Syntax Literate: Jurnal Ilmiah Indonesia p–ISSN: 2541-0849
e-ISSN: 2548-1398
Vol. 7, No. 10, Oktober 2022

ANALYSIS SELECTION OF THE WORK METHODS PIER HEAD CAST IN SITU TOLL ROAD BRIDGE ON HILLY TOPOGRAPHY

Abdul Kholiq, Tri Joko Wahyu Adi
Department of Civil Engineering, Institut Teknologi Sepuluh Nopember, Indonesia
E-mail: tri_joko@ce.its.ac.id, ab.kholiq78@gmail.com

Abstract

The implementation of construction projects must be managed professionally with good and appropriate management. One of them is through the selection of work methods in the implementation process. In bridge construction, several main parts, such as pier head construction, need special attention. This study aims to analyze the selection of the best work method in implementing pier head cast in situ in the construction of toll road projects from several alternative pier head work methods, including full shoring system, bracket truss system, and corbel truss systems. The best alternative method is selected using the AHP (Analytic Hierarchy Process) Method. Decision-making variables, which include four criteria and ten sub-criteria, were obtained from in-depth literature reviews and discussions with experts through FGD (Focus Group Discussion). From the results of the analysis using AHP, the values for corbel truss (0.530), full shoring (0.318), and bracket truss (0.152) were obtained. Compared to other alternatives, the corbel truss system method has advantages in duration, characteristics, and performance criteria. Hence, the corbel truss system method is the best alternative to be used as a pier head cast in situ bridge work method.

Keywords: pier head cast in situ, AHP (Analytic Hierarchy Process), Construction Project

Introduction

According to information from WebGIS BPJT (accessed on September 18, 2021, at 16:00 WIB), the length of the toll road that has been operating is 2,430.52 KM with a total of 63 sections. In addition, 30 toll road sections are in the construction phase, and several projects are still in the planning stage. In order to achieve the target of developing toll road infrastructure in Indonesia, the implementation of construction projects must be managed professionally with good and proper management. One of them is through the selection of work methods in the implementation process. One of the risk aspects of toll road development

How to cite:	Abdul Kholiq, Tri Joko Wahyu Adi (2022) Analysis Selection of The Work Methods Pier Head Cast in Situ Toll Road Bridge on Hilly Topography, *(7) 10. Doi: 10.36418/syntax-literate.v7i10.13103*
E-ISSN:	2548-1398
Published by:	Ridwan Institute

is the construction of bridges with the risk of working at height. This risk is always taken into account before determining the work method.

One of the previous studies was conducted by Youssef (2006) with the development of a decision support system that provides a systematic and structured framework to improve the process of selecting the current bridge superstructure construction method. This study identified that the selection process is heavily influenced by cost, construction duration, physical characteristics of the bridge, and the surrounding environment and, to a lesser extent, by stakeholder objectives and external constraints.

This study aims to analyze the selection of the best work method in implementing pier head cast in situ on hilly topography conditions that have a height of more than 15 meters in the construction of toll road projects using a comparison of 3 work methods, namely a full shoring system, bracket truss system, and corbel truss system. Analysis was carried out on several parameters based on relevant previous studies so that the best alternative can be optained and applied in the project to help achieve the goals and targets of the project.

Literature Review

In practice, the pier head construction method, in general, can use the precast method or the cast in situ method. Precast pier head is a pier head work method in which concrete casting is done outside the pier location so that it becomes precast concrete. When the pier is ready to support the pier head load, the precast concrete will be installed in its position. Meanwhile, pier head cast in situ is a conventional construction method in which concrete casting is carried out manually using formwork and supports. However, along with the development of method innovation with various considerations, several types of implementation methods exist.

This study specifically discusses the pier head construction method by casting in place/cast in situ. Several methods are commonly used in pier head work, including:

1. Full Shoring System. The formwork work method of the pier head cast in situ with a series of steel scaffolds, such as ring lock, PD-8, and H-beam as the base form support.
2. Bracket Truss System. The formwork work method of the pier head cast in situ with a truss with post-tensioning bar mounts as the base form support.
3. Corbel Truss System. The formwork work method of pier head cast in situ with a truss with corbel mounts (concrete console) as the base form support.

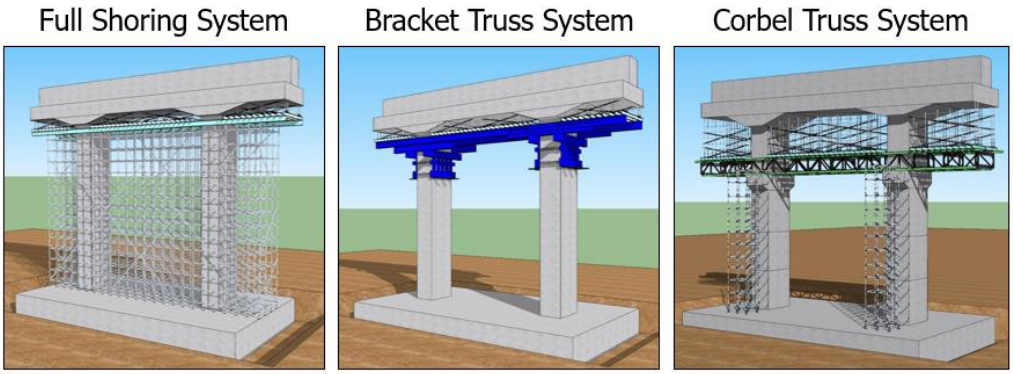

Figure 1. Types of pier head cast in situ work methods

Some problems encountered in the bridge construction process are implementation costs, implementation time, implementation safety, and topographical conditions. Implementation costs generally have several main components, including material costs, equipment costs, labor, and project profits. Implementation time management is the process of planning, compiling, and controlling project activity schedules to complete projects more quickly and efficiently. Implementation safety needs in-depth analysis to avoid construction failures and other possibilities that could endanger the safety of construction labor and the environment. Topographical conditions are required for the preparation of engineering plans in order to obtain the optimum result from both the technical and financial points of view of the project.

Research Methods

Variable synthesis in selecting construction methods is a summary of variables in previous studies based on the literature study. Variable synthesis is used to identify the best and the most relevant variables to the research topic. Table 1 below describes some of the variables from the literature study and the sources that convey them.

Table 1. Variable Synthesis

No	Variable	Youssef (2006)	Ali A. (2010)	Chen (2010)	Wang (2016)	Long (2018)
1	Construction Costs	v		v	v	
2	Construction Duration			v		
3	Safety			v		
4	Ease of construction	v	v	v	v	v
5	Topography			v		
6	Social and Environmental Impacts				v	v
7	Availability of resources	v		v		

8	Durability	v				
9	Design efficiency	v				
10	Maintenance	v	v	v		
11	Design		v			
12	Technology					v

Primary data is data obtained by researchers from the first or original source. In this study, primary data was obtained from FGDs (Focus Group Discussions) in a focused way to obtain information and/or data in order to get the best and most appropriate criteria/variables to be included in the questionnaire survey data collection. The number of research sub-criteria is initially 18 and then reduced to ten. Adjustment of the number of sub-criteria is due to several sub-criteria that are considered to have similarities and the relevance of the sub-criteria to other alternatives. The following is a variables synthesis used in the AHP hierarchy for selecting the pier head cast in situ work method on toll road construction.

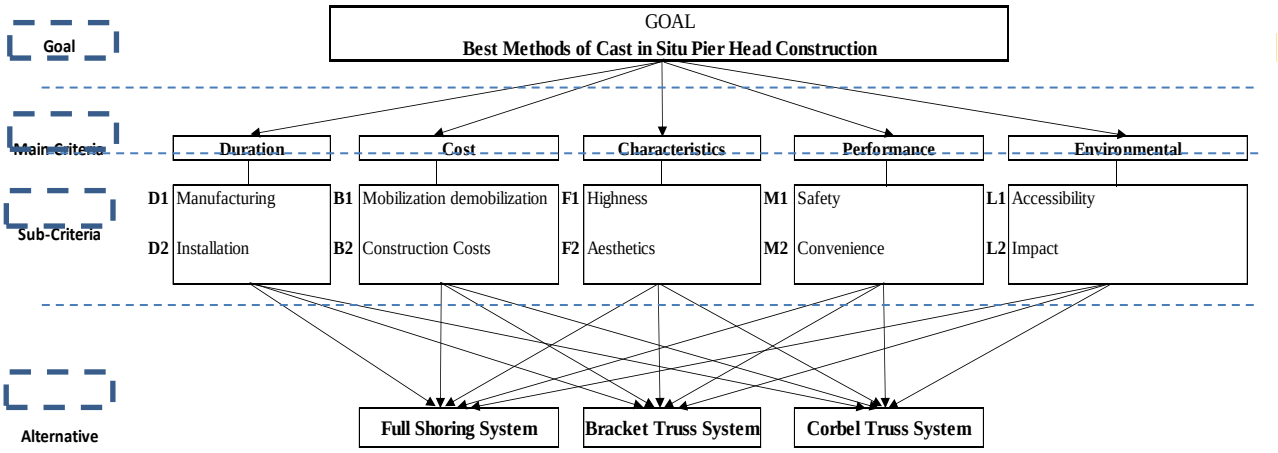

Figure 2. Hierarchy of AHP selection of pier head cast in situ work method

The sampling technique used in this study is Non-Probability Sampling with a purposive sampling method. The questionnaire survey was distributed to respondents who are professional practitioners of toll road bridge construction, totaling 22 project managers. In the respondents' profile, no one has less than five years of experience. Most respondents have an experience range of five to ten years in bridge construction projects, as much as 41%. There are even respondents with project experience of more than 20 years, as much as 9%.

Results and Discussion

Determination of the policy strategy in the effort to Select the Best Method of Pier Head Cast in Situ Construction was analyzed using AHP (Analytical Hierarchy Process)

analysis. To process the research results, the authors set four steps to solve the problem according to the basic principles of problem solving in AHP, which include decomposition, comparative judgment, synthesis of priority, and logical consistency (Wijono, 2015).

In decision-making, it is essential to know how good the consistency is because we want decisions based on things other than judgments with low consistency. Consistency measurement is done as many as existing comparison matrixes, namely comparisons between the main criteria, sub-criteria, and alternatives based on sub-criteria.

Based on the consistency ratio of all comparison matrixes, it is consistent because it has a consistency ratio below 0.10. The following is a summary of alternative weight calculations for the pier head cast in situ method.

Table 2. Summary of alternative weight calculations

Criteria	Weight	Sub-Criteria	Weight	Alternative		
				Full Shoring	***Bracket Truss***	***Corbel Truss***
Duration	0.114	Manufacturing	0.270	0.292	0.120	**0.588**
		Installation	**0.730**	0.235	0.111	**0.654**
Cost	0.262	Mob Demobilization	0.259	0.299	**0.375**	0.326
		Construction Costs	**0.741**	0.274	0.131	**0.596**
Characteristics	0.146	Highness	0.213	0.254	0.142	**0.604**
		Aesthetics	**0.787**	0.298	0.102	**0.600**
Performance	**0.352**	Safety	**0.795**	0.420	0.086	**0.495**
		Convenience	0.205	0.263	0.095	**0.642**
Environmental	0.126	Accessibility	0.416	0.246	0.119	**0.634**
		Impact	**0.584**	0.326	**0.484**	0.189
		Overall Weight		**0.318**	**0.152**	**0.530**
			Priority	**2**	**3**	**1**

From the weight calculation results of the alternative strategies of the five main criteria and ten sub-criteria, the corbel truss system method was the best alternative for the pier head cast in situ construction method in hilly topography.

The following are the results of global weighting, which have been outlined in the form of a decision hierarchy diagram in Figure 2, which will be used as an alternative selection assessment model in the Pier Head Cast in Situ Construction project.

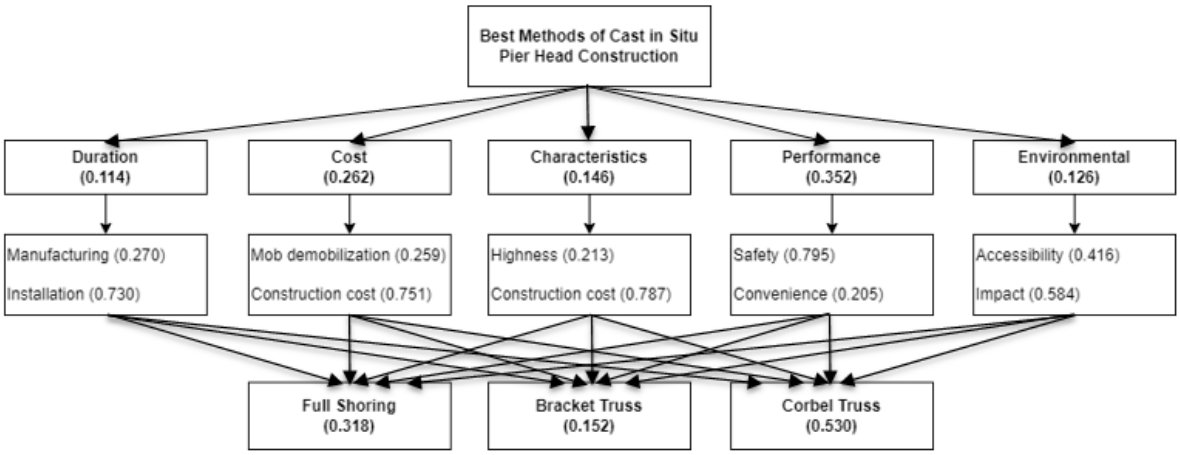

Figure 3. Weight values in the AHP Hierarchy

Based on the results of the overall AHP analysis with the calculation of the priority weights synthesis, the priority of alternative selection strategies for the Pier Head Cast in Situ Construction Project used is as follows.

Table 3. Overall alternative weight synthesis

Code	Alternative	Weight	Priority
A1	Full Shoring	0.318	2
A2	Bracket Truss	0.152	3
A3	Corbel Truss	0.530	1
	Total	1.000	

Based on the results of the AHP analysis as a whole, the priority methods are Corbel Truss (0.530), Full Shoring (0.318), and Bracket Truss (0.152) respectively.

Based on the results of the AHP analysis as a whole, the best method of pier head cast in situ in hilly topographic locations is the Corbel Truss Method. The Corbel Truss method, in performance, cost, and time, has advantages compared to other pier head cast in situ methods for locations with hilly topography.

From the description of several aspects, which include duration, cost characteristics, performance, and environment, the Corbel method has several advantages compared to other methods. The managerial implications obtained can be procedural and substantive. This research can be used as material for analysis and work planning for leaders and managers in bridge construction to increase productivity, profits, and safety and support the realization of the company's vision and mission.

Conclusions

The criteria and sub-criteria used in selecting the pier head cast in situ work method on the toll road project in this study were five main criteria, including ten sub-criteria with two sub-criteria for each of the main criteria. The main criteria and sub-criteria include the aspect of duration with the sub-criteria of manufacturing and installation, costs with the sub-criteria of mob-demob and construction costs, characteristics with the sub-criteria of height and aesthetics, performance with the sub-criteria of safety and convenience, and the environment with the sub-criteria of accessibility and impact on the environment.

The analysis using AHP found that the Corbel Truss method was the best alternative to use as a pier head cast in situ bridge work method on hilly topography with a pier head height of more than 15 meters to increase productivity, profits, and safety.

BIBLIOGRAPHY

Aliahmadi, Alireza, Seyed Jafar Sadjadi, and Meisam Jafari-Eskandari. 2011. *Design a New* Intelligence *Expert Decision Making Using Game Theory and Fuzzy AHP to Risk Management in Design, Construction, and Operation of Tunnel Projects (Case Studies: Resalat Tunnel), International Journal of Advanced Manufacturing Technology* 53 (5–8): 789–98.

G.A., Mendoza et al. 1999. *Guidelines for applying multi-criteria analysis to the assessment of criteria and indicators Guidelines for Applying Multi-Criteria Analysis to the Assessment of Criteria and Indicators*.

Saaty, Thomas L. 2001. *Fundamentals of the Analytic Hierarchy Process* : 15–35.

Saaty, Thomas L. 2003. *Decision-making with the AHP: Why is the principal eigenevector necessary* (Vol. 145).

Soemardi, Biemo W, R D Wirahadikusumah, M Abduh, and N Pujoartanto. 2006. *Konsep Earned Value Untuk Pengelolaan Proyek Konstruksi*. *Institut Teknologi Bandung*: 1–13.

Supriyadi, Bambang., and Agus Setyo Muntohar. 2007. "Jembatan (Edisi Pertama)." : 1–244.

Wang, Tao et al. 2016. *A Major Infrastructure Risk-Assessment Framework: Application to a Cross-Sea Route Project in China*. *International Journal of Project Management* 34 (7): 1403–15.

Wijono, Djoko & Idham Ibty. 2015. *Penggunaan Metode Analytic Hierarchy Process Dalam Pengambilan Keputusan Penentuan Prioritas Program Kerja Dompet Dhuafa Yogyakarta. Telaah Bisnis*, Volume 16, Nomor 1, Juli 2015

Youssef, Mohamed A., Chimay J. Anumba, and Tony Thorpe. 2005. *Proceedings of the 2005 ASCE International Conference on Computing in Civil Engineering Intelligent Selection of Concrete Bridge Construction Methods in Egypt*.