AN EXPERIENCE ON PAVEMENT MAINTENANCE TRAINING IN SAO PAULO PREFECTURE

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SUMMARY

This paper reports an experience on technology transfer of the Pavement Research Team of the Polytechnic School of Sao Paulo University. Training on pavement maintenance methods was offered to a selected group of engineers of the Sao Paulo Municipal Prefecture.

Details about the course structure and its evolution are given, as well as the criteria adopted for transferring technology and verifying the results of the learning process. The observed needs of providing theoretical knowledge to get best solutions for practical allowed the lecturers to acquire important experiences on teaching for a graduated level, producing technical notes and discussing daily problems and solutions for maintenance of urban pavements.

As a major conclusion it is stressed the relevant exchange of theoretical and practical experiences between the researchers (lecturers) and the maintenance engineers of the largest Brazilian city.

1. BACKGROUND

During the summer/autumn 1991, the paved network of Sao Paulo City was hardly distressed after the combination of three harmful factors: excessive and continuous rainfall, a prolonged strike of the staff engaged on the distribution of petroleum sub-products and, finally, a lack of asphalt sub-products for paving due to new economics police applied that time by the government /1/.

After almost two months of disorder on the pavement maintenance system, main local newspapers and other communication media mentioned more than 30,000 potholes on the arterial paved network.

The agency of pavements maintenance, obviously under all kind of pressure, has demanded for the Transportation Department of the Polytechnic School of Sao Paulo University. They have asked for short-term solutions in order to minimize the problems once the situation required for uncommon and atypical procedures. Although the reparation of localized distresses were already started, reinforcement and partial reconstruction of pavements were also necessary that time.

The needs of pavement reinforcement were something uncommon, and due to it, two kinds of help has been desired by the Prefecture. The first one concerned an optimization of the government budgets for the pavement maintenance by planning a concise schedule of interventions.

The second help was to train the maintenance engineers in order to give them all the technical concepts and fundaments to the design, construction and quality control of the pavements reinforcement works. As a sub-product of both proposed items, it was required a transfer of new technologies for preventive maintenance and periodic monitoring of pavements.

The whole work was supported by an agreement between the Prefecture and the University and ensured the total technology transfer. This agreement has became in an annual training and recycling of the technical staff. Moreover, it could be considered as a pioneer program of continuing education on pavement maintenance.

The success and benefits of the established program could be justified by the massive attendance for the proposed courses. On the other hand, it was necessary a great dedication from the lecturers on preparing manuals, practical works and tests, but mainly on finding best ways for the learning process, by using appropriate language for not academic persons.

2. TRAINING ON PAVEMENT CONDITION SURVEY

The first step was preparing the training for the evaluation of the present condition of pavements. Due to the fact that it is not common the use of the "comfort index" concept for urban pavements, it was necessary a preliminary training of the docents themselves. The use of the mentioned criterion and the identification of its difficulties were carried out by the University technical staff and, eventually, by the students.

The identified difficulties have allowed the definition of the data-sheet for pavement evaluation. In order to perform the overall evaluation in the first year (about 1,000 km of pavements),we set up a first approach by dividing the Prefecture staff in two groups, each one coordinated by a docent. This Prefecture staff has come from the central office for pavement maintenance.

As the City of Sao Paulo was composed by twenty Districts, we changed the former approach for the second year by using the district engineers instead of the Prefecture staff. During the third year, after a general meeting to define the organization of the tasks, the district engineers assumed the coordination of all field evaluations.

It must be remarked that every year the data-sheet was improved, in order to be more and more suitable to the city pavements. The obtained data from field evaluations were used as input for a pavement management system specifically developed for the city conditions, aiming the optimization of short-term solutions.

3. TRAINING ON PAVEMENT DESIGN

3.1 Course Structure (1st Year)

One of the interesting points for establishing the course structure was the discussion: “what to teach?” Supported by the urgent necessities in the first year, we decided to start with reinforcement of pavement structures.

Considering that the technical concepts for the design of reinforcements are actually related to concepts of pavement design, we have preferred to dedicate the initial part of the course on discussing basic concepts, in order to refresh memory of the engineers in some basic topics. The course was arranged in the following subjects:

- Load-Structure Interaction, studying the loads imposed over the pavements by the traffic and its interaction with the mechanical responses from the pavements.

- Design of Asphalt Pavements, presenting concepts and technique to define the required pavement structure for both a given traffic and foundations characteristics.

- Pavement Distresses, introducing the several kinds of distresses we can find on the surface of pavements and the reasons for each pathology.

- Functional and Structural Evaluation, studying the methods and criteria to perform evaluations of pavement distresses, as well as defining the applicability of them in several situations. The classes included how to treat statistically the field data, in order to define the necessary parameters for the reinforcement design.

- Reinforcement Design, introducing the criteria for calculating required thickness of reinforcement, observing necessities of routine and corrective maintenance, as well as reconstruction needs.

- Construction Technique, indicating materials, equipment and constructive methods requested for the field works.

The course had an endurance of 60 hours, during one month, with exhaustive examples and case studies. The hardest part of the course consisted in the time spent in the calculations to define the needs of reinforcement.

Attempt to the fact that exhaustive calculations could be a great limitation in the course, we developed a software package for PC-compatible microcomputer, in order to make the process easy. Obviously, it was also requested a training on using the software, and for this purpose, under-graduate students collaborated.

This method adopted for the classes was chosen due to the urgency needs of evaluation and designing solutions for a very large extension of damaged pavements. So, we focused the classes to the study and the use of design criteria.

The experience has demonstrated that selecting real cases for the design is fundamental for purposes of continuing education. Indeed, the attendants have been encouraged to bring real cases of pavement conditions and to discuss the problems during the classes. Furthermore, it was a very exciting experience applying concepts and methods on practical cases.

Two important deficiencies on the classes were realized. The first one was the inherent difficulty on learning about kinds of pavement distresses by using only slides and pictures. The second difficulty was to learn how to get measurements without a field practice.

On the other hand, we could realize that the most of the attendants had a fairly knowledge of asphalt products, and this lack was not desirable. Unfortunately, after the definition of the course structure, it was impossible to re-arrange the classes to fill these lacks.

The improvement of existing manuals (developed formerly by our team) was an important result from this experience. These manuals are still being used in under-graduate courses.

3.2 Course Structure (2nd Year)

As a sub-product of our first course addressed to the engineers, in the second year of works with the Prefecture, we proposed a practical course covering field evaluation and the use of the developed software with the acquired data. For the classes, we divided the engineers in four groups, and eight hours for each group.

The classes were directed to teach them to perform field evaluations, using typical check lists for distresses and for obtaining structural data. For this purpose, we developed the field works into the University area, in the principal avenue, were several common distresses could be found.

With the acquired data, we proposed as a practical examination, the use of the previously developed software on defining the needs of maintenance for that specific case. In fact, it was an opportunity of training the groups on using the software and to clarify specific doubts on its use.

3.3 Course Structure (3rd Year)

For the last period it was decided to give, once again, a course on pavement maintenance, but with significant changes. The main improvement was to spend more time teaching paving materials for pavement rehabilitation works, including the following aspects:

- Paving Aggregates, covering crushed rocks and sands, its mineral nature and its implication on admixtures, their exploration, refining process and their uses.

- Asphalt Materials, introducing their physical and technological aspects, as well as, the several kinds of asphalt products, and their applications.

- Asphalt Admixtures, presenting the application of paving materials, fabrication methods and admixtures design and technological controls in field and laboratory.

It is important to remember that in the last decade we got several changes in the specifications for these materials, and the engineers, with eight-year diplomat minimum, did not have knowledge about the evolution of the specifications. Therefore, the opportunity of getting new concepts about paving materials was very important for them. As a consequence from this step, new manuals have been published by the teaching group, and it has demanded time on consulting the school library.

Considering the experience acquired on the first year, the case examples used for the course have came exclusively from the Sao Paulo City paved network. The classes have consumed about 30 hours, but during a period of three months, two hours a week.

4. DISCUSSION

From the mentioned comments during the presentation of the proposed course structures and classes it could be realized that the Continuing Engineering Education is a powerful tool to bring for the engineers new concepts and knowledge, considering the non-stop developing and changing on technology. It was verified that, paving engineers, after some years without possibilities of studying, were still applying old methods and tools no more convenient for treating numerous problems emerged in recent years.

The experience has proved the that in Brazil the public staff in transportation preserve currently several characteristics due to the traditions and origins of the agencies itself, hence, presenting lacks on their technical qualification; so the needs of best knowledge on concepts and methods are evident /2/. In a dynamic world requiring more and more quality, the knowledge of up-to-date technique is not dispensable.

The technology transfer from the University to others Institutions and Agencies is fundamental, once the daily practices needs improvements and it can be obtained through the research of materials and methods, generally restrained in academic environments in Brazil.

Therefore, Continuing Engineering Education is very important to renew and to complement the engineers knowledge, giving them concepts several times not present on their minds or also not learned before.

About the teaching approach, it was also verified that for engineers to learn new concepts it is not sufficient the concept itself, but also to know how to use it on solving daily problems. So, it is essential for the teachers to have in mind, in a very clear way, the boundary limitations for the use of new materials and methods. It is also needed to compare the new method presented with other old ones, establishing deficiencies and advantages.

Another essential aspect is the high quality desired for texts and manuals. This point must be remarked once the success of the learning process is very dependent on it. By the way, during the classes, when single texts and abstracts were offered, the engineers required specific references for studying the proposed theme. The good quality of texts have the main implication on presenting solved examples, good figures and tables and on proposing case studies as homework.

For a good learning process is required, after explanations of evaluation methods and equipment, the possibility of going to field practice because, doing a work monitored by teachers at first time makes eases the following works, once the difficulties and failed interpretation of field data are discussed during the survey, in a way to avoid future errors on data collection.

As mentioned, for the 1st year we performed a concentrated course and for the 3rd year, the course endured three months, one classes per week. This last distribution has proved to be more judicious instead of concentrated courses, once the engineers have had sufficient time to develop study cases and exercises proposed by teachers during the classes.

About examinations to verify the knowledge got by engineers, it is more interesting to apply tests and problems during the classes and not exclusively at the end of the course, motivated essentially for the lack of custom, after years, in doing tests.

5. CONCLUDING REMARKS

The integration between University and other Institutions and Agencies for purposes of Continuing Engineering Education is very important for both involved parts. If the others organizations need new concepts to get high quality works and to take the best advantages on using methods and criteria, the integration is very important also for the University.

The profits for the University are evident in the sense of developing methods for teaching, once the traditional criteria of learning process are not very convenient for continuing education. The improvement in teaching methods is very clear, considering the necessities of writing learning texts on a different way, searching for an equilibrium between theory and practice.

The given problems presented by the engineers are very useful in the sense of permitting the teachers/researchers of applying and verifying the potentiality and limitations of new methods of analysis and design. It must be remarked that, in our case, developed concepts of pavement management systems were, for the first time, used to simulate the needs of maintenance on a real paved network, something probably impossible using only resources from the University. If the use of an up-to-date engineering tool was very important from the point of view of the municipality, it was the sole opportunity we had on proofing the real applicability of the developed model.

Finally, the experience has demonstrated that through Continuing Engineering Education it is possible to advice for the present necessities of technical improvements for an agency that, although

it has the coordination over the process, generally is not visible for whom are not inserted on the process of services and tasks in engineering.

ACKNOWLEDGMENT

I am specially grateful for the given support (during the several training steps) by engineer Liedi Bernucci (MSc lecturer), Mr. Luis Carlos Tallarico (engineering student), Dr. Nicolau Gualda (Contract Manager-University) and engineer Janos Bodi (Contract Manager-Prefecture). Many thanks to Dr. Silvio Nabeta (Department of Energy and Automation) for the patient revision of this paper.

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