

# Concrete crack repair with polymer modified materials. The need for specialized training of applicators, suppliers, consultants and clients.

Mr Jannes Bester<sup>1, a \*</sup> and Mr Deon Kruger<sup>2, b</sup>

<sup>1</sup>Faculty of Engineering and the Built Environment, Department of Civil Engineering Science,  
University of Johannesburg, South Africa

<sup>2</sup>Faculty of Engineering and the Built Environment, Department of Civil Engineering Science,  
University of Johannesburg, South Africa

<sup>a</sup>[jannesb@uj.ac.za](mailto:jannesb@uj.ac.za), <sup>b</sup>dkruger@uj.ac.za

**Keywords:** patch repair; training

**Abstract.** Concrete repair with polymer modified materials has become an integral part of the civil construction industry. Often, under-performance or even failure of such repairs can be attributed to the incorrect selection, preparation, application or care of the repair process. The root cause of this is basically the lack of adequate knowledge and understanding of the repair material and the repair process by the applicator, the supplier, the consultant and the client. Unfortunately, it seems that there is very little done in terms of the training of these four stakeholders. Decisions regarding repair materials and processes are often based on personal preferences, an elementary cost analysis and convincing sales pitches by some snake-oil salesmen.

By using questionnaires designed specifically for each of the four different sectors of the concrete repair industry, a survey was done with regards to the state of training in South Africa in this specialized field. The results indicate that, although there is agreement that polymer-modified concrete patch repair is a highly specialized field; there is an unacceptably low level of training in each of these sectors with regards to the correct selection, application and care of such repair materials. Incorrect specification, inappropriate material selection, misunderstanding of the material properties and inadequate quality control are outcomes of this lack of knowledge and understanding which subsequently may lead to premature failures and/or under-performance of the repair. In addition, the survey results also indicate that the workforce performing the physical repair work, is mainly unskilled and some serious intervention is required to correct this situation.

## Introduction

It is common to find that large volumes of concrete placed worldwide are flawed due to either ignorance, or by error. Some reasons for this is that designers often only focus on strength of the mix without taking environmental issues into consideration, poorly written specifications for placing and curing and also poor site practice by construction staff [1]. This leads to degradation of the concrete and the subsequent need for concrete restoration. For concrete rehabilitation and restoration to be a success, the process that lead to the deterioration needs to be identified so that the root cause of the problem can be identified [2,3]. Due to the superior quality and unique properties which polymers modifiers adds to cementitious concrete, many repairs undertaken would have been more costly, and would have taken longer to complete [4].

A major concern when rehabilitation of a structure is required, is the changes that occur to the structure before, during and after repairs [5]. For this reason, it is imperative that all the stakeholders understand the complexities and effects of the concrete patch repairs process. For this reason training for the correct diagnostics of the root cause of the degradation, repair material selection, application methods and care of the polymer-modified concrete patch repairs is of paramount importance to enhance and ensure the success of the repair. Tuutti summarizes this scenario by stating: “Repair of concrete structures is considerably more complex than the design and construction of new structures” [6].

### **Research methodology**

This research project made use of four different questionnaires, each one designed specifically for a different stakeholder within the concrete repair industry. The four different stakeholders are clients, consultants, applicators and suppliers of the repair materials.

It must be mentioned at this point that all four questionnaires was designed under the supervision of STATCON, a statistical consultation service within the University of Johannesburg. STATCON specializes in the design of questionnaires and the statistical analysis of data. The rationale behind this was to have professionals lead in the design of the four different questionnaires to ensure that the wording of the questions, as well as the possible answers that were provided to the respondents do not lead the respondent in any way. This would ensure that unbiased answers are received from the respondents.

Although much more information was gathered from these questionnaires than what is presented in this paper, the goal of the specific section of the four questionnaires reported on in this paper was to gather more information concerning the training of the consultants, applicators and suppliers. This goal was achieved by focusing on three different sets of questions as described below:

The first set (SET 1) consisted of a single question, which objective was to determine if the consultants, the applicators and the suppliers believe that polymer-modified concrete patch repair material is a specialized field. The question asked was the following:

QUESTION 1: Do you believe that concrete repair is a specialist area?

The second set of questions (SET 2) consisted of nine questions of which the objective was to ascertain the extent of training of the consultants, the applicators and the suppliers. These questions included:

QUESTION 1: Please specify the training programs that you have attended on concrete technology.

QUESTION 2: Does your company offer internal training programs for personnel using concrete repair materials?

QUESTION 3: If yes, what is the duration of these programs?

QUESTION 4: Have you received internal training from your company on specifying the use of concrete crack repair materials?

QUESTION 5: Have you received any other training on using concrete crack repair materials?

QUESTION 6: If yes, what is the duration of these programs?

QUESTION 7: Do you provide training to your personnel that work with the concrete crack repair products?

QUESTION 8: Have you received any training on designing concrete crack repair systems?

QUESTION 9: If yes, then where was this training done?

The third set of questions (SET 3) objective was to determine the level of training and education of the applicator's foremen and the labourers that apply the polymer-modified concrete patch repair materials, as well as the level of education of the consultants, the applicators and the suppliers of the products. The following questions were asked:

QUESTION 1: What is the average education level of the foremen that work with the concrete crack repair material?

QUESTION 2: What is the average education level of the labourers that work with the concrete crack repair material?

QUESTION 3: Please indicate your highest tertiary qualification

### Results and Analysis of Results

Table 1 indicates the response rate to the questionnaire for each of the four different stakeholder sectors. Clients had a very low response rate, but the other three sectors had acceptable response rates. As mentioned above, the questionnaires were set up in such a way that they do not lead individuals in any way, however, it must be noted that the results are dependent on the honesty of the individuals answering the questionnaires, which is a disadvantage when using questionnaires in gathering such information.

Table 1: The response rates to the questionnaires of the four different stakeholders in polymer-modified concrete patch repair.

	Consultants	Contractors	Clients	Suppliers of repair materials
Contacted	102	119	130	152
Replied	37	30	16	34
Response rate (%)	36	25	12	22

SET 1 results, shown in Figure 1, indicate that almost all of the respondents of the consultants, applicators and suppliers believe that concrete repair is a specialised area. From this confirmation, it should follow that there should be significant training in correctly specifying the repair materials as well as designing the repair system. In addition, the applicators' staff that works with the repair materials should also be well trained to apply the polymeric-repair systems correctly.

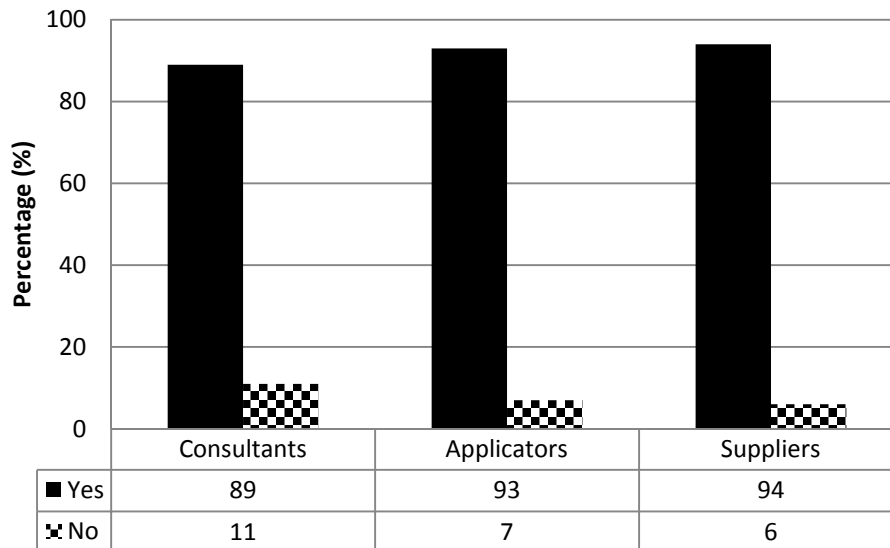


Figure 1: Sectors believing concrete repair is a specialist area.

Some of the highlights of the findings of the SET 2 questions are presented in Figures 2 – 5. Figure 2 indicates that for each of the consultants, applicators and suppliers, less than half of the respondents have received any training on how to correctly specify polymer-modified materials for use in concrete patch repairs. Suppliers have the highest percentage of respondents that have received specialized training on specifying materials for the use in concrete patch repairs. However, this percentage is only 42%. This minimal amount of training on specifying materials for repair use without doubt could lead to people not specifying the most correct concrete patch repair material to be used in a repair project.

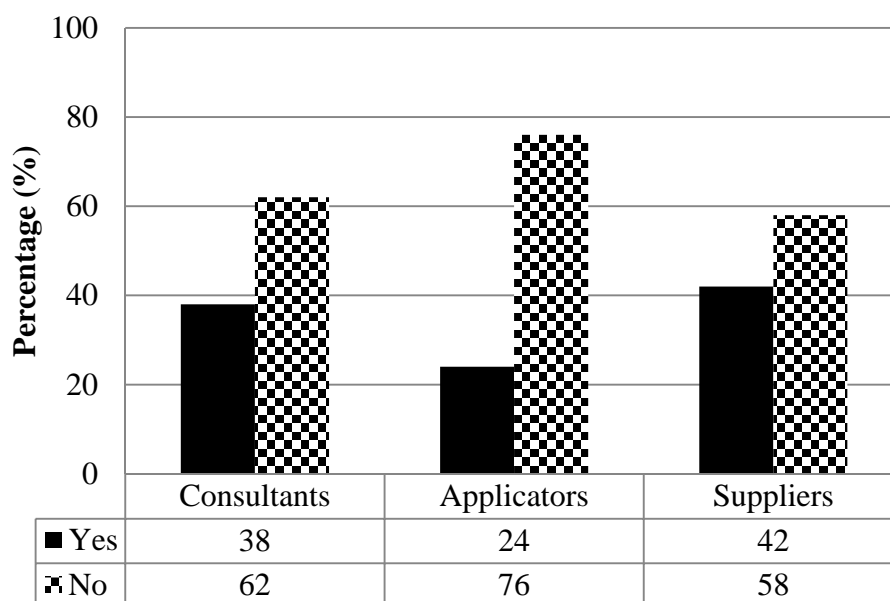


Figure 2: Training received on specifying concrete patch repair materials

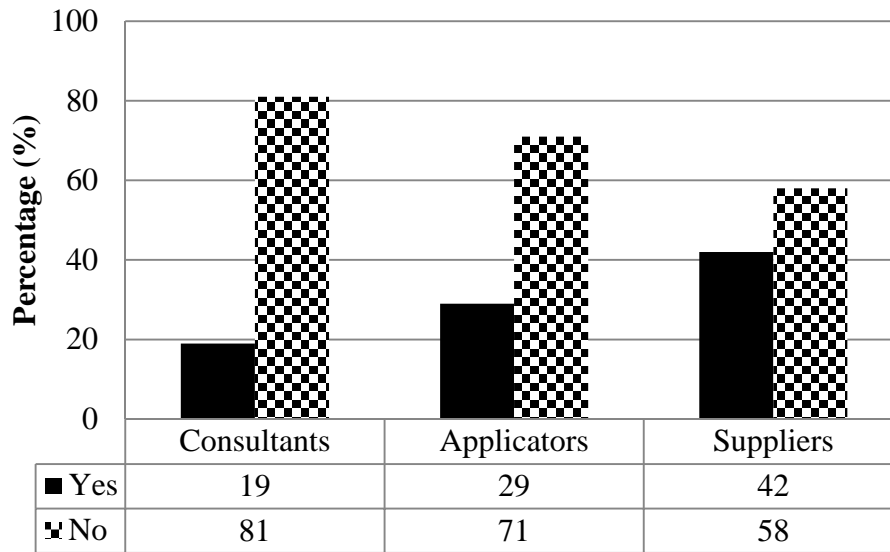


Figure 3: Training received on designing concrete crack repair systems

Figure 3 indicates that only 19% of the consultants that responded to the questionnaires have received training in the design of concrete crack repair systems, with suppliers having the highest at 42%. These results again indicates inadequate training of all the stakeholders which may well lead to poor quality patch repairs systems being used on structures.

Figure 4 indicates that about one quarter of applicators' companies offer internal training programs for members of staff that work with concrete repair materials, whereas just over 50% of the suppliers have internal training programs. This lack of training at both applicator and supplier level unquestionably leads to inadequate knowledge and understanding of repair material properties and processes.

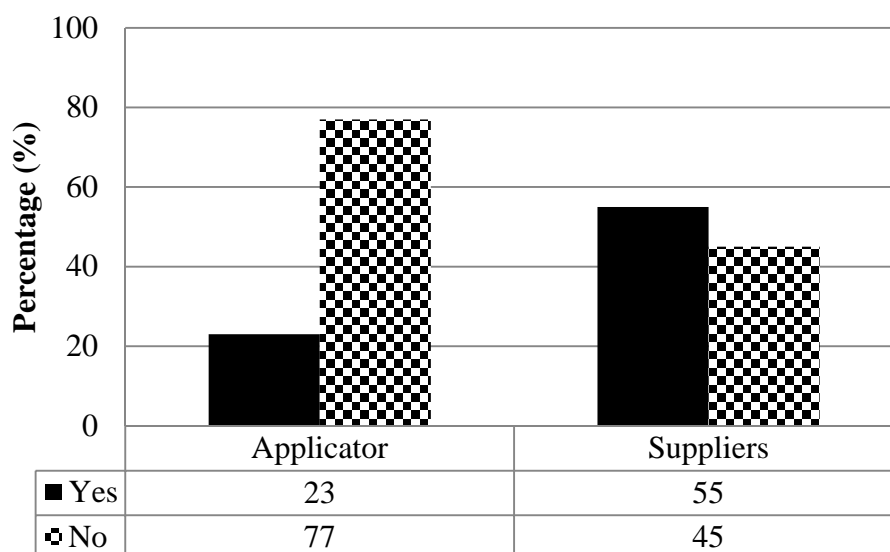


Figure 4: Internal training programs offered.

In addition to the above question, the respondents were also asked whether their company does offer training and if so, what the duration of this training is. Figure 5 indicates that the vast majority of applicators and suppliers have a maximum of one days' worth of training. This scenario again exhibits very limited knowledge acquisition of material properties and processes. This undoubtedly also leads to inadequate knowledge of understanding repair material properties and processes.

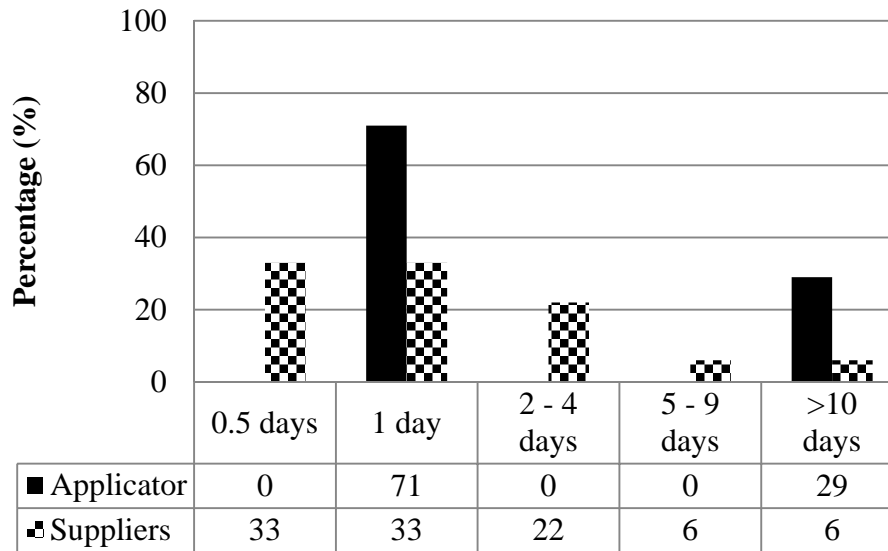


Figure 5: Duration of training offered

In summary, as can be seen in Figures 2 – 5, there is minimal training in specifying and designing concrete patch repairs. This conceivably translates into specifying incorrect materials for use in polymer-modified patch repair, as well as incorrect repair system design. This results in under-performance or even failure of polymer-modified concrete patch repairs.

Figure 6 represents the results of the 3<sup>rd</sup> set of questions. SETt 3 results indicate that none of the labourers involved in this study possessed any tertiary education. In fact, more than halve of the labourers only had a basic primary school level education. This again may well lead to poor quality workmanship due to lack of understanding the basics of this specialized process. In addition, a very low level of training and education for the foremen working with polymer-modified concrete patch repair materials exist. Only 19% of the respondents indicated that they had some form of tertiary education. This may lead to the supervisors of the labourers not being able to identify possible poor workmanship and incorrect application when working polymer-modified concrete patch repair materials.

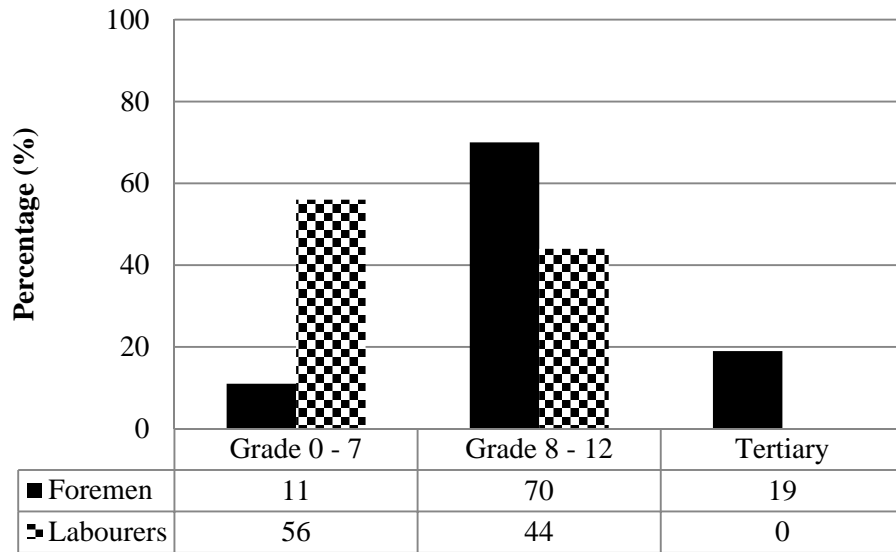


Figure 6: Education level of foremen and labourers working with polymer-modified concrete patch repair materials.

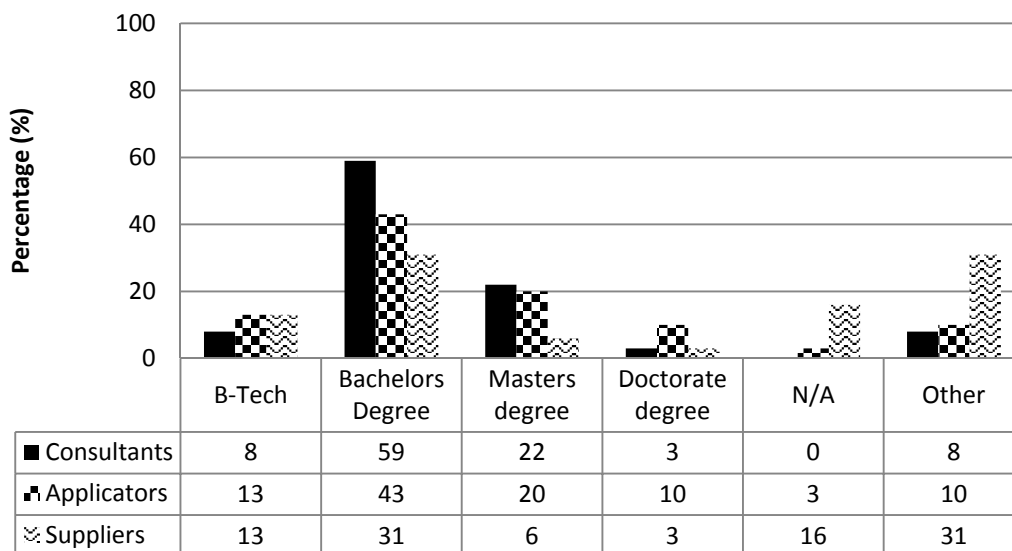


Figure 7: Education level for consultants, applicators and suppliers.

Figure 7 indicates that, unlike the labourers and foremen who perform the physical patch repair work, a high percentage of consultants, applicators and suppliers do have tertiary education. There is thus a significant gap in the education levels between the foremen and labourers that are working with the polymer-modified concrete patch repair materials and the consultants, applicators and suppliers that design and specify the polymer-modified concrete patch repair material. This could lead to miscommunication and misunderstanding in the application of the repair material, thus leading to under performance and even failure of the repairs.

## Conclusions

The results indicate that, although there is agreement that polymer-modified concrete patch repair is a highly specialized field; there is an unacceptably low level of training in each of the three stakeholder sectors for the correct selection, application and care of repair materials. Incorrect specification, inappropriate material selection, misunderstanding of the material properties and

inadequate quality control are all outcomes of this lack of knowledge and understanding which subsequently leads to premature failures and/or under-performance of the repair system. In addition, the survey results also indicate that the workforce performing the actual repair work is unskilled whilst the specifiers and designers are often well-qualified which may lead to miscommunication amongst the various parties.

All of the above leads to the conclusion that serious and urgent intervention in the training and education levels of foremen and labourers is required to correct this situation in order to ensure sustainable and durable concrete patch repair projects when using specialized polymer-modified repair systems.

## **References**

- [1] P-C. Aïtcin, S. Mindess, Sustainability of concrete, first ed., Spon Press, Oxon, 2011.
- [2] M. Walker, An overview of rehabilitation methods and selection of an appropriate system, in R.K. Dhir, M.D. Newlands (Eds.), Controlling concrete degradation, Thomas Telford Publishing, London, 1999, pp.169 – 180.
- [3] W.G. Smoak, Guide to Concrete Repair, United States Department of the Interior Bureau of Reclamation, Technical Services Center, 1997.
- [4] J.D.N. Shaw, Polymers for concrete repair, in: R.T.L. Allen, S.C. Edwards and J.D.N. Shaw (Eds.), The repair of concrete structures, second ed., Blackie Academic & Professional, Glasgow, 1993, pp.37 – 55.
- [5] J.G.M. Wood, Structural aspects of repair, in: M.G. Grantham (Ed.), Concrete Repair A practical guide, Taylor & Francis, Oxon, 2011, pp. 75 – 89.
- [6] K. Tuutti, Repair philosophy for concrete structures, in: R.K. Dhir, M.J. McCarthy (Eds.), Concrete durability and repair technology, Thomas Telford Publishing, London, 1999, pp. 159 – 170.