Joost J. Kalker  
(1933-2006)  
A Life in Rolling Contact

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Acknowledgement

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Born

The Hague, July 25, 1933

Jewish Family; Father: GP, Mother: Dentist
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The Hague, July 25, 1933

Jewish Family; Father: GP, Mother: Dentist
II World War 1940-1945

After the Holocaust, 1945
Youth

1945-1951: Gymnasium (secondary school)
1951: enters TUDelft in the new department of Applied Mathematics
TUDelft studies 1951-1958

Cokkie Kalkman

Prof Timman

(Prof) de Pater

Prof van der Poel
TUDelft studies 1951-1958

1956-1957: Research Associate at Brown University (Fulbright Grant)

Applied Math group of Prager and Sternberg
TUDelft studies 1951-1958

1956-1957:
Research Associate at Brown University (Fulbright Grant)

Applied Math group of Prager and Sternberg
TUDelft studies 1951-1958

1956-1957:
Research Associate at Brown University (Fulbright Grant)

Topic: programming an IBM 704 for minimal weight design of steel frames
TUDelft studies 1951-1958

1958 MSc thesis (Summa Cum Laude):
`The forces transmitted by two elastic bodies’
1960: Assistant Professor working with Timman and de Pater who is now (1958) full Professor in the group of Prof W. T. Koiter.
ON THE ROLLING CONTACT OF TWO ELASTIC BODIES
IN THE PRESENCE OF DRY FRICTION

PROEFSCHRIFT

TER VERKRIJGING VAN DE GRAAD VAN DOCTOR IN DE
TECHNISCHE WETENSCHAPPEN AAN DE TECHNISCHE
HOGESCHOOL TE DELFT OP GEZAG VAN DE RECTOR
MAGNIFICUS IR. H. J. DE WIJS, HOOGLERAAR IN DE
AFDELING DER MIJNBOUWKUNDE, TE VERDEGEN OP
WOENSDAG 5 JULI 1967 DES NAMIDDAGS TE 2 UUR

DOOR

JOOST JACQUES KALKER
WERKENDIG INGENIEUR
GEBORVEN TE 'S-GRAVENHAGE

Advised by de Pater and Timman
Magnus Opus
Starting: Carter, Fromm and Love.

On the Action of a Locomotive Driving Wheel.
(Communicated by Prof. A. E. H. Love, F.R.S.—Received April 15, 1926.)

We next consider the normal operation of the wheel. Assuming it to be
running in the positive direction of the z-axis, let A'OA in the figure represent
the contact surface, A being the point of first contact, and A' the point of leaving.
Let ABA' be the curve of limiting tangential traction TTP. The actual
curve of tangential traction will follow some line ADCA', starting at A and never
exceeding the limiting curve. Over the portion ADC of the curve, the surfaces

in contact are locked together, and the surface-strain is accordingly constant;
\[ I(x, y) = \int \int_E \left( J(x', y') \right) H(x-x', y-y') \text{d}x' \text{d}y', \]

then, if \((x, y)\) lies in \(E = \{ y, x : x^2 + y^2 / 4 \leq 1 \} \),

\[ I(x, y) = \sum_{n=0}^{\infty} \sum_{m=0}^{\infty} a_{nm} y^m x^n, \]

that is, \(I(x, y)\) is a polynomial in \(x, y\) of the same degree as \(K(x, y)\).

The lemma was established by GAUSS [1], ch. 2, sec. 8, in the special case that \(K=0\), by means of LEIBNIZ's formulae. Its significance for the solution of the integral equations (2.18) and (2.19) is the following. We see that all functions of \((x-x', y-y')\) that occur in the integrands of (2.18) and (2.19) are of the form \(H(x-x', y-y')\). If we suppose that the tractions \(x, y, z\) are of the form \(J(x, y)K(x, y)\), then it follows that the displacement differences \(u, v, w\) inside the elliptical area are polynomials in \(x\) and \(y\) of the same degree as that of \(K(x, y)\). But that means that there are as many parameters in the displacement differences as there are in the tractions. There is a strong presumption \(z\) on the part of the numerical work, that the displacement fields are independent of each other. It follows that we may invert the argument, and say that when \(u, v, w\) are given as polynomials inside \(E\), the tractions \(x, y, z\) must be of the form \(J(x, y)K(x, y)\). Clearly, the connection between the constants \(a_{pq}\) and \(a_{mn}\) is linear, owing to the linearity of the equations. Summarising, we see that the lemma provably implies that

\[ (u, v, w) = \sum_{n=0}^{\infty} \sum_{m=0}^{\infty} a_{nm} y^m x^n \text{ inside } E, \]

\[ \leftrightarrow (x, y) = J(x, y) K(x, y) \sum_{p=0}^{\infty} \sum_{q=0}^{\infty} a_{pq} y^q x^p, \]

where the constants \((a_{pq})\) are connected with \((a_{mn})\).

By linear equations,

We now turn to the

Proof of the Lemma

Consider a typical term of the polynomial \(K(x, y)\), viz. \(x^p y^q\).

Then the lemma is proved, if we can show that

\[ \int \int_E J(x', y') x^p y^q H(x-x', y-y') dx' dy' = B_{pq}(x, y), \]

where \(B_{pq}(x, y)\) denotes an arbitrary polynomial in \(x, y\) of degree \(n\). We introduce polar coordinates \(r, \theta\) about the point \((x, y)\):

\[ x = r \cos \theta, y = r \sin \theta, \]

and we introduce a new notation: \(F_{n}(\theta)\) is an unspecified function of \(r\), independent of \(x,\) and \(y\), for which

\[ F_{n}(\theta) = (-1)^n \int_{0}^{2\pi} F_{n}(\theta) \text{d} \theta. \]

For example, \(\sin \theta = F_{1}(\theta), \cos \theta = F_{0}(\theta)\). Multiplication of functions \(F_{n}(\theta)\) is governed by the law that \(F_{n}(\theta) F_{m}(\theta) = F_{n+m}(\theta)\). Now,

\[ H(x-x', y-y') = (x-x')^2(y-y')^2 \text{ inside } E, \]

\[ H(x-x', y-y') = \frac{1}{r^2} \text{ outside } E. \]

We must write the factor \((-x^2/a^2-y^2/b^2)^2\) in polar coordinates:

\[ \frac{1}{r^2} - \frac{1}{(a^2-x^2)^2} - \frac{1}{(b^2-y^2)^2}, \]

\[ = \frac{1}{r^2} \left( \frac{1}{(a^2-x^2)^2} + \frac{1}{(b^2-y^2)^2} \right), \]

\[ = - \frac{1}{A} \left( \frac{1}{(r^2-C)^2} + \frac{1}{(r^2-D)^2} \right), \]

with

\[ A = \frac{B_{pq}^2}{a^2} + \frac{B_{pq}^2}{b^2}, \]

\[ C = \frac{1}{2} (1 - x^2/a^2 - y^2/b^2), \]

\[ D = \frac{1}{2} (\frac{\text{norm} x}{a^2} + \frac{\text{norm} y}{b^2}), \]

\[ B = B(\phi) = \frac{1}{2} \left( \frac{1}{A} \left( \frac{1}{(1-x^2/a^2)^2} + \frac{1}{(1-y^2/b^2)^2} \right), \right), \]

\[ = B(\phi) = \frac{1}{4} \left( \frac{1}{A} \left( \frac{1}{(1-x^2/a^2)^2} + \frac{1}{(1-y^2/b^2)^2} \right), \right). \]
TUDelft position

1979: Full Professor on a personal chair in Applied Mathematics

K. L. Johnson    A. R. Savkoor    J. J. Kalker
The role of Prof de Pater

Wheel-Rail
Joost Kalker PhD 1967

A. D. de Pater
(1920-2001)

Tire-Road
Hans Pacejka PhD 1966
The role of Prof de Pater

IAVSD 1991
The role of Prof de Pater

IAVSD 1991
Work continues

A living legend: the `Kalker Coefficients'

```
C******************************************************************************
C Subroutine Contac (Iwp)
C Performs calculations for one case. Calls Dis, RzNorm, RxTang, GenCr if
C this is requested, and if R=0.1 computes tractions Ps and Contact area Igs.
C Implicit None
C INCLUDE 'matrsize.new'

C Variables of the commons
   Integer Ic(16), MaxSS, MaxIn, MaxNR, MaxOut, Dcvp, Kigowr, Vtnfs,
   Mx, My, Npot, Rowlist(NF0), Rowlist(NF0), IBase, IPlan, Nn, Col(NP0),
   Mz2, My2, Row(NF0), Igs(NP0), IxKomb, iNorm, iTang
   Double Precision Eps, Dx, Dy, Dz, X(Npo), Y(Npo), Z(Npo),
   ExRhs(NP0,3), H(NP0,3), Vx(Mxh,3), Ak, Cr(-2*NP0:2*NP0,3,3),
   CrT(-2*NP0:2*NP0,3,3), CrS(-2*NP0:2*NP0,3,3), Ch, Exin, Fn,
   FStat, Fux, Fury, Fuv, Fy, Fx, Fury, Flux, Fuv, Fury, Fx, Fy,
   Fux, Fv, Fx, U, Uy, Couple, du(NP0,3), Elan, Fric, Ps(NP0,3),
   Pz(NP0,3), Sens(SJ, WAbs(NP0))
C Local variables:
   Integer It, Inp
   Logical zKombi

   Common /Contri/ Ic, MaxSS, MaxIn, MaxNR, MaxOut, Kigovr, Vtnfs, Eps
   Common /DisCons/ Mx, My, Npot, Rowlist, RowList,
   Dx, Dy, Dz, X, Y, Z
   Common /Geomet/ iBase, ifPlan, Nn, D, ExRhs, H, Xb
   Common /Infi/ Col, Mz2, My2, Row, Ak, Cr, CrT, CrS
   Common /KinsCons/ Ch, Ekin, Fn, EStat, Fur, Fuv, Fury, Fx, Fy,
   Fux, Fv, Fx, U
   Common /OutCons/ Igs, IxKomb, iNorm, iTang,
   Couple, du, Elan, Fric, Ps, Fv, Sens, WAbs

   External UnPack
   Call UnPack (Vtnfs, Dcvp, Kigowr, Ic)
   zKombi = Ic(IxKomb).Eq.1 .And. Ic(Force).Eq.0 .And. Ic(Tang).Eq.0
   if (Ic(Dis) .Or. 0) Then

C make new discretisation
```

1982: Computer code ‘CONTACT’
Work continues

Simplified theory

```
C FASTSIM VERSION 1980.02.01 (FORTRAN), SIMPLIFIED THEORY OF ROLLING.
* 14-NOV-02 software created.
IMPLICIT NONE
LOGICAL KLEIN, NK
DOUBLE PRECISION UX, UY, FX, FY, TX, TZ, TOU, NUX, NUY, FI, C1, C2, C3.
C PI, B, C, Y, YM1, YV
INTEGER NJ, N Speakers, N, S, J
C INPUT OF CREEP QUANTITIES
PK=3.141592653D0
CSY=1
READ(5,*) PK
500 CONTINUE
IF(RH) 100, 101, 102
100 CONTINUE
READ(5,*) MX, MXY, TOU, C1, C2, C3, B
102 READ(5,*) NUX, NUY, FI
UX=C1*X
UY=C2*Y
FX=C3*FI
FY=CY*FI
C THE CALCULATION
C
C SET THE TANGENTIAL FORCES EQUAL TO ZERO
FX=0.000
FY=0.000
S=1.000
10 CONTINUE
IF(ABS(UX).GT.ABS(FX).OR.ABS(UY).GT.ABS(FY)) GOTO 105
GOTO 110
105 KLEIN=.FALSE.
BY=2.000-NY
S=-1.000
WMI=-1.000
GOTO 115
106 KLEIN=.TRUE.
C=UX/FX+2
D=INT((1.000-C)*NY/2.000)+1
```

Computer code ‘FASTSIM’
Advisor

- Max Viergever (1980): ‘Mechanics of the inner ear; a mathematical approach’
- Gerard Braat (1993): ‘Theory and experiments on layered, viscoelastic cylinders in rolling contact’
- Zili Li (2002): ‘Wheel-rail rolling contact and its application to wear simulation’
International Contacts & Travel

1991, TGV Lyon

1990, Cokkie & Joost in China
International Contacts & Travel

1990, Cokkie & Joost in the Shinkansen

1990, Cokkie & Joost in Japan
International Contacts & Travel

1996, Joost in India
Garden Parties & Cooking
Family Life

1981, Pauline Kalker, Titia Kalker, Cokkie & Joost

2004, Joost, Felix Kalker, Cokkie
Family Life

July 2005
Family Life

Herman Helle
Pauline Kalker
Floor Kalker
Simon Kalker
Titia Kalker
Olaf Duin
Cokkie Kalker
Felix Kalker

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