```
#include "DelMar_hamilton_v1.spec"

Problem Description
    title = TITLE
    type  = surface

Analysis Parameters
    static-relaxation = 0.1
    static-iterations = 1000
    static-tolerance  = 0.001

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

    static-outer-iterations = 100

    static-outer-relaxation = 0.98
    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  */

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

        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 = 490/1.5     wet = 10/1.5
                d = .762        Cdn = 0.5       Cdt = 0.5
                               /* Cat = .5       Can = 1.0 */
                                amt =  100/1.5       amn = 150/1.5

        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

    nilspin_3/8in   EA = 4.944e+06  EI = 20.0        GJ = 1.0
             m = 0.446                         wet = 3.109
             d = 0.0127     Cdn = 1.5         Cdt = 0.005
                            Can = 1.0         Cat = 0.0


    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 = 4.944e+06  EI = 1.0        GJ = 1.0
                            m = 0.106                      wet = 0.0759*9.81
                            d = 0.00635     Cdn = 1.2       Cdt = 0.005
                            Can = 1.0       Cat = 0.0

    nilspin_1/4in           EA = 4.944e+06  EI = 1.0        GJ = 1.0
                            m = 0.174                      wet = 0.1314*9.81
                            d = 0.00794     Cdn = 1.2       Cdt = 0.005
                            Can = 1.0       Cat = 0.0
```

```
        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 = 100                                 wet = 100*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
        }

#ifdef CONFIG3  /*Taut mooring */
segment = {
        material = chain_mr3/4in
        length = 1
        nodes = (3, 1.0)
        }

segment = {
        material = chain_mr3/4in
        length = 1
        nodes = (3, 1.0)
        }

   segment = {
      length = 4.5
      material = nilspin_3/8in
      nodes = (8, 1.0)
   }

#else  /* Chain Catenary Mooring (CONFIG 1 or CONFIG 2) */

segment = {
        material = chain_mr3/4in
        length = 24
        nodes = (48, 1.0)
        }

        segment =
        {
```

```
        length = 30
        material = chain_5/8in
        nodes = (60, 1.0)
        }
       connector = pivot

#ifdef CONFIG1
        segment =
        {
        material = del_mar_pig
        length = 1
        nodes = (3, 1.0)
        }
#endif
#ifdef CONFIG2
        segment =
        {
        material = del_mar_pig
        length = 2
        nodes = (6, 1.0)
        }
#endif




#endif

       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)
        }

#ifdef CONFIG1
        segment = {
        length = 1.5
        material = ESP_Assembly_ForCatenary
        nodes = (4, 1.0)
        }

        segment = {
        length = 8.5
        material = Stretch_Hose
        nodes = (30, 1.0)
```

```
        }
#endif

#ifdef CONFIG2
        segment = {
        length = 1.5
        material = ESP_Assembly_ForCatenary
        nodes = (4, 1.0)
        }

        segment = {
        length = 13
        material = EM_Chain
        nodes = (30, 1.0)
        }

#endif

#ifdef CONFIG3
        segment = {
        length = 1.5
        material = ESP_Assembly_ForTaut
        nodes = (4, 1.0)
        }

        segment = {
        length = 9
        material = Stretch_Hose
        nodes = (32, 1.0)
        }
#endif



  terminal =
        {
        buoy = del_mar_buoy
        }
End
```

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