```
#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  */


fl32_cage
                type = sphere
                m = 270
                d = 2.1
                Cdn = 0.47
                Cdt = 0.47
                buoyancy = 270

        fl45_cage       type = sphere
                        m = 380
                        d = 1.143
                        Cdn = 0.47
                        Cdt = 0.47
                        buoyancy = 308

        fl64_cage
                type = sphere
                m = 1300
                d = 1.63
                Cdn = 0.5
                Cdt = 0.5
                /* buoyancy = */

        fl64_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
        fl45     m    = 380
                d    = 2.1
                wet = -300 * 9.81
                Cdn  = 0.47


        fl49
                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

        fl49_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_FACTO
R^4)*e*e*e*e
                 Te = 2*(2563/STRAIN_FACTOR^2)*e-3*(885/STRAIN_FACTOR^3)*e*e+4*(7423/STRAIN_FA
CTOR^4)*e*e*e
                 Tee = 2*(2563/STRAIN_FACTOR^2)-2*3*(885/STRAIN_FACTOR^3)*e+3*4*(7423/STRAIN_F
ACTOR^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_FAC
TOR^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_FACT
OR^4)*e*e*e*e
                 Te = 2*(5126/STRAIN_FACTOR^2)*e-3*(8682/STRAIN_FACTOR^3)*e*e+4*(4962/STRAIN_F
ACTOR^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
                                m = 72/1.2/2         am=7.713/1.2/2          wet = 55/1.2*9.8
1/2
                                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
```

```
                                m = 72/1.2          am=7.713/1.2          wet = 154*.454/1.94*
9.81
                                d = 0.5         Cdt = 1.0        Cdn = 1.0
                        Cat = 1.0       Can = 1.0
                                length = 1.94

         depressor   EA = 5.0e7 EI = 10000.0            GJ = 10000.0
                m = 520.0                               wet = 889.64432
                d = 0.290       Cdt = 0.01              Cdn = 1.0
                        Cmt = 1.26      Cmn = 2.0

         del_mar_pig   EA = 5.0e7       EI = 10000.0            GJ = 10000.0
                m = PIG_MASS                            wet = PIG_MASS*9.81
                d = 0.290       Cdt = 0.01              Cdn = 1.0
                        Cmt = 1.26      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      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      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 EI = 1000.0             GJ = 1000.0
                m = 26.48/0.21                          wet = 225.7/0.21
                d = 0.057       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 Corportation"

        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
```