THE DESIGN OF POTAIN MCR225A CRANE FOUNDATION IN A CONFINED SITE CONDITION

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Problem Statement

The Royal Bangkok Sports Club (RBSC) site has very limited space, and a conventional tower crane would swing over neighbouring areas. The Potain MCR225A Luffing Jib Crane was chosen for its small slewing radius, but it brings difficult load distribution and foundation stability issues on Bangkok's soft clay under high wind. This study checks the stability and safety of the crane and its foundation so work can proceed without affecting the surroundings.

Design Objectives

1. To study and analyze the reaction forces and stability of the Potain MCR225A crane under various operational conditions, including in-service and out-of-service states.
2. To design an appropriate foundation for Bangkok's soft clay conditions that can effectively support the loads and operational forces in accordance with engineering standards.

Design Constraints

Technical Constraints

- Soft Bangkok clay: a 10 to 20 m soft clay layer has low bearing capacity and large settlement, so loads go to stiffer soil through 17.00 m bored piles.
- High wind and uplift: the open racecourse exposes the crane to high wind, and windward piles take up to 7.64 t of uplift, resisted by skin friction and stud bolts.
- Limited footprint: the 4.00 x 4.00 x 1.35 m pile cap must carry the reactions without reinforcement so congested that concrete cannot flow.

Non-Technical Constraints

- Confined site: the club stays in use, so work zones, worker routes and truck routes are kept apart, and the piling rig needs access on a tight site.
- Boundary rules: the jib must never oversail neighbouring land or the racecourse, so one luffing jib crane is fixed at the centre of the building.

Key Courses and Software Applied

Applied Academic Courses

- **CVE 332 Soil Mechanics & CVE 434 Foundation Engineering:** soil parameters from boring logs, skin friction and end bearing, pile capacity in soft clay.
- **CVE 321 Reinforced Concrete Design**: WSD pile cap, beam and punching shear, bar anchorage.
- **CVE 215 Structural Analysis**: mast reactions, storm wind overturning, pile group reactions.
- **CVE 322 Design of Steel and Timber Structures**: base plate thickness, ASTM A325 bolt shear-tension check.

Engineering Software

- Drawings: foundation detail and Section A (Sheet TC-1)
- Microsoft Excel: design calculation package (Appendix A).

BOQ / Cost Estimation

BILL OF QUANTITIES

Project: Foundation of Potain MCR225A luffing jib crane (RBSC), pile cap TC-1

No.	Description	Qty	Unit	Material (THB/unit)	Labour (THB/unit)	Amount (THB)
1. Sub-grade and bedding						
1.1	Compacted coarse sand 0.10 m under footing	1.60	m³	450.00	150.00	960.00
1.2	Lean concrete 1:3:5, 0.05 m	0.80	m³	1,750.00	350.00	1,680.00
1.3	Non-shrink grout, 25 mm	4.00	sets	480.00	150.00	2,520.00
2. Bored piles Ø0.60 m × 17.00 m (8 piles)						
2.1	Drilling and concreting bored piles Ø0.60 m, 17.00 m deep	136.00	m	2,200.00	600.00	380,800.00
2.2	Pile main bars DB16 SD40 (64 bars × 10.00 m)	1,011.20	kg	26.50	4.50	31,347.20
2.3	Spiral ties RB9 SR24 @ 0.20 m	532.73	kg	27.00	4.50	16,781.00
2.4	Dowel bars DB16 SD40 (64 bars × 6.64 m)	671.44	kg	26.50	4.50	20,814.64
3. Pile cap TC-1, 4.00 × 4.00 × 1.35 m						
3.1	Structural concrete f'c = 320 ksc	21.60	m³	2,450.00	450.00	62,640.00
3.2	Formwork	21.60	m²	320.00	120.00	9,504.00
3.3	Main bars DB25 SD40 (80 bars × 4.45 m)	1,370.60	kg	26.50	4.50	42,488.60
3.4	Side bars / hoops DB12 SD40	71.04	kg	26.50	4.50	2,202.24
4. Base plate and anchor bolts						
4.1	Base plate SS400, 60 × 60 × 5 cm (4 plates)	565.20	kg	48.00	12.00	33,912.00
4.2	High-strength stud bolts / J-bolts A325 Ø42 mm, L = 1.30 m	8.00	sets	2,800.00	400.00	25,600.00
				Direct cost (materials + labour)		631,249.68
				Overhead and profit	10%	63,124.97
				VAT	7%	48,606.22
				GRAND TOTAL		**742,980.87**

Conclusion and Recommendations

The foundation of the Potain MCR225A tower crane uses 8 bored piles (0.60 m diameter, 17.00 m long) under a 4.00 × 4.00 × 1.35 m reinforced concrete pile cap. The most loaded pile carries 46.35 t against a safe load of 47 t, and the maximum uplift of 7.64 t is resisted by 65.97 t of skin friction.

All pile reactions, uplift and overturning checks are within the allowable limits, and SD40 reinforcement with A325 anchor bolts gives a stable foundation for crane operation and storm wind on the confined site.

Design Specs, Standards, and Codes

Material Specifications

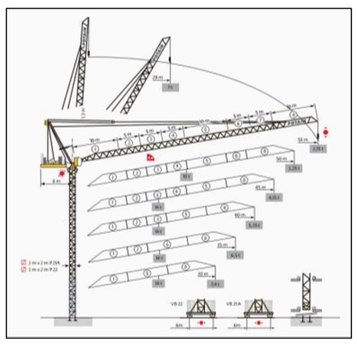
Structural Material	Mechanical Properties / Specified Design Strengths
Pile Cap Concrete	Cylindrical compressive strength at 28 days (Allowable bending stress)
Bored Pile Concrete	Cylindrical compressive strength at 28 days
Deformed Bars (SD40)	Grade SD40 yield strength (Allowable tensile stress)
Round Bars (SR24)	Grade SR24 yield strength (Allowable tensile stress)
Anchor Stud Bolts	High-strength ASTM A325, allowable tension, allowable shear

Engineering Codes and Standards

- ACI 318: pile cap and pile load distribution
- DPT 1101-57 & TIS 1027-2535: WSD reinforced concrete design
- AISC 360 (ASD): base plate and stud bolts; DPT 1311-50: wind load on the crane
- Success criteria: max pile load within the 47 t safe load, uplift below skin friction, shear below vc = 5.22 ksc, and resisting moment above overturning moment.

Design Approach, Concept, and Methodology

Maximum In-Service and Out-of-Service reactions (axial, shear and moment) of the MCR225A were taken from manufacturer data and combined with soil parameters from STS reports. A symmetrical 8-pile group under a square cap spreads the bi-directional overturning moments evenly. After the pile checks pass, the cap is detailed for flexure, shear and anchor bolts, and drawn as shop drawings.



Reactions Out of Service ■

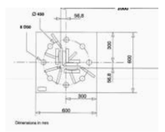
w	=	2.00	m.
F2	=	229.00	Tons
F3	=	190.00	Tons
DL	=	63.00	Tons
Moment at Center	=	265.65	Tons
V (Total)	=	102.00	Tons

Reactions In Service •

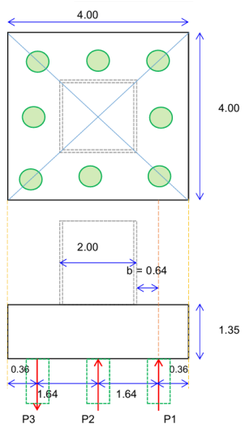
w	=	2.00	m.
F2	=	164.00	Tons
F3	=	124.00	Tons
DL	=	63.00	Tons
Moment at Center	=	229.87	Tons
V (Total)	=	103.00	Tons

Design Plate

ข้อมูล Tower Crane MCR225	
ET (ton)*แรงกระทำด้านข้าง	0
V Shear (ton)	190.00
Moment (T-m)	265.65
ข้อมูลต่างๆ	
fy เหล็ก (ksc)	2450
fc' (ksc)	320



Free Standing at 23,4



Design Foundation

Width	=	4.00	m.
Length	=	4.00	m.
Depth	=	1.35	m.
Weigh of Foundation	=	51.84	Tons
V (Max) = V(Total, max) + Weigh of Foundation			
V (Max)	=	154.84	Tons

Bored Pile D-0.6 m. รับน้ำหนักปลอดภัย = 47.00 Tons/Pile
จำนวนเสาเข็มที่ต้องการ = 3.10 Piles
เลือกใช้ Bored Pile จำนวน = 8.00 Piles Ø = 0.60 m.
Load per Pile = V (max)/No. of piles = 19.36 Tons/Pile < 60 ✓ Pass

$P_0 = P/n \pm \sum Md_y/\sum d^2$

$\sum d^2$ = 16.14 m^2

Sol⁰

P_1	=	46.35	Tons
P_2	=	19.36	Tons
P_3	=	- 7.64	Tons
$\sum P$	=	154.84	Tons Check ✓ OK

check ระยะห่างระหว่างเสาเข็ม > $3\sqrt{2}$ D
= 3.28 m. > 2.55 m. Check ✓ OK

Bore Pile

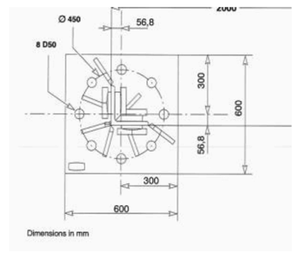
Dia of Bored Pile Ø	=	0.60	m
Depth	=	17.00	m
Ag = πr^2	=	2,827.43	cm^2
No of Rebar	=	8	Line
Rebar	=	16	mm
As	=	16.08	cm^2

fc'	=	240	ksc
fy	=	2400	ksc
fs = 0.5fy	=	1200	ksc
Pg	=	As/Ag	
Pg	=	0.01	
P	=	(Ag(0.25*fc'+fs*Pg))/0.4fy	
P	=	196.82	Ton

F.S. = 2.5
Safe Load = P/F.S. = 78.73 Tons > P1 = 46.35 Tons ✓ OK

Design Stud Bolt

ข้อมูล Tower Crane MCR225	
ET (ton)*แรงกระทำด้านข้าง	0
V Shear (ton)	190.00
Moment (T-m)	265.65
ข้อมูลต่างๆ	
fy เหล็ก (ksc)	2450
fc' (ksc)	320



Step 1 เลือกใช้ Stud Bolt A325 Dia 42
Ab= 13.85 cm^2 n = 8 ตัว
Use 8 Bolts ø 42 mm / 1 Fix angle = 443.12 cm^2

Step2 หน่วยแรงเฉือนที่เกิดขึ้น (fv)
fv=P/A 0.00 ksc

Step3 หน่วยแรงดึงที่เกิดขึ้น (ft)
ft=P/A 42.88 Ksc

Step 4 Check Horizontal Shear
หน่วยแรงเฉือนที่ยอมให้ (Fv) = $1{,}190(1-\frac{fcAb}{\gamma b})$ Tb= 58,990.00 kg
Fv = 1,178.02 ksc Check ✓ OK

Step 5 Check Tension
หน่วยแรงดึงที่ยอมให้ (Ft) = $\sqrt{3080^2 - 2..15(fv^2)}$
Ft = 3,080.00 ksc Check ✓ OK

Step 6 Check J-BolT
จากสูตร $L = \frac{0.06Ab * Fy}{Fc'^{0.5}}$
L = 113.79 cm
Use J-BolT 1.30 m

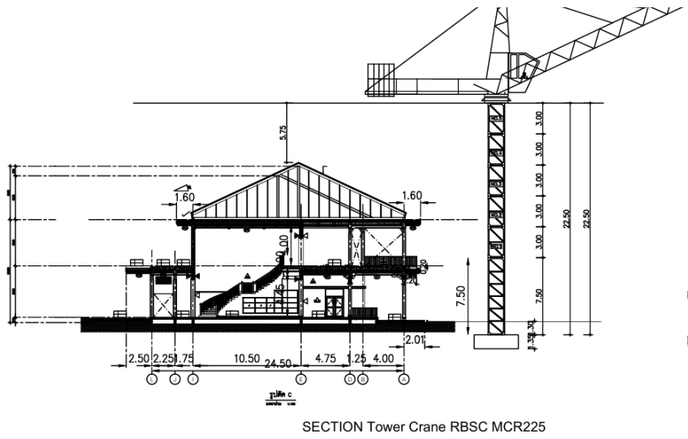
Step 1 พื้นที่ฐานรองรับคอนกรีต
A= 3600 cm^2

Allowable Bearing Stress (Fp) = 112 ksc
Bearing Stress (fp) = 52.78 ksc
Fb = 1,837.50 ksc

Step 2 หาความหนาแผ่นเหล็กที่รองรับ
n= ส่วนยื่นของแผ่นเหล็ก Plate 60 cm.
n=(D-0.8B)/2 18
จากสูตร $t = \sqrt{\frac{3 * fp * n^2}{Fb}}$
t= 5.28 cm

ดังนั้น ใช้ Plate ขนาด 60 x 60 x 5 cm

Design Deliverables



SECTION Tower Crane RBSC MCR225

