

Targeted Comparative Research Efforts A New Value for International Conferences

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Abstract

This paper discusses how the added value of international conferences on concrete roads could be improved. During international conferences on concrete pavements, a lot of interesting innovative techniques are shared with colleagues from all over the world. However, the author is of the opinion that too little innovative conference material is used to actually induce changes in the familiar practice at home, once the participants have returned to their normal professional occupation. In recent years, the exchange of innovative practices and experience has also gained increasing attention from the perspective and concern of implementing concrete pavements in a sustainable manner. In addition to the above observation, it strikes the author that, for certain issues, variations seem to persist, one right next to the other, even within the same country (e.g., the different end treatment techniques and details used for CRCP). The intent of this paper is to look in detail at the reasons of the above state of affairs and to present ideas as to how this situation can be improved and as to how the effectiveness of exchange of alternative techniques and practices could be increased. The paper also makes specific suggestions to improve the comparability and interchangeability of alternative techniques. It is hoped that the paper will instigate a fruitful international discussion, also with regard to sustainability-related considerations on concrete pavements.

Introductory observations

Observation 1. During international road conferences in general and during international conferences on concrete pavements in particular, a lot of interesting alternative or innovative techniques, concepts and findings are presented and shared with colleagues from countries all over the world. However, once the conference has come to an end and participants have returned to their normal professional occupation back home, apparently too little alternative or innovative conference material or ideas seems to induce changes in the familiar standard practice at home.

The above does not mean that exchanging new issues or practices at international conferences would have no sense or, even worse, that international conferences should no longer be organized. To the contrary, the author is of the opinion that this exchange of new and alternative ideas and practices is a necessary first step to continuously try to improve the quality and, consequently, the life cycle performance of concrete pavements worldwide. Moreover, this concern for continuous improvement goes hand in hand with the recent attention that is being paid to ensure that new concrete pavements are being implemented in a sustainable manner.

However, this first step is obviously not sufficient. Before alternative and innovative practices will possibly be adopted it must be proven that, taking into

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account the standard parameters in the home country, these practices will improve the life cycle performance of the concrete pavement in comparison with their own standard concepts.

Observation 2. It is striking that, for certain issues related to concrete pavements, variations seem to persist, one right next to the other, such as:

Variations within the same technique.

Example: the issue of end treatments for CRCP consisting of an end-anchorage. This technique is adopted worldwide, but with clear variations with regard to the number of lugs, dimensions and reinforcement. These variations even exist within the same country (e.g., the USA).

Variations with regard to the technique itself.

Example: in the USA about 50% of the states use end-anchorages with lugs and about 50% use the wide flange beam end treatment.

Based on this observation, one would tend to conclude that both alternatives provide an optimal solution for the issue of end treatments in CRCP. However, if so, then the question arises why not use everywhere in the USA the same, the simplest and cheapest technique for the end treatment? Translated in terms of sustainability the question arises why not use the technique that provides the best sustainability- related results.

In this paper the author looks at the possible reasons for the above observations and presents ideas as to how, in the author's opinion, the effectiveness of exchange of alternative techniques and practices could be improved.

Reasons for observations 1 and 2

The author sees the following aspects as possible reasons why engineers from a certain country or region seem to be reluctant to adopt alternative solutions from other countries or regions:

Human nature. It belongs to human nature to adhere to what one knows, to what one is acquainted with because experience with one's own circumstances and concepts gives the certainty or at least the likelihood what one can expect. So one keeps on using the same practice out of certain indolence.

Personal or national pride or customs. Although we may not easily admit this, our personal or national pride may make us less critical with regard to our own solutions and more critical versus new or alternative solutions from elsewhere, so that we tend to let our own standard practice prevail.

Focus on theoretical matters. Looking at the issues presented during international conferences on concrete roads, the impression arises that papers deal more often with theoretical issues than with practical ones. Theoretical issues will likely instigate less interest for change than practical issues.

Legislation. Certain solutions may result from legislation. For example, in The Netherlands it is standard practice to place a silent (porous) asphalt concrete wearing course on top of each new CRCP, because this is the only manner to comply with legislation in respect of traffic noise levels.

Price. Some alternatives are more expensive than others and may therefore be less attractive.

Testing methods. The fact that, among different countries, quite often different testing methods are used makes it difficult, if not impossible, to evaluate and compare the advantages and disadvantages of alternative solutions versus one's own standard practice.

Variation of parameters. The design and construction practices in various countries or regions are based on varying parameters (traffic, climate, design and construction methods and concepts, availability and characteristics of materials, specifications, etc.). The variation of these parameters can be minor or major. The greater the variation, the more difficult it is to transpose blindly the alternatives or findings from elsewhere to one's own practice.

Past experience. In many situations, it appears that local practices evolve as a consequence of specific local circumstances. So, for example, in a country that has traditionally enjoyed a culture of high standards in construction workmanship, you might find that the specifications are less stringent than in neighboring countries, but expectations are high (example: smooth pavements). Conversely, in a country where authorities are seeking to raise standards, the specification controls are likely to be more stringent.

Ideas for improvement

Following below are some ideas on how the situation described above could be modified.

Human nature. The best remedy to ease human biases consists of regularly repeating and emphasizing the fact that, throughout history, progress has only been made by exploring the unknown and emphasizing the importance of learning from experiences of others.

Personal or national pride or customs. One will tend to overcome this reflex by being critical regarding one's own customs and looking at what and how colleagues are approaching or doing things differently, even with regard to slight differences. An illustrating example is the following:

- In Belgium we manage to construct very good CRCP that complies in all respects with the specifications. Notwithstanding this, the author sometimes notices a vibration of the steering wheel when riding over a newly constructed CRCP.
- In Germany, the author notices (using the same car) that, on most new projects, newly constructed JCP is finished so smoothly that such vibration is not at all noticed. It is not even noticeable that the pavement has transverse joints.
- The author's point is that Belgian concrete pavement experts should meticulously analyze in the field in Germany the slightest differences in finishing of the concrete to find out how this vibration can be avoided on new CRCP in Belgium.

Focus on theoretical matters. If the impression, that more attention is paid to

theoretical matters than to practical issues, is correct, the author suggests that international organizations on concrete roads (e.g., the International Society for Concrete Pavements - ISCP) stimulate research on practical issues and that this research be continued over a long term.

On the new CRCP of the Antwerp Ring Road (2004 – 2005) a new type expansion joint (bridge type joint) was used as an alternate to lugs. The behavior of this new type joint was monitored. However, this monitoring was suspended after two years, probably due to lack of funds. Since then, the standard type end-anchorage with lugs is used again.

The author suggests that funds be made available on an international scale for long term fundamental research on the behavior of new techniques.

Legislation. Referring to the example of the porous asphalt wearing course, the author suggests that the amount of research on silent surface finishes of concrete be increased so that the legislative noise requirements can be met without the need of a silent asphalt wearing course. If this could be achieved, the construction cost and more importantly, the maintenance cost, related to this asphalt wearing course, could be avoided.

Price. The price should always play a role in adopting new practices. When comparing alternative techniques pricewise, it is important not to consider only the construction cost but all life cycle costs of the pavement

Testing methods. The author suggests that the test results on the performance of pavements be obtained using identical testing methods, regardless which country the results come from. It will undoubtedly be a challenge that all funding research agencies would adopt a specific set of testing methods. However, the author is of the opinion that this challenge can be overcome by convincing the participating agencies of the advantages of using identical testing methods to the benefit of ready comparison and interchangeability of the results. Furthermore, many agencies already use testing methods that they adopted from other (larger) countries (e.g., USA testing standards or European standards). A criterion for the selection of a particular testing method could be that the testing method that is presently mostly widely adopted worldwide be selected for general use. Lastly, the above does not exclude the possibility of continuing to use one's own familiar testing method simultaneously with the internationally adopted testing method.

Variation of parameters. The author contends that the variation in the parameters is one of the most important reasons why too little alternative techniques from abroad are adopted or trialed back home. Therefore, the remainder of this paper is devoted to finding solutions to lessen the variation in parameters.

Importance of differences in design and construction parameters

The design and construction of concrete roads is dependent on a number of parameters that differ, to a smaller or larger degree from country to country and from one region to another.

These parameters are mainly:

- a) Traffic (axle loads, intensity)
- b) Climate i.e. the environmental conditions (e.g. freeze/thaw cycles, high

- amounts of precipitation, high temperature variations)
- c) Design standards, details and specifications
- d) Construction practices, details and equipment
- e) Testing methods
- f) Pavement structure (concept, characteristics of layers)
- g) Characteristics of raw materials
- h) Personnel (education, experience, composition of team)

Traffic and climate (parameters a) & b)) are dictated by local circumstances and can substantially differ from region to region, e.g. Northern American or European regions have to take into account heavy to lighter frost conditions which are not experienced in milder regions. Regions in tropical or arid climates will have to cater for very high temperatures and varying humidity and amounts of precipitation to which the concrete pavement is subjected during construction and under service. The two parameters traffic and climate, have an important influence on most of the other parameters.

The very existence of the differences in the parameters makes the interchangeability of alternatives or new ideas and concepts not always self-evident. Moreover, depending on the magnitude of the differences, it becomes also difficult, if not impossible, to compare practices and results from various regions. Surprisingly, during international conferences, the existence of these differences seems to be overlooked, underestimated or ignored.

An example may illustrate this.

Let us consider the general topic “CRCP” being the subject of a given conference. During consecutive presentations and discussions on this topic by different authors from various countries, participants at international conferences seem to assume inadvertently that all presentations pertain to the **same pavement**. So, notwithstanding the fact that the findings presented concern **various countries or regions** it is inadvertently assumed that the pavements presented have the same parameters: same CRCP structure, same composition of the concrete mix, same raw materials, same climate, same traffic. Yet it is clear that all or many of these parameters differ from one country (or state) to another, e.g. thickness of CRCP for freeways of 230 mm in Belgium versus thicknesses of up to 350 mm elsewhere.

Targeted (goal-oriented) comparative research – the solution?

Concept. The main goal of adopting alternative techniques from elsewhere, is to continuously try to improve one’s own practice to obtain a better performance of the concrete pavement. This goal is also related to the attention that is recently being paid to sustainability-related considerations. The main reason why this adoption of alternative techniques is not easily implemented lies in the fact that, in research projects worldwide, the difference in parameters is probably too great to transpose blindly the conclusions of this research.

Due to this difference, engineers from a particular country are reluctant to introduce alternative practices which are standard practice in other countries because, without further research, they do not know what effect the difference in parameters may have if the alternative is applied to their own design and/or construction practice.

To counteract this reluctance, one has to minimize, as much as feasible this difference in parameters so that the results of the alternative practice from elsewhere can be readily compared with their own standard practice at home.

In the author's opinion, this can be achieved if one were to build **various alternatives of pavement** in the **same country or region** so that the differences in performance are dictated by the difference in the alternatives of pavement in lieu of by the differences in traffic and climate.

By "alternatives of pavement" is meant "alternative techniques for one particular research issue" while the remainder of the pavement characteristics, i.e. parameters, remain the same or almost the same.

The author calls this approach "targeted (goal-oriented) comparative research" because it is oriented towards the goal of comparing the performance of alternative techniques with regard to a specific research issue.

Test sections. To perform this targeted comparative research, successive test sections would be built in which various alternative techniques or concepts, for one particular research issue, are implemented, one alternative per test section. These successive test sections would be executed at the same location in the same country or region. Such a location could be for instance the right lane between two consecutive exits/entrances of a certain freeway.

As already mentioned, it is the intent that, for all successive test sections, the other parameters mentioned below are the same unless the research issue itself (e.g. thickness of the pavement) concerns one of the parameters, in which case the parameter will be varying from test section to test section.

- design method
- testing and monitoring methods
- mix composition and characteristics
- materials type and characteristics
- construction equipment for comparable layers
- pavement structure (composition and dimensions)
- personnel (composition of team, education and training)

Once the test sections are executed as described above, their behavior and performance should be monitored, tested, recorded and evaluated. This should be done according to a "well defined and internationally agreed upon research program" and over a long-term period.

Subsequently the results pertaining to the performance of the alternative techniques and concepts would be compared, conclusions drawn and recommendations made.

It is recommended that, for as much as possible, the uniformity with regard to the parameters above be maintained, not only within a country or region, but also, between different countries or regions with similar traffic and climate conditions. This would facilitate the interchangeability of the results between these countries or regions. An international organization on concrete pavements could play an important role to have this uniformity agreed upon and implemented. This group could also participate in working out the above mentioned "well defined ...research program"

Examples of possible research issues

Below are a few examples given of issues that could be subject to comparative research. These examples are given to illustrate what is meant in this paper by the proposal for executing "targeted comparative research". It is of course possible to

think of more or better research issues. The author recommends that at least a certain number of research issues be agreed upon by the various national organizations of concrete roads. In this regard, an international organization could play a coordinating role.

Example 1 - Terminal treatments for CRCP. Primarily two techniques are used: End anchorages with lugs in order to restrain cyclic movement. The alternative solutions for this technique pertain primarily to the number and dimensions of the lugs.

Terminal expansion joints that accommodate the cyclic movements of the end of the CRCP. Alternative solutions for this technique are in use, e.g. the wide flange beam (USA) and the expansion joint similar to bridge deck joint (Belgium).

The purpose of the targeted comparative research is to investigate the effect on the behavior when applying the alternative techniques on test sections that have identical CRCP structures.

Example 2 - Interlayer between concrete pavement and base course. Worldwide primarily three alternative standard techniques are in use:

1. JCP or CRCP structures without an interlayer
2. An asphalt concrete interlayer (e.g. used in Belgium, The Netherlands, Austria, ...)
 - Variations on this technique are related to the composition and characteristics of the bituminous mix, thickness of the interlayer.
 - The interlayer has several functions: load distribution, realization of bond between the base and the CP, avoidance of erosion of the base, provide good riding surface for the tracks of the slip-form paver if executed with an over-width
3. A geo-textile interlayer e.g. in Germany. A geo-textile interlayer is also used in the USA in unbonded concrete overlay applications.
 - Variables of this technique are related to the characteristics of the geo-textile.
 - The interlayer has the following functions: drainage of seepage water, flexible interlayer without bond between the base and the CP, avoidance of erosion of the base

The purpose of the targeted comparative research would be to investigate the effect on the behavior of the CP when applying the alternative techniques on test sections. For JCP the test sections should have the same joint type and horizontal dimensions of the slabs in order to reduce the variables. However, the test sections (of both JCP and CRCP) may not have necessarily an identical structure depending on, whether or not, bond and the asphalt concrete interlayer are taken into account in the design method used.

Example 3 - Bond of interlayer. When applying an asphalt concrete interlayer, the existence of a good bond is considered as very important. However, this bond can decrease or even disappear either as time passes by or in pavement sections subject to cyclic movement (e.g. end section of CRCP). Furthermore, the magnitude of bond is not exactly specified or known and is seldom measured.

The purpose of the targeted comparative research would be to determine whether the bond is important and more research should be done with regard to

different degrees and means to create bond, with regard to the evolution of bond as a function of time and location. In order to focus the research on the bond, the test sections should have identical structures. In this way the number of variables in the parameters is brought back to the minimum possible.

Example 4 - Reinforcement of CRCP. Even though the basic concept of CRCP is the same worldwide, differences (alternatives) in standard practice occur. These differences concern either the characteristics of the concrete (and thus the thickness of the pavement) or the reinforcement. In this example it is assumed that, in the subsequent test sections, the same concrete (and thus the same thickness of the pavement) is used but that the alternatives pertain to the reinforcement.

The possible variables with regard to the reinforcement are primarily the following:

- Percentage of reinforcement
- Diameter and spacing of bars
- Vertical position of reinforcement in concrete layer
- Arrangement (oblique or perpendicular) of transverse versus longitudinal reinforcement and supporting system of the reinforcement, if any.

The purpose of this targeted comparative research would be to investigate whether or not (even small) differences in these variables result, on a long term basis, in meaningful differences in performance. Especially the effect of an oblique arrangement versus a perpendicular arrangement of the reinforcement deserves attention as an oblique arrangement complicates execution.

Funds for targeted research

It is not desirable or even not feasible that a single agency from a single country would fund the targeted multi-national research activities. The above made suggestions for targeted multi-national research should be financed through some kind of “pooled funding” brought together by interested national and international societies involved in all activities throughout the pavement’s lifetime (design, construction, maintenance).

The following organizations from different states or countries could benefit from this initiative and may therefore be interested to participate:

- State and/or country Highway Officials and DOTs
- Cement associations
- Reinforcing steel associations
- Road Research Centers
- University Research Centers
- Paving Equipment Manufactures
- Concrete Pavement Contractors Associations

The amount of participation in the pooled funding should be agreed upon among the participants on the targeted research program using certain criteria. As an example, a criterion could be that states or countries with a lot of concrete roads contribute relatively more than those with few concrete roads.

The author suggests that ISCP and other international concrete roads organizations become involved to create a platform that would have, as its main task,

the responsibility to:

- Instigate discussion on the idea of targeted research suggested in this paper
- Set-up a program of such research
- Coordination of the research
- Gathering funds for the research
- Allocating the funds and control the spending
- Organizing reporting of the results

Concluding statement

It is the author's hope that the above ideas will instigate a fruitful international discussion, as to how the effectiveness of exchange of alternative techniques and concepts can be increased. This exchange is an important means for our everlasting efforts to improve the quality of concrete pavements worldwide and should instigate innovative approaches for the implementation of sustainable concrete pavements. The author hopes too that this discussion will lead to actual steps to further take into consideration or realize some of the ideas above.

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