

# Comparative Efficiency Analysis of Crawler Crane and Launcher Gantry Methods for PCI Girder Erection

Raditya Muhammad Fauzan<sup>1\*</sup>, Odih Supratman<sup>1</sup> and Yudi Sekaryadi<sup>1</sup>

<sup>1</sup>Civil Engineering Study Program, Faculty of Engineering and Industrial Education, Universitas Pendidikan Indonesia

\*Corresponding Author: Raditya Muhammad Fauzan. Email: [radityamuhammadf10@gmail.com](mailto:radityamuhammadf10@gmail.com)

## Abstract

This study analyzes the efficiency of two heavy equipment methods, Crawler Crane and Launcher Gantry, for the erection of Precast Concrete I-Girder (PCI Girder) in bridge construction. With a focus on the Cibeet Bridge at STA 32+200 on the Jakarta-Cikampek II South Toll Road Package 3 project, this study compared the time and cost aspects of the two methods. The findings show that although the Launcher Gantry method is 11% faster in execution time (48 days versus 54 days for Crawler Crane), the Crawler Crane method is 19.11% more cost efficient (IDR 21,398,982,000.00 versus IDR 21,438,834,000.00 for Launcher Gantry). This highlights the trade-off between speed and cost, emphasizing the importance of considering site conditions and project objectives when choosing an erection method.

Keywords: Efficiency, Crawler Crane, Launcher Gantry

## 1. INTRODUCTION

Infrastructure development, especially toll roads, is a government priority in Indonesia to drive economic growth and improve regional connectivity. The Jakarta-Cikampek II South Toll Road is a significant project that aims to reduce traffic congestion. PCI girder erection is a critical phase in bridge construction, which requires careful consideration due to the use of heavy equipment and inherent risks. The selection of the right erection method has a direct impact on project efficiency in terms of time, cost, and quality. This study aims to compare the efficiency of Crawler Crane and Launcher Gantry methods for PCI girder erection.

## 2. METHOD

Research methods can include research tools and materials as well as research work steps. The materials and instruments used in the research are mentioned in full. Procedures for obtaining data, processing data, and interpreting data are clearly presented. Provide enough detail about the research methods to allow the work to be reproduced. Published methods should be indicated by reference, only relevant modifications should be described.

This study uses a comparative method to analyze the efficiency of Crawler Crane and Launcher Gantry methods for girder erection. Data collection involved field surveys (primary data) and interviews, method statements, working drawings, cost budget plan (RAB), and S-curve (secondary data). The research stages include problem formulation, literature review, data collection, work item arrangement, method determination, volume calculation, productivity and duration calculation, scheduling using Microsoft Project, Gantt Chart creation, and Cost Budget Plan (RAB) analysis.

### 2.1. PCI Girder Erection Method

Erection is the process of fixing a girder beam to its supports, usually rubber pads or elastomeric pads [1]. Erection methods are generally divided into cast-in-situ and segmental precast. This research focuses on the segmental precast method, which involves the use of precast concrete elements transported from off-site fabrication.

### 2.2. Crawler Crane

A crawler crane is a type of mobile crane capable of lifting and transporting heavy loads vertically or horizontally without outriggers. Its main advantage lies in its ability to lift heavy capacities and maneuver in challenging and extreme construction areas. Crawler cranes are often classified

as heavy cranes due to their capabilities [2]. For girder erection, two cranes are often preferred over one to ensure horizontal alignment and prevent rotation [3].

2.3. Gantry Launcher

The Launcher Gantry method involves installing precast segmental concrete girders manufactured off-site. This relatively new technique differs from monolithic construction by pre-stressing individual segments together using external tendons. The Gantry Launcher utilizes a winch system to lift and move the heavy load, allowing precise transverse movement to the bearings for placement. Once one span is installed, the gantry moves forward to the next span [3]. Key components include Rail and Roller Assembly, Leg Assembly, Winch Motion, Main Beam, and Counter Balance [4].

2.4. Cycle Time Analysis

The Launcher Gantry method involves the installation of precast segmental concrete girders manufactured off-site. This relatively new technique differs from monolithic construction by pre-stressing individual segments together using external tendons. The Gantry Launcher utilizes a winch system to lift and move the heavy load, allowing precise transverse movement to the bearings for placement. Once one span is installed, the gantry moves forward to the next span [3]. Key components include Rail and Roller Assembly, Leg Assembly, Winch Motion, Main Beam, and Counter Balance [4].

Productivity is defined as the ratio of output to input (labor, material, equipment, and time) [5]. Project duration is determined by calculating cycle time, which is the time required to complete one unit of production from start to finish [6]. The basic formula for cycle time is:

$$CT = LT + HT + DT + RT + ST \dots\dots\dots 1$$

Where:

- LT= loading time
- HT= transportation time
- DT = discharge time
- RT = return time
- ST = spotting time

Productivity is calculated as:

$$Productivity = \frac{Capacity}{Cycle Time} \dots\dots\dots 2$$

Considering the tool efficiency (Fa), the production per unit time (Q) is:

$$Tool\ Efficiency = \frac{Long\ time\ effective\ tool\ works}{Length\ of\ effective\ working\ time} \times Q \dots\dots\dots 3$$

Taking into account the tool efficiency (Fa), the production per unit of time (Q) is:

$$Q = q \times \frac{60}{cycle\ time} \times Tool\ Efficiency \dots\dots\dots 4$$

Where:

- Q= Production per unit of time (units/hour)
- q= Production capacity per unit of time
- CT= Cycle time (minutes)

The tool coefficient is used to determine how efficient a work tool is, with the following formula:

$$Ka = \frac{1}{Q} \dots\dots\dots 5$$

Description:

Ka : tool coefficient with n units in the form of time units (hours or days).

Q : production capacity with units in the form of units of measurement per unit of time,

## 2.5. Cost Analysis

Project cost analysis is essential for managing limited resources. Engineers estimate the total project budget and control the cost realization against the planned estimate. Project costs are categorized into Direct Costs (related to field construction, estimated based on volume and unit price) and Indirect Costs (not directly related to construction but essential for project execution) [7].

## 2.6. Scheduling

Project scheduling estimates the time required for each task, defining start and finish dates. Effective scheduling manages time, labor, equipment, materials, and finances to prevent cost overruns, delays, and disputes [8]. Gantt Chart is widely used for construction scheduling due to its ease of creation, readability, and ability to integrate with other methods for cost control.

## 3. Results and Discussion

### 3.1. Research Data

This project involves the erection of 54 PCI girders, each 45.8 meters long and 2.1 meters high, at Cibeeet Bridge STA 32+200 on the Jakarta-Cikampek II South Toll Road project Package 3.

### 3.2. Cycle Time Calculation

The project involves the erection of 54 PCI girders, each 45.8 meters long and 2.1 meters high, at Cibeeet Bridge STA 32+200 on the Jakarta-Cikampek II South Toll Road project Package 3.

#### 3.2.1 Girder Mobilization

The fabrication plant is about 69.6 km away from the site. Each flatbed truck transports 2 segments. With an effective working time of 7 hours and an average speed of 20 km/h (heavy) and 30 km/h (empty), the cycle time for mobilization is 408 minutes. The production capacity is 9.15 tons/hour, or 64.08 tons/day (2 segments/day). To supply 36 segments per day, 9 trailers are required.

#### 3.2.2 Girder Levelling

This involves adjusting the position of the girder from the flatbed truck to the slipper for tendon hole precision. Based on field observation, the total duration for alignment of one girder is 30 minutes (0.5 hour).

#### 3.2.3 Girder Install

This is the process of installing the 15mm diameter tendon cable into the PCI Girder mold. Each girder has 5 tendons (C1-C5) with varying number of strands (12-15 strands per tendon), totaling 63 strands for 45.8m long girder. The total duration to install the tendons for one girder is 170 minutes (2.83 hours).

#### 3.2.4 Girder Stressing

This involves pulling the tendon wires using jacking to achieve the required camber. The total duration to tension 5 tendons is 160 minutes (2.67 hours).

#### 3.2.5 Grouting & Patching Girder

Grouting seals the tendon wires after tensioning to prevent corrosion, followed by patching to close the gap in the anchor head. The total duration for grouting and patching one girder was 65 minutes (1.08 hours).

#### 3.2.6 Erection with Crawler Crane

Based on observation, for 54 girders, the average cycle time for erection using Crawler Crane is 90.5 minutes (1.51 hours) per girder. Considering an effective working time of 7 hours, a tool efficiency factor (Fa) of 0.83, and a skilled operator efficiency of 0.8, the productivity was 0.345 tons/hour. The duration to install one girder is 22.7 days. For 54 girders, the total duration is about 54 days.

### 3.2.7 Erection with Gantry Launcher

Based on field observation for 54 girders, the average cycle time for erection using Launcher Gantry is 41.3 minutes (0.69 hours) per girder. With the same efficiency factor, the productivity is 0.874 tons/hour. The duration to erect one girder is 8.88 days, rounded to 9 days. For 54 girders, the total duration is about 48 days.

### 3.3. Lifting Calculation

The Safety Factor analysis for Crawler Crane 150 T shows that a 10m radius is suitable (SF = 1.36), while a 12m radius is not suitable (SF= 1.06). For the SCC2000A 200 T Crawler Crane, a 12m radius is suitable (SF= 1.41).

### 3.4. Scheduling and Cost Calculation

The Factor of Safety analysis for Crawler Crane 150 T shows that a 10m radius is suitable (SF = 1.36), while a 12m radius is not suitable (SF= 1.06). For the SCC2000A 200 T Crawler Crane, a 12m radius is suitable (SF= 1.41).

#### 3.4.1 Scheduling\

Scheduling is done using Microsoft Project, incorporating the calculated duration for each work item.

#### 3.4.2 Cost Calculation

Scheduling is done using Microsoft Project, incorporating the calculated duration for each work item.

Unit prices for labor, materials, and equipment were determined based on the Binamarga Division 2024 AHSP standard.

- A. **Girder Mobilization:** The cost per segment is IDR 590,000.00.
- B. **Levelling Girder:** The cost per girder is IDR 10,030,000.00.
- C. **Girder Install:** The cost per girder is IDR 14,240,000.00.
- D. **Stressing Girder:** The cost per girder is IDR 15,890,000.00.
- E. **Grouting & Patching:** Cost per girder is IDR 4,900,000.00.
- F. **Crawler Crane Erection:** Hourly cost for Crawler Crane IHI 150 T is IDR 353,470.44, SUMITOMO 100 T is IDR 319,829.00, and FUWA QUY 75 T is IDR 256,804.00. Cost unit cost for erection using Crawler Crane (including tandem crane arrangement) is IDR 3,862,000.00 per girder. If using two SCC2000A 200 T and one FUWA QUY 75 T, the unit cost is IDR 3,929,000.00 per girder.
- G. **Gantry Launcher Erection:** The hourly cost for Launcher Gantry is IDR 1,390,350.78. The unit cost for erection using Launcher Gantry is IDR 4,600,000.00 per girder.

#### 3.4.3 Cost Budget Plan (RAB)

##### **Crawler Crane Method:**

- A. Cost per span (9 girders): IDR 461,538,000.00
- B. Total cost for 54 girders: IDR 2,663,028,000.00
- C. Total project cost including PCI Girder supply: IDR 21,398,982,000.00

##### **Launcher Gantry Method:**

- A. Cost per span (9 girders): IDR 468,180,000.00
- B. Total cost for 54 girders: IDR 2,702,880,000.00
- C. Total project cost including PCI Girder supply: IDR 21,438,834,000.00

## 4. Conclusions

The main conclusions of this study can be presented in a short Conclusions section, which can stand alone. It should not repeat the Results, but rather provide the significant findings and contributions of the study. Conclusions should be presented in the text and aligned with the problem formulation and research/writing objectives. Similarly, for research purposes, if more than one conclusion can be written, use numbering instead of bullets.

Based on the analysis of the Jakarta-Cikampek Toll Road Package 3 project at Cibebet Bridge STA 32+200:

1. Time Efficiency: The Launcher Gantry method was 11% faster, completing erection in about 48 days compared to 54 days for the Crawler Crane method.

2. Cost Efficiency: The Crawler Crane method is 19.11% more cost efficient, with a total cost of IDR 21,398,982,000.00 compared to IDR 21,438,834,000.00 for the Launcher Gantry method.

In summary, the Crawler Crane method is more cost efficient, while the Launcher Gantry method is more time effective. Therefore, the choice of erection method should consider the specific site conditions and project objectives, balancing time and cost to achieve optimal results.

#### ACKNOWLEDGMENT

I would like to express my gratitude to my first supervisor, Drs. Odih Supratman S.T., M.T., and my second supervisor, Drs. H. Yudi Sekaryadi S.T., M.T., for their guidance and supervision. I would like to express my gratitude to PT Jasamarga Jalan Jakarta-Cikampek Selatan Paket III for providing me with the opportunity to grow and develop, as well as for allowing me to conduct my research there. I would also like to thank my parents and friends for their constant support in helping me complete this research.

#### REFERENCES

- Hadiyatmoko, D., Hatmoko, J. U. D., & Wibowo, M. A. (2023). Analysis of Launcher's Productivity in Erection Girder Using Time Motion Study Method. *Civil Engineering Journal (Iran)*, 9(8), 1897–1911. <https://doi.org/10.28991/CEJ-2023-09-08-06>
- Hari Murti, R. (2021). *Seminar Nasional Metode dan Teknologi Bidang Konstruksi*. 1–23.
- Hasdian, E., Arief Maulana, M., Candra Fertilia, N., & Lutfiansyah, Y. (2021). Attribution 4.0 International (CC BY 4.0) Analysis Comparissons of Erection Girder Implementations Methods Using Launcher Gantry and Crawler Crane Based on Cost and Time (Case Study: Cimanggis-Cibitung Toll Road Project Section II Cibubur Area). *International Journal of Sciences, Engineering and Technology*, 6(2), 78–88. <http://adri.journal.or.id/index.php/ijset/index>
- Kadriadi, K., Wirakusuma, K. W., Opu, A. S., & Alfian, M. (2024). Analisis Crane Portable Dengan Kemampuan Angkat 1 Ton. *SINERGI POLMED: Jurnal Ilmiah Teknik Mesin*, 5(2), 52–61. <https://doi.org/10.51510/sinergipolmed.v5i2.1652>
- Kwak, H. G., & Son, J. K. (2006). Determination of design moments in bridges constructed with a movable scaffolding system (MSS). *Computers and Structures*, 84(31–32), 2141–2150. <https://doi.org/10.1016/j.compstruc.2006.08.044>
- Patil, V. S., & Kushwah, R. P. S. (2023). Bridge Construction Using Innovative Technology of Open Web Girder Launching. *International Research Journal of Modernization in Engineering Technology and Science*, September. <https://doi.org/10.56726/irjmets43861>
- Peraturan Menteri PUPR Nomor 8, 61 (2023). [www.peraturan.go.id](http://www.peraturan.go.id)
- PT Freyssinet Total Technology. (n.d.). *Precast segmental erection methods*. Retrieved February 21, 2025, from <https://www.freyssinet.com/solution/build/bridge-deck-construction/precast-segmental-erection/>
- Sampaio, A. Z., & Martins, O. P. (2014). The application of virtual reality technology in the construction of bridge: The cantilever and incremental launching methods. *Automation in Construction*, 37, 58–67. <https://doi.org/10.1016/j.autcon.2013.10.015>
- Soegiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. ALFABETA.
- Susanti, I. I., & Hadi, D. S. (2020). Comparative Analysis Methods Fullslab Precast Erection of Cost and Time. *Journal of World Conference (JWC)*, 2(2), 81–91. <https://doi.org/10.29138/prd.v2i2.217>
- Think's, D. S. (2018). *SOP Bagian LG*. <https://www.scribd.com/document/371104577/Sop-Bagian-Lg>
- Umar, A. R., & Ranap Tua Naibaho, P. (2022). Proyek Pembangunan Jembatan Rumah Susun Padat Karya “Pengamatan Pelaksanaan Pekerjaan Plat pada Jembatan Rumah Susun Padat Karya.” *Nucleus*, 3(1), 76–84. <https://doi.org/10.37010/nuc.v3i1.791>
- Widiasanti, I., & Lenggogeni. (2013). Manajemen Kontruksi. In *Widiasanti, Lenggogeni dan Irika* (p. 7).