



UNIVERSITI PUTRA MALAYSIA

***PROPERTIES OF RESIDUAL SOIL TREATED
WITH SILICON DIOXIDE AND CEMENT***

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**PROPERTIES OF RESIDUAL SOIL TREATED WITH SILICON DIOXIDE
AND CEMENT**

By

SAYED HESSAM BAHMANI

**Thesis Submitted to the School of Graduate Studies,
Universiti Putra Malaysia, in Fulfilment of the
Requirements for the Degree of Master of Science**

December 2013

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Degree of Master of Science

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December 2013

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Faculty: Engineering

The present study addresses the effect of nano particles on engineering properties of residual soil from Malaysia. This study looks at the innovative work being done by nanotechnology and Nano-materials. Nanoparticles are particles whose dimensions can range between 1 to 100 nm. Due to their extremely small size in nano-scale (10^{-9} m) and ultra-high surface area, some nano particles show unique properties that can help to improve physical and mechanical properties of the materials. The residual soil is classified as a soil that is the in-situ weathered remnants of a pre-existing parent rock; the parent rock can be sedimentary, igneous or metamorphic, accordingly the term 'residual soil' covers a broad range of materials and possible engineering behaviour.

The study was conducted to investigate the effect of nano particles (SiO_2) with two different sizes 15 and 80 nm that mixed with water and after that add to residual soil treated by cement with different ratios. The investigation includes the evaluation of soil properties such as consistency, compaction, shear strength and hydraulic conductivity properties. Results of Atterberg limit tests showed that the plasticity index increased initially, but decreased at lesser percentage of additives. The addition of nano particles and Portland cement is found to increase the optimum water content but to decrease the maximum dry density weight of the mix soils. Their addition also resulted in significant improvement in unconfined compressive strength and modulus of elasticity after 7 and 28 days curing time. From the viewpoint of plasticity, compaction and strength characteristics, and economy, addition of 0.2 - 0.4% nano particles are recommended as useful amounts. The hydration products were determined by X-Ray diffraction (XRD), Scanning Electron Microscopy (SEM); moreover, the synthesized gels were exposed to different amounts of nano particles to determine their chemical stability and subsequently characterized by Fourier Transform IR Spectroscopy (FTIR). Their addition also resulted in significant improvement in unconfined compressive strength. The results showed that the addition of different amount of nano particles leads to C-S-H gel modification even in the very short term.

Abstrak tesis ini dikemukakan kepada Senat Universiti Putra Malaysia untuk memenuhi keperluan untule Ijazah Master Sains

SIFAT TANAH RESIDUAL YANG DIRAWAT DENGAN SILIKON DIOKSIDA DAN SIMEN

Oleh

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Kajian ini mengenalpasti kesan zarah nano terhadap ciri tanah baki di Malaysia. Kajian ini mengkaji langkah-langkah inovatif dilakukan oleh teknologi nano dan bahan nano. Zarah nano adalah zarah yang mempunyai dimensi antara 1 hingga 100nm. Oleh sebab saiz zarah nano yang terlalu kecil (10^{-9} m) dan luas permukaan yang terlalu tinggi, sesetengah zarah nano mempunyai ciri-ciri unik yang boleh meningkatkan ciri fizikal dan mekanikal bahan. Tanah baki dikategorikan sebagai tanah baki hasil rempuhan batu induk secara in-situ, batu induk sama ada batu endapan, igneus atau metomorf.

Kajian ini dijalankan untuk mengkaji kesan zarah nano (SiO_2) dengan dua saiz yang berbeza, 15 dan 80nm yang dicampur dengan air dan ditambahkan tanah baki yang telah dirawat dengan simen dengan pelbagai kadar. Kajian meliputi penilaian ciri-ciri tanah seperti konsistensi, kepadatan, kekuatan ricih dan konduksi hidraulik. Hasil daripada ujian Had Atterberg menunjukkan indeks plastik meningkat pada awalnya tetapi menurun apabila peratusan penambah dikurangkan. Penambahan zarah nano dan simen Portland menyebabkan peningkatan kandungan air optimum tetapi menunjukkan penurunan berat ketumpatan kering tanah campur. Penambahan juga hasil yang signifikan bagi unconfined kekuatan mampatan tidak terkumag dan elastik modulus selepas 7 dan 28 hari pengawetan. Dari segi keplastikan, kemampatan, dan kekuatan dan ekonomi, penambahan sebanyak 0.2-0.4% zarah nano adalah disarankan sebagai satu kuantiti yang berkesan.

Penghidratan produk ditentukan dengan X-Ray (XRD), Scanning Elctron Microscopy (SEM); tambahan, gel sintesis didedahkan kepada pelbagai kuantiti zarah nano untuk menentukan kestabilan kimikal dan seterusnya dikategorikan dengan Fourier Transform IR Spectroscopy (FTIR). Penambahan tersebut juga menunjukkan perubahan signifikan terhadap kekuatan mampatan tidak terkurung. Hasil kajian menunjukkan bahawa penambahan zarah nano dalam pelbagai kuantiti mengalakkan modifikasi gel C-S-H dalam masa singkat.

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I certify that a Thesis Examination Committee has met on date of viva voice to conduct the final examination of Sayed Hessem Bahmani on his thesis entitled “Effect of nano particles on properties of residual soil treated by cement” in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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DECLARATION

Declaration by graduate student

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