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MSc Thesis

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**Aerodynamic Force Modification
via Base Roughness**

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the degree of Master of Science

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Abstract

This thesis report focuses on a numerical simulation done on a simplified quarter scale car model called Windsor body. Thesis report has been written during the Erasmus Scholarship Program at Cranfield University in the academic year 2012/2013. The study is based on an experimental investigation of drag reduction with passive flow control by Rob Littlewood. Measurement consist a baseline configuration and additional roughness element test cases. The results showed drag and lift reduction via the roughness. This has been numerically investigated by former Cranfield University students and my task was to further improve the model. Drag reduction is the main interest of the automotive flow and this roughness study approach present promising results.

The report includes two study investigating the drag mechanism. The Roughness Study is a project on investigating the FLUENT solver roughness options capabilities. The $k-\epsilon$ Realizable and $k-\omega$ SST turbulence models have been tested with the result that the $k-\epsilon$ is not suitable for such an investigation, while the $k-\omega$ SST performs reasonably well. The other study is based on the different vertically mounted roughness element cases flow analysis. The conclusion of the investigation is that the numerical simulation with the applied assumptions and conditions is able to estimate the drag mechanism and reproduce a realistic wake structure behind the body but only with the $k-\omega$ SST turbulence model .

Keywords

Windsor, drag, roughness, wake

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List of Symbols

Abbreviations

CFD	Computational Fluid Dynamics
RANS	Reynolds Averaged Navier Stokes
URANS	Unsteady Reynolds Averaged Navier Stokes
LES	Large Eddy Simulation
3D	3 Dimension
CAD	Computer Aided Design
PIV	Particle Image Velocimetry
LDA	Laser Doppler Anemometry
TKE	Turbulent Kinetic Energy

Notations

C0	Configuration 0 - Baseline Geometry
C1	Configuration 1 - 3 full added slat Geometry
C2	Configuration 2 - 3 short added slat Geometry
C3	Configuration 3 - 5 full added slat Geometry
C4	Configuration 4 - 5 short added slat Geometry
ROOF	Refers to roof surface in the Roughness Study Case
BACK	Refers to back and roof surface in the Roughness Study Case
R H	Refers to type of Surface Roughness Study Cases
SST	Refers to $k-\omega$ Shear Stress Transport Model
KEPS	Refers to $k-\epsilon$ Realizable Model