LEADER
Civil Engineering and Architecture Journal

Civil Engineering and Architecture Journal Vol (Year) E-ISSN
DOI 10.37253/leader.v1i2.7891

Reconstruction of the Kanaan Composite Bridge Bontang City, East Kalimantan

Fenia Hayatun Nikmah[1*], Mulia Pamadi[2]
[1,2]Faculty of Civil Engineering and Planning, Universitas Internasional Batam
*e-correspondence: 2011018.fenia@uib.edu

ARTICLE INFO

Keywords:

Bridge
Reconstruction
Composite
Steel
Concrete

ABSTRACT

Bridges are elements or parts of roads; traffic is a global problem. Bridges have a special role in transportation infrastructure because they are directly connected to other places, and used to cross rivers, roads, and valleys. Each structure has different needs, therefore there are already various types of bridges with materials that are often used in bridge construction, namely steel, reinforced concrete, prestressed concrete, or post-tensioned concrete. This paper aims to redesign the Canaan Bridge which almost collapsed. The method used in re-planning this bridge is a survey research method, the research location is Jalan Damai RT 07 Kanaan Village, Bontang City with a length of 15-17 meters and a width of 5.8 meters. The results of the research and planning results related to the reconstruction of wooden bridges into composite bridges, it can be concluded that the planning uses FC' 25 concrete quality, HB 450.300.9.16 for girder profiles, and HB 350.175.6.9 for the diaphragm and elastomer placement 400x350x39mm. The analysis of the lower structure uses an abutment measuring 4,073 meters in height and 1,880 meters in width. For the foundation, use a mini pile foundation with a size of 250x250 with a depth of 18 meters.

1. Introduction

The bridge is an element or part of the road. Construction of roads, buildings, and infrastructure can improve visibility as the country becomes more industrialized but can cause congestion. There are many causes of congestion, including population growth, construction of high-rise buildings, traffic restrictions, and ongoing bridge construction (Rifai & Isradi, 2022). Bridges play a special role in transportation infrastructure because they are directly connected to other. Bridges are used to cross rivers, highways, valleys, and canyons. All structures have different requirements, such as traffic flow, span distance, building characteristics, and geometry. Therefore, there are already various types of bridges with materials often used in bridge construction, namely steel, reinforced concrete, prestressed concrete, or post-tensioned concrete. (Chen et al., 2020).

Using an effective structural design, the type of bridge to be used is determined by the loads and environmental conditions that must be supported effectively by the new and existing structures, including dead load, traffic, rain, wind, flood, and earthquake events. Other long-term damage issues, such as corrosion, wear, and fatigue, depend on the treatment process. Prevention and control of degradation processes can apply protections such as paints and coatings. (Gonzalez et al., 2020). The first bridge was built in 2650 BC by King Manes of Egypt to cross the Nile. Then in 783 BC, it was developed by Queen Semirawis from Babylon, who built a bridge to cross the Euphrates River.

Receieved 20 Mei 2023
Available online 30 Juni 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol (Year) E-ISSN
DOI 10.37253/leader.v1i2.7891

Indonesia is a tropical country consisting of more than 17,000 islands. The hot, wet, and humid climate can destroy bridges. Based on data from the Directorate General of Highways, the whole road network in Indonesia was 488,181 km in 2015. In 2019 it is expected that there will be 15,000 km of new roads to support tourism, airports, ports, and railroads. (Oktavianus et al., 2020). Indonesia is ranked 5th with the largest population, with 276 million people. Cause Indonesia is not free from the problem of congestion (Wahyudi et al., 2022). In addition to the high maintenance costs, several significant bridges have collapsed yearly in Indonesia for the last eight years, such as the Tenggarong Kutai Bridge in 2011, the Lebak Banten Bridge in 2015, the Bengkulu Bengkulu Bridge in 2016, the Klungkung Bali Bridge in 2016, the Tanipah Bridge in South Kalimantan in 2017, and the Widang Bridge in East Java in 2018. The bridge is a newly built structure, and new facilities are installed, and the old bridges have served their lives (Oktavianus et al., 2020).

One of the bridge repair projects, including the Canaan Bridge repair project. The bridge is part of the road that must be designed as well as possible to meet the needs. Bridge planning is very complex, from several aspects and variables that must be considered. Bridge planning must follow the concepts of effective, efficient, economical, safe, and environmentally friendly. It aims to ensure the safety and comfort of bridge users (Andito et al., 2023). The Kanaan Bridge is located on Jalan Damai RT 07, Kanaan Village, Bontang City, with a length of 15-17 meters and a width of 5,8 meters. Residents use the Kanaan Bridge as a shortcut to connect the Kanaan area with parts of Telihan Village, West Bontang Region. This bridge is an infrastructure project that stopped in 2014 due to several factors. The budget for this bridge construction project is Rp. 2.5 billion, with an auction process, won by CV Elza Jaya Prima. This is always conveyed every 3 years at the Subdistrict Development Planning Meeting (Musrenbang) but has never been made a development priority. Several times, the related offices, both city, and province, have conducted surveys and taken samples of bridges, but repairs have yet to be carried out, as a result, the condition of this bridge is getting worse and endangering residents.

From the sampling and site survey results, the previous construction plan with a wooden bridge was considered imperfect or inadequate if a heavy load passed through the bridge (Mitoulis, 2020). In addition to the fragile nature of wood, the use of wooden bridge construction in Indonesia is also decreasing, except for wood, which is still used in some new bridge construction. However, wooden construction has been largely replaced by concrete and steel (Ali et al., 2019). The old wooden bridge is still in use but needs to be repaired and maintained correctly. A temporary wooden bridge is used for bridge emergencies or during construction work, and existing bridges may require intensive upgrading. If wood is still used, you should choose wood with class I or according to specifications. This wood material must be protected from marine animal attacks and termite attacks (Anderson, 2018). This study aims to examine the bridge that will be reconstructed using a composite bridge as a substitute for the old bridge. Explaining the advantages and disadvantages of the new bridge. Designing a composite bridge with design standards ensures the resulting bridge is strong, comfortable, and has an aesthetic function. This composite bridge will use a mini pile foundation. This new bridge uses D19-150 main reinforcement plate with FC' 25 concrete quality, HB 450.300.9.16 for girder profiles, and HB 350.175.6.9 for diaphragms and elastomeric placement diameter of 400x350x39mm.

2. Literature Review

In Indonesia, bridge planning refers to the normative guidelines of SNI 03-1725-1989, SNI 2838:2008, SNI 03-2850-1992, RSNI T-02-2005, RSNI T-03-2005, etc. The prestressed bridge is a long-span bridge that uses a cable system as the main foundation (Lai et al., 2018). It is known that from the 1800s until now and from year to year have experienced several innovations in both construction systems and methods (Kadir, 2019). Prestressing is generally applied to composite bridges with precast concrete

Receieved 20 Mei 2023
Available online 30 Juni 2023

Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol (Year) E-ISSN
DOI 10.37253/leader.v1i2.7891

girders and in-situ cast concrete slabs. Given the relatively large weight of the beam, the erection of the girder requires heavy equipment with a large capacity and must be carried out with extra care so as not to suffer damage and structural failure (Beatrix et al., 2018).

Most of the bridges in Indonesia use a simple placement system. The structure between the vehicle's floor and the road plate is separate from the beam. Broadcasts are normally closed using a different construct called an expansion joint which is usually made of iron or steel (Naji et al., 2020). The problems with this broadcast often cause inconvenience for bridge users because it is felt that it could be smoother when crossing the bridge while driving. Improved With this problem, the connecting plate can be used to close the gap in the bridge plate (Liu & Fu, 2019). This study describes the construction plan for the connection plate, which is preceded by additional support inspection based on the span of the bridge and the steel beams to be used (Hermansyah, 2018).

Using strength concrete and expanded clay in bridge structures, density standards according to European standard EN 206-1 development of lightweight concrete structures with increased strength, lightweight concrete, and lightweight concrete development prospects favor the use of lightweight concrete in bridge construction by increasing the proportion of lightweight concrete structures with a strength of 45-70 MPa in bridge construction (Yang & Yang, 2018). Based on the analysis, experimental and theoretical studies, clay concrete is used as a substitute for heavy concrete with dense aggregates of the same strength (ChS et al., 2022).

Composite bridges have several advantages over non-composite structures. Several advantages of using this composite structure are steel profiles that can be saved compared to non-composite beams, the cross-section or height of the steel profile is lower to reduce or save floor height in buildings, and free space height in bridge buildings. The stiffness of the reinforced concrete slab floor is higher due to the influence of the composite (fused with the steel girder), so the floor deflection plate (composite) is getting smaller (Meteș et al., 2018). The span length for specific rods can be more significant, meaning that with a steel and concrete composite system, the bearing moment is more significant for the same cross-section. Bridge planning using the mixed type is very advantageous because the composite structure can withstand a load of about 33% to 50% greater than the load that steel can carry without any configuration behavior (Anggraini et al., 2020).

Slab damage on a composite bridge structure consisting of reinforced concrete slabs and steel I beam, using vibration characteristics and Artificial Neural Networks (ANN). ANN is used together with the strain damage index to find and measure damage to steel beams which are the main load-bearing elements of bridges, changes in relative capital flexibility are used to find and measure bridge damage (L Gould et al., 2019). A cost-effective Lightweight Composite Bridge Deck (LCBD) System, lightweight Ultra-High-Performance Concrete (UHPC) lining including Orthotropic Steel (OSD) Deck is proposed to improve the rigidity and fatigue performance of conventional OSD (Hall et al., n.d.). Static and fatigue tests on the full-scale strip model experienced buckling. Increasing the ratio of reinforcement can increase the flexural stiffness of LCBD and reduce the tensile strain of the UHPC layer, while the change in the span is relatively small. The flexural strength and reinforcement ratio of UHPC are important factors affecting the fatigue life of UHPC coatings (Nakamura et al., 2019). Application of UHPC on steel deck pavements, rib-to-diaphragm welded joints are still prone to cracking. The S–N curve is difficult to use directly in predicting the fatigue life of UHPC coatings due to the large differences in the stress level definition and failure evaluation index in the fatigue test, it needs to be modified in further studies (Dyke et al., 2019).

The application of UHPC in bridge engineering is limited due to its high cost, and relatively little is known about the mechanical behavior of UHPC in bridges (Zhou et al., 2018b). Applications of various bridge

Receieved 20 Mei 2023
Available online 30 Juni 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol (Year) E-ISSN
DOI 10.37253/leader.v1i2.7891

components, such as pillars, girders, decks, and girders used for seamless bridges, can implement a mixed design of UHP and UHPC optimized considering the cost and application for the bridge (Forde et al., 2020). The bridge structure can be selected by considering the implementation cost factor. Box culvert structures can be practical for span bridges and short bridge heights. With the box culvert structure, there is no need to plan the bridge's foundation, substructure, and superstructure. The bridge structure becomes more straightforward, thus facilitating the implementation process and more cost-effective (Nurdiana et al., 2021).

Cable-stayed and deck arch bridges are several types of existing bridges. Cable bridges consist of pillars and girders supported by cables connected to the pylons and beams. The advantage of using this type of bridge is to minimize the scouring effect on the bridge pillars, and it is beautiful from an aesthetic point of view. This is inversely proportional to the steel frame warren-type steel frame bridge in the initial plan, which uses two pillars. The main structural form of this cable-stayed bridge is a combination of various structural components between towers or pylons, cables, and box girders (Opirina & Ulfa, 2023). The suspension bridge is a type in which the deck is suspended on vertical suspensions. Built-in the early 1800s, this type of bridge has cables strung between the towers and vertical suspender cables that transfer live and dead loads from the decks below. Allows the deck to be flat or curved up for additional weight. These bridges are often built without the use of falsework. The highway is supported by cables or vertical suspender rods, i.e., hangers. In some situations, the towers are at the edge of a cliff where a path can lead directly into the main span. Otherwise, bridges usually have two smaller spans sandwiched between pillars and a walkway, which may be supported by cables or trusses (Kasus et al., 2021).

The flexural test results for meranti-balau composite wood samples with a high-quality wood composition of 10% obtained an average flexural strength value of 559.89 kg/cm2 (E11). Meranti-Balau composite wood with a high-quality wood composition of 20% obtained an average flexural strength value of 597.79 kg/cm2 (E11). At the same time, Meranti-Balau composite wood with a high-quality wood composition of 30% obtained an average flexural strength value of 673.92 kg/cm2 (E13). This result can make an alternative to using strong class wood that is difficult to find as a bridge. So, it was concluded that using class I and class III composite wood was feasible for bridge structures with a maximum load of 500 kg (Murtono et al., 2019).

The choice of wood as the primary material for the bridge is not without reason. Suryoatmono (2013) stated that the structural design requirements, apart from meeting the needs for strength and serviceability, must also meet the requirements for being environmentally friendly and energy efficient. Therefore, wood is the answer. Wood is an environmentally friendly material compared to other materials (concrete and steel). Based on the APA report in Suryoatomo (2013), the energy required to produce 1 ton of cement, glass, and steel is 5 times, 14 times, and 24 times the need to produce 1 ton of wood, respectively. The obstacle to using wood for construction is the need for more wood with large dimensions. To overcome this problem, engineered wood emerged, including box-beam. Hollow sections have been shown to increase the usability of the material, which can significantly increase the amount of inertia when compared to solid wood of the same cross-sectional area. Camphor wood (Dryoblanas sp.) is the wood used in most buildings. Camphor wood is resistant to sawdust, has little shrinkage, and is easy to process. The elastic modulus of camphor wood at a moisture content of 13.79% is 14783.58 MPa. Based on these conditions, the strength comparison between conventional wooden bridges and wooden bridges using box beam elements from camphor wood needs to be studied further (Wijaya et al., 2018).

Receieved 20 Mei 2023
Available online 30 Juni 2023

Published by Fakultas Teknik Sipil dan Perencanaan UIB

I-profile is the most used shape for bridges. The prestressed bridge was designed using the post-tensioned method using I-profile support beams as the main structure. Using Uncoated 7 wire super strands prestressed cable ASTM 416 Grade 270 Low Relaxation (Manalip & Handono, 2018). Steel-concrete composite bridges are used as an alternative to concrete bridges because of their ability to adapt their geometry to design constraints and the possibility of reusing some of the materials in the structure. In addition to qualitative analysis, multivariate analysis was used to identify knowledge about bridge design and detect trends in research. Life cycle impacts and decision-making strategies enable bridges to get better, especially at the end of the life of composite bridges (Martínez-Munõz et al., 2020).

Steel-concrete box girder composite bridges consider cost and CO2 emissions as objective functions. Takes CO2 emissions to add sustainability criteria in comparing results to costs. Metaheuristics of SAMO2, SCA, and applied to achieve goals (Yepes et al., 2019). From cost optimization and CO2 analysis, it can be seen that a reduction of 2.51 kg CO2 is obtained for every euro reduced by metaheuristic techniques, and for optimization, it is seen that the addition of cells to bridge the cross section for optimal results. The proposed design of a double composite action on the abutment eliminates the continuous longitudinal stiffeners (Martínez-Muñoz et al., 2022).

3. Method

Expected to ensure the comfort and safety of users, this paper aims to redesign the Kanaan bridge, which almost collapsed. The method used in the re-planning of this bridge is a survey research method, which later the plan will refer to the applicable standards (Rifai & Djamal, 2022). The research location is Jalan Damai RT 07, Kanaan Village, Bontang City, with a length of 15-17 meters and a width of 5,8 meters, can be seen in Figure 1.

Figure 1. Research Location (Source: Google Earth, 2023)

The data used in this study consisted of primary data and secondary data. The primary data is the bridge location condition and the bridge dimensions. Then secondary data, location maps, and standard reference books apply. Research stages:

a. Observation

b. Planning Method

c. Design Method

d. Planning Stages

To ensure all methods are successful then applied to avoid bridge degradation, planned maintenance. The cost of the maintenance plan is included in the bridge budget (Zhang et al., 2019). The first step is to review the structural elements of the bridge within the scheduled time. Beams, piers, joints, cables, decks, and materials used must show no damage, such as cracks, corrosion, deformation, and other problems. For mitigation and prevention of corrosion, the treatment process must have a plan considering the following:

Receieved 20 Mei 2023
Available online 30 Juni 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol (Year) E-ISSN
DOI 10.37253/leader.v1i2.7891

a. The expected useful life of the bridge.

b. Classification of bridges.

c. Details of corrosion mitigation and prevention methods.

d. Maintenance program.

4. Result and Discussion

Observations were made in February 2023 at the Kanaan Bridge, which is located on Jalan Damai RT 07 Kanaan Village, Bontang City. The condition of the bridge before being repaired can be seen in Figure 2 and the condition of the Kanaan bridge while under construction can be seen in Figure 3.

Figure 2. The Condition of the Kanaan Bridge Before the Reconstruction (Source: Google, 2023)

Figure 3. Kanaan Bridge under construction work (Source: Google, 2023)

Data obtained from the existing Kanaan Bridge has a length of 15-17 meters and a width of 5.8 meters. The Canaan Bridge today uses wood from the girders to the railings. This research partly collects data from a survey conducted by the Public Works Department of Bontang City together with a planning consultant from CV Elza Jaya Prima as a service provider. The main function of the Kanaan Bridge is used by residents as a shortcut to connect the Kanaan area with parts of Telihan Village, West Bontang Region. Thus, the burden borne by the Canaan Bridge is not too large, because the heaviest burden is only passed by motorcyclists. Reinforcement planning for this right bridge can be seen in Figure 4.

Receieved 20 Mei 2023
Available online 30 Juni 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol (Year) E-ISSN
DOI 10.37253/leader.v1i2.7891

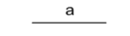
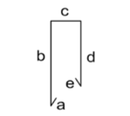
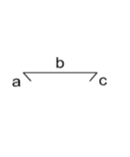
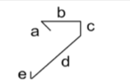
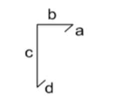
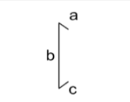
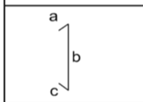
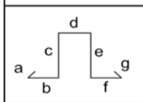
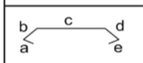
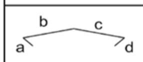
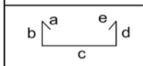
PROFILE	DIMENSION (m)							DIAMETER (mm)	LENGTH (m)	PROFILE REQUIREMENT (stems)	MATERIAL WEIGHT (kg/m)	TOTAL WEIGHT (kg)
	a	b	c	d	e	f	g					
	6.90							10 19	6.90	78 19	0.62 2.23	280.77 76.78
	0.08	1.40	0.20	1.40	0.80			12	3.15	47	0.89	131.52
	0.08	1.17 0.20 0.40 1.53 1.38 1.21 1.05 0.87 1.78	0.80					8	1.33 0.36 0.56 1.69 1.54 1.37 1.21 1.03 1.94	47 72 24 48 24 24 24 264 48	0.39	2.23 10.23 5.30 16.02 14.56 13.01 11.47 107.71 36.74
	0.08	0.40	0.79	1.24	0.80			19	2.59	47	2.23	271.34
	0.08	1.53	2.99	0.08				19	4.68	47	2.23	489.33
	0.08	2.99 3.20	0.08					8	3.15 3.36	48 72	0.39	59.58 95.51
	0.08	0.46 0.47 0.48 0.49 0.50	0.08					8	0.62 0.63 0.64 0.65 0.66	24	0.39	5.58 5.97 6.06 6.15 6.24
	0.08	0.20	3.18	0.51	3.18	0.20	0.08	19	7.44	47	19	19
	0.08	0.07	0.46	0.07	0.08			19	0.76	47	19	19
	0.08	0.88	0.91	0.08				19	1.94	47	19	19
	0.08	0.45	1.78	0.45	0.08			19	2.84	47	19	19

Figure 4. Reinforcement Planning (Source: CV Elza Jaya Prima)

The reconstruction plan for the Right Bridge can be seen in Figure 5.

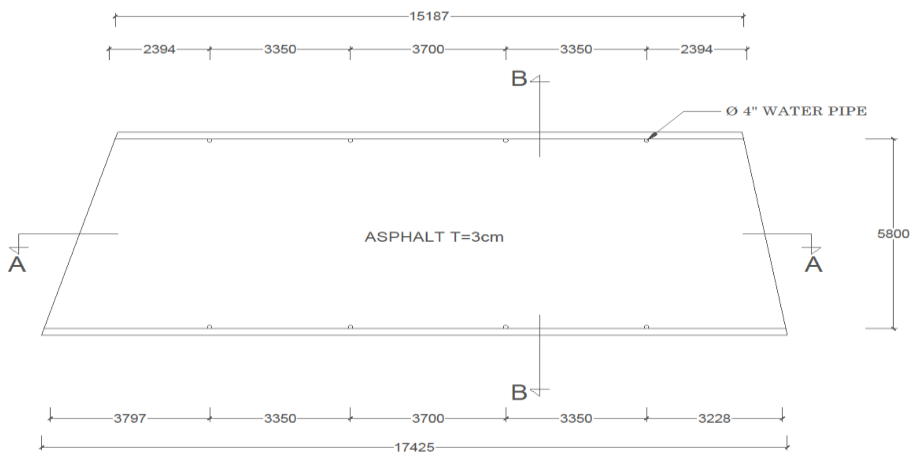


Figure 5. Plan of the Kanaan Bridge (Source: CV Elza Jaya Prima)

Section of the right bridge reconstruction can be seen in Figure 6 and Figure 7.

Receieved 20 Mei 2023
Available online 30 Juni 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol (Year) E-ISSN
DOI 10.37253/leader.v1i2.7891

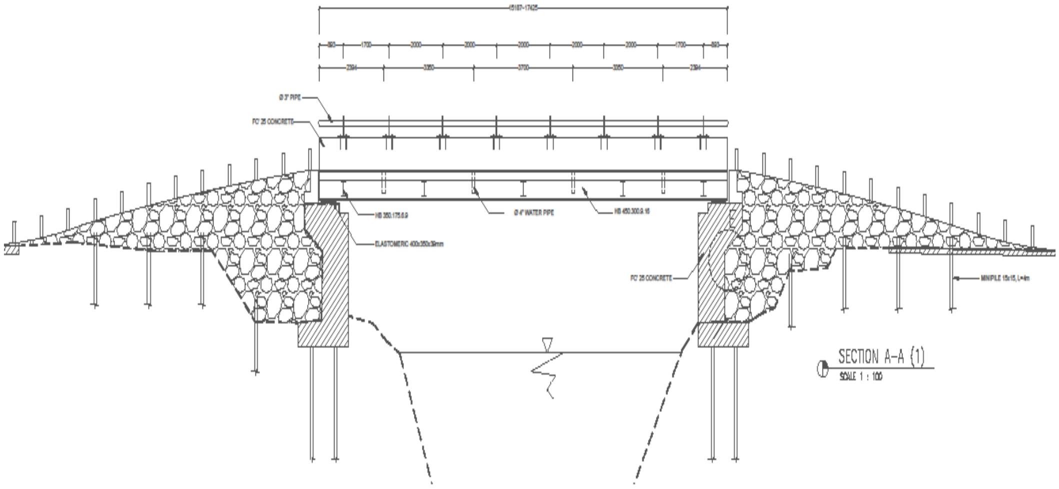


Figure 6. Section of the Kanaan Bridge (Source: CV Elza Jaya Prima)

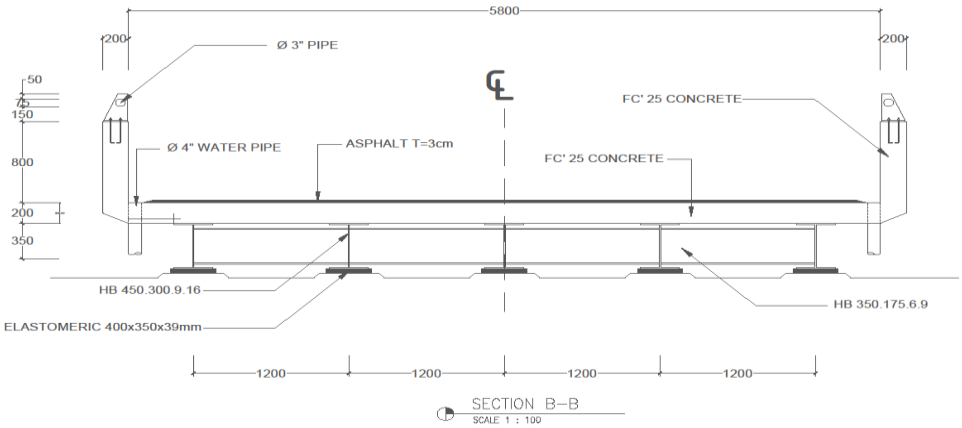


Figure 7. Section of the Kanaan Bridge (Source: CV Elza Jaya Prima)

The Kanaan bridge abutments can be seen in Figure 8.

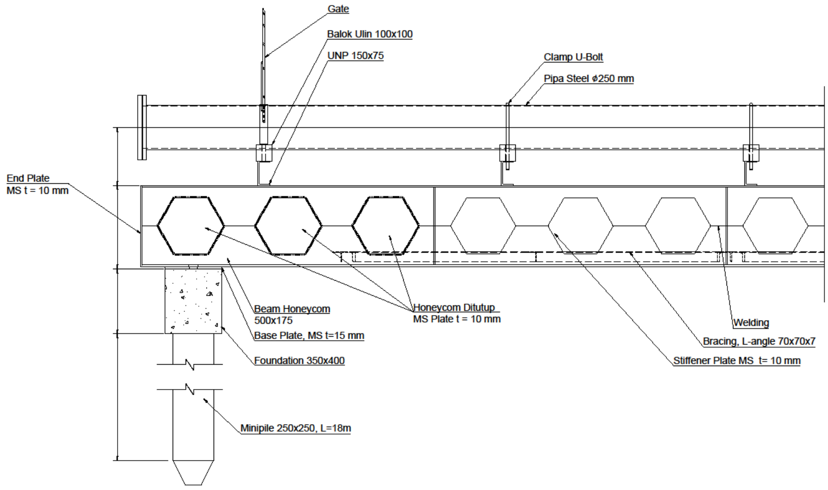


Figure 7. Abutments Section (Source: CV Elza Jaya Prima)

Receieved 20 Mei 2023
Available online 30 Juni 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol (Year) E-ISSN
DOI 10.37253/leader.v1i2.7891

5. Conclusion

Based on research and planning results related to reconstructing wooden bridges into composite bridges. The design of a composite bridge superstructure with a span length of 15-17 meters and a width of 5.8 meters uses concrete quality FC' 25, HB 450.300.9.16 for girder profiles, and HB 350.175.6.9 for diaphragm and elastomer 400x350x39mm placement. Analysis of the lower structure of a composite bridge with a length of 15-17 meters and a width of 5.8 meters using abutments measuring 4,073 meters in height and 1,880 meters in width. For the foundation, use a mini pile foundation of 250x250 with a depth of 18 meters.

6. References

Anderson, I. (2018). Assessment of The Composite Arch Bridge. Https://Vtrans.Vermont.Gov/ Sites/Aot/Files/Planning/Documents/Research/Publishedreports/2018-

Andito, I. R., Rifai, A. I., & Akhir, A. F. (2023). The Design of Alignment Horizontal Using Indonesia Highway Design Standard: A Case of Jalan Babat-Tapen, East Java.

Chen, C., Eisenhut, W. O., Lau, K., Buss, A., & Bors, J. (2020). Performance Characteristics of Epoxy Asphalt Paving Material for Thin Orthotropic Steel Plate Decks. International Journal of Pavement Engineering, 21(3), 397–407. Https://Doi.Org/10.1080/10298436.2018.1481961

Chs, R., & Student Zokirov, D. J. (N.D.). Eurasian Journal of Academic Research Foreign Experience in The Use of High-Strength Expanded Clay Concrete In Bridge Construction (Literature Review). Https://Doi.Org/10.5281/Zenodo.7119543

Dyke, S. J., L Gould, P. P., Professor A Mang, E. H., Professor Kitipornchai, P. S., Adam, J. M., A Bradford, P. M., S Cai, S. C., Chan, S. L., R Ellingwood, P. B., Fragiacomo, M., M Frangopol, P. D., V Galambos, P. T., Gulkan, P. P., Lin-Hai Han, P., Hao, P. H., B D Hueste, P. M., Kalkan, E., Professor Kang, A. T., Ahsan Kareem, P., … Sneed, L. H. (N.D.). Editor-In-Chief Americas and Rest of World Associate Editors.

Forde, M. C., Adam, J. M., Harries, K. A., Ohtsu, M., Aggelis, D., Corradi, M., Crews, K., Herrera, A. D., Gruyaert, E., Ho, C. L., Nassif, H., Radlin´Ska, A., Radlin´Ska, R., Rossignol, S., Saisi, A., Shi, C., Sergi, G., Sideris, K., Smith, S., … Mirza, J. (N.D.). Construction And Building Materials Editor-In-Chief Senior Editors Editorial Advisory Board.

Gonzalez, A., Schorr, M., Valdez, B., & Mungaray, A. (2020). Bridges: Structures and Materials, Ancient and Modern. In Infrastructure Management and Construction. Intechopen. Https://Doi.Org/10.5772/Intechopen.90718

Irfan Rifai, A., & Djamal, E. Z. (2022). Geometric Redesign of Jalan Cisauk-Jaha, Banten with Manual Method (Sta. 0+000-Sta. 0+350). 2(5), 2022. Https://Doi.Org/10.53866/Jimi.V2i5.201

Irfan Rifai, A., & Isradi, M. (2022). The Road Performance Analysis in Jalan Ahmad Yani Batam Using Ihcm 1997.

Kadir, A. (2019). Prestressed Bridge Construction: Systems and Methods. International Journal of Research & Review (Www. Ijrrjournal. Com) Vol, 6. Www.Ijrrjournal. Com

Kasus, S., Sebio, J., Kangkung, K., Kendal, K., Tengah, J., Wicaksono, B., & Masagala, A. (N.D.). Perencanaan Ulang Struktur Atas Jembatan Warren Truss Menggunakan Suspension Bridge.

L Gould, P. P., A Nethercot, P. D., Professor A Mang, E. H., Professor Kitipornchai, P. S., Adam, J. M., A Bradford, P. M., Bruneau, P. M., S Cai, S. C., Chan, S. L., R Ellingwood, P. B., M Frangopol, P. D., V Galambos, P. T., Gulkan, P. P., Hao, P. H., B D Hueste, P. M., Professor Kang, A. T., Ahsan Kareem, P., Maier Milan Polytechnic, P. G., Professor R Mari, I. A., … Zingoni, P. A. (N.D.). Editor-In-Chief Americas and Rest of World Book Review Editor.

Receieved 20 Mei 2023
Available online 30 Juni 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol (Year) E-ISSN
DOI 10.37253/leader.v1i2.7891

Lai, D., Mihaljevic, R., & Kenedi, W. (N.D.). Evolution Of Bridge Practices in Ontario, Canada Acknowledgements.

Liu, X., & Fu, C. C. (2019). Interdependence Between Structural Engineering and Construction Management Edited by Ozevin Case Study Of 3d Seismic Pushover Analysis of Integral Abutment Bridge.

Mahasiswa, J., & Sipil, T. (2022). Perencanaan Ulang Struktur Atas Jembatan Komposit (Vol. 1, Issue 1). Juni.

Manalip, A. H., & Dwi Handono, B. (2018). Perencanaan Balok Girder Profil I Pada Jembatan Prestressed Dengan Variasi Bentang. Jurnal Sipil Statik, 6(2), 67–74.

Martínez-Muñoz, D., García, J., Martí, J. V., & Yepes, V. (2022). Optimal Design of Steel–Concrete Composite Bridge Based on A Transfer Function Discrete Swarm Intelligence Algorithm. Structural And Multidisciplinary Optimization, 65(11). Https://Doi.Org/10.1007/S00158-022-03393-9

Martínez-Munõz, D., Martí, J. V., & Yepes, V. (2020). Steel-Concrete Composite Bridges: Design, Life Cycle Assessment, Maintenance, And Decision-Making. In Advances in Civil Engineering (Vol. 2020). Hindawi Limited. Https://Doi.Org/10.1155/2020/8823370

Meteş, E., Toduţi, L., Petzek, E., & Băncilă, R. (2018). Integral Bridges - Length Limitation, Transition Slabs, Examples. Zbornik Radova Građevinskog Fakulteta, 34, 17–24. Https://Doi.Org/10.14415/Konferencijagfs2018.000

Mitoulis, S. A. (2020). Challenges And Opportunities for The Application of Integral Abutment Bridges in Earthquake-Prone Areas: A Review. In Soil Dynamics and Earthquake Engineering (Vol. 135). Elsevier Ltd. Https://Doi.Org/10.1016/J.Soildyn.2020.106183

Naji, M., Firoozi, A. A., & Firoozi, A. A. (2020). A Review: Study of Integral Abutment Bridge with Consideration of Soil-Structure Interaction. Latin American Journal of Solids and Structures, 17(2). Https://Doi.Org/10.1590/1679-78255869

Nakamura, S., Ogata, T., Takano, M., & Kobayashi, Y. (2019). New Technologies in Retrofitting and Strengthening of Ageing Steel and Composite Bridges in Japan. Structural Engineering International, 29(4), 519–526. Https://Doi.Org/10.1080/10168664.2019.1628618

Nurdiana, A., Susanti, R., & Rifqi Naufaldy, M. (2021). Jurnal Proyek Teknik Sipil Perencanaan Jembatan Mlulon Dengan Box Culvert. In Journal of Civil Engineering Project (Vol. 4, Issue 1). Https://Ejournal2.Undip.Ac.Id/Index.Php/Potensi

Oktavianus, Y., Sofi, M., Lumantarna, E., Kusuma, G., & Duffield, C. (2020). Long-Term Performance of Trestle Bridges: Case Study of An Indonesian Marine Port Structure. Journal Of Marine Science and Engineering, 8(5). Https://Doi.Org/10.3390/Jmse8050358

Opirina, L., & Ulfa, D. Z. (2023). Analisis Defleksi Jembatan Cable Stayed Menggunakan Software Allplan Bridge (Alue Buloh Bridge) (Vol. 9, Issue 1).

Wahyudi, M. A., Rifai, A. I., & Prasetijo, J. (N.D.). Analysis Of The Effectiveness of Traffic Flow Diversion on Road Performance: A Case of Jalan Gajah Mada Development Project, Batam.

Wijaya, S. H., & Oktaviastuti, B. (2018). Perbandingan Tegangan Aksial Antara Jembatan Rangka Kayu Box Beam Section dan Konvensionall Dari Kayu Kamper.

Yang, Y. B., & Yang, J. P. (2018). State-Of-The-Art Review on Modal Identification and Damage Detection of Bridges by Moving Test Vehicles. International Journal of Structural Stability and Dynamics, 18(2). Https://Doi.Org/10.1142/S0219455418500256

Yepes, V., Dasí-Gil, M., Martínez-Muñoz, D., López-Desfilis, V. J., & Martí, J. V. (2019). Heuristic Techniques for The Design of Steel-Concrete Composite Pedestrian Bridges. Applied Sciences (Switzerland), 9(16). Https://Doi.Org/10.3390/App9163253

Receieved 20 Mei 2023
Available online 30 Juni 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol (Year) E-ISSN
DOI 10.37253/leader.v1i2.7891

Zhang, Z., Hu, J., & Ma, H. (2019). Feasibility Study of Ecc with Self-Healing Capacity Applied on The Long-Span Steel Bridge Deck Overlay. International Journal of Pavement Engineering, 20(8), 884–893. Https://Doi.Org/10.1080/10298436.2017.1356173

Zhou, M., Lu, W., Song, J., & Lee, G. C. (2018a). Application Of Ultra-High-Performance Concrete in Bridge Engineering. In Construction and Building Materials (Vol. 186, Pp. 1256–1267). Elsevier Ltd. Https://Doi.Org/10.1016/J.Conbuildmat.2018.08.036

Zhou, M., Lu, W., Song, J., & Lee, G. C. (2018b). Application Of Ultra-High-Performance Concrete in Bridge Engineering. In Construction and Building Materials (Vol. 186, Pp. 1256–1267). Elsevier Ltd. Https://Doi.Org/10.1016/J.Conbuildmat.2018.08.036

Receieved 20 Mei 2023
Available online 30 Juni 2023
Published by Fakultas Teknik Sipil dan Perencanaan UIB