

OrcaFlex version 9.2

Summary of key features:

- ★ Fully 3D, non-linear, large displacement analysis
- ★ Consistent and robust modelling of compression and snatching
- ★ Fully coupled tension, bending and torsion
- ★ Bend Stiffener / Tapered Stress Joint model generation
- ★ Rayleigh damping
- ★ Highly robust, accurate and proven finite element formulation
- ★ Choice of implicit or explicit time integration methods
- ★ Fully coupled vessel/line analysis
- ★ Full 3D seabed surface
- ★ Linear elastic or non-linear hysteretic soil model
- ★ Best of class fully interactive GUI
- ★ System visualisation as either wire frame or shaded view
- ★ Modal analysis
- ★ Contact and clearance analyses
- ★ Fatigue analysis (regular, rainflow & spectral)
- ★ Full environmental description including wave spreading
- ★ Vortex induced vibration analysis (VIV)
- ★ Parallel processing on multi-core hardware
- ★ Wake Interference modelling (Huse, Blevins, User Specified)
- ★ Complete automation facilities for max QA and efficiency

ANALYSIS, PROCEDURES AND DATA I/O

ANALYSIS

- Full 3D modelling
- Complete and partial quasi-static analysis
- Extremely quick and robust static analysis
- Time domain dynamic analysis with ramp-up (to minimise starting transients)
- Non-linear large displacement analysis, including line compression and snatch loads
- Modal analysis
- Contact, clashing and clearance analyses
- Fatigue analysis (regular, rainflow & spectral)
- Fully coupled tension, bending and torsion
- Vessel manoeuvres (forward speed and turn rate)
- Surface piercing fully modelled
- Line setup wizard to set line lengths for specified tension or top angle

NUMERICAL PROCEDURES

- Finite element with 6 degrees of freedom at each end
- Element formulation is extremely robust, accurate and widely applicable
- Choice of implicit or explicit time integration methods
- Parallel processing to take advantage of modern multi-core and multi-processor hardware
- Slow varying water particle loads can be computed at a larger time step than structural displacements
- Facilities for FFT re-construction of wave field from single point elevation time history
- Fluid forces based on industry-standard Morison and cross-flow assumptions
- 1st and 2nd order wave loads on floaters calculated from wave load RAOs and QTFs

DATA INPUT

- Interactive Graphical User Interface
- Visualisation as wire frame and/or shaded view with perspective and hidden line removal
- Powerful Model Browser to organise and manage complex models
- Drag and drop facilities to import data from pre-prepared OrcaFlex Library files
- Group, move, show/hide, locate and lock operations can be applied to individual or user defined groups of modelling objects
- Simple object replication
- Batch processing
- Batch script facility for generating systematic load case or parametric variations
- Wave scatter conversion facility for easy processing of sea scatter tables
- Comprehensive facilities for vessel RAO import, including graphical RAO realism checks
- Dedicated import facilities for AQWA and WAMIT hydrodynamic data
- Typical Line properties available through built-in wizard facility (for chains, ropes, wires, lines with floats, homogeneous pipes, hoses and umbilicals)
- Pipe Plasticity wizard
- Powerful Variable Data structure allows many data items to be set as a function of other data
- External functions admit user defined calculations (e.g. heave compensation devices, DPS systems etc.)
- Import facility for vessel motion and wave elevation time history
- SI, US or User Defined units
- Full and comprehensive context sensitive help

RESULTS OUTPUT

- Native Windows user interface
- Shaded graphics (with perspective, lighting, hidden line removal etc.) for realistic, presentation ready, system visualisation
- Unlimited multiple views and graphs of the model simultaneously visible
- Replay wizard to prepare animations of multiple simulations and / or moving camera
- AVI file export of animations to presentation applications such as Powerpoint
- Results can be monitored at run time and during simulation replay
- Output can be graphical (time histories, range and X-Y graphs), values (in Excel spreadsheet format), statistical analysis and screen snapshots
- Graphs and 3D images can be pasted into other Windows applications
- Raw data and results of analyses can be exported as spreadsheets for further post processing
- Excel post processing spreadsheet allows selected data to be extracted from multiple simulation files and processed
- Reporting of vessel response to specified wave spectra

OTHER FEATURES

- Distributed OrcaFlex to make the most efficient use of multiple OrcaFlex licences
- Orcina Licence Monitor allows network administrators to monitor software usage patterns
- Programming interface (OrcFxAPI) provides OrcaFlex functionality to bespoke third party applications

MODELLING OBJECTS

The inherent stability and robustness of OrcaFlex mean that modelling objects can be connected to build very sophisticated models

- Line objects are used to model SCRs, TTRs, mooring chains, wire, ropes, homogeneous pipe, flexibles, floating hoses, cables, umbilicals etc.
- The Vessel object offers the user a huge range of modelling options to cater for all types of boundary conditions
- Buoy objects provide yet more sophisticated boundary conditions used for many diverse purposes
- Shapes, winches and links provide many features to model boundary surfaces and control line behaviour

LINE OBJECT

- Fully coupled bending / torsion, and axial stiffness
- Bend Stiffener/Tapered Stress Joint model generation
- Centrifugal internal flow effects included
- Bending stiffness, drag and added mass can be non-isotropic
- Axial, bending and torsional stiffness can be non-linear
- Hysteresis model available for bending
- Rayleigh damping
- Line CofG may be displaced from geometric centre
- Pre-bend can be modelled (e.g. spool pieces)
- Clumped line attachments (buoyancy or weight), drag chains or flex joints
- Non-isotropic Coulomb friction with seabed and elastic solids
- Contact stiffness and damping for clash modelling
- Post clash behaviour modelled
- Hydrodynamic and aerodynamic loading
- Wake Interference Modelling (Huse, Blevins, User Specified)

- Partially submerged lines (e.g. floating hoses) handled robustly
- Line drag and lift coefficients can vary as Reynolds Number varies
- Line drag and lift coefficients can vary with proximity to seabed
- Compressibility specified by bulk modulus

VESSEL OBJECT

- Fully coupled analysis with coupling between vessel and attached moorings, risers etc.
- Wave frequency motions from either first order displacement RAOs or first order wave load RAOs
- Frequency dependent added mass and damping coefficients using the convolution integral
- Impose vessel manoeuvres and/or harmonic motions
- Impose user-defined loads for thrusters, DP etc.
- Calculated second order slow drift motions
- Use motion time history files
- Add wind and current force coefficients

BUOY OBJECT

- Full 3D and 6D modelling of buoys
- Lumped option with overall properties
- SPAR and Towed Fish options modelled with co-axial cylinders, each cylinder with individual properties
- Buoyancy and hydrodynamic loads calculated based on the instantaneous wetted surface
- Attach wings for hydrofoil & tail fin modelling
- Impose user-defined loads
- Compressibility specified by bulk modulus
- Coulomb friction with seabed and elastic solids

SHAPES AND WINCHES

- Solid shapes with elastic stiffness and Coulomb friction for contact modelling
- Plane, cuboid, cylinder (solid / hollow), and bellmouth options
- Trapped water option for moonpool modelling
- Winches, with sophisticated control of length or tension
- Links: linear or non-linear stiffness and damping

ENVIRONMENTAL DESCRIPTION

Wide range of options to apply environmental loads directly on Lines and boundary control objects (Vessels and Buoys)

SEA

- User defined water density, kinematic viscosity, temperature, hor. and vert. density variation
- Temperature varies with position, kinematic viscosity with temperature and temperature with depth

SEABED

- Horizontal, sloping, 2D or 3D seabed surface
- User defined stiffness and damping
- Linear elastic or non-linear hysteretic (trenching, suction, re-penetration) soil model
- Non-isotropic Coulomb friction in both statics and dynamics

WAVES

- Choice of regular wave models (Airy, Stokes' 5th order, Dean Stream Function, Cnoidal)
- Choice of irregular wave spectra (ISSC, JONSWAP, Ochi-Hubble, Torsethaugen, User defined, time history)
- Multiple wave trains for combinations of sea states, e.g. swell plus local waves from different directions
- Wave particle kinematics fully computed at all points in wave profile
- Choice of stretching methods (Wheeler, kinematic or extrapolation)
- Random waves have wave spreading option
- Preview and selection of irregular wave profile
- White noise option for spectral response calcs

CURRENT

- 3D current profile
- Both magnitude and direction can be time varying
- Horizontal variation factor on magnitude
- Multiple current data sets can be defined

WIND

- User defined air density
- Wind velocity can be constant, specified by either API or DNV spectrum, or specified by a time history file of speed and direction
- Vertical variation factor specified as a profile

VORTEX INDUCED VIBRATION

OrcaFlex provides the most comprehensive set of VIV analysis tools available in one riser design environment

OVERVIEW

- Uses the leading methods for the analysis of Vortex Induced Vibrations
- Built into the OrcaFlex GUI - the key to reliable and efficient model building
- Application to 3D risers (not just 2D tensioned risers)
- Consistency as only one structural model needs to be constructed which can then be used with any VIV model
- Automatic integration with OrcaFlex's diverse modelling capabilities
- Reliably tested and fully documented interfaces to Shear7 and VIVA
- Quality assured implementation of time domain models
- Easy and consistent comparison between the results from different VIV models

SHEAR7 INTERFACE

- Export Shear7 data file (.dat) from OrcaFlex; this increases productivity and improves QA because no separate Shear7 model is required
- Export Shear7 mode shape file (.mds) from OrcaFlex using the OrcaFlex modal analysis feature
- Automatically selects transverse modes for mode shape file using method developed in collaboration with Shear7 author Prof K. Vandiver

VIVA INTERFACE

- VIVA called directly from OrcaFlex by linking to the VIVA DLL
- OrcaFlex statics calculation includes enhanced drag coefficients as calculated by VIVA
- Enhanced drag coefficients output as results

WAKE OSCILLATOR MODELS

- Choice of Milan wake oscillator model or Iwan and Blevins wake oscillator model

- Attaches a wake degree of freedom to each node in the line
- The wake oscillator models can be disabled for selected line sections to model VIV suppression devices
- In-line drag enhancement

VORTEX TRACKING MODELS

- Choice of two models that inherently account for the physics of VIV
- Model both in-line and transverse VIV effects
- Boundary layer theory for stagnation and separation points
- Uses inviscid Navier-Stokes equation for the region outside the boundary layer
- Much less computationally demanding than full CFD
- These models give useful qualitative results, but generally over-predict VIV