

The Mechanics of Tractor - Implement Performance

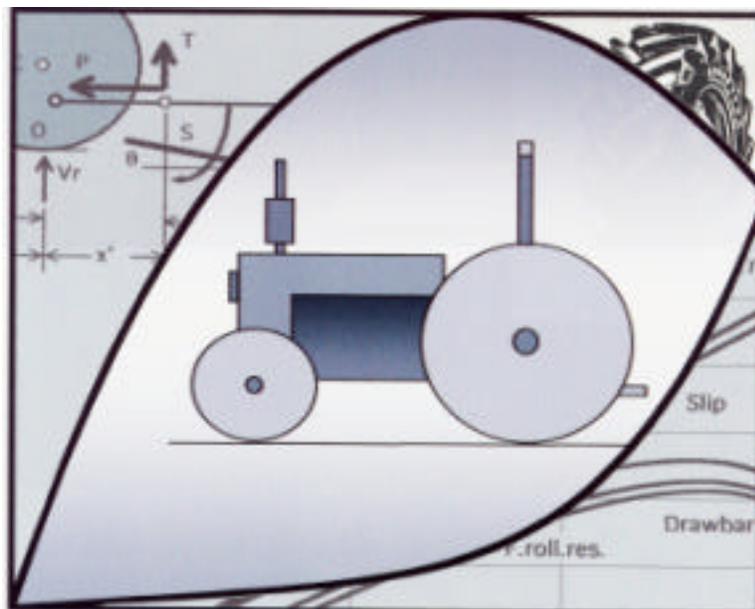
Theory and Worked Examples

A TEXTBOOK FOR STUDENTS AND ENGINEERS

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Chapter 1 includes the title, contents, index, and list of symbols etc.
Chapter 7 & 8 are together. Total pages -165.

R. Macmillan with a book review by D. Gee Clough. "The Mechanics of Tractor-Implement Performance". Agricultural Engineering International: the CIGR Journal of Scientific Research and Development. Invited Overview. May, 2003.

BOOK REVIEW by

Prof. David Gee Clough (Retired)
 Agricultural Systems and Engineering
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 Thailand

The author is aiming to produce a textbook suitable for second year or later undergraduate engineering students and I think he has succeeded. This is not a book describing the state-of-the art in tractor-implement performance. It would have to be much more comprehensive to be such a book. The following therefore should be taken as suggestions and not criticisms.

I am delighted to see a work in which both the Bekker plate sinkage method and the Freitag mobility number method are described in the traction theory chapters. Too often in the past scholars have chosen to use one or the other and then pretend that the other does not exist. This is quite stupid since each method has its advantages and disadvantages. The plate sinkage method gives closed form predictive equations for a towed wheel but cannot deal conveniently with a driven wheel. It predicts the state of stress at the soil-wheel interface which is useful in predicting soil compaction due to the passage of a wheel. After numerous field experiments the empirical mobility number method makes it possible to produce equations that predict the performance of both towed and driven wheels. However it cannot make any predictions about the state of stress at the soil-wheel interface. I think mention of these points in the text would be useful.

Even though Figs. 1.3 a) and 1.3 b) show a two wheeled power tiller and Fig 1.4 f) a cage wheel, which these machines are always fitted with when operating in flooded, puddled soils, there is very little further mention made of them in the text. They are the dominant field machine in many Asian countries and there is now a considerable amount of literature describing this performance.

Equation 5.5 and 5.7-5.9 give empirical equations to describe off-road traction tyre performance (equation 5.9 incidentally is wrong; it should read $\mu_{max} = \dots\dots$) It is surprising then that the author does not show how these equations can be used to select appropriate tyre sizes for agricultural vehicles or indicate the relationship between traction power, weight and speed and the wheel slip needed to obtain optimum power transmission.

Although the title mentions tractor-implement performance very little information is given about implements. The author might consider including such information e.g. in the form of appendix A of the 3rd edition of Kepner, Bainer and Barger.

With my very best wishes for the success of the book.

David Gee Clough.
 Bangkok

The Mechanics of Tractor-Implement Performance

Theory and Worked Examples

1. Introduction

This book, for engineering students and engineers, is about the functional performance of agricultural tractors – how, and how well, they perform the function for which they are designed - pulling loads. It is not about construction, operation, or management but about performance and the factors that determine it. Because it treats the tractor in terms of the fundamentals of the subject, it is not limited to any type, size or make.

This book is written for professional agricultural engineering courses or equivalent subjects for mechanical engineers. It could also form the basis for short courses for practicing engineers. It assumes a 2nd year university level of engineering science.

2. Summary

Chapter 1 gives an outline of the subject, a justification for its study and an overview of the main systems in the power train of both the conventional and two wheeled tractor.

The analysis of performance starts in **Chapter 2** with the engine performance as a 'given' and extends this, via a simple mechanical analysis, to give the ideal performance of the tractor.

The results of tests that are performed by the testing stations following procedures such as those used by the OECD are presented graphically and explained in **Chapter 3**. This approach is shown to confirm (within appropriate limits) the analysis presented in Chapter 2.

Chapters 4 and 5 treat both traction theory (Bekker, Reece etc) and empirical analysis (Wismer, Dwyer etc) in terms of the relevant parameters. Both are required for students to understand the subject and to break into the extensive research literature based on these analyses.

Chapter 6 on chassis mechanics covers the fundamentals of the subject appropriate to tractor performance and includes material that has not previously been published in a readily accessible form.

In **Chapter 7** all of the factors that determine tractor performance are brought together and their relevance to the selection of a tractor to match an implement and their efficient operation, in terms of performance, are illustrated.

3. Special Features:

The book develops the subject of tractor performance through the common alternative techniques used in engineering analysis:

- * ideal (theoretical, simple mechanics),
- * experimental (ideal [firm surface], measurement based)
- * theoretical (soft surface)
- * empirical (soft surface)

This has an incidental didactic purpose that is lost when authors move from one analytical technique to another without any explanation.

The book takes the student / reader through a number of stages from the simple to the more complex; from elementary mechanics of the tractor alone to that for the tractor when attached to an implement.

One of the most significant features of the book is that it treats performance in quantitative terms and illustrates this with many associated graphs. These enable the reader to obtain a picture of the relationships that is not possible in a merely descriptive or numerical presentation.

The tractor on which the book is based was a typical but actual (30+ kW) tractor (now out of production). It is only used to illustrate the principles being explained and thus follows a well accepted engineering approach.

The book is basically analytical but its connection with the 'practical' is through the worked examples and the problems with answers given through the text.

R.H. Macmillan
November 2002

R. Macmillan with a book review by D. Gee Clough. "The Mechanics of Tractor-Implement Performance". Agricultural Engineering International: the CIGR Journal of Scientific Research and Development. Invited Overview. May, 2003.

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