BRICKWALL MACROMODELLING USING STAAD III

ABG. MOHAMAD FAIZAL B. ABG. ABDUL GHAPOR

Universiti Malaysia Sarawak
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ABG. MOHAMAD FAIZAL
B. ABG. ABDUL GHAPOR

A Project Submitted in Partial Fulfillment for the
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Judul: **BRICKWALL MACROMODELLING USING STAAD III**

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(TANDATANGAN PENULIS)

(TANDATANGAN PENYELIA)

Alamat tetap:
2392, Lorong C5, RPR
Fasa2, Jalan Astana, Petra Jaya,
93050, Kuching, SARAWAK.

En. Ahmad Kamal bin Abdul Aziz
(Nama Penyelia)

Tarikh: 21.4.2001

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APPROVAL SHEET

This project report attached here to, entitled "Brickwall Macromodelling using STAAD III", prepared and submitted by Abg. Mohamad Faizal b. Abg Abdul Ghapor in partial fulfillment of the requirements for the degree of Bachelor of Engineering (CIVIL) is hereby accepted.

21.4.2001

En. Ahmad Kamal b. Abdul Aziz
(Project Supervisor)
Lecturer
Civil Engineering Department
Faculty Of Engineering
Universiti Malaysia Sarawak

Date

21.4.2001

Abg. Mohamad Faizal b. Abg. Abdul Ghapor
2392, Lorong C5, RPR Fasa2, Jalan Astana
Petra Jaya, 93050, Kuching, Sarawak.

Date

Dedicated to my
parents, brother and sisters,
friends & loves one.

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ABSTRACT

In this project, a macro model is used and the basic material properties are adopted to predict the response of brick wall under axial loading. The main research tool was by using STAAD III. For validation purposes, Fortran90 program code was used. The basic finite element used for both approaches was plate element. Basic assumptions have to be taken to simplify the analysis. These will be discussed further in the project report. From the analysis conducted we will be able to assess the capability of plate element in STAAD III to be used to predict the response of brick wall elements exposed to compressive force.

ABSTRAK

Dalam projek ini, suatu makro model akan digunakan di mana ia akan memenuhi sifat-sifat asas bahan. Model ini diharap dapat meramal tindak balas struktur bata terhadap beban menegak. Kaedah utama penyelidikan ialah dengan menggunakan program STAAD III. Untuk tujuan pengesahan, program kod Fortran90 akan digunakan. Elemen terhingga yang akan digunakan dalam kedua-dua kaedah ialah elemen plat. Anggapan-anggapan asas akan diambil kira bagi memudahkan penyelidikan. Ini akan dibincangkan dengan lebih mendalam dalam laporan projek ini. Daripada analisis yang telah dikendalikan, kita akan dapat mengetahui akan keupayaan elemen plat pada STAAD III dalam meramal tindak balas struktur bata terhadap beban menegak.

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CHAPTER ONE

INTRODUCTION

1.1. General

In the last few decades, the resurgence of brick masonry as a structural material has prompted a wide range of studies to investigate its structural behaviors for various of structural applications. Presently, such applications are limited to compression members like walls and columns. Research are done to determine the properties of brick masonry including those using the finite element analysis.

1.2. Brick

The term brick as used today denotes a solid masonry rectangular unit formed in a plastic state from clay and shale and burned in a kiln. Clay and shale are the principal materials used to make brick. Usually concentrated in large deposits, these materials are found all over the world.

Clay is a natural product, which is formed by the weathering of rocks. Shale is made in very much the same way from the same material but is compressed into layers in the ground. Shale is very dense and is harder to remove from the ground than clay. As a result, shale is a more costly raw material. Two or more kinds of clay and shale may be mixed together to obtain a material having the proper consistency and composition.

1.3. Finite element

Although the name "finite element" is of recent origin, the concept has been used for centuries. The basic philosophy is to replace and simulate the actual problem by a simpler model, in order to closely approximate predict and assess the solution of the problem at hand.

As far as structural analysis is concerned, from the initial attention focused on the elastic analysis of plane stress and plate bending problems, the method has been successfully extended to the cases of analyses of three dimensional structures, curved structures, stability, and vibration problems.

The main advantage of the finite element analysis is the physical problems, although intractable and complex for any closed-bound solution, can now be analysed by this method. Furthermore, the material anisotropy and nonhomogeneity can be catered without much difficulty. Also, any type of loading can be handled.

One of the main disadvantages of this method is the cost involved in the solution of the problem. For vibration and stability problem in many cases, the cost of analysis by the finite element method may be prohibitive. It may, therefore be a luxury to undertake vibration and stability analysis of simpler structures where application of even simpler computer method such as the finite strip or other semi analytic methods will lead to more economic solution. But those methods will work within their own limitations and will not be as versatile as the finite element method.

1.4. Research Significance

A macro model is used and adopted the basic material properties to predict the response of brick wall under compressive loading. The macro model hopefully will be able to predict the brick wall mechanical response including the tensile behavior, compression, shear and failure pattern.

The model developed will be of much value to researchers and practitioners alike. It also can be used for future study, and be of great guidance for devising experimental testing.

Thus, by identifying the relationship between the brick macro response and its macro structure, the material behavior can be engineered toward improved performance. In addition, enhancing the knowledge of load bearing using Finite Element Analysis can help the local load bearing industry indirectly.

1.5. Objective

The principal objectives of the study were:

(1) To assess the capability of plate element in Staad 3 to be used to predict the response of brick wall elements exposed to compressive force.

(2) Validate the elements used.

(3) Compare and interpret the results obtained from computational method with results obtained experimentally.

1.6. Conclusion

General information on this study is presented in this chapter. Further descriptions, reviews and assumptions for the modelling processes will be explained in the coming chapters.

CHAPTER TWO

LITERATURE REVIEW

2.1. General

In this chapter, related information, past experimental and numerically results are presented briefly. These informations are significant along the study period. The correct assumptions and method taken will surely consume less time and cost.

2.2. Clay Bricks Properties

2.2.1. Physical

The composition of the raw materials used and the manufacturing process affect the properties of structural clay products such as bricks. Basically, important properties of bricks are color, texture and absorption.

2.2.1.1.Color

The chemical composition of the natural clay and the minerals, which may be added to the natural clay, determine the color of the finished brick. Another factor, which affects color, is the temperature at which the clay is burned and how well the temperature is controlled in the kiln. Of all the natural oxides found in clays, that of iron has the greatest effect on color. Regardless of its natural color, clay that has any iron in it will burn red due to the formation of ferrous oxide.

2.2.1.2. Texture

Texture in brick is the arrangement of the particles of raw materials in the brick and the appearance and finish of the brick. For example, a hard, smooth brick has a fine finish or texture, while brick that has a sand finish is said to have a coarse texture.

2.2.1.3. Absorption

Absorption is the weight or amount of water a masonry unit absorbs at certain conditions for a stated length of time. This weight is expressed as a percentage of the weight of the dry unit.

2.2.2. Mechanical Properties for Modelling

The properties required in the modelling include the Elastic modulus, Poisson's ratio, dimension of the units, and thickness of the joints. Below are the typical values for the some common bricks [5]:

Product	Compressive strength		Modulus of rupture		Absorption
	(lb/in^2)	(MPa)	(lb/in^2)	(MPa)	(%)
Facing bricks	1250-20000	3.62-137.90	500-2000	3.45-13.79	2-25
Paving bricks	2500-20000	17.24-137.90	1500-2500	10.34-17.24	1-6

Two types of bricks, ordinary hand-made bricks of normal strength and medium high strength bricks manufactured by a semi mechanised process were chosen for casting the test specimens [1]. The average brick size and compressive strength for the two types were found to be 230 mm × 110 mm × 70 mm and 18.47 Mpa for the normal strength bricks and 222 mm × 106 mm × 70 mm and 27.16 Mpa for the medium strength bricks, respectively.

Below are sample results of homogenisation under three influences, variation of Young's modulus, variation of Poisson's ratio and; variation of joints thickness [8].

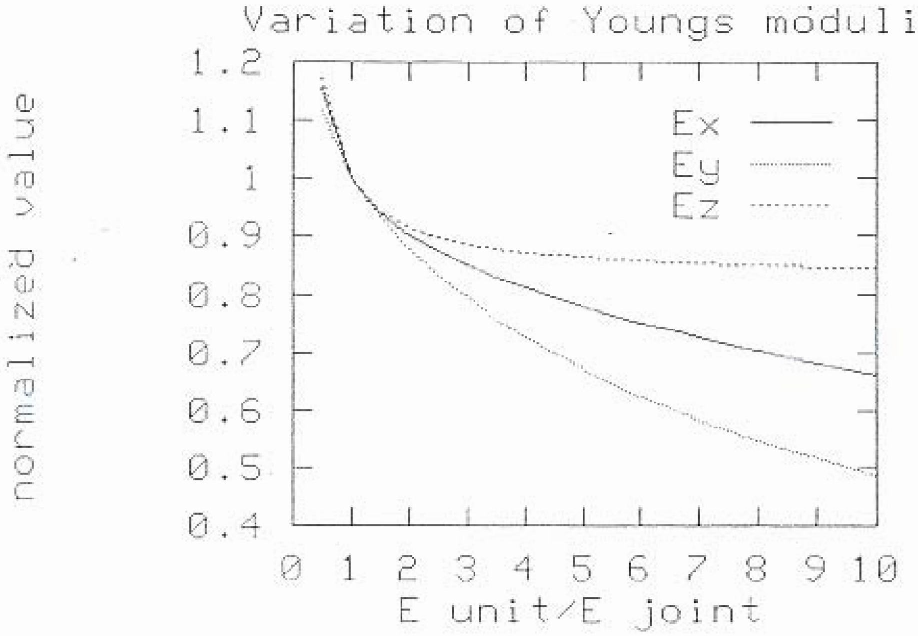
a. Influence of variations of Young's modulus of the constituents.

Units:	Mortar
E = 10000 MPa	E = varied
P = 0.20	P = 0.25
L = 215 mm	T = 10 mm
H = 65 mm	

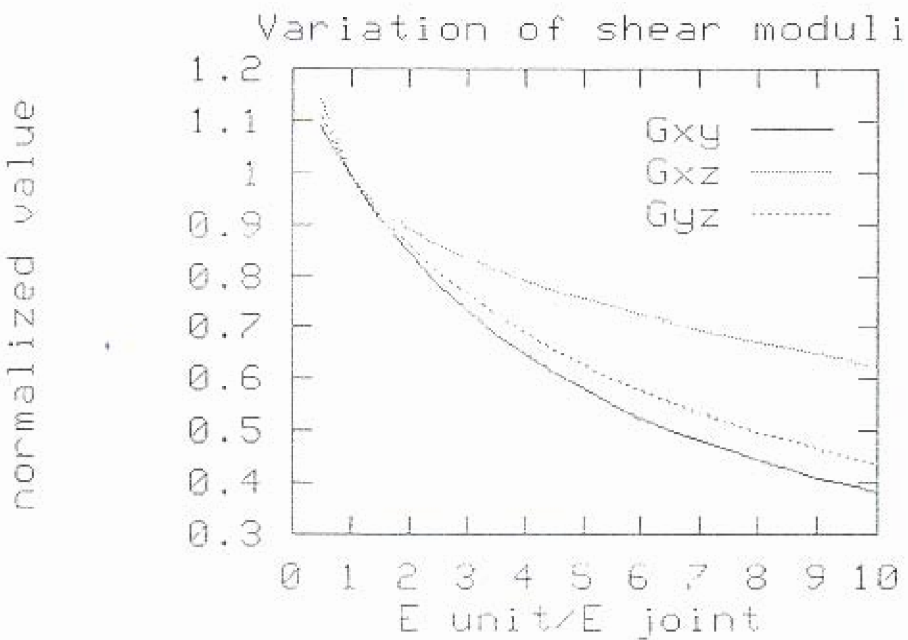
In the following figures, the symbols have the following meaning:

- Normalized value - Elastic property of the equivalent material divided by the respective elastic property of the unit.
- E stands for Young's modulus.
- G stands for shear modulus and is followed by its direction.
- P stands for Poisson's ratios and is followed by its direction.

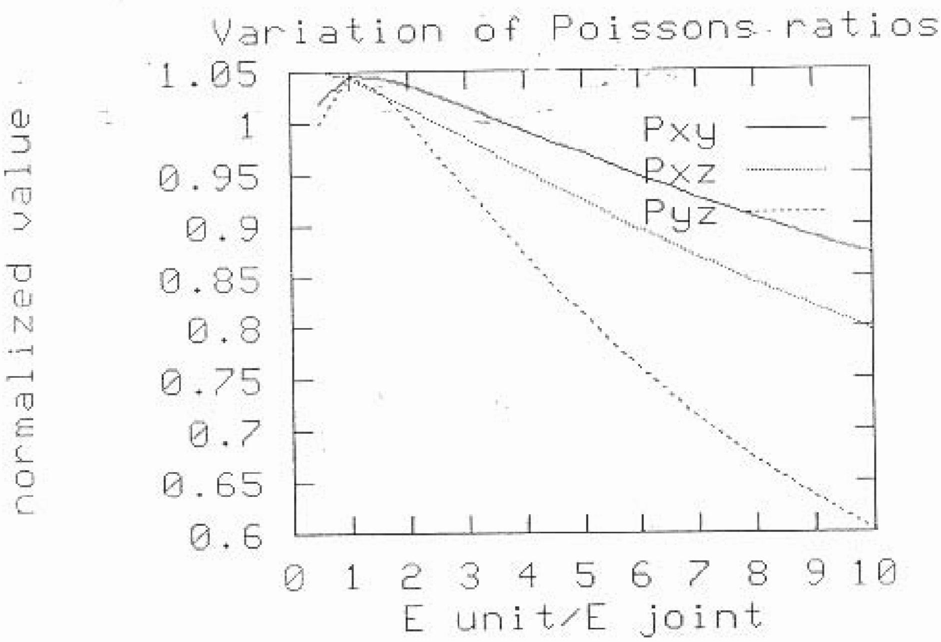
Influence on normalised equivalent Young's moduli:



Influence on normalised equivalent shear moduli:



Influence on normalised equivalent Poisson's ratios:



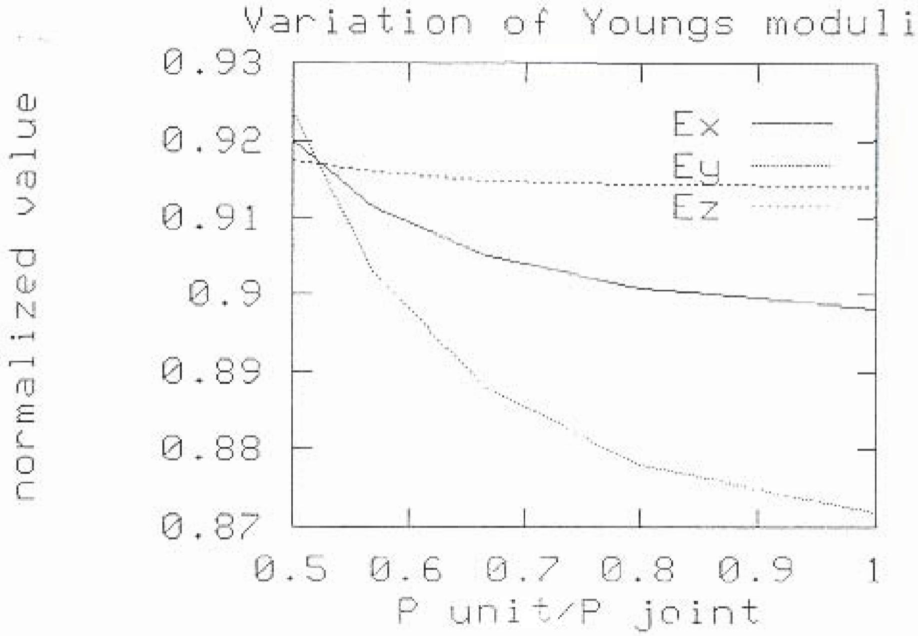
b. Influence of variations of Poisson's ratio of the constituents.

Units:	Mortar
E = 10000 MPa	E = 5000 MPa
P = 0.20	P = varied
L = 215 mm	T = 10 mm
H = 65 mm	

In the following figures, the symbols have the following meaning:

- Normalized value - Elastic property of the equivalent material divided by the respective elastic property of the unit.
- E stands for Young's modulus.
- G stands for shear modulus and is followed by its direction.
- P stands for Poisson's ratios and is followed by its direction.

Influence on normalised equivalent Young's moduli:



Influence on normalised equivalent shear moduli: