TMK Consulting Engineers

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TMK Ref. 2202023_R1 | 16 March 2022

STRUCTURAL ASSESSMENT

(BRIDGE) TWENTY FIRST STREET, RENMARK.

for

RENMARK PARINGA COUNCIL

tmkeng.com.au

Civil – Geotechnical – Environmental – Structural – Mechanical – Electrical – Fire – Hydraulics – Forensic – Construction Assist - Vertical Transport

TMK Ref: 2202023
Your Ref: E/222/2246

16 March 2022

RENMARK PARINGA COUNCIL
61 Eighteenth Street
PO Box 730 Renmark
RENMARK SA, 5341

ATTENTION: TARIK WOLF **Email:** twolf@renmarkparinga.sa.gov.au

Dear Tarik,

RE: STRUCTURAL ASSESSMENT
AT: 21ST STREET BRIDGE, RENMARK SA 5341

TMK Consulting Engineers is pleased to present a PDF copy of our report on the investigation undertaken at the above location.

If you require further information or clarification regarding any aspect of this report, please do not hesitate to contact the undersigned.

For and on behalf of
TMK Consulting Engineers

Vuk Pijovic
Engineer

Report Issue	Author	Reviewed	Issue date
2202023_R1	**Vuk Pijovic** *BEng (Hons.) (Civil)* Engineer	**Raik Bosse** *BEng (Civil & Struct.), CPEng, MIEAust, NER* Associate Director	16 March 2022

The work carried out in the preparation of this report has been performed in accordance with the requirements of TMK Consulting Engineer's Quality Management System which is certified by SAI Global to comply with the requirements of ISO 9001.

EXECUTIVE SUMMARY

- TMK attended the site at 21st Street, Renmark SA to investigate the structural condition of the 21st Street Bridge of its individual elements, identify current deficiencies and present remedial options.
- A comprehensive desktop site review was conducted involving the condition analysis of structural elements of the bridge, review of provided documentation & photographs and the determination of the current load rating provided.

CONTENTS

ATTACHMENTS:

A.W. BAULDERSTONE (DRAWING NO. 1)
A.W. BAULDERSTONE (DRAWING NO. C60-108 SHEET 2)
STRUCTURAL CALCULATIONS (SC1 – SC11)

1 INTRODUCTION

At your request TMK Consulting Engineers have successfully undertaken an asset condition assessment on the 21st Street Bridge, located on 21st Street, Renmark SA Civic Building in Whyalla, South Australia. The visual assessment was undertaken on 24 January 2022.

- The visual condition assessment was carried out on site by Associate Director, Mr Raik Bosse and Engineer, Mr Vuk Pijovic.

The aim of this assessment is to provide Council with a record of the condition of the included infrastructure, such that you may:

- Plan for and manage the delivery of the required level of future maintenance and remediation.
- Avoid premature asset failure and enable the option of cost-effective remediation.
- Inform future expenditure requirements through understanding remaining asset life and capital investment needs.
- Provide Structural Assessment of Adequacy for 10 tonne Vehicle Loading.

This report contains informative, high-level summaries of asset elements, including the overall condition, observations and causation for identified defects where applicable. Separately, significant asset observations have been tabulated within a CAPEX report to identify remediation works required and estimate costings.

Figure 1 - Aerial image of the site in question, 21st Street Bridge, Renmark SA (dated February 2022).

1.1 DESKTOP SITE REVIEW

1.1.1 Document Review

Prior to the preparation of this report TMK has perused the following provided documents:

- 21st Street Bridge original structural plans (A.W. BAULDERSTONE LTD. – Drawing no'. 1 & C60-108)
- Photographic evidence of defects taken during the investigation carried out by TMK.

1.2 GENERAL CONSTRUCTION

The beam supported bridge visually appeared to be constructed in accordance to the original design.

The building was of varied types of construction due to numerous additions / retrofits over the life of the structure:

Piers: 355 x 355mm reinforced concrete piers founded to a depth of 7.9m as indicated on the original engineering drawings; (depth of piers not confirmed onsite).

End Support Beams: 660 x 455mm reinforced concrete beams as indicated on original engineering drawings;

Centre Bridge Beams: 5 x 24" x 7 ½" British Standard Steel Beams;

Deck: Reinforced Concrete slab with bitumen topping cover;

Photo 1 – 21st Street Bridge, Renmark SA (orientation facing North)

2 ASSET CONDITION ASSESMENT & DISCUSSION

- The bridge superstructure comprised of a system of reinforced concrete and steel elements including a suspended reinforced concrete decking slab, steel and reinforced concrete beams as well as footing piers. The bridge deck comprised of a two-lane trafficable roadway, with an additional perimeter footpath allocated for pedestrian accessibility on one side.
- The 21st Street Bridge was visually inspected and overall determined to be in a structurally ‘poor’ condition with immediate structural concerns requiring action.
- Reinforced Concrete Posts within the hand rail barrier system displayed significant cracking and deterioration.
- Typical deterioration of concrete and steel elements was observed to the bridge soffit and structural steel beams.
- Significant concrete spalling and delamination present on bridge soffit.
- Minor surface corrosion to structural steel beams.

2.1.1 Bridge Footing Piers (355 x 355mm reinforced concrete piers)

A. No signs of significant differential movement were observed during the non-destructive investigation, to the concrete piers.

2.1.2 Reinforced Concrete Support Beam Ends (660 x 455mm reinforced concrete beams)

A. Concrete degradation and spalling occurring to both ends of the concrete support beam to east embankment, exposing internal steel reinforcement. Location indicated as per figures 2 – 5.

B. Concrete repair and reinstatement required to encase the currently exposed steel reinforcement constituent of the concrete support beam.

C. Recommended Scope;

- Provide well scabbled surface and remove loose material
- Apply surface preparation adhesive product as outlined in Concrete Repair Procedure. Refer to section 2.1.3 (F).
- Box up formwork to suit existing dimensions of concrete beam. Ensure minimum concrete cover of 50mm throughout.
- Ensure new concrete encases exposed reinforcement.

Photo 2 – Concrete degradation showing exposed reinforcement of concrete support beam on East end of bridge.

Photo 3 – Concrete degradation showing exposed reinforcement of concrete support beam on East end of bridge.

Photo 4 – Concrete degradation showing exposed reinforcement of concrete support beam on East end of bridge.

Photo 5 – Concrete degradation showing exposed reinforcement of concrete support beam on East end of bridge.

2.1.3 Reinforced Concrete Suspended Slabs (Bridge Soffit)

A. Concrete delamination and spalling occurring, exposing corroded reinforcement on both the east and west ends of the bridge. Area of concrete degradation requiring remedial works determined upon initial site investigation is approximately 25m2. Further carbonation and "tap" testing required onsite, when remedial works are to take place in order to accurately determine full extent of substrate affected by carbonation. Locations indicated as per figures 6 – 9.

B. Exposed reinforcement requires cleaning and stripping of all corroded and loose materials, in order to determine full extent of sectional losses. If it is determined that level of reinforcement corrosion exceeds an adequately acceptable limit of 20 percent, installation of additional reinforcement may be required throughout the concrete remediation process.

Photo 6 – Concrete delamination and spalling from bridge soffit on east end.

Photo 7 – Concrete delamination and spalling from bridge soffit on east end.

Photo 8– Concrete delamination and spalling from bridge soffit on west end.

Photo 9 – Concrete delamination and spalling from bridge soffit on west end.

C. Concrete spalling was caused by the expansion of internal reinforcement, and could be attributed to a combination of a processes known as **'concrete carbonation'** and **moisture ingress**.

The Standards Australia Handbook **'**SA HB 84: 2018 *'Guide to concrete repair and protection'* describes the process and detrimental effect of **carbonation** within concrete structures that are exposed to the atmosphere over a long period.

The document states:

The two main gases in the atmosphere that attack concrete are carbon dioxide (C02) and sulphur dioxide. Normal air currently contains -0.04% carbon dioxide, although higher concentrations can be expected to occur in urbanized areas and localities around heavy industry estates. The reaction of atmospheric C02 with Portland cement concrete results in the formation of calcium carbonates and to a lesser extent sodium carbonate. The chemical equation for the reaction of carbon dioxide with calcium hydroxide produced from cement hydration is:

$$C02 + Ca(OH)2 \rightarrow CaC03 + H20$$

This reaction is referred to as the carbonation process and leads to a depletion of hydroxyl ions in the cement gel and pore solution. Thus, extensive carbonation leads to a reduction in the pH of the pore solution within the concrete. Concrete made with Portland cement typically has a pH value in excess of 13. However, this high pH is lowered to a value of -9 with carbonation.

The diffusion of C02 into concrete occurs via the capillary pore structure. Since C02 reacts rapidly with hydroxides, its penetration into concrete is governed by the barrier of uncarbonated concrete that it encounters. One end of the barrier has a low C02 concentration due to ongoing reaction with concrete, whilst the other end in contact with the atmosphere is relatively rich in C02. A diffusion process results due to the existing concentration difference.

While the carbonation process does not unduly affect the durability properties of concrete, the pH drop can have important implications on the corrosion of steel reinforcement embedded in the concrete. At pH values of 10 or less, the reinforcing steel is generally no longer passivated and can corrode. Some shrinkage of concrete may, however, occur as a result of carbonation. The extent of shrinkage depends largely on concrete porosity.

The normally high pH environment provided by the hydrating cement (binder) protects steel reinforcement from corrosion, with the formation of an adherent and chemically protective iron oxide surface passive film. The surface oxide film dissolves at values of pH < 10 with loss of corrosion protection as a result of carbonation. The corrosion of steel can then occur in the presence of oxygen and moisture and generate expansive and disruptive reaction (corrosion) products. These corrosion (rust) products induce cracking and/or spalling of the cover concrete.

A simple test is used to determine the extent or depth of carbonation of concrete. The test involves spraying freshly fractured concrete samples with a phenolphthalein pH indicator solution designed to change colour at a pH higher than approximately 9.5. The depth of carbonation is readily measurable due to the bright pink colour change of the phenolphthalein indicator at higher pH values.

D. Previously completed repair works were undertaken on the west end of bridge soffit due to pre-existing spalling and concrete degradation. It should be noted that the date of which repairs were conducted, extent of remediation (including the process undertaken and products used during these remedial works) is unknown to this office. Location indicated as per figures 10 - 11.

E. Previously completed concrete slab soffit repairs were visually inspected by TMK at the time of inspection and no signs of further degradation at the indicated location were evident.

Photo 10 – Prior completed repairs (East end of bridge)

Photo 11 – Prior completed repairs (East end of bridge)

F. Remedial Procedure for Bridge Soffit

Surface Preparation

1. Concrete

- Saw cut or cut back the perimeter of the repair area to 10mm deep maximum to avoid feather-edging and to provide a clean square edge. Break out the complete repair area to a minimum depth of 10mm up to the sawn edge and 50mm minimum beyond any visible signs of corroding reinforcement or embedded steelwork.
- Clean concrete surfaces and remove any dust, unsound or contaminated material, plaster, oil, paint, grease, corrosion deposits or algae. Where break out is not required, roughen the surface and remove any laitance by light scabbling or abrasive-blasting.

2. Reinforcement

- Steelwork must be clean and free of scale or rust. Remove any contaminants and coatings to achieve a Class 2.5 'very thorough' / 'near white' surface finish to AS 1627.4. (Note: An adequate surface finish is achievable with the use of hand tools; e.g. grinder or wire brush).

3. **At this stage, a visual inspection (and carbonation test where appropriate) should be undertaken by this office to confirm the adequacy of preparation works prior to treating the steelwork and reinforcement and repairing the concrete.**

   Please note: additional reinforcement may be required if the existing is inadequate, has significantly deteriorated or if the concrete repair area is too large to adequately bond with the existing structure. This is typically provided by dowelling starter bars into the concrete with an epoxy chemical adhesive.

Reinforced Concrete Repairs

4. Prime reinforcement and concrete with MasterEmaco P 5000 AP or similar approved.
5. Apply MasterEmaco S 5300CI or similar approved.

2.1.4 Bridge support Steal beams (5 x 24" x 7 ½" British Standard Steel Beams)

A. Upon TMK's site investigation, it was determined the primary structural steel beams presented minor levels of corrosion associated with negligible section loss, as indicated in figures 12 – 15.

B. Steel beams displayed minor signs of torsion buckling, (beams 2 and 4. Locations as per figure 12. (Steel beam numbers determined in order facing west end of bridge).

C. Upon review of the original structural design documentation of the bridge, followed by the onsite investigation conducted by TMK, indicated in figure 13, it can be seen that cross bracing has been installed to mitigate the effects of torsion buckling throughout the steel beams. As part of the remedial process and scope of works, it is recommended by this office to install additional cross bracing (100x100x12 EA – Hot Dipped Galvanised) in order to control the risk of further torsion buckling.

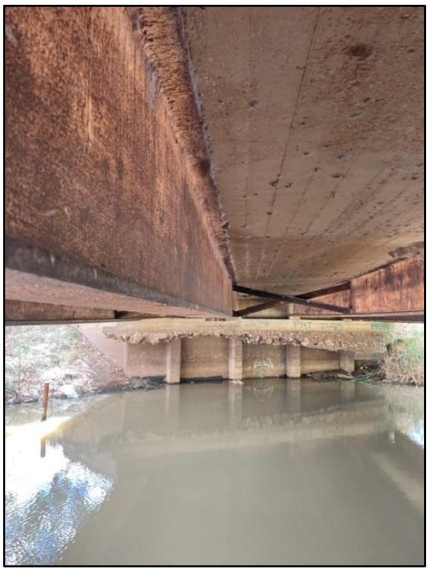

Photo 12 – Steal beam #2 displaying minimal torsion buckling (bottom flange showing minor curvature)

Photo 13 – Steal beam #2 displaying minimal torsion buckling (bottom flange showing minor curvature)

Photo 13 – Steal beam #4 displaying minimal torsion buckling (bottom flange showing minor curvature)

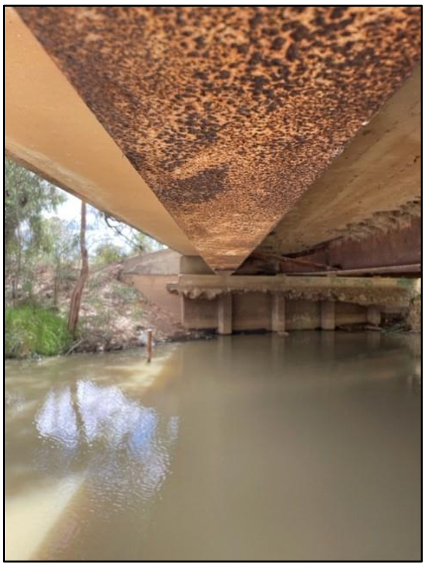

Photo 15 – Steel beam condition indicating minor level of corrosion, no sectional losses.

2.1.5 Perimeter hand rails

A. Hand rails on both external perimeters of the bridge were observed during TMK's onsite investigation to have visually evident deterioration and cracking, due to the expansion caused by corrosion of the internal reinforcement of the concrete posts, as indicated in figures 16

B. It was observed that the hand rail system was not structurally adequate to serve as a vehicular impact barrier, rather just a pedestrian access perimeter barrier.

C. Based upon site investigation, the extent of damages presented structural significance. It was the considered opinion of this office, that the hand rail system on the foot path side of the bridge was structurally unsafe in its current state and beyond economical repair.

D. Hand rail system appeared to be original from the time of initial construction, it is the advice of this office that full replacement of the hand rail system is required without delay.

Photo 16 – Cracked Concrete post of hand rail system.

Photo 17 – Evidence of impact damage to concrete post.

Photo 18 – Deterioration of concrete post exposing corroded reinforcement

Photo 19 – Deterioration of concrete post exposing corroded reinforcement

3 CONCLUSION

1. As part of the desktop analysis conducted, it is considered opinion of this office that, subject to the successful completion of the remedial works outlined in this report, the bridge' loading capacity will again be adequate to support 10 tonne vehicle loading with 5 tonne axel load. (refer to appendix A).
2. However, concluded from the desktop analysis conducted, it was determined that the 10-tonne loading limit is recommended to remain.
3. A minor potential increase (i.e. to suit school bus), may be acceptable under the condition, that oncoming traffic can be managed and excluded, to guarantee one-way traffic loading exclusively at the time of crossing.

4 FINAL STATEMENT

We trust this report is sufficient for your present requirements. If you have any further queries regarding this matter, please do not hesitate to contact this office.

The conclusions reached in this report have been based on opinions derived from site observations and our experience in understanding the causes of building/asset damage. If you consider that the circumstances in this matter justify any additional testing or measurement, please contact this office so that we can discuss whether any appropriate further testing or procedure may be of assistance to gain further insight to the observed site conditions.

For and on behalf of
TMK Consulting Engineers

5 APPENDIX

5.1.1 RECOMMENDATIONS AND CAPEX

10 Year Capital Expenditure and Maintenance Forecast - Civil / Structural
Structural Due Diligence Assessment - Whyalla Civic Centre

Condition Rating

1	Excellent
2	Satisfactory
3	Fair
4	Poor
5	Very Poor

Key

Mechanical (M)	Fire (F)	Lift (L)
Hydraulics (H)	Electrical (E)	Structural (S)

Priority grades recommended within a ten year planning period

Priority 1	Work that will require immediate attention "Short (Years 1 - 2)"
Priority 2	Work that will require attention "Medium (Years 3-5)"
Priority 3	Work that will require attention "Long (Years 6-10)"

Date: 23/02/2022
Job Number: 2202023
Address: 21st Bridge, Renmark SA

Probable CAPEX & Maintenance Costs ($) excl GST

Section/ Item #	Element	Location	Condition	Current Condition Rating	Remedial Works Required	CAP / R&M / BCA	Priority	Replacement Date & Cost			Total Budget
								Short (Years 1-2)	Medium (Years 3-5)	Long (Years 6-10)	(excludes per annum)
2	**BRIDGE SUPERSTRUCTURE**										
2.1.2	**REINFORCED CONCRETE END SUPPORT BEAMS (660 X 455mm REINFORCED CONCRETE BEAMS)**										
1	Deteriorated ends of concrete support beam	East end of bridge	Exposed internal reinforcement of concrete support beams at each end due to deteriorations.	3	Removal of all loose materials, with the preparation of surface and existing reinforcment as per the recommended concrete repair procedure (CRP). Folllowing the completion of preparation, formwork is required to reinstate and enacse the existing reinforcent.	R&M	1	$2,500.00			
2.2.3	**REINFORCED CONCRETE SUSPENDED SLAB (SOFFIT)**										
2	Further Investigations - Concrete Properties	Bridge Soffit	Retrieve concrete core samples for laboratory testing; to determine concrete properties such as strength, condition and chloride ion ingress.	4	Core three, 80mm diameter samples in the bridge. Samples to be sent to laboratory for further testing. The 'Bridge Soffit' is the suggested location the retrieve the concrete core samples.	R&M	1	$3,500.00			
3	Spalling/delaminated Concrete	Bridge Soffit	Existing spalling/delaminted concrete (Approx. 25m^2).	4	Prepare surfaces and reinstate as per the recommended Concrete Repair Procedure (CRP).	R&M	1	$35,000.00			
4	Scaffolding requirment to provide working accessability to bridge sofit	Bridge Soffit	Due to limited access and presence of water way underneath bridges. Scaffolding services are required to provide working platforms in accordance with standard safe work regulations.	3	-	R&M	1	$7,500.00			
5	Further Investigations - Tap Testing	Bridge Soffit	Potential for additional undetected defects throughout deck soffit due to unidentified extent of carbonation effected areas, unable to visually asses onsite due to access limitiations.	3	Thorough visual inspection followed by tap-testing of spot locations.	R&M	1	$2,500.00			
6	Concrete Protection	Bridge soffit	Following outcomes of tap tests to the bridge soffit, and localised patch repairs if required, concrete protection may be deemed appropriate for future concrete asset protection and inhibition of corrosion (est. 120m^2).	2	Apply high-quality penetrative concrete protection (**MasterProtect 8500 CI** or similar) to preserve reinforced concrete assets.	R&M	1	$10,000.00			

2.1.4	**BRIDGE SUPPORT STEEL BEAMS (5 - 24"x7 1/2" BRITISH STANDARD STEEL BEAMS)**							
7	Surface Corrosion	Bridge Soffit	Structural steel framework generally appeared to be in a fair condition with some surface corrosion / dusting. Hence neglegable section loss can be concluded	2	Steelwork should be cleaned of surface corrosion and coated with a protective paint system.	R&M	1	$12,500.00
8	Minor evidene of torsion buckling in steel beam.	Bridge soffit (beams 2 and 4)	visuallly identified minor evidece of torsion buckling (deflection of bottom flange) of two inernal support beams.	2	Installation of additonal Eaqual Angle cross bracing members to mitigate any potential for future buckling effects.(members sizes specified by TMK)	R&M	1	$10,000.00
2.1.5	**BRIDGE PERIMETER HAND RAILS**							
9	Concrete Breakout (Removal of Exisiting Hand Rail System) & Surface Preparation	Bridge deck	Depending on extent of deteriorated concrete cover identified upon removal of concrete posts. Repair may consist of either localised patch repairs or potentially total concrete cover replacement.	4	Recommend to remove exisiting concrete post and rail perimeter system, follwoed by the surface preparation of concrete base as per the recommended Concrete Repair Procedure (CRP).	R&M	1	$3,500.00
10	Perimeter Hand Rail Replacement	Bridge deck (east end)	Hand Rail system to be replaced due to extent of degradation beyond economical repair.	4	Suitable Steel Post and Rail system should be installed as soon as practical following the removal of exisitng hand rail systm.	R&M	1	$7,500.00

Total	**$94,500.00**	**$0.00**	**$0.00**	**$0.00**

Total Capital Expenditure	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Total Repairs and Maintenance	**$94,500.00**	**$0.00**	**$0.00**	**$94,500.00**
Total Compliance with Building Code of Australia	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Mechanical Services				
Fire Protection Services				
Vertical Transportation				
Hydraulic Services				
Electrical Services				
Structural	**$94,500.00**	**$0.00**	**$0.00**	**$94,500.00**
Total Cost (CAP, BCA and R&M)	**$94,500.00**	**$0.00**	**$0.00**	**$94,500.00**

5.1.2 STRUCTURAL CALCULATIONS – (SC1 – SC11)

TMK Consulting Engineers
Level 6, 100 Pirie Street, Adelaide SA 5000
Tel: 08 8238 4100
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Civil • Geotechnical • Environmental
Structural • Mechanical • Electrical • Fire
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Riverland Office: 29 Vaughan Terrace, Berri SA 5343

STRUCTURAL CALCULATIONS (SC1)

Builder / Agent:	RENMARK PARINGA COUNCIL	**Job Number:**	2202023
Owner:	RENMARK PARINGA COUNCIL	**Date:**	3/03/2022
Project:	STRUCTURAL ASSESSMENT - TWENTY FIRST STREET BRIDGE		
Project Location:	(BRIDGE) TWENTY FIRST STREET, RENMARK		

GENERAL NOTES:

1. These calculations are to be read in conjunction with the associated Architectural Drawings, Footing Construction Report, Structural Drawings and / or Details.

2. All work to comply with relevant Australian Standards including but not limited to:

AS/NZ 1170	-	Structural design actions
AS 3600	-	Concrete structures
AS 4100	-	Steel structures
AS 5100.1	-	Bridge design-scope and general principle
AS 5100.2	-	Bridge design-Design Loads

SPACE GASS 14.00 - TMK CONSULTING ENGINEERS
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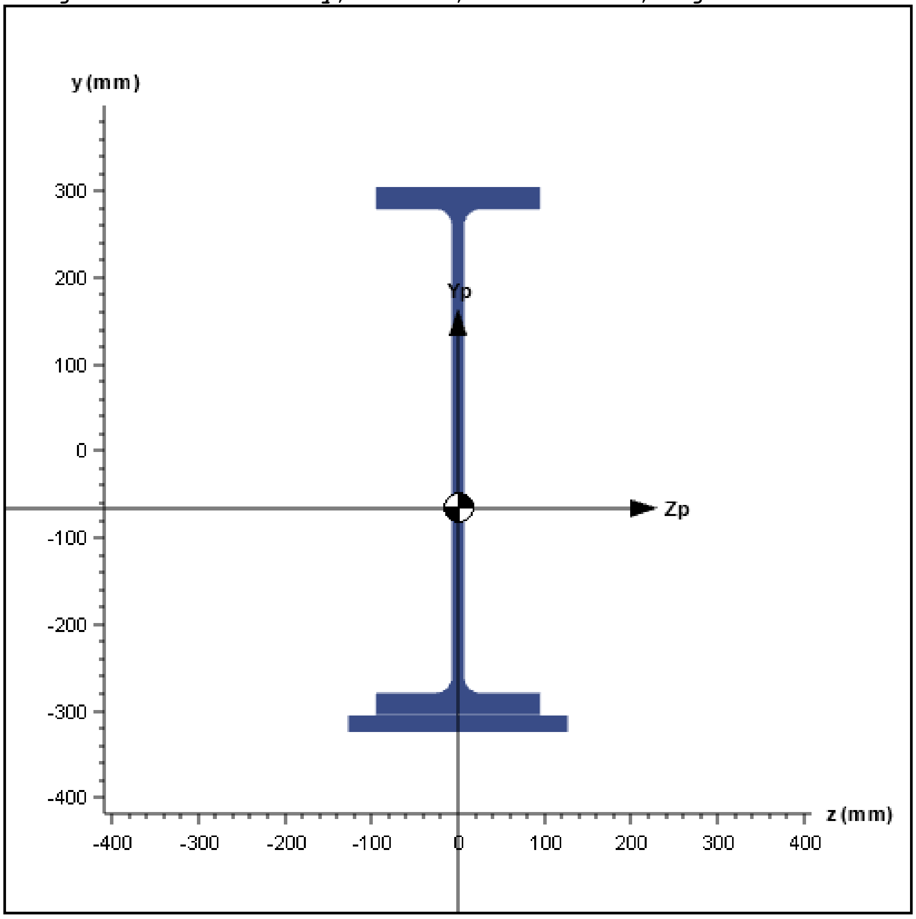
Designer: Date: Thursday, March 3, 2022 9:33 AM, Page: 1



Shape Builder

Section: bridge

Basic Properties		Elastic Section Modulii		Plastic Section Modulii	
A:	22.95x10^3 mm^2	Zyb:	436.9x10^3 mm^3	Sy:	802.6x10^3 mm^3
Iyp:	55.49x10^6 mm^4	Zyt:	436.9x10^3 mm^3	Sz:	5.169x10^6 mm^3
Izp:	1.439x10^9 mm^4	Zzb:	5.581x10^6 mm^3	Syp:	802.6x10^3 mm^3
Iyz:	52.27x10^-12 mm^4	Zzt:	3.883x10^6 mm^3	Szp:	5.169x10^6 mm^3
Iy:	55.49x10^6 mm^4	Zypb:	436.9x10^3 mm^3		
Iz:	1.439x10^9 mm^4	Zypt:	436.9x10^3 mm^3		
Alpha:	0.00 deg	Zzpb:	5.581x10^6 mm^3		
Cy:	-66.1 mm	Zzpt:	3.883x10^6 mm^3		
Cz:	0.0 mm				

Torsional Properties		Shear Center		Radii of Gyration	
J:	3.255x10^6 mm^4	Vy:	Not Calculated	Ry:	49.2 mm
Iw:	Not Calculated	Vz:	Not Calculated	Rz:	250.4 mm
				Ryp:	49.2 mm
				Rzp:	250.4 mm

Shape 1 (mm, MPa)

Name:	I Shape1		
Shape type:	I or H Section		
D:	609.0	Bt:	190.0
Bb:	190.0	Tt:	25.7
Tb:	25.7	Tw:	14.5
Radius:	18.5		
Y Translation:	0.0	Z Translation:	0.0
Mirror Y:	No	Mirror Z:	No
β Rotation:	0.00	Transposed:	No
Negative shape:	No		

Shape 2 (mm, MPa)

Name:	Trapezoid1		
Shape type:	Trapezoid		
D:	19.0	Bt:	254.0
Bb:	254.0		
Y Translation:	-314.5	Z Translation:	0.0
Mirror Y:	No	Mirror Z:	No
β Rotation:	0.00	Transposed:	No
Negative shape:	No		

* Load:-

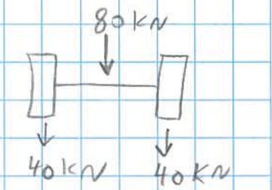
Dead Load:- Concrete slab 150mm, $\gamma_C = 24\ kN/m^3 \rightarrow W_1 = 0,15 \times 24 = 3,6\ kPa$

Toping concrete 50mm, $\gamma_C = 24\ kN/m^3 \rightarrow W_2 = 0,05 \times 24 = 1,2\ kPa$

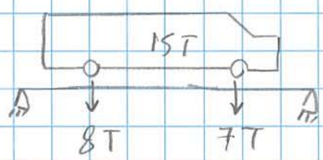
Ashfalt 40mm, $\gamma_{AS} = 22\ kN/m^3 \rightarrow W_3 = 0,04 \times 22 = 0.09\ kPa$

Total = 4,9 kPa

Live load:- Max axle load 8 tonne → shared between 2 wheels (40kN/wheel)



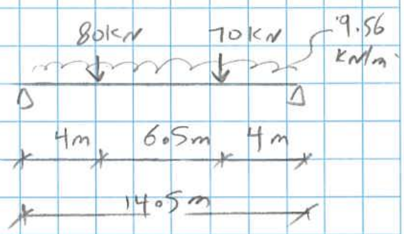
• As we checked a 15 tonne mass school bus, we will assume that the rear Axle is 8 tonne (80kN) and front Axle is 7 tonne (70kN).



* Load Cases:-

Case 1: all loads applied on one beam only and the bus is in the middle of bridge:-

Tributary width = 1.95m $\Rightarrow W_{DL} = 4.9 \times 1.95 = 9.56\ kN/m$



$W_{DL}^* = 1,2 \times 9,56 = 11,5\ kN$

$P_{LL}^* = 1,8 \times (1 + (\alpha = 0.4)) \times 80 = 201,6\ kN$ (dynamic)

from SG: $M_u^* = 1116,2\ kN.m$

the bridge beam is restrained by concrete slab → section capacity = member capacity

$\Rightarrow \sigma_{tension} = \frac{M}{I} \times y$; $I_z = 1,439 \times 10^9\ mm^4$ (SC2)

$y = \frac{609}{2} - 66 = 238.5\ mm$

$\Rightarrow \sigma_{tension} = \frac{1116,2 \times 10^6\ N.mm}{1.439 \times 10^9} \times 238.5 = 185\ MPa$

$\sigma_{comp} = \frac{1116,2 \times 10^6}{1.439 \times 10^9} \times 370.5 = 287\ MPa$

Allowable stress is $0.9 \times 170\ MPa = 153\ MPa < 185/287\ MPa$

(steel strength not known) ↵ Not ok

Checked : ....

Date : ..../..../....

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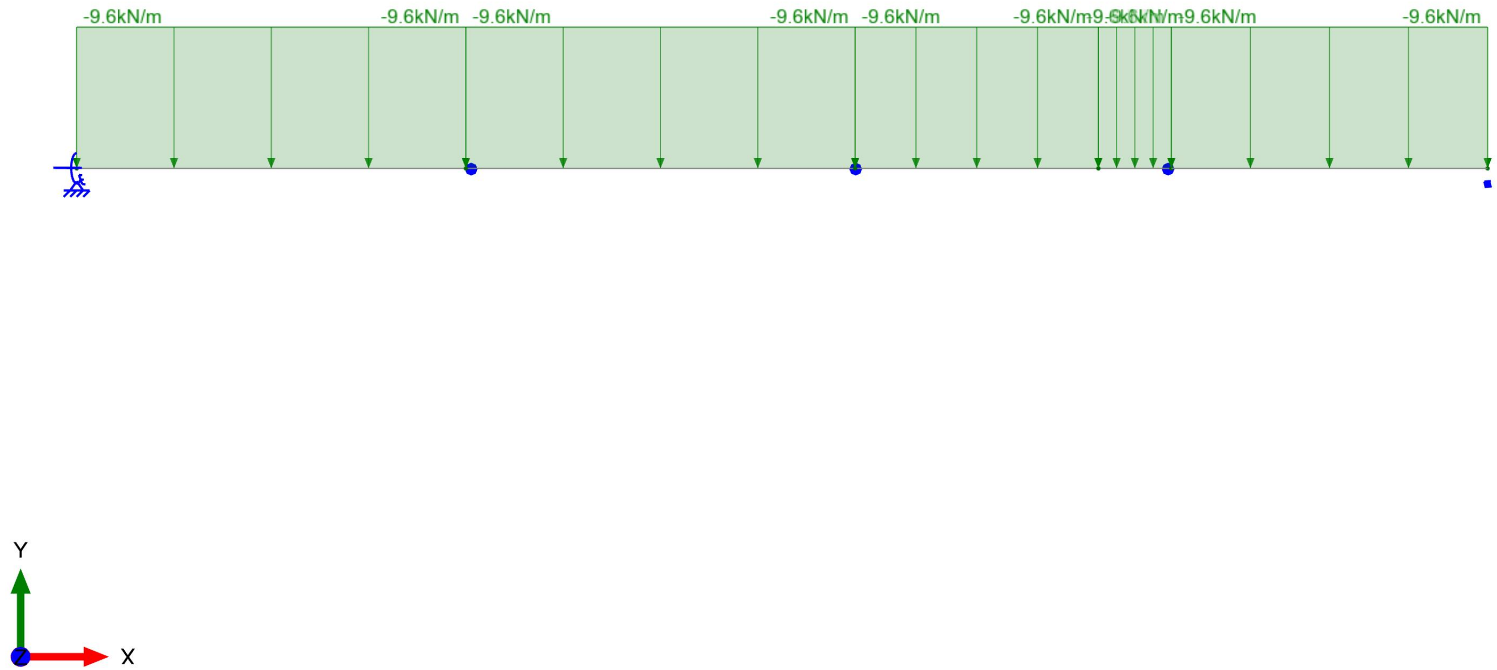
Load case 2
2 dl



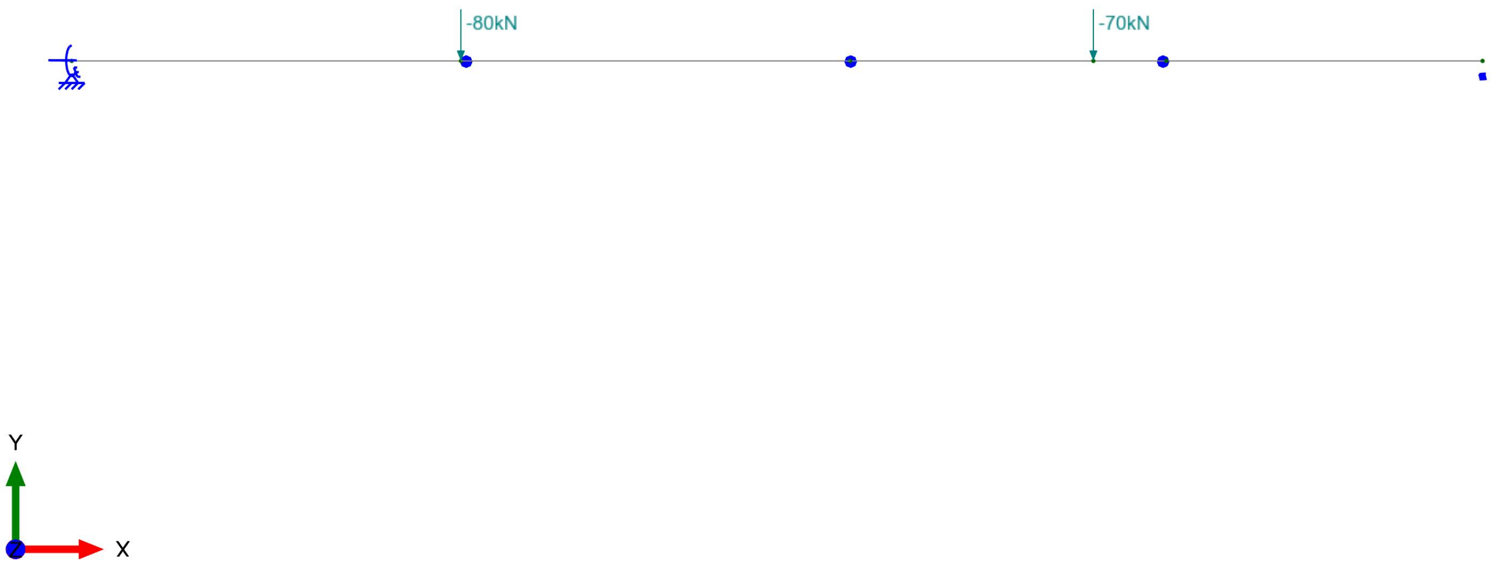
Viewpoint (0,0), Loads

Materials: 1 STEEL

Sections: 1 bridge

Load case 3

3 ll



Viewpoint (0,0), Loads

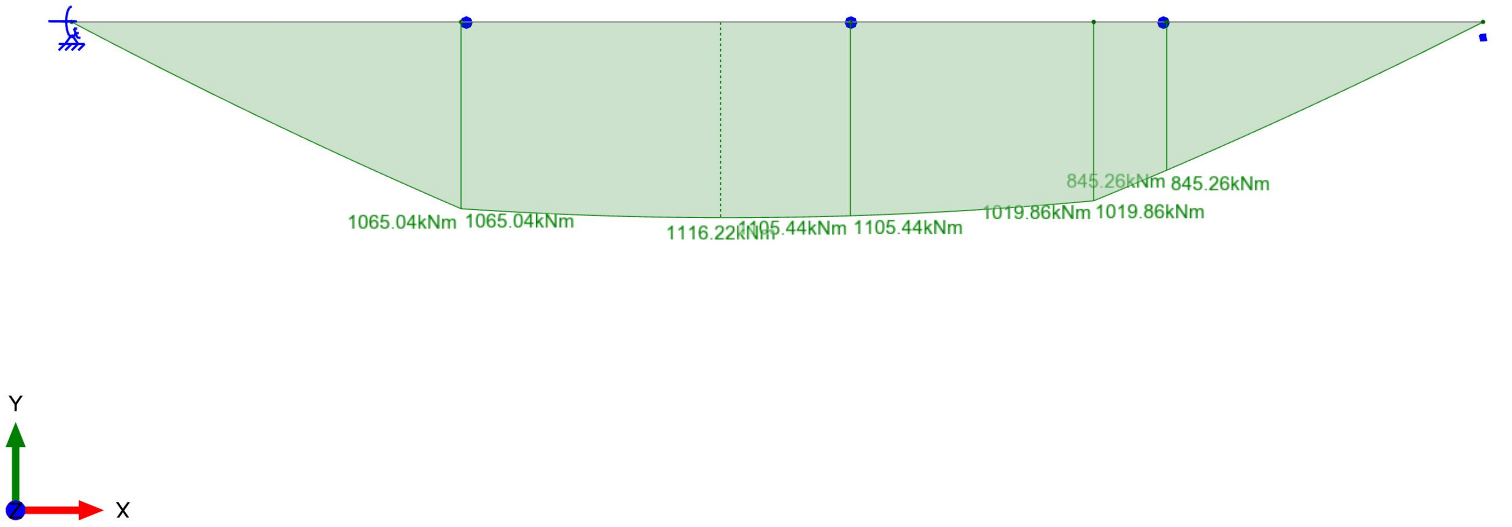
Materials:
1 STEEL

Sections:
1 bridge

SPACE GASS 14.00 - TMK CONSULTING ENGINEERS
Path: K:\2022\02\2202023\Structural Drawings and Ca...\Bridge\load on 1 beam
Designer: Date: Thursday, March 3, 2022 10:30 AM, Page: 1

Load case 102

102 (SW) 1.2DL+2.52LL

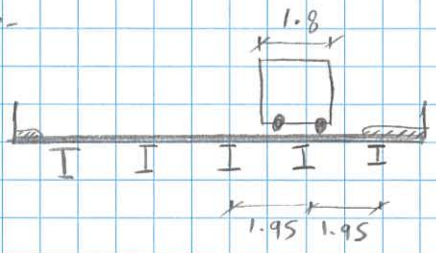


Viewpoint (0,0), Moments

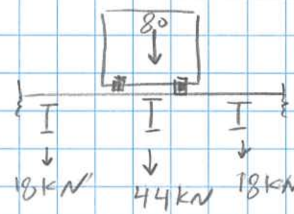
Materials: 1 STEEL

Sections: 1 bridge

Case 2: the loads shared between adjacent beams:-

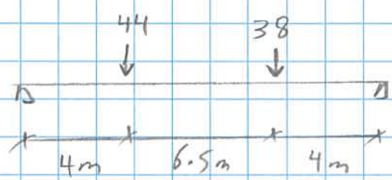


- considering bus width is 1.8 & tributary width between beams is 1.95 → max axle load on beam is $\frac{80kN}{2} \times \frac{1.95}{1.8} = 43.3\,kN \approx 44\,kN$



• we will recheck the beam based on new loads:-

SG → $M_u^* = 773\,kN.m$

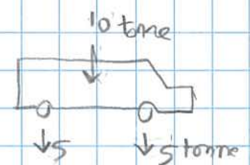


* check stress diagram of the beam:-

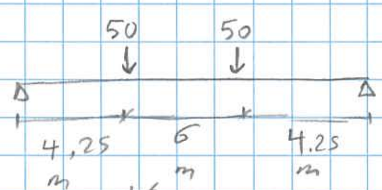
SC-09 → { max compression stress is 198 > 153 Mpa not ok
max tension stress is 139 < 153 Mpa ok

⇒ [15 Tonne bus is not allowed to cross the bridge until further assessment of steel grade (Properties f_y, f_u) to be done]

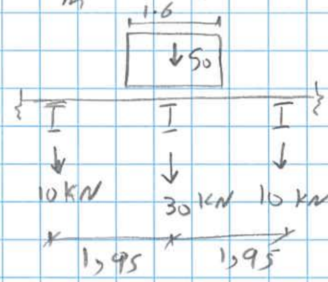
Case 3: Check vehicles of 10 tonne Max, with sharing loads between 3 beams:-



⇒ Each beam max load is $\frac{50}{2} \times \frac{1.95}{1.6} = 30.5\,kN$ max



• we will check Bending:-



SG-10 $M_u^* = 660\,kN.m$

SG-11 max stress on bridge beam:

- compression flange 170 Mpa ≈ f_y
- Tension flange 118 Mpa

⇒ [we can accept (10 tonne) vechicle with 5 t axle load at max]

Checked : ....

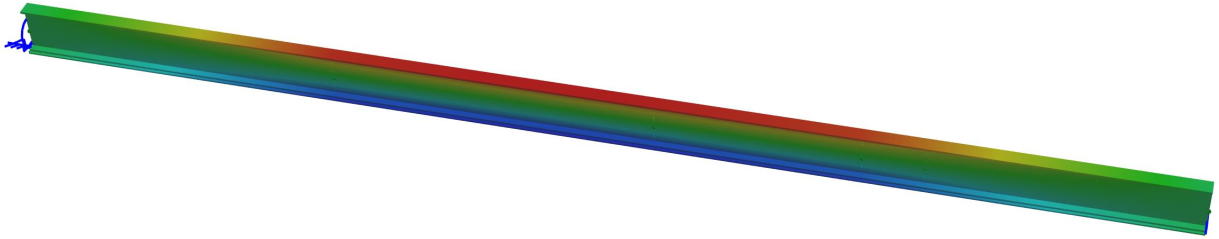
Date : ..../..../.....

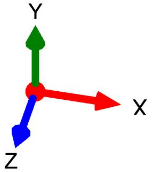
SPACE GASS

Load case 102

Bending Stress:

- 287.43 MPa
- 261.78 MPa
- 236.13 MPa
- 210.47 MPa
- 184.82 MPa
- 159.16 MPa
- 133.51 MPa
- 107.85 MPa
- 82.20 MPa
- 56.55 MPa
- 30.89 MPa
- 5.24 MPa
- -20.42 MPa
- -46.07 MPa
- -71.72 MPa
- -97.38 MPa
- -123.03 MPa
- -148.69 MPa
- -174.34 MPa
- -200.00 MPa



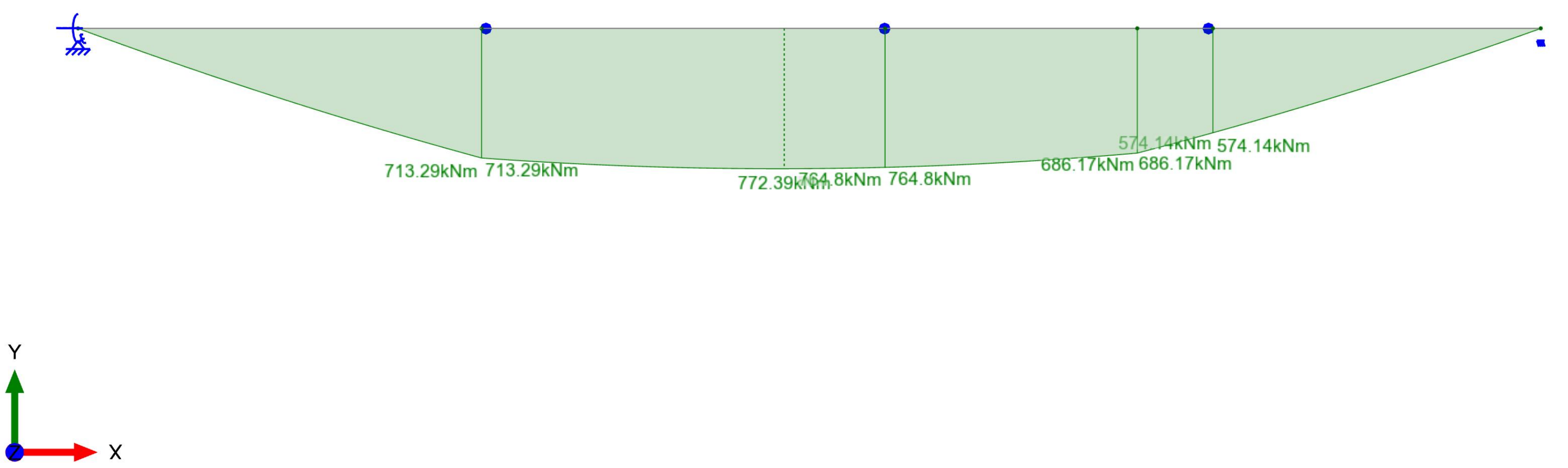


Viewpoint (13,41)

Materials:
1 STEEL

Sections:
1 bridge

Load case 102
102 (SW) 1.2DL+2.52LL

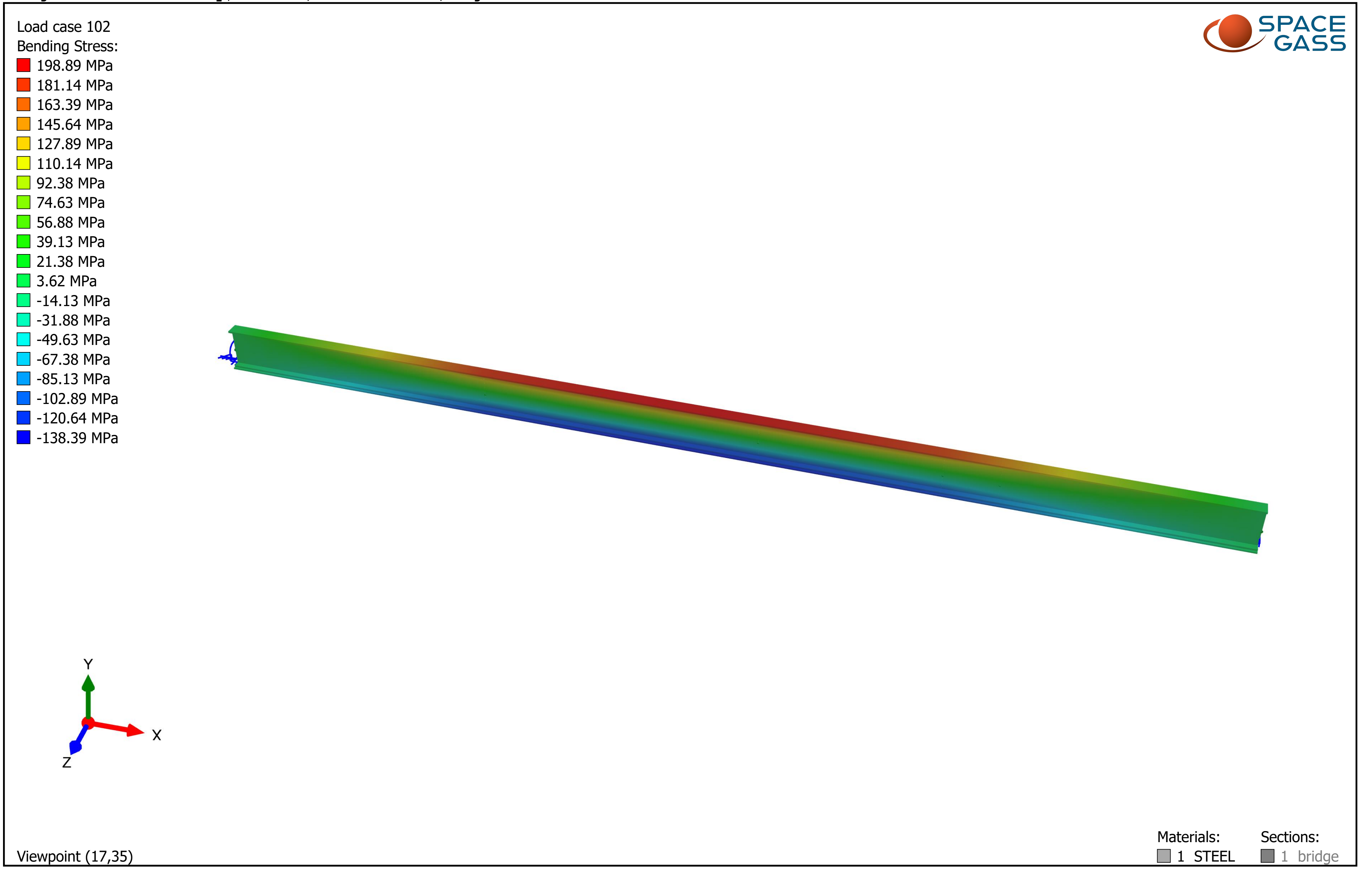


Viewpoint (0,0), Moments

Materials:
1 STEEL

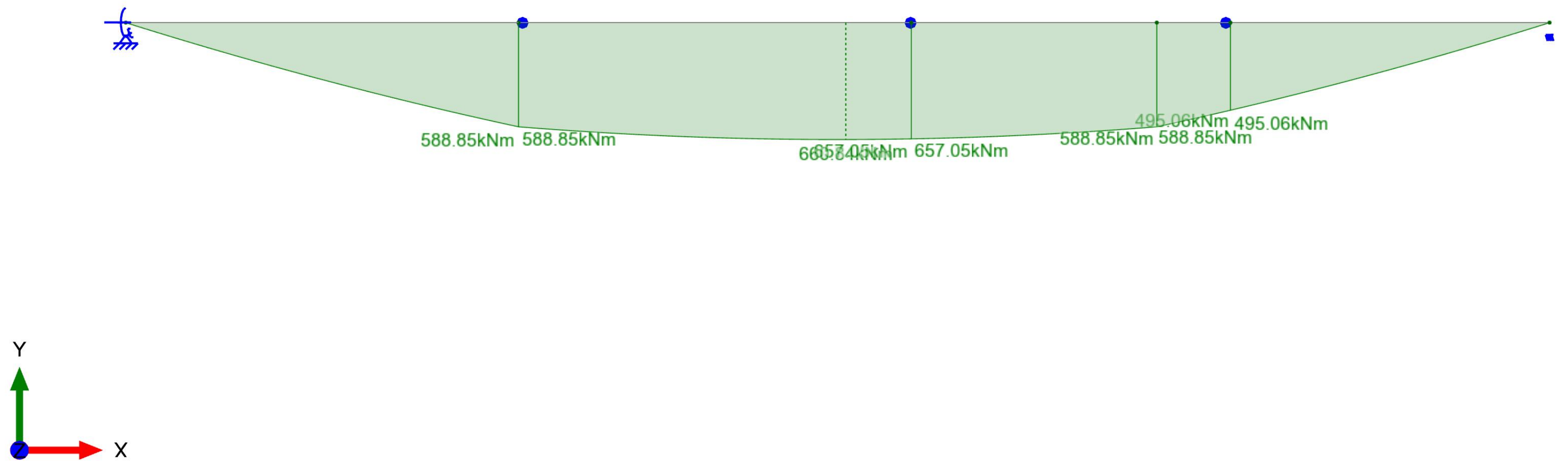
Sections:
1 bridge

SPACE GASS 14.00 - TMK CONSULTING ENGINEERS
Path: K:\2022\02\2202023\Structural Dra...\Bridge\load shared between 3 beam
Designer: Date: Thursday, March 3, 2022 10:58 AM, Page: 1



SPACE GASS 14.00 - TMK CONSULTING ENGINEERS
Path: K:\2022\02\2202023\Struc...\Bridge\10 tonne load shared between 3 beam
Designer: Date: Thursday, March 3, 2022 11:39 AM, Page: 1

Load case 102
102 (SW) 1.2DL+2.52LL

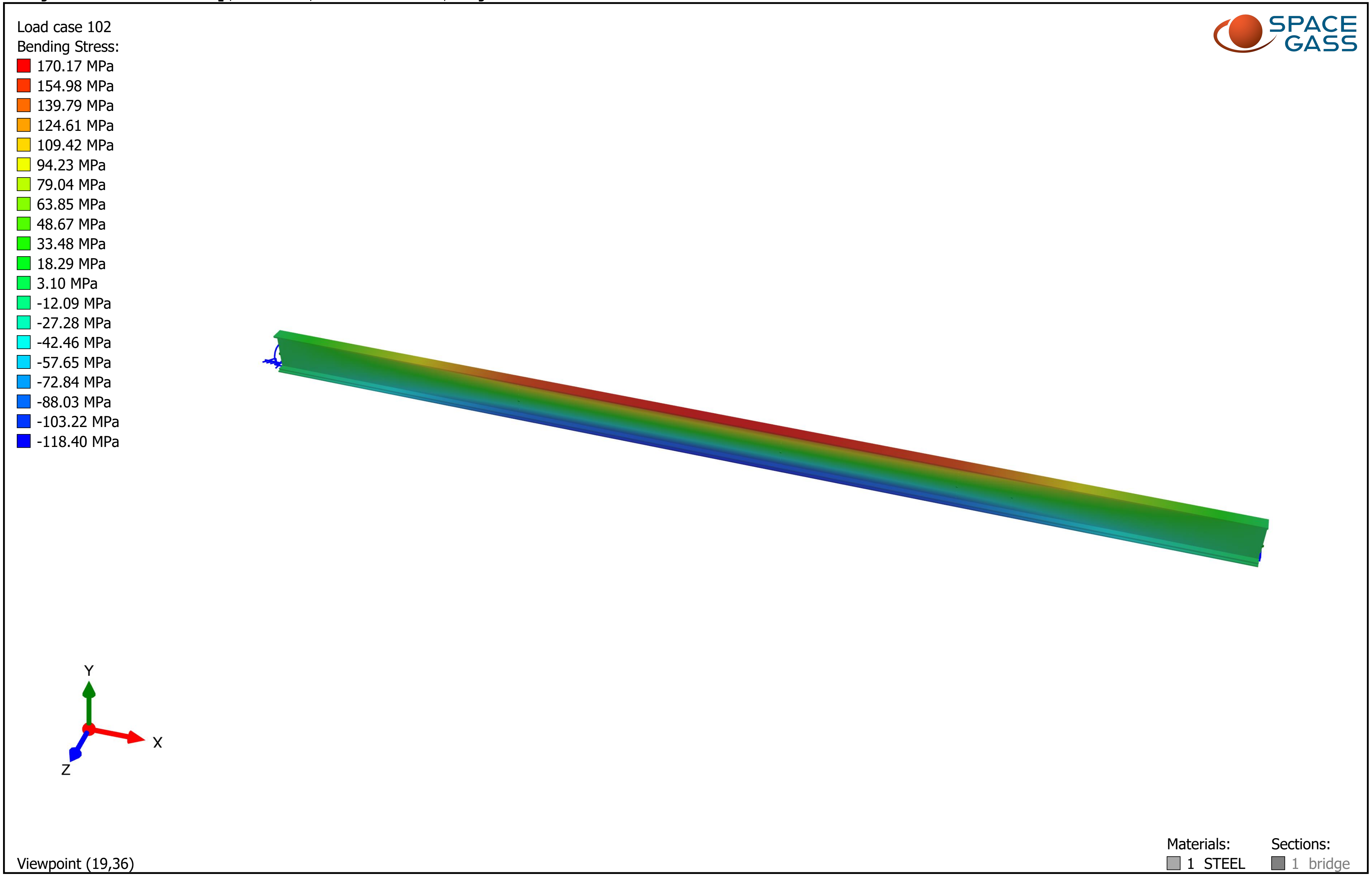


Viewpoint (0,0), Moments

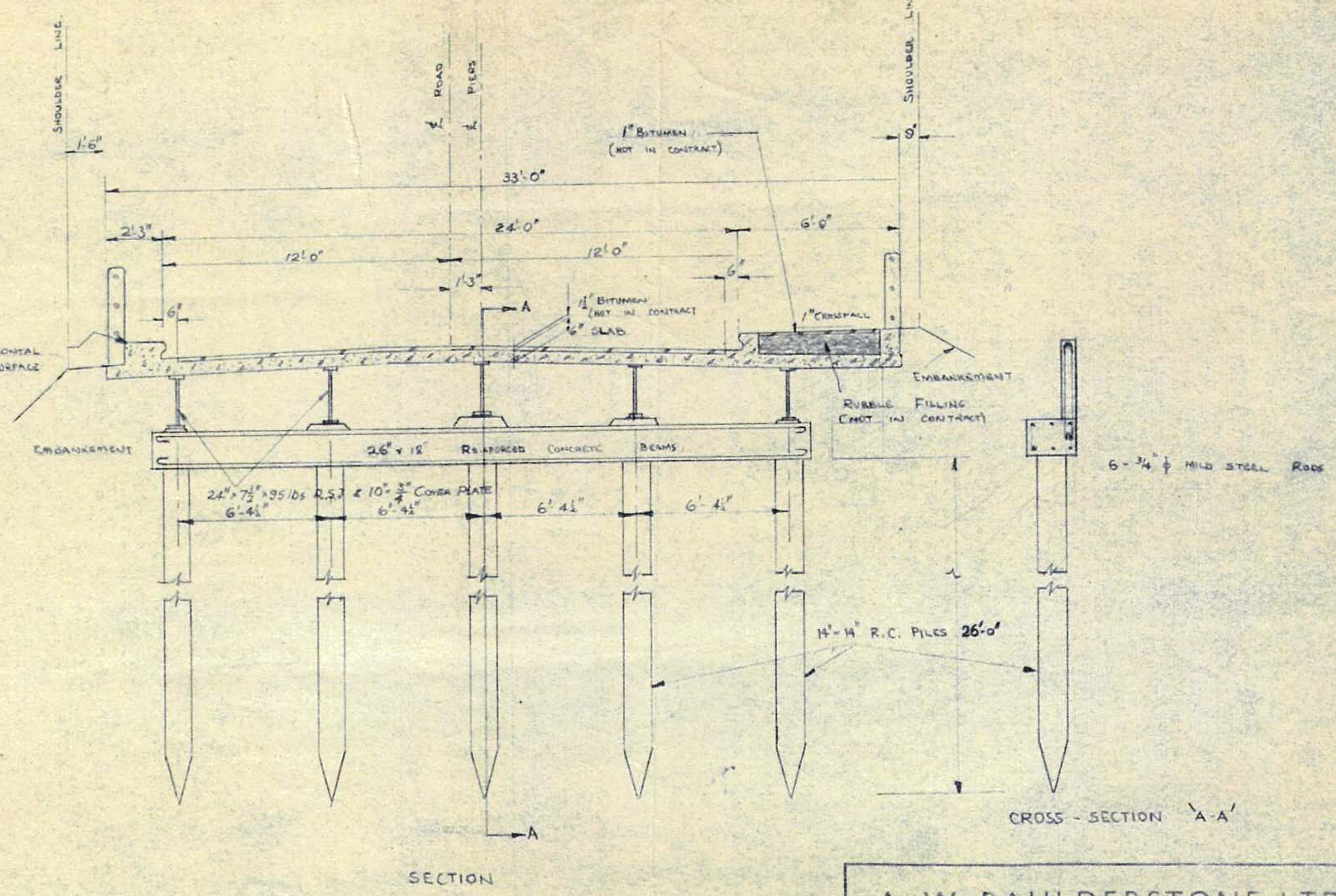
Materials:
1 STEEL

Sections:
1 bridge

SPACE GASS 14.00 - TMK CONSULTING ENGINEERS
Path: K:\2022\02\2202023\Struc...\Bridge\10 tonne load shared between 3 beam
Designer: Date: Thursday, March 3, 2022 11:39 AM, Page: 1



5.1.3 ENGINEERING DRAWINGS – (A.W. BAULDERSTONE – DRAWING NO. 1 & DRAWING NO. C60-108 SHEET 2)

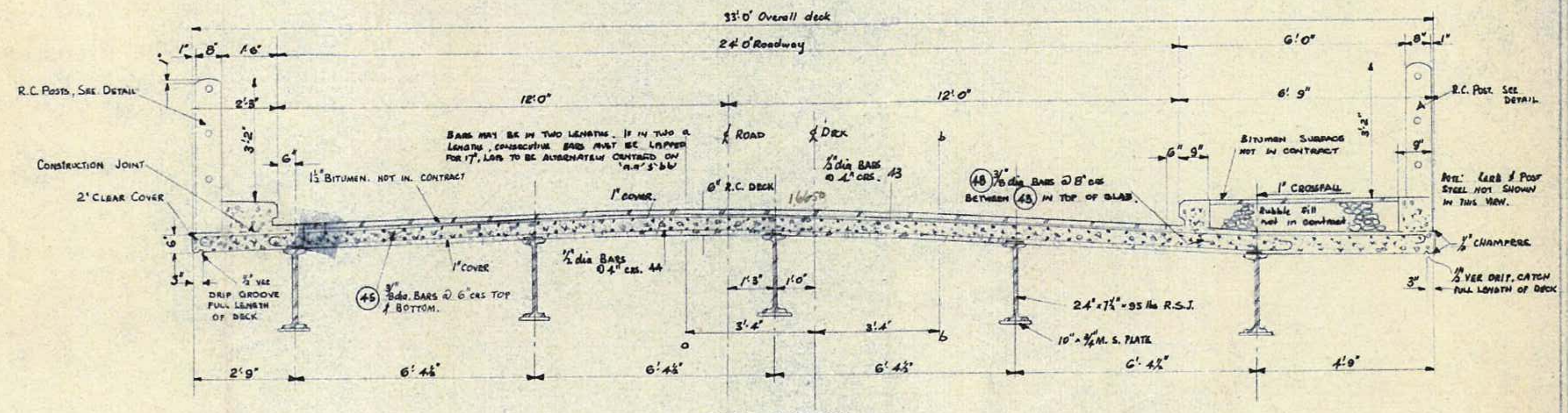


A. W. BAULDERSTONE LTD.

CIVIL ENGINEERS & BUILDING CONTRACTORS

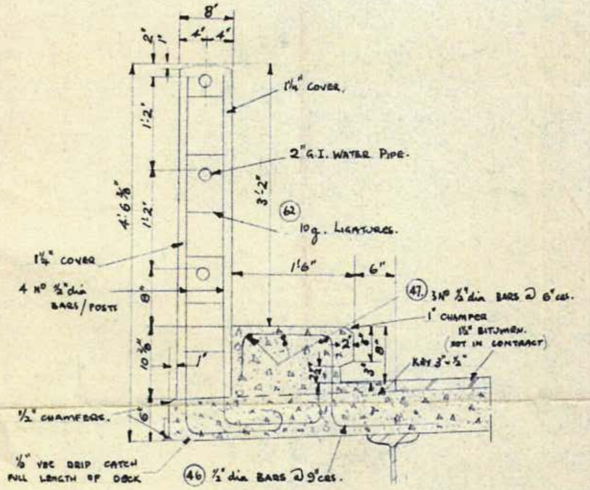
60 KENSINGTON TERRACE, KENSINGTON : FA 7221-5

DRAWN: Laddison	JOB No. D59 - 99
SCALE: ¼" = 1'	
DATE: 10 · 9 · 59	DRG. No. 1



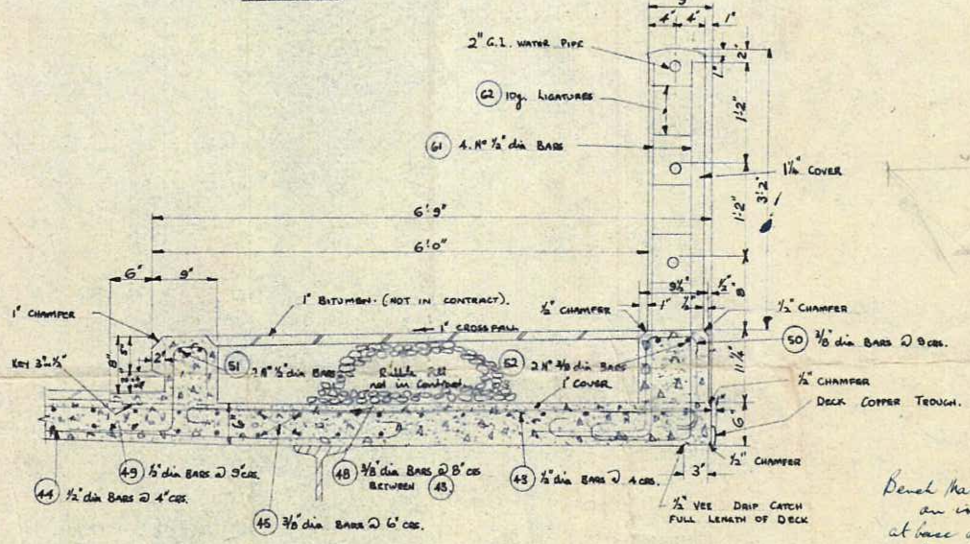
DECK SECTION

SCALE: ½" = 1'0"



POST - ROAD KERB SIDE

SCALE: 1" = 1'0"



POST - FOOTPATH SIDE

SCALE: 1" = 1'0"

Bench Mark on iron at base of tree } Value –

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RENMARK. IRRIGATION TRUST
21 st. STREET BRIDGE.

Eng ref 150,352

DR6-2

DRAWN	L. G. ADDISON
SCALE	AS SHOWN.
DATE	FEB. '60.
JOB No.	
DWG No.	C60 - 108.

Sheet 2.