Wind EUROPE

CONFERENCE & EXHIBITION

2019 2-4 APRIL BILBAO

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Eneko Gorritxategi, CTO, Atten2 Advanced Monitoring Technologies

PO002 *GREENCHAIN: commercial blockchain platform of renewable origin of Acciona's fleet*
Pedro Benitez Estebanet, Blockchain Project Manager, Acciona Energía

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Jason Fields, Senior Engineer, National Renewable Energy Laboratory (NREL)

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Anna Maria Sempreviva, Senior Scientist, DTU Wind Energy

PO007 *Set up a control and monitoring room for today's power plants*
Dino Esposito, Digital Strategist, Microsoft Corporation

PO008 *Site-specific load assessment for fatigue analysis and life prediction of wind turbine components*
Mercedes Irujo, Expert in Aeroelastic and Structural Simulation of Wind Turbines, Acciona Energía

PO009 *Why data quality matters*
Bjørn Dörr Jensen, Decision Intelligence Specialist, Vestas Wind Systems A/S

PO010 *Leapfrogging the met mast: integrating lidar with simulations*
Daniel Gallacher, Senior Lidar Consultant, Wood Group

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Michael Smailes, Research Engineer Offshore Electrical Infrastructures, ORE Catapult

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Philip Totaro, CEO, IntelStor

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Jan-Hendrik Piel, Chief Information Officer, Nefino GmbH

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Bart Visser, Senior Chief Engineer, MECAL Wind

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Abbas Kazemi Amiri, Research Associate, University of Strathclyde

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Laure Fitzmaurice, Research Associate, Ulster University

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Fabrice Estézet, Head of Type Certification, Bureau Veritas

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Dionysios Andronas, Mechanical Engineer, Andronas Bros

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Eva Topham, Project Engineer, DNV GL

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Brogan Morton, Senior Product Manager, NRG Systems

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Miguel Aguirre, Mechanical Designer, ABB

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José Miguel Oliveira, Project Director, Empreendimentos Eólicos do Vale do Minho S.A.

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Maxime Bellorge, Project Sales Director, Akrocean

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Yvonne Cronin, Masters Student, University College Cork

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Philipp Schmid, Marketing Manager, SKF

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Adrian Young, Senior Aviation Consultant, To70

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Alex Raventos, CEO & Co-founder, X1 Wind

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Caroline Le Floc'h, Head of Renewables, DORIS Engineering

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Jaime Liew, Research Assistant, DTU Wind Energy

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Hans Kyling, Group Manager, Fraunhofer IWES

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Bryce Wade, MSc. Energy Technologies, Instituto Superior Técnico

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Parametric study of vane-type vortex generators under adverse pressure gradient by source term modelling in OpenFOAM

Iñigo Errasti, Unai Fernández-Gamiz, Pablo Martínez-Filgueira and Jesús María Blanco

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Abstract. The aim of the study is to analyse and characterize the primary vortices produced by single low profile vane-type vortex generators (VGs) of different heights positioned on a flat plate with a backward-facing ramp and adverse gradient pressure for an incident angle of 15º. The effect of the vortex generator is implemented by using a source term in the Navier-Stokes equations according to the so-called jBAY source term model. In order to carry out the parametric study of the primary vortex, Computational Fluid Dynamics (CFD) simulations have been performed for different VG heights using the Navier-Stokes equations at a Reynolds number of Re_θ=9100 based on the local boundary layer momentum thickness θ in open-source code OpenFOAM. As a preliminary result, the jBAY model reproduces relatively well the streamwise pressure coefficient distributions on the flat plate floor. Finally, the advantage of using this model over a fully mesh-resolved vortex generator model for certain cases must be remarked because a lower number of cells is needed in the model domain with a saving of computational time and resources.

1. Introduction

Flow separation control and the energy losses associated with the boundary layer (BL) have emerged as a key point in certain industrial fluid dynamics applications. The flow separation from a continuous surface is governed by the adverse pressure gradient and the viscosity. If the flow must remain attached to the wall, the stream should have enough energy to overcome the adverse pressure gradient, the viscous dissipation along the flow path and the energy loss caused by the modification in momentum. If the loss is such that further advancement of the fluid is no longer possible, then the flow separates from the surface.

Vortex generators (VGs) are passive devices to control flow which are able to change the motion performance of the fluid in the BL region. VGs are small vanes not aligned with the oncoming flow and they act by exchanging momentum from the distant flow region to the wall-closed inner region. Triangular and rectangular conventional VGs have been implemented onto wings of airplanes (**Figure**

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Parametric study of vane-type vortex generators under adverse pressure gradient by source term modelling in OpenFOAM

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Abstract

The aim of the study is to analyse and characterize the primary vortices produced by single low profile vane-type vortex generators (VGs) of different height positioned on a flat plate with a backward-facing ramp and adverse gradient pressure for an incident angle of 15º. The effect of the vortex generator is implemented by using a source term in the Navier-Stokes equations according to the so-called jBAY source term model. In order to carry out the parametric study of the primary vortex, Computational Fluid Dynamics (CFD) simulations have been performed for different VG heights using the Navier-Stokes equations at a Reynolds number of Re =9100 based on the local boundary layer momentum thickness in open-source code OpenFOAM. As a preliminary result, the jBAY model reproduces relatively well the streamwise pressure coefficient distributions on the floor. Finally, the advantage of using this model over a fully mesh-resolved vortex generator model for certain cases must be remarked because a lower number of cells is needed in the model domain with a saving of computational time and resources.

Objectives

The main goal of this study is to analyze and characterize the primary vortices produced by single low profile vane-type vortex generators (VGs) of different heights positioned on a flat plate with a backward-facing ramp and adverse gradient. The implementation of the vortex generator in the CFD simulations is carried out by means of the so-called jBAY source term model proposed by Jirasek [1] into the open source OpenFOAM code. As a secondary goal, we want to investigate how well the CFD simulations are able to mimic the physics of the flow behind a series of vortex generators (VGs) mounted on a three-dimensional flat plate with a backward-facing ramp and adverse pressure gradient, Fernandez-Gamiz et al. [2].

Methods

In the current work, the jBAY source term model by Jirasek [1] based on the BAY model developed by Bender et al. [3] is implemented. The BAY model was designed for simulating vane-type vortex generators into finite volume CFD codes and allows substituting the VG geometry by a subdomain of similar size at the original VG location where a specific body force distribution is then applied. In the Figure 2, the selected cells where the body force will be applied are indicated. The model is incorporated into the CFD code as a source term in the Navier-Stokes momentum and energy equations.

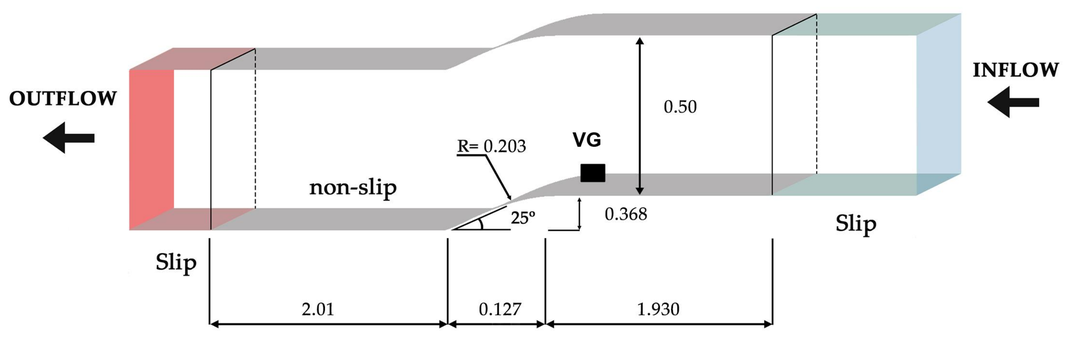

Figure 1. Description of the computational domain representing the extended wind tunnel test section. The domain dimensions are expressed in meters.

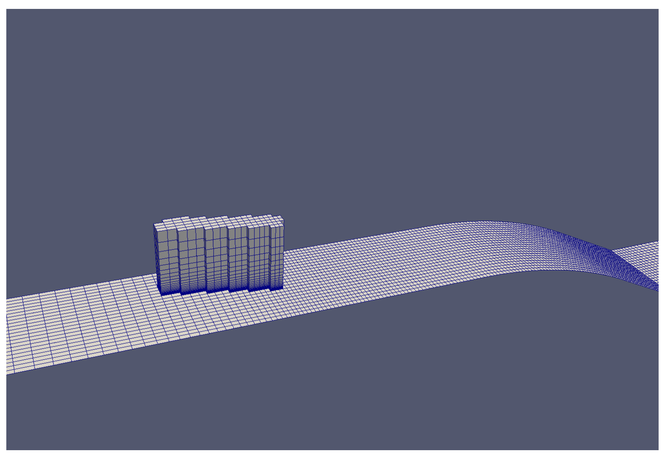

Figure 2. Selected cells representing a vane-type vortex generator (VG) of height H1=0.8 placed on a flat plate upstream the backward-facing ramp.

Results

As a preliminary result, the effect generated by the VG of height H1=0.8 placed at x=-5 upstream the ramp on the streamwise pressure coefficient distribution along a measurement line on the flat plate floor is shown in Figure 3.

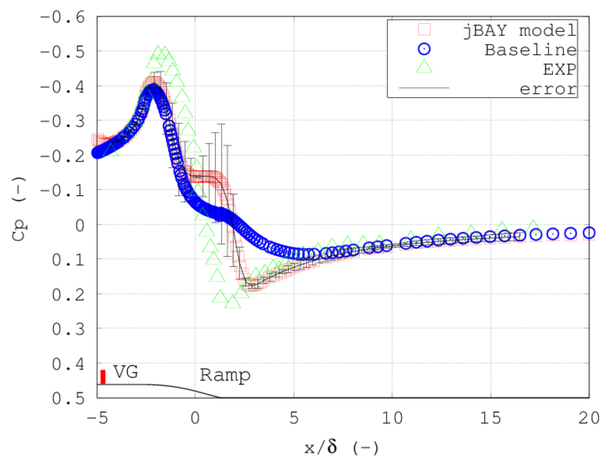

Figure 3. Streamwise pressure coefficient distribution c_p along a measurement line on the flat plate floor. The red rectangles represent the simulated data (jBAY model), the blue circles the distribution data (Baseline) obtained from the baseline simulation and the green triangles the experimental (EXP) distribution data from Lin et al. [4].

Conclusions

The generation of vortices and their effects by single low profile vane-type vortex generators of different heights positioned on a flat plate with a backward-facing ramp and adverse gradient pressure has been successfully carried out by CFD simulations using the OpenFOAM code in a preliminary approach. The influence of these vortex generators (VGs) on the computational domain flow is implemented by using a source term in the corresponding Navier-Stokes equations according to the so-called jBAY source term model.

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