

**FINITE ELEMENT ANALYSIS OF COOLING TOWER FOUNDATION
UNDER WIND LOAD**

By

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

April 2006

Specially Dedicated

To my

Father

Mother

Brother

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

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Chairman : Jamaloddin Noorzaei, PhD

Faculty : Engineering

The natural draught cooling tower is very important and essential component in the thermal nuclear power stations and industrial power plants. Due to their complexities in geometry the analysis of such type of structures has attracted many researches throughout the world. At the initial stage of this study an attempt was made to write a computer programme for calculating the symmetrical and unsymmetrical wind loading using FORTRAN program, which is compatible with FORTRAN 90 Power Station. The programme was written according to IS: 11504/BS: 4485.

The present study deals with physical and material modeling of cooling tower-foundation-soil system. The physical modeling has been carried out using solid twenty-noded isoparametric element to model the cooling tower, annular raft foundation and soil media. Coupled finite elements were employed to represent the soil media in the near and far field the cooling tower. Cooling tower, foundation-soil system was analyzed under vertical and lateral load generated from wind loads. The

soil nonlinearity was taken into the consideration using DUNCAN'S hyperbolic constitutive stress strain law.

Therefore, based on those physical and material modeling a finite element program has been written. The computer software package works under FORTRAN power station and the validity of this package has been verified by solving some examples available in the literature. Finally an attempt has been made to demonstrate the applicability of the finite element program in analysis of cooling tower with the total height of 115.35 m and the radius at top, bottom and throat level are 27.535 m, 52.877 m, 25.304 m respectively, subjected to static loading . The response of the structure has been discussed with respect to displacement and stresses. Moreover an attempt has been made to study the effect of the interactive and non-interactive analysis and comparison with conventional analysis was also made. It was concluded that the interactive analysis of the cooling tower-foundation-soil media plays a major role in releasing the stresses in the cooling tower, particular at the bottom ring beam.

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

**Analisis Elemen Finit Asas Menara Penyejuk Di bawah Muatan Angin
Taksimetri**

Oleh

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April 2006

Pengerusi : Jamaloddin Noorzaei, PhD

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Menara penyejuk semulajadi adalah satu komponen penting dan amat perlu di dalam stesen janakuasa nuklear dan penjanaan kuasa industri. Di sebabkan geometrinya yang kompleks itu mengakibatkan penganalisan struktur yang sedemikian rupa itu menjadi minat para pengkaji dari seluruh dunia. Pada peringkat awaln, kajian ini, cubaan telah dibuat untuk satu program komputer bagi mengira angin simetrikal dan taksimetri menggunakan bahasa FORTRAN yang kompatibel dengan FORTRAN 90 Power Station. Program ini telah ditulis berpandukan IS: 11504/BS: 4485.

Kajian ini mengkaji pemodelan fizikal dan bahan menara penyejuk asas –sistem tanah. Pemodelan fizikal telah dilakukan menggunakan elemen isoparametrik dua-puluh nod bagi memodelkan menara sejuk, asas raft anular dan media tanah. Elemen-elemen berpasangan telah digunakan bagi mewakili media tanah di lapangan jauh dan dekat. Menara penyejuk, sistem asas tanah telah dianalisa menggunakan muatan tegak dan datar yang terhasil dari muatan angin. Ketidak-linearitan tanah telah telah diambil kira menggunakan DUNCAN’S hyperbolic constitutive stress law.

Justeruitu, berdasarkan pemodelan fizikal dan bahan di atas satu program elemen finit telah ditulis. Pakej perisian komputer ini beroperasi menggunakan FORTRAN Power Station. Keboleh-percayaan pakej ini telah diselesaikan menggunakan beberapa contoh yang boleh didapati daripada literatur sediada.

Akhir sekali satu usaha telah dibuat untuk menunjukkan kegunaan program elemen finit di dalam penganalisan menara penyejuk dengan ketinggian 115.35 m dan secara urutannya jejari atas, bawah dan paras kerongkong adalah 27.535 m, 52.877 m dan 25.304 m bergantung kepada muatan statik. Respon struktur terhadap sesaran dan tekanan telah dibincangkan. Usaha juga dibuat untuk mengkaji kesan interaktif dan tak interaktif. Bandingan dengan analisis konvensional telah juga dibuat. Adalah dilihat bahawa analisis interaktif menara sejuk asas media tanah memainkan peranan besar dalam melegakan tekanan di dalam menara sejuk terutamanya di lingkungan bawah tiang.

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I certify that an Examination Committee has met on 3rd April 2006 to conduct the final examination of Ali Naghshineh on his Master of Science thesis entitled “Finite Element Analysis of Cooling Tower Foundation under Wind Load” 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.

ALI NAGHSHINEH

Date:

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