Sandia National Laboratories

NREL

WEC-Sim Training Course

Using MoorDyn with WEC-Sim

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PRESENTED BY

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Using MoorDyn with WEC-Sim

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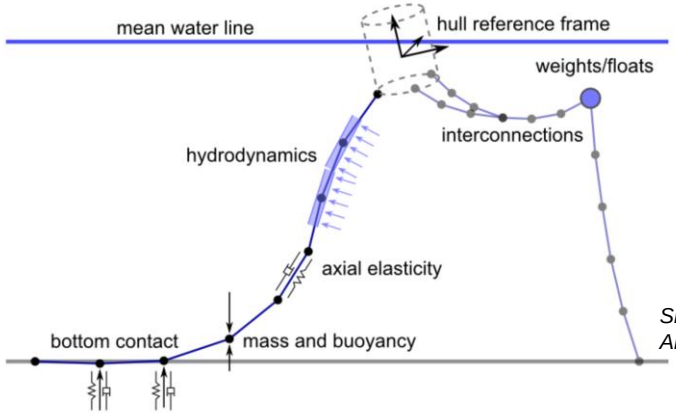
What is MoorDyn?

- MoorDyn is a lumped-mass mooring line model for simulating the **dynamics of moorings** connected to floating offshore structures.

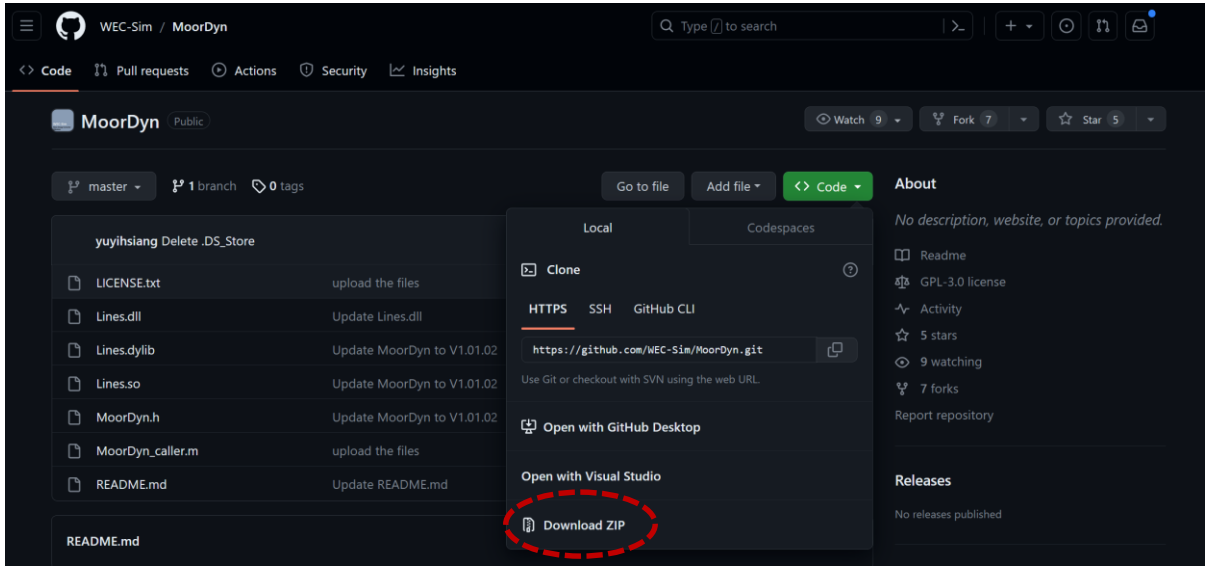


Sirnivas et al (2016) – Coupled Mooring Analyses for the WEC-Sim WEC Design Tool

- Dynamic mooring models are critical in order to obtain a more accurate estimate of a WEC's response and the mooring line loads.

Download the necessary MoorDyn files

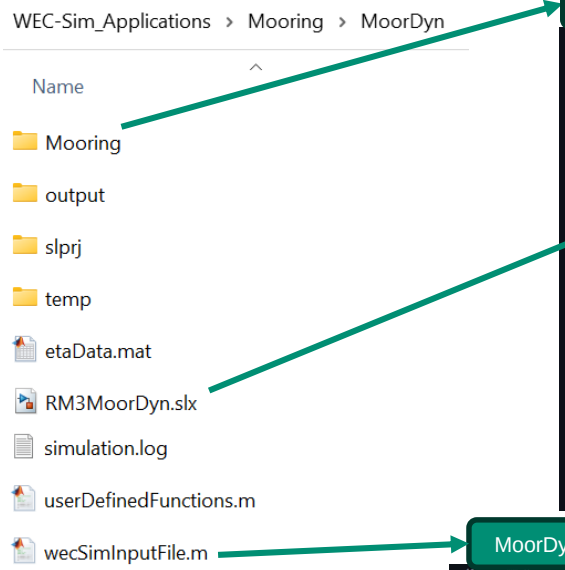
- Navigate to https://github.com/WEC-Sim/MoorDyn and download the repo:



- Save the repo to the directory: *WEC-Sim/source/functions/moorDyn*

WEC-Sim RM3 MoorDyn Example

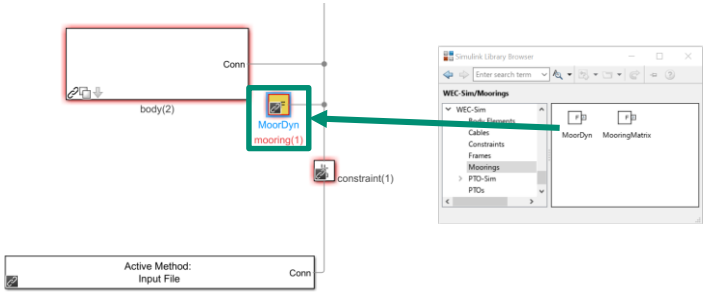
- Now head to the MoorDyn example: *`WEC-Sim_Applications/Mooring/MoorDyn`*



lines.txt MoorDyn input file

```
Mooring line data file for MoorDyn in Lines.dll
---------------------- LINE DICTIONARY -----------------------------------------------
LineType  Diam   MassDenInAir   EA          BA/-zeta    Can    Cat    Cdn    Cdt
(-)       (m)      (kg/m)       (N)         (Pa-s/-)    (-)    (-)    (-)    (-)
chain     0.144    126.0     583.37E6         -0.8      1.0    0.0    1.6    0.05
---------------------- NODE PROPERTIES -----------------------------------------------
Node     Type       X        Y        Z        M        V          FX       FZ       CdA    CA
(-)      (-)       (m)      (m)      (m)      (kg)     (m^3)      (kN)     (kN)     (m^2)  (-)
1        Vessel    -3.0      0      -10.00      0        0          0        0        0      0
2        Fix      -267.0     0      -70.00      0        0          0        0        0      0
3        Vessel     1.5     2.598    -70.00      0        0          0        0        0      0
4        Fix       133.5    231.29   -70.00      0        0          0        0        0      0
5        Vessel     1.5    -2.598    -10.00      0        0          0        0        0      0
6        Fix       133.5   -231.23   -70.00      0        0          0        0        0      0
7        Connect   -40.0      0      -10.00    16755    33.510       0        0      12.566   1
8        Connect    20.0     34.642  -10.00    16755    33.510       0        0      12.566   1
9        Connect    20.0    -34.642  -10.00    16755    33.510       0        0      12.566   1
---------------------- LINE PROPERTIES -----------------------------------------------
Line     LineType  UnstrLen  NumSegs   NodeAnch  NodeFair  Flags/Outputs
(-)      (-)       (m)       (-)       (-)       (-)       (-)
1        chain     240.0       15        2         7        tp
2        chain     240.0       15        4         8        tp
3        chain     240.0       15        6         9        tp
4        chain      40.0        5        7         1        tp
5        chain      40.0        5        8         3        tp
6        chain      40.0        5        9         5        tp
---------------------- SOLVER OPTIONS-------------------------------------------------
0.0005   dtM          - time step to use in mooring integration
0        WaveKin      - wave kinematics flag (0=neglect, the only option currently supported)
3.0e6    kBot         - bottom stiffness
3.0e5    cBot         - bottom damping
70       WtrDpth      - water depth
5.0      CdScaleIC    - factor by which to scale drag coefficients during dynamic relaxation IC gen
0.001    threshIC     - threshold for IC con
0        WriteUnits   - option to skip units line in output files if zero
---------- OUTPUTS --------------------------------
FairTen4 FairTen5 FairTen6
------------------ need this line ------------------
```

Check MoorDyn block is within .slx file



MoorDyn info is specified in wecSimInputFile.m

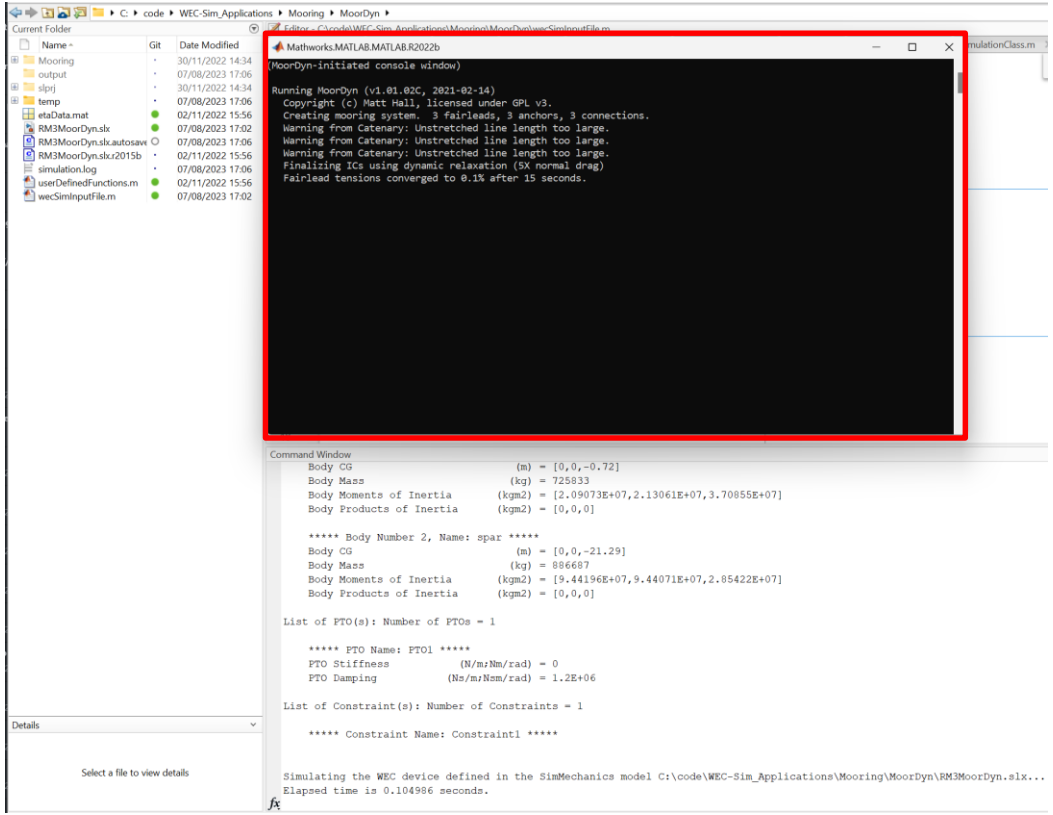
```
%% Mooring
% Moordyn
mooring(1) = mooringClass('mooring');          % Initialize mooringClass
mooring(1).moorDynLines = 6;                   % Specify number of lines
mooring(1).moorDynNodes(1:3) = 16;             % Specify number of nodes per line
mooring(1).moorDynNodes(4:6) = 6;              % Specify number of nodes per line
mooring(1).initial.displacement = [0 0 -0.21]; % Initial Displacement
```

Note

You may need to install the MinGW-w64 compiler to run this simulation.

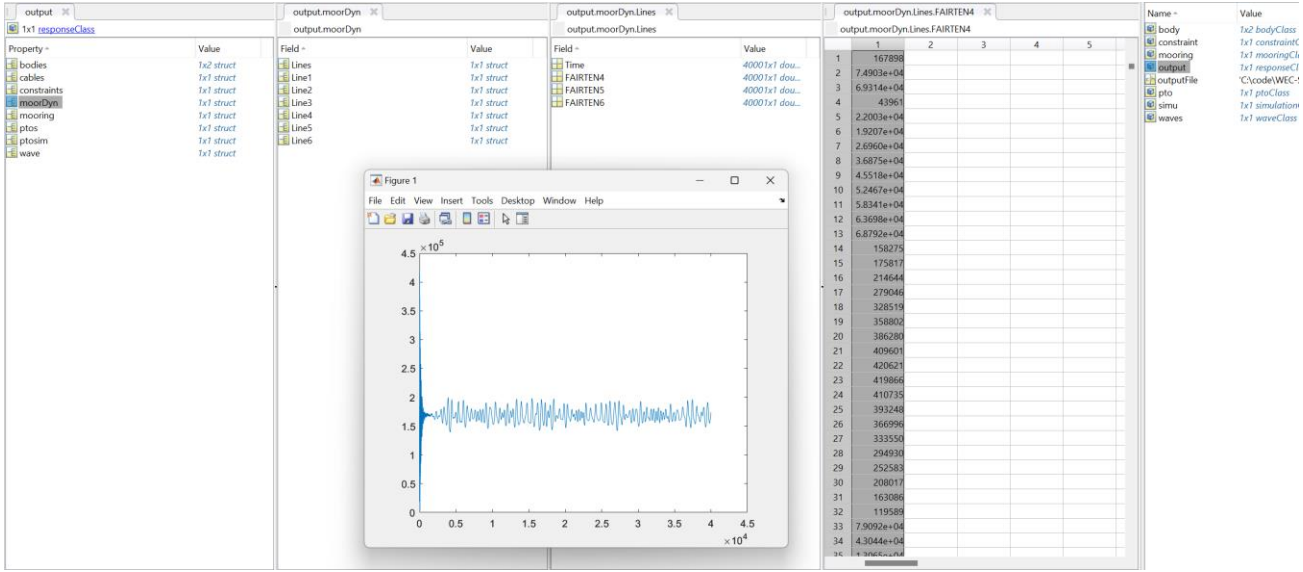
Running the WEC-Sim RM3 MoorDyn Example

- When you run the example, you should see a MoorDyn-initiated console window pop up:



Check results of the WEC-Sim RM3 MoorDyn Example

- The MoorDyn data should automatically appear in the workspace, within the ‘output’ object:



- Modify this part of the MoorDyn input file in order to change which data is saved:

```
36    ------------------------- OUTPUTS --------------------------------
37    FairTen4 FairTen5 FairTen6
```

Developing your own MoorDyn models

For a comprehensive explanation of the different sections of the MoorDyn input file, please see the MoorDyn documentation:

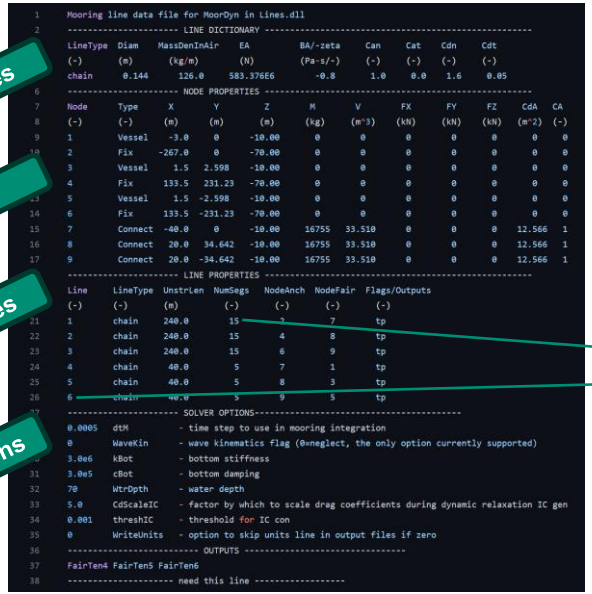
https://moordyn.readthedocs.io

Line types

Nodes

Line properties

Solver options



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Mooring line data file for MoorDyn in Lines.dll
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chain     0.144     126.0       583.376E6       -0.8       1.0    0.0    1.6    0.05
---------------------- NODE PROPERTIES -----------------------------------------------------
Node      Type      X       Y       Z       M       V       FX      FY      FZ      CdA   CA
(-)       (-)       (m)     (m)     (m)     (kg)    (m^3)   (kN)    (kN)    (kN)    (m^2) (-)
1         Vessel    -3.0    0       -10.00  0       0       0       0       0       0     0
2         Fix       -267.0  0       -70.00  0       0       0       0       0       0     0
3         Vessel    1.5     2.598   -10.00  0       0       0       0       0       0     0
4         Fix       133.5   231.23  -70.00  0       0       0       0       0       0     0
5         Vessel    1.5     -2.598  -10.00  0       0       0       0       0       0     0
6         Fix       133.5   -231.23 -70.00  0       0       0       0       0       0     0
7         Connect   -40.0   0       -10.00  16755   33.510  0       0       0       12.566  1
8         Connect   20.0    34.642  -10.00  16755   33.510  0       0       0       12.566  1
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Line      LineType  UnstrLen  NumSegs   NodeAnch  NodeFair  Flags/Outputs
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2         chain     240.0       15        4         8       tp
3         chain     240.0       15        6         9       tp
4         chain     40.0         5        7         1       tp
5         chain     40.0         5        8         3       tp
6         chain     40.0         5        9         5       tp
---------------------- SOLVER OPTIONS---------------------------------------
0.0005    dtM           - time step to use in mooring integration
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70        WtrDpth       - water depth
5.0       CdScaleIC     - factor by which to scale drag coefficients during dynamic relaxation IC gen
0.001     threshIC      - threshold for IC con
0         WriteUnits    - option to skip units line in output files if zero
--------------------------- OUTPUTS --------------------------------
FairTen4 FairTen5 FairTen6
---------------------- need this line ------------------
```

In your WEC-Sim input file, ensure that the number of lines and nodes (segments+1) matches the MoorDyn lines.txt input file:

```
%% Mooring
% Moordyn
mooring(1) = mooringClass('mooring');          % Initialize mooringClass
mooring(1).moorDynLines = 6;                   % Specify number of lines
mooring(1).moorDynNodes(1:3) = 16;             % Specify number of nodes per line
mooring(1).moorDynNodes(4:6) = 6;              % Specify number of nodes per line
mooring(1).initial.displacement = [0 0 -0.21]; % Initial Displacement
```

Thank you

For more information please visit the WEC-Sim website:

http://wec-sim.github.io/WEC-Sim

If you have questions on this presentation please reach out to any of the WEC-Sim Developers on GitHub:

https://github.com/WEC-Sim/WEC-Sim

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