

# orcaflex for offshore wind



OrcaFlex is a general purpose dynamic analysis software program suitable for a wide range of global dynamic analysis applications. Its user interface, functionality, productivity features and wide range of applications, along with very active program development and technical support, make it the leading option in its peer group.

The long-established hydrodynamic capabilities of OrcaFlex can be coupled with a built-in aerodynamic turbine model, giving a fully-coupled dynamic analysis tool suitable for both fixed and floating platform offshore wind turbines. Its analysis applications include, but are not limited to, platform motion, power cable design & installation, cable protection systems, mooring systems, turbine installation / heavy lift, and tow-out.

## **Offshore wind features include**

- Dedicated horizontal-axis turbine object
- Clockwise or anticlockwise spinning rotor
- Aerodynamic loading via Blade Element Momentum (BEM) model
- Unsteady aerodynamics models (González / Minnema Pierce)
- Flexible blades capturing aeroelastic coupling effects
- Blade pre-bend
- Drivetrain flexibility (main shaft stiffness & damping)
- Collective or individual blade pitch control
- Prandtl tip and hub loss models
- Pitt and Peters skewed wake model

- Øye dynamic inflow model
- Interface via API to blade pitch and generator torque controllers (e.g. Bladed-style DLLs)
- Choice of tower influence / shadow models
- Rayleigh damping on blades
- Spatially varying wind models including full field (turbulent) wind, as well as linear vertical shear, horizontal shear & gust speed variation
- Excellent agreement between OrcaFlex and OpenFAST / AeroDyn
- Automation tools using Python, Matlab or Excel

The back page......4

• Fully interactive User Interface

### Contents

OrcaFlex wind functionality	2
Wind turbine validation	.3

# **OrcaFlex wind functionality**

OrcaFlex is widely used for analysis work related to fixed offshore wind turbines, such as foundation and turbine installation, power cables, cable protection systems etc., which generally do not require modelling of the turbine.

For floating wind turbines however, there is a need for coupled dynamic analysis of the entire system – including the mooring system, platform, tower, turbine and nacelle.

THE PLACE										
DIVITY RAY I										
tial position and	attitude:									
Connect to				У	z	Azimuth	Declination	Gan	nma	
object			(m)	(m) (m)	(m)	(deg)	(deg)	(deg)	eg)	
Vacelle			<ul> <li>✓ -12</li> </ul>	.032 0.0	5.6141	0.0	96.0		180.0	
Imposed motio Generator Hyj Blade <u>c</u> ount:	n consistent with solver	ry Blade jne Blade gecti	ertia Blade stru ions: 50	icture BEM and UA	Tower Draw = 117.163m	ving Shaded d	Irawing Jags			
3			Section Target segment		Number of Wing type		Wing type		Cumulative values	
Pre-cone angle	deals	No.	length (m)	length (m)	segments				Length (m)	Segments
Pre-cone angle	deg):	1	1.19459	~	1 🖨	AF01		~	1.19459	1
4.0		2	2.38918	~	1 🗢	AF02			3.58377	2
Pitch control mode:		3	2.38738	~	1 🗟	AF03			5.97115	3
O Common		4	2.38876	~	1 🖨	AF04		~	8.35991	4
Individual		5	2.38957	~	1 🕏	AF05			10.7495	5
		6	2.39076	~	1 🖨	AF06		$\sim$	13.1402	6
Blade no.	Initial pitch (deg)	7	2.3897	~	1 🗟	AF07			15.5299	7
1	0.0	8	2.38833	~	1 🖨	AF08		$\sim$	17.9183	8
2	0.0	9	2.38778	-	1 🗘	AF09		~	20.306	9
3	0.0	10	2.38837	~	1 🗢	AF10		~	22.6944	10
Ritch controller		11	2.38767	~	1 单	AF11			25.0821	11
Plade Disch		12	2.38799	~	1 单	AF12		~	27.4701	12
blade Pitch V		13	2.38763	~	1 🖨	AF13		~	29.8577	13
Blade DOFs:		14	2.38844	~	1 🗟	AF14		~	32.2461	14
○ Fixed		15	2.38749	~	1 🖨	AF15		~	34.6336	15
O Free		16	2.38831	~	1 🗘	AF16		~	37.0219	16
		17	2.38742	~	1 🖨	AF17		~	39,4094	17
Rayleigh damping coefficients: 18			2.38825	~	1 🖗	AF18		~	41.7976	18
Blade damping ~		19	2.38741	~	1 单	AF19		$\sim$	44.185	19

#### Mooring system analysis

This fully-coupled dynamic capability enables efficient analysis of floating platform mooring systems.

OrcaFlex offers a variety of analysis methods: frequency domain, quasi-dynamic time domain and nonlinear finite element time domain.

#### Power cable / CPS analysis

Export power cable and cable protection system (CPS) design and installation analyses are common to both fixed and floating platform systems. Here, OrcaFlex provides all the functionality to perform all types of in-place and installation analyses, including VIV and fatigue.



#### **Floating wind turbines**

We have developed a dedicated wind turbine object, which allows you to perform this type of analysis entirely within OrcaFlex.

The OrcaFlex wind turbine uses a Blade Element Momentum (BEM) model for aerodynamic loading. Turbine blades are represented by beam elements, closely related to OrcaFlex line objects. Blade pitch can be controlled by an external function. The generator can be controlled by either rate of rotation or applied torque, each of which may take a constant value or be calculated by an external function. You can write your own external functions or take advantage of our interface to standard Bladed-style DLLs.





## Wind turbine validation

We have carried out some detailed validation studies to give us confidence in the turbine features we have added so far.

The studies compare the aeroelastic response of different floating and fixed-bottom reference wind turbines against equivalent results determined by other analysis codes e.g. OpenFAST and HAWC2.

The considered results compare the steady-state response of the rotor, as well as the structural dynamics of the turbine blade & tower to different wind conditions.

Overall, we have found the results to be in very close agreement, supporting both the validity of the OrcaFlex turbine model and consistency across the considered aeroelastic codes.

Shown here are some select results comparisons for the International Energy Agency's (IEA) 15 MW reference wind turbine (RWT).



NREL 5MW RWT on OC3 Hywind floater



IEA 15MW RWT validation model



15MW RWT steady-state generator power & blade pitch (left) and the blade & tower response to turbulent wind (right)

### **Further information**

Please contact us at orcina@orcina.com or check out the available resources on our website, including:

- Wind turbine validation reports, showing validation of the OrcaFlex turbine model against both fixed and floating platform systems: www.orcina.com/resources/validation/
- Example OrcaFlex turbine models. Note that these models can be viewed with the OrcaFlex demo if a full licence is not available: www.orcina.com/resources/examples/?key=k
- Wind turbine controller example set, modelled using external functions: https://github.com/Orcina-Ltd/turbine-controllers/

# orcaflex

# the back page

# **Further applications**

OrcaFlex can also be used for a huge range of other applications, including:

- Riser Systems: TTRs, SCRs, hybrids, flexibles, umbilicals, offloading & floating hoses
- Installation: Risers, moorings, anchors, lift dynamics, subsea hardware, floatover, decommissioning, etc.
- **Moorings**: Global Performance, coupled, permanent & mobile, SPMs, TLPs, SPARs, oceanographic & jetty, etc.
- Pipelines: on-bottom stability, spans, VIV analysis, trawl impact, etc.
- Renewables: compliant wind & wave systems, power cables.
- Towed Systems: Bundles, seismic arrays, towed fish, etc.
- Other applications: aquaculture, booms, sea-fastening, minesweeping,...

# **Key features**

- Time and Frequency Domain solvers
- Automate via Excel, Python, Matlab, C+
- +, etc
- Proven FE engine
- Most efficient & robust in class

# **Commercial options**

OrcaFlex is easily the most cost-effective in its peer group

- All-in-1 package no extra modules
- Multi-threading at no extra cost
- 'Distributed' tool boosts throughput
- Comprehensive MUS (Maintenance,
- Upgrades & Support) contract
- Multi-copy price discounts
- Purchases include a free MUS period
- Month-by-month leasing, includes MUS
- Lease-to-purchase credit option

# **More information**

Please see our website for OrcaFlex release information, User Group Meetings, training courses, newsletters, papers, validations, technical notes, and many other resources.

# About Orcina

Founded in 1986, Orcina is now widely recognised as a global leader in its field, with a well-established reputation for innovation, excellence and real-world capability. Our software and approach is flexible enough to accommodate the needs of large corporates requiring hundreds of licenses and individuals who just require one. The core sectors we serve are focused on research, analysis and engineering in oil & gas, wet renewables, oceanographic, seismic, defence, and aquaculture. However we are constantly developing our software to meet the needs of evolving engineering challenges and new market requirements.



Orcina Limited +44 (0)1229 584 742 orcina@orcina.com www.orcina.com

# OrcaWave diffraction solver

- Coupled or uncoupled analysis
- Major releases annually
- Best-in-class technical support
- Worldwide annual user meetings

#### Orcina Agents

Orcina is supported in its marketing and technical support activities by the following agents:

#### USA, Canada & Mexico

Jacob Technologies Paul Jacob pj@jtec-tx.com +1 713 398 9595

Heron Offshore Dongmei Chu dchu@heronoffshore.com +1 832 725 2438

#### South Korea

SACSKO OceanTech Hyunwoo Jang hyun.j@sacsko.com +82 2 421 8018

#### South America

NSG Engenharia Nelson Galgoul nelson.galgoul@nsg.eng.br +55 21 99995 9212.

#### **Social Media**

If you use LinkedIn please follow us: Orcina Ltd

