UNIVERSITI TEKNOLOGI MARA

FSPU
FACULTY OF ARCHITECTURE, PLANNING AND SURVEYING

FULL PAPER
PROCEEDING

3RD UNDERGRADUATE SEMINAR

BUILT ENVIRONMENT & TECHNOLOGY

SEPTEMBER
2018

ISBN 978-967-5741-67-8

FACULTY OF ARCHITECTURE, PLANNING & SURVEYING
UNIVERSITI TEKNOLOGI MARA PERAK BRANCH
SERI ISKANDAR CAMPUS

UiTM PERAK @ Seri Iskandar

PERMEABLE CONCRETE IN ROADWORK CONSTRUCTION

Nurul Natasya Binti Ahmad Sata
Department of Building, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, 32610 Perak
Email: natasyasata@gmail.com

Abstract:
Permeable concrete is a different type of concrete with high porosity that is usually used for roadwork construction and pavement that allows water from heavy rain or other sources to seep through it. Basically, the reason behind the necessary use of permeable concrete is because of the related issues and problems that occur with the use of conventional concrete. There are several problems that occur which are flood incidents, low environment management, road safety and also the negative impact on durability of concrete. The significance of this research is to identify the issues and problems according to the use of conventional concrete, to evaluate the durability and permeability of permeable concrete, and to propose the new concept of permeable concrete that can cope with the stated issues and problems. The methodology used for this research is by critical review of related articles. The used of permeable concrete may reduce the problem of flood incidents where it provides voids to allow water to drain freely and also reduces pollution by lack of environmental management by humans. Besides, with the application of permeable concrete, accidents may be reduced and it may also keep the durability for roadwork construction. Therefore, permeable concrete is a good application for roadwork construction as it can minimize the issues and problems that occurwith the use of conventional concrete.

Keywords*:* Permeable Concrete; Problem; Conventional Concrete; Drain; Void

1.0 INTRODUCTION

As we know the world nowadays keeps on urbanizing and the Earth is covered with impervious surfaces which are incresing. Problems keep on occurring as the world urbanizes and there is minimum surface that can absorb water from the precipitation or other sources.

Additionally, with the use of conventional concrete in roadwork construction it will lead to several issues and problems as it cannot absorb storm water runoff into the ground. One of the issues and problems that may occurr is flood incident. It is known that floods are not a small matter and is faced by every country not to mention Malaysia that usually faces rainfall that is influenced by the North east and South West monsoons (Ndon, 2017). The flood incidents that occurr come from several effects which aare dam break, pollution and management of the environment. As a result, it leads to inverse effects which are damages to homes, shops and industries. Human attitude that litter, bin, illegal dumping by irresponsible contractors and also low drainage maintenance system will result in improper drainage of storm water runoff. Moreover, according to road safety, accumulation of storm water on road surfaces will creates conditions that reduce the safety of the traveling public due to splash and spray of road water, reduced skid resistance (reduced pavement friction coefficient), and hydroplaning problem where all this phenomenon will lead to accidents. Lastly, storm water that fall on roads that is not drained away will lead to accumulation of water in the pavement structure that can result in pavement damage.

From the issues and problems stated above, it is clear that the useof permeable concrete is a good option in reducing the problems related to conventional concrete. Therefore, permeable concrete is produced to minimize the impervious surfaces according to the use of conventional concrete in roadwork construction. This type of concrete contains raw materials like coarse aggregate and cementitious paste that act as glue or coating to coat the coarse aggregate that will preserve the interconnectivity of the voids. As a result, with the voids and the porosity provided it is enough to receive large amount of water and prevent the hydroplaning phenomenon where vehicle tires lose contact with the pavement surface because

of accumulated storm water on the road pavement. In conclusion, it is important to carry out a study on permeable concrete. The purpose of this study is to identify the issues and problems according to the use of conventional concrete, to evaluate the durability and permeability of permeable concrete, and to propose the new concept of concrete that can cope with the issues and problems. According to the objectives stated, recommendations will be proposed for the new concept of permeable concrete.

2.0 LITERATURE REVIEW

Basically, conventional concrete is commonly used in roadwork construction. This type of concrete will have covered the Earth because conventional concrete provides impervious surfaces. The impervious surfaces characterized by conventional concretemay cause several issues and problems Firstly, lack of drainage maintenance system caused by improper waste disposal. Secondly, the environmental management by humans is low, for instance littering, improper waste disposal management. The failure to take the responsibilities of this by the authorities in will cause pollution that could lead to flood incidents (Sani Garba, 2014). Thirdly, the weather conditions that include precipitation and water accumulation on pavements are factors that affect road safety, as the hydroplaning phenomenon can occur by water accumulation which will make vehicles tires lose contact with the pavement surface and lead to accidents. Lastly, the hydroplaning phenomenon may also lead to damages of the pavement (Ndon, 2017).

The raw material used by the permeable concrete is only coarse aggregate and cementitious paste. There is no fine aggregate used because the cementitious paste will coat the coarse aggregate particles that preserve interconnectivity of the void that allows water from precipitation or other sources to pass through it (Nevada Ready Mix, 2018). Compared to Tarmac company, other than coarse aggregate and cementitious material, they also use very little amount of sand in the matrix which allows the final product to have a substantial void content that is perfect or permeation of rainwater (McFadden, 2017).

The benefits behind the uses of permeable concrete as mentioned in articlesabout Tarmac company are the permeable concrete allows water to permeate through its microstructure to regenerate groundwater and it prevents surface water runoff that is commonly associated with hard surfaces. Besides, it also provides efficient cost savings for long term maintenance for authorities take charge on storm water management (McFadden, 2017). It also recharges precious groundwater that acts on the facilities like infiltration to the soil over a large area (Nevada Ready Mix, 2018). Other than that, permeable concrete provides a fast draining system through the concrete and it also may reduce the risk of water shortage by redirecting the rainwater into the natural aquifer (Matchar, 2015).

3.0 METHODOLOGY

The method used is by detailed review on articles related to permeable concrete and conventional concrete done by researchers and specialized manufacturers or contractors By using this method, explanations on the benefits of using permeable concrete can be evaluated as each article states the benefits of using this type of concrete, for instance in Nevada Ready Mix article, it is mentioned that it will provide first-flush pollution control and reduces need of retention pond (Nevada Ready Mix, 2018) while in an article by Christopher McFadden, which stated that it will allow water to seep through its microstructure to regenerate groundwater and also it is cost saving as it offers a long term maintenance regarding storm water management (McFadden, 2017). However, low mortar content and high porosity of permeable concrete may reduce the final strength but as mentioned by Tarmac company, advances in compaction is an option to cope with that issues. Therefore, in this research we will take this recommendation into consideration in this methodology section.. Other than that, from previous articles it is recommended that the test is to be carried out on permeable concrete with the presence of admixture such as fly ash and tire chips (Kim, 2016).

4.0 ANALYSIS AND FINDINGS

4.1 Identification of issues and problems according to the use of conventional concrete

From the articles reviewed, the identification of issues and problems have been highlighted where the issues and problems with the use of conventional concrete are flood incidents, environmental management, road safety and negative impact on durability of concrete due to accumulated storm water. With this information, the solutions of the issues and problems can be found.

4.2 Evaluation on durability and permeability of permeable concrete

The evaluation carries out by desk study on the creation permeable concrete. By reviewing Nevada Ready Mix company article, which stated that proper preparation of subgrade is important because it should be compacted properly to provide event surfaces. The type of soil to lay on of the permeable concrete needs to be taken care of when permeable pavement is placed directly on sandy or gravelly soils. It is recommended to compact the subgrade to 92 to 96% of the maximum density. Addition of a small amount of fine aggregate will generally reduce the void content and increase the strength, which may be desirable in certain situations. For the durability, mix ratio and compaction are important in ensuring the durability of permeable concrete. Care must be taken not to over compact it with swelling potential. Besides, in terms of mix ratio for permeable concrete, commonly it has water to cementitious material (w/cm) ratio of 0.35 to 0.45 with a void content of 15 to 25%. The mixture content of materials like cementitious materials, coarse aggregate and water with little to none aggregates. In order to get the desirable strength of concrete, adjustment of the fresh concrete is necessary by adding a small amount of fine aggregate that will generally reduce the void content but increases the strength (Nevada Ready Mix, 2018).

Other than that, there were also tests carried out by researchers to ensure the porosity of permeable concrete. The test done is a porosity test, which consists of saturating all the gaps of a sample with water to relate the porosity with the total water volume used. In order to achieve this, the lateral faces of the samples are covered with PVC film and the specimen is introduced into a cylindrical metallic mold to guarantee that the PVC film will not go under any deformation. Finally, both the mold and the sample which consist of different used of aggregate characteristic within it are placed on a scale and water is introduced to fill the permeable concrete gaps. Considering the difference in weight, the volume of water is obtained. Then, knowing the volume of water (Vw) and the volume of the sample (Vs) the porosity is calculated. Since it is recommended to perform the test on a minimum of three samples to assess the porosity of the permeable concrete, five samples were tested over 28 days, fulfilling the requirements of the method. It is resulted in the CW type of aggregate have the highest porosity values of 27.06% (Sandoval,2017).

4.3 Proposal on new concept of permeable concrete

Finally, the proposal of new concept of concrete is put forward as it addresses the issues and problem statement regarding the previous concept of concrete used for roadwork construction. This proposal may solve the issues and problems which have occurred with a better concept of permeable concrete. The new concept for this permeable concrete is with the mix of catalyst like fluid catalytic cracking (FCC) to build up the durability and with a better method on compaction with the use of updated vibrator technology.

5.0 CONCLUSION

In conclusion, with the identification of issues and problems regarding the use of conventional concrete in roadwork construction, the used of permeable concrete is a solution and needs to be used widely in roadwork construction such as for highways, parking lots, pavements and biking pathways as it has several advantages. It allows water to seep through its microstructure to regenerate groundwater and also prevent surface water runoff that is usually associated with hard surface. Furthermore, this type of concrete reduces the flood incident by the voids provided that will delay the discharge of water into water courses or drainage system. On top of that, it may reduce heating during hot weather. It also helps in environmental management with the contaminants filtration, for example, when motor oil is filtered out of water by putting multi layers of porous stone.Lastly, the structures of permeable concrete fulfills the

requirement of structural strength to serve in highway environments while providing its intended safety functions.

REFERENCES

Matchar, E. (2015). Thıs Concrete Can Absorb a Flood in UK 2015. Available online at: https://www.smithsonianmag.com/innovation/concrete-can-absorb-flood-180956830/, Accessed on 17 March 2018

McFadden, C. (2017) Topmix Permeable Concrete Can Absorb an Impressive 4 Lites of Water per Mınute in UK 2017. Avaılable online at: https://interestingengineering.com/topmix-permeable-concrete-can-absorb -water, Acessed on 17 March 2018

Nevada Ready Mix (2018). Pervious Concrete — What, why, & how?. Available online at: http://www.nevadareadymix.com/concrete-tips/pervious-concrete/, Accessed on 25 March 2018

Ndon, U. J. (2017) Trends in the Application of Permeable Pavement as Sustainable Highway Storm Water Management Option for Safe-Use of Roadways in US 2017. Available online at: https://www.omicsonline.org/open-access/trends-in-the-application-of-permeable-pavement-as-sustainable-highway-storm-water-management-option-for-safeuse-of-roadways-2165-784X-1000288-97227.html?view=mobile, Acessed on 29 April 2018

Sandoval, G. F. (2017). Comparison between the falling head and the constant head permeability tests to assess the permeability coefficient of sustainable Pervious Concretes. *Case Studies in Construction Materials*, 317-323.