```
\ ------------------------------------------------------------------------------------------------------------
\ Environment OO-star
\ ------------------------------------------------------------------------------------------------------------
set_environment
wave_amplitude  0.001
wavelength  351
spectral_peak  15.3
wave_direction  0
seed  0.3
nfreq  64
current_speed  1.24
current_exponent  0.142857142857143
current_direction  0
wind_speed  12
wind_ref_height  90
wind_exponent  0.11
wind_direction  0
wind  mean_profile
wind_force  drag
gravity  on
buoyancy  on
waves  irregular_airy_wavelets
norder  -1
hydro_force  morison
tsweeps  0
tsweepe  -1
stretch  0
wave_ramps  0.
wave_rampe  200.  ! TAN
rho_water  1025.
rho_air  1.225
pre_computed_waves_file  off
random_mode  right_file randomfile
```

tshift_waves 0. ! JB 3000.

tshift_wind 0.

nu_water 0.00001

nu_air 0.000001

depth 95

dtwkin .1

!wave_kinematics_reference_node 0. 0. 0.

! jonswap_wavelets_constant hs: 10. tp: 15.3 tstart: 10800 tcut: -1. gamma: 1.929

! nomega: 10000 depth: 95.   file: wavelets.txt

! wavelets scale_amplitude: 1.   file   ..\wavelets.txt

!test_irreg_airy dt .01 nstep 1000 x 0. 0. 0. filename waveheight.txt

\ ----------

\ End of environmental setting

\----------

\\\ Main Geometry - materials and keypoints

\==========

\Name rho E-mod G_mod

define_material name: Steel rho: 7800 e: 210000000000 g: 70000000000

define_material name: tower_dens rho: 7300 e: 210000000000 g: 210000000000

define_material name: Reinforced_conc rho: 2275 e: 30000000000 g: 70000000000

define_material name: ext_watbal rho: 1240.7 e: 30000000000 g: 70000000000

define_material name: ext_cyl_walls rho: 5638.5 e: 30000000000 g: 70000000000

define_material name: Nacelle rho: 0.0 e: 210000000000 g: 70000000000

define_material name: Chain rho: 7850 e: 39458300000 g: 808000 ! JBDV: reduced G stiffness by 0.0001 / 10 = 1e-5

define_material name: Reinforced_conc_CC rho: 3226.49713819676 e: 30000000000 g: 70000000000

define_material name: Reinforced_conc_CS rho: 2816.47568962454 e: 30000000000 g: 70000000000

define_material name massless1   rho 0.0001   e 210.e9 g 80.8e9

define_material name: steel1000 rho: 7800 e: 210.e15 g: 70.e15

define_material name: pontoon rho: 8330 e: 40000000000 g: 70000000000

define_material name: massless rho: 0 e: 21000000000000 g: 7000000000000

new_keypoints ! node # x y z [m]

1 0 0 -20 ! center column bottom

3 0 0 -17 ! center column attachment

4 0 0 -11.5 ! Node for point mass

5 0 0 0 ! center still water node

6 0 0 10 ! NOT USED high-resolution (wave forces) up to here

7 0 0 13 ! tower base

8 0 0 47.8 ! Pressure centre for wind forces on tower

9 -7.102 0 -17 ! center shaft pontoon attachment

10 -24 0 -17 ! column 1 surface pontoon attachment

11 -31 0 -17 ! column 1 center pontoon attachment

12 -31 0 -18.1073056998536 ! water level in column

13 -31 0 0 ! column 1 swl

14 -31 0 -20 ! column 1 bottom

15 -15.5 0 -17 ! Center of pontoon

new_boxmember_properties ! Pontoon, see python script for calculations

iprop: 1 ! Property set no

material: pontoon

connect_mode: auto

btype: beam_lid1_lid2

ea1: 627200000000 ea2 627200000000 ! axial stiffness at keypoints 1 and 2

eiy1: 3986602666666.67 eiy2: 3986602666666.67 ! EIyy bending stiffness, STIFFNESS FOR BENDING ABOUT Z AXIS !

eiz1: 15605930666666.7 eiz2: 15605930666666.7 ! EIzz bending stiffness, STIFFNESS FOR BENDING ABOUT Y AXIS !

lx1: 18.5 lx2: 18.5 ! equiv section length for use in drag calculations

ly1: 14.0 ly2: 14.0 ! section width for use in drag calculations

lz1: 6. lz2: 6. ! section height for use in drag calculations

m1: 128157.2 m2: 128157.2 ! mass per unit length at keypoint 1 and 2

ab1: 99.82604728219 ab2: 99.82604728219 ! area for buoyancy calculation

pre_strain_long: .0 ! longitudal pre-strain. optional keywords from here

pointmass1: 0. pointmass2: 0.

cdx: 0 cdy: 1.8 cdz: 3 ! drag coefficients Cm8 10.4

cmx: 1 cmy: 1.8 cmz: 3.5 ! inertia coefficients cmz 4.77

new_boxmember_properties ! Pontoon, see python script for calculations

iprop: 2 ! Property set no

material: pontoon

connect_mode: auto

btype: beam_lid1_lid2

ea1: 627200000000 ea2 627200000000 ! axial stiffness at keypoints 1 and 2

eiy1: 3986602666666.67 eiy2: 3986602666666.67 ! EIyy bending stiffness, STIFFNESS FOR BENDING ABOUT Z AXIS !

eiz1: 15605930666666.7 eiz2: 15605930666666.7 ! EIzz bending stiffness, STIFFNESS FOR BENDING ABOUT Y AXIS !

lx1: 18.5 lx2: 18.5 ! equiv section length for use in drag calculations

ly1: 14.0 ly2: 14.0 ! section width for use in drag calculations

lz1: 6. lz2: 6. ! section height for use in drag calculations

m1: 128157.2 m2: 128157.2 ! mass per unit length at keypoint 1 and 2

ab1: 99.82604728219 ab2: 99.82604728219 ! area for buoyancy calculation

pre_strain_long: .0 ! longitudal pre-strain. optional keywords from here

pointmass1: 0. pointmass2: 0.

cdx: 0 cdy: 1.8 cdz: 3 ! drag coefficients Cm8 10.4

cmx: 1 cmy: 1.8 cmz: 2 ! inertia coefficients cmz 4.77

wave_forces cd_morison 1 cm_morison 1.4

\==========

\\\ Main Geometry - Floater & tower

\==========

\ Central tower

\

new_body

reftype: inertial

name: center_column

parent: inertial

axes: normal

new_elements_beam1 nelem 1 material Reinforced_conc connect_mode no_connect ! Bottom plate

x1 0 0 -20 dcyl1 13.8 tcyl1 6.8999 pre_strain_long 0.

x2 0 0 -19.4 dcyl2 13.8 tcyl2 6.8999 btype beam_lid1

cda 4 cma 7.6

new_elements_beam1 nelem 1 material Reinforced_conc connect_mode auto ! Bottom plate to pontoon attachment

x1 0 0 -19.4 dcyl1 13.8 tcyl1 0.4 pre_strain_long 0.

x2 0 0 -17 dcyl2 13.8 tcyl2 0.4 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 1 material Reinforced_conc connect_mode auto !Pontoon attachement to lower cone

x1 0 0 -17 dcyl1 13.8 tcyl1 0.4 pre_strain_long 0.

x2 0 0 -14 dcyl2 13.8 tcyl2 0.4 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 1 material Reinforced_conc_CS connect_mode auto !Cone

x1 0 0 -14 dcyl1 14.204 tcyl1 0.51 pre_strain_long 0. pointmass 0

x2 0 0 -11.5 dcyl2 13.2456666666667 tcyl2 0.494375 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 4 material Reinforced_conc_CS connect_mode auto !Cone

x1 0 0 -11.5 dcyl1 13.2456666666667 tcyl1 0.494375 pre_strain_long 0. pointmass 0

x2 0 0 -0.5 dcyl2 9.029 tcyl2 0.425625 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 2 material Reinforced_conc_CS connect_mode auto ! Cone to SWL

x1 0 0 -0.5 dcyl1 9.029 tcyl1 0.425625 pre_strain_long 0. pointmass 200000

x2 0 0 0 dcyl2 8.83733333333333 tcyl2 0.4225 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 2 material Reinforced_conc_CS connect_mode auto ! SWL + 0.5

x1 0 0 0 dcyl1 8.83733333333333 tcyl1 0.4225 pre_strain_long 0.

x2 0 0 0.88 dcyl2 8.5 tcyl2 0.417 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 4 material Reinforced_conc_CS connect_mode auto ! 0.5 to base of tower

x1 0 0 0.88 dcyl1 8.5 tcyl1 0.417 pre_strain_long 0.

x2 0 0 13 dcyl2 8.6 tcyl2 0.55 btype beam

cdn 1 cmn 1.8

\==========

\\ Tower Full scale + nacelle mass

new_body name tower reftype inertial parent inertial axes normal

! JBDV: Increased nelem from 1 to 2

new_elements_beam1 nelem 2 material tower_dens connect_mode auto ! Tower part1

x1 0 0 13 dcyl1 9.7 tcyl1 0.090 pre_strain_long 0.

x2 0 0 30 dcyl2 8.86 tcyl2 0.081 btype beam

! JBDV: Increased nelem from 1 to 2

new_elements_beam1 nelem 2 material tower_dens connect_mode auto ! Tower part2

x1 0 0 30 dcyl1 8.86 tcyl1 0.081 pre_strain_long 0.

x2 0 0 47.8 dcyl2 7.99197530864198 tcyl2 0.0665 btype beam

! JBDV: Increased nelem from 1 to 4

new_elements_beam1 nelem 4 material tower_dens connect_mode auto ! Tower part3

x1 0 0 47.8 dcyl1 7.99197530864198 tcyl1 0.0665 pre_strain_long 0.

x2 0 0 94.8 dcyl2 5.7 tcyl2 0.04 btype beam

! JBDV: Remove these two elements for better visualisation

! new_elements_beam1 nelem 1 material Nacelle connect_mode auto ! Nacelle1

! x1 0 0 94.8 dcyl1 4 tcyl1 2 pre_strain_long 0.

! x2 0 0 97.8 dcyl2 4 tcyl2 2 btype beam

! new_elements_beam1 nelem 1 material Nacelle connect_mode auto ! Nacelle2

! x1 0 0 97.8 dcyl1 4 tcyl1 2 pre_strain_long 0.

! x2 0 0 100.8 dcyl2 4 tcyl2 2 btype beam

\==========

\\ Pontoon 1 & external column 1

new_body

name: pontoon_1

reftype: refnode

xfind: 0. 0. 0.

rotorder: 123

rotation: 0. 0. 0.

axes: normal

parent: center_column

new_boxmembers nelem_default: 2 ! member_no keypoint_1 keypoint_2 Property_Set optional nelem

1 9 15 1 nelem: 3

new_boxmembers nelem_default: 2 ! member_no keypoint_1 keypoint_2 Property_Set optional nelem

2 15 10 2 nelem: 3

new_elements_beam1 nelem 1 material massless connect_mode auto ! Center shaft to pontoon

x1 0 0 -17 dcyl1 8 tcyl1 1.2 pre_strain_long 0.

x2 -7.102 0 -17 dcyl2 8 tcyl2 1.2 btype beamwb

cmn 1.000

new_elements_beam1 nelem 1 material massless connect_mode auto ! Exentric shaft to pontoon

x1 -24 0 -17 dcyl1 8 tcyl1 1.2 pre_strain_long 0.

x2 -31 0 -17 dcyl2 8 tcyl2 1.2 btype beamwb

cmn 1.000

!==========

!! External Column 1

new_elements_beam1 nelem 1 material Reinforced_conc connect_mode auto ! Heave plate bot

x1 -31 0 -20 dcyl1 21 tcyl1 10.499 pre_strain_long 0.

x2 -31 0 -19.8 dcyl2 21 tcyl2 10.499 btype beam_lid1

cda 3 cma 1.55

new_elements_beam1 nelem 1 material Reinforced_conc connect_mode auto ! Heave plate top

x1 -31 0 -19.8 dcyl1 21 tcyl1 10.499 pre_strain_long 0.

x2 -31 0 -19.6 dcyl2 21 tcyl2 10.499 btype beam_lid2

cda 3 cma 1.55

new_elements_beam1 nelem 1 material ext_watbal connect_mode auto ! Heave plate to water level

x1 -31 0 -19.6 dcyl1 14 tcyl1 6.9999 pre_strain_long 0.

x2 -31 0 -17.7073056998536 dcyl2 14 tcyl2 6.9999 btype beam_lid1

cdn 1 cmn 1.8

new_elements_beam1 nelem 1 material ext_cyl_walls connect_mode auto ! water level to Pontoon attachment

x1 -31 0 -17.7073056998536 dcyl1 14 tcyl1 0.4 pre_strain_long 0.

x2 -31 0 -17 dcyl2 14 tcyl2 0.4 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 1 material ext_cyl_walls connect_mode auto ! Pontoon attachment to Cone

x1 -31 0 -17 dcyl1 14 tcyl1 0.4 pre_strain_long 0.

x2 -31 0 -14 dcyl2 14 tcyl2 0.4 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 3 material Reinforced_conc_CC connect_mode auto ! Cone

x1 -31 0 -14 dcyl1 14 tcyl1 0.435 pre_strain_long   0.

x2 -31 0 -3.1 dcyl2 12 tcyl2 0.38 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 3 material Reinforced_conc_CC connect_mode auto ! Cone to SWL

x1 -31 0 -3.1 dcyl1 12 tcyl1 0.3 pre_strain_long   0.

x2 -31 0 0 dcyl2 12 tcyl2 0.3 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 1 material Reinforced_conc_CC connect_mode auto ! SWL to +0.5

x1 -31 0 0 dcyl1 12 tcyl1 0.3 pre_strain_long   0.

x2 -31 0 0.5 dcyl2 12 tcyl2 0.3 btype beam

cdn 1 cmn 1.8

new_elements_beam1 nelem 3 material Reinforced_conc_CC connect_mode auto ! SWL to top of cone

x1 -31 0 0.5 dcyl1 12 tcyl1 0.3 pre_strain_long   0.

x2 -31 0 12 dcyl2 12 tcyl2 0.3 btype beam_lid2

cdn 1 cmn 1.8

new_elements_beam1 nelem 1 material Steel connect_mode auto ! Top slap on cyliner (steel)

x1 -31 0 12 dcyl1 11.43 tcyl1 5.7149 pre_strain_long   0.

x2 -31 0 12.05 dcyl2 11.43 tcyl2 5.7149 btype beam

cdn 1 cmn 1.8

\==========

\ Mooring attachment

new_elements_beam1 nelem 1   material massless connect_mode connect_1 ! Attachment column to mooring

x1 -31 0 12 dcyl1 8 tcyl1 1.2 pre_strain_long   0.

x2 -37 0 12 dcyl2 8 tcyl2 1.2 btype beamwb

cmn 1.000

\==========

\\ Pontoon 2 & external column 2

new_body

name: pontoon_2

reftype: refnode Total for all elements

xfind: 0. 0. 0.

rotorder: 123

rotation: 0. 0. 120.

axes: normal

parent: center_column

copy_elements

from_body: pontoon_1

to_body: pontoon_2

!==========

!! Pontoon 3 & external column 3

new_body

name: pontoon_3

reftype: refnode

xfind: 0. 0. 0.

rotorder: 123

rotation: 0. 0. -120.

axes: normal

parent: center_column

copy_elements

from_body: pontoon_1

to_body: pontoon_3

\==========

\\ End of Floater Geometry

\----------

```
\\ Main geometry - Mooring lines
\----------------------------------------------------------------------------------------------------------------
\ Mooring line 1
\----------------------------------------------------------------------------------------------------------------
new_body
reftype: inertial
name:    mooring
parent:  inertial
axes:    normal
\----------------------------------------------------------------------------------------------------------------
\\ End of mooring geometry
\----------------------------------------------------------------------------------------------------------------
\\ End of Main Geometry
\================================================================================
\ RNA 6MW flexible blade system - without attached
\------------------------------------------------------------------------
! 3dfloat definition of Statoil 6MW 154m generic rotor
! Created by:   Tor Anders Nygaard May 22, 2014
!
! Implement generator eta from table
! compare generator eff with dll
! check vaxial to controller

define_material name massless1    rho 0.0001       e  210.e9 g  80.8e9
define_material name mod_nacelle  rho 5587.5       e  210.e9 g  70.e9
! ------------------------------------------------------------------------------------------------------------
! NACELLE DEFINITIONS:
! ------------------------------------------------------------------------------------------------------------
! yaw drive
new_body name yawdrive parent tower reftype refnode xfind 0. 0. 94.8
rotorder 123 rotation 0. 0. 0. axes normal   ! yaw can be added here eg rotation  0.  0.  8.
```

```
! yaw bearing to Nacelle reference point
! mass 9 ton
new_elements_beam1 nelem 1 material steel1000  connect_mode connect_1
x1   0.   0.  0.     dcyl1 4.0   tcyl1  0.0409686373997
x2   0.   0.  3.0    dcyl2 4.0   tcyl2  0.0409686373997  btype beam

! nacelle
new_body name nacelle parent yawdrive reftype refnode xfind 0. 0. 3.0
rotorder 123 rotation 0. 6. 0. axes normal ! rotor tilt: 6 degrees      ! dbg  rotation 0. 6. 0.

! nacelle ref point to rotor counterweight
! mass 30 ton
new_elements_beam1 nelem 1 material steel1000  connect_mode connect_1
x1   0.    0.  0.     dcyl1 4.0   tcyl1  0.0393770908273
x2   7.8   0.  0.     dcyl2 4.0   tcyl2  0.0393770908273  btype beam

! half rotor counterweight
! mass .5*(80 + 61)ton
new_elements_beam1 nelem 1 material steel1000  connect_mode connect_2
x1   6.8   0.  0.     dcyl1 4.0   tcyl1  0.93168666634785957
x2   7.8   0.  0.     dcyl2 4.0   tcyl2  0.93168666634785957  btype beam

! another half rotor counterweight
! mass .5*(80 + 61)ton
new_elements_beam1 nelem 1 material steel1000  connect_mode connect_1
x1   7.8   0.  0.     dcyl1 4.0   tcyl1  0.93168666634785957
x2   8.8   0.  0.     dcyl2 4.0   tcyl2  0.93168666634785957  btype beam

! shaft from main bearing to nacelle ref point
new_elements_beam1 nelem 1 material steel1000 connect_mode connect_2
x1 -6.     0. 0. dcyl1 4.0 tcyl1 0.0393770908273
x2  0.     0. 0. dcyl2 4.0 tcyl2 0.0393770908273 btype beam
```

! mainbearing

new_body name mainbearing parent nacelle reftype refnode

xfind -6. 0. 0. rotorder 123 rotation 0. 0. 0. axes normal

shaft next element

! shaft from hub CG to moment sensor

new_elements_beam1 nelem 1 material steel1000 connect_mode no_connect

x1 -1.8 0.   0. dcyl1 4.0   tcyl1 0.0393770908273

x2 -1.   0.   0. dcyl2 4.0   tcyl2 0.0393770908273 btype beam

!generator statoil_154m

!shaft_element_position: -7.3808E+00   0.0000E+00   9.8206E+01   ! with 6 deg tilt

!   -7.4215E+00   0.0000E+00   9.7430E+01   ! with 0 deg tilt

! moment sensor

!

new_elements_beam1 nelem 1 material steel1000 !s355j2g3

connect_mode connect_both

x1 -1. 0. 0. dcyl1 4.0 tcyl1 0.0393770908273

x2 0. 0. 0. dcyl2 4.0 tcyl2 0.0393770908273 btype beam

! hub

new_body

 name: hub

 parent: mainbearing

 reftype: refnode   xfind   -1.8   0. 0.

 rotorder: 123

 rotation: 0. 0.   0.

 axes: normal

!generator name: statoil_154m gen_eta: 1.   ! mgen here is mechanical. El power = omega*mgen*eta

scale_omega: 1.   scale_mgen: 1.

omega: mgen: ! [rad/s] [Nm]

0.182840692439 0.0

0.387567813698 430141.912747

0.441498487584 621442.571746

0.54674184148 1292009.93602

0.603395228999 1680263.65716

0.660153336274 2079292.64135

0.718586959631 2498248.64116

0.785607602908 2985179.20285

0.839014678019 3374700.07262

0.890536797538 3753666.44906

0.948970420894 4183570.14056

1.03326982377 4802855.55266

1.10207070288 5307247.30492

1.15191730632 5686051.22915

1.18961641816 5964681.08692

omega_eta: eta:

0.182840692439 0.85

1.15191730632 0.91605

! blade element structural coordinate system:

!

! y out TE along flap principal axis

! z out suction side along lag principal axis

! x = y x z ! NB CAN THEREFORE BE TOWARDS TIP OR HUB

!

! structural twist is positive around x

! mass center and shear center offsets are given in blade element structural

! coordinate system

!

! distributed structural properties for blade

!

r[m],eiflap[Nm**2],eiedge[Nm**2],gtors[Nm**2],ea[N],rho[kg/m],structwist[deg],flpinert[kgm],edginert[kgm],&

! flpcgofs[m],edgcgofs[m],flpshrofs[m],edgshrofs[m]

!

read_airfoil

file c:\3dfloat\3dfloat\airfoils\Cylinder1.dat afname Cylinder1 thick 1.

read_airfoil

file c:\3dfloat\3dfloat\airfoils\NACA4415_RE6E6.dat afname NACA4415 thick .15

read_airfoil

file c:\3dfloat\3dfloat\airfoils\NACA4418_RE6E6.dat afname NACA4418 thick .18

read_airfoil

file c:\3dfloat\3dfloat\airfoils\NACA4421_RE6E6.dat afname NACA4421 thick .21

read_airfoil

file c:\3dfloat\3dfloat\airfoils\NACA4424_RE6E6.dat afname NACA4424 thick .24

read_airfoil

file c:\3dfloat\3dfloat\airfoils\NACA4430_RE6E6.dat afname NACA4430 thick .30

!0. 1.3013E+11 1.3013E+11 1.0039E+11 3.5669E+11 13333.33 0.00 1. 1. 0. 0. 0. 0. ! hub 80 ton 0 to 2m

!1.999 1.3013E+11 1.3013E+11 1.0039E+11 3.5669E+11 13333.33 0.00 1. 1. 0. 0. 0. 0. ! hub 80 ton 0 to 2m

! JBDV: Change blade twist from 0.0 to 37.0 for the first two elements in this table - for visualisation

blade_table blname: 6mwgeneric stiffness_option: global ! stored in bltable()%r,eiflap ...

2. 30.0e9 30.0e9 2.3e11 -1. 1260. 37.00 1. 1. 0. 0. 0. 0. ! torsion increased 10X

3.5 30.0e9 30.0e9 -1 -1. 1184. 37.00 1. 1. 0. 0. 0. 0. ! extra line to provide pitch sensor with no twist

5.0 30.0e9 30.0e9 -1. -1. 774. 37.00 1. 1. 0. 0. 0. 0. ! dbg twist 37. deg

10.0 13.0e9 27.0e9 -1. -1. 649. 20.10 1. 1. 0. 0. 0. 0.

15.0 7.5e9 14.0e9 -1. -1. 525. 11.20 1. 1. 0. 0. 0. 0.

20.0 5.0e9 12.5e9 -1. -1. 430. 5.50 1. 1. 0. 0. 0. 0.

25.0 3.5e9 10.0e9 -1. -1. 405. 2.50 1. 1. 0. 0. 0. 0.

30.0 2.4e9 8.0e9 -1. -1. 378. 1.00 1. 1. 0. 0. 0. 0.

35.0 1.8e9 6.0e9 -1. -1. 342. 0.10 1. 1. 0. 0. 0. 0.

40.0 11.e8 4.8e9 -1. -1. 300. 0.00 1. 1. 0. 0. 0. 0.

45.0 7.7e8 4.2e9 -1. -1. 252. -0.70 1. 1. 0. 0. 0. 0.

50.0 4.5e8 3.2e9 -1. -1. 216. -1.80 1. 1. 0. 0. 0. 0.

55.0 2.7e8 2.5e9 -1. -1. 171. -2.30 1. 1. 0. 0. 0. 0.

60.0 1.7e8 1.8e9 -1. -1. 135. -2.40 1. 1. 0. 0. 0. 0.

65.0 1.2e8 1.3e9 -1. -1. 99. -2.90 1. 1. 0. 0. 0. 0.

70.0 7.0e7 7.5e8 -1. -1. 80. -3.20 1. 1. 0. 0. 0. 0.

75.0 3.0e7 3.75e8 -1. -1. 50. -1.00 1. 1. 0. 0. 0. 0.

76.5 7.0e6 17.5e7 -1. -1. 36. -0.10 1. 1. 0. 0. 0. 0.

76.9 1.5e5 7.5e5 -1. -1. 25. 0.0 1. 1. 0. 0. 0. 0. ! extra line, elastic tip twist sensor

77.001 1.5e5 7.5e5 -1. -1. 25. 0.0 1. 1. 0. 0. 0. 0.

! JBDV: Change blade twist from 0.0 to 37.0 for the first two elements in this table - for visualisation

aero_blade_table blname: 6mwgeneric ! r/R c/R twist[deg] t/c airfoil ! stored in bltable()%ra,chord,atwist,airfoil

0. 0.038961038961 37. 1. interpolate

0.025974025974 0.038961038961 37. 1. interpolate

0.0649350649351 0.038961038961 37. 1. Cylinder1

0.12987012987 0.0428571428571 20.1 .78 interpolate

0.194805194805 0.0844155844156 11.2 .36 interpolate

0.25974025974 0.0831168831169 5.5 .3 NACA4430

0.324675324675 0.0714285714286 2.5 .3 interpolate

0.38961038961 0.0597402597403 1. .3 interpolate

0.454545454545 0.0519480519481 0.1 .3 NACA4430

0.519480519481 0.0454545454545 0.0 .28 interpolate

0.584415584416 0.038961038961 -0.7 .265 interpolate

0.62770562770 0.0366233766233 -1.43 .24 NACA4424

0.649350649351 0.0354545454545 -1.8 .237 interpolate

0.714285714286 0.0319480519481 -2.3 .212 interpolate

0.779220779221 0.0285714285714 -2.4 .21 NACA4421

0.844155844156 0.0250649350649 -2.9 .189 interpolate

0.873376623376 0.0234870129870 -3.035 .18 NACA4418

0.909090909091 0.0215584415584 -3.2 .169 interpolate

0.974025974026 0.0194805194805 -1.0 .152 interpolate

0.993506493506 0.0168831168831 -0.1 .15 NACA4415

1.000 0.0038961038961 0.0 .15 interpolate

! BLADE STRUCTURE

! ----------

! blade 1

! blade_1_root - body coordinate system that does not pitch

new_body name blade_1_root parent hub reftype refnode xfind -1.8 0. 0.

rotorder 321 rotation 0. -2. 0. axes normal ! dbg bcone angle 0. -2. 0.

! blade_1_pitching - this body has coordinate system that pitches (user defined pre-pitch)

new_body name blade_1_pitching parent blade_1_root reftype refnode

xfind 0. 0. 0. rotorder 321 rotation 0. 0. 0. axes normal ! pitch (z axis) eg for failure cases

blade 1 pitch actuation blade second element from here ! useful for log file to pick out coordinates

! from blade root to hub CG 1/3 of hub mass (80t/3), never mind angular momentum of hub compared to blades

! Got rid of point mass here, no node force due to gravity needed

! The middle of the 3 elements is used for pitch actuation

!

new_elements_beam1 nelem 3 material s355j2g3 connect_mode connect_2

x1 0. 0. 2. dcyl1 2.0 tcyl1 0.3222491125

x2 0. 0. 0. dcyl2 2.0 tcyl2 0.3222491125 btype beam

! from blade tip to root

! mass is supposed to be 61ton/3, have to adjist quite a bit. Checked mass in separate calculation, 3df is OK.

! scale factor for 20 elements: 0.8115465974855319

new_elements_beam1 nelem 1 material massless1 connect_mode no_connect

x1 0. 0. 77. dcyl1 1. tcyl1 .45

x2 0. 0. 76.9 dcyl2 1. tcyl2 .45 btype beam

blname 6mwgeneric scale_mass 0.8115465974855319 frac_stiff 1

new_elements_beam1 nelem 20 material massless1 connect_mode connect_1

x1 0. 0. 76.9 dcyl1 1. tcyl1 .45

x2 0. 0. 3.5 dcyl2 3. tcyl2 .45 btype beam

blname 6mwgeneric scale_mass 0.8115465974855319 frac_stiff 1

new_elements_beam1 nelem 1 material massless1 connect_mode connect_both

x1 0. 0. 3.5 dcyl1 3. tcyl1 .45

x2 0. 0. 2.   dcyl2 3. tcyl2 .45 btype beam

blname 6mwgeneric scale_mass 0.8115465974855319 frac_stiff 1

! new body that pitches with the blade root, given by the pitch controller

!

new_body reftype refnode   xfind   0.   0. 2. !3.5

rotorder 321   rotation 0. 0. 0.   axes normal !

name blade_1_pcontrol parent blade_1_pitching

! blade 2

! blade_2_root - body coordinate system that does not pitch

new_body name blade_2_root parent hub reftype refnode xfind -1.8 0. 0.

rotorder 321 rotation 120. -2.   0.   axes normal   ! dbg cone rotation 120. -2.   0.

! blade_2_pitching - this body has coordinate system that pitches

new_body name blade_2_pitching parent blade_2_root reftype refnode

xfind 0. 0. 0. rotorder 321 rotation 0. 0. 0. axes normal ! pitch (z axis)

blade 2 pitch actuation blade 2 elements from here ! useful for log file to pick out coordinates

copy_elements

from_body: blade_1_pitching

to_body: blade_2_pitching

!new_elements_beam1 nelem 3 material s355j2g3 connect_mode connect_2

!x1 0. 0. 2. dcyl1 2.0 tcyl1 0.3222491125

!x2 0. 0. 0. dcyl2 2.0 tcyl2 0.3222491125 btype beam

! from blade tip to root

!new_elements_beam1 nelem 20 material massless1 connect_mode connect_2

!x1 0. 0. 77. dcyl1 1. tcyl1 .45

!x2 0. 0. 2. dcyl2 3. tcyl2 .45 btype beam

!blname 6mwgeneric scale_mass 1. frac_stiff 1.

! new body that pitches with the blade root, given by the pitch controller

!

new_body reftype refnode   xfind   0.   0. 2.

rotorder 321   rotation 0. 0. 0.   axes normal !

name blade_2_pcontrol parent blade_2_pitching

! blade 3

! blade_3_root - body coordinate system that does not pitch

new_body name blade_3_root parent hub reftype refnode xfind -1.8 0. 0.

rotorder 321 rotation -120. -2. 0.   axes normal   ! dbg rotation -120. -2.   0. ! cone

! blade_3_pitching - this body has coordinate system that pitches

new_body name blade_3_pitching parent blade_3_root reftype refnode

xfind 0. 0. 0. rotorder 321 rotation 0. 0. 0. axes normal ! pitch (z axis)

blade 3 pitch actuation blade 2 elements from here ! useful for log file to pick out coordinates

copy_elements

from_body: blade_1_pitching

to_body: blade_3_pitching

!new_elements_beam1 nelem 3 material hub connect_mode connect_2

!x1 0. 0. 2. dcyl1 2.0 tcyl1 .1

!x2 0. 0. 0. dcyl2 2.0 tcyl2 .1 btype beam

```
! from blade tip to root
!new_elements_beam1 nelem 10 material massless1 connect_mode connect_2
!x1 0. 0. 77. dcyl1 1. tcyl1 .45
!x2 0. 0. 2.  dcyl2 3. tcyl2 .45 btype beam
!blname 6mwgeneric scale_mass 1. frac_stiff 1.

! new body that pitches with the blade root, given by the pitch controller
!
new_body  reftype  refnode   xfind   0.   0.  2.
rotorder 321       rotation  0.  0.  0.   axes normal !
name blade_3_pcontrol  parent blade_3_pitching
! ------------------------------------------------------------------------------------------
!monitor_element_b1  type plot nmonitor 100
!file turb1.plot

monitor_element_b1  type tecplot nmonitor 1
file turb1.dat

monitor_element_b1 find  0. 0. -.5  nmonitor 20  node 1 type forces
file rotor_1_force.txt  body_name mainbearing label s1 s2 s3 shaft_fx shaft_fy shaft_fz
monitor_element_b1 find  0. 0. -.5  nmonitor 20  node 1 type moments
file rotor_1_moment.txt  body_name mainbearing label s1 s2 s3  shaft_mx  shaft_my  shaft_mz

file rotor_sensors.txt  label rotor_gather    toffset 0.
sensors:

nfact: 1 source: shaft_fx     scale:  -.001        unit: [kN]
nfact: 1 source: shaft_fy     scale:  -.001        unit: [kN]
nfact: 1 source: shaft_fz     scale:  -.001        unit: [kN]
nfact: 1 source: shaft_mx     scale:  -.001        unit: [kNm]
nfact: 1 source: shaft_my     scale:  -.001        unit: [kNm]
nfact: 1 source: shaft_mz     scale:  -.001        unit: [kNm]
```

wind_transient

0. 12. 0.

200. 12. 0.

!turbulence_box

turbulence: file

turbulence_info: C:\turbulence1\turbsim\NTM_U12_I18.3_PL0.09\TurbSim.bts
!c:\turbulence\IEA_OC4_v1_18_u.txt

turb_tstart: 0.

turb_intens: 0.136

turbulence_scaling: none

reference_node: 0. 0. 90.

reference_height: 98.2

!rotor_wake

name: rotor_1

shaft_element_body: mainbearing

shaft_element_position: -1.4 0. 0. ! expressed in body mainbearing system

rotating_node: 1

induction: all

logfile: rotor_1.txt

nblades: 3

bladenames: blade_1_pitching

blade_2_pitching

blade_3_pitching

pitch_control_name: 5mw_floating

pitch_actuator_bodies: blade_1_pitching

blade_2_pitching

blade_3_pitching

pitch_actuator_positons: 0. 0. 1.

0. 0. 1.

0. 0. 1. ! expressed in body blade_1_pitching system

!pitchcontrol

control_type: iea_oc3_floating !_floating

name: 5mw_floating

scale_omega: 1.1 ! this controller has nominal 12.1 rpm

scale_vaxial: 1.0

scale_pitchcoll: -1.0

omeganom: 1.1519173063162573

ti: 10.

gain: 1.

pitchref: 0.

aux: 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

\==========

\\ End of Main Geometry

\==========

\\Monitors

\----------

!monitor_element_b1 type plot nmonitor 100

!file turb1.plot

! Tecplot

!monitor_element_b1 type: tecplot nmonitor: 20 file: turb1.dat

monitor_element_b1 find 0.000 0.000 0.0 nmonitor 20 node 2 type waveheight_origin

file waves.txt label WaveElev

monitor_element_b1 find 0.000 0.000 0.0 nmonitor 20 node 2 type waveheight

file waves_atplatform.txt label WaveElev_platf

monitor_element_b1 find 0.000 0.000 94.800 nmonitor 20 node 2 type orientation

file d_top.txt label d_top

monitor_element_b1 find 0.000 0.000 94.800 nmonitor 20 node 2 type velocity

file v_top.txt label v_top

monitor_element_b1 find 0.000 0.000 94.800 nmonitor 20 node 2 type acceleration

file a_top.txt label a_top

monitor_element_b1 find 0.000 0.000 0.0 nmonitor 20 node 2 type orientation

file d_swl.txt label d_swl PtfmSway PtfmHeave Ptfm_xx Ptfm_xy Ptfm_xz Ptfm_yx

monitor_element_b1 find 0.000 0.000 0.0 nmonitor 20 node 2 type velocity

file v_swl.txt label v_swl

monitor_element_b1 find 0.000 0.000 0.0 nmonitor 20 node 2 type acceleration

file a_swl.txt label a_swl

monitor_element_b1 find 0.000 0.000 -20.000 nmonitor 20 node 1 type orientation

file d_bot.txt label d_bot

monitor_element_b1 find 0.000 0.000 -20.000 nmonitor 20 node 1 type velocity

file v_bot.txt label v_bot

monitor_element_b1 find 0.000 0.000 -20.000 nmonitor 20 node 1 type acceleration

file a_bot.txt label a_bot

monitor_element_b1 find -31.000 0.000 -20.000 nmonitor 20 node 1 type orientation

file d_bot_cc1.txt label d_bot_cc1

monitor_element_b1 find 15.500 26.847 -20.000 nmonitor 20 node 1 type orientation

file d_bot_cc2.txt label d_bot_cc2

monitor_element_b1 find 15.500 -26.847 -20.000 nmonitor 20 node 1 type orientation

file d_bot_cc3.txt label d_bot_cc3

monitor_element_b1 find -40.3490009953977 0 5.28924800541508 nmonitor 20 node 1 type forces

file f_line1.txt label f_line1

monitor_element_b1 find 21.8490009953977 -37.8435798186517 -1.42150398916983 nmonitor 20 node 1 type forces

file f_line2.txt label f_line2

monitor_element_b1 find 21.8490009953977 37.8435798186517 -1.42150398916983 nmonitor 20 node 1 type forces

file f_line3.txt label f_line3

monitor_element_b1 find -850.473 0 -95 nmonitor 20 node 2 type forces

file f_anchor_1.txt label f_anchor1

monitor_element_b1 find 424.9865 -736.098210530871 -95 nmonitor 20 node 1 type forces

file f_anchor_2.txt label f_anchor2

monitor_element_b1 find 424.9865 736.098210530871 -95 nmonitor 20 node 1 type forces

file f_anchor_3.txt label f_anchor3

monitor_element_b1 find -849.973 0 -95 nmonitor 20 node 1 type forces

file f_anchorbeam1.txt label f_anchbeam1

monitor_element_b1 find 0 0 0.88 nmonitor 20 node 1 type forces

file sec_f_cs_elv_0_88.txt label f_cs_e_0_88

monitor_element_b1 find 0 0 -14 nmonitor 20 node 1 type forces

file sec_f_cs_elv_-14.txt label f_cs_e_-14

monitor_element_b1 find -7.102 0 -17 nmonitor 20 node 1 type forces

file sec_f_pont_cs.txt label f_pont_cs

monitor_element_b1 find -15.5 0 -17 nmonitor 20 node 1 type forces

file sec_f_centpont.txt label f_c_pont

monitor_element_b1 find -24 0 -17 nmonitor 20 node 1 type forces

file sec_f_pont_cc.txt label f_pont_cc

monitor_element_b1 find -31 0 -14 nmonitor 20 node 1 type forces

file sec_f_cc_elv_-14.txt label f_cc_e_-14

monitor_element_b1 find -31 0 -3.1 nmonitor 20 node 1 type forces

file sec_f_cc_elv_-3.txt label f_cc_e_-3

monitor_element_b1 find 0 0 0.88 nmonitor 20 node 1 type moments

file sec_m_cs_elv_0_88.txt label m_cs_e_0_88

monitor_element_b1 find 0 0 -14 nmonitor 20 node 1 type moments

file sec_m_cs_elv_-14.txt label m_cs_e_-14

monitor_element_b1 find -7.102 0 -17 nmonitor 20 node 1 type moments

file sec_m_pont_cs.txt label m_pont_cs

monitor_element_b1 find -15.5 0 -17 nmonitor 20 node 1 type moments

file sec_m_centpont.txt label m_c_pont

monitor_element_b1 find -24 0 -17 nmonitor 20 node 1 type moments

file sec_m_pont_cc.txt label m_pont_cc

monitor_element_b1 find -31 0 -14 nmonitor 20 node 1 type moments

file sec_m_cc_elv_-14.txt label m_cc_e_-14

monitor_element_b1 find -31 0 -3.1 nmonitor 20 node 1 type moments

file sec_m_cc_elv_-3.txt label m_cc_e_-3

\ gathering partk - collects all results to one file

monitor_element_b1 find 0. 0. 0. nmonitor 20 body_name inertial node 1 type gather

file X_SIM_RES_ALL.txt label X_gather

sensors:

nfact: 1 source: WaveElev scale: 1. unit: [m] !

nfact: 1 source: d_top scale: 1. unit: [m] !

nfact: 1 source: v_top scale: 1. unit: [m/s] !

nfact: 1 source: a_top scale: 1. unit: [m/s**2] !

nfact: 1 source: d_swl scale: 1. unit: [m] !

nfact: 1 source: Ptfm_xx scale: 57.295779513082323 unit: [deg] header: PtfmPitch

nfact: 1 source: v_swl scale: 1. unit: [m/s] !

nfact: 1 source: a_swl scale: 1. unit: [m/s**2] !

nfact: 1 source: d_swl scale: 1. unit: [m] !

nfact: 1 source: v_swl scale: 1. unit: [m/s] !

nfact: 1 source: a_swl scale: 1. unit: [m/s**2] !

nfact: 1 source: f_line1 scale: 1. unit: [N] !

nfact: 1 source: f_line2 scale: 1. unit: [N] !

nfact: 1 source: f_line3 scale: 1. unit: [N] !

nfact: 1 source: f_bridle1 scale: 1. unit: [N] !

nfact: 1 source: f_bridle2 scale: 1. unit: [N] !

nfact: 1 source: f_bridle3 scale: 1. unit: [N] !

nfact: 1 source: f_bridle4 scale: 1. unit: [N] !

nfact: 1 source: f_bridle5 scale: 1. unit: [N] !

nfact: 1 source: f_bridle6 scale: 1. unit: [N] !

nfact: 1 source: f_anchor1 scale: 1. unit: [N] !

nfact: 1 source: f_anchor1 scale: 1. unit: [N] !

nfact: 1 source: f_anchor1 scale: 1. unit: [N] !

nfact: 1 source: sec_f_cs_elv_0_88 scale: 1. unit: [N] !

nfact: 1 source: sec_f_cs_elv_-14 scale: 1. unit: [N] !

nfact: 1 source: sec_f_pont_cs scale: 1. unit: [N] !

nfact: 1 source: sec_f_centpont scale: 1. unit: [N] !

nfact: 1 source: sec_f_pont_cc scale: 1. unit: [N] !

nfact: 1 source: sec_f_cc_elv_-14 scale: 1. unit: [N] !

nfact: 1 source: sec_f_cc_elv_-3 scale: 1. unit: [N] !

nfact: 1 source: sec_m_cs_elv_0_88 scale: 1. unit: [N] !

nfact: 1 source: sec_m_cs_elv_-14 scale: 1. unit: [N] !

nfact: 1 source: sec_m_pont_cs scale: 1. unit: [N] !

nfact: 1 source: sec_m_centpont scale: 1. unit: [N] !

nfact: 1 source: sec_m_pont_cc scale: 1. unit: [N] !

nfact: 1 source: sec_m_cc_elv_-14 scale: 1. unit: [N] !

nfact: 1 source: sec_m_cc_elv_-3 scale: 1. unit: [N] !

\==========

\\ End of Monitors

\==========

\\ Constraints

\----------

\ Define sea bed

!apply_nodal_bc find 0. 0. 0. wall idofs 3 idofe 3 displ -95 1. dstat 0.01

\ Force equal point mass allowance and tolerances

!apply_nodal_bc find: 0 0 -11.5 apply_force 0. 0. -8219340 0. 0. 0. tstart: 0. tend: 1000000.

\ Force equal point mass cylinder structure

!apply_nodal_bc find: 0 0 -0.5 apply_force 0. 0. -3437000 0. 0. 0. tstart: 0. tend: 1000000.

\ Force equal point mass mechanical outfitting

!apply_nodal_bc find: 0 0 -0.5 apply_force 0. 0. -1964000 0. 0. 0. tstart: 0. tend: 1000000.

!\\\----------Pitch test----------

!apply_nodal_bc find 0. 0. 0. apply_displ idofs 5 idofe 5 displ 0.08727 tstart: 0. tramp: 80. tend: 100.

!apply_nodal_bc find 0. 0. 0. apply_displ idofs 1 idofe 1 displ 0.0 tstart: 0. tend: 100.

!\\\----------Heave test----------

! Displacement to make heave decay test

!apply_nodal_bc find 0. 0. 0. apply_displ idofs 3 idofe 3 displ 1.234 tstart: 0. tramp: 80. tend: 100.

\ ----------

\ wind load applied as point loads

\ ----------

\   Anchors

\ ----------

! Anchor 1

!apply_nodal_bc find -850.973 0 -95 apply_displ idofs 1 idofe 6 displ 0. 0. 0. 0. 0. 0.

! Anchor 2

!apply_nodal_bc find 424.9865 -736.098210530871 -95 apply_displ idofs 1 idofe 3 displ 0. 0. 0.

! Anchor 3

!apply_nodal_bc find 424.9865 736.098210530871 -95 apply_displ idofs 1 idofe 3 displ 0. 0. 0.

! hub

!apply_nodal_bc find -7.7573E+00   0.0000E+00   9.8615E+01 apply_displ idofs 1 idofe 6 displ 0. 0. 0. 0. 0. 0.

! pontoons

!apply_nodal_bc find 0. 0. -17.   apply_displ idofs 1 idofe 6 displ 0. 0. 0. 0. 0. 0.

apply_nodal_bc find -31. 0. 0.   apply_displ idofs 1 idofe 3 displ 0. 0. 0. 0. 0. 0.

apply_nodal_bc find 15.5 26.84 0.   apply_displ idofs 1 idofe 3 displ 0. 0. 0. 0. 0. 0.

apply_nodal_bc find 15.5 -26.84 0.   apply_displ idofs 1 idofe 3 displ 0. 0. 0. 0. 0. 0.

!apply_nodal_bc find   0. 0.   94.8   apply_displ idofs 1 idofe 6 displ 0. 0. 0. 0. 0. 0.

!apply_nodal_bc find   0. 0.   94.8   apply_displ idofs 6 idofe 6 displ 0. 0. 0. 0. 0. 0.

\==========

\\ End of Constraints

```
\-------------------------------------------------------------------------------------------------------------------
\ Simultation settings
\-------------------------------------------------------------------------
\ Nodal damping included to take into account that morrison elements are not frequecny dependent
add_node_damping  find   0.  0.  0.88
 1   1      0.
 2   2      0.
 3   3      200000

!add_node_stiffness  find   0.  0.  0.    !  stiffness from mooring, water plane stiffness, set to 1., we are only after flexible modes here
 f_lin  0. 0. 0.  0. 0. 0.
 x_lin  0. 0. 0.  0. 0. 0.
 1  1    1.e3
 2  2    1.e3
 3  3    1.e3
 4  4    1.e3
 5  5    1.e3
 6  6    1.e3

add_node_stiffness  find   -31.  0.  0.     ! bucket heave stiffnes, arbitraty surge/sway
f_lin  0. 0. 0.  0. 0. 0.
x_lin  -31. 0. 0.  0. 0. 0.
 1  1    1.e3
 2  2    1.e3
 3  3    1.136816246389e6

add_node_stiffness  find   15.5  26.84  0.  ! bucket heave stiffnes, arbitraty surge/sway
f_lin  0. 0. 0.  0. 0. 0.
x_lin  15.5  26.84 0.  0. 0. 0.
 1  1    1.e3
 2  2    1.e3
 3  3    1.136816246389e6
```

add_node_stiffness find   15.5   -26.84 0. ! bucket heave stiffnes, arbitraty surge/sway

f_lin 0. 0. 0. 0. 0. 0.

x_lin 15.5 -26.84 0. 0. 0. 0.

 1 1   1.e3

 2 2   1.e3

 3 3   1.136816246389e6

 material_specific_damping   material Chain type rayleigh   alpha 0.   beta   0.02

! eigen frequency analysis

! short step to assemble matrices and apply added mass

newmark dt 0.000000001 nassemble 1 nnewton: 1 nsubmin: 0 rwilson: 0.9 relax: 0.0
resid_newton: 0.00000001 nmonitor: 1

step nstep 1 method new_gen_alpha

eigen_analysis   amplitude 20. nfreq 20 filename plotall

END