

Justin J. Marks
T (202) 772-0916
F +12027720919
Email:jjmarks@ClarkHill.com

Clark Hill
1001 Pennsylvania Avenue N.W.
Suite 1300 South
Washington, DC 20004
T (202) 772-0909
F (202) 772-0919

October 30, 2024

Danielle Gosselin
Director, Office of Environmental Analysis
Surface Transportation Board
395 E Street SW
Washington, DC 20024

Re: Green Eagle Railroad, LLC
– Construction and Operation of a Line of Railroad – In Maverick County, TX
Surface Transportation Board Finance Docket 36652

GER Response to Information Request #2

Dear Ms. Gosselin:

Green Eagle Railroad (GER) is submitting this letter in response to OEA's Information Request No. 2 dated October 22, 2024, seeking information from GER as to noise barriers along the proposed rail line. GER utilized structural analysis to support its decision to exclude noise barriers on bridge structures along each side of its proposed rail line. The results of GER's analysis indicate that inclusion of sound barriers over the bridges would present significant challenges in meeting the required performance standards for the bridges. Please see the enclosed slide presentation and engineers report (Spanish Language) in support of these findings.

Placing noise barriers along bridge sections introduces additional structural challenges in anchoring and supporting the weight and wind forces associated with the noise barrier panels. To distribute the flexural stress and provide additional support to the noise barriers, it was determined that the two opposing noise barriers to either side of the proposed rail line would need to be connected at the top to provide the necessary stability. As a result, this need to stabilize the noise barrier panels requires increasing the height of the noise barriers from GER's typical design of 20 feet to 23 feet in order to comply with minimum over-rail clearance requirements established by the American Railway Engineering and Maintenance-of-Way Association (AREMA).

GER's analysis is supported by modeling using STAAD PRO utilizing load factors per AREMA and AASHTO (American Association of State Highway and Transportation Officials) standards including dead load, live load, impact load, centrifugal force, wind load, wind load on live load, longitudinal force, and AREMA's group loading combinations.

GER's structural analysis focused on the bridge over US Highway 277. GER anticipates similar findings for other bridge structures along the proposed rail line given the longer horizontal spans associated with the other bridge structures in connection with the Rio Grande crossing

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Page 2

inclusive of sections along the banks of Secco Creek and floodplains associated with both waterways.

GER's analysis concluded that the inclusion of noise barriers on the bridge structure would lead to structural instability when subjected to wind load conditions and thus does not satisfactorily meet performance requirements.

If you have any questions related to this letter, please let me know.

Sincerely,

A handwritten signature in blue ink, reading "Justin J. Marks". The signature is written in a cursive, flowing style.

Justin J. Marks
Counsel to Green Eagle Railroad, LLC

Enclosure



GER – 277 bridge preliminary structural analysis

1.0 BACKGROUND

As part of the development of the GER rail line to connect the FXE Rio Escondido railyard (Nava, Coahuila) with the UP Clark's Park railyard (Eagle Pass, Texas), an overpass is planned to be constructed over Highway 277.

The Surface Transportation Board (STB), through its Office of Environmental Analysis (OEA), has issued a directive to review the installation of sound barriers along the entire route of the proposed railway, including this overpass on Highway 277, to mitigate noise levels that may impact the surrounding environment.

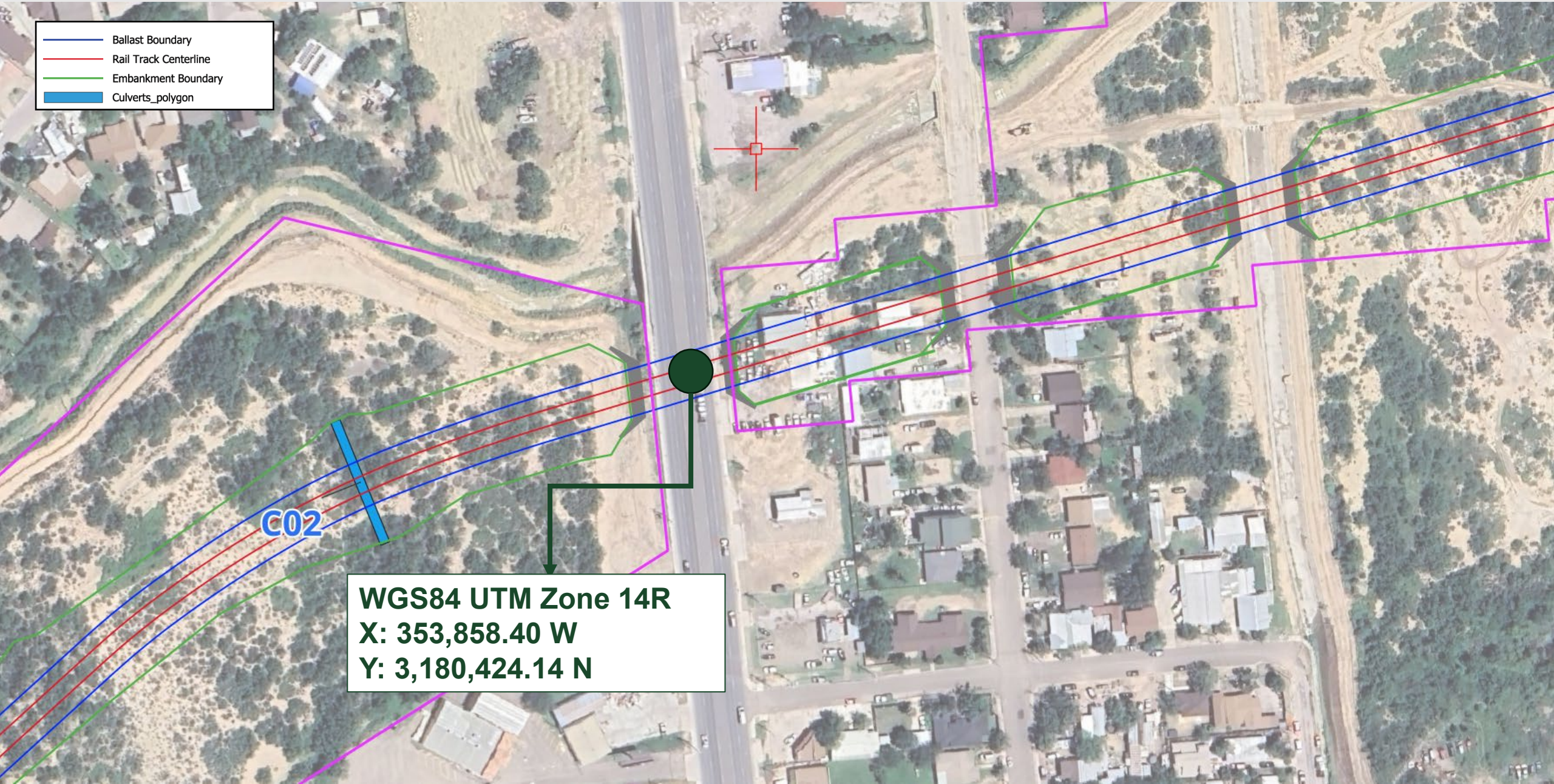
2.0 OBJECTIVE

The purpose of this preliminary structural review is to assess the potential impacts on the elevated crossing over Highway 277 resulting from the installation of acoustic barriers. These barriers must adhere to a minimum vertical clearance of 23ft as specified by the American Railway Engineering and Maintenance-of-Way Association (AREMA). This assessment aims to provide relevant information to support decision-making regarding the design and cost estimation for this railway project.

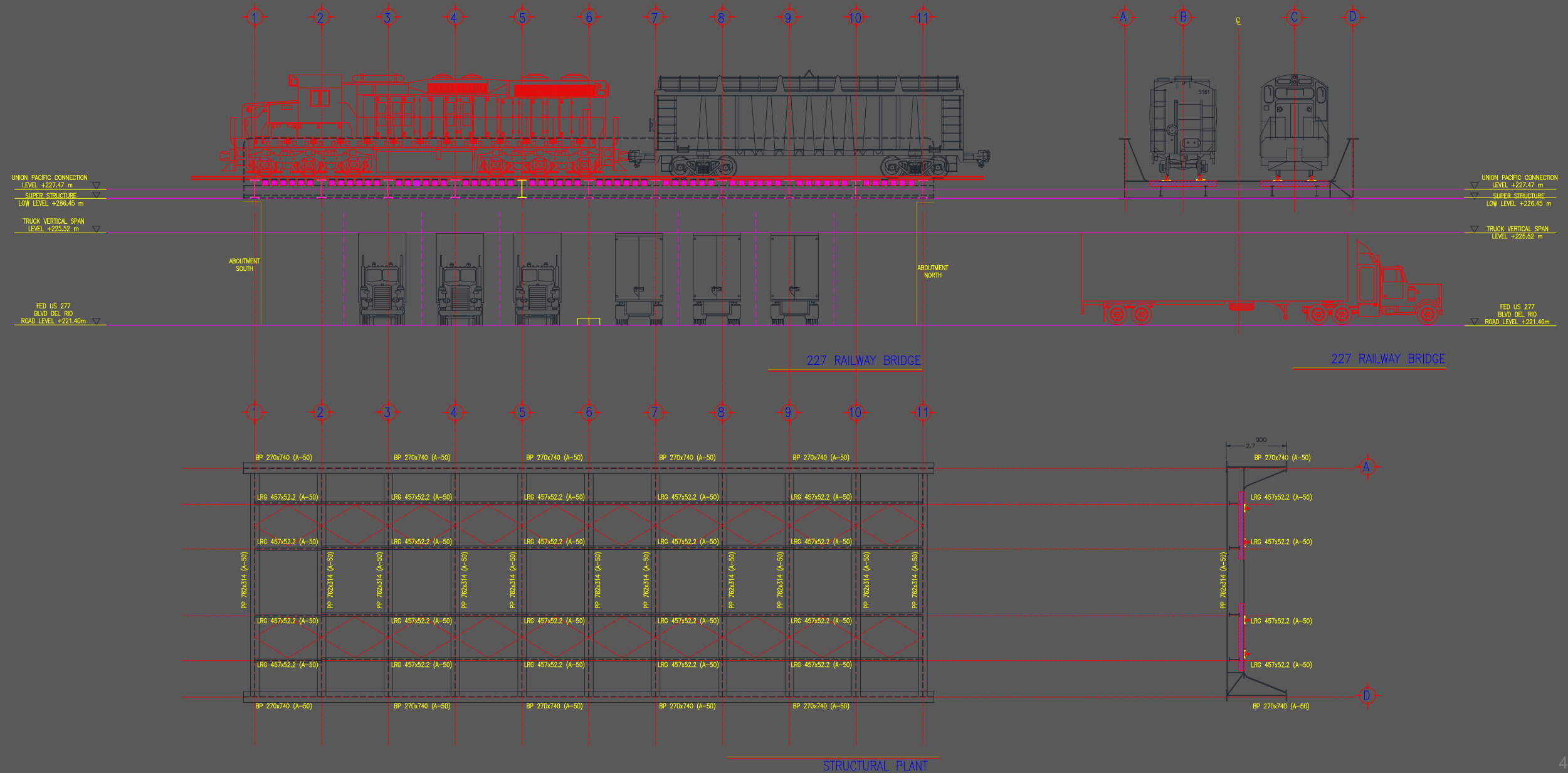
3.0 SCOPE

The scope of this report is to conduct a preliminary assessment of the impacts due to wind loads on the bridge once sound barriers are installed. This assessment will be performed in accordance with AREMA and AASHTO specifications and requirements.

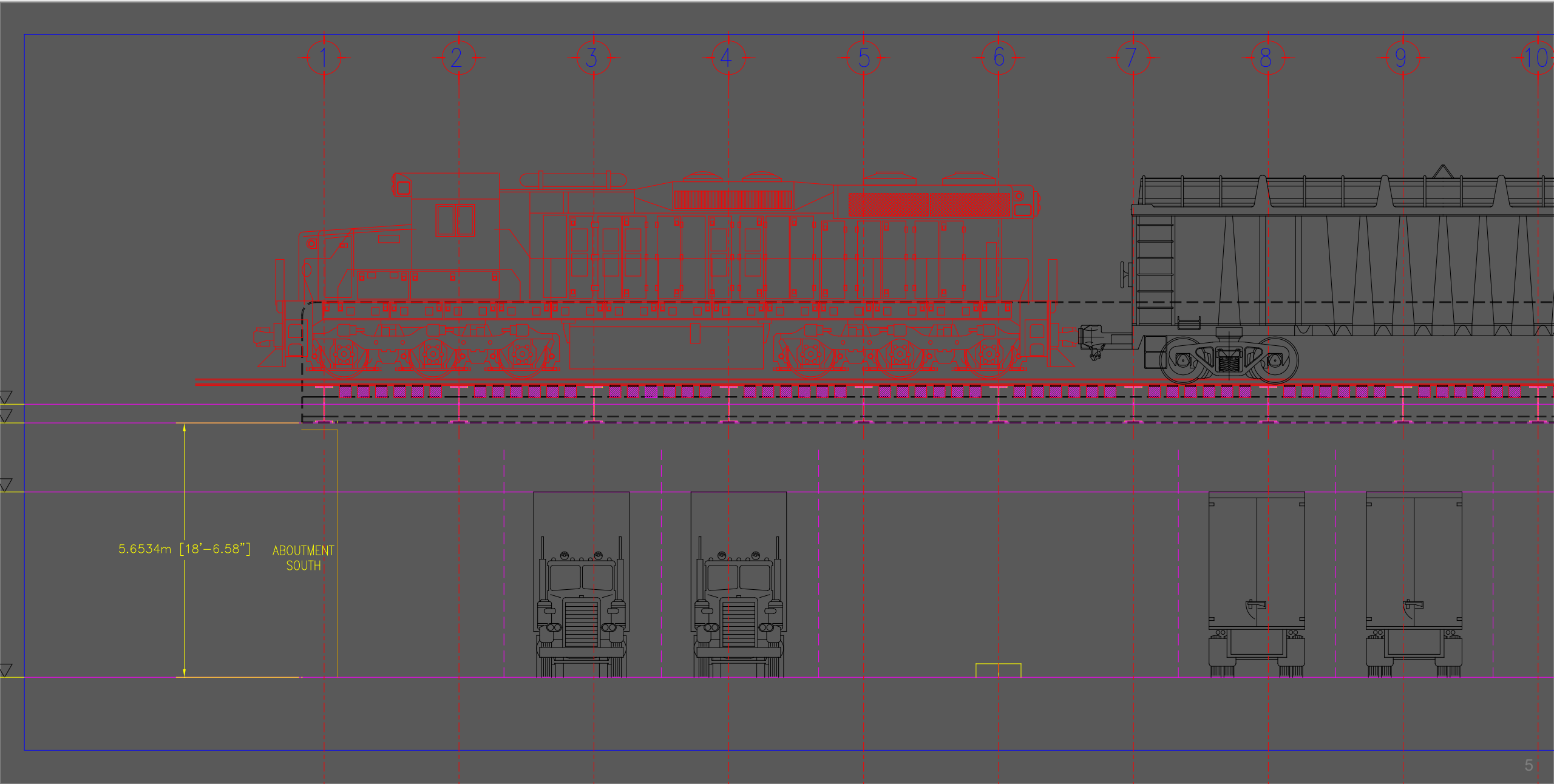
- Ballast Boundary
- Rail Track Centerline
- Embankment Boundary
- Culverts_polygon



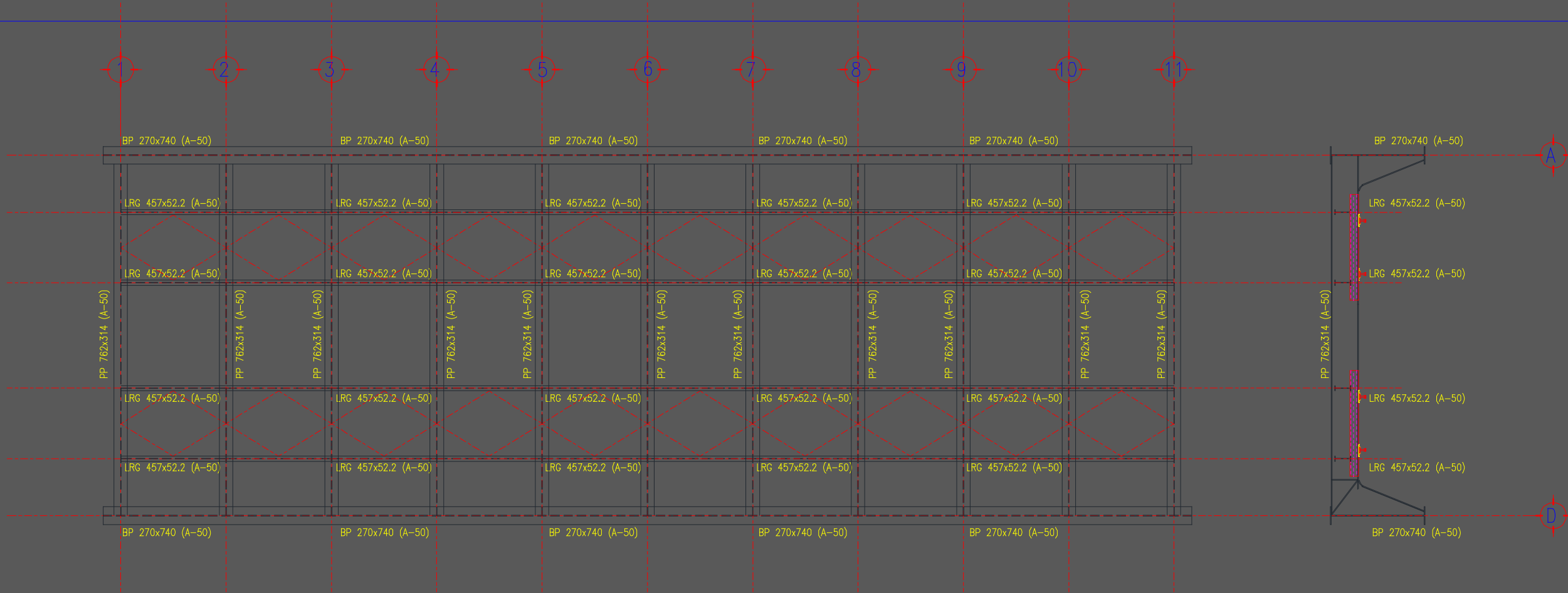
4.1 BRIDGE DESCRIPTION



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STRUCTURAL PLANT

5.0 ASSESSMENT DESCRIPTION

The engineering analysis conducted for this project consists of the following components:

- Development of a 3D model using STAAD PRO software and its analysis through the finite element method, applying self-weight, live loads, and wind loads.
- Preparation of technical documents supporting the objective outlined in section 2.0

6.0 SPECIFICATIONS AND STANDARDS

The technical standards considered for the development of this calculation are as follows:

• ACI-318	American Concrete Institute
• AREMA	American Railway Engineering And Maintenance Of Way Association, Volume 2 – Part 2, Reinforced Concrete Desing
• AASHTO	American Association of State Highway and Transportation Officials, Sound Barriers.

The model was developed using STAAD PRO, which allows for the creation of a spatial structural model.

This software enabled the generation of the bridge's geometry, and the application of loads based on AREMA and AASHTO standards, facilitating the preliminary structural analysis required for decision-making in the design process.

The following load types were considered in the model:

- **Dead Load:** This includes the weight of all permanent structural components of the bridge, such as the deck, beams, and piers.
- **Live Load:** Calculated based on AREMA specifications for railroad traffic on the bridge.
- **Wind Load:** Applied based on AREMA wind load standards, considering the additional effect of sound barriers on structural response.

This model aims to provide a comprehensive assessment of the bridge's behavior under anticipated loads, ensuring the design's integrity and compliance with relevant standards.

The loads considered on this assessment were:

- Dead Load
- Live Load
- Impact Load
- Centrifugal Force
- Wind Load
- Wind Load on Live Load
- Longitudinal Force
- AREMA's Group Loading Combinations

Although the self-weight of the structure is automatically calculated in the structural model using the SELFWEIGHT command, the dead loads recommended in the AREMA manual are considered as follows:

LOAD 1 CARGA MUERTA

SELFWEIGHT Y -1

```
* RIEL Y CONTRA RIEL 115 LB/YD
* 330 KG/M DE VIA ( 57.5 KG VIGA DUPLEX )
* DURMIENTE= ESO ESTIMADO DE DTE DE PUENTES 10 x 10 x 10 = 300 kg/ pza
* SON 3 PZA/M = 900 KG, ESTO EQUIVALE QUE CADA LARGUERO RECIBE
* 450 KG / M ( 225 KG VIGA DUPLEX)
*
*FIJACIONES*
* 6 PZAS DE 20 KG = 120 KG/M , CADA LARGERO RECIBE 60 KG/M (30 KG VIGA DUPLEX)
```

MEMBER LOAD

_VP1 UNI GY -3.125

_VP2 UNI GY -3.125

LOAD 1 CARGA MUERTA

```
*
*PESO ESTIMADO DE DTE DE PUENTES 10 x 10 x 10 = 300 kg/ pza
MEMBER LOAD
*RIEL Y CONTRA RIEL 115 LB/YD*
29 33 37 41 45 49 76 77 80 81 84 85 88 89 92 93 95 97 586 595 604 613 622 -
631 640 649 UNI GY -150
27 31 35 39 43 48 74 75 78 79 82 83 86 87 90 91 94 96 585 594 603 612 621 -
630 639 648 UNI GY -150
*
*DURMIENTE*
*PESO ESTIMADO DE DTE DE PUENTES 10 x 10 x 10 = 300 kg/ pza
*SON 3 PZA/M = 900 KG , ESTO EQUIVALE QUE CADA LARGUERO RECIBE
*450 KG / M
*FIJACIONES*
* 6 PZAS DE 20 KG = 120 KG/M , CADA LARGERO RECIBE 60 KG/M
27 31 35 39 43 48 74 75 78 79 82 83 86 87 90 91 94 96 585 594 603 612 621 -
630 639 648 UNI GY -450
29 33 37 41 45 49 76 77 80 81 84 85 88 89 92 93 95 97 586 595 604 613 622 -
631 640 649 UNI GY -450
*
```

SELFWEIGHT Y -1

7.2 LIVE LOAD

The Cooper E-80 load, as specified in Volume II of the AREMA manual, is used. An alternative load is selected because the bridge length (35.4 feet) does not exceed the actual axle spacing of the load unit or locomotive (55.8 to 137.8 feet).

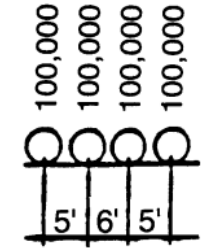


Figure 15-1-3. Alternate Live Load on 4 Axles

7.3 IMPACT LOAD

According to the AREMA manual, the impact load is calculated as a percentage of the live load, which depends on the span length of the bridge.

Impact load due to vertical effects, expressed as a percentage of live load applied at each rail, *shall be determined by the applicable formula below:*

(1) Percentage of live load for rolling equipment without hammer blow (*freight and passenger cars, and locomotives other than steam*):

(a) For L less than 80 feet:

$$40 - (3L^2 / 1600)$$

or

$$40 - \frac{3L^2}{1600}$$

```
*POSICION 1
LOAD 2 CARGA VIVA
*CARGA COOPER ALTERNATIVA 4 EJES DE 100 000 # = 45,300 KG/ EJE
*CARGA DE IMPACTO = 40- 3L^2/1600 = 40-(3*15^2)/1600= 39.57%
*CARGA TOTAL POR EJE= 63,225.21
*CARGA POR VIGA = 15,806.3025
JOINT LOAD
_P1 FY -158.063
```

```
**POSICION 2
LOAD 3 CARGA VIVA
*CARGA COOPER ALTERNATIVA 4 EJES DE 100 000 # = 45,300 KG/ EJE
*CARGA DE IMPACTO = 40- 3L^2/1600 = 40-(3*15^2)/1600= 39.57%
*CARGA TOTAL POR EJE= 63,225.21
*CARGA POR VIGA = 15,806.3025
JOINT LOAD
_P1 FY -158.063
_P2 FY -158.063
```

```
*POSICION 3
LOAD 4 CARGA VIVA
*CARGA COOPER ALTERNATIVA 4 EJES DE 100 000 # = 45,300 KG/ EJE
*CARGA DE IMPACTO = 40- 3L^2/1600 = 40-(3*15^2)/1600= 39.57%
*CARGA TOTAL POR EJE= 63,225.21
*CARGA POR VIGA = 15,806.3025
JOINT LOAD
_P1 FY -158.063
_P2 FY -158.063
_P3 FY -158.063
```

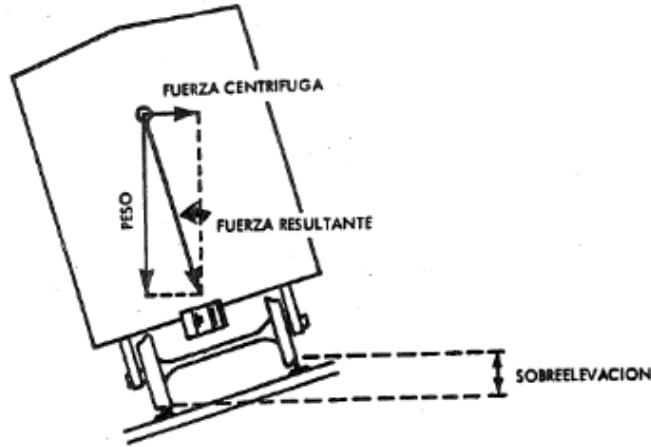
```
*POSICION 4
LOAD 5 CARGA VIVA
*CARGA COOPER ALTERNATIVA 4 EJES DE 100 000 # = 45,300 KG/ EJE
*CARGA DE IMPACTO = 40- 3L^2/1600 = 40-(3*15^2)/1600= 39.57%
*CARGA TOTAL POR EJE= 63,225.21
*CARGA POR VIGA = 15,806.3025
JOINT LOAD
_P1 FY -158.063
_P2 FY -158.063
_P3 FY -158.063
_P4 FY -158.063
```

```
**POSICION 5
LOAD 6 CARGA VIVA
JOINT LOAD
_P2 FY -158.063
_P3 FY -158.063
_P4 FY -158.063
_P5 FY -158.063
```

```
*POSICION 6
LOAD 7 CARGA VIVA
JOINT LOAD
_P3 FY -158.063
_P4 FY -158.063
_P5 FY -158.063
_P6 FY -158.063
```

```
*POSICION 7
LOAD 8 CARGA VIVA
*CARGA COOPER ALTERNATIVA 4 EJES DE 100 000 # = 45,300 KG/ EJE
*CARGA DE IMPACTO = 40- 3L^2/1600 = 40-(3*15^2)/1600= 39.57%
*CARGA TOTAL POR EJE= 63,225.21
*CARGA POR VIGA = 15,806.3025
JOINT LOAD
_P4 FY -158.063
_P5 FY -158.063
_P6 FY -158.063
_P7 FY -158.063
```

The determination of the centrifugal force CCC, expressed as a percentage of the live load, is given by the following expression taken from Table 7-2-2 in the AREMA manual (Imperial system):



D = Degree of curve.

E = Superelevation in inches.

S = Permissible speed in miles per hour.

C = Centrifugal force in percentage of live load.

$$C = .00117 S^2 D = 1.755 (E+3)$$

$$E = \frac{2}{3} \frac{S^2 D}{1000} - 3 = \frac{C - 5.265}{1.755}$$

$$S^2 = \frac{1500}{D} (E + 3)$$

Along with the bridge's location data from the track chart of Line, the following information is obtained:

Grado de Curvatura D: 0.0°
Sobreelevación E: 0"

S	E	D	C
MPH	"	°	% LL
-	0.0	0.0	0.00

LOAD 4 FUERZA CENTRIFUGA (CF)

* FUERZA CENTRIFUGA APLICADA A CADA CARGA POR EJE A TRAVÉS DE UN PUNTO 8 PIES (2.45 M),
 * 2.85 M ARRIBA DEL LARGUERO DEL PUENTE DEBIDO A LOS 25 CM DEL DTE Y PLACA DE ASIENTO Y 15 CM DEL
 RIEL
 * POR ENCIMA DE LA PARTE SUPERIOR DEL RIEL MEDIDO A LO LARGO DE UNA LÍNEA PERPENDICULAR
 * A LA LÍNEA QUE UNE EL LA PARTE SUPERIOR DE LOS RIELES Y EQUIDISTANTE DE ELLOS.
 * ESTA FUERZA SERA EL PORCENTAJE DE LA CARGA VIVA CALCULADA DE LAS FORMULAS SIGUIENTES.
 $E = 0.0068 S^2 D^{-0.75}$; $C = 0.000452 S^2 D^{-0.75}$; $S = (E + 75 / 0.0068 D)^{0.5}$;
 * EL GRADO DE CURVATURA OBSERVADO SEGUN CARTA DE VIA ES DE 0.0
 * A LA CUAL CORRESPONDE UNA FUERZA CENTRIFUGA DE 11.39 %
 * *EL MOMENTO DEBIDO A LA FUERZA CENTRIFUGA SER?:
 $11.39 * 30351 * (2.45 + .40) / 5.68 = 1734.57$
 *
 * DE ACUERO A CARTA DE VIA EL PUENTE ESTA LOCALIZADO EN TANGENTE, POR LO QUE
 * EL VALOR ES CERO.
 *

MEMBER LOAD

_VPI UNI GY 0.01
 _VP2 UNI GY -0.01

h. Wind Load on Structure.

The base wind load acting on the structure is assumed to be 45 lb per square foot (2160 Pa) on the vertical projection of the structure applied at the center of gravity of the vertical projection in any horizontal direction. A base wind velocity of 100 miles per hour (160 km/h) was used to determine the base wind load. If an increase in the design wind velocity is made, the design wind velocity and design wind load shall be shown on the plans.

For Group II and Group V loadings, when a design wind velocity greater than 100 miles per hour (160 km/h) is advisable, the base wind load may be increased by the ratio of the square of the design wind velocity to the square of the base wind velocity. This increase shall not apply to Group III and Group VI Loadings.

LOAD 13 CARGA POR VIENTO EN ESTRUCTURA (W)

* DE ACUERDO AREMA SE DEBE ADOPTAR UNA PRESION SOBRE LA ESTRUCTURA DE 2160 Pa (216 Kg/m²)

* PARA CFE VIENTO SE INDICAN PRESIONES

* BARLOVENTO= 78.73 Kg/m²

* SOTAVENTO= 19.68 kg/m²

* LATERALES= 51.17 kg/m²

* CUBIERTA = 55.11 kg/m²

* SE ADOPTA AREMA POR CONDICION MAS CRITICA

*LA SUPERFICIE DE CONTACTO ES DE .80 M² POR LO QUE LA CARGA A LO LARGO DE LA CARA DE CONTACTO SERA DE

* 216 X 2.10 = 453 KG/M

MEMBER LOAD

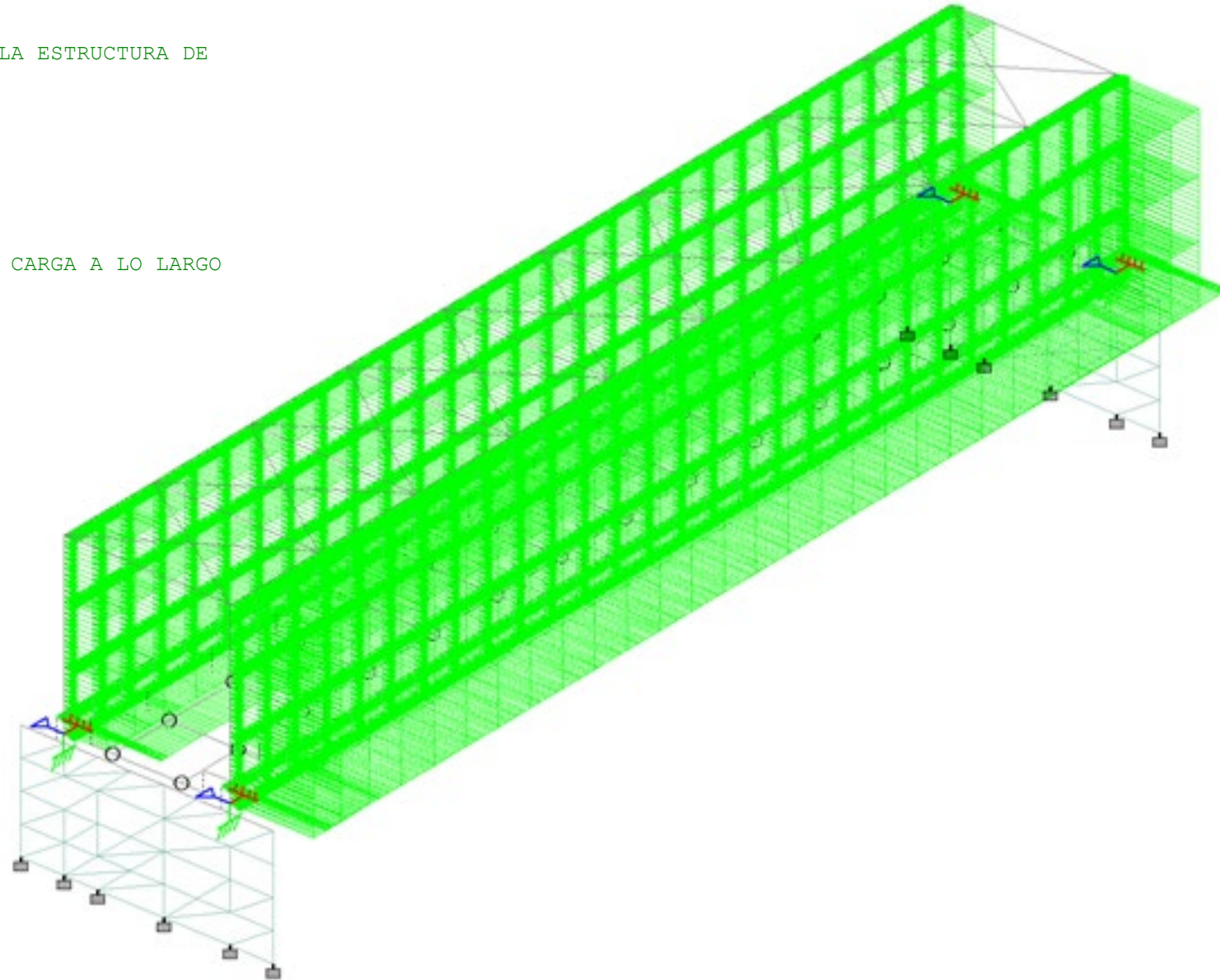
_V1L UNI GZ -453.6

_V1R UNI GZ -453.6

ELEMENT LOAD

_BSN PR 215

_BSS PR 110



i. Wind Load on Live Load.

A wind load of 300 lb per linear foot (4.4 kN/m) on the train shall be applied 8 feet (2450 mm) above the top of rail in a horizontal direction perpendicular to the centerline of the track.

```
LOAD 11 VIENTO SOBRE CARGA VIVA (WL)
* DE ACUERDO AREMA SE APLICA CARGA DE 4.4 KN/m (440 Kg/m) A LO LARGO DEL CENTRO DE LA CUBIERTA
* Y SE APLICA EL MOMENTO GENERADO POR DICHA CARGA POR EL BRAZO DE PALANCA DE 2.4 M POR ARRIBA DEL RIEL (0.40 M ARRIBA DE LA ESTRUCTURA)
*ENTRE EL ANCHO DE LA CUBIERTA (1.50 m)
*M= 440*(2.45 + 0.40)/1.50= 836 Kg-m (418 kg-m POR VIGA DUPLEX)
MEMBER LOAD
_VP1 UNI GY -4.18
_VP2 UNI GY 4.18
```

According to the AREMA manual, the braking force applied at 8 feet (2.45 m) from the rail head is as follows:

Longitudinal braking force (kips): $45 + 1.2L$
 (Longitudinal braking force in kN): $200 + 17.5L$

Longitudinal traction force (kips): $25\sqrt{L}$
 (Longitudinal traction force in kN): $200\sqrt{L}$

LOAD 12 CARGA LONGITUDINAL (LF)

* DE ACUERDO CON AREMA:

* FUERZA DE FRENADO= $200 + 17.5 L = 200 + (17.5 \times 15.0) = 462.5 \text{ KN} = 46,250.00 \text{ kg}$

* FUERZA DE ARRANQUE= $200 \times L^{0.5} = 200 (15.0)^{0.5} = 774.69 \text{ KN} = 77,469.00 \text{ kg}$ <----- (SE ADOPTA ESTE PARA DISEÑO)

* LA FUERZA LONGITUDINAL EFECTIVA SE DISTRIBUIRA ENTRE LOS DIVERSOS COMPONENTES DEL SOPORTE.

* ESTRUCTURA, TENIENDO EN CUENTA SU RIGIDEZ RELATIVA.

* EL 98% ABSORBIDO POR LA ESTRUCTURA GENERA UN MOMENTO CON BRAZO DE PALANCA DE 0.9 M (3FT) REPARTIDO EN LA CUBIERTA

* $77,469.00 \text{ Kg} \times 0.98 \times 0.9 \text{ m} / 15.00 \text{ m} = 4,454.62 \text{ kg} (1,113.65 \text{ Kg})$

*

JOINT LOAD

_1S FY -11.13

_2S FY -11.13

_3S FY -11.13

_4S FY -11.13

_1N FY 11.13

_2N FY 11.13

_3N FY 11.13

_4N FY 11.13

The load factor combinations recommended by AREMA are as follows:

Table 8-2-4. Group Loading Combinations – Service Load Design

Group	Item	Allowable Percentage of Basic Unit Stress
I	$D + L + I + CF + E + B + SF$	100
II	$D + E + B + SF + W$	125
III	$\text{Group I} + 0.5W + WL + LF + F$	125
IV	$\text{Group I} + OF$	125
V	$\text{Group II} + OF$	140
VI	$\text{Group III} + OF$	140
VII	$\text{Group I} + ICE$	140
VIII	$\text{Group II} + ICE$	150

LOAD COMB 19 $D+L+I+CF+E+B+SF$ (GRUPO I)
 1 1.4 3 1.4 9 1.4 10 1.4 11 1.4 12 1.4

LOAD COMB 20 $D+E+B+SF+W$ (GRUPO II)
 1 1.5 3 1.5 11 1.5 12 1.5 13 1.5

LOAD COMB 21 $D+L+I+CF+E+B+SF+0.5W+WL+LF+F$
 1 1.5 3 1.5 9 1.5 10 1.5 11 1.5 12 1.5 13 0.75 14 1.5

AutoRecovery On 277b.STD - STAAD.Pro CONNECT Edition

File View Select Results Utilities

Label Settings Zoom Window Whole Structure Display Whole Structure Tools Views Options Windows 3D Rendering

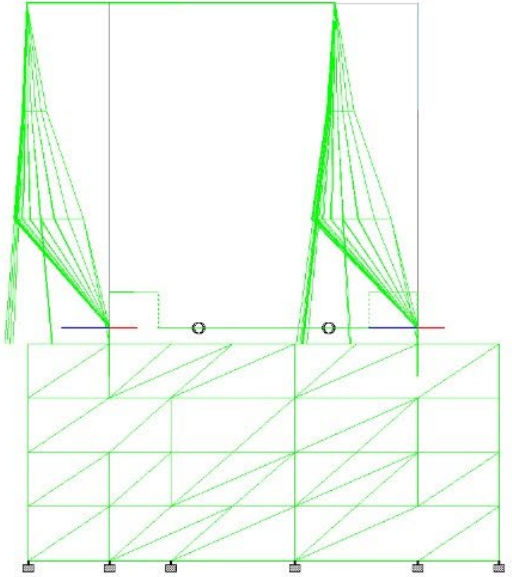
Workflow

- Analytical Modeling
- Physical Modeling
- Building Planner
- Piping
- Bridge Deck
- Postprocessing
- Foundation Design
- Steel AutoDrafter
- Chinese Steel Design
- Connection Design
- Advanced Concrete Design
- Advanced Slab Design
- Earthquake

Postprocessing: Displacements Reactions Beam Results Plate Results Solid Results Dynamics Reports

277b.STD - Whole Structure

FRONT VIEW



Y
X-Z

Load 13 : Displacement

277b.STD - Node Displacements:

			Horizontal X	Vertical Y	Horizontal Z	Resultant	Rotational		
			mm	mm	mm	mm	rX rad	rY rad	rZ rad
Max X	392	21 (1.4)D +	12.476	1.917	-19243.149	19243.153	-0.074	0.012	
Min X	394	21 (1.4)D +	-12.307	1.913	-19243.595	19243.599	-0.074	-0.012	
Max Y	431	13 CARGA P	0.811	10.200	-13781.713	13781.716	0.004	-0.001	-4
Min Y	389	20 (1.8)D + L	0.701	-55.614	0.712	55.623	0.004	0.000	-4
Max Z	576	26 1.0DL+1.0	0.784	-21.657	336.806	337.502	0.015	0.002	
Min Z	576	21 (1.4)D +	2.482	-31.675	-28261.208	28261.227	1.752	0.242	
Max rX	544	21 (1.4)D +	-0.525	-31.673	-24232.719	24232.738	1.762	0.242	
Min rX	516	21 (1.4)D +	1.449	0.657	-6074.348	6074.348	-4.316	3.434	-4
Max rY	516	21 (1.4)D +	1.449	0.657	-6074.348	6074.348	-4.316	3.434	-4
Min rY	518	21 (1.4)D +	-1.384	0.654	-6068.295	6068.295	-4.314	-3.486	-4
Max rZ	45	21 (1.4)D +	6.553	-5.496	-29.717	30.923	0.002	-0.007	-4
Min rZ	41	21 (1.4)D +	-6.538	-5.565	-29.714	30.930	0.002	0.007	-4
Max Rst	576	21 (1.4)D +	2.482	-31.675	-28261.208	28261.227	1.752	0.242	

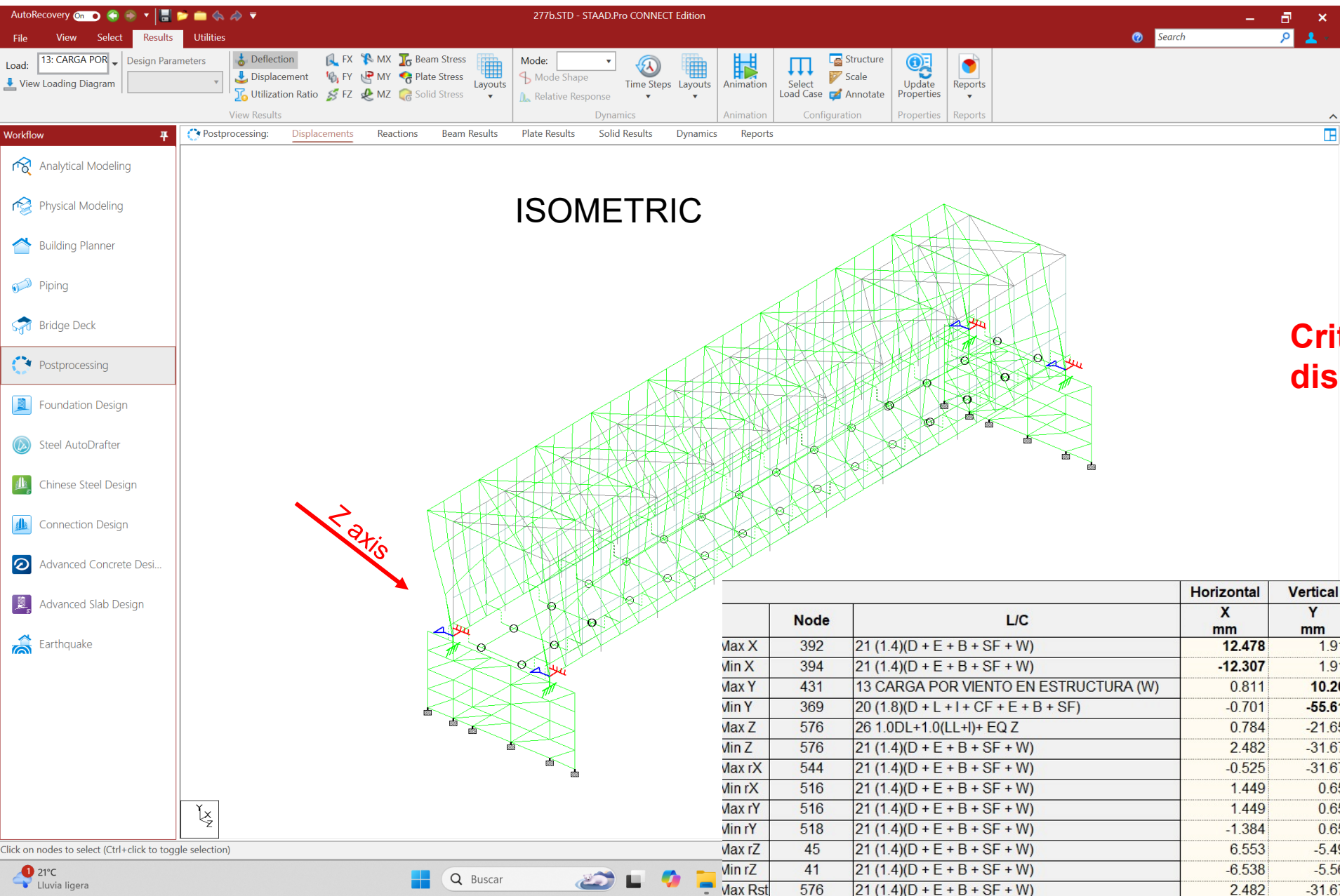
277b.STD - Beam Relative Displacement Detail: Whole Structure

All Relative Displacement / Max Relative Displacements /						
Beam	L/C	Dist cm	x mm	y mm	z mm	Resultant mm
2	1 CARGA MU	0.000	0.000	0.000	0.000	0.000
		22.500	-0.000	-0.000	0.002	0.002
		45.000	-0.000	-0.000	0.002	0.002
		67.500	-0.000	-0.000	0.001	0.001
		90.000	0.000	0.000	0.000	0.000
2	CARGA VI	0.000	0.000	0.000	0.000	0.000
		22.500	-0.000	-0.000	-0.000	0.000
		45.000	-0.000	0.000	-0.000	0.000
		67.500	-0.000	0.000	0.000	0.000
		90.000	0.000	0.000	0.000	0.000
3	CARGA VI	0.000	0.000	0.000	0.000	0.000
		22.500	0.000	-0.000	-0.000	0.000
		45.000	0.000	-0.000	-0.000	0.000
		67.500	0.000	-0.000	-0.000	0.000
		90.000	0.000	0.000	0.000	0.000
4	CARGA VI	0.000	0.000	0.000	0.000	0.000
		22.500	0.000	0.000	-0.001	0.001
		45.000	-0.000	0.000	-0.001	0.001
		67.500	-0.000	0.000	-0.000	0.000
		90.000	0.000	0.000	0.000	0.000
5	CARGA VI	0.000	0.000	0.000	0.000	0.000
		22.500	-0.000	0.000	0.010	0.010
		45.000	-0.000	0.000	0.013	0.013

Click on nodes to select (Ctrl+click to toggle selection)

Postprocessing Workflow | Load : 13: CARGA POR VIENTO EN ESTRUCTU | Input Units : kg-cm

05:57 p.m. 25/10/2024



Critical Resultant displacement of > 91 ft

Based on the graphs and matrix presented above, it is concluded that under the current design, **THE IMPLEMENTATION OF SOUND BARRIERS WITH A MINIMUM VERTICAL CLEARANCE PERMITTED BY AREMA (23 ft) WOULD LEAD TO STRUCTURAL INSTABILITY WHEN SUBJECTED TO WIND LOAD CONDITIONS**, and thus does not satisfactorily meet the performance requirements.

The addition of noise barriers presents significant challenges in meeting the required performance standards for the bridge. The primary concern is the added weight, and the wind loads imposed by the noise barriers, which would place considerable stress on the structural components. This increased load could compromise the bridge's stability and would make the engineering design particularly complex, potentially leading to higher construction and maintenance costs.

Furthermore, additional reinforcement may be required to accommodate these loads, which could involve modifying the bridge's foundational and support structures. Such modifications would not only increase the project's financial and logistical demands but could also affect the timeline and feasibility of implementation.

Evaluación preliminar del Desempeño Estructural
del Puente Ferroviario
US 277

Eagle Pass, Tx

CONTENIDO

<u>1.0 ANTECEDENTES.....</u>	<u>3</u>
<u>2.0 OBJETIVO.....</u>	<u>3</u>
<u>3.0 ALCANCE.</u>	<u>3</u>
<u>4.0 LOCALIZACIÓN.</u>	<u>3</u>
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1.0 ANTECEDENTES.

Como parte del desarrollo de la línea ferroviaria Piedras negras MX al patio ferroviario de Clark's Parkse ha desarrollado un paso superior ferroviario sobre la carretera federal 277 , ha sido indicación de la superioridad la revisión de la instalación de barreras de sonido sobre este con la finalidad de disminuir los niveles que el paso ferroviario pudiera emanar al ambiente.

2.0 OBJETIVO.

El objetivo de la presente **REVISIÓN ESTRUCTURAL** es dimensionar las afectaciones que se presentarían en sobre el paso superior ferroviario de la carretera federal 277 por la instalación de barreras de sonido no menores al galibo vertical indicado por la American Railway Engineering Maintenance Asociation, AREMA.

3.0 ALCANCE.

El presente dictamen tiene como alcance único y exclusivamente el revisar **LAS AFECTACIONES POR EMPUJE DE VIENTO** una vez instaladas las barreras de sonido conforme las indica la AASTHO.

4.0 LOCALIZACIÓN.

Las coordenadas Geodésicas del puente son:

14R
Latitud 353858.40 E
Longitud 3180424.14 N

5.0 DESCRIPCIÓN DEL DICTAMEN

La ingeniería a realizada para este trabajo consta de las siguientes partes:

- Desarrollo de un **modelo 3D a través del software STAAD PRO** y su análisis por el método de elementos finitos, aplicando las cargas por peso propio, cargas vivas, y viento.
- Elaboración de documentos técnicos donde se respalda el objetivo ya mencionado en el inciso 2.0

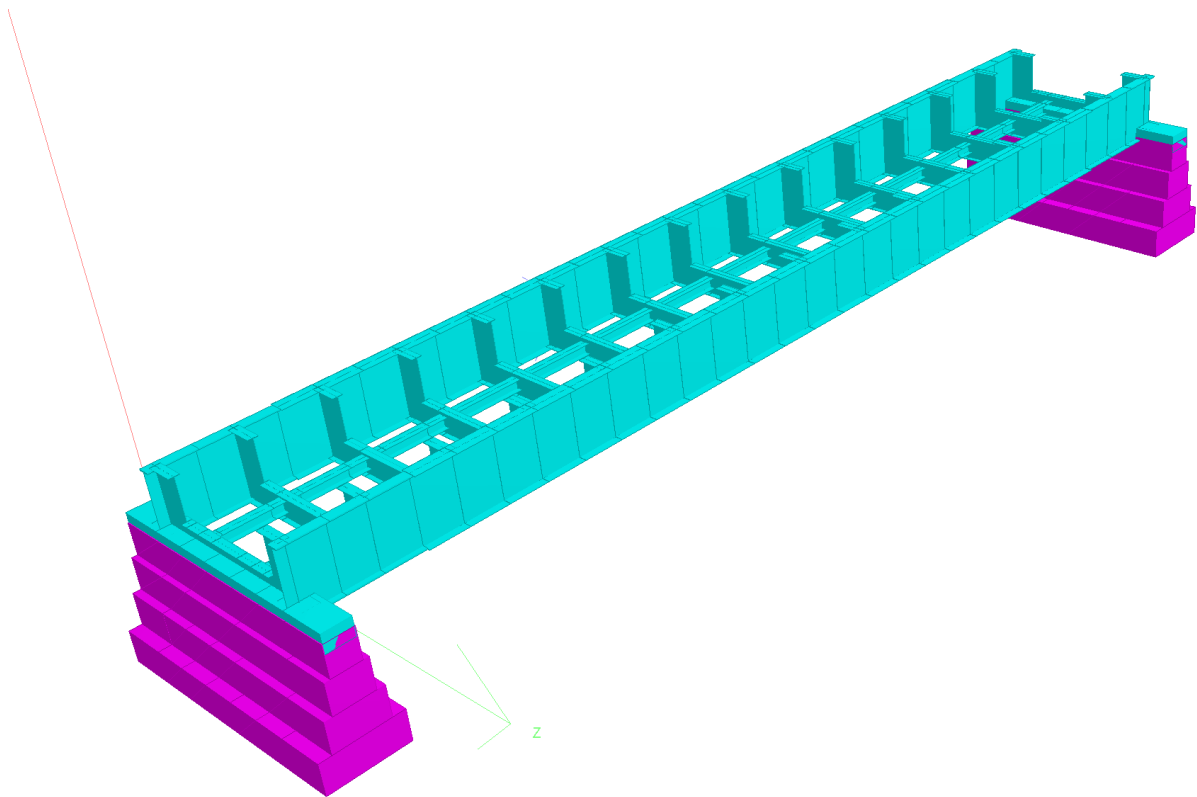
6.0 ESPECIFICACIONES Y NORMAS.

Las normas técnicas que son consideradas para el desarrollo del presente cálculo son las siguientes:

7.0 ANÁLISIS DE CARGAS.

• ACI-318	American Concrete Institute (Reglamento para las Construcciones de Concreto Estructural)
• AREMA	American Railway Engineering And Maintenance Of Way Association, Tomo 2 – Parte 2, Reinforced Concrete Desing
• AASHTO	American Association of State Highway and Transportation Officials, Sound Barriers.

A continuación, se enlistan las cargas consideradas en el presente análisis



7. 1 CARGA PERMANENTE

Si bien el peso propio de la estructura se determina en el modelo estructural automáticamente a través del comando SELFWEIGHT, las cargas recomendadas en el manual AREMA consideradas como peso muerto son:

```
LOAD 1 CARGA MUERTA
*
SELFWEIGHT Y -1
*
* RIEL Y CONTRA RIEL 115 LB/YD
* 330 KG/M DE VIA ( 57.5 KG VIGA DUPLEX )
* DURMIENTE= ESO ESTIMADO DE DTE DE PUENTES 10 x 10 x 10 = 300 kg/ pza
* SON 3 PZA/M = 900 KG, ESTO EQUIVALE QUE CADA LARGUERO RECIBE
* 450 KG / M ( 225 KG VIGA DUPLEX)
*
*FIJACIONES*
* 6 PZAS DE 20 KG = 120 KG/M , CADA LARGERO RECIBE 60 KG/M (30 KG VIGA DUPLEX)
MEMBER LOAD
_VP1 UNI GY -3.125
_VP2 UNI GY -3.125

LOAD 1 CARGA MUERTA
*
*PESO ESTIMADO DE DTE DE PUENTES 10 x 10 x 10 = 300 kg/ pza
MEMBER LOAD
*RIEL Y CONTRA RIEL 115 LB/YD*
29 33 37 41 45 49 76 77 80 81 84 85 88 89 92 93 95 97 586 595 604 613 622 -
631 640 649 UNI GY -150
27 31 35 39 43 48 74 75 78 79 82 83 86 87 90 91 94 96 585 594 603 612 621 -
630 639 648 UNI GY -150
*
*DURMIENTE*
*PESO ESTIMADO DE DTE DE PUENTES 10 x 10 x 10 = 300 kg/ pza
*SON 3 PZA/M = 900 KG , ESTO EQUIVALE QUE CADA LARGUERO RECIBE
*450 KG / M
*FIJACIONES*
* 6 PZAS DE 20 KG = 120 KG/M , CADA LARGERO RECIBE 60 KG/M
27 31 35 39 43 48 74 75 78 79 82 83 86 87 90 91 94 96 585 594 603 612 621 -
630 639 648 UNI GY -450
29 33 37 41 45 49 76 77 80 81 84 85 88 89 92 93 95 97 586 595 604 613 622 -
631 640 649 UNI GY -450
*
SELFWEIGHT Y -1
```

7.2 CARGA MÓVIL

La carga Cooper E-80 expresada en el tomo II del manual AREMA. Se opta por la carga alternativa debido a que la longitud del puente (10.8) no excede la distancia real entre ejes de unidad de carga o locomotora (17.0 a 42 m)

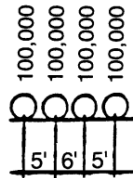


Figure 15-1-3. Alternate Live Load on 4 Axles

7.3 CARGA DE IMPACTO

De acuerdo al manual AREMA. la carga por impacto se toma como un porcentaje de la carga viva que está en función de la longitud del claro del puente.

- c. Impact load due to vertical effects, expressed as a percentage of live load applied at each rail, shall be determined by the applicable formula below:
- (1) Percentage of live load for rolling equipment without hammer blow (freight and passenger cars, and locomotives other than steam):

(a) For L less than 80 feet: $40 - \frac{3L^2}{1600}$.

```
*POSICION 1
LOAD 2 CARGA VIVA
*CARGA COOPER ALTERNATIVA 4 EJES DE 100 000 #= 45,300 KG/ EJE
*CARGA DE IMPACTO = 40- 3L^2/1600 = 40-(3*15^2)/1600= 39.57%
*CARGA TOTAL POR EJE= 63,225.21
*CARGA POR VIGA = 15,806.3025
JOINT LOAD
_P1 FY -158.063
```

```
**POSICION 2
LOAD 3 CARGA VIVA
*CARGA COOPER ALTERNATIVA 4 EJES DE 100 000 #= 45,300 KG/ EJE
*CARGA DE IMPACTO = 40- 3L^2/1600 = 40-(3*15^2)/1600= 39.57%
*CARGA TOTAL POR EJE= 63,225.21
*CARGA POR VIGA = 15,806.3025
JOINT LOAD
_P1 FY -158.063
_P2 FY -158.063
```

```
*POSICION 3
LOAD 4 CARGA VIVA
*CARGA COOPER ALTERNATIVA 4 EJES DE 100 000 #= 45,300 KG/ EJE
*CARGA DE IMPACTO = 40- 3L^2/1600 = 40-(3*15^2)/1600= 39.57%
*CARGA TOTAL POR EJE= 63,225.21
*CARGA POR VIGA = 15,806.3025
JOINT LOAD
_P1 FY -158.063
_P2 FY -158.063
_P3 FY -158.063
```

```

*POSICION 4
LOAD 5 CARGA VIVA
*CARGA COOPER ALTERNATIVA 4 EJES DE 100 000 # = 45,300 KG/ EJE
*CARGA DE IMPACTO =  $40 - \frac{3L^2}{1600} = 40 - \frac{3 \cdot 15^2}{1600} = 39.57\%$ 
*CARGA TOTAL POR EJE = 63,225.21
*CARGA POR VIGA = 15,806.3025
JOINT LOAD
_P1 FY -158.063
_P2 FY -158.063
_P3 FY -158.063
_P4 FY -158.063

**POSICION 5
LOAD 6 CARGA VIVA
JOINT LOAD
_P2 FY -158.063
_P3 FY -158.063
_P4 FY -158.063
_P5 FY -158.063

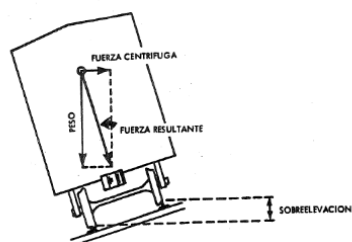
*POSICION 6
LOAD 7 CARGA VIVA
JOINT LOAD
_P3 FY -158.063
_P4 FY -158.063
_P5 FY -158.063
_P6 FY -158.063

*POSICION 7
LOAD 8 CARGA VIVA
*CARGA COOPER ALTERNATIVA 4 EJES DE 100 000 # = 45,300 KG/ EJE
*CARGA DE IMPACTO =  $40 - \frac{3L^2}{1600} = 40 - \frac{3 \cdot 15^2}{1600} = 39.57\%$ 
*CARGA TOTAL POR EJE = 63,225.21
*CARGA POR VIGA = 15,806.3025
JOINT LOAD
_P4 FY -158.063
_P5 FY -158.063
_P6 FY -158.063
_P7 FY -158.063

```

7. 4 CARGA CENTRIFUGA

La determinación de la fuerza centrífuga C en términos de porcentaje de la carga viva, es a través de la siguiente expresión tomada de la tabla 7-2-2 AREMA, en sistema inglés:



D = Degree of curve.

E = Superelevation in inches.

S = Permissible speed in miles per hour.

C = Centrifugal force in percentage of live load.

$$C = .00117 S^2 D = 1.755 (E+3)$$

$$E = \frac{2}{3} \frac{S^2 D}{1000} - 3 = \frac{C - 5.265}{1.755}$$

$$S^2 = \frac{1500}{D} (E + 3)$$

Junto con los datos de localización del puentes en la carta de vía de la línea Z, se obtienen los siguientes datos:

Grado de Curvatura D: 0.0°
Sobreelevación E: 0"

S	E	D	C
MPH	"	°	% LL
-	0.0	0.0	0.00

LOAD 4 FUERZA CENTRIFUGA (CF)

* FUERZA CENTRIFUGA APLICADA A CADA CARGA POR EJE A TRAVÉS DE UN PUNTO 8 PIES (2.45 M),
* 2.85 M ARRIBA DEL LARGUERO DEL PUENTE DEBIDO A LOS 25 CM DEL DTE Y PLACA DE ASIENTO Y 15 CM DEL RIEL

* POR ENCIMA DE LA PARTE SUPERIOR DEL RIEL MEDIDO A LO LARGO DE UNA LÍNEA PERPENDICULAR
* A LA LÍNEA QUE UNE EL LA PARTE SUPERIOR DE LOS RIELES Y EQUIDISTANTE DE ELLOS.

* ESTA FUERZA SERA EL PORCENTAJE DE LA CARGA VIVA CALCULADA DE LAS FORMULAS SIGUIENTES.

* $E = 0.0068 S^2 D - 75$; $C = 0.000452 S^2 D$; $S = (E + 75 / 0.0068 D)^{0.5}$;

* EL GRADO DE CURVATURA OBSERVADO SEGUN CARTA DE VIA ES DE 0.0

* A LA CUAL CORRESPONDE UNA FUERZA CENTRIFUGA DE 11.39 %

* EL MOMENTO DEBIDO A LA FUERZA CENTRIFUGA SERA:

* $11.39 * 30351 * (2.45 + .40) / 5.68 = 1734.57$

*

* DE ACUERDO A CARTA DE VIA EL PUENTE ESTA LOCALIZADO EN TANGENTE, POR LO QUE

* EL VALOR ES CERO.

*

MEMBER LOAD

_VPI UNI GY 0.01

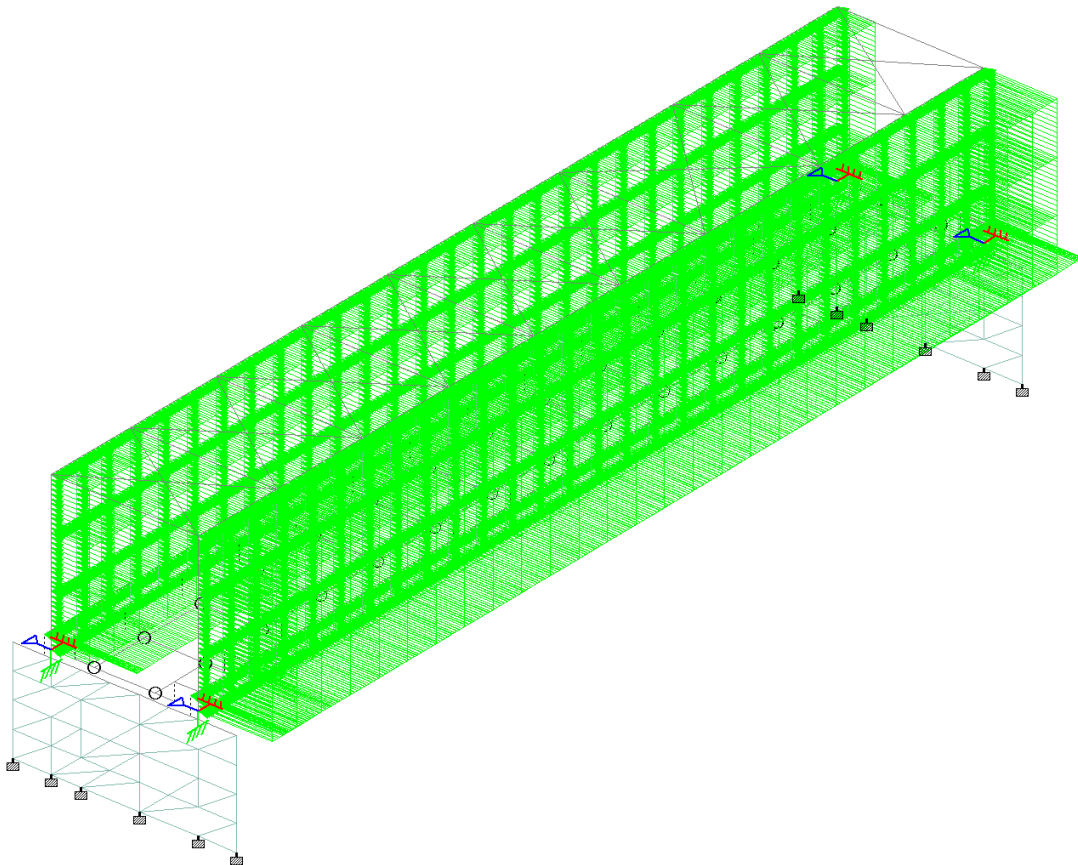
_VP2 UNI GY -0.01

7. 5 CARGA DE VIENTO

- h. *Wind Load on Structure.* The base wind load acting on the structure is assumed to be 45 lb per square foot (2160 Pa) on the vertical projection of the structure applied at the center of gravity of the vertical projection in any horizontal direction. A base wind velocity of 100 miles per hour (160 km/h) was used to determine the base wind load. If an increase in the design wind velocity is made, the design wind velocity and design wind load shall be shown on the plans.

For Group II and Group V loadings, when a design wind velocity greater than 100 miles per hour (160 km/h) is advisable the base wind load may be increased by the ratio of the square of the design wind velocity to the square of the base wind velocity. This increase shall not apply to Group III and Group VI Loadings.

```
LOAD 13 CARGA POR VIENTO EN ESTRUCTURA (W)
* DE ACUERDO AREMA SE DEBE ADOPTAR UNA PRESION SOBRE LA ESTRUCTURA DE 2160 Pa ( 216 Kg/m2)
* PARA CFE VIENTO SE INDICAN PRESIONES
* BARLOVENTO= 78.73 Kg/m2
* SOTAVENTO= 19.68 kg/m2
* LATERALES= 51.17 kg/m2
* CUBIERTA = 55.11 kg/m2
* SE ADOPTA AREMA POR CONDICION MAS CRITICA
* LA SUPERFICIE DE CONTACTO ES DE .80 M2 POR LO QUE LA CARGA A LO LARGO DE LA CARA DE CONTACTO
  SERA DE
* 216 X 2.10 = 453 KG/M
MEMBER LOAD
_V1L UNI GZ -453.6
_V1R UNI GZ -453.6
ELEMENT LOAD
_BSN PR 215
_BSS PR 110
```



7. 6 CARGA DE VIENTO SOBRE CARGA VIVA

- i. *Wind Load on Live Load.* A wind load of 300 lb per linear foot (4.4 kN/m) on the train shall be applied 8 feet (2450 mm) above the top of rail in a horizontal direction perpendicular to the centerline of the track.

LOAD 11 VIENTO SOBRE CARGA VIVA (WL)

* DE ACUERDO AREMA SE APLICA CARGA DE 4.4 KN/m (440 Kg/m) A LO LARGO DEL CENTRO DE LA CUBIERTA

* Y SE APLICA EL MOMENTO GENERADO POR DICHA CARGA POR EL BRAZO DE PALANCA DE 2.4 M POR ARRIBA DEL RIEL (0.40 M ARRIBA DE LA ESTRUCTURA)

*ENTRE EL ANCHO DE LA CUBIERTA (1.50 m)

M= 440(2.45 + 0.40)/1.50= 836 Kg-m (418 kg-m POR VIGA DUPLEX)

MEMBER LOAD

_VP1 UNI GY -4.18

_VP2 UNI GY 4.18

7. 7 FUERZA LONGITUDINAL DE FRENADO Y ARRANQUE

De acuerdo con lo dispuesto en el manual AREMA, la carga de frenado aplicada en a 2.45 m del hongo de riel es:

$$\text{Longitudinal braking force (kips)} = 45 + 1.2L$$

$$(\text{Longitudinal braking force (kN)} = 200 + 17.5L)$$

$$\text{Longitudinal traction force (kips)} = 25\sqrt{L}$$

$$(\text{Longitudinal traction force (kN)} = 200\sqrt{L})$$

LOAD 12 CARGA LONGITUDINAL (LF)

* DE ACUERDO CON AREMA:

* FUERZA DE FRENADO= $200 + 17.5 L = 200 + (17.5 \times 15.0) = 462.5 \text{ KN} = 46,250.00 \text{ kg}$

* FUERZA DE ARRANQUE= $200 \times L^{0.5} = 200 (15.0)^{0.5} = 774.69 \text{ KN} = 77,469.00 \text{ kg}$ <----- (SE ADOPTA ESTE PARA DISEÑO)

* LA FUERZA LONGITUDINAL EFECTIVA SE DISTRIBUIRA ENTRE LOS DIVERSOS COMPONENTES DEL SOPORTE.

* ESTRUCTURA, TENIENDO EN CUENTA SU RIGIDEZ RELATIVA.

*EL 98% ABSORBIDO POR LA ESTRUCTURA GENERA UN MOMENTO CON BRAZO DE PALANCA DE 0.9 M (3FT) REPARTIDO EN LA CUBIERTA

* $77,469.00 \text{ Kg} \times 0.98 \times 0.9 \text{ m} / 15.00 \text{ m} = 4,454.62 \text{ kg} (1,113.65 \text{ Kg})$

*

JOINT LOAD

_1S FY -11.13

_2S FY -11.13

_3S FY -11.13

_4S FY -11.13

_1N FY 11.13

_2N FY 11.13

_3N FY 11.13

_4N FY 11.13

8.0 COMBINACIONES DE CARGAS.

Las combinaciones de carga por factores recomendada por AREMA son:

Table 8-2-4. Group Loading Combinations – Service Load Design

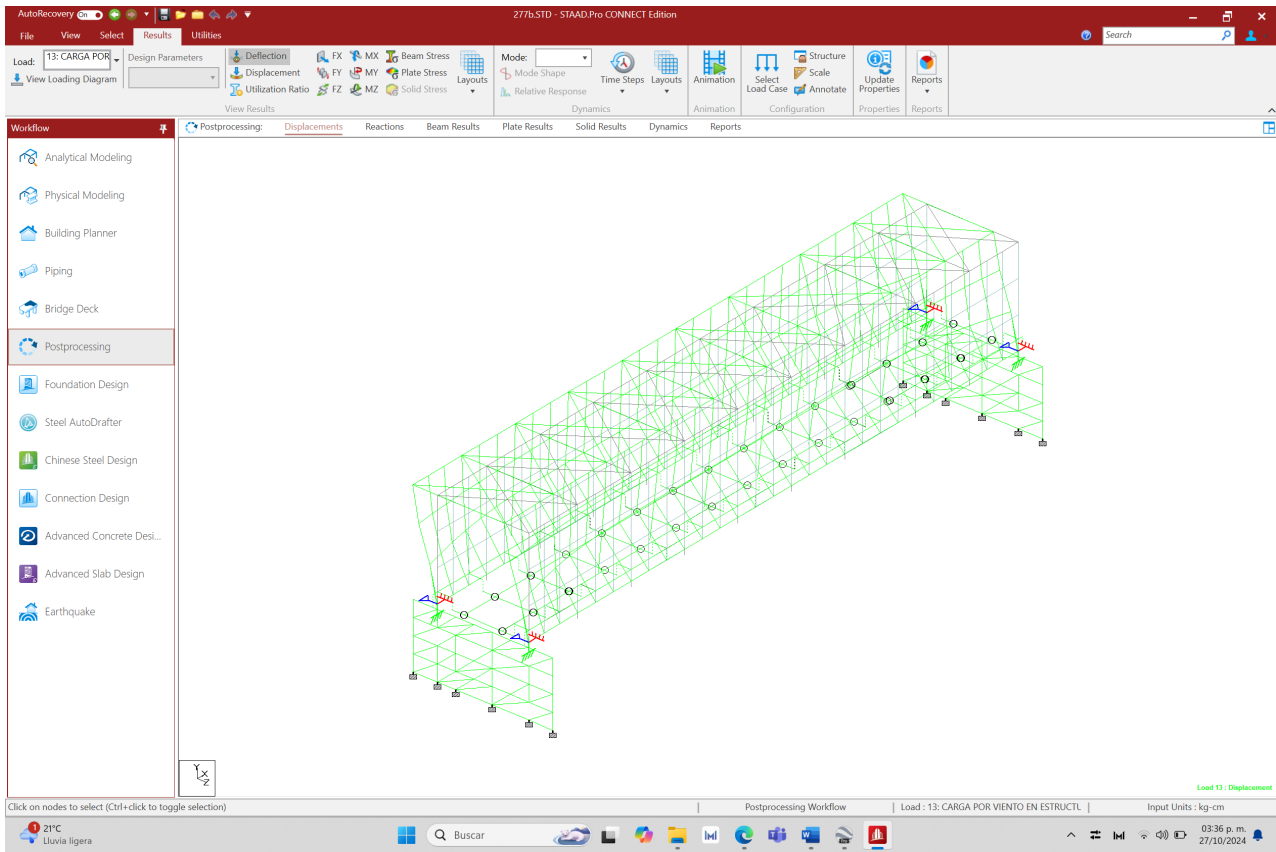
Group	Item	Allowable Percentage of Basic Unit Stress
I	$D + L + I + CF + E + B + SF$	100
II	$D + E + B + SF + W$	125
III	$\text{Group I} + 0.5W + WL + LF + F$	125
IV	$\text{Group I} + OF$	125
V	$\text{Group II} + OF$	140
VI	$\text{Group III} + OF$	140
VII	$\text{Group I} + ICE$	140
VIII	$\text{Group II} + ICE$	150

```

LOAD COMB 19 D+L+I+CF+E+B+SF (GRUPO I)
1 1.4 3 1.4 9 1.4 10 1.4 11 1.4 12 1.4

LOAD COMB 20 D+E+B+SF+W (GRUPO II)
1 1.5 3 1.5 11 1.5 12 1.5 13 1.5
LOAD COMB 21 D+L+I+CF+E+B+SF+0.5W+WL+LF+F
1 1.5 3 1.5 9 1.5 10 1.5 11 1.5 12 1.5 13 0.75 14 1.5
*
```

9. RESULTADOS DE LA REVISIÓN ESTRUCTURAL



			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	392	21 (1.4)(D +	12.478	1.917	-19243.149	19243.153	-0.074	0.012	0.002
Min X	394	21 (1.4)(D +	-12.307	1.913	-19243.595	19243.599	-0.074	-0.012	-0.002
Max Y	431	13 CARGA P	0.811	10.200	-13781.713	13781.716	0.004	-0.001	-0.000
Min Y	369	20 (1.8)(D + L	-0.701	-55.614	0.712	55.623	-0.004	-0.000	-0.000
Max Z	576	26 1.0DL+1.0	0.784	-21.657	336.805	337.502	0.015	0.002	0.000
Min Z	576	21 (1.4)(D +	2.482	-31.675	-28261.208	28261.227	1.752	0.242	0.001
Max rX	544	21 (1.4)(D +	-0.525	-31.673	-24232.719	24232.738	1.752	0.242	0.001
Min rX	516	21 (1.4)(D +	1.449	0.657	-6074.348	6074.348	-4.316	3.434	-0.002
Max rY	516	21 (1.4)(D +	1.449	0.657	-6074.348	6074.348	-4.316	3.434	-0.002
Min rY	518	21 (1.4)(D +	-1.384	0.654	-6068.295	6068.295	-4.314	-3.486	0.002
Max rZ	45	21 (1.4)(D +	6.553	-5.496	-29.717	30.923	0.002	-0.007	0.020
Min rZ	41	21 (1.4)(D +	-6.538	-5.565	-29.714	30.930	0.002	0.007	-0.020
Max Rst	576	21 (1.4)(D +	2.482	-31.675	-28261.208	28261.227	1.752	0.242	0.001

De acuerdo con las gráficas y el listado arriba expuesto, se concluye que **la IMPLEMENTACION DE BARRERAS DE SONIDO NO MENORES AL GALIBO VERTICAL PERMITIDO POR AREMA (7.1 MTS)**, genera inestabilidad estructural, ante las condiciones de carga por viento, por lo que no cumple satisfactoriamente ante la solicitud.

13.0 RECOMENDACIONES

De acuerdo con la revisión de las condiciones estructurales de la losa del puente Z 283+003 se emiten las siguientes recomendaciones para su conservación:

- Estructura de cubierta abierta conformada con 2 vigas remachadas de 140x33 cm, $I_x=2,992,263.43 \text{ cm}^4$, $A=884.28 \text{ cm}^2$, $w=696.28 \text{ kg/m}$, consideradas en acero A-36.
- Se procederá a realizar el desarmado de vía y retiro de la estructura y subestructura existente.
- Preparación de cubierta metálica con aplicación de cubre placas de 1" de espesor en patines superior e inferior,
- Proceso de sanblasteo y primeado RP5 con recubrimientos anticorrosivos autorizados por la supervisión.
- Montaje de estructura y armado de cubierta con madera creosotada de sección 10"x10"x10' @ 15 cm.
- Colocación de 4 pernos de anclaje de $\varnothing= 3/4"$, de alta resistencia $f_y= 5000 \text{ kg/cm}^2$ en placas base para conexión de los extremos del puente y muro estribo.
- Balastado, nivelado y calzado de aproches.
- Colocación de 10 durmientes de madera creosotada de escuadría 10x10x10 en cada aproche del puente, así como colocación y rotulado de placa kilométrica elaborada con durmientes de concreto de 4a. En ambos extremos del puente.