WORLD CRANE & TRANSPORT SUMMIT 2023
SINGAPORE 4 & 5 OCT

Super Heavy Lifting in Oil & Gas Offshore Construction and Services

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Presenter bio: Joseph Collins

Joe provides consulting and design services for lifting and transport of process equipment, machinery, chemical, refining and nuclear vessels and components.

His duties include consulting to clients using the world's largest cranes and super heavy lift projects. In addition, he is assisting major companies in updating their crane and rigging policies to assure compliance with the new OSHA crane rule.

Definition of a Super Lift

- There is no definition for a Super Lift in any current Standard.
- However, many companies that make extreme lifts within their facilities have coined the term and created their own definitions.
- The intent is to minimize risk by requiring a comprehensive engineered lift plan followed by a third party review of the plan.
- The definitions vary between companies but all are intended to achieve the same result.
- This system of checks and balances has proven value and has resulted in the safe lifting of massive objects worldwide.

An accident with these heavy loads and giant cranes would be catastrophic both to human life and the facilities.

Agenda

- Ground Bearing Pressure
- Crane Suitability
- Rigging Assemblies
- Lift Procedures
- Personnel Qualifications
- Heavy Lift Manual

Ground Bearing Pressure and Load Distribution Analysis

- Soil Analysis
- Load Distribution Systems (foundations)
- Underground Structures and Cavities
- Foundation Proof Test

Ground Bearing Pressure and Load Distribution Analysis

- Soil Analysis
  - The allowable ground bearing capacity has to be investigated and confirmed by an experienced soils engineering firm.

Sample Soil Report

The site surface cover generally consisted of gravel. The soil profile generally consisted of lean clay with varying amounts of sand to depths of about 13.5 feet underlain by fine to medium sand to below the boring termination depths. Groundwater was encountered at depths of 13.5 feet in the test boring at the time of field exploration.

Based on the subsurface conditions encountered and expected loads, shallow foundations could be used to support the proposed structures. Foundation design recommendations for the proposed structures are presented in the following table.

DESCRIPTION	VALUE
Foundation Type	Shallow foundation
Bearing Material	6 inches of ODOT Type "A" crushed aggregate base[2,3] over undisturbed native soil
Net Allowable Bearing Pressure[1]	2,500 psf
Total Estimated Settlement	1 inch
Estimated Differential Settlement	Approximately 1/2 of total settlement

1. The recommended net allowable bearing pressure is the pressure at the base of the shallow foundation in excess of the adjacent overburden pressure. Assumes any unsuitable materials, if encountered, will be undercut and replaced with engineered fill.

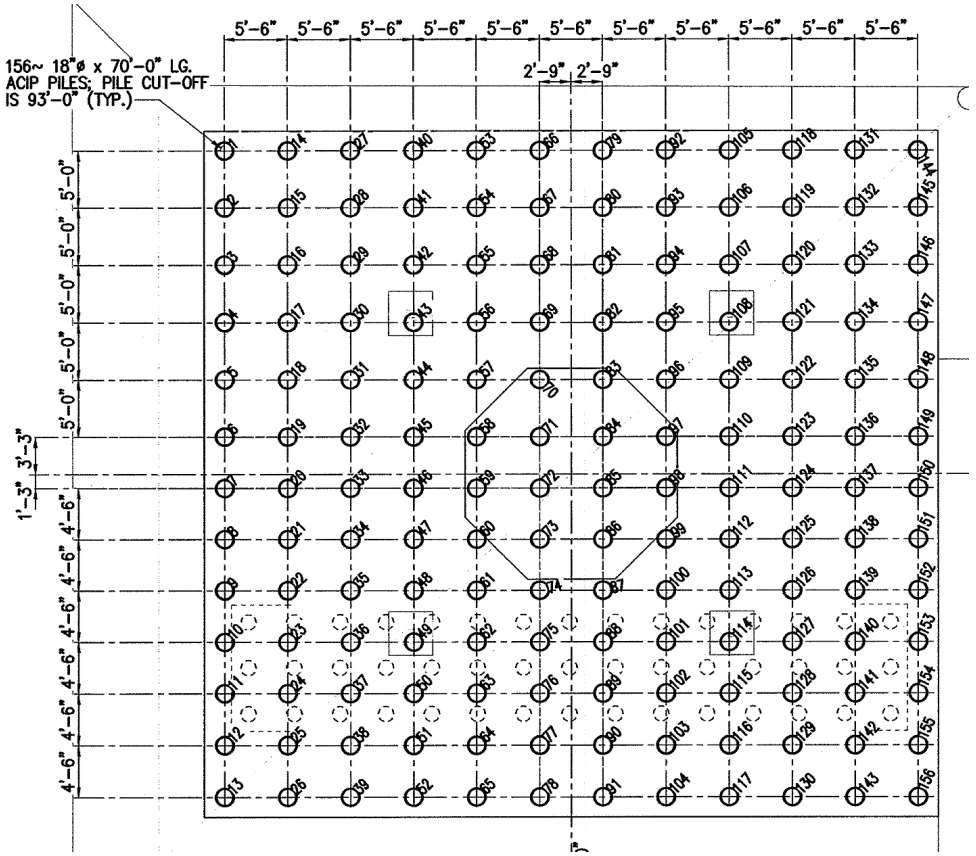
Ground Bearing Pressure and Load Distribution Analysis

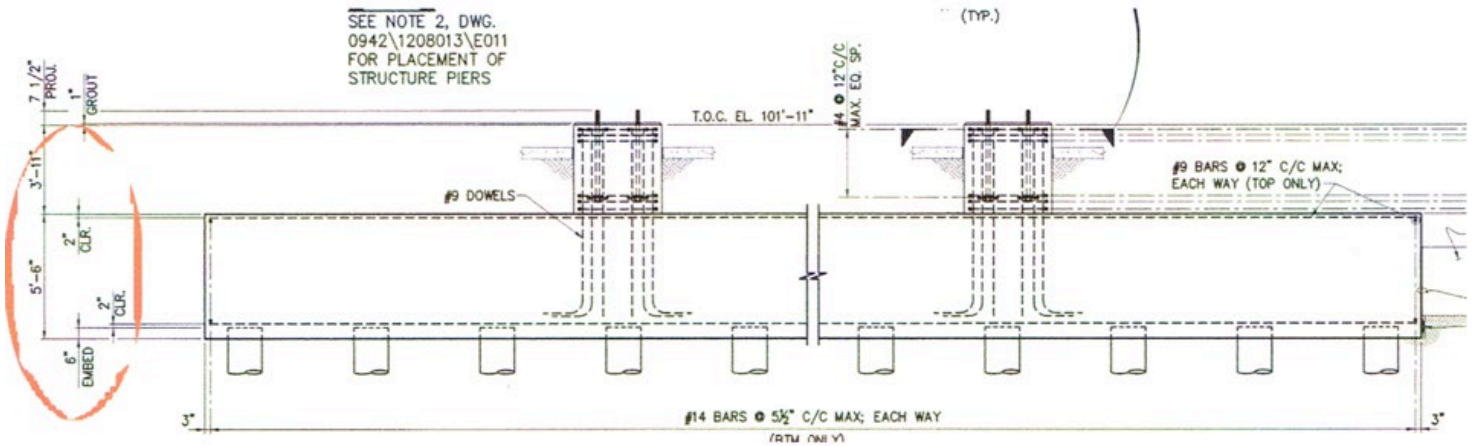
- Load Distribution Systems (foundations)
  - Foundations
    - Depending type of lift equipment, cranes or gantry systems, foundation is designed based on the allowable ground pressure.
    - The foundations may consist of:
      - piling with a concrete cap
      - wood and or steel crane mats
      - compacted fill

- *Sample Ground Bearing Pressures*
  - Terex CC6800 – 1200-ton capacity
    - GBP = 12,700 psf
  - Liebherr LTM 11200 – 1200-ton capacity
    - single outrigger force 418,000 lbs.
  - Mammoet PTC Ringer – 3500-ton capacity
    - GBP = 3,400 psf

2000-ton Country System (Mammoet)

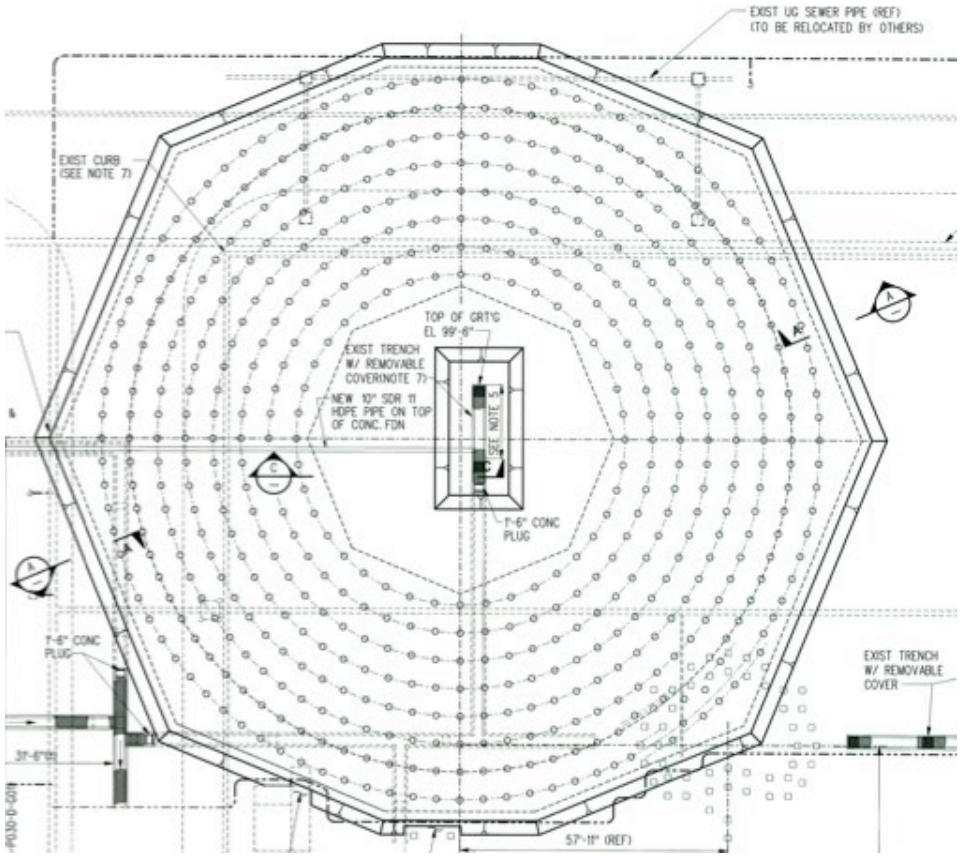
Sample Foundation Design with Piles and Concrete Cap



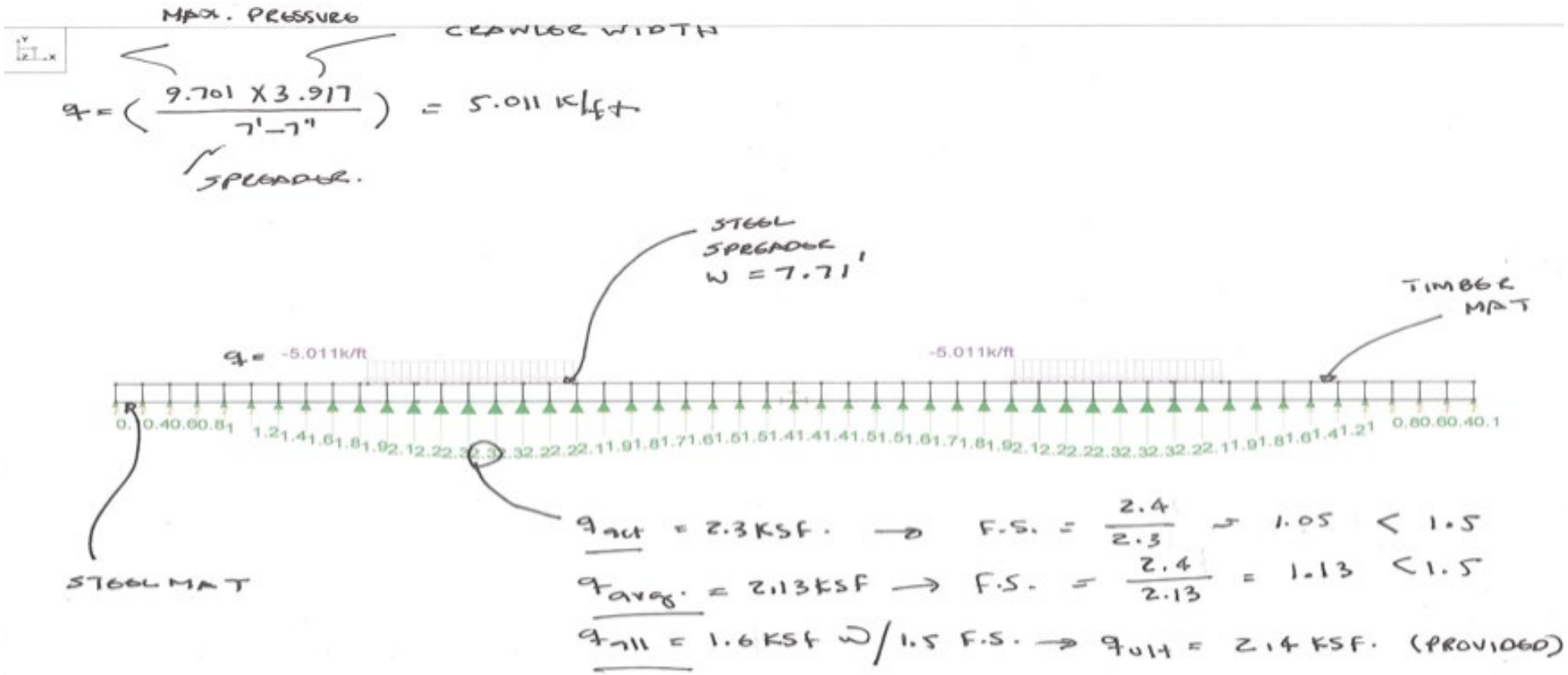


3500-ton Ring Crane (Mammoet)

Sample Foundation Design 3500 psf



Sample Ground Pressure Calculation



Underground Structures

A thorough investigation must be done to identify underground structures or buried cavities under or near the crane foundation.

Some good sources are:

- Site owner records and drawings
- Sounding with sonar equipment
- These hazards are sometimes exposed during excavation while improving the ground for the crane foundation

Proof Test the Foundation

•Static Test – Load the foundation with enough weight to simulate the ground bearing pressure the crane will apply.

- This can be done with the crane counterweights
- Measure the foundation elevation before, during and after the load is applied

▶ Static Test the Foundation

- Select test weight that, at a given boom angle, will simulate the ground bearing pressure applied by the crane
- Test weight only needs to be raised until it is freely suspended
- Measure foundation elevation before, during and after the test lift is conducted

Any settlement more than the engineered allowable is unacceptable and the foundation must be modified

Foundation Failures

Crane Suitability

- Crane capacity and proper configuration
- Assembly and Disassembly Procedures
- Inspection Records
- Maintenance Records

Crane Suitability

- Crane capacity and proper configuration

- New cranes with super lift counterweights are often misunderstood by the lay person.
- They have to achieve 80 to 90 percent of capacity to float auxiliary counterweight.
- Facility owners want to limit lifts to 75% of capacity. Good idea for conventional cranes - but may not work for super lift cranes

Crane Suitability

- Inspection Records

  Review the inspection records of the crane

  - Look for recurring problems that have been addressed multiple times
  - Use this information to zoom in on problem areas while the crane is being erected and during the final inspection

- Maintenance Records

  Review the maintenance records of the crane

  - Look for recurring problems that have been addressed multiple times
  - Use this information to assure commonly used parts and specific spare parts are on hand

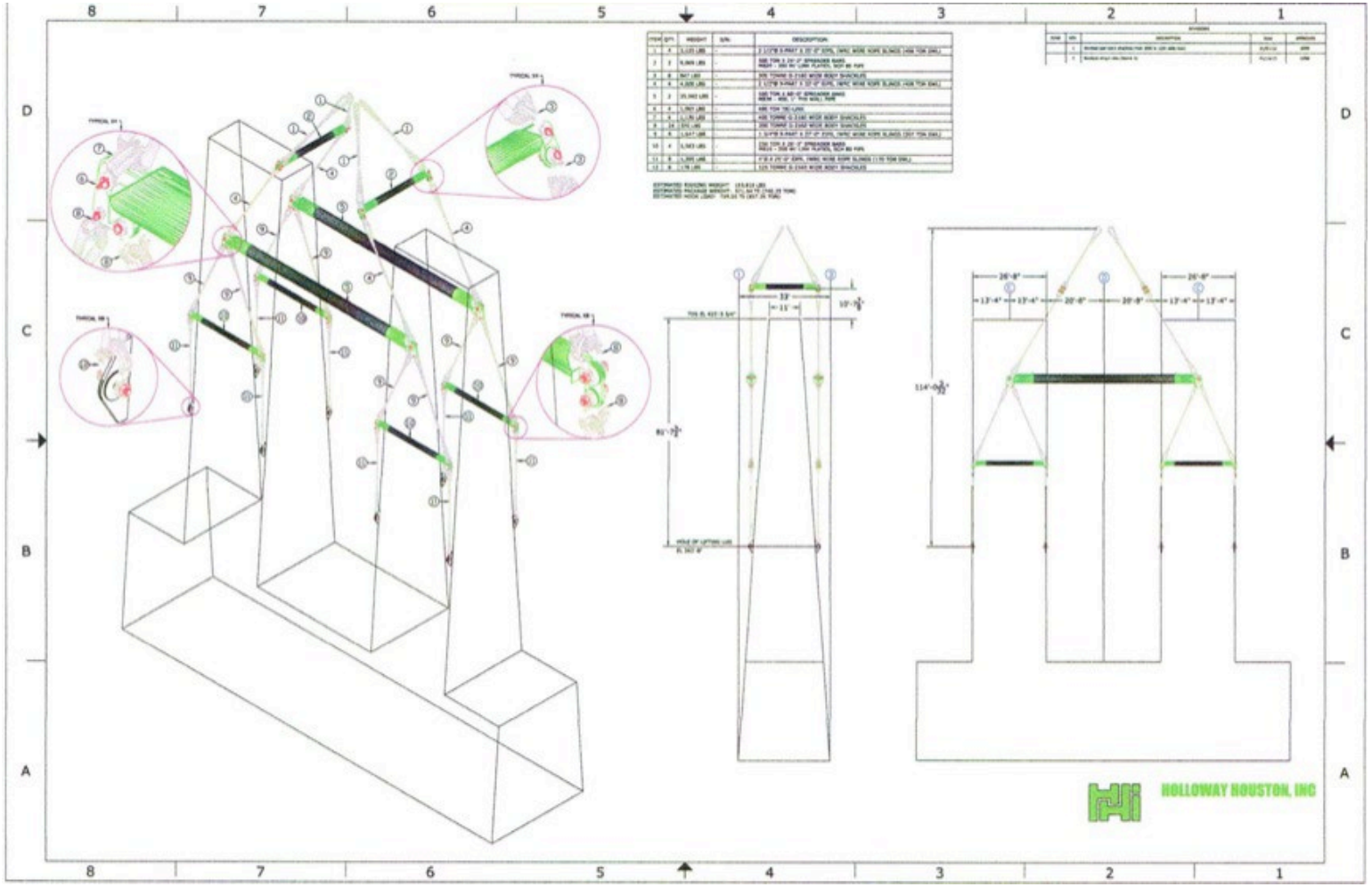
Rigging Assemblies

- Check rigging configurations for capacity
- Analyze rigging configuration for stability
- Analyze below the hook lifting devices
- Analyze points of attachment
- Assure compliance with current regulations

2000-ton Capacity Rigging System (Versabar)

Rigging System (Versabar)

Rigging Detail

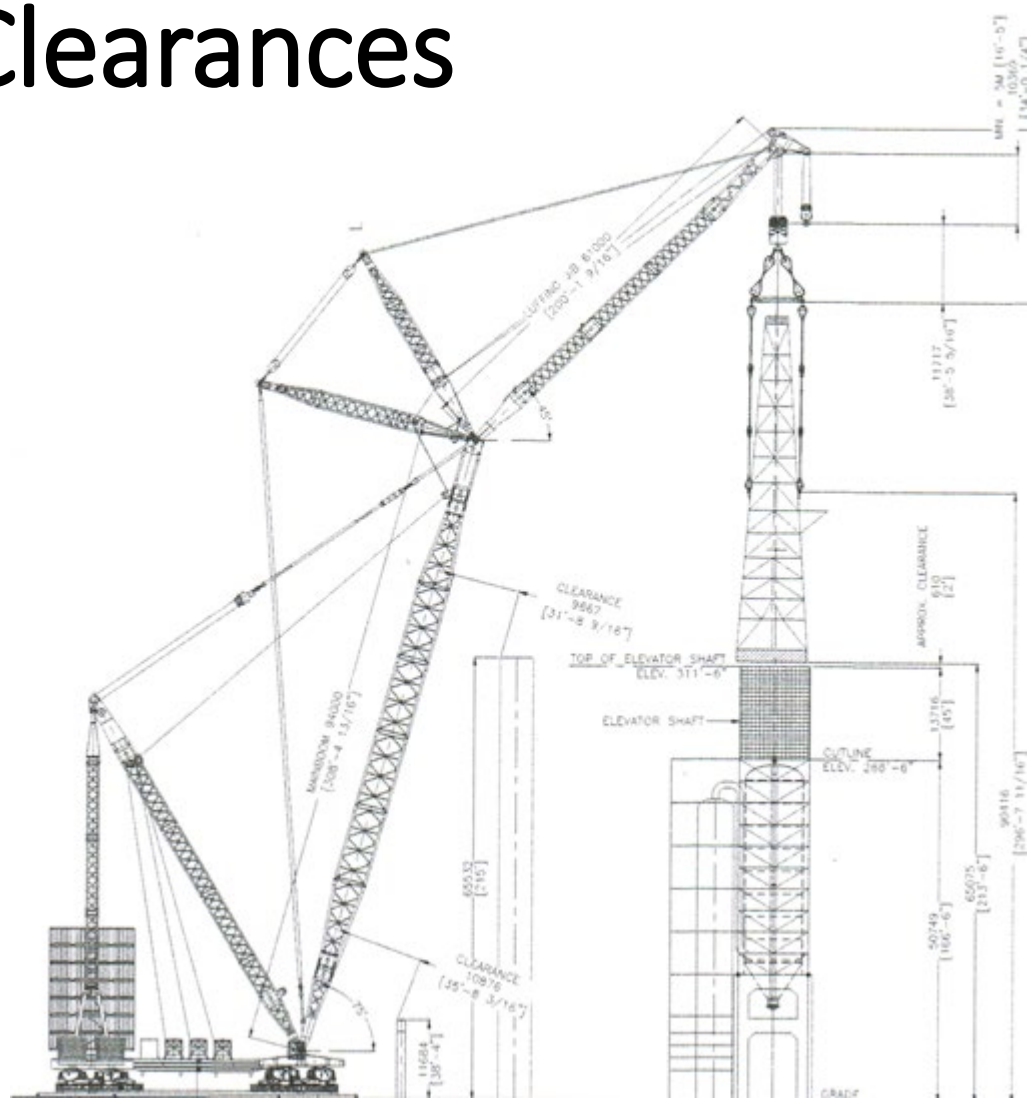


Lift Procedures

- Check all clearances
- Confirm all radii are within crane capacity
- Confirm safe wind speed limits
- Confirm rigging personnel can safely attach the rigging, land the load and disconnect the rigging

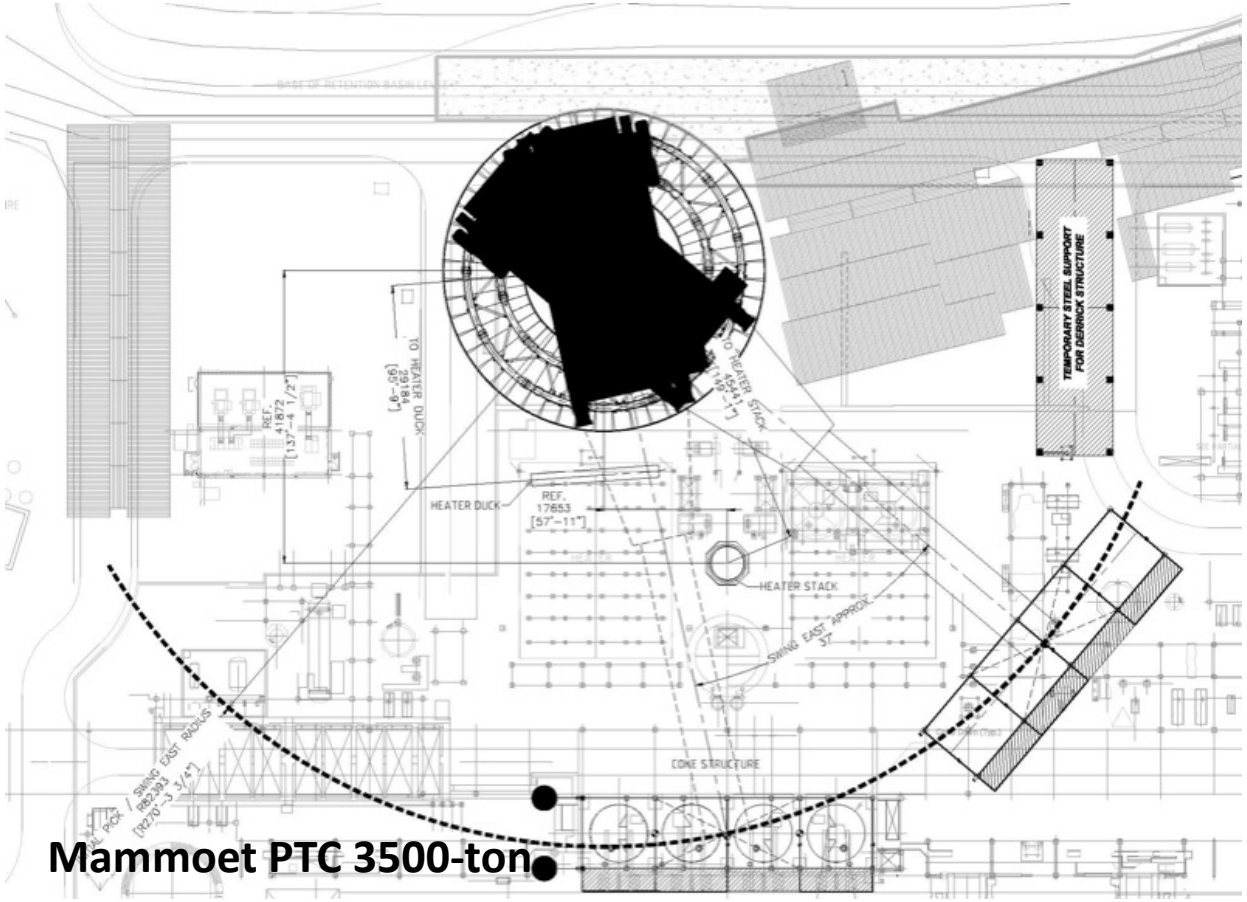
Lift Procedures – Check all Clearances

- *During the planning phase:*
  - Load to boom
  - Load to obstructions
  - Boom to obstructions
  - Remaining head room
  - Counterweight to obstructions



Mammoet PTC 3500-ton

Lift Procedures – Check all Clearances



Mammoet PTC 3500-ton


Mammoet PTC 3500-ton

Lift Procedures – Check all Clearances

Lift Procedures

Confirm radii are within crane capacity

Physically measure all radii in the field

- A tape measure is not much use due to obstructions
- Seek assistance from experienced field surveyors

Confirm safe wind speed limits

Wind Is Your Worst Enemy

- Refer to the crane manufacturers wind limit instructions
- Calculate the wind sail area of the load
- Determine what wind speed will move the load

Set the wind speed limit to the lower value

Keep in mind that even if the crane can safely lift the load, the riggers may not be able to safely control and/or land the load.

Lift Procedures

Confirm personnel safety

Can rigging personnel safely attach rigging, land the load and disconnect the rigging?

- Is scaffolding needed and will it be erected for the riggers to work from?
- Will the scaffolding obstruct the load path?
- Will a crane suspended personnel platform be required to disconnect the rigging?

These considerations must be included in the plan

Lift Procedures

Confirm personnel qualifications

- Review and confirm crane operator qualifications/certifications
- Review and confirm the lift director qualifications
- Review and confirm the rigging crew qualifications

Heavy lift manual

- Prepare a comprehensive lift manual containing all relevant support documents pertaining to the lift plan
- The manual will be a living document and will be modified as minor revisions are made to the overall plan