SEEN BUT NOT HEARD

THE NEED TO REDUCE CRANE NOISE

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Noise has become an important environmental issue across the globe. As transport hubs, container terminals are particularly loud. The most prevalent noise is an almost continuous flow of traffic coming in and out of the port. Then there are ships, port machinery, warning signals and alarms.

Adding to all this are dockside cranes, making their own noise as they load and unload ships. Each crane has motors, gears, ropes and machinery moving on steel wheels. Noise results whenever metal touches metal, crane motors run, and rope mechanisms operate, as they are built to do.

In the midst of a busy port, does reducing crane noise make much difference to the overall noise level? If so, how can you do it?

WHY REDUCE CRANE NOISE?

Konecranes has been manufacturing container cranes for more than four decades. In the beginning, noise wasn't a big issue, because the ways it affected humans were less well known and residential areas were separate to ports. However, noise pollution has become a major challenge as urban areas continue to expand across the seafront, ports have become busier, and the two areas have crept closer.

Current medical knowledge shows clear evidence that continuous residential noise and chronic sleep disturbance can cause significant health problems. In addition, machinery operators and those working near such heavy equipment are repeatedly exposed to a high noise level, with the potential for noise-induced hearing loss and elevated levels of stress.

Western governments began legislating about noise in the 1970s, when environmental issues started to catch on with the general public. Since 1996, the European Sea Ports Organisation (ESPO) has seen noise move from one of its lowest environmental priorities to one of the highest: in 2016, it was third out of ten. Noise is considered one of the major effects that a port has on its surroundings.

A LITTLE SOUND IS GOOD

Cranes can't be too quiet or it's difficult to operate them safely. Operators need to be aware of what their own crane is doing; although crane control devices and indicators guide them, the operator gets a lot of information about the status of the crane through hearing and sensing its motions. Similarly, yard personnel on the ground need to know what is going on around them. Moderate sound can therefore be considered an essential safety feature.

However, there are currently no rules about such noise. International standards cover some port equipment, like forklift trucks, but most port machinery is not subject to direct noise emission guidelines. In the future, standards like the Outdoor Noise Directive 2000/14/EC will most likely be expanded to include limits for more types of port equipment.

Regarding noise emissions, there is no industry or global standard for an entire port. Noise limits are usually defined by regional authorities, who issue local environmental permits at their own discretion. Ports can also get voluntary ESPO certification, which ensures certain industry-recognised standards for its members.

OSLO: A REAL CHALLENGE

Norway does a lot of international trade via sea. Oslo Havn (Port of Oslo) reports to the department of transport and the environment of the City of Oslo. Their charter is to offer efficient and environmentally-sound sea transport. Private enterprise does most of the work at the terminals, but the Port of Oslo takes care of the cranes.

Noise is of particular concern at the Port of Oslo because it operates day and night, a mere 300 metres from residential areas. The port has a close cooperative relationship with the local residents, and works with them to ensure they are disturbed as little as possible, while keeping the port fully operative. Because of this, one of the primary factors in their evaluation of bidders to supply new harbour equipment is always noise reduction.

In its plan to expand its operations, the Port of Oslo asked Konecranes to supply two brand new PMX STS cranes for delivery in December 2015. Each crane had a 48/64 T load, a 75/150 m/min hoisting speed, a maximum trolley speed of 180 m/min, and a 40m outreach with a 33m lift height.

Two of the key reasons they chose Konecranes was our clear understanding of the noise problem in their particular situation and our ability to provide a solution.

TOUGH AND DETAILED REQUIREMENTS

Sound control is more effective when specifications are clear from the very beginning of the project. This makes customisations target-oriented and more cost-efficient. Sometimes a requested low noise level might not even be physically possible. In this case, we worked carefully with the Port of Oslo to ensure specifications were clear, comprehensive and realistic.

Even with such preparation, this was still a challenging project. The Port of Oslo had very strict noise emission requirements for its new STS cranes. Sound power (Lw), the basic noise level of the crane, had to be 100dB(A) or less, which is roughly comparable to a normal passenger car.

A typical STS crane has a sound power of about 108dB(A). Due to the logarithmic scale usedan 8dB drop means, in practice, an 80% decrease in power level – quite an engineering challenge. Yet there was more: sound pressure (L_p, at various locations within the crane, such as inside the operator's cabin), had to be 60dB(A) or less. These requirements must apply 24/7, as the cranes could be used at any time, day or night.

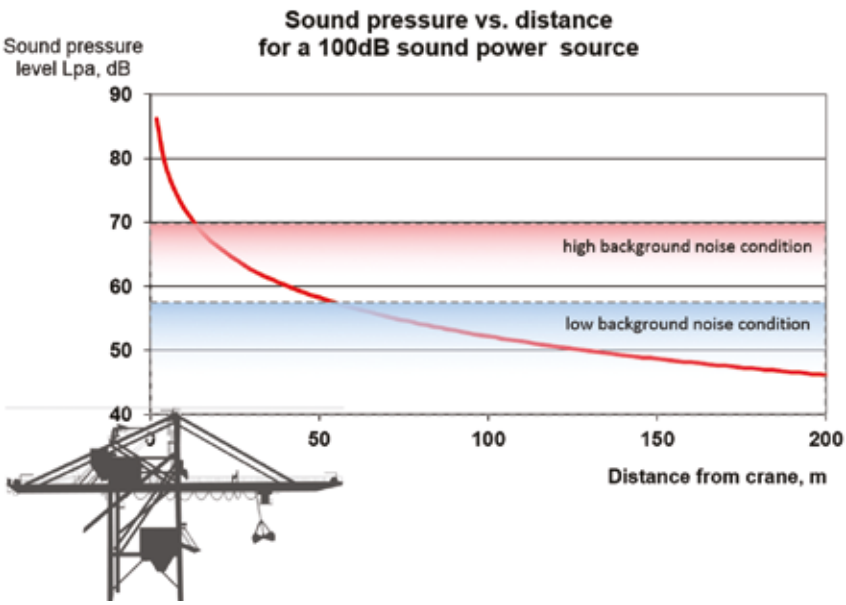

Figure 1. How sound pressure changes with distance from the crane

Figure 2. The sound pressure emitted by an STS crane

MEASURING AND ANALYSING NOISE

The noise of a large object like a crane is measured by the sound pressure around it. To cover all sound sources located within the crane structure, including moving components like the hoisting trolley, we located measurement points within an ample distance all around the crane.

Distance is important because the effect of the crane's noise on its environment decreases as the distance from the crane increases. Figure 1 shows how a crane with a sound power of 100 dB(A) gives off sound pressure of about 58dB at 50m and 52dB at 100m.

Outdoor measurement always captures background noise from wind, traffic and other machinery that cannot be controlled. For accuracy, measurement locations must have background noise at least 3-4dB lower than the measured noise. With the ideal 60dB(A) background, this condition is met less than 40m from the crane and with the more typical 70dB(A), less than 20m away. Such conflicting requirements mean good measurement conditions are often only available at night with good weather and little port traffic.

Figure 2 shows how noise emission from an STS crane fluctuates according to its operation cycle. Peaks indicate operation and troughs indicate a stop combined with background noise. In this case, at a distance of 125m, the observed noise level varied from 42 to 60dB(A).

Because of large variations, we evaluate crane noise using equal levels from several operational cycles rather than single peak

values. Continuous recording also shows the operational phases with the highest noise levels, information valuable for identifying noise reduction targets.

HOW TO MAKE CRANES QUIET

Design is key to low noise on cranes. There are two parts to any crane design: components and overall structure. Noise engineering is a way to identify noise sources to understand and manage them.

We started with the components, because components emit sound directly. Figure 3 shows nine noise sources on a typical STS crane. Motors, fans and festoon trolleys emit a steady noise while running. Impulse or intermittent noise is generated by running ropes, the spreader and trolley wheels that pass over rail joints.

The most efficient way to reduce overall noise is to address the sources of the highest levels first, as this has the strongest effect. Figure 2 shows that the highest noise levels occurred during high-speed operation with the hoist or trolley. The load being lifted doesn't affect noise nearly as much as speed.

So we used low-noise components. At Konecranes, we design and make all the core components for our cranes. In this case, the gearbox, motors, control system, trolleys, wheels and other machinery were all specially designed to minimise sound emission.

STRUCTURAL CHANGES

All crane components are attached to the structure in some way, and all crane structures transmit sound energy in some way. In addition, the load-carrying structure of an STS crane is particularly prone to emitting unwanted sound because of its box shape. The next thing we did was minimise the transfer or emission of sound through the structure.

We isolated all significant noise sources from the supporting structure by flexible joints or supports. Where possible, machinery was covered with soundproofing. The most challenging task was to optimise the crane's box structures and increase structural dampening with purpose-built dampening elements.

On the hoisting trolley, steel wheels in contact with a steel rail will always produce some vibration. To control the noise, we isolated this vibration transfer to the girder and boom, even in the tricky hinge section.

To manage the impulse noise made by the steel hoisting ropes as they hit the structure and the sound of the spreader touching containers, we used the drive control to minimise slack rope and enable smooth acceleration, reduced the contact speed at load pick-up and release, put soft cover pads at locations where ropes were most likely to hit guides, and added an impact reduction feature to the spreader.

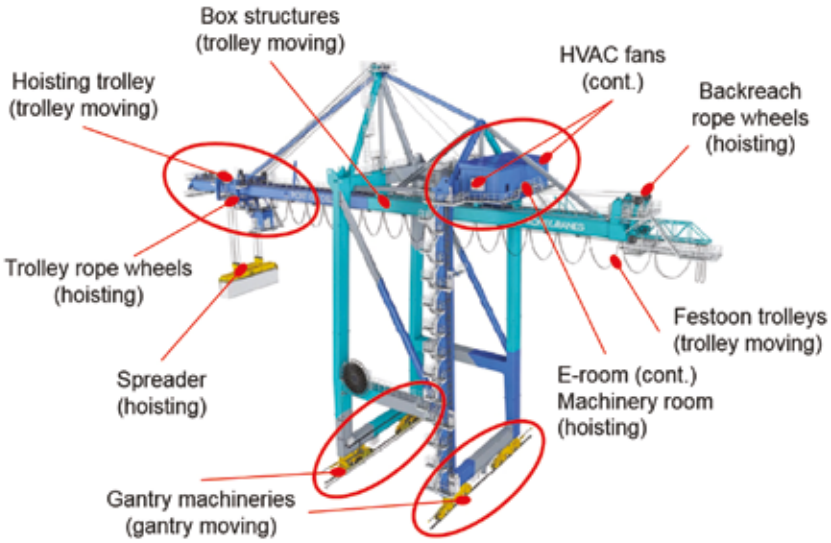

Figure 3. Sources of noise on an STS crane

Figure 4. One of the Konecranes STS cranes at the Port of Oslo

QUIETEST IN THE WORLD

Due to the very strict noise emission requirements from the Port of Oslo, these STS cranes are technically unique and possibly the quietest in the world. As urban areas everywhere move closer to harbours, we expect the demand for this type of crane to increase. Our achievements come through holistic noise engineering, a careful study of the environment in which the cranes would operate and low noise emissions built into the crane design from the beginning.

ABOUT THE AUTHOR

Ari Nieminen is Chief R&D Engineer in Konecranes, Port Cranes. He has an MSc degree in mechanical engineering and naval architecture from the Helsinki University of Technology, and is a certified Vibration Analyst (ISO Cat III). He has been working with noise and vibration engineering since he joined Konecranes in 1989.

ABOUT THE ORGANISATION

Konecranes is a world-leading group of Lifting Businesses™ offering lifting equipment and services that improve productivity in a wide variety of industries. With approximately 12,000 employees at 600 locations in nearly 50 countries, Konecranes has the resources, technology and determination to deliver on the promise of Lifting Businesses.™

ENQUIRIES

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