CONSTANTS:

$\mu := 1.4 \cdot 10^{-3} \cdot N \cdot \frac{sec}{m^2}$ $\rho_{sw} := 1026 \cdot \frac{kg}{m^3}$ $\rho_{sw} = 64.051 \frac{lb}{ft^3}$ $kt := 6076.115 \cdot \frac{ft}{hr}$

CABLE PROPERTIES:

$SB41343_{wt\_h20} := 63 \cdot \frac{lbf}{1000 \cdot ft}$ $SB41343_{wt\_h20} = 0.094 \frac{kgf}{m}$ $SB41343_{wt\_air} := 170 \cdot \frac{lbf}{1000 \cdot ft}$

$R7H314A_{wt\_air} := .272 \cdot \frac{kgf}{m}$ $R7H314A_{wt\_h20} := .228 \cdot \frac{kgf}{m} \cdot \frac{1000}{1026}$

$R7H375A_{wt\_air} := .369 \cdot \frac{kgf}{m}$ $R7H375A_{wt\_h20} := .309 \cdot \frac{kgf}{m} \cdot \frac{1000}{1026}$

$TotalCableWt_{h20} := Cable_{len} \cdot R7H314A_{wt\_h20}$ $TotalCableWt_{h20} = 97.983\,lbf$

$TotalCableWt_{air} := (Cable_{len} + 50 \cdot m) \cdot R7H314A_{wt\_air}$ $TotalCableWt_{air} = 149.914\,lbf$

$R7H314A_{wt\_air} = 119.931 \frac{lbf}{200 \cdot m}$ $R7H314A_{wt\_h20} = 97.983 \frac{lbf}{200 \cdot m}$

$SB41343_{wt\_air} = 111.549 \frac{lbf}{200 \cdot m}$ $SB41343_{wt\_h20} = 41.339 \frac{lbf}{200 \cdot m}$

$R_{18awg} := 6.3 \cdot \frac{\Omega}{km}$ $I := 5 \cdot A$ $R_{16awg} := 4.82 \cdot \frac{\Omega}{1000 \cdot ft}$

$Voltage_{drop} := I \cdot \frac{1}{5} R_{16awg} \cdot Cable_{len} \cdot 2$ $Voltage_{drop} = 6.325\,V$

PROFILER VELOCITIES:

$V_{max} := \pi \cdot \frac{Drum_{OD}}{2} \cdot Winch_{rpm}$ $V_{max} = 0.092 \frac{m}{s}$ $V_{max} = 5.515 \frac{m}{min}$

$V_{min} := \pi \cdot \frac{Drum_{ID}}{2} \cdot Winch_{rpm}$ $V_{min} = 0.075 \frac{m}{s}$ $V_{min} = 4.512 \frac{m}{min}$

$Motor_{rpm} := Winch_{rpm} \cdot Gear_{ratio}$ $Motor_{rpm} = 220 \frac{rev}{min}$

$Time_{profile} := \frac{Max_{depth}}{\frac{V_{max}+V_{min}}{2}}$ $Time_{profile} = 2.393 \times 10^{3} s$ $Time_{profile} = 39.89 min$

ROTATING DRUM INERTIA:

$Drum_{inertia} := \frac{TotalCableWt_{air} + 25 \cdot lbf}{g} \cdot \frac{Drum_{OD}^{2} - Drum_{ID}^{2}}{8}$

$Drum_{inertia} = 1.024 m^{2} \cdot kg$ $Drum_{inertia} = 1.024 \times 10^{4} kg \cdot cm^{2}$

$Inertia_{reflected} := \frac{Drum_{inertia}}{Gear_{ratio}^{2}}$ $Inertia_{reflected} = 2.115 \times 10^{-5} m^{2} \cdot kg$

$Inertia_{reflected} = 0.212 kg \cdot cm^{2}$

$Inertia_{reflected} = 2.995 \times 10^{-3} ozf \cdot in \cdot sec^{2}$ $Inertia_{reflected} = 1.872 \times 10^{-4} lbf \cdot in \cdot sec^{2}$

DRAG FORCE DUE TO PROFILING VELOCITY:

$C_d := 0.5$ $A_{ESP} := \frac{\pi}{4} ESP_{dia}^{2}$ $Re := \frac{V_{max} \cdot ESP_{dia} \cdot \rho_{sw}}{\mu}$ $Re = 3.764 \times 10^{4}$

$A_{ESP} = 0.245 m^{2}$ $A_{ESP} = 2.64 ft^{2}$

$Drag_{profile} := \frac{C_d \cdot A_{ESP} \cdot \rho_{sw} \cdot V_{max}^{2.}}{2}$ $Drag_{profile} = 0.531 N$ $Drag_{profile} = 0.119 lbf$

$\omega := 2 \cdot \pi \cdot \frac{1}{Wave_{period}} \cdot rad$ $\omega = 1.571 \frac{rad}{sec}$

DRAG FORCE DUE TO WAVE FOLLOWING:

$N := 20 \qquad i := 0 .. N \qquad t_i := \frac{Wave_{period}}{N} \cdot i \qquad zero_i := 0$

$Wave_{amp} := waveAmp_{max} \cdot \sin(\omega \cdot t) \qquad Wave_{vel} := waveAmp_{max} \cdot \omega \cdot \cos(\omega \cdot t)$

$polarity := sign(Wave_{vel}) \qquad Wave_{acc} := -waveAmp_{max} \cdot \omega^2 \cdot \sin(\omega \cdot t)$

$$\overrightarrow{Drag_{wave} := \left(\frac{C_d \cdot A_{ESP} \cdot \rho_{sw} \cdot Wave_{vel} \cdot |Wave_{vel}|}{2} \right)} \qquad \max(Drag_{wave}) = 155.214\,N$$

$maxVel_{wave} := waveAmp_{max} \cdot \omega \qquad maxVel_{wave} = 1.571 \frac{m}{s}$

$maxAcc_{wave} := -waveAmp_{max} \cdot \omega^2 \qquad maxAcc_{wave} = -2.467 \frac{m}{s^2}$

$$maxDrag_{wave} := \frac{C_d \cdot A_{ESP} \cdot \rho_{sw} \cdot maxVel_{wave}^{2.}}{2} \qquad maxDrag_{wave} = 155.214\,N$$

$maxDrag_{wave} = 34.893\,lbf$

LOAD DUE TO ACCELERATING A MASS THROUGH THE WATER:

Assume a spherical shape for added mass

$$Mass_{added} := \frac{2}{3} \cdot \rho_{sw} \cdot \pi \cdot \left(\frac{ESP_{dia}}{2} \right)^3 \qquad Mass_{added} = 46.869\,kg \qquad ESP_{mass} := \frac{ESP_{wt\_air}}{g}$$

$maxF_{inertial} := \left| (ESP_{mass} + Mass_{added}) \cdot maxAcc_{wave} \right|$

$maxF_{inertial} = 252.442\,lbf$

$maxF_{inertial} = 1.123 \times 10^3\,N$

$F_{inertial} := (ESP_{mass} + Mass_{added}) \cdot Wave_{acc}$

$Mass_{addedDisk} := \frac{8}{3} \cdot \rho_{sw} \cdot ESP_{dia}^3$

Assume a flat circular disk shape for added mass

$\max(F_{inertial}) = 1.123 \times 10^3\,N \qquad Mass_{addedDisk} = 477.403\,kg$

LOADS ON THE WINCH AND MOTOR:

$F_{winch} := ESP_{wt\_h20} + Drag_{wave} + TotalCableWt_{h20} + F_{inertial}$ $maxF_{winch} := \max(F_{winch})$

$T_{winch} := F_{winch} \cdot \frac{Drum_{OD}}{2}$ $maxF_{winch} = 1.959 \times 10^{3}\,N$

$maxF_{winch} = 440.426\,lbf$

$PlotESP_{wt\_h20_i} := ESP_{wt\_h20}$ $PlotTotalCableWt_{h20_i} := TotalCableWt_{h20}$

$maxT_{winch} := maxF_{winch} \cdot \frac{Drum_{OD}}{2}$ $maxT_{winch} = 4.845 \times 10^{3}\,in \cdot lbf$

$maxT_{winch} = 547.375\,N \cdot m$ $maxT_{winch} = 5.474 \times 10^{4}\,N \cdot cm$

$maxT_{winch} = 7.751 \times 10^{4}\,ozf \cdot in$ $maxT_{winch} = 403.723\,ft \cdot lbf$

$maxT_{motor} := \frac{maxT_{winch}}{Gear_{eff} \cdot Gear_{ratio}}$ $maxT_{motor} = 29.362\,in \cdot lbf$ $maxT_{motor} = 331.743\,N\,cm$

$maxT_{motor} = 3.317\,N\,m$ $maxT_{motor} = 469.787\,ozf \cdot in$

SUMMARY:

$Gear_{eff} \equiv .75$ $Winch_{rpm} \equiv 1 \cdot \frac{rev}{min}$ $Gear_{ratio} \equiv 220$ $Motor_{rpm} = 220\,\frac{rev}{min}$

$ESP_{len} \equiv 36 \cdot .in$ $ESP_{dia} \equiv 22 \cdot in$ $ESP_{wt\_air} \equiv 900 \cdot lbf$ $ESP_{wt\_h20} \equiv 90 \cdot lbf$

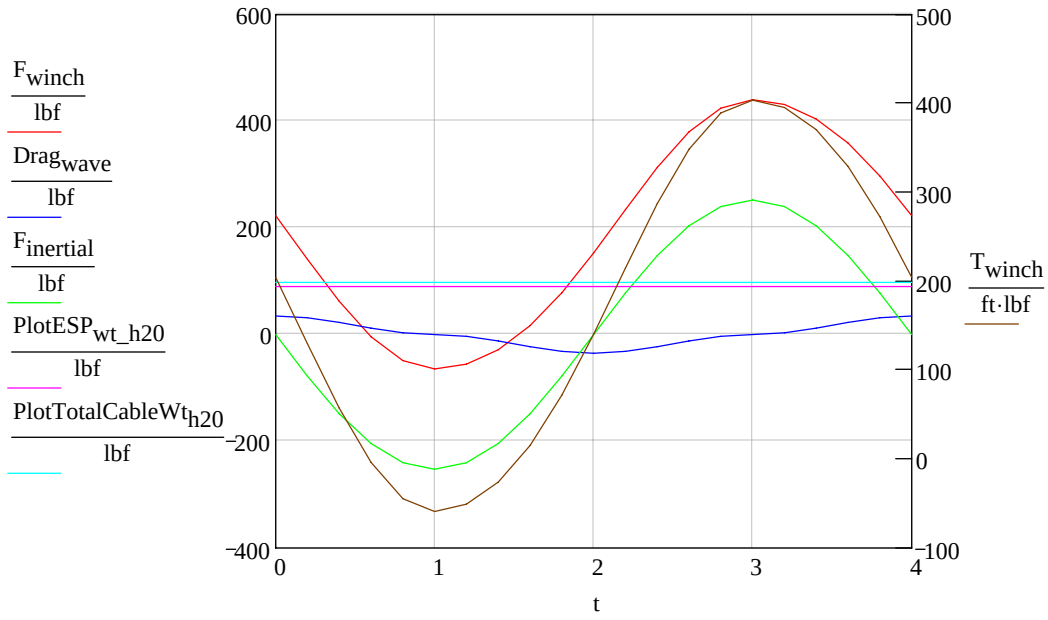
$Max_{depth} \equiv 200 \cdot m$ $Drum_{OD} \equiv 22 \cdot in$ $Drum_{ID} \equiv 18 \cdot in$ $Cable_{len} \equiv 200 \cdot m$

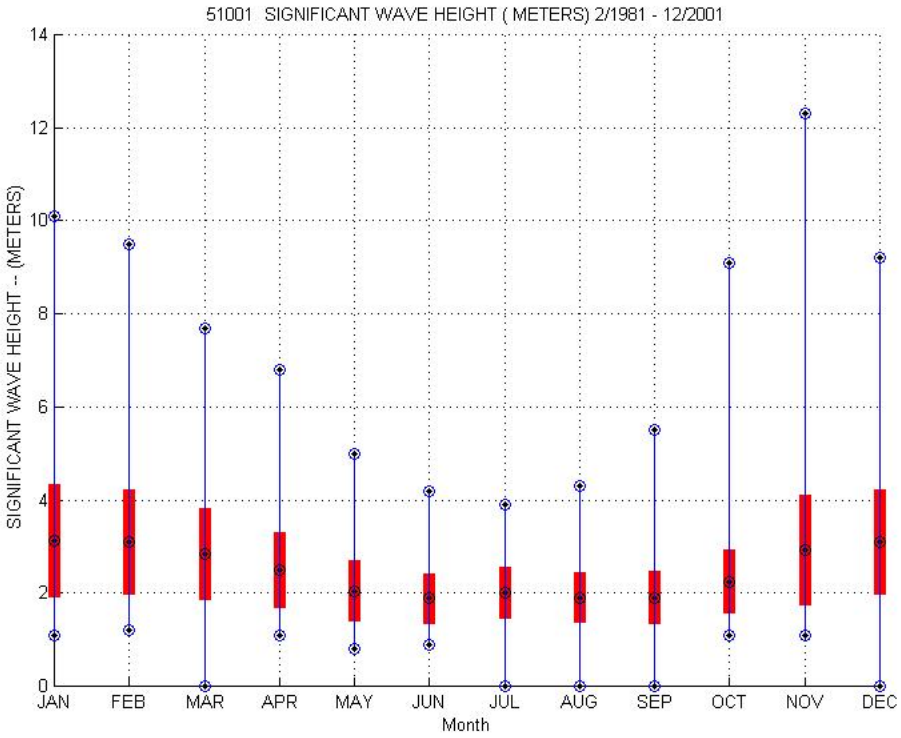
$Wave_{period} \equiv 4 \cdot sec$ $waveAmp_{max} \equiv 1 \cdot m$ $maxF_{winch} = 440.426\,lbf$

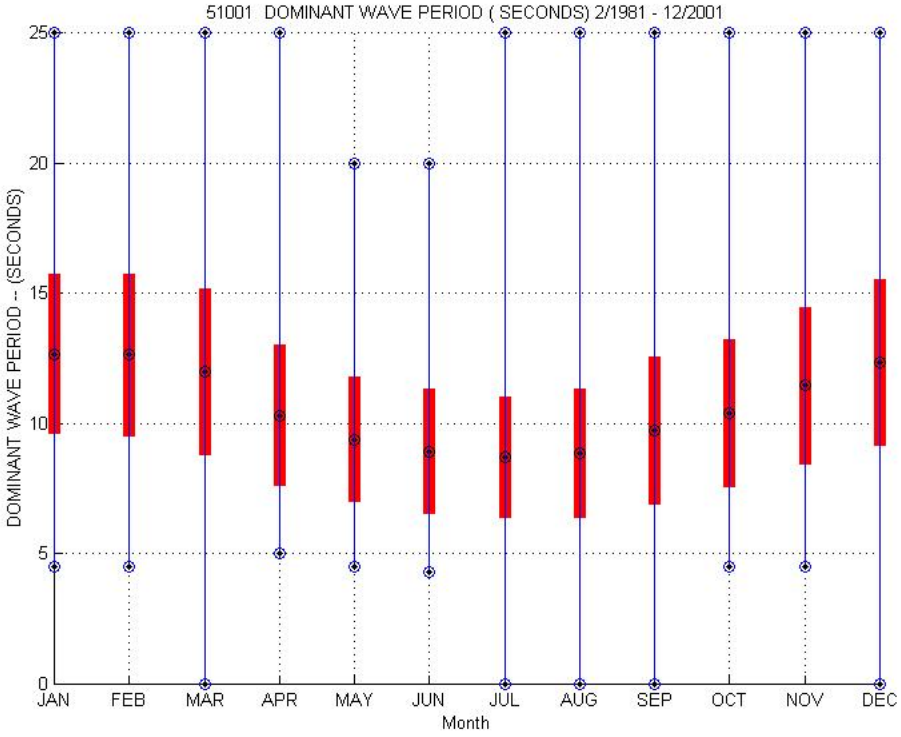
$maxT_{winch} = 547.375\,N\,m$ $Drum_{inertia} = 1.024\,m^{2} \cdot kg$ $maxDrag_{wave} = 155.214\,N$

:=

	0	1	2	3	4	5	6
0	"SWH"	"DWP"	ESP Wt H20"	inch max lbf"	k Twinch Nm"	"Comment"	"Cable"
1	2	10	90	304	377	"Sept Mean"	"7H375A"
2	4	18	60	273	339	ept +3Sigma"	"7H375A""
3	1	4	250	475	591	Sept -2sigma"	"7H375A"
4	1	4	250	440	547	Sept -2sigma"	"7H314"




51001 SIGNIFICANT WAVE HEIGHT (METERS) 2/1981 - 12/2001
SIGNIFICANT WAVE HEIGHT -- (METERS)
0
2
4
6
8
10
12
14
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month


51001 DOMINANT WAVE PERIOD (SECONDS) 2/1981 - 12/2001
DOMINANT WAVE PERIOD -- (SECONDS)
0
5
10
15
20
25
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month