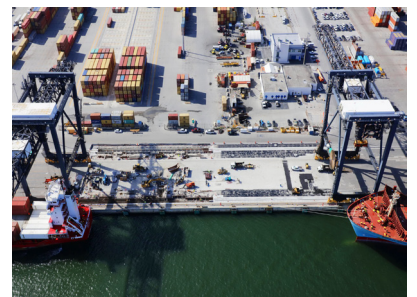
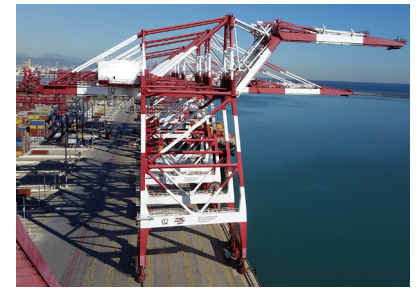


CRANE REPAIR SERVICES

Liftech Consultants Inc.

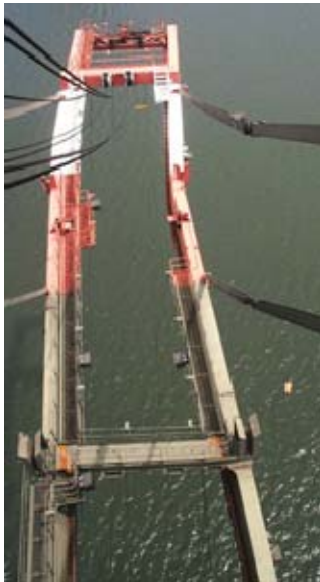


Liftech
LIFTECH CONSULTANTS INC.

ABOUT US

Founded in 1964, Liftech Consultants Inc. is an internationally recognized engineering firm specializing in container cranes, heavy lift cranes, rigging, vessels, wharves, marine structures, industrial and commercial buildings, and other special structures. We are at the forefront of marine terminal technology and strive to develop new technology that improves terminal productivity and safety. We are recognized worldwide as experts in the design of container handling cranes and other equipment. Our international clients include owners, engineers, operators, manufacturers, contractors, consultants, riggers, and architects.

ABOUT YOU – GETTING YOUR EQUIPMENT BACK TO WORK



Fatigue cracking and failures, corrosion, ship-to-crane collisions, crane-to-crane collisions, boom hoist failures, main hoist snag failures, dropped hatch covers and containers, earthquakes, severe winds, fire—when something happens to your equipment, you need it back up and running quickly, reliably, and safely.

Liftech's engineers have been designing, reviewing, and helping repair container cranes and other equipment for over 50 years. We are familiar with most worldwide container and bulk handling equipment designs and have an extensive library of analysis models, drawings, and designs that can be quickly adapted for a wide range of equipment. We have state-of-the-art calculation tools including our own in-house analysis software specially designed for cranes and fatigue loading. Combining our experience, our library, and our tools, we provide solutions that save money and get equipment back in safe and reliable operation as quickly as practical.

Our contribution to projects is tailored to meet your needs efficiently and quickly without unnecessary duplication of effort. The following are some ways we can help you get your equipment back to work:



- Review damage, including timely site visits and recommendations for securing damaged equipment

- Design repair concepts

- Perform analyses and special investigations

- Provide repair procedures, including design drawings or shop drawings with notes to help the contractor

- Provide field support and on-site engineering for repairs

- Provide geometry survey procedures to evaluate alignment

- Provide test procedures to identify causes of fatigue cracking

- Perform strain and acceleration measurements to identify the cause of fatigue cracking and inform design modifications to improve performance

- Perform forensic engineering investigation and analysis of failures including determination of root cause and failure progression

ATTACHMENTS

The following documents are related to Liftech's Crane Repair Services. For more information about us, please visit our website: www.Liftech.net

Selected Crane Repair Projects

Sample Projects

Company Principals

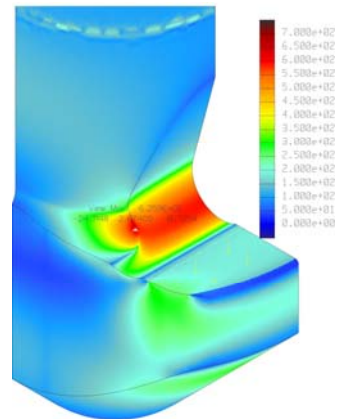
CONTACT INFORMATION

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Nick Grebe
Mechanical Engineer
NGrebe@Liftech.net



Client & Location	Year	Type	Project Description
Long Beach Container Terminal	2022	Intermodal Yard Crane	Provided detailed study including analysis and strain gage measurements to determine cause of premature fatigue cracking of the trolley girder. Provided repair procedures, developed structural and mechanical modification concepts, and addressed alignment requirements for the rail system, trolley girder, and trolley roller system to significantly improve the reliability of the rail system, trolley girder, and guide roller system.
Port Everglades Department, Broward County, Florida	2022	Samsung Low Profile Crane	Provided repair procedures for corrosion damage of the boom truss.
Modern Terminals Limited, Hong Kong	2022	Noell A-frame, monogirder boom	Provided damage assessment and repair procedures for a boom damaged by colliding with a crane on the ship. Provided damage assessment and repair procedures for a trolley damaged by colliding with a ship.
Modern Terminals Limited, Hong Kong	2022	WTUPMD Pedestal Crane	Provided repair procedures for fatigue cracking of anchor bolts between the pedestal base and foundation including pedestal modification details and tensioning requirements to significantly improve reliability.
Modern Terminals Limited, Hong Kong	2022	MHI STS Crane	Provided damage assessment and repair procedures for fatigue cracking in the landside legs. Provided repair procedures for fatigue cracking of boom tie beams.
DP World Fraser Surrey Canada	2022	Doosan STS Crane	Provided damage assessment and repair procedures for waterside leg damaged by colliding with a ship.
Confidential, South America	2022	Furnace Crane	Provided repair procedures to repair the cracking of the trolley girder.
APM Terminals Port of Los Angeles, California	2018-2022	Noell A-frame, monogirder boom	Provided damage assessment and repair procedures for a sill beam damaged by dropping a container on it. Provided repair procedures for fatigue cracking of equalizer beams. Provided repair procedures for fatigue cracking of the upper diagonal. Provided repair procedures for fatigue cracking of the MOT trolley. Provided repair procedures for fatigue cracking in the equalizer beams.
Timber Automation	2018-2022	Timber Log Boom Cranes	Provided repair procedures for fatigue cracking of various structural components of the cranes, some will significantly improve reliability.
Maher Terminals Elizabeth, New Jersey	2021	Fantuzzi STS Cranes	Provided repair procedures for fatigue cracking of the legs and main equalizer beams.

Client & Location	Year	Type	Project Description
Evergreen Shipping Agency Port of Los Angeles, California	2021	ZPMC STS Crane	Provided damage assessment and repair procedures for a portal beam damaged from collisions with yard equipment.
Everport Terminal Services Port of Oakland	2021	ZPMC STS Crane	Provided damage assessment and repair procedures for boom damaged from colliding with a ship.
Port Everglades Department, Broward County, FL	2021	Paceco STS Crane	Provided repair procedures for corrosion damage of the boom.
Confidential, South America	2018, 2021	Bauxite Loader	Provided repair procedures to correct significant design deficiencies and repair fatigue cracking in the boom. Provided design of new upper diagonal and reinforcements to the boom and various other structures. Provided support to replace the damaged boom. Performed a detailed analysis of the snag load condition and provided recommendations to mitigate the snag risk including bucket modifications and a hydraulic snag fuse that limits the loading.
Everport Terminal Services Port of Oakland	2020	ZPMC STS Crane	Provided damage assessment and repair procedures for waterside leg damaged and crane derailment by colliding with a ship.
Confidential, North America	2020	Coke Loader	Developed repair/replacement procedures to correct significant structural design deficiencies in a loader system, some of which had resulted in significant failures during operation.
Modern Terminals Limited, Hong Kong	2019	Noell A-frame, monogirder boom	Provided repair procedures to isolate the cladding from the trolley structure to accommodate the small amount of warping that occurs. Modifications will eliminate chronic cladding failures, allow warping to equalize the trolley wheel loads, and reduce trolley wheel and rail wear.
Portek	2017	MHI STS Crane	Repaired a boom that was damaged due to overtopping.
APM Terminals Port of Los Angeles, California	2015	Noell A-frame, monogirder boom	Provided damage assessment and repair procedures for a trolley damaged by colliding with a ship.
Various	2006 to 2012	ZPMC & others	Performed finite element analyses and fatigue studies. Provided/reviewed procedures for dozens of cranes with fatigue cracking in some equalizer beam web plates.
Port Everglades Midport Terminal, Florida	2012	Paceco A-frame, plate girder boom	Provided repair procedures for boom damage caused by overtopping the boom.
Termont Terminals Montreal, Canada	2011	Liebherr A-frame, twin girder boom	Assessed damage and provided repair procedures for leg damaged by vessel collision.
APM Terminals Portsmouth, Virginia	2011	ZPMC A-frame, monogirder boom	Assessed damage and provided repair procedures. Damaged when a vessel departing from the berth collided with the crane boom tip.

Client & Location	Year	Type	Project Description
GENPS Port of Kelang, Malaysia	2011	Hyundai A-frame, twin girder boom	Assessed damage and provided repair procedures for frame damaged by vessel collision.
Panama Ports Corporation Cristobal, Panama	2011	Hitachi and Samsung A-frame, twin girder boom cranes	Provided a variety of repair procedures, oversaw some repairs, and reviewed completed repairs for: boom tip platform damage from a snag accident, portal tie repair damage caused by a reach stacker, corrosion damage to boom tip platform, and corrosion damage to apex beam.
Freeport Container Port Freeport, Bahamas	2011	Hyundai A-frame, monogirder boom	Assessed tornado damage, provided repair procedures, and reviewed repairs for a variety of damage to five cranes.
San Antonio Terminals Internacional San Antonio, Chile	2011	Paceco Gunanusa A- frame, twin girder boom	Assessed earthquake-related damage and provided repair procedures for two Paceco cranes.
Virginia International Terminals, North Terminal Norfolk, Virginia	2010	ZPMC A-frame, twin girder boom	Provided repair procedures for waterside leg damaged by vessel collision.
Robert Reid & Associates Port of Burnie Tasmania, Australia	2010	Deerpark A-frame, twin girder boom	Assessed damage and provided repair procedures for both waterside legs damaged by vessel collision.
Various	2003 to 2009	Various	Performed finite element analyses and fatigue study. Provided repair procedures and modification concepts to improve the fatigue details on the forestay connections on dozens of cranes.
APL Limited Pier 300, Port of Los Angeles, California	2008	Noell A-frame, monogirder boom	Provided repair procedures, including temporary bracing and improved details, for repairing fatigue cracking in the pipe backstrut system of ten cranes.
APM Terminals Pier 400, Port of Los Angeles, California	2008	Noell A-frame, monogirder boom	Performed analytical and experimental studies. Provided repair procedures and modification concepts to significantly improve portal frame performance.
Maher Terminals Elizabeth, New Jersey	2007	Paceco A-frame, plate girder boom	Assisted with repairing crane-ship collision damage to boom girders and boom ties. Repairs involved replacement of boom sections and heat straightening.
Jakarta International Container Terminal Jakarta, Indonesia	2007	Sumitomo A-frame, truss boom	Assessed crane damage resulting from boom hoist failure and provided repair concepts.
Matson Navigation Co. Sand Island, Hawaii	2007	MES barge cranes and runways	Reviewed corrosion damage to two barge cranes and their runways and provided repair procedures.
Yantian International Container Terminals Ltd. Shenzhen, China	2006	Konecranes	Provided design to obtain structural redundancy to protect against failures due to material laminations in fracture critical members.
Port of Felixstowe Felixstowe, England, UK	2006	ZPMC A-frame, box girder boom	Assessed crane damage resulting from vessel collision and provided repair procedures.
APL Limited Kaohsiung, Taiwan	2005	ZPMC A-frame, box girder boom	Provided repair procedures including details for repair of ship-related damage to waterside leg.

Client & Location	Year	Type	Project Description
Port Everglades Southport Terminal, Florida	2005	Samsung low profile, truss boom	Reviewed leg damage caused by Hurricane Wilma.
Port Everglades Midport Terminal, Florida	2005	Paceco A-frame, box girder boom	Reviewed ship damage to crane, developed repair procedures, and oversaw repairs.
Port Everglades Southport Terminal, Florida	2005	Low profile, truss boom	Provided repair procedures for boom carriage wheel replacement.
Hongkong International Terminals Terminal 7, Hong Kong	2004	MES A-frame, box girder boom	Performed finite element analysis and fatigue study. Provided repair procedures and modification concepts.
Port Everglades Midport Terminal, Florida	2004	Konecranes A-frame, monogirder boom	Provided repair procedures for damage to sill beam caused by dropping a container.
Port Everglades Midport Terminal, Florida	2004	Paceco A-frame, box girder boom	Provided heat straightening repair procedures for damage caused by collision with vessel.
Port Everglades Southport Terminal, Florida	2003	Low profile, truss boom	Provided repair procedures for crane wheel derailment caused by collision with another low profile crane.
Hutchison Port Holdings Pusan Terminals, South Korea	2003	Daewoo A-frame, twin girder boom	Assessed damage and provided repair procedures for five cranes damaged by Hurricane Maemi.
Termont Terminal Montreal, Canada	2002	Liebherr tango A-frame, truss boom	Assisted with repairing damage caused by wind-induced collision between cranes. Landside and waterside frames were distorted. Repairs involved heat straightening the frames to repair distortions and localized buckling damage.



Crane Repair Port of Oakland, California

On February 7, 1997, a ship struck a Krupp crane at the Port of Oakland. The bow hit one of the waterside legs just above the portal beam, about 45' above the rail. The impact pushed the waterside legs 35" to the right and 30" toward the land. Because the wheels remained on the rail, the sill beams at the waterside and landside partially separated from the equalizer beams.

Liftech helped the port temporarily secure the crane, then reposition and repair the damage. The crane was secured by installing posts at two corners and a crib pile under the sill beam near one corner.

The crane was repositioned by lifting the waterside legs with a mobile crane, jacking up the landside legs, and jacking the landside horizontally until it could be placed back down on the equalizer assemblies. Replacing the buckled plates in the area of ship impact repaired the damaged leg.

The crane was recommissioned one week after the accident.

Reference:
Port of Oakland
Oakland, California, USA



Repair of Damaged Crane Booms Various Locations

Container crane booms are frequently damaged due to ship collisions.

Liftech has been involved in dozens of repairs and provides all aspects of engineering for repairs. Repairs range from rebuilding damaged sections to stiffening damaged sections to heat straightening damaged locations.



VIT Paceco Crane and Wharf Damage Review Newport News Marine Terminal, Virginia

Paceco Crane 313 was struck by a departing ship on January 31, 2004. Virginia International Terminals retained Liftech to review the damaged crane and wharf, design temporary bracing to stabilize the crane, and design repair details for the damaged crane stop.

Reference:
Virginia International Terminals, Inc.
Norfolk, Virginia, USA

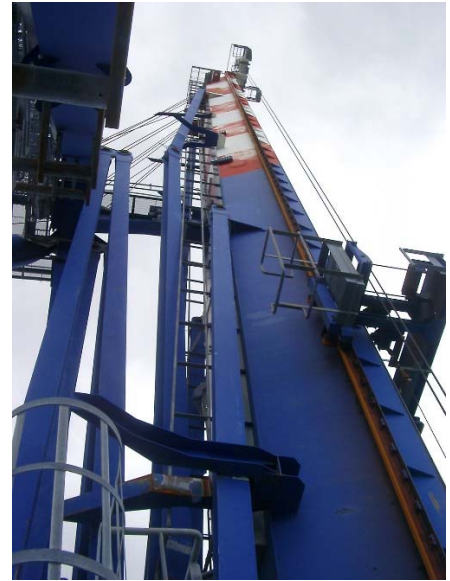


Crane Damage Assessment Pusan, Korea

On September 12, 2003, Typhoon Maemi struck the Dongbu Pusan Container Terminal causing the sequential collapse of six out of seven HHI container cranes at the terminal.

Liftech was retained to assist with the damage investigation and to provide expert opinion on technical issues related to the design and fabrication of the stowage hardware on the crane and in the wharf.

Reference:
Woo Un Kang Jeong & Han
Seoul, Korea



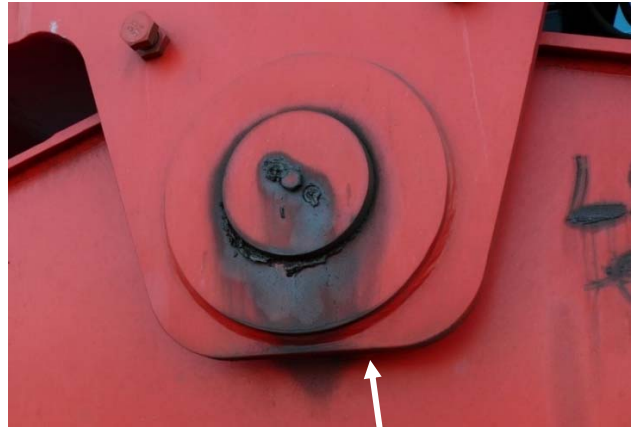
Crane Damage Assessment Freeport, Grand Bahama

The forestays of an Officine Meccaniche Galileo (OMG) crane were twisted and became entangled as a result of Hurricane Frances in September 2004. Liftech was retained to assist with the assessment and repair of the forestay system.

Reference:
Freeport Container Port Limited
Freeport, Grand Bahama



Equalizer Beams



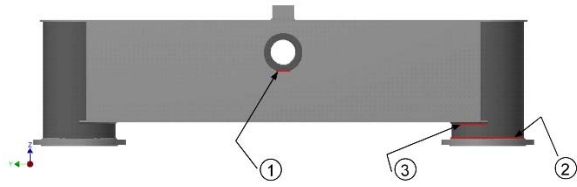
Intermediate equalizer beam crack (lower photo) that is obstructed by the pin ear plate in the upper photo.

STS Equalizer Beam Cracking Various Locations

As container cranes become bigger and faster, new types of fatigue problems emerge. Fatigue cracking of pin plates in equalizer beams has occurred in many cranes, made by different manufacturers, at various locations.

Liftech has been involved in numerous equalizer beam repairs. We have investigated the cause of the fatigue cracking, performed structural analyses, provided modification concepts, assessed the effectiveness of the modifications, and helped develop new equalizer beam designs.

Liftech's fatigue studies indicate that the modifications and new designs will significantly improve the fatigue performance of the equalizer beams.



1. Equalizer beam web under center equalizer pin



2. End pipe stub column at bolted flange plate



3. End pipe stub column at equalizer beam bottom flange

RTG Equalizer Beam Cracking Various Locations

Equalizer beam fatigue cracking has occurred in many rubber tire gantry cranes at various locations. The fatigue cracking is caused by a combination of factors including high fatigue stresses, undersirable design details, and poor workmanship.

Liftech has been involved in several RTG equalizer beam repairs. We have investigated the cause of the fatigue cracking, performed structural analyses, provided modification concepts, assessed the effectiveness of the modifications, and helped develop new equalizer beam designs.

Liftech's studies indicate that the modifications and new designs will significantly improve the fatigue performance of the equalizer beams.



Hyundai Crane Damage Assessment and Repair Freeport, Grand Bahama

A tornado damaged six Hyundai monogirder cranes and toppled another. Liftech assessed the damage to the untoppled cranes and assisted with engineering for the repairs.

Hyundai Crane 9 suffered severe damage when it collided with Crane 10. The boom detached from the right lower hinge pin, the upper hinge broke off, the forestay apex connection plate bent, and the boom rotated more than 45 degrees.

The boom was brought back into its lower hinge seating, the upper hinge connections were replaced, and the forestay connection plates were heat straightened.

Liftech also assisted with engineering for modifications to the gantry and gantry connections, geometry survey procedures, and reinforcing for recent wind code requirements.

Reference:
Freeport Container Port Limited
Freeport, Grand Bahama



Paceco Crane Damage Assessment and Repair San Antonio, Chile

Two Paceco cranes operated by San Antonio Terminal Internacional at their San Antonio Terminal in Chile suffered damage when the cranes were struck by departing ships in the aftermath of the February 2010 magnitude 8.8 earthquake.

One crane suffered significant damage to the boom and the portal frame. The other crane suffered significant damage to the boom and the trolley. The port was concerned with the structural integrity of the cranes and that the damaged cranes would cause long-term interruption to the port's operation.

Within days of the earthquake, Liftech sent a structural engineer to the site to assess the crane damage. We provided a damage assessment report, which allowed the port to evaluate whether to replace or repair the cranes. The port decided to repair the cranes since repairs would be completed within a few months and at a fraction of the cost of buying new cranes.

We worked with the contractor to develop the repair concepts, including an innovative frame straightening concept and a strongback system to support the damaged legs and portal beams. We provided design drawings for the frame straightening and the frame and boom repair.

Reference:
San Antonio Terminal Internacional
San Antonio, Chile



Repair of Fire Damaged Coal Loader Berth 301, Port of Los Angeles, California

Repair of damage from September 2000 fire, February 2001 fire, and April 2001 ship collision.

The coal loader built by Krupp was severely damaged in two fires and suffered significant damage during a ship collision.

After each incident, Liftech provided on-site engineering to assist with repairs. Repairs consisted of replacement or stiffening of buckled sections, restoring the geometry of the boom and shuttle structures to mitigate operational problems, and development of a structural maintenance program to ensure long-term reliability of the repaired structure.

The loader was returned to operation within five weeks of the first fire, within four weeks of the second fire, and within days of the ship collision.

Reference:
Bickerton Iron Works
Torrance, California, USA

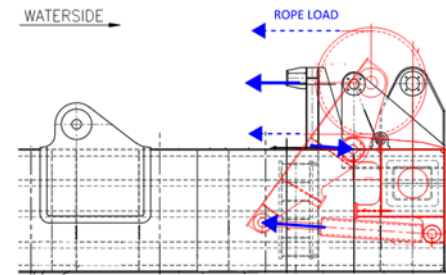


Bauxite Reclaimer Bridge Chord Repair

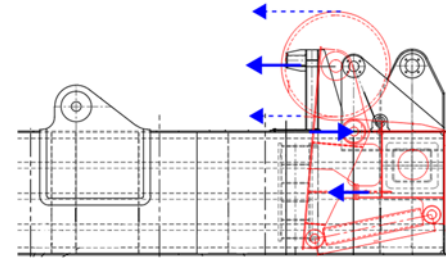
The client has a reclaimer that has been operating for over ten years at its facility in South America. This equipment experienced chronic fatigue cracking in the truss beam upper chord. After making in-house crack repairs and performing a modification that resulted in further fatigue cracking, the client retained Liftech to evaluate the cracking and to design repairs.

Client:
Confidential

Liftech performed analyses that determined the cause of cracking and developed a simple repair detail that improves fatigue performance by a factor of 20 to 400 depending on the loading condition. Liftech provided a report summarizing our review, the cause of cracking, and our recommendations, repair design drawings, and procedure.



NORMAL, CYLINDER EXTENDED



OVERLOAD, CYLINDER RELEASED

Fuse System (in Red), Between Girders at Boom End

Bauxite Unloader Boom Repair

The client operates two bulk unloaders at its facility in South America. The boom on one unloader buckled due to a snag event, when the grab bucket struck the edge of the vessel opening during operation.

Liftech provided engineering services for temporarily securing the damaged unloader, structural concepts and design for boom stabilization, and structural concepts for boom removal and repair. Other engineering services included a boom failure investigation, snag time history analysis to evaluate multiple modification concepts, structural design for a new snag protection system, and basis of design, specifications, and design review for procuring the snag protection system.

Snag mitigation methods considered included modifying the bucket geometry, integrating a mechanical or structural fuse in the hoist system, and integrating a fast-acting braking system.

Liftech developed concepts for modifying the bucket geometry and integrating a fuse into the hoist system. The recommended fuse consists of rocking beams and hydraulic cylinders. The system detects rope loads, and for loads above a preset value, the cylinders release, allowing the rocker beams to rotate a fixed amount. This results in a decrease in rope stretch, which provides time for the brakes to set and the machinery to stop rotation prior to overloading the structure and other components.

We provided concept drawings and a comprehensive report describing the hoist system response, including required characteristics and resulting improvements from the recommended hydraulic fuse system.

Client: Confidential



Furnace Crane Bridge Girder Repair

The client has furnace cranes that were in operation from 1984 to 2015 at its facility in South America. This equipment experienced significant chronic fatigue cracking in the crane bridge girder.

Client:
Confidential

The client retained Liftech to provide engineering services for repairing the fatigue cracks and improving the structural details to help reduce the likelihood of future cracking.

Liftech developed a practical repair design, contributing to a significant improvement to the fatigue life, and provided repair design drawings and procedure.

Erik Soderberg**President, Structural Engineer**

Mr. Soderberg is a skilled designer and project manager. He is experienced in the design, review, repair, and modification of a variety of structural and crane related systems including wharves, container cranes, and bulk loader structures. Other structures include crane lift and transfer systems and concrete and steel floats. He oversees the technical and contractual aspects of Liftech's projects in addition to his design work.

**Jonathan Hsieh****Vice President, Structural Engineer**

Mr. Hsieh is experienced in design, review, analysis, and modification of container cranes, bulk handling cranes, and special structures. His expertise includes crane procurement, fatigue failure investigation and repair, and computer modeling and analysis. He has also worked on structural maintenance programs, seismic design of container cranes, crane instrumentation, and voyage bracing.

**Arun Bhimani****Founding Principal, Past President, Structural Engineer**

Mr. Bhimani is an expert in all phases of container crane and wharf design. He has developed innovative solutions to container crane design problems, including a technique for combining analysis with heat straightening for repairing damaged container crane booms, the first seafastening design for transporting fully erected container cranes on barges, and a structural maintenance program used to periodically inspect cranes.

**Catherine Morris****Vice President, Structural Engineer**

Ms. Morris has a wide range of experience in the design of container cranes, buildings, and miscellaneous special structures. She has worked on all facets of container crane design including designing new cranes, reviewing crane designs, designing modifications, and voyage bracing. She has also reviewed and designed reinforcing for barge structures for transport of various equipment, designed chassis storage racks, and analyzed and designed equipment to lift and replace steam generators in nuclear power plants.



Nicholas Grebe**Principal, Mechanical Engineer**

Mr. Grebe has extensive experience performing conceptual and detailed designs of mechanisms and systems, analyzing dynamic mechanical systems, and developing designs and detailed drawings suitable for manufacture. He is responsible for developing purchase specifications and reviewing contractors' mechanical, hydraulic, and electrical designs for feasibility and contract compliance. He is experienced in reviewing heavy machinery and container crane controls including logic, interlocks, system architecture, and automation features. He provides project management, condition assessment, commissioning, troubleshooting, and acceptance testing of material handling equipment including container cranes and bulk loaders.

**Sugiarto Loni****Principal, Structural Engineer**

Mr. Loni has extensive management experience and design expertise with marine terminal structures including crane-wharf interface, container and intermodal yard structures, building facilities, and marine structures. He is responsible for contract negotiations, technical oversight, and quality assurance of project deliverables. His work includes managing a variety of engineering projects ranging from small projects with short duration to large projects with multi-discipline coordination. As project engineer, he performs civil and structural design of marine terminal facilities, seismic retrofit design of existing building structures, and civil and structural design of wharves and marine structures.

**Kenton Lee****Principal, Structural Engineer**

Mr. Lee is experienced in design, analysis, and project management of container cranes, floating cranes, rigging, and special structures. He specializes in container and floating crane procurement projects and crane modification projects. He is also involved in preparing structural maintenance programs. Some of the technical aspects of his work that are of special interest to him are steel connection design, wind effects on structures, wind tunnel testing, and structural fatigue of steel structures.

**Patrick McCarthy****Principal, Professional Engineer**

Mr. McCarthy is experienced in ship-to-shore and port yard container crane procurement, modification, reliability, and repairs. His work includes project management, condition assessment, and developing structural maintenance programs and repair procedures. He is Liftech's manager for developing crane technical specifications and helps clients with various aspects of the crane procurement process, including pre-bid assistance, post-award design and fabrication review, and post-delivery structural assessment. He also has expertise in wind provisions, has been involved in wind tunnel and other wind studies, and is an associate member of the Wind Load Subcommittee of ASCE 7.



Derrick Lind**Principal, Structural Engineer**

Mr. Lind is experienced with project management, design, review, analysis, and modification of many types of structures, including container cranes, unique industrial equipment, buildings, wharves, and bridges. He specializes in all facets of crane modification, including crane raises, boom extensions, capacity upgrades, and wheel load feasibility studies. His work has included crane procurement, structural analysis and design, checking shop drawings, developing construction documents, and managing design teams and project budgets and schedules.

**Simo Hoite****Principal, Professional Engineer**

Mr. Hoite is a registered professional engineer with extensive experience in container crane design, modifications, specifications, and procurement, as well as container and rail terminal operations. His experience includes development of innovative RTG and STS crane designs for container terminals. He is also experienced in the heavy rigging industry and has managed substantial design projects including wharf design.

**Anna Dix****Principal, Structural Engineer**

Ms. Dix is a registered structural engineer in California with experience in the design and analysis of various steel and concrete structures. Her focus is on ship-to-shore cranes and other structures that reside next to, in, or on top of the water, such as heavy lift and container handling equipment, wharves, and floating cranes. She likes earthquake and fatigue engineering topics and working with clients.

**Leah Olson****Principal, Professional Engineer**

Ms. Olson has managed multiple wharf and float projects, and has participated in the design, analysis, and modification of wharf and float structures, container cranes, steel barges, and other rigging structures. She has evaluated the behavior of various concrete and steel structures using finite element analysis (FEA) computer software. Her work includes project management, structural analysis and design, and site inspection and reporting.

**Di Liu****Principal, Professional Engineer**

Mr. Liu is an experienced designer and project manager. His work includes structural analysis, design review, modification review, and feasibility studies of container cranes, wharves, and other structures.

