



Template

Sections

Materials

XFrames

Restraint

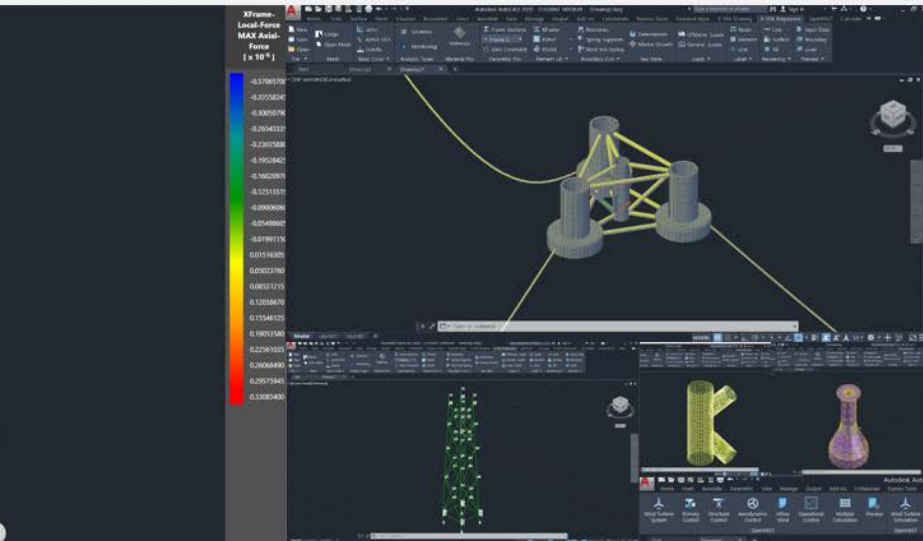
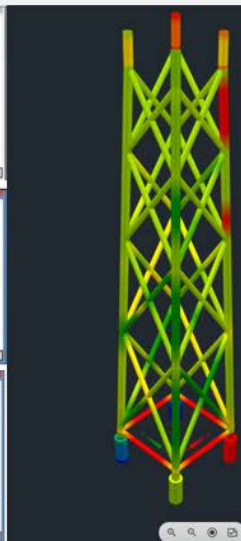
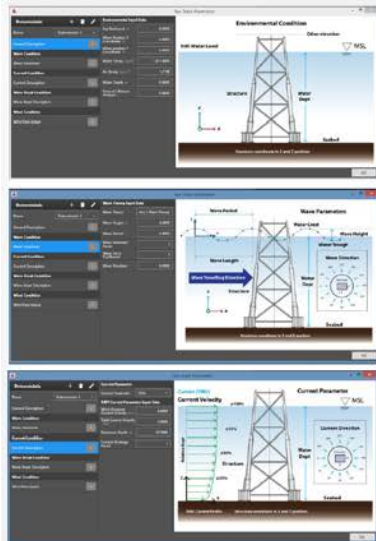
Primary  
ControlStructural  
ControlAerodynamic  
ControlOperational  
Control

Run

Post  
Processing

# Web-OpenFAST

(Web base program of OpenFAST:  
Fixed Framed offshore Structure is available at present)



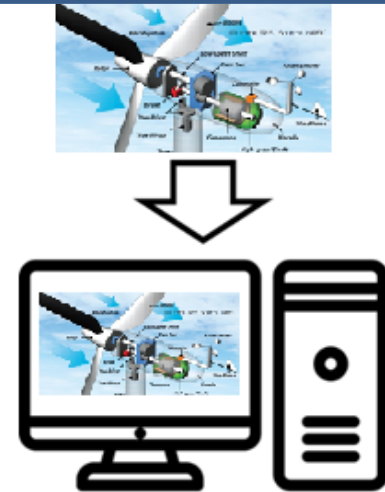
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# Introduction

- A **web base program** is also called a web application, which is a web service that allows you to use the functions of an application through a web browser without installing a separate application.
- It can be a web service that allows various functions of engineering solutions to be performed in one web after network connection.



OpenFAST is installed inside website.

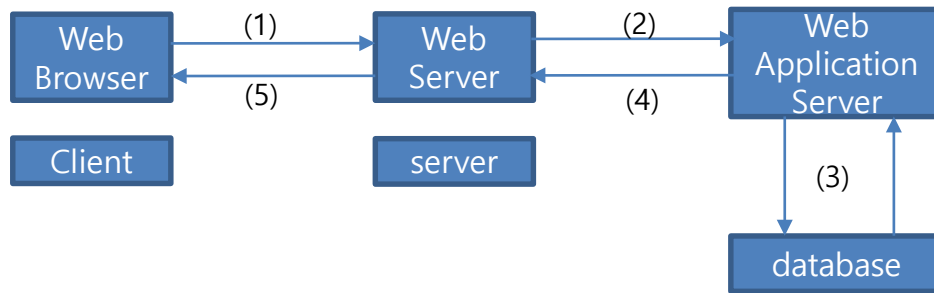
- Web programming basically takes the form of a client/server method. When a client (web browser) requests a specific content to a web server, the web server processes it and responds to the client (web browser).
- Cloud computing is a model that enables integrated access and use of the network to meet the needs of users from anywhere. It allows users to choose which services to receive and how according to their needs.



OpenFAST is in clouding system.

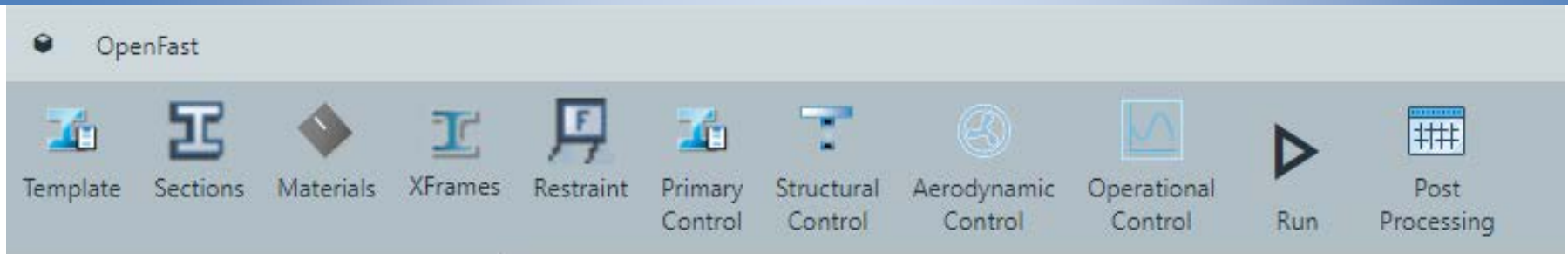
# Structure of web application

A web application is a program that runs on the web. Therefore, the relationship between web programming and web applications can be said to be 'implementation of web applications through web programming'. The structure of the web application is as follows.



- The processing order of the web application is
- (1) when a web browser requests a analysis from a web server,
  - (2) the web server receives the web browser's request and requests the application server to process them for interworking with the logic and database of the requested page.
  - (3) At this time, the web application server performs database and data processing if it needs to interwork with the database.
  - (4) Sends the processing result of the logic and database operation back to the web server.
  - (5) The web server then responds to the web browser again.

# Ribbon Menu of Webase Program: Web-OpenFAST.

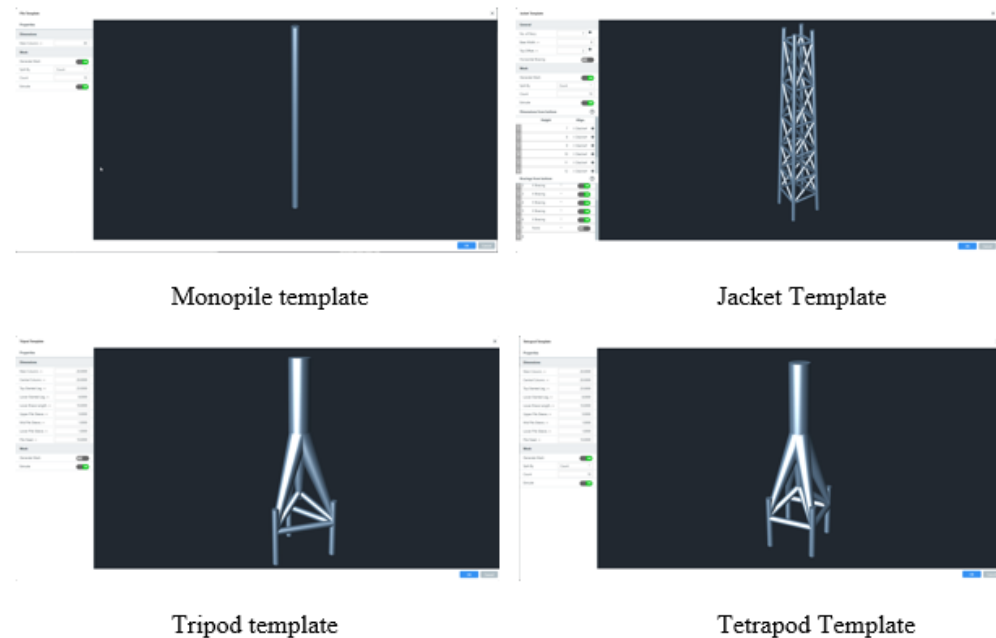


## Ribbon menu

OpenFAST (Fatigue, Aerodynamic, Structures, Turbulence) integrated software package is a comprehensive aeroelastic simulator capable of predicting both extreme and fatigue loads of two and three bladed horizontal axis wind turbines on onshore and offshore system. The main component of the program is contained template, section, material, element library (Xframe), restraint, primary control, aerodynamic control, operational control and post processing

## Template

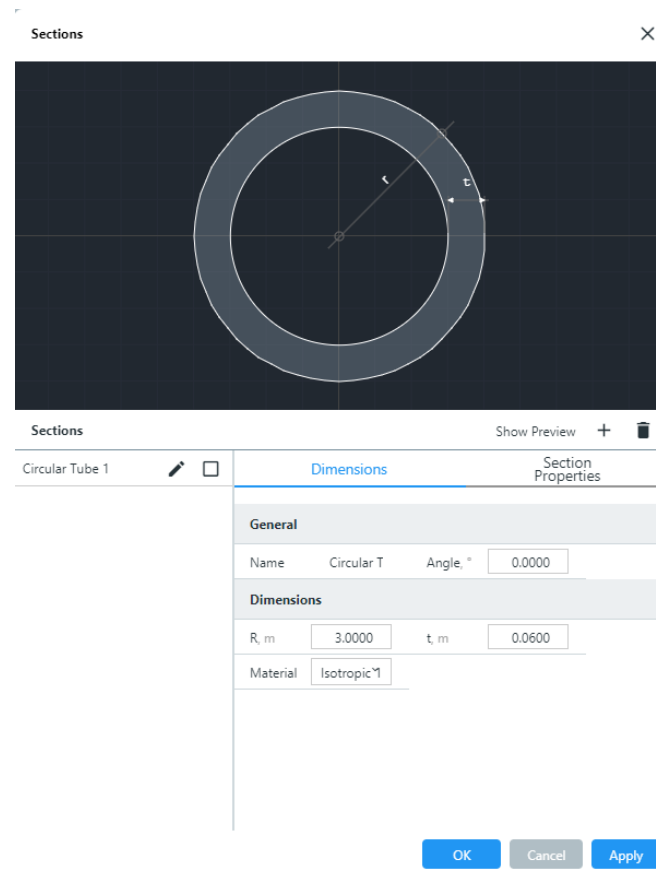
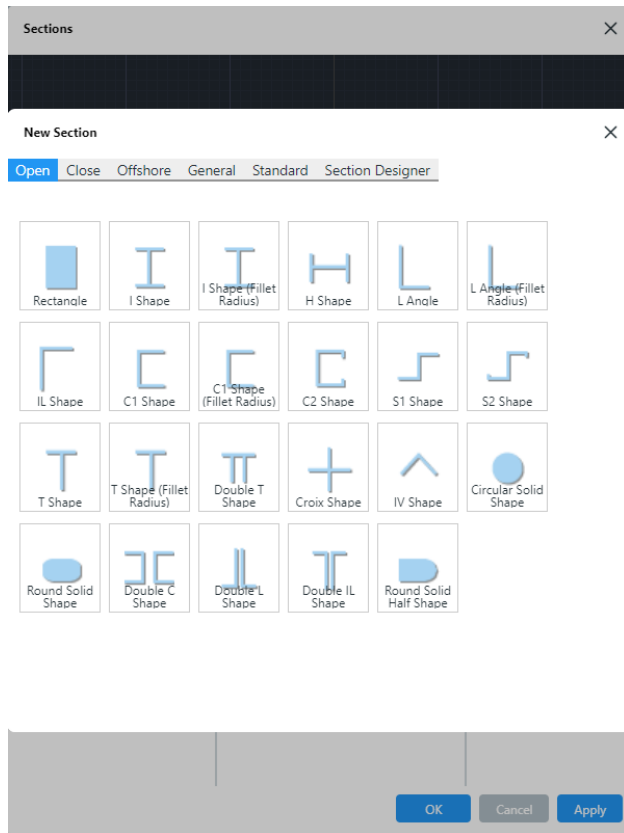
Generate offshore wind turbine structure using tools in SI unit, is allow edit length of section and size of mesh for monopile, jacket, tripod and tetrapod structure.



# Ribbon Menu of Webase Program: Web-OpenFAST.

## Section

The geometric properties of elements that cannot be defined by the coordinates of the nodes. This usually refers to the element cross-section properties. There are five section types, integrated into program: open section, close section, offshore section, general section, standard section and section designer.



# Ribbon Menu of Webase Program: Web-OpenFAST.

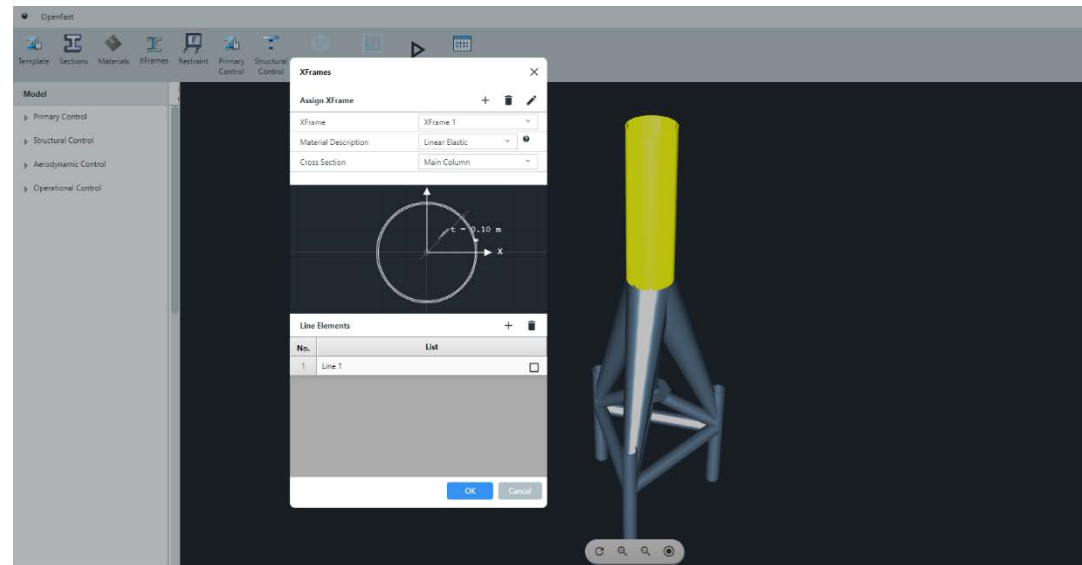
## Materials Properties

An intensive property of a material for wind turbine offshore structure, may use variety of material type including isotropic, steel, geotechnical, concrete, cable and prestress properties are provided

	Name	E (N/m <sup>2</sup> )	G (N/m <sup>2</sup> )	Poisson	Density (kg/m <sup>3</sup> )	Plasticity Properties
1	Isotropic 1	2.1000e+11	8.1000e+10	0.3	7.8500e+3	off
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						

## Xframe

Xframe is assigning tools for geometry section into drawing frame structure which is a three dimensional (3D) and 2-node frame element model.



# Ribbon Menu of Webase Program: Web-OpenFAST.

## Restraint

Boundary conditions at the supported nodes are specified by means of global supports. Three translation and three rotational restraints are provided for each global support whose directions.

The Restraint dialog box shows a list of restraints for 'Constraint 1'. The restraints are U, V, W, Ox, Oy, and Oz. U, V, and W are currently turned ON, while Ox, Oy, and Oz are turned OFF. Below the restraints is a 'Nodes' section with a 'Refresh' button and a table listing nodes. The table has columns for 'No.' and 'List'. Node 1 is listed as 'Node 3'. At the bottom are 'OK' and 'Cancel' buttons.

No.	List
1	Node 3

## Primary control

A Primary control is describing a wind turbine file controller. A blade, tower, furling, structure and aerodynamic parameters and wind-time histories are read from separate files. Most of input files are divided into five window sections: (1) Simulation Control, (2) Feature switch and flags, (3) Output control, (4) Linearization control, (5) Visualization control.

The Primary Control dialog box is divided into five sections: Simulation Control, Feature Switches and Flags, Output Control, Linearization Control, and Visualization Control. The Simulation Control section includes parameters like Echo Input Data (OFF), Error Level (Warning), Total Run time (60), Time Step (0.01), Interpolation Order (Linear), Number of Correction Iteration (1), Time to Get Jacobian (99999), and Scale Factor for Jacobians (1000000). The Feature Switches and Flags section includes Compute Structural Dynamics (ElastoDyn), Compute Inflow Wind velocities (Still Air), Compute Aerodynamic Loads (AeroDyn v15), Compute Control and Electrical-drive Dynamics (ServoDyn), Compute Hydrodynamic Loads (None), Compute Sub-structural Dynamics (None), Compute Mooring System (None), and Compute Ice Loads (None). The Output Control section includes Print Summary Data (ON), Amount of Time on Screen (1), Amount of Time Checkpoint (99999), Time Step for Tabular Output (0.05), Time to Begin Tabular Output (0), Tabular Output Binary File (Text File), TabDelim (OFF), and Format Used for Text Tabular Output (ES10.3E2). The Linearization Control section includes Linearization Analysis Option (OFF). The Visualization Control section includes VTK Visualization Data Output (None).



# Ribbon Menu of Webase Program: Web-OpenFAST.

## Structural Control

The structural control is divided 11 modules: (1) Simulation Control, (2) Environmental Condition, (3) Degree of Freedom, (4) Initial Condition, (5) Turbine Configuration, (6) Mass and Inertia, (7) Blade, (8) Rotor-Teeter, (9) Drivetrain, (11) Tower, (12) Output Control. Most of data describe basic tower-top properties, bladed properties and structure degree of freedom.

The screenshot displays the 'Structural Control (ElastoDyn)' ribbon menu in the Web-OpenFAST software. The interface is organized into several panels:

- Simulation Control:** Includes 'Echo Input Data' (set to TRUE), 'Integration Method' (Runge-Kutta 4th Order), and 'Integration Time Step, s' (Default).
- Environmental Condition:** Includes 'Gravity, m/s<sup>2</sup>' (9.80665).
- Blade DOF:** Includes 'Flapwise Model1', 'Flapwise Model2', and 'Edge-wise Mode', all set to ON.
- Nacelle DOF:** Includes 'Rotor-Teeter' (OFF), 'Drivetrain Rotation' (ON), 'Generator' (ON), and 'Yaw' (ON).
- Tower DOF:** Includes 'Fore-Aft Mode1', 'Fore-Aft Mode2', 'Side-Side Mode1', and 'Side-Side Mode2', all set to ON.
- Platform DOF:** Includes 'Horizontal Surge', 'Horizontal Sway', and 'Vertical Heave', all set to ON.
- Vertical Heave:** Includes 'Roll Tilt', 'Pitch Tilt', and 'Yaw', all set to ON.
- Rotor:** Includes 'Out-of-plane-tip Displacement, m' (0), 'In-plane-blade-tip Deflection, m' (0), 'Blade 1 Initial Pitch, °' (0), 'Blade 2 Initial Pitch, °' (0), 'Blade 3 Initial Pitch, °' (0), 'Teeter Angle' (0), 'Azimuth Angle for Blade 1, °' (0), and 'Rotor Speed, rpm' (12.1).
- Top Tower:** Includes 'Nacelle-yaw Angle, °' (0), 'Fore-aft Tower-top Displacement, m' (0), and 'Side-to-side Tower-top Displacement, m' (0).
- Platform:** Includes 'Platform Horizontal Surge, m' (0), 'Platform Horizontal Sway, m' (0), 'Platform Vertical Heave, m' (0.0009), 'Platform Roll Tilt, °' (0), 'Platform Pitch Tilt, °' (0), and 'Platform Yaw Rotational, °' (0).
- Rotor (Parameters):**
  - Number of blades: 3 blades
  - Distance form Rotor Apex to Blade Tip, m: 63
  - Distance form Rotor Apex to Blade Root, m: 1.5
  - Blade 1 Cone Angle, °: -2.5
  - Blade 2 Cone Angle, °: -2.5
  - Blade 3 Cone Angle, °: -2.5
  - Distance from Rotor Apex to Hub Mass, m: 0
  - Azimuth Value to Use for I/O Blade 1 Point Up, m: 0
  - Distance from Yaw Axis to Rotor Apex, m: -5.0191
  - Distance of Rotor Apex to Shaft Strain Gage, m: 1.9125
  - Rotor Shaft Tilt Angle, °: -5.0191
- Nacelle:**
  - Downwind Dist from Tower Top To Nacelle CM, m: 1.9
  - Lateral Dist from Tower Top To Nacelle CM, m: 0
  - Vertical Dist from Tower Top To Nacelle CM, m: 1.75
  - Downwind Dist from Tower Top To Nacelle IMU, m: -3.09528
  - Lateral Dist from Tower Top To Nacelle IMU, m: 0
  - Vertical Dist from Tower Top To Nacelle IMU, m: 2.23336
- Tower:**
  - Distance from tower top to rotor shaft m: 19.6256
  - Tower Height Above Ground or MSL, m: 87.6
  - Tower Height Base Above Ground Level or MSL, m: 10



# Ribbon Menu of Webase Program: Web-OpenFAST.

## Aerodynamic control

Aerodynamic 15<sup>th</sup> version is based on the principles of actuator lines, where the three-dimensional (3D) flow around a body is approximated by local two-dimensional (2D) flow at cross sections, and the distributed pressure and shear stresses are approximated by lift forces, drag forces, and pitching moments lumped at a node in a 2D cross section

**Beddoes-Leishman Unsteady**

Unsteady Aero Model: Minemima/Pierce Variant

Flookup:  TRUE

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**Airfoil Information**

Interpolation method: 1D interpolation on AoA

Angle of Attack: 1

Lift Coefficient: 2

Drag Coefficient: 3

Pitching-Moment Coefficient: 4

CP (min) Coefficient: 0

Airfoil Data Input: None

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**Rotor/Blade Properties**

UseB/Cm:  FALSE

Airfoil Data Input: None

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Type of Tower Influence: AOC

**Tower Influence Data Table**

Tower Influence Data Table of AOC

Generate Summary File:  TRUE

---

**Blade Output**

Number of Blade Node Table: >

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**Tower Output**

Number of Tower Node Table: >

---

**Output Lists**

Table of Output List: >

**Model**

- Primary Control
- Structural Control
  - Simulation Control
  - Environmental Control
  - Degree of Freedom
  - Initial Conditions
  - Turbine Configuration
  - Mass and Inertia
  - Blade
  - Rotor-Teeter
  - Drivetrain
  - Tower
- Output Control
- Aerodynamic Control
- Operational Control

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**Aerodynamic Control (AeroDyn V.15)**

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**General Option**

Echo:  FALSE

Time Step, s: Default

Type of wake/induction model: None

Type of Blade Airfoil: Beddoes-Leishman Model

Type Tower Influence: Baseline Potential Flow

Calculate Tower Influence: None

Calculate Tower Aerodynamic:  TRUE

Frozen Wake During Linearization:  FALSE

Perform cavitation check:  FALSE

Flag to compute AeroAcoustics:  FALSE

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**Environmental Condition**

Air Density, kg/m<sup>3</sup>: 1.225

Kinematic Air Viscosity, m<sup>2</sup>/s: 0.00001464

Speed of Sound, m/s: 335

Atmospheric Pressure, Pa: 103500

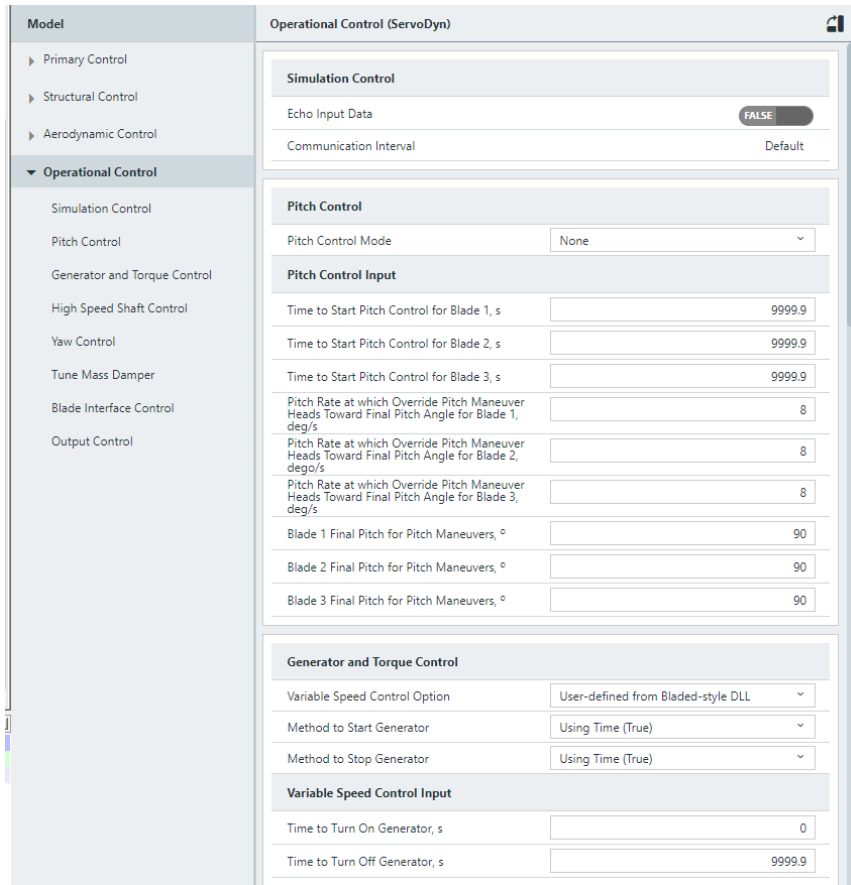
Vapour pressure, Pa: 1700

Fluid Depth, m: 0.5

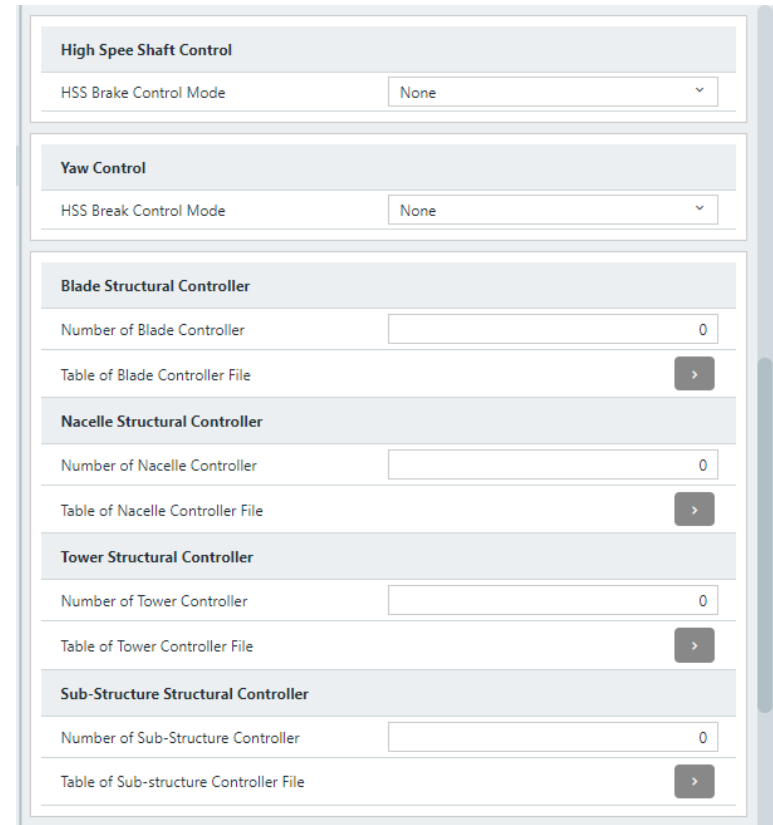
# Ribbon Menu of Webase Program: Web-OpenFAST.

## Operational control

The dynamic controller of electrical-drive for blade, drivetrain and nacelle are included. it is described in simulation control, pitch control, generator and torque control, high speed shaft control, yaw control, tune mass damper and output control.



Operational Control (ServoDyn)	
<b>Simulation Control</b>	
Echo Input Data	FALSE
Communication Interval	Default
<b>Pitch Control</b>	
Pitch Control Mode	None
<b>Pitch Control Input</b>	
Time to Start Pitch Control for Blade 1, s	9999.9
Time to Start Pitch Control for Blade 2, s	9999.9
Time to Start Pitch Control for Blade 3, s	9999.9
Pitch Rate at which Override Pitch Maneuver Heads Toward Final Pitch Angle for Blade 1, deg/s	8
Pitch Rate at which Override Pitch Maneuver Heads Toward Final Pitch Angle for Blade 2, deg/s	8
Pitch Rate at which Override Pitch Maneuver Heads Toward Final Pitch Angle for Blade 3, deg/s	8
Blade 1 Final Pitch for Pitch Maneuvers, °	90
Blade 2 Final Pitch for Pitch Maneuvers, °	90
Blade 3 Final Pitch for Pitch Maneuvers, °	90
<b>Generator and Torque Control</b>	
Variable Speed Control Option	User-defined from Bladed-style DLL
Method to Start Generator	Using Time (True)
Method to Stop Generator	Using Time (True)
<b>Variable Speed Control Input</b>	
Time to Turn On Generator, s	0
Time to Turn Off Generator, s	9999.9

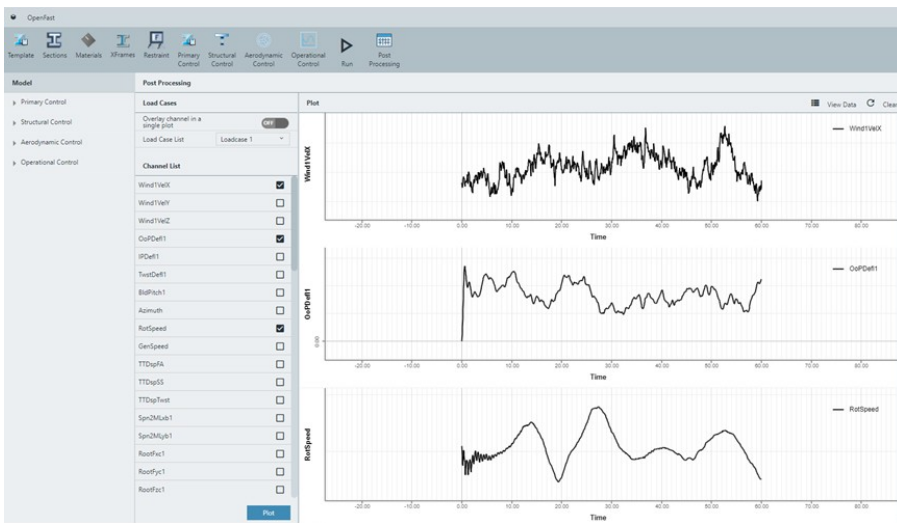


<b>High Speed Shaft Control</b>	
HSS Brake Control Mode	None
<b>Yaw Control</b>	
HSS Break Control Mode	None
<b>Blade Structural Controller</b>	
Number of Blade Controller	0
Table of Blade Controller File	>
<b>Nacelle Structural Controller</b>	
Number of Nacelle Controller	0
Table of Nacelle Controller File	>
<b>Tower Structural Controller</b>	
Number of Tower Controller	0
Table of Tower Controller File	>
<b>Sub-Structure Structural Controller</b>	
Number of Sub-Structure Controller	0
Table of Sub-structure Controller File	>

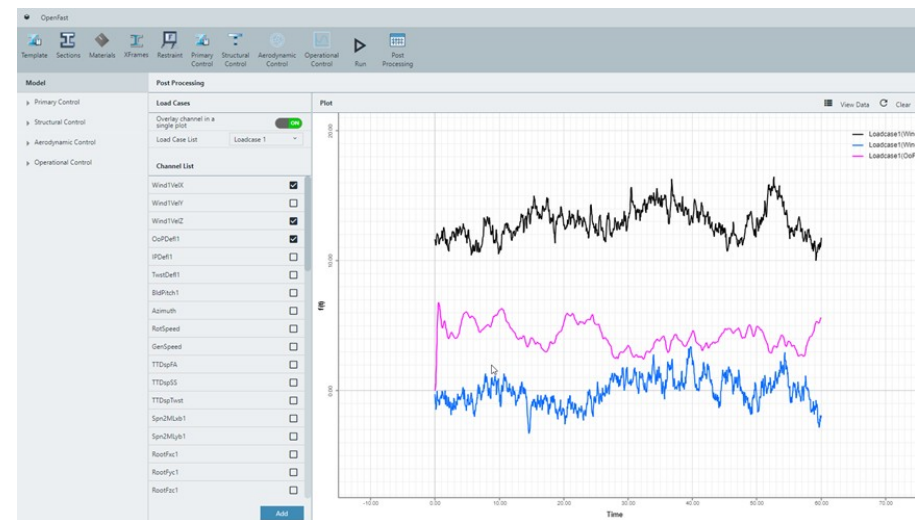
# Ribbon Menu of Webase Program: Web-OpenFAST.

## Post processing

Plotting an output result in single or multiple channels. It is allowed overlay data in a single channel plot and export into spread sheet form.



Overlay data in a single channel plot



Multiple channel plot

Web-OpenFAST will be announced sometime in this year