Static Behavior of Steel Frame Bridge (Case Study of Citanduy Bridge, Tasikmalaya Regency)

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Article Info

Article history:

Received April 3, 2023
Accepted April 22, 2023
Published April 30, 2023

Keywords:

Static Loading Test, Delfection, Citanduy bridge

ABSTRACT

The Citanduy bridge is a road-complementary structure that functions to connect two ends of the road crossed by rivers, canals, valleys, seas, highways, and railroads. A truss bridge is a bridge structure made by combining steel elements according to design criteria and binding technical aspects. Citanduy Bridge is located in Ancol Village, Cineam District, Tasikmalaya Regency, West Java. This bridge has been operated, and to determine the capacity of the bridge, the bridge will be tested for loading. Citanduy Bridge will be tested for loads using two types of loading tests: static loading tests and dynamic loading tests. A static loading test is a loading test on the bridge in which the load used in a stationary condition is placed in the middle of the bridge span based on SNI 1725:2016. The load of the trucks used in this study was 35 tons, and the number of trucks was 6. Structural analysis in this study was carried out using the evaluation version of the SAP 2000 program. Based on RSNI T-03-2005, the allowable deflection on the Citanduy bridge is 62.5 mm. Based on the results of the study, the maximum deflection value obtained from the static load test was 42 mm on a span of 25 m when combined 4, while the maximum deflection value from the results of the structural analysis was 33.7 mm on a span of 25 m when combined 4. Based on the comparison of the maximum deflection with the allowable deflection, the Citanduy bridge can be categorized as passing the static load test.

Available online at http://dx.doi.org/10.36055/fondasi

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1. INTRODUCTION

A bridge is a complementary structure that functions to connect the two ends of the road, which are crossed by rivers, canals, valleys, straits or seas, highways, and railroads [1]. A truss bridge is a type of bridge structure in which steel elements are combined according to design criteria and binding technical aspects [2].

Citanduy Bridge is located in Ancol Village, Cineam District, Tasikmalaya Regency, West Java. Citanduy Bridge was built as an access that makes it easier for local residents to move from place to

place, including two-wheeled or four-wheeled vehicles and others. Citanduy Bridge has three spans, the first with a length of 30 m, the second with a length of 50 m, and the third with a length of 30 m. This bridge has a width of 9 m and a road width of 7 m. This bridge has been operated, and to determine the ability of the bridge to reach its capacity, the bridge will be tested for loading [3].

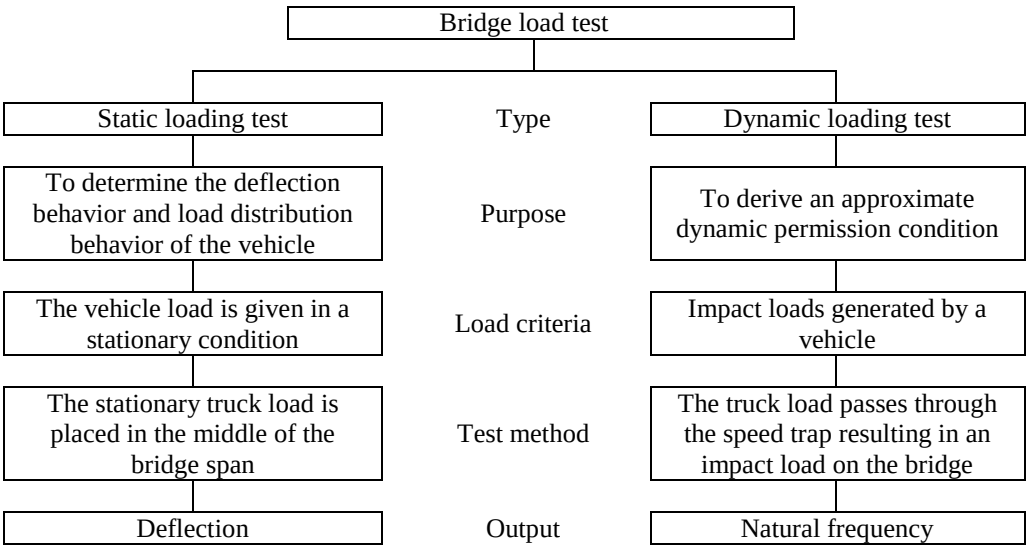

Figure 1. Outline of Bridge Loading Test

Citanduy Bridge will be tested for loads using two types of loading tests: a static loading test and a dynamic loading test. A static loading test is a loading test on a bridge in which the load used in a stationary condition is placed in the middle of the span of the bridge. Structural analysis was also carried out with the help of the evaluation version of the SAP2000 program to compare the deflection in the modeling with the deflection in the field where the results of the comparison are listed in table 5. The maximum deflection obtained from structural analysis and the reading of measuring signs in the field will be compared with the permissible deflection according to Article 4.7.2 concerning Deflection Requirements and Limitations on Beams and RSNI T-03-2005 concerning the Design of Steel Structures on Bridges.

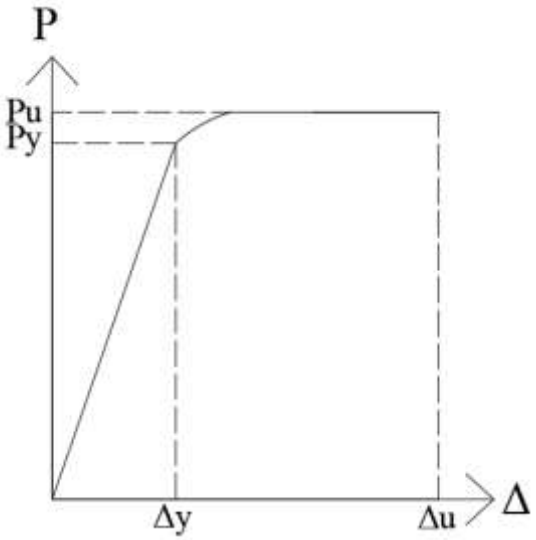

Figure 2. Relationship of Load – Deflection of the Beam

Based on the background of this research, the authors decided to formulate the problem as follows:

1. Check the maximum deflection value obtained at the Citanduy bridge when testing static loading of vehicles based on Article 8 of SNI 1725: 2016 concerning Loading on Bridges.
2. Check the maximum deflection value obtained at the Citanduy bridge during structural analysis with the help of the SAP2000 program based on Article 8 concerning Traffic Loads SNI 1725: 2016 concerning Loading on Bridges.
3. Determining the maximum deflection obtained is included in the safe or unsafe category (the maximum deflection is smaller than the permit deflection) according to Article 4.7.2 concerning Deflection Requirements and Limitations on Beams in RSNI T-03-2005 concerning the Design of Steel Structures on Bridges.

Ma'ruf et al. (2021) Static load test analysis of the bridge has previously been investigated by Bilal Ma'ruf, Akhmad Aminullah, and Moh Arief Herusiswoyo from Gadjah Mada University. The research is located at the Situ Gintung Bridge in Purbalingga Regency. The research aims to provide information about the deformation that occurs on the bridge. The results of this study show that after loading, the Situ Gintung Bridge does not return to its original position. The bridge was deformed by 3.5 mm at 14 L, 6.1 mm at 12 L, 5.2 mm at 34 L, and 2.8 mm at the supports. The amount of deflection is still below the maximum value set by SNI 1725:2016 concerning loading on bridges, which is 7.5 cm. In other words, this bridge has passed the load test [4].

Murwanto and Priadi (2018) Static load test analysis of the bridge has previously been investigated by Yohanes Murwanto and Eka Priadi from the University of Tanjungpura. This study aims to examine the deflection caused by test and inspection loads to assess the condition of the Bika bridge and the required handling methods. The results of this study are the results of static tests using a test load of 40% and a maximum deflection of 25 mm when loaded with eight dump trucks in the middle of the span [5].

Setiati (2012) An analysis of the static load test of the bridge has previously been investigated by N. Retno Setiati from the Center for Roads and Bridges Research. This study aims to determine the value of the capacity and performance of the bridge. Based on the results of these studies, the bridge structure that experienced deflection due to truck loading before reinforcement was still much smaller than the maximum allowable deflection value (based on SK SNI T-15-1991-03, the maximum permissible deflection is L/480 = 42 mm) and the deflection that occurs is 9.5 mm [6].

Kurniawan (2020) An analysis of the static load test of the bridge has previously been investigated by Feldi Kurniawan from the Islamic University of Riau. The purpose of this research is to analyze the deflection values and allowable limits according to RSNI T-03-2005 that occur in trusses due to combined loads. Based on the results of this study, the allowable deflection limit for a 50-m span is 0.0625 m; on the X-axis, there are 2 load combinations whose deflection value exceeds the allowable limit; on the Y-axis, all load combinations meet the allowable limits; and on the Z-axis, they do not exceed the allowable limit. For a span of 60 m, the allowable deflection limit is 0.075 m; on the X axis, all load combinations meet the allowable deflection limit; on the Y axis, all load combinations meet the allowable deflection limit; and on the Z axis, 3 combination loads meet the allowable deflection limit, namely Strong 4, Extreme 2, and Service 4 [7].

2. METHODS

The bridge used as a case study in this study is the Citanduy bridge, with a span length of 50 m, a width of 9 m, a width of 7 m, and a height of 6 m. The location of Citanduy Bridge is in Ancol Village, Cineam District, Tasikmalaya Regency, West Java. The following is a picture of the Citanduy bridge that will be tested for a load.

Figure 3. Citanduy Bridge

Figure 4. Research Sites

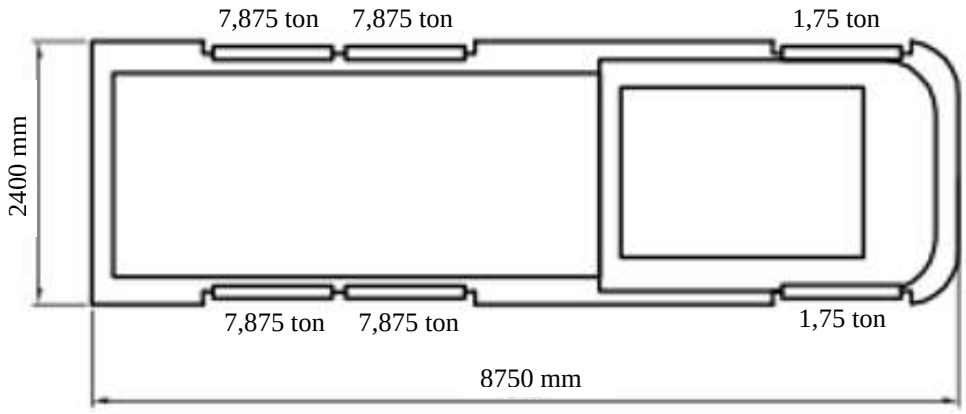

Figure 5. "T truck loading" (35 tons)

The guidelines used in this test are as follows:
1. SNI 1725: 2016, which is about loading on the bridge.
2. RSNI T-03-2005, which is about planning steel structures for bridges.

The equipment used in this test is as follows:
1. Test form
2. Stationery
3. Measuring Signs + Nivo Tubes
4. Calculator

5. 1 set of waterpass
6. Stative
7. Pilox
8. roller meter

The combination of loading used in the Citanduy bridge static load test is as follows:

Table 1. Load Combinations

No	Load Combinations	Number of Trucks	Truck Load (Tons)
1	Initial Data	0	0
2	Combination 1	1	35
3	Combination 2	2	70
4	Combination 3	4	140
5	Combination 4	6	210
6	Combination 5	2	70
7	Unloading	0	0

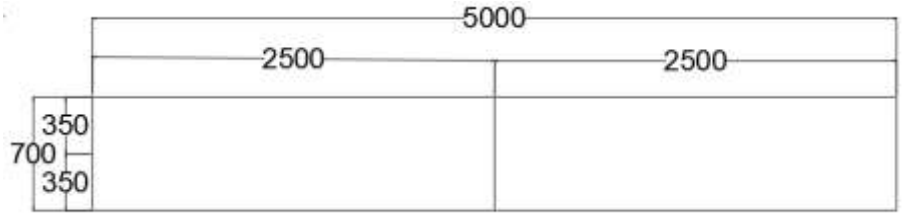

Figure 6. Initial data loading scheme

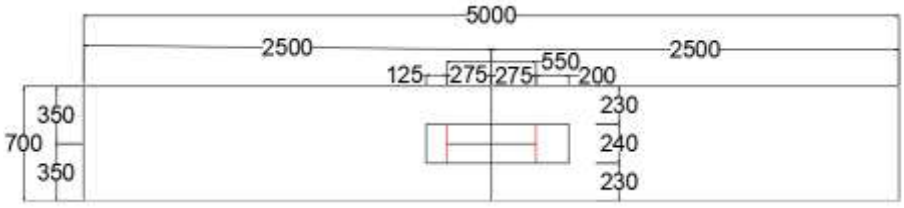

Figure 7. Combination 1 loading scheme

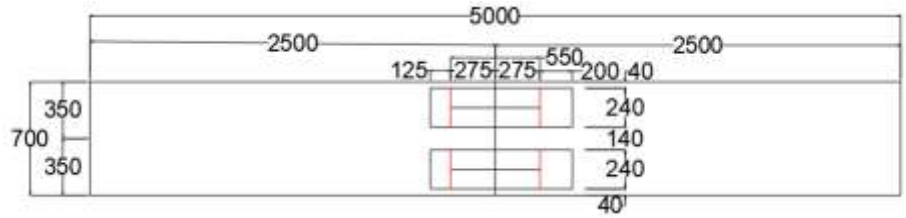

Figure 8. Combination 2 loading scheme

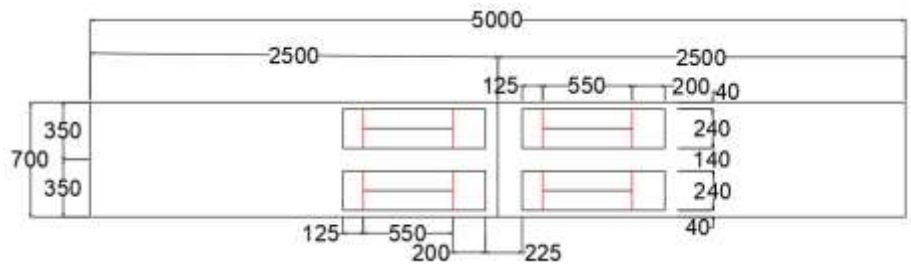

Figure 9. Combination 3 loading scheme

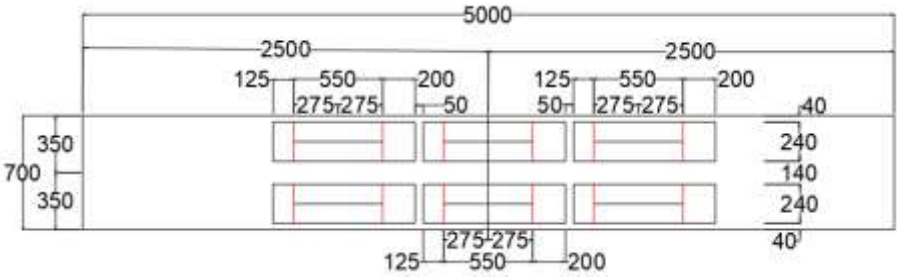

Figure 10. Combination 4 loading scheme

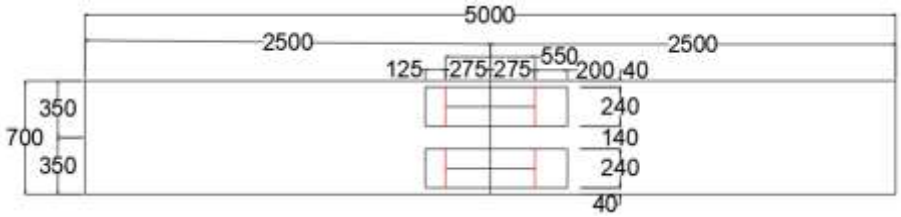

Figure 11. Combination 5 loading scheme

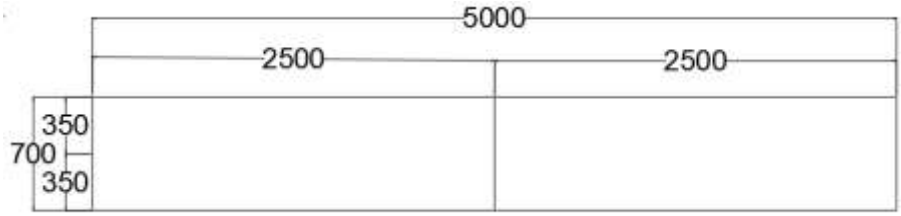

Figure 12. Unloading loading scheme

The following is a flowchart of this research:

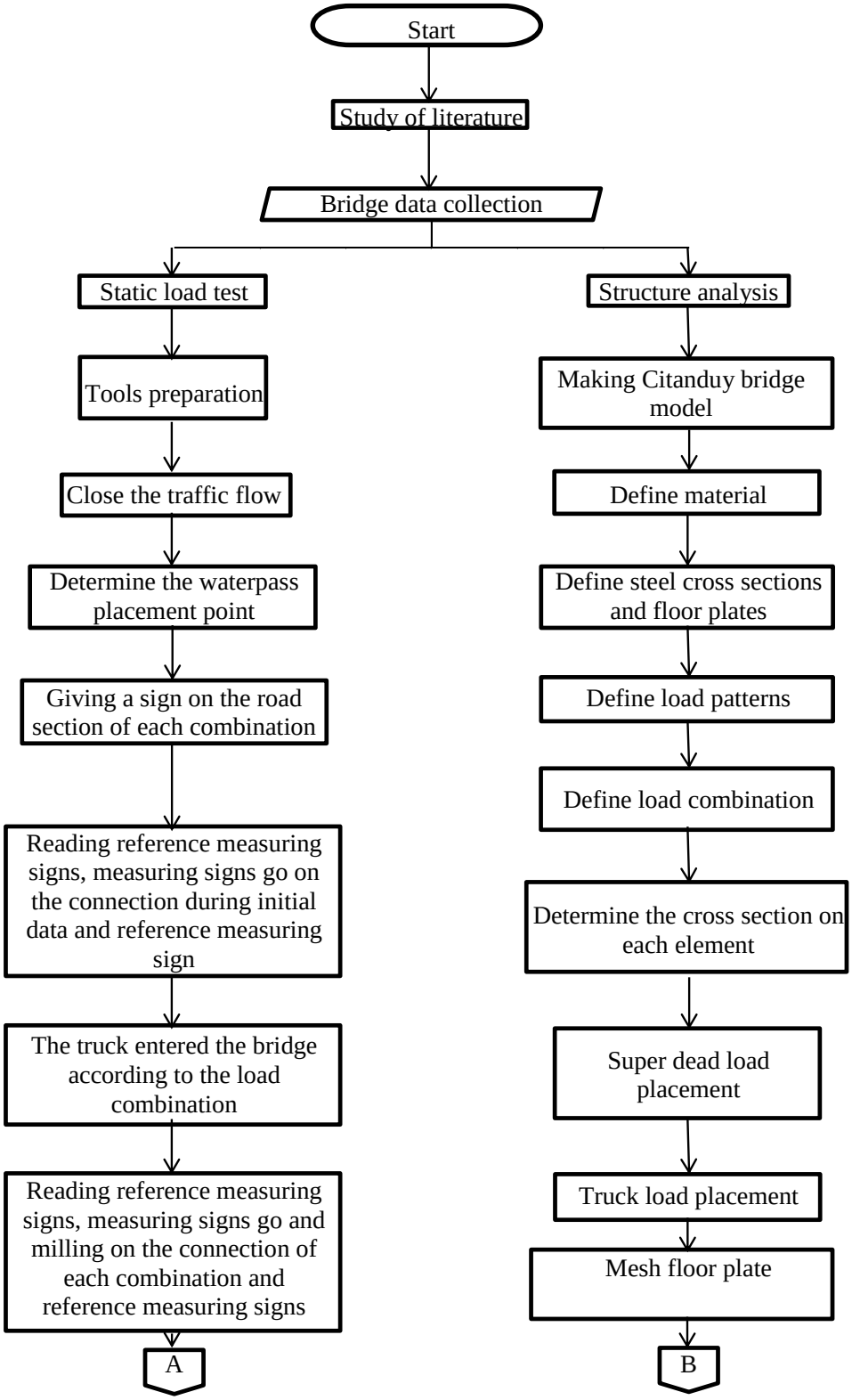

Figure 13. Research Flow Chart

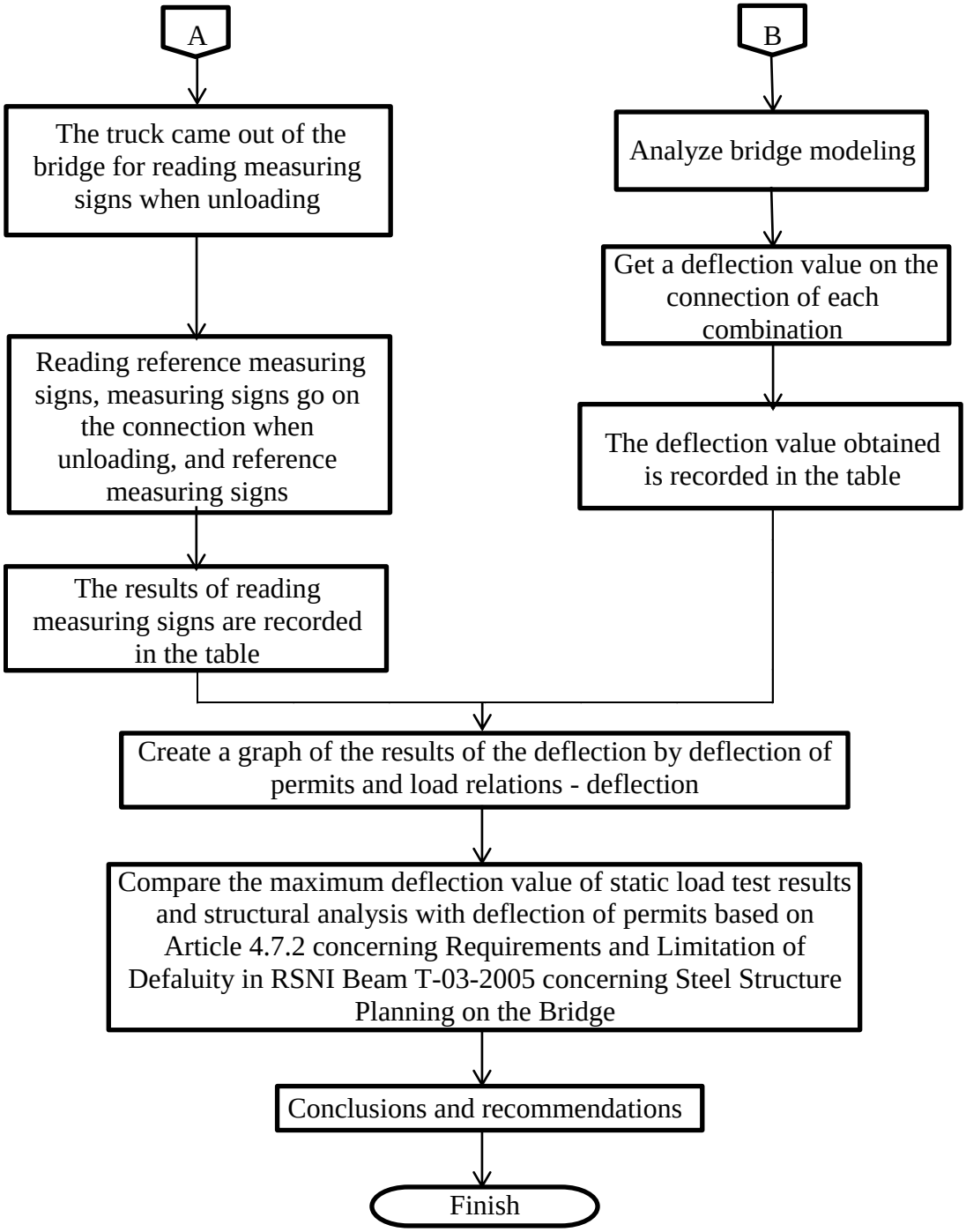

Figure 14. Research Flow Chart

3. RESULTS AND DISCUSSION

Figure 15. The process of testing the static loading of the Citanduy Bridge

From the results of the static loading test on the Citanduy bridge, the results of the deflection value are as follows:

Table 2. The results of the Left 50m Citanduy Bridge Leaning Measurement

Load Combination	Second span 50 m left Deflection (mm)						
	0 m	10 m	20 m	25 m	30 m	40 m	50 m
Initial Data	0	0	0	0	0	0	0
Combination 1	0	-2	-7	-10	-7	-2	0
Combination 2	0	-9	-14	-15	-14	-9	0
Combination 3	0	-13	-25	-28	-25	-13	0
Combination 4	0	-22	-38	-42	-38	-22	0
Combination 5	0	-10	-17	-18	-17	-10	0
Unloading	0	0	0	0	0	0	0

Table 3. The results of the Right 50m Citanduy Bridge Leaning Measurement

Load Combination	Second span 50 m right Deflection (mm)						
	0 m	10 m	20 m	25 m	30 m	40 m	50 m
Initial Data	0	0	0	0	0	0	0
Combination 1	0	-2	-5	-8	-5	-2	0
Combination 2	0	-7	-10	-11	-10	-7	0
Combination 3	0	-12	-23	-25	-23	-12	0
Combination 4	0	-22	-35	-37	-35	-22	0
Combination 5	0	-8	-12	-13	-12	-8	0
Unloading	0	0	0	0	0	0	0

Table 4. The results of the measurement deflection of the Citanduy 50 m bridge

Load Combination	Second Span 50 m Deflection (mm)						
	0 m	10 m	20 m	25 m	30 m	40 m	50 m
Initial Data	0	0	0	0	0	0	0
Combination 1	0	-3,2	-5,6	-6,3	-6,2	-4	0
Combination 2	0	-6,5	-11,2	-12,6	-12,5	-7,9	0
Combination 3	0	-12,9	-21,9	-23,8	-23,2	-15,7	0

Combination 4	0	-19,5	-32,2	-33,7	-33,1	-23	0
Combination 5	0	-6,5	-11,2	-12,6	-12,5	-7,9	0
Unloading	0	0	0	0	0	0	0

Table 5. The results of the comparison of the maximum deflection of the second Citanduy Bridge Bridge 50 m

Load Combination	Maximum deflection of each combination (mm)		
	Static Loading Test (Average)	Structure Analysis	Permit deflection
Initial Data	0	0	
Combination 1	-9	-6,3	
Combination 2	-13	-12,6	
Combination 3	-26,5	-23,8	62,5
Combination 4	-39,5	-33,7	
Combination 5	-15,5	-12,6	
Unloading	0	0	

Table 6. Category of Comparison of Maximum Citanduy Bridge Bridge Comparison of 50m

Load Combination	Maximum deflection of each combination (mm)		
	Static Loading Test (Average)	Structure Analysis	Permit Deflection
Initial Data	Safe	Safe	
Combination 1	Safe	Safe	
Combination 2	Safe	Safe	
Combination 3	Safe	Safe	62,5
Combination 4	Safe	Safe	
Combination 5	Safe	Safe	
Unloading	Safe	Safe	

4. CONCLUSION

Based on the results of the study, it can be concluded as follows:

The maximum deflection obtained from the static load test results is in the middle of the bridge; the maximum deflection at the initial data is 0 mm, the maximum deflection at combination 1 is 9 mm, the maximum deflection at combination 2 is 13 mm, the maximum deflection at combination 3 is 26.5 mm, the maximum deflection at combination 4 is 39.5 mm, the maximum deflection at combination 5 is 15.5 mm, and the maximum deflection when unloading is 0 mm. The maximum deflection obtained from the results of the structure analysis is in the middle of the bridge. The maximum deflection at the initial data is 0 mm, the maximum deflection at combination 1 is 6.3 mm, the maximum deflection at combination 2 is 12.6 mm, the maximum deflection at combination 3 is 23.8 mm, the maximum deflection at combination 4 is 33.7 mm, the maximum deflection at combination 5 is 12.6 mm, and the maximum deflection when unloading is 0 mm. From the results of the static load test and structural analysis, the maximum deflection value obtained is still below the permit deflection based on RSNI T-03-2005, which is 62.5 mm, so it can be concluded that the Citanduy Bridge passes the static load test.

REFERENCES

[1] Direktorat Jenderal Bina Marga, "Pedoman Konstruksi dan Bangunan No. 024/BM/2011 'Penentuan Nilai Sisa Kapasitas Jembatan.'" p. 72, 2011.
[2] Direktorat Jenderal Bina Marga, "Pelaksanaan Pengujian Jembatan," p. 65, 2012.
[3] PT. Graha Survei Indonesia, "Final Report Static and Dynamic Loading Test Jembatan

Citanduy," p. 48, 2022.
[4] B. Ma'ruf, A. Aminullah, and M. A. Herusiswoyo, "Analisis Uji Beban Jembatan Menggunakan Metode Levelling," *Pros. FIT ISI*, vol. 1, pp. 22–30, 2021.
[5] Y. Murwanto and E. Priadi, "Kajian Nilai Lendutan Pada Jembatan Rangka Baja (Study Kasus Jembatan Rangka Baja Bika Kabupaten Kapuas Hulu)," *J. Univ. Tanjung Pura*, pp. 1–16, 2018.
[6] N. R. Setiati, "Kajian Analisis Respon Statis Jembatan Tipe Gelagar Beton Bertulang Dengan Metode Pembebanan (Loading Test)," *Pros. Ind. Res. Work. Natl. Semin.*, vol. 3, pp. 260–268, 2012, [Online]. Available: https://jurnal.polban.ac.id/ojs-3.1.2/proceeding/article/view/473
[7] F. Kurniawan, "Analisa Lendutan Rangka Batang Akibat Beban Tetap Dan Sementara Terhadap Jembatan Rangka (Studi Kasus : Jembatan Desa Petapahan Kec. Gunung Toar Kab. Kuantan Singingi)," p. 88, 2020.
[8] Direktorat Jenderal Bina Marga, "Pemeriksaan Jembatan," p. 321, 2022.
[9] S. Yatnikasari, M. N. Asnan, and U. W. M. Liana, "Alternatif Perencanaan Jembatan Rangka Baja Dengan Menggunakan Metode Lrfd Di Jembatan Gelatik Kota Samarinda," *Rang Tek. J.*, vol. 4, no. 2, pp. 282–294, 2021, doi: 10.31869/rtj.v4i2.2518.
[10] D. Vitriyana, M. B. Gina, and Y. Agustina, *Badawang Twins Bridge*. 2015.
[11] K. K. Kartanegara, "Perhitungan Struktur Jembatan Rangka (Truss Bridge) Bentang 60 Meter di Samboja," 2014.
[12] I. G. A. E. Maharani, "Perencanaan Struktur Atas Jembatan Rangka Baja Sungai Ihi Kabupaten Barito Selatan," *Skripsi. Surabaya Univ. 17 Agustus 1945*, pp. 1–15, 2021.
[13] D. L. Schodeck, *Struktur*. 1991.
[14] J. Triyanto, Z. Djauhari, and M. Olivia, "Tinjauan Gaya Momen Pada Tiap Batang," vol. 01, no. 01, pp. 33–42, 2018.
[15] R. Amaliya Putri, M. Manajemen Rekayasa Konstruksi, J. Teknik Sipil, P. Negeri Malang, and D. Jurusan Teknik Sipil Politeknik Negeri Malang, "PERENCANAAN JEMBATAN RANGKA BAJA BENTANG 50 METER," vol. 9, no. 2, pp. 106–113, 1978.
[16] A. L. I. Sadikin and A. Alfani, "Perilaku Gable Frame Dari Profil Bentukan Dingin," 2003.
[17] PT. Graha Survei Indonesia, "Dokumentasi Pengujian Beban Jembatan Citanduy," 2022.
[18] SNI 1725:2016, "Pembebanan untuk Jembatan," pp. 1–63, 2016.
[19] RSNI T-03-2005, "Perencanaan Struktur Baja Untuk Jembatan," 2005.
[20] PT. Graha Survei Indonesia, "Kebutuhan Beban Pengujian Jembatan Citanduy," 2022.
[21] PT. Graha Survei Indonesia, "Static and Dynamic Loading Test Method Jembatan Citanduy," p. 33, 2022.