

## Psychological Effects towards Humans Living in the Environment Made of Biological Concrete in Malaysia at 2015

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Received: 1 Feb. 2016, Revised: 8 Apr. 2016, Accepted: 28 July 2016

### ABSTRACT

In day-to-day life concrete become a compulsory material in the construction field as to make it a real concern among researchers for producing concrete with improved properties. Biological method is one of the new methods to improve concrete properties. Although, much research about biological concrete has been carried out, but till now nobody has not studied for the psychological effects of using a house or offices made up of biological concrete. The aim of this study is to investigate and find out the person's opinion about staying in a house or offices made up of biological concrete. In this study, a questionnaire containing eight questions was prepared and distributed among 21 persons in Malaysia University of Technology including students, academic and non-academic staffs among which few of them was an expert in the field of biological concrete and others did not have any knowledge about the bioconcrete. Finally, the results obtained from the questionnaires were analyzed. The results showed that 81% of participants in this study would like to stay in a house or office made up of biological concrete. However, 38% of participants believe that staying in a house or office made of biological concrete can cause health related problems. The current research paper can be considered significant for architects and civil engineers to have the insight to look into the psychological aspects of using biological concrete for various applications in the field of construction.

**Key words:** Self-Healing Concrete, Biological Concrete, Psychological Aspects, Physical Health.

### INTRODUCTION

The cement is one of the most commonly used materials in the construction field all throughout the world and therefore its demand is increasing every year [1]. A large amount of concrete has been produced as a response shown to this increasing demand. In order to produce cement, its ingredients like clay and limestone need to be heated up to 1400°C which requires fuel combustion to complete the process. As a result large amount of carbon dioxide is released into the atmosphere, which will have a negative impact on the environment [2]. Also, during cement production limestone is converted to carbon dioxide and lime, thereby increases the rate of carbon dioxide emission [3]. The ingredients need to be transported to cement factories up to far distances which again increase carbon dioxide emission, landscape mutilation and energy consumption. This adds up to the estimation of 7% of the total anthropogenic carbon dioxide emission because of the production of cement. In consideration of the

above mentioned facts in cement certainly does not appear to be a suitable material to our environment [4]. Using biological concrete is a good idea to increase durability, strength and permeability of concrete. Many bacteria are investigated to be used in the designing of biological concrete. Staying in a house or offices made up of concrete containing bacteria is a bit of a scare factor for the people. Therefore, it can show its adverse effects on humans in the form of psychology. Although, much research about biological concrete has been carried out so far, but nobody has studied the psychological effects of using houses or offices made up of biological concrete. The aim of this study is to investigate the people's opinion about staying in a house or offices made up of biological concrete. In this study, firstly a questionnaire containing 8 questions was prepared and distributed among the persons in Malaysia University of Technology including students, academic and non-academic staffs among which a few of them are expert in the field of biological

concrete and others not. Finally, the results of questionnaires were analyzed.

## MATERIALS AND METHODS

In this study a questionnaire was prepared with the following questions to be addressed: (1) would you like to stay in a house or office made of biological concrete? (2) How much you are comfortable to stay in a house or office made of biological concrete? (3) Do you think may you become ill if you stay in a house or office made of biological concrete? (4) Would you like to recommend others to stay in a house or office made of biological concrete? (5) Would you like to invest more money to buy a house or office made of bio-concrete, which is considered as to be more durable? (6) Do you think staying in a house or office made of biological concrete will affect the health of children? Are you an expert in the field of biological concrete? (8) If you have any other ideas or suggestions which you consider to be important, please mention below. The questionnaire was distributed among 21 persons who included the lecturers and students of Malaysia University of Technology in order to their opinion about staying in an office or house made up biological concrete. Simple Random Sampling (SRS) was used for collecting data. The questionnaire was designed in a standards approach to facilitate our way for achieving the goals of the article and testing our hypothesis. Based on an introductory pre-sampling of size 15 and using Cronbach's alpha validity the reliability of the questionnaire was proved. Moreover the person taking up the questionnaire included few experts in the field of biological concrete and others not. There is necessary to at least 25 subjects to have a reliable statistical approach but in time of the study there were only 21 persons who exactly met the conditions for participating in our investigation. On the other hand, non-parametric methods have been used for the statistical analysis and as it is clear non-parametric tests are distribution free test which does not rely on any pre requisite assumptions like normality and sample size [12-17]. The results of the questionnaire were analyzed using SPSS software and for the data analysis non-parametric chi-square test was used. A chi-square test is commonly used to compare the ratio occurring between all the levels of response. The expected value of the non-parametric test was selected equal to 10.5. It should be noted that in all the questions the ratio of the subject response is significant only if it be less than 0.05 level by 95% of confidence.

## RESULTS AND DISCUSSION

Self-healing concrete is a new technology which is rapidly developed. Among different methods for producing of self-healing concrete, biological method has attracted much attention [1]. It is predicted that in the near future several building will be constructed by this kind of concrete [2]. As in biological concrete a certain types of microorganisms are used [5], maybe people do not have tendency to live in this kind of building. Therefore, it is of the most important to understand what is opinion of people for living in a building made of self-healing concrete. For this reason the questionnaire was designed and distributed among few people to know their opinion about living in such buildings. Results of this study have been divided into 7 sections. Each section is dedicated to each question of the questionnaire.

### *Question number 1*

This question asked was would you like to live in a house or office made of biological concrete? The questionnaire survey showed that 85% of people would like to stay in the house or office made up of biological concrete, whereas 15% of people did not like to stay, Table 1. The reason for the high tendency of people to stay in the house or office made up of biological concrete is because they think biological concrete has higher durability and lower maintenance cost. However, there is no clear information yet about the lifetime of biological concrete [5]. This lack of information is because this field is very young and more studies are required to answer to this question.

A frequency table is a method of summarizing data, which determines the number of times a data value occurs. The frequency of answers for question 1 is shown in Table 1. Also, the observed and expected values, to question 1 are shown in Table 1. According to statistical analysis, the number of values during a total calculation is free to vary and the degree of freedom is defined as the minimum number of independent coordinates that specifies the system position. As it can be seen from Table 1, the value of the degree of freedom (df) for question number 1 is equal to 1. As mentioned in the methodology, the test level (alfa) is 0.003. If the "Asymp. Sig. (2-sided)" for the non-parametric chi-square statistic is less than 0.05; there is a significant difference between the levels of responses. Table 1 shows that the Chi-Square significance value is 0.003, which is less than the test value of 0.05 and shows that there is a strong attraction for the people to stay in a house or office made of biological concrete.

### *Question number 2*

As in the walls of this kind of building an enormous number of microorganisms are existed, it is natural to scare people to live them [18]. The second question in the questionnaire was to know how much you are

comfortable to stay in a house or office made of biological concrete? In response to this question, 43% of people think they moderately prefer to stay in a house or office made up of biological concrete. Other information related to the second question is shown in Fig. 1. The frequency of answers for question 2 has been shown in Table 2. Also, the observed and expected values for question 2 have

Table 1: Frequency table for question 1

Parameters	Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Frequency table	Yes	29	85.0	85.0	85.0
	No	5	15.0	15.0	100.0
	Total	34	100.0	100.0	
Observed and expected values	Yes	29	17	12	Yes
	No	5	17	-12	No
	Total	34			Total
Chi-Square	9.328				
Df	1				
Asymp. Sig.	0.003				

Table 2: Frequency table for question 2

Preference	Frequency	Cumulative Percent
Slightly prefer	3	9
Moderately prefer	15	53
Very prefer	12	88
Mostly prefer	4	100
Total	34	-

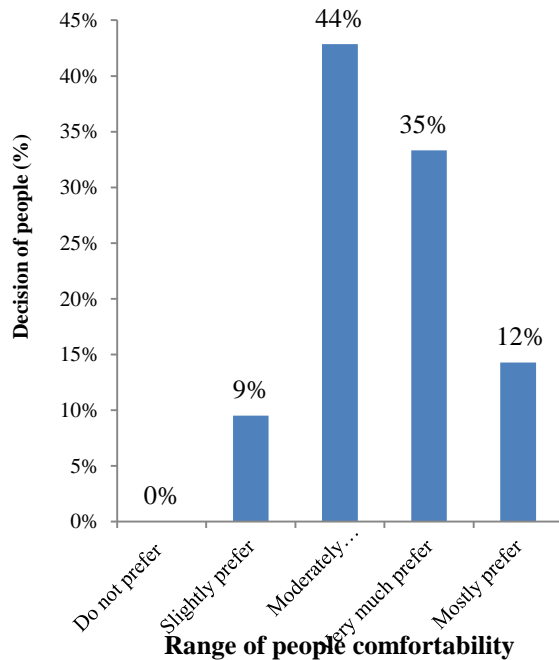


Fig. 1: Percentage of comfort ability of people to stay in a house or office made up of biological concrete

Table 3: Observed and expected values for question 2

Preference	Observed N	Expected N	Residual
Slightly prefer	3	8.5	-5.5
Moderately prefer	15	8.5	6.5
Very prefer	12	8.5	3.5

been shown in Table 3. As it can be seen in Table 4 it is clear that the level of the test is less than the calculated Asymp. Sig. therefore, the deference between the ratios of responses to each level is in equal despite for the non-significant calculation.

Table 4: Non-parametric chi-square test for question 2

Test	Question 2
Chi-Square	5.424
Df	3
Asymp. Sig.	0.158

As for the preparation of biological concrete, bacteria are mixed with cement and other aggregates, so some people scare of becoming ill. As many microorganisms such as *Sporosarcina pasteurii* (or *Bacillus pasteurii*), *Bacillus megaterium*, *Halomonas euryhaline*, *Myxococcus xanthus*, *Deleya halophila*, *Bacillus sphaericus*, *Bacillus lentus*, *Acinobacter* species, *Escherichia coli*, *Pseudomonas aeruginosa*, *Shewanella* species, *Bacillus Cohnii*, *Bacillus pseudofirmus*, *Bacillus amyloliquefaciens*, *Bacillus alkalinitrilicus*, *Proteus vulgaris*, *Proteus mirabilis* and *Leuconostoc mesenteroides* [1] have been applied for designing the biological concrete among which several of them are known to cause illnesses or infections, so public concern is very much understandable. For instance, *Proteus vulgaris* is considered to be an opportunist pathogen for humans that can cause urinary tract and wound infections. *Proteus mirabilis* is another bacterium which is used for designing biological concrete and mostly known to cause urinary tract infections. *Leuconostoc sp.*, another type of applicable bacterium for designing biological concrete is being reported that causes infection in humans. Buu-Hoi *et al.* [6] reported the cases of *Leuconostoc* infection in humans, but since then it has been implicated in a variety of infections [7-8], particularly in the immuno compromised patients. Therefore, the use of such bacterial strains for designing self-healing concrete certainly requires further investigation as to prevent the risk of causing various types of diseases [5].

Question number 3

In this question, it was asked, do you think may you will become ill if you stay in a house or office made of biological concrete? In this study, 38% of participants believe that staying in a house or office made of biological concrete can produce illness because of the above mentioned reasons see Table 5). Whereas some bacteria like *Bacillus pasteurii* are non-pathogenic in nature and also widely being used in the designing of biological concrete [9, 10, 11]. Since, *Bacillus pasteurii* is harmless for humans, it can be considered to be as the best choice for designing the biological concrete. Also the use of

*Bacillus pasteurii* can decrease of public concerns about transmitting illness to humans from the biological concrete.

Frequency of answers for question 3 is shown in Table 5. Also, the observed and expected values for question 3 are shown in Table 5. As it can be seen from Table 5, it is clear that the level of the test is less than the calculated Asymp. Sig. Therefore, the difference between the ratios of responses to each level is in equal despite for the non-significant calculation.

**Table 5:** Frequency table, observed and expected values and non-parametric chi-square test for question 3

Parameters	Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Frequency table	Yes	13	38	38	38
	No	21	62	62	100.0
	Total	34	100.0	100.0	-
Observed and expected values	Yes	13	17	-4	Yes
	No	21	17	4	No
	Total	34	-	-	Total
Chi-Square	1.583				
Df	1				
Asymp. Sig.	0.301				

**Question number 4**

The question asked was would you like to recommend others to stay in a house or office made of biological concrete? Nearly, 76% of people like to recommend for staying in this kind of houses or offices made of bioconcrete considering its durability and 24% would not like it due to fear of becoming ill due to the involvement of pathogenic bacteria in the making up of biological concrete (Table 6). Moreover, it should be noted that the lifetime of humans is shorter than concrete structures. Therefore,

people hesitate to invest more money for using biological concrete in their office or house. As a whole it can be mentioned that biological concrete can be important to those people who are thinking positive about making huge constructions such as dams, bridges, tunnels, etc. The frequency of answers for question 4 is shown in Table 6. Also, observed and expected values in question 4 are shown in Table 6. As it can be seen from Table 6 that there is a significant statistical difference between the ratios of responses for each level with 95% confidence.

**Table 6:** Frequency table, observed and expected values and non-parametric chi-square test for question 4

Parameters	Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Frequency table	Yes	26	76	76	76
	No	8	24	24	100.0
	Total	34	100.0	100.0	-
Observed and expected values	Yes	26	17	9	Yes
	No	8	17	-9	No
	Total	34	-	-	Total
Chi-Square	6.21				
Df	1				
Asymp. Sig.	0.011				

**Question number 5**

In this question it was asked would you like to invest more money to buy a house or office made of bio-concrete, which is considered as to be more durable? As a response to this, it can be seen from Table 7, that nearly 53% of participants would not like to invest more money for such a house or office made of bio-concrete and 47% would like to invest. Although, based on the presented results of the question, 81% of people would like to stay in houses or office made up bio-concrete, results obtained from

question 5 shows that they would not like to pay more money for that. Therefore, if bio-concrete can be commercialized, it should have the same price in comparison to the normal concrete as to persuade people. Frequency of answers for question 5 is shown in Table 7. Also, the observed and expected value for question 5 is shown in Table 7. As it can be seen from Table 7 that the level of the test is less than the calculated Asymp. Sig. therefore, the difference between the ratios of responses to each level is in equal despite to the non-significant calculation.

**Table 7:** Frequency table, observed and expected values and non-parametric chi-square test for question 5

Parameters	Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Frequency table	Yes	18	53	53	53
	No	16	47	47	100.0
	Total	34	100.0	100.0	-
Observed and expected values	Yes	18	17	1	Yes
	No	16	17	-1	No
	Total	34	-	-	Total
Chi-Square	0.039				
Df	1				
Asymp. Sig.	0.914				

#### Question number 6

In this question, it was asked, do you think staying in a house or office made of biological concrete will affect the health of children? As children are more sensitive when compared to adults 26% of participants in this study believe that houses made of biological concrete are going to affect their children's

**Table 8:** Frequency table, observed and expected values and non-parametric chi-square test for question 6

Parameters	Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Frequency table	Yes	9	26	26	26
	No	25	74	74	100.0
	Total	34	100.0	100.0	-
Observed and expected values	Yes	9	17	-8	Yes
	No	25	17	8	No
	Total	34	-	-	Total
Chi-Square	5.952				
Df	1				
Asymp. Sig.	0.014				

#### Question number 7

Although till now it is the first study to investigate opinion of experts about living in building made of biological concrete, few researchers in their articles say that there is a lot of unknown questions on health safety of living in this kind of building and that is why they are not sure it is a right decision to live in such buildings [18]. The question asked is you an expert in the field of biological concrete? As a response, it is to be noted that 25% of participants in this study are expert in biological concrete technology, whereas 75% did not have any information about biological concrete. It can be predicted that in the near future by gathering valuable information about biological concretes and its benefits, people's opinions will automatically change to overcome the drawbacks and to go towards the biological concrete by focusing on its merits.

## CONCLUSION

This study of the physiological effect of using houses or offices made up of biological concrete on the humans was investigated by the distribution of the questionnaire among students, academic and non-academic staffs of Universiti Teknologi Malaysia under shadow of non-parametric chi-square test. The results of this study show that although, people are keen to stay in this type of houses or offices, but they are seriously concerned with the negative effects of houses or offices made up biological concrete on

health. Frequency of answers for question 6 is shown in Table 8. Also, the observed and expected values for question 6 are shown in Table 8. As it can be seen from Table 8 there is a significant statistical difference between the ratios of responses for each level with 95% confidence.

their health. As many of the bacteria used in making biological concrete are pathogenic, so the public concern is understandable. However, the use of non-pathogen bacteria such as *Bacillus pasteurii* can decrease the public concerns about the transmission of illness to humans from the biological concrete. The current research paper can be considered significant for architects and civil engineers to have the insight to look into the psychological aspects of using biological concrete in the field of construction.

## ETHICAL ISSUES

Authors are aware of, and comply with, best practice in publication ethics specifically with regard to authorship (avoidance of guest authorship), dual submission, and manipulation of figures, competing interests and compliance with policies on research ethics. Authors adhere to publication requirements that submitted work is original and has not been published elsewhere in any language.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest that would prejudice the impartiality of this scientific work.

## AUTHORS' CONTRIBUTION

It is certified that all the authors have a same contribution in the experiments and manuscript writing.

**FUNDING/ SUPPORTING**

Universiti Teknologi Malaysia financially supported this study.

**ACKNOWLEDGEMENT**

The authors would like to thank for the financial support received from Ministry of Higher Education (MOE) to University Teknologi Malaysia (UTM) under GUP Tier 1 Grant with Vote No. Q.J130000.2509.06H43, Malaysian Ministry of Science, Technology and Innovation (MOSTI) with Vote No. R.J130000.7909.4S085 - Science fund grant, Research Management Center - UTM, Construction Research Alliance (CRA) –UTM and Research and Innovation Center (TNCPI) –UTM to carry out this work successfully.

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