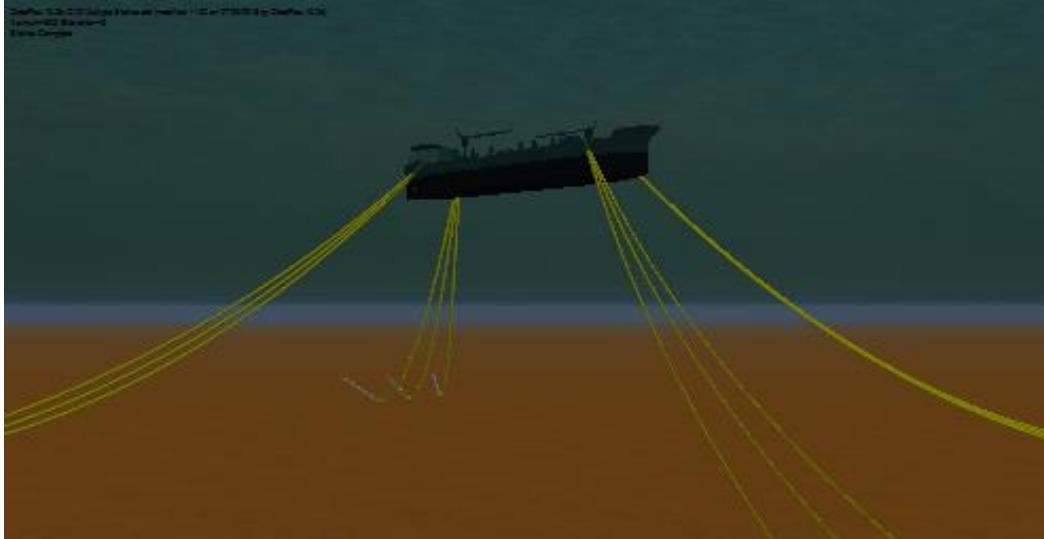


# C10 Multiple statics



## Introduction

In OrcaFlex version 10.0, a feature called Multiple Statics was removed. This was done because the automation tools that are now available allow the user to create the same set of actions, but with the flexibility to customise the parameters and output to suit their exact needs.

The *multiple statics* calculation performs a series of static analyses for a grid of different positions of a vessel, and is mainly used in mooring analyses. The output would typically be tables and graphs of load-offset curves. This example provides a Python script that replicates the multiple statics calculation that was previously built into OrcaFlex.

The calculation requires as input an OrcaFlex model, specified by file name. The model must contain at least one vessel object. In case multiple vessel objects are present, a single vessel must be identified. This vessel is then placed at a series of offsets about the assumed mean position. For each offset a static analysis is performed, and key results extracted. Finally, the results are output in an Excel workbook.

The Python script is supplied with a simple example to demonstrate its operation. The following files are provided:

|                          |   |
|--------------------------|---|
| C10 Multiple statics.dat | Example OrcaFlex data file                                  |
| MultipleStatics.bat      | A command script to execute the Python script               |
| MultipleStatics.py       | The Python script   |
| MultipleStatics.yml      | Specification of the data file, the vessel, and the offsets |

## Requirements

In order to use the script you will need a suitable Python installation, see the API Help file for guidance:

<http://www.orcina.com/SoftwareProducts/OrcaFlex/Documentation/OrcFxAPIHelp/Redirector.htm?PythonInterface,Installation.htm>

You will also need the OrcFxAPI module. This is installed as part of the OrcaFlex installation process if Python is present at the time of installation. If not, you will need to install this module manually, as described in the above Help link.

In addition, this particular script requires the following third party modules to be installed:

- numpy
- xlsxwriter
- yaml

On a standard Python installation this should be possible at the command line using pip:

```
C:\Users\ExampleUser> pip install numpy xlsxwriter pyyaml
```

## Input data

The input data for a multiple statics analysis is specified in a YAML (human readable structured data) file. For example, [MultipleStatics.yml](#) contains the following data:

```
Model: C10 Multiple statics.dat
VesselName: Vessel1
AzimuthFrom: 0
AzimuthTo: 90
AzimuthStep: 15
OffsetFrom: 0
OffsetTo: 30
OffsetStep: 2
```

- [Model](#) specifies the OrcaFlex data file that defines the model to be analysed.
- [VesselName](#) specifies which vessel is to be analysed. If the model contains only a single vessel, this entry can be omitted.
- [AzimuthFrom](#), [AzimuthTo](#) and [AzimuthStep](#) define the offset directions. In the example above the analysis is performed on azimuth directions 0°, 15°, 30°, 45°, 60°, 75° and 90°. These directions are relative to the global axis system. So, 0° is along the global X axis, 90° is along the global Y axis, and so on.
- [OffsetFrom](#), [OffsetTo](#) and [OffsetStep](#) define the offset steps. In the example above the analysis is performed at offsets of 0, 2, 4, ..., 28 and 30. These values use the same length units as the OrcaFlex data file.

The YAML file can be edited using a text editor e.g. Notepad++

## Running the script

For convenience a .bat command script, [MultipleStatics.bat](#), has been included. This can be double-clicked from a file explorer to run the script. For most purposes this method of running the script will suffice. However in case more control is required, the full command line options are now listed:

```
C:\Users\ExampleUser> python MultipleStatics.py --help
usage: MultipleStatics.py [-h] [-e] [spec]

OrcaFlex multiple static analysis.

positional arguments:
spec                  name of the specification file

optional arguments:
-h, --help           show this help message and exit
-e, --echo           echo specification
```

The specification file name can be passed as an argument, e.g.

```
C:\Users\ExampleUser> python MultipleStatics.py example.yml
```

If the specification file name is omitted then the script file name (with the .py extension replaced by .yml) is assumed. The --echo option (or abbreviated to -e) can be used to echo the specification to the console:

```
C:\Users\ExampleUser> python MultipleStatics.py --echo
Model file name: example.dat
Vessel name: Vessel1
Azimuths (from, to, step): 0, 90, 15
Offsets (from, to, step): 0, 30, 2

Case 1/112: azimuth 0 offset 0
Case 2/112: azimuth 0 offset 2
Case 3/112: azimuth 0 offset 4
...
```

## Results

The results are saved to an Excel workbook. This has the same file name stem as the OrcaFlex model data file, but with `.MultStat.xlsx` added. So, for the example input data, the output file name is *C10 Multiple statics.MultStat.xlsx*.

The workbook contains a sheet named *Input* that echoes the input specification:

|   | A                                  | B                        | C | D |
|---|------------------------------------|--------------------------|---|---|
| 1 | <b>Multiple statics input data</b> |                          |   |   |
| 2 |                                    |                          |   |   |
| 3 | Model file name                    | C10 Multiple Statics.dat |   |   |
| 4 | Vessel name                        | Vessel1                  |   |   |
| 5 | Azimuths (from, to, step)          | 0°, 90°, 15°             |   |   |
| 6 | Offsets (from, to, step)           | 0m, 30m, 2m              |   |   |

The remaining sheets contain the results for each offset direction. For example:

|    | A                    | B           | C             | D           | E             | F            | G             |
|----|----------------------|-------------|---------------|-------------|---------------|--------------|---------------|
| 1  | <b>Azimuth 60.0°</b> |             |               |             |               |              |               |
| 2  |                      |             |               |             |               |              |               |
| 3  |                      | Restoring   | Restoring     | Vertical    | Yaw           | Worst        | Worst tension |
| 4  | Offset (m)           | force (kN)  | direction (°) | force (kN)  | moment (kN.m) | tension (kN) | line name     |
| 5  | 0                    | 4.58773E-10 | 0             | 5665.315093 | -1.9495E-08   | 711.2847998  | Line3         |
| 6  | 2                    | 423.5340432 | 235.8574783   | 5677.003369 | 497.613456    | 795.2143965  | Line9         |
| 7  | 4                    | 864.7786125 | 235.6368763   | 5712.567146 | 2033.650911   | 898.6060154  | Line9         |
| 8  | 6                    | 1342.47679  | 235.279081    | 5772.804398 | 4725.558392   | 1027.539683  | Line9         |
| 9  | 8                    | 1881.346299 | 234.7835984   | 5860.672884 | 8816.705429   | 1191.175308  | Line9         |
| 10 | 10                   | 2509.7781   | 234.1485426   | 5978.978863 | 14692.78965   | 1401.748002  | Line9         |
| 11 | 12                   | 3272.131029 | 233.4067879   | 6133.251107 | 22899.27562   | 1677.526089  | Line9         |
| 12 | 14                   | 4270.550442 | 232.5347893   | 6342.9994   | 35120.46546   | 2092.716443  | Line9         |
| 13 | 16                   | 5962.073857 | 231.3356337   | 6725.688628 | 59163.58704   | 3011.703655  | Line9         |
| 14 | 18                   | 9697.901622 | 229.6860691   | 7621.821408 | 117466.9203   | 5347.107149  | Line9         |
| 15 | 20                   | 16767.01292 | 228.0553922   | 9355.528134 | 229049.7791   | 9178.007506  | Line9         |
| 16 | 22                   | 26952.29025 | 226.7498376   | 11858.83756 | 386105.4498   | 13466.49535  | Line9         |
| 17 | 24                   | 38885.61671 | 225.9170839   | 14786.62472 | 567621.3571   | 17863.36454  | Line9         |
| 18 | 26                   | 51342.07541 | 225.4599335   | 17817.5925  | 756920.6804   | 22295.78967  | Line9         |
| 19 | 28                   | 63950.19861 | 225.2091897   | 20867.64931 | 949158.2087   | 26743.80564  | Line9         |
| 20 | 30                   | 76623.50618 | 225.0710112   | 23912.4489  | 1143079.822   | 31200.32689  | Line9         |

The results variables are defined as follows:

*Restoring force*

The magnitude of the horizontal component of the total force applied to the vessel. Note that this force is not necessarily in the offset direction.

*Restoring direction*

The direction of the restoring force.

*Vertical force*

The vertically downwards component of the total force applied to the vessel.

*Yaw moment*

The total moment, about the vertical, applied to the vessel.

*Worst tension* and *Worst tension line name*

The largest tension in any segment of any line connected to the vessel, and the name of the line in which that tension occurs.

The workbook also generates plots of these results, for each offset direction. The graphs below show the results for the 60° offset direction, for our example spread moored vessel:

