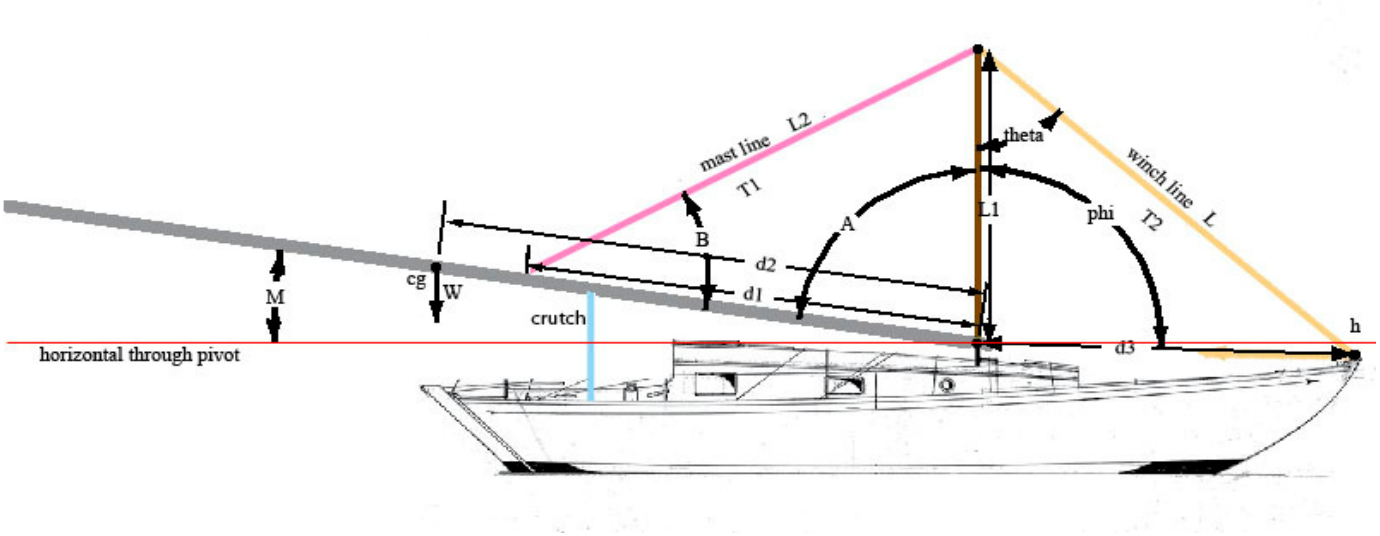
A spreadsheet illustrating various forces resulting when raising a mast using a gin pole
Of particular interest are the tensions in the mast line and winch line, and the compression force on the gin pole. Thin columns are prone to failure by buckling

Calculations are done by assuming the torques around the pivot point from the weight of the mast and gin pole balance the torque around the pivot point developed by the winch line.



Note: angles are in degrees, distances in feet

constant: degrees to radi	0.01745
constant: radians to deg	57

A= angle between mast and gin pole
d1=distance from pivot to mast line attachment point on mast
d2=distance from pivot to mast center of gravity (balance point)
d3=distance from pivot to winch line block (or winch, as the case may be)
h= distance that winch line block is above or below horizontal line through pivot. If the line block is below the horizontal, the value of "h" is negative
L1=length of gin pole from pivot to attaching point of winch and mast lines
Wm=weight of mast
Wg=weight of gin pole
M= angle of mast to horizontal

Entered values (degrees and feet)

A=	90.00	h=	0.5	note: if the line block is below the horizontal, "h" must be negative
d1=	12.00	L1=	6	
d2=	13.00	Wg=	6	
d3=	6.00	Wm=	150	

Calculated Values

Note that Excel uses and returns angles in radians. The spreadsheet makes the necessary conversions so any angles entered or displayed are degrees

L2=length of mast line (used to calculate value of angle "B") L2 = SQRT(L_1*L_1+d_1*d_1-2*d_1*L_1*COS(A*PI()/180))

L2= 13.42

B=angle between mast line and mast: B = ASIN(L1*SIN(A/L2))
B= 26.57

phi= angle between gin pole and the straight line from pivot to winch line block (used to calculate winch line length L): phi = -ASIN(h/d3)+(180-(A+M))
L=length of winch line from top of gin pole to winch line block: L = SQRT(L1*L1+d3*d3-2*L1*d3*COS(phi))
theta=angle between gin pole and winch line (used to calculate tension on winch line) theta = ACOS((L*L + L1*L1 - d3*d3)/2*L*L1)

T1= tension on line from top of gin pole to the mast T1 = torque/(d1*SIN(B))
T2= tension on line from top of gin pole to winch T2 = total_torque/(L1*SIN(theta))
F1= axial (compressive) force along mast axis F1 = T1*COS(B)
F2= axial (compressive) force along "gin pole" axis F2 = T1*COS(180-B-A) + T2*COS(theta)

forces on pivot from mast (weight and winch forces) and gin pole (weight and compression forces)
Fx=horizontal (shear) force on pivot
Fy=vertical (normal) force on pivot

Note: counter clockwise torques are positive, clockwise torques are negative
component forces Fx to the left (stern) are negative, to the right (bow) are positive
component forces Fy downward are positive, up are negative
Negative line tensions will occur in the winch line if the net torque is clockwise (unstable condition)
Negative line tensions will occur in the mast line if the mast angle is more than 90 degrees (unstable condition)

Note:
The pivot forces include the weight forces as well as the rigging forces

mast angle (M)	torque from mast weight torque (ft-lb)	torque from gin pole weight torque (ft-lb)	total torque (ft-lb)	length winch line L (feet)	phi (degrees)	theta (degrees)	tension mast line T1 (lb)	tension winch line T2 (lb)	rigging compression on mast F1 (lb)	rigging compression on gin pole F2 (lb)	mast pivot force Fx	mast pivot force Fy	gin pole pivot force Fx	gin pole pivot force Fy	total pivot force Fx (shear)	total pivot force Fy (normal)
0	1950	0	1950	8.12	85.22	47.39	363.36	441.59	325.00	461.46	325.00	-12.50	0.00	467.46	325.00	454.96
5	1943	-2	1941	7.73	80.22	49.89	361.98	422.98	323.76	434.39	336.64	16.95	-38.12	495.15	298.52	512.10
10	1920	-3	1917	7.32	75.22	52.39	357.84	403.37	320.06	406.20	342.99	47.98	-71.05	517.09	271.94	565.07
15	1884	-5	1879	6.90	70.22	54.89	350.98	382.80	313.93	377.13	343.85	79.64	-98.36	532.58	245.50	612.21
20	1832	-6	1826	6.47	65.22	57.39	341.45	361.34	305.40	347.43	339.21	110.96	-119.79	541.03	219.42	651.99
25	1767	-8	1760	6.02	60.22	59.89	329.32	339.03	294.55	317.35	329.19	141.01	-135.27	542.05	193.93	683.05
30	1689	-9	1680	5.56	55.22	62.39	314.68	315.94	281.46	287.15	314.11	168.85	-144.87	535.39	169.24	704.24
35	1597	-10	1587	5.09	50.22	64.89	297.65	292.11	266.22	257.07	294.43	193.66	-148.86	520.99	145.57	714.65
40	1494	-12	1482	4.61	45.22	67.39	278.35	267.60	248.96	227.36	270.73	214.67	-147.62	498.99	123.11	713.67
45	1379	-13	1366	4.13	40.22	69.89	256.94	242.47	229.81	198.27	243.75	231.25	-141.70	469.70	102.05	700.95
50	1253	-14	1240	3.63	35.22	72.39	233.56	216.77	208.91	170.03	214.30	242.89	-131.73	433.60	82.57	676.49
55	1118	-15	1104	3.13	30.22	74.89	208.42	190.54	186.41	142.88	183.27	249.24	-118.45	391.34	64.83	640.58
60	975	-16	959	2.62	25.22	77.39	181.68	163.85	162.50	117.02	151.61	250.10	-102.64	343.72	48.97	593.82
65	824	-16	808	2.11	20.22	79.89	153.56	136.76	137.35	92.68	120.29	245.46	-85.15	291.67	35.14	537.13
70	667	-17	650	1.59	15.22	82.39	124.28	109.30	111.16	70.05	90.24	235.44	-66.79	236.22	23.45	471.66
75	505	-17	487	1.07	10.22	84.89	94.04	81.54	84.12	49.32	62.40	220.36	-48.39	178.47	14.01	398.83
80	339	-18	321	0.55	5.22	87.39	63.10	53.54	56.44	30.66	37.59	200.68	-30.70	119.57	6.89	320.25
85	170	-18	152	0.02	0.22	89.89	31.67	25.34	28.33	14.21	16.58	176.98	-14.42	60.70	2.16	237.68
90	0	-18	-18	0.50	-4.78	87.61	0.00	-3.00	0.00	-0.13	0.00	150.00	0.13	3.00	0.13	153.00