranties of about 5 years, performance specifications are established confidently but the warranties are not long enough to cover the pavement's life cycle. However, for long contract periods of 20 years or more, for example, performance is much more difficult to predict and several events are likely to occur with impacts on the contractual obligations. Needs other than the strict requirements of pavement rehabilitation may interfere with the nature of the interventions required.

Some special conditions of road building projects cannot be changed, even when performance specifications exist. For example, the responsibilities for traffic management, security and environmental impacts still rest with the client. This means that, to some extent, there is inevitable interference with the quality of the work.

The need to innovate

How can innovation, risks and obligations related to warranties be reconciled? Is it appropriate to rely only on innovations introduced by the contracts under contracts containing performance specifications? Can other innovation efforts be supported to improve the intended quality even further?

Do we need performance contracts to improve our current end-result specifications? Probably we don't, but the steps to arrive at the same improvements will be more difficult. Let's take the example of the range of values permitted for a material for a given characteristic. It is much more difficult to prove the feasibility of restricting deviations in a context where the client itself defines the deviations allowed in the quality of the materials by consulting the production history of all suppliers. Contractors then have little incentive to go beyond the prescribed deviations.

In a context of application of performance specifications, there is undoubtedly good reason to believe that contractors are more aware of the impact on warranties and that they themselves choose to control their production more strictly. This is in their interest, because they can design a pavement structure adapted accordingly. In itself, this is an innovative design approach.

Contractors can also innovate regarding techniques, products and processes and thus free themselves from the constraints of standardization. In fact, standards are the normal outcome of innovation. They express the state of the art established by consensus. A standard is never an end in itself, but rather a target, any deviation from which must be justified. It gives the client a reference for a clear definition of the objective it is seeking to achieve. For a client using performance specifications, standardization is only shifted to another level. Once performance specifications are mastered, there will be a tendency to standardize performance measurement itself from the client's point of view, instead of focusing on material characteristics and on construction requirements.

The industry and the clients want to introduce better materials quickly, but we often have little or no knowledge of their future behaviour and their impacts on pavement performance. The more risks are involved in innovation, the more contractors are to be aware of their impact on warranties. Performance specifications are not the only tool to use. It is therefore necessary to look for means other than these specifications to stimulate innovation, such as innovation support programs with risk sharing, recognition of the company's products, and partnerships with research organizations.

The development of new design methods and the improvement of existing design methods are good examples of innovations that have a major impact on performance and that must be produced upstream from performance contracts. This research on design methods requires considerable resources and will be spread over long periods. It pertains much more to the public sector and is not comparable to the innovations that performance specifications can generate. It can even raise performance requirements to a higher level than is currently prescribed.

Let us also take the example of recycling techniques. Before these techniques are tested, performance specifications would only apply to known techniques and the performance levels observed on the basis of these latter techniques. Recycling is a societal need that supports sustainable development while trying to maintain competitiveness. Without the cooperation and support of the clients and without partnership with industry, these techniques would not have emerged. They should be mastered adequately before adjusting the performance specifications accordingly. Also in the case of recycling, it is necessary to innovate upstream from the performance specifications, first to create an environment that allows this technique to flourish, and then to master and consolidate its use.

Finally, innovation is not the exclusive preserve of industry or of clients. Each partner has a role to play and complementary resources. However, both parties should remain competent so that they can foster exchanges and achieve progress together.

CONCLUSION

Performance specifications are evolving quickly. They represent a synergistic way of increasing the quality of pavements, improving performance by reducing the costs over their whole life cycle, and encouraging the preservation of resources. This type of specification undoubtedly will lead to profound changes in road building and maintenance practices.

Performance specifications open doors to contractors in terms of innovation potential but these specifications do not open every door. Research and development efforts are required regarding other aspects, such as design methods. The client should then play a major role.

Based on everything we have said, given that performance specifications are directly related to the objective of pavement performance, with all the benefits that this involves, and to ensure progress to better knowledge by stimulating innovation, the following goals should be pursued:

- Support and stimulate testing of performance specifications by providing for a large enough volume of projects to increase experience, transfer knowledge and make the most of the benefits of such specifications.

- Study the use of performance specifications in markets where the scope and context of projects justifies this.
- Preserve and fuel the expertise required by contractors, by the client and by other partners to promote a climate of constructive and lasting exchanges. For the client, preserve the potential of the knowledge and competencies necessary to define objectives, develop methods, and audit activities, and to respond adequately to unexpected situations. The client should also be capable of coordinating implementation of all innovations and developing products and techniques that are more within the jurisdiction of the public sector.

- Consider risk sharing and incentive formulas that promote the development of innovation, both in contracts with performance specifications and in other research and development activities.
- Share the experience achieved at the international level in innovation and performance specifications to ensure harmonization and progress of techniques and specifications. The PIARC, with its network of experts, is a privileged forum for producing a complete and objective assessment that can serve as a reference.

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