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DESIGN OF PERKUWEN BRIDGE PART WAY LONG IKIS-LAMBAKAN PASER TANA PASER REGENCY PROVINCE EAST KALIMANTAN

Humaira Afrila and Markawie

Civil Engineering Department, Lambung Mangkurat University

Email: humaira.afrila@gmail.com

ABSTRAK

Long Kali is a sub-district of Paser Tana Paser Regency Prov. East Kalimantan. In this sub-district have two village separate by a river, that is Perkuwen river, there is bridge has a broke. Whereas the village very needed a bridge because it is used as a transportation infrastructure for peoples and also passed by vehicles transporting oil palm yields . Therefore, the design of composite bridges made with spans 25 m and 7 m wide bridge.

In this plan the analysis of Standard methods of loading refers to the bridge imposition For RSNI T-02-2005 about composite bridge structure design method, refers to RSNI T-03-2005 about Steel Structural Design For Bridge, SNI 03-1729-2002 about Steel Structures Planning Procedures and SNI 03-2847-2002 about Concrete Structures Calculation for Building.

The result is used the main girder profile SH 950 x 400 x 16 x 32 and diaphragm WF 400 x 200 x 8 x 13. Vehicle floor plate thickness 20 cm using quality concrete f'_c 30 MPa and quality reinforcing steel reinforcement f_y 360 MPa with subject dividers reinforcement D22- 100 and D12-100 mm. In using concrete pavement f'_c 30 MPa D22-100 mm staple reinforcement and shear reinforcement rebars quality D12-100 mm f_y 360 MPa. Concrete abutment in the form f'_c 25 MPa at 2 m height and length of 8,5 m. Steel pipe pile foundations quality f'_c 25 MPa are 16 pieces with a length of 10 meters and a diameter of 0.4 m.

Keyword: Bridge, composite, steel pipe pile.

1. INTRODUCTION

Long Kali is a sub-district of Paser Tana Paser Regency Prov. East Kalimantan. In this sub-district have two village separate by a river, that is Perkuwen river, This river separates Perkuwen village dan Lambakan village. On the river there is a simple wooden bridge that the small dimension. The existence of two bridges in the village are very vital for the local population because the bridge is used as a transport infrastructure for the citizens and also bypassed by private cars and vehicles transporting palm oil yields. The condition of the bridge is not feasible because it is considered less safe for traveling around the community as a result of the reduced strength and dimensional bridge impossible to pass two vehicles passed, whereas if the bridge does not work anymore it will impact on the economy of the village. Therefore, it is necessary to increase the bridge of a wooden bridge into the bridge concrete structure / composite bridges and also required the soil investigation more detailed result of the location of the bridge is located in a mountainous area which is expected to provide infrastructure facilities are safe and convenient for road users and local communities

Composite bridge is a combination of floor slabs of concrete materials and girders of the steel material. Selection of bridges of this type have been selected for the process is easy and can also make the bridge more efficient in the use of steel.

The purpose of making this final task is to design a composite bridge is safe, relatively inexpensive, and can function properly and meet the technical requirements so that access to transport in the district of Long Kali particular village by village Lambakan Perkuwen can run well.

2. THEORITICAL STUDY

Secondary data is needed at this time include the design of building functions, building dimensions, material data, load plans, soil data, the data stream of the highest water level, and drawing plans.

Determination of Initial Dimensions are bridge class B, Span 25 meters, Width 7 meters, Sidewalks 2 x 0.5 meters, the road width 6 meters, and Plate thickness 20 cm. For standard loading on composite bridge design using RSNI regulatory T-02-2005.

All fixed load coming from its own weight of the bridge or bridge sections were reviewed, including any additional elements are considered to constitute a unity remained with him. All expenses derived from moving heavy vehicles/traffic/pedestrian who considered work on the bridge. Traffic load is divided into two, namely first load “D” is load evenly split (BTR) has an intensity qt/m/track, where the magnitude of q depends on the length of the total loaded. While load lines with intensity p kN/m should be placed perpendicular to the direction of traffic on the bridge. Large load P lines on the floor of the bridge amounted to 49.0 kN/m, second load “T” consists of semi-trailer trucks that have tabled and heavy axles. The weight of each axle load evenly distributed into two equally large is the area of contact between the wheels with the floor surface. Top structure using concrete K350 with fc’ 30 MPA. Bottom structure for abutment using K350 with fc; 30 MPA and for foundation using concrete quality K300 with fc; 25 MPA. In planning the bridge plate plate using one-way analysis for comparison spans the longest and the shortest span of more than 2.5. The main girder serves to hold the load of the floor plate, pavement and rain water loads and loads due to its own weight before it is transformed into a composite.

The horizontal shear force arising between the concrete slab and the steel beam during loading must be retained to work monolithic composite section, or in other words that there is interaction between the concrete slab and the steel beam. To ensure the bond between the concrete and steel beams to be installed device connecting the mechanical shear (shear Connector) over the beam related to a concrete slab. Besides, the function of the shear Connector is to resist / avoid lifting a concrete slab during burdened. In planning tool can be implemented based on a sliding dial.

3. RESULT AND DISCUSSION

Bridge Conditions :

Bridge class = B

Bridge length = 25 m

The width of the bridge = 7 m

Sidewalk = 2 x 0.5 m

Floor slab thickness = 0.2 m

Thick rain = 0.05 m

Specifications Concrete Reinforcing Steel

1. Top structure

   Quality concrete slab K350 vehicle with fc '30 MPa and for the quality of the concrete parapet is K300 with fc' 25 MPa.

2. Bottom Structure

Abutment K350 to use concrete with fc '30 MPa and for the foundation using concrete quality K300 with fc' 25 MPa

Weight alone (Kms = 1,3). Weight alone is calculated by reviewing lengthwise about 1 meter wide bridge. Weight = 0,20 . 1 . 25. 1,3 = 6,5 kN/m

The additional dead load (Kma = 2)

The burden of road pavement= 2,2 kN/m

load rainwater =0,49 kN/m

Q_{MA} = 2 x (0,49 + 2,2) =5,38 kN/m

Load Truck (Ktt = 1.8)

Wind Load (K = 1,2)

$$R = \frac{S.T.W.\,½\,t}{\text{distance tires}}$$

$$R = \frac{(1{,}5)\,.\,(2)\,.\,(1{,}296)\,.\,(½\,2)}{1{,}75}$$

R = 2,22 kN

R = 1,2 x 2,22 kN = 2,66 kN

wheel	Weight (kN)	Weight * (1 + D_{LA}) (kN)	distance between the tires (m)
1	25	32,5	0
2	112,5	146,25	5
3	112,5	146,25	9

Calculation Of Moments On The Vehicle Floor

Due to the dead load

amount of expenses = 11,88 kN/m

M_{lap}=0,077. q. L =0,077.11,8.1= 0,91 kNm

M_{Tump}=-0,107. q. L=0,107.11,8.1=-1,26 kNm

Due to the live load

amount of expenses = 265,92 kN/m

M_{lap} =0,2 . q . L =0,2 .265,92 .1=53,184 kNm

M_{Tump}=-0,1 . q . L=-0,1.265,92.1=-26,59 kNm

So we get the total moment on the floor plate is:

M_{lap} = 0,91 + 53,184 = 54,094 kNm

M_{Tump} = -1,26 + (-26,592) = -27,852 kNm

Calculation Of The Floor Slab Reinforcement

Regional Pedestal

Main reinforcement D22-300

reinforcement For D12-400

Regional Field

Main reinforcement D22-150

reinforcement For D12-200

Calculation Of Sidewalks And Backrest

Steel pipe D 2.4 'with a weight of 3.98 kg / m, external load of 1 kN / m and obtained q is 1.039 kN / m.

$M_{max} = \frac{1}{8} . q . l^2 = 0,52$ kNm

M_u = 1,6 M_{max} =831200 Nmm

d = D- 2. 2,4 (tebal) = 56,16 mm

Zx = t . d^2 =7569,47 m^3

M_n = Z_x . fy = 2195146,3 Nmm

$\frac{M_u}{M_n} = \frac{831200}{2195146,3} = 0,4 < 1$ .....OK reinforcement sidewalk

Mu = -0,104 kNm

Obtained to the main reinforcement for the D22-100 and D12-200 reinforcement

Planning Top Gelagar Bridge

Section Properties

For the planning of this bridge girder using SH steel profiles with the following conditions:

yield stress ; *fy* = 360 Mpa

voltage ultimate ; *fu* = 490 Mpa

modulus of elasticity

E_s = 2×10^5 kg/cm²

Span = 25 meter

Widht Road = 6 meter

Sidewalk = 0,5 meter kiri+0,5 meter kanan

Distance between girder = 1,5 meter

For the main girder been the initial planning SH profile with dimensions: 950x400x16x32

Profile document

g = 314 kg/m ; I_x = 638000 cm^4

A = 400,5 cm^2 ; I_y = 34200 cm^4

d = 950 mm ; Z_x = 15000 cm^3

b = 400 mm ; Z_y = 2620 cm^3

t_w = 16 mm ; t_f = 32 mm

$b_e = b_o =$ 150 cm

E_s = 2×10^5 MPa

E_c $= 4700\sqrt{f_c'} = 4700\sqrt{30}$

$= 25742{,}96$ MPa

$n = \frac{E_s}{E_c} \approx 7$

Concrete transformed cross-section:

$\frac{b_e}{n} = \frac{150}{7} = 21{,}43$ cm

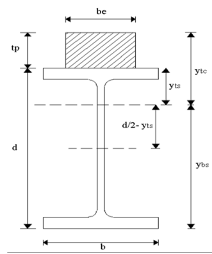
$\bar{y} = y_{tc} = 41{,}369$ cm

$y_{bs} = (tp + d) - y_{tc}$

$= 73{,}631$ cm

$y_{ts} = y_{tc} - tp$

= 21,37



	A	y	Ay
plat beton	428.5714286	10	4285.7143
profil baja	400.5	67.5	27033.75
jumlah	757.07		31319.464

	A (cm^2)	y (cm)	I_0 (cm^4)	d (cm)	$I_0 + Ad^2$ (cm^2)
Pelat Beton	428.5714286	10	100000	31.36931	521728.7171
Profil	400.5	67.5	638000	26.13069	911466.5693
				Itr	1433195.286

Imposition Top Gelagar Bridge

No	Jenis Beban	Kode Beban	Q (kN/m)	P (kN)	M (kNm)	Mmax (kNm)	Vmax (kN)	M Komb. 1	V komb.1	M Komb. 2	V komb. 2	M Komb. 3	V komb.3	M Komb. 4	V komb. 4	M Komb. 5	V komb 5	M Komb. 6	V komb 6	M Komb. 7	V komb. 7
1	Sebelum Komposit	SM	13.34	1.1		1058.69	168.95														
2	Sesudah Komposit	MS	11.6	1.1		922.75	147.2	922.75	147.2	922.75	147.2	922.75	147.2	922.75	147.2	922.75	147.2	922.75	147.2	922.75	147.2
3	Mati Tambahan	MA	8.07			768.28	122.925	768.28	122.925	768.28	122.925	768.28	122.925	768.28	122.925	768.28	122.925	768.28	122.925	768.28	122.925
4	Lajur "D"	TD	24.3	185.22		1326.375	119.61	1326.375	119.61	1326.375	119.61	1326.375	119.61	1326.375	119.61					1326.375	119.61
5	Gaya Rem	TB			210.6	0	0	0	0	0	0	0	0	0	0					0	0
6	Angin	EW		26.64		16.65	1.332					16.65	1.332	16.65	1.332						
7	Gempa	EQ	1.967			153.67	24.59									153.67	24.59				
8	Temperature	TM		0.24		1.5	0.12			1.5	0.12			1.5	0.12						
9	Arus/Hanyutan					0	0	0	0	0	0	0	0	0	0	0	0				
10	Beban Tumbukan					0	0													0	0
11	Beban Pelaksanaan					0	0											0	0		
							Jumlah	3017.405	389.735	3018.905	389.855	3034.055	391.067	3035.555	391.187	1844.7	294.715	1691.03	270.125	3017.405	389.735
							Tegangan yang terjadi (Mpa)	201.0026842		201.1026058		202.1118143		202.2117359		122.883621		112.646983		201.0026842	
							Tegangan yang diperbolehkan (Mpa)	360		450		450		504		540		468		540	

The Voltage On The Main Girder

The voltage on the fiber on concrete :

$$f_c = \frac{M_{max} \times y_{tc}}{n \times I_{tr}} = -12{,}52 \text{ MPa}$$

The voltage on the fiber over steel:

$$f_{sa} = \frac{M_{max} \times y_{ts}}{n \times I_{tr}} = -6{,}466 \text{ MPa}$$

Voltage at the bottom of the steel fibers

$$f_{sb} = \frac{M_{max} \times y_{bs}}{I_{tr}} = 155{,}95 \text{ MPa}$$

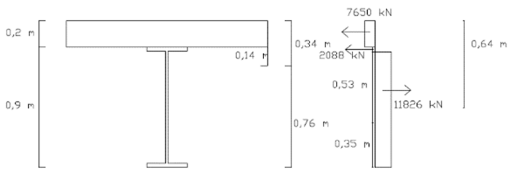
Strong Nominal Bending

$$C_c = 0{,}85.f'_c.b_e.t_p = 7650000 \text{ N}$$

$$C_s = \frac{A_S.f_y - 0{,}85.f'_c.b_e.t_p}{2} = 3384000$$

$$d_f = \frac{C_s}{b_f.f_y} = 23{,}5 \text{ mm} < 32\ mm$$

	A (cm^2)	y (cm)	A.y
Profil baja	400.5	47.5	19023.75
Flens	-70.5	93.825	-6614.6625
Jumlah	330		12409.088



$d' = (d - \bar{y}) + \frac{t_p}{2}$ = 673,9mm

d'' = 562,217 mm

Strong nominal bending

$M_n = C_c . d' + C_s . d''$ = 7058,39 kNm

ϕM_n = 5646,712 > Mu = 3035,5 kNm

Deflection Plate

$\delta_{ijin} = \frac{L}{240} = \frac{25000}{240}$ = 104,167 mm

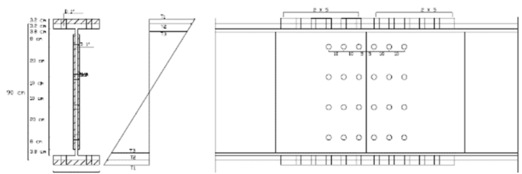
No	Jenis Beban	Kode Beban	Q (kN/m)	P (kN)	M (kNm)	Lendutan	Komb. 1	Komb. 2	Komb. 3	Komb. 4	Komb. 5	Komb. 6	Komb. 7
1	Sebelum Komposit	SM	13.34	1.1		0.0237961							
2	Sesudah Komposit	MS	11.6	1.1		0.0207085	0.02070853	0.0207085	0.020709	0.0207085	0.0207085	0.020709	0.020709
3	Mati Tambahan	MA	8.07			0.0143198	0.0143198	0.0143198	0.01432	0.0143198	0.0143198	0.01432	0.01432
4	Lajur "D"	TD	24.3	185.22		0.0641536	0.06415356	0.0641536	0.064154	0.0641536			0.064154
5	Gaya Rem	TB			210.6	0	0	0	0	0			0
6	Angin	EW		26.64		0.0030254			0.003025	0.0030254			
7	Gempa	EQ	1.967			0.0034903					0.0034903		
8	Temperature	TM		0.24		2.726E-05		2.726E-05		2.726E-05			
9	Arus/Hanyutan					0	0	0	0	0	0		
10	Beban Tumbukan					0							0
11	Beban Pelaksanaan					0						0	
						Jumlah(m)	0.09918189	0.0991819	0.099182	0.0991819	0.0350283	0.035028	0.099182
						Jumlah(mm)	99.1818873	99.181887	99.18189	99.181887	35.028327	35.02833	99.18189
						lendutan yang diperbolehkan (mm)	104.166667	104.16667	104.1667	104.16667	104.16667	104.1667	104.1667

Calculation Of Shear Connector

Each line used 3 pieces stud with Ø1 "height H = 15 cm, 1 span = 2 (22 + 14) + 1 = 72 lines

5 girder = 5. 72. 3 = 1080 stud with a distance of 30 cm

Bolt Connector



Bottom Structure

Permanent Load

Nama	Simbol	Beban (kN)	
		Normal	Terkurangi
Berat Baja	WS	215.88	176.63
Berat Pelat Lantai	WP	487.50	281.25
Beban Tambahan	WT	456.37	178.23
Berat Sendiri Abutment	WA	758.24	454.37
Tekanan Tanah Aktif	PA	273.69	-

Nama	Simbol	Beban Vertikal (kN)	Beban Horizontal (kN)	Beban Momen (kNm)
Berat Baja	WS	215.88	0.00	0.00
Berat Pelat Lantai	WP	487.50	0.00	0.00
Beban Tambahan	WT	456.37	0.00	0.00
Berat Sendiri Abutment	WA	758.24	0.00	-69.34
Tekanan Tanah Aktif	PA	0.00	273.69	166.67

Transient Load

Nama	Simbol	Beban Vertikal (kN)	Beban Horizontal(kN)	Beban Momen (kN)
Beban Lajur "D"	TD	1874.39		0.00
Gaya Rem	TB		93.72	356.13
Beban Trotoar	TT	164.06		0.00
Beban Angin	TA		13.67	36.56
Beban Angin pada Lalu Lintas	TAL		20.25	64.80
Temperature	T		2.06	4.13
Beban Gempa :				
Struktur permanen (L)	TWL		198.90	437.57
Struktur permanen (B)	TWB		99.45	218.79
Abutment	TWA		65.02	54.06
Tekanan Tanah	PD		64.04	39.00

Aksi	Simbol	Kombinasi Beban Vertikal (kN)				
		1	2	3	4	5
Beban Tetap Kecuali Tekanan Tanah	W	1917.98	1917.98	1917.98	1917.98	1917.98
		1090.47	1090.47	1090.47	1090.47	1090.47
Tekanan Tanah	PA	0.00	0.00	0.00	0.00	0.00
		-	-	-	-	-
Beban Lalu Lintas	TL	1874.39				
Temperature	T		0.00			
Beban Angin	TA			0.00		
Beban Gempa	TW				0.00	
Tekanan Tanah Dinamis	PD				0.00	
Jumlah		4882.836031	3008.451031	3008.451031	3008.451031	3008.451031
momen yang diizinkan		46200	57750	57750	64680	69300
		Aman	Aman	Aman	Aman	Aman

Aksi	Simbol	Kombinasi Beban Horizontal (kN)				
		1	2	3	4	5
Beban Tetap Kecuali Tekanan Tanah	W	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00
Tekanan Tanah	PA	273.69	273.69	273.69	273.69	273.69
		-	-	-	-	-
Beban Lalu Lintas	TL	113.97				
Temperature	T		2.06			
Beban Angin	TA			13.67		
Beban Gempa	TW				363.36	
Tekanan Tanah Dinamis	PD				64.04	
Jumlah		387.66	273.69	287.36	637.05	273.69

Aksi	Simbol	Kombinasi Beban Momen (kNm)				
		1	2	3	4	5
Beban Tetap Kecuali Tekanan Tanah	W	-100.53	-100.53	-100.53	-100.53	-100.53
		-71.20	-71.20	-71.20	-71.20	-71.20
Tekanan Tanah	PA	166.67	166.67	166.67	166.67	166.67
		-	-	-	-	-
Beban Lalu Lintas	TL	420.93				
Temperature	T		4.13			
Beban Angin	TA			36.56		
Beban Gempa	TW				710.41	
Tekanan Tanah Dinamis	PD				39.00	
Jumlah		415.87	-5.06	31.51	705.36	-5.06

Calculation of forces acting on the pole

Kombinasi		Satuan	Baris I			Baris II		
			Vi	Hi	Vn Aksial	Vi	Hi	Vn Aksial
Kombinasi I		kN	675.33	79.29	678.70	545.37	67.53	545.37
Kombinasi II		kN	300.21	39.91	301.71	301.48	30.02	301.48
Kombinasi III		kN	304.78	41.28	306.30	296.91	30.48	296.91
Kombinasi IV		kN	347.33	66.34	349.07	189.89	34.73	189.89
Kombinasi V		kN	250.18	33.26	251.43	251.23	25.02	251.23

Carrying capacity of the pile

Method mayerhoff :

$$Q_{ijin} = \frac{qc \ x \ A}{SF \ 1} + \frac{JHP \ x \ P}{SF \ 2}$$

$$= \frac{250 \ x \ 1256}{3} + \frac{980 \ x \ 125{,}6}{5}$$

= 129,283 ton

Method schmertman :

$q_p = \dfrac{\left(\frac{qc1+qc3}{2}\right)+qc2}{2} = \dfrac{\left(\frac{250+250}{2}\right)+44{,}12}{2} = 1470600\ \text{kg/m}^2$

$Q_p = q_p \cdot A = 184{,}71$ ton

$Q_f = K\ ½\ (f_c\ A_s)_{0\text{-}8d} + (f_c\ A_s) = 0{,}75\ [½\ (490\ .1256) + (980.\ 1256)] = 692{,}37$ ton

$Q_{ijin} = \frac{Qp}{SF\ 1} + \frac{Qf}{SF\ 2} = \frac{184{,}71}{3} + \frac{692{,}37}{5} = 138{,}474$ t

Efficiency pole group

Used efficiency value 0.88

$Q_{ag1} = eff\ .Q_{ijin} = 113{,}77$ ton > Vn

$Q_{ag2} = eff\ .Q_{ijin} = 121{,}86$ ton > Vn

Control of lateral load

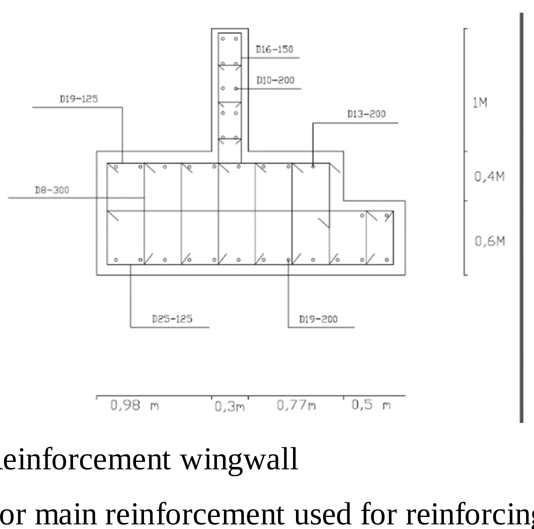
Based on the chart with a value $\frac{M_y}{C_u . d^3} = 151{,}4093$ then the obtained value

$$\frac{H_u}{C_u . d^3} = 38$$

$$H_u = 38 . C_u . d^2 = \frac{38\ .\ 0{,}255\ .\ 40^2}{1000} = 15{,}504\ ton$$

$H_{ijin} = \frac{H_u}{Sf} = \frac{15{,}504}{1{,}5} = 10{,}336\ ton > H_{kerja}$

Reinforcement abutment



Reinforcement wingwall

For main reinforcement used for reinforcing the D22-300 and D13-400 used.

4. CONCLUSION

1. The bridge meets the technical requirements below:

a. Deflection plates that happened was f = 0.14 mm <fizin = 6.25 mm

b. By using an application SAP2000 obtained maximum moment that occurs is 3035.555 KNM, so we get a voltage that occur after the composite is

c. At the top of the concrete fiber = -12.52 MPa <30 MPa (Aman)

d. At the top of the steel fibers = -6.466 MPa <30 MPa (Aman)

e. At the bottom of the steel fibers = 155.95 MPa <360 MPa
As for the nominal moment what happens is 5646.71 KNM> 3035.555 KNM

f. Deflection plates are permitted after the composite is 104.167 mm and is based on the calculation of deflection occurs is less than 99 mm so that the license plate deflection.

g. Control of the strength of the stake: maximum axial force = 678.703 kN < Qstandar = 1137.7 kN and lateral forces 8.717 tons <lateral clearance of 10.4 tons.

h. Control requirement secure abutment against the vertical force: Pnetto = 758.43 kN> Pwork 678.703 kN .

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