

```
#include "DelMar_hamilton_v2.spec"
```

Problem Description

```
title = TITLE
type  = surface
```

Analysis Parameters

```
static-relaxation = 0.1
static-iterations = 1000
static-tolerance  = 0.0001

relax-adapt-up     = 1.02
relax-adapt-down   = 1.1

static-outer-iterations = 200

static-outer-relaxation = 0.995
static-outer-tolerance  = 0.01
static-initial-guess    = catenary

duration            = TF
ramp-time           = RAMPTIME
time-step           = DT
dynamic-relaxation  = .95
dynamic-iterations  = 1500
dynamic-tolerance   = 1e-6
dynamic-rho         = -0.5
```

Environment

```
rho          = 1025
gravity       = 9.81
depth        = DEPTH
bottom-stiffness = 600
bottom-damping  = 20
x-current     = XCURRENT
x-wind        = XWIND
```

```
input-type = INPUT_TYPE
```

#ifdef WAVE_FOLLOWING

```
forcing-method = wave-follower
x-wave = (XWAVEAMP, XWAVEPERIOD, XWAVEDIR)
#endif
```

#ifdef VELOCITY_FORCING

```
forcing-method = velocity
z-input = (XWAVEAMP, XWAVEPERIOD, XWAVEDIR)
#endif
```

Buoys

```
atlas_buoy  type = cylinder
            m = 245
            d = 2.3
            h = 1
            Cdn = 1.0   Cdt = 1.0
            Sw = 3.0    Cdw = 1.5 /* reduce area by 50% for ATLAS */
                                   /* relative to 3-meter discus */
geoce_buoy  type = cylinder
            m = 1475
            d = 2.3
            h = 1
```

```
Cdn = 1.0
Cdt = 1.0
buoyancy = 3400 * 9.81
```

```
del_mar_buoy      type = cylinder
  m = 1500
  d = 2.3
  h = 1
  Cdn = 1.0
  Cdt = 1.0
  /*buoyancy = 3403 * 9.81  */
```

```
del_mar_buoy_axi      type = axisymmetric
  m = 1500
  diameters = (0,.2) (1.49,.2) (1.5,1.5) (1.75, 2.3) (2.5,2.3)
  Cdn = 1.0
  Cdt = 1.0
  /*buoyancy = 3403 * 9.81  */
```

f132_cage

```
type = sphere
m = 270
d = 2.1
Cdn = 0.47
Cdt = 0.47
buoyancy = 270
```

```
f145_cage      type = sphere
  m = 380
  d = 1.143
  Cdn = 0.47
  Cdt = 0.47
  buoyancy = 308
```

```
f164_cage
  type = sphere
  m = 1300
  d = 1.63
  Cdn = 0.5
  Cdt = 0.5
  /* buoyancy = */
```

```
f164_cage_pilot
  type = sphere
  m = 1300
  d = 1.524
  Cdn = 0.5
  Cdt = 0.5
  /* buoyancy = */
```

Anchors

```
five_wheel_stack
  d = 0.8
  Cdn = 1.0
  Cdt = 1.0
  /*wet = 4000*.454*9.81*/
  wet = 2300*9.81
```

```
del_mar_anchor
  d = 0.8
  Cdn = 1.0
```

```
Cdt = 1.0
/*wet = 4000*.454*9.81*/
wet = 1250*9.81
```

Connectors

```
pivot          d = 0.3 /* to release moments - use segments mostly */
                m = 1.5
                wet = 1.5 * 9.81
                Cdn = 0.5
                length = 0.3
```

```
f145      m      = 380
          d      = 2.1
          wet    = -300 * 9.81
          Cdn    = 0.47
```

```
f149
          m      = 580
          d      = 2.2
          wet    = -335 * 9.81
          Cdn    = 0.47
```

```
benthos_4m
          m      = 96
          d      = .5
          wet    = -88 * 9.81
          Cdn    = 0.47
```

```
          length = 4
benthos_2m
          m      = 48
          d      = .5
          wet    = -44 * 9.81
          Cdn    = 0.47
          length = 2
```

```
f149_adcp      m      = 580
                d      = 2.4892
                wet    = -380 * 9.81
          Cdn    = 0.47
                Cdt    = 0.47
```

attachments

```
mc_im
          m      = 3.8
          d      = 0.075
          length = .563
          wet    = 2.8* 9.81
          Cdn    = 1.4
          Cdt    = .5
```

```
mcp_im
          m      = 3.8
          d      = 0.075
          wet    = 2.8* 9.81
          Cdn    = 1.4
          Cdt    = .5
          length = .563
```

```
icc
          m      = 2
          d      = .1
          length = 0.2
```

```

      wet = 1* 9.81
Cdn  = 1.4
      Cdt = 1

```

```

sc_im

```

```

      m      = 10.7
      d      = 0.11
      length = 0.8
      wet = 9.8 * 9.81
Cdn  = 1.4
      Cdt = 1

```

Materials

```

Stretch_Hose EA = 5e4      EI = 1e4      GJ = 1.0
      d = .078      Cdn = 0.5      Cdt = 0.2
      wet = 9.8*3.94/2      m = 3.94 /*These are rough guesses */
type = nonlinear
T = 11675*e*e-25086*e*e*e+19235*e*e*e*e
Te = 2*11675*e-3*25086*e*e+4*19235*e*e*e
Tee = 2*11675-2*3*25086*e+3*4*19235*e*e

```

```

Stretch_Hose_Stiff EA = 5e4      EI = 1e4      GJ = 1.0
      d = .078      Cdn = 0.5      Cdt = 0.2
      wet = .1      m = 4.9 /* Mass set for neutral buoyancy */
type = nonlinear
T = (2563/STRAIN_FACTOR^2)*e*e-(885/STRAIN_FACTOR^3)*e*e*e+(7423/STRAIN_FACTOR^4)*e*e*e*e
Te = 2*(2563/STRAIN_FACTOR^2)*e-3*(885/STRAIN_FACTOR^3)*e*e+4*(7423/STRAIN_FACTOR^4)*e*e*e
Tee = 2*(2563/STRAIN_FACTOR^2)-2*3*(885/STRAIN_FACTOR^3)*e+3*4*(7423/STRAIN_FACTOR^4)*e*e

```

```

Stretch_Hose_Nominal EA = 5e4      EI = 1e4      GJ = 1.0
      d = .078      Cdn = 0.5      Cdt = 0.2
      wet = .1      m = 4.9 /* Mass set for neutral buoyancy */
type = nonlinear
T = (5505/STRAIN_FACTOR^2)*e*e-(10951/STRAIN_FACTOR^3)*e*e*e+(8290/STRAIN_FACTOR^4)*e*e*e*e
Te = 2*(5505/STRAIN_FACTOR^2)*e-3*(10951/STRAIN_FACTOR^3)*e*e+4*(8290/STRAIN_FACTOR^4)*e*e*e
Tee = 2*(5505/STRAIN_FACTOR^2)-2*3*(10951/STRAIN_FACTOR^3)*e+3*4*(8290/STRAIN_FACTOR^4)*e*e

```

```

Stretch_Hose_Soft EA = 5e4      EI = 1e4      GJ = 1.0
      d = .078      Cdn = 0.5      Cdt = 0.2
      wet = .1      m = 4.9 /* Mass set for neutral buoyancy */
type = nonlinear
T = (5126/STRAIN_FACTOR^2)*e*e-(8682/STRAIN_FACTOR^3)*e*e*e+(4962/STRAIN_FACTOR^4)*e*e*e*e
Te = 2*(5126/STRAIN_FACTOR^2)*e-3*(8682/STRAIN_FACTOR^3)*e*e+4*(4962/STRAIN_FACTOR^4)*e*e*e
Tee = 2*(5126/STRAIN_FACTOR^2)-2*3*(8682/STRAIN_FACTOR^3)*e+3*4*(4962/STRAIN_FACTOR^4)*e*e

```

```

EM_Chain      EA = 1e+05      EI = 1000      GJ = 1e-4
      m = 3.5      wet = 1.*9.81
      d = 0.04      Cdt = 0.05      Cdn = 0.55
      Cat = 0.1      Can = 1.0

```

```

ESP_Assembly_ForCatenary      EA = 1e7      EI = 5e5      GJ = 1e5

```

```

m = 400/1.5    wet = ESP_WETWEIGHT/1.5 /*-220/1.5 */
d = .762      Cdn = 0.5      Cdt = 0.5
              /* Cat = .5      Can = 1.0 */
              amt = 100/1.5    amn = 200/1.5

ESP_Assembly_ForTaut EA = 1e7 EI = 5e5      GJ = 1e5
m = 730/1.5    wet = -1690/1.5
d = .762      Cdn = 0.5      Cdt = 0.5
              /* Cat = .5      Can = 1.0 */
              amt = 300/1.5    amn = 450/1.5

ESP_Can EA = 1e+7      EI = 5e6      GJ = 1.0
d = .762      Cdn = 0.5      Cdt = 0.5
wet = -1540/.84      m = 235/0.84
/*wet = -400/.84      m = 235/0.84 */

BatteryCase EA = 1e+7      EI = 5e5      GJ = 1.0
m = 181.8/0.66      wet = 980/0.66
d = .91      Cdt = 0.5      Cdn = 0.5
              Cat = .5      Can = 1.0

float_chain_4m EA = 1.08e8      EI = 4.508e+06      GJ = 2.25e+06
m = 96      am = 12      length = 4      wet = -88/4* 9.81
d = 0.5      Cdt = 0.47      Cdn = 0.47

float_chain_2m EA = 1.08e8      EI = 4.508e+06      GJ = 2.25e+06
m = 48      am = 6      length = 2      wet = -44/2* 9.81
d = 0.5      Cdt = 0.47      Cdn = 0.47

float_chain_5m EA = 1.08e8      EI = 4.508e+06      GJ = 2.25e+06
m = 48      am = 6      length = 2      wet = -112/5*9.81
d = 0.5      Cdt = 0.47      Cdn = 0.47

chain_mr1/2in EA = 9.2e+07      EI = 20      GJ = 1e-4
m = 3.5      wet = 3.04*9.81
d = 0.02      Cdt = 0.05      Cdn = 0.55
Cat = 0.1      Can = 1.0

chain_drop_1/2in EA = 9.2e+07      EI = 1e-4      GJ = 1e-4
m = 7.8      wet = 6.8*9.81
d = 0.04      length = 0.6      Cdt = 1.0
Cdn = 1.6
Cat = 0.1      Can = 1.0

chain_5/8in EA = 9.2e+07      EI = 1      GJ = 1e-4
m = 6.070      wet = 51.7608
d = 0.0587      Cdt = 0.05      Cdn = 0.55
Cat = 0.1      Can = 1.0

adcp_frame EA = 1.0e8      EI = 4.508e+06      GJ = 2.25e+06
m = 40/1.4      wet = 370/1.4
d = 0.5      Cdt = 0.05      Cdn = 0.5
length = 1.4

adcp_cage_up EA = 1.0e8      EI = 4.508e+06      GJ = 2.25e+06
m = 100/1.9      wet = 45/2.2*9.81
d = 0.18      Cdt = 0.9      Cdn = 1.3
length = 2.2

```

adcp_cage_up_pilot EA = 1.0e8 EI = 4.508e+06 GJ = 2.25e+06
 m = 80/1.47 wet = 74/1.47*9.81
 d = 0.18 Cdt = 0.9 Cdn = 1.3
 length = 1.47

sensor_cage EA = 1.0e8 EI = 4.508e+06 GJ = 2.25e+06
 m = 50/1.9 wet = 25/1.9*9.81
 d = 0.5 Cdt = 0.05 Cdn = 0.5
 length = 1.9

sensor_cage_d_star EA = 1.0e8 EI = 4.508e+06 GJ = 2.25e+06
 m = 100/1.9 wet = 50/1.9*9.81
 d = 0.5 Cdt = 0.05 Cdn = 0.5
 length = 1.9

d_star EA = 1.0e8 EI = 4.508e+06 GJ = 2.25e+06
 m = 100/1.9 wet = 34.73/2.2*9.81
 d = 0.5 Cdt = 0.05 Cdn = 0.5
 length = 2.2

nilspin_3/16in EA = 1.91e+06 EI = 1.0 GJ = 1.0
 m = 0.110 wet = 0.7592
 d = 0.00635 Cdn = 1.2 Cdt = 0.005
 Can = 1.0 Cat = 0.0

nilspin_1/4in EA = 3.34e+06 EI = 1.0 GJ = 1.0
 m = 0.192 wet = 1.38
 d = 0.00794 Cdn = 1.2 Cdt = 0.005
 Can = 1.0 Cat = 0.0

nilspin_3/8in EA = 1.56e7 EI = 20.0 GJ = 1.0
 m = 0.89477 wet = 3.109
 d = 0.0127 Cdn = 1.5 Cdt = 0.01
 Can = 1.0 Cat = 0.0 bt = 5 /*100 */

nylon_1in EA = 100084 EI = 0.01 GJ = 0.01
 m = 0.214 wet = 0.02648*9.81
 d = 0.020 Cdn = 1.2 Cdt = 0.005
 Can = 1.0 Cat = 0.0

dual_release EA = 5.0e7 EI = 10000 GJ = 10000
 m = 72/1.2 am=7.713/1.2 wet = 55/1.2*9.81
 d = 0.5 Cdt = 1.0 Cdn = 1.0
 Cat = 1.0 Can = 1.0
 length = 1.2

single_release EA = 5.0e7 EI = 10000 GJ = 10000 wet = 55/1.2*9.8
 m = 72/1.2/2 am=7.713/1.2/2
 d = 0.5 Cdt = 1.0 Cdn = 1.0
 Cat = 1.0 Can = 1.0
 length = 1.2

dual_release_pilot EA = 5.0e7 EI = 10000 GJ = 10000

9.81

$$m = 72/1.2$$

$$am = 7.713/1.2$$

$$wet = 154 * .454/1.94 *$$

$$d = 0.5$$

$$Cdt = 1.0$$

$$Cdn = 1.0$$

$$Cat = 1.0 \quad Can = 1.0$$

$$length = 1.94$$

$$\text{depressor} \quad EA = 5.0e7 \quad EI = 10000.0$$

$$GJ = 10000.0$$

$$m = 520.0$$

$$wet = 889.64432$$

$$d = 0.290 \quad Cdt = 0.01$$

$$Cdn = 1.0$$

$$Cmt = 1.26 \quad Cmn = 2.0$$

$$\text{del_mar_pig} \quad EA = 5.0e7 \quad EI = 10000.0$$

$$GJ = 10000.0$$

$$m = \text{PIG_MASS}$$

$$wet = \text{PIG_MASS} * 9.81$$

$$d = 0.290 \quad Cdt = 0.01$$

$$Cdn = 1.0$$

$$Cmt = 1.26 \quad Cmn = 2.0$$

nystron_1in

$$EA = 748784$$

$$EI = 0.01$$

$$GJ = 0.01$$

$$m = 0.506$$

$$wet = 0.097957 * 9.81$$

$$d = 0.026$$

$$Cdn = 1.2$$

$$Cdt = 0.005$$

$$Can = 1.0$$

$$Cat = 0.0$$

long_chain_3_4

$$EA = 5.0e7 \quad EI = 10.0$$

$$GJ = 10.0$$

$$m = 6.35$$

$$wet = 5.74 * 9.81$$

$$d = 0.066$$

$$Cdt = 0.006$$

$$Cdn = 0.5$$

$$Cmt = 1.1$$

$$Cmn = 2.0$$

short_chain_3_4

$$EA = 5.0e7 \quad EI = 10.0$$

$$GJ = 10.0$$

$$m = 8.0$$

$$wet = 7.80 * 9.81$$

$$d = 0.066$$

$$Cdt = 0.006$$

$$Cdn = 0.5$$

$$Cmt = 1.1$$

$$Cmn = 2.0$$

swivel_3t

$$EA = 5.0e7$$

$$EI = 1000.0$$

$$GJ = 1000.0$$

$$m = 3.1$$

$$wet = 2.65 * 9.81$$

$$d = 0.08$$

$$Cdt = 0.01$$

$$Cdn = 1.0$$

$$Cmt = 1.18$$

$$Cmn = 2.0$$

$$length = 0.5$$

swivel_5T

$$EA = 5.0e7 \quad EI = 1000.0$$

$$GJ = 1000.0$$

$$m = 26.48/0.21$$

$$wet = 225.7/0.21$$

$$d = 0.057 \quad Cdt = 0.01$$

$$Cdn = 1.0$$

$$Cmt = 1.18$$

$$Cmn = 2.0$$

$$length = 0.21$$

term_d

$$EA = 5.0e7$$

$$EI = 1e-4$$

$$GJ = 1e-4$$

$$m = 12.694$$

$$wet = 107.922 * 9.81$$

$$d = 0.0805$$

$$Cdt = 0.05$$

$$Cdn = 0.55$$

$$Cat = 0.1$$

$$Can = 1.0$$

$$length = .26$$

chain_mr3/4in

$$EA = 9.2e+07$$

$$EI = 10$$

$$GJ = 1e-4$$

$$m = 7.6$$

$$wet = 6.61 * 9.81$$

$$d = 0.03$$

$$Cdt = 0.05$$

$$Cdn = 0.55$$

$$Cat = 0.1$$

$$Can = 1.0$$

aquadopp_pilot

$$EA = 1.0e8$$

$$EI = 4.508e+06$$

$$GJ = 2.25e+06$$

$$m = 20/1$$

$$wet = 15.89/1 * 9.81$$

$$d = 0.5$$

$$Cdt = 0.05$$

$$Cdn = 0.5$$

$$length = 1$$

nylon_3/4in

$$EA = 56715$$

$$EI = 0.01$$

$$GJ = 0.01$$

$$m = 0.2202$$

$$wet = 0.216$$

$$d = 0.01905$$

$$Cdn = 1.5$$

$$Cdt = 0.005$$

$$Can = 1.0$$

$$Cat = 0.0$$

```
comment = "3/4 in nylon - Columbian Rope Corporation"
```

```
nilspin_5/16in EA = 3.434e+06 EI = 1.0 GJ = 1.0
```

```
m = 0.3124
```

```
wet = 2.0867
```

```
d = 0.0111
```

```
Cdn = 1.5
```

```
Cdt = 0.005
```

```
Can = 1.0
```

```
Cat = 0.0
```

```
comment = "Nilspin jacketed 5/16in wire rope (WRCA)"
```

```
Layout
```

```
terminal =
```

```
{
```

```
anchor = del_mar_anchor
```

```
}
```

```
segment = {
```

```
material = chain_mr3/4in
```

```
length = 24
```

```
nodes = (48, 1.0)
```

```
}
```

```
segment =
```

```
{
```

```
length = 30
```

```
material = chain_5/8in
```

```
nodes = (60, 1.0)
```

```
}
```

```
connector = pivot
```

```
segment =
```

```
{
```

```
material = del_mar_pig
```

```
length = 1
```

```
nodes = (3, 1.0)
```

```
}
```

```
connector = pivot
```

```
segment =
```

```
{
```

```
material = swivel_5T
```

```
nodes = (2, 1.0)
```

```
}
```

```
connector = pivot
```

```
segment = {
```

```
length = 75
```

```
material = nilspin_3/8in
```

```
nodes = (75, 1.0)
```

```
/*attachments = icc : (2), mc_im : (3, 8, 13, 18, 23, 28, 38, 48, 58, 72), sc_im : (33, 84)*/
```

```
}
```

```
connector = pivot
```

```
segment = {
```

```
length = 0.5
```

```
material = chain_mr3/4in
```

```
nodes = (3, 1.0)
```

```
}
```

```
segment = {
```

```
length = 1.5
```

```
material = ESP_Assembly_ForCatenary
```

```
nodes = (4, 1.0)
```

```
}
```

```
    segment = {  
        length = STRETCH_HOSE_LENGTH  
#ifdef HOSE1  
        material = Stretch_Hose_Soft  
#endif  
#ifdef HOSE2  
        material = Stretch_Hose_Nominal  
#endif  
#ifdef HOSE3  
        material = Stretch_Hose_Stiff  
#endif  
        nodes = (30, 1.0)  
    }
```

```
terminal =  
    {  
        buoy = del_mar_buoy_axi  
    }  
End
```