THE EFFECT OF VARIOUS POSITION OF SQUARE HOLLOW SECTION ON THE STRENGTH OF FOAMED CONCRETE BEAM WITH PROCESSED SPENT BLEACHING EARTH AS PARTIAL REPLACEMENT OF CEMENT

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

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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.

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ABSTRAK

Konkrit mempunyai ciri kekuatan tinggi, keplastikan yang baik, modulus keanjalan yang tinggi dan kebolehkerjaan di dunia. Tetapi pengeluaran simen akan menggunakan sekitar 12% hingga 15% daripada jumlah tenaga perindustrian, oleh itu ia menjadi penyumbang CO_2 kedua terbesar di dunia. Spent Bleaching Earth (SBE) adalah sisa pepejal yang berasal dari proses penapisan minyak yang boleh dimakan yang dapat menjana banyak sisa kerana proses penapisan minyak masak mentah. Komponen utama Spent Bleaching Earth adalah silikon dioksida yang sekitar 57% atau lebih bergantung pada jenisnya. Selain itu, ia adalah serbuk yang sangat halus. Objektif kajian ini adalah untuk menentukan beban maksimum lenturan lentur dengan menggunakan ujian lenturan empat titik, untuk menentukan pesongan rasuk dan juga untuk menentukan mod kegagalan rasuk lenturan. Dalam kajian ini, tiga kedudukan rasuk berongga (150x200x 1500mm) yang dihasilkan dengan konkrit 1600kg / m^3 foamed dengan 30% PSBE dan semua rasuk telah mengalami pengawetan air selama 28 hari. Juga, semua rasuk akan digunakan untuk menentukan beban maksimum, pesongan dan mod kegagalan oleh ujian lenturan 4-mata. Hasil menunjukkan bahawa beban muktamad berkurangan apabila kedalaman kedudukan berongga meningkat (peratusan kekuatan yang hilang untuk setiap rasuk adalah 12.7%, 35.4% dan 37.3% untuk Beam 2, Beam 3 dan Beam 4). Di samping itu, peningkatan kedalaman bahagian berongga (dekat dengan paksi neutral), pesongan meningkat. Ini bermakna kekuatan lenturan sampel bergantung pada jarak ke paksi neutral rasuk. Beban maksimum dan lenturan kekuatan rasuk dengan bahagian berongga persegi pada paksi neutral adalah 3.937kN dan 0.787N / mm^2 yang lebih tinggi daripada rasuk berongga lain. Kesimpulan, rasuk dengan bahagian berongga yang terletak pada paksi neutral adalah rasuk terbaik untuk pembangunan masa depan kerana ia mencapai beban yang lebih tinggi dan pesongan selepas bahagian bahan yang digunakan menurun. Dalam cadangan, beban maksimum dan pesongan rasuk akan meningkat dengan menambah tetulang dan mutu kerja harus diseragamkan untuk memastikan keseragaman rasuk pemadatan.

ABSTRACT

Concrete have the characteristic of high strength, well plasticity, high elasticity modulus and workability in the world. But production of cement will consumes around 12% to 15% of the total industrial energy, therefore it becomes the second largest CO_2 contributor in the world. Spent Bleaching Earth (SBE) is a solid waste that originating from edible oil refinery process which can generates high quantities of waste due to refining process of crude edible oil. The main component of Spent Bleaching Earth is silicon dioxide which around 57% or more depending to the type. Also, it is a very fine powder. The objective of this study is to determine the maximum load of the flexural beam by using 4-point bending test, to determine the deflection of beams and also to determine the mode of failure of the flexural beam. In this study, three different position of hollow beam (150x 200x 1500mm) which produced with 1600kg/m^3 foamed concrete with 30% PSBE and all the beams were subjected to water curing for 28 days. Also, all the beams will use to determine the maximum load, deflection and the mode of failure by 4-point bending test. Results exhibit that the ultimate load decreased as the depth of hollow position increased (the percentage of strength lost for each beam were 12.7%, 35.4% and 37.3% for Beam 2, Beam 3, and Beam 4 respectively). Also, the increases of the depth of hollow section (close to neutral axis), the deflection is increases. It means that the flexural strength of the samples depends on the distance to the neutral axis of the beams. The maximum load and flexural strength of the beams with square hollow section at the neutral axis were 3.937kN and 0.787N/mm^2 which was higher than other hollow beams. In conclusion, the beams with square hollow section located at the neutral axis is the best beams for the future work development because it achieved higher loading and deflection after the portion of materials used decreased. In recommendation, the maximum loading and deflection of the beams will increase by added the reinforcement and the workmanship should be standardized to ensure the uniformity of beam compaction.

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LIST OF SYMBOLS

δ	Deflection
σ	Flexural Strength
%	Percentage

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
BS	British Standard
$Ca(OH)_2$	Calcium Hydroxide
CIDB	Construction Industry Development Board
CO_2	Carbon Dioxide
C_2S	Dicalcium Silicate
C_3A	Tricalcium Aluminate
C_3S	Tricalcium Silicate
C_4AH	Tetracalcium Alumino Ferite
C-S-H	Calcium Silica Hydrate
DAQ	Data acquisition
FPB	Four point bending
OPC	Ordinary Portland Cement
LVDT	linear variable displacement transducer
PSBE	Processed Spent Bleaching Earth
RC	Reinforced Concrete
SBE	Spent Bleaching Earth

CHAPTER 1

INTRODUCTION

1.1 Background of Study

As the most easily consumed building materials, concrete have the characteristic of high strength, well plasticity, high elasticity modulus and workability in the world. For the modern civil engineering structures, the orientation is high-rise, long design lifetime and high strength, which consist higher performance or requirements on concrete. (Peng Zhang a,⇑, Jinyi Wana, Kejin Wangb, Qingfu Li a 2017). But production of cement will consumes around 12% to 15% of the total industrial energy, therefore it becomes the second largest CO_2 contributor in the world. (M.B. Ali a, R. Saidur a,b,∗, M.S. Hossainb2011).

Besides that, the cost of raw materials increase gradually so that utilisation of industrial wastes in concrete can makes it cheaper and reuse of wastes is more environmental friendly. Also, it supposed as the good ecological option for solving the issue of waste disposal. (Bahoria et al., 2013). Spent Bleaching Earth (SBE) is a solid waste that originating from edible oil refinery process which can generates high quantities of waste due to refining process of crude edible oil. (Soh Kheang Loha,∗, Stephen James b, Muzzamil Ngatimana, Kah Yein Cheonga,c, Yuen May Chooa, Weng Soon Lima 2013). The main component of Spent Bleaching Earth is silicon dioxide which around 57% or more depending to the type. Also, it is a very fine powder. (Soh Kheang Loha,∗, Stephen Jamesb, Muzzamil Ngatimana, Kah Yein Cheonga,c,Yuen May Chooa, Weng Soon Lima 2013). The Nano silica can be accelerate the speed of hydration process and it can also reach with calcium hydroxide to produces more Calcium-Silicate-Hydrates gel (pozzolanic reaction) which can improving the durability and workability of the concrete. Also, the concrete will compact microstructure with lesser quantity of the calcium hydroxide crystals and in denser. (A.M. Said, M.S. Zeidan, M.T. Bassuoni, Y.

Tian,2012). If the Nano silica is added to the concrete, it is found that the pozzolanic reactivity is up to 3%. (Tao Ji *2005)

Moreover, foamed concrete is more attractive for many construction application because of light weight (800 to 1600 kg/m^3), high workability (flowing and self-compacting) and excellent thermal insulating properties (< 0·50 W/mK) (M. R. Jones*, and A. McCarthy* 2005). Therefore, protein foaming agent was used to produce foamed concrete and hollow beam will be fabricated to reduce the weight of the beam and the materials used in the concrete. The advantages of Reinforced concrete (RC) hollow section piers is the larger moment of inertia than solid sections with the similar area, savings of equipment and materials during construction, reduced inertia masses and reduced problem that will occur due to hydration of massive concrete. (Paolino Cassese ⇑, Paolo Ricci, Gerardo M. Verderame 2016). Thus, this study is to investigate the effect of various position of square hollow section on the strength of foamed concrete beam with processed spent bleaching earth (PSBE) as partial replacement of cement.

1.2 Problem Statement

As mentioned above the production of cement will bring negative impact to the environment so that the concrete manufacturers are focusing on reducing the use of Ordinary Portland Cement (OPC) due to the estimation of emit 0.8-0.9 ton of Carbon Dioxide (CO2) per ton of cement (Yang, Lee, Song, & Gong, 2014). The waste materials that choose to replace the cement content is Spent Bleaching Earth (SBE). It is a waste that hard to manage due to the large quantity produce, the nature of itself and the lack of way to recover it. (Krzyśko-Łupicka, Cybulska, Wieczorek, Możdżer, & Nowak, 2014). Besides that, the main component of Spent Bleaching Earth is silicon dioxide which around 57% or more depending to the type. Also, it is a very fine powder which it can be react more with the calcium dioxide to produce more C-S-H gel and directly improve the durability and workability of concrete. (Soh Kheang Loha,∗, Stephen Jamesb, Muzzamil Ngatimana, Kah Yein Cheonga,c,Yuen May Chooa, Weng Soon Lima 2013). After that, Lightweight concrete is about 28% lighter than ordinary concrete and the dead load is equal 8 to the live load in a design, it can save up to 14% in the energy intensive steel reinforcement. Also, the increased thermal resistance of lightweight concrete which is normally six times that of normal weight concrete in the energy savings result .(T. W. Bremner, Ph.D., P.Eng 2001) So that, to produce the lightweight concrete, we need to reduce the cement used by PSBE and produce the hollow section of beam.

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