DEVELOPMENT OF A METHODOLOGY FOR CALCULATING STRESSES IN TRACK COMPONENTS

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Submitted in fulfilment of part of the requirements, for the degree of

MASTER OF ENGINEERING (MECHANICAL)

in the

FACULTY OF ENGINEERING

UNIVERSITY OF PRETORIA

October 2004

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SUMMARY

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Degree: Master of Engineering (Mech)

An existing analytical model, in use by Spoornet for the past two decades for calculating rail stresses on railway track, was revisited and improved. The model provided engineers with an easy-to-use program for evaluating track capacity and authorizing heavier loads on track. The model was modified to calculate rail and track component stresses more accurately. These modifications include the incorporation of current best practices and presentation of guidelines for the engineer on how to determine some input parameters which are normally difficult to obtain.

Firstly it was determined which input parameters the model was the most sensitive to. Thereafter it was determined whether or not the correct information would generally be readily available for those sensitive parameters. The most sensitive parameters were further investigated and test results, as well as best practice analytical methods, were used to establish nominal input values and guidelines for determining such values.

This research was necessary to establish whether or not the currently used analytical model still provided railway engineers with a useful tool and whether or not more modern and popular tools could validate or replace it.

After some modifications to the analytical model, it was proved that it provides engineers with a suitably accurate tool for calculating rail and track component stresses, without the need to build time-consuming models of the track under investigation. It showed that the model, after some modifications, is current with calculational methods in recent publications and provides an immediate answer to "what-if" questions without the need to run lengthy analyses.

ACKNOWLEDGEMENTS

I would like to thank and acknowledge contributions by the following persons:

- All my former Spoornet colleagues for their invaluable assistance and support during this research.
- Mr Hannes Maree for supporting this project and for providing valuable information and guidelines.
- Mr Mike Tomas for sharing his expertise and unlimited supply of test data.
- Professor Nico Theron for his support, enthusiasm and guidance.
- Dr Robert Fröhling for his consistent vision, technical contributions and for his driving force without which this project may not have been completed!
- Spoornet and Land Mobility Technologies (Pty) Ltd for making this research possible.
- I wish to thank my wife for all the hours I spent in seclusion and for her everlasting understanding, support and love, and my daughter, Andrea, whose birthdate marked a D-date for the delivery of this dissertation and forced many a late night's work!

Lastly, I want to echo my wife and thank my Lord and Saviour, in heaven, here and everywhere, for the opportunity to have an occupation that keeps me busy (Ecclesiastes 3:10).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

NOMENCLATURE

A	Section area
A_e	Effective area
A_{rs}	Baseplate area
a	Sleeper spacing
a_0	Coefficient of locomotive maintenance
a_1	Railhead depth
a_2	Top of rail to top of flange
α	Coefficient of thermal expansion
b_1	Width of railhead
b_2	Width of rail flange
β	Inverse of the characteristic length
b_0	Coefficient of track maintenance
C	Foundation modulus
C_1	Torsion stiffness
c	Actual super elevation
D	Wheel diameter [m]
d	Section height
δ	Running top condition
E	Elasticity modulus
e	Eccentricity of vertical forces
F_0	Pretension force of fastening system
f	Flange thickness
fL	Factor of static load
g	Gravitational acceleration
h	Head NA to flange NA
h	Track cant
h_1	Distance from head NA to section rotation point
h_2	Distance from flange NA to section rotation point
η	Influence factor of adjoining wheels

NOMENCLATURE

I	Second moment of area
I_{yy}	Second moment of area yy
I_{zz}	Second moment of area zz
I_{yy} *Head*	Second moment of area yy head
I_1 or I_{zh}	Second moment of area zz head
I_2 or I_{zf}	Second moment of area zz flange
ϕ	Dynamic factor
k	Equivalent spring stiffness (*MN/m*)
κ	Characteristic value
λ	Characteristic length
L	Lateral load
NA	Neutral Axis
n	Position of lateral force below rail top
P	Static wheel load
p_c	Vehicle centre of gravity height
Q	Dynamic wheel load
q'	Reaction force per unit area
R	Curve radius
R'	Sleeper reaction force
s	Track width (gauge)
σ	Stress
σ_{rs}	Mean contact pressure between rail and sleeper
T	Torsion
ΔT	Temperature change
t	Web thickness
t'	Statistical confidence level
ΔT	Max temp change
UTS	Ultimate Tensile Strength
U	Track modulus

NOMENCLATURE

υ	Poisson
V	Speed (*km/h*)
v	Type of sleeper
x	Distance from wheel
x_1	Distance from wheel in front
x_2	Distance from wheel behind
x_3	Distance from third wheel
Y	Lateral load
yk	Top to section NA
z	Deflection of beam