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ENGINEERING

1. Specific Energy Absorption Study on External Inversion of Metal Tubes 3
   Mohd Rozaiman Aziz
   Roslan Ahmad

2. The Effect of the Nano Silicon Carbide on Mechanical Properties of Aluminium 15
   Rizal Mohamed Noor
   Khairul Fauzi Karim
   Aznifa Mahyam Zainuddin

3. A Study of Laminated Composite Materials Using ACLAP Computer Program 25
   Syahrul Fithry Senin
   Ayurahani Che Lah

4. A Study on the Effectiveness of Palm Oil Mill Effluent (POME) Treatment Systems 33
   Caroline Marajan
   Rosliana Rozali

5. Investigation on California Bearing Ratio (CBR) Characteristics of Cement Bound Shredded Tire Geocomposite 53
   Chow Shiao Huey
   Sayani Khorim

6. Geotechnical Properties of Alor Setar Clay Along Jalan Kuala Kedah-Hutan Kampung 65
Mohd Farid Ahmad
Damanhuri Jamalludin
Eliyani Yazreen A.Rani
Tuan Juliana Tuan Sulong

7. The Effects of Dry Sludge from Waste Water Treatment Plant on the Compressive Strength of Concrete 77
Caroline Marajan
Mohd Yustafari Yunus

8. Comparison between Hydrated Lime Dry Powder and Slurry on Peat Soil Stabilization 87
Anas Ibrahim
Muhammad Sofian Abdullah
Damanhuri Jamalludin
Mustan Apo

9. Stabilization of Highway Embankment Using Stabilized Cohesive Frictional Soil with Shredded Scrap Tire 101
Anas Ibrahim
Abd. Naser Abd. Ghani
Muhammad Akram Adnan
Damanhuri Jamalludin

10. Modeling of Bolt Behavior Using Finite Element 113
Syahrul Fithry Senin
Jumatirah Mohd Alias

SCIENCE TECHNOLOGY

11. Detecting and Correcting for Heteroscedasticity 123
Teoh Sian Hoon

SOCIAL SCIENCES

12. Jalinan Pengajian Tinggi dan Rendah: Cabaran dan Pengalaman 137
Rafizah Kechil
Peridah Bahari
Salina Hamed

13. Pengkelasan Gaya Pembelajaran Pelajar Kejuruteraan UiTM Pulau Pinang Menggunakan Model Gaya Pembelajaran Felder~Silverman 153
Azmi Mohd Yusof
Rozita Kadar

14. Perhubungan Antara Persekitaran Pembelajaran Matematik, Sikap dan Pencapaian Akademik Pelajar: Satu Analisa Kualitatif 169
Salina Hamed
Peridah Bahari
Abdul Ghani Kanesan Abdullah

15. Kajian ke Atas Pelajar-pelajar Diploma Kejuruteraan UiTM Pulau Pinang Terhadap Pengetahuan dan Sikap ke Arah Teknologi Maklumat 185
Rosley Jaafar
Abd. Rahman Hemdi
Lim Jiunn Hsuh

16. Malay Loanwords in English: Reasons for Its Survival, Disappearance and Revival 197
Nazima Versay Kudus

ENGINEERING

A Study of Laminated Composite Materials Using ACLAP Computer Program

Syahrul Fithry Senin
Ayurahani Che Lah

ABSTRACT

This study is focused on the analysis of the composite materials by using the developed computer program, Automatic Composite Laminated Analysis Program (ACLAP), in FORTRAN language. The purposes of this study are to determine the capability and the accuracy of the program for solving the analysis that related with the laminate materials. This study also can provide an understanding of the underlying principles and techniques associated with the stress analysis and strength predictions of composite material structures. There are six examples that are going to be analyzing by using the FORTRAN program, each of the examples has their own problem statement. The FORTRAN results from the examples will be compared with the theory calculation. At the end of this study a user friendly computer program is produced with the intention to assist the lecturer for teaching or learning purpose.

Introduction

Analysis of composite by using manual calculation is not favorable nowadays since it is subjected to human errors and requires more time to do it. From the best author's knowledge, it was found that the developed computer programs are limited to certain structural element such as trusses (Stephen Hunt Robinson). As a result, a computer program for composite analysis is obviously needed. Design softwares which are available in the market are too costly and require specific knowledge especially for new user. In order to overcome this problem, a computer program that can analyse laminate analysis was developed.

The mechanics of materials deal with stress, and deformations in engineering structures subjected to mechanical and thermal loads. A common assumption in the mechanics of conventional materials, such as steels and aluminum, is that they are homogeneous and isotropic continua. For a homogeneous material, properties do not depend on the location, and for isotropic materials, properties do not depend on the orientation.

Unless severely cold worked, grains in metallic materials are randomly oriented so that, on a statically basis, the assumption of isotropy can be justified. Fiber-reinforced composites, on other hand, are microscopically in homogeneous and orthotropic. As results mechanics of fiber-reinforced composite are far more complex than that of conventional materials (W.Hyer, 1997)

Methodology

The phase that includes on the analysis of this example is identifying the important variables and the main subroutine that contain in the FORTRAN program. Variables are an identifier that is the symbolic address of a location in memory in which we can store a value and a subroutine is a subprogram to which any amount of data maybe sent including none, and which can return any number of results including none at all. A user defined subroutine is invoked by writing the FORTRAN command, CALL, followed by the name of the subroutine and its argument list.

For the final phase in the programming is the execution of the program. The materials properties data file that created using guideline (Appendix 2) will be tested to the program. Only when all bugs have been eliminated, and the program will produce the results, are the program its documentation released to the user.

Results and Discussions

This chapter will present and evaluate the result from the developed computer program and verification by manual calculation. Results comparison also will be conducted.

a) Example 1: [0/90] s Laminate Subjected to Known $\varepsilon^{0}_{x} = 1000 \times 10^{-6}$

Consider a four layer [0/90] s graphite-epoxy laminate, like the one shown in Figure 1. The thickness of layer, *h*, will be assumed to be 0.150 mm.

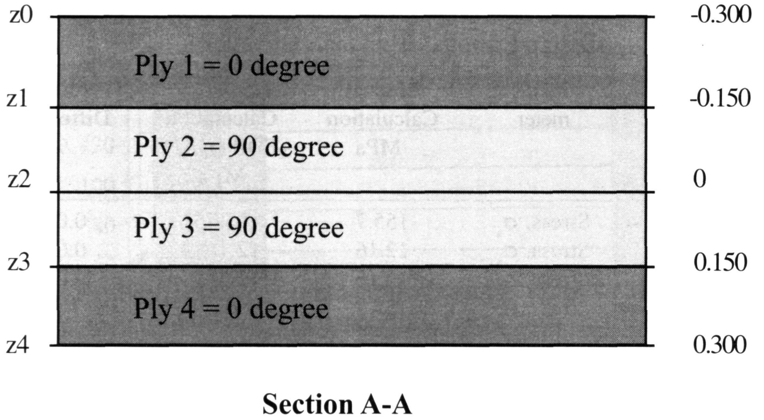

Figure 1: Graphite- epoxy Laminates for Example 1.

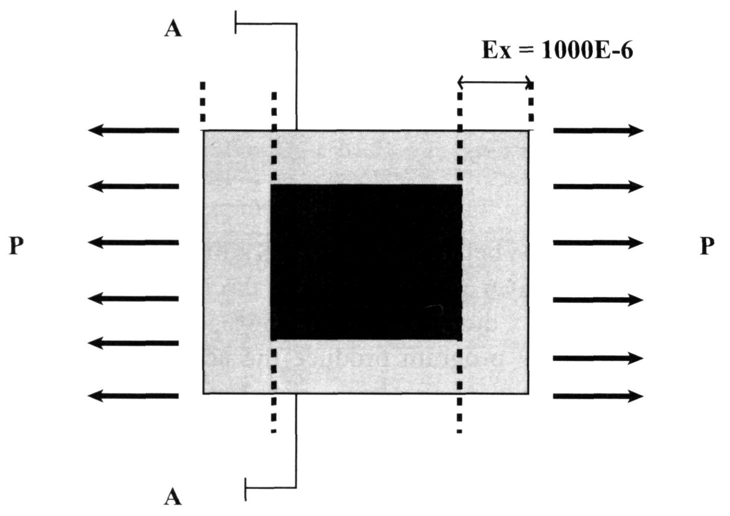

Figure 2: Forces Required Producing State of Deformation $\varepsilon^{0}_{x} = 1000 \times 10^{-6}$

Table 1 and 2 illustrate the distribution of stresses through the thickness of the laminate. Base on the comparison between the FORTRAN and manual calculation that shown in the Table 4.7, the maximum percentage difference of stress in x direction, σ_x is 0.033% which stated at layer no 1(0°) and 4 (0°). From the problem here the stress component σ_x is constant within each ply but it varies from layer to layer.

Table 1: Comparison Results between Manual and FORTRAN Program in Determination of Stress in x Direction

Layers	Para-meter	Manual Calculation MPa	Numerical Calculation (FORTRAN) MPa	Percentage Difference %
Layer 1 (0^o)	Stress, σ_x	155.7	155.751	0.033
Layer 2 (90^o)	Stress, σ_x	12.16	12.1614	0.012
Layer 3 (90^o)	Stress, σ_x	12.16	12.1614	0.012
Layer 4 (0^o)	Stress, σ_x	155.7	155.751	0.033

Table 2: Comparison Results between LUSAS and FORTRAN Program in Determination of Stress in x Direction

Layers	Para-meter	Manual Calculation MPa	Numerical Calculation (FORTRAN) MPa	Percentage Difference %
Layer 1 (0^o)	Stress, σ_x	155.835	155.751	0.054
Layer 2 (90^o)	Stress, σ_x	12.1651	12.1614	0.030
Layer 3 (90^o)	Stress, σ_x	12.1651	12.1614	0.030
Layer 4 (0^o)	Stress, σ_x	155.835	155.751	0.054

For the comparison between the LUSAS software and FORTRAN program in Table 1 layer no 1 and 4 give the maximum percentage difference of stress in x direction, $\sigma_{x,}$ is 0.054%. This two table shows that these FORTRAN program produce the accurate result for the composite laminate.

Figure 3 illustrate the comparison value of stress in x direction for the three methods of estimation which is manual calculation, FORTRAN program and LUSAS model. From this figure we can see that the results are almost equal for all the method.

b) Example 3: [±30/0] s Laminate Subjected to Known ε^0_x=1000x10^{-6}

Table 3 illustrates the stress, s_x for manual result and FORTRAN results distribution through the thickness of the laminate. From the manual calculation, the stress component s_x is continuous with the thickness between ± 30^o. By comparing the stress components that obtain from this program with the manual and LUSAS like illustrating on the Table 3 and 4, we can see that the percentage difference is less than 1%. Since

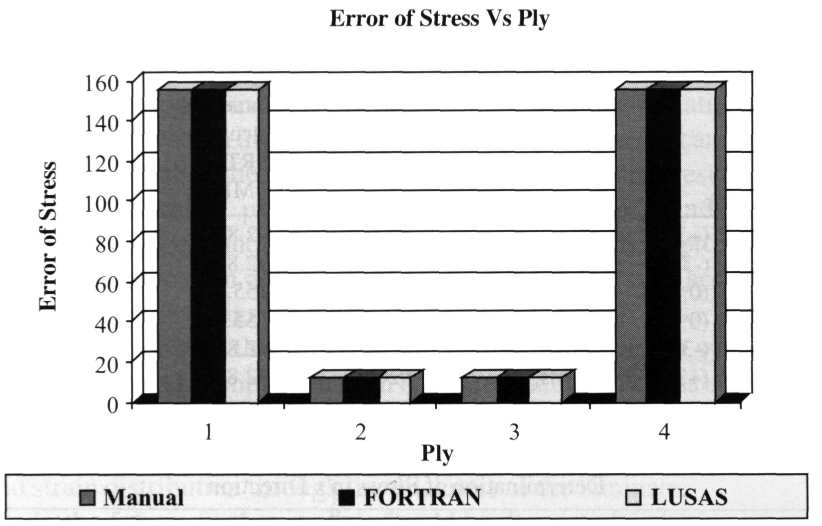

Figure 3: Figure Shows the Comparison Value of Stress in x Direction (σ_x) for Manual Calculation and Numerical Estimation

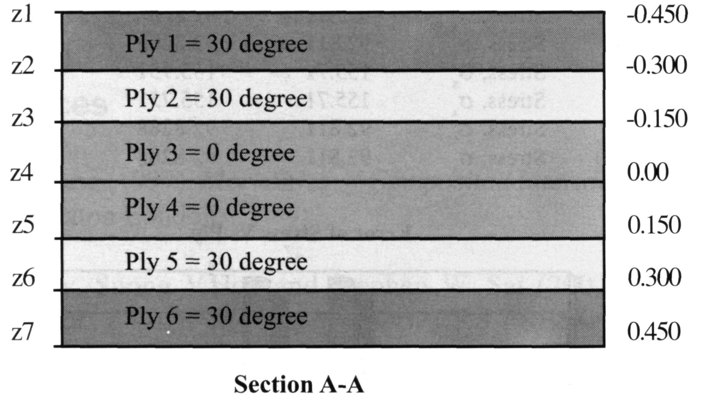

Figure 4: Graphite-epoxy Laminates for Example 3

the percentages of difference are less than 1% this program can produce the accurate result for stress component.

Figure 5 illustrate the comparison value of stress in x direction for the three methods of estimation which is manual calculation, FORTRAN program and LUSAS model. From this figure we can see that the results are almost equal for all the method

Table 3: Comparison Results between Manual and FORTRAN Program in Determination of Stress in x Direction

Layers	Para-meter	Manual Calculation MPa	Numerical Calculation (FORTRAN) MPa	Percentage Difference %
Layer 1 (+30°)	Stress, σ_x	92.8	92.8288	0.031
Layer 2 (-30°)	Stress, σ_x	92.8	92.8288	0.031
Layer 3 (0°)	Stress, σ_x	155.7	155.751	0.033
Layer 4 (0°)	Stress, σ_x	155.7	155.751	0.033
Layer 5 (-30°)	Stress, σ_x	92.8	92.8288	0.031
Layer 6 (+30°)	Stress, σ_x	92.8	92.8288	0.031

Table 4: Comparison Results between LUSAS and FORTRAN Program in Determination of Stress in x Direction

Layers	Para-meter	Manual Calculation MPa	Numerical Calculation (FORTRAN) MPa	Percentage Difference %
Layer 1 (+30°)	Stress, σ_x	92.811	92.8288	0.019
Layer 2 (-30°)	Stress, σ_x	92.811	92.8288	0.019
Layer 3 (0°)	Stress, σ_x	155.71	155.751	0.026
Layer 4 (0°)	Stress, σ_x	155.71	155.751	0.026
Layer 5 (-30°)	Stress, σ_x	92.811	92.8288	0.019
Layer 6 (+30°)	Stress, σ_x	92.811	92.8288	0.019

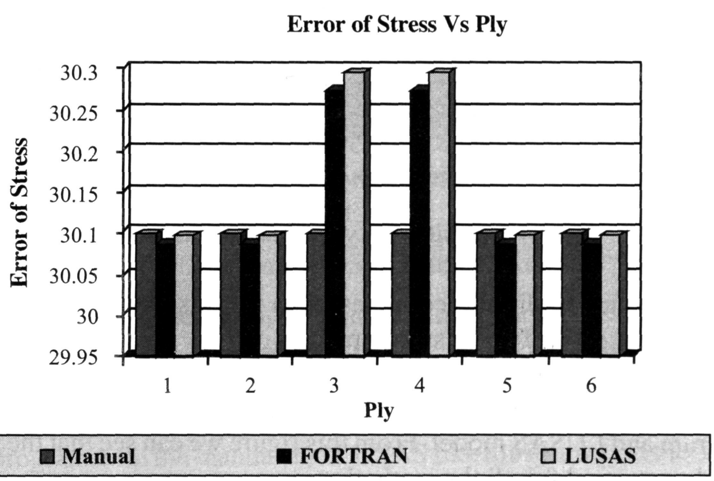

Figure 5: Comparison Value of Stress (σ_y) for Manual Calculation and Numerical Estimation

Conclusion and Recommendations

Based on the comparison, it can be conclude that the utilization of the computer software in the analysis of the composite material can produce accurate result than the manual calculation, the compared result shows that the difference percentage between FORTRAN and manual calculation vary 0% until 13.3%. It is able to determine the approximation values by application of numerical analysis. In the term of accuracy, it will improve the designing works, and reduce the errors.

It is proven that this program can be used to solve the symmetric (Example 1 and Example 2 in term of determination of stress and strain in x and y direction. It is also available in solving the anisotropic and isotropic composite materials. This program also can determine the stress and strain distribution through the thickness of the laminate.

In the future, further studies should be done on developing source code on how to provide optimization in composite materials in term of ply thickness, orientation of fiber angle and the number of fiber. It is also recommended that the user should be understood about the basic stress analysis of composite before used this program.

References

Autar K. Kaw (1997). *Mechanics of Composite Materials*, CRC Press, Boca Taton London.

Daniel Gay, Suong V.Hon and Stephen W. Sai (2002). *Composite Materials Design and Applications*, CRS PRESS, Boca Ranton London.

Gene Zirkel and Eli Berlinger (1994). *Understanding FORTRAN 77 & 90*, Library of Congress Boston.

Michael, W. Hyer (1997). *Stress Analysis of Fiber-Reinforced Compositre Materials*, Virginia Polytechnic Institute and State University.

P.K.Mallick (1993). *Fiber-Reinforced Composite Materials, Manufacturing, and Design*. Department of Mechanical Engineering University of Michingan-Dearbone, Dearbone, Michingan.

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