
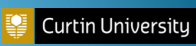


Effects of asphalt layer thickness on the dynamic analysis of flexible pavement: A numerical study

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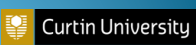







Introduction

- Research aim:
 - Develop new modelling of pavement structure to calculate:
 - Permanent deformation of layers (known as rutting or shoving)
 - Asphalt cracking (known as fatigue cracking).
- The main input parameters:
 - Loading Condition
 - Material Properties
 - Layers Thicknesses
- Numerical simulation leads to an inclusive understanding of the distribution of stress, strain and mechanical behaviour in all pavement layers under the wheel loads.


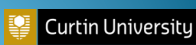
Numerical Programs

Programs investigated

- CIRCLY (Wardle 1977)
- KENLAYER (Huang 1993)
- ABAQUS (Hibbit, K., And Sorenson, Inc., 2000)



These methods have been used by many researchers:

- Duncan et al. 1968,
- Mallela and George 1994,
- Uddin et al. 1994,
- Cho et al. 1996,
- Hadi and Symons 1996,
- Myers et al. 2001,
- Tutumluer et al. 2003,
- Gedafa 2006

Method

- The main focus is on numerical modelling of pavement layers and materials.
- Numerical modelling will be performed using FE approach and linear elastic programs.
- Analyses are performed using :
 - CIRCLY,
 - KENLAYER,
 - ABAQUS and
 - FORTAN
- Geometry of analysis consists of 2D and 3D
- Material modelling will be developed from simple linear elastic modelling and will go toward more complicated modelling.
- Analysis is performed statically and dynamically and results are compared




Background Theory

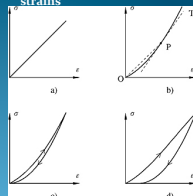
Theory

Burmister (1943) developed the essential equations, and developed sets of tabulated solutions, (e.g. Acum & Fox, 1951)

Development

Need for unified and mechanistic constitutive models for pavement materials including:
elastic, plastic, creep, fracture, microcracking, failure, healing, repetitive mechanical and thermal loadings

- Linear elastic
- Nonlinear elastic
- Elastoplastic-without residual strains
- Elastoplastic-with residual strains



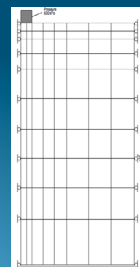
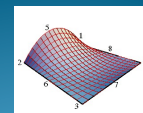
Analysis of Pavement response

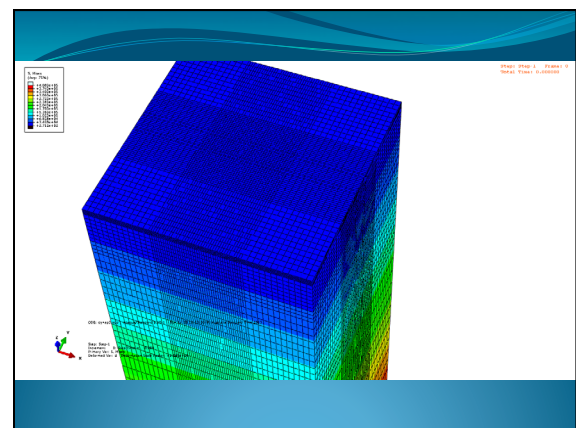
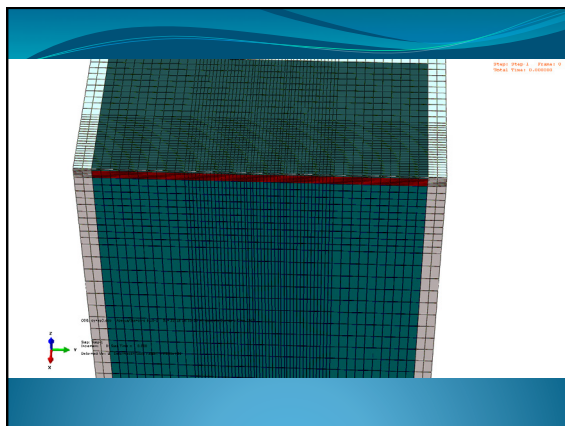
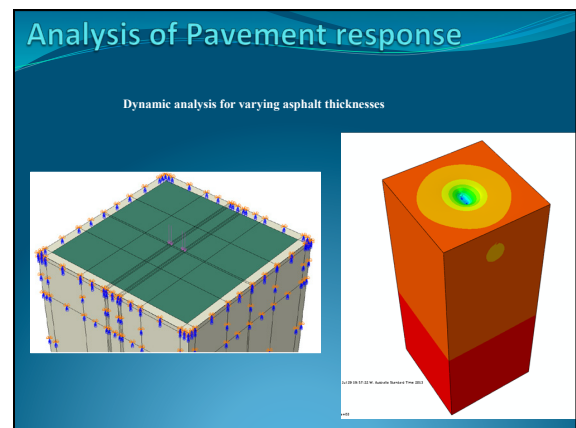
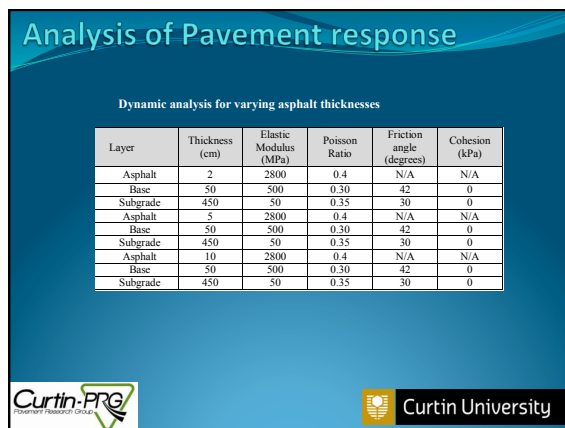
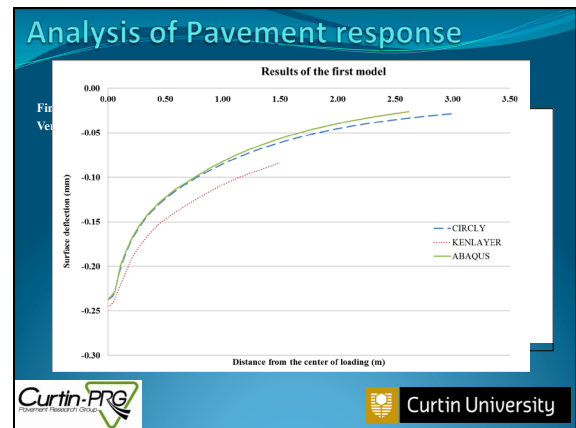
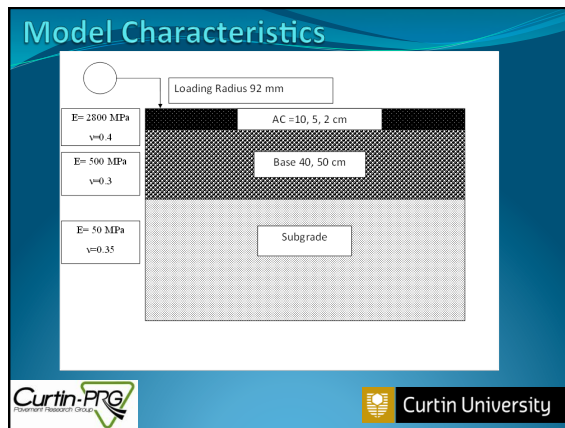
Finite Element Approach

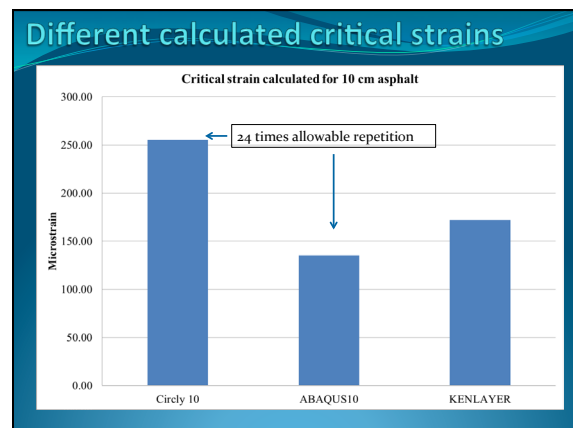
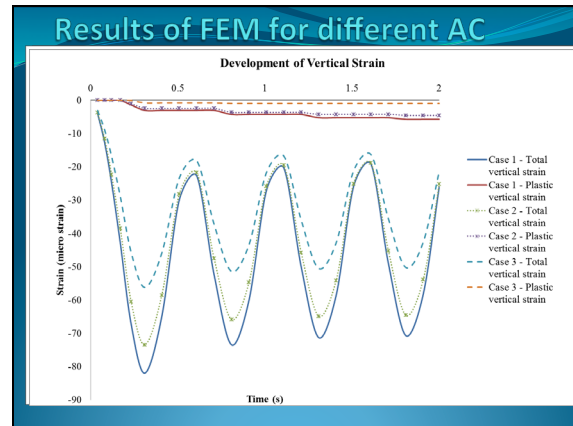
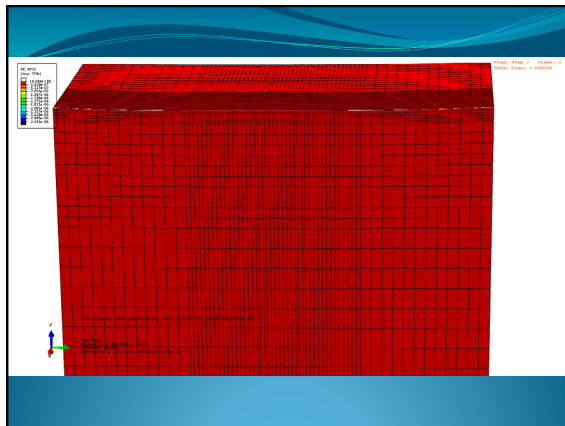
Advancing technology in computers is making it more attractive for engineers to use advanced computational methods instead of analytical solutions.

The main advantage of **FEM-based** programs is their ability to model various types of mechanical loadings and behaviours in a two or three dimensional medium.

ABAQUS, a general purpose FEM program, has been employed to model layered flexible pavement system.







Conclusion

- dynamic analysis results in lower surface deflection than static analysis
- increasing thickness from 2cm to 10cm reduces surface deflection up to 13%.
- increasing asphalt thickness can reduce both the total and plastic strain
- linear elastic analysis indicates moderately thick asphalt layers are at risk of fatigue
- economical solutions to pavement design are overlooked in favour of very thin or very thick asphalt layers

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