Flexcom

Advanced simulation software for dynamic offshore structures

November 2024

A software newsletter by Wood

WELCOME

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Flexcom Product Manager

Wood is pleased to announce the release of Flexcom 2025.1. This version incorporates several significant new features, including a flexible blade model for wind turbines, accounting for blade deformations, rotor inertia, and low speed shaft torque. Numerous improvements have been made to the zero-gap guide feature, providing greater options in terms of contact modelling. A host of other helpful features are present, including postprocessing via Python, element twist loading, a licence monitoring feature, and several new examples. Full details may be found in this newsletter.

We receive many helpful suggestions from our users and our focus is on delivering new features in the areas where you need them most. We welcome your continued feedback on Flexcom, it is an essential part of our software development process. So please feel free to contact me directly, you'll find my contact details below.

We hope you enjoy working with Flexcom 2025.

Kind regards
Aengus

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Flexcom 2025.1 Highlights

Wind Turbine Modelling

- New flexible blade model, accounting for blade deformations, rotor inertia, and low speed shaft torque
- Aerodynamic and control variables now available in Summary Postprocessing
- Updated version of OpenFAST now coupled with Flexcom
- Printout of aerodynamic forces in OUT file for detailed scrutiny
- New example added to the Wind Energy section: *Example L5 – Stiesdal Tetraspar*. Paper published at OMAE 2025 summarising Flexcom modelling of the Stiesdal Tetraspar in OC6 Phase IV (IEA Wind Task 30)
- Several extensions to Wind Energy *Example L4 – UMaine Semi-sub*

Zero-Gap Guides

- Stiffness based contact model
- Contact zone input (also added for flat guides)
- Advanced friction model
- Node rotation lock
- Display diameter

Postprocessing

- Python interface
- Sidewall pressure
- Nodal displacements in a local axis system
- Summary postprocessing with smart units on plots

Miscellaneous

- Element twist feature
- Dynamic buoyancy
- Variable time step, as a function of time
- Support for Shear7 v4.12
- New Fortran compiler
- Licence Monitor Feature
- New example: *Example J5 – Tower Crane & Pulleys*

Fault Corrections

- Flexcom 2025.1 corrects several program faults identified in the preceding version. Refer to Known Software Faults for further information.

Contents

Software Installation

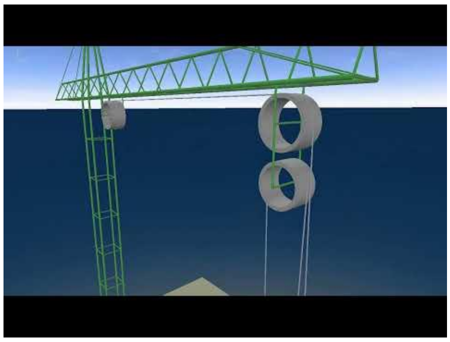
Flexcom 2025.1 is now available for download.

Download Flexcom

Should you have any questions, refer to our Software Installation Guide, or Contact our Support Team.

Join the Flexcom Community!

We have over 4900 followers on LinkedIn and we encourage everyone to sign up. You will find some very interesting videos on the page, such as the one below…



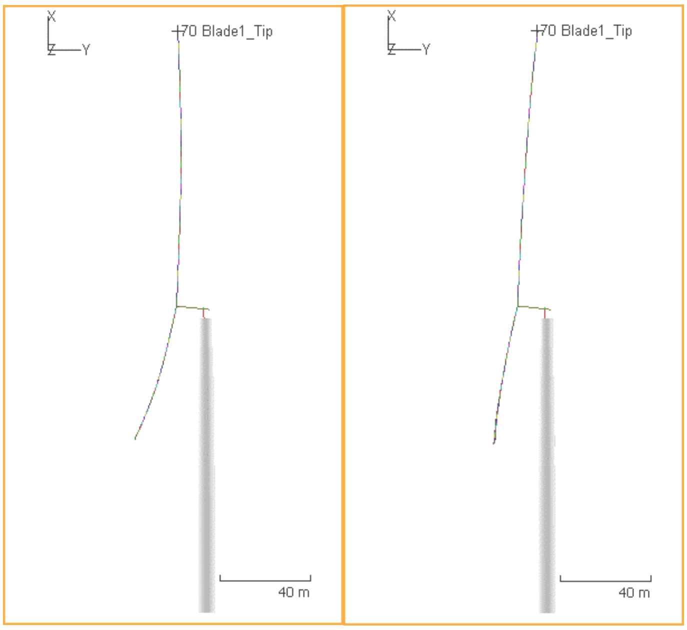
If you have an interesting model which you would like to share with the Flexcom community, please contact us.

Wind Turbine Modelling

Blade Flexibility

A fully flexible rotor blade model has been introduced in Flexcom 2025.1, in which the rotating blades are modelled explicitly using finite elements thereby capturing local blade deformations and their effects on aerodynamic loads. In earlier versions up to and including Flexcom 2022.1, a simplified rotor nacelle assembly (RNA) model was provided, which models the blade geometries as rigid profiles. While this provides a robust modelling approach, variations in aerodynamic loading due to blade deformations are not captured. The new RNA model represents a significant advance on this.

Model construction is automatically handled by Flexcom, you simply enter the required data via a series of new keywords: *BLADE GEOMETRY, *BLADE STRUCTURE, *TURBINE ROTOR and *TURBINE GEOMETRY. These data inputs are based on OpenFAST and will be intuitively familiar to any engineer with prior knowledge of wind turbine modelling. In fact, the blade information may be simply copied and pasted directly from OpenFAST if you are modelling one of the standard turbines which are publicly available; the Flexcom Wind Examples already cover two of these (NREL 5MW and IEA 15MW).



No Wind **10m/s Wind**

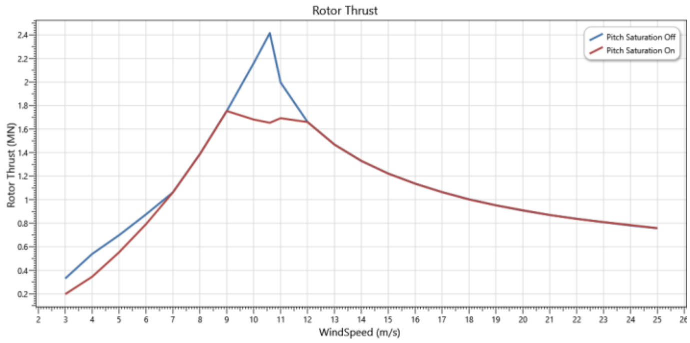
The (low speed) shaft is also modelled using beam elements. The shaft rotates within a rigid shaft housing concentric with it, with the rotor bearings simulated using freely rotating hinge elements. Generator torque on the shaft is simulated using a rotational damper element. Blade pitch control is modelled using a torsional actuator feature which allows a twist to be applied to the blade root element without imparting any torsional strain to the blade structure. Yaw control is handled in a similar manner via the yaw bearing element. These modelling features have been developed in Flexcom specifically for application in wind turbines.

A related benefit of the flexible rotor model is that the rotational inertia of the blades is also captured. Additionally, in the case of a floating platform, the gyroscopic moment induced by the continually changing orientation of the rotor axis, caused by platform pitch and/or yaw in the ocean environment, is automatically included in the solution.

To demonstrate the modelling accuracy of Flexcom regarding the aerodynamic and structural modelling of the RNA, the new modelling capability has been validated against OpenFAST.

Summary Postprocessing

All the standard output variables associated with rotor aerodynamics and turbine control are now available in Summary Postprocessing and Collation. For example, you can examine the steady-state performance of the turbine as a function of wind speed, including key variables such as rotor thrust, rotor speed, generator torque, blade pitch, generator power etc.

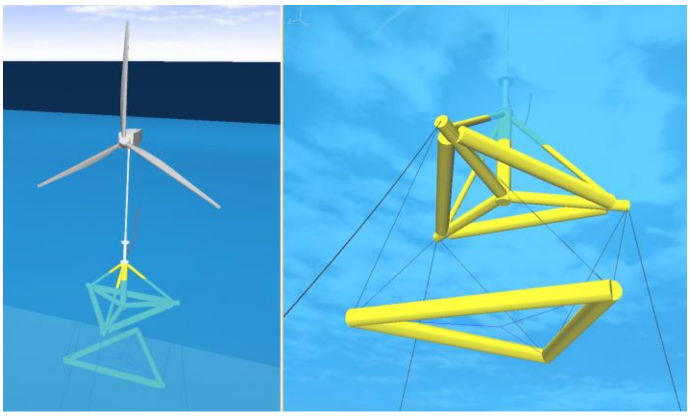


OpenFAST Version

Flexcom 2025.1 is coupled with OpenFAST V3.5.3 (April 2024), the latest version on general release at the time of our software development programme. This ensures that Flexcom users are using the latest aerodynamic modelling code available to the OpenFAST user community. Previously, Flexcom 2022.1 was coupled with OpenFAST V2.6.0 (May 2021).

Example L5 – Stiesdal Tetraspar

The Tetraspar FOWT platform features a unique design with a low centre of gravity which gives the platform stability which is comparable to a spar, whilst retaining the construction and installation advantages of a semi-submersible. The platform is comprised of two separate steel sub-structures, a floating hull which supports the tower and wind turbine, and a keel which is suspended beneath the waterline. The lower keel structure has a high density and hence results in an overall low centre of gravity for the platform. The sub-structures (hull and keel) are connected via synthetic ropes which are referred to as keel lines. The structure is versatile and therefore, does not require deep-water ports. Additionally, the tubular steel members are readily manufacturable and do not require welding during assembly. See Example L5 – Stiesdal Tetraspar for further information.



Conference Paper

We presented a conference paper at OMAE 2025 summarising Flexcom modelling of the Stiesdal Tetraspar in OC6 Phase IV (IEA Wind Task 30). It may be obtained from the conference organisers at https://doi.org/10.1115/OMAE2024-126681.

Output File

The software coupling between Flexcom and OpenFAST may be examined in detail using the *PRINT keyword. You may request a printout of the aerodynamic forces being applied to each individual blade node. You may also inspect the direction cosine matrices (DCMs) which Flexcom passes to AeroDyn at each timestep. Although the latter is of specialised interest, it provides full transparency regarding the internal workings of the software.

Zero-Gap Guides

Several enhancements have been made to zero-gap guide surfaces. All these new features may be invoked using the *GUIDE keyword.

Contact Model

Lateral restraint provided by the guide is modelled using elastic stiffness terms. The contact stiffness is specified in units of N/m or lb/ft, depending on the unit system employed. This contrasts with previous versions of Flexcom where boundary conditions were used. A stiffness-based approach offers increased numerical stability.

Contact Zone Diameter

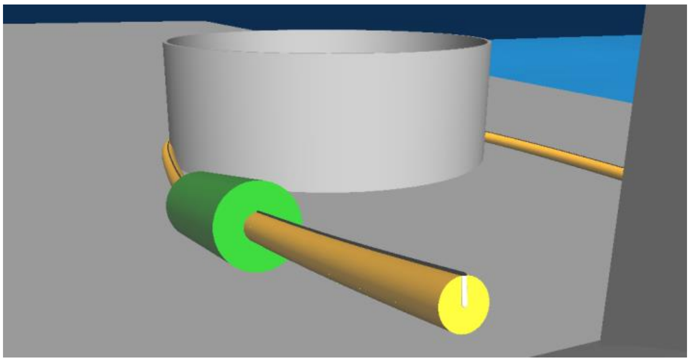
The contact zone diameter identifies a cylindrical region enclosing the guide within which nodes are monitored for contact. This means that only nodes close to the contact surface are checked, and nodes relating to other parts of the model may be disregarded.

Friction Model

Longitudinal restraint due to frictional resistance is modelled using a stiffness-based approach also. For loads lower than the limiting friction, a non-linear stiffness term provides the resistance. Beyond this limit, resistance is provided by a force term equal in magnitude but opposite in sign to the limiting friction. The spring stiffness is determined by the mobilisation length which is 5% of the characteristic length, the latter being a user input, and the normal reaction force. If omitted, the characteristic length defaults to 10% of the guide length.

Node Rotation Lock

This new feature allows rotational restraints to be applied to the contact nodes. When switched on, any nodal rotations present when a node enters the guide are maintained (using boundary conditions) until the node leaves the guide.



Display Diameter

Zero-gap guides are displayed using auxiliary elements, sized by a user-specified display diameter. If none is specified, the display size defaults to 0.1m or 0.1ft, depending on the local unit system.

Output File

Guide surface contact may be monitored in detail using the *PRINT keyword. This new option provides greater transparency regarding the internal workings of the software.

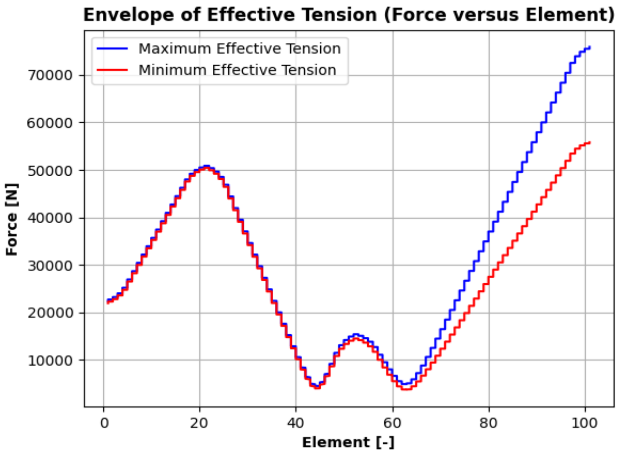
Contact Zone Input for Flat Guides

This new entry defines a rectangular cuboid underneath the guide within which nodes are monitored for contact. This contrasts with previous versions of Flexcom where the contact zone was infinitely large, meaning that any node beneath the guide is deemed to be in contact, regardless of the separation distance between node and guide. The new feature means that only nodes close to the contact surface are monitored for contact, and nodes relating to other parts of the model may be disregarded.

Postprocessing

Python Interface

Python offers a useful means of extracting data from Flexcom results databases, given its ease of use, flexibility, and suitability for first-time programmers. The simplest way to use Python with Flexcom is to invoke the VBA functions which underpin Flexcom's Excel Add-in. Example J02 - Advanced Database Postprocessing now includes a sub-section on data retrieval via Python. The sample code accesses a Flexcom database, retrieves time histories of effective tension and bending moment, and evaluates maximum and minimum values as a function of time. It creates an Excel version of the output and plots the data as PNG images.



Sidewall Pressure

Sidewall pressure has been added as a new postprocessing variable. It is computed based on effective tension and curvature:

$$P_{SW} = T_{eff}\left(\kappa_y \sin\theta + \kappa_Z \cos\theta\right)$$

where Teff is effective tension and Ky and Kz are the curvatures about the local y- and z-axes, respectively. These are combined to produce curvature at a particular angle θ around the element circumference.

Nodal Displacements in a Local Axis System

*TIMETRACE (database postprocessing) and *PARA KINEMATIC (summary postprocessing) now accept a local axis system in which to extract nodal displacements. For example, this feature could be useful when examining blade tip displacements out of the rotor plane in a wind turbine simulation.

As a modelling convenience, the *AXIS/VECTOR keyword has also been extended to accept the definition of a local axis system based on the nomination of two node numbers or node labels, the first an origin node, the second a local x node. The local x vector is formed by the straight line connecting the origin node to the local x node, and then normalised to a unit vector. The local y and local z vectors are formed automatically by Flexcom using cross products. As the local y and local z vectors are somewhat arbitrary, the node-based axis system definition is most useful when you are interested in one particular direction only. For example, if you would like to monitor out of plane displacements, you would set the local x vector to be perpendicular to the plane of interest. In a wind turbine simulation, you could nominate the front and rear shaft nodes to define the local axis system and then extract out of plane displacements.

Smart Units in Summary Collation

Summary collation plots and spreadsheet now have smart units (e.g., kN rather than base units of N).

Miscellaneous

Element Twist

Twist Loading allows you to apply a twist load about an element's local axis. You specify the angle of twist φ in degrees which is to be applied to an element. This can be expressed as a torsional strain ε_T in radians/metre, taking the element length into account.

$$\varepsilon_T = \frac{\varphi}{L}$$

The torque force T induced by the torsional strain is governed by the torsional stiffness GJ.

$$T = GJ.\varepsilon_T = GJ.\frac{\varphi}{L}$$

If the element is fixed at one end and free to rotate at the other end, the free end will experience a twist equal to φ. If the element is rotationally constrained at both ends, the element will experience a torque force equal to T. The direction of twist follows a right-hand rule with respect to the element convected axis system, so a positive twist tends to rotate the local-y axis towards the local-z axis. A negative twist acts in the opposite direction.

In terms of practical applications, the twist feature is used by Flexcom to model blade pitch control and turbine yaw control.

Dynamic Buoyancy

The presence of waves causes dynamic pressure fluctuations resulting in changes to buoyancy forces. Wave-induced pressure variations reduce with depth below the mean water line so that in deep water the hydrostatic pressure accounts for practically all the uplift force. Closer to the mean water line, dynamic pressure effects can be significant. The dynamic component of buoyancy force was not automatically included until now, but this has been rectified in 2025.1.

Variable Time Step

The variable time stepping parameters (e.g., max, min, etc.) may be varied over the course of a simulation if desired. It may be useful if modelling circumstances change significantly at some point during a time domain simulation. Several Flexcom users have asked for this feature so there must be applications out there!

Shear7 v4.12

Flexcom 2025.1 supports Shear7 v4.12, the latest version on general release at the time of writing. Refer to the Shear7 website for further details of new features available in this version.

Fortran Compiler

Flexcom 2025.1 uses modern Intel technology including oneAPI 2023.1. You may notice a slight performance improvement in your Flexcom simulations.

Licence Monitoring

Flexcom provides a license monitoring feature which allows you to check how many licenses are currently in use and which computers they have been assigned to. It creates a log file, *Licencing.fclog*, which contains a record of license transactions enacted by all Flexcom users in your organisation. As the feature operates via the Network Licensing Client app, it is completely generic and works with NetHASP Hardware Dongles and Web Hosted Licensing. Also, it doesn't matter if the users are in the office or working remotely (provided they have an active VPN connection).

Licence Client Logging Report

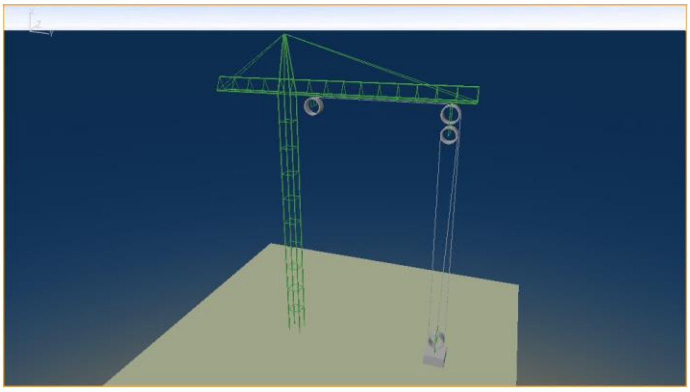
According to information in the log, as of 12 November 2024 12:10,

Machine: FZBWJS3
Flexcom - Modes Module
Flexcom - Fatigue Module
Flexcom - Main Module

Machine: 615LZ33
Flexcom - Main Module
Flexcom - Modes Module
Flexcom - Fatigue Module

Example J5 – Tower Crane & Pulleys

A new example has been added to the Specialised Examples section. The crane lifts a 10ton block from the ground up to an elevation of 14m. A 32mm wire rope is used, designed to support a safe working load of almost 12tons. The pulley diameters are set equal to 40 times the cable diameter. The tower is equipped with 3 pulleys on the hoist, two at the end of the jib, and one at the lower end of the hoist close to the hook/weight. Another pulley close to the tower facilitates the lifting process. The cable is reeled onto the tower pulley at a constant rate of 0.1m/s.



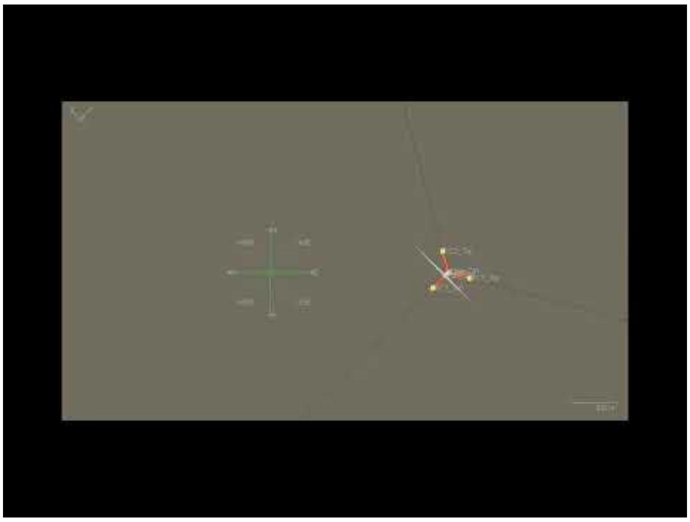
The pulleys are modelled using cylindrical guide surfaces with relatively high contact stiffness to prevent any significant penetration of the pulley surfaces by the cable. The tower pulley in particular, has a very high contact stiffness which is capable of withstanding the compressive radial loads exerted by multiple wraps of cable as the block is lifted upwards. The upper end of the cable is attached to a rigid frame within the tower pulley. The frame and pulley are rotated at a constant speed using a time history file, causing the cable to wrap itself around the contact surface. The mesh density is relatively fine in order to model the cable-pulley interaction in sufficient detail. See Example J05 - Tower Crane & Pulleys for further information.

Excel Output for RAO Plots

You have the option of creating Excel versions of plots, via the *OUTPUT FILES keyword. This feature was unavailable for RAO plots in previous versions, an oversight which has been rectified now.

Did you know…

You can quickly add a directional compass to your Flexcom model using a small number of auxiliary nodes and elements. This helps to visualize how the model and applied loading align with their real-world orientations, as illustrated in this video clip.



Fault Corrections

Flexcom 2025.1 corrects several program faults identified in the preceding version. Refer to the online documentation on Known Software Faults for further information.