Accelerated Bridge Construction and Structural Move - Workshop

MARCH 2014

Department of Civil & Construction Engineering
College of Engineering and Applied Sciences
Western Michigan University
Accelerated Bridge Construction and Structural Move - Workshop

Appendices

Project Manager: Matthew Chynoweth, P.E.

Submitted to:

Western Michigan University
Department of Civil & Construction Engineering
College of Engineering and Applied Sciences
Kalamazoo, MI 49008
Fax: (269) 276 – 3211
APPENDIX D (PART-I)

WORKSHOP PRESENTATIONS
Welcome to MDOT's first ABC/PBES workshop
- We have two bridge slide projects to be done via CM/GC next year
- Future bridge slide/structural move projects will most likely be design/bid/build, and we want the Michigan contracting industry, and those delivering the projects to be comfortable, and knowledgeable of these techniques

Every Day Counts (EDC)
- Goal: 25% of bridges constructed/reconstructed with Federal Aid to incorporate at least one Accelerated Bridge Construction (ABC) or major precast component.
- Goal was to have 25% of bridges in program by December 2012
- MDOT executive leadership approved policy document in October 2012
The MDOT ABC policy was selected as a national example, and presented at the 2013 TRB meeting.

MDOT is also working at the national level, through the AASHTO Subcommittee on Bridges and Structures on the advancement of ABC/PBES methods and technologies.

ABC/PBES is a part of our business practice, and must now be part of our culture when thinking about how our projects impact the public, and the economy.

Why ABC, Why now?
MDOT ABC Policy

- Progress at MDOT:
  - Committee established with members from MDOT, Consultant, and Industry staff
  - Goals over the Next Few Years:
    - Move this Technology Forward from demonstration to standardized deployment
    - Gain additional experience
    - Develop a Program Approach
    - Develop Selection Criteria and a Decision Making Framework
    - Develop methods for Performance Measurement

MDOT ABC Policy

- Section 7.01.19 of the MDOT Bridge Design Manual covers ABC and PBES considerations
- This section will be further updated as means and methods are further evaluated

MDOT ABC Policy

- Special provision for Prefabricated Superstructure, Laterally Slide

MDOT ABC Policy

- Development of Performance Framework: Phase 1 - First in Series
  - Initial PHASE 1 - Development of Performance Framework: Phase 1 - First in Series
  - Initial PHASE 1 - Development of Performance Framework: Phase 1 - First in Series
MDOT ABC Policy

- Prefabricated Superstructure, Laterally Slide SP requirements:
  - Working drawings, calculations and submittals
  - Move Operations Manual
  - Geometry Control and Monitoring Plan
  - Contingency Plan
  - Trial Horizontal Slide
  - Movement of Superstructure requirements
  - Allowable Tolerances
- Also working on SPMT special provision

MDOT ABC Policy Update:

- Developing static and kinetic friction calculations and criteria for jacking force calculations:
  $$f_{\text{max, static}} = \mu_{\text{static}} \times F_{\text{normal}}$$
  $$f_{\text{max, kinetic}} = \mu_{\text{kinetic}} \times F_{\text{normal}}$$

<table>
<thead>
<tr>
<th>Surfaces</th>
<th>$\mu_{\text{static}}$</th>
<th>$\mu_{\text{kinetic}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel on steel</td>
<td>0.74</td>
<td>0.57</td>
</tr>
<tr>
<td>Glass on glass</td>
<td>0.94</td>
<td>0.40</td>
</tr>
<tr>
<td>Steel on metal</td>
<td>0.15</td>
<td>0.06</td>
</tr>
<tr>
<td>Ice on ice</td>
<td>0.10</td>
<td>0.03</td>
</tr>
<tr>
<td>Teflon on Teflon</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Tire on concrete</td>
<td>1.00</td>
<td>0.80</td>
</tr>
<tr>
<td>Tire on wet road</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Tire on snow</td>
<td>0.38</td>
<td>0.20</td>
</tr>
</tbody>
</table>

MDOT ABC Policy

- Currently working on updates to MDOT Project Scoping Manual and Mobility Manual for evaluation of ABC/PBES techniques with respect to:
  - Site and Structure considerations
  - Work zone Safety and Mobility
  - Cost
  - Technical Feasibility
  - Seasonal Constraints and Project Schedule
  - Environmental Issues

Why Accelerated Bridge Construction?
Reduced Time

- Project Schedule (Length/Events)
- Part-Width / Detour / Temp Bridge
- User Delay Costs
- MDOT Mobility Policy
  - Volume to capacity ratio less than 0.80
  - Work zone travel delay less than 10 minutes.
  - Corridors of significance
  - Level of service shall not be D or less or drop from A to C.
Why Accelerated Bridge Construction?

Recommended Activities

- Achieve industry buy-in
  - Workshops and Technical Exchange Conferences
  - Allow time to become comfortable and knowledgeable using PBES.
- Think like a Contractor
  - Consider equipment capabilities and capacities
  - Means and methods to be more thoroughly developed during the design phase
- Plan a Program of Projects
  - Build Momentum – a clear signal to the industry that the business model is changing.

Barriers and Challenges to ABC

- Think like a contractor during design
  - Consider equipment capacities
- Lack of Knowledge and Experience
  - Detailing Connections
  - Tracking Durability
  - Designing Curvilinear Geometry
  - Accounting for Negative Moment Continuity
- Availability of Precast Contractors
  - Designing component size for transport and site erection
  - Contractor Proposing to go Back to CIP After Award
- Connections
- Tolerances
- Weight of segments
- Construction Staging
Barriers and Challenges to ABC

- When to innovate during design
  - Without becoming too prescriptive on means and methods

Barriers and Challenges to ABC

- Costs
  - User delay vs. construction cost, and what equipment to select

Guidelines for Choosing ABC

- Decision making framework and analysis tools currently being developed as part of an ongoing research project

  - Based on AHP (Analytical Hierarchy Process) taking into account both qualitative and quantitative values

  - Tool to be used during call for projects process, and project scoping

Decision-Making Model Analysis Result

- Stadium Drive Bridge
  - ABC = 0.775
  - CIP = 0.225
**Successful ABC Projects**

- Choose proper projects/material applications
- Target abilities of contractors/fabricators
- Analyze effects of cost and schedule
- Partnering
- Shared risk

**MDOT’s Past and Present with ABC/PBES**

- Parkview Avenue over US 131 - 2008
- US 31 BR over White Lake - 2011
- M-25 over the White River - 2011

**Parkview Avenue over US 131**
Kalamazoo, MI

**US 31 Business Route over White Lake Trail**
Whitehall
The Future of ABC at MDOT

- 2014 and beyond
  - 3 structural moves scheduled for 2014
  - 1 bridge involving PBES elements (with IBRD funding)
  - Looking for first Self Propelled Modular Transporter candidate
  - Evaluating standard joint and connection details

Thank You

Questions?
Bridge Slides and Moves
Owner Perspective

Rebecca Nix, S.E., Bridge Program Manager
Utah Department of Transportation
MDOT Bridge Move Workshop
December 9, 2013

Presentation Outline

- ABC Implementation
- Contracting Methods
- Contract Documents
- SPMT vs. Lateral Slide
- Monitoring
- Contingency Plan
- Lessons Learned

ABC Implementation

History

- Half depth deck panels – 1999
- Full depth deck panels – 2004
- Precast Substructures – 2007
- Self Propelled Modular Transports (SPMT) – 2007
- Lateral slide – 2009
- Superstructure launch - 2010

ABC Implementation

History
ABC Implementation

History

ABC Implementation

Benefits

- Enhanced safety
- Shortened on-site construction time
- Reduced traffic/mobility impacts
- Potentially reduced project costs
- Improved quality
- Increased constructability

Contracting Methods

Design Bid Build

- Traditional contracting method
- No contractor involvement during design
- In house or consultant design
- Higher level of risk to owner
- High level of change orders
- Strong team partnering and coordination needed
**Contracting Methods**

**Design Build**

- Design and construction concurrent
- Early known cost
- Reduced delivery time
- Improved constructability
- Encourage innovation
- Risk mostly transferred to contractor
- Higher bidding effort for contractor

**Contracting Methods**

**Construction Manager/General Contractor**

- Contractor on board to consult during design
- Owner able to select innovations
- Reduce design errors, constructability issues, and change orders
- Identify and mitigate risk
- Allows for early procurement
- Limits negotiation on project costs
Contract Documents

**Plans**

- Level of detail
  - No detail regarding move
  - Show one viable option, schematic
  - Show only permissible move details

**Specifications**

- Clearly define goals, limitations, and requirements of project
  - Submittal requirements
  - Contractor flexibility
  - Tolerance requirements
  - Maintenance of traffic requirements
  - Incentives and disincentives

Contract Documents

**Submittals/Acceptance**

- Allow for review time in schedule
- Based on level of detail of plans
  - Changes to contract plans
  - Temporary supports (including geotech evaluation)
  - Staging areas
  - Hour by hour schedule
  - Communication plan
  - Contingency plan

<table>
<thead>
<tr>
<th>SPMT vs. Lateral Slide</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPMT</strong></td>
</tr>
<tr>
<td>High equipment cost</td>
</tr>
<tr>
<td>Flexible staging area</td>
</tr>
<tr>
<td>Feature crossed less critical</td>
</tr>
<tr>
<td>Pick points vary from final load path</td>
</tr>
</tbody>
</table>
Monitoring

- Survey
- Levels
- String lines
- Measure gaps
- Simplistic
- Basic

Contingency Plan

- Hour by hour schedule
- Well coordinated public involvement
- Backup equipment
- Ability to adjust bridge alignment
**Lessons Learned**

**SPMT**

- Survey is crucial
- Account for all utilities in travel path
- Specifications need to clearly outline expectations
- Account for varying load paths
- Provide adequate roadway tie-in lengths

**Lessons Learned**

**Lateral Slide**

- Select appropriately based on site constraints
- Account for interaction between temporary and permanent supports
- Consider moving approach slabs with superstructure
- Provide adequate roadway tie-in lengths

---

Thank you

Rebecca Nix, S.E.
Bridge Program Manager
Utah Department of Transportation
rnix@utah.gov
801.633.2810
Rapid Renewal Project (SHRP-02 R04) Findings
December 2013
Bala Sivakumar
HNTB Corp.

Outline

• SHRP2 R04 Goals
• SHRP2 ABC Toolkit
• ABC Standard Design Concepts
• ABC Erection Concepts
• ABC Design Examples
• ABC Specifications
• ABC Training Course
• PBES Demonstration Projects

INNOVATIVE BRIDGE DESIGNS FOR RAPID RENEWAL
2008 -- 2013
HNTB (Prime)
Iowa State University Structural Engineering Assoc.
Genesis Structures

SHRP2 Project R04

PROJECT GOAL

To develop standardized approaches to designing and constructing complete bridge systems that address rapid renewal needs
SHRP2 R-04 Tasks

- Capture current impediments to the use of ABC
- Gather successful experiences in ABC
- Propose improved ABC concepts to overcome impediments
- Develop ABC design standards / specifications
- Develop ABC Toolkit / Training materials
- Construct ABC demonstration projects

SHRP2 Project R04
ABC TOOLKIT

- Standardize Prefabricated Bridge Elements and Systems
- Make Accelerated Bridge Construction Standard Practice

ABC Toolkit

- *SHRP2 ABC Tool Kit* was developed for PBES (currently being extended to slide-in construction)
- Will bring about greater familiarity about ABC technologies
- Foster more widespread use of prefabricated elements
- Make best use of program dollars by standardizing design through pre-engineered systems

Published Dec 2012
**Expected Outcome**

The designer, guided by the Toolkit will be able to easily complete an ABC design for a routine bridge replacement project.

---

**ABC Design Concepts**

**Guiding Philosophy**

- Focus on “workhorse” bridges
- Complete bridges using prefabricated elements and modular systems
- Contractor could self-perform the work
- Simple to fabricate and easy to erect using conventional equipment
- Fast assembly in the field in 1 to 2 weeks
- Durable connections / durable bridges

---

**Conceptual Drawings for PBES**

- **DECKED STEEL GIRDERS**
  - Decked Steel Girder Interior Module
  - Decked Steel Girder Exterior Module
- **DECKED CONCRETE GIRDER**
  - Prestressed Deck Bulb-Tee Interior Module
  - Prestressed Deck Bulb-Tee Exterior Module
  - Prestressed Double-Tee module (NEXT Beam)

---

**Conceptual Drawings for PBES**

- **ABUTMENTS & WINGWALLS**
  - Semi Integral Abutments
  - Integral Abutments
  - Wingwalls
  - Pile Foundations and Spread Footings
- **PIERS**
  - Precast Conventional Pier
  - Precast Straddle Bent
  - Drilled Shaft and Spread Footing Option
Span Ranges for Superstructures

- Simple / continuous spans from 40 ft to 130 ft.
- Simple for DL; Continuous for LL; No Open Joints
- Plans are grouped in the following span ranges:
  - 40 ft to 70 ft
  - 70 ft to 100 ft
  - 100 ft to 130 ft.
- Transported and erected in one piece.
- Weight < 200 Kips for erection using conventional cranes

Prefabricated Decked Beam Elements

Pre-decked Modular Steel Beams

- Not proprietary
- Contractor can self-perform precasting of deck onsite
- Barriers can be precast

Precast Decked Girders

- Based on the PCI NEXT beam
- Spans to 90 ft
- Low depth alternative
Integral and Semi-Integral Bridges for Rapid Renewal

- Well suited for ABC / rapid assembly
- They allow the joints to be moved beyond the bridge
- Close tolerances required when utilizing expansion bearings and joints are eliminated
- The backwall is precast with the deck.
- Fast erection in 1 to 2 days, economical

Semi-Integral Abutment Suspended Backwall

- H piles or spread footings
- Fill pile pockets with SCC
- Easy fit-up in the field

Integral Abutment

- Only one row of vertical piles
- Precast backwall - dowelled
- Fast construction

Precast Approach Slab

- Exp joint can be moved to sleeper slab
- UHPC / rapidset closure pours
Precast Piers

- Conventional Pier
- Straddle Bent

- Non-prestressed so contractor can self-perform precasting
- Fast erection using grouted splice couplers
- Deep foundation may be outside existing footprint

Erection Concept Drawings

1. Erection using conventional cranes.
2. Erection using ABC construction technologies adapted from long span construction

Erection Using Conventional Cranes

- Weight of Module
- Pick Radius
- Crane Set Up Locations
- Ground Access / Barge / Causeway / Work Trestle
- Truck Access for Delivery

Most Economical

Crane Placement for Erection

- Short Single Span over Stream
  Cranes selected for 90 Kip pick
- Longer Span over Roadway
  Weight up to 200 kips
Crane Picks for Erection

Erection with ABC Construction Technologies

- Use where ground access for cranes may be limited.
- ABC technologies allow construction from above:
  - Above Deck Driven Carriers
  - Launched Temporary Bridge (LTB)
  - Transverse Gantry Frames
  - Longitudinal Gantry Frames
  - Regular cranes with enough reach

Above Deck Driven Carriers

- Allows fast rate of erection
- Rides on existing bridge, new bridge (check capacity to support)
- Ideal for bridges with many spans, long viaducts

Launched Temporary Bridge

- LTTB's are launched across or lifted over a span to act as a “temporary bridge”
- Used to deliver the heavier modules without inducing large erection stresses.
- Increases the possibility of erecting longer spans
- LTTB example would be a set of standardized lightweight steel trusses that would be assembled to a specific length that suites a given project.
Launched Temporary Bridge

- Sites with limited ground access or long spans
- Launched across or lifted over a span to act as a “temporary bridge”
- Used to deliver the heavier modules without inducing large erection stresses.
- Temp bridge can also support transverse gantry frames

Erection Using Longitudinal Gantry Frame

Erection Using Transverse Gantry Cranes

Sample Drawings from ABC Toolkit

- Shows typical level of detail
- Plan sheets contain ABC specific details for routine bridges
- Guides the designer new to ABC on appropriate module configurations and connections
- Guidance on erection
SHRP2 Proposed LRFD Specs for ABC

- Prepare LRFD formatted design and construction specifications based on research
- Address impediments in LRFD Specs to ABC implementation:
  - Loads and Load combinations
  - Construction load cases, Erection stresses
  - Design of connections
  - Design responsibility — EOR / Contractor’s engineer
  - Prefabrication tolerances, quality, rideability
  - Assembly plans

Loads for ABC Design

- **Construction Loads** —
  - What kinds of loads are unique to rapid construction?
  - Loads associated with support conditions during fabrication that may be different than the permanent supports
  - Loads associated with member orientation during prefabrication
  - Loads associated with suggested lift points,
  - Load associated with impact considerations for shipping and handling of components,
  - Loads associated with camber leveling, etc.
ABC Specific Construction Loads

- **Dynamic Dead Load Allowance** — An increase in the self-weight of components to account for inertial effects during handling and transportation.

- **Camber Leveling Force** — A vertically applied force used to equalize differential camber prior to establishing connectivity between the elements.

---

ABC Design Examples

- In ABC design, the careful determination of span arrangement, girder spacings, and module dimensions for shipping and erection can add significant savings.

- Span length is equally important as it is a primary factor in component length.

---

Decked Steel Girder Design for ABC

### Organization of Design Examples in the Toolkit

<table>
<thead>
<tr>
<th>I. General:</th>
<th>III. Deck Design:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Philosophy</td>
<td>Flexural Strength Check</td>
</tr>
<tr>
<td>Design Criteria</td>
<td>Deck Reinforcing Design</td>
</tr>
<tr>
<td>Material Properties</td>
<td>Deck Overhang Design</td>
</tr>
<tr>
<td>Load Combinations</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. Girder Design:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Strength Checks</td>
</tr>
<tr>
<td>Flexural Service Checks</td>
</tr>
<tr>
<td>Shear Strength</td>
</tr>
<tr>
<td>Fatigue Limit States</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IV. Continuity Design:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression Splice</td>
</tr>
<tr>
<td>Closure Pour Design</td>
</tr>
</tbody>
</table>

---

ABC Design Example – Deck Bulb Tee

### Organization of Deck Bulb Tee Design Example

<table>
<thead>
<tr>
<th>General:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Philosophy</td>
</tr>
<tr>
<td>Design Criteria</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Girder Design:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent Loads</td>
</tr>
<tr>
<td>Precast Lifting Weight</td>
</tr>
<tr>
<td>Live Loads</td>
</tr>
<tr>
<td>Prestress Losses – Erection</td>
</tr>
<tr>
<td>Prestress Losses – Final</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concrete Stresses at Release</th>
<th>Concrete Stresses at Erection</th>
<th>Concrete Stresses at Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Strength</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shear Strength</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Moment Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camber and Deflections at Release / Erection / Final</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** Engineer of Record should perform own ABC design ***

---

A-98
Proposed ABC Construction Specifications

Recommended Special Requirements for ABC

Proposed Section in LRFD Construction Specifications

XX.1 GENERAL
XX.2 RESPONSIBILITIES
XX.3 MATERIALS
XX.4 FABRICATION
XX.5 SUBMITTALS
XX.6 QUALITY ASSURANCE
XX.7 HANDLING, STORING, AND TRANSPORTATION
XX.8 GEOMETRY CONTROL
XX.9 CONNECTIONS
XX.10 ERECTION METHODS
XX.11 ERECTION PROCEDURES

SHRP2 Project R04

One-Day Course on

ACCELERATED BRIDGE CONSTRUCTION

Introduction

- The course is geared for engineers, owners, and contractors new to ABC.
- One goal of this course is to familiarize the participants with the ABC Toolkit and its use in ABC designs.
- The slides should be used in conjunction with the ABC Toolkit.
- The slides introduce and explain the use of the ABC Toolkit, which provides the “Training Wheels” for those new to ABC.
- Can be incorporated into an NHI course

- Pertain specifically to PBES.
- Focus heavily on means and methods for PBES.
- Mainly a compilation of best practices for ABC construction
- To be updated as new information and lessons learned are accumulated from future ABC projects.
- Use as a guide could develop Special Provisions for an ABC project.
Course Outline

• Structured into six lessons as follows:
  – Lesson 1: Introduction to ABC
  – Lesson 2: Prefabricated Elements and Systems
  – Lesson 3: Bridge Movement Technologies
  – Lesson 4: ABC Toolkit for Designers from SHRP2 – Part 1
  – Lesson 5: ABC Toolkit for Designers from SHRP 2 – Part 2
  – Lesson 6: ABC Demonstration Projects

1 day and ½ day versions for DOTs:
NY, MI, PA, OK, LA, ME

SHRP2 R04 ABC Demonstration Project #1
Prefabricated Elements (IADOT)

Keg Creek Bridge

Oct 17, 2011
14 Day ABC Period

Nov 1, 2011

Prefabrication of Abutments and Piers

Erection of the Modular Beam Elements

Span = 70 ft

112 K

A-100
UHPC Joints in Bridge Deck

Precast Approach Slabs

Lateral Slide -- Oct 21 2013

7 hours to demolish exist bridge and slide-in new bridge

SHRP2 R04 ABC Demonstration Project #2

Slide-In Construction NY I-84 Bridges 2013

20 Hr Closure
Rapid Bridge Deployment Overview

JOHN ALMEIDA P.ENG
General Manager,
Aecon Infrastructure
December 9, 2013

HWY 417 – RAPID BRIDGE REPLACEMENT

Background
Incentives & Disincentives
Planning
Geotech
Sequence of Operations
Future of RBR in Ontario

PROJECT FILE:

PROJECT:
Highway 417 Bridge Rehabilitation & Rapid Bridge Replacement

CLIENT:
Ministry of Transportation of Ontario (MTO)

NUMBER OF EMPLOYEES:
110 (at peak)

TIMING:
Location 1: July 6th-7th, 2013
Location 2: July 13th-14th, 2013

LOCATION:
Ottawa, Ontario
BACKGROUND

- 4 East and Westbound Bridges located at Kirkwood and Carling Avenues in Ottawa originally constructed in 1969
- After minor repairs and rehabilitation in 1983 and 2002 the bridge decks exceeded their design life
- Ministry of Transportation Ontario procured $18M rehabilitation contract

BACKGROUND

- Moving 400 Tonnes of Thin Slab Bridges
- The Procedure Lasted 14 Hours
- Fastest Rapid Bridge Replacement Time in Ontario
- 7 Rapid Replacements Carried Out in Ontario to Date
- Required a temporary limited interest(TLI) from adjacent land owner

SCOPE OF WORK

- Rapid replacement and rehabilitation of four 55-year-old bridges
- Widening of substructures to accommodate an extra traffic lane
- Construction of 4 replacement bridges in an adjacent lay down areas
- Resurfacing of asphalt and site restoration

OPERATIONAL CONSTRAINTS

- All bridges had to be replaced between July 5th, 2013 and August 26th, 2013
- Close one lane at 5:00pm; full closure at 6:00pm (Saturday)
- Median lane in each direction must be open by 11:00am (Sunday); lane 2 in each direction to be open by 12:00pm
- Remaining lanes and ramps must be open by 6:00am (Monday)
- Only base course asphalt is required
INCENTIVES & DISINCENTIVES (Lane Closures Pre & Post Bridge Moves)

Penalty For Early Closure
- On each occasion when the Contractor closes lanes to traffic earlier than the specified times, an initial penalty of $1,000.00.
- Thereafter, a further penalty of $100.00 per minute will be assessed against the Contractor for every minute outside the permitted closure window that the traffic lanes are not open to traffic.

Penalty For Late Opening
- On each occasion when the Contractor fails to reopen the traffic lanes by the specified time, an initial penalty of $10,000.00 will be applied.
- If traffic lanes are not open within 15 minutes of the specified time, a further penalty of $1,000.00 will be assessed.
- Thereafter, a further penalty of $100.00 per minute will be assessed against the Contractor for every minute that the traffic lanes are not open to traffic.

INCENTIVES & DISINCENTIVES (Bridge Move Weekends)

Incentive For Opening Lane 1 (Median Lanes) or Lane 3 (Outside Through Lanes)
- If eastbound and westbound median are completed to a usable facility by 11:00 a.m. Sunday, the Contractor receives an incentive of $20,000.00.
- In the event that all work required in opening of either the eastbound and westbound median lanes or the outside through lanes to public traffic is completed prior to 11:00 a.m. Sunday, the Contractor receives an additional incentive of $5,000.00 per each 15-minute period earlier opening to a maximum of four periods, for a total maximum of $20,000.00.
- The total maximum incentive is $40,000.00.

Disincentive for Not Opening Lane 1 (Median Lanes) or Lane 3 (Outside Through Lanes)
- If eastbound and westbound median lanes are NOT completed prior to 11:01 a.m. Sunday, a penalty of $20,000.00 to the Contractor.
- After 11:01 a.m. Sunday, a additional penalty of $5,000.00 per each 15-minute period to a maximum of four periods, for a total maximum of $20,000.00.
- The total maximum disincentive is $40,000.00.
Incentive for Opening Lane 2 and the Ramps

- If Lane 2 and ramps are completed by prior to 12 noon, Sunday, the Contractor receives an incentive of $20,000.00.
- In the event that work required in opening lane 2 and the ramps to public traffic to a usable facility is completed prior to 12 noon, Sunday, the Ministry will pay to the Contractor an additional incentive of $5,000.00 per each 15-minute period to a maximum of four periods, for a maximum of $20,000.00.
- The total maximum incentive is $40,000.00.

Disincentive for Not Opening Lane 2 and the Ramps

- In the event that all work required in opening lane 2 and the ramps to public traffic is NOT completed to a usable facility prior to 12:01 p.m. Sunday, the Ministry will deduct from its payments to the Contractor $25,000.00.
- In the event that all work required in opening lane 2 and the ramps to public traffic is NOT completed to a usable facility prior to 12:01 p.m., Sunday, the Ministry will deduct from its payments to the Contractor an additional $10,000.00 per each 15-minute period thereafter until 5:00 p.m., Sunday to a maximum of $200,000.

What does all this mean?

- If things go great, the contractor receives $80,000 incentive per weekend
- If things go very badly then the contractor is penalized $280,000 per weekend

WHY?

HIGHLY DETAILED PLANNING REQUIRED FROM START TO FINISH
PRE-RAPID BRIDGE REPLACEMENT

- Six-months of non-stop planning and pre-rapid lift work
- Strategic resource management of equipment and labour
- Developed a plan with 5 minute milestones with comprehensive if-then-else mitigation measures
- Several field engineers whose sole responsibility was to track and report progress to Superintendent

GEOTECH

"The temporary supports located in the construction staging area shall have adequate foundation capacity to prevent settlement before, during and after the construction of the superstructure.

The maximum permissible settlement at any point in the temporary structure shall be 4 mm and the maximum differential settlement between any two points in the temporary structure shall be 2 mm."

Temporary Structures

- "Hi-load" concrete sill pads, size 1.2 m x 1.2m
- Using the dimensions of the sill pad and the loading values, contact stresses of 127 kPa (Carling Ave Structure) and 114 kPa (Kirkwood Structure) were calculated at the top of the granular pad. At the natural ground surface, below a 0.6 m thick granular pad, the contact stresses were calculated to be 59 kPa (Carling Ave Structure) and 51 kPa (Kirkwood Structure).
- The ULS factored bearing resistance for the native material, based on the geotechnical information provided, was 100 kPa. Therefore, the applied bearing stresses of 56 kPa and 51 kPa were acceptable.
Self-Propelled Modular Transporters (SPMT)

- Based on the loading provided, the SPMT, under loading during transport of the bridges, will have a maximum contact stress of 100 kPa. At the natural ground surface, below a 0.6 m thick granular pad, the contact stress is calculated to be 40 kPa.
- The ULS factored bearing resistance for the native material, based on the geotechnical information provided, is 100 kPa. Therefore, the applied bearing stress of 40 kPa is acceptable.

Strategic surveying techniques
- Double-checking the numbers
- Skew angles
- Bearing elevations
- Span lengths
- Ensuring the optimal level of detail & accuracy is achieved
- Getting the right fit

TEMPORARY SHORING

- Standard 25K shoring frames were used
- Differential elevation was critical
- Choice of temporary shoring system greatly impacts how old bridges will be demolished
SEQUENCE OF OPERATIONS

- Pre-rapid Lift
- Rapid Lift
- Post Rapid Lift

Pre-Rapid Lift Operations
To be completed during 3 weekends in lane closures

- Removal of the approach slabs and asphalt;
- Earth excavation;
- Saw-cutting and stabilizing of the ballast walls;
- Backfilling to the existing structure ballast walls including sub-drain installation and connection to;
- Sub-drain below; and
- Placement of temporary hot mix asphalt.

Rapid Lift Operations
To be completed on a weekend with full lane closure

- Earth excavation;
- Removal of the existing EBL and WBL superstructures (including the attached ballast walls) from their existing location and transportation to the construction staging area for dismantling;
- Transportation and erection of the new EBL and WBL superstructures from the construction staging area to their permanent location;
- Granular backfilling to the structure;
- Placement of hot mix asphalt on structures and lanes 1, 2 and 3, and corresponding shoulders;
- Placement of hot mix asphalt on approaches except for exterior portions of eastbound and westbound structures;
- Installation of temporary concrete barriers.

POST Rapid Lift Operations
To be completed during 3 weekends in lane closures

- Earth excavation (including saw-cutting and removal of hot mix asphalt);
- Grading and placement of granular base for approach slabs;
- Construction of approach slabs using rapid set concrete (or alternatively precast approach slabs);
- Placement of hot mix asphalt on approach slabs and in the exterior portions of the eastbound and westbound structures (e.g., future Lane 4 and shoulder);
- Placement of median barrier walls on approach slabs using rapid set concrete and including electrical embedded work.
NIGHT WORK

- Working at night, enabled minimal traffic disruption
  - An estimated 136,000 vehicles travel Highway 417’s bridges on a daily basis
  - Commuter friendly technology
  - Alternate techniques construct bridges section by section in long term lane closures, creating major traffic delays

NIGHT WORK (On Weekends)

- Less traffic disruption and greater public satisfaction
- Cost and time benefit savings
- Becoming the standard bridge replacement technique in heavily travelled highways

FUTURE OF RAPID BRIDGE DEPLOYMENT

- Lift/transport & place precast footings
- Pressure grout gaps between leveling pads and underside of new footings
- Drill & install dowels
- Lift/transport and dry-fit rigid frame on new fittings; repeat dry-fit and grinding until full contact has been made between surfaces
- Grout key immediately prior to final lowering upon attaining requisite contact area criteria

FUTURE OF RAPID BRIDGE REPLACEMENT

Two Lift Pilot Project for Rigid Frame Bridge
Rigid frame bridge transported complete with footings from adjacent yard
New bridge temporarily set on shim plates; space between bottom of new footings and top of existing footings is pressure grouted
New footings are doweled into existing bridge footings

FUTURE OF RAPID BRIDGE REPLACEMENT
Single Lift Pilot Project

BRIDGE REPLACEMENT
Eragny France

Finger installed in lifting pocket in wall of precast bridge

RAPID BRIDGE REPLACEMENT
Eragny France

Less traffic disruption and greater public satisfaction
Cost and time benefit savings
Used whenever and wherever possible
Becoming the standard bridge replacement technique
Longer bridge life expectancy
AGENDA

• Introduction: Mammoet & Frido deGreef
• Pro’s of ABC: Move by example
• ABC move methods: Vertical, Horizontal, Monitoring
• What goes up must come down: Removal of old structures
• Procuring ABC lifting & transportation solution Cost, quality,
**INTRODUCTION: Frido deGreef**

- Studied Ship’s Engineering in Netherlands.
- Started @ Mammoet in 1990: Weighing Engineer, SPMT Equipment Engineering, Equipment manager, Procurement manager, Account Manager.
- Live in Lake Jackson, TX with wife Kim & 4 kids.

**First civil job: small church in Germany; 45 x 45ft; 300 ton**

---

**INTRODUCTION: MAMMOET GLOBAL**

Mammoet: A Global Brand With Local Experience

- Global Revenues: USD $1.4B+
- Employees: ~5,000
- Cranes: >1,400
- SPMT’s: >2,700 axle lines
- Conventional Lines: >1,650 axle lines
- Jacking & Skidding: >40,000 ton capacity
- Worldwide Offices: 80

London’s EYE construction time was cut in half!!

---

**INTRODUCTION: MAMMOET USA, INC.**

Global coordination with local experience

- Incorporated 1989
- Employees: ~400
- Cranes: >35 (440-3300ton)
- SPMT’s: >500 axle lines
- Conventional Lines: >400 axle lines
- Locations: Rosharon, TX; Houston, TX; Port Allen, LA; New Iberia, LA; Atlanta, GA; Vancouver, WA; Rockdale, IL

We live where we work!

---

**“MAMMOET IS A COMPANY FULLY COMMITTED TO SAFETY”**

- Decreasing EMR/IMR As Workload Increases

**THE TARGET**

0 ACCIDENTS/INCIDENTS

---

Mammoet USA, Inc.: EMR October 2013: 0.41, TRIR 0.70
**PRO'S OF ABC: Move by example: Mammoet Netherlands**

Fact Sheet:
- Weight: approx. 2500 ton
- Height: 120 ft
- Max 5° allowed
- 10 Stories, 45000 sqft
- Transport: 11/10/2001

Rail Bridge had to be overridden for last 3ft of clearance

---

**ABC MOVE METHODS**

- **VERTICAL**
  - Cranes
  - Tower Systems
    - Strand JACKs
    - Gantry Systems
  - Jacking
    - Climbing JACKs
    - Titan Systems
    - JS 500

- **HORIZONTAL**
  - Trailers
    - SPMT’s
    - Conventional Trailers
  - Skidding
  - Barging

**MONITORING**

**Considerations:**
- Possibility for use in demolition / removal projects. Major savings possible if in combination with installation!!

---

**PRO'S OF ABC: Move by example: Mammoet USA**

Fact Sheet:
- Weight: approx. 1200 ton
- Fully functional within 2 weeks after move
- Max 2° slant allowed
- 2 Stories, 32,000 sqft
- Transport: 12/17/2011

Total distance transported: ½ mile in 4 hours

---

**ABC MOVE METHODS**

- **VERTICAL**
  - Cranes
  - Tower Systems
    - Strand JACKs
    - Gantry Systems
  - Jacking
    - Climbing JACKs
    - Titan Systems
    - JS 500

- **HORIZONTAL**
  - Trailers
    - SPMT’s
    - Conventional Trailers
  - Skidding
  - Barging

**MONITORING**

**Considerations:**
- Possibility for use in demolition / removal projects. Major savings possible if in combination with installation!!

---

**IMPACT TO YOUR BUDGET**

<table>
<thead>
<tr>
<th>Engineering</th>
<th>$650k</th>
<th>$550k</th>
<th>$450k</th>
<th>$350k</th>
<th>$0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Availability (probabil)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mob / Demob</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Installing of equipment</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed of execution</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Demolition possibilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>OVERALL IMPACT TO BUDGET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
ABC MOVE METHODS

**VERMICAL**
- Cranes
- Tower Systems
  - Strand Jacks
  - Gantry systems
- Jacking
  - Climbing Jacks
  - Titan Systems
  - JS 500

**HORIZONTAL**
- Trailers
  - SPMT’s
  - Conventional Trailers
- Skidding
- Barging

**MONITORING**

**Considerations:**
- Ideal for hard to reach areas
- Extreme savings when implemented early in design phase
- Computer controlled slow lift
- Can be used for bridge removal

**IMPACT TO YOUR BUDGET**

### 13
For cost savings mount strand jacks on your structure

### 14

### 15
Strands will be considered scrap after use

### 16

---

**VERMICAL**
- Cranes
- Tower Systems
  - Strand Jacks
  - Gantry systems
- Jacking
  - Climbing Jacks
  - Titan Systems
  - JS 500

**HORIZONTAL**
- Trailers
  - SPMT’s
  - Conventional Trailers
- Skidding
- Barging

**MONITORING**

**Considerations:**
- 1000-300t-900t capacity per tower, with multiples per tower possible
- Hammerhead tower design ideal for bridges
- Electrical power possible
- Support cranes needed

**IMPACT TO YOUR BUDGET**

### 13
For cost savings mount strand jacks on your structure

### 14

### 15
Strands will be considered scrap after use

### 16
ABC MOVE METHODS

- **VERTICAL**
  - Cranes
  - Tower Systems
    - Strand Jacks
    - Gantry systems
  - Jacking
    - Climbing Jacks
    - Titan Systems
    - JS 500
- **HORIZONTAL**
  - Trailers
    - SPMT’s
    - Conventional Trailers
  - Skidding
  - Barging
- **MONITORING**

**Considerations:**
- Pressure point to both structure as well as support
- Height restricted
- Labor intensive, slow

**Jacks come from 5-1000ton with strokes up to multiple feet**

---

ABC MOVE METHODS

- **VERTICAL**
  - Cranes
  - Tower Systems
    - Strand Jacks
    - Gantry systems
  - Jacking
    - Climbing Jacks
    - Titan Systems
    - JS 500
- **HORIZONTAL**
  - Trailers
    - SPMT’s
    - Conventional Trailers
  - Skidding
  - Barging
- **MONITORING**

**Considerations:**
- Ideal in combination with SPMT’s
- Extremely stable & support friendly

**OVERALL IMPACT TO BUDGET**

---

**IMPACT TO YOUR BUDGET**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
ABC MOVE METHODS

- VERTICAL
  - Cranes
  - Tower Systems
    - Strand Jacks
    - Gantry systems
  - Jacking
    - Climbing Jacks
    - Titan Systems
    - JS 500

- HORIZONTAL
  - Trailers
    - SPMT’s
    - Conventional Trailers
  - Skidding
  - Barging

- MONITORING

ABC MOVE METHODS

- VERTICAL
  - Cranes
  - Tower Systems
    - Strand Jacks
    - Gantry systems
  - Jacking
    - Climbing Jacks
    - Titan Systems
    - JS 500

- HORIZONTAL
  - Trailers
    - SPMT’s
    - Conventional Trailers
  - Skidding
  - Barging

- MONITORING

Impact to Your Budget

| Engineering | X |
| Spacelift | X |
| Availability | 2014-2020 | X |
| Mob / Demob | X |
| Installing of equipment | X |
| Speed of execution | X |
| Demolition possibilities | X |
| OVERALL IMPACT TO BUDGET | X |

Considerations:
- Above 33 ft additional bracing needed
- Stable
- Computer controlled jacking
- 500 ton per tower

IMPACT TO YOUR BUDGET

| Engineering | |
| Spacelift | |
| Availability | 2014-2020 | |
| Mob / Demob | |
| Installing of equipment | |
| Speed of execution | |
| Demolition possibilities | |
| OVERALL IMPACT TO BUDGET | |
**ABC MOVE METHODS**

- **VERTICAL**
  - Cranes
  - Tower Systems
    - Strand Jacks
    - Gantry systems
  - Jacking
    - Climbing Jacks
    - Titan Systems
    - JS 500
- **HORIZONTAL**
  - Trailers
    - SPMTs
    - Conventional Trailers
  - Skidding
  - Barging
- **MONITORING**

**Considerations:**
- Ground pressure
- Extremely versatile
- Bracing between SPMT’s and structure is extremely important
- Air filled tires

**IMPACT TO YOUR BUDGET**

<table>
<thead>
<tr>
<th>Engineering</th>
<th>Speciation</th>
<th>Speed of execution</th>
<th>Demolition possibilities</th>
<th>OVERALL IMPACT TO BUDGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**MAMMOET**

---

**ABC MOVE METHODS**

- **VERTICAL**
  - Cranes
  - Tower Systems
    - Strand Jacks
    - Gantry systems
  - Jacking
    - Climbing Jacks
    - Titan Systems
    - JS 500
- **HORIZONTAL**
  - Trailers
    - SPMTs
    - Conventional Trailers
  - Skidding
  - Barging
- **MONITORING**

**Considerations:**
- 30 ton per axle line!!
- 360° steering
- Spacers available for cost savings
- Titan system combination
- Hydraulic systems can be set up for 3 or 4 point set up.

**IMPACT TO YOUR BUDGET**

<table>
<thead>
<tr>
<th>Engineering</th>
<th>Speciation</th>
<th>Speed of execution</th>
<th>Demolition possibilities</th>
<th>OVERALL IMPACT TO BUDGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**MAMMOET**

---

**ABC MOVE METHODS**

- **VERTICAL**
  - Cranes
  - Tower Systems
    - Strand Jacks
    - Gantry systems
  - Jacking
    - Climbing Jacks
    - Titan Systems
    - JS 500
- **HORIZONTAL**
  - Trailers
    - SPMTs
    - Conventional Trailers
  - Skidding
  - Barging
- **MONITORING**

**Considerations:**
- 10ft wide & thus more stable than SPMT if used as single trailer
- Less steering possibilities in most conventional trailer types
- Different loading chart for different types and brands

**IMPACT TO YOUR BUDGET**

<table>
<thead>
<tr>
<th>Engineering</th>
<th>Speciation</th>
<th>Speed of execution</th>
<th>Demolition possibilities</th>
<th>OVERALL IMPACT TO BUDGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**MAMMOET**

---

25 SPMT stands for Self Propelled Modular Trailer  (containerized cargo)

27 Cost & safety impact: SPMT to SPMT to structure bracing

A-118
ABC MOVE METHODS

- **VERTICAL**
  - Cranes
  - Tower Systems
    - Strand Jacks
    - Gantry systems
  - Jacking
    - Climbing Jacks
    - Titan Systems
    - JS 500

- **HORIZONTAL**
  - Trailers
    - SPMT’s
    - Conventional Trailers
  - Skidding
  - Barging

- **MONITORING**

  - **Considerations:**
    - Great solution for value engineering

  - Engineering
  - Specification
  - Availability (from 2014-2020)
  - Mob / Demob
  - Installing of equipment
  - Speed of execution
  - Demolition possibilities
  - Installing of equipment
  - Overall impact to budget

  - Engineering
  - Specification
  - Availability (from 2014-2020)
  - Mob / Demob
  - Installing of equipment
  - Speed of execution
  - Demolition possibilities
  - Installing of equipment
  - Overall impact to budget

**Considerations:**
- Great solution for value engineering
- Combination with jacking / installation
- Loads from 100-750 ton

- Weather, water level
- Additional equipment needed: ballasting, winching, mooring, tugs
- Deck load calculations
- Can be used for spacing between other barges

Engineering is required on most additional equipment needed
ABC MOVE METHODS

• VERTICAL
  - Cranes
  - Tower Systems
    - Strand Jacks
    - Gantry Systems
  - Jacking
    - Climbing Jacks
    - Titan Systems
    - JS 500

• HORIZONTAL
  - Trailers
    - SPMT’s
    - Conventional Trailers
  - Skidding
  - Barging

• MONITORING

<table>
<thead>
<tr>
<th>Considerations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load cells 5-750ton</td>
</tr>
<tr>
<td>Lasers for measuring and / or compare distance</td>
</tr>
<tr>
<td>Strain gauges for stress indication</td>
</tr>
<tr>
<td>Pressure indicators for hydraulic cylinders</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact to Your Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
</tr>
<tr>
<td>Speculation</td>
</tr>
<tr>
<td>Availability</td>
</tr>
<tr>
<td>Mob / Derrick</td>
</tr>
<tr>
<td>Installing of equipment</td>
</tr>
<tr>
<td>Speed of execution</td>
</tr>
<tr>
<td>Derrivation possibilities</td>
</tr>
<tr>
<td>Overall Impact to Budget</td>
</tr>
</tbody>
</table>

WHAT GOES UP MUST COME DOWN

Most structures can be removed by using same methods as for installation. Keep in mind:
- Deterioration of structural members for support or lifting
- Weight prediction
- Cost savings when structure is lowered to manageable height for demolition access

ABC MOVE METHODS

• VERTICAL
  - Cranes
  - Tower Systems
    - Strand Jacks
    - Gantry systems
  - Jacking
    - Climbing Jacks
    - Titan Systems
    - JS 500

• HORIZONTAL
  - Trailers
    - SPMT’s
    - Conventional Trailers
  - Skidding
  - Barging

• MONITORING

<table>
<thead>
<tr>
<th>Considerations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software written for special projects</td>
</tr>
<tr>
<td>Generic software is available</td>
</tr>
<tr>
<td>Warnings based on parameters indicated by owner / engineering bureau</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact to Your Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
</tr>
<tr>
<td>Speculation</td>
</tr>
<tr>
<td>Availability</td>
</tr>
<tr>
<td>Mob / Derrick</td>
</tr>
<tr>
<td>Installing of equipment</td>
</tr>
<tr>
<td>Speed of execution</td>
</tr>
<tr>
<td>Derrivation possibilities</td>
</tr>
<tr>
<td>Overall Impact to Budget</td>
</tr>
</tbody>
</table>

PROCURING ABC LIFTING & TRANSPORTATION SOLUTION

Procurement is the acquisition of goods, services or works from an external source. It is favorable that the goods, services or works are appropriate and that they are procured at the best possible cost to meet the needs of the purchaser in terms of quality and quantity, time, and location.
Corporations and public bodies often define processes intended to promote fair and open competition for their business while minimizing exposure to fraud and collusion.
**PROCURING AN ABC LIFTING AND TRANSPORT SOLUTION**

- **Best possible cost** practices:
  - Method of lift and / or transport to be reviewed by specialized engineers
  - Support and lifting points to be designed in early stage of engineering
  - Construction of structure as low as possible but with ample space for transportation or lifting access
  - Combine removal and installation of structures with same equipment
  - Involve lifting / transportation contractor in design phase

Savings up to 20-30% of contract value can be achieved

**PROCURING AN ABC LIFTING & TRANSPORT SOLUTION**

- **Quality & Quantity** practices:
  - Education and experience should be documented for all involved in preparation and execution of project: training, testing, certification of employees.
  - Safety should not be reactive but pro-active: training, pre-employment & random drug screens, kick off, toolbox & lessons learned meetings.
  - Equipment maintenance & repairs according or surpassing guide lines of manufacturers, spare part management, documentation & certification.
  - Communication of whole project through available & clear lines.

Equipment maintenance shows when it stops working

**PROCURING AN ABC LIFTING & TRANSPORT SOLUTION**

- **Best possible cost** avoidances:
  - Adding extra weight
  - False work
  - Custom made rigging, towers, etc.
  - Extreme deadlines

Extra equipment
Transportation
Fabrication
Labor cost

**PROCURING AN ABC LIFTING & TRANSPORT SOLUTION**

- **Quality and quantity** avoidances:
  - Engineering guidelines unclear
  - Poor planning for mob /demob
  - On-site spectators

Site congestion
Liability

A safe employee is trained BEFORE entering your site