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John Sisk & Son Ltd. (Sisk) is an innovative engineering and construction company employing over 1,800 people in Ireland, the UK, and Europe. Sisk has the track record, scale, and capacity to successfully undertake large, complex, multi-disciplinary programmes, and we are recognised by our global customers as world leaders in sustainability and safe delivery. Sisk is a progressive business and Ireland's No. 1 ranked provider of construction services. Operating since 1859, we have built many iconic buildings and landmark pieces of infrastructure. Our continued success is due to:

- Our ability to collaborate with customers and supply chain to provide technical and delivery solutions in an open and can-do way.
- Safety, innovation, quality, efficiency, and value are integral to everything we do.

We deliver projects in key sectors such as Data and Technology, Pharmaceutical and Life Sciences, Infrastructure, Transportation, Healthcare, Commercial, Residential, Retail, Industrial, Leisure, Education, Water, and Energy.

Author

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Overview & Background to the Lean Initiative

This case study is based on a new Dublin city-centre office development of approx. 250,000 square feet. The building superstructure is a 7-storey reinforced concrete frame over a double-storey basement, and the concrete slabs are designed to be post-tensioned.

Our goal was to complete a 19,500 square feet slab pour of a nominal 250mm thickness in one shift using 2 placing booms, 1 static pump, and a spider pump extended to reach all corners of the C-shaped slab. The plan was to break each slab into 4 separate pours. Because we chose to use Jump Form formwork to construct the cores, the use of placing booms was restricted. For this reason, we used spider pumps to reach areas around the rear of the two central cores. A second significant constraint was the working time restrictions imposed by the Local Authority which meant that we were restricted to working between the hours of 06:00 and midnight.

Lean Initiative Undertaken – Lean Thinking, Tools, Techniques

Define

The first slab pour commenced on schedule and in line with the out of hours working arrangements we had agreed with the Local Authority. All local residents had been notified of the pour 48 hours in advance. Placing booms had been set up from the evening before and the spider pump was also in position.

The concrete supply all morning was in line with the planned delivery rate. We hit our first milestone mark on schedule and started to ramp down for the placing boom line clean-out and swap-over. The planned timeline for the swap-over was 45 minutes, but on the day of the pour it took over 2.5 hours from the time placing boom 1 stopped pumping to starting again with placing boom 2. This was the main cause of the knock-on delays to the second half of the pour and completion of the overall schedule, which ran much later than planned. It also meant that we were not able to get the quality finish to the last 30% of the slab as planned because we had to complete all floating work within the working hours imposed by the Local Authority.

Measure

The steps involved in the process are outlined in Figure 1. We created this process flow to detail the steps involved, ensuring any critical milestone activities were tracked. Setting up the placing booms the day before and ensuring all equipment was in full working order were key.

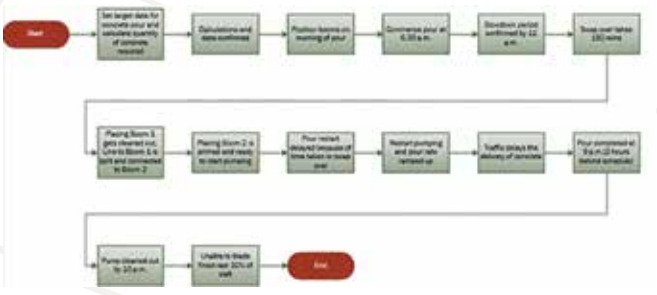

Figure 1. As-Is Process Map

The costs incurred because of the late finish included:

- Fifteen resources tied up working out-of-hours at a cost in the region of €3,700. Had we not developed the solution we did, this figure would be multiplied by 19 pours on-site for the duration of the superstructure, equating to €70,000 in overtime costs.
- Where the slab could not be finished completely, the knock-

on effect on quality required a crew to grind the slab to achieve the finish at a cost of €1,680. Again, the overall cost could have amounted to €31,920.
- The total exposure on this issue equated to more than €100,000.

We created a Cause and Effect diagram to help with the determination of the elements of the problem. This helped us to focus on the critical few causes of the problem we were trying to solve.

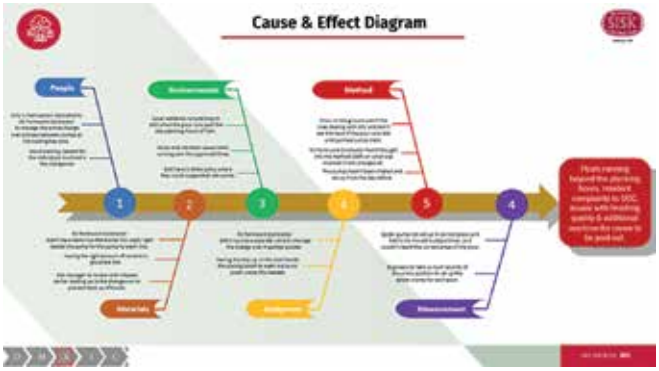

Figure 2. Cause and Effect Diagram

Figure 3 shows the concrete pump and the area of the swap-over where the root cause of the problem lay.

Figure 3. The Concrete Pump

Analyse

Having completed the first pour, it became evident that some streamlining of the process would be required to improve efficiency. We therefore held a Kaizen event with the team to review the current process and the issues it raised, and to develop solutions for subsequent pours. To get the pour completed within 10 hours, the swap-over between placing boom 1 and placing boom 2, whilst washing out the line back to the pump, was highlighted as being critical. It became clear that it was more beneficial to pour the slab in two separate large pours rather than split it up into the four smaller pours as originally planned. In addition, we determined that the swap-over needed to be achieved in 45 minutes and not the existing 150 minutes.

From our analysis, it became evident that the main issue we faced was the swap-over between the placing booms. A secondary issue was the spider pump locations. Although we had picked these beforehand, we still had to lift them with the tower crane three times instead of the planned two because they didn't reach exactly where we wanted to. The solution we proposed to adopt included the following elements:

- Ensure that the slab pours were completed between 17:00 and 18:00 to allow time for the quality of finish required on the last 30% section of the slab.
- Work with the Local Authority to determine if they would agree to start the pour 1 hour earlier and allow us to take advantage of this time before peak morning traffic.
- Determine the optimum number of pours for the slab in conjunction with the reinforced concrete formwork contractor and the concrete supplier.
- Review and standardise the procedure around cleaning out the lines from the first placing boom to the static concrete pump, and then swapping over the pipework connections to the second placing boom to complete the second half of the pour.
- Determine the optimum positions for the spider pumps so as to maximise their use and minimise the number of moves required, thus releasing the tower crane for other critical tasks.
- Take an as-built record of the ideal locations of the spider pump on the deck by our engineers and set these out again for each pour.

Figure 4 is an isometric view of a typical floor. Our original plan was to divide the pour into 4 sections. Having discussed this with the team involved, we decided to go with 2 pours as depicted in Figure 4.

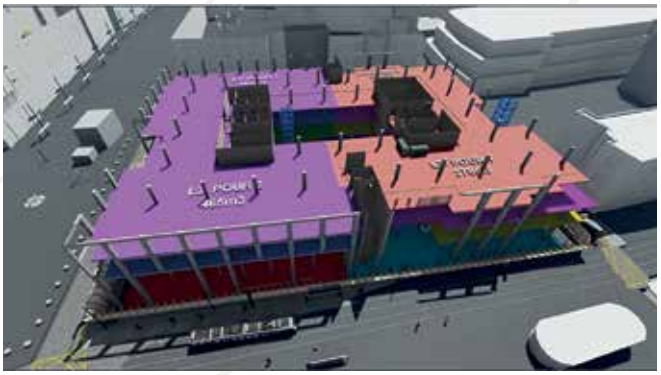

Figure 4. Isometric View of a Typical Floor

Another key item was ensuring that we efficiently ramped up the flow rate from the commencement of the pour to the point in time at approx. 11:00 when we needed to clean out the first placing boom line and swap-over the pipework connections to place boom 2.

We communicated this process to the concrete supplier so they were aware of the need to slow down the pour rate for approx. 45 minutes while the changeover happened. They then needed to ramp back up to the original rate to start pouring again at full pace, either through the placing boom on its own or through the placing boom connected to the spider pump.

Figure 5. Actual View of Slab Showing the Locations of the Placing Booms

Figure 6. Placing Boom Locations

Lean Initiative Improvements & Impact

Improve

We looked at the-swap-over for the placing booms as being the area where we would focus our improvement efforts. We needed to reduce the time taken to complete the swap-over and we used SMED as the principle for achieving this. Additional resources were needed by the formwork contractor to manage the changeover, and we developed the following solution:

- Break the task into its constituent parts and ensure there were separate crews for:
  - Washing out the placing boom on the slab.
  - Cleaning out the line back to the pump.
  - Changing the line over from one placing boom to the other.

Each of these crews went through additional training in advance so they were very much aware of their specific tasks on the next pour day.

We also ensured that some additional SMED elements were in place on the day of the pour:

- Having a mortar bin full of water adjacent to the pump.
- Having the compressor within reach of the pump.
- Having a skip to blow the line safely on the slab so that no crane time was taken up locating these and getting them into position.

There have been several notable wins for all involved in achieving the changeover process on schedule. The 2 hours saved overall in the middle of the pour had a knock-on effect that meant that the following could be achieved so as to impact positively on the remainder of the project:

- The risk of the late pours costing more than €100,000 was mitigated.
- Better relationship with local residents by completing the pours on schedule and not impacting them in terms of out of hours work.
- Local Authority relationship maintained because there would be fewer complaints from the local residents.
- Client relationship is also key, and, by achieving the changeover procedure on time, the pours would finish on time. This meant power-floating the slabs could happen earlier, giving us a significantly better chance of achieving a better quality finish to the entire slab as opposed to the 70% of the area on the first slab.
- In this case, the addition of something as straightforward as additional trained and skilled operatives made the difference to enable a swifter and more efficient changeover.
- The importance of having simple things like a mortar bin in the right place for washout, the right amount of cement to grout a pump, the concrete skip in place to wash out the placing boom, and so on, all meant that the tower crane was not required to lift over each of these items and further delay the changeover process.

Control

A dedicated Sisk package owner and dedicated reinforced formwork contractor supervisor were required each time to supervise this process and ensured everything went according to schedule.