# ESP MOORING WHOI CABLE MODEL

## BUOY

mass = 34 kg (75 lbs)

Axisymmetric

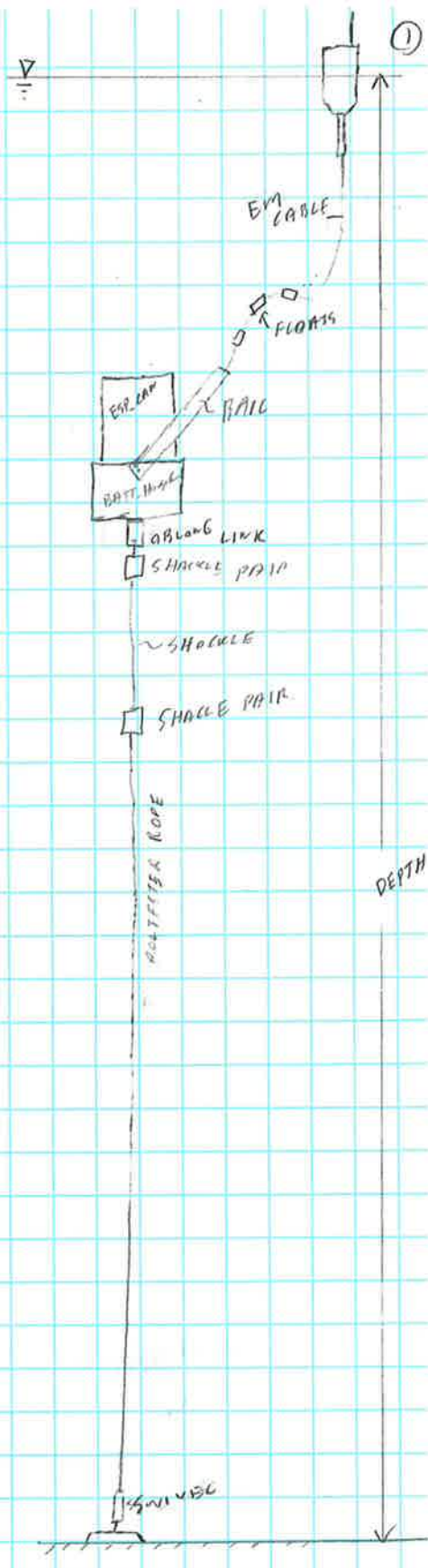
| z | d |
|---|---|
| 0 | 3" |
| 33" | 3" |
| 33" | 11" |
| 42" | 16" |
| 69" | 16" |

$S_w = .15 m^2$

$C_{dw} = 0.75$

$C_{dn} = 1.0$

$C_{df} = 0.1$




## ESP ASSEMBLY

- THERE ISN'T A GREAT WAY TO MODEL THIS BAIL ARRANGEMENT IN WHOI CABLE. TWO APPROACHES ARE USED:

A) SIMPLEST, AND WRONG B/C IT DOESN'T INCLUDE THE BAIL HINGED DOWN LOW

→ MODELED AS A CYLINDER OF APPROPRIATE SIZE WITH A MOMENT RELEASING CONNECTOR AT THE TOP AND BOTTOM.

m = 386 kg (850 lbs) [193 kg/m]

WET WEIGHT = -890 N (-200 lbs) [-445 N/m]

d = .762 m (30")

L = 2.0 m (79")

$C_d = 1.0$ $C_{an} = 1.0$

$C_L = 1.0$ $C_{at} = 1.0$

B) MORE COMPLICATED, MODEL ASSEMBLY AS THREE COMPONENTS, BATTERY CASE BAIL CONNECTED TO TOP OF BATTERY CASE, WITH A MOMENT RELEASING CONNECTOR AND ESP AS "ATTACHMENTS" ADDING DRAG/MASS/WET-WEIGHT TO TOP NODE OF BATTERY CASE. SUM OF THE MASS AND WEIGHT OF THE THREE ELEMENTS SUM TO THE APPROPRIATE TOTAL VALUE.

B (cont.)

BATTERY CASE

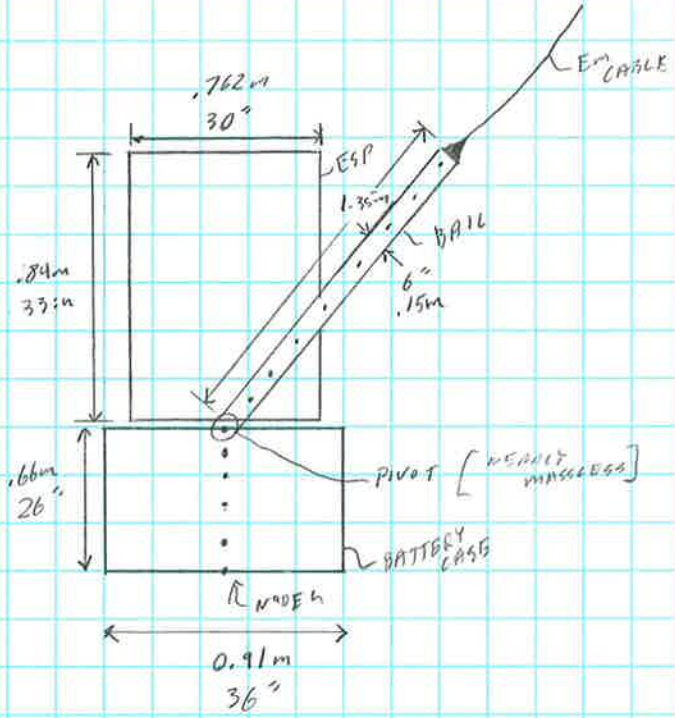
EA = 1e7 EI = 5e5

m = 120 kg 181.8 kg/m

264 lbs

WET WEIGHT = 647 N 980 N/m

145 lbs




BAIL

EA = 1e7 EI = 1.9e4

m = 30.9 kg 22.9 kg/m

68 lbs

WET WEIGHT = 0 N } CONSIDER IT
0 lbs } NEUTRAL.

ESP CAN

m = 235 kg = 517 lbs

WET WEIGHT = -1540 N = -346 lbs

Sums

m = 120 kg + 30.9 kg + 235 kg = 386 kg = 849 lbs

WET WEIGHT =

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POLYESTER ROPE

EA = $1 \times 10^6$ N [FROM SPEC SHEET THAT INDICATES 1.1% ELONGATION @ 2540 lbs]

EI = 31 N·m² [EQUIVALENT ROD]

d = .022 m [7/8"]

m = .403 kg/m

wet weight = 1.53 N/m [FROM SPECIFIC GRAVITY = 1.38 SPEC]

ROCHESTER EM CABLE

EA = $3.226 \times 10^6$ N [FROM SPEC SHEET]

EI = 18 N·m² [EQUIVALENT ROD]

d = .0096 m

m = .370 kg/m

wet weight = 2.97 N/m [FROM SPEC SHEET, ADJUSTED FOR SEAWATER]

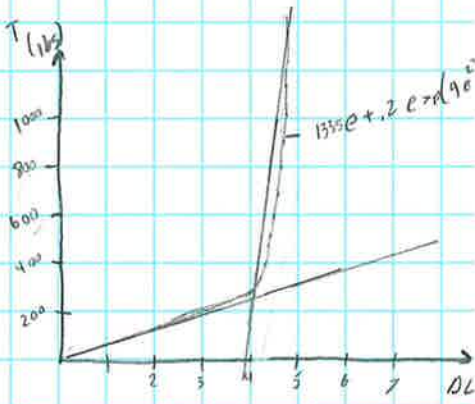
SYNTACTIC FLOATS - MODELED AS CYLINDERS

$d = .0762\ m$ [3"]
$length = .1016\ m$ [4"]
$m = .230\ kg$ [MEASURED FROM SAMPLE]
$wet\_weight = -2.17\ N$ [COMPUTED FROM MEASURED MASS AND COMPUTED VOLUME]

SHACKLE → 3m long
~5m long @ 200 lbs [DL = 2m]
@7m LIMITER TAKES OVER [DL = 4m]

LINEAR OPTION:
$m = .909\ kg/m$ [6 LBS FOR 3m LENGTH]
$d = .952\ m$ [~2" DIAM]
$EA = 1335\ N$ [300 lbs STRETCHES 3m LENGTH TO 5m]
$EI = .226\ N \cdot m^2$ [BASED ON ROD EQUIVALENT, NOT A GREAT ASSUMPTION...]
$wet\ weight = 0$ [NEUTRAL]

NON-LINEAR OPTION ⇒ LOCUS
$m = .909\ kg/m$ [6 LBS FOR 3m Length]
$d = .054\ m$ [~2" DIAM]
$wet\_weight = 0$
$T(e) = 1335e + .2\exp(4e^2)$ ← SIMULATE SPECTRA STIFFNESS ABOVE 5m LENGTH
$T'(e) = 1335 + .16e\exp(4e^2)$
$T''(e) = (.16e)^2\exp(4e^2) + .16\exp(4e^2)$
$= .16[.16e^2 + 1]\exp(4e^2)$




SWIVEL AT ANCHOR
$m = 5\ kg$ [9.43 kg/m]
$L = .53\ m$
$d = .0508\ m$ (2")
$wet\_weight = 20\ N$ [37.7 N/m]

SHACKLE PAIR
$m = 2\ kg$
$L \approx 0$ (connection)
$wet\_weight = 8\ N$

OBLONG LINK
$m = 3\ kg$ (10 kg/m)
$L = .3\ m$
$wet\_weight = 12\ N$ [40 N/m]

## POLYESTER ROPE (5/8")

$EA = 560{,}000\,N$ [SPEC SHEET INDICATES 1.1% ELONGATION AT 1390 lbs]

$EI = 22\,N\cdot m^2$ (EQUIV ROD)

$d = .0151\,m$ [5/8"]

$m = 0.14\,\frac{lbs}{ft} \cdot \frac{1ft}{12in} \cdot \frac{1in}{.0254m} \cdot \frac{1kg}{2.2lbs} = 0.2088\,kg/m$

wet weight = $0.778\,N/m$ § BASED ON S.G = 1.38

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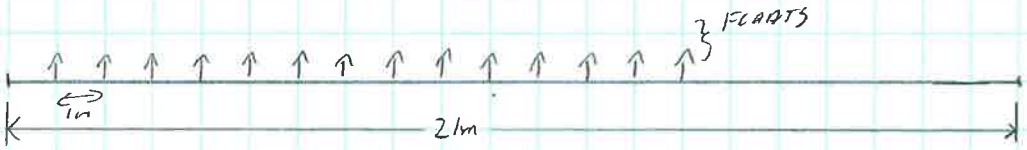
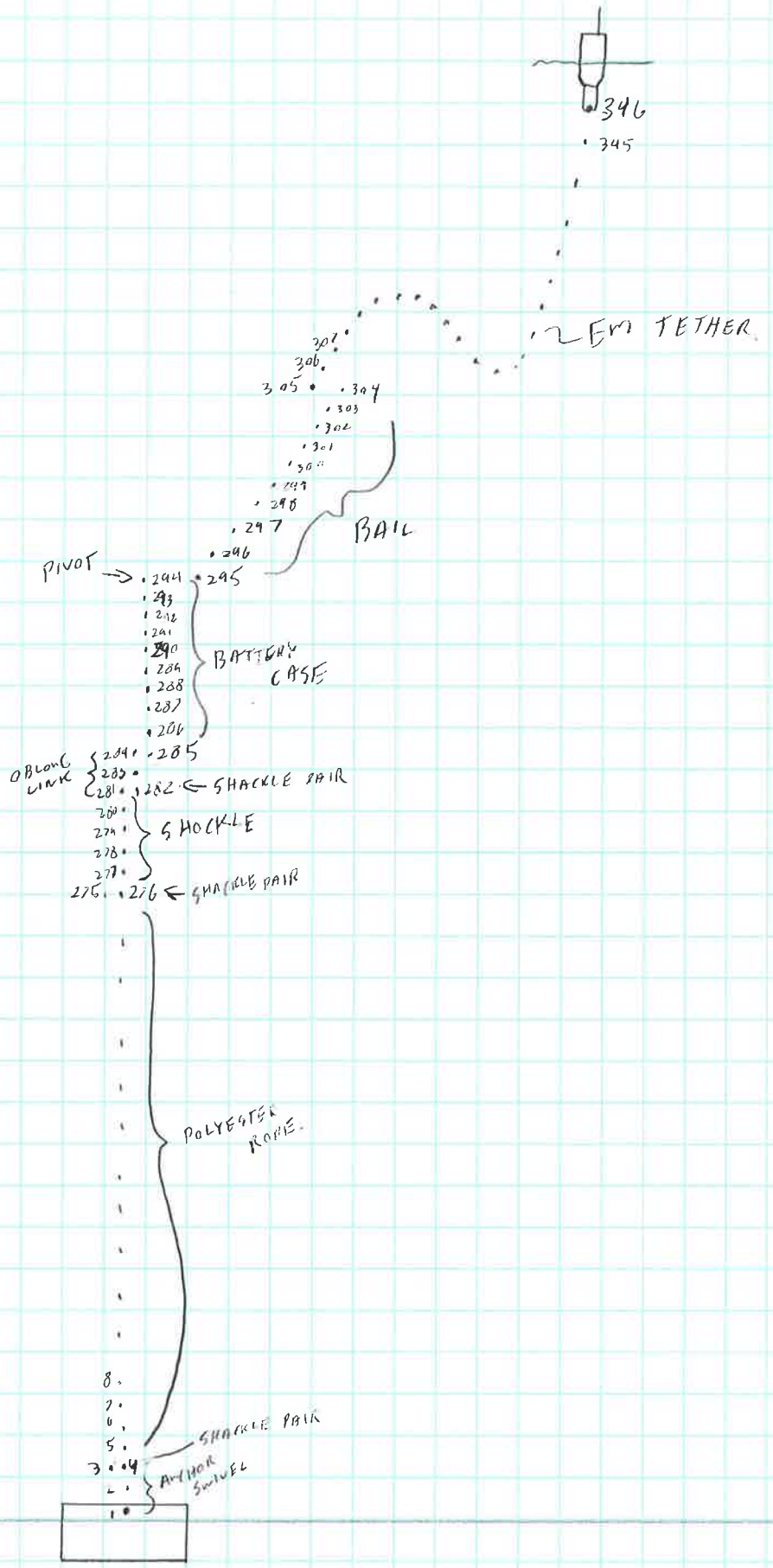
## EM CABLE WITH FLOATS




→ CABLE WET WEIGHT = $2.97\,N/m$ = 62.4 N TOTAL

→ FLOAT WET WEIGHT = $-2.17\,N$/FLOAT = 30.4N TOTAL

→ MEAN WEIGHT OF FLOATED SECTION: $= 0.8\,N/m$


346
345
EM TETHER
BAIL
PIVOT
BATTERY CASE
OBLONG LINK
SHACKLE PAIR
SHACKLE
SHACKLE PAIR
POLYESTER ROPE
SHACKLE PAIR
ANCHOR SWIVEL