STUDIES ON PRECAST REINFORCED CONCRETE FLOOR PANELS USING OIL PALM SHELL AGGREGATE

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SCHOOL OF ENGINEERING AND INFORMATION TECHNOLOGY
UNIVERSITI MALAYSIA SABAH
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VIVA DATE	:	**27 JULY 2010**

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1. SUPERVISOR
Assoc. Prof. Dr. Md. Abdul Mannan *Signature*

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I hereby declare that the material in this thesis is my own except for quotations, excerpts, equations, summaries and references, which have been duly acknowledged.

24 August 2010

Ng Chee Hiong
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SYNOPSIS

Kajian telah dijalankan ke atas panel lantai konkrit bertetulang pratuang dengan menggunakan konkrit ringan. Bancuhan konkrit ringan ini telah dihasilkan dengan 70% tempurung kelapa sawit (OPS) dan 30% batu granit sebagai agregat kasar. Sejumlah 50 panel-panel lantai pratuang prototaip jenis pratuang separuh, pratuang sepenuh dan C-channel telah dihasilkan. C-channel yang mempunyai seksyen yang lebih kecil dan berat diri yang lebih kurang telah menunjukkan prestasi struktur yang terbaik. Kajian secara extensif telah dijalankan ke atas C-channel dengan rentang-rentang 3, 4, 5, 6, 7 dan 8 m. Kajian ini telah memberikan satu pengetahuan kritikal terhadap sifat-sifat C-channel dan dengan demikian, mengesahkan bahawa C-channel sebagai panel konkrit bertetulang pratuang adalah alternatif yang lebih berkesan secara struktur, lebih dijaminkan dan praktikal berbanding kepada sistem lantai konvensional.

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To God be all the glory!

Ng Chee Hiong
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ABSTRACT

STUDIES ON PRECAST REINFORCED CONCETE FLOOR PANELS USING OIL PALM SHELL AGGREGATE

Experimental studies were performed on precast reinforced concrete floor panels using lightweight concrete. The mix design of lightweight concrete was developed using 70% Oil Palm Shell (OPS) and 30% granite as coarse aggregates. Its basic engineering properties using standard specimens were studied under water and steam curing conditions. A total of 50 prototype precast floor panels of solid section, semi-precast and C-channels were made. At initial stage, they were investigated using 3 m spans only. C-channel having smaller cross-section and reduced self-weight showed the best structural performance. Further extensive investigations were made using C-channels of 3, 4, 5, 6, 7 and 8 m spans. Two-line loads and uniform distributed load were applied for tests at ultimate failure and serviceability conditions. The flexural properties determined were (i) service load and moment capacity, (ii) deflection, (iii) crack width, (iv) ductility, (v) strains in concrete and steel, and (vi) end rotation. The deflection recovery and the flange load capacity of C-channels were studied. The lifting hooks, bearing width and the monolithic behaviour at panel joints using pull-down mechanism were also investigated. The experimental investigations were verified with British Standards (BS 8110), Eurocode (EC2), American Standard (ACI 318) and Indian Standard (IS). The experimental results obtained for C-channel have fulfilled the requirements as stipulated in the above standards. The study has provided the critical understanding on the behaviour of C-channel, thereby confirming that C-channel being fully precast reinforced concrete panel is structurally more efficient, promising and viable alternative to the conventional floor system.

ABSTRAK

Kajian eskperimen telah dijalankan ke atas panel lantai konkrit bertetulang pratuang dengan menggunakan konkrit ringan. Bancuhan konkrit ringan ini telah dihasilkan dengan 70% tempurung kelapa sawit (OPS) dan 30% batu granit sebagai agregat kasar. Sifat-sifat kejuruteraan asas berdasarkan sampel-sampel piawaian telah dikaji di bawah keadaan-keadaan pengawetan air dan stim. Sejumlah 50 panel-panel lantai pratuang prototaip jenis pratuang separuh, pratuang sepenuh dan C-channel telah dihasilkan. Pada peringkat awal, panel-panel tersebut telah disiasat dengan menggunakan rentang 3 m sahaja. C-channel yang mempunyai seksyen yang lebih kecil dan berat diri yang lebih kurang telah menunjukkan prestasi struktur yang terbaik. Kajian secara extensif telah dilakukan dengan mengunakan C-channel dengan rentang-rentang 3, 4, 5, 6, 7 dan 8 m. Beban dua garis dan beban taburan seragam telah dikenakan untuk ujian-ujian pada kegagalan muktamad and keadaan servis. Sifat-sifat lentur yang ditentukan termasuklah (i) kapasiti beban servis dan momen, (ii) pesongan, (iii) kelebaran keretakan, (iv) kemuluran, (v) terikan konkrit dan besi, dan (vi) peputaran hujung. Pemulihan pesongan dan kapasiti beban papak C-channel telah dikaji. Penyangkuk-penyangkuk, lebar bearing, dan sifat monolithic di sambungan panel dengan menggunakan mekanisma pull-down juga telah disiasat. Penyiasatan eskperimen telah disahkan berdasarkan Piawaian British (BS 8110), Kod Euro (EC), Piawaian Amerika (ACI 318) dan Piawaian Indian (IS). Keputusan eskperimen yang diperolehi dari kajian ini ke atas C-channel telah memenuhi syarat-syarat sepertimana yang dinyatakan dalam Piawaian-Piawaian tersebut. Kajian ini telah memberikan satu pengetahuan kritikal terhadap sifat-sifat C-channel dan dengan demikian, mengesahkan bahawa C-channel sebagai panel konkrit bertetulang pratuang adalah alternatif yang lebih berkesan secara struktur, lebih dijaminkan dan praktikal berbanding kepada sistem lantai konvensional.

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LIST OF ABBREVIATIONS

AAC	Autoclaved Aerated concrete
ACV	Aggregate crushing value
AIV	Aggregate impact value
CIDB	Construction Industry Development Board
ESCSI	Expanded Shale, Clay & Slate Institute
FFB	Fresh Fruit Bunch
IBS	Industrialized Building System
LVDT	Linear Variable Displacement Transducer
LWC	Lightweight concrete
LWCs	Lightweight concretes
NWC	Normal weight concrete
OPS	Oil Palm Shell
PVA	Polyvinyl (alcohol)
RCPT	Rapid chloride penetrability test
SSD	Saturated surface dry
TLL	Two-line loading
UDL	Uniformly distributed loading
VPVs	Volume of permeable voids

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LIST OF SYMBOLS

A	Area of contact between the mould and the precast unit being lifted
b	Panel width
D	Total panel depth or total rib depth
d	Effective depth
E	Modulus of elasticity of concrete (kN/mm^2)
$E_c(t_0)$	Modulus of elasticity at the age of loading, t_0, which is related to the compressive cube strength, $f_{cu}(t_0)$
E_{sq}	Plan and elevation end squareness
F	Force per anchor
f	Method of craning
f_r	Modulus of rupture of concrete (MPa)
f_s/f_y	Steel stress ratio
f_y	Yield stress of steel (MPa)
f'_c	28-day compressive strength of the concrete (MPa)
G	Deadweight of the precast unit
h	Flange thickness
H_a	Adhesion to the formwork
I	Second moment of inertia of section (mm^4)
I_g	Second moment of inertia of gross area ignoring reinforcement (mm^4)
l	Effective span
l_b	Bearing length
l_w	Bearing width
L	Total panel span