Kiln shell success

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A kiln shell replacement project, large or small, needs to be given the respect and importance it merits. While there are many variables to be considered in bringing the project to a successful completion, the choice of a technical expert is a key requirement. Bridge Gap Ltd explains why.

Simply finding an experienced contractor who has performed these jobs before is not enough, as each installation provides unique challenges and obstacles that could spell the difference between success and failure. Consider finding a technical expert, one who has only the plant's best interests at heart and is there to deliver a safe and flawless installation worthy of the project's financial burden.

The following case study illustrates some of the trials encountered during a kiln shell replacement project. It is not a step-by-step procedural analysis of kiln shell replacement. The study illustrates some of the challenges encountered and why adding another level of support and expertise to these projects can be the added value that pays dividends in the end.

The limited space available placed special demands on the crane and kiln shell support frames used

The project

In February 2013 Bridge Gap Ltd (Bridge Gap) was given the opportunity to provide technical support to a contractor replacing 30m (98ft) of kiln shell. The plant was supplying the new shell sections through another supplier so Bridge Gap had no control over the quality of the fabrication.

Planning is the key to success and with the right plan in hand even unfortunate circumstances or oversights can be handled successfully. Getting the lay of the land is one of the first things Bridge Gap does before setting a plan into action.

The kiln was an Allis Chalmers-style, ϕ3m (10ft) by 106m (350ft) in length with five piers running in an east-west direction (discharge-feed). The discharge end was under an arch-shaped concrete roof over piers 1 and 2, covering 24m (80ft) of the 30m (98ft) of kiln shell to be replaced. The roof, its support columns and the fact that the plant had three such kilns running parallel to each other, were all impingements on removing and subsequently installing this quantity of kiln shell. The project needed a crane that had the capacity to traverse with a load, so Bridge Gap chose a 70t crawler crane. It did not possess the capacity to lift the loads that the contractor wanted but Bridge Gap recognised the problem and modified the procedure to install one section at a time, starting just uphill of pier 2 and working downhill towards pier 1.

Bridge Gap engineered modular kiln shell support frames to support the kiln during the removal and installation of the shell sections. These stands were positioned so they would also support the pier 1 and 2 tyres during the installation procedure. This type of planning may not seem important, but these stands took 4-6h to erect, level and then equip with saddles and hydraulic jacks. Placing them in the right locations at the beginning and planning the removal with the installation required only one stand to be moved once.

Kiln shell alignment procedures & challenges

The kiln shell itself is one of the most important components to consider when planning a shell section replacement. Bridge Gap employs strict guidelines pertaining to the manufacture, inspection and testing of kiln shells. These guidelines address such topics as material quality, manufacturing, welding procedures, dimensional tolerances and inspection documentation. When performing a shell section replacement project, it

New spiders were installed on site

helps considerably if the company is charged with supplying the shell and has complete control of the project as a whole. Unfortunately, on this project the shell sections provided by another supplier arrived missing the angles usually welded in at either end of the shell sections for use with Bridge Gap's 'pull hardware' (threaded rods, nuts and washers used to pull the shell sections together). The support spiders were also not of the correct design and lacked the proper structural integrity.

Bridge Gap uses the centreline targeting technique to align kiln shell sections. This procedure involves the use of a theodolite with a built-in laser in conjunction with the eight-armed spiders with centre targets welded in at either end of the shell sections. The inner shell is then trammeled at eight corresponding points to mark the centre of the shell section at either end. These markings are placed upon a piece of paper that has been secured to the centre target. Once all the shell sections are marked accordingly there is a definitive way to align each section with the existing kiln centreline and with each other. This procedure allows Bridge Gap to negate all the imperfections that exist from the shell sections fabrication process and assures a perfect alignment.

To obtain the existing kiln centreline information, Bridge Gap traverses back into the kiln and sets up targets at pier 3 and 4 tyre sections. The shell sections directly underneath the kiln tyres are most likely to be the roundest sections available and closest to the original kiln centreline. It is best if two targets are picked that are the furthest apart as possible. Bridge Gap did not go back to Pier 5 as there was too much feed product and scale left in that section of the kiln and working back there would be too difficult and unsafe. With the targets set up at piers 3 and 4 it is time to drill into the refractory brick with a masonry bit to the depth of the inner steel shell. This is carried out at each target and at eight corresponding points, equal distances apart from each other circumferentially. Now the inner steel shell can be trammeled off and targets scribed to find the existing kiln centreline points.

After setting up the theodolite, the two kiln centreline points are 'bucked in', giving an optical line of sight that is in the centre of the existing kiln and on the correct slope. When the laser is turned on, it gives a visual centreline that can be used to align the new kiln sections via their centre point marks.

Overcoming challenges

There were eight sections of kiln shell to install and they ranged from 3m (10ft) to almost 5m (16ft) in length. The install started uphill of pier 2 so the first lift was the pier 2 tyre that was hung on the existing shell and supported using the kiln shell support stand. This allowed Bridge Gap to install the first 3m (10ft) shell section. Once aligned using its 'push-pull' hardware, the sections were secured together with eight 2x4x16in pieces of flat bar called 'strong-backs'. These were welded in spanning the shell sections joint at evenly-spaced intervals.This procedure secures the alignment and gives strength to the shell sections in supporting each other and allows for the turning of the kiln when performing the submerged arc welding procedure. The pier 2 tyre section


Trammeled target with markings and the theodolite laser dot aligned with the centre


Installation of the target inside the kiln

is then installed and slid into position on the support rollers.

The nose section and the pier 1 tyre section were aligned and 'seal welded' on the ground and then placed into position on the supports Bridge Gap had designed. A crew worked a shell section back to remove the 'push-pull' hardware, the spiders and grind the shell clean and 'seal weld' the kiln shell joints preparing them for the Submerged Arc Welding procedure (SAW).

The welding procedures implemented on this project were 'pre- and post-' welding. Before any 'seal welding' was to be performed the shell joint was heated to 94˚C (200˚F), which removed all latent moisture from the steel. When it came time to Submerge Arc Weld (SAW) the joints, Bridge Gap wanted the kiln shell to be heated to 94˚C six inches on either side of the kiln joint 'pre'-welding to ensure good heat penetration and the joint to be blanketed with insulation 'post-'welding to retard the 'cooling-off' process and diminish the thermal stress associated with welding.

To complete the kiln joint welding procedure the inside of the weld was 'back-gouged' out, ground clean and then welded up using 'flux core' wire Mig welding machines in continuous circumferential welding beads called 'stringers'. It is preferable to SAW the inner joint seam if that type of equipment is available.

Ensuring a quality installation

In the use of optical alignment equipment, it is important to be diligent in verifying, checking and rechecking the data and alignment readings. There are certain procedures that are followed and learned once one is qualified to use optical alignment equipment. All the errors associated using this equipment are human errors. That is why if properly trained in the use of this equipment, the operator is diligent and methodical. Trusting in the equipment is paramount, however, being aware of the surroundings and environmental changes is just as important. A kiln shell is just a long steel tube that is tremendously affected by heat.

Using its 'push-pull' hardware, Bridge Gap secured the sections together with eight 2x 4x16in pieces of flat bar called 'strong-backs'

In Texas, the sun was out and shining brightly by 7am, with no cloud cover, and shining on the south side of that kiln shell all day long. To make matters worse, there was a wind howling down from the north, gripping the north side of the kiln in a cold embrace. The difference in temperature from one side of the kiln to the other was significant. It actually pulled the targets on piers 3 and 4 out of alignment as the south side expanded and the north side stayed constant. Not knowing about this thermal expansion and movement of the kiln would have had catastrophic effects on the final alignment. Anticipating this and knowing that there would be no radiant heat from the adjacent kilns that were in shutdown, Bridge Gap performed all of its alignment shots at 6 am and 8 pm This allowed the company to track and reference the data as it progressed with the installation, resulting in a total kiln shell run-out of only 3mm (0.188in).

As kiln shell replacement projects are dynamic in nature, adhering to a strict static schedule is not possible. These projects take on a life of their own and it is up to the cement plant and the contractor to direct the project in the most reasonable manner. While the project will surge ahead in some areas and lag behind in others, this need not be an issue if the plan can be manipulated accordingly with minimal disruptions.

The nose section and the pier 1 tyre section were aligned and "seal welded" on the ground and then placed into position on the supports Bridge Gap had designed

Conclusion

At the inception, these types of projects look ominous and they are undoubtedly very labour intensive. However, with the proper planning and the right competent people they will end in success. It is never a bad idea to bring in an expert, someone who is a third party to 'bridge that gap', as their success is tied to the cement plant's.