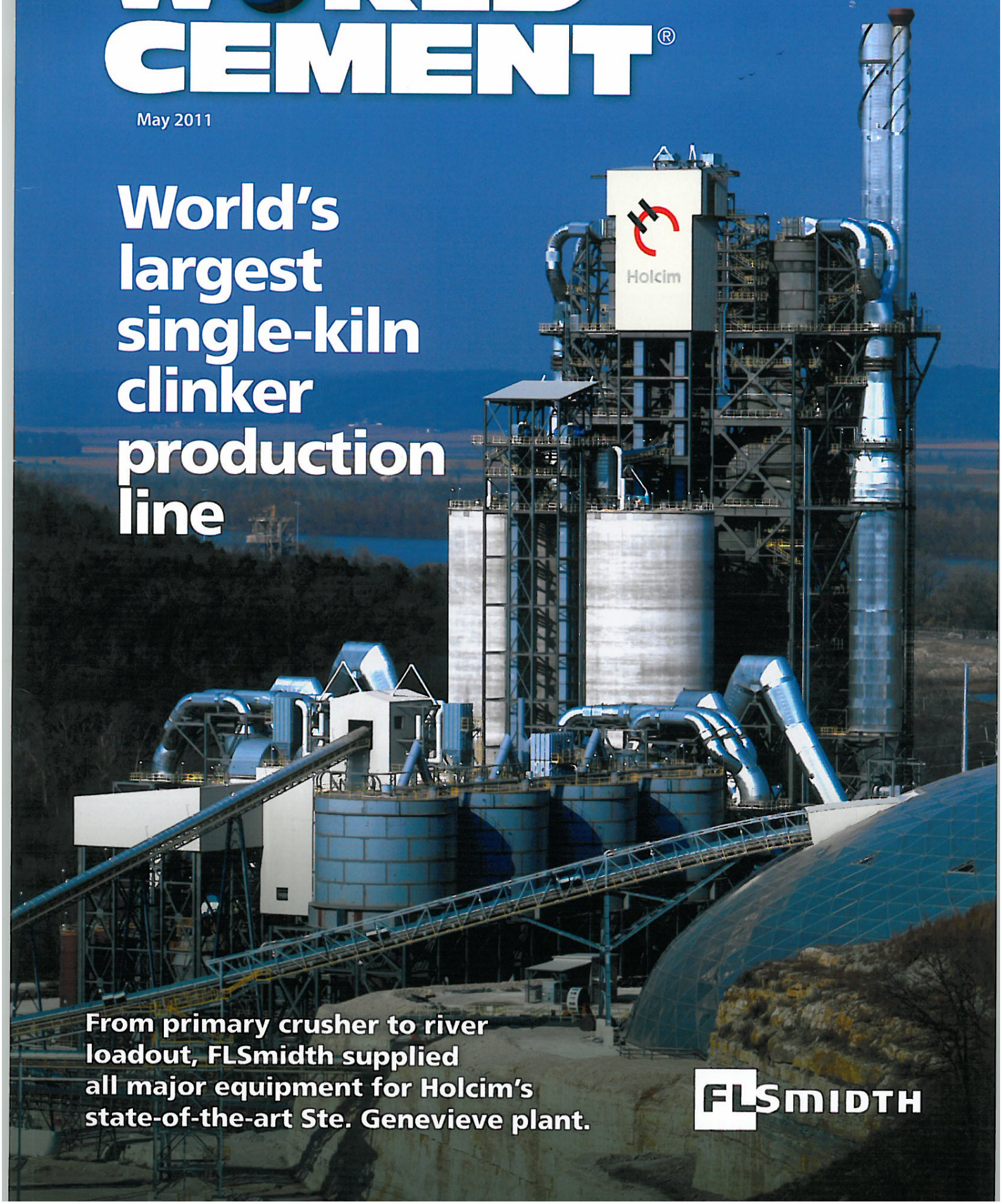
WORLD CEMENT®

May 2011

World's largest single-kiln clinker production line



From primary crusher to river loadout, FLSmidth supplied all major equipment for Holcim's state-of-the-art Ste. Genevieve plant.

FLSmidth

A Silver Lining

R. DANIEL CHAVIS, BROKK BRICKING SOLUTIONS (BBS), USA, EXPLAINS WHY LOW CEMENT DEMAND IS NO REASON FOR LOW SAFETY STANDARDS.

Introduction

The weak economy and low cement demand in the North American market is difficult for everyone, but for every negative aspect of business there is always a positive opportunity. This economy presents an opportunity to review quality safety standards for refractory related installation equipment, such as pneumatic brick installation machines, kiln access ramp systems and safety inspection cages.

The following article will describe what to look for and how to determine if refractory installation equipment meets industry and international safety, design, engineering and manufacturing standards.

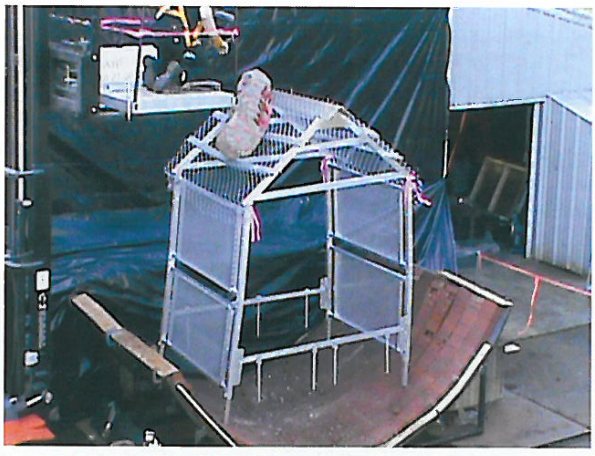
Most refractory related installation equipment or machinery is used for temporary or periodic maintenance. The equipment usually has to be portable and must be disassembled and reassembled in variable situations with limited access or confined space. The design and manufacture of this equipment should comply with the standards set forth in the ASME (American Society of Mechanical Engineers) codes for equipment and machinery. Safety or code requirements sometimes fall into grey areas and are subject to interpretation by local enforcement agencies, the objective being the safe yet efficient use of machinery equipment to provide the fastest and highest quality maintenance for the owner.

Kiln access

The first safety concern that needs to be addressed will be safe and efficient kiln access where the refractory maintenance process begins. Refractory installation equipment is often fabricated out of high strength aluminium. Properly selected aluminium alloy has the strength of steel, yet the advantage of being lightweight and easier to handle. Aluminium equipment and machinery should be fabricated from high grade heat treated aluminium alloy and designed according to specifications from the Aluminum Association Inc. The welding of the aluminium components should be performed by certified welders and all welds should conform to AWS (American Welding Society) specifications AWS-D1.2 'structural welding code/aluminum'.

Bricking Solutions' lightweight aluminium ramp systems are designed and manufactured using 6061 T6 aluminium with a tensile strength of 4200 psi and yield strength of 35 000 psi. They are designed by a professional engineer and fabricated under strict international design, safety manufacturing and welding standards. The ramp should have a built in 3:1 safety factor. Compared to steel, an aluminium ramp system is much safer and easier to install and remove from the kiln. In most cases, installation should take approximately two hours to complete and each ramp system should, in most cases, be designed to allow working demolition equipment to break off the bridge section. It should be noted that when breaking off the bridge section, outrigger support matting should be used to protect the bridge from damage due to reactive forces.

Load testing is an important factor when designing and fabricating equipment. To confirm the 3:1 safety factor, Bricking Solutions conducts load testing using ecology blocks weighing 1700 kg each. Four ecology blocks with a total weight of 6800 kg are used to ensure that the ramp systems meet the safety and load rating that is required.



Safety cage testing using a piece of concrete weighing 201 kg.

Safety inspection cage supporting simulated falling coating weighing 201 kg.

Physical inspection

Once safe access to the kiln is established, it may be necessary to physically inspect inside the kiln. The safest way to do this is to remove the coating. This may not be a problem during low cement demand, but time is a critical factor during high demand, considering that kiln downtime in an average 3000 tpd kiln can cost in the range of US$150 000/day in lost production.

There are few ways to physically inspect the kiln safely. Using a safety inspection cage is one option that does not require the coating to be removed. Safety inspection cages need to be custom-designed under strict criteria. Bricking Solutions' cages are designed to withstand up to a 110 kg impact of falling coating or refractory from a maximum distance of 30.5 cm with a built in 3:1 safety factor. As a rule of thumb, safety cages should not be used under coating thicker than 30 cm.

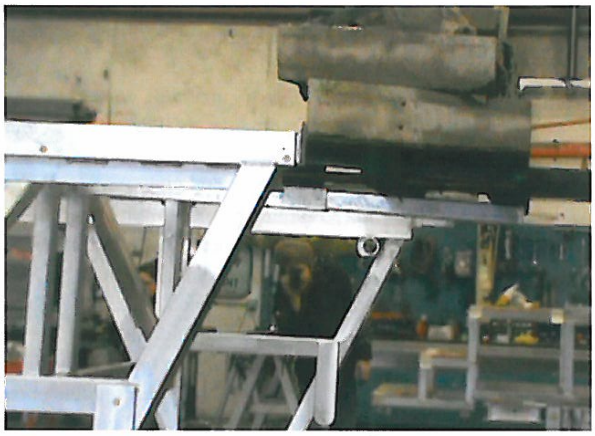
Physical testing of the company's safety cages helps to determine the design criteria and to try to identify conditions and environments that are beyond control. The plant personnel must take responsibility for risk assessment whenever personnel enter the kiln and especially when entering under coating. An experienced supervisor with a background in both brick and coating condition is absolutely necessary to provide the risk assessment prior to kiln entry and this must also include inspection of the condition and proper assembly of the safety cage to be used when conducting a brick or coating inspection.

Every major design modification and improvement to the safety cage has been intensively reviewed. Enclosures using updated components and materials are tested by dropping a 113 kg object from the design heights onto all areas of the enclosure's top and side panel top areas. Once the test enclosure has successfully withstood all design impact loads, the heights for dropping are increased to simulate the 3:1 safety factors. The shock absorbing spring proved to be a vital component for achieving the necessary safety; however, after multiple impacts ranging from 113 – 204 kg on the same cage, the weld joining the frame was the first to show signs of failure or cracking. These scenarios in which we tested the cage could not occur inside a kiln. All users of these safety cages must be informed of the requirement to inspect and replace any damaged components of this system in order to maintain its safe design impact resistance.

Installation

Another important aspect to kiln maintenance is installation. When looking at a pneumatic brick installation machine there are several key factors to determine the safest and most efficient machine. It is important to consider what type of load rating is needed for the work platform based on the job at hand. With this in mind, it is essential to stage enough refractory on the machine's work platform so that the masons can install accurately.

With two full pallets of refractory, it is not difficult to have key bricks, crew and tools on the work platform that weigh in excess of 3628 kg. However, most refractory installation



Machine frame point load testing of 3401 kg.

Kiln access ramp load testing.

machines only have a gross live load capacity of 2750 kg. Exceeding the safe limits and capacity of the refractory installation machine will cause catastrophic failure and potential injury to the crew. Limiting the work platform to one pallet of refractory reduces risk, but also reduces installation speed.

Bricking Solutions' EZ Flex bricking machine has the largest work platform at 5.2 m long and a 6800 kg live load capacity, as well as a built in 3:1 safety factor holding up to three full pallets of refractory, crew and tools. To meet safety standards, continuous load testing needs to take place.

In recent testing, a point load of 3400 kg, double the weight of an average pallet of refractory, was set on the outrigger and the second load spread out on two points on the work platform to ensure the machine will meet the current standards.

Inspection and repair

In addition to testing equipment, inspection and repair work also needs to be accounted for. Firstly, it is important not to expect aluminium to react like steel. Although aluminium is as strong as steel, it is three times more flexible. Therefore, the design, fabrication, welding and repair of aluminium structures can be very challenging. Welding and inspection should be carried out by a certified welder or under the supervision of a certified inspector guided by the AWS standards.

Unlike steel, aluminium welds cannot be inspected with a mag-flux process. Instead, a dye penetrate process can be utilised. Care should be taken to clean the area thoroughly before applying the chemicals used in this process. Any cracks or defects (inclusions, contaminants, etc.) will be highlighted in red. Visual inspection by an experienced or certified welder is another option. The inspector looks for obvious stress cracks or heat distortions in craters at the beginning or end of a weld. Cracks within the crater are fine, but cracks extending outwards from the crater indicate a defect. Visual separation between the weld material and base material is another indication of a defect and can often be found at the beginning or end of a weld.

Conservative aluminium experts will usually recommend that aluminium defects should not be repaired, but instead discarded. This is because the heat of a repair welding procedure tends to reduce the strength of the aluminium in the area of repair (for example, a structure with a 3:1 safety factor may be reduced to a 2:1 safety factor or lower). If the repair is decided upon, the following should be noted:

- The type of aluminium to be repaired (6061-T6) must be determined, perhaps by contacting the original manufacturer. It is essential to determine the correct filler material and then prepare for repair – new cutting wheels or abrasive wheels should be used to avoid contamination of the repair area by wheels that may have been used on other materials, thus reducing the chance of porosity or inclusions.
- All traces of paint or other residue must be removed.
- The surface to be repaired should be degreased with Baltane or an equivalent solvent.
- The old weld must be removed – one should never weld new filler over an old weld.
- The repair weld must always be started ahead of and continue past the area to be repaired to avoid new cracks.
- If the structure is fabricated from tubular material, avoid welding across the face of the tube except at designed joints where the effects of welding across the face have been taken into account. Weld tubes on edges as welding across the face weakens the member.

Conclusion

Although this may not be the best of times for the cement industry, it does present an opportunity to address safety, efficiency and reliability issues. One of the best things to do during this slow period is to have the refractory related installation equipment evaluated. The manufacturer or an appointed expert should do this. Special attention should be given to the welds' structural integrity through dye penetration testing (a non-destructive test). In addition, the equipment and machines' working components can be inspected for function and reliability, and plant personnel can be trained on safe and proper procedures in assembly and the use of equipment and machinery. All this will be useful preparation for the next period of high demand, just around the corner.

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