Crane accidents and how to prevent them*

Accidents and emergencies involving quayside cranes are occurring more frequently in ports around the world. Portek's own "case load" has risen from four or five incidents a year to more than 12. Its overall assessment is that frequency of incidents where damage exceeds US$0.2M has risen to around 40 a year. Based on a global population of 4000 quayside cranes, this computes to a probability of about 1%. Incidents normally, but by no means always, involve insurance claims and repairs could cost anything up to US$2M per crane.

The number of incidents is understandable, says the company, given the big rise in crane numbers, increasing crane dimensions that result in reducing visibility and operator control, and more frequent adverse and unpredictable weather conditions.

But in some cases, too, there is insufficient understanding of the increasing risks and demands of a fast-paced, modern terminal and standards of crane maintenance and safety in operating procedures have been allowed to slip.

Human factor

A crane accident is defined by Portek as an unplanned and unintentional event involving one or more cranes or other objects that result in damage or injury of some kind and it normally involves a strong human element in its causation.

For example, in a collision between a ship and a crane, one or both is under control of an operator and hence there is an immediate human element involved. Such accidents tend to be more often preventable than not.

In one case handled by Portek last year (in Dunkirk), the flare of a ship's bow hit the inside face of a crane leg in the direction of gantry travel and moved the crane some way along the quay, causing bending of the leg and sill beam. Damage was relatively minor and was confined to one plane.

Apart from collisions between ship and crane, a crane may contact another crane or an object during operation. When cranes contact each other due to strong wind gusts during operation, a multiple chain collision is often the result. In another incident in the Caribbean (Port of Havana) attended by Portek last year, wind gusts possibly exceeding 20 m/sec blew a working crane along the quay into the adjacent crane that in turn pushed a third crane into its dead stop. The portal structure of the second crane and the bogies of the third crane sustained severe damage.

Emergencies

A crane emergency is defined by Portek as an unexpected and sudden event in which the crane is subject to damage but its causation is not immediately linked to the operator and is generally not preventable by him. Examples are crane structural failures and crane collapse, derailment or severe damage due to typhoons or earthquakes. Sometimes electrical fires break out in the diesel generator or electrical room, or crane drive faults lead to free fall of the load.

Mechanical faults such as brake or twistlock failure can result in uncontrolled fall of load. Structural damage may be caused by fatigue failure, by poor workmanship or design, or by heavy weather during ocean transportation of cranes, perhaps because the lashings and bracing were inadequate. In other words, human fault is often involved, but "remotely" from the incident itself.

There are typically two phases

**This article is based on "Crane Accidents and Emergencies: causes, repairs and prevention," a paper by Larry Lam, chairman, Portek International, S C Tok, technical director, Portek International and Peter Darley, director, Portek Systems & Equipment*

in any crane accident or emergency incident. First, the recovery phase comprises survey, salvage and stabilisation. This refers to the process of survey and damage assessment, temporary bracing to stabilise the crane to prevent further damage, and isolating operational cranes from the damaged, non-operational crane(s), so as to allow operation to resume in part.

The second phase covers repairs and re-commissioning and refers to design and analysis, submitting proposals for repairs, obtaining approval from insurers and port authorities, and carrying out the repairs in shortest time possible, conducting checks, testing and recommissioning the cranes so they can be returned to operation.

Isolation zone

Bracing and support for cranes facing imminent danger of further instability or collapse has to be carried out immediately, usually relying on common sense and sound engineering practices in the absence of detailed analysis. The crane has to be isolated and contained so that the berth can continue partial operation.

Immediately after an incident, surveyors or claim executives appointed by the ship or crane owner's insurers would have been notified and deployed to site. At the same time, crane specialists such as Portek or others would also be called by respective parties to assess damage jointly and to undertake some emergency measures to stabilise the crane. The damage survey report would form the basis for the various parties to agree on actions to be taken.

Visual inspection is usually able to throw up most of the areas in need of repairs. Non-destructive testing (NDT) may be performed in certain areas if needed. Dimensional checks using theodolite survey instrument will be able to determine the degree of structural deflection or deformation, and the extent of repairs and correction needed to bring the crane back to required tolerances.

If the crane is somehow tangled up with a ship or other objects, it must be freed as it is dangerous to have the ship and the crane bobbing up and down with the tide. Scraps on the quay would be cleared, and the crane isolated to allow port operations to continue around it

Typical damages could include bending and buckling of the legs and sill beams, derailment of waterside or landside bogies, bending of legs and sundering of joints between the equaliser beam and sill beam.

Boom time blues

The most common ship/crane collision occurs when the flare of a ship's bow hits part of the crane. Usually, however, the most serious damage occurs when a ship snags a crane boom in the down position. If the ship catches one end of the crane boom it has a long lever arm and can easily bring the crane down.

More generally, damaged booms pose a real headache as they may need to be taken down for repairs. This usually necessitates calling up a heavy duty floating crane for removal and reinstallation after repairs, a costly affair. Boom hinges may be

A damaged crane should be braced and supported immediately to prevent further instability or collapse. (Source: Portek)

damaged and *in situ* line-boring will be needed.

Claims, compensation

Liability pertaining to equipment such as a quay crane comes under the FFO ("fixed or floating object") clause of a shipowner's third party liability insurance policy, or the hull and machinery or P & I insurance. Consequential damages resulting from lost production may also be claimable from the insurer as, for example, was the case at a coal terminal serving a power plant in Indonesia.

One might think that in an emergency situation, all parties would act expeditiously to come to an agreement on the claim and return the damaged crane to operation as soon as possible. In reality, however, it could take anything from just a few hours to days or months or even years for the parties to reach agreement.

It is not unusual for a crane owner to claim a higher amount than the insurer is prepared to pay, or to insist on a brand new replacement crane. The final outcome is a matter of negotiation involving the insurance loss adjusters and what the crane owner is prepared to accept.

In some cases, the crane owner, especially if it is a port authority, may take a hard-line approach by (attempting to) put the vessel under arrest, as was the case recently in an incident in the Port of Mobile that involved a fatality.

Repairs

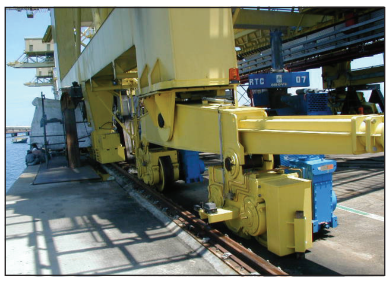
Crane structures are designed to lift vertical loads and can tolerate only limited horizontal loads from

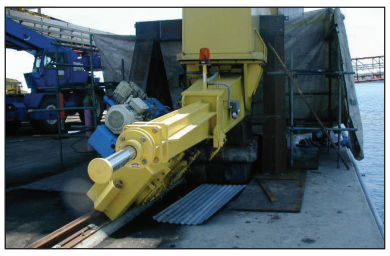
Typical ship/crane collisions - crane boom that struck a ship's funnel (above) and waterside crane leg hit diagonally by ship's bow. (ibid)

wind and earthquake conditions. They are not meant to absorb horizontal impact loads arising from collisions with ships or adjacent cranes. Any slight impact from the ship can result in drastic deformation and distortion of the portal structures, or total collapse.

It is often useful to construct a numerical model of the crane with finite element stress analysis software. The impact forces are simulated and correlated to the real life scenario. The simulation

Portek explains that as derailment (top picture) allows displacement, damage to the sill beam or leg is often much less severe than when the bogies stay on the rail (lower picture), due to the sever bending forces. (ibid)





results can be used to help understand the behaviour of the crane structures under impact and to identify the extent of affected areas and possible points of failure not seen by the naked eye. They also help the repairer to determine the correct points of support and design the correct repair methods, and even improve the crane beyond its original design.

Spring back

As noted above, it is vital to construct supports for the crane to ensure that it is stable, and to bear the weight of that portion of the crane where repairs are to be carried out. Considerable potential energy, associated with elastic deformation, remains "locked" in the deformed structures. These structures tend to spring back violently as restraints are removed and hence care must be taken to avoid serious injuries or damage.

Repairs normally involve cutting away the damaged plating. This tends to release the "locked" energy, allowing the structure to spring back somewhat to its original form. Jacking or heat application may be needed to get the structure fully back to its true form. New plating is then fabricated and installed.

In the case of bolted joints construction, it is advisable to replace the bolts if there is any chance that they have been stressed and weakened. Electrical damages are normally confined to power supply trailing cables being overstretched or broken, or cable reels being crushed. These items have a long lead time, and new cable should be ordered immediately to prevent recomissioning being delayed.

Geometry check

On completion of repairs, X-ray NDT should be carried out on the welds in the repaired areas, as well as on other critical welds to ensure that hitherto undetected cracks are identified and dealt with. The crane's geometry in terms of perpendicularity, diagonality, trueness of hinges, etc should be checked to ensure they are within tolerance. If the original tolerance cannot be maintained, the parties involved can agree on various measures such as additional reinforcement, or a regime of monitoring the crane over a period of time to ensure there is no deterioration.

The joint at the equaliser beam has become separated and twisted. (ibid)

Better than cure

Modern container cranes are behemoths of steel and machinery, often fabricated in a hurry in low cost countries. The complexity of such huge and hence highly flexible structures, subject to fatigue loading and exceptional impact loads, are still not fully understood. Crane owners should be more aware of the risks. There is no substitute for a rigorous risk management scheme that includes stringent safety standards in crane design and manufacturing, day to day operating procedures of the crane and the terminal as a whole.

Visual surveys to check for structural cracks have to be carried out rigorously once a year. At longer intervals the internal faces of the girders need to be inspected. This often throws up manufacturing faults; insufficient welding and lack of penetration are common cause of failure. The terminal manager should ensure that equipment maintenance standards are not compromised by a busy schedule or the operations department not releasing cranes for maintenance.

Usually the load test as witnessed by a professional engineer does not amount to much. It is nothing more than just a formality and says very little about the safety standard of the crane. The crane owner cannot rely on such regulatory certification; it only gives a false sense of security.

Brakes

It is common for sudden strong wind gusts to act on a crane under operation and propel it along the rail, out of operator control, until it collides with an adjacent crane. In Portek's view rail clamps are ineffective and so are motor-mounted, multi-disc brakes, which are inaccessible for servicing, and deteriorate over time.

According to Portek, the trend today is to install electro-hydraulic thruster disc brakes in each gantry drive. They should be selected to ensure ample braking effect and should be able to generate sufficient sliding friction between the wheel and the rail to prevent a runaway situation. To provide even more braking power, caliper brakes acting directly on the idle wheel can be installed.

In ports subject to strong winds, it is vital that cranes are gantried to designated points to have the storm locking engaged when the crane is not in operation. It is also advisable to gantry the cranes and park them in a safe spot during ship berthing manoeuvres. The harbour master should ensure that harbour tugs deployed have sufficient power and bollard pull to control the ship's movement. The ship's captain and pilot should try to ensure the ship comes alongside as parallel to the quay as possible.

The importance of safety training for the operator cannot be overemphasised. Emergency drills have to be ingrained. Drivers should be trained like airline pilots on how to react in any emergency situation. For example, the natural tendency in a crane run-away situation is to drive against the wind. But this only makes things worse, as when gantry motion is activated, the gantry brake would be open, thus further reducing friction. ❑

Wnd gust effects: a chain collision of three cranes that left two inoperable. (Ibid)