9

7.4.4 BOX CULVERT (LOCATION 0 + 816 M)

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page

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APPENDIX

I : Output of Internal Analysis

DESIGN CRITERIA

1.

影響

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1.1. Regulation Reference.

- The Design Load are based on The Specification of Perumka Railway Bridge (AVBP 1932) and 100 % Load Scheme 1921.
- PD 10
- Indonesian Concrete Code (PBI 1971)
- Elastic Analysis of Reinforced Concrete Section (PU)

1.2. Material

Concrete.

Quality K - 225 Concrete cover 5 cm =

Rebar / Reinforcement

Quelity U - 39 (Deformed Steel rebar) 3900 kgf/cm2

÷.

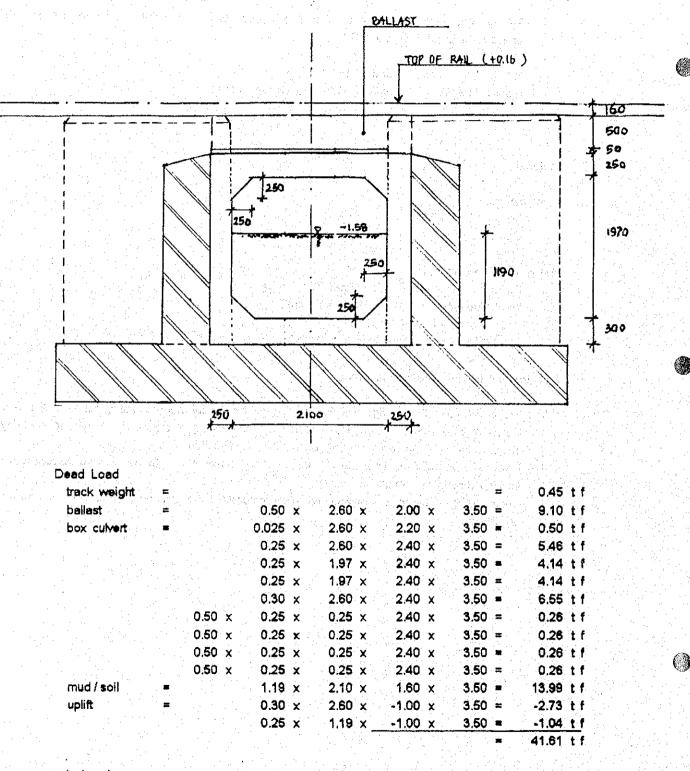
Yield Strength 52

Requirement in The Construction Stage. 1.3.

- Trains will pass this Bridge with low speed during the full period of excecution of the Works.
- Sufficient time shall be taken into account for Hardenning of the concrete material (28 days)
- Train Traffic shall not be disturbed during the Construction stage.
- Removal / Demolishing of a part of the existing sub-structures to be allowed except the existing footing of sub-structures.
 - Contractor shall be improved and renewal / replaced if the existing footing are damaged or cracks

STABILITY ANALYSIS. 3.

3.1. Stress On Brick Masonry



train Load

qt

2 x

2.100 19.000 x

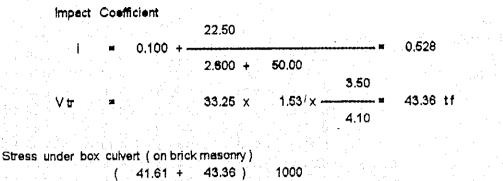
33.250 tf

*

2.400

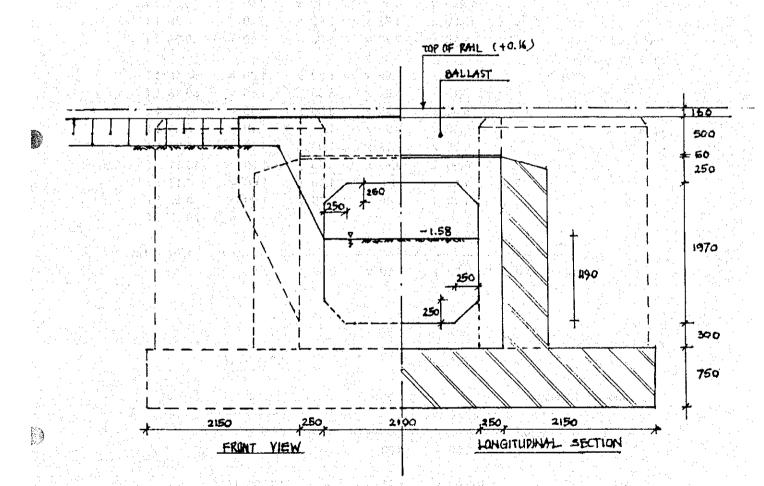
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BH. 5 - 4



σ = _____= 0.93 kgf/cm2 < σ a = 15 kgf/cm2 260.00 x 350.00

3.2. Stability of bearing capacity



BH. 5 - 6

nit Weight track weight	2	•				=	0.45	t
ballast	ана) — народна 1 32	0.50	x	2.60 x	2.00 x	3,50 =	9.10	t
box culvert	=	0.025		2.60 x	2.20 x	3.50 =	0.50	t
		0.25	x	2.60 x	2.40 x	4.10 =	6.40	t
		0.25	x	1.97 x	2.40 x	4.10 =	4,85	t
•		0.25		1.97 x	2.40 ×	4.10 =	4.85	t
· · ·		0.30	x	2.60 x	2.40 x	4.10 =	7.68	t
	0.50 ×	0.25	x	0.25 x	2.40 ×	4.10 =	0.31	t
	0.50 ×		x (0.25 x	2.40 ×	4 10 =	0.31	t
	0.50 ×	1	x (0.25 x	2.40 x	4.10 =	0.31	t
	0.50 ×	0.25	x (0.25 x	2.40 x	4.10 =	0.31	t
		0.375	x	5.10 x	2.40 ×	0,55 =	2.52	t
	an an taon 1990. An taona amin' a	0.375	x	5.10 x	2.40 x	0.55 =	2.52	t
		1.250	x (0.45 x	0.60 ×	2.40 =	0.81	t
	0.50 >	c 1.250	x	1.77 ×	0.60 x	240 =	3.19	t
		1.250	x	0.45 x	0.60 x	2.40 =	0.81	t
	0.50 >	c 1.250	X	1.77 ×	0.60 x	2.40 =	3.19	t
mud / soil		1.19	x	2.10 x	1.60 x	4.10 =	16.39	t
brick masonry 8				an an taon an t Taon an taon an t				i.
soil	=	2.15	x	3.82 ×	3.50 x	1.85 =	53.18	t
		2.15	x	3.82 X	3.50 x	1.85 =	53,18	t
	i se e se e se e Nor se so se se se s	6.90	x	0.75 x	3.50 x	2.00 =	36.23	t
uplift	=	0.30	x	2.60 x	-1.00 x	4.10 =	-3.20	t
		0.25	x	1.19 x	-1.00 x	4.10 =	-1.22	t
		6.90	X	0.75 x	3.50 x	-1.00 =	-18.11	t
	2 >	x 1.40	X	1.49 x	1.00 x	-1.00 =	-4.17	t
n in earlier die die seerst en operaties als die seerste	2 >	x 1.40	X	1.49 x	1.00 x	-1.00 =	-4.17	
						*	176.19	t
		176.19		e e e gui				
Υ.	=	3 50		2 60 v	0.60)	3.82	1.79	t
	(6.90)	x 3.50	т	2.60 x	0.00 } .	JUZ		2
								i.
train Load								÷
Axle Load on s	and a second	47.000	ul Nutr	a di suya tanya m		400.000 14		J.
۹۳	= 6	x 17.000		and ge		102.000 tf		
in a second s	Coefficient							
inipaci v		22.50						
1	= 0.100	+			8	0.528		
		2.600	+ 5	00.00				
Vtr	n (n. s. standard) National N ⊞ (n. s.	102.00	x	1.53		155.83 tf		

Soil Properties

- Ballast Material

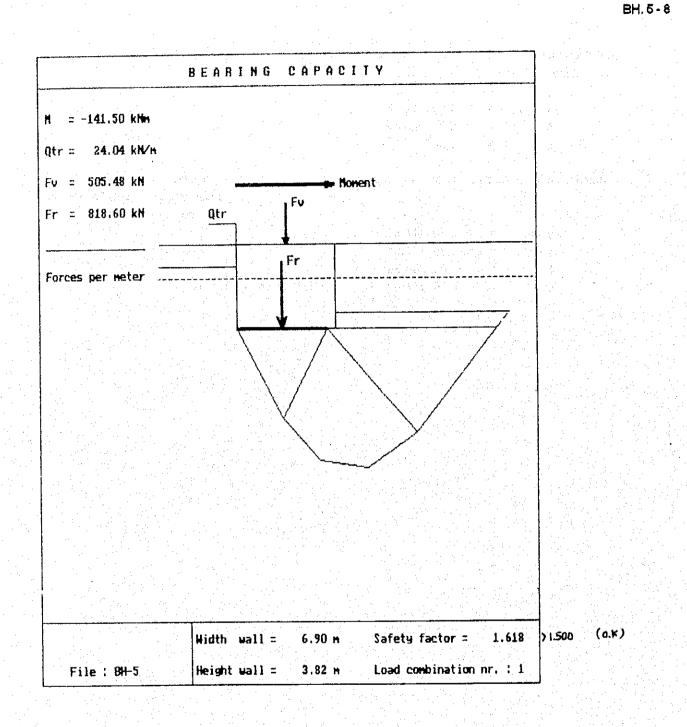
8

Y	wet	÷	=	2.00	tf/m3
Ŷ	dry		=	1.90	tf/m3
ф	2	·	=	35.00	degree
¢			=	0.00	

- Material under ballast Layer and existing structure

 Soft Clay settlement and consolidation have occured on this layer

			and the second second			
y wet	=	1.70	tf/m3			
γ dry	=	1.60	tf/m3			
¢	=	10,00	degree			
c	=	0.56	tf/m2	(c=N/9	where a	Is N=5)
		14 J. 16 N.	1.1.1			



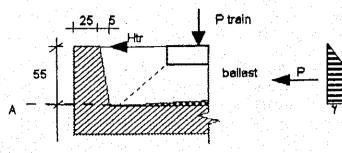
7 - 4 - 202

0.05

4. STRUCTURAL CALCULATION

4.1. SIDE WALL FOR BALLAST.

4.1.a. Sketch



- 4.1.b. Earth Pressure caused by ballast. $\gamma = 2.000 \text{ tf/m3}$ $\phi = 35 \text{ degree}$ c = 0 tf/m2K o = 0.244
- 4.1.c. Lateral earth pressure

- Caused by ballast. P = 0.500 x 2.000 x 0.550 x 0.550 x 0.244 = 0.0738 tf/m

- Caused by Transversal Load.

Htr = 12.00 × 0.10 = 1.20 t-f/sleeper

friction coefficient between ballast and bottom of sleeper = H'tr = 1.20 - 0.05 x 12.00 = 0.60 t-f/sleeper

for 1 m length of side wall

1.20

4.1.d. Internal force

	ala da series			C	9 [tf]					x [m]	Mx [tfm]
								•			
concrete :	0,500	Χ	0.050	X 21	0.550	X	2,400	. =	0.033	-0.117	-0.004
		1.11	0.250	x	0.550	X	2.400	=	0.330	0.025	0,008
ballast :	0,500	X	0.050	X	0.550	X	2.000	F	0.028	-0.133	-0.004
		le e ja d						• .	0.391	0.002	0.001
Therefore :		1.2917								e liese slies	
M =	0.0738	x	0.1833	[+].:	0.50	X	0,55	+	0.391 ×	0.002	
=	0.289	t f-n	n /m					inte.			
Q =	0.0738	+	0.50	- 1	0.574	tf		÷ .		an an an Ariana. An an Ariana	

N = 0.391 tf

BH. 5 - 10

(

4.1.e. Reinforcement

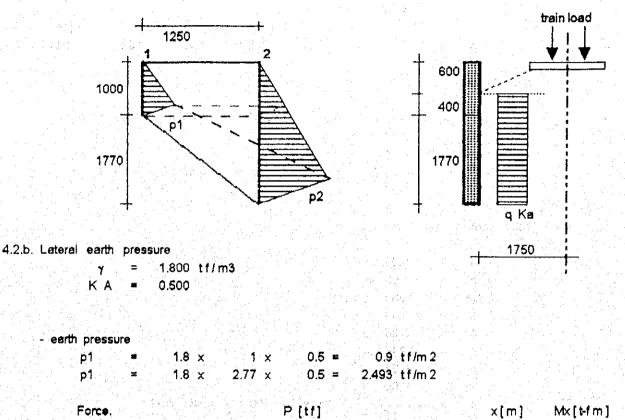
h	=	0.24	m			· . · ·	· · · · ·							
Ь	=	1.00	m			÷	11							:
Сө	ä	14.61						· .					· · · ·	
δ	æ	1.00					t i						•	
.	=	8,09	÷									· .·	. :	
5		0.963								•				
nw	Ξ	0.0068	-		1900 B. 1910 B.									
		0.0068											1997 - 19	
A	H		- X _	29	X	100	= 0	.9404	cm2	11 A.				•
		. 21										D 16	2.050	
A min		0.0025	X	29	X	100	•	7.25	cm2	e l	USO) = 20U	
						4000								
	5	a da antar Antaria	je i	0.574	FX.	1000		10081	kg / cr	- 	ok.		: :	
τ	= 	0.875	v	20	X	100	- L	1.2201	ry i u	114	v n,			

4.2. WING WALL .

De log

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4.2.a. Sketch



; Fo	rce, :	et i se se	· . • • •				P	[tf]					X	(m) –	Mx[t-fm]
	P1 -	=		0.50	X	1.00	X	0.90	X 5.5	0.42	=	0.19		0.63	0.12
나는 사람 같이 사람	P2	=				0.90	X	1.77	X	0.42	=	0.66		0.42	0.28
				0.50	x	1.59	x	1.77	x	0.42	=	0.59	$\mathbb{E}_{q \in \mathbb{N}}$	0.42	0.24
				·					a v J			1.44		0.44	0.64
1		der .	신문		bişteri		1.5							de el	

- earth pressure caused by train load

		8.75				
qK	a *	x	0.5	* 1	1.25 tf/	m2
	di bitan	3.5				

Force.	P [tf]	x[m] Mx[t-fm]
P1 =	1.25 × 0.40 × 1.25 =	0.63 0.63 0.39
P2 *	1.25 x 1.77 x 0.42 =	0.92 0.42 0.38
		1.55 0.50 0.77

- Caused by Transversal Load.

Htr = 12.00 x 0.10 = 1.20 t-f/sleeper

friction coefficient between ballast and bottom of sleeper = 0.05H'tr = $1.20 - 0.05 \times 12.00 = 0.60$ t-f/sleeper

7 - 4 - 205

BH. 5 - 12

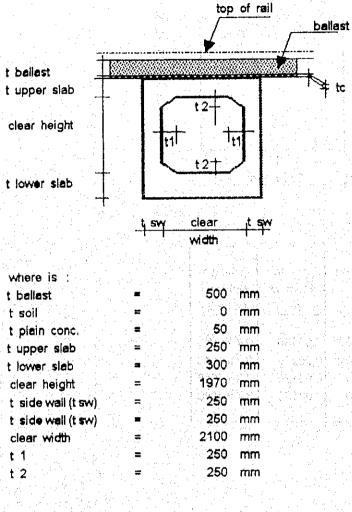
• .	for	1 m l	ength of s	ide wali						
			0.60	■ 0.50 t	Hm			· .		
•	н	'tr ≡ .	1.20	- 0.50 1	er 10		11 - A	÷ 1.		
			1.20		P [tf]	raa in t			x[m]	Mx[t-fm]
	P				0.5	X	1.25 =	0.625	0.625	
						 	en an			
	Total Force									
. A		-	1	na an an an an an an Ar An ang					• • • • • • • • •	
•	М	i . 💻	(0.64	+ 0.77	+	0.39)=	0.81	term/m	
			2.22							
			1		+ 1,55		183 1=	1 63	t f / m'	e de la prese
	Q	 	2.22		+		0.00 /-	1.00		
			2.22							
4.2.c.	Reinforcem	ent		an a						
n na heinin Alternet Alternet	n h	· · · =	0.23	and the second			en la servici			
ve de	Þ	1. A. A.	1.00	m						
	Ci		8.352			e datione e				
	8		0.40							
	4		5,25 0,945							
	ς nv	1 A A A A A A A A A A A A A A A A A A A	0.945							
a ta Rajt	1.04		0.04	en an eile de la de Recentration						

ζ =	0.945					
mw =	0.04					
	0.04			a far i shekara na shekara Tarihi na shekara <u>a</u> ta		
A = -	x	23 X	100 =	4.381 cm2		
	21 ₂₀ 30		400 -	7.05		D 16 - 250
Amin =	0.0025 ×	29 x	100 =	7.25 cm2	nra	U 10-200
		1.626 x	1000			
		1.020 X		0.8081 kg/cn	n2 ok.	
•	0.875 x	23 x	100			

4.3. BOX CULVERT







4.3.b. Unit Weight of Mass

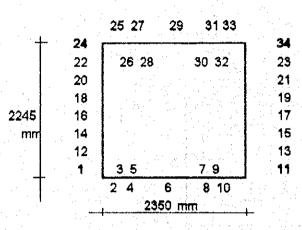
Track Weight	=	0.450 ff / m'
Ballast	1 -	2,000 tf/m3
Filled Material (soil)	- =	1,800 tf/m3
Plain Concrete	. =	2.200 ff/m3
Reinforced Concrete		2,400 tf/m3

4.3.c. Reinforced Concrete Quality

Concrete		K	-	225	an da An an an	1997 -	
Reinfordir	ng Bar	U	•	39 (deform	steel)

に近る旅客ともひた 選索和る 含

4.3.d. Schematization of Rigid Frame Diagram.



4.3.e Property of Members

Member	Thickness	Area	Inersia	Young's
			Moment	Modulus
	[m]	[m2]	[m4]	[#/m2]
				la av vi
upper slab	0.250	0.250	0.00130	2.7 × 10 %
lower slab	0.300	0,300	0.00225	2.7 x 10*6
side wall	0.250	0.250	0.00130	2.7 x 10^8
side wall	0.250	0.250	0.00130	2.7 × 10*6

4.3.f. Loadings

1. Track Load.		0 150		^			0.005	
Track weight Ballast / Gravel		0.450		2.000			5	tf/m /
				· · · · · ·	٩t		1.225	
2. Dead Load.								
a. Upper slab load - Lean concrete	•	0.050	X	2.200		•	0.110	tf/m
- Top sl e b	=	0.250	×	2.400	qdl	=	0.600	
b Olda Jatali (a su		0.050					la photos 14 an an	
b. Side Well (q sw]. ≡ 	0.250	X	2.400			0.600	tf/m -/

3. Earth and Water Pressure.

Ŧ

a. Soil data :

K' o

- 1, Fill Material at the back side of side wall
 - $\gamma = 1.800 \text{ tf/m}3$
 - Ko = 0.500 (assumption)
 - 1.000 (Water)

b. Intensity of 1. Condition		sure earth pressui	19 19			
		(∕0.175√x		0.500 =	0.770	tf/m
		2.245 x				
2. Condition	of earth a	ind water pre	ssure	· · · · · · · · · · · · · · · · · · ·		
Pel=(1.225 +	0.175 ×	0.800) x	0,500 =	0.683	tf/m
P e2 =	0.683 +	2.245 x	0.800 x	0.500 =	1.581	tf/m
Pw1=					0.000	tf/m
P w2 =	0.000 +	2.245 x	1.000 ×	1.000 =	2.245	tf/m
P (e+w) 1	=	0.683 +	0.000	=	0.683	tf/m
P (e+w) 2				=	3.826	tf/m

4. Train Load.

```
a impact Coefficient
```

	22.5	50			
i = 0.1	00 +			#	0.530
	2.3	50 + 50.00) (1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1		

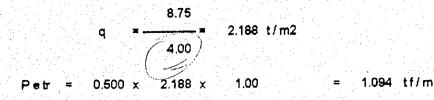
b. Uniform Load

an an an A	 - -	19.000		1. A. A. A.	
atr	: 2		-	4.948	tf/m
	2.400 ×	3.200			
		an a		1994. 1	e de la des
i+t p	= 4.948 × (1.000 + 0.530))	7,569	tf/m

5. Earth Pressure due to Train Load.

Ph = Ko x Pw

- where is :
 - Ph : Horizontal Pressure due to train load
 - Ko : Earth pressure coefficient
 - q : Distributed Train Load

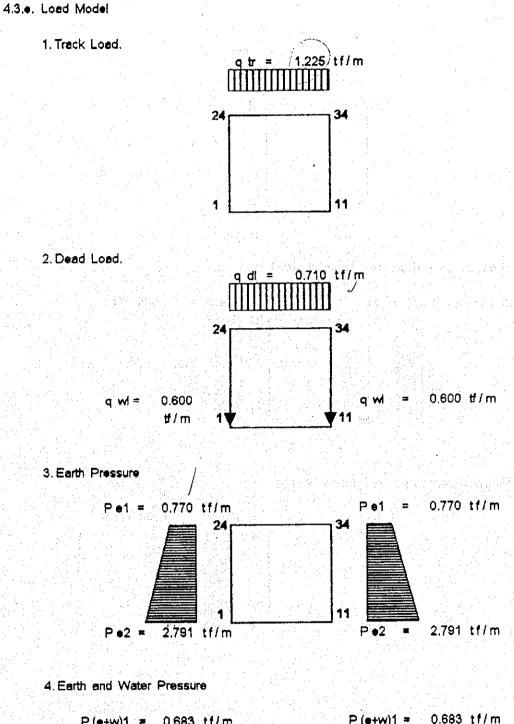


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BH. 5 - 16

6. Spring Constante

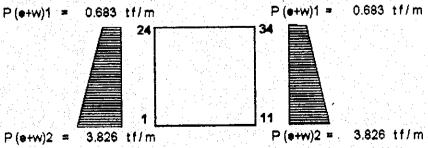
Ċ¢	1.11	πt : ≕		2800	b t/	m3					· · ·	1000 an 1000 <u>a</u> n 1000 1000
	Kh	=		933	3 t/i	m3			, sa si ji	1		
	point	• 1	&	.11		Ky		0.063 x	2800	=	175	t/m
		ģ.				Kh				12	58	t/m
	point	2	&	10	:	Kv	=	0.075 x	2800	=	210	t/m
		- 14 - 14	. <u>.</u>	tan t an t	i.	Kh				=	70	t/m
	point	3	8	9	:	Kv	=	0.125 x	2800	Ξ	350	t/m
						Kh				=	117	t/m -
	point	4	8,	8		Κv		0.125 x	2800		350	t/m
•						Kh	×.			=	117	t/m
.i	point	5	&	8		Κγ		0.400 x	2800	×	1120	t/m
				 	1.1	Kh				=	373	t/m
:	point	6		din ya	:	Ky		0.775 x	2800	. =	2170	t/m
		÷ .				Kh					723	t/m



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A. 10

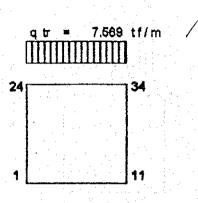
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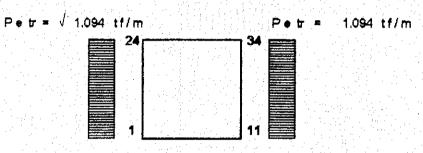
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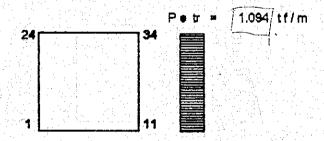
5. Train Load.



6. Earth Pressure caused by Train (both of side)



7. Earth Pressure caused by Train (one side only)



4.3.f. Load Combination

1. Basic Case.

No.	Aplicetions	Note
1.	1. Track Load.	
2.	2. Deed Load.	
3.	3. Earth Pressure	
4.	4. Earth and Water Pressure	
5.	5. Train Load.	
6.	6. Earth Pressure caused by Train (both of side)	
7.	7. Earth Pressure caused by Train (one side only)	
and the second		

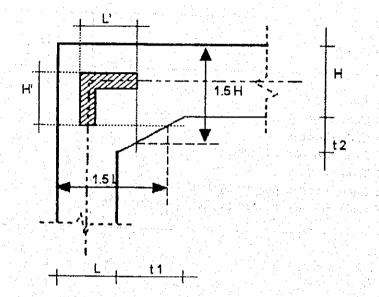
2. Load Combination.

)

No.		Combin	ation	Case		Load Factor α	
1 2 3	1 2 1 2 1 2	3 7 3 7 3 6	5			1.00 1.00 1.00	
4 5 6	1 2 1 2 1 2	4 7 4 7 4 6	5			1.00 1.00 1.00	
7 8 9	1 2 1 2 1 2	4 7 4 7 4 6	5			1.00 1.00 1.00	$\alpha = 0.50$ for load no. 4 $\alpha = 0.50$ for load no. 4 $\alpha = 0.50$ for load no. 4

BH. 5 - 20

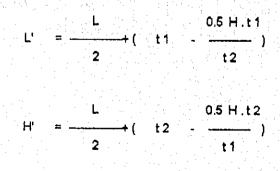
4.3.g. Check point at edge of box culvert



1. Bending Moment at Panel Point.

The effect of haunches may be neglected on rigid frames analysis if it's satisfied conditions of below.

Length of rigidity zone is 1.5 times the depth of member because inclination of haunch (9) is 45 degrees Rigidity structure analyze from this point :



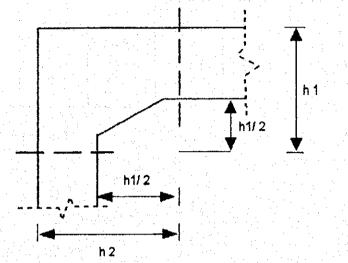
1 (o.k.) 1 (o.k.)

×۲ ۲

2. Calculation of Shear Point.

1

9



Examination of shear is at drawing below beacuse that member support directory.

Rigid Length Calculation

		Joint Co	onnection	
items	Top Slab and Wall		Bottom Slab and	
			Wall	
		at a start		
H [m]	0.250	$= \frac{22}{2} \frac{1}{2} \frac$	0.300	
L[m]	0.250		0.250	
t1 [m]	0.250		0.250	
t2 [m]	0.250		0.250	
L'[m]	0,250		0.225	
H'[m]	0.250		0.275	
L'7L	1.000		0.900	
нин	1.000		0.917	

Calculation Stress Point.

		a and the second second			
Members		Distan	ce from poi	nt I 👘 👘	
	xm1 [m]	xs1 [m]	x m2 [m]	xs2 [m]	x3 [m]
	L		6		
upper slab	0.125	0.125	0,375	0,375	1.175
lower slab	0.125	0.150	0.375	0.400	1,175
side wall	0.125	0.125	0.375	0.375	1.123
side wall	0.125	0.125	0.375	0.375	1.123

front rigid area

BH. 5 - 22

Members	Distance from point i						
	×3	x s 4	xm4	× \$5	x m5		
	[m]	[m]	[m] -	[m]	[m]		
upper slab	1.175	1.975	1.975	2.225	2.225		
lower slab	1.175	1.950	1.975	2.200	2.225		
side wall	1.123	1.845	1.845	2.120	2.095		
side wall	1.123	1.845	1.845	2.120	2.095		
		and a company					

front rigid area

7 - 4 - 216

4.3.h.	Reinforcement	Analysis
	Concrete	1 A. 1

- Concrete к-

К-	225	>	ellowable compressive stress ellowable tension stress E b	, = =	- 7	kg f /cm 2 kg f /cm 2 kg f /cm 2	
- Steel Reber U -	39	>	allowable compressive / tensi stress F a	- =		kg f /cm 2 kg f /cm 2	

ł	8			

. .

ITEMS	TOP SLAB			BOTTOM SLAB			SIDE WALL		
			Section 29	Section 2	Section 4	Section 6	Section 12	Section 18	Section 2
nternal Force						e te pte e se			
M {tf m }	1.93	1.67	3.09	0.94	2,62	5.34	1.87	1.90	3.03
N [1 1	2.55	2.55	1.64	4.00	1.83	0.44	12.43	11.62	11.62
- Q [#]	10,39	10.16	0,75	10.91	8.01	4.83	2.82	1.47	2.90
Dimension			A second second						
b [m]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
h (m)	0.33	0.25	0.25	0.30	0.30	0.30	0.33	0.25	0.25
d (m)	0.26	0.18	0.18	0.31	0.23	0.23	0.26	0.10	0.18
ď (m)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Inalysis		1							
n	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
∕ ₹ 0	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
700									
901 (m)	0.76	0.65	2.37	0.23	1.43	12.14	D 15	0.16	0.28
e o 2 [m]	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
eo (m)	0.78	0.67	2.39	0,25	1.45	12.16	0.17	0.18	0.28
eo/h	2.33	2.70	9.57	0.65	4.84	40.52	0.51	0.73	1.12
C	7.00	7.00	7.00	6.95	7.00	7.00	6.92	6.94	7.00
e1 [m]	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02
	0.05	0.04	0.04	0.08	0.05	0.05	0.05	0.04	0.04
e2 [m]		0.73	2.44	0.32	1.51	12.21	0.23	0.24	0.33
e (m)	0.84	0.79	2.50	0.44	1.59	12.29	0.33	0.29	0.39
ea [m]	0.94	2.00	4.10	1.79	2.91	5.41	4.08	3.39	4.52
N ea [tf m]	2.30	2.00	4.19	3.10	2.01				
Ca	5.582	4,170	2.910	7 658	4.414	3.237	4.265	3.202	2.772
delta	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.200
	3.444	2.448	1.667	4.882	2.448	1.857	2.509	1.857	1.469
0	6.200	3.737	2.273	11.860	3.737	2.600	3.865	2.600	1.951
0		0.290	0.375	0.170	0.290	0.350	0.285	0.350	0.405
ksi	0.225		0.879	0.942	0.903	0.886	0.904	0.066	0.869
zeta	0.923	0.903		3.372	2.482	2,199	2.500	2.199	2.105
СЪ	2.884	2.482	2.095	0.018	0.066	0.111	0.084	0.111	0.154
	0.035	0.066	0.137	0.010	1 0.000			1	
Reinforcement	1.351	1.262	1.069	3.044	1.150	1.017	3.830	2.209	1.673
an a dhaa ar as as a' a' a' a	3.25	4.48	11.00	0.69	6.20	11.96	2.21	4.31	7.89
A [cm]		2.26	4.70	1.07	2.89	4.86	3.21	3.81	2.64
A' [cm]	1.76		4.50	7.03	5.75	5.75	6.58	4.50	4.50
A min (cm2)	6.50	4.50	4.00	7.05	0.10		0.00		
	0.50	4.50	11.00	7.83	8.28	11.96	6.59	4.50	4.50
A [cm]	6.58	4.50		1	16	16	16	18	16
Rebar diameter	16	16	16	16	25	14	25	33	33
Distance [cm]	25	33	17	10	40		20		
an a	3 50	7 17	4.70	9.53	2.69	4.66	9.55	3.96	1.51
A' [cm2]	3.56	2.27		16	18	16	16	16	16
Rebar dismeter	16	16	16	10	50	33	17	33	50
Distance [cm]	33	50	33	<u> </u>	<u> </u>		••••••••••••••••••••••••••••••••••••••	- -	
Checking Shea		1 4 00	1 1 20		1.20	1.20	1.20	1.20	1.20
Load Factor	1.20	1.20	1.20	1.20		2.66	1.47	1.12	2.21
To kg f /cm2		7.74	0.57	4.79	4.78	2.00	1.41		"''''
Tb-Ta [kg f/cm2]		3.74		0.78	0.79				
Ts [kgf/cm2] 4.78	4.78		4 79	4.78			<u> </u>	

7.4.5 BOX CULVERT (LOCATION 1 KM + 177M)

Table	Con	ante	
18.DI9		GN CRITERIA	
1.	1.1.	Regulation Reference.	
	1.2.	Material	$(1,1) \in \mathbb{R}^{d}$
		Requirement in The Construction Stage.	
1999 - 17 B	1.3.	Kadnitaurair III IIIa Coustinciou Oraĝo.	
		NSION OF BOX CULVERT	
2.		INSION OF BOX COLVERT	
3,	CTA	BILITY ANALYSIS.	
э.	3.1.	Stress on existing brick masonry	
	3.2.	Stability of bearing capacity	etter en
	5.2.	Stability of bearing capacity	
	~	UCTURAL CALCULATION	
4.	4.1.	a da na antiga da cara	
	4.1.	4.1.a. Sketch	
	2012-01	4.1.b. Earth Pressure caused by ballast.	
		4.1.c. Lateral earth pressure	
		4.1.d. Internal force	Style Color
		4.1.e. Reinforcement	
$w_{1}^{(1)} = w_{1}^{(1)} + w_{1}^{(1)} = w_{1}^{(1)} + $	4.2.	TRANSITION SLAB	
	4.2.	4.2.a, Sketch	
		4.2.b. Loading	
		4.2.c. Reinforcement	
	4.3.	CONSOLE FOR TRANSMON SLAB	
	4.9.	4.3.a, Sketch	
		4.3.b. Loading	
		4.3.c. Reinforcement	
	A A 1	WING WALL	
	4,4,	4.4.a. Sketch	u san tanan sa ta mwana tan
		4.4.b. Lateral earth pressure	
e Bette det N		4.4.c. Reinforcement	
	4.5.	BOX CULVERT	
		4.5.a. Sketch	
		4.5.b. Unit Weight of Mass	
	de pre la	4.5.c. Reinforced Concrete Quality	
		4.5.d. Schematization of Rigid Frame Diagram.	
		4.5.e Property of Members	
		4.5.f. Loadings	$\frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} + \frac{1}{2} \right)$
		4.5.e. Load Model	
n fili san Igrin an tin		4.5.f. Load Combination	a ay a sa tata.
n an said Tha saidh Agus gairtí		4.5.g. Check point at edge of box cutvert	
		4.5.b. Reinforcement Analysis	an she dan ƙw

APPENDIX

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1 : Output of Internal Analysis

1. DESIGN CRITERIA

1.1. Regulation Reference.

- The Design Load are based on The Specification of Perumka Railway Bridge (AVBP 1932)
- and 100 % Load Scheme 1921.
- PD 10
- Indonesian Concrete Code (PBI 1971)
- Elastic Analysis of Reinforced Concrete Section (PU)

1.2. Material

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Concrete.

- Quality K-225
- Concrete cover = 5 cm

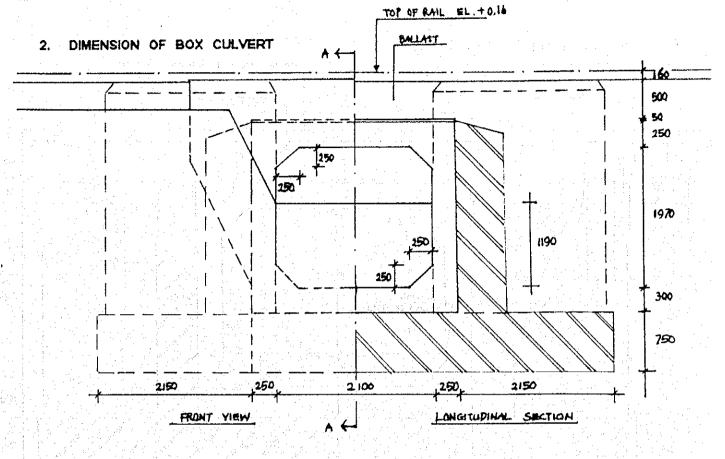
Rebar / Reinforcement

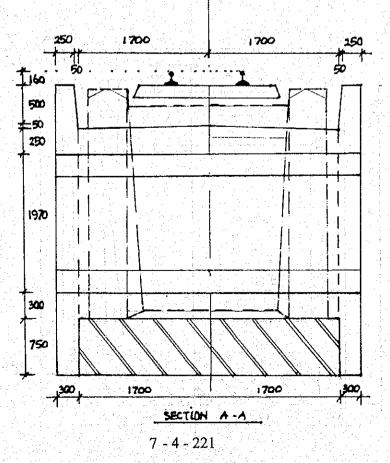
- Quality U 39 (Deformed Steel rebar)
- Yield Strength = 3900 kg f/ cm2

1.3. Requirement in The Construction Stage.

- Trains will pass this Bridge with low speed during the full period of excecution of the Works.
 Sufficient time shall be taken into account for Hardenning of the concrete material (28 days)
- Train Traffic shell not be disturbed during the Construction stage.
- Removal / Demolishing of a part of the existing sub-structures to be allowed except the existing footing of sub-structures.
- Contractor shell be improved and renewal / replaced if the existing footing are damaged or cracks



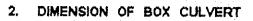




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EXISTING BRIDGE

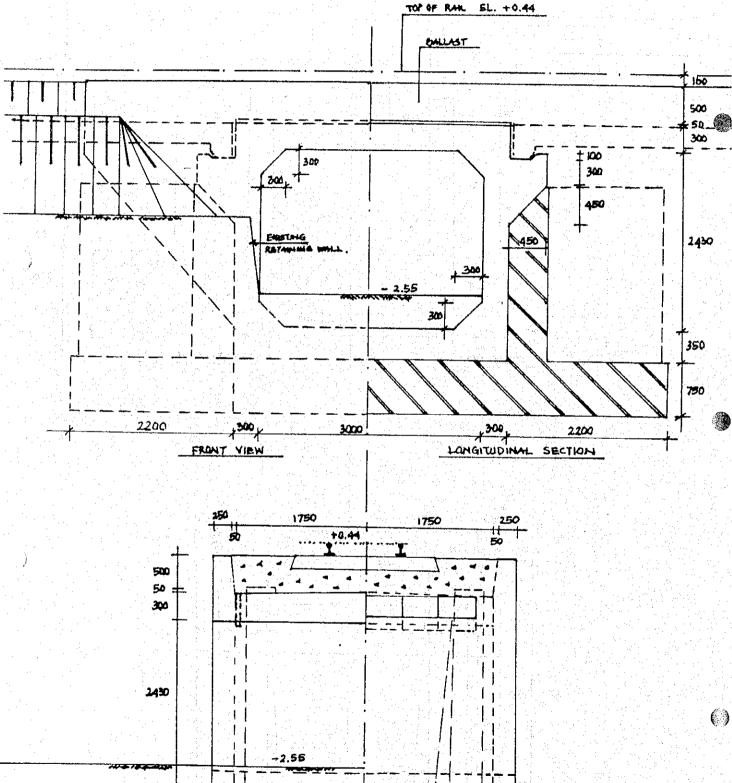
4.10

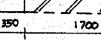
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2050

SIDE VIEW 7 - 4 - 222



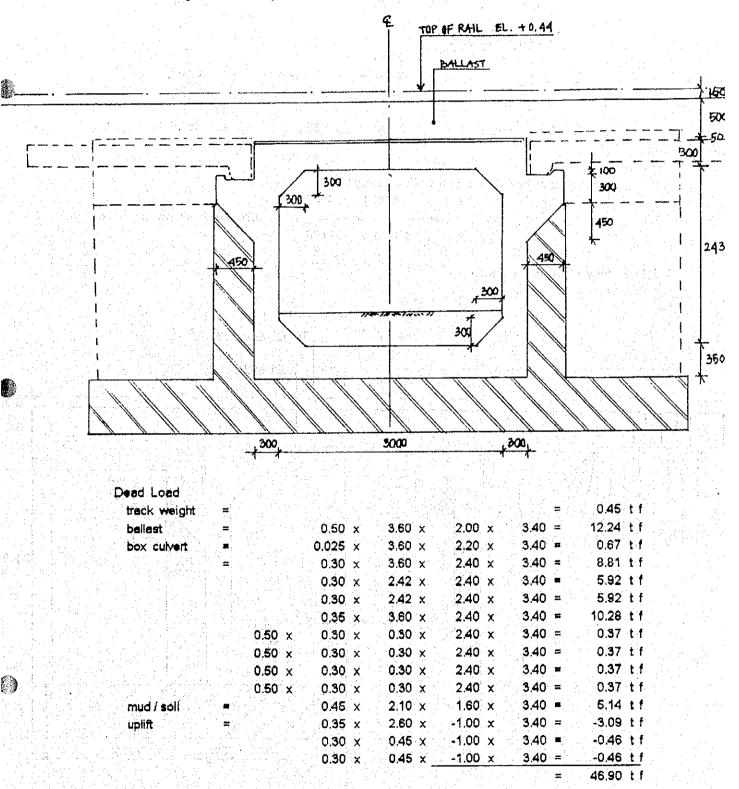


350

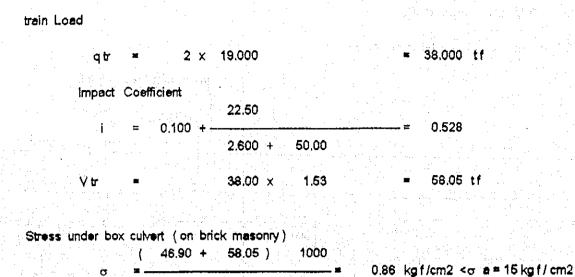
750

3. STABILITY ANALYSIS.

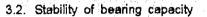
3.1. Stress on existing brick masonry

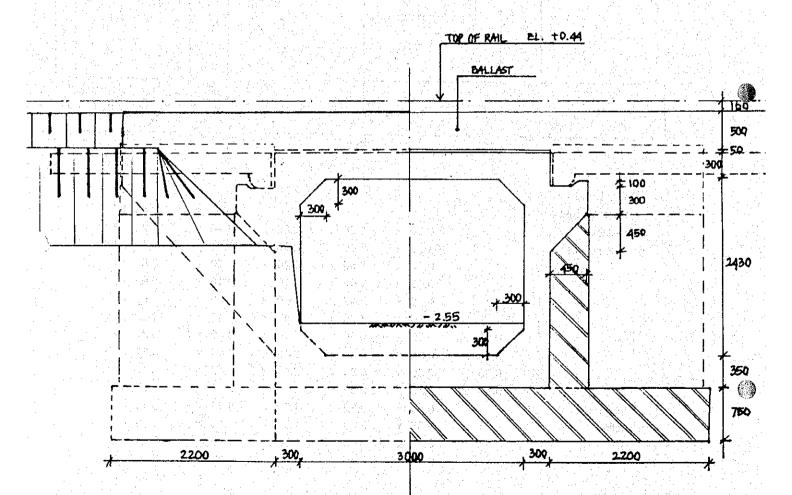


BH. 6 - 5



360,00 x 340.00



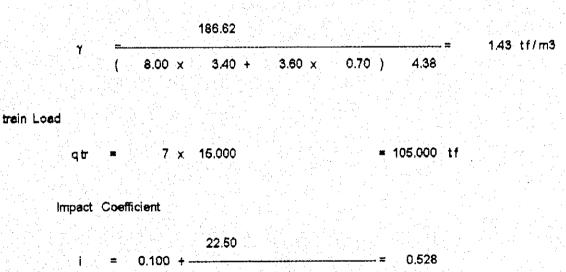


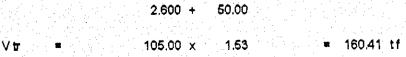
Unit Weight

(The second

track weight = 0.45 t bellast = 0.50 x 3.60 x 2.00 x 3.60 = 12.96 t	t f
	÷ F
box culvert = 0.025 x 3.60 x 2.20 x 3.60 = 0.71	
= 0.30 x 3.60 x 2.40 x 4.10 = 10.63 1	: 1
$0.30 \times 2.43 \times 2.40 \times 4.10 = 7.17$: f .
0.30 x 2.43 x 2.40 x 4.10 = 7.17 1	f
$0.35 \times 3.60 \times 2.40 \times 4.10 = 12.40$	f
0,50 x 0.30 x 0.30 x 2.40 x 4.10 = 0.44 1	: f ::
$0.50 \times 0.30 \times 0.30 \times 2.40 \times 4.10 = 0.44$	f.
$0.50 \times 0.30 \times 0.30 \times 2.40 \times 4.10 = 0.44$ I	f
0.50 x 0.30 x 0.30 x 2.40 x 4.10 = 0.44 1	(•f
$0.275 \times 7.60 \times 0.55 \times 2.40 \times 2 = 5.52$	f
$0.50 \times 0.50 \times 0.50 \times 2.40 \times 4.10 = 1.23 1$, f
0.50 x 2.000 x 2.28 x 0.60 x 2.40 = 3.28 i	f
2 x 2,000 x 0,45 x 0.60 x 2.40 = 2.59 1	: f
mud / soil = 0.45 x 3.00 x 1.60 x 4.10 = 8.86 1	f
brick mesonry = 2.20 x 3.63 x 3.40 x 1.80 = 48.87 1	: f _
2.20 x 3.63 x 3.40 x 1.80 = 48.87 1	(f -,
8.00 x 0.75 x 3.40 x 2.00 = 40.80 1	f
uplift = 0.35 x 3.60 x -1.00 x 4.10 = -5.17 1	f
0.30 x 0.45 x -1.00 x 4.10 = -0.55 1	.f .
0.30 x 0.45 x -1.00 x 4.10 = -0.55 I	f.
8.00 x 0.75 x <u>3.40 x -1.00 = -20.40 1</u>	f

186.62 tf





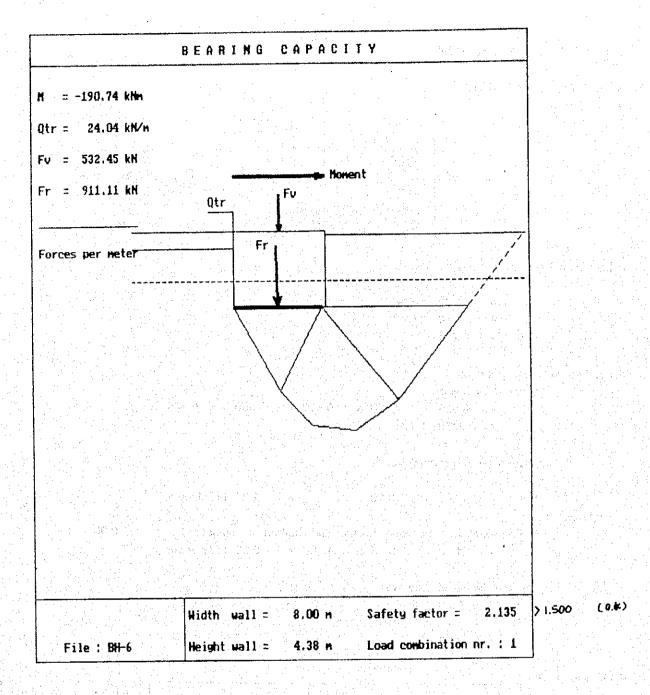
BH. 6 - 7

Soil Properties

Ballast Met	eriai		
y wet	= 1	2.00	tf/m3
γ dry	्र	1.90	tf/m3
ф	×	35.00	degree
c	=	0.00	tf/m2

- Material under ballast an	d existing structure		Soft Clay	
				consolidation have
			occured on this	layer
y wet = 1.70	tf/m3			
	tf/m3		in sud i su su de la su Companya as su	
	degree tf/m2 (c=	N/9 where as		

BH. 6 - E

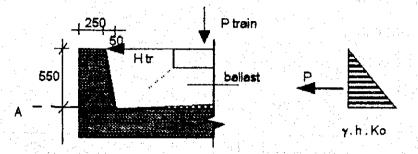


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4. STRUCTURAL CALCULATION

4.1. SIDE WALL FOR BALLAST.

4.1.a. Sketch



4.1.b. Earth Pressure caused by ballast. y = 2.000 tf/m3

- φ = 35 degree c = 0 tf/m2 K o = 0.244
- 4.1.c. Lateral earth pressure
 - Caused by ballest. P = 0.500 x 2.000 x 0.550 x 0.550 x 0.244 = 0.0738 tf/m

- Caused by Transversal Load.

 $Htr = 12.00 \times 0.10 = 1.20 t-f/sleeper$

friction coefficient between ballast and bottom of sleeper = 0.05H'tr = $1.20 - 0.05 \times 12.00 = 0.60 \text{ t-f/sleeper}$

for 1 m length of side wall

1.20

0.60 H'tr = _____= 0.50

0.50 t-f/m

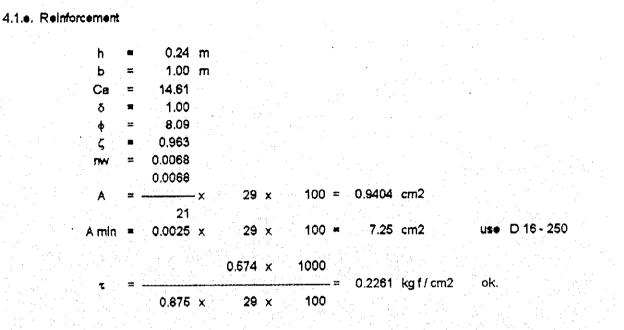
4.1.d. Internal force

	an a		G [tf]			× [m]	Mx [tfm]
concrete :	0.500 x	0.050 x	0.550	x 2.400 =	0.033	-0.117	-0.004
		0.250 x	0.550	× 2.400 =	0.330	0.025	0.008
ballast :	0.500 x	0.050 x	0.550	x 2.000 =	0.028	-0.133	-0.004
					0.391	0.002	0.001

Therefore :

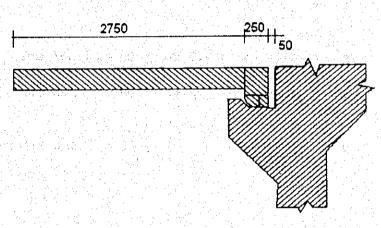
```
 \begin{array}{rcl} M &=& 0.0738 \ x & 0.1833 \ + & 0.50 \ x & 0.55 \ + & 0.391 \ x & 0.002 \\ &=& 0.289 \ tf\mbox{-m/m} \\ Q &=& 0.0738 \ + & 0.50 \ = & 0.574 \ tf \\ N &=& 0.391 \ tf \end{array}
```

BH. 6 + 10



4.2. TRANSITION SLAB

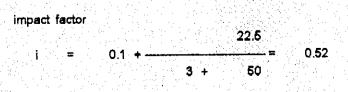
4.2.a. Sketch



4.2.b. Loading

Dead Load 0.72 tf/m 0.30 x 1.00 x 2.40 = concrete = 1.00 x 2.00 = 1.10 tf/m bellast 0.55 x 0.14 tf/m 0.45 x 0.31 æ tracks 1,96 tf/m

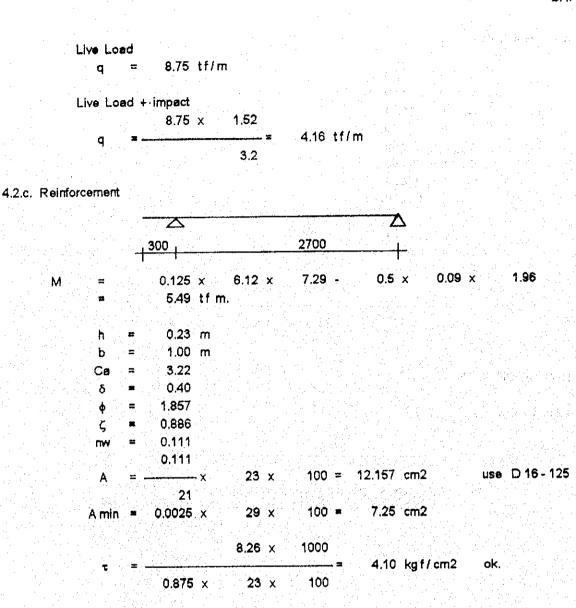
Live Load



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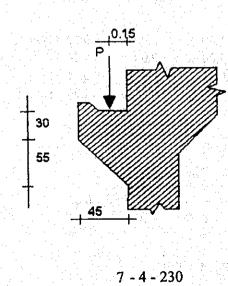
BH.6-11

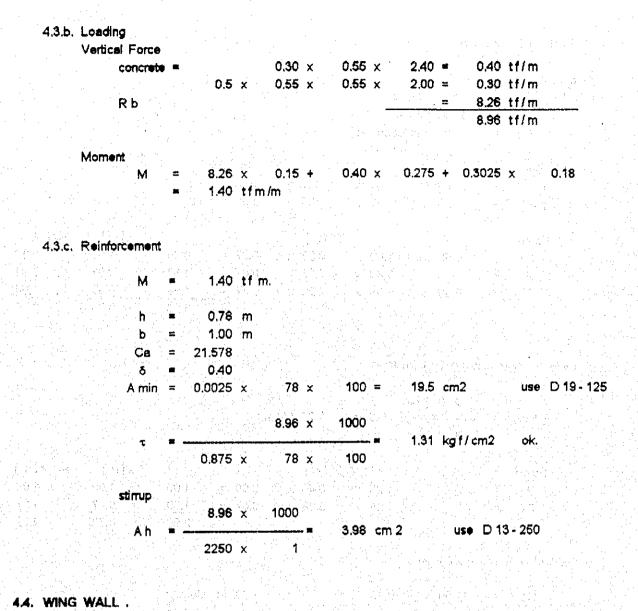
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4.3. CONSOLE FOR TRANSITION SLAB

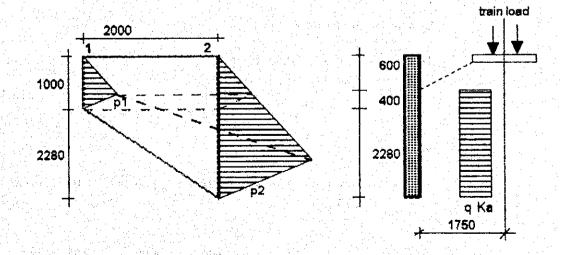
4.3.a. Sketch





6

4.4.a. Sketch



•	data of soil		
	Y =	1.800 tf/m3	
	φ =	35.00 degree	
	Ko =	0.500 (assumption))

earth pressure

p1	÷	=	5	1.8	X	1	x	0.5	#		0.9	tf/m2
p1		-	та н. П.	1.8	x	3,28	x	0.5		2	.952	tf/m2

Force.		P [tf]	×[m]	Mx[t-fm]
P1 =	0.50 ×	1.00 × 0.90 × 0.67	= 0.30 1.00	0.30
P2 =		0.90 x 2.28 x 0.67	= 1.37 0.67	0.91
	0.50 ×	2.05 × 2.28 × 0.67	= 1.56 0.67	1.04
			323 070	2 25

- earth pressure caused by train load

	8.75						
q Ka 💻	X	0.5 =	1.25 tf/	m2			
	3.50	n na sangan sa Ngangganggan sa		t daga sebagai Aliyo sebagai			
Force.			⊃ [tf]			viml	Mx[t-fm]
P1 =		and the second		2.00 =	e generale de la companya de la comp	1.00	1.00
P2 =		the second se		0.67 =	1.90	0.67	1.27
					2.90	0.78	2.27

- Caused by Transversal Load.

Htr = 12.00 x 0.10 = 1.20 t-f/sleeper

friction coefficient between ballast and bottom of sleeper = 0.05H'tr = $1.20 - 0.05 \times 12.00 = 0.60$ t-f/sleeper

for 1 m length of side wall

2.73

23		÷ .	1 L	0.60	 	55 545 68 1 1 1 1		
	H. D.	Ξ.	-	3	0.50	t-f/m	. A	

in se Regio		1.20							
			an taon 1990. Ng taong t	P [1	1			x[m]	Mx[1-fm]
ص ا	김 승규는 영화 문화	1	1 (14) (14) (14)	•	6.4	· · · · · · · · · · · · · · · · · · ·	4	1 - 1 -	1 00



- $M = \frac{1}{2.73}$ (2.25 + 2.27 + 1.00)= 2.02 t-fm/m'
- Q = _____{3.23 + 2.90 + 1.00 = 2.61 t+f/m'
 - 7 4 232

4.4.c. Reinforcement

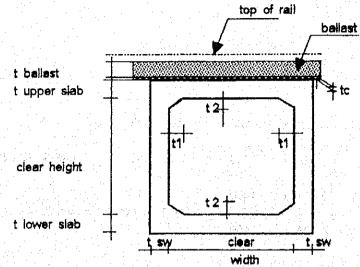
9

h	#	0.23	m							
ь	£	1.00	m	· · ·						
Ca	=	5.295					•			
δ	E	0.40								
ф [′]	Ξ	3.255			1997 - A.					
ζ	= '	0.92					n an th The state The states			
nw	=	0.04					- 11 - 1 		a series	en Nel George en
		0.04					14			
A	=		×	23 x	100	#	4.381	cm2		
		21				· · · ·			en de la composition de la composition Composition de la composition de la comp	
A min	=	0.0025	$\mathbf{X} = \{\mathbf{x}_i\}_{i=1}^{n}$	29 X	100		7.25	cm2	U\$¢	D 16 - 250
	• •		2.	611 x	1000	- 1 C				
τ	=						1.2973	kg / cm2	ok.	
		0.875	X	23 x	100	l 				

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4.5. BOX CULVERT

4.5.a. Sketch



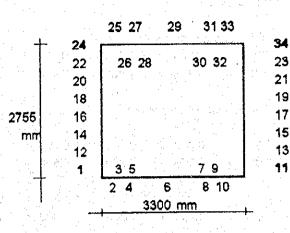
where is :		
t ballast =	500	mm
t soll =	0	mm
t plain conc. =	50	mm
t upper siab =	300	mm
t lower slab =	350	mm
clear height =	2430	mm
t side wail (t sw) =	300	mm
t side wall (t sw) =	300	mm
clear width =	3000	mm
tt t statistication and the statistication of the statistication	300	mm
t 2 =	300	mm

4.5.b. Unit	Weight of Mass				
	Track Weight		=	0.450	f/m
an dhugan	Ballast		 ■	2.000	tf/m3
	Filled Material		=	1.800	tf/m3
	Plain Concrete		=	2.200	f/m3
	Reinforced Con	erete	=	2.400	tf/m3

4.5.c. Reinforced Concrete Quality

Reinforcing Ber U - 39 (deform steel	Concrete	1. A. 19
	Reinforcing Ber	steel)

4.5.d, Schematization of Rigid Frame Diagram.



4.5.e Property of Members

٢

Member	Thickness [m]	Area	Inersia Moment [m4]	Young's Modulus [tf/m2]
				et gestaget
upper slab	0.300	0.300	0.00225	2.7 × 10%
lower sleb	0.350	0.350	0.00357	2.7 × 10%
side wall	0.300	0.300	0.00225	2.7 x 10%
side wall	0.300	0.300	0.00225	2.7 x 10*6

4.5.f. Loadings

1. Track Load.					
Track weight	= 0.450	1 2		= 0.225	tf/m
Ballast / Gravel	= 0,500	x 2.000		= 1.000	tf/m
			dр	= 1.225	tf/m
2 Dead Load.			n an the second seco		en e
a. Upper slab load					
- Lean concrete	= 0.050	x 2.200		= 0.110	tf/m
- Top slab	= 0,300	x 2.400)	= 0.720	tf/m
		يەر ئىلى يەر يې مەر بىر مۇرى	qdl	= 0.830	tf/m
b. Side Wall (q sw)	= 0,300	x 2,400)	• 0,720	tf/m

3. Earth and Water Pressure.

a. Soil data :

1. Fill Material at the back side of side wall

γ = 1.800 tf/m3

- K o = 0.500 (assumption)
 - K'o = 1.000 (Water)

b. Intensity of earth pressure

1.	Condition	100 %	of	earth pre	\$\$L	i re	an di baran Manadaran		e sa e tra e			
	Pe1:(1.225	÷	0.200	X		1.800)	x	0.500	H	0.793	tf/m
	P e2 =	0.793	÷	2.755	x	•	1.800	X	0.500	=	3.272	tf/m

2. Condition of earth and water pressure

Pe1=(1.225 +	0.200 x	0.800) x	0.500 =	0.693 tf/m
P #2 =	the second se			1	1.795 tf/m
Pw1 =				=	0.000 tf/m
Pw2 =	0.000 +	2.755 x	1.000 ×	1.000 =	2.755 tf/m
P (e+w) 1		0,693 +	0,000	*	0.693 tf/m
P (e+w) 2		1.795 +	2.755	=	4.550 tf/m

4. Train Load.

8.

impact	Coefficient				
-	= 0.100	22.50		= 0.522	; ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
		3.300	+ 50.00		

b. Uniform Load

	2 x	19.000				
qtr 📜 🏛					Se 🕈	4.948 tf/m
	2.400 x	3.200			н., н , н	이 가지 있는 것은 것을 알려요. 영상 같은 것은 것은 것은 것은 것은 것을 같이 없는 것을 같이 없는 것을 같이 없다.
				이 감독한 것 :		and a start of the
qtr+i =	4.948 x (1.000	+ 0,5	22)	=	7.531 tf/m

5, Earth Pressure due to Train Load.

Ph	=	Ko	X.	Pw		1		1414 - 1425 1
where is					1999 - 1999 -	С. 1.	$\{ f_{i} \}_{i \in I}$	
		1.1	- 1 - 1					
P N		Horizont		ressure	ane	το	Tain	DBOI

- Ko : Earth pressure coefficient
 - q : Distributed Train Load

8.75

q = _____= 2.188 t/m2

4.00

Petr = 0.500 x 2.188 x 1.00 = 1.094 tf/m

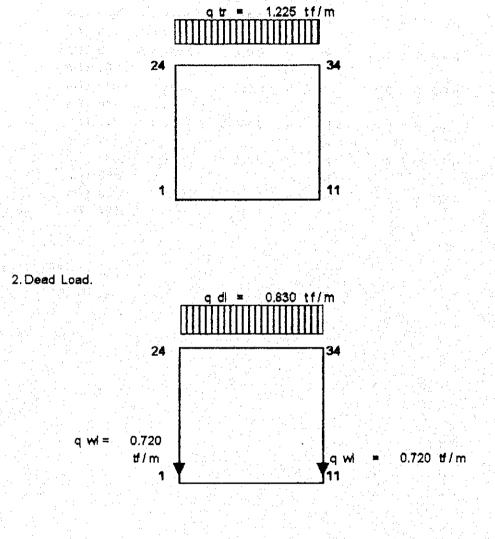
6. Spring Constanta

Coefficien Kv = Kh =	=		grade 2800 933	÷IJ	m3				
point	1	&	11	:	Ky	=	0.075 ×	2800 =	210 t/m
•					Kh				70 t/m
point	2	&	10	÷.	Kv	Z	0.088 x	2800 =	246 t/m
	. •		1.1		Kh			*	82 t/m
point	3	&	9 🖉	÷	Kv	=	0.150 x	2800 =	420 t/m
				. •	Kh			=	140 t/m
point	4	8,	8	:	Ky		0.150 x	2800 =	420 t/m
	•				Kh			=	140 t/m
point	5	&	8	:	Ky		0.600 x	2800 =	1680 t/m
				<u>.</u>	Kh				560 t/m
point	6			:	Ky	. =	1.175 x	2800 =	3290 t/m
					Kh			=	1097 t/m

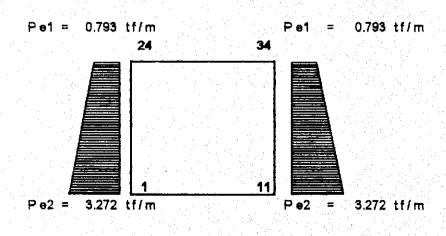
6

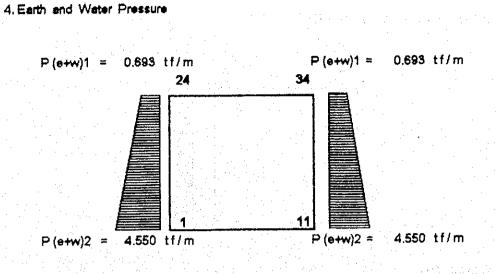
4.5... Load Model

1. Track Load.



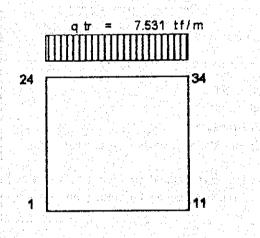




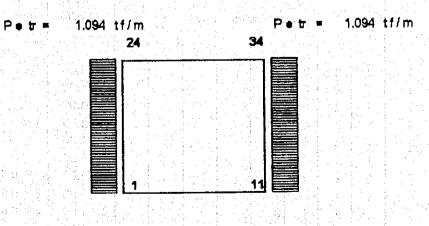


5. Train Load.

.

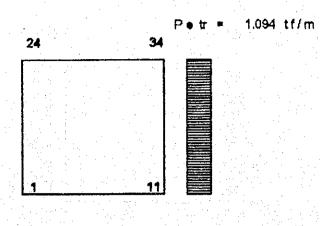


6. Earth Pressure caused by Train (both of side)



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7. Earth Pressure caused by Train (one side only)



4.5.f. Load Combination

1. Basic Case.

No.	Aplications	Note
1. 2. 3. 4. 5. 6. 7.	 Track Load. Dead Load. Earth Pressure Earth and Water Pressure Train Load. Earth Pressure caused by Train (both of side) Earth Pressure caused by Train (one side only) 	

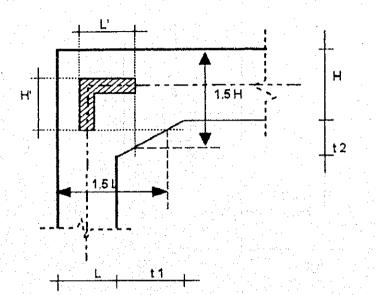
2. Load Combination,

No.		С	ombin	ation	Case		Lo a d Factor α	
1 2 3 4 5 6 7 8 9 10	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	3 3 3 4 4 4 4 4 5	77676776	5 5 5 5 5 5			1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	$\alpha = 0.50$ for earth pressure $\alpha = 0.50$ for earth pressure $\alpha = 0.50$ for earth pressure

0.50 for earth pressure

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4.5.g. Check point at edge of box culvert



1. Bending Moment at Panel Point.

The effect of haunches may be neglected on rigid frames analysis if it's satisfied conditions of below.

Length of rigidity zone is 1.5 times the depth of member because inclination of haunch (0) is 45 degrees Rigidity structure analyze from this point :

$$H' = ---+ (t_2 - ----)$$

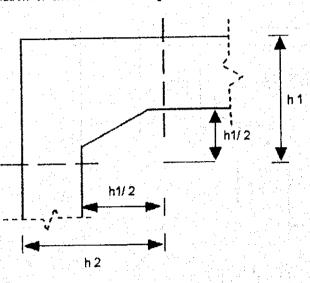
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Calculation of Shear Point,

2.

Examination of shear is at drawing below beacuse that member support directory.



Rigid Length Calculation

		Joint Co	nnection	
items	Top Slab and Wall		Bottom Slab and Wall	
H [m]	0.300		0.350	
L [m]	0.300		0.300	
t1 [m]	0.300		0.300	
t2 [m]	0.300		0.300	
L'[m]	0.300		0.275	
H'[m]	0.300		0.325	
L'/L	1.000		0.917	
H'/H	1.000		0,929	

18 1 A.	Members		Distan	ce from pol	nti	and the second
		xm1	X \$1	x m2	x 92	×3
		[m]	[m]	[m]	[m]	[m]
	upper sisb	0.150	0,150	0.450	0.450	1.650
•	lower slab	0.150	0.175	0.450	0.475	1.650
	side wall	0.150	0,150	0.450	0.450	1.378
	side wall	0.150	0.150	0.450	0.450	1.378

front rigid area

Members	energials report Distance from point i energials								
315	× 3	x e4	x m4	X 65	x m5				
an Angeler Angeler	[m]	[m]	[m]	[m]	[m]				
		an An ann an Airte		1	· ·				
upper slab	1.650	2.850	2.850	3,150	3,150				
lower slab	1,650	2.825	2,850	3.125	3.150				
side wall	1,378	2.280	2.280	2.605	2,580				
side wall	1.378	2,280	2.280	2,605	2,580				
		The second s							

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front rigid area

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4,5.h. Reinforcement Analysis

- Concrete K -	225	>	ellowable	CON
			aliowable	ten
- Steel Rebar			Eb	1000 1000 1000
0 U -	39	·>	allowable	com

compressive stress = 75 kg f /cm 2 tension stress = 7 kg f /cm 2 = 140000 kg f /cm 2

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allowable compressive / tension stress

Еa

2250 kg f /cm 2 2100000 kg f /cm 2

ITEMS	TOP SLAB			BOTTOM SLAB		SIDE WALL			
	Section 25		Section 29		مرم مر	Section 6		Section 18	
Internal Force	1		National States	ta tiko a				••••••••••••••••••••••••••••••••••••••	
M [tfm]	3.38	0.71	7.99	1.63	3.23	6.35	3,59	3.13	3.58
N [H]	3.69	2.92	0.77	3.95	3.04	3.82	17.69	16.59	16.09
Q[H]	14.60	11.73	0.22	15.59	11.77	5.32	4.37	1.54	3.85
Dimension					uter glass Arr	tetu sete			
b [m]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
h [m]	0.40	0,30	0.30	0.45	0.35	0.35	0.40	0.30	0,30
d [m]	0.33	0.23	0.23	0.38	0.28	0.28	0.33	0.23	0.23
(m) b	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Analysis	And a second			1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -					a particular
n	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
∠ 0′0	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
	a de para				e da area e de la comunicación A de la comunicación de la comunicación de la comunicación de la comunicación de				
e o1 [m]	0.92	0.24	10.38	0.41	1.06	2.19	0.20	0.19	0.22
e o 2 [m]	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
eo (m)	0.94	0.26	10.40	0.43	1.08	2.21	0.22	0.21	0.24
eo/h	2.34	0.88	34.68	0,96	3.09	8.30	D.56	0.70	0.80
$\boldsymbol{w}_{1} \in \boldsymbol{C} \subset [\boldsymbol{v}_{1}]_{\boldsymbol{v}_{1}}^{T}$	7.00	6.99	7.00	7.00	7.00	7.00	6.93	6.96	6.99
e1 [m]	0.02	0.03	0.03	0.02	0.02	0.02	0.01	0.02	0.02
e2 [m]	0.06	0.05	0.05	0.07	0.05	0.05	0.08	0.05	0.05
e [m]	1.02	0.33	10.47	0.52	1.16	2.28	0.30	0.27	0.30
ea (m)	1.15	0.41	10.55	0.67	1.26	2.38	0.43	0.35	0.39
N 98 [17 m]	4.23	1.21	0.12	2.65	3.84	9.11	7.54	5.83	6.19
Сз	5.255	6.851	2.642	7.634	4,680	3.036	3.934	3,119	3.029
delta 👘	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
0	3.167	4.283	1.500	4.714	2.774	1.740	2.333	1.817	1.740
0'	5,429	9.000	2.000	11.000	4.454	2.396	3,500	2.529	2.396
ksi	0.240	0,190	0.400	0.175	0.285	0.365	0.300	0.355	0,385
zeta	0.918	0.935	0.873	0.940	0.911	0.882	0.900	0.885	0.884
СЬ	2.778	3.172	2.000	3.319	2.621	2.136	2.430	2.178	2.027
TW .	0.041	0.023	0.170	0.019	0.053	0.130	0.073	0.116	0.140
Reinforcement		eret turne							
e de la companya de l	1.360	2.084	1.019	2.134	1.253	1.115	3,301	2.378	2.126
A [cm]	4.74	1.21	18.26	1.61	5. 64	15.54	3.48	5,34	7.21
A' [cm]	2.58	1.01	7.45	1.38	2.93	6.93	4.59	5.09	6.13
A min (cm2)	8.25	5.75	5.75	9.50	7.00	7.00	8.25	5.75	5.75
A [cm]	8.25	5.75	18.26	9.50	7.00	15.54	8.25	5.75	7.21
Reber diemeter	16	16	19	16	16	19	16	18	16
Distance [cm]	20	25	14	17	25	17	20	25	20
A [cm2]	4,49	4.79	7,45	0.11	3.51	6.93	10.89	5.47	6.13
Rebar diameter	16	16	15	18	16	16	16	18	16
Distance [cm]	33	33	20	20	33	25	17	25	25
Checking Shear							a an de gour d'a		e systèmet et s
Load Factor	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Tb [kgf/cm2]		6.99	0.13	5.63	5.76	2.81	1.82	0.92	2.30
Tb-Ta (kg f/cm2)	2.07	2.99		1.63	1.76				
Ts [kgf/cm2]	4.78	4.70		4.78	4.78	and the second sec			