TEL: 360-204-4818

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MARINE ENGINEERING, INC.

10 April 2022

From: Tullio Celano III P.E.
To: Wil Clark, Pacific Pile and Marine

Subj: **DB *Pacific Lifter* At-Sea Lifting Capability**

Ref: (1) T2091073 PACIFIC LIFTER_Stability_Cover and Stability Letter_123614012.pdf

BACKGROUND

The DB *Pacific Lifter* was originally built as the McDermott DB17, an 860ST manned crane derrick barge, intended for at-sea pipelaying and oil rig construction work in the North Sea in the 1960's. Our firm became involved with the rig immediately after its purchase by Boyer Towing and Pacific Pile & Marine in 2018. Having configured many floating crane installations, and done clean-sheet boom designs, we have in-house developed analysis software that allows rapid evaluation of marine crane boom designs, as well as standard Naval Architectural software for assessing static and dynamic stability of floating vessels. We utilize General Hydrostatics (GHS), and hold a Full Salvage license package from Creative Systems.

In 2019-2020, the complete upperworks, which is an American 509 Revolver, was moved from the original DB17 barge, and installed aboard the ex-Crowley 450-7 barge, a 400' x 99.5' x 25' load-lined ABS barge. Stability work was completed by West Sound Maritime, and approved by ABS in 2021. The crane stability work roughly mirrors that preliminarily generated by our firm for the slightly-different Crowley 450-1 barge that we were investigating as one of several options for Boyer Towing.

The original crane charts were approved in the 1960's for a 2-degree list angle, with the intention of at-sea work. The boom has a tapered heel with a 25' heel pin spread, obviously intended to be capable of withstanding far higher boom side-loads than conventional cranes.

We have augmented our normal static-side loading calculations will a full-physics, time-domain based simulation set, which enabled us to evaluate the crane response in a wide range of sea states and hook loads. It was found that the normal methods of evaluating ship seakeeping response in a seaway, which involves linearization of response operators, and frequency-domain statistical analysis, does not simulate barge rolling response well. This is because the linearized response is based on initial wave slope, and if the entire wave length at the wave periods of interest are in the scale range of the vessel beam itself, the response is based upon a full-beam waterplane heeling moment, whereas in actuality, the actual waveform will have cycled within the beam of the vessel, or thereabouts. Furthermore, those methods offer no ability to model a suspended weight that may be free to swing, as a crane load is. For these reasons, we chose to develop the time-domain simulation, and task it with simulating a full range of conditions. This allowed direct evaluation of the vessel's expected roll time-history, the swing of the suspended load, the boom inertia, and therefore a fairly complete picture of the additional loads on the boom beyond those imparted by the static forces.

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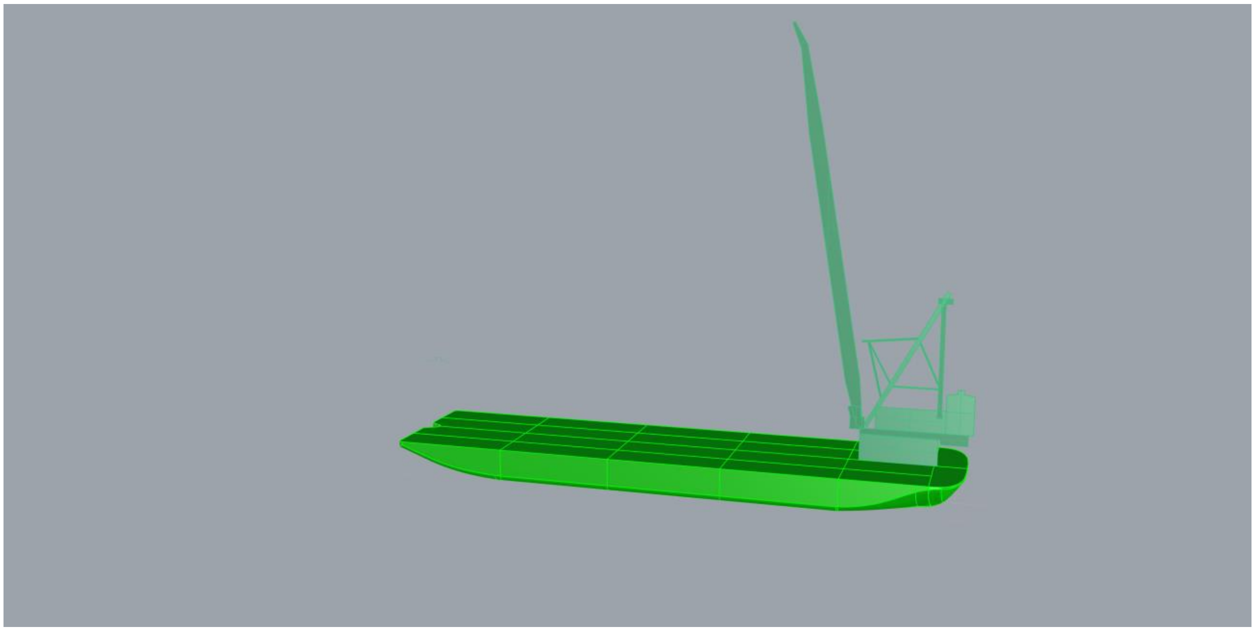
Crane Barge Configuration

The vessel, as described in Reference (1), is the DB *Pacific Lifter*, a 400' x 99.5' x 25' deck barge, with the American 509 crane installed on the bow of the vessel, with its center-pin located 46' aft of the Forward Perpendicular. The boom heel is at 50' above baseline, or 25' above the main deck of the barge. The standard operating condition of the vessel is for the centerline ballast tanks #2 through #4 completely filled with fresh water, and the centerline stern rake ballast tanks #5 70% filled to level the vessel's trim condition. This condition provides for a 13,550 LT displacement, as the baseline condition, prior to adding any lifted load.



Boom Analysis

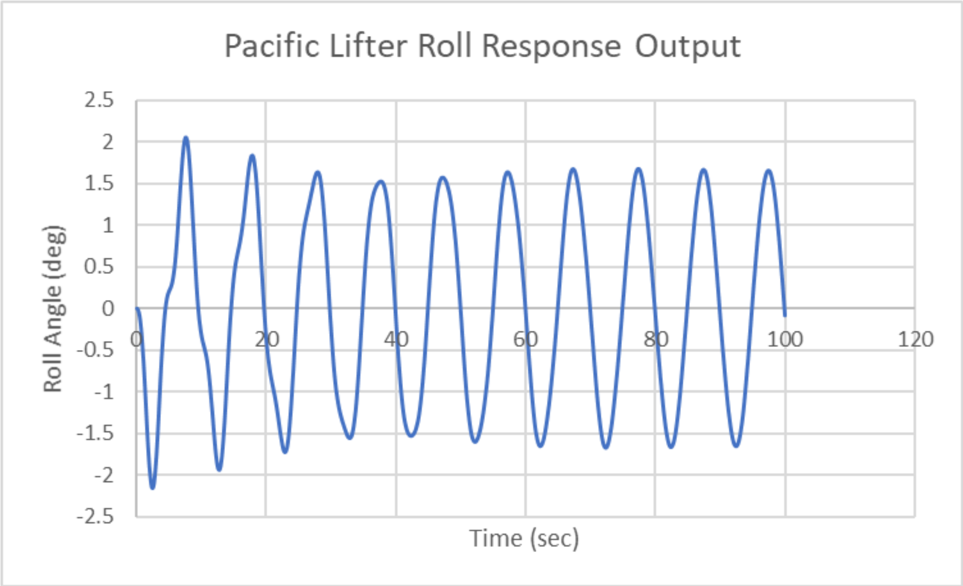
The standard analysis for marine crane booms under ANSI B30.8, AISC, and SAE J1093 involve resolving weights and balances on the crane boom about the heel pin, and determining the combined boom chord stresses arising from compression and bending (due to side loads and winds). Normal crane calculations are static, assuming that the operator is very deliberate with movements, and that out-of-plane loads are avoided, such as using the crane to drag loads, or lift in a direction other than vertical. Allowance for operator mistakes and other effects are captured within factors of safety, which results in maximum allowable stresses that are limited to values below the actual yield or buckling stress. Some manufacturers (primarily Manitowoc), released barge load charts for their cranes, which provided reduced working capacities, based on list angle, since operation on a non-counterballasted barge may result in some list angle. Again, however, the assumption is made that this list angle will be smoothly attained, and that no additional dynamic forces are applied due to sea-state.

Usually, some side-load allowance for winds is included, typically up to 25 mph while lifting. This present analysis does not only all of this, but then adds in the additional effects arising from the dynamic rolling simulation. In this way, the total maximum boom stress is determined for each condition, so that evaluation can be made as to the capacity of the boom for each particular load condition, across the range of wave heights and frequencies. Logically, wave conditions that result in more crane motion will have a lower crane lifting capacity in order to keep the boom within safe stress limits. Other portions of the structure that are analyzed statically under the crane rigging loads, such as the backstay and forelegs, are not significantly affected by side-loads on the boom.

BARGE ROLLING RESPONSE

The time-domain simulation alluded to previously, captures the rolling inertia and stability characteristics of the DB *Pacific Lifter*, along with the effects arising from the suspended weight. In a statical analysis (i.e. for conventional lifting stability, and boom strength analysis), the suspended with is modeled as being applied to the boom tip sheave. This is a good assumption for static analysis, and basic barge stability computations, but would lead to significantly excessive polar moment of inertia when it comes to rolling response. Therefore the dynamic simulation must account for the vertical reaction being applied at the boom tip, but the load being free to swing as a pendulum, both being influenced by the boom tip position, and then also feeding back lateral loads into the boom, which, in turn, affects the rolling of the barge.

For the purposes of simulation, the range of wave frequencies and height are assigned one case at a time, and are assumed to radiate from directly broadside. The crane barge is assumed to be initially stationary before the wave train arrives. The initial wave cycles are then allowed to influence the barge, and 100 seconds of data are simulated at 10 hZ for each condition. Almost always, the initial few rolling cycles are predicted to be erratic, as the as the swinging hook load goes in and of phase with the barge, but then we see an equilibrium condition with fairly steady rolling amplitudes and sinusoidal wave forms stabilize for the latter portions of the simulation run. An example output is shown below:



It should be noted that although tag lines are typically required for crane lifts, they are not assumed to control the load in any way. For large crane loads in this tonnage category, there is nothing that can be done by humans, and very little with tugger winches, that can be done to directly control the swing of the hook load. As with all marine crane operations, the conditions and relative movement may make the operation dangerous and prohibitive practically, long before a structural limit is reached. Certain picks, such as gross movement of cargo or pilings may be possible in a wider range of sea states, whereas landing equipment on foundations may require very calm conditions to avoid damage to the equipment or risk to personnel.

Simulation Results

A matrix of conditions was developed which includes:

Hook Loads: 0 ST to 900 ST in 100 ST intervals
Wave Period: 5 seconds to 10 seconds
Wave Height: 0.5 meters to 1.3 meters

For each hook load range, a color-coded results table was developed. The maximum expected roll angle and boom side load (only the main wire side load is shown, other inertial side-loads are incorporated into the boom structural calculations) are in the top row. For roll angles below 2 degrees amplitude, the color code is green. Roll angles 2 to 3 degrees are yellow, and above 3 degrees is red. The color scheme for these blocks constitutes general recommendations based on roll amplitude, and not structural limits.

The lower line of each results block shows a Structural Capacity factor, which represents the maximum of all of the structural loading limits, with 1.0 being maximum allowable for each condition, with the appropriate factors of safety applied.

A condition, such as one with a light hook load may have rolling motions that are above the arbitrary operational limits, but within the structural limitations. Conversely, many of the heavier hook-load conditions are shown to reach structural limits well before an operational motion limit would be reached. In each of the conditions simulated, a 25 mph wind load was applied to the boom, simultaneously.

The simulation results tables are presented as follows:

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DB Pacific Lifter Seaway Lifting Simulation 0

Lifted Load Condition 0 **ST**

Wave Period (sec)

Wave Height (m)	**5** Roll Angle	Boom Load Struct Cap	**6** Roll Angle	Boom Load Struct Cap	**7** Roll Angle	Boom Load Struct Cap	**8** Roll Angle	Boom Load Struct Cap	**9** Roll Angle	Boom Load Struct Cap	**10** Roll Angle	Boom Load Struct Cap
	2.71	12546	1.99	3886	1.57	2003	1.15	1209	0.89	836	0.71	600
0.5		0.59		0.54		0.53		0.52		0.52		0.52
	3.26	15058	2.39	4663	1.89	2404	1.38	1451	1.07	1003	0.85	720
0.6		0.60		0.54		0.53		0.52		0.52		0.52
	3.80	17571	2.79	5440	2.20	2804	1.62	1693	1.25	1170	1.00	840
0.7		0.62		0.55		0.53		0.52		0.52		0.52
	4.35	20087	3.19	6218	2.52	3204	1.85	1935	1.42	1338	1.14	960
0.8		0.64		0.55		0.53		0.53		0.52		0.52
	4.89	22604	3.58	6995	2.83	3604	2.08	2176	1.60	1505	1.28	1080
0.9		0.65		0.56		0.54		0.53		0.52		0.52
	5.44	25124	3.98	7773	3.15	4004	2.31	2418	1.78	1672	1.42	1200
1		0.67		0.56		0.54		0.53		0.52		0.52
	5.99	27647	4.38	8551	3.46	4403	2.54	2660	1.96	1839	1.57	1320
1.1		0.68		0.57		0.54		0.53		0.53		0.52
	6.53	30172	4.78	9328	3.78	4803	2.77	2902	2.14	2007	1.71	1441
1.2		0.70		0.57		0.54		0.53		0.53		0.52
	7.08	32700	5.18	10106	4.09	5202	3.00	3144	2.32	2174	1.85	1561
1.3		0.71		0.58		0.55		0.53		0.53		0.52

Lifted Load Condition 100 **ST**

Wave Period (sec)

Wave Height (m)	**5** Roll Angle	Boom Load Struct Cap	**6** Roll Angle	Boom Load Struct Cap	**7** Roll Angle	Boom Load Struct Cap	**8** Roll Angle	Boom Load Struct Cap	**9** Roll Angle	Boom Load Struct Cap	**10** Roll Angle	Boom Load Struct Cap
	2.74	17745	1.99	14433	1.58	11663	1.15	11204	0.90	9668	0.71	9395
0.5		0.62		0.60		0.58		0.58		0.57		0.57
	3.29	21295	2.39	17318	1.89	13995	1.38	13444	1.07	11602	0.85	11274
0.6		0.64		0.62		0.60		0.60		0.58		0.58
	3.84	24845	2.79	20201	2.21	16327	1.61	15685	1.25	13535	0.99	13153
0.7		0.66		0.64		0.61		0.61		0.60		0.59
	4.39	28396	3.18	23082	2.52	18658	1.84	17925	1.43	15468	1.14	15031
0.8		0.69		0.65		0.63		0.62		0.61		0.60
	4.94	31947	3.58	25961	2.84	20989	2.07	20165	1.61	17401	1.28	16910
0.9		0.71		0.67		0.64		0.64		0.62		0.62
	5.49	35499	3.98	28838	3.15	23320	2.30	22404	1.79	19334	1.42	18789
1		0.73		0.69		0.65		0.65		0.63		0.63
	6.04	39050	4.38	31713	3.47	25650	2.53	24644	1.97	21266	1.56	20667
1.1		0.75		0.71		0.67		0.66		0.64		0.64
	6.59	42602	4.77	34585	3.78	27979	2.76	26883	2.15	23198	1.70	22545
1.2		0.77		0.72		0.68		0.68		0.65		0.65
	7.14	46154	5.17	37454	4.10	30308	2.99	29121	2.33	25130	1.84	24423
1.3		0.79		0.74		0.70		0.69		0.67		0.66

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	200	ST											
Lifted Load Condition		Wave Period (sec)											
		5	Boom Load	6	Boom Load	7	Boom Load	8	Boom Load	9	Boom Load	10	Boom Load
		Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap
Wave Height (m)		2.75	33552	2.00	27573	1.57	21748	1.15	20554	0.90	17577	0.71	16880
0.5			0.72		0.68		0.65		0.64		0.62		0.62
		3.30	40260	2.40	33083	1.89	26100	1.38	24664	1.08	21092	0.85	20256
0.6			0.76		0.71		0.67		0.66		0.64		0.64
		3.86	46966	2.80	38589	2.20	30453	1.60	28774	1.26	24607	0.99	23631
0.7			0.80		0.75		0.70		0.69		0.66		0.66
		4.41	53670	3.20	44093	2.52	34809	1.83	32884	1.44	28121	1.13	27007
0.8			0.84		0.78		0.72		0.71		0.68		0.68
		4.96	60371	3.60	49593	2.83	39166	2.06	36993	1.62	31635	1.27	30382
0.9			0.88		0.81		0.75		0.74		0.70		0.70
		5.51	67069	4.01	55088	3.15	43525	2.29	41102	1.80	35149	1.41	33757
1			0.92		0.85		0.78		0.76		0.73		0.72
		6.06	73763	4.41	60578	3.46	47886	2.52	45210	1.98	38662	1.55	37132
1.1			0.96		0.88		0.80		0.79		0.75		0.74
		6.61	80452	4.82	66063	3.77	52250	2.75	49317	2.16	42175	1.69	40506
1.2			1.00		0.91		0.83		0.81		0.77		0.76
		7.16	87136	5.22	71542	4.09	56617	2.98	53424	2.34	45687	1.84	43880
1.3			1.04		0.94		0.86		0.84		0.79		0.78

	300	ST											
Lifted Load Condition		Wave Period (sec)											
		5	Boom Load	6	Boom Load	7	Boom Load	8	Boom Load	9	Boom Load	10	Boom Load
		Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap
Wave Height (m)		2.75	49184	2.04	40192	1.57	32424	1.14	29752	0.90	25513	0.70	24490
0.5			0.81		0.76		0.71		0.69		0.67		0.66
		3.30	59010	2.44	48220	1.88	38912	1.37	35702	1.08	30615	0.84	29387
0.6			0.87		0.80		0.75		0.73		0.70		0.69
		3.85	68830	2.85	56242	2.20	45402	1.60	41650	1.26	35718	0.98	34284
0.7			0.93		0.85		0.79		0.77		0.73		0.72
		4.40	78642	3.26	64258	2.51	51895	1.82	47598	1.44	40821	1.12	39181
0.8			0.99		0.90		0.83		0.80		0.76		0.75
		4.95	88445	3.67	72266	2.83	58390	2.05	53545	1.62	45923	1.26	44077
0.9			1.05		0.95		0.87		0.84		0.79		0.78
		5.50	98238	4.08	80265	3.14	64887	2.28	59491	1.80	51026	1.41	48973
1			1.11		1.00		0.90		0.87		0.82		0.81
		6.06	108019	4.49	88254	3.45	71388	2.51	65436	1.98	56128	1.55	53868
1.1			1.17		1.05		0.94		0.91		0.85		0.84
		6.61	117797	4.90	96232	3.77	77893	2.73	71380	2.16	61231	1.69	58763
1.2			1.23		1.09		0.98		0.94		0.88		0.87
		7.16	127588	5.31	104198	4.08	84401	2.96	77323	2.34	66333	1.83	63657
1.3			1.29		1.14		1.02		0.98		0.91		0.90

	400	ST											
Lifted Load Condition		Wave Period (sec)											
		5	Boom Load	6	Boom Load	7	Boom Load	8	Boom Load	9	Boom Load	10	Boom Load
		Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap
Wave Height (m)		2.75	64775	2.07	52482	1.56	43150	1.13	38806	0.90	33912	0.70	32013
0.5			0.90		0.83		0.77		0.75		0.72		0.71
		3.30	77717	2.48	62965	1.88	51784	1.36	46566	1.08	40695	0.84	38415
0.6			0.98		0.89		0.83		0.79		0.76		0.75
		3.85	90651	2.89	73416	2.19	60419	1.59	54325	1.26	47477	0.98	44817
0.7			1.06		0.96		0.88		0.84		0.80		0.78
		4.40	103577	3.31	83905	2.50	69057	1.82	62083	1.45	54259	1.12	51218
0.8			1.14		1.02		0.93		0.89		0.84		0.82
		4.95	116491	3.72	94360	2.81	77697	2.04	69840	1.63	61041	1.26	57618
0.9			1.22		1.08		0.98		0.93		0.88		0.86
		5.50	129393	4.14	104803	3.12	86339	2.27	77596	1.81	67823	1.40	64018
1			1.30		1.15		1.03		0.98		0.92		0.90
		6.05	142280	4.55	115232	3.44	94985	2.50	85350	1.99	74605	1.53	70417
1.1			1.38		1.21		1.09		1.03		0.96		0.94
		6.60	155149	4.97	125646	3.75	103634	2.72	93103	2.17	81387	1.67	76815
1.2			1.46		1.28		1.14		1.07		1.00		0.98
		7.15	167999	5.38	136044	4.06	112287	2.95	100855	2.35	88168	1.81	83212
1.3			1.54		1.34		1.19		1.12		1.05		1.02

	500	ST											
Lifted Load Condition		**Wave Period (sec)**											
		5	Boom Load	**6**	Boom Load	**7**	Boom Load	**8**	Boom Load	**9**	Boom Load	**10**	Boom Load
		Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap
Wave Height (m)		2.74	80119	2.09	64351	1.55	53878	1.15	47789	0.90	42097	0.69	39572
0.5			1.00		0.90		0.84		0.80		0.77		0.75
		3.29	96115	2.50	77200	1.86	64656	1.38	57344	1.08	50517	0.83	47487
0.6			1.09		0.98		0.90		0.86		0.82		0.80
		3.83	112096	2.92	90036	2.17	75435	1.61	66899	1.26	58935	0.97	55400
0.7			1.19		1.06		0.97		0.92		0.87		0.85
		4.38	128059	3.34	102859	2.48	86215	1.84	76451	1.45	67354	1.11	63314
0.8			1.29		1.13		1.03		0.97		0.92		0.90
		4.93	143999	3.76	115666	2.79	96998	2.07	86002	1.63	75772	1.25	71227
0.9			1.39		1.21		1.10		1.03		0.97		0.94
		5.47	159915	4.18	128454	3.10	107782	2.30	95551	1.81	84190	1.39	79140
1			1.49		1.29		1.17		1.09		1.02		0.99
		6.02	175803	4.60	141223	3.41	118568	2.53	105098	1.99	92608	1.52	87053
1.1			1.59		1.37		1.23		1.15		1.07		1.04
		6.56	191657	5.02	153968	3.72	129356	2.76	114642	2.17	101025	1.66	94965
1.2			1.69		1.45		1.30		1.21		1.12		1.09
		7.10	207476	5.44	166725	4.03	140146	2.99	124184	2.35	109441	1.80	102876
1.3			1.79		1.53		1.37		1.27		1.18		1.13

	600	ST											
Lifted Load Condition		**Wave Period (sec)**											
		5	Boom Load	**6**	Boom Load	**7**	Boom Load	**8**	Boom Load	**9**	Boom Load	**10**	Boom Load
		Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap
Wave Height (m)		2.71	94978	2.11	76492	1.54	64576	1.16	56589	0.90	50182	0.69	47499
0.5			1.09		0.97		0.90		0.85		0.82		0.80
		3.26	113929	2.53	91775	1.85	77492	1.40	67903	1.08	60218	0.82	56999
0.6			1.20		1.07		0.98		0.92		0.88		0.86
		3.80	132853	2.95	107048	2.16	90410	1.63	79216	1.26	70253	0.96	66498
0.7			1.32		1.16		1.06		0.99		0.94		0.91
		4.34	151748	3.37	122311	2.47	103328	1.86	90526	1.44	80288	1.10	75997
0.8			1.44		1.26		1.14		1.06		1.00		0.97
		4.89	170608	3.80	137562	2.77	116248	2.09	101834	1.62	90323	1.24	85495
0.9			1.56		1.35		1.22		1.13		1.06		1.03
		5.44	189427	4.22	152799	3.08	129169	2.33	113139	1.80	100357	1.37	94993
1			1.68		1.45		1.30		1.20		1.12		1.09
		5.99	208201	4.64	168020	3.39	142091	2.56	124441	1.98	110390	1.51	104491
1.1			1.79		1.54		1.38		1.27		1.18		1.14
		6.54	226924	5.06	183224	3.70	155014	2.79	135739	2.17	120423	1.65	113987
1.2			1.91		1.64		1.46		1.34		1.24		1.20
		7.09	245589	5.49	198407	4.01	167938	3.03	147034	2.35	130455	1.79	123484
1.3			2.03		1.73		1.54		1.41		1.31		1.26

	700	ST											
Lifted Load Condition		**Wave Period (sec)**											
		5	Boom Load	**6**	Boom Load	**7**	Boom Load	**8**	Boom Load	**9**	Boom Load	**10**	Boom Load
		Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap
Wave Height (m)		2.76	109300	2.12	88271	1.53	75185	1.18	65447	0.91	58155	0.68	55375
0.5			1.17		1.05		0.97		0.91		0.86		0.85
		3.31	131109	2.54	105899	1.83	90220	1.41	78537	1.09	69785	0.82	66449
0.6			1.31		1.15		1.06		0.99		0.93		0.91
		3.87	152889	2.97	123514	2.14	105255	1.65	91627	1.27	81415	0.95	77523
0.7			1.45		1.26		1.15		1.07		1.00		0.98
		4.42	174636	3.39	141112	2.44	120289	1.88	104718	1.45	93044	1.09	88596
0.8			1.58		1.37		1.24		1.15		1.07		1.05
		4.98	196343	3.81	158691	2.75	135322	2.12	117809	1.63	104672	1.22	99669
0.9			1.72		1.48		1.34		1.23		1.15		1.11
		5.54	218005	4.24	176248	3.05	150353	2.35	130901	1.81	116299	1.36	110741
1			1.86		1.59		1.43		1.31		1.22		1.18
		6.09	239615	4.66	193780	3.36	165383	2.59	143993	1.99	127926	1.49	121813
1.1			1.99		1.70		1.53		1.39		1.29		1.25
		6.65	261168	5.09	211285	3.66	180411	2.82	157085	2.17	139552	1.63	132884
1.2			2.13		1.81		1.62		1.47		1.36		1.32
		7.22	282655	5.51	228760	3.97	195437	3.06	170179	2.36	151177	1.77	143954
1.3			2.26		1.92		1.71		1.56		1.44		1.39

	800	ST											
Lifted Load Condition		Wave Period (sec)											
		5	Boom Load	6	Boom Load	7	Boom Load	8	Boom Load	9	Boom Load	10	Boom Load
		Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap
Wave Height (m)		2.80	123286	2.12	99469	1.51	85518	1.18	74701	0.92	66056	0.67	63159
0.5			1.26		1.11		1.03		0.96		0.91		0.89
		3.36	147868	2.55	119327	1.81	102616	1.42	89640	1.10	79266	0.81	75790
0.6			1.42		1.24		1.13		1.05		0.99		0.97
		3.92	172410	2.97	139166	2.11	119711	1.66	104579	1.28	92475	0.94	88421
0.7			1.57		1.36		1.24		1.15		1.07		1.05
		4.48	196902	3.40	158983	2.41	136804	1.90	119518	1.47	105684	1.08	101051
0.8			1.72		1.49		1.35		1.24		1.15		1.12
		5.04	221338	3.82	178773	2.72	153892	2.13	134456	1.65	118892	1.21	113680
0.9			1.88		1.61		1.45		1.33		1.23		1.20
		5.61	245709	4.25	198534	3.02	170976	2.37	149393	1.83	132099	1.35	126308
1			2.03		1.73		1.56		1.43		1.32		1.28
		6.17	270007	4.67	218261	3.32	188054	2.61	164330	2.01	145306	1.48	138936
1.1			2.18		1.86		1.67		1.52		1.40		1.36
		6.73	294222	5.10	237952	3.62	205128	2.84	179266	2.20	158511	1.61	151563
1.2			2.33		1.98		1.77		1.61		1.48		1.44
		7.30	318347	5.52	257603	3.92	222194	3.08	194201	2.38	171715	1.75	164188
1.3			2.48		2.10		1.88		1.71		1.57		1.52

	900	ST											
Lifted Load Condition		Wave Period (sec)											
		5	Boom Load	6	Boom Load	7	Boom Load	8	Boom Load	9	Boom Load	10	Boom Load
		Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap	Roll Angle	Struct Cap
Wave Height (m)		2.83	136480	2.12	110078	1.49	95528	1.19	83784	0.92	73948	0.67	70866
0.5			1.35		1.18		1.09		1.02		0.96		0.94
		3.39	163676	2.55	132050	1.79	114626	1.43	100539	1.11	88737	0.80	85039
0.6			1.52		1.32		1.21		1.12		1.05		1.03
		3.96	190816	2.97	153997	2.09	133720	1.67	117293	1.29	103526	0.93	99210
0.7			1.69		1.45		1.33		1.22		1.14		1.11
		4.53	217891	3.40	175917	2.39	152809	1.91	134047	1.48	118313	1.06	113381
0.8			1.85		1.59		1.45		1.33		1.23		1.20
		5.10	244890	3.82	197804	2.68	171893	2.15	150799	1.66	133100	1.20	127551
0.9			2.02		1.73		1.57		1.43		1.32		1.29
		5.67	271804	4.25	219654	2.98	190970	2.39	167550	1.85	147887	1.33	141720
1			2.19		1.87		1.69		1.54		1.42		1.38
		6.24	298620	4.67	241464	3.28	210041	2.63	184300	2.03	162672	1.46	155889
1.1			2.36		2.00		1.81		1.64		1.51		1.47
		6.81	325328	5.10	263229	3.58	229103	2.87	201048	2.22	177457	1.60	170056
1.2			2.53		2.14		1.92		1.75		1.60		1.56
		7.38	351917	5.52	284945	3.87	248157	3.11	217794	2.40	192241	1.73	184222
1.3			2.69		2.27		2.04		1.85		1.69		1.64

Application of Analysis Results

The tables presented above can be used to determine if a particular pick is possible. The table for hook load intervals above the expected net hook load should be consulted. For instance, if the expected hook load is 160 ST, then use the 200 ST table. Then, find the block for the intersection of the expected wave height, in meters, and the dominant wave period, in seconds.

If either the top row of the block is green or yellow, then rolling limits are expected to be within safe operational limits. If red, then it is recommended that the lift be postponed.

The bottom row of each block shows the Structural Utilization Factor, along with its color code. A value below 0.85 will be green, while 0.85 to 1.0 is yellow. Anything beyond 1.0 will be red, and represents a condition that is beyond the allowable structural capacity of the boom. This is the more important of the two color-coded parameters.

It should be noted that hook loads up past 700 ST will start to have a fairly limited range of allowable sea states, especially if the waves are coming at higher frequencies (shorter wave periods)

Please contact me with any questions regarding this Stability Booklet.

Very Respectfully,

Tullio Celano III P.E.
360-204-4818

REGISTERED PROFESSIONAL ENGINEER
79462PE
4/10/2022
OREGON
MAY 11, 2007
TULLIO CELANO III

EXPIRATION DATE: 12/31/23