

**STRUCTURAL BEHAVIOR OF FERROCEMENT-AUTOCLAVE BLOCK  
COMPOSITE SLAB**

**By**

**SALEH YHYA LASEIMA**

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

**December 2006**

**Dedicated To My Parents and My Wife**

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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**Chairman: Associate Professor Waleed A. Malik Thanoon, PhD**

**Faculty: Engineering**

Recently, different types of composite floor slabs have been developed and used in the construction industry worldwide. These floor slabs are developed to cater for the shortcomings that are observed in the existing floor slabs. Some of these shortcomings are: long construction time, heavy weight and, bad thermal and sound barrier. All these shortcomings are dependant on the heavy equipment on job site and on formwork and the jointing problems.

Ferrocement-Brick composite slab is one of the recent developments in composite slab systems. The composite is a semi-precast floor slab system which consists of an inverted ribbed ferrocement layer interlocked with bricks used in situ concrete ribs. Aerated autoclaved concrete (AAC) blocks are used, instead of bricks, in a ferrocement-brick composite. The blocks provides a very light weight material ( $\gamma=6$  kN/m<sup>3</sup>), effective thermal insulation and sound barrier compared to normal bricks. Using the aerated autoclaved concrete block will lead to 30% reduction in the weight of the slab compared to the reinforced concrete slab.

This study aims at investigating the structural behaviour of ferrocement-AAC block composite floor slab under flexural loading focusing on the effect of different AAC block layouts in the composite slab on the structural performance of the composite slab. Nine full-scale ferrocement-block composite slabs of different block layouts are cast and tested experimentally under two-point loads. In addition, three ferrocement layers are tested to identify their capabilities to carry the construction loads. The structural performance of the composite slabs is investigated in terms of their deformation and ductility characteristics, cracking characteristics, strain distribution and failure mechanism.

The AAC block layouts play a significant role in the structural behaviour of the ferrocement-AAC block composite slab. It is also concluded that the interlocking mechanism is capable of connecting the two layers and the slab behaved as a full composite slab. The system can sustain the required design load for the residential building.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah Master Sains

**KELAKUAN STRUKTUR PAPAK KOMPOSIT BONGKAH AUTOKLAF-  
SIMENFERO**

Oleh

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Pelbagai jenis lantai papak komposit diperkenalkan dan digunakan dalam industri pembinaan di seluruh dunia pada hari ini. Ia dibangunkan bagi mengatasi kelemahan-kelemahan yang terdapat pada lantai konkrit. Antara kelemahan-kelemahannya adalah: masa pembinaan yang panjang, berat yang berlebihan, penghalang kesan thermal dan bunyi yang lemah, dan bergantung kepada jentera berat dan acuan serta masalah penyambungan.

Salah satu penemuan terbaru dalam sistem papak-papak komposit ialah papak komposit bata simenfero. Ia merupakan satu sistem papak lantai pra-tuang yang terdiri daripada lapisan tetulang simenfero terbalik yang terkunci dengan bata di dalam tetulang konkrit.

Di dalam komposit bata simenfero, bongkah AAC (aerated autoclaved concrete) digunakan bagi menggantikan bata biasa. AAC terdiri daripada bahan yang ringan ( $\gamma = 6 \text{ kN/m}^3$ ) dan mempunyai kelebihan dari segi kesan penebatan haba dan bunyi berbanding bata biasa. Penggunaan bongkah AAC dapat mengurangkan berat papak sehingga 30 % berbanding dengan papak konkrit bertetulang.

Kajian ini dijalankan bertujuan untuk menyiasat tindak balas struktur bongkah lantai papak komposit AAC-simenfero dibawah bebanan lenturan, dengan fokus diberikan kepada kesan susunan bongkah AAC yang berbeza. Sembilan bongkah papak komposit simenfero berskala penuh telah melalui ujian beban dua titik. Tiga lapisan simenfero juga telah disediakan dan diuji untuk mengenal pasti kebolehannya dalam menampung beban pembinaan. Prestasi struktur papak komposit diselidik berdasarkan ciri-ciri ubahbentuk (deformasi) dan kemuluran, keretakan, pengagihahan dan mekanisma kegagalan.

Susunan bongkah AAC memainkan peranan yang penting dalam kelakuan struktur papak komposit bongkah autoklaf-simenfero. Kajian ini juga menunjukkan bahawa mekanisma memanca dapat menyambung antara dua lapisan dan ianya juga menunjukkan tindak-balas sebagai satu papak komposit. Sistem ini dapat menampung beban rekabentuk yang diperlukan untuk bangunan perumahan.

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I certify that an Examination Committee has met on 27<sup>th</sup> December 2006 to conduct the final examination of Saleh Yhya Laseima on his Master of Science thesis entitled "Structural Behavior of Ferrocement-Autoclave Block Composite Slab" in accordance with Universiti Pertanian Malaysia (Higher degree) Act 1980 and Universiti Pertanian Malaysia (Higher degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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## **DECLARATION**

I hereby declare that the 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 UPM or other institution.

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**SALEH YHYA LASEIMA**

Date: 31 JUNARY 2007

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## LIST OF ABBREVIATIONS

AAC	Aerated autoclaved concrete
L	Length of slab
B	Width of slab
$b_{r1}$	Width of longitudinal ribs
$b_{r2}$	Width of longitudinal ribs
$d_r$	Depth of longitudinal ribs
$d_f$	Depth of ferrocement layer
$b_v$	Total width of longitudinal ribs
$b_{aac}$	Total width of AAC
$L_{\text{effective}}$	Effective length of slab
d	Effective depth of longitudinal ribs
$A_c$	Area of slab
$A_{sb}$	Total area of steel bars
$A_{sw}$	Total area of steel wire mesh
$A_{st}$	Total steel area (steel bar + wire mesh)
$A_{\text{req}}$	Required area of steel
$f_{\text{cu(Concrete)}}$	Characteristic strength of concrete
$f_{\text{cu(aac)}}$	Characteristic strength of AAC
$f_{yb}$	Yield strength of steel bar
$f_{yw}$	Yield strength of steel wire mesh
$U_c$	Unit weight of concrete
$U_{aac}$	Unit weight of AAC
$E_s$	Modulus of elasticity for steel

$V_r$	Volume of ribs
$V_w$	Volume of wing
$V_f$	Volume of ferrocement layer
$V_p$	Volume of precast layer
$V_i$	Volume of cast insitu topping
$V_{aac}$	Volume of AAC
$W_p$	Load of precast layer
$W_i$	Load of cast insitu topping
$W_{aac}$	Load of AAC
$W_D$	Total dead load
$W_V$	Imposed load
$W_T$	Design load
$W_u$	Ultimate load
$M_u$	Ultimate moment
$M.f$	Modification factor for tension reinforcement
$S$	Maximum shear force
$S_s$	Shear stress
$S_d$	Design shear
$C_{AAC}$	Compressive force of AAC
$C_{Concrete}$	Compressive force of concrete
$T_b$	Tensile force of steel bar
$T_w$	Tensile force of wire mesh
$x$	Neutral axis
$Y$	Specimen centroid
$I$	Moment of inertia

$M_{cr}$	Crack moment
$W_{cr}$	Crack load
$k(\mu)$	Thermal conductivity