

Mobile Crane Lift Planning in Construction Environments

Guest Speaker: **Kevin O'Neill, P.E.**
Project Engineer, Sieffert Associates

Host: **Mike Parnell**
President / CEO, ITI
ASME B30 Vice Chair (Cranes & Rigging)
ASME P30 Chair (Lift Planning)

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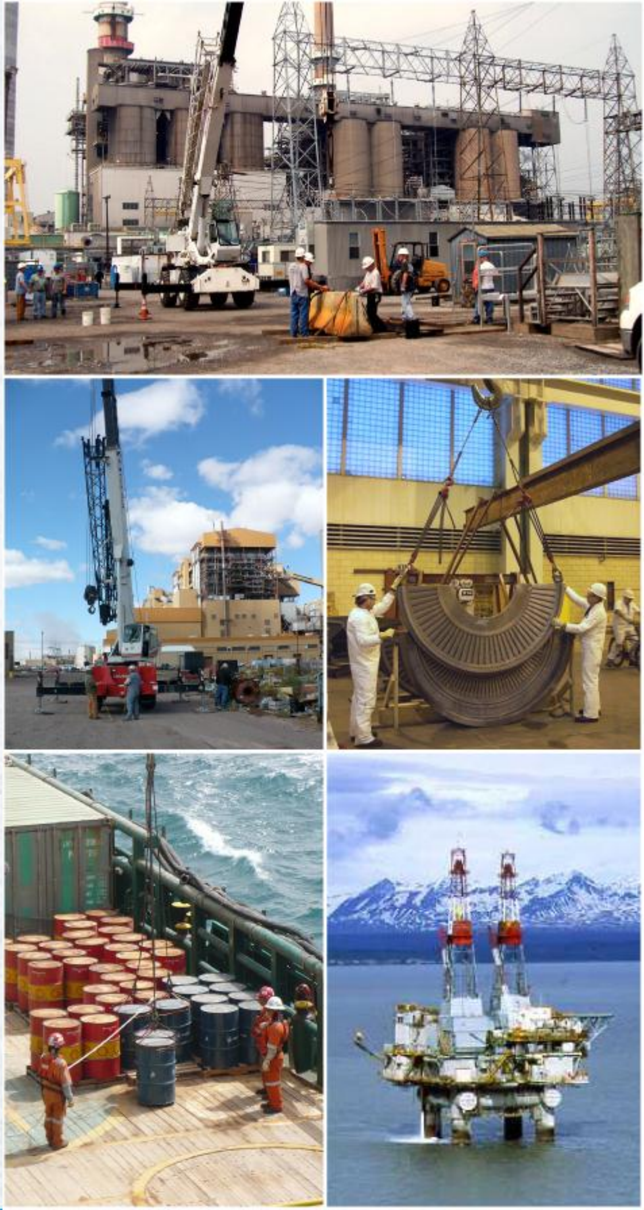

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How Studies of Crane Accidents and Trends Lead to a Safer Work Environment

Today's Presentation:

Mobile Crane Lift Planning in Construction Environments

Upcoming Presentations:

4 Major Lifting Considerations in Power Gen Environments

MIKE PARNELL – ABOUT YOUR HOST

Mr. Parnell has a wealth of knowledge regarding cranes, rigging, and lifting activities throughout a variety of industries.

- 30+ years learning about wire rope, rigging, load handling, and lifting activities.
- Vice Chair of the ASME B30 Main Committee which sets the standards in the US for cranes and rigging
- Chair of the ASME P30 Main Committee which sets the standards for lift planning.

ASME standards are also adopted by many countries around the world.

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ABOUT THE SPEAKER

Kevin O' Neill, P.E., Project Engineer, Siefert Associates

Mr. O'Neill is a member of the ASME P30 Main Committee (Planning for the Use of Cranes, Derricks, Hoists, Cableways, Aerial Devices and Lifting Accessories) and currently serves as a Project Engineer for Siefert Associates, Naugatuck, Connecticut.

Current responsibilities as a Project Engineer include directing and managing multiple concurrent engineering projects while ensuring their success in meeting their respective objectives.

Mr. O'Neill provides Construction Engineering Services for contractors including erection and demolition plans, crane and rigging layouts/design and equipment foundation analysis.

Mobile Crane Lift Planning in Construction Environments

Kevin O’Neill, P.E.
Siefert Associates, LLC

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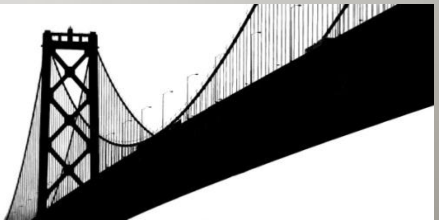
Mobile Crane Lift Planning in Construction Environments

- Demolition and Erection Plans for Bridges and Buildings
- Crane Layout and Rigging Design
- Temporary Bridges and Structures
- Heavy Hauling and Alternative Lifting Schemes
- Structural Rehabilitation and Retrofit Operations
- Access Platforms and Debris Shields
- Bridge Jacking and Bearing Replacement
- Concrete Forming and Shoring
- Temporary Earth Support - Sheet Piling etc.
- Temporary Cofferdams
- Detailed Work Plans
- Analysis of Construction Loads on Structures
- Detailed Work Plans

Permanent Design Drawings and Calculations for:

- Foundations and Retaining Walls
- Bridges and Buildings



New Definitions ASME P-30

- **Lift Director** – Responsible for verifying the category of the load handling activity, reviewing and implementing the lift plan.
- **Lift Planner** - Responsible for developing the lift plan.
- Load Handling Equipment (**LHE**)
- Load Handling Activity (**LHA**)

Assessing Loads to Be Handled

- New Construction
  - Known weights of loads, pick point locations & center of gravity
  - Drawings/data available
- Demolition
  - Unknown weights of loads and center of gravity
  - Elaborate calculations/very conservative guesswork
  - Cutting free while hoisting

Assessing Loads to Be Handled Cont.

- Equipment Loads
  - Hook block(s) – rigging – falls - jib
- Chart Reduction
  - 125% -150% picking capacity (i.e. RR)
  - 85% capacity of rated chart – rule of thumb

LHE Position

- Cost Considerations
  - Relative efficiency of operation from one location over another
  - Radius increase leads to crane increase

Mobile Crane Lift Planning in Construction Environments

LHE Selection

- **Crane Basics**
  - Capacity
  - Reeving
  - Reach
  - Clearance
  - Constructability
  - Availability

LHE Selection Continued

- Telescopic/Hydraulic
  - Short term operation
  - Quick setup/small crew
  - May have limited onsite mobility (larger cranes)
  - Higher rental rate

LHE Selection Continued

- Lattice Boom Truck/Crawler
  - Long term operation
  - Onsite mobility
  - Added labor for assembly/disassembly
  - High transportation cost
  - Low rental rate

Mobile Crane Lift Planning in Construction Environments

<u>Lift/Swing Clearances</u>

- **Lift Clearances**
  - Tip height
  - Range diagram
  - Rigging drift
  - Two blocking
- **Swing Clearances**
  - Spreadsheet calculations
  - Drafting
  - Lift planning programs

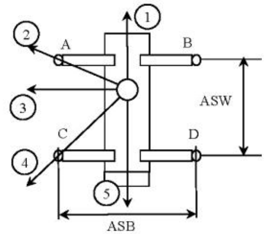
LHE Loads on Surface

- Spreadsheet Calculations
  - Component weights and centers of gravity
- Manufacturer's Programs or Charts
- Hydraulic/Truck Cranes
  - Point loads
- Crawler Cranes
  - Pressure diagrams (uniform, trapezoidal & triangular)

LHE Loads on Structures

- Foundation walls
- Tunnels or subways
- Bridge decks
- Piers
- Slabs
- Utility banks

Mobile Crane Lift Planning in Construction Environments



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OUTRIGGER LOADING 75.00 %
****

0-360Degr.
OUTRIGGER LOADING IN LB*1000 PSI= 1.00

CRANE : AC 40-1 * HA * 87922340 Bl. 1-2 * GGW 5.4to * Stuetzbasis 6.35x6.20

GO,	GU,	EO,	EU,	ASB,	ASW,	AFD,	EASH,	BR
5.10	12.70	1.31	-0.52	6.20	6.35	2.98	3.45	0.00

GGW = 5.40 EGG = 2.87

MAIN BOOM

LENGTH OF MAIN BOOM 25.6 FEET AS= 2.99 T AF= 3.34 T

RADIUS CAPACITY BOOM ANGLE (DEGREES)

RADIUS FT	CAPACITY LB*1000	1 (0) 5 (180) AB	CD	2 (43) 4 (131) A	B	C	D	3 (90) A	B	C	D
9.8	88.2	53	24	59	38	41	15	52	20	59	22
		19	57	37	13	66	38				
9.8	75.6	47	23	52	35	37	16	46	20	52	22
		19	51	34	14	58	35				
11.5	71.4	48	20	54	34	36	12	47	17	54	18
		16	52	33	11	60	33				
13.1	67.2	49	17	56	33	35	8	48	15	54	15
		14	52	32	7	61	32				
14.8	62.4	49	15	56	32	34	5	48	13	54	12
		11	52	31	5	62	30				

MAX. OUTRIGGER LOAD FRONT OUTRIGGER CD 25 9.8 FT * 88.2 LB = 66
MAX. OUTRIGGER LOAD REAR OUTRIGGER AB 25 9.8 FT * 88.2 LB = 59

MAIN BOOM

LENGTH OF MAIN BOOM 35.1 FEET AS= 3.39 T AF= 2.95 T

RADIUS CAPACITY BOOM ANGLE (DEGREES)

RADIUS FT	CAPACITY LB*1000	1 (0) 5 (180) AB	CD	2 (43) 4 (131) A	B	C	D	3 (90) A	B	C	D
9.8	55.1	38	22	41	29	32	18	37	20	42	21
		19	41	29	16	46	30				
11.5	55.1	40	20	45	30	32	14	40	18	45	18
		17	43	29	12	49	30				
13.1	55.1	43	17	48	30	32	10	42	15	47	16
		14	46	29	9	53	29				
14.8	55.1	45	15	52	30	32	6	44	13	50	13
		12	48	29	6	57	29				
16.4	52.9	46	13	53	30	31	4	45	11	51	10
		10	49	29	3	58	28				

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MANNESMANN-DEMATIC R
OUTRIGGER LOADING 75.00 %
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0-360Degr.
OUTRIGGER LOADING IN LB*1000 PSI= 1.00

CRANE : CC 2800 SH 0t ZB

GO,	GU,	EO,	EU,	ASB,	ASW,	AFD,	EASH,	BR
40.13	92.00	1.43	-0.10	8.40	8.40	-2.00	4.20	1.50

GGW = 160.00 EGG = 6.18

MAIN BOOM

LENGTH OF MAIN BOOM 78.7 FEET AS= 14.83 T AF= 9.40 T

RADIUS CAPACITY BOOM ANGLE (DEGREES)

RADIUS FT	CAPACITY LB*1000	1 (0) 5 (180) AB	CD	2 (45) 4 (135) A	B	C	D	3 (90) A	B	C	D
19.7	941.4	624	195	712	411	408	107	624	198	622	195
		198	622	411	109	710	408				
23.0	895.1	651	145	755	399	397	41	651	147	649	145
		147	649	399	43	753	397				
26.2	855.4	678	99	817	369	366	0	678	101	675	99
		101	675	371	0	813	369				
29.5	736.3	637	80	787	325	322	0	637	82	634	80
		82	634	327	0	782	325				
32.8	604.1	571	80	693	305	303	0	571	82	568	80
		82	568	308	0	689	305				
39.4	440.9	489	80	578	281	279	0	489	82	487	80
		82	487	284	0	573	281				
45.9	343.9	441	80	515	262	259	6	441	82	438	80
		82	438	262	8	512	259				
52.5	280.0	409	80	476	246	243	13	409	83	406	80
		83	406	246	15	474	243				
59.1	235.9	388	79	451	235	232	16	388	82	385	79
		82	385	235	18	449	232				
65.6	202.8	372	78	432	226	224	18	372	81	370	78
		81	370	226	20	430	224				
72.2	176.4	359	78	416	220	217	21	359	81	356	78
		81	356	220	23	414	217				

MAX. OUTR. LOAD FRONT OUTRIGGER CD 78 26.2 FT * 855.4 LB*1000 = 813
MAX. OUTR. LOAD REAR OUTRIGGER AB 78 26.2 FT * 855.4 LB*1000 = 817

MAX. GROUND PRESSURE BY 736.3 LB*1000 AT 29.5 FEET = 219.35 PSI

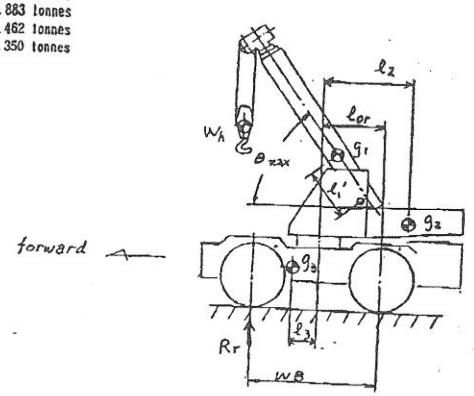
RADIUS FT	CAP LB*1000	FPMAX PSI	1	2	3 PSI	4	5
19.7	941.4	117.34	117.34	109.16	64.16	108.08	115.91
23.0	895.1	149.19	149.19	128.03	66.94	126.64	146.75
26.2	855.4	208.22	208.22	153.29	69.64	151.29	203.26
29.5	736.3	219.35	219.35	150.88	65.48	148.65	212.92
32.8	604.1	180.99	180.99	130.85	58.71	128.80	175.68

Mobile Crane Lift Planning in Construction Environments

2 4 Major component weights and center of gravity

	weight (kg)	distance from center of slewing (m) (forward :+)
Boom portion	5774	———
Slewing portion	6883	-1.506 m
Carrier portion	14462	-0.364 m

ℓ1' = 4.786m g1= 5.774 tonnes
ℓ2 = 1.506m g2= 6.883 tonnes
ℓ3 = 0.364m g3=14.462 tonnes
ℓor= 1.73 m Wh= 0.350 tonnes
WB= 3.460m



2 5 Amount of counterweight (Drg. No. 342-812-30000)
mass : 1800 kg
mounting bolt : JIS B1051 M24×140, class 10.9, number:2
JIS B1051 M24×60, class 10.9, number:4

2 6 Drawings of jib sections :
Drg. No. 342-207-32000 and Drg. No. 342-207-33000

2 8 Details of jib mounting on boom :Drg. No. 342-208-41000 and 342-207-02200

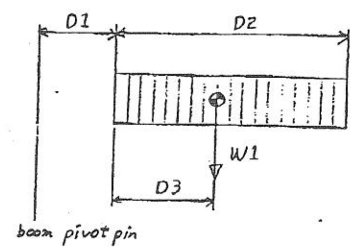
2 9 Details of jib top sheave mounting :Drg. No. 342-208-41000

2 0 Boom section weight and center of gravity

	weight(kg)	distance from boom pivot pin(m)
Base boom	1476	4.270
2nd boom	1026	4.348
3rd boom	908	4.375
Top boom	850	6.652

2 1 Weight of boom extension cylinder

D1:distance to bottom of a boom part
D2:length of a boom part (If D2=0, it means concentration load.)
D3:distance from bottom of the boom part to center of gravity
W1:weight of a boom part
W2:weight increase due to unit extension of the telescoping cylinder



		W1 (kg)	D1 (m)	D2 (m)	D3 (m)	W2 (kg)
No. 1 cylinder	rod	216	0.21	6.877	0.0	———
	cylinder	229	-0.03	7.057	0.0	0.0107
No. 2 cylinder	rod	213	0.55	6.877	0.0	———
	cylinder	229	0.31	7.0575	0.0	0.0107

Mobile Crane Lift Planning in Construction Environments

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Naugatuck, CT 06770

Subject: Maximum Outrigger Load
Tadano TR450-XL4

Job No.: XXXX
Sheet No____ Of ____
Made By ___ Date ___
Ckd By ____ Date___

Shadow Length Boom Angle $\gamma := \mathrm{acos}\left(\frac{R - t}{d}\right)$ $\gamma = 47.704\,deg$

Boom Angle $\theta := \beta + \gamma$ $\theta = 48\,deg$

Tip Height:

$$H_{tip} := h + \sqrt{d^2 - (R - t)^2} \qquad H_{tip} = 64.5\,ft$$

Boom Moment:

$$M_b := \left[W_b \cdot \left(t + d_b \cdot \cos(\theta)\right)\right] + \left[W_j \cdot \left(t + L_b \cdot \cos(\theta) + d_j \cdot \cos(\theta - \mu)\right)\right] \qquad M_b = 433.7\,kip \cdot ft$$

Superstructure Moment:

$$M_u := M_b + W \cdot R - W_u \cdot d_u - W_{ctw} \cdot d_{ctw} \qquad M_u = 577.3\,kip \cdot ft$$

Superstructure Vertical Load:

$$V_u := W_b + W_j + W_u + W_{ctw} + W \qquad V_u = 33.3\,kip$$

Total Vertical Load:

$$V := V_u + W_c \qquad V = 71.1\,kip$$

Portion of Moment:

Over Rear $M_{nr_\alpha} := \left(M_u \cdot \cos(\alpha \cdot deg) - W_c \cdot d_c - V_u \cdot x_o\right)$

Over Side $M_{ns_\alpha} := \left(M_u \cdot \sin(\alpha \cdot deg)\right)$

Outrigger Reactions:

Front Outrigger Boom Side $P_{fb_\alpha} := \frac{V}{4} + \frac{1}{2}\left(\frac{M_{ns_\alpha}}{d_t} - \frac{M_{nr_\alpha}}{d_l}\right)$

Front Outrigger Counterweight Side $P_{fc_\alpha} := \frac{V}{4} - \frac{1}{2}\left(\frac{M_{ns_\alpha}}{d_t} + \frac{M_{nr_\alpha}}{d_l}\right)$

Rear Outrigger Boom Side $P_{rb_\alpha} := \frac{V}{4} + \frac{1}{2}\left(\frac{M_{ns_\alpha}}{d_t} + \frac{M_{nr_\alpha}}{d_l}\right)$

Rear Outrigger Counterweight Side $P_{rc_\alpha} := \frac{V}{4} - \frac{1}{2}\left(\frac{M_{ns_\alpha}}{d_t} - \frac{M_{nr_\alpha}}{d_l}\right)$

Total Outrigger Loads $P_{crane_\alpha} := P_{fb_\alpha} + P_{fc_\alpha} + P_{rb_\alpha} + P_{rc_\alpha}$

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Tadano TR450-XL4

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This document creates the maximum outrigger load for a Tadano TR-450XL-4 Hydraulic Crane.
Reference: Shapiro, Cranes and Derricks Third Edition

Crane Data

Outrigger Spread (Front to Rear) $d_l := 22.974ft$

Outrigger Spread (Side to Side) $d_t := 22.97ft$

Distance from CL to Outrigger Centroid (+ Rear of CL) $x_o := .485ft$

Boom Pin Distance (+ Front of CL) $t := 7.22ft$

Boom Pin Height $h := 12ft$

Length of Boom $L_b := 71ft$

Length of Jib $L_j := 0ft$

Jib Offset $\mu := 0 \cdot deg$

Operating Radius $R := 55ft$

Slew Range (deg) $\alpha := 0, 5 .. 180$

Weights

Weight of Carrier $W_c := 37.8kip$

Weight of Superstructure $W_u := 14.2kip$

Weight of Counterweight $W_{ctw} := 0kip$

Weight of Boom $W_b := 15.1kip$

Weight of Jib $W_j := 0kip$

Weight of Hook Load (Block, Rigging, lifted Load, Falls) $W := 4kip$

CG Distances

Carrier CG $d_c := 1ft$

Superstructure CG $d_u := 5.38ft$

Counterweight CG $d_{ctw} := 0ft$

Boom CG $d_b := L_b \cdot .45$ $d_b = 32\,ft$

Jib CG $d_j := L_j \cdot .45$ $d_j = 0$

Calculations

Boom Angle:

X-Y Components of Jib $x_j := L_j \cdot \sin(\mu)$ $x_j = 0$

$y_j := L_j \cdot \cos(\mu)$ $y_j = 0$

Enclosed Angle $\beta := \mathrm{atan}\left(\frac{x_j}{L_b + y_j}\right)$ $\beta = 0\,deg$

Shadow Length of Combined Boom $d := \sqrt{x_j^2 + \left(L_b + y_j\right)^2}$ $d = 71\,ft$

Mobile Crane Lift Planning in Construction Environments

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Tadano TR450-XL4

Job No.: XXXX
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Summary

Counterweight $W_{ctw} = 0\,kip$ **Operating Radius** $R = 55\,ft$ **Tip Height** $H_{tip} = 64.5\,ft$

Length of Boom $L_b = 71\,ft$ **Boom Angle** $\theta = 47.7\,deg$ **Max Pick** $W = 4\,kip$

Length of Jib $L_j = 0$ **Jib Offset** $\mu = 0$

$\alpha =$	$\frac{M_{nr_\alpha}}{ft\cdot kip} =$	$\frac{M_{ns_\alpha}}{ft\cdot kip} =$	$\frac{P_{fb_\alpha}}{kip} =$	$\frac{P_{fc_\alpha}}{kip} =$	$\frac{P_{rb_\alpha}}{kip} =$	$\frac{P_{rc_\alpha}}{kip} =$	$\frac{P_{crane_\alpha}}{kip} =$
0	523.3	0	6.4	6.4	29.2	29.2	71.1
5	521.1	50.3	7.5	5.3	30.2	28	71.1
10	514.6	100.2	8.8	4.4	31.2	26.8	71.1
15	503.7	149.4	10.1	3.6	32	25.5	71.1
20	488.5	197.4	11.4	2.8	32.7	24.1	71.1
25	469.3	244	12.9	2.3	33.3	22.7	71.1
30	446	288.6	14.4	1.8	33.8	21.2	71.1
35	418.9	331.1	15.9	1.4	34.1	19.7	71.1
40	388.3	371.1	17.4	1.2	34.3	18.1	71.1
45	354.3	408.2	19	1.2	34.4	16.6	71.1
50	317.1	442.2	20.5	1.2	34.3	15.1	71.1
55	277.2	472.9	22	1.4	34.1	13.5	71.1
60	234.7	499.9	23.5	1.8	33.8	12	71.1
65	190	523.2	25	2.3	33.3	10.5	71.1
70	143.5	542.5	26.5	2.8	32.7	9.1	71.1
75	95.5	557.6	27.8	3.6	32	7.7	71.1
80	46.3	568.5	29.1	4.4	31.2	6.4	71.1
85	-3.6	575.1	30.4	5.3	30.2	5.2	71.1
90	-54	577.3	31.5	6.4	29.2	4	71.1
95	-104.3	575.1	32.6	7.5	28	3	71.1
100	-154.2	568.5	33.5	8.8	26.8	2	71.1
105	-203.4	557.6	34.3	10.1	25.5	1.2	71.1
110	-251.4	542.5	35.1	11.4	24.1	0.5	71.1
115	-297.9	523.2	35.6	12.9	22.7	-0.1	71.1
120	-342.6	499.9	36.1	14.3	21.2	-0.6	71.1
125	-385.1	472.9	36.4	15.9	19.7	-0.9	71.1
130	-425	442.2	36.7	17.4	18.2	-1.1	71.1
135	-462.2	408.2	36.7	18.9	16.6	-1.2	71.1
140	-496.2	371.1	36.7	20.5	15.1	-1.1	71.1
145	-526.8	331.1	36.4	22	13.5	-0.9	71.1
150	-553.9	288.6	36.1	23.5	12	-0.6	71.1
155	-577.2	244	35.6	25	10.5	-0.1	71.1
160	-596.4	197.4	35.1	26.5	9.1	0.5	71.1
165	-611.6	149.4	34.3	27.8	7.7	1.2	71.1
170	-622.5	100.2	33.5	29.1	6.4	2	71.1
175	-629	50.3	32.6	30.4	5.2	3	71.1
180	-631.2	0	31.5	31.5	4	4	71.1

Max Outrigger Load $MaxP = 36.7\,kip$

Mobile Crane Lift Planning in Construction Environments

KMK-5160 **Outrigger Loads** (in 1000 lbs) **Base-Nr. 2.295.640**

10-06-1992

MAIN BOOM: **72.17 feet**
Telescoping: Tel.1 = 1.0 Tel.2 = 0.0 Tel.3 = 0.0 Tel.4 = 0.0

COUNTERWEIGHT: **99210 lbs**
Outrigger base: 26.90 x (17.22 + 10.91) feet
Slewing range: 360°

<<------------------------------- L o a d p o s i t i o n s ---------------------------->>

A	P	I				II				III				IV				V			
feet	(**)	VL	VR	HL	HR	VL	VR	HL	HR	VL	VR	HL	HR	VL	VR	HL	HR	VL	VR	HL	HR
10	194.0	101.8	101.8	108.8	108.8	92.2	104.9	101.9	122.1	81.5	99.6	105.6	134.3	76.3	89.0	117.8	138.0	79.4	79.4	131.1	131.1
10	0.0	29.7	29.6	83.9	83.8	49.7	23.1	98.1	56.2	71.9	34.1	90.4	30.7	82.8	56.2	65.0	23.0	76.3	76.3	37.3	37.3
15	190.0	119.5	119.6	88.9	89.1	94.0	127.9	70.8	124.4	65.7	113.9	80.7	156.8	51.7	85.6	113.1	166.6	60.1	60.1	148.5	148.5
15	0.0	32.1	32.0	81.5	81.5	50.0	26.2	94.3	56.6	70.0	36.0	87.3	33.8	79.8	55.9	64.5	26.9	73.9	73.9	39.7	39.7
20	164.0	124.5	124.6	71.0	71.1	90.4	135.7	46.7	118.3	52.5	117.0	59.9	161.7	33.8	79.2	103.2	174.8	45.0	45.0	150.5	150.5
20	0.0	34.4	34.4	79.2	79.1	50.4	29.2	90.5	57.1	68.0	37.9	84.3	36.8	76.7	55.6	64.1	30.7	71.5	71.5	42.0	42.0
25	141.0	126.7	126.8	57.2	57.4	86.8	139.8	28.9	112.5	42.6	118.0	44.3	163.3	20.8	73.8	94.9	178.6	33.8	33.8	150.2	150.2
25	0.0	36.8	36.8	76.8	76.7	50.7	32.2	86.6	57.5	66.1	39.9	81.3	39.8	73.7	55.2	63.6	34.5	69.2	69.2	44.4	44.4
30	123.0	128.5	128.7	46.3	46.6	84.1	143.2	14.8	108.0	34.8	118.8	32.0	164.6	10.5	69.5	88.4	181.7	25.0	25.0	150.0	150.0
30	0.0	39.2	39.1	74.4	74.4	51.0	35.3	82.8	58.0	64.2	41.8	78.2	42.9	70.7	54.9	63.2	38.3	66.8	66.8	46.8	46.8
35	108.0	129.6	129.7	37.8	38.0	81.7	145.3	3.8	104.2	28.7	119.1	22.3	165.1	2.5	66.1	83.1	183.5	18.2	18.2	149.4	149.4
35	0.0	41.5	41.5	72.0	72.0	51.4	38.3	79.0	58.4	62.3	43.7	75.2	45.9	67.6	54.6	62.7	42.1	64.4	64.4	49.1	49.1
40	96.0	130.7	130.8	30.7	30.9	74.5	152.8	0.0	95.8	23.5	119.5	14.2	165.8	0.0	59.0	74.5	189.6	12.4	12.4	149.1	149.1
40	0.0	43.9	43.9	69.7	69.6	51.7	41.4	75.2	58.9	60.3	45.6	72.2	49.0	64.6	54.2	62.3	46.0	62.0	62.0	51.5	51.5
45	81.0	126.7	126.8	27.2	27.4	68.6	151.3	0.0	88.2	21.5	115.7	11.0	159.8	0.0	54.8	68.6	184.7	10.6	10.6	143.5	143.5
45	0.0	46.3	46.3	67.3	67.3	52.0	44.4	71.4	59.3	58.4	47.5	69.1	52.0	61.6	53.9	61.8	49.8	59.7	59.7	53.9	53.9
50	68.0	122.2	122.3	25.2	25.4	65.0	147.1	0.0	83.0	20.6	111.6	9.6	153.3	0.0	52.5	65.0	177.5	10.1	10.1	137.5	137.5
50	0.0	48.7	48.6	64.9	64.9	52.4	47.4	67.5	59.8	56.5	49.5	66.1	55.0	58.5	53.6	61.4	53.6	57.3	57.3	56.2	56.2

SH11S3C

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Siefert Associates LLC
180 Church Street
Naugatuck, CT 06770
203.723.1477

Krupp KMK 5175
Outrigger Load

Job No.: 263.1
Sheet No_______Of_______
MADE BY KON DATE 11/26/2012
CK'D BY______DATE______

CALCULATE MAX OUTRIGGER LOADS USING REACTION TABLES

Calculate outrigger reactions for KMK5175

72ft boom - 99.2k ctwt Load wt = 73.3k Radius = 40ft

Left Rear Outrigger

$P_{n1} := 189.6 \cdot k$ Outrigger loading at position IV 45 deg over Rear outrigger(HR) for 96.0k and 40ft

$P_{n0} := 46k$ Outrigger loading at position IV (HR) for 0k and 40ft

$W_L := 73.3 \cdot k$ Load to be lifted

$W_T := 96k$ Load according to Lifting capacity table

$$P_{IVLR} := \left(P_{n1} - P_{n0}\right) \cdot \frac{W_L}{W_T} + P_{n0} \qquad P_{IVLR} = 155.6 \cdot k$$

Right Rear Outrigger

$P_{n2} := 74.5k$ Outrigger loading at position IV 45 deg over Rear outrigger(HL) for 96.0k and 40ft

$P_{n02} := 62.3 \cdot k$ Outrigger loading at position IV (HL) 0k and 40ft

$$P_{IVRR} := \left(P_{n2} - P_{n02}\right) \cdot \frac{W_L}{W_T} + P_{n02} \qquad P_{IVRR} = 71.6 \cdot k$$

Right Front Outrigger

$P_{n3} := 0k$ Outrigger loading at position IV 45 deg over Rear outrigger(VL) for 96.0k and 40ft

$P_{n03} := 64.6k$ Outrigger loading at position IV (VL) 0k and 40ft

$$P_{IVRF} := \left(P_{n3} - P_{n03}\right) \cdot \frac{W_L}{W_T} + P_{n03} \qquad P_{IVRF} = 15.3 \cdot k$$

Left Front Outrigger

$P_{n4} := 59.0k$ Outrigger loading at position IV 45 deg over Rear outrigger(VR) for 96.0k and 40ft

$P_{n04} := 54.2k$ Outrigger loading at position IV (VR) 0k and 40ft

$$P_{IVLF} := \left(P_{n4} - P_{n04}\right) \cdot \frac{W_L}{W_T} + P_{n04} \qquad P_{IVLF} = 57.9 \cdot k$$

Max Outrigger Reaction

$$OR_{max} := \max\left(P_{IVLR}, P_{IVRR}, P_{IVRF}, P_{IVLF}\right) \qquad OR_{max} = 155.6 \cdot kip$$

KMK517572boom_99.2ctwt_

Mobile Crane Lift Planning in Construction Environments

CRANIMATION V2.64 graphics

Details for crane 1
SerialNr.:100739

Type: CC2800-1

SerialNo.: 62202
Ident.-Nr.: 25298812
Config.: SSL/LSL+SGL

Main B.: 255.9 ft	M.B. Angle: 71.9°
Jib: - - - -	Jib Angle: - - - -
CWT: 396.8 klb	SL-Radius: 49.2 ft
SLCWT: 661.4 klb	Load at: HA
CB: 132.3 klb	Runner: 0
No. of falls: 2x9	Jib-Offset: - - - -
Slew. Range: 0-360 °	
Seq.:	

Load incl. Rigging: 500 klb
max. load at radius : 543.03 klb
Load-Radius: 90ft
Angle of Superstr.: 0°
Support: 27.6ft
DS-Code: 4170000159
LK-Code:

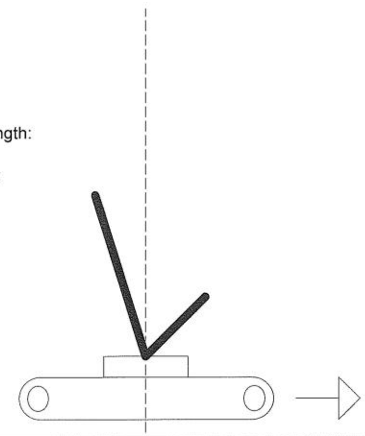
view 90° to Boom

Jib Length
- - - -
Jib Angle:
- - - -

Main B. Length:
255.9 ft
M.B. Angle:
71.9°

SL-Radius:
49.2 ft

Support:
27.6ft

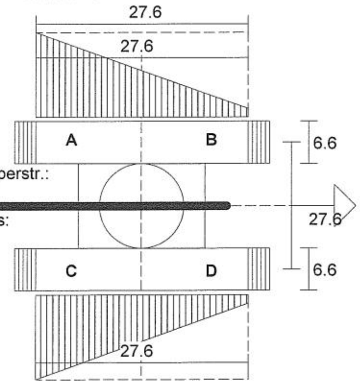


min - max table

F[klb]	r[ft]	h[ft]
156.5	229.7	135.52
175.3	216.5	156.7
200.6	196.9	181.18
235.9	177.2	201.05
275.6	157.5	216.78
326.3	137.8	229.85
396.8	118.1	240.47
500.4	98.4	249.17
533.5	91.9	251.48
566.6	85.3	253.77
595.2	78.7	255.75
595.2	72.2	257.55

top view

A-act = 011.0 klb/ft2 B-act = 000.9 klb/ft2
A-max = 011.3 klb/ft2 B-max = 011.2 klb/ft2



Angle of Superstr.:
0°
Load-Radius:
90ft

Support:
27.6ft

C-act = 011.0 klb/ft2 D-act = 000.9 klb/ft2
C-max = 011.3 klb/ft2 D-max = 011.2 klb/ft2

Results without warranty !(see help "Disclaimer")

Project: q
Job site: q
User: q
Date:

CRANIMAX GmbH
Software development - and sales company for industrial solutions
Prager Ring 4-12
D-66482 - Zweibruecken
Tel: (+49) 63 32 / 78 22 20 ** Fax: (+49) 63 32 / 78 22 28
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Your global partner for CRANIMATION Software and crane job planning

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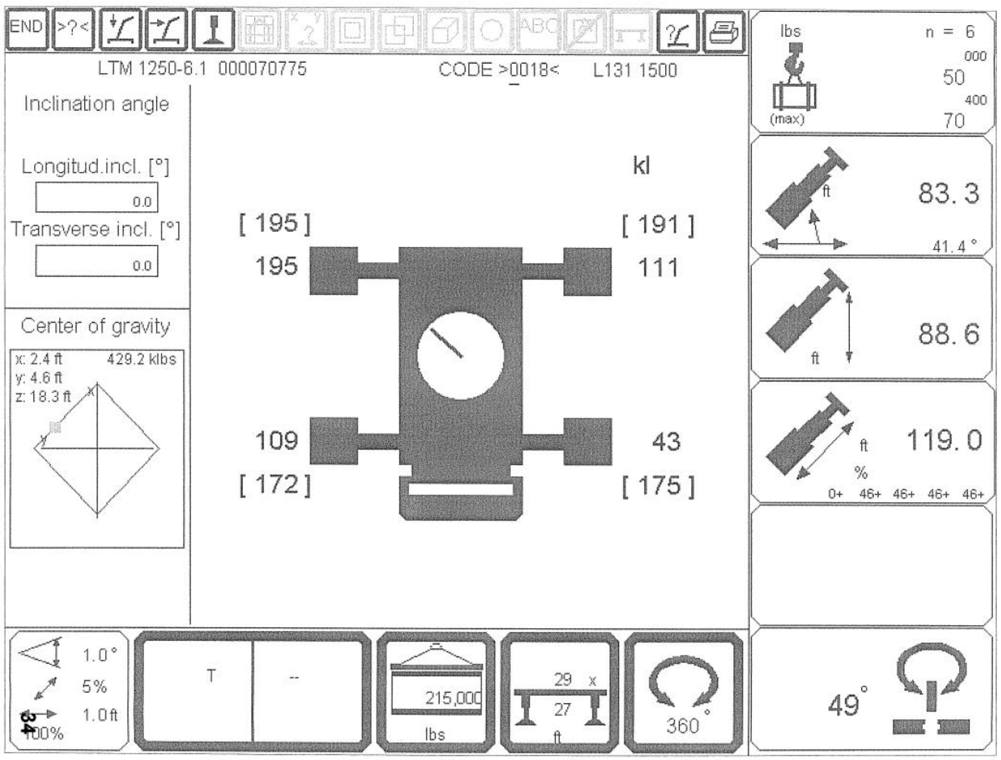


Mobile Crane Lift Planning in Construction Environments

Eingabedaten zur Berechnung des Bodendruckes beim LR 1300

Input for the calculation of ground pressure of LR 1300

Länge Hauptausleger / Length of boom	min 20.0 / max 321.5	242.8	ft
Länge Wippspitze / Length of luffing jib	max 0.0	65.6	ft
Winkel Hauptausleger / Boom angle		88°	(Nur bei Betrieb mit Wippspitze von Bedeutung) (Angle is only necessary for operation with luffing jib)
Länge Hauptausleger Leicht / Length of high reach boom	max 0.0	226.4	ft
Länge Fixe Spitze / Length of fixed jib	max 0.0	36.1	ft
Winkel Fixe Spitze / Offset angle fixed jib		15°	
Spur Unterwagen / Track width		22	ft
Ballast am Unterwagen / Carbody counterweight		125.7	1000 lbs
Ballast am Oberwagen / Counterweight		273.4	1000 lbs
Ballast am Derrick / Super lift couterweight		120.0	1000 lbs

Ausl. Konfiguration / **Boom configuration**	Boom 2821	
	Luffing jib 2316	
Derrick Super lift	No	Fixed Jib 1008
Input - Units	American Units	
Lastfall / Load Case		
Ausladung / Load radius	ok 40.0	ft
Last / Load	50.0	1000 lbs
Ballast-Radius / Radius couterweight	13.0	ft

Bodendruck / Ground pressure	Längs / front (rear)	Seite / side	Eck / corner	Diagramm siehe Blatt "ground pressure" / Diagramm see at sheet "ground pressure"
	Load over			
kg/cm²	2.8	2.1	3.1	Gerät auf festem, anpassungsfähigem Untergrund
psi	39.8	29.9	44.1	Crawlers on compact ground
kg/cm²	4.1	2.9	4.6	Gerät auf Beton, Stahlplatten etc.
psi	58.3	41.2	65.4	Crawlers on concrete or steel plates

Eckdaten für die Berechnung des Bodendruckes:
Technical datas for the calculation of ground pressure

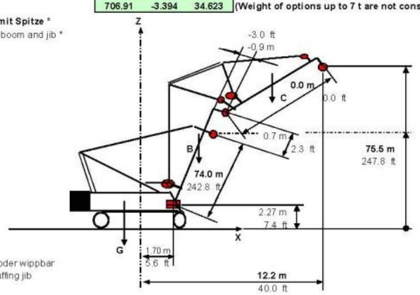
Vertikalkraft am Drehkranz statisch / Vertical load at the slewing ring without dynamic effects	2105 kN	473113 lbf
Moment am Drehkranz statisch / Moment at the slewing ring without dynamic effects	-3317 kNm	-2446379 ft lbf

Schwerpunkt Grundgerät, Ausleger und Spitze *

Center of gravity of basic machine, boom and jib *

Schwerpunkte / Center of gravity		Gewicht / weight [1000 lbs]	X [ft]	Z [ft]	Bemerkung / Remarks
Grundgerät / Basic machine	G	586.18	-9.324	6.990	**Mit Ballast, 1 Hubseil, ohne Haken** / With ballast, 1 hoist rope, without hook
Ausleger / Boom	B	70.74	15.080	112.919	**Komplettes System incl. A-Bock** / Complete system incl. A-frame
Spitze * / Jib *	C	0.00	0.000	0.000	**Komplettes System incl. obere A-Böcke** / Complete system incl. upper A-frames
Schwerpunkt / Center of gravity		656.91	-6.697	18.397	**Kran Standard ohne Last und ohne Optionen** / Crane standard without load and without optional add on
		including load at boom head			
		706.91	-3.394	34.623	**(Weight of options up to 7 t are not considered)**

Geometrie mit Spitze *
System with boom and jib *



*) Spitze fix oder wippbar
*) Fixed or luffing jib

Calculation of ground pressure LR 1300

Crawlers on compact ground

Load:	**22.7 t**	Radius:	**12.2 m**	Boom:	**74.0 m**	Fixed jib: **0.0 m**
		Counter weight at the -		Upper carriage:	**124.0 t**	Carbody: **57.0 t**

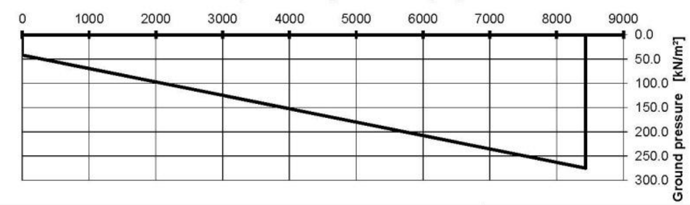
Forces at the slewing ring:			Dimensions of the undercarriage:			
Moment	3316.8	[kNm]	Width of track shoes	b	1200.0	[mm]
Ver.Load	2104.5	[kN]	Length of crawlers	l	8435.0	[mm]
Center of gravity	1034.4	[mm]	Track width	s	6800.0	[mm]
Weight of undercarriage	1102.0	[kN]	Tipping line	kk	7100.0	[mm]

Load over front:
p max 274.9 kN/m² = 2.800 kg/cm² distribution of pressure in shape of trapezium

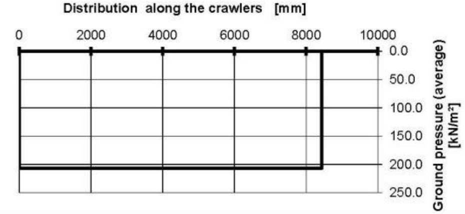
Load over side:
p average 206.6 kN/m² = 2.100 kg/cm² distribution of pressure in shape of trapezium

Maximum ground pressure at an angle of: **35.0°** (0° = longitudinal to the crawlers)
p max 306.9 kN/m² = 3.100 kg/cm² distribution of pressure in shape of trapezium

Load longitudinal to the crawlers



Load over the side

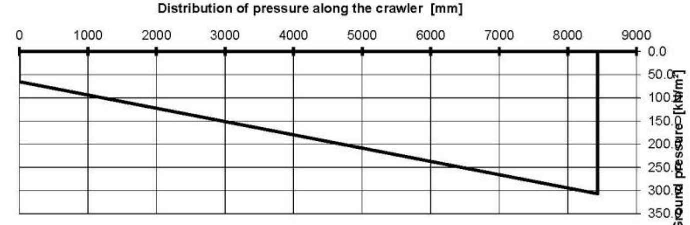


Load over the side

Ground pressure under front track
206.6 kN/m²
29.38 psi

Ground pressure under rear track
110.2 kN/m²
15.67 psi

Load over the edge



Mobile Crane Lift Planning in Construction Environments

Manufacturer Hydraulic/Truck Crane Outrigger Loads

- **Manitowoc/Grove**
  http://compucrane.manitowoc.com/
- **Liebherr**
  LICCON (Lliebherr Computer CONtrolling) program that needs a USB Key to operate, software comes with crane.
- **Tadano**
  https://www.tadano.co.jp/service/data/tdnsys/jackale/register.asp
- **Terex/Demag**
  http://www.cranimax.com
  Program that needs a USB Key to operate, third party provider.
- **Krupp**
  Outrigger load tables provided by manufacture.
- **Link-Belt**
  http://www.linkbelt.com/gbpl/gbnav.asp

Mobile Crane Lift Planning in Construction Environments

Manufacturer Crawler Crane Loads

- **Manitowoc**
  http://www.manitowoccranes.com/en/Resources/tools
- **Liebherr**
  LICCON for the LR 1400. Excel spread sheets for the later models
- **Demag/Terex**
  http://www.cranimax.com
  Program that needs a USB Key to operate, third party provider
- **Link-Belt**
  http://www.linkbelt.com/gbpl/gbnav.asp
- **Kobelco**
  https://www.kobelco-kenki.com/en_cris/top/home.htm
- **Mantis**
  Some success calling a dealer for crawler loads

Supporting the LHE

- Crane must be level
- Surface protection
- Allowable ground bearing pressure
  - Loading diagrams, project requirements
- Cribbing/Dunnage design – timber, steel plate or steel beam
- Structural analysis (i.e. bridge deck)

Siefert Associates LLC
180 Church Street
Naugatuck, CT 06770
203.723.1477

Steel Plate Outrigger Dunnage Calculation

Job No.: XXX.X
Sheet No_______Of_______
MADE BY AAB DATE 11/21/2012
CK'D BY______DATE______

Liebheer LTM-1400 Hydraulic Crane

Inputs

Maximum Outrigger Reaction: $P := 151kip$

Maximum Allowable Soil Bearing Pressure: $F_{max} := 3.5ksf$

Outrigger Length (Parallel to Length of Plate): $L_O := 2ft + 8in$

Outrigger Width (Parallel to Width of Plate): $W_O := 2ft + 8in$

Actual Steel Plate Length: $L_P := 7ft$

Actual Steel Plate Width Length: $W_P := 7ft$

Actual Steel Plate Thickness: $T_P := 2in$

Properties

Minimum Yield Stress: $F_Y := 36ksi$

Maximum Allowable Bending Stress: $F_B := 0.75 \cdot F_Y = 27 \cdot ksi$

Maximum Allowable Shear Stress: $F_V := 0.4 \cdot F_Y = 14.4 \cdot ksi$

Modulus of Elasticity: $E := 29000ksi$

Calculations

Minimum Bearing Area on Surface: $A_{min} := \frac{P}{F_{max}} = 43.143 ft^2$

Actual Bearing Area: $A := L_P \cdot W_P = 49 ft^2$

Actual Section Modulus of Plate: $S_x := \frac{\left(W_P \cdot T_P^2\right)}{6} = 56 \cdot in^3$

Cross Sectional Area of Plate: $A_C := W_P \cdot T_P = 168 \cdot in^2$

Moment of Inertia: $I := W_P \cdot \left(\frac{T_P^3}{12}\right) = 56 \cdot in^4$

Moment Arm: $M_{arm} := \frac{\left(L_P - L_O\right)}{2} = 2.167 ft$

Uniform Load Under Plate: $q := \frac{P}{L_P} = 21.571 \cdot \frac{k}{ft}$

Steel Plate Bending Moment: $M := \frac{\left(q \cdot M_{arm}^2\right)}{2} = 50.63 \cdot kip \cdot ft$

Minimum Section Modulus: $S_{xmin} := \frac{(M)}{F_B} = 22.504 \cdot in^3$

Minimum Plate Thickness: $T_{min} := \sqrt{\frac{\left(S_{xmin} \cdot 6\right)}{min\left(W_P, L_P\right)}} = 1.268 \cdot in$

Actual Bearing Pressure on Surface: $F_{actual} := \frac{P}{A} = 3.08 \cdot ksf$

$check_{bearing\_pressure} := if\left(F_{max} > F_{actual}, \text{"OK"}, \text{"Revise"}\right) = \text{"OK"}$

Actual Bending Stress on Plate: $F_{B\_actual} := \frac{M}{S_x} = 10.8 \cdot ksi$

$check_{bending\_stress} := if\left(F_B > F_{B\_actual}, \text{"OK"}, \text{"Revise"}\right) = \text{"OK"}$

Actual Shear Stress on Plate: $F_{V\_actual} := 1.5 \cdot q \cdot \frac{\left(M_{arm}\right)}{A_C} = 0.42 \cdot ksi$

$check_{shear\_stress} := if\left(F_V > F_{V\_actual}, \text{"OK"}, \text{"Revise"}\right) = \text{"OK"}$

Maximum Deflection: $d := \left(q M_{arm}\right) \left[\frac{\left(M_{arm}\right)^3}{8 \cdot E \cdot I}\right] = 0.063 \cdot in$

Minimum Steel Plate Outrigger Dunnage Centered Under all Outriggers - Use:

Minimum Width of Plate: $L_P = 7 ft$

Minimum Length of Plate: $W_P = 7 ft$

Minimum Thickness of Plate: $T_P = 2 \cdot in$

MathCAD Dunnage Calc Steel

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Siefert Associates, LLC
180 Church Street Naugatuck, CT 06457
Tel. (203) 723-5830 Fax. (203) 723-9346

Job Number: 259
Date: 11/26/2012
By: KON

Check
Date: _______
By: _______

LIEBHERR LR-1300 CRAWLER CRANE
MIXED HARDWOOD CRANE MAT DUNNAGE CALCULATION

INPUT		
Maximum Crawler Reaction	Pmax	7.373 kips/ft²
Minimum Crawler Reaction	Pmin	1.044 kips/ft²
Maximum Allowable Bearing Pressure	Fmax	5.15 kips/ft²
Actual Timber Length	L	30.0 ft
Actual Timber Width	W	12.0 in
Actual Timber Depth	D	12.0 in
Width of Centerline of Crawlers	w	22.32 ft
Effective Tread Bearing Length	DL	27.67 ft
Tread Bearing Width	DW	3.93 ft
Design Value Bending (Beam and Stringers No. 2)	B	0.625 ksi
Design Value Shear (Beam and Stringers No. 2)	V	0.155 ksi
Load Duration Adjustment Factor (Ten Miniute Load)	CD	1.60
PROPERTIES		
Maximum Allowable Bending Stress Fb = B x CD = 0.625 x 1.60 = 1.00 ksi	Fb	1.00 ksi
Maximum Allowable Shear Stress Fv = V x CD = 0.155 x 1.60 = 0.248 ksi	Fv	0.248 ksi
CALCULATIONS		
Rate of Pressure Under Tread: Pr = ((Pmax-Pmin)/DL)x1ft = ((7.37 - 1.04) / 27.67) x 1 = 0.23 kips / ft^2	Pr	0.23 kip/ft²
Minimum Pressure on One 4 ft Pontoon: Q(min) = Pmax-(4*Pr) = 7.4 - 0.92 = 6.46 ft^2	Q(min)	6.46 kips/ft²
Total Load on One 4 ft Pontoon: Qp = DW x 4ft x (Pmax+Q(min))/2 = 3.9 X 4ft X (7.37 + 6.46)/2 = 108.8 kips	Qp	108.8 kips
Minimum Required Surface Bearing Area: A(min) = Qp / Fmax = 108.8 / 5.15 = 21.1 ft^2	A(min)	21.1 ft²
Effective Bearing Length Under 4ft Pontoon: C = L - w = 30.0 - 22.3 = 7.68 ft *(<= 22.32 ft Length OK)*	C	7.68 ft
Moment Arm: Arm = (C -DW) / 2 = (7.68 - 3.93) / 2 = 1.87 ft	Arm	1.87 ft
Maximum Load on an Individual Timber: P = Qp / 4 = 108.8 / 4 = 27.2 kips	P	27.2 kips
Actual Section Modulus of Wood: Sx = (W x D^2)/6 = (12.00 x 12.00^2) / 6 = 288.0 in^3	Sx	288.0 in³
Actual Bearing Pressure on Surface: F = P /(C x W) = 27.20 / (7.68 x (12/12)) = 3.54 k/ft^2 *(<= 5.15 ksf OK)*	F	3.54 kips/ft²
Pontoon Bending Moment: M = (F x Arm^2) / 2 = (3.54 x 1.87^2) / 2 = 6.21k-ft	M	6.21 kip-ft
Actual Bending Stress in Timbers: fb = M / Sx = 6.21 /288.00 = 0.259 ksi *(<= 1.00 ksi OK)*	fb	0.259 ksi
Actual Shear Stress in Timbers: fv = 1.5 x F x (Arm) / D = 1.5 x (3.54/144) x ((1.87 x 12) / 12 = 0.069 ksi *(<= 0.248 ksi OK)*	fv	0.069 ksi
RESULTS		
MIXED HARDWOOD CRAWLER DUNNAGE **ONE (1) LAYER OF 12" x 4'-0" x 30' TIMBER CRANE MATS MINIMUM CENTERED UNDER CRANE**		

Note: Mixed Hardwood is one or more of the following - Beech-Birch-Hickory, Mixed Oak or Mixed Maple. The Design Value Bending and Shear is the minimum combination.

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Naugatuck, CT 06770
203.723.1477

Steel Plate Outrigger Dunnage Calculation

Job No.: XXX.X
Sheet No______Of______
MADE BY AAB DATE 11/26/2012
CK'D BY______DATE______

Grove GMK-5210Hydraulic Crane - Top Dunnage Layer - Steel Plate

Inputs

Maximum Outrigger Reaction: $P := 151kip$

Maximum Allowable Soil Bearing Pressure: $F_{max\_P} := 11ksf$

Outrigger Length (Parallel to Length of Plate): $L_{O\_P} := 1ft + 11.6in$

Outrigger Width (Parallel to Width of Plate): $W_{O\_P} := 1ft + 11.6in$

Actual Steel Plate Length: $L_P := 3ft + 9in$

Actual Steel Plate Width Length: $W_P := 3ft + 9in$

Actual Steel Plate Thickness: $T_P := 1in$

Properties

Minimum Yield Stress: $F_Y := 36ksi$

Maximum Allowable Bending Stress: $F_{BP} := 0.75 \cdot F_Y = 27 \cdot ksi$

Maximum Allowable Shear Stress: $F_{VP} := 0.4 \cdot F_Y = 14.4 \cdot ksi$

Modulus of Elasticity: $E := 29000ksi$

Calculations

Minimum Bearing Area on Surface: $A_{min} := \frac{P}{F_{max\_P}} = 13.7ft^2$

Actual Bearing Area: $A_S := L_P \cdot W_P = 14.1ft^2$

Actual Section Modulus of Plate: $S_{x\_P} := \frac{\left(W_P \cdot T_P^2\right)}{6} = 7.5 \cdot in^3$

Cross Sectional Area of Plate: $A_{C\_P} := W_P \cdot T_P = 45 \cdot in^2$

Moment of Inertia: $I_P := W_P \cdot \left(\frac{T_P^3}{12}\right) = 3.8 \cdot in^4$

Moment Arm: $M_{arm\_P} := \frac{\left(L_P - L_{O\_P}\right)}{2} = 0.9ft$

Uniform Load Under Plate: $q_P := \frac{P}{L_P} = 40.267 \cdot \frac{k}{ft}$

Steel Plate Bending Moment: $M_P := \frac{\left(q_P \cdot M_{arm\_P}^2\right)}{2} = 16 \cdot kip \cdot ft$

Minimum Section Modulus: $S_{xmin\_P} := \frac{\left(M_P\right)}{F_{BP}} = 7.1 \cdot in^3$

Minimum Plate Thickness: $T_{min\_P} := \sqrt{\frac{\left(S_{xmin\_P} \cdot 6\right)}{min\left(W_P, L_P\right)}} = 1 \cdot in$

Actual Bearing Pressure on Surface: $F_{actual\_P} := \frac{P}{A_S} = 10.7 \cdot ksf$

$check_{bearing\_pressure\_P} := if\left(F_{max\_P} > F_{actual\_P}, "OK", "Revise"\right) = "OK"$

Actual Bending Stress on Plate: $F_{B\_actual\_P} := \frac{M_P}{S_{x\_P}} = 25.6 \cdot ksi$

$check_{bending\_stress\_P} := if\left(F_{BP} > F_{B\_actual\_P}, "OK", "Revise"\right) = "OK"$

Actual Shear Stress on Plate: $F_{V\_actual\_P} := 1.5 \cdot q_P \cdot \frac{\left(M_{arm\_P}\right)}{A_{C\_P}} = 1.2 \cdot ksi$

$check_{shear\_stress\_P} := if\left(F_{VP} > F_{V\_actual\_P}, "OK", "Revise"\right) = "OK"$

Maximum Deflection: $d := \left(q_P M_{arm\_P}\right) \left[\frac{\left(M_{arm\_P}\right)^3}{8 \cdot E \cdot I_P}\right] = 0.051 \cdot in$

Minimum Steel Plate Outrigger Dunnage Centered Under all Outriggers - Use:

Minimum Width of Plate: $L_P = 3.75ft$

Minimum Length of Plate: $W_P = 3.75ft$

Minimum Thickness of Plate: $T_P = 1 \cdot in$

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Naugatuck, CT 06770
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Steel Plate Outrigger Dunnage Calculation

Job No.: XXX.X
Sheet No______Of______
MADE BY AAB DATE 11/26/2012
CK'D BY______DATE______

Grove GMK-5210Hydraulic Crane - Bottom Dunnage Layer - Timber

Inputs

Maximum Outrigger Reaction: $P = 151 \cdot kip$

Maximum Allowable Soil Bearing Pressure: $F_{max\_T} := 4ksf$

Outrigger Length (Parallel to Length of Timber): $L_{O\_T} := L_P = 3.75ft$

Outrigger Width (Parallel to Width of Timber): $W_{O\_T} := W_P = 3.75ft$

Try Timber Length: $L_T := 11ft$

Timber Type: $Type_T = "Mixed Hardwood"$

Nominal Timber Size: $Size_T = "12" x 12""$

Dressed Width of Timber: $W_{D\_T} := 12in$

Number of Timbers: $Num_T := ceil\left(\frac{W_{O\_T}}{W_{D\_T}}\right) = 4$

Actual Timber Width: $W_T := Num_T \cdot W_{D\_T} = 4ft$

Actual Timber Thickness: $T_T := W_{D\_T} = 12 \cdot in$

Constants

(American Wood Council NDS)

Bending Design Value: (No. 2) $B_T = 0.6 \cdot ksi$

Shear Design Value: (No. 2) $V_T = 0.2 \cdot ksi$

Repetitive Member Adjustment Factor: (2"-4" Thick Only) $C_{RT} = 1$

Load Duration Adjustment Factor: (Ten Minute Load) $C_{DT} := 1.6$

Properties

Max Allowable Bending Stress: $F_{BT} := B_T \cdot C_{RT} \cdot C_{DT} = 1 \cdot ksi$

Max Allowable Shear Stress: $F_{VT} := V_T \cdot C_{RT} \cdot C_{DT} = 0.2 \cdot ksi$

Calculations

Minimum Bearing Area on Surface: $A_{min\_T} := \frac{P}{F_{max\_T}} = 37.8ft^2$

Actual Bearing Area: $A_T := L_T \cdot W_T = 44ft^2$

Actual Section Modulus of Wood: $S_{x\_T} := \frac{\left(W_T \cdot T_T^2\right)}{6} = 1152 \cdot in^3$

Cross Sectional Area of Wood: $A_{C\_T} := W_T \cdot T_T = 576 \cdot in^2$

Moment of Inertia: $I_T := W_T \cdot \left(\frac{T_T^3}{12}\right) = 6912 \cdot in^4$

Moment Arm: $M_{arm\_T} := \frac{\left(L_T - L_{O\_T}\right)}{2} = 3.6ft$

Uniform Load Under Wood: $q_T := \frac{P}{L_T} = 13.727 \cdot \frac{k}{ft}$

Timber Bending Moment: $M_T := \frac{\left(q_T \cdot M_{arm\_T}^2\right)}{2} = 90.2 \cdot kip \cdot ft$

Minimum Section Modulus: $S_{xmin\_T} := \frac{\left(M_T\right)}{F_{BT}} = 1082.3 \cdot in^3$

Minimum Timber Thickness: $T_{min\_T} := \sqrt{\frac{\left(S_{xmin\_T} \cdot 6\right)}{min\left(W_T, L_T\right)}} = 11.6 \cdot in$

Actual Bearing Pressure on Surface: $F_{act\_T} := \frac{P}{A_T} = 3.43 \cdot ksf$

$check_{bearing\_pressure\_T} := if\left(F_{max\_T} > F_{act\_T}, "OK", "Revise"\right) = "OK"$

Actual Bending Stress in Timbers: $F_{B\_act\_T} := \frac{M_T}{S_{x\_T}} = 0.94 \cdot ksi$

$check_{bending\_stress\_T} := if\left(F_{BT} > F_{B\_act\_T}, "OK", "Revise"\right) = "OK"$

Actual Shear Stress in Timbers: $F_{V\_act\_T} := 1.5 \cdot q_T \cdot \frac{\left(M_{arm\_T} - T_T\right)}{A_{C\_T}} = 0.09 \cdot ksi$

$check_{shear\_stress\_T} := if\left(F_{VT} > F_{V\_act\_T}, "OK", "Revise"\right) = "OK"$

Minimum Top Layer Timber Outrigger Dunnage Centered Under all Outriggers - Use:

Number of Timbers: $Num_T = 4$

Size of Timbers: $Size_T = "12" x 12""$

Minimum Length of Timbers: $L_T = 11ft$

Rigging Design

- Sling & rigging hardware capacities (charts)
- Inspected and/or tested
- Determining load in such components
- BTH-1 (lift lugs, spreader bars)
- Rigging protection

Mobile Crane Lift Planning in Construction Environments

Lifted/Braced Load Analysis

- Rigging attachment points
  - Lift lugs, precast inserts, trunnions
- Stability during lift
  - Steel girder buckling
  - Precast cracking
  - Tilting operations
- Temporary bracing and stability after release form crane

Multiple LHE Lifts

- More complex
- Location of cranes at the beginning of lift
- Movement of cranes during lift
- Distribution of load between the cranes
  - Change of load distribution during lift
- Clearances between the load, fixed obstructions and the cranes themselves
- Communication during lift
- Reduced allowable loads +/- 75%

Decision Tree ASME P-30

- Review the list of Considerations
  - Hazards to Persons or Work Area
  - Impact - Commercial or Environmental
  - Complexity of Lift , Repetitive, Capacities
  - Site Requirements
- Standard Lift – verbal or brief written document
- Critical Lift – fully written plan (engineered drawings and calculations)

Mobile Crane Lift Planning in Construction Environments

LIFT DATA SHEET (Single Crane)

Clear Form

Project:		**Originator:**		**Date**	
Job No.:		**Checker:**		**Date**	
Lift Company		**Preparing Co.:**			
Sheet No.		**Revision:**		**Date**	
Units of Measure:	U.S. (Ft - Lbs)	**Length:** ft		**Weight:** lbs	
Pay Load Name		**Lift Description**			

Load details	Quantity	Wt./each	Weight	
			0.0	lbs
			0.0	lbs
			0.0	lbs
			0.0	lbs
Net load (actual weight of item to be lifted)			**0.0**	lbs

Manbasket lift (y/n) NO **(NB: 50% crane chart reduction applied when using manbasket)**

Rigging Bill of Material's	Quantity	Wt./each	Weight	
			0.0	lbs
			0.0	lbs
			0.0	lbs
			0.0	lbs
			0.0	lbs
			0.0	lbs
			0.0	lbs
			0.0	lbs

Crane Details	**Manufacturer**		**Model No.**		
Boom Type:		Block Capacity:		Jib Type:	
Boom Length Used		Line size:		Jib Length Used:	
CWT's - Main:		Parts of line actual		Jib Offset Used:	Degrees

Gross Capacity Deductions		
Main Load Block		lbs
Wire Rope		lbs
Jib Block		lbs
Aux Boom Sheaves		lbs
Stowed jib		lbs
Other (specify):		lbs
Gross Capacity Deductions:	**0.0**	lbs

Net crane capacities	**Radius 1**		**Radius 2**		**Radius 3**	
Actual Radius:		ft		ft		ft
Chart Radius:		ft		ft		ft
Chart Capacity:		lbs		lbs		lbs
Capacity if manbasket used:	N/A	lbs		lbs		lbs
Total Capacity Deductions (from above):		lbs		lbs		lbs
Net Capacity at hook:		lbs		lbs		lbs
Gross load to hook (load & rigging)		lbs		lbs		lbs
Max % of capacity used	0.0%					

Ground Bearing Pressure: Actual | Allowable

Min clearance boom to obstruction: **3 ft** **Min clearance boom to load or spreader:**

Notes

Attach sketch showing plan and elevation. Attach relevant crane chart extract

APPROVALS: Signature | Title | Date

Yellow (shaded cells) are input cells, remainder are calculated

Z:\P-30\Lift Plan Forms\Crane Lift Plan.xls Page 1

16000 S-3

ANSI B30.5

Manitowoc

58 HL

332,000 lb + 120,000 lb

157.5 ft

ft	°	ft	lb
28	83.0	164.6	597,000 *
30	82.3	164.3	592,900 *
32	81.5	164.0	579,600 *
34	80.8	163.6	541,100 *
36	80.0	163.2	507,100 *
38	79.3	162.8	476,900 *
40	78.6	162.4	449,700 *
45	76.7	161.1	388,000 *
50	74.8	159.7	339,900 *
55	72.9	158.2	301,400 *
60	71.0	156.4	269,900 *
65	69.0	154.4	243,600 *
70	67.0	152.3	219,400
75	65.0	149.9	198,200
80	63.0	147.3	180,300
85	60.9	144.5	164,900
90	58.7	141.4	151,600
95	56.6	138.1	139,900
100	54.3	134.4	129,600
105	52.0	130.5	120,400
110	49.6	126.2	112,100
115	47.1	121.5	104,700
120	44.5	116.4	98,000
125	41.8	110.8	91,900
130	38.9	104.6	86,300
135	35.8	97.7	81,100
140	32.4	89.9	76,400
145	28.7	81.0	71,900
150	24.4	70.3	67,800
155	19.2	56.9	64,000

177.2 ft

ft	°	ft	lb
32	82.5	183.9	483,000 *
34	81.8	183.6	467,100 *
36	81.2	183.2	451,800 *
38	80.5	182.9	437,300 *
40	79.9	182.5	423,300 *
45	78.2	181.4	384,700 *
50	76.5	180.2	336,900 *
55	74.9	178.8	298,700 *
60	73.2	177.2	267,300 *
65	71.5	175.5	241,200 *
70	69.7	173.6	219,000 *
75	68.0	171.6	197,900
80	66.2	169.3	180,000
85	64.4	166.9	164,600
90	62.6	164.3	151,200
95	60.7	161.4	139,500
100	58.8	158.4	129,200
105	56.9	155.1	120,000
110	54.9	151.5	111,700
115	52.9	147.7	104,300
120	50.8	143.6	97,600
125	48.6	139.2	91,500
130	46.4	134.4	85,900
135	44.1	129.2	80,800
140	41.6	123.6	76,000
145	39.1	117.4	71,700
150	36.3	110.6	67,600
155	33.4	103.1	63,800
160	30.2	94.7	60,300
165	26.7	84.9	57,000
170	22.6	73.4	53,400 *
175	17.6	58.8	49,500 *

196.9 ft

ft	°	ft	lb
34	82.6	203.5	435,600 *
36	82.1	203.2	422,500 *
38	81.5	202.9	409,700 *
40	80.9	202.5	397,400 *
45	79.4	201.6	367,100 *
50	77.9	200.4	333,400 *
55	76.4	199.2	295,300 *
60	74.9	197.8	264,100 *
65	73.4	196.3	238,000 *
70	71.8	194.6	216,000 *
75	70.3	192.8	197,000
80	68.7	190.8	179,000
85	67.1	188.7	163,600
90	65.5	186.4	150,200
95	63.9	183.9	138,400
100	62.3	181.2	128,100
105	60.6	178.4	118,900
110	58.9	175.3	110,600
115	57.2	172.1	103,200
120	55.4	168.6	96,500
125	53.6	164.9	90,300
130	51.7	160.9	84,700
135	49.8	156.6	79,600
140	47.8	152.1	74,900
145	45.8	147.2	70,500
150	43.7	142.0	66,500
155	41.5	136.3	62,700
160	39.2	130.2	59,200
165	36.8	123.5	55,900
170	34.2	116.2	52,700 *
175	31.4	108.1	49,300 *
180	28.4	99.0	46,100 *
185	25.0	88.6	42,900 *
190	21.1	76.2	39,800 *
195	16.3	60.4	36,700 *

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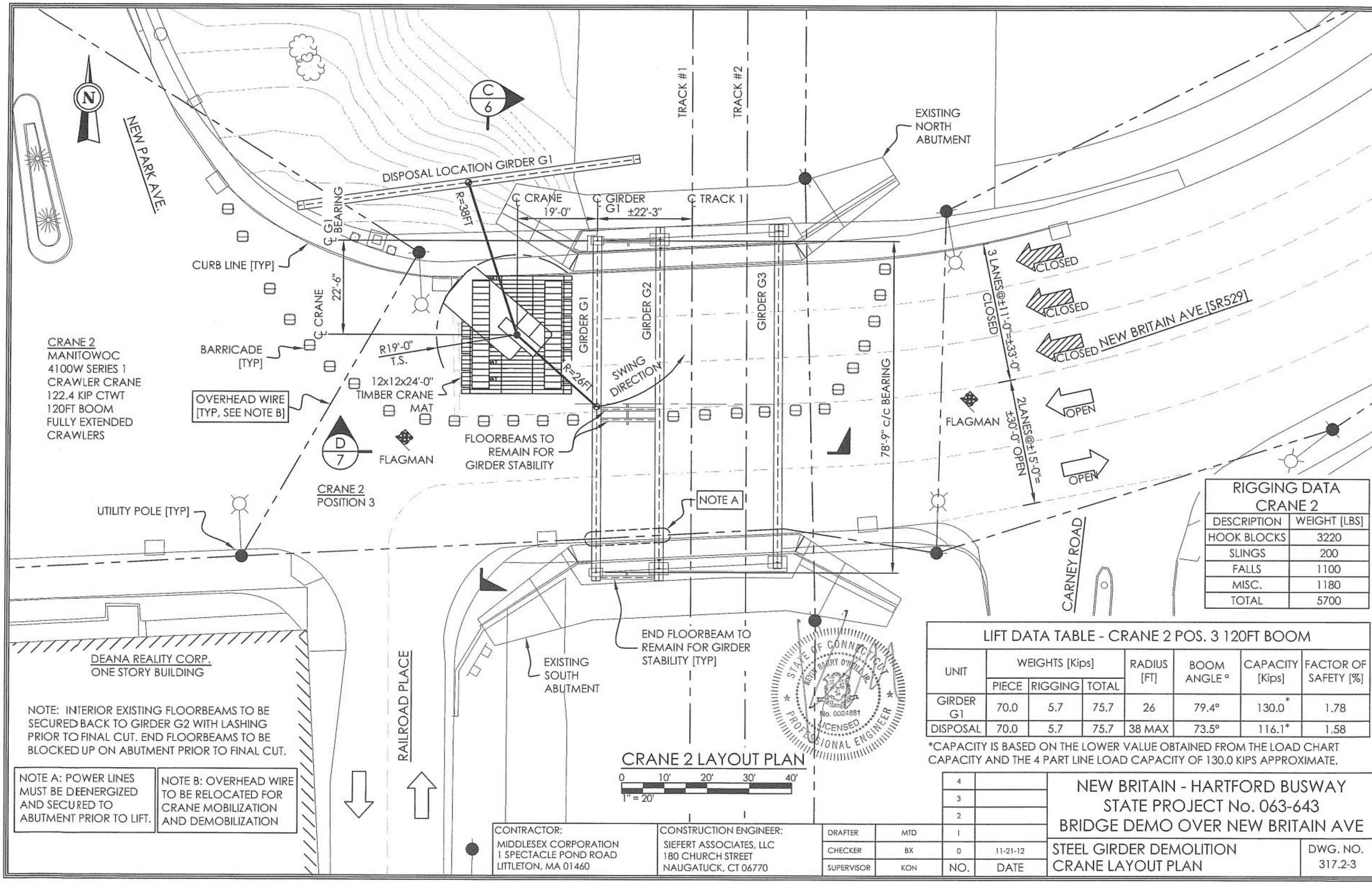
Manitowoc Cranes, Inc.
Manitowoc, Wisconsin 54220 U.S.A.

Mobile Crane Lift Planning in Construction Environments



RIGGING DATA CRANE 2

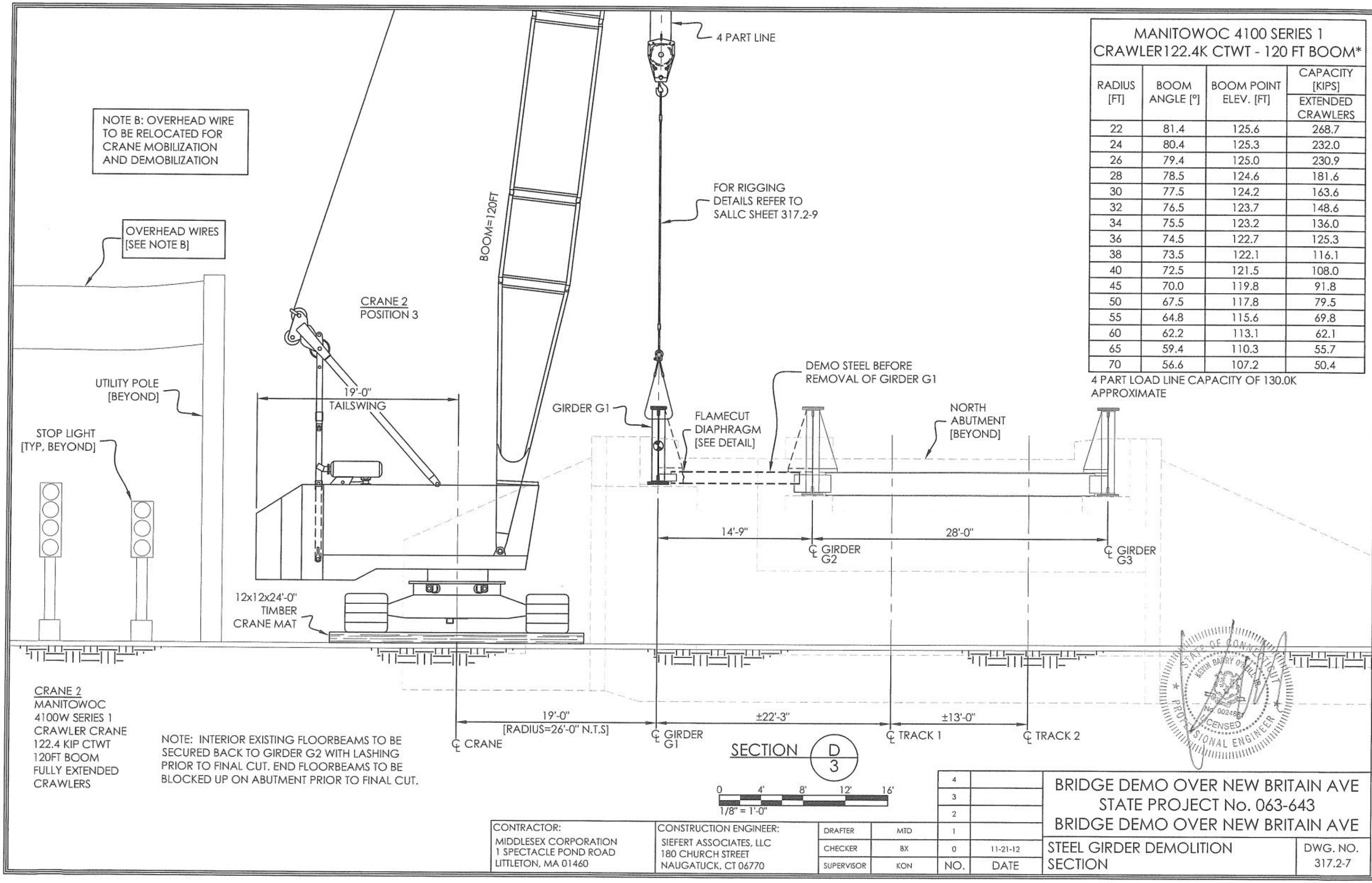
DESCRIPTION	WEIGHT [LBS]
HOOK BLOCKS	3220
SLINGS	200
FALLS	1100
MISC.	1180
TOTAL	5700

LIFT DATA TABLE - CRANE 2 POS. 3 120FT BOOM

UNIT	WEIGHTS [Kips]			RADIUS [FT]	BOOM ANGLE °	CAPACITY [Kips]	FACTOR OF SAFETY [%]
	PIECE	RIGGING	TOTAL				
GIRDER G1	70.0	5.7	75.7	26	79.4°	130.0*	1.78
DISPOSAL	70.0	5.7	75.7	38 MAX	73.5°	116.1*	1.58

*CAPACITY IS BASED ON THE LOWER VALUE OBTAINED FROM THE LOAD CHART CAPACITY AND THE 4 PART LINE LOAD CAPACITY OF 130.0 KIPS APPROXIMATE.

Mobile Crane Lift Planning in Construction Environments

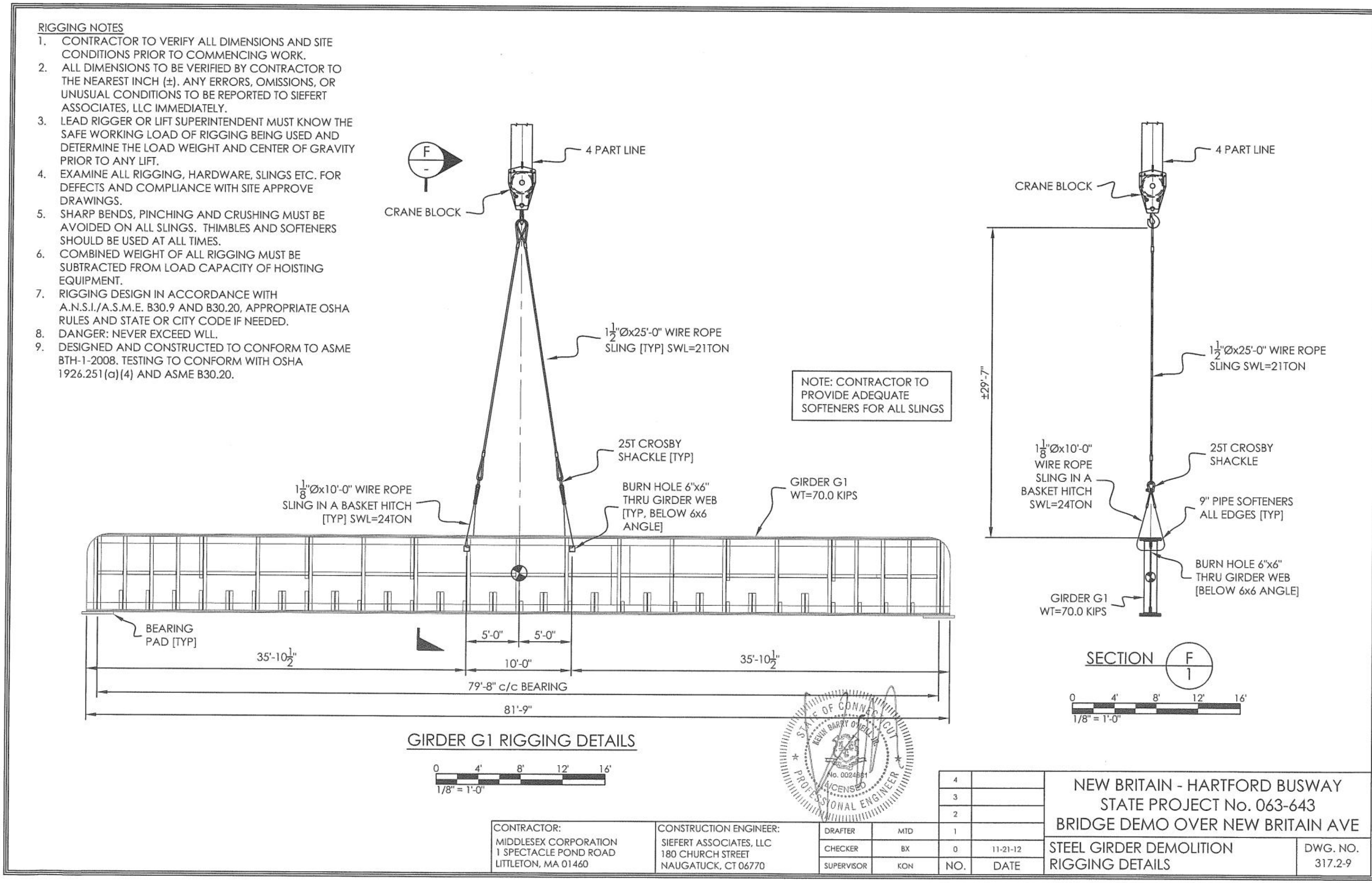


MANITOWOC 4100 SERIES 1
CRAWLER122.4K CTWT - 120 FT BOOM*

RADIUS [FT]	BOOM ANGLE [°]	BOOM POINT ELEV. [FT]	CAPACITY [KIPS] EXTENDED CRAWLERS
22	81.4	125.6	268.7
24	80.4	125.3	232.0
26	79.4	125.0	230.9
28	78.5	124.6	181.6
30	77.5	124.2	163.6
32	76.5	123.7	148.6
34	75.5	123.2	136.0
36	74.5	122.7	125.3
38	73.5	122.1	116.1
40	72.5	121.5	108.0
45	70.0	119.8	91.8
50	67.5	117.8	79.5
55	64.8	115.6	69.8
60	62.2	113.1	62.1
65	59.4	110.3	55.7
70	56.6	107.2	50.4

4 PART LOAD LINE CAPACITY OF 130.0K APPROXIMATE

Mobile Crane Lift Planning in Construction Environments



Mobile Crane Lift Planning in Construction Environments

GENERAL NOTES

1. THESE DRAWINGS AND THE ACCOMPANYING CALCULATIONS WERE PREPARED TO REPRESENT THE FOLLOWING: DEMOLITION OF GIRDER G1 AND FLOORBEAMS.
2. CRANE 1 TO BE A GROVE RT 760 HYDRAULIC CRANE, WITH 13.9K CTWT. AND 55 FOOT BOOM, OPERATED ON FULLY EXTENDED OUTRIGGERS.
3. CRANE 2 TO BE A MANITOWOC 4100W SERIES 1 CRAWLER, WITH 122.4k CTWT. AND 120 FOOT BOOM, OPERATED ON FULLY EXTENDED TRACKS.
4. CRANES TO BE OPERATED PER MANUFACTURERS RECOMMENDATIONS, IN ACCORDANCE WITH ANSI/ASME B30.5 [LATEST REVISION] AND APPROPRIATE OSHA RULES.
5. THE CONTRACTOR IS RESPONSIBLE FOR THE ACTUAL OPERATION AND PROCEDURES. THESE PLANS ARE PROVIDED BASED ON THE BEST INFORMATION AVAILABLE AT THE TIME OF PREPARATION.
6. CONTRACTOR MAY ADJUST PICK/DISPOSAL LOCATION INDICATED AS LONG AS THE CRITICAL RADII AND CLEARANCES ARE MAINTAINED.
7. PICK AND RADII GIVEN IN LIFT DATA TABLE MUST NOT BE EXCEEDED. THE WEIGHT SHOWN IS THE MAXIMUM ALLOWABLE WEIGHT TO BE LIFTED AT THE CORRESPONDING RADIUS.
8. REDUCE CRANE LOAD RATINGS TO ACCOUNT FOR WIND ON LOAD. CONSULT OPERATOR'S MANUAL FOR REQUIREMENTS WHEN WIND EXCEEDS 20 M.P.H. DO NOT OPERATE IN WINDS OVER 30 M.P.H. IF WINDS EXCEED 50 M.P.H. LOWER BOOM TO GROUND UNLESS MANUFACTURER'S INSTRUCTIONS INDICATE OTHERWISE.
9. CRANE IS TO BE OPERATED ONLY BY A LICENSED OPERATOR.
10. ALL DIMENSIONS AND WEIGHTS TO BE VERIFIED PRIOR TO THE LIFTING OPERATION.
11. NO CRANE WILL BE OPERATED IN A MANNER THAT WILL EXCEED ITS RATED CAPACITY AT ANY RADIUS AS SPECIFIED BY THE MANUFACTURER.
12. ALL TRUCKS/CRANES SHALL BE LOCATED ON-SITE OR WITHIN BARRICADED AREA AND NO LIFTING SHALL BE DONE OVER PEDESTRIANS, VEHICLES AND ADJACENT BUILDINGS.
13. CRANE MAY OPERATE IN VARIOUS POSITIONS ON SITE PROVIDING THAT THE PICK-RADII LIMITATIONS SHOWN ON THE DRAWINGS ARE NOT EXCEEDED
14. THE TABLE OR CHART PREPARED BY THE CRANE MANUFACTURER TO DESCRIBE THE MAXIMUM LIFT AT ALL CONDITIONS OF LOADING SHALL BE POSTED IN EACH CRANE CAB IN CLEAR VIEW OF THE OPERATOR.
15. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE WEIGHT OF EACH LIFT AND FOR INSURING THE STABILITY OF EACH UNIT DURING ALL PHASES OF ERECTION, INCLUDING LIFTING AND RELEASE OF THE UNIT.
16. THE DESIGN GIRDER WEIGHT REPRESENTS THE MAXIMUM WEIGHT THAT CAN BE ERECTED BY THE SPECIFIED CRANE WHILE MEETING THE GEOMETRY CRITERIA STATED IN THESE DRAWINGS.
17. ALLOWABLE GROUND BEARING PRESSURE TO BE 3.5 KSF MINIMUM ON ASPHALT.
18. FLAGMAN SHALL STOP PEDESTRIANS AND VEHICLES WHEN LIFTING OVERHEAD [AS APPLICABLE].
19. MAXIMUM FLOORBEAM PICK WEIGHT TO BE 10.0 KIPS FOR CRANE 1.
20. MAXIMUM GIRDER WEIGHT TO BE 70.0 KIPS FOR CRANE 2.
21. CRANE 1 & 2 IS CONFIGURED WITH 1.5 SAFETY FACTOR FOR PICKING CAPACITY.

MATERIAL NOTES

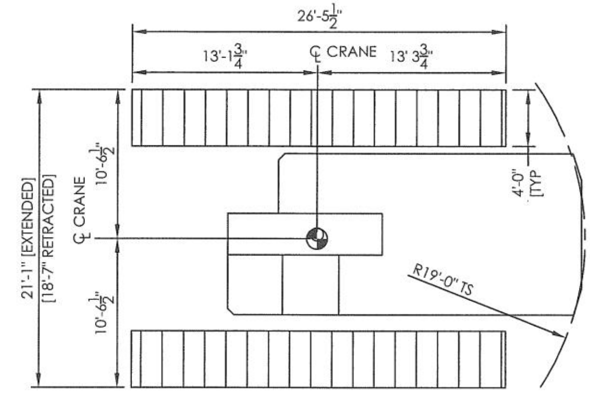
1. ALL STEEL PLATES TO BE GRADE A36 OR BETTER.
2. ALL WIRE ROPE SLINGS TO BE XIPS [EXTRA IMPROVED PLOW STEEL] IWRC 6X19 OR 6X37 WITH MECHANICALLY SPLICED ENDS.
3. ALL SHACKLES TO BE CROSBY OR EQUAL.
4. TIMBER TO BE MIXED HARDWOOD No. 2 [BEECH-BIRCH-HICKORY, MIXED OAK OR MIXED MAPLE] OR BETTER.
5. CRANE MATS TO BE TIMBER BLOCKING, 12" THICK, MIXED HARDWOOD NO. 2 [BEECH-BIRCH-HICKORY, MIXED OAK OR MIXED MAPLE] OR BETTER.

GIRDER DEMOLITION PROCEDURE:

1. PRIOR TO CRANE MOBILIZATION DEENERGIZE POWERLINES UNDER BRIDGE AND SECURE TO ABUTMENT.
2. SECURE INTERIOR EXISTING FLOORBEAMS BACK TO GIRDER G2 WITH LASHING PRIOR TO FINAL CUT. END FLOORBEAMS TO BE BLOCKED UP ON ABUTMENT PRIOR TO FINAL CUT.
3. MOBILIZE CRANE 2 INTO POSITION 3.
4. CONNECT RIGGING FROM CRANE 2 GIRDER G1.
5. CUT EXISTING FLOORBEAM BRACING AT MID SPAN.
6. CUT EXISTING FLOORBEAM BRACING AT THE NORTH, SOUTH ABUTMENT.
7. RAISE GIRDER ABOVE BEARING ELEVATION.
8. SWING GIRDER G1 TOWARDS EXISTING NORTH ABUTMENT.
9. LOWER GIRDER G1 TO DISPOSAL LOCATION.
10. TEMPORARILY SECURE THE GIRDER ON THE GROUND [BY CONTRACTOR'S MEANS AND METHODS].
11. DISCONNECT RIGGING.
12. SWING CRANE BACK AND CONNECT ADEQUATE RIGGING TO FLOORBEAM.
13. REMOVE LASHING FROM GIRDER 2 AND CUT FREE FROM GIRDER 2.
14. REPEAT STEPS 7-11.
15. REPEAT STEPS 12-14 FOR ALL REMAINING FLOORBEAMS.
16. DEMOBILIZE CRANE 2 AS NEEDED.

FLOORBEAM DEMOLITION PROCEDURE:

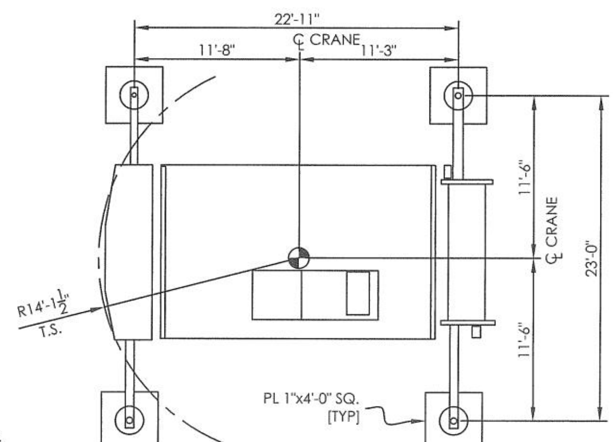
1. REMOVE CONCRETE BALLAST BY CONTRACTORS MEANS AND METHODS.
2. REMOVE SLOPED STEEL BALLAST PLATES, DIAGONAL ANGLES, TRIANGULAR STIFFENER PLATES FROM BOTH SIDES OF GIRDERS G1 AND G2 BY CONTRACTOR'S MEANS AND METHODS.
3. MOBILIZE CRANE 1 INTO POSITION 1.
4. BURN DEMO HOLES ON THE HORIZONTAL BALLAST PLATE.
5. CONNECT RIGGING ON THE HORIZONTAL BALLAST PLATE SUPPORTING THE FLOORBEAMS.
6. FLAME CUT THE HORIZONTAL BALLAST PLATE AND FLOORBEAM TO GIRDER CONNECTIONS AS SHOWN ON THESE DRAWINGS.
7. WITH THE FLOORBEAM ASSEMBLY ENTIRELY SUPPORTED ON CRANE HOOK, SWING TO DISPOSAL LOCATION AS SPECIFIED BY CONTRACTOR'S MEANS AND METHODS.
8. DISCONNECT RIGGING.
9. REPEAT STEPS 4-8 FOR THE REMAINING FLOORBEAM UNITS
10. MOBILIZE CRANE 1 INTO POSITION 2.
11. REPEAT STEPS 4-8 FOR THE REMAINING FLOORBEAM UNITS.
12. DEMOBILIZE CRANE 1 AS NEEDED.



PART PLAN - MANITOWOC 4100 SERIES 1 CRAWLER

0 4' 8' 12' 16'

1/8" = 1'-0"



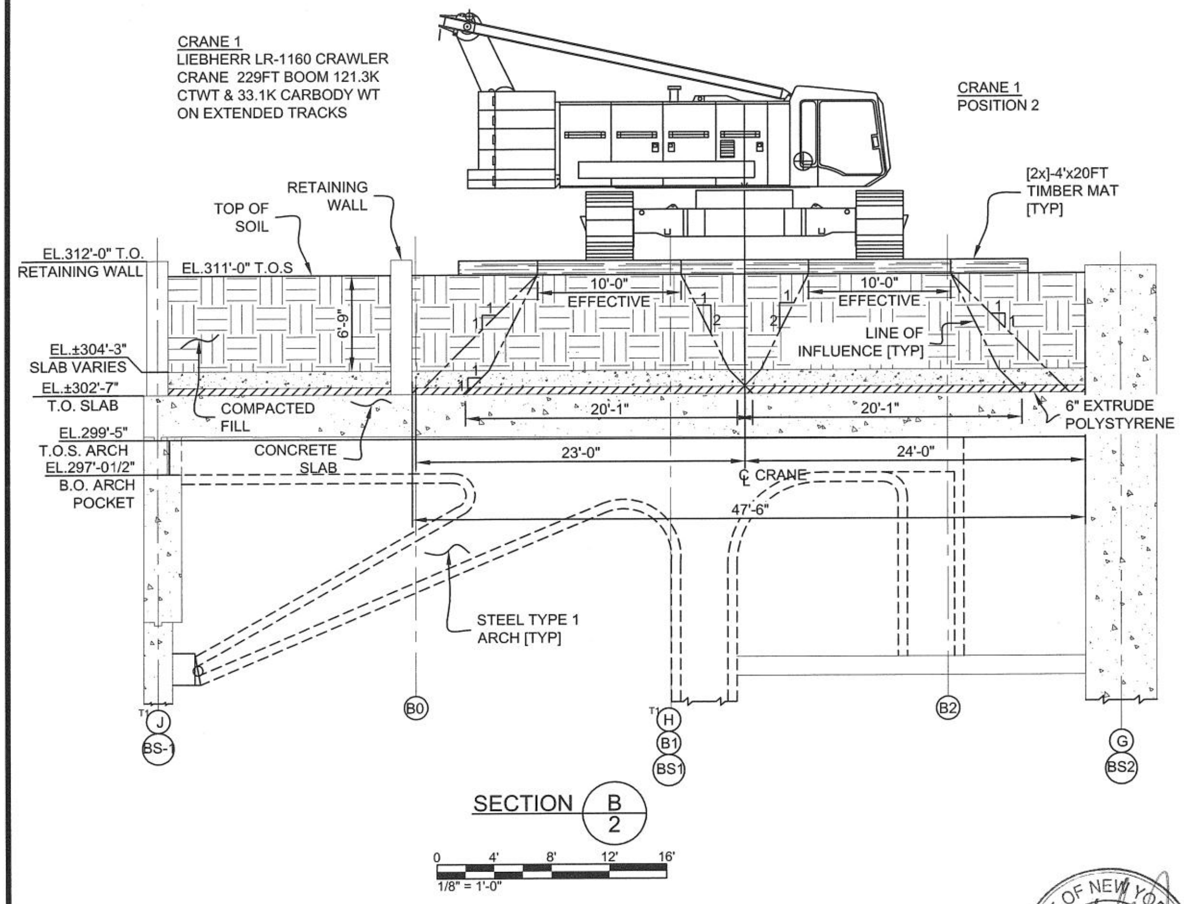
PART PLAN - GROVE RT 760 HYDRAULIC CRANE

0 4' 8' 12' 16'

1/8" = 1'-0"

				4		NEW BRITAIN - HARTFORD BUSWAY STATE PROJECT No. 063-643 BRIDGE DEMO OVER NEW BRITAIN AVE
				3		
				2		
CONTRACTOR:	CONSTRUCTION ENGINEER:	DRAFTER	MTD	1		
MIDDLESEX CORPORATION 1 SPECTACLE POND ROAD LITTLETON, MA 01460	SIEFERT ASSOCIATES, LLC 180 CHURCH STREET NAUGATUCK, CT 06770	CHECKER	BX	0	11-21-12	STEEL GIRDER DEMOLITION NOTES & PART PLAN — DWG. NO. 317.2-10
		SUPERVISOR	KON	NO.	DATE	

Mobile Crane Lift Planning in Construction Environments



GENERAL NOTES:

1. CRANE 1 TO BE A LIEBHERR LR-1160 WITH 229FT BOOM 121.3k CTWT AND 33.1k CARBODY WT ON EXTENDED TRACKS
2. CRANE TO BE OPERATED PER MANUFACTURERS RECOMMENDATIONS, IN ACCORDANCE WITH ANSI/ASME B30.5-LATEST REVISION, APPROPRIATE OSHA RULES, AND RS 19-2 OF THE NEW YORK CITY BUILDING CODE.
3. THE CONTRACTOR IS RESPONSIBLE FOR THE ACTUAL OPERATION AND PROCEDURES. THESE PLANS ARE PROVIDED BASED ON THE BEST INFORMATION AVAILABLE AT THE TIME OF PREPARATION. CONTRACTOR MAY ADJUST PICK/DISPOSAL LOCATION INDICATED AS LONG AS THE CRITICAL RADII AND CLEARANCES ARE MAINTAINED WITH.
4. MAXIMUM SUSTAINED WIND SPEED DURING ALL LIFTING OPERATIONS SHALL NOT EXCEED 30 MPH. REDUCE PICKING LOADS BY 10% WHEN WIND SPEED IS 25MPH OR GREATER.
5. CRANE IS NOT TO BE DELIVERED TO SITE BEFORE INSPECTION DATE AND IS TO BE OPERATED ONLY BY NEW YORK CITY LICENSED OPERATOR.
6. ALL DIMENSIONS AND WEIGHTS TO BE VERIFIED PRIOR TO THE LIFTING OPERATION.
7. NO CRANE WILL BE OPERATED IN A MANNER THAT WILL EXCEED ITS RATED CAPACITY AT ANY RADIUS AS SPECIFIED BY THE MANUFACTURER.
8. THIS INSTALLATION REQUIRES CONTROLLED INSPECTION OF THE CRANE SUPPORT AND PLACEMENT BY NEW YORK STATE LICENSED PROFESSIONAL ENGINEER OR REGISTERED ARCHITECT [FORMS 10E & 10F].
9. THIS APPROVAL IS FOR CRANE PLACEMENT ONLY WITH PERMISSION TO OPERATE AND LIFT LOADS SUBJECT TO WRITTEN APPROVAL BY ENGINEER OR ARCHITECT DESIGNATED FOR CONTROLLED INSPECTION AS EVIDENCED BY SIGNED AND SEALED FORM 10E. COPY OF SIGNED AND SEALED FORM 10E TO BE KEPT ON CRANE AT ALL TIMES.
10. APPROVAL OF THIS APPLICATION IS GRANTED CONTINGENT UPON THE APPLICANT FURNISHING A LETTER OF APPROVAL FROM THE DEPARTMENT OF TRANSPORTATION AND A PERMIT FROM THE BUREAU OF HIGHWAY OPERATIONS [IF REQUIRED].
11. APPROVAL OF THIS APPLICATION IS GRANTED CONTINGENT UPON THE APPLICANT FURNISHING A LETTER OF APPROVAL FROM THE PORT AUTHORITY OF NY AND NJ.
12. DURING TRAVEL 12"x12"x10FT CRANE MATS MUST BE CENTERED UNDER EACH CRAWLER AT ALL TIMES WHEN TRAVELING OVER POUR STRIP.
13. BOOM ANGLE RANGE DURING TRAVEL IS BETWEEN 61° AND 78° WITH BOOM OVER TOES ONLY AND NO LOAD.

MATERIAL NOTES:

1. ALL TIMBER TO BE MIXED HARDWOOD [BEECH-BIRCH-HICKORY, MIXED MAPLE OR MIXED OAK] NO.2. Fb = 1.00 k.s.i. ; Fv = .248 k.s.i. MINIMUM.
2. PLYWOOD TO BE APA STRUCTURAL 1 RATED SHEATHING EXT. $\frac{3}{4}$" THICKNESS.

ERECTION PROCEDURE

1. MOBILIZE CRANE INTO ON-SITE POSITION
2. TRANSPORT THE APPROPRIATE MATERIAL TO BUILDING SITE TO THE ASSEMBLY LOCATION
3. LOWER HOOK BLOCKS AND ATTACH RIGGING
4. RAISE HOOK BLOCKS TO LIFT MATERIAL TO ERECT ON SITE
5. SWING WITH LOAD TO NECESSARY LOACTION
6. LOWER LOAD FOR TEMPORARY PLACEMENT OR ERECTION
7. DISCONNECT RIGGING
8. REPEAT STEPS 2-7 FOR THE REMAINDER OF THE MATERIAL ERECTION
9. DEMOBILIZE CRANE

CRANE ON-SITE GENERAL NOTES:

1. PICK AND RADII GIVEN IN LIFT DATA TABLE MUST NOT BE EXCEEDED.
2. ALL TRUCKS SHALL BE LOCATED ON-SITE OR WITHIN BARRICADED AREA AND NO LIFTING SHALL BE DONE OVER PEDESTRIANS, VEHICLES AND ADJACENT BUILDINGS.
3. FLAGMAN SHALL STOP PEDESTRIANS AND VEHICLES WHEN LIFTING OVERHEAD [AS APPLICABLE].
4. ONLY 1 CRANE SHALL BE ON-SITE AT ANY 1 TIME UNDER THIS CRANE APPLICATION.

STATE OF NEW YORK · KEVIN BARRY O'NEILL JR. · 085821 · LICENSED PROFESSIONAL ENGINEER

WORK THIS DRAWING WITH: 226.36-1 THRU 226.36-3

WORLD TRADE CENTER
PATH HALL CONSTRUCTION
CONTRACT NO. WTC - 264.595

CONTRACTOR: SKANSKA/GRANITE/SKANSKA J.V. 2 RECTOR STREET 8TH FLOOR NEW YORK, NY 10006

CONSTRUCTION ENGINEER: SIEFERT ASSOCIATES, LLC 180 CHURCH STREET NAUGATUCK, CT 06770

NO.	DATE
2	11-30-11
1	11/18/11
0	11/14/11

MOBILIZATION/DEMOBILIZATION
LR1160 - SECTION- NOTES - POS. 2

DWG. NO. 226.36-4

IT IS A VIOLATION OF THE PROFESSIONAL LICENSE LAW FOR ANY PERSON TO ALTER THE DRAWING IN ANY WAY, UNLESS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER/ARCHITECT AS APPLICABLE. THE ALTERING ENGINEER/ARCHITECT SHALL AFFIX HIS/HER SEAL AND THE NOTATION 'ALTERED BY' FOLLOWED BY HIS/HER SIGNATURE AND DATE OF ALTERATION.

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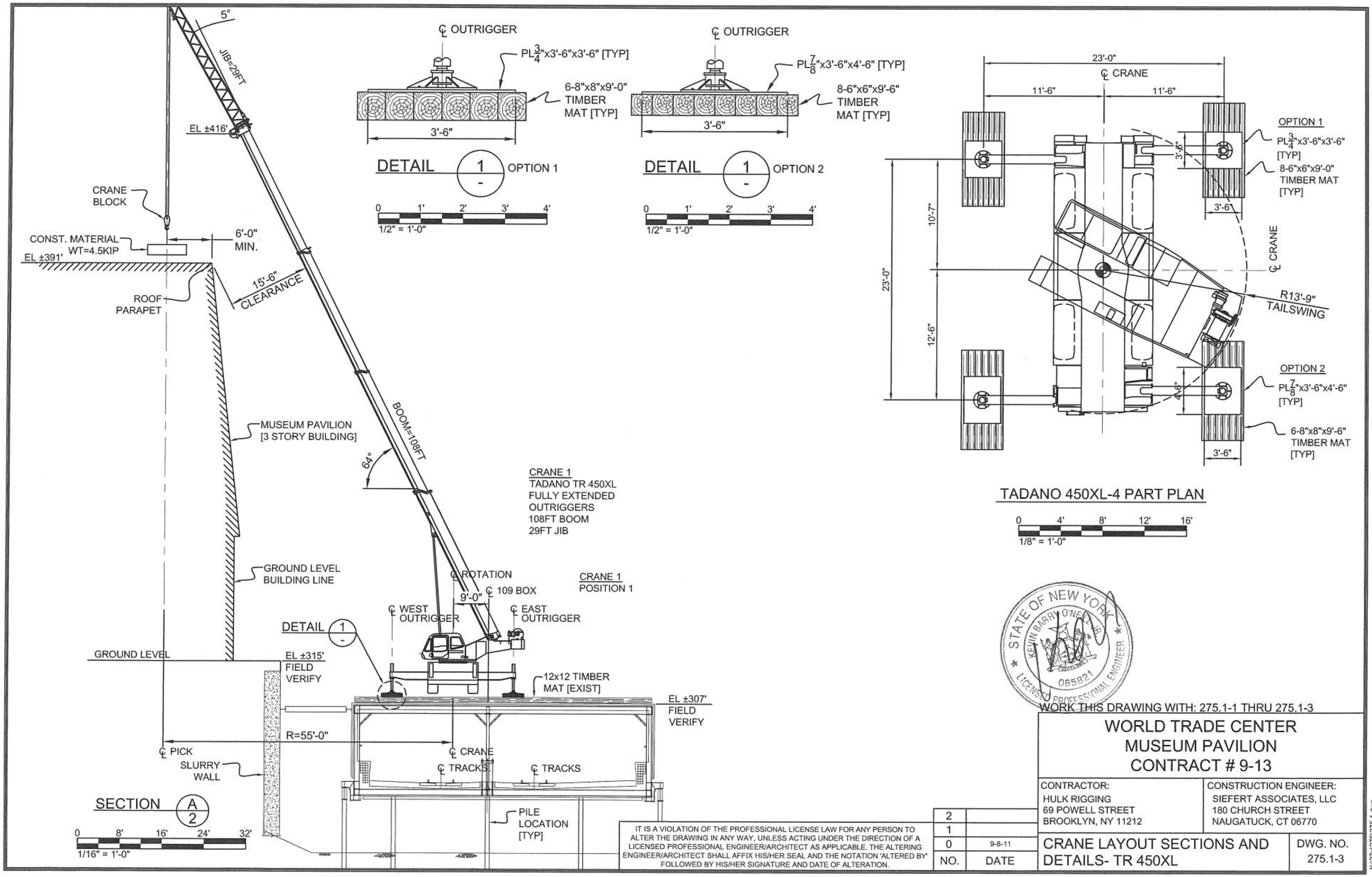

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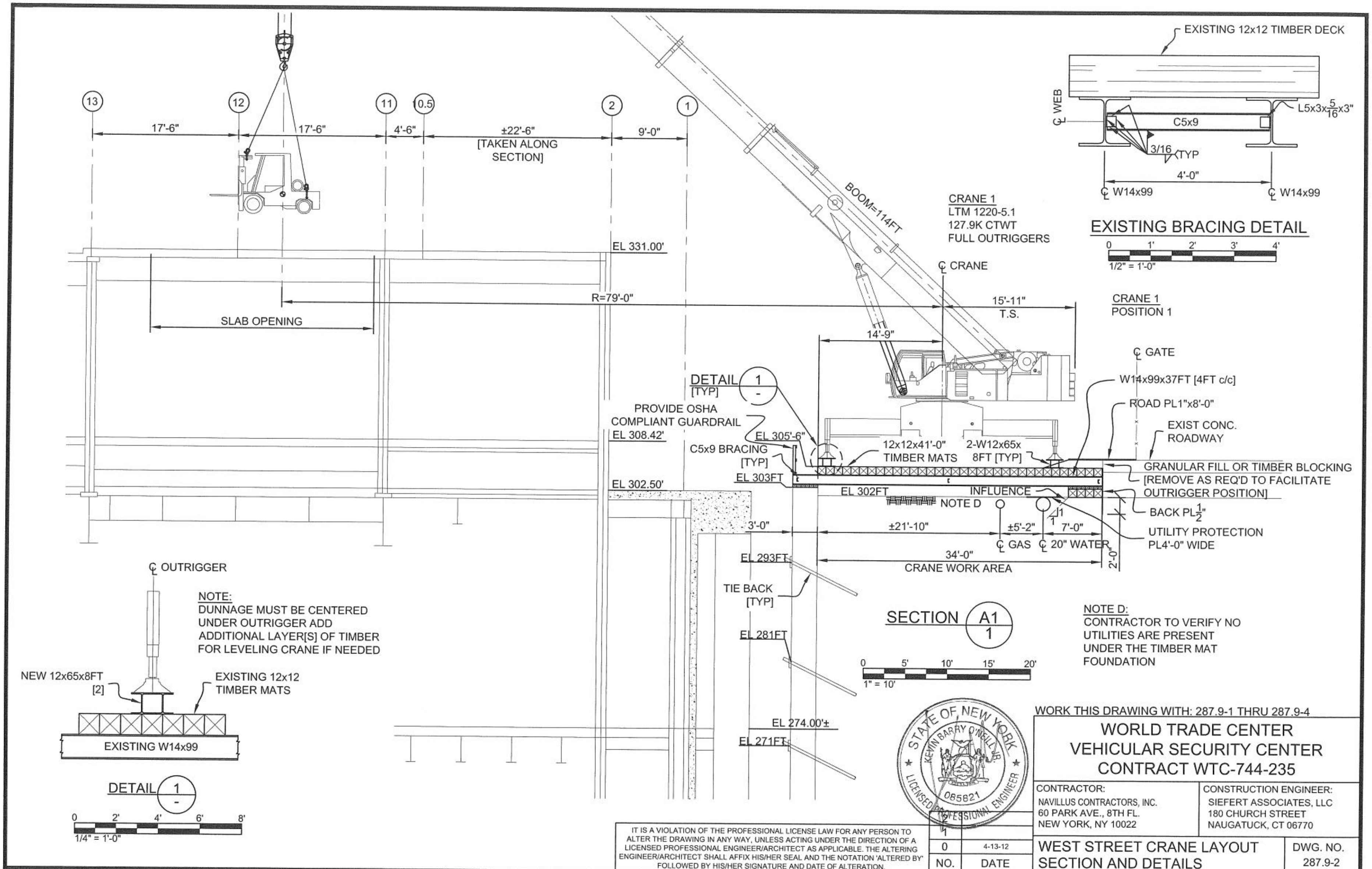
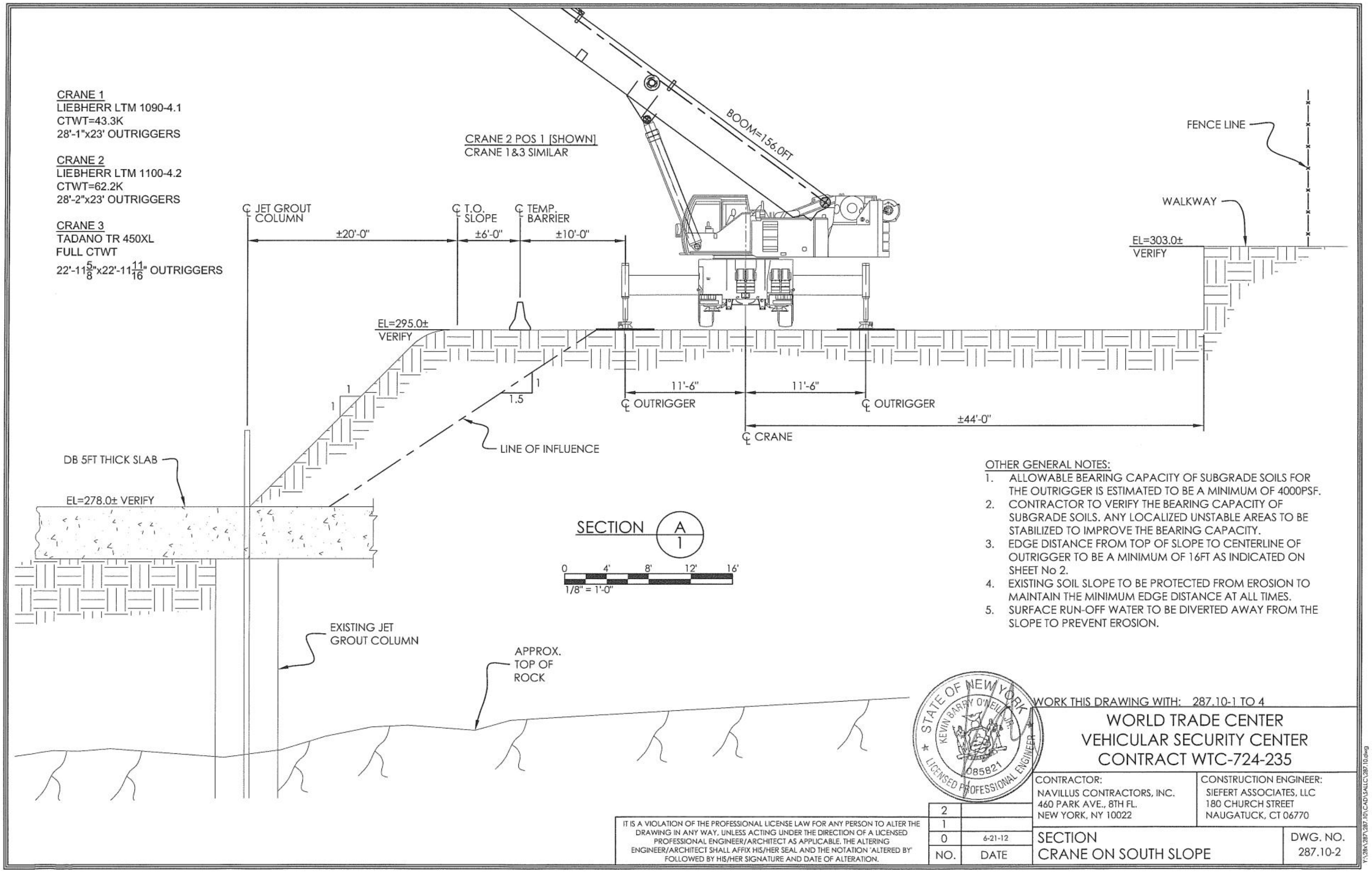


Mobile Crane Lift Planning in Construction Environments



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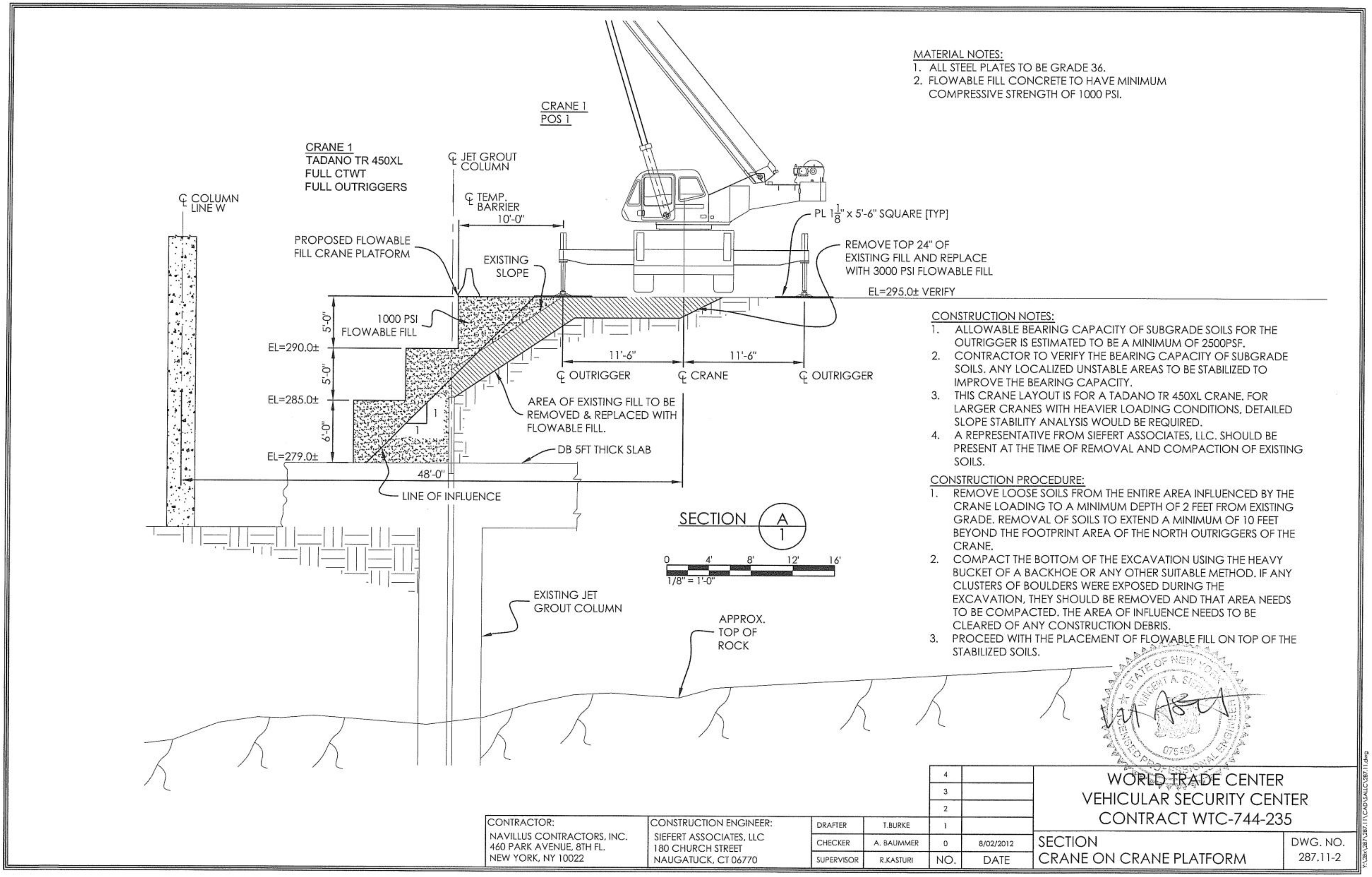

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Questions?

Mobile Crane Lift Planning in Construction Environments

Thank You