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Evaluation The Upper Structure Of Railway Bridge

Complex Profile Steel Frame

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A B S T R A C T

In order to support learning facilities, The Indonesian Railway Polytechnic Madiun plans to build a Railway Bridge, where the bridge is the dismantling of the Kertosono-Sembung BH-259 railway bridge. Before construction needs to be done an evaluation of the skeletal structure of the railway bridge. Evaluation of the structure of the railway bridge begins with the identification of the profile of the bridge structure, the selection of loading in accordance with the means that will pass through, then continued by determining the combination of loading and modeling and running using structural analysis software. Loading refers to PM No.60 the year 2012, while the combination of loading refers to the Indonesian Railway Technical Standard for Steel Bridge Structure (DJKA, 2006). The results of the analysis and calculation showed that the maximum deflection of bridge girder occurring at $\delta = 0.416$ cm occurred in a joint located in the middle of the railway bridge and met the requirements of $\delta \leq \delta'$ but based on the analysis of the dimensions of the bridge structure capacity in Software analysis structure the maximum capacity ratio value at the transverse bridge girder of 2,286 exceeded the required capacity ratio value requirement. So it is necessary to re-analyze to determine the strengthening on the overstressed profile.

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INTRODUCTION

In addition to being a provider of transportation facilities and infrastructure in the field of railways[1], the Indonesian Railway Polytechnic Madiun Ministry of Transportation conducts human resources development in an effort to create professional railway human resources[2][1].

Until now Politeknik Per railway Indonesia has had a field practicum area consisting of stations, railroads and workshops. Furthermore, in order to support learning facilities and infrastructure, a bridge will be built that is devoted to learning.[3][2], The Indonesian Railway Polytechnic Madiun received a grant in the form of an upper structure Kertosono-Sembung BH-259 railway bridge[3].

Kertosono-Sembung BH-259 railway grant bridge in the form of dismantling the frame over the steel bridge that has a complex profile, namely the profile of IWF steel or plate assembled into a single profile unit[4][5]. To build or assemble the BH-259 bridge, a study is needed to evaluate the capacity of the structure.

The research is intended to evaluate the structure of the BH-259 railway bridge, which includes its maximum deflection and capacity ratio value[5][6][7]. The calculation of loading refers to PM 60 Th. 2012 and Loading Plan 1921 (RM 21); the combination of Loading adopted the Indonesian Railway Technical Standard for Steel Bridge (DJKA); calculation analysis using structure analysis software; decrease in quality from steel type BJ 41 to BJ 34, and does not take into account the service life of the construction[6].

Literature Review

Railway bridge is a structure used by railways to cross obstacles such as rivers, valleys or obstacles that break the rail road[7][8] Based on the material for the bridge structure is divided into three, namely:

a. Steel bridge;
b. Concrete bridge;
c. Composite bridge.

As for the type of steel bridge itself is divided into four groups as seen in the following table[9][8].

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Table 1. Bridge Type

Type	Girder	Frame
Wall	Wall Girder	Wall Frame
Beam	Beam Girder	Beam Frame

Some of the charges used include dead loads, live loads, dinamic load allowance, lateral loads, braking and traction loads. The dead load is all fixed loads derived from the weight of the bridge or the part of the bridge under review, including any additional elements that are considered to be a permanent unity with it[10][11]. While beban life is all the burden that comes from the weight of moving vehicles/traffic and/or pedestrians who are considered to work on the bridge[12] [11]

It is explained in PM No.60 Th. 2012 that the shock load is obtained by multiplying factor i against the train load, for its simple calculation through the following formula:

a. For rail on the under ballast, i=0.1+22.5/(50+L)
b. For rail on the under ballast, i=0.2+25/(50+L)
c. For rail on the under ballast, i=0.3+25/(50+L)

Where i = Dinamic Load Allowance factor and L = length of the span (m)

Magnitudo of lateral load is 15% or 20% of axle load for each locomotive or electric train / diesel. This load works at the top and is perpendicular to the direction of the rail. Further braking and traction loads are used at 25% of the train load, working at the center of the train's weight force towards the rail (longitudinally)[13][14].

According to the Indonesian Railway Technical Standard for Steel Bridge Structure[14][15], the combination of bridge loading is taken into account from the results of the largest loading combination[16][17]. The Loading Combination can be seen in Table 2. Loading Combination.

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Table 2. Loading Combination

No	Factor									
	Fixed Load	Transiaen Load								
	D	L	I (L*i)	C (L*α)	LR	LF	B	W1	W2	E
1	1,0	1,1	1,1	1,1	1,0					
2	1,0	1,1	1,1		1,0	1,0			1,0	
3	1,0	1,1			1,0		1,0		1,0	
4								1,2		
5					1,0		1,1			
6						1,1			1,0	
7							1,1		1,0	
8	1,0	1,0		1,0						1,0
9										1,0
10	1,0	1,0		1,0						

RESEARCH METHOD

Systematically the stages of research conducted will be explained in the following flow chart:

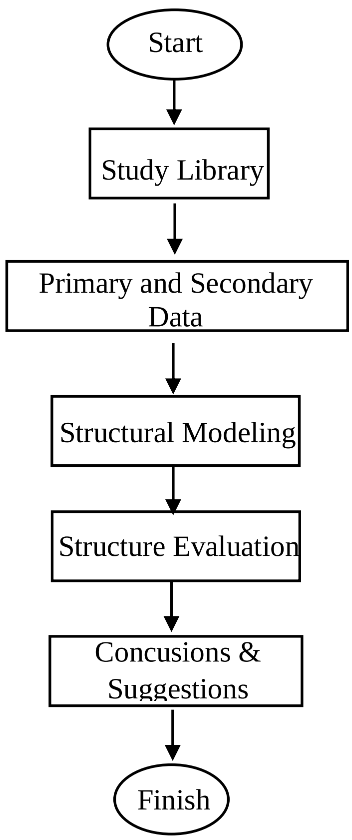

Figure 1. Research Flow Chart

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Based on the flow chart above this study begins with the study of the Library, followed by obtaining primary data (dimensions and profile of the bridge); secondary data (bridge loading data)[18][19]. Data retrieval is done by direct surveying visual checking and profil dimension measurement. The data obtained is then done 3D structure modeling and analysis using structure analysis software[20][18]. Then the results of the analysis is carried out evaluation followed by the withdrawal of conclusions and suggestions.

RESULTS AND DISCUSSIONS

Visual identification, observation and direct measurement in the field. Where in direct identification obtained that the bridge BH-259 in the form of complex profile and in the form of a wall frame; Bridge length 37.2 M; there is a profile that has cross-sectional deformation and rust.

The load used in the evaluation of the structure of the railway bridge consists of dead load (D), Life load (L) in the form of moving load, dinamic load allowance (I) in the form of moving load, lateral load (Lf) and braking load/traction (B) [3],[4],[6],[11]. Here is the table of loading calculation results.

Tabel 3. Loading Recapitulation

No.	Load	Value	Unit
1	D	150,87	kg/m'
2	L	90	ton
3	I	20,24	ton
4	Lf	1,136	ton/m'
5	B	1,42	ton/m'

Source: Research Data

The structure of the railway bridge is modeled as a 3D structure in the structure analysissoftware, the modeling can be seen in Figure 2 below.

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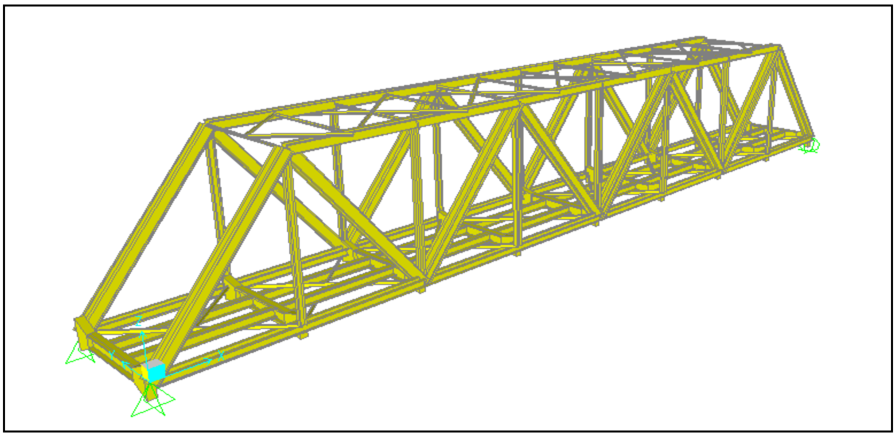
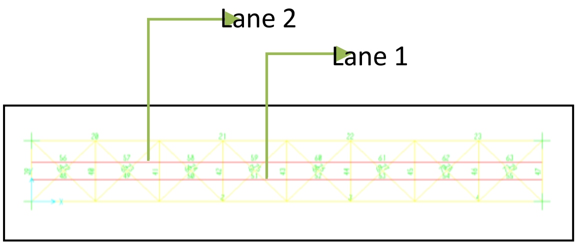


Figure 2. Pemodelan Struktur 3D

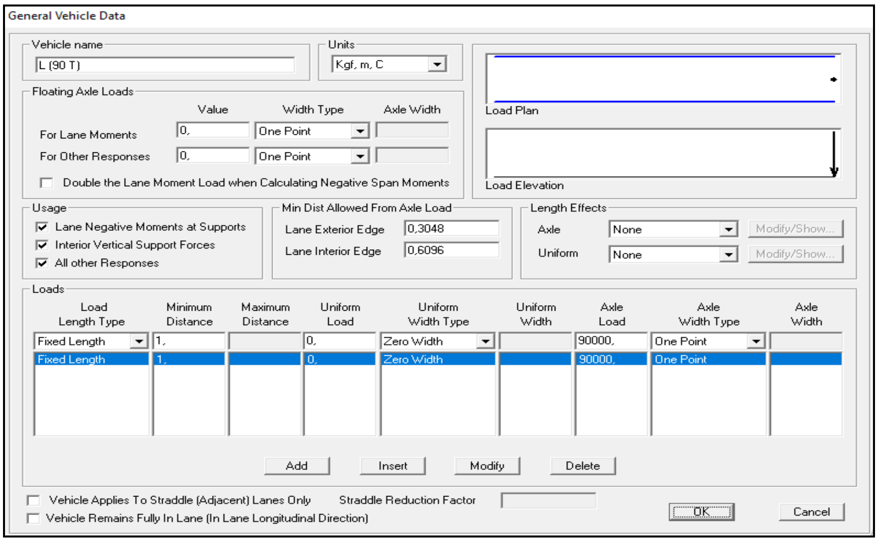
Source: Research Data

Because there is a load with a type of moving load, it is made the direction of the moving load as shown 3. Lane 1 and lane 2 are the lengthening of the railway bridge that serves as the track of the moving load. Loading restrictions can be seen in Figures 4, 5, 6, 7 and 8.



Source: Research Data

Figure 3. Moving Load Track



Source: Research Data

Figurer 4. Live Load Definition

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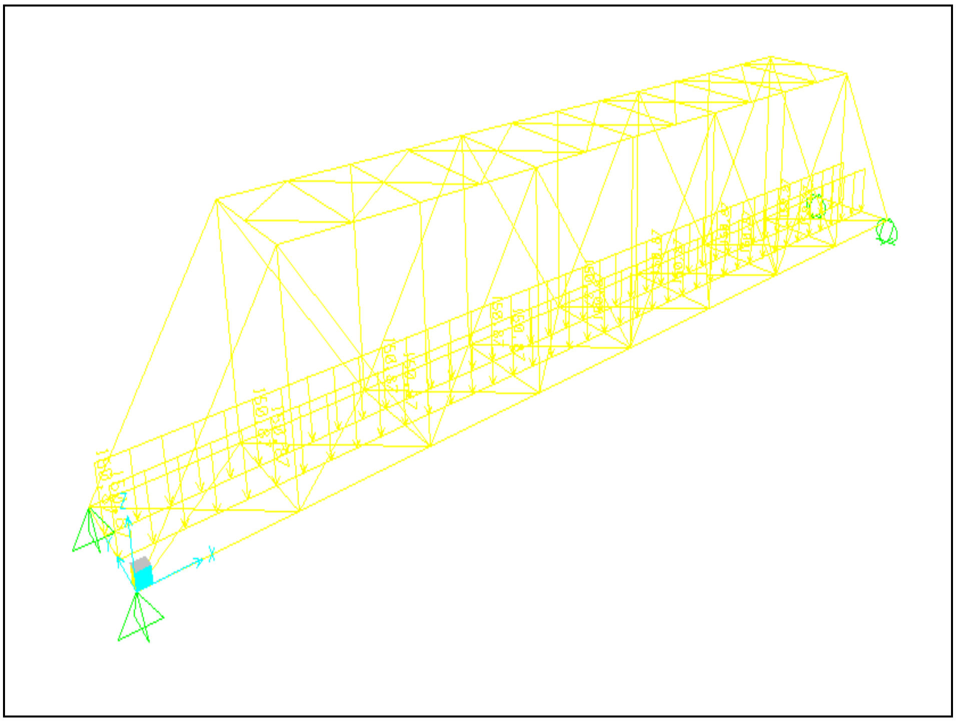
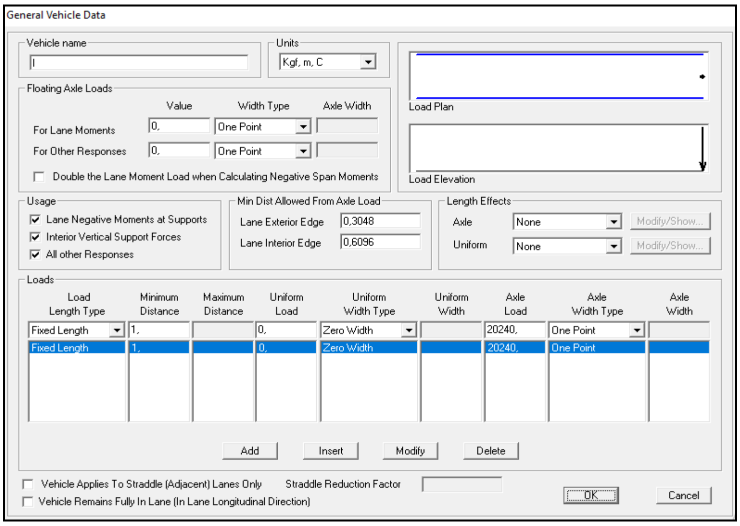


Source: Research Data

Figure 5. Dead Load Definition



Source: Research Data

Figure 6. Dinamic Load Allowance Definition

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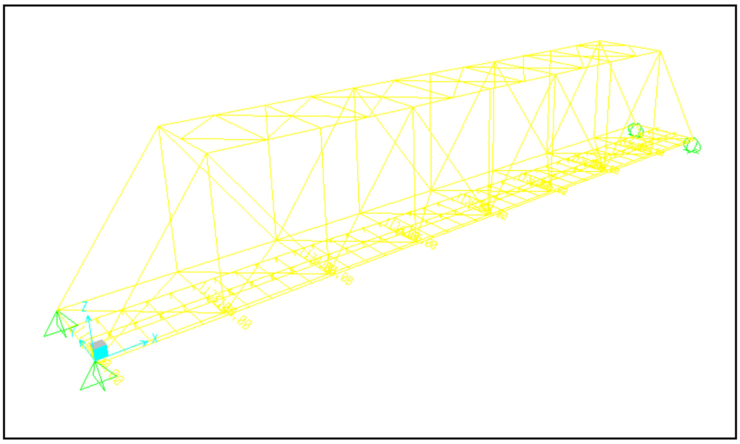
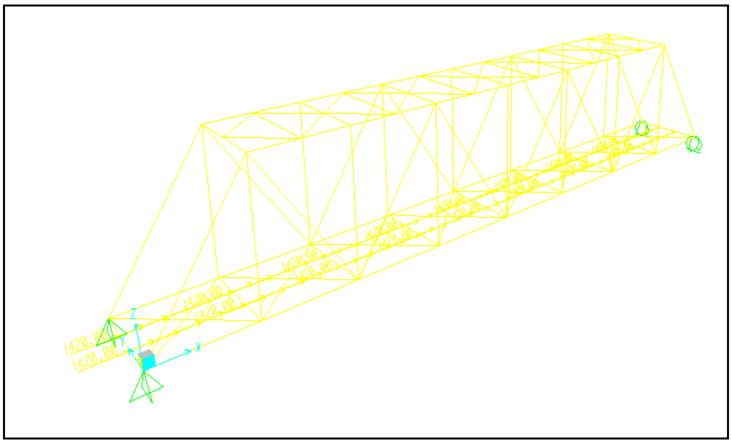


Source: Research Data

Figure 7. Lateral Load Definition



Source: Research Data

Figure 8. Traction Load Definition

The results of the running program are obtained by deflection and capacity ratio as described below. Analysis using structure analysis program obtained deflection value in the lower girder eligible deflection permit [4], [6], that is:

$$\delta = \frac{L}{700} \quad \text{..} \quad (1)$$

= 37,2/ 700

= 0,053 m = 5,3 m

Description:

δ = Deflection Allowed

δ' = Deflection

L = Bridge Lenght

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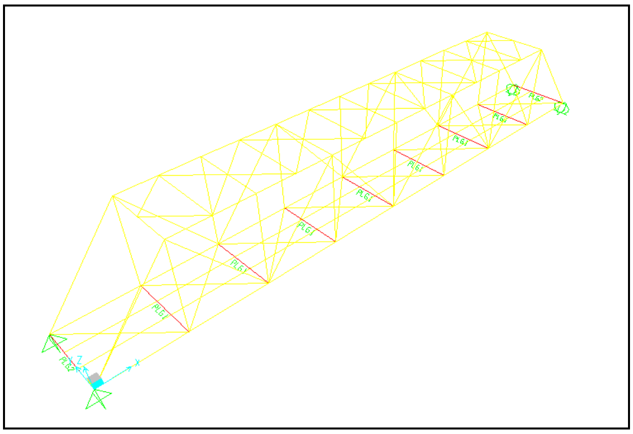
Here's a recapitulation of the maximum deflection on the railway bridge.

Table 4. Deflection Recapitulation

No	No. Joint	Deflection Girder (cm)
1.	1	0,000
2.	2	-0,180
3.	3	-0,307
4.	4	-0,400
5.	**5**	**-0,416**
6.	6	-0,386
7.	7	-0,291
8.	8	-0,169
9.	9	0,000

Source: Research Data

Analysis of the dimensional capacity of railway bridge structures in structural analysis software using the "steel frame design" feature. Basic analysis using SNI regulation 03-1729-2012, because there is no regulation of SNI then selected regulation AISC-LRFD 99 and made some adjustments to the reduction factor [4]. The results of the analysis of the dimensional capacity of railway bridge structures using structural analysis software can be seen in Figure 9. and Table 5. following information.



Source: Research Data

Figure 9. Design Analysis Results

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Table 5. Results of Capacity Analysis of Bridge Structure Dimensions

No	No Frame	Maksimum Capacity Ratio
1	39	2,089
2	40	2,286
3	41	2,259
4	42	2,119
5	43	2,128
6	44	2,159
7	45	2,165
8	46	2,146
9	47	2,089

Source: Research Data

Based on Figure 9. and Table 5. found a red capacity ratio occurs in all cross girder under the bridge. Where the capacity ratio SR > 1, it is identified dimensional capacity of the girder transverse under overstressed which means the cross-sectional capacity is categorized as unsafe. This is likely due to a significant decrease in steel quality, that is BJ34.

CONCLUSION

Based on the discussion of the results of the analysis and calculation above, can be drawn some conclusions as follows:

1) The Maximum deflection of δ = 0.416 cm occurs in a joint located in the middle of the railway bridge, the maximum value deflection of the δ is still under the allowed (δ'), i.e. δ = 0.416 cm ≤ δ' = 5.3 cm, so that it meets the requirements of deflection which can be interpreted that the configuration and profile of the bridge structure can be used.
2) While based on the analysis of the dimensional capacity of the railway bridge structure in the structural analysis software there are several structures that are red (overstressed). The maximum overstressed value occurs in frame 40 section PLG1 with a value of 2,286 > 1 which means the cross-sectional capacity is categorized as unsafe.

Suggestion

Some of the suggestions that can be given related to this research are:

a. The load used are added for wind loads and earthquake loads, in order to better review the reliability of the structure profile;

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b. Tried for a decrease in the quality of this type of steel on BJ 37;
c. Perform comparisons using manual calculation analysis

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