

APPLICATION OF JUST IN TIME TO THE FABRICATION AND INSTALLATION OF PREFABRICATED CONCRETE FACADES IN BUILDINGS

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ABSTRACT

This paper will demonstrate the advantages of using Lean Construction methodologies on projects, specifically Just In Time, to the entire process of fabrication, transportation, and installation of prefabricated concrete facades.

The objective was to change the traditional process of mass production, with production of big lots of each different piece and the need of important areas for storage of the material waiting for installation.

As Sven Bertelsen and Rafael Sacks (2006) propose on their paper presented at the IGLC 14 conference: “The construction industry must therefore be seen as an industry conducting an eternal chain of interwoven projects as any participant is involved in more than one project at the same time. The aspect distinguishing the construction industry from mass or customized production is thus not the individuality of the product per se but the fact that the huge variation in project outcomes makes it necessary for the industry to set up a new production process—and therefore a new production system for each project”.

The proposed change was to fabricate very small lots of one- or two units of each different piece, send it to the construction site to be installed, checked for changes and adjustments needed, communicate those to production and implement the changes on the molds and on the production processes.

This change is of particular importance because it is difficult to make sound decisions on materials management and supply chain management in regards to how much and when to order the materials on a construction project, combined with the uncertainty of its delivery (Tommelein 2006) IGLC 14, Tommelein and Li 1999).

KEY WORDS

Just in Time, Lean Construction

INTRODUCTION

The traditional process of fabrication and installation of this type of facades was analyzed back in 2008 on a very similar previous project. The problems encountered on that time were:

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- Long time needed for installation.
- Rework on most of the pieces of the façade, adjusting one piece with the next.
- Waste of many pieces, caused by long storage periods, mostly breakage.
- Quality problems, appearance below expectations of the client.

Figure 1 shows the installation of these concrete facades.

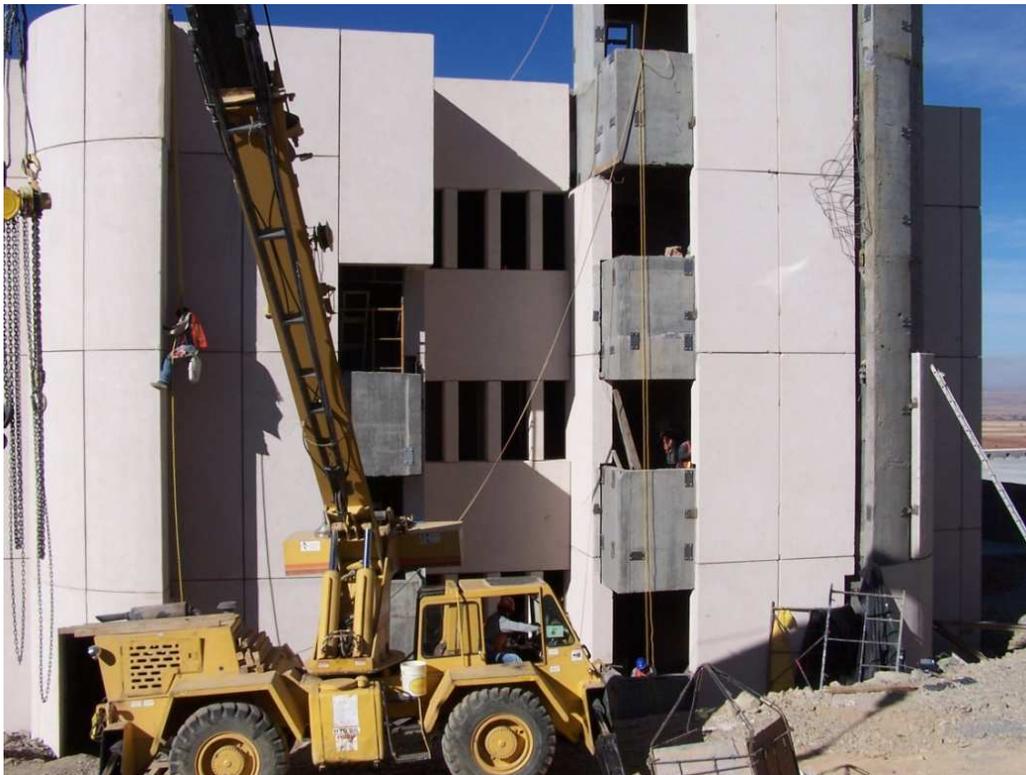


Figure 1: Installation of concrete facades in process (2008 project)

A similar project had started on 2008, with 1,380 pieces of the same type of prefabricated facades. The number of pieces for the new project were 2,032 units to be installed in fewer months than was done on that previous, similar project.

Discussions were held with the general contractor and his supplier to apply Just in Time to solve the problems of the previous project. The major concerns of the supplier were the incremental costs of small lots versus large production lots, and the low reliability of supplying Just in Time to the construction site. These concerns were analyzed and references to other projects in which Just in Time was used, set the decision to apply the methodology in the new project.

METHODOLOGY

Initial conversations with the supplier were conducted to address the main concerns about the changes that could be a resultant of the implementation of Just in Time methodology:

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- Changes in the size of the production lots, instead of big lots of the same type of piece, a single piece at the initial stage and after that, only the amount needed for installation at the construction site.
- Delays in production caused by the installation of the first piece, to be checked for corrective action, feedback to the supplier plant, correction of the molds and then start again production.
- Lack of reliability caused by the reduced inventory on plant and at the supplier plant, not having time to absorb production and transportation delays.

These concerns are typical when a new process is decided to transform onto a Just in Time operation.

To cope with the problems enlisted, and to promote the transformation to the Just in Time operation, the following was done:

- **Changes in the process of fabrication and installation.**

Instead of the traditional steps on the process, as shown in Figure 2, a couple of modifications were proposed, to avoid large production lots and the storage on site, as shown in Figure 3.

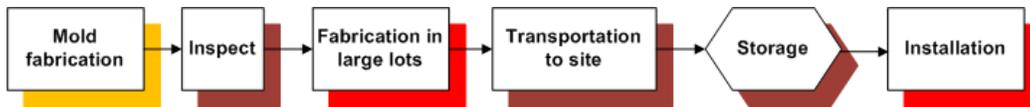


Figure 2: Traditional fabrication and installation process

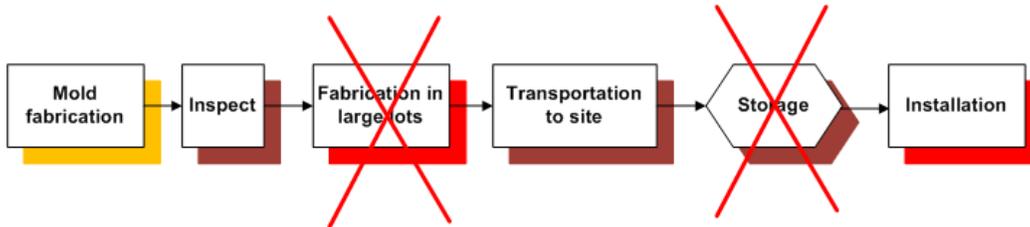


Figure 3: Proposed changes, steps to modify.

A new process was developed to produce a single piece and before to start production, to be checked on the field, as shown in Figure 4:

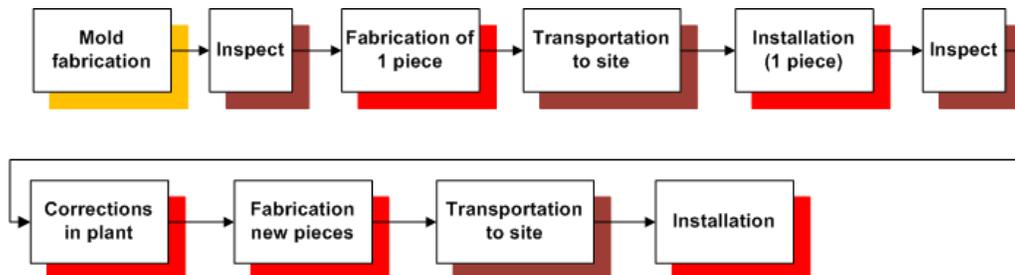


Figure 4: New process, lean single piece

The process was longer with additional steps, for correcting and adjusting the molds after the first trial at the construction site. This proved to be one key element to avoid rework on site and to reduce the time needed by the installation crew. Figure 5 shows one of the molds used for each piece:



Figure 5: Molds to be modified

- **Reduced amount of storage in the construction site.**

Another major change introduced was the reduction of inventory on hand (only 3 days inventory) before a piece was installed.

During all the project, the installation crew never stopped because a lack of material from plant, demonstrating that the new way to doing the entire process under the Just in Time principles were feasible and avoided damage of the material on the field.

- **Review the installation sequence.**

Frequent reviews and discussions were held to analyze the sequence of the installation. Major changes were introduced to improve the sequence and reduce idle time of the installation crews waiting for cranes to be moved from one position to the next.

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Figure 6: Installation of concrete facades with new sequence

The initial sequence was horizontal, installing the first 2 levels of facades and moving to the left to install the following pieces. That sequence was causing to move the cranes very often and having waiting of the crews.

The horizontal sequence was changed to a vertical sequence, installing from down to top all the pieces in all levels before moving the cranes to the next position.



Figure 7: Vertical sequence

Steps for the success of the Just in Time implementation:

The following steps were very important to obtain the desired results of the Just in Time implementation:

- a. Work very close with the supplier. Design the new process, in collaboration with hm.
- b. Assign an engineer to be half the time on the construction site, and half the time on the plant, looking after the fabrication process.
- c. Analyze the problems encountered during the installation, identify the root causes and the changes to be done at the plant to improve quality and facilitate the installation.
- d. Review daily the coordination for fabrication, transportation, storage and installation.

RESULTS

The main results from the execution of the project under Just in Time methodologies was the completion three (3) months in advance, compared to the previous project, the productivity gains and the better quality of the product.

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The production rate during the installation period increased in a very important amount as it can be seen in Figure 8, that shows the production figures, expressed in production per week for the period September – December 2009.

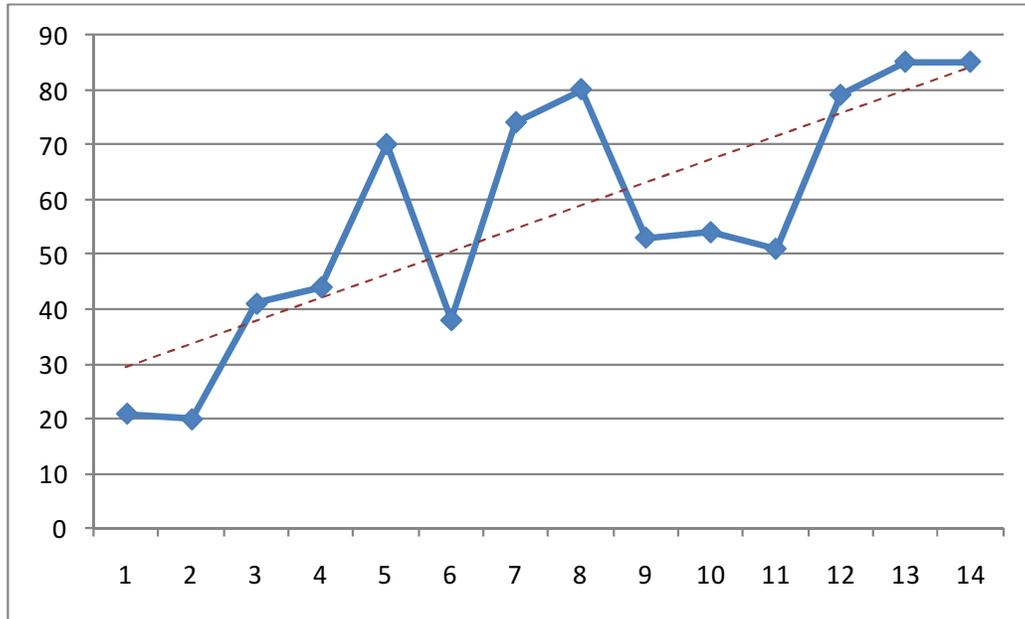


Figure 8: Installation rate, week by week

The quality at the end of the installation (Figure 9) was superior to the expectations of the client. Only minor repairs were needed.



Figure 9: Installation complete, 3 months earlier than previous project.

CONCLUSIONS

Just in Time is a very useful methodology for the construction projects and can be applied in a very different type of processes.

In the example we just reviewed, the benefits were evident and the reductions in time and cost well pay back the effort and difficulties of the changes involved to make it a success history. The most important roadblock to overcome is the resistance to change that is inherent in the human being. From all the stakeholders in the project, general contractor, suppliers, and superintendents, resistance to change can be expected.

Fortunately, this type of changes is very feasible to accomplish because of the quick results that could be obtained from the initial weeks that started the project changes.

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