



UNIVERSITY OF DIPONEGORO

**DETERMINISTIC CONTACT ANALYSIS OF ROUGH SURFACE
USING FINITE ELEMENT METHOD**

BACHELOR THESIS

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BACHELOR THESIS

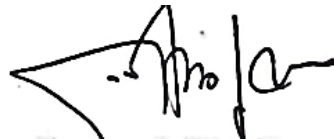
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Finite Element Method.**

Substantive Material :

1. Generating three dimensional models of rough surfaces in commercial finite element software.
2. Comparing generated surface with normal surface on ABAQUS.
3. Applying generated surface in static case of elastic and elastic-plastic contact.
4. Comparing finite element model with experimental result.

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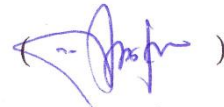
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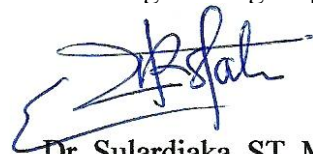


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PROVERB AND ACKNOWLEDGMENT

”Rise and rise again until lambs become lions”

When I type this page, suddenly I am wondering what my parents has done to make me as fine and healthy as today in condition to able finish my bachelor thesis. Even thousand of this work will never equal compared with all of their love and bless. Also my little brother who fought lot with me, even we never made any phone call during my time in university. I know that we are apparently close each other, as you are a person I spent most of my playing time with. This thesis is dedicated to all of you, MY FAMILY.

PS: Since department of mechanical engineering was established in June 1983, this is the first ever bachelor thesis written in English.

ABSTRACT

A surface geometry of many components and systems is not always known and not always be measured. This condition make study of real surface was hard to accomplish. Numerical contact simulations of rough surfaces are common but most models contain extensive assumptions and idealizations about asperity shape and size. This thesis presents a new method for generating deterministic of rough surface in ABAQUS with pre-treatment in SolidWorks. Validation by comparing simple geometry which generated by this method and generated directly in ABAQUS shows a good agreement. Random geometry of a real rough surface and a deformable smooth ball is then taken for simulating real rough surface contact using finite element analysis. The result is covering on contact area, contact pressure, von Misses stress contour distribution and plot of surface topography. Random rough and sinusoidal solid surface were used in contact simulation. In the end, an experimental result is taken then generated to form finite element surface. The simulation results compared with the experimental result show identical contact area and surface topography at y-axis in $x = 288 \mu\text{m}$. These techniques, combined with the ability to model real surfaces in ABAQUS, can be used to help researchers in material science, mechanical engineering, and beyond to better understand micro scale surface contact mechanics.

Key words: Rough surface, FEM, contact mechanics, asperity

PREFACE

Praise be to Allah SWT who has bestowed his mercy and grace to the author, so I can get through the study and completed the bachelor thesis which is the final stage of the process to obtain *Sarjana Teknik* of Mechanical Engineering at the University of Diponegoro

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Author realize that in preparing this thesis there are mistakes and failures, therefore, criticism and suggestions that are built to perfection and progress in the future are encouraged. In the end, author hope that this work can be useful for all readers.

Semarang, March 2012

Author

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NOMENCLATURE

Symbol	Description	Unit
a	Radius contact area	[mm]
A	Contact area	[mm ²]
A_{c-KE}	Contact area on critical KE model	[mm ²]
A_e	Contact area elastic	[mm ²]
A_{ep}	Contact area elastic-plastic	[mm ²]
A_p	Contact area fully plastic	[mm ²]
E	Modulus elastisity	[MPa]
E^*	Effectie modulus elastisity	[MPa]
E_1	Modulus elastisity material 1	[MPa]
E_2	Modulus elastisity material 2	[MPa]
E^*	Modulus efective contact	[MPa]
H	Hardness of material	[MPa]
h	Distance between two point which is contacting each other	[mm]
p	Average contact pressure	[MPa]
p_e	Average contact pressure elastic	[MPa]
p_{ep}	Average contact pressure elastic-plastic	[MPa]
p_p	Average contact pressure fully plastic	[MPa]
P	Contact force	[N]
P_e	Contact force elastic	[N]
P_{ep}	Contact force elastic-plastic	[N]
P_p	Contact force fully plastic	[N]
P_c	Contact force during initial yield	[N]
R_e	Effective radius curvature	[mm]
R_1	Radius 1	[mm]
R_2	Radius 2	[mm]
R_x	Effective radius principal x direction	[mm]
R_y	Effective radius principal y direction	[mm]
Y	Yield modulus	[MPa]

δ	Deflection	[mm]
ν	Poisson's ratio	[-]
ω_{P1}	Plastic deformation material 1	[mm]
ω_{P2}	Plastic deformation material 2	[mm]
ω_{PL}	Plastic deformation during loading	[mm]
ω_{PU}	Plastic deformation during unloading	[mm]
e	Elastic spring back	[mm]
ω	Interference	[mm]
ω_1	Interference initial yield	[mm]
ω_2	Interference fully plastic	[mm]
ω_{1-CEB}	Interference initial yield CEB model	[mm]
ω_{1-KE}	Interference initial yield KE model	[mm]
ω_{1-ZMC}	Interference initial yield ZMC model	[mm]
ω_{2-KE}	Interference fully plastic KE model	[mm]
ω_{2-ZMC}	Interference fully plastic ZMC model	[mm]