SUPERVISOR'S DECLARATION

I hereby declare that We have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of civil Engineering

(Supervisor's Signature)

Full Name : MOHD FAIZAL BIN MD. JAAFAR

Position : LECTURER

Date : 13 JUNE 2017

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at University Malaysia Pahang or any other institutions.

(Student's Signature)

Full Name : MOHAMAD AMIRULNAIN BIN ADI

ID Number : AA13110

Date :13 JUNE 2017

INFLUENCE OF ELEVATED TEMPERATURE ON COMPRESSIVE STRENGTH OF RUBBERIZED ULTRA-HIGH PERFORMANCE CONCRETE

MOHAMAD AMIRULNAIN BIN ADI

Thesis submitted in fulfillment of the requirements
for the award of the
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

13 JUNE 2017

ACKNOWLEDGEMENTS

First and foremost, I have to thank my research supervisors Mohd Faizal bin Md Jaafar. Without their assistance and dedicated involvement in every step throughout the process, this paper would have never been accomplished. I would like to thank you very much for your support and understanding over these past two semesters

My gratitude also goes to my collagenous who helped me to maintain my faith in humanity and encourage me especially Azhroul and Syed Arzmierul for their support and motivation during the tough time throughout the duration of this study. Thanks for the support, courage and helping me on writing and so on.

In completing the lab experiment, thanks to the entire lab technician that give me full cooperation and helping me on completing, whether concrete specimen preparation and concrete specimen testing.

Thank to every person that involve in this study direct and indirectly may Allah bless all of you of your kindness is appreciated

ABSTRAK

Ultra-High Performance Concrete (UHPC), is a high-strength, ductile material formulated by combining ordinary Portland cement, silica fume, quartz flour, fine silica sand, water and steel or organic fibers. It is state that the strength of UHPC has more than 100 MPa compressive strength. The successful production of UHPC depends on its material ingredients and mixture proportioning, which leads to denser and relatively more homogenous particle packing. A series of UHPC mix proportion was designed by replacing the conventional sand with waste rubber chipped (WRC) and Waste Rubber Powder(WRP). The levels of replacement comprise of 5%, 10% and 15% of WRC and WRP from the weight of sand used. In this study, the effects of elevated temperatures at 100 ^{O}C, 180 ^{O}C and 260 ^{O}C on the compressive strength of rubberized-UHPC was studied. The weight loss ratio of the rubberized-UHPC also was taken to compare the percentage of weight loss before and after the heat treatment. The result shows that the inclusion of WRC and WRP in UHPC mix recorded no enhancement in strength as compared to plain UHPC. However, UHPC with 5% WRC and WRP shows a comparable to that plain UHPC. It also found that the compressive strength at 100 ^{O}C was higher as compared to other temperatures for 5% mix at 28 days curing and it is comparable to other temperature. For weight loss, the result show the percentage of weight loss was gradually increase with percentage of WRC and WRP for 7, 14 and 28 days .The higher weight loss obtained after the specimen was heated at 260^{o}C for 28 days.

ABSTRACT

Ultra-Konkrit Berprestasi Tinggi (UHPC), adalah kekuatan tinggi, bahan mulur digubal dengan menggabungkan simen Portland biasa, silika, kuarza, pasir silika halus, air dan keluli atau gentian organik.Ia telah dinyatakan bahawa UHPC mempunyai lebih daripada 100 MPa kekuatan mampatan. Kejayaan UHPC bergantung kepada bahan-bahan dan campuran yang membawa kepada lebih padat dan zarah pembungkusan agak lebih homogen. Satu siri UHPC campuran bahagian direka bagi menggantikan pasir konvensional dengan sisa potongan getah (WRC) dan sisa serbuk getah (WRP). Tahap penggantian terdiri daripada 5%, 10% dan 15% daripada WRC dan WRP daripada berat pasir digunakan. Dalam kajian ini, kesan suhu tinggi pada 100 ^{O}C, 180 ^{O}C dan 260 ^{O}C pada kekuatan mampatan UHPC telah dikaji. Nisbah berat konkrit yg dicampurkan bersama getah juga diambil untuk membandingkan peratusan penurunan berat sebelum dan selepas rawatan haba. Hasilnya menunjukkan bahawa campuran WRC dan WRP dalam UHPC mencatatkan tiada peningkatan dalam kekuatan berbanding UHPC biasa. Walau bagaimanapun, UHPC dengan 5% WRC dan WRP menunjukkan setanding dengan UHPC biasa . Ia juga mendapati bahawa kekuatan mampatan pada suhu 100 ^{O}C pada 5% campuran pada 28 hari pengawetan adalah lebih tinggi berbanding dengan suhu yang lain. Untuk nisbah berat , keputusannya, menunjukkan bahawa peratusan nisbah penurunan berat secara beransur-ansur dengan peningkatan peratusan WRC dan WRP selama 7, 14 dan 28 hari .Nisbah penurunan berat yang lebih tinggi diperolehi selepas spesimen telah dipanaskan pada 260 ^{O}C selama 28 hari.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Worldwide tire production is estimated to exceed 2.9 billion units per year by the end of 2017 according to Samar et al.,2016 and it is estimated that for every tire placed in the market, another tire reaches its service life and becomes waste. Over 300 million tires reach their service life every year in the European Union alone. According to the Environmental Protection Agency (EPA), the United States alone generates 289 million scrap tires annually. In addition to the amount of waste alone, the EPA provides that stockpiled waste tires can pose significant health and safety hazards including rodent and mosquito habitation which can facilitate the increase of disease and an increased risk of fire as mention by Nathan et al. (2017).

Ultra High Performance Concrete (UHPC), is a class of concrete defined by its exceptionally high strength and durability. It was developed in Europe in the 1980s for specialized applications that demand superior strength and corrosion resistance. UHPC was also used as marine anchors, piers and seismic structures. Basically, UHPC can be defined as 100 MPa of compressive strength as mention by Alkaysi et al. (2015). UHPC has a discontinuous pore structure that reduces liquid ingress, significantly enhancing durability as compared to conventional and high-performance concretes. UHPC also widely use in highway infrastructure application. The high compressive and tensile strengths allow for the redesign and optimization of structural elements.

Furthermore, natural rubber is material that produce by tapping the rubber tree. In addition, Malaysia is the fifth largest consumer of natural rubber and latex in the world. These could be advantage to get cheap rubber in Malaysia. Rubber has elasticity properties, resistance to water and its uses as an electrical insulator. When rubber is heated, it becomes sticky, and when it is colder temperature, it tends to break, just like the synthetic variety. To enhance the properties of rubber, a process known as vulcanization is done. During the vulcanization process, rubber is treated with sulphur while being heated. The sulphur is important to the process because it enhances the rubber's elasticity and resistance to the damaging effects of higher or lower temperatures. The aim of this study was to investigate the influence of compressive strength on rubberized-UHPC at different elevated temperature and weight loss of the rubberized-UHPC after heat treatment.

1.2 Problem Statement

In the making of UHPC, silica fume, quartz flour, fine silica sand, high-range water reducer is needed as raw material. Unfortunately, quartz material is expensive compared to another material. In order to reduce the cost for making the UHPC, they came out with another idea which is to replace quartz with sand. Unfortunately, sand is natural material that can be find in earth through sand mining. Through a year, the amount of sand is decrease because of sand mining activity. All construction project needs sand as raw material to do the project. Beside, sand also mined from beaches and river. This could give impact to environment. Then for this study, the waste material is added to the concrete to minimize the usage of sand. In this study, the waste rubber is used as sand replacement to reduce the cost of sand and to save the environment. There are two type of waste rubber used in this study which is Waste Rubber Chip (WRC) and Waste Rubber Powder (WRP).

1.3 Objective of Study

i. To determine the compressive strength of rubberized-UHPC at different elevated temperatures

ii. To determine the effect of using different levels of waste rubber chipped replacement in the rubberized-UHPC with respect to different elevated temperature

iii. To determine the optimum levels replacement of waste rubber chipped as sand replacement in rubberized-UHPC

1.4 Scope of Study

This study concentrated on investigation of the effect of high temperature on rubberized-UHPC subjected to compressive strength with different percentage of combination with ratio 50:50 waste rubber crumb (WRC) and waste rubber powder (WRP) respectively. The size of WRC and WRP is 2.65 mm and 600 μm respectively. The levels of percentage replacement of waste rubber used is 0%, 5%, 10%, 15% from weight of sand.

The mix design with water cement ratio (w/c) of 0.2 is constant for all mixes. The amount of superplasticizer used is constant at 3% from weight of cement. Silica fume used is 10% from weight of cement.

The hardened rubberized-UHPC was taken out from the mould after 24 hours casting The specimen was cured at age 7, 14, and 28 days. There is three (3) different elevated temperature consist of 100 ^{O}C, 180 ^{O}C, 260 ^{O}C temperature for two hours for every percentage of rubberized-UHPC before the specimens was subjected to compressive strength test. For compressive strength test, rubberized-UHPC with 100 mm × 100 mm × 100 mm in size were conducted The weight loss before and after the heat treatment was taken.

REFERENCES

Abdullah Huzeyfe Akca, Nilüfer Özyurt Zihniog˘lu, High performance concrete under elevated temperatures, Construction and Building Materials 44 (2013) 317–328

H.J. Yim, S.J. Park, J.H. Kim, H.G. Kwak, Nonlinear ultrasonic method to evaluate residual mechanical properties of thermally damaged concrete, ACI Mater. J. 11 (2014) 399-409.

J. Lv, T. Zhou, Q. Du, and H. Wu, "Effects of rubber particles on mechanical properties of lightweight aggregate concrete," Construction and Building Materials, vol. 91, pp. 145–149, 2015.

Kashani A., Ngo T.D., Mendis P., Black J.R., Hajimohammadi A, A sustainable application of recycled tire crumbs as insulator in lightweight cellular concrete, Journal of Cleaner Production,149, (2017) 925–935

Khalid B. Najim, Matthew R. Hall, Mechanical and dynamic properties of self-compacting crumb rubber modified concrete, Construction and Building Materials,27 (2012) 521-530

Layachi Guelmine, Hadda Hadjab , Amar Benazzouk, Effect of elevated temperatures on physical and mechanical properties of recycled rubber mortar, Construction and Building Materials, Volume 126, 15 November 2016, Pages 77–85

M. Arafa, S. Shihada and M. Karmout, 2010. Mechanical Properties of Ultra High Performance Concrete Produced in the Gaza Strip, Asian Journal of Materials Science, 2: 1-12.

Magda I. Mousa, Effect of elevated temperature on the properties of silica fume and recycled rubber-filled high strength concretes (RHSC), HBRC Journal, Volume 13, Issue 1, April 2017,1–7

Mo Alkaysi, Sherif El-Tawil, Zhichao Liu, Will Hansen, Effects of silica powder and cement type on durability of ultra high performance concrete (UHPC), Cement and Concrete Composites.(2015) 47-56

Mohammed Islamuddin Faraz, Utkarsh Jain, Ketan Jain, Shailendra Singh, Effect of Crumb Rubber Material on Concrete Mix, SSRG International Journal of Civil Engineering (SSRG-IJCE) – volume 2,(2015)

Nathan M. Miller, Fariborz M. Tehrani, Mechanical properties of rubberized lightweight aggregate concrete, Construction and Building Materials, Volume 147, 30 August 2017, Pages 264–271

Nelson Flores Medina, Darío Flores Medina, F. Hernández-Olivares, M.A. Navacerrada, Mechanical and thermal properties of concrete incorporating rubber and fibres from tyre recycling, Construction and Building Materials, Volume 144, 30 July 2017, Pages 563–573

S. Abbas, M. L. Nehdi and M. A. Saleem, Ultra-High Performance Concrete Mechanical Performance,Durability, Sustainability and Implementation Challenges, International Journal of Concrete Structures and Materials, Vol.10, No.3, (2016) 271–295

Samar Raffoul , Reyes Garcia, David Escolano-Margarit, Maurizio Guadagnini, Iman Hajirasouliha, Kypros Pilakoutas, Behaviour of unconfined and FRP-confined rubberised concrete in axial compression, Construction and Building Materials, Volume 147, 30 August 2017, Pages 388–397

Shi, C., Wu, Z., Xiao, J., Wang, D., Huang, Z., & Fang, Z., A review on ultra high performance concrete: Part 1. Raw materials and mixture design. Construction and Building Materials, 101, (2015). 741–751.

Trilok Gupta, Salman Siddique, Ravi K. Sharma, Sandeep Chaudhary, Effect of elevated temperature and cooling regimes on mechanical and durability properties of concrete containing waste rubber fiber, Construction and Building Materials, Volume 137, 15 April 2017, Pages 35–45

Y.B. Ahn, J.G. Jang, H.K. Lee, Mechanical properties of lightweight concrete made with coal ashes after exposure to elevated temperatures, Cement and Concrete Composites 72 (2016) 27-38

Yong-chang Guoa, Jian-hong Zhanga, Guang-ming Chena, Zhi-hong Xieb, Compressive behaviour of concrete structures incorporating recycled concrete aggregates, rubber crumb and reinforced with steel fibre, subjected to elevated temperatures, Journal of Cleaner Production, Volume 72,(2014) 193–203