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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.

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Overview & Background to the Lean Initiative

This case study is based on a project undertaken as part of a Green Belt training course. To complete the course, we were required to identify and solve a problem using the tools and techniques we learned on the course. The problem selected entailed examining how to reduce the time it took to install precast concrete panels on a project the author was working on. The issue was the additional time it took to install the non-standard unbalanced panels. These non-standard panels are unbalanced because of the uneven distribution of weight and the slinging arrangements were carried out on a trial-and-error basis with constant adjustment of lifting gear.

The project itself comprised a 472-bed apartment complex, configured in 5 blocks and constructed using a precast concrete frame. This precast frame uses three different types of panels: one with 2 lifting eyes, one with 3 lifting eyes, and one with 4 lifting eyes. The panels that presented the biggest challenge were the ones with 4 lifting eyes.

Lean Initiative Undertaken – Lean Thinking, Tools, Techniques

Define

As part of a Green Belt training programme, a problem was identified that impacted the progress of the construction project and which didn't have an obvious solution. We focussed on the main elements of the project and sought to identify a challenge that met these criteria.

Many of the potential opportunities we determined were of the just do it sort, where we had the solution to hand but were not using it. We decided to look at the precast panel installation as a potential source of an improvement project because of the variation in time it took to install different panels.

On a Gemba walk focused on the installation of the precast concrete panels, we discussed the challenges faced by the installation crew. Their biggest issue was how to determine the lifting chain lengths for the unbalanced panels due to their uneven weight distribution. The process they had been using was balancing the non-symmetric panels on a trial-and-error basis, with the chain lengths from the crane being adjusted until sufficiently balanced to enable the lifting of the panels into position.

As a result, time was lost trying to figure out the best way to fit these panels. The daily quota required to meet the construction of the building's frame was not being met and installation set-up times were identified as being a critical element of the process.

The typical response to these challenges is to apply more pressure to the installation crew or add more people to the task. However, the Lean training taught us to analyse problems and to understand

Figure 1. The 4 Lifting Eye Unbalanced Panel During Lifting

their root causes. In addition, the process of resolving issues required fact-based decision making, and for this we needed to understand what the contributory factors to the issue were and to measure their impact.

Figure 1 shows an unbalanced panel being lifted into position. A successful installation depends on the panel being presented evenly to the starter bars in the floor slab. To achieve this, the left-heavy side of the panel must be dropped vertically into place and level with the right side of the panel. The trial-and-error method meant that the panel had to be lifted back to the stillage and re-configured.

We mapped the process to understand the steps involved, from the arrival of the panel on site to its final placing in position (see Figure 2).

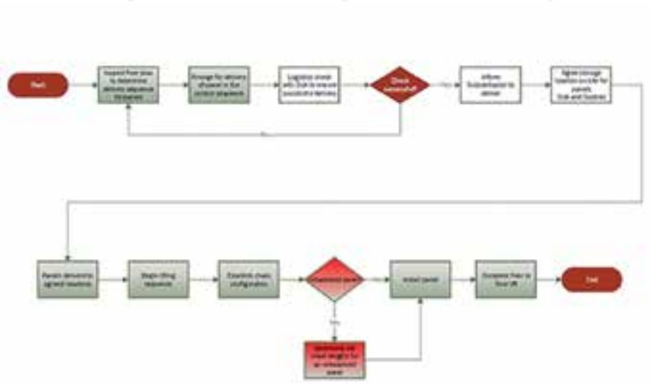


Figure 2. As-Is Process Map for Precast Panel Installation

We then used the process as the spine of a SIPOC diagram (see Figure 3).

Suppliers	Inputs	Processes	Outputs	Customers
Sisk/supply chain on-site package managers	Plan works with subcontractor	Inspect floor plan, identify areas of panel commonality and/or	Arrange lifting sequence of walls, coordination of logistics, crane usage/demands etc	Package managers
Package managers	Marked up drawing	Itemise panels	Programme of works	Project team
Project team	Site walk/whiteboard meeting	Check storage/access based on day's/week's activities	Ensuring continuation of works	Precast factory
Precast factory	Communication	Call off material	Material on site	Project team
Project team	Stillage arrival times, locations	Coordinate lifting plan	Having the correct material in the correct area at the correct time	Crane operator
Crane operator	Lifting of precast panels	Bring crane into position, lift and drop into position	Begin assembly of structural frame	Project team
Project team	Walk the finished area	QAQC check	Sign off	Project client

Figure 3. SIPOC for Precast Panel Installation

Measure

Figure 4 presents an isometric view of a typical floor, and shows that on Level 03 Block D2 there are 24 unbalanced panels.

Over the 3 blocks, each with 8 floors, we identified 969 potentially unbalanced panels. The details for each floor and block are shown in Table 1.

We measured the time taken to install 24 unbalanced panels from chain engagement to panel dropping on the slab on one of the blocks using the current process. The sum of these times was 7 hours, 34 minutes, and 36 seconds, equating to an average time per panel of 18 minutes and 56 seconds. By comparison, for a standard balanced panel, installation was completed in less than 6 minutes.

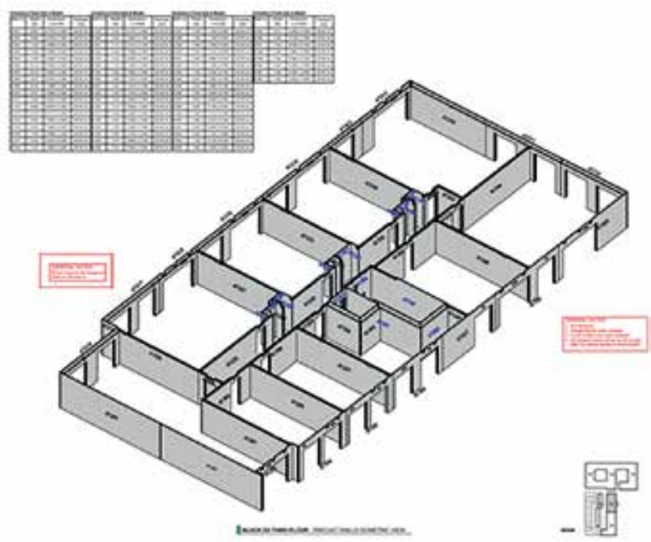


Figure 4. Isometric View of a Typical Floor Plan

Unbalanced Panels					
Block A1		Block A2		Block B1	
Level 00	37	Level 00	45	Level 00	29
Level 01	39	Level 01	47	Level 01	44
Level 02	42	Level 02	52	Level 02	51
Level 03	42	Level 03	52	Level 03	51
Level 04	42	Level 04	52	Level 04	51
Level 05	42	Level 05	52	Level 05	51
Level 06	40	Level 06	51	Level 06	48
Level 07	3	Level 07	3	Level 07	3
Total	287	Total	354	Total	328
Total unbalanced panels = 969no = 30.576 10hr working days					

Table 1. Potential Number of Unbalanced Panels in Blocks A1, A2, B1

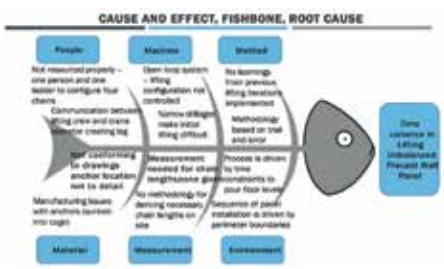
Analyse

In the analysis phase, we used a Fishbone Diagram (see Figure 5) to understand contributory factors to the problem. From this review we identified two main factors impacting the installation time:

i. The as-built anchor locations on the panels did not conform to the design locations.
ii. Due to a lack of communication between the precast panel factory and on-site precast installation crew, chain lengths had to be determined based on the actual locations of the lifting eyes.

While a major process error was found in the positioning of the lifting anchors, we decided to focus our improvement efforts on the time taken to manage chain lengths.

Figure 5. Fishbone Diagram for the Process of Lifting Precast Walls



Lean Initiative Improvements & Impact

Improve

We held a Kaizen event with the team involved in the process of installing the panels. From our analysis using the Fishbone Diagram, we knew that time was being lost waiting for the correct configuration of the chains to lift the panels. We thus arrived at a solution based on the geometry of the lifting chains.

To settle on the correct chain lengths we used the cosine rule. This states that the side 'c' of any triangle can be found with the following information:

- The angle gamma 'γ' (must be the angle opposite side 'c')
- Triangle side length 'a'
- Triangle side length 'b'

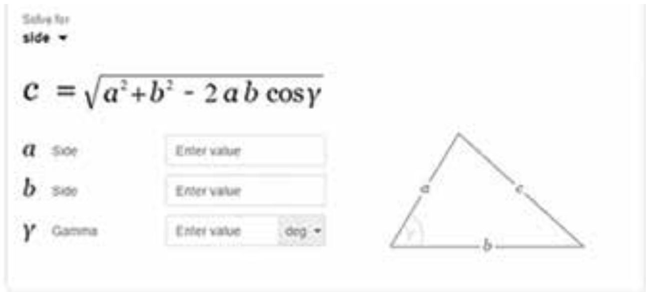


Figure 6. The Cosine Rule

With this formula, we could establish the correct chain lengths for the unbalanced panels. In a lifting configuration, such as the one shown in Figure 1, there are four chains. If we set these two exterior chain lengths to be the same length as the span of the panel, we have created an equilateral triangle. The three angles within the triangle are all 60, as per the equilateral triangle rule.

With these parameters set, we could factor in the two shorter, interior chain lengths within the lifting configuration, and we could now break the lifting configuration down into two further smaller obtuse triangles and designate these two smaller chain lengths as side 'c' in their respective triangles. Therefore, for a typical configuration

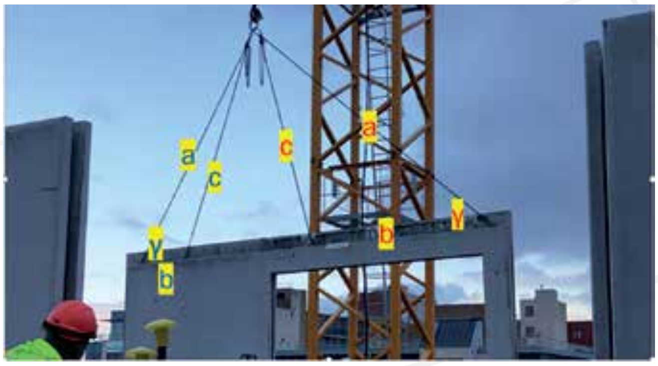


Figure 7. Lifting Configuration with the Cosine Rule Built-In

(Figure 7 shows these angles and triangle sides) these would be:

- a = wall span length
- b = distance between lifting hooks as per shop drawings
- γ = 60°
- c = formula in Figure 6

Having agreed that this formula calculated the correct chain lengths for the unbalanced panels, we created a spreadsheet where the correct chains lengths were calculated. To test our solution, we installed 8 unbalanced panels using the cosine rule formula. This resulted in an average installation time of 6 minutes and 48 seconds per panel. The floor-to-floor build cycle is 3 weeks, which gives sufficient time to plan and prepare for handling future unbalanced panels. Using the drawings from the precast panel supplier, we can make decisions based on their geometry.

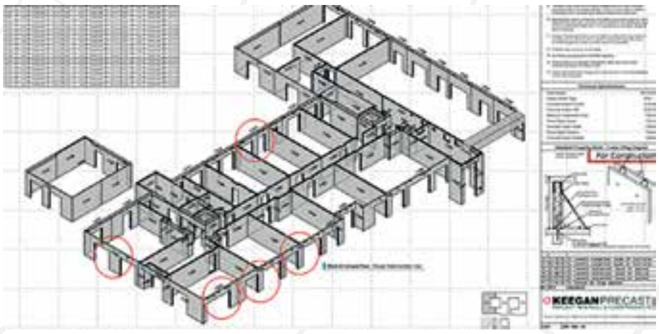


Figure 8. Isometric Plan of Block A1 Level 01 (samples of potentially unbalanced panels circled in red)

Some panels that appear to be unbalanced are in fact balanced. To find out which panel will require the additional work, we entered the dimensions into the spreadsheet we created for this purpose and arrived at the final number of unbalanced panels. As a result of this exercise, we arrived at a total of 96 unbalanced panels.

The installation times achieved using the solution above saves approx. 12 minutes per unbalanced panel. In addition, by using the spreadsheet we could calculate that the actual number of unbalanced panels was averaging at 4 panels per floor for 8 floors across 3 blocks. Therefore, over 24 floors there would be approximately 96 actual unbalanced panels. The cost of installing pre-cast panels approximates to €275 per hour and includes the following elements:

- Crane
- Crane Operator
- Installation Gang
- Sisk Supervision

Using our solution, time saved installing an unbalanced panel is approx. 20 hours, and, on that basis, the overall saving to the project is approximately €5,500.