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Film thickness in lubricated Hertzian point contacts (Use of computer program A9138)

Associated software: ESDUpac A9138

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THE PREPARATION OF THIS DATA ITEM

The work on this particular Data Item was monitored and guided by the Tribology Steering Group which has the following membership:

Chairman	
Mr. F.A. Martin	— Independent
Vice-Chairman	
Dr. P.B. Neal	University of Sheffield
Members	
Prof. Dr-Ing. W.J. Bartz*	— Technische Akademie Esslingen, Federal Republic of Germany
Mr O. von Bertele	— Independent
Prof. H.S. Cheng*	— Northwestern University, Illinois, USA
Prof. D. Dowson†	— University of Leeds
Mr T.I. Fowle	— Independent
Prof. J. Halling	— Independent
Prof. Y. Hori*	— University of Tokyo
Mr M.J. Neale†	— Michael Neale & Associates
Dr D.W. Parkins	— Cranfield Institute of Technology
Dr S.Y. Poon	— I.T. Research Ltd
Mr G.S. Ritchie	— European Gas Turbines, GEC Alsthom
Dr W.H. Roberts	— National Centre of Tribology
Prof. C.M. Taylor	— University of Leeds
Dr D.F. Wilcock*	— Tribolock Incorporated, NY, USA
Dr R.W. Wilson	— Independent.

* Corresponding Member

† Member Emeritus.

The construction and subsequent development of the Data Item were undertaken by

Mr K.A. Waters — Senior Engineer.

The person with overall responsibility for the work in this subject area is Mr C.J. Loughton, Head of the Mechanical Motion and System Dynamics Group.

The Tribology Steering Group, which first met in September 1973, is continuing the work that was previously the responsibility of the former Bearing and Lubrication Committee, which first met in July 1964.

FILM THICKNESS IN LUBRICATED HERTZIAN POINT CONTACTS (USE OF COMPUTER PROGRAM A9138)

CONTENTS

	Page
1. INTRODUCTION	1
2. NOTATION AND UNITS	1
3. RUNNING THE PROGRAM	2
4. THE INPUT DATA FILE	3
4.1 Specification of Problem	5
5. THE OUTPUT DATA FILE	7
5.1 Interpretation of Results	8
APPENDIX A INPUT FILE FORMAT	10
A.1 Input Data File Program Identifier	10
A.2 Specification of Input Data	10
APPENDIX B INPUT FILE PARAMETERS	11
APPENDIX C ERROR AND WARNING MESSAGES	13
C.1 Input/Output and Data Validation Messages	13
C.2 Contact Geometry Messages	15

FILM THICKNESS IN LUBRICATED HERTZIAN POINT CONTACTS (USE OF COMPUTER PROGRAM A9138)

1. INTRODUCTION

This Data Item describes the use of ESDUpac A9138 which is a computer program for determining the minimum lubricant film thickness in concentrated point contacts that occur, for example, in rolling element bearings and gears. The program implements the calculation method of ESDU 89045 which must be referred to for the theoretical limitations of the method and for discussion of practical considerations.

2. NOTATION AND UNITS

The symbols (parameter names) used in the input and output files of ESDUpac A9138 of necessity differ from those used in the derivative ESDU 89045. Both sets of symbols are listed in this notation. Note also that the International System of units is used.

Symbol used by ESDUpac A9138	Symbol used by ESDU 89045	Description	Units
alpha	α	pressure exponent of lubricant	m^2/N
eta0	η_0	lubricant dynamic viscosity at atmospheric pressure and at operating temperature	$\text{N s}/\text{m}^2$
Edash	E'	effective modulus for the contact	N/m^2
E1dash	–	effective modulus for material of body 1	N/m^2
E2dash	–	effective modulus for material of body 2	N/m^2
gamma	γ	direction of lubricant entrainment velocity vector (see Section 5.1)	degree
G	G	material parameter	–
h	h	minimum lubricant film thickness	m
Hk	H_k	non-dimensional lubricant film thickness	–
lambda	λ	specific film thickness	–
phi	ϕ	angle between corresponding principal axes (see Section 4.1)	degree
psi	ψ	orientation angle of contact ellipse (see Section 5.1)	degree
P	P	pressure parameter	–
Po	p_0	maximum Hertzian pressure	N/m^2

Issued December 1991 – 9 pages
With Amendments A and B May 2010 – 15 pages
This page Amendment B

R	R	effective radius of curvature	m
Rdash	R'	radius ratio	—
Rx1, Ry1	R_{x1} and R_{y1}	principal radii at contact point for body 1 (see Section 4.1)	m
Rx2, Ry2	R_{x2} and R_{y2}	principal radii at contact point for body 2 (see Section 4.1)	m
Rq1, Rq2	R_{q1} and R_{q2}	RMS (root mean square) roughnesses of contacting surfaces	m
S	S	speed parameter	—
u	u	magnitude of lubricant entrainment velocity vector	m/s
U	U	lubricant entrainment parameter	—
Ux1, Uy1	—	surface velocity components relative to contact point for body 1 (see Section 4.1)	m/s
Ux2, Uy2	—	surface velocity components relative to contact point for body 2 (see Section 4.1)	m/s
w	w	load applied to contact	N

3. RUNNING THE PROGRAM

The supplied executable version of the ESDUpac program is suitable for Microsoft Windows operating systems.

To run the executable version of the program from the keyboard, type the program name[†], A9138V11, at the operating system prompt and press return. The program will prompt for the name of the input data file and the name of the output data file. Alternatively, the name of the input data file and the name of the output data file can be specified on the command line using the operating system redirection symbols as in,

A9138V11 < EXP1.IN > EXP1.OUT

If a problem occurs in reading the data from the input file or if the data are invalid in any way, error messages are recorded in the output file. These error messages describe the error and, where applicable, indicate the line number at which the error occurred in the input data file.

A number of example input data files are supplied with the program (files with the extension ".IN"). These input files and the corresponding output data files (with the extension ".OUT") can be examined using a text editor.

[†] The program name used here is that of Version 1.1 (V11) which may not be the latest.

4. THE INPUT DATA FILE

The input data file provides the specification of the problem that is to be analysed. An example input file, which incorporates comments for documentation purposes, is shown here.

```
* This is a sample data input file for Example 1 of Data Item 89045.
* You may wish to use this file as a template for your data input files.
* If you wish, comments can be added for documentation purposes.

ESDU A9138      !This line is the input data file program identifier.

* Example 1: Sphere in groove
* -----

phi      angle between principal axes of bodies      =    0.0      degree
Rx1      principal radius of body 1 in x direction   =    0.0075   m
Ry1      principal radius of body 1 in y direction   =    0.0075   m
Rx2      principal radius of body 2 in x direction   =   -0.0082   m
Ry2      principal radius of body 2 in y direction   =   -0.05     m

Ux1      surface velocity of body 1 in x direction   =    0.0      m/s
Uy1      surface velocity of body 1 in y direction   =    3.24     m/s
Ux2      surface velocity of body 2 in x direction   =    0.0      m/s
Uy2      surface velocity of body 2 in y direction   =    3.24     m/s

E1dash   effective modulus for material of body 1    =   220.0E9   N/m^2
E2dash   effective modulus for material of body 2    =   220.0E9   N/m^2

w        load applied to contact                     =   1500.0   N

eta0     lubricant dynamic viscosity                 =   17.7E-3   N s/m^2
alpha    lubricant pressure exponent                 =   20.5E-9   m^2/N

Rq1      RMS roughness of body 1                     =    0.13E-6   m
Rq2      RMS roughness of body 2                     =    0.13E-6   m
```

Input parameters can be specified in any order. However, the first non-comment line of the file must identify the name of the ESDUpac program, A9138 in this case, that is to be used for the analysis. The following observations apply (a formal specification of the input file format is given in Appendix A).

- (i) All lines beginning with an asterisk, '*', are comment lines. Such comments can be freely inserted for documentation purposes.
- (ii) The first non-comment line in the input file specifies the name of the ESDUpac program that is to be used for the analysis. The keyword 'ESDU' is used for this purpose and the line must be present in all input files.
- (iii) Each input parameter has an identifying symbol. The explanatory text following the parameter symbol may be omitted in which case the '=' sign is not strictly necessary.
- (iv) Units have been stated in the file purely for documentation purposes. All text following the actual numerical value is ignored.