

**FINITE ELEMENT PROGRAMME DEVELOPMENT FOR THE ANALYSIS
OF PRECAST FLOORING AND ROOFING SYSTEM**

By

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**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
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Faculty : Engineering

At the initial stage of this study an attempt was made to write a computer programme for the analysis and design of precast floor slabs on the FORTRAN language, which is compatible with FORTRAN 90 Power Station. The programme considers various types of precast reinforced concrete slabs such as solid slab (one-way and two-way), hollow core slab, ribbed slab and composite slab. The programme consists of a main and several subroutines. The programme was written according to BS 8110 and was verified by using it to analyse a few examples. The software is capable of analysing and designing different floor slabs with a provision for generating the optimal cross-section and plotting the cross section graphically. Further, the effect of different design parameters on the solid slab, hollow slab and ribbed slab design had been presented.

One of the main objectives of this study was the development of a finite element code using the semi-loof beam and shell elements. The application of these elements to model the precast flooring and roofing system was illustrated. The validity of the developed programme was established by analysing some benchmark problems and

comparing the results with those from a commercial package. The results indicate that the use of the semi-loof elements resulted in a powerful programme, which is suitable for the analysis of complex shell type structures.

Another primary objective of this investigation was the analysis of a composite slab, which consisted of precast and insitu layers. There was a need to model two different materials along with their interface characteristic. An interface element sandwiched between two 16-noded isoparametric brick element has been formulated. This interface element was used in an existing three dimensional finite element package. The behaviour of the composite slab under load with respect to displacements, stresses and strains was studied. It was found that it was important to model frictional behaviour between the two different materials as in composite slabs.

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

**PEMBANGUNAN PROGRAM KAEDAH UNSUR TERHINGGA UNTUK
ANALISIS SISTEM LANTAI DAN BUMBUNG PASANG SIAP**

Oleh

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Pada peringkat awal kajian ini, satu percubaan dilakukan untuk menulis satu aturcara komputer untuk analisis dan rekabentuk papak pasang siap dengan menggunakan pengaturcaraan FORTRAN yang sepadan dengan FORTRAN 90 Power Station. Perisian komputer yang dihasilkan merangkumi berbagai jenis papak tetulang konkrit pasang siap seperti papak pejal (sehalu and dua-halu), papak teras berongga, papak rusuk dan papak komposit. Program ini terdiri daripada satu bahagian utama dan beberapa subrutin. Perisian komputer ini ditulis berdasarkan BS 8110 dan kejituannya ditentukan dengan menggunakannya untuk menyelesaikan beberapa masalah. Perisian komputer ini berupaya untuk menganalisa dan merekabentuk berbagai jenis papak lantai dengan kebolehan menghasilkan keratan optima dan memplotkan keratan tersebut secara grafik. Selanjutnya, kesan daripada pelbagai parameter rekabentuk keatas papak pejal, papak teras berongga dan papak rusuk telah dipersembahkan.

Salah satu objektif utama kajian ini ialah penghasilan kod komputer unsur terhingga menggunakan unsur-unsur semi-loof beam dan semi-loof. Aplikasi unsur-unsur ini

dalam model rantai dan bumbung pasang siap telah dipamerkan. Kejituan perisian komputer yang dihasilkan ini telah diuji dengan membandingkan keputusan kajian ini dengan analisis yang dilakukan oleh penyelidik terdahulu dan juga perbandingan dengan satu pakej komersial. Hasil perbandingan menunjukkan bahawa unsur semi-loof menghasilkan program yang berkebolehan dan sesuai digunakan untuk analisis struktur cangkerang yang kompleks.

Objektif lain kajian ini adalah mengenai analisis papak komposit yang terdiri daripada dua lapisan iaitu lapisan pasang siap dan lapisan siap di tapak. Maka, terdapat keperluan untuk model dua lapisan yang berlainan bahan ini bersama dengan ciri-ciri permukaan sambungannya. Satu unsur antara muka diantara dua unsur 16-nod isoparametrik telah diformulasikan. Unsur antara muka ini telah diimplimentasi dalam satu pakej tiga dimensi unsur terhingga yang sedia ada. Kelakuan papak komposit iaitu pesongan, terikan dan tegasan telah dikaji. Kajian mendapati kelakuan geseran antara dua bahan seperti yang terdapat pada papak komposit perlu diberi perhatian.

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I certify that an Examination Committee met on 2nd September 2004 to conduct the final examination of Wong Jern Nee on her Master of Science thesis entitled “Analysis of Precast Flooring/Roofing System Using Finite Element Method” 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 institutions.

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