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Attorneys for the Government of Guam

RECEIVED
OFFICE OF PUBLIC ACCOUNTABILITY
PROCUREMENT APPEALS
DATE: 02.12.18
TIME: 4:32 ☐AM ☑PM BY: [illegible]
FILE NO OPA-PA: 18-002

IN THE OFFICE OF PUBLIC ACCOUNTABILITY PROCUREMENT APPEAL

IN THE APPEAL OF:	DOCKET NO. OPA-PA-18-002
KORANDO CORPORATION,	
Appellant.	**DEPARTMENT OF PUBLIC WORKS SUPPLEMENTAL TO PROCUREMENT RECORD**
And	
DEPARTMENT OF PUBLIC WORKS,	
Purchasing Agency.	

Comes now, Department of Public Work ("DPW"), and through its undersigned counsel, herein submits the Bile/Pigua Bridge Replacement Project, Merizo, Project No. GU-NH-NBIS(007).

- Bile and Pigua Bridges Reconstruction and Widening
  Existing Interim Bridges Capacity and Alleged Power Line Conflict

///

ORIGINAL

Dated this 12th day of February, 2018.

OFFICE OF THE ATTORNEY GENERAL
Elizabeth Barrett-Anderson, Attorney General

By: ______________________________

THOMAS KEELER
Assistant Attorney General

The Honorable
Eddie Baza Calvo
Governor

The Honorable
Ray Tenorio
Lieutenant Governor

Received
Korando Corp.
3/4/16
4:50 p.m.

public works
DIPATTAMENTON CHE'CHO PUPBLEKO
Glenn Leon Guerrero
Director
Felix C. Benavente
Deputy Director

TN16-354

MAR 0 4 2016

Mr. Byong Ho Kim
President
Korando Corporation
PO Box 20538
GMF, GU 96921

Ref: **Bile/Pigua Bridges Replacement**
Project No. GU-NH-NBIS(007)
<u>Existing Interim Bridges Capacity and Alleged Power Line Conflict</u>

Dear Mr. Kim:

Korando Corporation declined to sign Change Order No. 01 which was to establish a new Notice to Proceed (NTP) date of January 25, 2016, citing that issues regarding the load capacity of the existing bridges and conflicts with the overhead power lines need to be resolved before agreeing to a new NTP date. A meeting was held with you on February 1, 2016 with follow-on meetings with your staff and consultants on February 4, 2016 and February 8, 2016 discussing these two issues. This letter addresses both issues and provides the Department of Public Works' (DPW) position.

LOAD BEARING CAPACITY OF THE EXISTING BRIDGES

Item 5.b of the Stipulation and Order dated December 16, 2015 to Rescind the Termination of Korando Corporation on the Bile/Pigua Bridge Replacement Project (GU-NH-NBIS(007)) states: " *Korando's Alternate Phasing Plan requires the construction of a new temporary steel bridge ("New Steel Bridge") due to its contention of the inadequacy of the existing temporary steel bridges. Korando will submit a change order for all costs associated with the New Steel Bridge as proposed in Submittal No. 562.001-02.*"

Following the meeting held on February 8, 2016, Parsons Brinkerhoff's (PB) bridge staff in Portland, Oregon initiated an independent review of the letter, report, and calculations provided by GK2 shortly prior to the meeting. During the review, a number of issues requiring verification were found. As part of the verification process, on February 10, 2016, condition assessment inspections were made on both the Bile and Pigua bridges. During those inspections, measurements were made, pictures taken, and condition assessments were performed. See attached Bridge Inspection Reports (Exhibits 1 and 2).

Additionally, DPW and Duenas, Camacho & Associates, Inc. (DCA) performed a record search for the materials purchased by DPW for the interim structures and inspection records. That search produced a copy of the purchase order used by DPW to acquire the materials, a mill certification from the steel supplier in Korea, and pictures of the fabrication and construction. These documents are also attached for your reference (Exhibits 3 thru 5).

The review by PB has determined that the GK2 hand calculations (Methods I and II) have several issues that indicate an overly conservative approach and therefore were dismissed and not evaluated. The 3rd method, the finite element analysis, appears to be the most accurate of the three.

To assess the finite element analysis by GK2, both PB and DCA performed independent analyses of the

The Honorable
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public works
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TN16-354

MAR 04 2016

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President
Korando Corporation
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Project No. GU-NH-NBIS(007)
Existing Interim Bridges Capacity and Alleged Power Line Conflict

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The review by PB has determined that the GK2 hand calculations (Methods I and II) have several issues that indicate an overly conservative approach and therefore were dismissed and not evaluated. The 3rd method, the finite element analysis, appears to be the most accurate of the three.

To assess the finite element analysis by GK2, both PB and DCA performed independent analyses of the structures using the measurement information from the bridge inspections held on February 10, 2016. Those analyses have been completed and are attached for your reference (Exhibits 6 and 7). The results from both analyses conclude that the bridges are safe for Guam legal loads and thus do not need to be posted, and are also adequate when analyzed using AASHTO crtiteria. Note that both the PB and DCA analysis were based on a beam steel yield of 36 ksi versus the actual value of 48 ksi. Had this been accounted for in the analysis, greater capacities would have resulted.

An additional issue discussed during the February 8, 2016 meeting was the proposed crane owned by Smithbridge. The proposed crane as depicted, weighs 132,000 pounds, has 5 axles, and has a wheelbase of 25.72'. This is not a Guam legal load and Smithbridge would have to acquire a permit to drive it on any Guam roadway. Given the magnitude of the crane weight, it remains to be verified that such a crane could be legally permitted as configured in Korando's/GK2's documents. The entire travel route from the Smithbridge yard to the project site would have to be analyzed and capacity calculations made for each bridge crossed. Should the results indicate that it could not be driven as configured, it would have to be partially dismantled and transported separately to the job site, and then re-assembled.

For your convenience, a quick check against the current law shows that the maximum permitted load with the noted wheelbase is only 64,000 pounds (Bridge Formula). Note that the proposed crane also fails under the single axle criteria (26,400 pounds versus the allowable 20,000 pounds) and also the tandem axle criteria (52,800 pounds versus the allowable 34,000 pounds). The prior law, pre-February 2, 2016, would have limited this crane as well (76,800 pounds maximum) and for single axle and tandem axles (20,000 pounds and 36,000 pounds, respectively). DPW's conclusion from this quick check is that Korando/Smithbridge would have to develop an acceptable and legal transportation plan before this crane could be considered for use at the Bile and Pigua sites. Hence, it is premature to assess any potential impacts to the existing bridges until Korando can demonstrate how this crane can be permitted for transportation to the project sites.

THE EXISTING OVERHEAD POWER LINES

Item 5.c of the Stipulation and Order dated December 16, 2015 to Rescind the Termination of Korando Corporation on the Bile/Pigua Bridge Replacement Project (GU-NH-NBIS(007)) states: *"Korando contends there is a conflict between the existing overhead power lines and the operation of the crane when hoisting and positioning the piles during the pile driving operation (the "Conflict") as depicted in the Department of Public Works' (DPW) construction documents. If DPW/owner in coordination with Korando reasonably determines this is a design issue, DPW will be responsible for: (i) finding a constructable solution, redesigning and providing the new plans to address this conflict, and (ii) contacting Guam Power Authority (GPA) and third party communication providers".*

It was noted in the February 8, 2016 meeting, Korando's conclusion that crane operations which require a 180 degree swing path to offload the piles and then install them is unproven given there are options for off-loading the piles and performing crane operations in a straight boom line configuration, without substantial swing. It was also noted that Korando's assertion that no legal traffic load can safely cross the existing bridges is based purely on GK2's assumptions and calculations discussed above. And therefore, the 180 degree swing path is the only viable solution to installing the piles. DPW determines that GK2's conclusion is without basis and the independent analyses prove that legal loads can traverse the existing bridges, leaving the crane as the only equipment which cannot legally cross the bridges. With GPA allowing backfeeding and outages and considering the actual voltage in the power lines, the safe offset from the lines is reduced to 10 feet. The crane boom pick line can therefore be straight and the boom distances are remarkably close to Korando's original approach diagrams. In short, since both bridges can safely carry legal loads, the alleged electrical line conflicts are the result of contractor convenience and not constructability.

Per OSHA 1926.1408, there are 3 options for safe operation of cranes and derricks from a live *power line up to 350 kV:*

1. *De-energize power line*
2. *Maintain 20' clearance*
3. *Maintain minimum clearance per Table A (OSHA 1926.1408).*

Since the existing power line is 13.8 kV and in accordance with Table A requires a minimum clearance of 10'. A copy of OHSA 1926.1408 including Table A is attached for your reference (Exhibit 8).

CONCLUSION

DPW has reasonably determined that the construction of a new temporary steel bridge ("New Steel Bridge") as required by Korando's Alternate Phasing Plan due to its contention of the inadequacy of the existing temporary steel bridges as presented in Item 5b of the December 16, 2015 Stipulation and Order is unfounded. The Bridge Replacement Interim Repair Plans and accompanying calculations provided by DCA, plus both independent analyses indicate that both existing bridges are safe for normal highway loading. DPW has reasonably determined that the "Conflict" between the overhead power lines and the crane operation when hoisting and positioning during the pile driving operations as presented in Item 5c of the December 16. 2015 Stipulation and Order is not a design issue. Pile off-load, positioning, and driving and bridge construction can be accomplished using the contract 2-phase construction plan at both bridges, as conceived by DCA, without requiring the lowering or undergrounding of the power lines as is contended by Korando.

Per the Construction Progress Meeting held on March 3, 2016, Korando will be given the opportunity to review PB and DCA's bridge analyses and present any questions or concerns during the next scheduled progress meeting on March 10, 2016. DPW will revise and reissue Change Order No. 01 with a NTP date of March 14, 2016.

If you have any questions or need additional information, please contact Mr. Houston Anderson, Construction Manager with Parsons Transportation Group, Inc. at 648-1066 or Jeff Miller, Chief Resident Project Representative, TG Engineers at 647-0808.

Sincerely,

GLENN LEON GUERRERO

Encl. Exhibit 1 Bile Bridge Inspection Report
Exhibit 2 Pigua Bridge Inspection Report
Exhibit 3 Purchase Order and Invoice
Exhibit 4 Mill Test Certificate
Exhibit 5 Construction Photos
Exhibit 6 Bridge Load Rating Report Bile & Pigua Bridges
Exhibit 7 Bile and Pigua Bridge Temporary Bridge Analysis
Exhibit 8 OSHA 1926.1408

Cc: Isidro Duarosan, DPW
Crispin Bensan, DPW
Richelle Takara, FHWA
Houston Anderson, PTG
David Yao, PTG
Jeff Miller, TGE

IDuarosan JBlaz
3/04/16

BRIDGE INSPECTION REPORT

GUAM DEPARTMENT OF PUBLIC WORKS

BILE BRIDGE

STRUCTURE NO. **32**

INSPECTION TYPE: SPECIAL

INSPECTION DATE: 2/10/2016

Report Prepared by:

PARSONS BRINCKERHOFF

590 S. Marine Corps Dr.
Suite 421, Tamuning, GU
96913

LYNDEN M. KOBAYASHI
CERTIFICATE No. 1821
(CIVIL)
EXP. 04/30/17
GUAM
PROFESSIONAL ENGINEER

03/03/16

I HEREBY CERTIFY THAT THIS WORK WAS PREPARED BY ME OR UNDER MY RESPONSIBLE CONTROL.

CONDITION RATING CODE & EQUIVALENTS		
BRIDGE ELEMENTS	**CODE**	**EQUIV.**
DECK	-	-
SUPERSTRUCTURE	-	-
SUBSTRUCTURE	-	-
CHANNEL	-	-
CULVERT	-	-
APPROACHES	-	-
RETAINING WALL	-	-
TRAFFIC & SAFETY FEATURES	-	-
BRIDGE RAILINGS	-	-
TRANSITIONS	-	-
APPROACH GUARDRAILS	-	-
APPROACH GUARDRAIL ENDS	-	-

BRIDGE CONDITION DESCRIPTION

This single span, one lane, steel beam bridge has been built up over the old Bile bridge and acts independently on its own abutment and foundation. Overall the deck and superstructure are in good condition with only moderate surface corrosion of the exterior (inland) beam and inland end of the steel plate edge. The tops of the bottom flanges for the remaining beams show very minor corrosion with minor deterioration of the coating surface.

BILE BRIDGE STRUCTURE NO. **32**

FIELD INSPECTION REPORT INSPECTION DATE: 2/10/2016

SUMMARY OF FINDINGS

MEMBER	FIELD NOTES
Deck	The deck is in good condition overall, with moderate surface corrosion on the upstream edge with no measurable section loss (compared measurement to non-corroded section). The deck edge was cleaned with a wire brush to remove debris and surface rust and the thickness was measured using calipers with an accuracy of one thousandths of an inch. The thickness measured to be 0.800" thick.
Deck splice plate	The deck composed of 2, 6'-1/2" wide by 20'-2" long steel plates that are welded together by rectangular splice plates at the forward and rear ends and at the centerline of the bridge. The welds and the plates appear to be in good condition.
Superstructure	The superstructure consists of 10 steel "W" beams. Based on the field measurements with calipers the "W" beams do not match standard sizes from the AISC steel manual and would fit somewhere between a W6x15 and W6x20. The flange thickness was measured to be 0.316", flange width of 5.972", web thickness of 0.244", and clear height between the flanges at 5.500". The clear spacing between beam webs was measured at 1'-3 3/4". Overall, there was only minimal corrosion with majority isolated to the exterior, inland beam.
Superstructure top flange weld	The welds between the top flange of the beams and the deck soffit were 5" long by 14" o.c. They appeared to be in good condition with no noticeable cracks.
Substructure	The substructure consisted of a reinforced concrete spread footing with a abutment cap that acts independently of the old Bile bridge. The clear spacing measured to be 17'-9", with a centerline bearing to centerline bearing distance of 19'-2". Based on what was accessible and visible, the abutment caps appeared to be in good condition with no noticeable spalling, cracking or settlement. The bearing devices were only partially visible and accessible, and appeared to be in fair condition.
Lateral bracing	It was confirmed that the bridge consisted of 3" by 3" by 0.236" thick steel angle lateral bracing spaced at 4'-2" o.c. welded to the bottom of each beam flange. The bracing and welds appeared to be in good condition with no corrosion.
Approaches	No visible settlement of the approaches were observed.

SPECIAL INSPECTION TEAM:

2/29/16
LYNDEN KOBAYASHI, P.E.
FIELD TEAM LEADER

2/26/16
DAVID YAO, PTG
RESIDENT ENGINEER

2/26/16
ISIDRO DUAROSAN, DPW
ENGINEERING SUPERVISOR

REPORT REVIEW / APPROVAL:

3-1-2016
MICHAEL LANNING, P.E., ACTING DPW CHIEF ENGINEER

BILE BRIDGE		STRUCTURE NO.	**32**
FIELD INSPECTION REPORT		INSPECTION DATE:	2/10/2016

PHOTOGRAPHS

Photo no. 1

Deck overview looking south

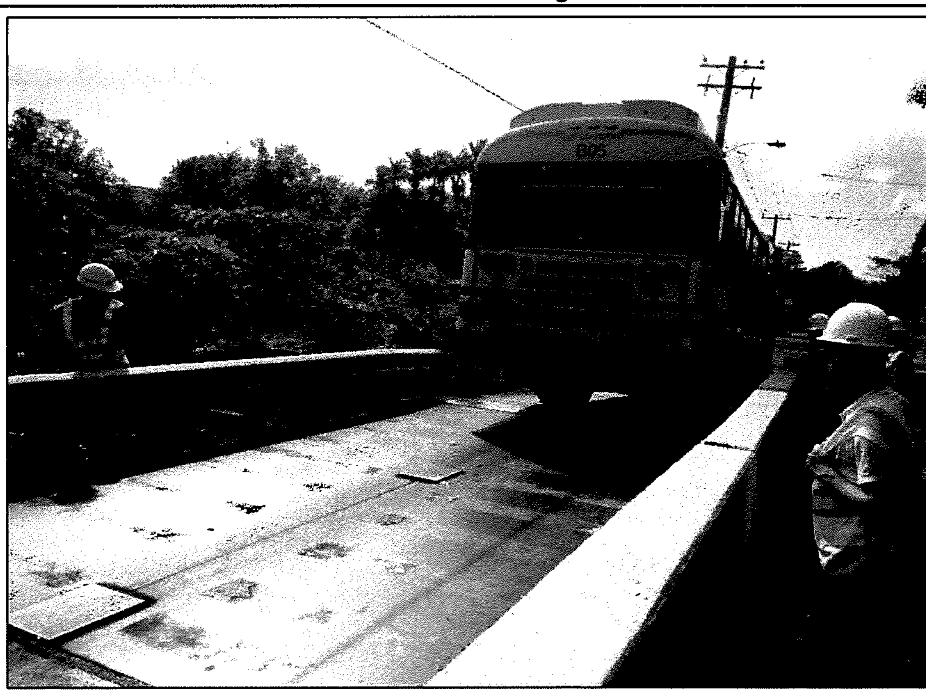


Photo no. 2

Passage of bridge by tour bus

BILE BRIDGE	STRUCTURE NO.	32
FIELD INSPECTION REPORT	INSPECTION DATE:	2/10/2016

PHOTOGRAPHS

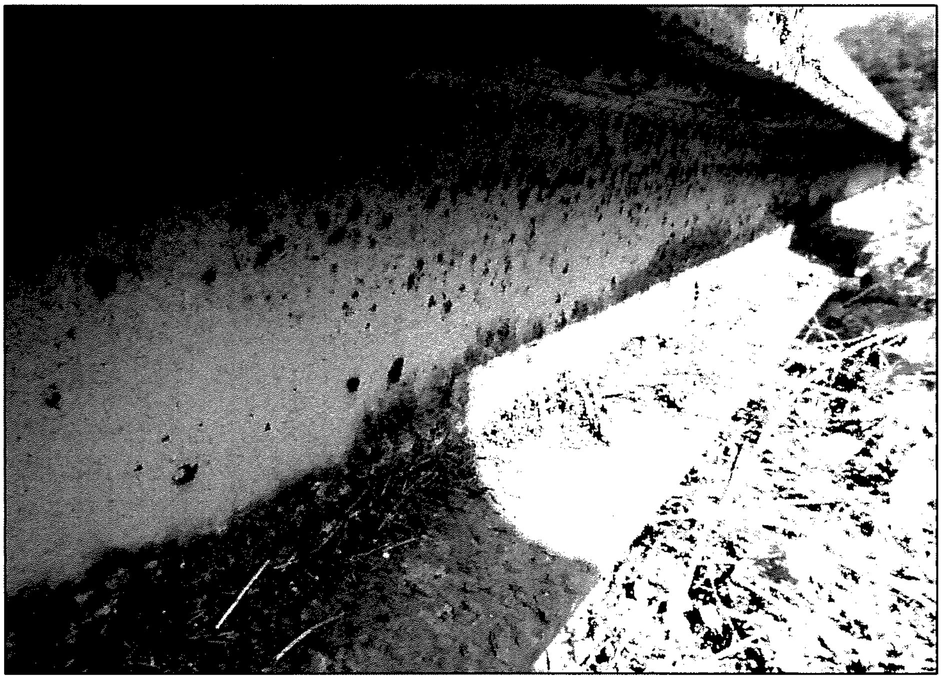


Photo no. 3

Moderate corrosion of the exterior upstream beam

Photo no. 4

Typical condition of beam flanges, wth minor freckled rust on the top of the bottom flange

Exhibit 1

BILE BRIDGE	STRUCTURE NO. **32**
FIELD INSPECTION REPORT	INSPECTION DATE: 2/10/2016

PHOTOGRAPHS

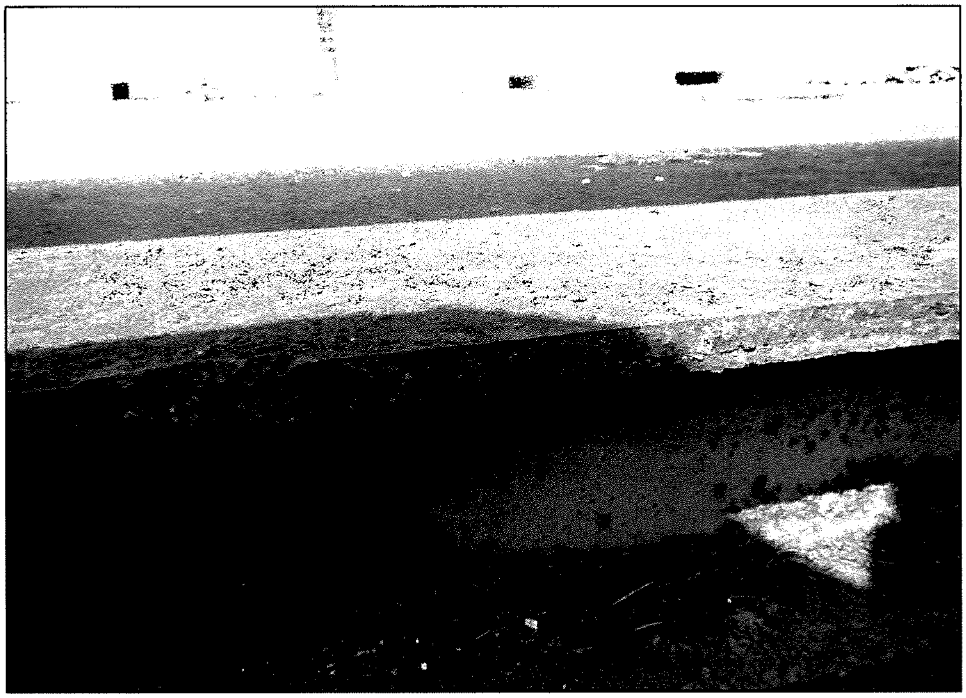


Photo no. 5

Typical moderate corrosion of upstream edge of deck.

Photo no. 6

Beam coating system is in fair condition

BILE BRIDGE	STRUCTURE NO. **32**
FIELD INSPECTION REPORT	INSPECTION DATE: 2/10/2016

PHOTOGRAPHS

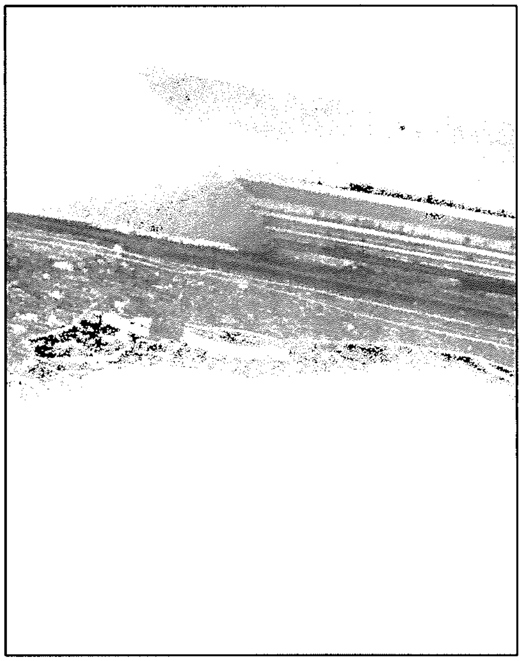


Photo no. 7

Horizontal bracing is in good condition

Photo no. 8

North abutment bearing seat is in fair condition

BRIDGE INSPECTION REPORT

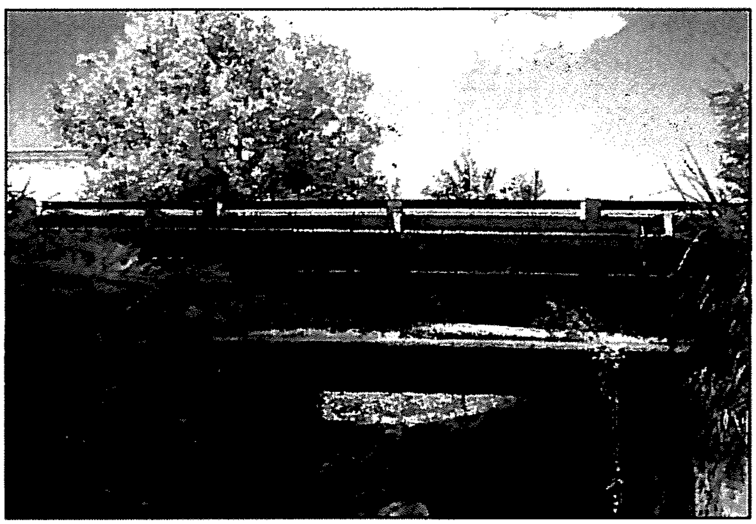
GUAM DEPARTMENT OF PUBLIC WORKS

PIGUA BRIDGE

STRUCTURE NO. 33

INSPECTION TYPE: SPECIAL

INSPECTION DATE: 2/10/2016



Report Prepared by:

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CONDITION RATING CODE & EQUIVALENTS		
BRIDGE ELEMENTS	CODE	EQUIV.
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SUBSTRUCTURE	-	-
CHANNEL	-	-
CULVERT	-	-
APPROACHES	-	-
RETAINING WALL	-	-
TRAFFIC & SAFETY FEATURES	-	-
BRIDGE RAILINGS	-	-
TRANSITIONS	-	-
APPROACH GUARDRAILS	-	-
APPROACH GUARDRAIL ENDS	-	-

BRIDGE CONDITION DESCRIPTION
This single span, one lane, steel beam bridge has been built up over the old Pigua bridge and acts independently on its own abutment and foundation. Overall the deck and superstructure are in good condition with only minor surface corrosion of the exterior (inland) beam and inland end of the steel plate edge.

PIGUA BRIDGE STRUCTURE NO. **33**

FIELD INSPECTION REPORT INSPECTION DATE: 2/10/2016

SUMMARY OF FINDINGS

MEMBER	FIELD NOTES
Deck	The deck is in good condition overall, with minor surface corrosion on the upstream edge with no measurable section loss (compared measurement to non-corroded section). The deck edge was cleaned with a wire brush to remove debris and surface rust and the thickness was measured using calipers with an accuracy of one thousandths of an inch. The thickness measured to be 0.800" thick.
Deck splice plate	The deck composed of 2, 6'-1/2" wide by 20'-2" long steel plates that are welded together by rectangular splice plates at the forward and rear ends and at the centerline of the bridge. The welds and the plates appear to be in good condition.
Superstructure	The superstructure consists of 10 steel "W" beams. Based on the field measurements with calipers the "W" beams do not match standard sizes from the AISC steel manual and would fit somewhere between a W6x15 and W6x20. The flange thickness was measured to be 0.316", flange width of 5.972", web thickness of 0.244", and clear height between the flanges at 5.500". The clear spacing between beam webs was measured at 1'-3 3/4".
Superstructure top flange weld	The welds between the top flange of the beams and the deck soffit were 5" long by 14" o.c. They appeared to be in good condition with no noticeable cracks. It should be noted that vibration and clicking was noticed during vehicle passage.
Substructure	The substructure consisted of a reinforced concrete spread footing with and abutment cap that acts independently of the old Pigua bridge. The clear spacing measured to be 17'-9", with a centerline bearing to centerline bearing distance of 19'-2". Based on what was accessible and visible, the abutment caps appeared to be in good condition with no noticeable spalling or cracking The bearing devices were not visible or accessible.
Lateral bracing	It was confirmed that the bridge consisted of 3" by 3" by 0.236" thick steel angle lateral bracing spaced at 4'-2" o.c. welded to the bottom of each beam flange. The bracing and welds appeared to be in good condition with no corrosion.
Approaches	There was no observed settlement at the approaches.

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FIELD TEAM LEADER

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DAVID YAO, PTG
RESIDENT ENGINEER

2/26/16
ISIDRO DUAROSAN, DPW,
ENGINEERING SUPERVISOR

REPORT REVIEW / APPROVAL:

3-1-2016
MICHAEL LANNING, P.E., ACTING DPW CHIEF ENGINEER

PIGUA BRIDGE	STRUCTURE NO.	**33**
FIELD INSPECTION REPORT	INSPECTION DATE:	2/10/2016

PHOTOGRAPHS

Photo no. 1
Deck overview looking east

Photo no. 2
Deck overview looking west

PIGUA BRIDGE	STRUCTURE NO. **33**
FIELD INSPECTION REPORT	INSPECTION DATE: 2/10/2016

PHOTOGRAPHS

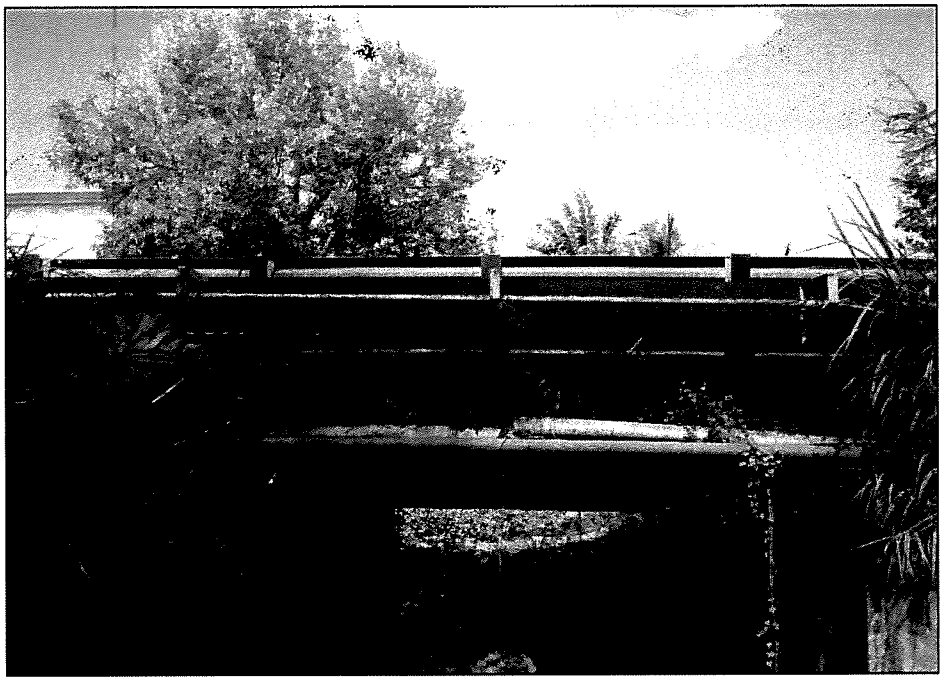


Photo no. 3

Elevation view from upstream

Photo no. 4

Non-traffic side of bridge on downstream end

PIGUA BRIDGE STRUCTURE NO. **33**

FIELD INSPECTION REPORT INSPECTION DATE: 2/10/2016

PHOTOGRAPHS

Photo no. 5

Typical underside view of beams with cross bracing are in good condition

Photo no. 6

Deck consisting of 2 steel plates welded together with splice plates is in good condition

PIGUA BRIDGE	STRUCTURE NO.	**33**
FIELD INSPECTION REPORT	INSPECTION DATE:	2/10/2016

PHOTOGRAPHS

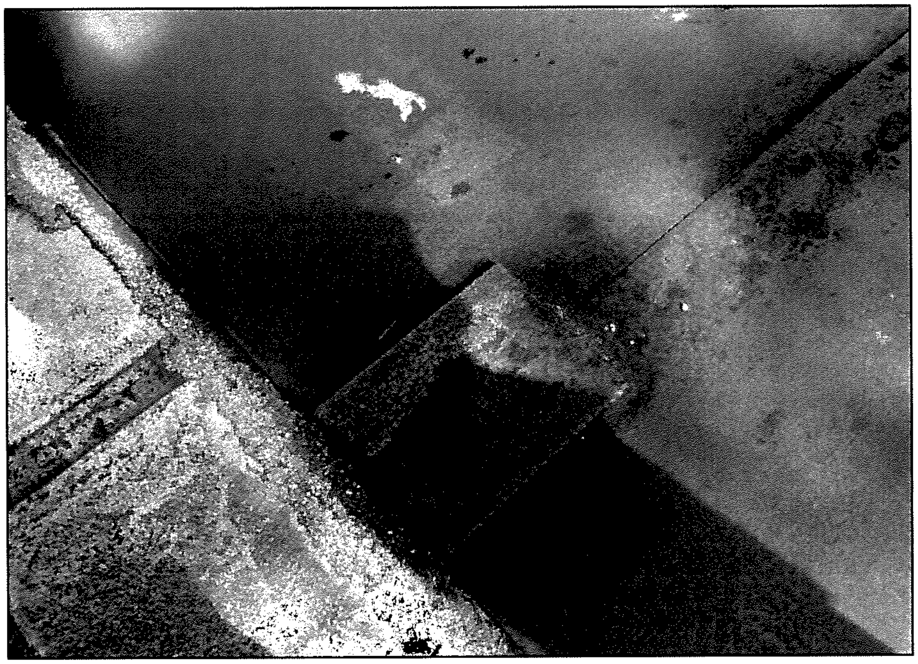


Photo no. 7

Splice plate welds are in good condition

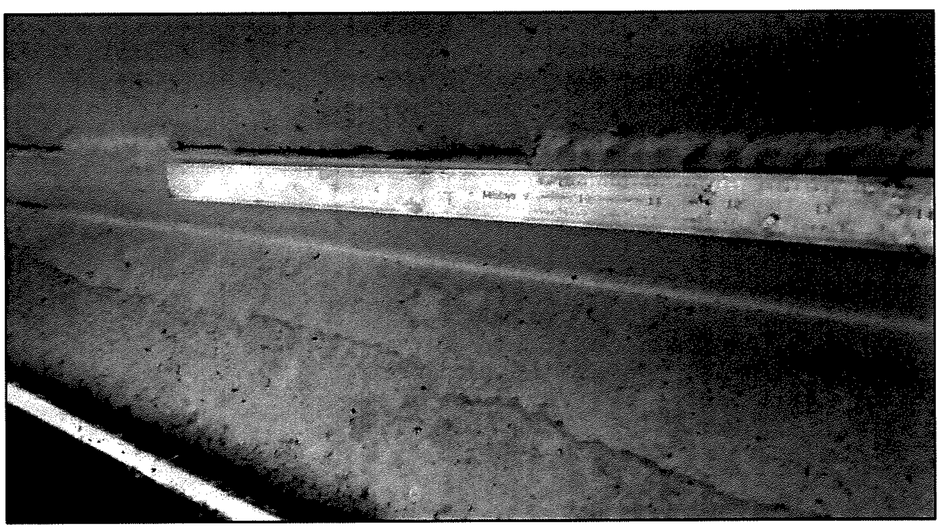


Photo no. 8

Welded connection between the beam top flange and deck soffit are in good condition

PIGUA BRIDGE	STRUCTURE NO.	**33**
FIELD INSPECTION REPORT	INSPECTION DATE:	2/10/2016

PHOTOGRAPHS

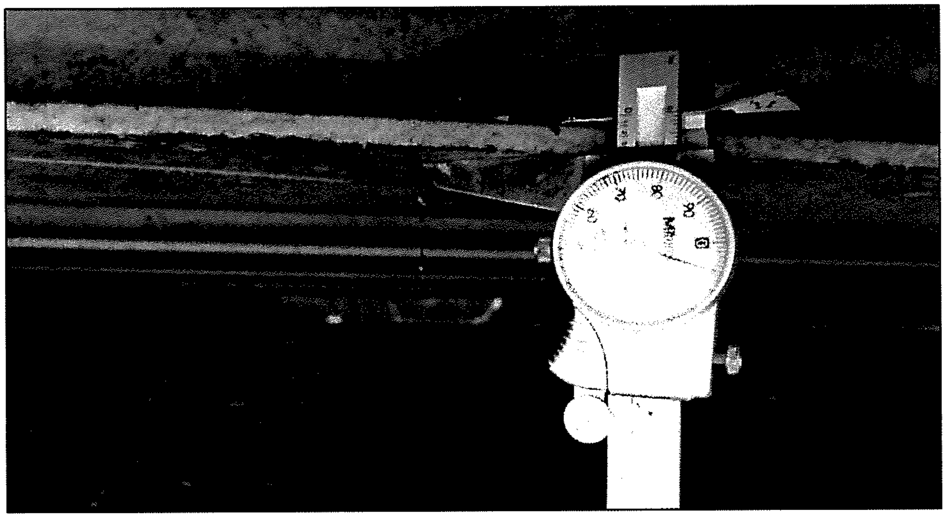


Photo no. 9

Minor corrosion with no section loss to only the exterior, upstream beam (t_f=0.316")

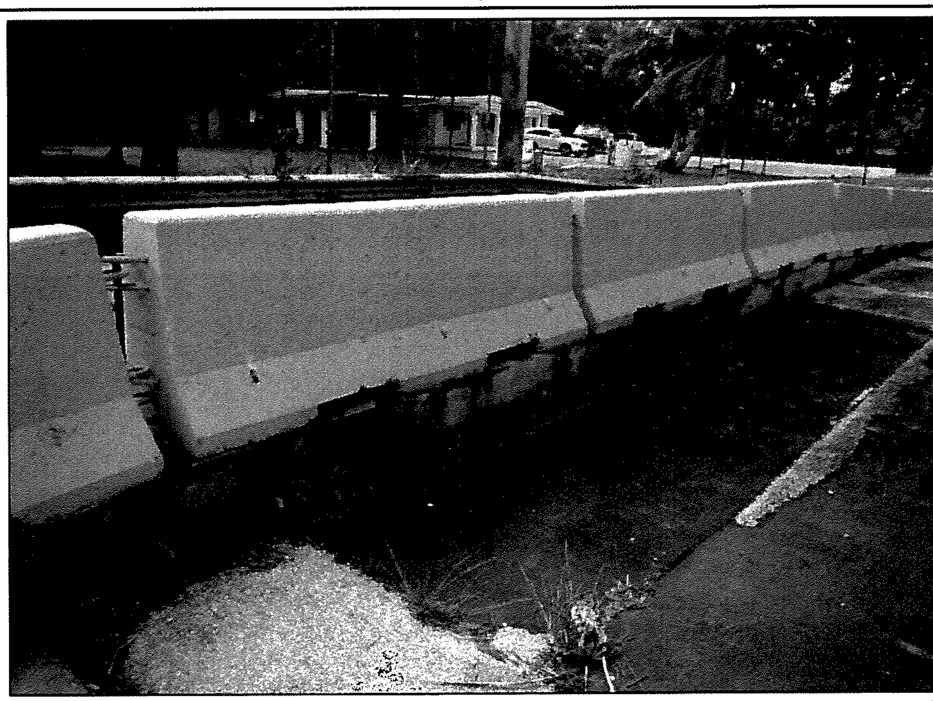


Photo no. 10

Bridge barriers sit on concrete coping that is supported by the old Pigua Bridge

PIGUA BRIDGE	STRUCTURE NO. **33**
FIELD INSPECTION REPORT	INSPECTION DATE: 2/10/2016

PHOTOGRAPHS

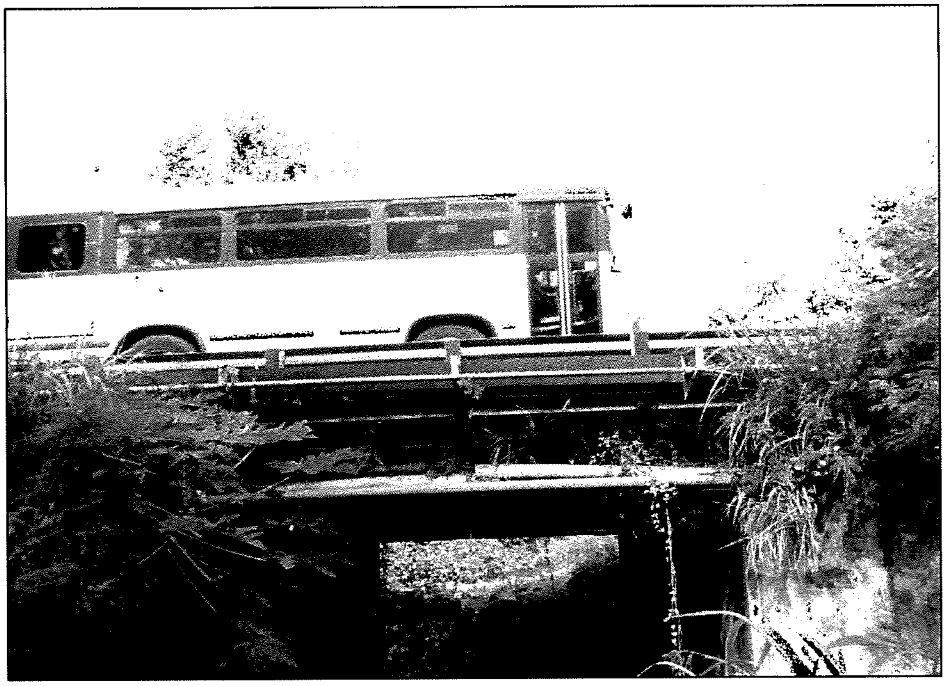


Photo no. 11

Passage on Pigua bridge by MRT bus

Photo no. 12

Overall condition of beam coating system is in good condition

PIGUA BRIDGE	STRUCTURE NO.	**33**
FIELD INSPECTION REPORT	INSPECTION DATE:	2/10/2016

PHOTOGRAPHS

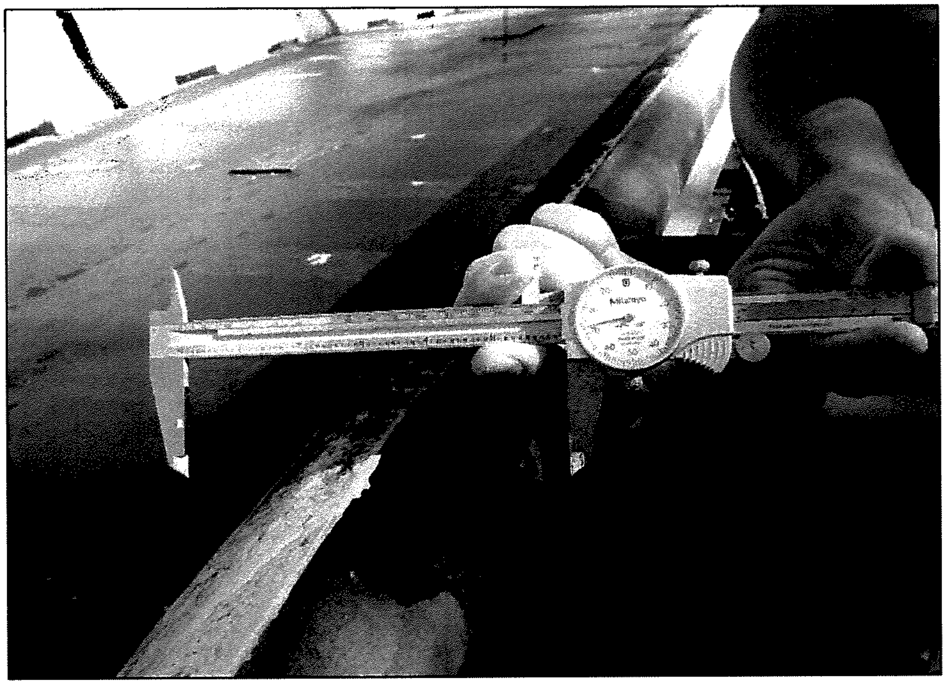


Photo no. 13

Flange width measured at 5.972"

Photo no. 14

Typical fair condition of abutment bearing seat

Exhibit 3

PURCHASE ORDER

GENERAL SERVICES AGENCY
DEPARTMENT OF ADMINISTRATION
GOVERNMENT OF GUAM
148 Route 1
Marine Drive
Piti, Guam 96925

TRAN CODE #16A

THIS PURCHASE ORDER NUMBER
No. P076B00040 P076B00040
MUST APPEAR ON ALL INVOICES, PACKING SLIPS, PACKAGES, B/L, CORRESPONDENCE ETC.

F.O.B.	* AIR FREIGHT TEL CONTACT	SHIP VIA	DATE	JOB ORDER NO.	OBJ CL
		PREPAID-SHOW SHIPPING CHARGES AS SEPARATE ITEM ON INVOICE.	8/21/2007	1D8008C10	0 240

VENDOR T2981001

TO:
TSANG BROTHERS CORP
P O BOX 10198
TAMUNING, GU 96931
Telephone: 671-648-8133 Fax: 671-646-1117

CONSIGNEE, DESTINATION & MARKING:
DEPARTMENT OF PUBLIC WORKS
542 NORTH MARINE DRIVE
TAMUNING, , GU 96913-0000

PIGUA/BILE BRIDGE REPLACEMENT

AUTHORITY	** INVITATION NO.	** CONTRACT NO.	TIME FOR DELIVERY	EXPIRING	DISCOUNT TERMS
3113			SEE BELOW		

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	6" X 6" X 20' I-BEAM	22	EA	230.00	5060.00	007105B062
	POC: JESSIE GARSIA 889-1469					
	EXE.NO. 2007-11 BILE & PIGUA BRIDGE REPAIR					

PAYMENT RECOMMENDED
07/21/07

NOTE:
THE GOVERNMENT OF GUAM WILL NOT BE RESPONSIBLE FOR UNAUTHORIZED PURCHASES OR SERVICES
*TO BE COORDINATED BETWEEN REQUESTING AGENCY AND VENDOR.
Note: Amounts due this Purchase Order may be off set for monies due the Govt. of Guam inclusive of but not limited to taxes, fees, and returned checks, liquidated damages or other damages, penalties and attorney's fees after failure to pay according to law.
ALL LATE DELIVERIES AND ACCEPTANCES ARE SUBJECT TO THE LIQUIDATED DAMAGE CLAUSE IN SECTION 6101(9)(a) OF THE GAR.

RECEIVED OCT 29 2007 DEPT OF ADMIN DIV OF ACCTS

SPECIAL INSTRUCTIONS TO VENDOR:
B. SEND CERTIFIED ORIGINAL AND THREE (3) COPIES OF INVOICE TO DIVISION OF ACCOUNTS, DEPARTMENT OF ADMINISTRATION, GOVERNMENT OF GUAM, P.O. BOX 884, AGANA, GUAM 96910.
C. PAYMENT UPON RECEIPT OF MERCHANDISE IN GUAM IN GOOD CONDITION.
D. THIS ORDER SUBJECT TO CONDITIONS ON REVERSE SIDE.
E. ** THIS ORDER IS SUBJECT TO THE SPECIAL PROVISIONS, AND BID GENERAL TERMS AND CONDITIONS SPECIFIED ON THIS BID.
F. * ON ALL AIR SHIPMENTS HAVE AIR FREIGHT COMPANY CALL THIS NUMBER UPON ARRIVAL OF GOODS IN GUAM.

5060.00 ↑ TOTAL ↑

A. DO NOT FILL THIS ORDER IF YOUR TOTAL COST EXCEEDS THIS TOTAL.
INSERT CHANGES AND RETURN THIS ORDER FOR AMENDMENT.

I CERTIFY THE ABOVE ARTICLES AND/OR SERVICES HAVE/HAS BEEN RECEIVED AND/OR RENDERED AND THE SAME HAS BEEN INSPECTED AND ACCEPTED EXCEPT AS OTHERWISE NOTED HEREIN.

DATE RECEIVED ______ SIGNATURE ______ PAGE 1 OF 1

ADVANCE PAYMENT AUTHORIZATION
PAYMENT ENCLOSED ☐

SIGNATURE: for: Pedro F. San Nicolas
Claudia S. Acfalle — Chief Procurement Officer
NAME — TITLE

RECEIVING REPORT

Tsang Brothers Corporation

INVOICE

Steel & Building Material Specialist

P.O. Box 10198 Tamuning, Guam 96931
Tel: (671) 649-8133 / 646-1113 / 1115
Fax: (671) 646-1117/5508

Date	9/1/2007
Invoice No.	216533
P.O. Number	P076E00040
Terms	Net 30
Sales Rep	WENZ
Ship Date	9/1/2007

Bill To

*DEPT. OF PUBLIC WORKS
DIVISION OF ACCOUNTS
P.O. BOX 884
AGANA,GUAM 96910

Deliver To/Memo

pick up/ JESSE GARCIA

Item Code	Description	TAM Code	Qty	HAR Code	Unit	U-Price	Amount
10-BI9002516	BI H-Beam 5/16' x 6 x 6 x 19'8"		22	HYD2	Each	230.00	5,060.00
	Subtotal of NET Items						5,060.00

NOTE: I BEAM AND H BEAM SAME ITEM

DIVISION OF ACCOUNTS
Batch No. ______ Tran Code 160
Evidence of ... value received ... correctness of bill ... amounts checked and verified by ...
Approved by:
Data Entry by: KP/NSQ
Audited by:

PAYMENT RECOMMENDED
Department of Public Works
09.21.07

RECEIVED OCT 29 2007 DEPT OF ADMIN DIV OF ACCTS

TERMS & CONDITION: Returned items must be accompanied by this bill. Returned merchandise is subject to a 10% handling charge and will not be accepted after 10 days from the above date of purchase. Purchaser agrees to pay interest at the rate of 1.5% per month on all overdue invoices. If said accounts are place in the hands of an attorney for collection or suit is brought on same, Purchaser agrees to pay an additional amount of 33 1/2% of the amount found due (including interest as foresaid) as attorney fees, plus any costs of suit.

RECEIVED BY:

CONFIRMED ABOVE MATERIAL(S) IN GOOD CONDITION

Total:	$5,060.00
Pmt/Cr:	$0.00
Bal Due:	$5,060.00

Exhibit 3 #16-A

S/No.7556 TS-07/021 STM2008620

MILL TEST CERTIFICATE

DONGKUK STEEL

POHANG WORKS, 588 SONGDONG-RI DAESONG-MYEON NAM-GU POHANG-SI GYEONGSANGBUK-DO 790-841, KOREA

ORIGINAL

ORDER NO. : 3000201305

PO NO. :

COMMODITY : H BEAM

SPECIFICATION : BS 4360-43A

Supplier : DAEWOO INTERNATIONAL CORP.

CUSTOMER : WO LEE STEEL CO.

CERTIFICATE NO. : PSS-2-070430-022

DATE OF ISSUE : Apr.30.2007

Dimension	Product No	Quantity B/D PCS	Weight kg	Heat No	Position	Tensile Test GL	YP N/mm²	TS N/mm²	EL %	Division	Chemical Composition (%) x100:2, x1000:3, x10000:4 C 2	Si 2	Mn 2	P 3	S 3	Remark
H 152 x 152x 23 12000mm •Specimen No : PS00181203-a	P02114D-037	12	3,312	P02114	T	1	334	468	27	L	11	19	115	20	23	
	Sub Total (10)	1 12	3,312													
H 152 x 152x 23 12000mm •Specimen No : PS00202804-a	P02359D-023,024	24	3,312	P02359	T	1	322	457	29	L	8	18	96	21	26	
	Sub Total (10)	2 24	6,624													
H 152 x 152x 23 12000mm •Specimen No : PS00285307-a	P03440D-044,045,046, 047,048,049,050	84	3,312	P03440	T	1	337	470	28	L	9	17	112	17	30	
	Sub Total (10)	7 84	23,184													
H 152 x 152x 23 12000mm •Specimen No : PS00287701-a	P03446D-005,006,007, 008,009,010,011, 012	96	3,312	P03446	T	1	338	475	25	L	9	22	10[illegible]	14	20	
	Sub Total (10)	8 96	26,496													
H 152 x 152x 30 12000mm •Specimen No : PS00181603-a	P02109D-017	9	3,240	P02109	T	1	321	487	35	L	10	20	103	15	33	
	Sub Total (20)	1 9	3,240													
H 152 x 152x 30 12000mm •Specimen No : PS00202804-a	P02359D-021	9	3,240	P02359	T	1	322	457	29	L	8	18	96	21	25	
	Sub Total (20)	1 9	3,240													

• Tensile Test Direction-Longitudinal
• Supply Condition-As Rolled

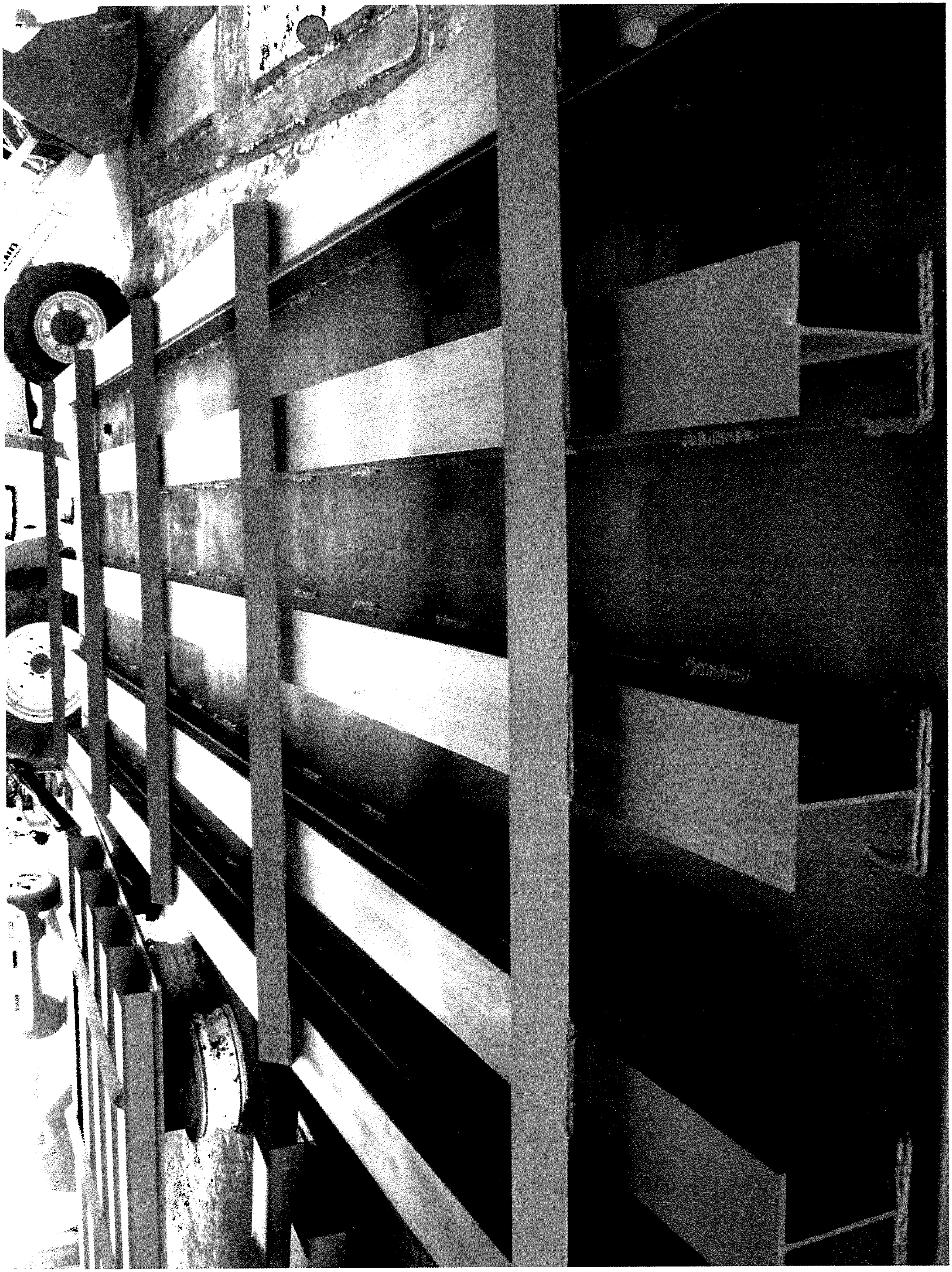
We hereby certify that the material herein has been made and tested in accordance with above specification and also with the requirements called for by the above order.

When using the ordered product for other uses, rather than the above specification use, product damage and safety accidents may be caused.

• Specimen No. : a-Tension
• Position : T-Top, M-Middle, B-Bottom
• Division : L-Ladle Analysis, P-Product Analysis
• Sub(Sub Size,Real Value, mm) : Blank-Full Size, 1-7.5×10, 2-5.0×10
• GL(Gauge Length, mm) : 1-200, 2-100, 3-80, 4-70, 5-50, 6-5.65√A, 7-5d, 8-4d, 9-8d • T(S),Al : Total(Soluble) Al

Surveyor Ic	Surveyor Ic	Surveyor Ic	Surveyor Ic	Chief of Quality Assurance Team

Exhibit 4



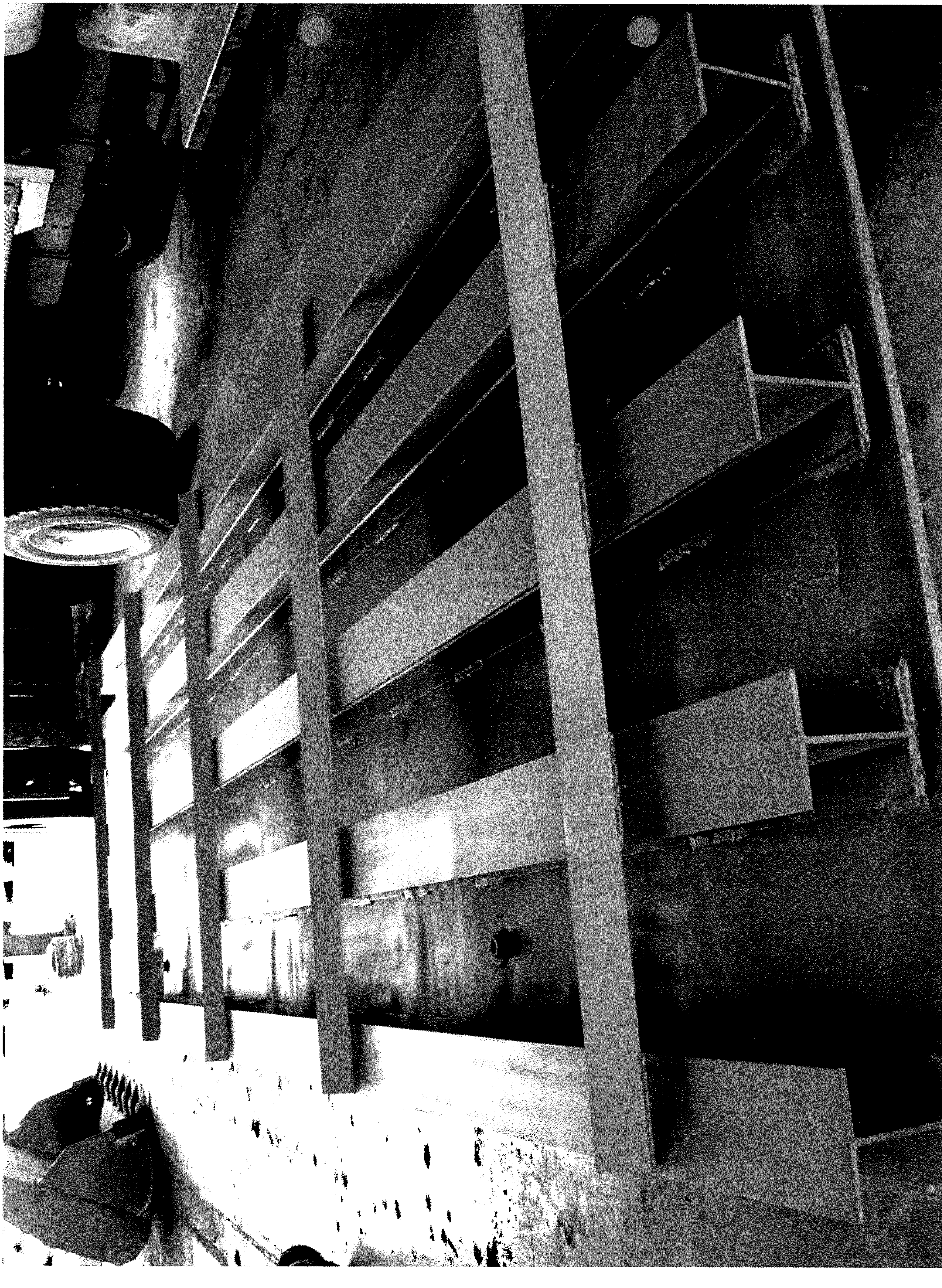
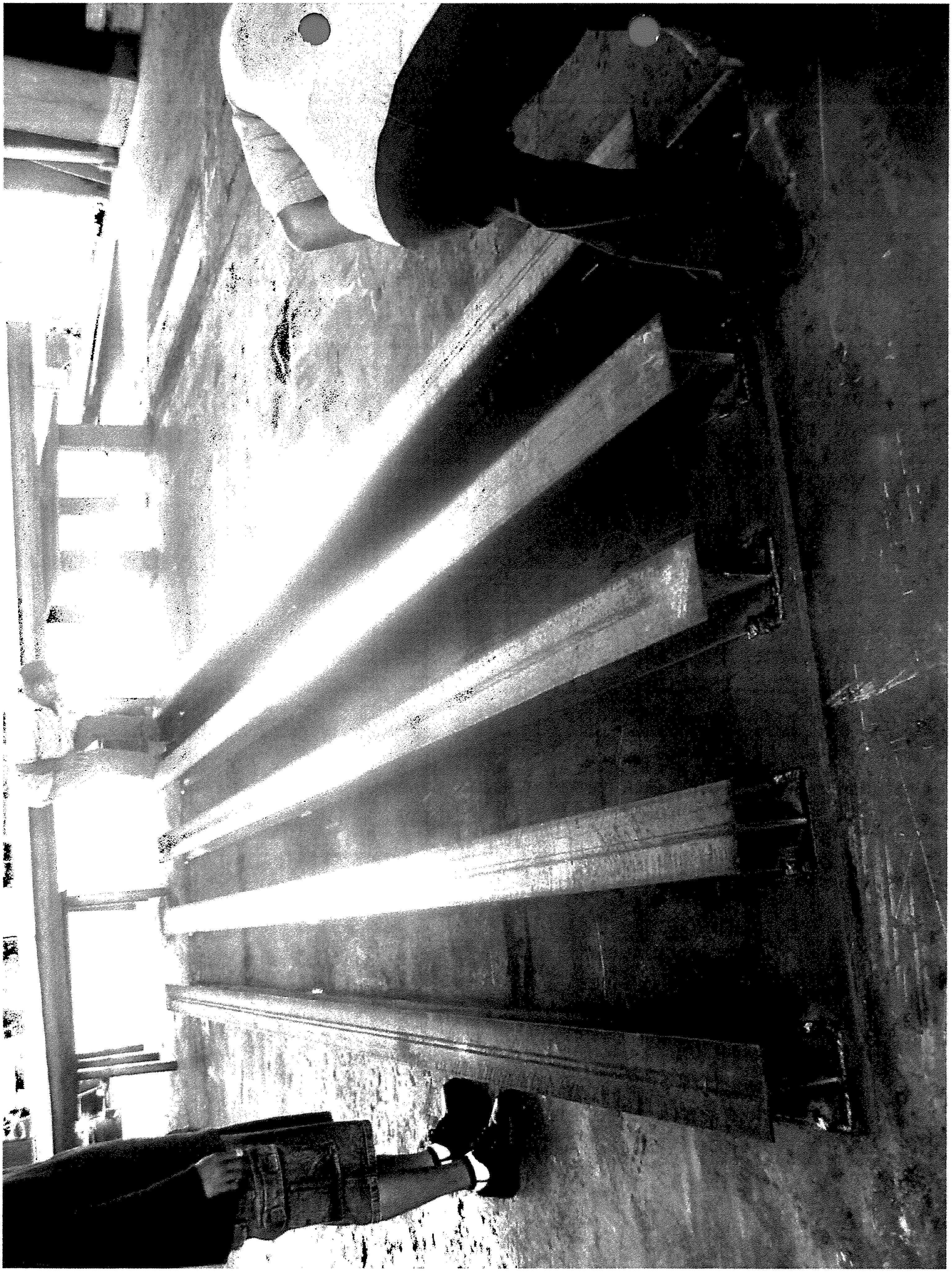
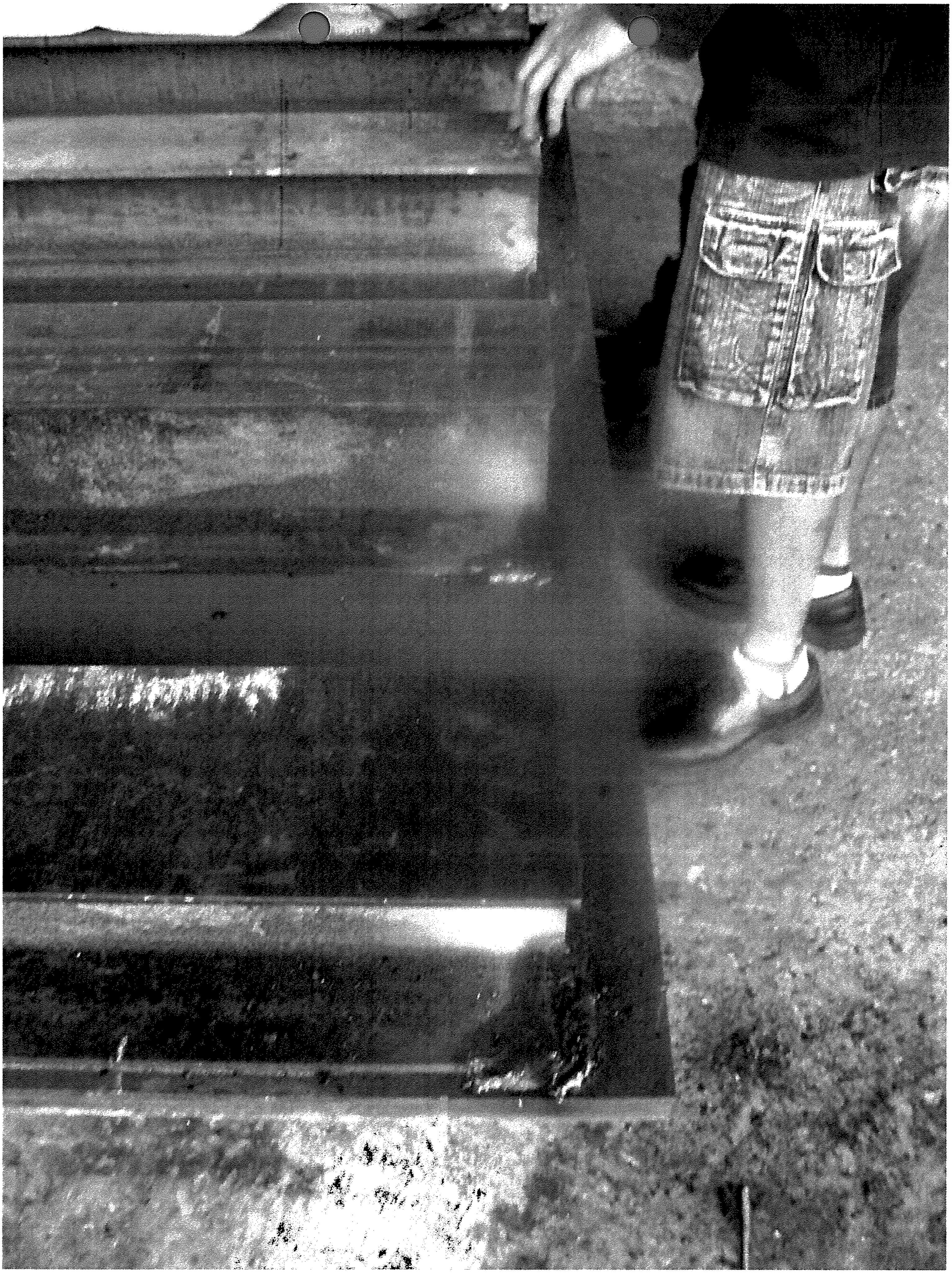


Exhibit 5


HOLLAND





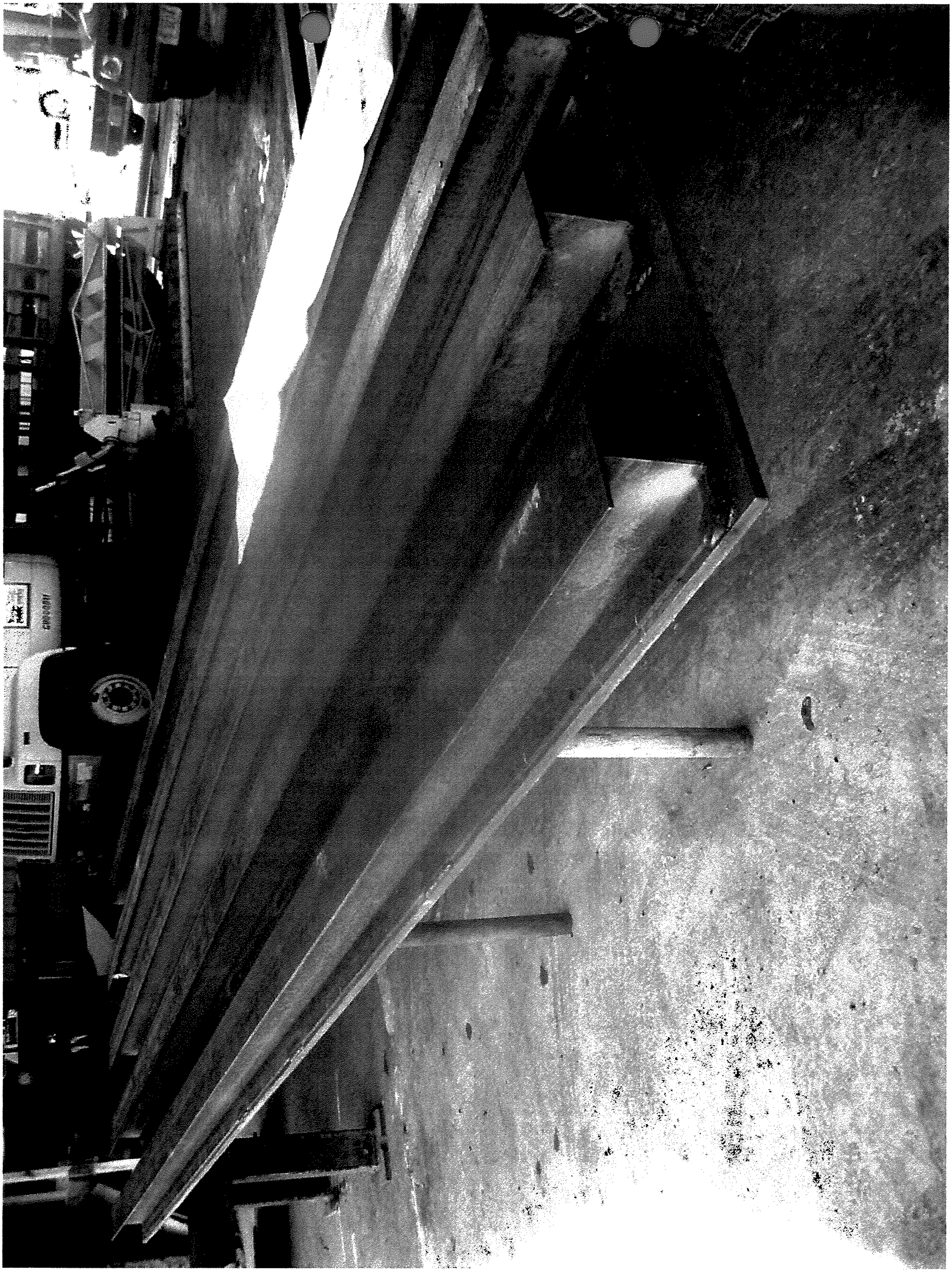


Exhibit 6

BRIDGE LOAD RATING REPORT
GUAM DEPARTMENT OF PUBLIC WORKS
Bile & Pigua Bridges

STRUCTURE TYPE: Steel Orthotropic Deck
LOAD RATING TYPE: Legal Load Rating
DATE: 3/1/2016

MARK E. HIROTA
CERTIFICATE
No 1366
CIVIL
EXP. 04/30/16
GUAM
PROFESSIONAL ENGINEER

THIS WORK WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION

Report Prepared by:
Parsons Brinckerhoff, Inc.
590 S. Marine Corps Dr.
Suite 421, Tamuning, GU
96913

Guam Department of Public Works - Bridge Load Rating
Load Rating Calculations Table of Contents

Bridge Name: Bile & Pigua Temporary Bridges
Bridge Type: Single Span Orthotropic Steel Deck

Table of Contents

* Output results are too large to reasonably include in this report. Electronic files will be provided as necessary.

Load & Resistance Factor Rating Summary - Legal Load Ratings

Bridge Name: Bile & Pigua Temporary Repair Bridges
Span Description: Single Span Steel Orthotropic Deck (19.25' Brg-Brg)

Table 1 - Controlling factors using W6x15 & 0.75" deck plate and including angle stiffness

Vehicle	Rating Factor	Live Load Factor γ_L	Limit State	Force Effect	Capacity Reduction Factor Φ	Member	Span	Location
LEGAL VEHICLES:								
TYPE 3 MOD (56K)	1.23	1.30	Str-I	+M	0.95	Ext. Beam	1 of 1	0.500L
TYPE 3S2 MOD (77K)	1.35	1.30	Str-I	+M	0.95	Ext. Beam	1 of 1	0.500L
TYPE 3-3 (80K)	1.59	1.30	Str-I	+M	0.95	Ext. Beam	1 of 1	0.500L

Table 2 - Controlling factors using field-measured dimensions and including angle stiffness

Vehicle	Rating Factor	Live Load Factor γ_L	Limit State	Force Effect	Capacity Reduction Factor Φ	Member	Span	Location
LEGAL VEHICLES:								
TYPE 3 MOD (56K)	1.45	1.30	Str-I	+M	0.95	Ext. Beam	1 of 1	0.500L
TYPE 3S2 MOD (77K)	1.58	1.30	Str-I	+M	0.95	Ext. Beam	1 of 1	0.500L
TYPE 3-3 (80K)	1.86	1.30	Str-I	+M	0.95	Ext. Beam	1 of 1	0.500L

Table 3 - Controlling factors using W6x15 & 0.75" deck plate and excluding angle stiffness

Vehicle	Rating Factor	Live Load Factor γ_L	Limit State	Force Effect	Capacity Reduction Factor Φ	Member	Span	Location
LEGAL VEHICLES:								
TYPE 3 MOD (56K)	1.29	1.30	Str-I	+M	1.00	Int. Beam	1 of 1	0.500L
TYPE 3S2 MOD (77K)	1.40	1.30	Str-I	+M	1.00	Int. Beam	1 of 1	0.500L
TYPE 3-3 (80K)	1.65	1.30	Str-I	+M	1.00	Int. Beam	1 of 1	0.500L

GUAM DEPARTMENT OF PUBLIC WORKS

DESCRIPTION OF BRIDGE

BRIDGE NO.	BILE & PIGUA BRIDGES
Date of Construction:	2007
Original Design Loading:	HS20
Posted Limit:	Open, No Restrictions
Structure Type:	Single Span Orthotropic Steel Deck
Primary Material:	Structural Steel
Skew:	0°
Structure Length:	20'-2" (out-out)
Span Length:	19'-3" (bearing-bearing)
Structure Width:	12'-1" (out-out)
Roadway Width:	12'-1" (curb-curb)
Wearing Surface:	None
Utilities:	None

GUAM DEPARTMENT OF PUBLIC WORKS

RATING ANALYSIS ASSUMPTIONS AND CRITERIA

The legal load ratings of the bridges were estimated using the provisions of:

- The Manual for Bridge Evaluation, Second Edition 2011 with 2014 Interims (MBE)
- AASHTO LRFD Bridge Design Specifications, 7th Edition 2014 with 2015 Interims (LRFD)

The live load distribution was determined using a refined finite element model in accordance with LRFD Article 4.6.3 using LARSA 4D v7.08.05.

The following material strengths & unit weights were used in the rating of this structure:

- Structural steel yield stress: Fy = 36 ksi (A36 based on plans)
- Structural steel unit weight: 490 lbs/cu. ft.

Each bridge consists of two orthotropic steel decks, each approximately 6' wide, placed side-by-side to form a 12' wide bridge. Each half consists of a single 6' wide by 20' long steel plate measured to be 0.80" thick (plans show 0.75"). For this load rating, the bridge was analyzed using both plate thicknesses.

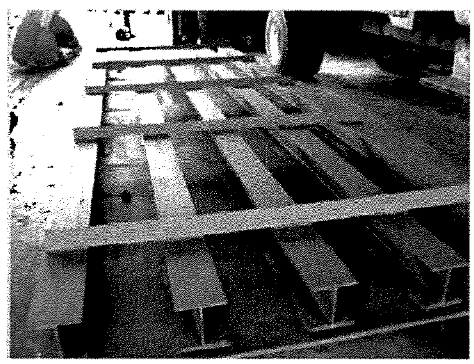


Figure 1 - Orthotropic steel deck section during fabrication (shown upside-down)

Welded to the underside of each plate are five rolled beams at equal spaces of approximately 16" on-center which act as orthotropic steel deck ribs. The design plans show W6x20 beams should be used. Field-measurements of the as-constructed bridge indicate actual dimensions are between those of a W6x15 and W6x20. For this load rating, the bridge was analyzed with both the smaller W6x15 rolled-beams and the calculated beam section properties using the field-measured dimensions.

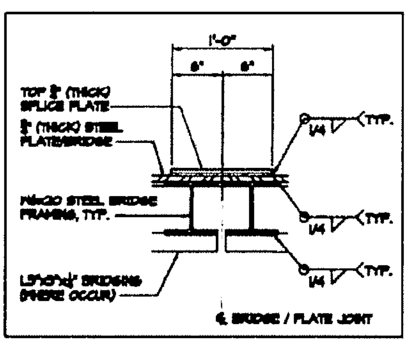


Figure 2 - Splice Plate Detail

To connect the two halves together, three splice plates are welded to the top surface of the deck. One located at midspan and one near each end. The design plans show five splice plates but inspection reveals only three are present.

Additionally, five angles (L3x3x0.25"), each approximately 6'-0" long, are oriented transverse to the centerline of the bridge and welded to the bottom flanges of each rolled beam to act as lateral bracing for the beam bottom flanges, see Figure 1. The angles are located near the quarter points of the span and are not continuous across the longitudinal joint between each 6'-0" section of the bridge. Both legs of each angle are welded to the rolled beams using fillet welds for the full width of the bottom flange. Based on observation, the welds connecting the angles to the beams are intact and of a size capable of providing lateral distribution of live loads to adjacent beams. Therefore, the angles were included in the analysis model using a rigid connection to the beams.

In order to demonstrate the lateral live load distribution gained from including the angle bracing in the analysis model, an additional model was created which included the weight of the angles but neglected their stiffness, thereby eliminating any ability of the angles to distribute live loads laterally.

Therefore, the load and resistance rating factor summary includes the results from three separate analyses:

1. W6x15 beams, 0.75" deck plate, and **including** bracing angle stiffness
2. Field-measured beams, 0.80" deck plate, and **including** bracing angle stiffness
3. W6x15 beams, 0.75" deck plate, and **excluding** bracing angle stiffness

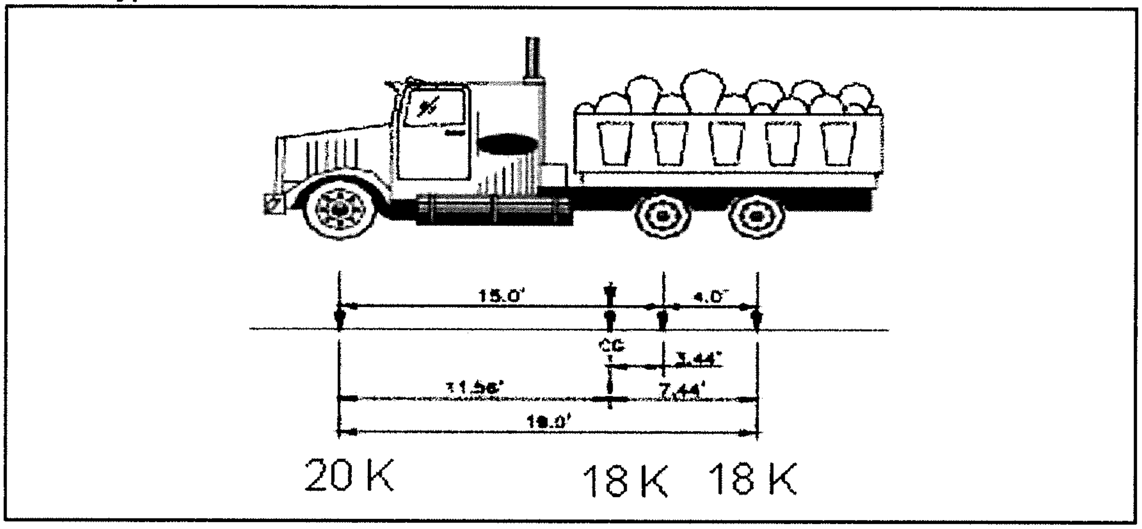
The following assumptions were used in the rating of this structure:

- Beam connection to deck is sufficient to provide composite behavior
- Span length between centerline of bearings is 19'-3" based on field measurements
- One vehicle on the bridge at a time
- Splice plate connections are sufficient to provide deck continuity across longitudinal joint
- Wheel loads applied as point loads

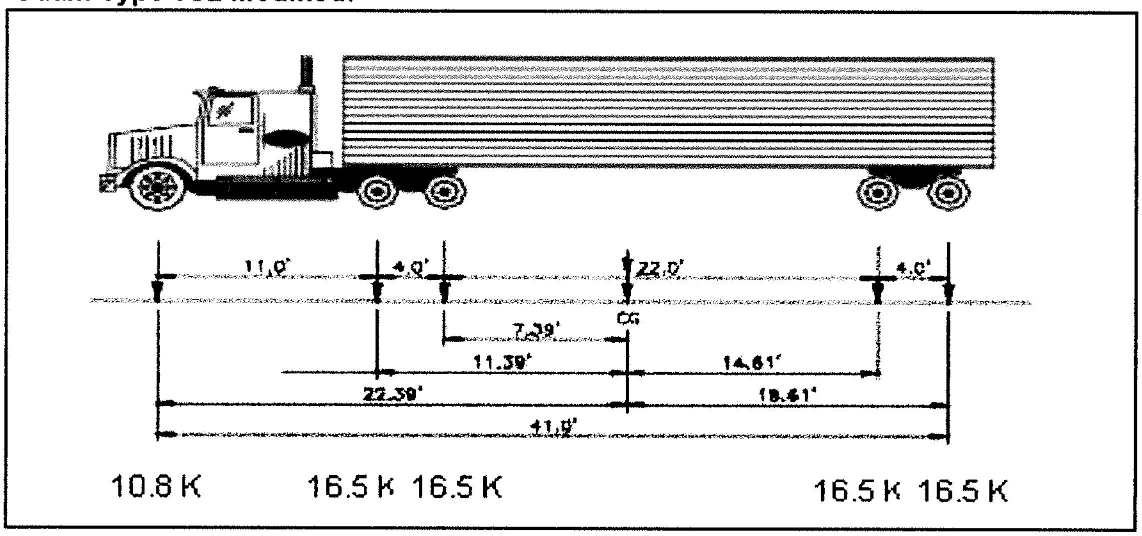
The bridge was rated using LARSA 4D v7.08.05 and PTC Mathcad Prime 3.1.

Rating was performed based on the information shown in the Interim Repair Drawings circa 2007 and field measurements gathered February 2016.

Guam Type 3 Modified:



Guam Type 3S2 Modified:



AASHTO Type 3-3:

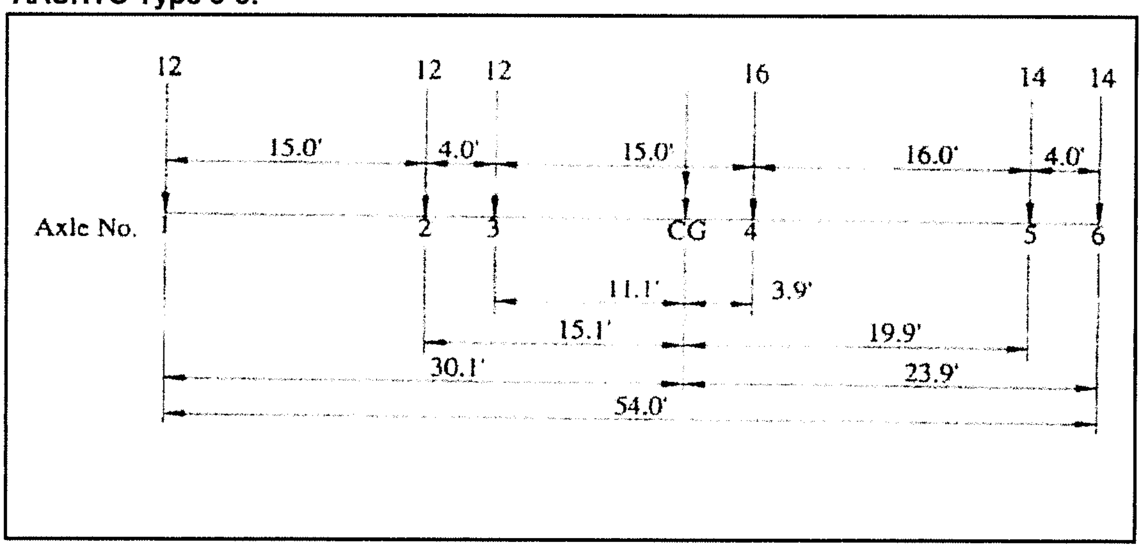
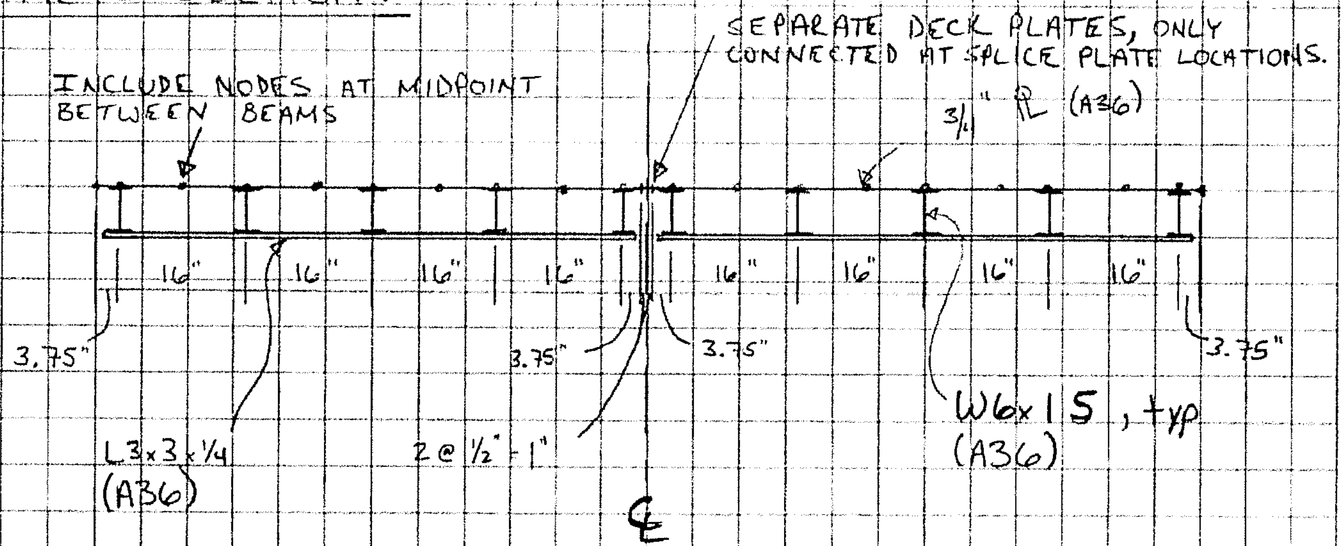


Exhibit 6

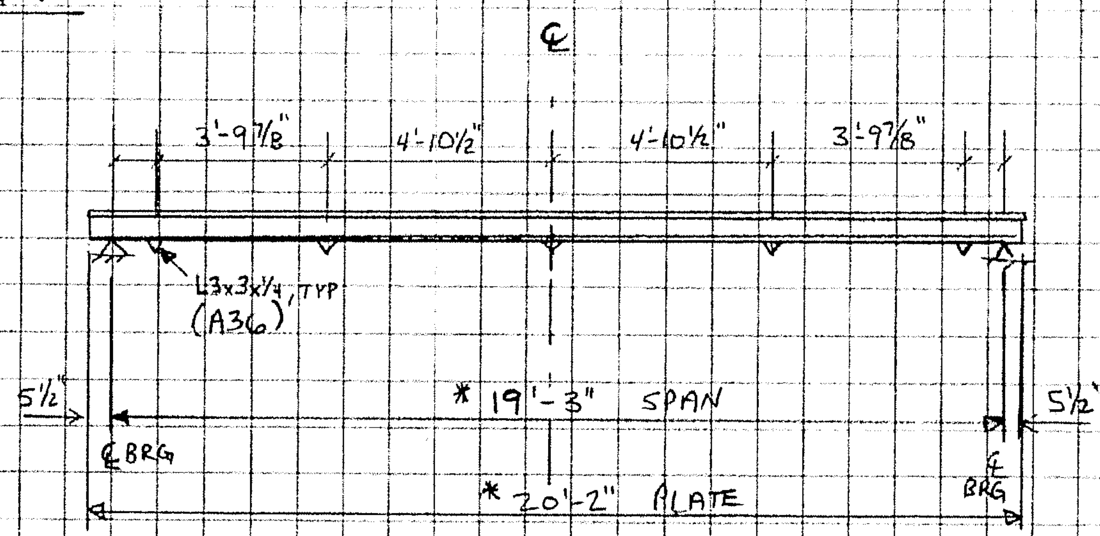
WSP | PARSONS BRINCKERHOFF

Project #
Project GUAM DPW - Bile & Pigua Load Rating
Computed By MKM Date 2/22/16
Checked By Date
Sheet No of
Subject BRIDGE DETAILS

TYPICAL SECTION:



ELEVATION:



* FIELD MEASUREMENT

WSP | PARSONS BRINCKERHOFF

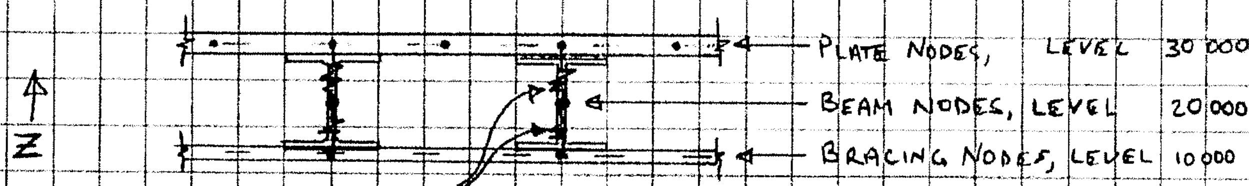
Exhibit 6

Project # .... Computed By MKM Date 2/22/16 Sheet No 1 of 2

Project GUAM DPW: BILE + PIGUA LOAD RATING Checked By .... Date .... Subject FEA MODEL SUMMARY

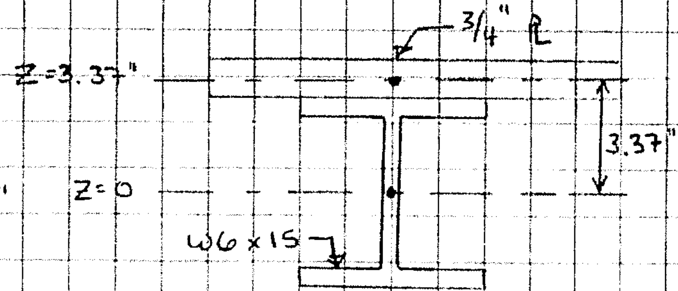
ANALYSIS MODEL:

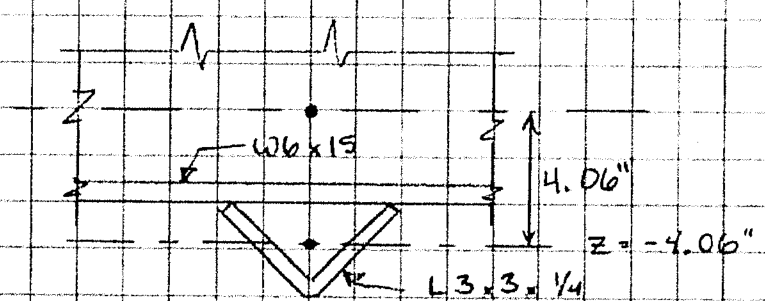
COMPOSITE BEHAVIOR:



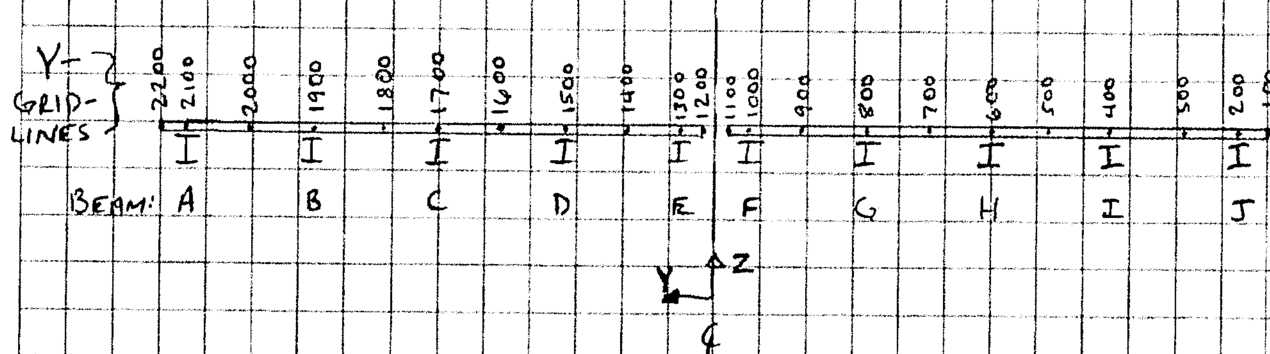
GEOMETRY:

C.G. BEAMS @ Z = 0.0
C.G. ANGLES @ Z = -4.06"
C.G. PLATES @ Z = 3.37"

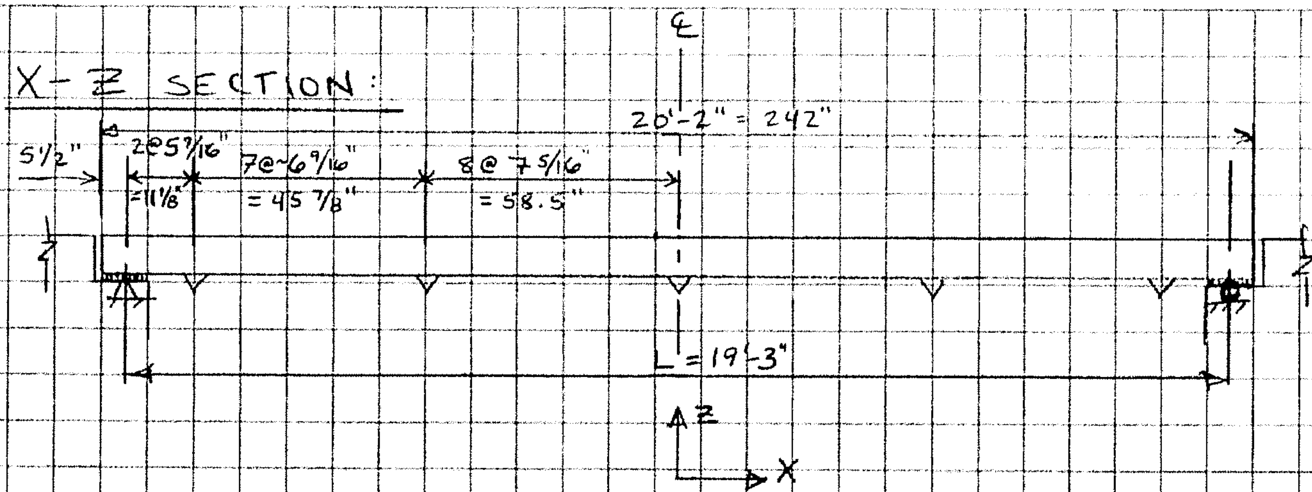




Y-Z SECTION:



X-Z SECTION:



STARTING AT GRIDLINE 1 @ X = -121.0", X-GRID LINES NUMBER FROM 1 @ X = -121" TO 37 @ X = 121" (ORIGIN @ MIDSPAN).

GRID SPACING CHOSEN TO PROVIDE ASPECT RATIOS < 2 IN DECK PLATES.

JOINT NUMBERING:

LEVEL (Z-GRIDLINES) + Y-GRIDLINE + X-GRIDLINE

EXAMPLE:

JOINT ID FOR: C.G. BEAM "C" @ MIDSPAN

LEVEL 20000 — C.G.; "C" — Y-GRID LINE 1700; ℄ — X-GRIDLINE 19

JOINT ID = 20000 + 1700 + 19 = **21719**

BEAMS (AND PLATES) (AND ANGLES) ARE NUMBERED AS THE JOINT THEY START WITH. (i.e. THE "I-JOINT".)

LARSA

WSP | Parsons Brinckerhoff

Guam DPW: Bile & Pigua

Exhibit 6

Exhibit 6

PROJECT SUMMARY

INPUT PROPERTIES	Count	INPUT GEOMETRY	Count	Load Cases	Count
Universal Restraints	NONE	Joints	1234	Load Cases	2
Materials	1	Members	400	Combination Cases	NONE
Sections	2	Plates	729	Construction Stages	NONE
User Coordinate System	NONE	Springs	NONE	Linked Databases	1
Spring Curves	NONE	Isolaters	NONE		
Isolater Property	NONE	Mass Elements	NONE		
Creep Definitions	NONE	Slave / Masters	NONE		
		Tendons	NONE		

Exhibit 6

TABLE OF CONTENTS

Exhibit 6

Graphics View 1

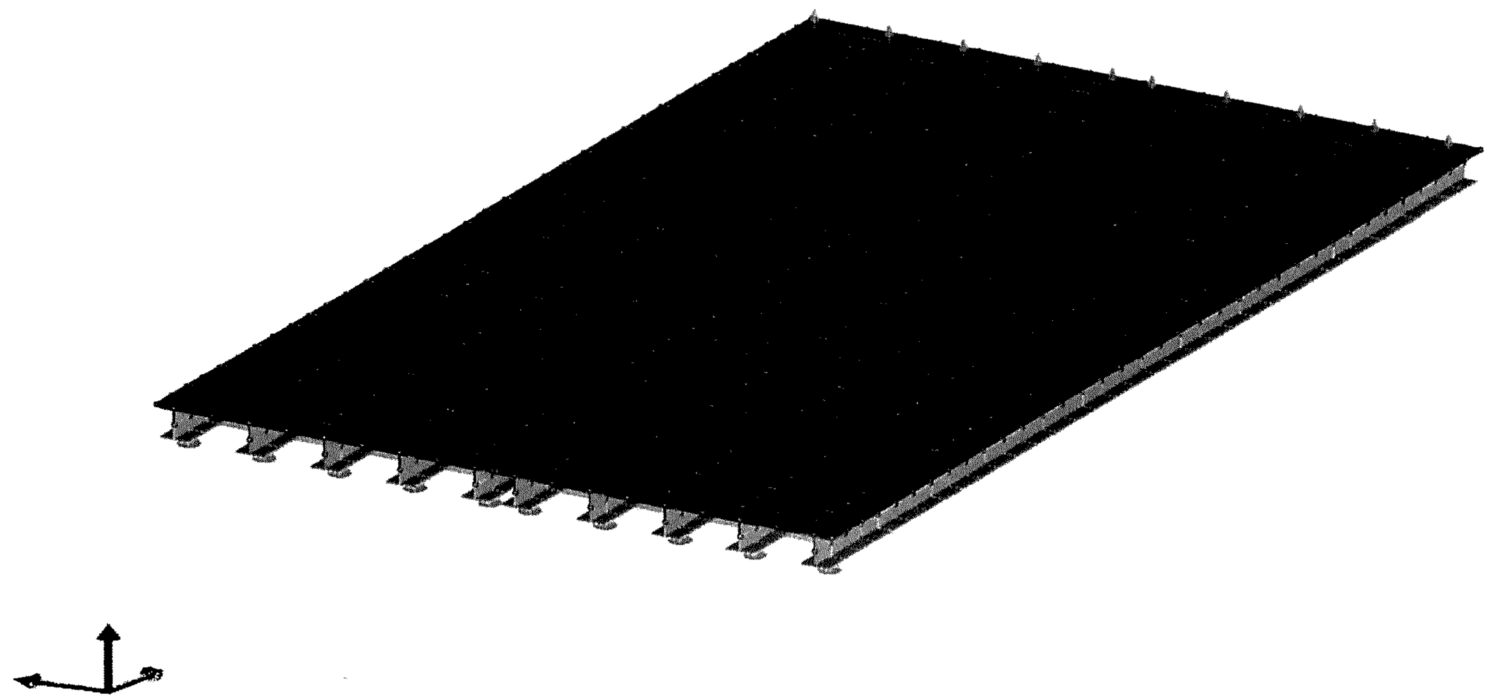


Exhibit 6

INPUT : Material Properties

Name	Modulus of Elasticity (lb/in²)	Poisson Ratio	Shear Modulus (lb/in²)	Unit Weight (lb/in³)	Thermal Expansion (1/°F *10^-6)	Assigned
A36	2.90e7	0.2946	1.12e7	0.2836	6.500000	Yes

INPUT : Sections

Name	Section Area (in²)	Shear Area in yy (in²)	Shear Area in zz (in²)	Torsion Constant (in^4)	Inertia Izz (in^4)	Inertia Iyy (in^4)	Plastic Modulus Zyy (in³)	Plastic Modulus Zzz (in³)	Perimeter (in)	Material Time-Effect	Ductility	Residual Strength (%)	Assigned
W6x15 [DB:American]	4.43	1.3777	2.5957	.1	29.1	9.32	4.75	10.8	35.48	0	50	0	Yes
L3x3x1/4 [DB:American v3]	1.44	.625	.625	.0313	1.23	1.23	1.02	1.02	12	0	50	0	Yes

INPUT : Section Stress Points

Name	Point 1 Y (in)	Point 1 Z (in)	Point 2 Y (in)	Point 2 Z (in)	Point 3 Y (in)	Point 3 Z (in)	Point 4 Y (in)	Point 4 Z (in)	Point 5 Y (in)	Point 5 Z (in)	Point 6 Y (in)	Point 6 Z (in)
W6x15 [DB:American]	2.9950	2.9950	2.9950	-2.9950	-2.9950	-2.9950	-2.9950	2.9950	(NONE)	(NONE)	(NONE)	(NONE)
L3x3x1/4 [DB:American v3]	2.1576	-0.8424	-0.8424	-0.8424	-0.8424	2.1576	(NONE)	(NONE)	(NONE)	(NONE)	(NONE)	(NONE)

INPUT : Section Dimensions

Name	Shape	Dimension D1	Dimension D2	Dimension D3	Dimension D4	Dimension D5	Dimension D6
W6x15 [DB:American]	I Shape (DB)	5.99	5.99	.26	.23		
L3x3x1/4 [DB:American v3]	Angle (DB)	3	3	.25			

INPUT : More Material Properties

Name	Yield Stress (lb/in²)	Post-yield to Initial Slope Ratio	Concrete Strength Specimen	Concrete fc28 or Steel Fu (lb/in²)	Concrete Cement Hardening Type	Tendon GUTS (lb/in²)	Material Time-Effect	Assigned
A36	36,000.00	0.020	Cylinder	58,000.00	Not Concrete	0.00	(NONE)	Yes

DATABASE:: Legal-Type 3 Mod (2D) on C:\Program Files (x86)\Larsa 2000\Data\Guam_Moving_Loads.dml

Type	Magnitude at Start (kips or kips-ft)	Magnitude at End (kips or kips-ft)	Location Start (ft)	Location End (ft)	Transverse Offset (ft)	Transverse Width (ft)
Point Force	10.0000	10.0000	0.0000	0.0000	-3.0000	0.0000

DATABASE:: Legal-Type 3 Mod (2D) on C:\Program Files (x86)\Larsa 2000\Data\Guam_Moving_Loads.dml

Type	Magnitude at Start (kips or kips-ft)	Magnitude at End (kips or kips-ft)	Location Start (ft)	Location End (ft)	Transverse Offset (ft)	Transverse Width (ft)
Point Force	9.0000	9.0000	15.0000	15.0000	-3.0000	0.0000
Point Force	9.0000	9.0000	19.0000	19.0000	-3.0000	0.0000
Point Force	10.0000	10.0000	0.0000	0.0000	3.0000	0.0000
Point Force	9.0000	9.0000	15.0000	15.0000	3.0000	0.0000
Point Force	9.0000	9.0000	19.0000	19.0000	3.0000	0.0000

DATABASE:: Legal-Type 3S2 Mod (2D) on C:\Program Files (x86)\Larsa 2000\Data\Guam_Moving_Loads.dml

Type	Magnitude at Start (kips or kips-ft)	Magnitude at End (kips or kips-ft)	Location Start (ft)	Location End (ft)	Transverse Offset (ft)	Transverse Width (ft)
Point Force	5.4000	5.4000	0.0000	0.0000	-3.0000	0.0000
Point Force	8.2500	8.2500	11.0000	11.0000	-3.0000	0.0000
Point Force	8.2500	8.2500	15.0000	15.0000	-3.0000	0.0000
Point Force	8.2500	8.2500	37.0000	37.0000	-3.0000	0.0000
Point Force	8.2500	8.2500	41.0000	41.0000	-3.0000	0.0000
Point Force	5.4000	5.4000	0.0000	0.0000	3.0000	0.0000
Point Force	8.2500	8.2500	11.0000	11.0000	3.0000	0.0000
Point Force	8.2500	8.2500	15.0000	15.0000	3.0000	0.0000
Point Force	8.2500	8.2500	37.0000	37.0000	3.0000	0.0000
Point Force	8.2500	8.2500	41.0000	41.0000	3.0000	0.0000

DATABASE:: Legal-Type 3-3 (2D) on C:\Program Files (x86)\Larsa 2000\Data\Guam_Moving_Loads.dml

Type	Magnitude at Start (kips or kips-ft)	Magnitude at End (kips or kips-ft)	Location Start (ft)	Location End (ft)	Transverse Offset (ft)	Transverse Width (ft)
Point Force	6.0000	6.0000	0.0000	0.0000	-3.0000	0.0000
Point Force	6.0000	6.0000	15.0000	15.0000	-3.0000	0.0000
Point Force	6.0000	6.0000	19.0000	19.0000	-3.0000	0.0000
Point Force	8.0000	8.0000	34.0000	34.0000	-3.0000	0.0000
Point Force	7.0000	7.0000	50.0000	50.0000	-3.0000	0.0000
Point Force	7.0000	7.0000	54.0000	54.0000	-3.0000	0.0000
Point Force	6.0000	6.0000	0.0000	0.0000	3.0000	0.0000
Point Force	6.0000	6.0000	15.0000	15.0000	3.0000	0.0000
Point Force	6.0000	6.0000	19.0000	19.0000	3.0000	0.0000
Point Force	8.0000	8.0000	34.0000	34.0000	3.0000	0.0000

DATABASE:: Legal-Type 3-3 (2D) on C:\Program Files (x86)\Larsa 2000\Data\Guam_Moving_Loads.dml

Type	Magnitude at Start (kips or kips-ft)	Magnitude at End (kips or kips-ft)	Location Start (ft)	Location End (ft)	Transverse Offset (ft)	Transverse Width (ft)
Point Force	7.0000	7.0000	50.0000	50.0000	3.0000	0.0000
Point Force	7.0000	7.0000	54.0000	54.0000	3.0000	0.0000

Exhibit 6

POST-COMPUTED RESULT CASES SUMMARY

Influence Based Case: GMK5100

Influence Coefficients	Influence Surface - Influence Surface
Vehicle	GMK5100 (2D) - Lane Configuration - UDL Factor: 0
Transverse Offset	0
Lane Loading Method	Constant Loading
Lane Load	0
Include Lane Load Under Vehicles	Yes
Back-to-Front Vehicle Spacing	0
Side-to-Side Vehicle Spacing	0
Load for Extreme Force Effects	Yes
AASHTO-LFD Point Loading	Yes
Complete Patterns Only	No
Vehicle Placement	Standard Method
Design Lane Width	144
Design Lane Margin	12
Multiple Presence Factors	1
Overall Factor	1

Influence Based Case: Legal-Type 3 Mod (2D)

Influence Coefficients	Influence Surface - Influence Surface
Vehicle	Legal-Type 3 Mod (2D) - Lane Configuration - UDL
Transverse Offset	0
Lane Loading Method	Constant Loading
Lane Load	0
Include Lane Load Under Vehicles	Yes
Back-to-Front Vehicle Spacing	0
Side-to-Side Vehicle Spacing	0
Load for Extreme Force Effects	Yes
AASHTO-LFD Point Loading	Yes
Complete Patterns Only	No
Vehicle Placement	Standard Method
Design Lane Width	144
Design Lane Margin	24
Multiple Presence Factors	1
Overall Factor	1

Exhibit 6

Influence Based Case: Legal-Type 3S2 Mod (2D)

Influence Coefficients	Influence Surface - Influence Surface
Vehicle	Legal-Type 3S2 Mod (2D) - Lane Configuration - UDL
Transverse Offset	0
Lane Loading Method	Constant Loading
Lane Load	0
Include Lane Load Under Vehicles	Yes
Back-to-Front Vehicle Spacing	0
Side-to-Side Vehicle Spacing	0
Load for Extreme Force Effects	Yes
AASHTO-LFD Point Loading	Yes
Complete Patterns Only	No
Vehicle Placement	Standard Method
Design Lane Width	144
Design Lane Margin	24
Multiple Presence Factors	1
Overall Factor	1

Influence Based Case: Legal-Type 3-3 (2D)

Influence Coefficients	Influence Surface - Influence Surface
Vehicle	Legal-Type 3-3 (2D) - Lane Configuration - UDL Factor: 0
Transverse Offset	0
Lane Loading Method	Constant Loading
Lane Load	0
Include Lane Load Under Vehicles	Yes
Back-to-Front Vehicle Spacing	0
Side-to-Side Vehicle Spacing	0
Load for Extreme Force Effects	Yes
AASHTO-LFD Point Loading	Yes
Complete Patterns Only	No
Vehicle Placement	Standard Method
Design Lane Width	144
Design Lane Margin	24
Multiple Presence Factors	1
Overall Factor	1

Exhibit 6

Purpose: Determine the slenderness of the Bile and Pigua orthotropic deck elements in accordance with AASHTO LRFD Article 6.14.3 requirements.

References:

- MBE - AASHTO Manual for Bridge Evaluation 2nd Edition w/ 2014 Interims
- LRFD - AASHTO LRFD Bridge Design Specifications 7th Edition w/ 2015 Interims
- AISC - AISC Steel Construction Manual, 14th Edition (for rolled-shape properties)

Properties:

$F_y := 36\ ksi$ A36 steel per GU-NH-NBIS(003) Dwg. S-0
$E := 29000\ ksi$ Steel elastic modulus

W6x15 properties:

$b_f := 5.99\ in$ Flange width
$t_f := 0.260\ in$ Flange thickness
$t_w := 0.230\ in$ Web thickness

Deck plate properties:

$t_d := 0.75\ in$ Deck plate thickness

1. Interior strut (single interior beam and effective plate deck width):

1.1 Check slenderness of deck plate between beams for local buckling per LRFD 6.14.3.2.1:

In accordance with C6.14.3.2.2, the interior deck plate can be considered a stiffened element because both longitudinal edges have support.

$e := 16\ in$ Beam spacing, c-c

$b_d := e - b_f = 10.01\ in$ Clear distance between supports (LRFD Table 6.9.4.2.1-1)

$k_d := 1.49$ Plate buckling coefficient for "All Other Stiffened Elements" (LRFD Table 6.9.4.2.1-1)

Check slenderness per LRFD 6.9.4.2.1:

$\frac{b_d}{t_d} = 13.347$ $k_d \cdot \sqrt{\frac{E}{F_y}} = 42.29$ (LRFD Eq 6.9.4.2.1-1)

if $\frac{b_d}{t_d} \le k_d \cdot \sqrt{\frac{E}{F_y}}$ = "Nonslender" (LRFD Eq 6.9.4.2.1-1)
‖ "Nonslender"
else
‖ "Slender"

<u>1.2 Check slenderness of W6x15 web for local buckling per LRFD 6.14.3.2.1:</u>

$b_w := 4.5\ in$	Clear distance between flanges minus corner radii	(LRFD Table 6.9.4.2.1-1)
$k_w := 1.49$	Webs of I-sections	(LRFD Table 6.9.4.2.1-1)

Check slenderness per LRFD 6.9.4.2.1:

$\frac{b_w}{t_w} = 19.565$ $k_w \cdot \sqrt{\frac{E}{F_y}} = 42.29$ (LRFD Eq 6.9.4.2.1-1)

if $\frac{b_d}{t_d} \le k_d \cdot \sqrt{\frac{E}{F_y}}$ = "Nonslender" (LRFD Eq 6.9.4.2.1-1)
‖ "Nonslender"
else
‖ "Slender"

Conclusion:

<u>Therefore, the orthotropic deck is not controlled by stability-related behaviors and the beam capacity will be determined using compact section flexure and shear behavior.</u>

<u>Given the small overhang at exterior beams, slenderness of the exterior ribs will not be checked.</u>

<u>The field measured dimensions are thicker than the assumed dimensions using the design plans, therefore, by observation the field measured sections will also be compact.</u>

INTERIOR BEAM CAPACITY ASSUMING W6x15 & 0.75" DECK PLATE

Purpose: Determine nominal shear and flexural resistance of interior beam comprised of a W6x15 rolled-beam and 0.75" thick effective deck width in accordance with LRFD 6.14.3.2.3.

References:

- MBE - AASHTO Manual for Bridge Evaluation 2nd Edition w/ 2014 Interims
- LRFD - AASHTO LRFD Bridge Design Specifications 7th Edition w/ 2015 Interims
- AISC - AISC Steel Construction Manual 14th Edition (for rolled-shape properties)

Properties:

Global steel properties:

$F_y := 36\ \mathbf{ksi}$ Yield strength of A36 steel

$E := 29000\ \mathbf{ksi}$ Steel elastic modulus

W6x15:

$A_{beam} := 4.43\ \mathbf{in}^2$ Area of rolled-shape

$D_{beam} := 5.99\ \mathbf{in}$ Depth of rolled-shape

$t_w := 0.230\ \mathbf{in}$ Web thickness

$b_f := 5.99\ \mathbf{in}$ Flange width

$t_f := 0.260\ \mathbf{in}$ Flange thickness

$I_{xx} := 29.1\ \mathbf{in}^4$ Strong-axis moment of inertia

Steel plate deck:

$t_d := 0.75\ \mathbf{in}$ Deck plate thickness

$b_d := 16\ \mathbf{in}$ Effective deck width equal to rib spacing

1. Web slenderness check per LRFD 6.10.6.2.3:

Determine depth of web in compression in accordance with LRFD D6.3.2 (all members have the same yield strength):

$D := D_{beam} - 2 \cdot t_f = 5.47\ \mathbf{in}$ Depth of the web between flanges

$A_w := t_w \cdot D = 1.258\ \mathbf{in}^2$ Area of the web

$A_c := t_d \cdot b_d + t_f \cdot b_f = 13.557\ \mathbf{in}^2$ Area of the compression flange

$A_t := t_f \cdot b_f = 1.557\ \mathbf{in}^2$ Area of the tension flange

Per LRFD Eq D6.3.2-3:

$A_w = 1.258\ in^2$

$|A_c - A_t| = 12\ in^2$

$D_{cp} :=$ if $A_w < |A_c - A_t|$ $\quad = 0\ in$ (LRFD Eq D6.3.2-3)

  $\|\ 0\ in$

  else

  $\|\ \dfrac{D}{2 \cdot A_w} \cdot (A_t + A_w - A_c)$ (LRFD Eq D6.3.2-4)

<u>1.1 Check web slenderness per LRFD Eq 6.10.6.2.3-1:</u>

$\dfrac{2 \cdot D_{cp}}{t_w} = 0 \qquad 5.7 \cdot \sqrt{\dfrac{E}{F_y}} = 161.779$

$Check_{1.1} :=$ if $\dfrac{2 \cdot D_{cp}}{t_w} < 5.7 \cdot \sqrt{\dfrac{E}{F_y}}$ $\quad =$ "Yes"

  $\|$ "Yes"

  else

  $\|$ "No"

<u>1.2 Check flange ratio per LRFD Eq 6.10.6.2.3-2:</u>

$I_{yc} := \dfrac{t_d \cdot b_d^{\,3}}{12} + \dfrac{t_f \cdot b_f^{\,3}}{12} = 260.657\ in^4$

$I_{yt} := \dfrac{t_f \cdot b_f^{\,3}}{12} = 4.657\ in^4$

$Check_{1.2} :=$ if $\dfrac{I_{yc}}{I_{yt}} \geq 0.3$ $\quad =$ "Yes"

  $\|$ "Yes"

  else

  $\|$ "No"

<u>Therefore, okay to use LRFD Appendix A6 to determine nominal flexural resistance.</u>

2. Web plastification factors per LRFD A6.2:

2.1 Determine plastic moment using LRFD D6.1:

2.1.1 Find plastic neutral axis:

$P_d := b_d \cdot t_d \cdot F_y = 432\ \boldsymbol{kip}$ Yielding force in deck plate

$P_{cf} := A_t \cdot F_y = 56.066\ \boldsymbol{kip}$ Yielding force in top flange

$P_w := A_w \cdot F_y = 45.292\ \boldsymbol{kip}$ Yielding force in web

$P_t := A_t \cdot F_y = 56.066\ \boldsymbol{kip}$ Yielding force in bottom flange

if $P_d > P_{cf} + P_t + P_w$ = "PNA in deck plate"
‖ "PNA in deck plate"
else if $P_d + P_{cf} > P_t + P_w$
‖ "PNA in top flange"
else
‖ "PNA in web"

Use LRFD Table D6.1-1, CASE II to find depth of PNA from top of deck plate:

$$Y_{pna} := \left(\frac{t_d}{2}\right) \cdot \left(\frac{P_{cf} + P_t + P_w}{P_d} + 1\right) = 0.512\ \boldsymbol{in} \qquad \text{(LRFD Table D6.1-1)}$$

2.1.2 Find distance from PNA to centroid of element forces:

$d_{cf} := t_d + \frac{t_f}{2} - Y_{pna} = 0.368\ \boldsymbol{in}$ PNA to centroid top flange

$d_w := t_d + \frac{D_{beam}}{2} - Y_{pna} = 3.233\ \boldsymbol{in}$ PNA to centroid web

$d_t := t_d + D_{beam} - \frac{t_f}{2} - Y_{pna} = 6.098\ \boldsymbol{in}$ PNA to centroid bottom flange

Plastic moment using LRFD Table D6.1-1, Case II:

$$M_p := \frac{P_d}{2 \cdot t_d} \cdot \left(Y_{pna}^{\ 2} + \left(t_d - Y_{pna}\right)^2\right) + \left(P_{cf} \cdot d_{cf} + P_w \cdot d_w + P_t \cdot d_t\right) = 50.064\ \boldsymbol{kip \cdot ft}$$

2.2 Determine yield moment using LRFD D6.1:

Total section properties using parallel axis theorem:

$A_d := t_d \cdot b_d = 12\ in^2$ Area of effective deck

$y_d := \frac{t_d}{2} = 0.375\ in$ Depth to c.g. of deck from top

$y_{beam} := t_d + \frac{D_{beam}}{2} = 3.745\ in$ Depth to c.g. of beam from top

$y_{total} := \frac{A_{beam} \cdot y_{beam} + A_d \cdot y_d}{A_{beam} + A_d} = 1.284\ in$ Depth to c.g. from top

$$I_{total} := I_{xx} + A_{beam} \cdot \left(y_{total} - y_{beam}\right)^2 + \frac{b_d \cdot t_d^{\,3}}{12} + A_d \cdot \left(y_{total} - y_d\right)^2$$

$$I_{total} = 66.408\ in^4$$

$S_{total.top} := \frac{I_{total}}{y_{total}} = 51.734\ in^3$ Section modulus for top fiber

$S_{total.bot} := \frac{I_{total}}{t_d + D_{beam} - y_{total}} = 12.171\ in^3$ Section modulus for bottom fiber

Yield moment capacity of total section per LRFD D6.2.1:

$$M_{yc} := F_y \cdot S_{total.top} = 155.202\ kip \cdot ft$$

$$M_{yt} := F_y \cdot S_{total.bot} = 36.512\ kip \cdot ft$$

$$M_y := min\left(M_{yc}, M_{yt}\right) = 36.512\ kip \cdot ft$$

Hybrid factor (all steel is the same):

$R_h := 1.0$ All steel is the same (i.e. not hybrid) (LRFD 6.10.1.10.1)

2.3 Limiting slenderness ratio for compact webs per LRFD A6.2.1:

$$\lambda_{pw.Dcp1} := \frac{\sqrt{\frac{E}{F_y}}}{\left(0.54 \cdot \frac{M_p}{R_h \cdot M_y} - 0.09\right)^2} = 67.091$$ (LRFD Eq A6.2.1-2)

$$\lambda_{rw} := 5.7 \cdot \sqrt{\frac{E}{F_y}} = 161.779$$ (LRFD Eq A6.2.1-3)

None of the web is in compression in the elastic nor the plastic ranges:

$$D_c := D_{cp} = 0 \ \boldsymbol{in}$$

$$\lambda_{pw.Dcp2} := \lambda_{rw} \cdot (1.0) = 161.779$$

$$\lambda_{pw.Dcp} := min\left(\lambda_{pw.Dcp1}, \lambda_{pw.Dcp2}\right) = 67.091$$

$$Check_{2.3} := \text{if } \frac{2 \cdot D_{cp}}{t_w} > \lambda_{pw.Dcp} = \text{“Compact”}$$
$$\quad \| \text{“Noncompact”}$$
$$\text{else}$$
$$\quad \| \text{“Compact”}$$

Web plastification factors:

$$R_{pc} := \frac{M_p}{M_{yc}} = 0.323$$ Compression flange (LRFD Eq A6.2.1-4)

$$R_{pt} := \frac{M_p}{M_{yt}} = 1.371$$ Tension flange (LRFD Eq A6.2.1-5)

3. Flexural capacity with discretely braced tension flanges per LRFD A6.1.2:

$$\phi_f := 1.0$$ Resistance factor for flexure (LRFD 6.5.4.2)

$$M_{nt} := R_{pt} \cdot M_{yt} = 50.064 \ \boldsymbol{kip \cdot ft}$$ (LRFD Eq A6.4-1)

$$\phi_f \cdot M_{nt} = 50.064 \ \boldsymbol{kip \cdot ft}$$

4. Flexural capacity with continuously braced compression flange per LRFD A6.1.3:

$\phi_f = 1$ Resistance factor for flexure (LRFD 6.5.4.2)

$\phi_f \cdot R_{pc} \cdot M_{yc} = 50.064\ \boldsymbol{kip \cdot ft}$ (LRFD Eq A6.1.3-1)

5. Nominal Shear resistance (unstiffened web) per LRFD 6.10.9.2:

$k := 5.0$ (LRFD Eq 6.10.9.2-2)

$\dfrac{D}{t_w} = 23.783$ $1.12 \cdot \sqrt{\dfrac{E \cdot k}{F_y}} = 71.081$

$C := \text{if } \dfrac{D}{t_w} \le 1.12 \cdot \sqrt{\dfrac{E \cdot k}{F_y}} = 1$ (LRFD Eq 6.10.9.3.2-4)
‖ 1.0
else
‖ "See LRFD Eq 6.10.9.3.2–5"

$V_p := 0.58 \cdot F_y \cdot D \cdot t_w = 26.269\ \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-2)

$V_{cr} := C \cdot V_p = 26.269\ \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-1)

$V_n := V_{cr} = 26.269\ \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-1)

$\phi_v := 1.0$ (LRFD 6.5.4.2)

$\phi_v \cdot V_n = 26.269\ \boldsymbol{kip}$

EXTERIOR BEAM CAPACITY USING W6x15 & 0.75" DECK PLATE

Purpose: Determine nominal resistance of exterior strut assuming W6x15 rolled-shape and 0.75" thick deck plate in accordance with LRFD 6.14.3.2.3.

References:

- MBE - AASHTO Manual for Bridge Evaluation 2nd Edition w/ 2014 Interims
- LRFD - AASHTO LRFD Bridge Design Specifications 7th Edition w/ 2015 Interims
- AISC - AISC Steel Construction Manual 14th Edition (for rolled-shape properties)

Properties:

Steel properties:

$F_y := 36\ ksi$	Yield strength of A36 steel
$E := 29000\ ksi$	Steel elastic modulus

W6x15:

$A_{beam} := 4.43\ in^2$	Area of rolled-shape
$D_{beam} := 5.99\ in$	Depth of rolled-shape
$t_w := 0.230\ in$	Web thickness
$b_f := 5.99\ in$	Flange width
$t_f := 0.260\ in$	Flange thickness
$I_{xx} := 29.1\ in^4$	Strong-axis moment of inertia

Steel plate deck:

$t_d := 0.75\ in$	Deck plate thickness

$b_d := \frac{16\ in}{2} + 3.75\ in = 11.75\ in$ Effective deck width equal to beam (rib) spacing

1. Web slenderness check per LRFD 6.10.6.2.3:

Determine depth of web in compression in accordance with LRFD D6.3.2 (all members have the same yield strength):

$D := D_{beam} - 2 \cdot t_f = 5.47\ in$ Depth of the web between flanges

$A_w := t_w \cdot D = 1.258\ in^2$ Area of the web

$A_c := t_d \cdot b_d + t_f \cdot b_f = 10.37\ in^2$ Area of the compression flange

$A_t := t_f \cdot b_f = 1.557\ in^2$ Area of the tension flange

Per LRFD Eq D6.3.2-3:

$A_w = 1.258\ in^2$

$|A_c - A_t| = 8.813\ in^2$

$D_{cp} :=$ if $A_w < |A_c - A_t|$ $= 0\ in$ (LRFD Eq D6.3.2-3)
  ‖ $0\ in$
else
  ‖ $\dfrac{D}{2 \cdot A_w} \cdot (A_t + A_w - A_c)$ (LRFD Eq D6.3.2-4)

<u>1.1 Check web slenderness per LRFD Eq 6.10.6.2.3-1:</u>

$\dfrac{2 \cdot D_{cp}}{t_w} = 0$ $\qquad 5.7 \cdot \sqrt{\dfrac{E}{F_y}} = 161.779$

$Check_{1.1} :=$ if $\dfrac{2 \cdot D_{cp}}{t_w} < 5.7 \cdot \sqrt{\dfrac{E}{F_y}}$ $=$ "Yes"
  ‖ "Yes"
else
  ‖ "No"

<u>1.2 Check flange ratio per LRFD Eq 6.10.6.2.3-2:</u>

$I_{yc} := \dfrac{t_d \cdot b_d^{\,3}}{12} + \dfrac{t_f \cdot b_f^{\,3}}{12} = 106.046\ in^4$

$I_{yt} := \dfrac{t_f \cdot b_f^{\,3}}{12} = 4.657\ in^4$

$Check_{1.2} :=$ if $\dfrac{I_{yc}}{I_{yt}} \geq 0.3$ $=$ "Yes"
  ‖ "Yes"
else
  ‖ "No"

<u>Therefore, okay to use LRFD Appendix A6 to determine nominal flexural resistance.</u>

2. Web plastification factors per LRFD A6.2:

2.1 Determine plastic moment using LRFD D6.1:

2.1.1 Find plastic neutral axis:

$P_d := b_d \cdot t_d \cdot F_y = 317.25\ \boldsymbol{kip}$ Yielding force in deck plate

$P_{cf} := A_t \cdot F_y = 56.066\ \boldsymbol{kip}$ Yielding force in top flange

$P_w := A_w \cdot F_y = 45.292\ \boldsymbol{kip}$ Yielding force in web

$P_t := A_t \cdot F_y = 56.066\ \boldsymbol{kip}$ Yielding force in bottom flange

if $P_d > P_{cf} + P_t + P_w$ = "PNA in deck plate"
‖ "PNA in deck plate"
else if $P_d + P_{cf} > P_t + P_w$
‖ "PNA in top flange"
else
‖ "PNA in web"

Use LRFD Table D6.1-1, CASE II to find depth of PNA from top of deck plate:

$$Y_{pna} := \left(\frac{t_d}{2}\right) \cdot \left(\frac{P_{cf} + P_t + P_w}{P_d} + 1\right) = 0.561\ \boldsymbol{in}$$ (LRFD Table D6.1-1)

2.1.2 Find distance from PNA to centroid of element forces:

$d_{cf} := t_d + \frac{t_f}{2} - Y_{pna} = 0.319\ \boldsymbol{in}$ PNA to centroid top flange

$d_w := t_d + \frac{D_{beam}}{2} - Y_{pna} = 3.184\ \boldsymbol{in}$ PNA to centroid web

$d_t := t_d + D_{beam} - \frac{t_f}{2} - Y_{pna} = 6.049\ \boldsymbol{in}$ PNA to centroid bottom flange

Plastic moment using LRFD Table D6.1-1, Case II:

$$M_p := \frac{P_d}{2 \cdot t_d} \cdot \left(Y_{pna}^{\ 2} + \left(t_d - Y_{pna}\right)^2\right) + \left(P_{cf} \cdot d_{cf} + P_w \cdot d_w + P_t \cdot d_t\right) = 47.946\ \boldsymbol{kip \cdot ft}$$

2.2 Determine yield moment using LRFD D6.1:

Total section properties using parallel axis theorem:

$A_d := t_d \cdot b_d = 8.813\ in^2$ — Area of effective deck

$y_d := \frac{t_d}{2} = 0.375\ in$ — Depth to c.g. of deck from top

$y_{beam} := t_d + \frac{D_{beam}}{2} = 3.745\ in$ — Depth to c.g. of beam from top

$y_{total} := \frac{A_{beam} \cdot y_{beam} + A_d \cdot y_d}{A_{beam} + A_d} = 1.502\ in$ — Depth to c.g. from top

$$I_{total} := I_{xx} + A_{beam} \cdot \left(y_{total} - y_{beam}\right)^2 + \frac{b_d \cdot t_d^3}{12} + A_d \cdot \left(y_{total} - y_d\right)^2$$

$$I_{total} = 62.994\ in^4$$

$S_{total.top} := \frac{I_{total}}{y_{total}} = 41.93\ in^3$ — Section modulus for top fiber

$S_{total.bot} := \frac{I_{total}}{t_d + D_{beam} - y_{total}} = 12.027\ in^3$ — Section modulus for bottom fiber

Yield moment capacity of total section per LRFD D6.2.1:

$$M_{yc} := F_y \cdot S_{total.top} = 125.789\ kip \cdot ft$$

$$M_{yt} := F_y \cdot S_{total.bot} = 36.081\ kip \cdot ft$$

$$M_y := min\left(M_{yc}, M_{yt}\right) = 36.081\ kip \cdot ft$$

Hybrid factor (all steel is the same):

$R_h := 1.0$ All steel is the same (i.e. not hybrid) (LRFD 6.10.1.10.1)

2.3 Limiting slenderness ratio for compact webs per LRFD A6.2.1:

$$\lambda_{pw.Dcp1} := \frac{\sqrt{\frac{E}{F_y}}}{\left(0.54 \cdot \frac{M_p}{R_h \cdot M_y} - 0.09\right)^2} = 72.063 \qquad \text{(LRFD Eq A6.2.1-2)}$$

$$\lambda_{rw} := 5.7 \cdot \sqrt{\frac{E}{F_y}} = 161.779 \qquad \text{(LRFD Eq A6.2.1-3)}$$

None of the web is in compression in the elastic nor the plastic ranges:

$$D_c := D_{cp} = 0\ \boldsymbol{in}$$

$$\lambda_{pw.Dcp2} := \lambda_{rw} \cdot (1.0) = 161.779$$

$$\lambda_{pw.Dcp} := min\left(\lambda_{pw.Dcp1}, \lambda_{pw.Dcp2}\right) = 72.063$$

$$Check_{2.3} := \text{if } \frac{2 \cdot D_{cp}}{t_w} > \lambda_{pw.Dcp} \ \| \text{"Noncompact"} \ \text{else} \ \| \text{"Compact"} \quad = \text{"Compact"}$$

Web plastification factors:

$$R_{pc} := \frac{M_p}{M_{yc}} = 0.381$$ Compression flange (LRFD Eq A6.2.1-4)

$$R_{pt} := \frac{M_p}{M_{yt}} = 1.329$$ Tension flange (LRFD Eq A6.2.1-5)

3. Flexural capacity with discretely braced tension flanges per LRFD A6.1.2:

$$\phi_f := 1.0$$ Resistance factor for flexure (LRFD 6.5.4.2)

$$M_{nt} := R_{pt} \cdot M_{yt} = 47.946\ \boldsymbol{kip \cdot ft} \qquad \text{(LRFD Eq A6.4-1)}$$

$$\phi_f \cdot M_{nt} = 47.946\ \boldsymbol{kip \cdot ft}$$

4. Flexural capacity with continuously braced compression flange per LRFD A6.1.3:

$\phi_f = 1$ Resistance factor for flexure (LRFD 6.5.4.2)

$\phi_f \cdot R_{pc} \cdot M_{yc} = 47.946\ \boldsymbol{kip \cdot ft}$ (LRFD Eq A6.1.3-1)

5. Nominal Shear resistance (unstiffened web) per LRFD 6.10.9.2:

$k := 5.0$ (LRFD Eq 6.10.9.2-2)

$\frac{D}{t_w} = 23.783$ $1.12 \cdot \sqrt{\frac{E \cdot k}{F_y}} = 71.081$

$$C := \text{if } \frac{D}{t_w} \le 1.12 \cdot \sqrt{\frac{E \cdot k}{F_y}} = 1$$ (LRFD Eq 6.10.9.3.2-4)

‖ 1.0
else
‖ "See LRFD Eq 6.10.9.3.2–5"

$V_p := 0.58 \cdot F_y \cdot D \cdot t_w = 26.269\ \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-2)

$V_{cr} := C \cdot V_p = 26.269\ \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-1)

$V_n := V_{cr} = 26.269\ \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-1)

$\phi_v := 1.0$ (LRFD 6.5.4.2)

$\phi_v \cdot V_n = 26.269\ \boldsymbol{kip}$

INTERIOR BEAM CAPACITY USING FIELD MEASURED DIMENSIONS

Purpose: Determine nominal shear and flexural resistance of interior beam comprised of the field measured dimensions for the rolled-beam and 0.80" thick deck in accordance with LRFD 6.14.3.2.3.

References:

- MBE - AASHTO Manual for Bridge Evaluation 2nd Edition w/ 2014 Interims
- LRFD - AASHTO LRFD Bridge Design Specifications 7th Edition w/ 2015 Interims
- AISC - AISC Steel Construction Manual 14th Edition (for rolled-shape properties)

Properties:

Global steel properties:

$F_y := 36\ ksi$ Yield strength of A36 steel

$E := 29000\ ksi$ Steel elastic modulus

Field-measured dimensions of rolled-shape:

$D_{beam} := 152.4\ mm = 6\ in$ Depth of rolled-shape

$t_w := 6.198\ mm = 0.244\ in$ Web thickness

$b_f := 5.972\ in$ Flange width

$t_f := 0.316\ in$ Flange thickness

$A_{beam} := 2 \cdot b_f \cdot t_f + t_w \cdot (D_{beam} - 2 \cdot t_f) = 5.084\ in^2$ Area of rolled-shape

$$I_{xx} := \frac{t_w \cdot (D_{beam} - 2 \cdot t_f)^3}{12} + 2 \cdot \left(\frac{b_f \cdot t_f^3}{12} + b_f \cdot t_f \cdot \left(\frac{D_{beam}}{2} - \frac{t_f}{2} \right)^2 \right) = 33.662\ in^4$$

Steel plate deck:

$t_d := 0.80\ in$ Deck plate thickness

$b_d := 16\ in$ Effective deck width equal to rib spacing

1. Web slenderness check per LRFD 6.10.6.2.3:

Determine depth of web in compression in accordance with LRFD D6.3.2 (all members have the same yield strength):

$D := D_{beam} - 2 \cdot t_f = 5.368\ in$ Depth of the web between flanges

$A_w := t_w \cdot D = 1.31\ in^2$ Area of the web

$A_c := t_d \cdot b_d + t_f \cdot b_f = 14.687\ in^2$ Area of the compression flange

$A_t := t_f \cdot b_f = 1.887\ in^2$ Area of the tension flange

Per LRFD Eq D6.3.2-3:

$A_w = 1.31\ in^2$

$|A_c - A_t| = 12.8\ in^2$

$$D_{cp} := \text{if } A_w < |A_c - A_t| \quad \| \ 0\ in \quad \text{else} \quad \| \ \frac{D}{2 \cdot A_w} \cdot (A_t + A_w - A_c) \qquad = 0\ in$$

(LRFD Eq D6.3.2-3)

(LRFD Eq D6.3.2-4)

<u>1.1 Check web slenderness per LRFD Eq 6.10.6.2.3-1:</u>

$\frac{2 \cdot D_{cp}}{t_w} = 0 \qquad 5.7 \cdot \sqrt{\frac{E}{F_y}} = 161.779$

$$Check_{1.1} := \text{if } \frac{2 \cdot D_{cp}}{t_w} < 5.7 \cdot \sqrt{\frac{E}{F_y}} \quad \| \ \text{"Yes"} \quad \text{else} \quad \| \ \text{"No"} \qquad = \text{"Yes"}$$

<u>1.2 Check flange ratio per LRFD Eq 6.10.6.2.3-2:</u>

$$I_{yc} := \frac{t_d \cdot b_d^3}{12} + \frac{t_f \cdot b_f^3}{12} = 278.675\ in^4$$

$$I_{yt} := \frac{t_f \cdot b_f^3}{12} = 5.609\ in^4$$

$$Check_{1.2} := \text{if } \frac{I_{yc}}{I_{yt}} \geq 0.3 \quad \| \ \text{"Yes"} \quad \text{else} \quad \| \ \text{"No"} \qquad = \text{"Yes"}$$

$Check_{1.1} = \text{"Yes"}$ and $Check_{1.2} = \text{"Yes"}$

<u>Therefore, okay to use LRFD Appendix A6 to determine nominal flexural resistance.</u>

2. Web plastification factors per LRFD A6.2:

2.1 Determine plastic moment using LRFD D6.1:

2.1.1 Find plastic neutral axis:

$P_d := b_d \cdot t_d \cdot F_y = 460.8\ \mathbf{kip}$ Yielding force in deck plate

$P_{cf} := A_t \cdot F_y = 67.937\ \mathbf{kip}$ Yielding force in top flange

$P_w := A_w \cdot F_y = 47.156\ \mathbf{kip}$ Yielding force in web

$P_t := A_t \cdot F_y = 67.937\ \mathbf{kip}$ Yielding force in bottom flange

```
if Pd > Pcf + Pt + Pw        = "PNA in deck plate"
  || "PNA in deck plate"
else if Pd + Pcf > Pt + Pw
  || "PNA in top flange"
else
  || "PNA in web"
```

Use LRFD Table D6.1-1, CASE II to find depth of PNA from top of deck plate:

$$Y_{pna} := \left(\frac{t_d}{2}\right) \cdot \left(\frac{P_{cf} + P_t + P_w}{P_d} + 1\right) = 0.559\ \mathbf{in}$$ (LRFD Table D6.1-1)

2.1.2 Find distance from PNA to centroid of element forces:

$d_{cf} := t_d + \frac{t_f}{2} - Y_{pna} = 0.399\ \mathbf{in}$ PNA to centroid top flange

$d_w := t_d + \frac{D_{beam}}{2} - Y_{pna} = 3.241\ \mathbf{in}$ PNA to centroid web

$d_t := t_d + D_{beam} - \frac{t_f}{2} - Y_{pna} = 6.083\ \mathbf{in}$ PNA to centroid bottom flange

Plastic moment using LRFD Table D6.1-1, Case II:

$$M_p := \frac{P_d}{2 \cdot t_d} \cdot \left(Y_{pna}^{\ 2} + \left(t_d - Y_{pna}\right)^2\right) + \left(P_{cf} \cdot d_{cf} + P_w \cdot d_w + P_t \cdot d_t\right) = 58.327\ \mathbf{kip \cdot ft}$$

2.2 Determine yield moment using LRFD D6.1:

Total section properties using parallel axis theorem:

$A_d := t_d \cdot b_d = 12.8\ in^2$ Area of effective deck

$y_d := \frac{t_d}{2} = 0.4\ in$ Depth to c.g. of deck from top

$y_{beam} := t_d + \frac{D_{beam}}{2} = 3.8\ in$ Depth to c.g. of beam from top

$y_{total} := \frac{A_{beam} \cdot y_{beam} + A_d \cdot y_d}{A_{beam} + A_d} = 1.367\ in$ Depth to c.g. from top

$$I_{total} := I_{xx} + A_{beam} \cdot (y_{total} - y_{beam})^2 + \frac{b_d \cdot t_d^3}{12} + A_d \cdot (y_{total} - y_d)^2$$

$I_{total} = 76.409\ in^4$

$S_{total.top} := \frac{I_{total}}{y_{total}} = 55.913\ in^3$ Section modulus for top fiber

$S_{total.bot} := \frac{I_{total}}{t_d + D_{beam} - y_{total}} = 14.063\ in^3$ Section modulus for bottom fiber

Yield moment capacity of total section per LRFD D6.2.1:

$M_{yc} := F_y \cdot S_{total.top} = 167.74\ kip \cdot ft$

$M_{yt} := F_y \cdot S_{total.bot} = 42.188\ kip \cdot ft$

$M_y := min(M_{yc}, M_{yt}) = 42.188\ kip \cdot ft$

Hybrid factor (all steel is the same):

$R_h := 1.0$ All steel is the same (i.e. not hybrid) (LRFD 6.10.1.10.1)

<u>2.3 Limiting slenderness ratio for compact webs per LRFD A6.2.1:</u>

$$\lambda_{pw.Dcp1} := \frac{\sqrt{\frac{E}{F_y}}}{\left(0.54 \cdot \frac{M_p}{R_h \cdot M_y} - 0.09\right)^2} = 65.839$$ (LRFD Eq A6.2.1-2)

$$\lambda_{rw} := 5.7 \cdot \sqrt{\frac{E}{F_y}} = 161.779$$ (LRFD Eq A6.2.1-3)

None of the web is in compression in the elastic nor the plastic ranges:

$$D_c := D_{cp} = 0 \; in$$

$$\lambda_{pw.Dcp2} := \lambda_{rw} \cdot (1.0) = 161.779$$

$$\lambda_{pw.Dcp} := min\left(\lambda_{pw.Dcp1}, \lambda_{pw.Dcp2}\right) = 65.839$$

$$Check_{2.3} := \text{if } \frac{2 \cdot D_{cp}}{t_w} > \lambda_{pw.Dcp} \;\; \text{“Noncompact”} \;\; \text{else} \;\; \text{“Compact”} \quad = \text{“Compact”}$$

Web plastification factors:

$$R_{pc} := \frac{M_p}{M_{yc}} = 0.348$$ Compression flange (LRFD Eq A6.2.1-4)

$$R_{pt} := \frac{M_p}{M_{yt}} = 1.383$$ Tension flange (LRFD Eq A6.2.1-5)

3. Flexural capacity with discretely braced tension flanges per LRFD A6.1.2:

$$\phi_f := 1.0$$ Resistance factor for flexure (LRFD 6.5.4.2)

$$M_{nt} := R_{pt} \cdot M_{yt} = 58.327 \; kip \cdot ft$$ (LRFD Eq A6.4-1)

$$\phi_f \cdot M_{nt} = 58.327 \; kip \cdot ft$$

4. Flexural capacity with continuously braced compression flange per LRFD A6.1.3:

$\phi_f = 1$ Resistance factor for flexure (LRFD 6.5.4.2)

$\phi_f \cdot R_{pc} \cdot M_{yc} = 58.327\ \boldsymbol{kip \cdot ft}$ (LRFD Eq A6.1.3-1)

5. Nominal Shear resistance (unstiffened web) per LRFD 6.10.9.2:

$k := 5.0$ (LRFD Eq 6.10.9.2-2)

$\frac{D}{t_w} = 21.999 \qquad 1.12 \cdot \sqrt{\frac{E \cdot k}{F_y}} = 71.081$

$$C := \text{if } \frac{D}{t_w} \le 1.12 \cdot \sqrt{\frac{E \cdot k}{F_y}} \quad \| \ 1.0 \quad \text{else} \quad \| \ \text{“See LRFD Eq 6.10.9.3.2–5”} \qquad = 1$$

(LRFD Eq 6.10.9.3.2-4)

$V_p := 0.58 \cdot F_y \cdot D \cdot t_w = 27.35\ \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-2)

$V_{cr} := C \cdot V_p = 27.35\ \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-1)

$V_n := V_{cr} = 27.35\ \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-1)

$\phi_v := 1.0$ (LRFD 6.5.4.2)

$\phi_v \cdot V_n = 27.35\ \boldsymbol{kip}$

EXTERIOR BEAM CAPACITY USING FIELD MEASUREMENTS

Purpose: Determine nominal resistance of exterior beam using field-measured dimensions of the rolled-beam and 0.80" thick deck plate in accordance with LRFD 6.14.3.2.3.

References:

- MBE - AASHTO Manual for Bridge Evaluation 2nd Edition w/ 2014 Interims
- LRFD - AASHTO LRFD Bridge Design Specifications 7th Edition w/ 2015 Interims
- AISC - AISC Steel Construction Manual 14th Edition (for rolled-shape properties)

Properties:

Steel properties:

$F_y := 36\ ksi$ Yield strength of A36 steel

$E := 29000\ ksi$ Steel elastic modulus

W6x15:

$D_{beam} := 152.4\ mm = 6\ in$ Depth of rolled-shape

$t_w := 6.198\ mm = 0.244\ in$ Web thickness

$b_f := 5.972\ in$ Flange width

$t_f := 0.316\ in$ Flange thickness

$A_{beam} := 2 \cdot b_f \cdot t_f + t_w \cdot (D_{beam} - 2 \cdot t_f) = 5.084\ in^2$ Area of rolled-shape

$$I_{xx} := \frac{t_w \cdot (D_{beam} - 2 \cdot t_f)^3}{12} + 2 \cdot \left(\frac{b_f \cdot t_f^{\,3}}{12} + b_f \cdot t_f \cdot \left(\frac{D_{beam}}{2} - \frac{t_f}{2}\right)^2\right) = 33.662\ in^4$$

Steel plate deck:

$t_d := 0.80\ in$ Deck plate thickness

$b_d := \frac{16\ in}{2} + 3.75\ in = 11.75\ in$ Effective deck width equal to beam (rib) spacing

1. Web slenderness check per LRFD 6.10.6.2.3:

Determine depth of web in compression in accordance with LRFD D6.3.2 (all members have the same yield strength):

$D := D_{beam} - 2 \cdot t_f = 5.368\ in$ Depth of the web between flanges

$A_w := t_w \cdot D = 1.31\ in^2$ Area of the web

$A_c := t_d \cdot b_d + t_f \cdot b_f = 11.287\ in^2$ Area of the compression flange

$A_t := t_f \cdot b_f = 1.887\ in^2$ Area of the tension flange

Per LRFD Eq D6.3.2-3:

$$A_w = 1.31\ in^2$$

$$|A_c - A_t| = 9.4\ in^2$$

$$D_{cp} := \text{if } A_w < |A_c - A_t| \quad = 0\ in \qquad \text{(LRFD Eq D6.3.2-3)}$$
$$\quad \| \ 0\ in$$
$$\quad \text{else}$$
$$\quad \| \ \frac{D}{2 \cdot A_w} \cdot (A_t + A_w - A_c) \qquad \text{(LRFD Eq D6.3.2-4)}$$

1.1 Check web slenderness per LRFD Eq 6.10.6.2.3-1:

$$\frac{2 \cdot D_{cp}}{t_w} = 0 \qquad 5.7 \cdot \sqrt{\frac{E}{F_y}} = 161.779$$

$$Check_{1.1} := \text{if } \frac{2 \cdot D_{cp}}{t_w} < 5.7 \cdot \sqrt{\frac{E}{F_y}} \quad = \text{"Yes"}$$
$$\quad \| \ \text{"Yes"}$$
$$\quad \text{else}$$
$$\quad \| \ \text{"No"}$$

1.2 Check flange ratio per LRFD Eq 6.10.6.2.3-2:

$$I_{yc} := \frac{t_d \cdot b_d^{\ 3}}{12} + \frac{t_f \cdot b_f^{\ 3}}{12} = 113.758\ in^4$$

$$I_{yt} := \frac{t_f \cdot b_f^{\ 3}}{12} = 5.609\ in^4$$

$$Check_{1.2} := \text{if } \frac{I_{yc}}{I_{yt}} \geq 0.3 \quad = \text{"Yes"}$$
$$\quad \| \ \text{"Yes"}$$
$$\quad \text{else}$$
$$\quad \| \ \text{"No"}$$

Therefore, okay to use LRFD Appendix A6 to determine nominal flexural resistance.

2. Web plastification factors per LRFD A6.2:

2.1 Determine plastic moment using LRFD D6.1:

2.1.1 Find plastic neutral axis (PNA):

$P_d := b_d \cdot t_d \cdot F_y = 338.4\ \textbf{kip}$ Yielding force in deck plate

$P_{cf} := A_t \cdot F_y = 67.937\ \textbf{kip}$ Yielding force in top flange

$P_w := A_w \cdot F_y = 47.156\ \textbf{kip}$ Yielding force in web

$P_t := A_t \cdot F_y = 67.937\ \textbf{kip}$ Yielding force in bottom flange

if $P_d > P_{cf} + P_t + P_w$ = "PNA in deck plate"
  || "PNA in deck plate"
else if $P_d + P_{cf} > P_t + P_w$
  || "PNA in top flange"
else
  || "PNA in web"

Use LRFD Table D6.1-1, CASE II to find depth of PNA from top of deck plate:

$$Y_{pna} := \left(\frac{t_d}{2}\right) \cdot \left(\frac{P_{cf} + P_t + P_w}{P_d} + 1\right) = 0.616\ \textbf{in} \qquad \text{(LRFD Table D6.1-1)}$$

2.1.2 Find distance from PNA to centroid of element forces:

$d_{cf} := t_d + \frac{t_f}{2} - Y_{pna} = 0.342\ \textbf{in}$ PNA to centroid top flange

$d_w := t_d + \frac{D_{beam}}{2} - Y_{pna} = 3.184\ \textbf{in}$ PNA to centroid web

$d_t := t_d + D_{beam} - \frac{t_f}{2} - Y_{pna} = 6.026\ \textbf{in}$ PNA to centroid bottom flange

Plastic moment using LRFD Table D6.1-1, Case II:

$$M_p := \frac{P_d}{2 \cdot t_d} \cdot \left(Y_{pna}^{\ 2} + \left(t_d - Y_{pna}\right)^2\right) + \left(P_{cf} \cdot d_{cf} + P_w \cdot d_w + P_t \cdot d_t\right) = 55.849\ \textbf{kip} \cdot \textbf{ft}$$

2.2 Determine yield moment using LRFD D6.1:

Total section properties using parallel axis theorem:

$A_d := t_d \cdot b_d = 9.4\ in^2$ Area of effective deck

$y_d := \dfrac{t_d}{2} = 0.4\ in$ Depth to c.g. of deck from top

$y_{beam} := t_d + \dfrac{D_{beam}}{2} = 3.8\ in$ Depth to c.g. of beam from top

$y_{total} := \dfrac{A_{beam} \cdot y_{beam} + A_d \cdot y_d}{A_{beam} + A_d} = 1.593\ in$ Depth to c.g. from top

$$I_{total} := I_{xx} + A_{beam} \cdot \left(y_{total} - y_{beam}\right)^2 + \frac{b_d \cdot t_d^{\,3}}{12} + A_d \cdot \left(y_{total} - y_d\right)^2$$

$$I_{total} = 72.306\ in^4$$

$S_{total.top} := \dfrac{I_{total}}{y_{total}} = 45.377\ in^3$ Section modulus for top fiber

$S_{total.bot} := \dfrac{I_{total}}{t_d + D_{beam} - y_{total}} = 13.887\ in^3$ Section modulus for bottom fiber

Yield moment capacity of total section per LRFD D6.2.1:

$$M_{yc} := F_y \cdot S_{total.top} = 136.13\ kip \cdot ft$$

$$M_{yt} := F_y \cdot S_{total.bot} = 41.662\ kip \cdot ft$$

$$M_y := min\left(M_{yc}, M_{yt}\right) = 41.662\ kip \cdot ft$$

Hybrid factor (all steel is the same):

$R_h := 1.0$ All steel is the same (i.e. not hybrid) (LRFD 6.10.1.10.1)

2.3 Limiting slenderness ratio for compact webs per LRFD A6.2.1:

$$\lambda_{pw.Dcp1} := \frac{\sqrt{\frac{E}{F_y}}}{\left(0.54 \cdot \frac{M_p}{R_h \cdot M_y} - 0.09\right)^2} = 70.639$$ (LRFD Eq A6.2.1-2)

$$\lambda_{rw} := 5.7 \cdot \sqrt{\frac{E}{F_y}} = 161.779$$ (LRFD Eq A6.2.1-3)

None of the web is in compression in the elastic nor the plastic ranges:

$$D_c := D_{cp} = 0 \; \boldsymbol{in}$$

$$\lambda_{pw.Dcp2} := \lambda_{rw} \cdot (1.0) = 161.779$$

$$\lambda_{pw.Dcp} := min\left(\lambda_{pw.Dcp1}, \lambda_{pw.Dcp2}\right) = 70.639$$

$$Check_{2.3} := \text{if } \frac{2 \cdot D_{cp}}{t_w} > \lambda_{pw.Dcp} = \text{“Compact”}$$
$$\quad \| \text{“Noncompact”}$$
$$\text{else}$$
$$\quad \| \text{“Compact”}$$

Web plastification factors:

$$R_{pc} := \frac{M_p}{M_{yc}} = 0.41$$ Compression flange (LRFD Eq A6.2.1-4)

$$R_{pt} := \frac{M_p}{M_{yt}} = 1.341$$ Tension flange (LRFD Eq A6.2.1-5)

3. Flexural capacity with discretely braced tension flanges per LRFD A6.1.2:

$$\phi_f := 1.0$$ Resistance factor for flexure (LRFD 6.5.4.2)

$$M_{nt} := R_{pt} \cdot M_{yt} = 55.849 \; \boldsymbol{kip \cdot ft}$$ (LRFD Eq A6.4-1)

$$\phi_f \cdot M_{nt} = 55.849 \; \boldsymbol{kip \cdot ft}$$

4. Flexural capacity with continuously braced compression flange per LRFD A6.1.3:

$\phi_f = 1$ Resistance factor for flexure (LRFD 6.5.4.2)

$\phi_f \cdot R_{pc} \cdot M_{yc} = 55.849 \; \boldsymbol{kip \cdot ft}$ (LRFD Eq A6.1.3-1)

5. Nominal Shear resistance (unstiffened web) per LRFD 6.10.9.2:

$k := 5.0$ (LRFD Eq 6.10.9.2-2)

$\frac{D}{t_w} = 21.999 \qquad 1.12 \cdot \sqrt{\frac{E \cdot k}{F_y}} = 71.081$

$C := \text{if } \frac{D}{t_w} \le 1.12 \cdot \sqrt{\frac{E \cdot k}{F_y}} \qquad = 1$ (LRFD Eq 6.10.9.3.2-4)

$\quad \| \; 1.0$

$\quad$ else

$\quad \| \;$ "See LRFD Eq 6.10.9.3.2–5"

$V_p := 0.58 \cdot F_y \cdot D \cdot t_w = 27.35 \; \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-2)

$V_{cr} := C \cdot V_p = 27.35 \; \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-1)

$V_n := V_{cr} = 27.35 \; \boldsymbol{kip}$ (LRFD Eq 6.10.9.2-1)

$\phi_v := 1.0$ (LRFD 6.5.4.2)

$\phi_v \cdot V_n = 27.35 \; \boldsymbol{kip}$

Purpose: Determine the Legal Load Rating of the Bile & Pigua bridge beams in accordance with MBE 6A.4.4 using Guam modified AASHTO legal vehicles and requirements for load posting in accordance with MBE 6A.8.3.

References:

- MBE - AASHTO Manual for Bridge Evaluation 2nd Edition w/ 2014 Interims

Evaluation Factors for Strength Limit States:

$\phi := 1.0$ Resistance factor already applied in capacity calculations.

<u>Interior beams:</u>

$\phi_{c.int} := 1.00$ Condition factor for beams in good condition based on photos (MBE Table 6A.4.2.3-1)

$\phi_{s.int} := 1.00$ System factor for bridge with more than 4 girders (MBE Table 6A.4.2.4-1)

$\phi_{cs.int} := \max\left(\phi_{c.int} \cdot \phi_{s.int}, 0.85\right) = 1$ (MBE Eq 6A.4.2.1-3)

<u>Exterior beams:</u>

$\phi_{c.ext} := 0.95$ Condition factor for beams in fair condition based on photos (MBE Table 6A.4.2.3-1)

$\phi_{s.ext} := 1.00$ System factor for bridge with more than 4 girders (MBE Table 6A.4.2.4-1)

$\phi_{cs.ext} := \max\left(\phi_{c.ext} \cdot \phi_{s.ext}, 0.85\right) = 0.95$ (MBE Eq 6A.4.2.1-3)

Member capacities using W6x15 & 0.75" deck plate:

<u>Interior beams:</u>

Moment: $M_{r.int} := 50.0\ \boldsymbol{kip \cdot ft}$

Shear: $V_{r.int} := 26.2\ \boldsymbol{kip}$

<u>Exterior beams:</u>

Moment: $M_{r.ext} := 47.9\ \boldsymbol{kip \cdot ft}$

Shear: $V_{r.ext} := 26.2\ \boldsymbol{kip}$

Load effects:
Controlling load effects are determined using a LARSA 4D finite element analysis model with surface area influence analysis. The beams were modeled as W6x15 rolled-beams acting composite with the 0.75" thick steel deck plate. Compound Element Force results were used to determine the controlling moment and shear in the combined "beam" which includes a single W6x15 and the tributary effective deck plate width, defined as the deck plate extending half the distance to the adjacent W6x15 (or the free edge in the case of exterior beams).

<u>Interior beams:</u>

Moment:

Dead load moment at midspan:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	DC
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-0.441
Fy	2e-3
Fz	-2e-3
Mx	-1e-3
My	2.475
Mz	-6e-3

$M_{DC.int} := 2.475\ \boldsymbol{kip \cdot ft}$ from self-weight of components

Maximum live load moments at midspan:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	Type 3 Mod (2D): s348.1/l12 /d1.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-2.394
Fy	0.724
Fz	-4.652
Mx	0.888
My	18.93
Mz	0.624

$M_{Type3Mod.int} := 18.93\ \boldsymbol{kip \cdot ft}$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	pe 3S2 Mod (2D): s301.1/l12 /d1.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-2.194
Fy	0.594
Fz	-3.705
Mx	0.756
My	17.18
Mz	0.558

$M_{Type3S2Mod.int} := 17.18\ \boldsymbol{kip \cdot ft}$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	al-Type 3-3 (2D): s165.8/l12 /d0.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-1.852
Fy	0.668
Fz	-3.347
Mx	0.589
My	14.51
Mz	0.553

$M_{Type33.int} := 14.51\ \boldsymbol{kip \cdot ft}$

Interior beams (continued):

Shear:

Dead load shear at support face:

Compound Element Forces	
Units: in	
Elements	M21902 P31802, P31902
Coor Sys	Global X Axis
Station	-110
Result Case	DC
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-0.098
Fy	-0.101
Fz	0.490
Mx	-7e-3
My	0.210
Mz	-0.025

$V_{DC.int} := 0.49\ kip$ from self weight of components

Maximum live load shear at support face:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M21902 P31802, P31902
Coor. Sys.	Global X Axis
Station	-110
Result Case	Type 3 Mod (2D): s73.13/t12./d0.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-9.384
Fy	0.064
Fz	7.286
Mx	0.204
My	0.756
Mz	0.017

$V_{Type3Mod.int} := 7.286\ kip$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M21902 P31802, P31902
Coor. Sys	Global X Axis
Station	-110
Result Case	pe 3S2 Mod (2D): s203.7/t12./d1.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-8.425
Fy	4e-3
Fz	6.851
Mx	0.214
My	0.876
Mz	5e-4

$V_{Type3S2Mod.int} := 6.851\ kip$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M21902 P31802, P31902
Coor Sys	Global X Axis
Station	-110
Result Case	gal-Type 3-3 (2D): s674.9/t12./d1.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-7.402
Fy	0.069
Fz	5.485
Mx	0.137
My	0.497
Mz	0.026

$V_{Type33.int} := 5.485\ kip$

Exterior beams:

Moment:

Dead load moment at midspan:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	DC
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	1.020
Fy	-3e-4
Fz	0.014
Mx	-5e-4
My	2.351
Mz	-0.785

$M_{DC.ext} := 2.351\ \boldsymbol{kip \cdot ft}$ from self-weight of components

Maximum live load moments at midspan:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	Type 3 Mod (2D): s146.3/t12./d0.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	6.828
Fy	0.933
Fz	1.251
Mx	0.023
My	19.97
Mz	-5.113

$M_{Type3Mod.ext} := 19.97\ \boldsymbol{kip \cdot ft}$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	)e 3S2 Mod (2D): s277.5/t12./d1.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	6.257
Fy	0.863
Fz	1.115
Mx	0.024
My	18.31
Mz	-4.682

$M_{Type3S2Mod.ext} := 18.31\ \boldsymbol{kip \cdot ft}$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	)al-Type 3-3 (2D): s745.9/t12./d1.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	5.310
Fy	0.728
Fz	0.962
Mx	0.019
My	15.53
Mz	-3.975

$M_{Type33.ext} := 15.53\ \boldsymbol{kip \cdot ft}$

Exterior beams (continued):

Shear:

Dead load shear at support:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	DC
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	0.029
Fy	-0.169
Fz	0.485
Mx	0.060
My	0.217
Mz	-0.087

$V_{DC.ext} := 0.485\ \boldsymbol{kip}$ from self weight of components

Maximum live load shear at support:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	Type 3 Mod (2D): s298.4/12./d1.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	-4.920
Fy	-1.184
Fz	4.035
Mx	0.422
My	0.732
Mz	-0.099

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	›e 3S2 Mod (2D): s430.9/12./d0.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	-4.593
Fy	-1.105
Fz	3.701
Mx	0.386
My	0.652
Mz	-0.085

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	›al-Type 3-3 (2D): s118.4/12./d0.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	-3.832
Fy	-0.923
Fz	3.138
Mx	0.328
My	0.568
Mz	-0.077

$V_{Type3Mod.ext} := 4.035\ \boldsymbol{kip}$ $V_{Type3S2Mod.ext} := 3.701\ \boldsymbol{kip}$ $V_{Type33.ext} := 3.139\ \boldsymbol{kip}$

Load factors and impact factors:

Legal load ratings for Strength Limit State use Strength-I Limit State Load factors in accordance with MBE Table 6A.4.2.2-1:

$\gamma_{DC} := 1.25$

$\gamma_{LL} := 1.30$ Assuming ADTT < 1,000 (MBE Table 6A.4.4.2.3a-1 in 2013 & 2014 Interims)

$IM := 33\%$ Impact factor (dynamic load allowance) (MBE 6A.4.4.3)

Rating factor formula:

$$RF(C, DC, LL) := \frac{C - \gamma_{DC} \cdot DC}{\gamma_{LL} \cdot (LL \cdot (1 + IM))}$$ (MBE Eq 6A.4.2.1-1)

<u>Interior beams:</u>

Moment:

$RF_{M.int.Type3Mod} := RF\left(\phi_{cs.int} \cdot M_{r.int}, M_{DC.int}, M_{Type3Mod.int}\right) = 1.433$

$RF_{M.int.Type3S2Mod} := RF\left(\phi_{cs.int} \cdot M_{r.int}, M_{DC.int}, M_{Type3S2Mod.int}\right) = 1.579$

$RF_{M.int.Type33} := RF\left(\phi_{cs.int} \cdot M_{r.int}, M_{DC.int}, M_{Type33.int}\right) = 1.87$

Shear:

$RF_{V.int.Type3Mod} := RF\left(\phi_{cs.int} \cdot V_{r.int}, V_{DC.int}, V_{Type3Mod.int}\right) = 2.031$

$RF_{V.int.Type3S2Mod} := RF\left(\phi_{cs.int} \cdot V_{r.int}, V_{DC.int}, V_{Type3S2Mod.int}\right) = 2.16$

$RF_{V.int.Type33} := RF\left(\phi_{cs.int} \cdot V_{r.int}, V_{DC.int}, V_{Type33.int}\right) = 2.698$

<u>Exterior beams:</u>

Moment:

$$RF_{M.ext.Type3Mod} := RF\left(\phi_{cs.ext} \cdot M_{r.ext}, M_{DC.ext}, M_{Type3Mod.ext}\right) = 1.233$$

$$RF_{M.ext.Type3S2Mod} := RF\left(\phi_{cs.ext} \cdot M_{r.ext}, M_{DC.ext}, M_{Type3S2Mod.ext}\right) = 1.345$$

$$RF_{M.ext.Type33} := RF\left(\phi_{cs.ext} \cdot M_{r.ext}, M_{DC.ext}, M_{Type33.ext}\right) = 1.585$$

Shear:

$$RF_{V.ext.Type3Mod} := RF\left(\phi_{cs.ext} \cdot V_{r.ext}, V_{DC.ext}, V_{Type3Mod.ext}\right) = 3.481$$

$$RF_{V.ext.Type3S2Mod} := RF\left(\phi_{cs.ext} \cdot V_{r.ext}, V_{DC.ext}, V_{Type3S2Mod.ext}\right) = 3.795$$

$$RF_{V.ext.Type33} := RF\left(\phi_{cs.ext} \cdot V_{r.ext}, V_{DC.ext}, V_{Type33.ext}\right) = 4.474$$

Purpose: Determine the Legal Load Rating of the Bile & Pigua bridge beams in accordance with MBE 6A.4.4 using Guam modified AASHTO legal vehicles and requirements for load posting in accordance with MBE 6A.8.3.

References:

- MBE - AASHTO Manual for Bridge Evaluation 2nd Edition w/ 2014 Interims

Evaluation Factors for Strength Limit States:

$\phi := 1.0$ Resistance factor already applied in capacity calculations.

<u>Interior beams:</u>

$\phi_{c.int} := 1.00$	Condition factor for beams in good condition based on photos	(MBE Table 6A.4.2.3-1)
$\phi_{s.int} := 1.00$	System factor for bridge with more than 4 girders	(MBE Table 6A.4.2.4-1)
$\phi_{cs.int} := \max(\phi_{c.int} \cdot \phi_{s.int}, 0.85) = 1$		(MBE Eq 6A.4.2.1-3)

<u>Exterior beams:</u>

$\phi_{c.ext} := 0.95$	Condition factor for beams in fair condition based on photos	(MBE Table 6A.4.2.3-1)
$\phi_{s.ext} := 1.00$	System factor for bridge with more than 4 girders	(MBE Table 6A.4.2.4-1)
$\phi_{cs.ext} := \max(\phi_{c.ext} \cdot \phi_{s.ext}, 0.85) = 0.95$		(MBE Eq 6A.4.2.1-3)

Member capacities using Field Measurements:

<u>Interior beams:</u>

Moment: $M_{r.int} := 58.3\ \boldsymbol{kip \cdot ft}$

Shear: $V_{r.int} := 27.3\ \boldsymbol{kip}$

<u>Exterior beams:</u>

Moment: $M_{r.ext} := 55.8\ \boldsymbol{kip \cdot ft}$

Shear: $V_{r.ext} := 27.3\ \boldsymbol{kip}$

Load effects:
Controlling load effects are determined using a LARSA 4D finite element analysis model with surface area influence analysis. The beams were modeled as rolled-shapes of the dimensions measured in the field and 0.80" thick steel plate deck. Compound Element Force results were used to determine the controlling moment and shear in the combined "beam" which includes a single rolled-beam and the tributary effective deck plate width, defined as the deck plate extending half the distance to the adjacent beam (or the free edge in the case of exterior beams).

Interior beams:

Moment:

Dead load moment at midspan:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	DC
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.412
Units: kips, ft	
Fx	-0.473
Fy	1e-3
Fz	-2e-3
Mx	-1e-3
My	2.696
Mz	-7e-3

$M_{DC.int} := 2.696\ \boldsymbol{kip \cdot ft}$ from self-weight of components

Maximum live load moments at midspan:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	Type 3 Mod (2D): s169.4/t12./d0.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.412
Units: kips, ft	
Fx	-2.323
Fy	0.362
Fz	3.466
Mx	-1.415
My	19.54
Mz	0.511

$M_{Type3Mod.int} := 19.54\ \boldsymbol{kip \cdot ft}$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	pe 3S2 Mod (2D): s301.3/t12./d1.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.412
Units: kips, ft	
Fx	-2.128
Fy	0.339
Fz	3.188
Mx	-1.317
My	17.95
Mz	0.469

$M_{Type3S2Mod.int} := 17.95\ \boldsymbol{kip \cdot ft}$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	al-Type 3-3 (2D): s769.1/t12./d1
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.412
Units: kips, ft	
Fx	-1.804
Fy	0.293
Fz	2.713
Mx	-1.132
My	15.27
Mz	0.398

$M_{Type33.int} := 15.27\ \boldsymbol{kip \cdot ft}$

Interior beams (continued):

Shear:

Dead load shear at support face:

Compound Element Forces	
Units: in	
Elements	M21902, P31802, P31902
Coor. Sys.	Global X Axis
Station	-110
Result Case	DC
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.412
Units: kips, ft	
Fx	-0.107
Fy	-0.112
Fz	0.533
Mx	-7e-3
My	0.228
Mz	-0.027

$V_{DC.int} := 0.533\ \boldsymbol{kip}$ from self weight of components

Maximum live load shear at support face:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M21902, P31802, P31902
Coor. Sys.	Global X Axis
Station	-110
Result Case	Type 3 Mod (2D): s71.05/112./d0
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.412
Units: kips, ft	
Fx	-9.487
Fy	0.130
Fz	7.200
Mx	0.200
My	0.730
Mz	0.042

$V_{Type3Mod.int} := 7.200\ \boldsymbol{kip}$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M21902, P31802, P31902
Coor. Sys.	Global X Axis
Station	-110
Result Case	e 3S2 Mod (2D): s202.7/112./d1
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.412
Units: kips, ft	
Fx	-8.652
Fy	0.094
Fz	6.843
Mx	0.182
My	0.791
Mz	0.035

$V_{Type3S2Mod.int} := 6.843\ \boldsymbol{kip}$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M21902, P31802, P31902
Coor. Sys.	Global X Axis
Station	-110
Result Case	al-Type 3-3 (2D): s670.2/112./d1
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.412
Units: kips, ft	
Fx	-7.341
Fy	0.095
Fz	5.685
Mx	0.167
My	0.607
Mz	0.028

$V_{Type33.int} := 5.685\ \boldsymbol{kip}$

Exterior beams:

Moment:

Dead load moment at midspan:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	DC
Centroid X	0.000
Centroid Y	66.87
Centroid Z	2.187
Units: kips, ft	
Fx	1.097
Fy	-2e-3
Fz	0.014
Mx	-9e-4
My	2.554
Mz	-0.840

$M_{DC.ext} := 2.554\ \boldsymbol{kip \cdot ft}$ from self-weight of components

Maximum live load moments at midspan:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	Type 3 Mod (2D): s147.6/t12./d0.
Centroid X	0.000
Centroid Y	66.87
Centroid Z	2.187
Units: kips, ft	
Fx	6.768
Fy	0.916
Fz	1.287
Mx	4e-3
My	19.94
Mz	-5.004

$M_{Type3Mod.ext} := 19.94\ \boldsymbol{kip \cdot ft}$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	)e 3S2 Mod (2D): s279.4/t12./d1.
Centroid X	0.000
Centroid Y	66.87
Centroid Z	2.187
Units: kips, ft	
Fx	6.202
Fy	0.842
Fz	1.172
Mx	5e-3
My	18.28
Mz	-4.586

$M_{Type3S2Mod.ext} := 18.28\ \boldsymbol{kip \cdot ft}$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	jal-Type 3-3 (2D): s747.2/t12./d1.
Centroid X	0.000
Centroid Y	66.87
Centroid Z	2.187
Units: kips, ft	
Fx	5.261
Fy	0.717
Fz	0.988
Mx	5e-3
My	15.52
Mz	-3.891

$M_{Type33.ext} := 15.52\ \boldsymbol{kip \cdot ft}$

Exterior beams (continued):

Shear:

Dead load shear at support:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	DC
Centroid X	0.000
Centroid Y	66.87
Centroid Z	2.187
Units: kips, ft	
Fx	0.024
Fy	-0.184
Fz	0.528
Mx	0.064
My	0.234
Mz	-0.093

$V_{DC.ext} := 0.528\ kip$ from self weight of components

Maximum live load shear at support:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	Type 3 Mod (2D): s114.8/t12./d0.
Centroid X	0.000
Centroid Y	66.87
Centroid Z	2.187
Units: kips, ft	
Fx	-4.521
Fy	-1.125
Fz	4.024
Mx	0.404
My	0.827
Mz	-0.139

$V_{Type3Mod.ext} := 4.024\ kip$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	e 3S2 Mod (2D): s246.5/t12./d1.
Centroid X	0.000
Centroid Y	66.87
Centroid Z	2.187
Units: kips, ft	
Fx	-4.115
Fy	-1.025
Fz	3.690
Mx	0.371
My	0.766
Mz	-0.129

$V_{Type3S2Mod.ext} := 3.690\ kip$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	al-Type 3-3 (2D): s714.2/t12./d1.
Centroid X	0.000
Centroid Y	66.87
Centroid Z	2.187
Units: kips, ft	
Fx	-3.464
Fy	-0.864
Fz	3.133
Mx	0.315
My	0.657
Mz	-0.112

$V_{Type33.ext} := 3.133\ kip$

Load factors and impact factors:

Legal load ratings for Strength Limit State use Strength-I Limit State Load factors in accordance with MBE Table 6A.4.2.2-1:

$\gamma_{DC} := 1.25$

$\gamma_{LL} := 1.30$ Assuming ADTT < 1,000 (MBE Table 6A.4.4.2.3a-1 in 2013 & 2014 Interims)

$IM := 33\%$ Impact factor (dynamic load allowance) (MBE 6A.4.4.3)

Rating factor formula:

$$RF(C, DC, LL) := \left\| \frac{C - \gamma_{DC} \cdot DC}{\gamma_{LL} \cdot (LL \cdot (1 + IM))} \right.$$ (MBE Eq 6A.4.2.1-1)

<u>Interior beams:</u>

Moment:

$$RF_{M.int.Type3Mod} := RF\left(\phi_{cs.int} \cdot M_{r.int}, M_{DC.int}, M_{Type3Mod.int}\right) = 1.626$$

$$RF_{M.int.Type3S2Mod} := RF\left(\phi_{cs.int} \cdot M_{r.int}, M_{DC.int}, M_{Type3S2Mod.int}\right) = 1.77$$

$$RF_{M.int.Type33} := RF\left(\phi_{cs.int} \cdot M_{r.int}, M_{DC.int}, M_{Type33.int}\right) = 2.081$$

Shear:

$$RF_{V.int.Type3Mod} := RF\left(\phi_{cs.int} \cdot V_{r.int}, V_{DC.int}, V_{Type3Mod.int}\right) = 2.139$$

$$RF_{V.int.Type3S2Mod} := RF\left(\phi_{cs.int} \cdot V_{r.int}, V_{DC.int}, V_{Type3S2Mod.int}\right) = 2.251$$

$$RF_{V.int.Type33} := RF\left(\phi_{cs.int} \cdot V_{r.int}, V_{DC.int}, V_{Type33.int}\right) = 2.71$$

Exterior beams:

Moment:

$$RF_{M.ext.Type3Mod} := RF\left(\phi_{cs.ext} \cdot M_{r.ext}, M_{DC.ext}, M_{Type3Mod.ext}\right) = 1.445$$

$$RF_{M.ext.Type3S2Mod} := RF\left(\phi_{cs.ext} \cdot M_{r.ext}, M_{DC.ext}, M_{Type3S2Mod.ext}\right) = 1.576$$

$$RF_{M.ext.Type33} := RF\left(\phi_{cs.ext} \cdot M_{r.ext}, M_{DC.ext}, M_{Type33.ext}\right) = 1.857$$

Shear:

$$RF_{V.ext.Type3Mod} := RF\left(\phi_{cs.ext} \cdot V_{r.ext}, V_{DC.ext}, V_{Type3Mod.ext}\right) = 3.633$$

$$RF_{V.ext.Type3S2Mod} := RF\left(\phi_{cs.ext} \cdot V_{r.ext}, V_{DC.ext}, V_{Type3S2Mod.ext}\right) = 3.962$$

$$RF_{V.ext.Type33} := RF\left(\phi_{cs.ext} \cdot V_{r.ext}, V_{DC.ext}, V_{Type33.ext}\right) = 4.666$$

Purpose: Determine the Legal Load Rating of the Bile & Pigua bridge beams in accordance with MBE 6A.4.4 using Guam modified AASHTO legal vehicles assuming the angle bracing provides no lateral live load distribution.

References:

- MBE - AASHTO Manual for Bridge Evaluation 2nd Edition w/ 2014 Interims

Evaluation Factors for Strength Limit States:

$\phi := 1.0$ Resistance factor already applied in capacity calculations.

<u>Interior beams:</u>

$\phi_{c.int} := 1.00$	Condition factor for beams in good condition based on photos	(MBE Table 6A.4.2.3-1)
$\phi_{s.int} := 1.00$	System factor for bridge with more than 4 girders	(MBE Table 6A.4.2.4-1)
$\phi_{cs.int} := \max\left(\phi_{c.int} \cdot \phi_{s.int}, 0.85\right) = 1$		(MBE Eq 6A.4.2.1-3)

<u>Exterior beams:</u>

$\phi_{c.ext} := 0.95$	Condition factor for beams in fair condition based on photos	(MBE Table 6A.4.2.3-1)
$\phi_{s.ext} := 1.00$	System factor for bridge with more than 4 girders	(MBE Table 6A.4.2.4-1)
$\phi_{cs.ext} := \max\left(\phi_{c.ext} \cdot \phi_{s.ext}, 0.85\right) = 0.95$		(MBE Eq 6A.4.2.1-3)

Member capacities using W6x15 & 0.75" deck plate:

<u>Interior beams:</u>

Moment: $M_{r.int} := 50.0\ \boldsymbol{kip \cdot ft}$

Shear: $V_{r.int} := 26.2\ \boldsymbol{kip}$

<u>Exterior beams:</u>

Moment: $M_{r.ext} := 47.9\ \boldsymbol{kip \cdot ft}$

Shear: $V_{r.ext} := 26.2\ \boldsymbol{kip}$

Load effects:
Controlling load effects are determined using a LARSA 4D finite element analysis model with surface area influence analysis. The beams were modeled as W6x15 rolled-beams acting composite with the 0.75" thick steel deck plate. Compound Element Force results were used to determine the controlling moment and shear in the combined "beam" which includes a single W6x15 and the tributary effective deck plate width, defined as the deck plate extending half the distance to the adjacent W6x15 (or the free edge in the case of exterior beams). This version of the model used staged construction analysis to remove the angle bracing stiffness prior to applying the live load analysis, thereby neglecting any live load distribution from the bracing angles.

Interior beams:

Moment:

Dead load moment at midspan:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	Stage 2: Remove Bracing
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-0.400
Fy	-6e-3
Fz	2e-5
Mx	-2e-3
My	2.429
Mz	-0.018

$M_{DC.int} := 2.429\ \boldsymbol{kip \cdot ft}$ from self-weight of components

Maximum live load moments at midspan:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	Type 3 Mod (2D): s345.1/t12./d1.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	0.390
Fy	0.167
Fz	-2.956
Mx	0.651
My	21.10
Mz	0.186

$M_{Type3Mod.int} := 21.10\ \boldsymbol{kip \cdot ft}$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	)e 3S2 Mod (2D): s478.2/t12./d0.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	0.326
Fy	0.102
Fz	-2.872
Mx	0.651
My	19.44
Mz	0.133

$M_{Type3S2Mod.int} := 19.44\ \boldsymbol{kip \cdot ft}$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M21918 P31818, P31918
Coor. Sys.	Global X Axis
Station	0
Result Case	)al-Type 3-3 (2D): s165.8/t12./d0.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	0.287
Fy	0.104
Fz	-2.382
Mx	0.534
My	16.46
Mz	0.126

$M_{Type33.int} := 16.46\ \boldsymbol{kip \cdot ft}$

Interior beams (continued):

Shear:

Dead load shear at support face:

Compound Element Forces	
Units: in	
Elements	M21902, P31802, P31902
Coor. Sys.	Global X Axis
Station	-110
Result Case	Stage 2: Remove Bracing
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-0.190
Fy	-0.053
Fz	0.489
Mx	-2e-3
My	0.187
Mz	-0.016

$V_{DC.int} := 0.489\ \boldsymbol{kip}$ from self weight of components

Maximum live load shear at support face:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M21902, P31802, P31902
Coor. Sys.	Global X Axis
Station	-110
Result Case	Type 3 Mod (2D): s73.13/t12./d0.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-23.01
Fy	0.240
Fz	9.612
Mx	-0.071
My	-1.483
Mz	-0.074

$V_{Type3Mod.int} := 9.612\ \boldsymbol{kip}$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M21902, P31802, P31902
Coor. Sys.	Global X Axis
Station	-110
Result Case	)e 3S2 Mod (2D): s203.7/t12./d1.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-21.72
Fy	0.043
Fz	8.962
Mx	-0.068
My	-1.349
Mz	-0.110

$V_{Type3S2Mod.int} := 8.962\ \boldsymbol{kip}$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M21902, P31802, P31902
Coor. Sys.	Global X Axis
Station	-110
Result Case	jal-Type 3-3 (2D): s674.9/t12./d1.
Centroid X	0.000
Centroid Y	52.25
Centroid Z	2.461
Units: kips, ft	
Fx	-18.17
Fy	0.280
Fz	7.301
Mx	-0.061
My	-1.281
Mz	-0.031

$V_{Type33.int} := 7.301\ \boldsymbol{kip}$

<u>Exterior beams:</u>

Moment:

Dead load moment at midspan:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	Stage 2: Remove Bracing
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	0.919
Fy	-7e-3
Fz	-1e-3
Mx	-3e-3
My	2.247
Mz	-0.761

$M_{DC.ext} := 2.247\ \boldsymbol{kip \cdot ft}$ from self-weight of components

Maximum live load moments at midspan:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	Type 3 Mod (2D): s146.3/t12./d0.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	2.994
Fy	-0.302
Fz	0.207
Mx	-0.204
My	17.54
Mz	-5.694

$M_{Type3Mod.ext} := 17.54\ \boldsymbol{kip \cdot ft}$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	pe 3S2 Mod (2D): s277.5/t12./d1.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	2.737
Fy	-0.277
Fz	0.165
Mx	-0.182
My	16.08
Mz	-5.218

$M_{Type3S2Mod.ext} := 16.08\ \boldsymbol{kip \cdot ft}$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M22118 P32018, P32118
Coor. Sys.	Global X Axis
Station	0
Result Case	jal-Type 3-3 (2D): s745.9/t12./d1.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	2.326
Fy	-0.235
Fz	0.152
Mx	-0.157
My	13.64
Mz	-4.428

$M_{Type33.ext} := 13.64\ \boldsymbol{kip \cdot ft}$

Exterior beams (continued):

Shear:

Dead load shear at support:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	Stage 2: Remove Bracing
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	0.337
Fy	-0.124
Fz	0.440
Mx	0.055
My	0.261
Mz	-0.104

$V_{DC.ext} := 0.440\ kip$ from self weight of components

Maximum live load shear at support:

from Guam Modified Type 3:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	Type 3 Mod (2D): s146.3/t12./d0.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	5.263
Fy	0.141
Fz	2.270
Mx	0.176
My	2.094
Mz	-0.787

$V_{Type3Mod.ext} := 2.270\ kip$

from Guam Modified Type 3S2:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	e 3S2 Mod (2D): s277.5/t12./d1.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	4.936
Fy	0.145
Fz	2.083
Mx	0.162
My	1.945
Mz	-0.731

$V_{Type3S2Mod.ext} := 2.083\ kip$

from AASHTO Type 3-3:

Compound Element Forces	
Units: in	
Elements	M22102 P32002, P32102
Coor. Sys.	Global X Axis
Station	-110
Result Case	al-Type 3-3 (2D): s745.9/t12./d1.
Centroid X	0.000
Centroid Y	66.84
Centroid Z	2.243
Units: kips, ft	
Fx	4.133
Fy	0.115
Fz	1.766
Mx	0.137
My	1.637
Mz	-0.615

$V_{Type33.ext} := 1.766\ kip$

Load factors and impact factors:

Legal load ratings for Strength Limit State use Strength-I Limit State Load factors in accordance with MBE Table 6A.4.2.2-1:

$\gamma_{DC} := 1.25$

$\gamma_{LL} := 1.30$ Assuming ADTT < 1,000 (MBE Table 6A.4.4.2.3a-1 in 2013 & 2014 Interims)

$IM := 33\%$ Impact factor (dynamic load allowance) (MBE 6A.4.4.3)

Rating factor formula:

$$RF(C, DC, LL) := \left\| \frac{C - \gamma_{DC} \cdot DC}{\gamma_{LL} \cdot (LL \cdot (1 + IM))} \right.$$ (MBE Eq 6A.4.2.1-1)

<u>Interior beams:</u>

Moment:

$$RF_{M.int.Type3Mod} := RF\left(\phi_{cs.int} \cdot M_{r.int}, M_{DC.int}, M_{Type3Mod.int}\right) = 1.287$$

$$RF_{M.int.Type3S2Mod} := RF\left(\phi_{cs.int} \cdot M_{r.int}, M_{DC.int}, M_{Type3S2Mod.int}\right) = 1.397$$

$$RF_{M.int.Type33} := RF\left(\phi_{cs.int} \cdot M_{r.int}, M_{DC.int}, M_{Type33.int}\right) = 1.65$$

Shear:

$$RF_{V.int.Type3Mod} := RF\left(\phi_{cs.int} \cdot V_{r.int}, V_{DC.int}, V_{Type3Mod.int}\right) = 1.54$$

$$RF_{V.int.Type3S2Mod} := RF\left(\phi_{cs.int} \cdot V_{r.int}, V_{DC.int}, V_{Type3S2Mod.int}\right) = 1.651$$

$$RF_{V.int.Type33} := RF\left(\phi_{cs.int} \cdot V_{r.int}, V_{DC.int}, V_{Type33.int}\right) = 2.027$$

<u>Exterior beams:</u>

Moment:

$$RF_{M.ext.Type3Mod} := RF\left(\phi_{cs.ext} \cdot M_{r.ext}, M_{DC.ext}, M_{Type3Mod.ext}\right) = 1.408$$

$$RF_{M.ext.Type3S2Mod} := RF\left(\phi_{cs.ext} \cdot M_{r.ext}, M_{DC.ext}, M_{Type3S2Mod.ext}\right) = 1.536$$

$$RF_{M.ext.Type33} := RF\left(\phi_{cs.ext} \cdot M_{r.ext}, M_{DC.ext}, M_{Type33.ext}\right) = 1.81$$

Shear:

$$RF_{V.ext.Type3Mod} := RF\left(\phi_{cs.ext} \cdot V_{r.ext}, V_{DC.ext}, V_{Type3Mod.ext}\right) = 6.202$$

$$RF_{V.ext.Type3S2Mod} := RF\left(\phi_{cs.ext} \cdot V_{r.ext}, V_{DC.ext}, V_{Type3S2Mod.ext}\right) = 6.758$$

$$RF_{V.ext.Type33} := RF\left(\phi_{cs.ext} \cdot V_{r.ext}, V_{DC.ext}, V_{Type33.ext}\right) = 7.971$$

FIELD MEASURED AS-CONSTRUCTED 07/10/16

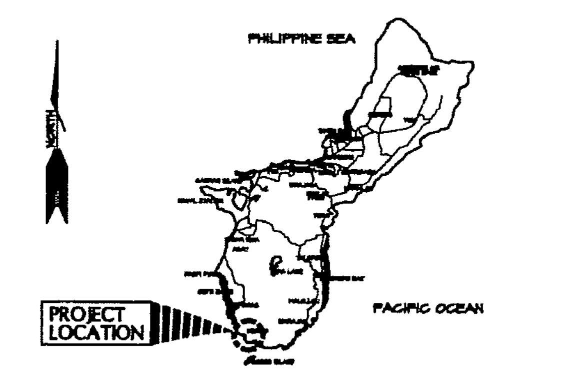
Exhibit 6

DEPARTMENT OF PUBLIC WORKS
FEDERAL-AID HIGHWAY SECTION
GOVERNMENT OF GUAM

DESIGN PLANS
BILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)
PROJECT NUMBER: GU-NH-NBIS(003)

MERIZO GUAM

LOCATION MAP



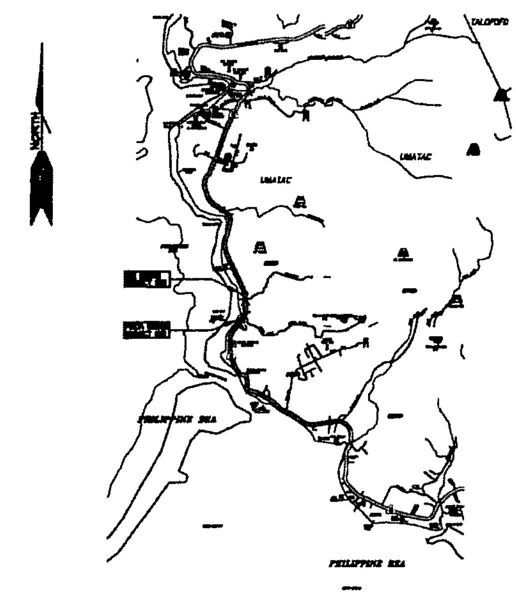
PROJECT DESCRIPTION

The project involves the construction of a temporary single lane bridge as an interim solution to address the immediate concerns to the structural integrity of the existing Bile and Pigua Bridges. The bridges are approximately 750 feet apart and located within the village of Merizo in the southern part of Guam. This temporary bridge will be constructed to span over the existing bridge with no addition impact to the structural integrity of the existing bridges. The scope of improvements entails the construction of a temporary single lane bridge within the confines of the existing Route 4 rights-of-way corridor. This will include, the installation of a ¾" thick steel plate with steel frame bridge structure supported by cast-in-place concrete foundations constructed adjacent to the existing concrete bridge abutments. Also included are asphalt concrete pavement approach ramps, concrete barriers, installation of ample warning and traffic regulatory signage and pavement markers and markings to direct vehicular movement throughout the limits of this project site, and any other roadway appurtenances, where applicable, to provide for a complete, usable and safe facility.

DESIGN CRITERIA

Number of Lanes along the Bridge:	Single Lane
Design Vehicular Load:	20 Tons (Maximum Loading)
Posted Vehicular Load:	Weight Limit 20 Tons
Posted Speed:	15 MPH (Maximum)
Traffic Signalization System:	Alternating Vehicular Movement

VICINITY MAP



duenasbordallo & ASSOCIATES INC.

- ENGINEERING (Civil, Structural, Mechanical, Environmental)
- CONSTRUCTION MANAGEMENT
- PLANNING ■ ENVIRONMENTAL SERVICES
- SURVEYING ■ DEVELOPMENT CONSULTATION
- GEOGRAPHIC INFORMATION SYSTEMS

P. O. BOX 8900 TAMUNING, GUAM 96931

INDEX OF DRAWINGS

SHEET NO.	DWG. NO.	DESCRIPTION
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2 OF 14	C-1	KEY PLAN, GENERAL NOTES AND LEGEND
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4 OF 14	C-3	PIGUA BRIDGE TRAFFIC CONTROL PLAN (TCP)
5 OF 14	C-4	BILE BRIDGE – ENLARGE PLAN
6 OF 14	C-5	PIGUA BRIDGE – ENLARGE PLAN
7 OF 14	C-6	TYPICAL ENVIRONMENTAL PROTECTION PLAN
8 OF 14	C-7	TEMPORARY TCP – DURING CONSTRUCTION
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10 OF 14	MD-1	MISCELLANEOUS DETAILS
11 OF 14	S-0	STRUCTURAL DESIGN CRITERIA, GENERAL NOTES AND TYPICAL DETAILS
12 OF 14	S-1	TYPICAL BRIDGE PLAN
13 OF 14	S-2	TYPICAL SECTIONS and DETAILS (BILE BRIDGE)
14 OF 14	S-3	TYPICAL SECTIONS and DETAILS (PIGUA BRIDGE)

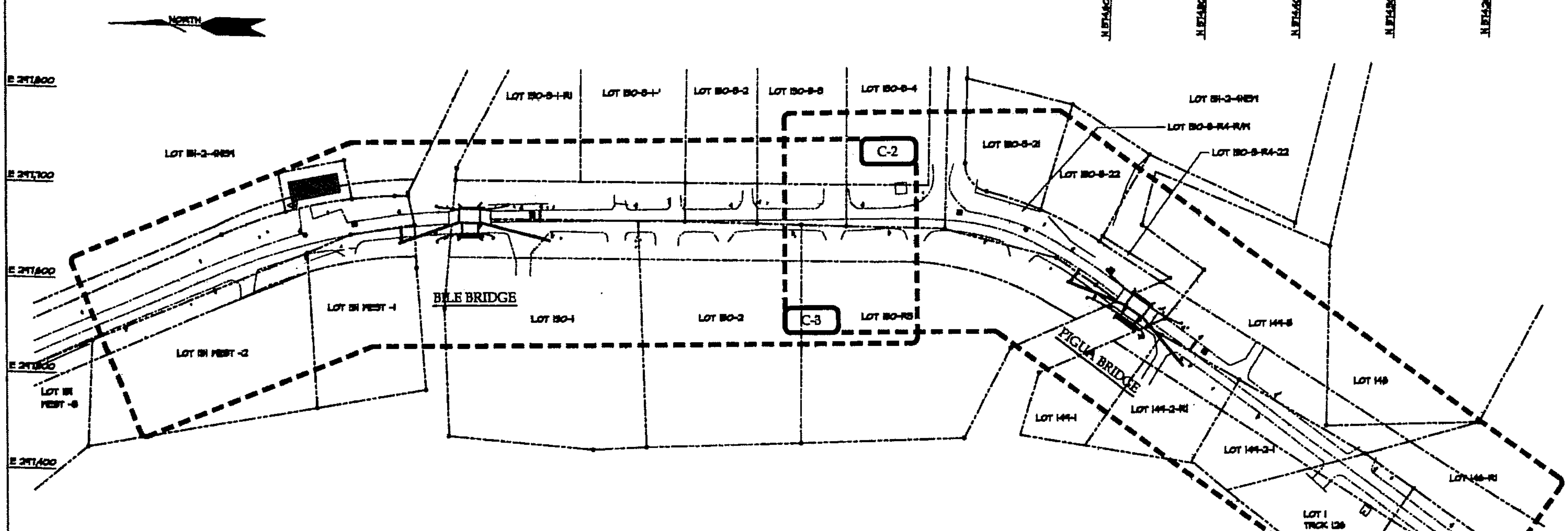
CLEARED BY:

HIGHWAYS (HORIZONTAL) ENGINEERING and MAINTENANCE DEPARTMENT OF PUBLIC WORKS — DATE

APPROVED BY:

LAWRENCE P. PEREZ DIRECTOR DEPARTMENT OF PUBLIC WORKS — DATE

TERRITORY	VILLAGE	PROJECT	PROJECT No.	DRAWING No.	SHEET
GUAM	MERIZO	BILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)	GU-NH-NBIS(###)	C-1	2 OF 14
REVISION	DATE	BY	DESCRIPTION		APPROVED



GENERAL NOTES:

1. HORIZONTAL AND VERTICAL CONTROLS WERE BASED ON THE TOPOGRAPHIC SURVEY BY: DUENAS, BORDALLO & ASSOCIATES, DATED AUGUST 2009. THE CONTRACTOR SHALL REFER THIS SURVEY FOR HORIZONTAL AND VERTICAL CONTROLS.
2. THE CONTRACTOR SHALL USE A REGISTERED LAND SURVEYOR (RLS) FOR THE LAYOUT OF ALL NEW CONSTRUCTION. THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE CONTRACTING OFFICER OF ANY DISCREPANCIES BETWEEN THE PLANS FOR THIS PROJECT AND ACTUAL FIELD CONDITIONS WHICH MAY INTERFERE WITH THIS PROJECT.
3. THE CONTRACTOR SHALL COORDINATE AND OBTAIN ALL THE NECESSARY CLEARANCES FROM LAND MANAGEMENT, GWA, DPW, GPA, GEPA, DPR AND GTA PRIOR TO ANY WORK ACTIVITY WITHIN THE GOVGUAM EASEMENT OR RIGHT-OF-WAY. THE CONTRACTOR SHALL REPAIR DAMAGES TO EXISTING GOVGUAM UTILITY LINES, DAMAGED BY THE CONTRACTOR DURING THE DURATION OF THIS CONTRACT, AND AT NO COST TO THE GOVERNMENT. REPAIR WORK SHALL BE PER GOVGUAM STANDARDS AND APPROVAL.
4. ALL EXISTING UTILITY LINES SHOWN ON THESE PLANS WERE BASED ON AVAILABLE DOCUMENTS AND FIELD SURVEY AND ARE SHOWN AT APPROXIMATE LOCATIONS ONLY. PRIOR TO THE START OF CONSTRUCTION, THE CONTRACTOR SHALL FIELD VERIFY ACTUAL SIZE AND LOCATION OF ALL EXISTING UTILITY LINES. IF THERE ARE DISCREPANCIES NOTED BETWEEN THE PLANS FOR THIS PROJECT AND ACTUAL FIELD CONDITIONS THAT MAY INTERFERE OR EFFECT THE DESIGN INTENT OF THE PROJECT, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE CONTRACTING OFFICER.
5. REFER TO ELECTRICAL DRAWINGS FOR SITE LOCATIONS OF ALL ELECTRICAL SITE ITEMS.

BILE/PIGUA BRIDGE KEY PLAN

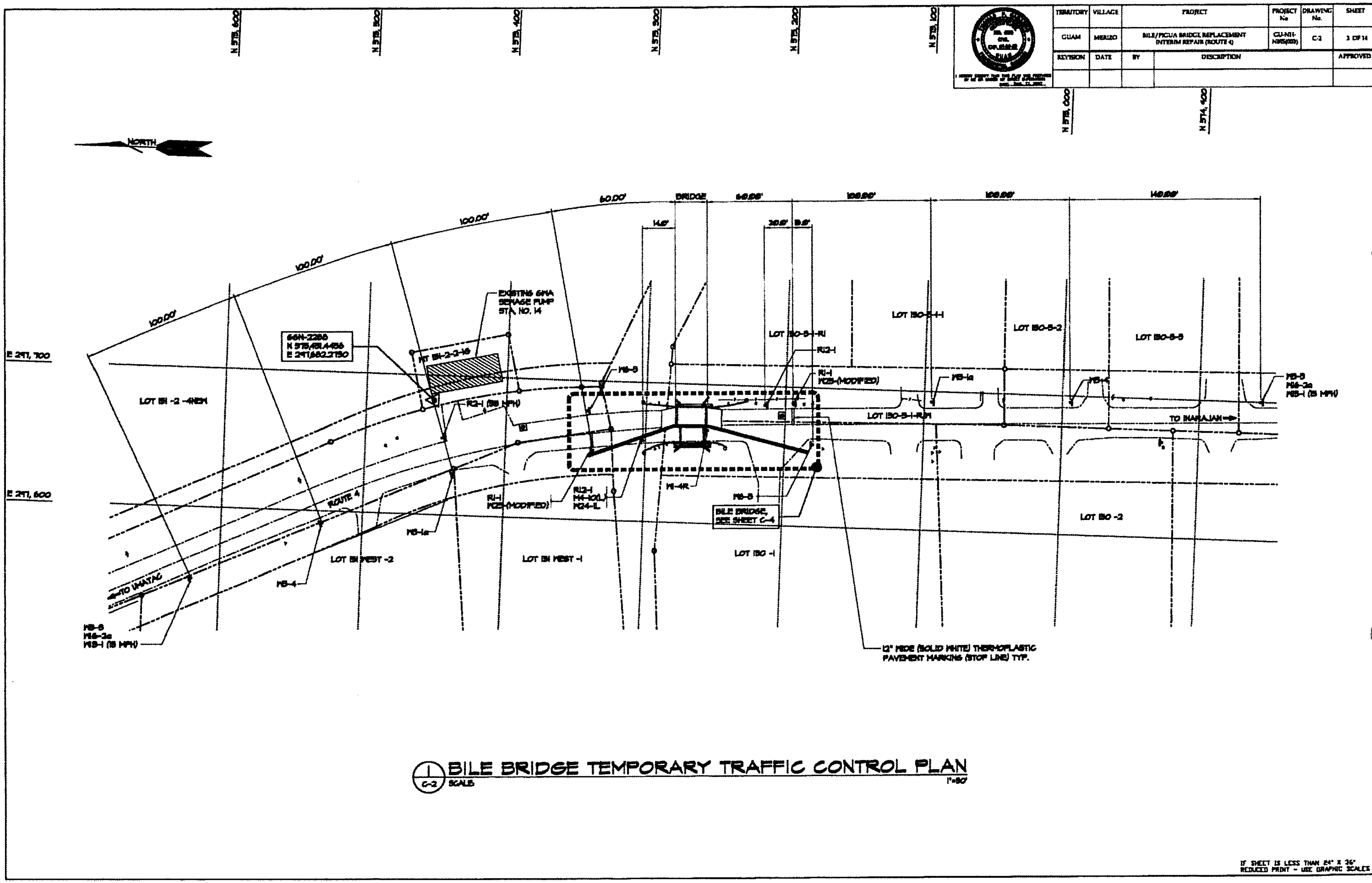
1 / C-1 SCALE: 1"=80'

LEGEND:

EXISTING	NEW	
(hatched)		STRUCTURE
(blank box)	(shaded box)	BITUMINOUS PAVEMENT, SEE SHEETS C-4 & C-5
	(hatched)	STEEL PLATE BRIDGE, SEE SHEETS C-4 & C-5
-------		PROPERTY LINE, SEE NOTE #1
	R4-1	REGULATORY SIGN, SEE SHEETS C-2 & C-5
--00--		CONTOURS
0.00	0.00	SPOT ELEVATIONS
⊕		SEWER MANHOLE
⋈		GATE VALVE
		FIRE HYDRANT
		POWER POLE
□		TELEPHONE BOX

IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

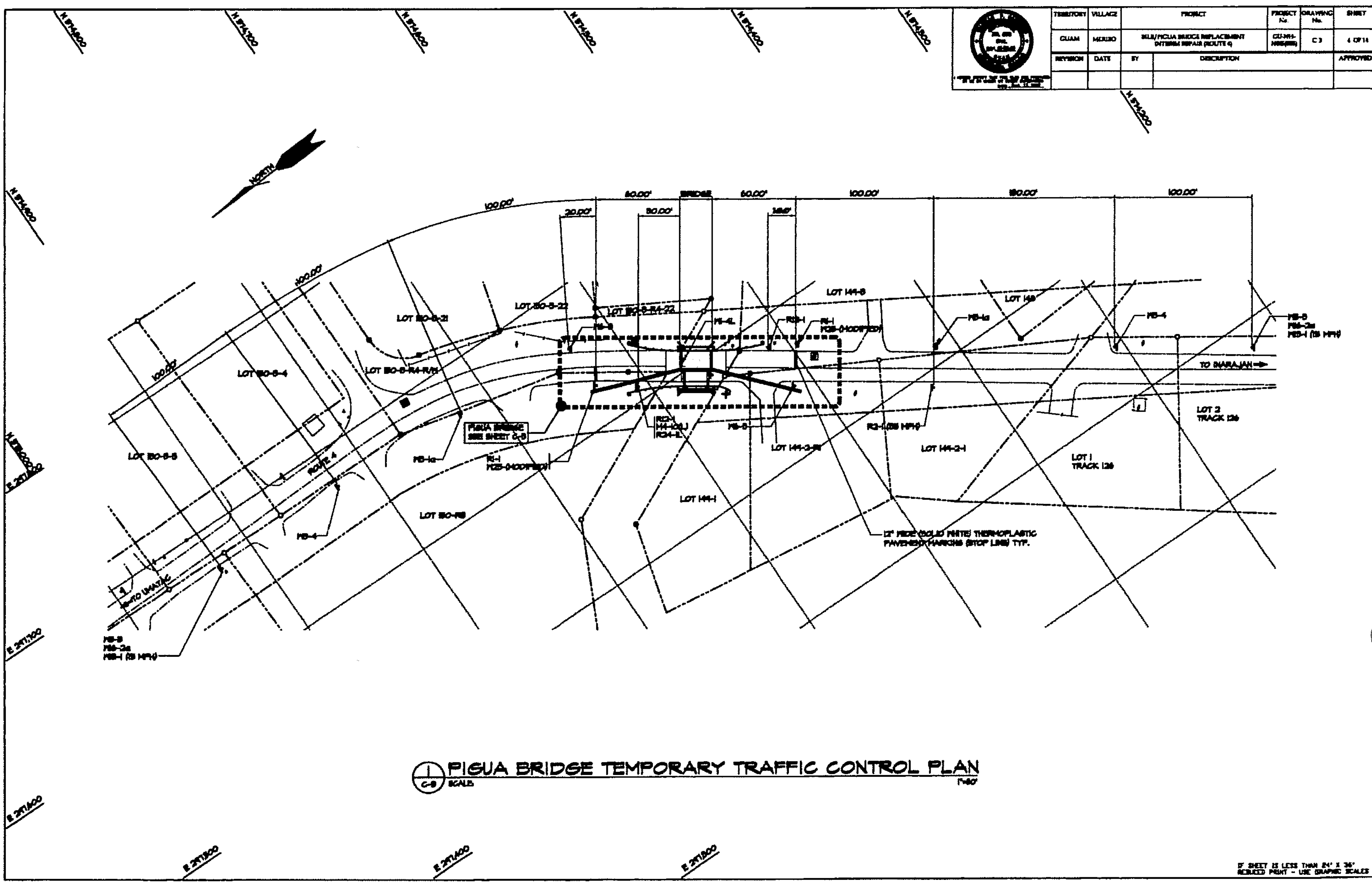
Exhibit 6



TERRITORY	VILLAGE	PROJECT	PROJECT No.	DRAWING No.	SHEET
GUAM	MERIZO	BILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)	GU-NH-NH5(000)	C-2	3 OF 14
REVISION	DATE	BY	DESCRIPTION		APPROVED

Exhibit 6

TERRITORY	VILLAGE	PROJECT	PROJECT No.	DRAWING No.	SHEET
GUAM	MERIZO	PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)		C3	4 OF 14
REVISION	DATE	BY	DESCRIPTION		APPROVED



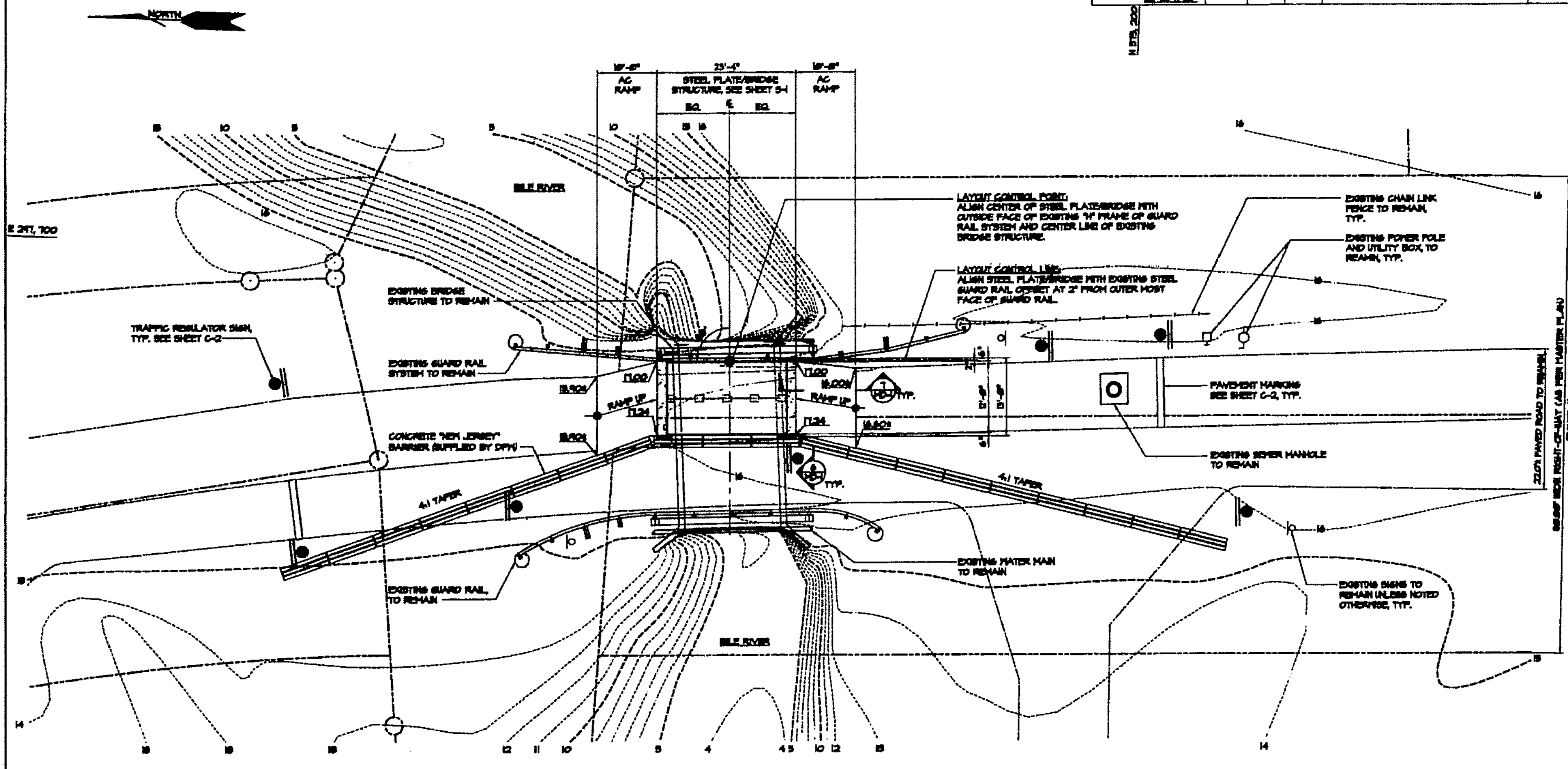
PIGUA BRIDGE TEMPORARY TRAFFIC CONTROL PLAN

C-3 SCALE 1"=50'

IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

Exhibit 6

TERRITORY	VILLAGE	PROJECT	PROJECT No.	DRAWING No.	SHEET
GUAM	MERIZO	BILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)	GU-NH-[illegible]	C-4	5 OF 14
REVISION	DATE	BY	DESCRIPTION		APPROVED



1 / C-4 BILE BRIDGE - ENLARGE PLAN

SCALE: 1/8" = 1'-0"

IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

Exhibit 6

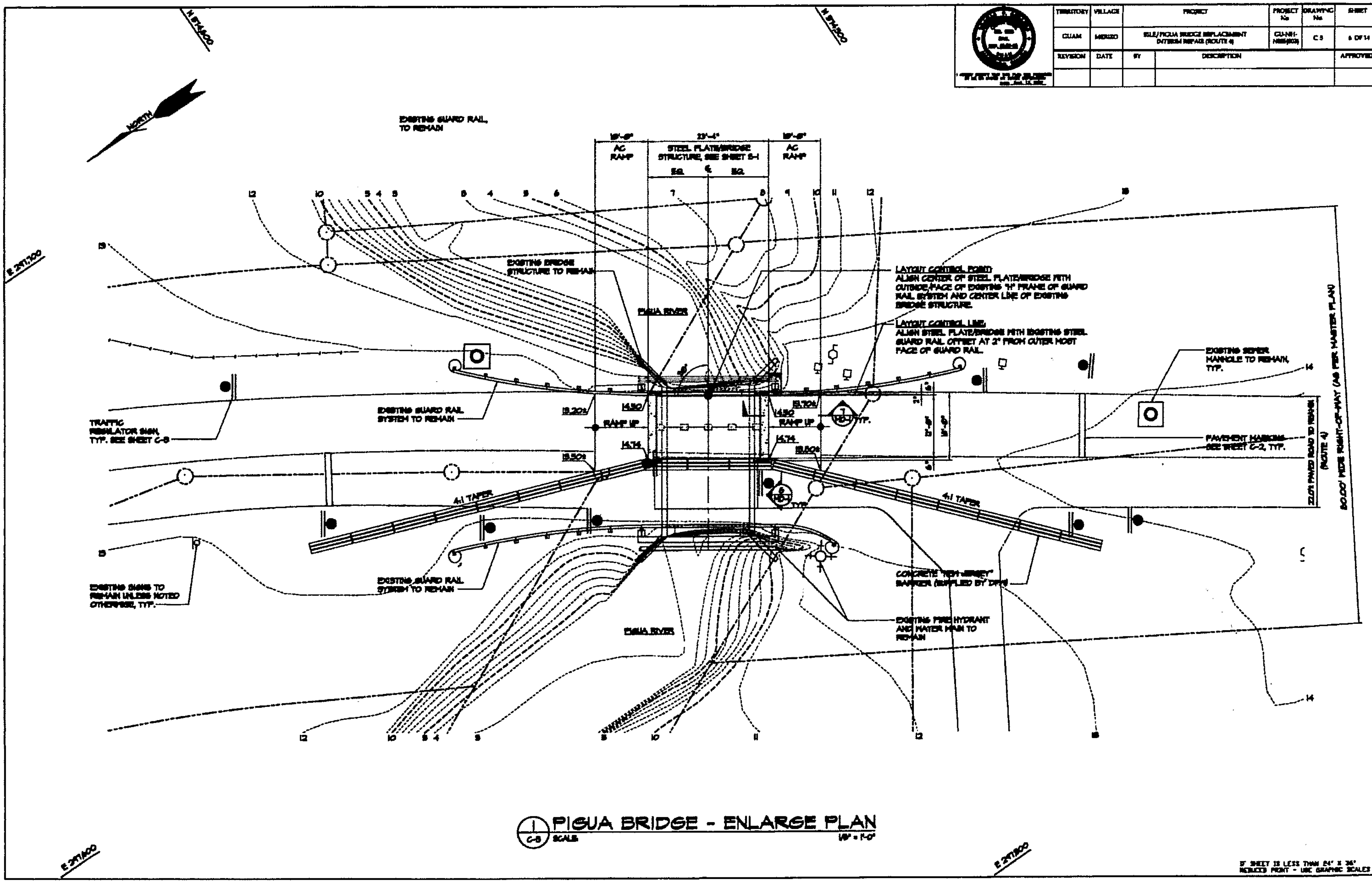
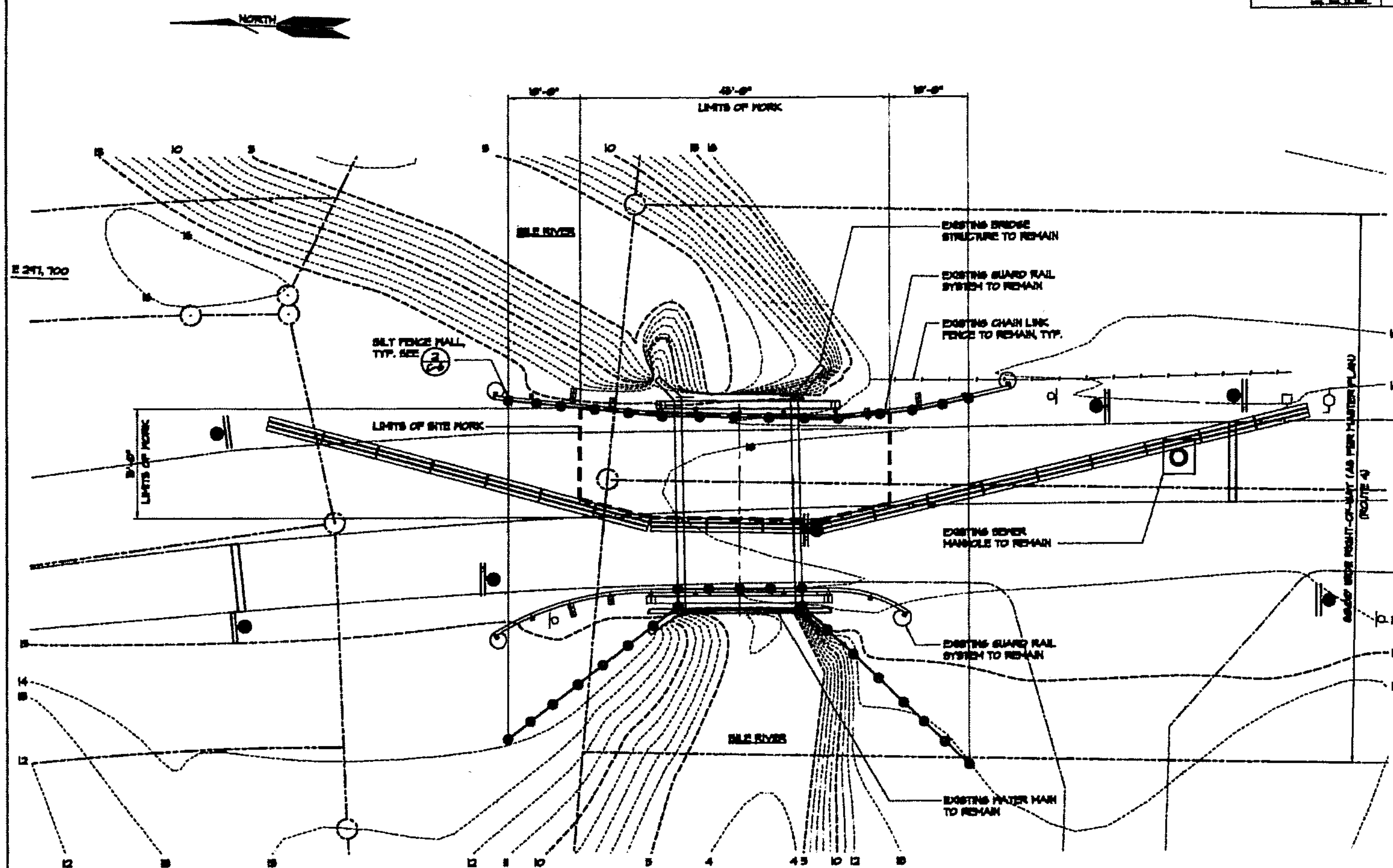

PIGUA BRIDGE - ENLARGE PLAN
SCALE
1/8" = 1'-0"
NORTH
EXISTING GUARD RAIL, TO REMAIN
AC RAMP
STEEL PLATE/BRIDGE STRUCTURE, SEE SHEET S-1
EXISTING BRIDGE STRUCTURE TO REMAIN
PIGUA RIVER
LAYOUT CONTROL POINT
LAYOUT CONTROL LINE
EXISTING SEWER MANHOLE TO REMAIN, TYP.
TRAFFIC REGULATOR SIGN, TYP. SEE SHEET C-8
EXISTING GUARD RAIL SYSTEM TO REMAIN
RAMP UP
PAVEMENT MARKINGS SEE SHEET C-2, TYP.
4:1 TAPER
EXISTING SIGNS TO REMAIN UNLESS NOTED OTHERWISE, TYP.
CONCRETE "NEW JERSEY" BARRIER (SUPPLIED BY DPW)
EXISTING FIRE HYDRANT AND WATER MAIN TO REMAIN
TERRITORY
VILLAGE
PROJECT
GUAM
MERIZO
REVISION
DATE
BY
DESCRIPTION
APPROVED
SHEET

Exhibit 6

TERRITORY	VILLAGE	PROJECT	PROJECT No.	DRAWING No.	SHEET
GUAM	MERIZO	SILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)	GU-NH-NH6(00)	C-6	7 OF 14

REVISION	DATE	BY	DESCRIPTION	APPROVED

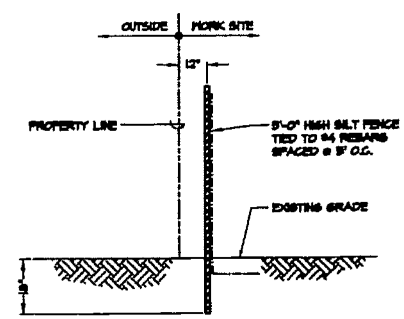


① TYPICAL ENVIRONMENTAL PROTECTION PLAN PLAN

C-6 SCALE 1/8" = 1'-0"

NOTES:

THE ENVIRONMENTAL PROTECTION PLAN (EPP) SHOWN ON THIS SHEET IS FOR REFERENCE ONLY. THE CONTRACTOR SHALL PREPARE AND SUBMIT A COMPREHENSIVE EPP PACKAGE FOR REVIEW AND APPROVAL BY THE GOVERNMENT PRIOR TO COMMENCEMENT OF ANY SITE WORK.



② SILT FENCE DETAIL

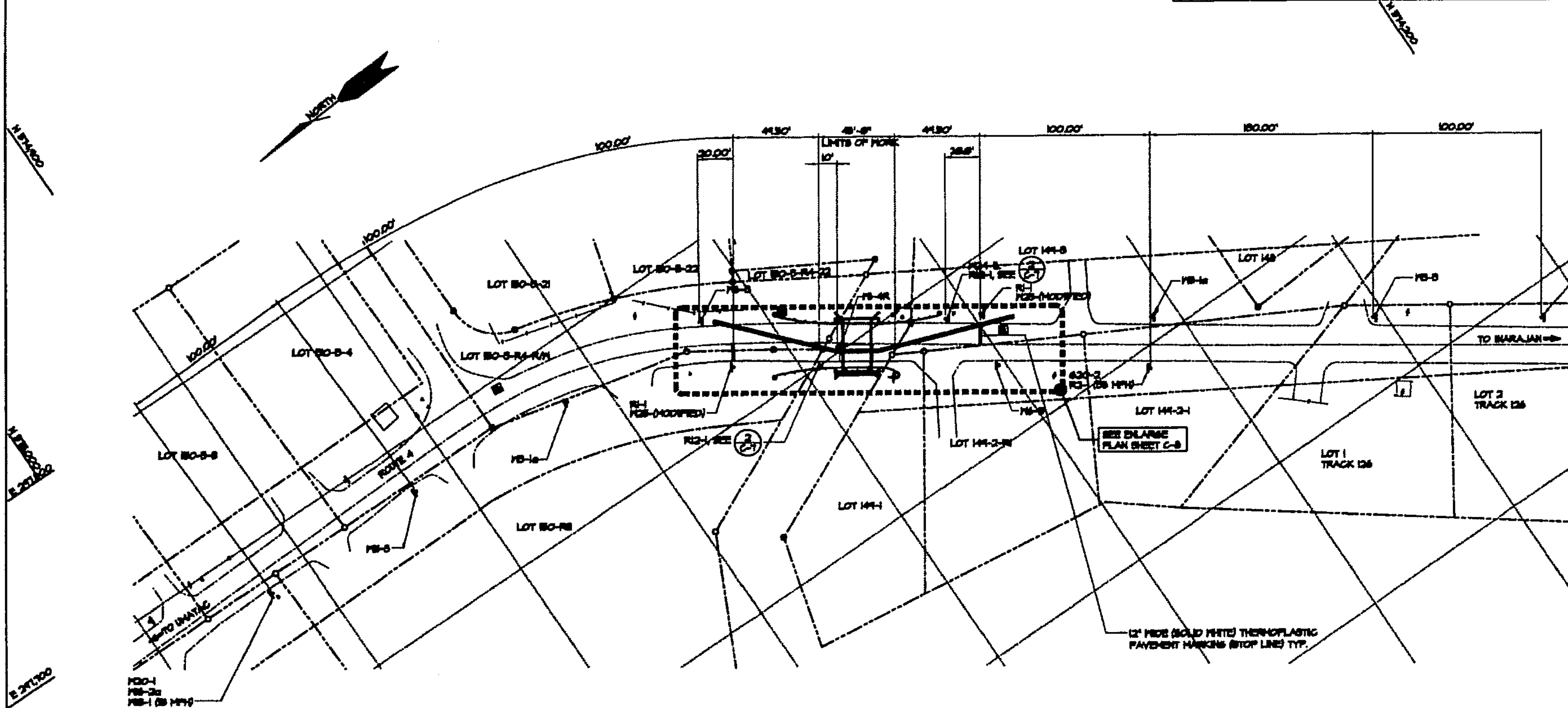
C-6 NOT TO SCALE

IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

Exhibit 6

TERRITORY	VILLAGE	PROJECT	PROJECT No.	DRAWING No.	SHEET
GUAM	MERIZO	SILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)	GU-NH-[illegible]	C 7	8 OF 14

REVISION	DATE	BY	DESCRIPTION	APPROVED



① TYPICAL TEMPORARY TRAFFIC CONTROL PLAN - DURING CONSTRUCTION

C-7 SCALE 1"=80'

NOTES:

THE TEMPORARY TRAFFIC CONTROL PLAN (TTCP) FOR USE DURING CONSTRUCTION AS SHOWN ON THIS SHEET IS FOR REFERENCE ONLY. THE CONTRACTOR SHALL PREPARE AND SUBMIT A TTCP FOR USE DURING CONSTRUCTION FOR REVIEW AND APPROVAL BY THE GOVERNMENT PRIOR TO COMMENCEMENT OF ANY SITE WORK. THE PREPARATION OF THE TTCP SHALL BE IN ACCORDANCE WITH THE LATEST EDITION AND STANDARDS OF THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES (MUTCD).

NOTES: THESE SIGNS WILL BE USED AS PART OF THE TTCP SIGNAGE DURING CONSTRUCTION AND WILL BE REMOVED AFTER THE CONSTRUCTION OF THE TEMPORARY BRIDGE. REFER TO SHEET MD-1 FOR ADDITIONAL SIGNS AND SIGN POST DETAILS.

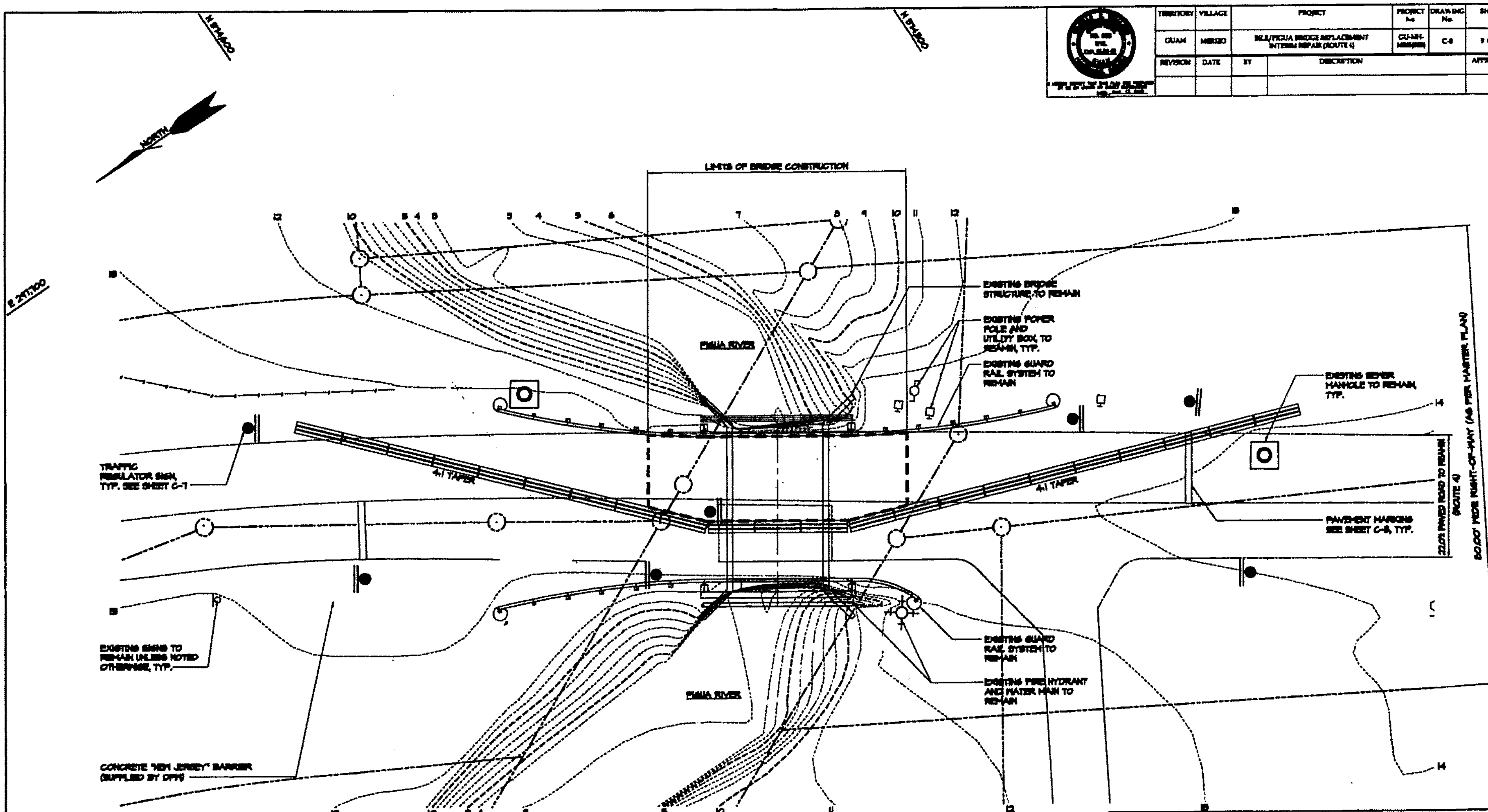
② TTPC SIGNAGE

C-7 NOT TO SCALE

IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

TERRITORY	VILLAGE	PROJECT	PROJECT No.	DRAWING No.	SHEET
GUAM	MERIZO	SILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)	GU-NH-[illegible]	C-8	9 OF 14

REVISION	DATE	BY	DESCRIPTION	APPROVED



1/C-8 TYPICAL ENLARGE PLAN of TCP - DURING CONSTRUCTION

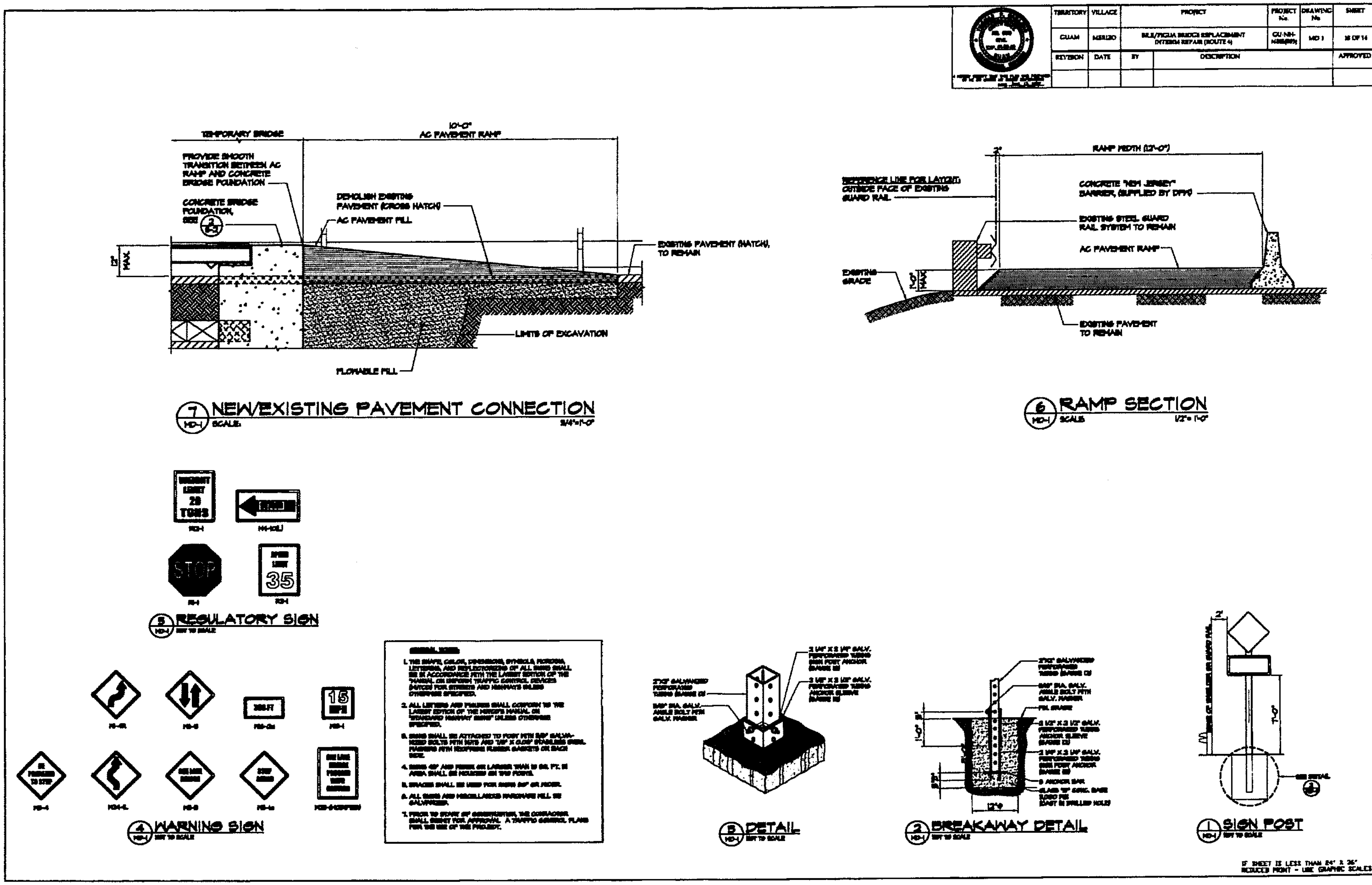
SCALE: 1/8" = 1'-0"

NOTES:

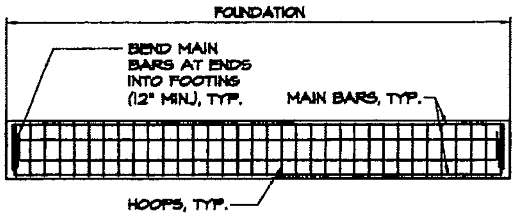
1. THE TTCP LAYOUT SHOWN ON THIS SHEET AND ON SHEET C-7 IS FOR THE CONSTRUCTION OF THE BRIDGE PHASE ONLY. FOR THE CONSTRUCTION OF THE RAMP PHASE, THE COMPLETE CLOSURE OF THE BRIDGE ACCESS TO VEHICULAR TRAFFIC WILL BE NECESSARY. THE CONTRACTOR MUST SUBMIT A TTCP FOR THE COMPLETE CLOSURE OF THE BRIDGE FOR REVIEW AND APPROVAL BY THE GOVERNMENT PRIOR TO COMMENCEMENT OF ANY SITE WORK. THE CONTRACTOR MUST INCLUDE A TIME LINE FOR THE COMPLETE CLOSURE AND REOPENING OF THE BRIDGE THAT WILL MINIMIZE THE IMPACT TO TRAFFIC.
2. CONTRACTOR SHALL PROVIDE TEMPORARY ACCESS TO ALL DRIVEWAYS BLOCKED-OFF BY THE BARRICADES THROUGHOUT THE DURATION ON THE CONTRACT.

IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

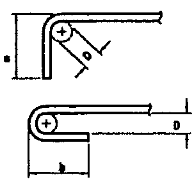
Exhibit 6


TERRITORY | VILLAGE | PROJECT | PROJECT No. | DRAWING No. | SHEET
GUAM | MERIZO | BILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4) | MD 1
REVISION | DATE | BY | DESCRIPTION | APPROVED
TEMPORARY BRIDGE
10'-0" AC PAVEMENT RAMP
PROVIDE SMOOTH TRANSITION BETWEEN AC RAMP AND CONCRETE BRIDGE FOUNDATION
CONCRETE BRIDGE FOUNDATION, SEE 2
DEMOLISH EXISTING PAVEMENT (CROSS HATCH)
AC PAVEMENT FILL
EXISTING PAVEMENT (HATCH), TO REMAIN
LIMITS OF EXCAVATION
FLOWABLE FILL
12" MAX
7 NEW/EXISTING PAVEMENT CONNECTION
SCALE: 3/4"=1'-0"
RAMP WIDTH (12'-0")
REFERENCE LINE FOR LAYOUT, OUTSIDE FACE OF EXISTING GUARD RAIL
CONCRETE "NEW JERSEY" BARRIER, (SUPPLIED BY DPW)
EXISTING STEEL GUARD RAIL SYSTEM TO REMAIN
AC PAVEMENT RAMP
EXISTING GRADE
EXISTING PAVEMENT TO REMAIN
6 RAMP SECTION
SCALE 1/2"= 1'-0"
STOP
35
15 MPH
5 REGULATORY SIGN
NOT TO SCALE
4 WARNING SIGN
NOT TO SCALE
GENERAL NOTES
5 DETAIL
NOT TO SCALE
2 BREAKAWAY DETAIL
NOT TO SCALE
12"Ø
7'-0"
1 SIGN POST
NOT TO SCALE
IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

TERRITORY	VILLAGE	PROJECT	PROJECT No.	DRAWING No.	SHEET
GUAM	MERIZO	BILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)	GU-NH-[illegible]	S-0	11 OF 14
REVISION	DATE	BY	DESCRIPTION		APPROVED

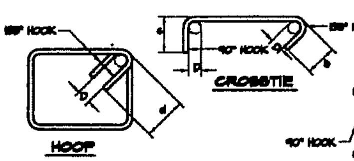


1/S-0 TYPICAL FOUNDATION ELEVATION
NOT TO SCALE

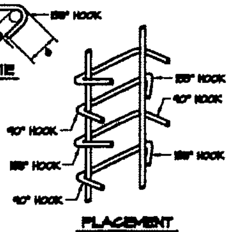


PRIMARY REINFORCING STD 90° and 180° HOOK			
BAR SIZE	a (MIN)	b (MIN)	D
#3	6"	5"	2 1/4"
#4	8"	6"	3"
#5	10"	7"	3 3/4"
#6	12"	8"	4 1/2"
#7	14"	10"	5 1/4"
#8	16"	11"	6"
#9	19"	15"	9"

PRIMARY REINFORCING TYPICAL BENDS
NOT TO SCALE



BAR SIZE	e	d	D
#3	4 1/2"	4 1/2"	1 1/2"
#4	3"	3"	2"



1/S-0 TYP. HOOPS AND CROSS-TIES DETAIL
NOT TO SCALE

MINIMUM EMBEDMENT REQUIREMENTS (INCHES)					MINIMUM LAP REQUIREMENTS (INCHES)								
					CLASS "A" SPLICE				CLASS "B" SPLICE				
BAR SIZE	f'c = 3000 psi		f'c = 4000 psi		f'c = 3000 psi		f'c = 4000 psi		f'c = 3000 psi		f'c = 4000 psi		BAR SIZE
	TOP [2]	OTHERS	TOP [2]	OTHERS	TOP [2]	OTHERS	TOP [2]	OTHERS	TOP [2]	OTHERS	TOP [2]	OTHERS	
#3	18	12	14	12	18	12	14	12	21	18	18	14	#3
#4	21	18	18	14	21	18	18	14	28	21	24	18	#4
#5	27	21	23	18	27	21	23	18	35	27	30	23	#5
#6	32	25	28	21	32	25	28	21	42	32	36	28	#6
#7	38	29	32	25	38	29	32	25	48	38	42	32	#7
#8	45	35	38	29	45	35	39	29	58	45	51	38	#8

NOTE: FOR 6000 PSI USE MINIMUM EMBEDMENT/LAP REQUIREMENTS FOR 4000 PSI.

EMBEDMENT AND LAP NOTES

1. PROVIDE STANDARD ACI 90 DEGREE BEND OR HOOK IF EMBEDMENT IS LESS THAN MINIMUM SHOWN IN TABLE. REINFORCEMENT IN WALLS, SLABS, BEAMS, ETC. SHALL BE EMBEDDED INTO SUPPORTING OR INTERSECTING STRUCTURAL ELEMENTS.
2. TOP BARS ARE DEFINED AS REINFORCEMENT WITH MORE THAN 12 INCHES OF FRESH CONCRETE IN THE MEMBER BELOW THE REINFORCEMENT.
3. FOR SLABS, LOCATE LAPS WITHIN THE MIDDLE THIRD OF SPANS FOR TOP BARS AND AT SUPPORTS FOR BOTTOM BARS. USE CLASS A SPLICE IF LAPS ARE STAGGERED. OTHERWISE USE CLASS B SPLICE.
4. FOR WALLS, LOCATE LAPS ANYWHERE, USE CLASS B SPLICES. FOR DOUBLE CURTAIN REINFORCEMENT, STAGGER LOCATION OF LAPS FROM ONE CURTAIN TO ANOTHER.
5. FOR BEAMS AND COLUMNS, LOCATE LAPS AS SHOWN IN DETAILS. USE CLASS B SPLICES UNLESS NOTED OTHERWISE.

GENERAL STRUCTURAL NOTES

1. "GENERAL NOTES AND TYPICAL DETAILS" APPLY TO ALL DRAWINGS UNLESS NOTED OR SHOWN OTHERWISE.
2. FEATURES OF CONSTRUCTIONS SHOWN ARE TYPICAL AND THEY SHALL APPLY GENERALLY THROUGHOUT FOR SIMILAR CONDITIONS.
3. BUILDING DIMENSIONS SHALL BE AS PER ARCHITECTURAL DRAWINGS UNLESS SHOWN OTHERWISE. CONTRACTOR SHALL VERIFY ALL DIMENSIONS BEFORE WORK IS BEGUN.
4. SLAB ELEVATIONS SHALL BE COORDINATED WITH ARCHITECTURAL DRAWINGS. PROVIDE SLAB DEPRESSIONS AS REQUIRED FOR VARIOUS FLOOR FINISHES.
5. THE CONTRACTOR SHALL RETAIN THE SERVICES OF A SOILS ENGINEER TO VERIFY SOIL CONDITIONS AND TO PROVIDE RECOMMENDATIONS FOR SUBGRADE PREPARATION, EXCAVATION, BACKFILLING, COMPACTION AND TO MONITOR AND SUPERVISE THE INSTALLATION OF THE MICROPILES.
6. FOUNDATION PREPARATION, BACKFILLING AND COMPACTION SHALL BE UNDER THE SOILS ENGINEER SUPERVISION AND TESTING

PRECAST CONCRETE NOTES

1. ALL PRECAST AND PRESTRESSED CONCRETE SHALL CONFORM TO THE LATEST APPLICABLE STANDARDS.
2. THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS SHOWING ALL THE REQUIRED INFORMATION FOR THE PROPER FABRICATION, HANDLING AND ERECTION OF THE STRUCTURE. SHOP DRAWINGS SHALL INCLUDE THE DESIGN OF ALL THE STRUCTURAL MEMBERS AND CONNECTIONS TO SUPPORT ALL THE LOADS IMPOSED ON THE MEMBER. DESIGN SHALL BE PREPARED BY A GUAM REGISTERED STRUCTURAL ENGINEER.

STRUCTURAL DESIGN CRITERIA

1. BASIS OF DESIGN :
   STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, 17TH EDITION 2002
   UNIFORM BUILDING CODE, 1994 EDITION
2. WIND FORCE:
   WIND VELOCITY ———— 155 MPH — EXPOSURE D — W = ACTUAL
   WIND PRESSURE (BASIC) —— 61.5 PSF — IMPORTANCE FACTOR = 1.0
3. SEISMIC FORCE
   EQUIVALENT STATIC ANALYSIS IN ACCORDANCE WITH AASHTO STANDARDS SPECIFICATIONS FOR HIGHWAY BRIDGES, DIVISION I-A, SEISMIC PERFORMANCE CATEGORY C. THE MAXIMUM ELASTIC SEISMIC RESPONCE COEFFICIENT, Cs = 2.5A.
4. LIVE LOAD
   20 TONS (MAXIMUM LOADING)
5. REINFORCED CONCRETE
   REINFORCING STEEL: ———— fy = 60,000 PSI
   CONCRETE:
   FOUNDATION, SLAB ON GRADE ———— f'c = 4000 PSI
   FOUNDATION WALLS ———— f'c = 4000 PSI
   OTHERS ———— f'c = 4000 PSI
6. CONCRETE STRENGTH DESIGN
   1.4D + 1.7L — D = DEAD LOAD
   0.75 (1.4D + 1.7L + 1.7W) — L = LIVE LOAD
   1.4 (D + L + E) — W = WIND LOAD
   0.9D + 1.3W — E = SEISMIC LOAD
   0.9D + 1.4E
7. CONCRETE COVERING
   FACE OF WALL AGAINST EARTH OR EXPOSED TO WEATHER —— 2"
   FORMED FOOTINGS ———— 2"
   FOOTINGS CAST AGAINST EARTH ———— 3"
8. ALLOWABLE SOIL BEARING PRESSURES
   DL + LL — 3000 psf (Assumed)
   DL + LL + Wind (Earthquake) — 4500 psf (Assumed)
9. STRUCTURAL STEEL
   SHAPES and PLATES : ASTM A36
   TUBES and PIPES : ASTM A500B
   BOLTS : ASTM A325
   ANCHOR BOLTS : ASTM A307
   WELDING ELECTRODE : E70XX

IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

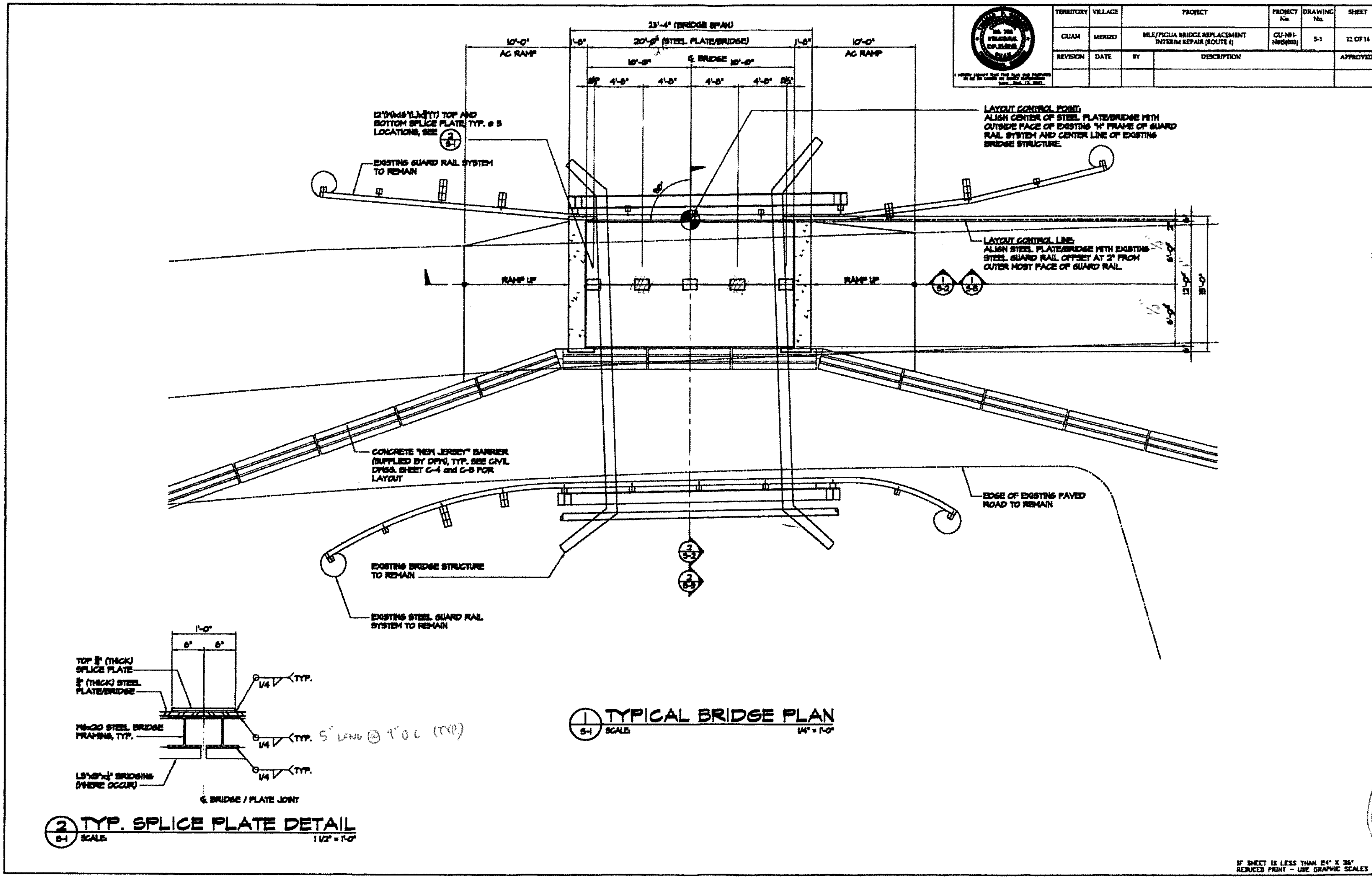
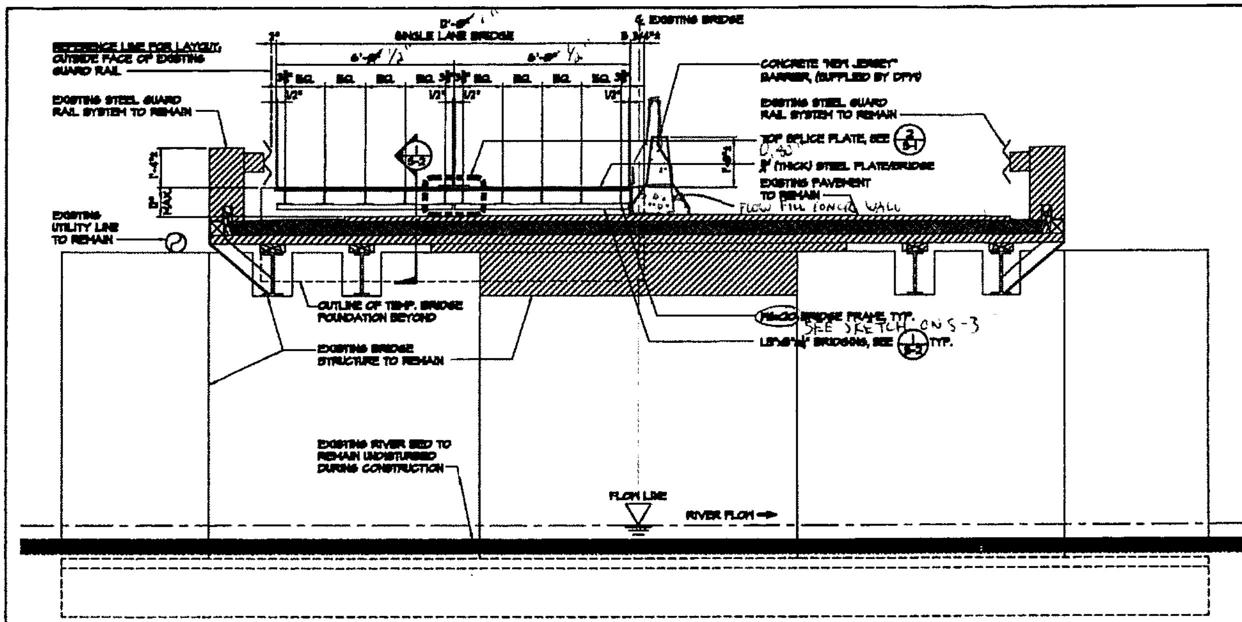
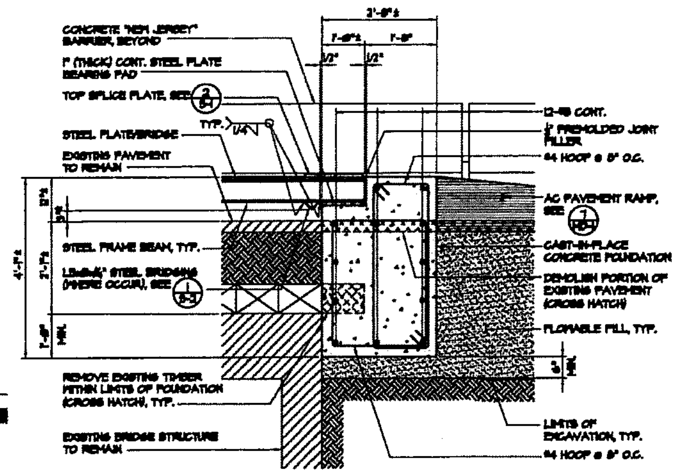

TERRITORY: GUAM
VILLAGE: MERIZO
PROJECT: BILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)
PROJECT No.: GU-NH-NH5(003)
DRAWING No.: S-1
SHEET: 12 OF 14
REVISION
DATE
BY
DESCRIPTION
APPROVED
23'-4" (BRIDGE SPAN)
20'-0" (STEEL PLATE/BRIDGE)
10'-0" AC RAMP
10'-0" AC RAMP
1'-8"
1'-8"
10'-0"
10'-0"
℄ BRIDGE
4'-8"
4'-8"
4'-8"
4'-8"
12"(W)x8"(L)x5/8"(T) TOP AND BOTTOM SPLICE PLATE, TYP. @ 5 LOCATIONS, SEE 2 S-1
EXISTING GUARD RAIL SYSTEM TO REMAIN
LAYOUT CONTROL POINT: ALIGN CENTER OF STEEL PLATE/BRIDGE WITH OUTSIDE FACE OF EXISTING "H" FRAME OF GUARD RAIL SYSTEM AND CENTER LINE OF EXISTING BRIDGE STRUCTURE.
LAYOUT CONTROL LINE: ALIGN STEEL PLATE/BRIDGE WITH EXISTING STEEL GUARD RAIL OFFSET AT 2" FROM OUTER MOST FACE OF GUARD RAIL.
RAMP UP
RAMP UP
6'-0"
6'-0"
12'-0"
15'-0"
CONCRETE "NEW JERSEY" BARRIER (SUPPLIED BY DPW), TYP. SEE CIVIL DWGS. SHEET C-4 and C-8 FOR LAYOUT
EDGE OF EXISTING PAVED ROAD TO REMAIN
EXISTING BRIDGE STRUCTURE TO REMAIN
EXISTING STEEL GUARD RAIL SYSTEM TO REMAIN
1 S-1 TYPICAL BRIDGE PLAN
SCALE: 1/4" = 1'-0"
1'-0"
6"
6"
TOP 5/8" (THICK) SPLICE PLATE
5/8" (THICK) STEEL PLATE/BRIDGE
W6x20 STEEL BRIDGE FRAMING, TYP.
L3"x3"x1/4" BRIDGING (WHERE OCCUR)
1/4 TYP.
1/4 TYP.
1/4 TYP.
5" LONG @ 9" O.C. (TYP)
℄ BRIDGE / PLATE JOINT
2 S-1 TYP. SPLICE PLATE DETAIL
SCALE: 1 1/2" = 1'-0"
IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

Exhibit 6

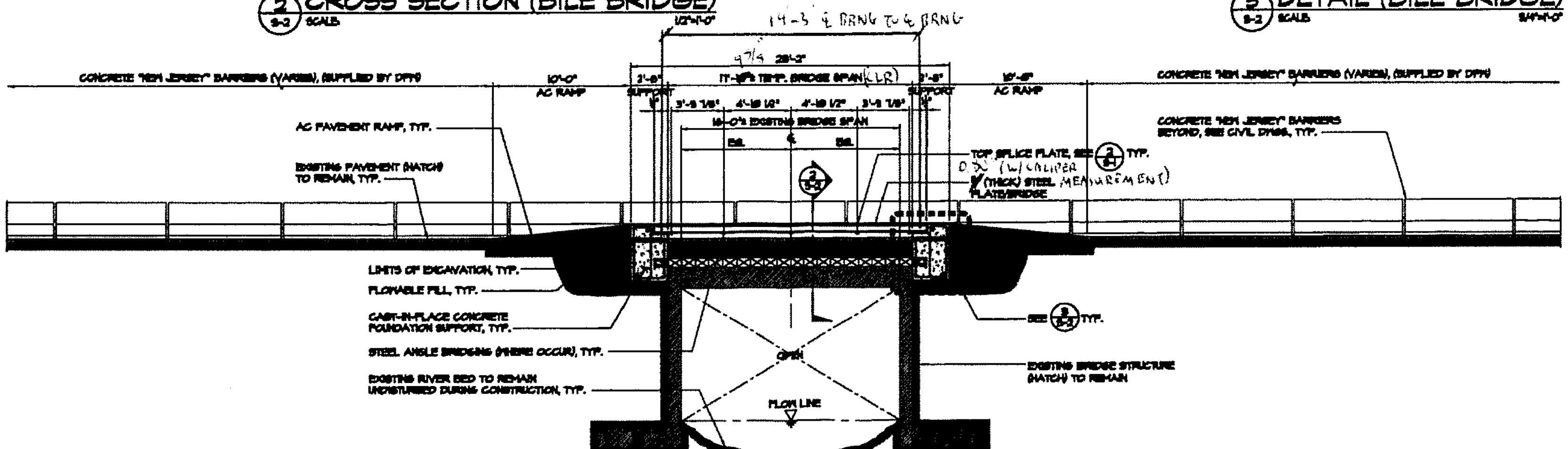
TERRITORY	VILLAGE	PROJECT	PROJECT No	DRAWING No	SHEET
GUAM	MERIZO	BILE/PIGUA BRIDGE REPLACEMENT INTERIM REPAIR (ROUTE 4)	CU NH	S-2	13 OF 14
REVISION	DATE	BY	DESCRIPTION		APPROVED



2 S-2 CROSS SECTION (BILE BRIDGE)
SCALE 1/2"=1'-0"



5 S-2 DETAIL (BILE BRIDGE)
SCALE 3/4"=1'-0"

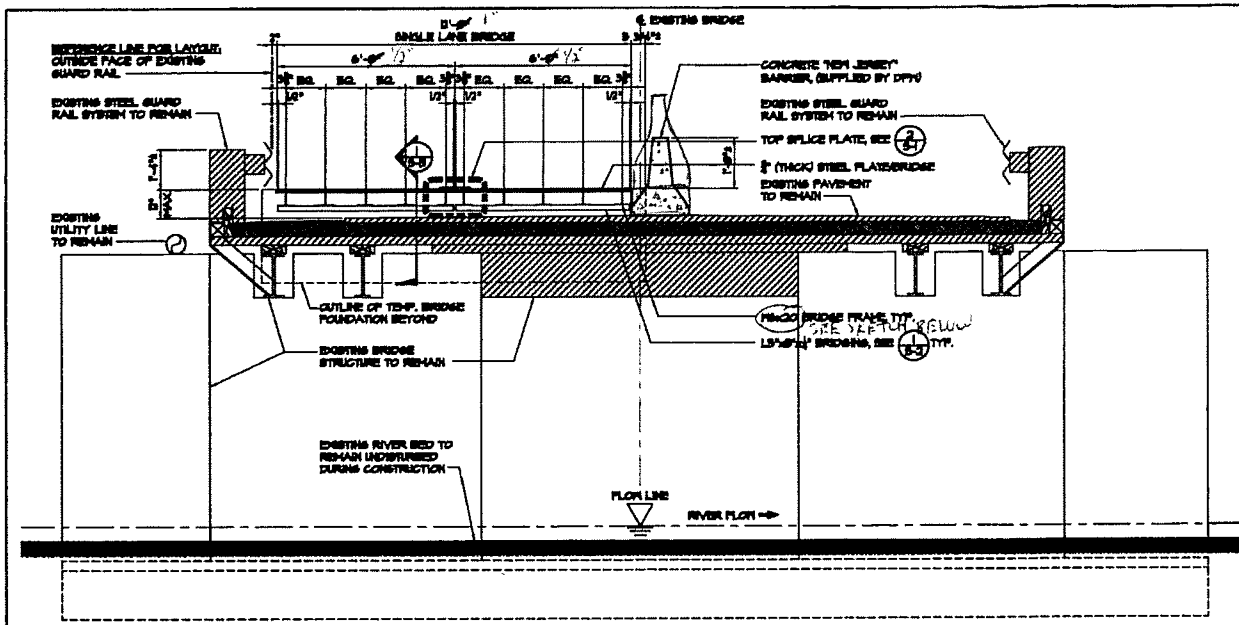


1 S-2 LONGITUDINAL SECTION (BILE BRIDGE)
SCALE 1/4"=1'-0"

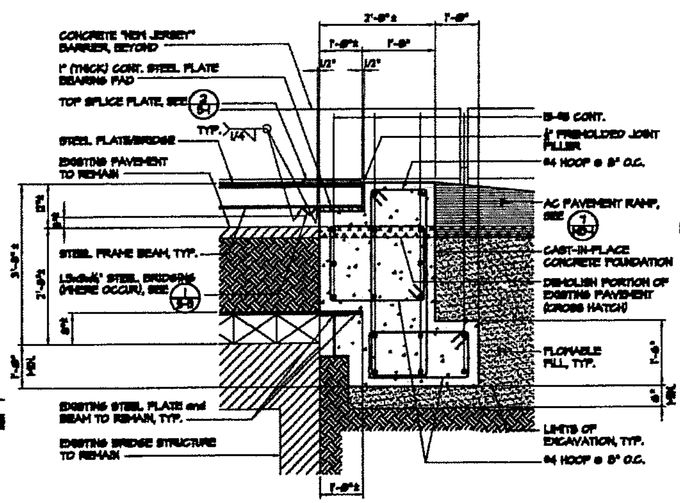
IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

Exhibit 6

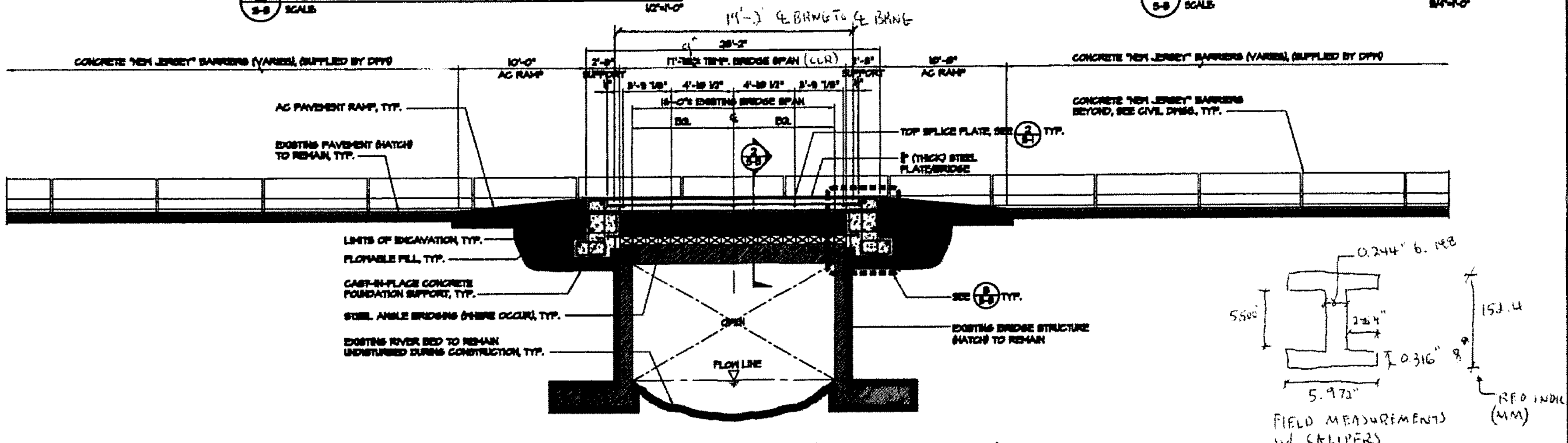
TERRITORY	VILLAGE	PROJECT	PROJECT No.	DRAWING No.	SHEET
GUAM	MERIZO	SILE/PIGUA BRIDGE REPLACEMENT (INTERIM REPAIR (ROUTE 4)	GU-NH-NBIS(…)	S-3	14 OF 14
REVISION	DATE	BY	DESCRIPTION		APPROVED



2 CROSS SECTION (PIGUA BRIDGE)
S-3 SCALE 1/2"=1'-0"



5 DETAIL (PIGUA BRIDGE)
S-3 SCALE 3/4"=1'-0"



1 LONGITUDINAL SECTION (PIGUA BRIDGE)
S-3 SCALE 1/4"=1'-0"

IF SHEET IS LESS THAN 24" X 36" REDUCED PRINT - USE GRAPHIC SCALES

Website: www.dcaguam.com
Email: dca@dcaguam.com

DUEÑAS · CAMACHO

March 2, 2016

Department of Public Works
Government of Guam
542 North Marine Corps Drive
Tamuning, Guam 96913

Attention: Mr. Glenn Leon Guerrero, Director

Subject: Bile & Pigua Bridges

Re: **Temporary Bridge Capacities**

Hafa Adai Mr. Leon Guerrero:

We have completed our analysis of the Bile and Pigua bridges based on the as-built conditions of the two bridges. Parsons Brinkerhoff (PB) and Duenas Camacho & Associates (DCA) conducted field verification measurements of the as-built conditions of the bridges on February 10, 2016. All findings regarding steel shapes, steel framing spacing, bracings, plate thicknesses, weld sizes, weld lengths and weld spacing were documented and presented in the Bridge Inspection Reports for the Bile & Pigua Bridges prepared by PB. Additionally, the condition of the temporary bridge structures were documented and presented in the reports.

Attached are the structural calculations for the AASHTO HS20-44 loading conditions on the short span temporary bridges. A single axle load of 32 kips was applied to the center span of the temporary bridges and Demand to Capacity ratios computed. The Demand to Capacity ratio dictates whether the bridge will yield or not, and ranges from 0% to 100%, for structures with no capacity concern. The supporting beams of the referenced bridges are assumed to act as a composite section with the steel bridge plates, as they are welded together and act as a single unit. Please note that the bridges were analyzed using the Load Resistance and Factor Design (LRFD) method, which factors loads. Impact Load factors were not applied since conditions at the bridge and speed of the vehicles simply do not create impact loads as defined in AASHTO. (Section 3.6.2.1)

The Demand to Capacity Ratios of the beams directly subjected to the wheel loads are slightly over 100% by only a fraction of 1%. Given the factors of safety built into the applied loads, it is our professional opinion that the temporary bridge structures are capable of supporting HS20-44 loading conditions.

Further to the temporary bridge analysis, we performed an additional analysis utilizing the Legal Load Limits for Guam highways based on the most recently adopted law. Similar to the HS20-44 approach,

ENGINEERING * PLANNING * SURVEYING * ENVIRONMENTAL SERVICES * GEOGRAPHIC INFORMATION SYSTEM * CONSTRUCTION MANAGEMENT
GUAM P.O. Box 8900, Tamuning, Guam 96931 / 238 E. Marine Corps Drive, Suite 201 Diamond Plaza, Hagatña, GU 96910 / Tel: (671) 477-7991 / Fax: (671) 479-6315
SAIPAN PMB 164 Box 10000 Saipan, CNMI MP 96950 / Chalan Pale Arnold, Ada's Building South Garapan, Saipan 96950 / Tel: (670) 234-9017 / Fax: (670) 234-3842

the bridges were analyzed using the LRFD method with no impact load factors considered. Our conclusions find that the bridge is capable up supporting legal load limits for Guam with demand to capacity ratios of 95%.

In conclusion, we find that the temporary bridge structures do meet HS20-44 Loading criteria and also the legal load limits for Guam Highways and thus, reconfirm the constructability approach included our plans.

Sincerely,

Thomas P. Camacho, SE
Vice President

Enclosures

ENGINEERING * PLANNING * SURVEYING * ENVIRONMENTAL SERVICES * GEOGRAPHIC INFORMATION SYSTEM * CONSTRUCTION MANAGEMENT
GUAM P.O. Box 8900, Tamuning, Guam 96931 / 238 E. Marine Corps Drive, Suite 201 Diamond Plaza, Hagatña, GU 96910 / Tel: (671) 477-7991 / Fax: (671) 479-6315
SAIPAN Caller Box PPP, Suite 164, Saipan, MP 96950 / Chalan Pale Arnold, Ada's Building South Garapan, Saipan 96950 / Tel: (670) 234-9017 / Fax: (670) 234-3842

DUEÑAS · CAMACHO

STRUCTURAL CALCULATIONS

BILE AND PIGUA BRIDGE TEMPORARY BRIDGE ANALYSIS
Umatac, Guam

THOMAS P. CAMACHO
CERTIFICATE
NO. 752
STRUCTURAL
EXP. 04-30-16
GUAM
PROFESSIONAL ENGINEER

March 3, 2016

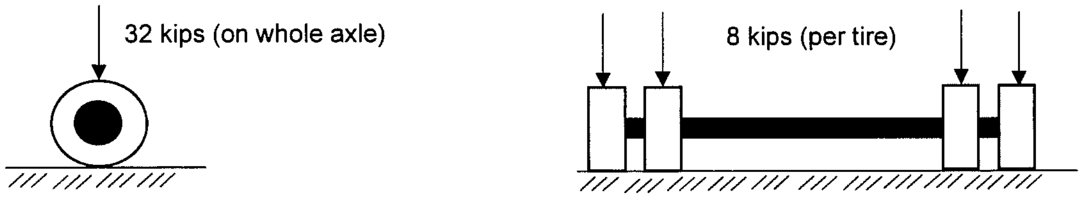
ENGINEERING PLANNING SURVEYING CONSTRUCTION MANAGEMENT ENVIRONMENTAL SERVICES
238 East Marine Corps Drive, Diamond Plaza, Suite 201, Hagatna, Guam 96910
Tel: (671)477-7991 Fax: (671)479-6315 email: dca@dcaguam.com

DUEÑAS · CAMACHO
& Associates Inc.

Wheel Load Calculations

ENGINEERING PLANNING SURVEYING CONSTRUCTION MANAGEMENT ENVIRONMENTAL SERVICES
238 East Marine Corps Drive, Diamond Plaza, Suite 201, Hagatna, Guam 96910
Tel: (671)477-7991 Fax: (671)479-6315 email: dca@dcaguam.com

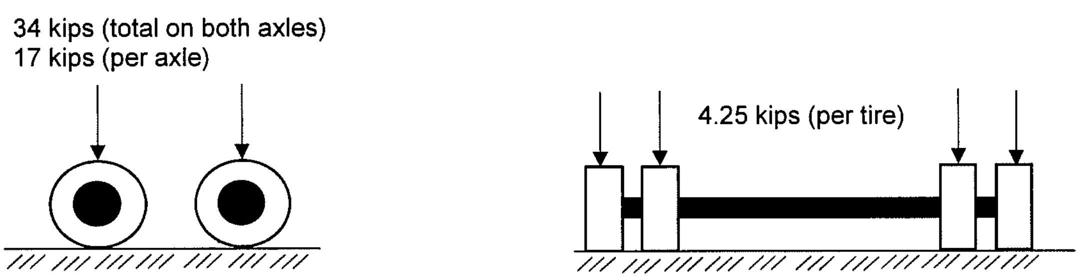
HS20-44 Wheel Load



The HS20-44 axle load is distributed along two tires on each side, and will be distributed along a 10" x 20" tire patch.

Tire Load = (8 kips) / [(10 in * 20 in) / (144 in^2 / ft^2)]
<u>Tire Load = 5.76 kips / ft^2 = 5760 lb / ft^2</u>

Guam Tandem Axle Wheel Load (for Tandem Axles More Than 40" Apart)



The Guam tandem axle load is distributed along two tires on each side, and will be distributed along a 10" x 20" tire patch.

Tire Load = (4.25 kips) / [(10 in * 20 in) / (144 in^2 / ft^2)]
<u>Tire Load = 3.06 kips / ft^2 = 3060 lb / ft^2</u>

See ETABS model for application of wheel loads.

DUEÑAS · CAMACHO				PROJECT: Bile and Pigua Bridges	SHEET 1
BY: EGS	DATE: 3/1/2016	CHECKED BY: TPC	DATE: 3/1/2016	SUBJECT: Wheel Load Calculations	OF 1

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ETABS Analysis Using HS20-44 Wheel Loads

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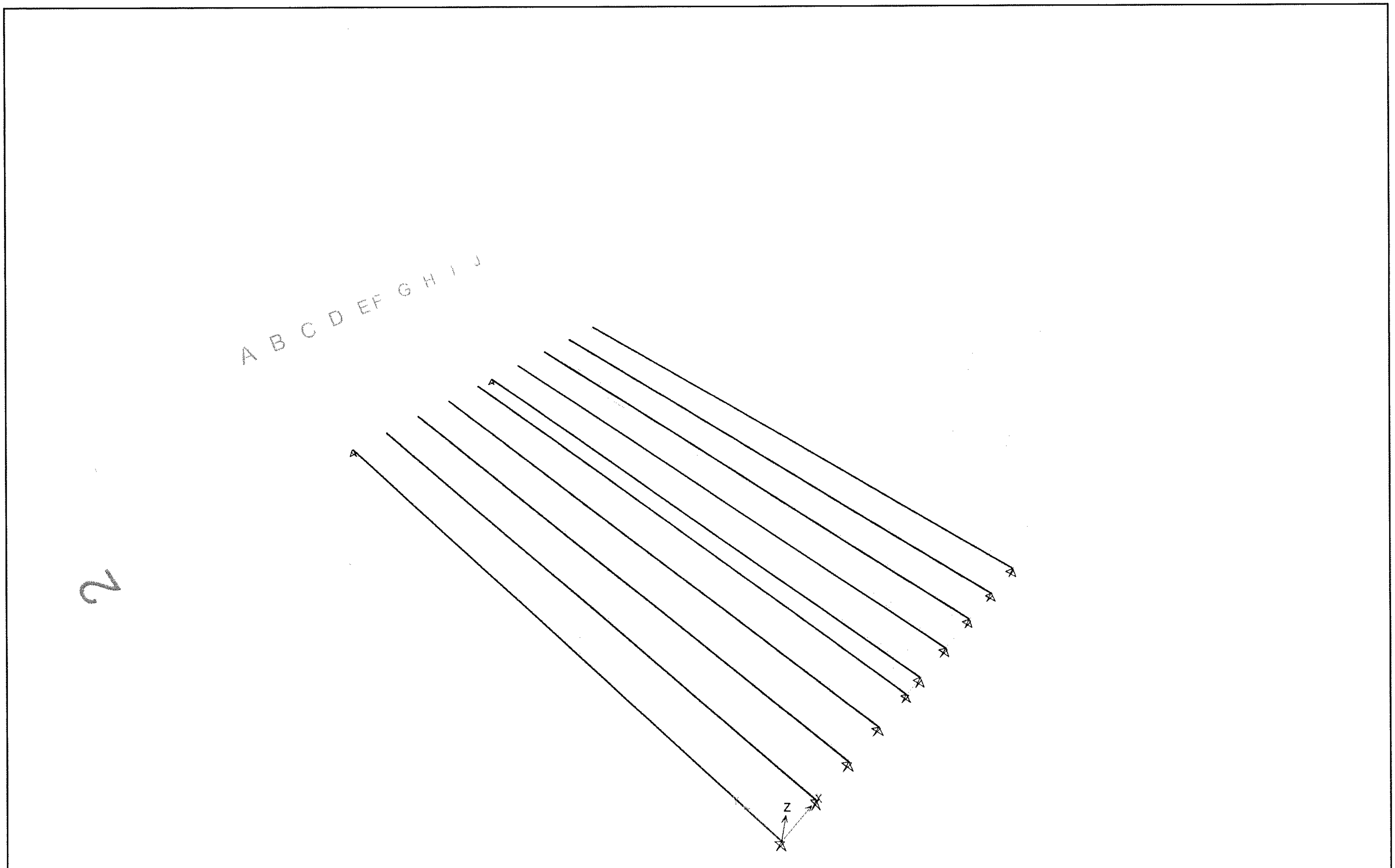


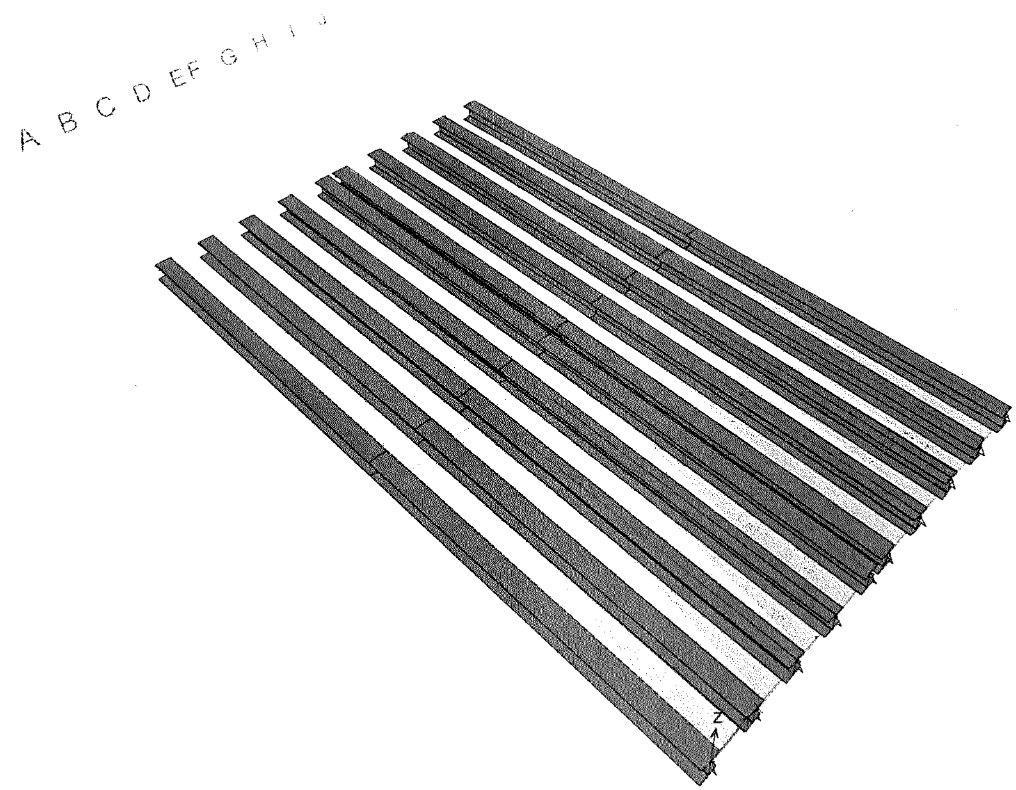
16-2-23 Bile Pigua Existing Loads Separated.EDB

3-D View

Exhibit 7

Exhibit 7

ETABS 2015 15.2.0 2/23/2016



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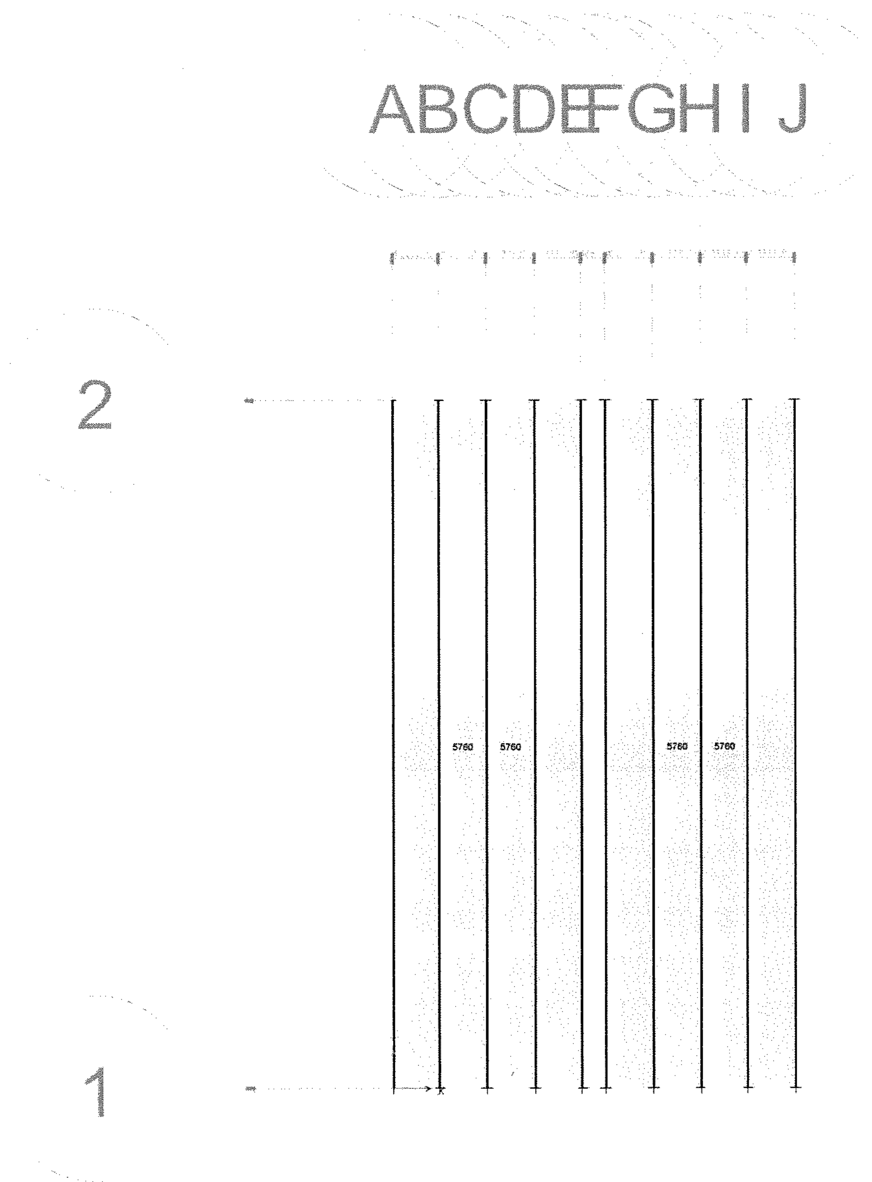
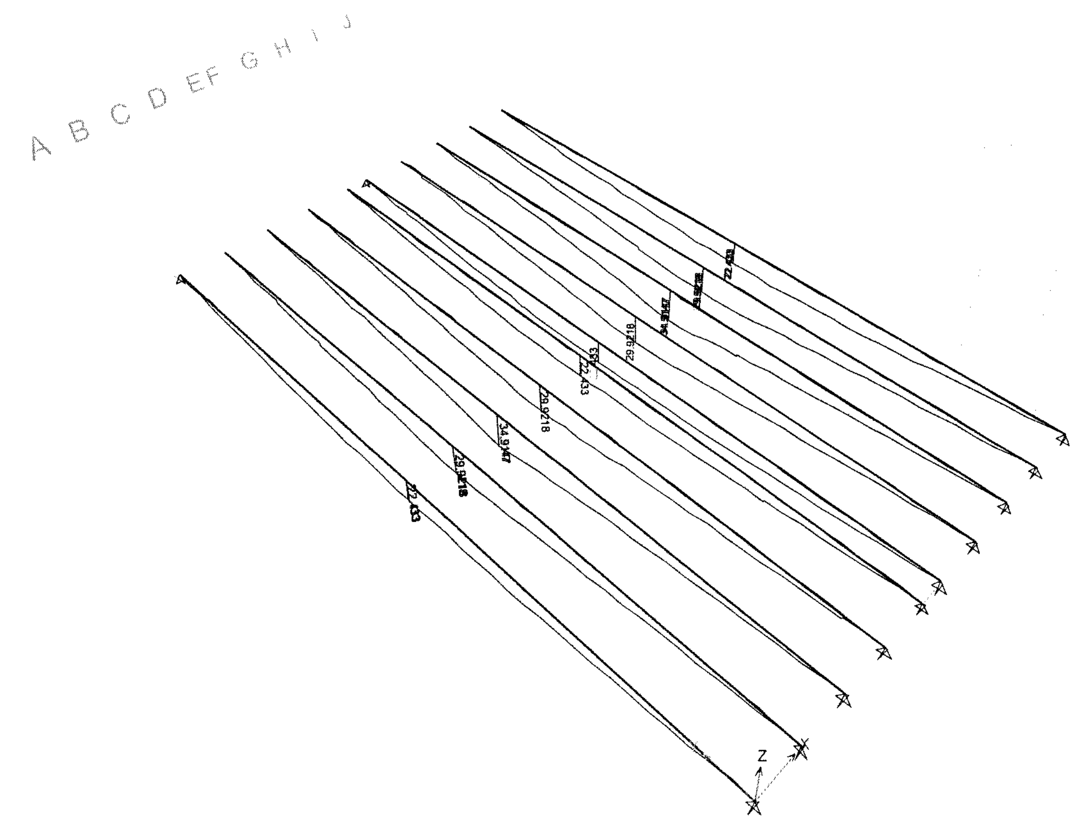
16-2-23 Bile Pigua Existing Loads Separated.EDB 3-D View



16-2-23 Bile Pigua Existing Loads Separated.EDB Plan View - Base - Z = 0 (ft) Uniform Loads Gravity (Live)



16-2-23 Bile Pigua Existing Loads Separated.EDB 3-D View Moment 3-3 Diagram (Comb1) [kip-ft]

Exhibit 7

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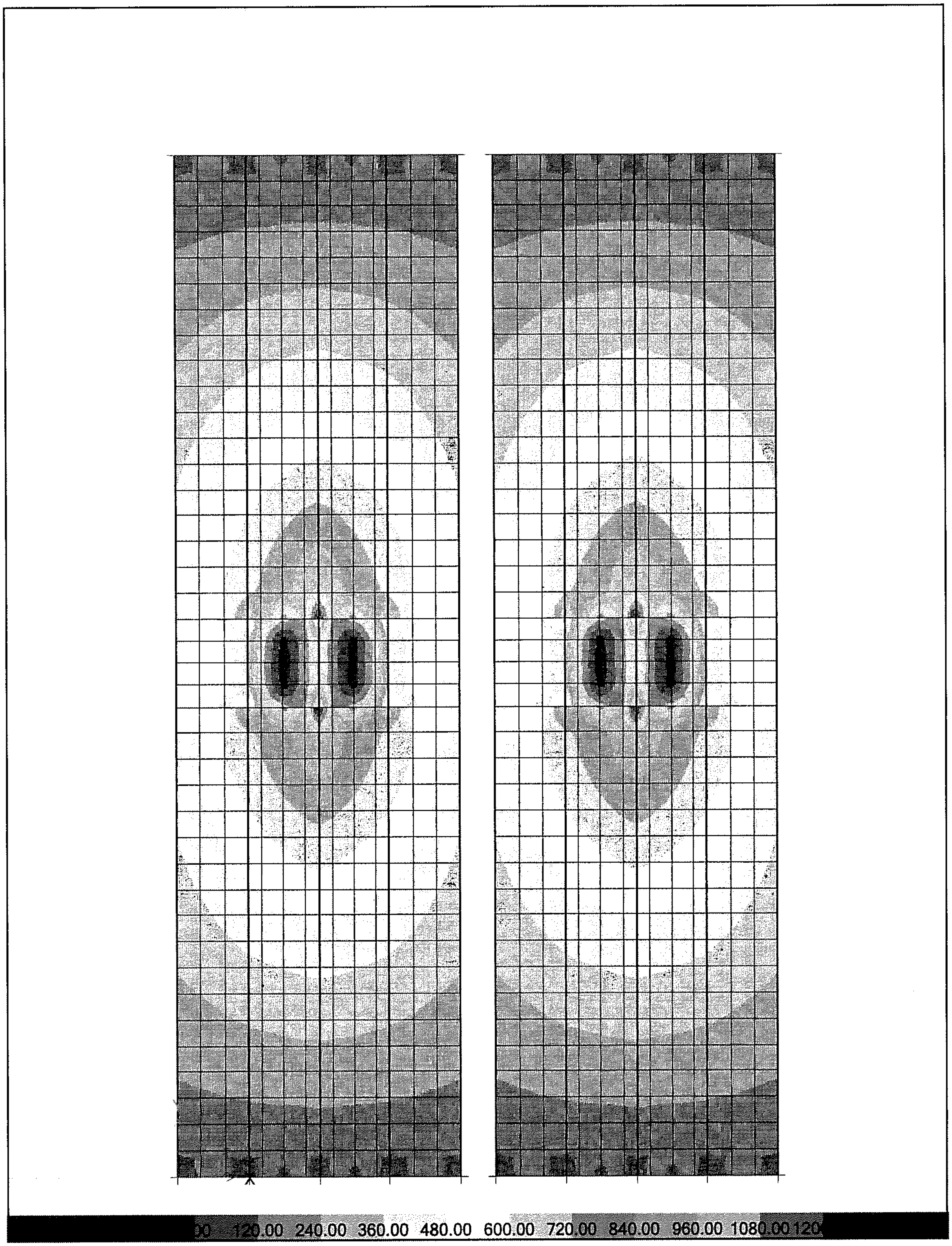
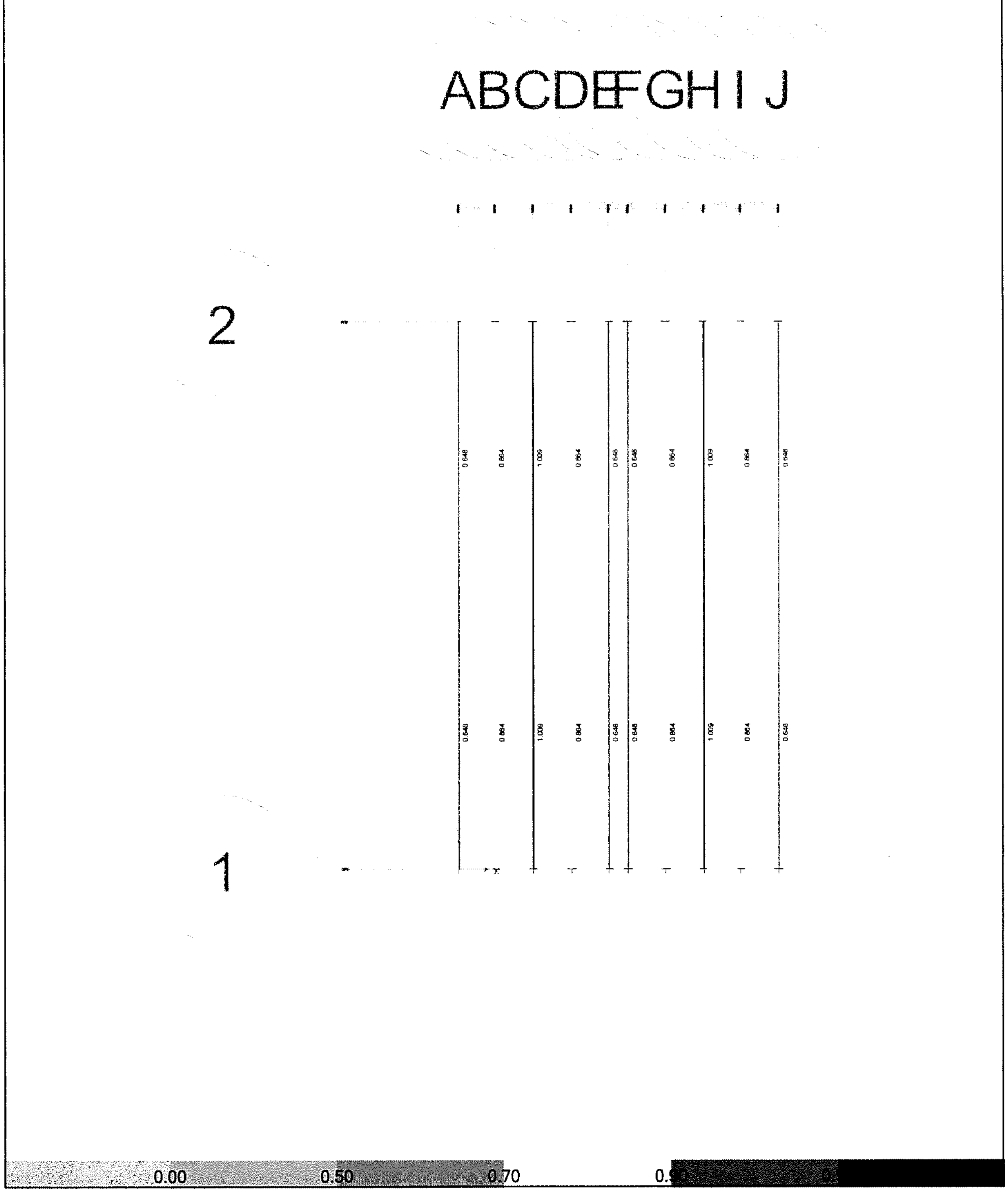
ETABS 2015 15.2.0

2/23/2016



16-2-23 Bile Pier Existing Bases Separated.EDB Plan View - Base Z = 0 (ft) Resultant M22 Diagram (Comb1) [kip-ft/ft]



16-2-23 Bile Pigua Plan View Base Z = 0 (ft) Steel P-M Interaction Ratios (AISC 360-10)

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AASHTO 2010 Loading Criteria

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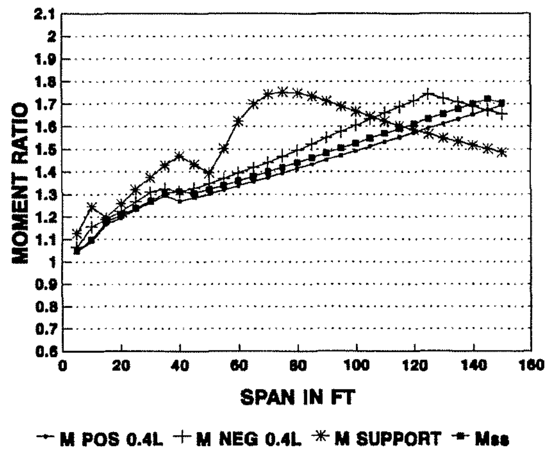

Figure C3.6.1.2.1-5—Moment Ratios: Notional Model to HS20 (truck or lane) or Two 24.0-kip Axles at 4.0 ft

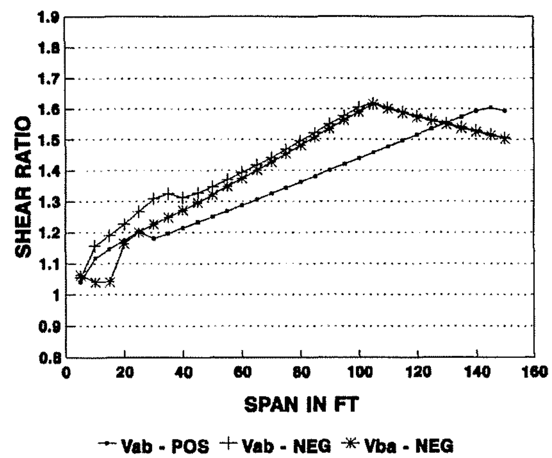

Figure C3.6.1.2.1-6—Shear Ratios: Notional Model to HS20 (truck and lane) or Two 24.0-kip Axles at 4.0 ft

In reviewing Figures C3.6.1.2.1-5 and C3.6.1.2.1-6, it should be noted that the total design force effect is also a function of load factor, load modifier, load distribution, and dynamic load allowance.

3.6.1.2.2—Design Truck

The weights and spacings of axles and wheels for the design truck shall be as specified in Figure 3.6.1.2.2-1. A dynamic load allowance shall be considered as specified in Article 3.6.2.

Except as specified in Articles 3.6.1.3.1 and 3.6.1.4.1, the spacing between the two 32.0-kip axles shall be varied between 14.0 ft and 30.0 ft to produce extreme force effects.

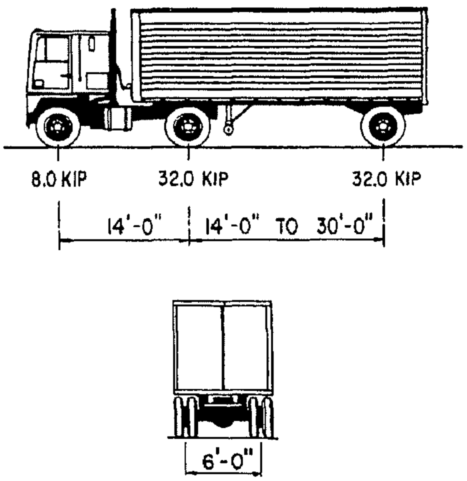

Figure 3.6.1.2.2-1—Characteristics of the Design Truck

3.6.1.2.3—Design Tandem

The design tandem shall consist of a pair of 25.0-kip axles spaced 4.0 ft apart. The transverse spacing of wheels shall be taken as 6.0 ft. A dynamic load allowance shall be considered as specified in Article 3.6.2.

3.6.1.2.4—Design Lane Load

The design lane load shall consist of a load of 0.64 klf uniformly distributed in the longitudinal direction. Transversely, the design lane load shall be assumed to be uniformly distributed over a 10.0-ft width. The force effects from the design lane load shall not be subject to a dynamic load allowance.

3.6.1.2.5—Tire Contact Area

The tire contact area of a wheel consisting of one or two tires shall be assumed to be a single rectangle, whose width is 20.0 in. and whose length is 10.0 in.

The tire pressure shall be assumed to be uniformly distributed over the contact area. The tire pressure shall be assumed to be distributed as follows:

- On continuous surfaces, uniformly over the specified contact area, and
- On interrupted surfaces, uniformly over the actual contact area within the footprint with the pressure increased in the ratio of the specified to actual contact areas.

C3.6.1.2.5

The area load applies only to the design truck and tandem. For other design vehicles, the tire contact area should be determined by the engineer.

As a guideline for other truck loads, the tire area in $in.^2$ may be calculated from the following dimensions:

Tire width = $P/0.8$

Tire length = $6.4\gamma(1 + IM/100)$

where:

γ = load factor

IM = dynamic load allowance percent

P = design wheel load (kip)

3.6.1.6—Pedestrian Loads

A pedestrian load of 0.075 ksf shall be applied to all sidewalks wider than 2.0 ft and considered simultaneously with the vehicular design live load in the vehicle lane. Where vehicles can mount the sidewalk, sidewalk pedestrian load shall not be considered concurrently. If a sidewalk may be removed in the future, the vehicular live loads shall be applied at 1 ft from edge-of-deck for design of the overhang, and 2 ft from edge-of-deck for design of all other components. The dynamic load allowance need not be considered for vehicles.

Bridges intended for only pedestrian, equestrian, light maintenance vehicle, and/or bicycle traffic should be designed in accordance with AASHTO's *Guide Specifications for the Design of Pedestrian Bridges.*

C3.6.1.6

See the provisions of Article C3.6.1.1.2 for applying the pedestrian loads in combination with the vehicular live load.

3.6.1.7—Loads on Railings

Loads on railings shall be taken as specified in Section 13.

3.6.2—Dynamic Load Allowance: *IM*

3.6.2.1—General

Unless otherwise permitted in Articles 3.6.2.2 and 3.6.2.3, the static effects of the design truck or tandem, other than centrifugal and braking forces, shall be increased by the percentage specified in Table 3.6.2.1-1 for dynamic load allowance.

The factor to be applied to the static load shall be taken as: $(1 + IM/100)$.

The dynamic load allowance shall not be applied to pedestrian loads or to the design lane load.

Table 3.6.2.1-1—Dynamic Load Allowance, *IM*

Component	IM
Deck Joints—All Limit States	75%
All Other Components:	
• Fatigue and Fracture Limit State	15%
• All Other Limit States	33%

The application of dynamic load allowance for buried components, covered in Section 12, shall be as specified in Article 3.6.2.2.

Dynamic load allowance need not be applied to:

- Retaining walls not subject to vertical reactions from the superstructure, and
- Foundation components that are entirely below ground level.

C3.6.2.1

Page (*1976*) contains the basis for some of these provisions.

The dynamic load allowance (*IM*) in Table 3.6.2.1-1 is an increment to be applied to the static wheel load to account for wheel load impact from moving vehicles.

Dynamic effects due to moving vehicles may be attributed to two sources:

- Hammering effect is the dynamic response of the wheel assembly to riding surface discontinuities, such as deck joints, cracks, potholes, and delaminations, and
- Dynamic response of the bridge as a whole to passing vehicles, which may be due to long undulations in the roadway pavement, such as those caused by settlement of fill, or to resonant excitation as a result of similar frequencies of vibration between bridge and vehicle.

Field tests indicate that in the majority of highway bridges, the dynamic component of the response does not exceed 25 percent of the static response to vehicles. This is the basis for dynamic load allowance with the exception of deck joints. However, the specified live load combination of the design truck and lane load, represents a group of exclusion vehicles that are at least 4/3 of those caused by the design truck alone on short- and medium-span bridges. The specified value of 33 percent in Table 3.6.2.1-1 is the product of 4/3 and the basic 25 percent.

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ETABS Analysis Using Guam Legal Loads

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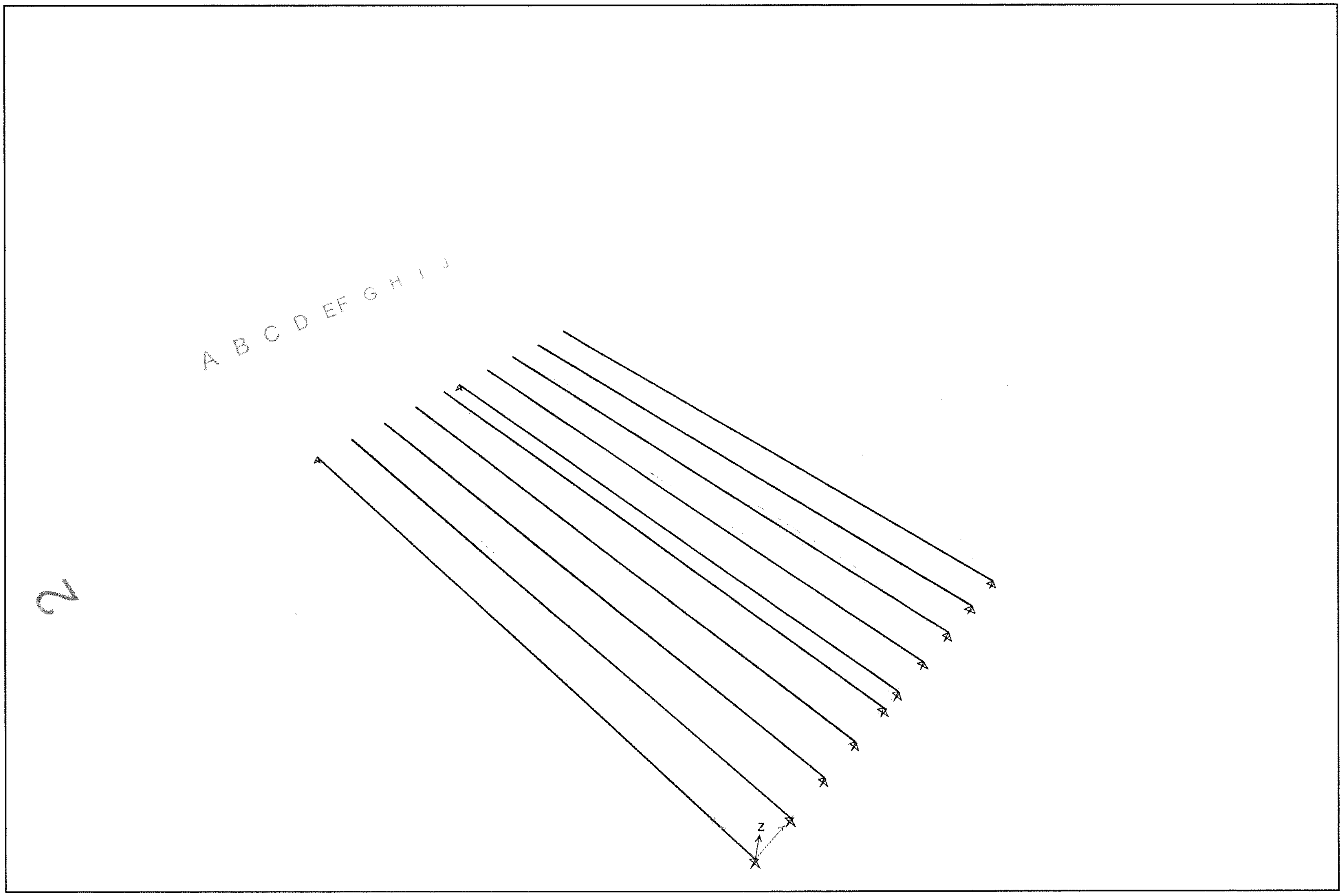
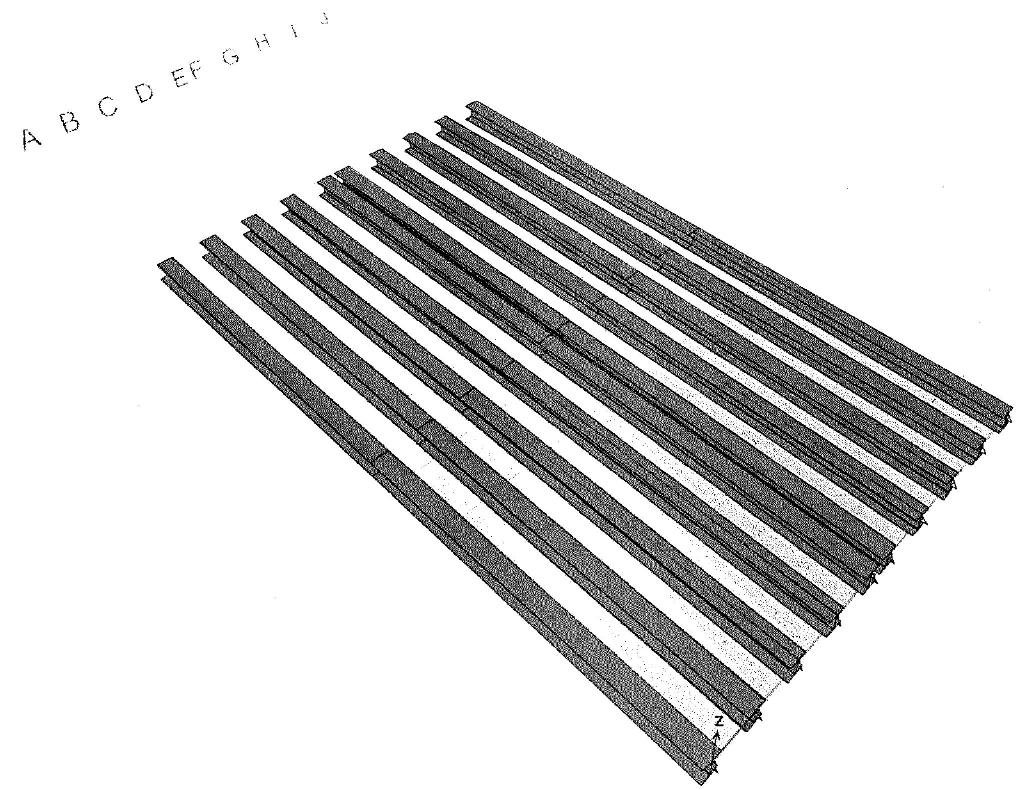


16-2-23 Tandem Axle.EDB

3-D View

Exhibit 7



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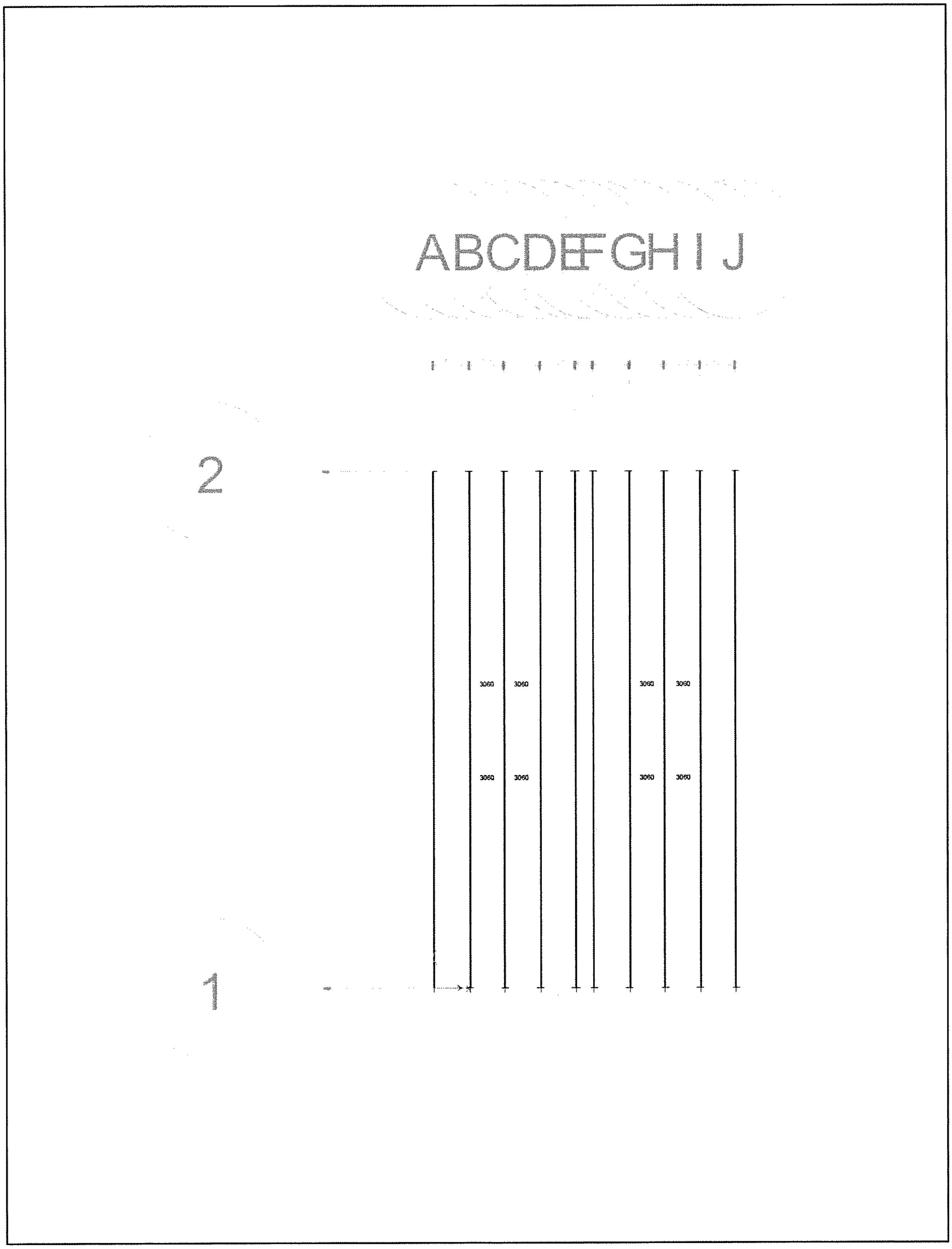

16-2-23 Tandem Axle.EDB Plan View - Base - Z = 0 (in) Uniform Loads Gravity (Live)

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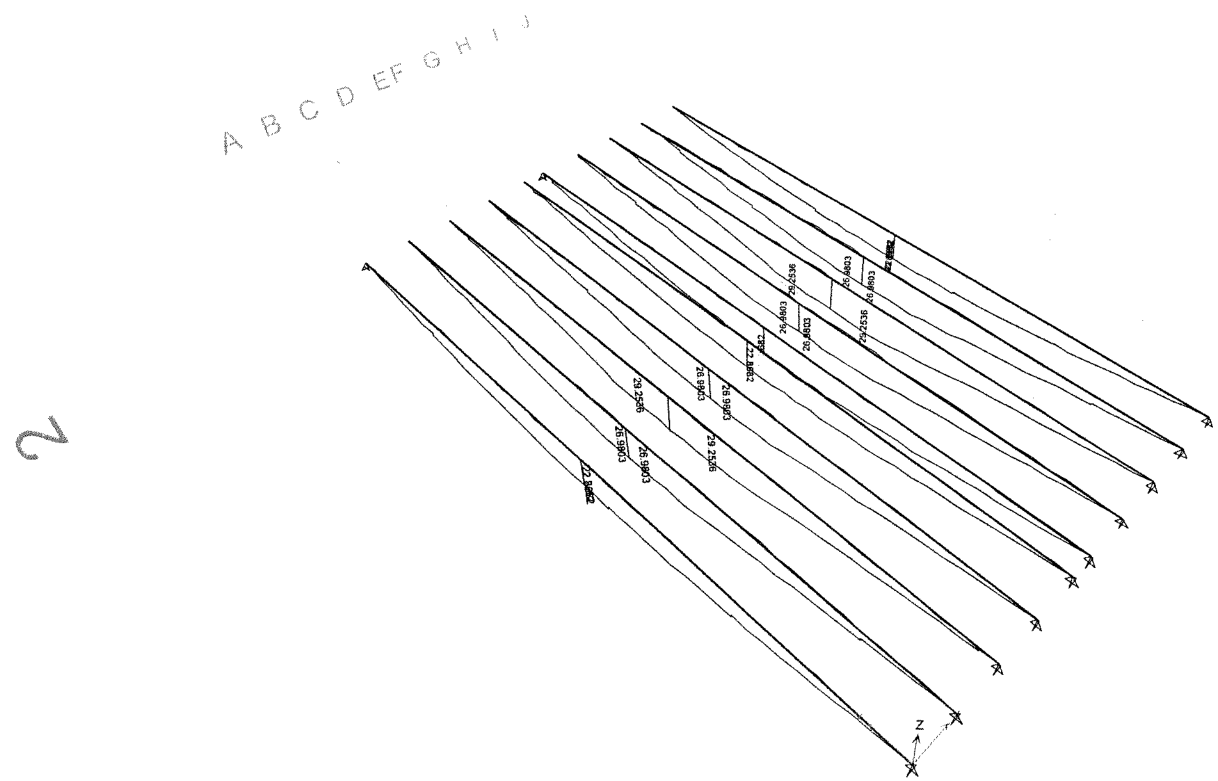
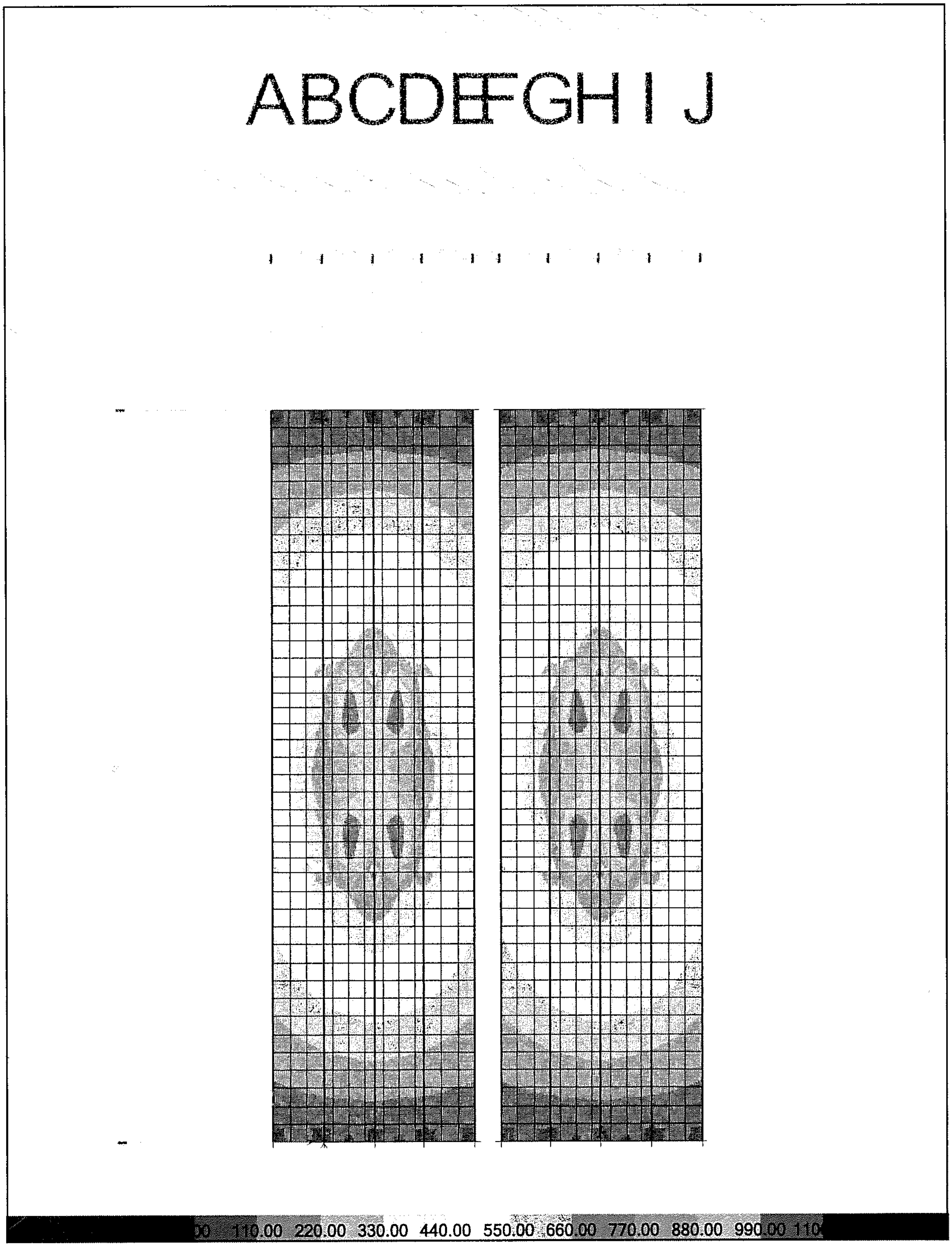
ETABS 2015 15.2.0 2/23/2016



16-2-23 Tandem Axle.EDB 3-D View Moment 3-3 Diagram (Comb1) [kip-ft]

ETABS 2015 15.2.0 2/23/2016



16-2-23 TandemAxleEDB Plan View - Base - Z = 0 (in) Resultant M22 Diagram (Comb1) [kip-ft/ft]

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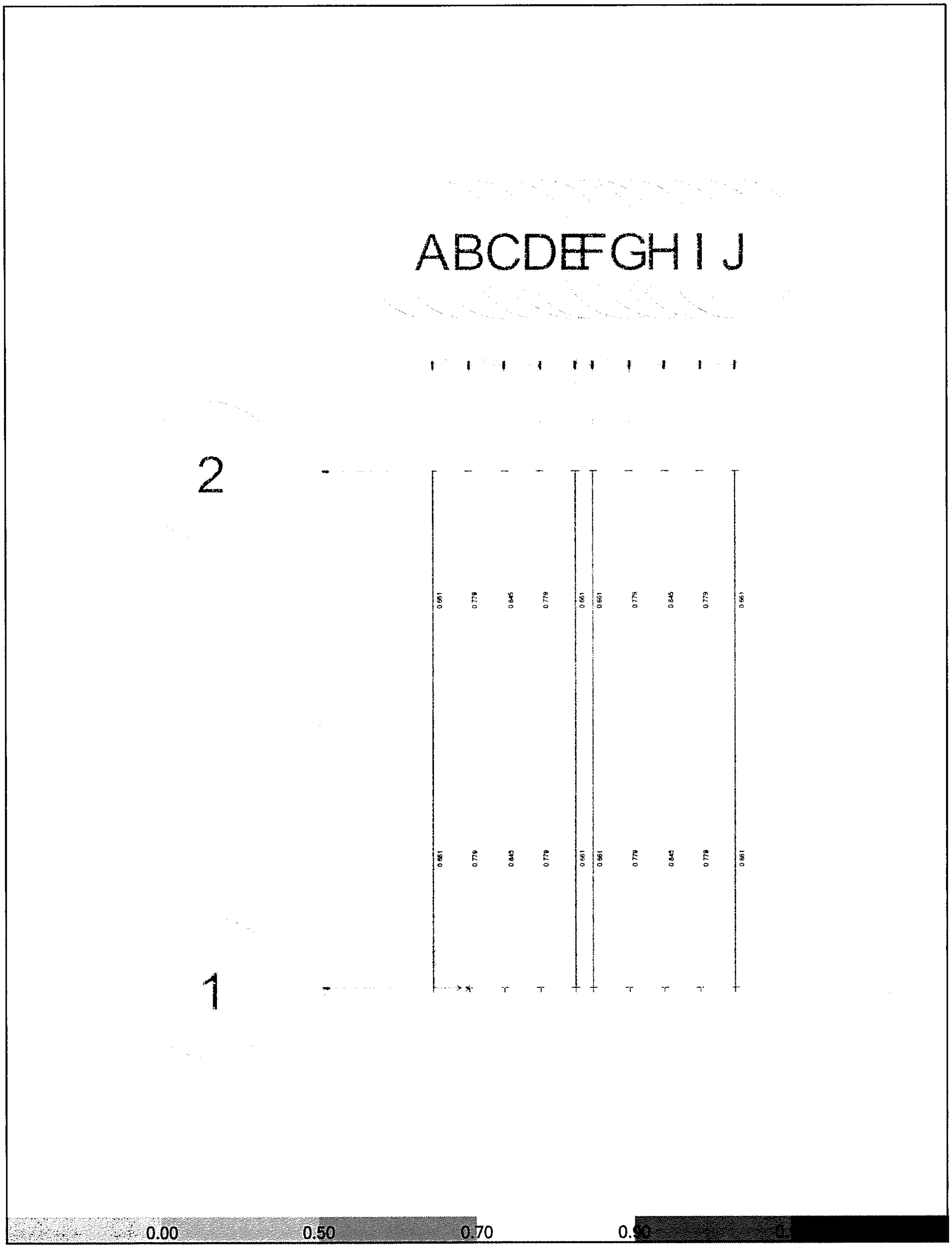

16-2-23 Tandem Axle.EDB Plan View - Base - Z = 0 (in) Steel P-M Interaction Ratios (AISC 360-10)

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Bill 147-33 (COR) Wheel Loads

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FILE COPY

I MINA'TRENTAI TRES NA LIHESLATURAN GUÅHAN

THIRTY-THIRD GUAM LEGISLATURE

155 Hesler Place, Hagåtña, Guam 96910

November 19, 2015

The Honorable Edward J.B. Calvo
I Maga'låhen Guåhan
Ufisinan I Maga'låhi
Hagåtña, Guam

Dear *Maga'låhi* Calvo:

Transmitted herewith are Bill Nos. 75-33 (COR), 124-33 (COR), 147-33 (COR), 163-33 (LS), and 188-33 (COR); and Substitute Bill Nos. 133-33 (COR), 196-33 (LS) and 203-33 (COR), which were passed by *I Mina'Trentai Tres Na Liheslaturan Guåhan* on November 19, 2015.

Sincerely,

TINA ROSE MUÑA BARNES
Legislative Secretary

Enclosure (8)

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I MINA'TRENTAI TRES NA LIHESLATURAN GUÅHAN
2015 (FIRST) Regular Session

CERTIFICATION OF PASSAGE OF AN ACT TO *I MAGA'LÅHEN GUÅHAN*

This is to certify that **Bill No. 147-33 (COR), "AN ACT TO *AMEND* §§ 5101, 5104, 5107, 5109, 5112 AND 5114, AND TO *ADD* A NEW § 5118, ALL OF CHAPTER 5, TITLE 16, GUAM CODE ANNOTATED, RELATIVE TO THE AUTHORITIES AND RESPONSIBILITIES OF THE DEPARTMENT OF REVENUE AND TAXATION AND THE DEPARTMENT OF PUBLIC WORKS TO ENFORCE WEIGHT LIMITS AND SAFE OPERATIONS OF COMMERCIAL VEHICLES ON GUAM'S HIGHWAYS; ESTABLISHING PENALTIES FOR VIOLATIONS; ESTABLISHING PERMIT REQUIREMENTS; AND ESTABLISHING A TRUCK ENFORCEMENT SCREENING STATION (TESS) FACILITY FUND,"** was on the 19th day of November 2015, duly and regularly passed.

Judith T. Won Pat, Ed.D.
Speaker

Attested:

Tina Rose Muña Barnes
Legislative Secretary

This Act was received by *I Maga'låhen Guåhan* this 19th day of November, 2015, at 550 o'clock P.M.

Assistant Staff Officer
Maga'låhi's Office

APPROVED:

EDWARD J.B. CALVO
I Maga'låhen Guåhan

Date:

I MINA'TRENTAI TRES NA LIHESLATURAN GUÅHAN
2015 (FIRST) Regular Session

Bill No. 147-33 (COR)
As amended by the Sponsor.

Introduced by:

T. C. Ada
V. Anthony Ada
FRANK B. AGUON, JR.
Frank F. Blas, Jr.
B. J.F. Cruz
James V. Espaldon
Brant T. McCreadie
Tommy Morrison
T. R. Muña Barnes
R. J. Respicio
Dennis G. Rodriguez, Jr.
Michael F.Q. San Nicolas
Mary Camacho Torres
N. B. Underwood, Ph.D.
Judith T. Won Pat, Ed.D.

AN ACT TO *AMEND* §§ 5101, 5104, 5107, 5109, 5112 AND 5114, AND TO *ADD* A NEW § 5118, ALL OF CHAPTER 5, TITLE 16, GUAM CODE ANNOTATED, RELATIVE TO THE AUTHORITIES AND RESPONSIBILITIES OF THE DEPARTMENT OF REVENUE AND TAXATION AND THE DEPARTMENT OF PUBLIC WORKS TO ENFORCE WEIGHT LIMITS AND SAFE OPERATIONS OF COMMERCIAL VEHICLES ON GUAM'S HIGHWAYS; ESTABLISHING PENALTIES FOR VIOLATIONS; ESTABLISHING PERMIT REQUIREMENTS; AND ESTABLISHING A TRUCK ENFORCEMENT SCREENING STATION (TESS) FACILITY FUND.

BE IT ENACTED BY THE PEOPLE OF GUAM:

Section 1. Legislative Findings and Intent. *I Liheslaturan Guåhan* finds that Guam's public highways, road, and streets must be protected from undue wear and tear caused by commercial vehicles that exceed weight limits that the highways and roads are designed to carry.

I Liheslaturan Guåhan further finds that safe travel of vehicles on the highways is equally important. It is imperative that commercial vehicles used to transport material throughout the island are mechanically sound, the operators are properly licensed, and their loads are properly secured. Safe travel can be further assured by establishing inspection programs that would serve to verify the weight of vehicles and their loads, the mechanical soundness of the vehicles, and the proper securement of loads thereon.

I Liheslaturan Guåhan intends to establish the respective authorities and responsibilities of the Department of Public Works (DPW) and the Department of Revenue and Taxation (DRT) to stop, inspect, and weigh commercial vehicles operating on Guam's roads and highways.

Section 2. § 5101 of Chapter 5, Title 16, Guam Code Annotated, is hereby *amended* to read as follows:

"**§ 5101. Definitions.**

As used in this Chapter, the following definitions will hold true:

Axle: The common axis of rotation of one (1) or more wheels, whether in one (1) or more segments and regardless of the number of wheels carried thereon.

Axle Group: An assemblage of two (2) or more consecutive axles considered together in determining their combined load effect on a bridge or pavement structure.

Axle Load: The total weight transmitted to the road by a single axle.

Connecting Mechanism: An arrangement of parts interconnecting two (2) or more consecutive axles to the frame of a vehicle in such a manner as to equalize the load between the axles.

Continuous Trip Permit: A special permit issued for oversize or overweight loads, valid for multiple days, multiple routes and/or between multiple points of destination, for the duration of a specific project, but not to exceed ninety (90) days, unless deemed warranted otherwise by the DPW Director.

Gross Combination Weight (GCW): The total weight of the power unit and the total weight of the towed unit and any load thereon.

Gross Combination Weight Rating (GCWR): The value specified by the manufacturer as the loaded weight of a combination (articulated) motor vehicle. In the absence of a value specified by the manufacturer, GCWR will be determined by adding the GVWR of the power unit and the total weight of the towed unit and any load thereon.

Gross Vehicle Weight (GVW): The total weight of the loaded vehicle. This includes the vehicle itself and the cargo that is loaded within that vehicle.

Gross Vehicle Weight Rating (GVWR): The value specified by the manufacturer as the loaded weight of a single motor vehicle.

Gross Weight: The weight of a vehicle and/or vehicle combination without load, plus the weight of any load thereon.

Height: The total vertical dimension of any vehicle above the ground surface including any load and load holding device thereon.

Highway: The entire width between the boundary lines of every publicly maintained surface, when any part thereof is open to the use of the public for purposes of vehicular travel; synonymous and interchangeable in usage with "street".

Length: The total longitudinal dimension of any vehicle or combination of vehicles, including any load or load holding devices thereon.

Load: A weight or quantity of anything resting upon a support.

Motor Vehicle: A vehicle which is self-propelled or propelled by electric power obtained from overhead trolley wires, but not operating upon rails.

Owner: A person, other than a lienholder, having the property in or title to a vehicle, including a person entitled to use and possession of a vehicle subject to a security interest in another person, but excluding a lessee under a lease not intended as security.

Portable Scales: A movable weighing device.

Primary Road: A primary road is a road with two (2) or more lanes each way, or any road with at least two (2) contiguous miles with a speed limit of thirty-five (35) miles per hour or greater.

Scale Tolerance: An allowable variation in the static weight of an axle load in accordance with, but not exceeding, the precision of the scale involved.

Secondary Road: A secondary road is any road, paved or unpaved, that does not meet the definition of "primary road" as herein stated.

Semi-Trailer: A vehicle designed for carrying persons or property and drawn by a truck-tractor on which parts of its weight and load rests.

Single Axle: *A*n assembly of two (2) or more wheels, whose centers are on one (1) transverse vertical plane or may be included between two (2) parallel transverse vertical planes forty (40) inches or less apart extending the full width of the vehicle.

Single Axle Weight: The total weight transmitted to the road by a single axle.

Single Trip Permit: A special permit issued for oversize or overweight loads, valid for a single trip on a specified route between predetermined points of origin and destination, and which *shall* expire within twenty-four (24) hours.

Special Permit: A written authorization to move or operate on a highway, a vehicle or vehicles with indivisible load of a size and/or weight exceeding the limits prescribed for vehicles in regular operation. Said permit may be for a single trip or for a continuous trip.

Static Scales: An immovable measuring scale, similar to a ruler, that is attached to the edge of an optical comparator screen.

Tandem Axle: Any two (2) or more consecutive axles whose centers are more than forty (40) inches and not more than ninety-six (96) inches apart, and are individually attached and/or articulated from a common attachment to the vehicle including a connecting mechanism designed to equalize the load between the axles.

Tandem Axle Weight: The total weight transmitted to the road by a tandem axle.

Trailer: A vehicle designed for carrying persons or property and drawn by a motor vehicle which carries no part of the weight and load of the trailer on its own wheels.

Truck: A motor vehicle designed, used or maintained primarily for the transportation of property.

Truck-Tractor: A motor vehicle designed for drawing other vehicles, but not for a load other than a part of the weight of the vehicle and load drawn.

Vehicle: A device in, upon or by which any person or property may be transported or drawn upon a highway.

Vehicle Combination: A truck-tractor and semi-trailer, either with or without a full trailer, or a truck with one (1) or more full trailers.

Weigh-in-Motion Scales: Weighing-in-Motion (WIM) is, as the name implies, the process of weighing a vehicle as it is moving along the highway in an effort to estimate the equivalent static weight of the vehicle.

Wheel Load: The total load transmitted to the road by a wheel. Dual wheels that share an axle mounting are considered a single wheel for load requirements.

Width: The total outside transverse dimension of a vehicle, including any load or load holding devices thereon, but excluding approved safety devices and tire bulge due to load."

Section 3. § 5104 of Chapter 5, Title 16, Guam Code Annotated, is hereby *amended* to read as follows:

"**§ 5104. Height of Vehicles and Loads.**

No vehicle, including any load and load holding devices thereon, shall exceed a total height of fifteen (15) feet for public roads, streets or highways."

Section 4. § 5107 of Chapter 5, Title 16, Guam Code Annotated, is hereby *amended* to read as follows:

"**§ 5107. Gross Weight, Axle, and Wheel Loads.**

No motor vehicle or combination of vehicles equipped wholly with pneumatic tires, which has a gross weight, an axle load, or a wheel load in excess of the limits set forth in this Section shall be operated or moved upon any public road, street, or highway; and no vehicle or combination of vehicles shall be operated on or moved over any bridge or other highway structure if the gross weight, including vehicle and load, exceeds the posted maximum gross weight limitation for the bridge or other highway structure.

(a) The total gross weight, in pounds, imposed on any public road, street, or highway by any axle group on a vehicle or combination of vehicles *shall not* exceed the following when the distance between the first and last axles of the group under consideration is:

(1) forty (40) inches or less; the axle load *shall not* exceed twenty thousand (20,000) pounds;

(2) more than forty (40) inches, but not more than eight (8) feet; the tandem axle weight imposed *shall not* exceed thirty-four thousand (34,000) pounds.

(b) The total gross weight, in pounds, imposed on any public road, street, or highway by any axle group on a vehicle or combination of vehicles *shall not* exceed that resulting from application of the Bridge Formula:

W = 500 (LN/(N-1) + 12N + 36) when the distance between the first and last axles of the axle group under consideration is over eight (8) feet and where

W = maximum gross weight in pounds carried on any axle group,

L = distance in feet between the outer axles of any axle group, to the nearest foot, and

N = number of axles in group under consideration; provided that two (2) consecutive sets of tandem axles may carry a gross load of thirty-four thousand (34,000) pounds each providing the overall distance between the first and last axles of such consecutive sets of tandem axles is thirty-six (36) feet or more; and provided also that the overall gross weight *does not* exceed eighty thousand (80,000) pounds.

(c) No vehicle or combination of vehicles shall be used or operated on any public road, street, or highway with:

(1) a load upon any single or tandem axle or combination of axles which exceeds the carrying capacity of the axles specified by the manufacturer; or

(2) with a total weight in excess of its designed capacity as indicated by its designed gross vehicle weights or gross combination weights.

(d) The single axle weight *shall not* exceed twenty thousand (20,000) pounds.

(e) The maximum wheel load imposed upon any public road, street, or highway *shall not* exceed ten thousand (10,000) pounds.

(f) The Director of the Department of Public Works (DPW Director) may place and maintain signs to limit the gross weight of a vehicle or combination of vehicles traveling over a bridge or other highway structure in the interest of public safety when it is determined that the theoretical load carrying capacity of the bridge or structure is less than the maximum gross vehicular weight allowed by this Chapter.

(g) The DPW Director may issue an Overweight Vehicle Load Permit for a vehicle that meets the axle group load requirements of the formula in Subsection (b) of this Section, but with a gross vehicle weight in excess of eighty thousand (80,000) pounds. Such special permit *shall* be issued in accordance with § 5114 of this Chapter."

Section 5. § 5109 of Chapter 5, Title 16, Guam Code Annotated, is hereby *amended* to read as follows:

"**§ 5109. Authority to Stop, Inspect and Weigh Vehicles; Removal of Excess Loads.**

(a) For purposes of the enforcement of this Chapter, the Director of Revenue and Taxation (DRT Director) and the DPW Director *shall* have such powers of enforcement as may be necessary to implement their respective responsibilities under this Chapter.

(1) The DRT Director, whose Department is primarily responsible for implementing and enforcing this Chapter as such relates to the registration and safety of vehicles, may delegate enforcement to the Administrator of the Division of Motor Vehicles/Motor Carrier Safety Assistance Program (DMV/MCSAP).

(2) The DPW Director, whose Department is primarily responsible for implementing and enforcing this Chapter as such relates to truck gross weight and the safety and maintenance of Guam's public roads, streets and highways, may delegate the enforcement of this Chapter to the Administrator of the Division of Highways.

(b) For the purpose of the safety, welfare and health of the general public, and the safe transportation of hazardous materials, waste and other materials on any public road, street or highway, and the enforcement of this Chapter and of all rules adopted pursuant to this Chapter, the responsibilities of each agency *shall* be as follows:

(1) Department of Revenue and Taxation (DRT):

(A) inspect business premises, buildings, freight and equipment of commercial motor carriers;

(B) stop and inspect freight and equipment of all motor carriers operating on any public road, street or highway, except that any motor carrier with military cargo shall be permitted to proceed, unless safety to the general public dictates otherwise, to the vehicle's destination for appropriate review therein and such action shall not be a violation of this Chapter;

(C) inspect shipping papers and hazardous waste manifests of all motor carriers and persons subject to this Chapter operating on any public road, street or highway;

(D) during the course of an inspection, weigh any vehicle and/or combination of vehicles equipped wholly with pneumatic tires to ensure compliance with the provisions of § 5107(c)(1) and (2) of this Chapter;

(E) whenever a police officer or DMV/MCSAP inspector, upon inspection of a vehicle and/or load, determines the existence of a violation, a citation may be issued. The vehicle may be allowed to proceed directly to its own shop or facility for correction. When a vehicle is found to be unsafe to the driver or the public, the police officer or DMV/MCSAP inspector has the authority to direct the discontinuance of the vehicle passage and require corrective action on the spot as appropriate, and such vehicle *shall not* be allowed back into normal operations until corrections are made;

(F) every police officer, or DMV/MCSAP inspector *shall* assist in the enforcement of this Chapter and of all rules adopted pursuant to this Chapter and may issue citations for violations as appropriate; and

(G) fines collected from citations issued by DMV/MCSAP inspectors for violations of this Subsection *shall* be deposited in the Better Public Service Fund and expended in accordance with § 16101 of Chapter 161, Title 11, Guam Code Annotated.

(2) Department of Public Works (DPW):

(A) operate the Truck Enforcement Screening Station (TESS) Facility located on Route 11 to weigh vehicles and/or combinations of vehicles operating on Guam's roads, streets, or highways;

(B) every police officer or DPW inspector having reason to believe that the weight or dimension of a vehicle operating on a public road, street or highway, either with or without load, is in violation of the provisions of this Chapter, *shall* be authorized to require the driver to stop and submit to an inspection of same by means of portable scales, static scales, or weigh-in-motion scales, or as otherwise appropriate, except that any motor carrier with military cargo shall be permitted to proceed, unless safety to the general public dictates otherwise, to the vehicle's destination for appropriate review therein and such action shall not be a violation of this Chapter. Violations for any dimensions or GVW in excess of permissible limits, as established by the provisions of this Chapter, *shall* be subject to the penalties cited in § 5112(a) of this Chapter;

(C) whenever a police officer or DPW inspector, upon weighing a vehicle and load, as provided above, determines that the GVW exceeds allowable limits, such police officer or DPW inspector may require the driver to stop the vehicle in a suitable area where corrective action can be determined by the police officer or DPW inspector. Corrective action may include removal of the non-conforming portion of the load and distribution to another vehicle, or allowance of the vehicle to proceed to another location for unloading. Nothing herein is intended to waive any applicable fines;

(D) every police officer or DPW inspector *shall* assist in the enforcement of this Chapter and of all rules adopted pursuant to this Chapter and issue citations for violations as appropriate;

(E) fines collected from citations issued by DPW inspectors for violations of this Subsection *shall* be deposited in the TESS Facility Fund, and *shall* be expended in accordance with § 5118 of this Chapter.

(c) Any driver of a vehicle who fails or refuses to stop and submit the vehicle, either with or without load, to an inspection and/or weighing, or who fails or refuses when directed by a police officer, DMV inspector, or DPW inspector upon inspection and/or weighing of the vehicle to discontinue the operation of the vehicle and otherwise comply with the provisions of this Section *shall* be guilty of a civil violation. Each violation for failure or refusal to stop and submit the vehicle to an inspection and/or take subsequent corrective actions *shall* be subject to the following:

(1) a first violation *shall* be subject to a penalty of One Hundred Dollars ($100.00);

(2) a second violation of the provisions of this Subsection within a six (6) month period from the date of the first violation *shall* be subject to a penalty of Two Hundred Dollars ($200.00);

(3) a third violation of the provisions of this Subsection within a six (6) month period from the date of a second violation *shall* be subject to a penalty of Five Hundred Dollars ($500.00);

(4) a fourth violation of the provisions of this Subsection within a six (6) month period from the date of the third violation *shall* be subject to a penalty of One Thousand Dollars ($1,000.00) and the operator *shall* be subject to revocation of their driver's license."

Section 6. § 5112 of Chapter 5, Title 16, Guam Code Annotated, is hereby *amended* to read as follows:

"**§ 5112. Penalties.**

(a) Every person, entity or organization convicted of a violation of any of the provisions of this Chapter for which another penalty is not provided *shall* be guilty of a civil violation and subject to a penalty of up to Five Hundred Dollars ($500.00). Every person, entity or organization found to be in violation of the weight limitations established in this Chapter *shall* be subject to the following:

(1) for a first violation, such person, entity or organization *shall* be guilty of a civil violation and punished by a fine of up to Five Hundred Dollars ($500.00) and Twenty-five Cents ($0.25)/pound over the maximum allowable load authorized in § 5107;

(2) for a second violation within a six (6) month period from the date of the first violation, such person, entity or organization *shall*

be guilty of a civil violation and punished by a fine of up to Seven Hundred Fifty Dollars ($750.00) and Fifty Cents ($0.50)/pound over the maximum allowable load authorized in § 5107; and

(3) should a person, entity or organization be found guilty of a third violation of the weight limitations established by this Chapter within six (6) months after a second violation, such person, entity or organization *shall* be guilty of a civil violation and subject to fine of *not less than* One Thousand Dollars ($1,000.00) and Seventy-five Cents ($0.75)/pound over the maximum allowable load authorized in § 5107; and the responsible party, as defined in Subsection (d) of this Section, may have their Guam business license revoked in accordance with the following:

(A) The Director of the Department of Public Works (DPW Director) *shall* notify the responsible party (respondent), in writing, of the finding of a third violation of this Section.

(B) The respondent may request, in writing, an administrative hearing to dispute the findings of the Director. Said request for a hearing must be delivered, in writing, to the Office of the DPW Director within fifteen (15) calendar days from the date of receipt of the DPW Director's findings.

(C) Notwithstanding § 9220 of Chapter 9 of Title 5, Guam Code Annotated, the hearing *shall* be conducted by the DPW Director who *shall* be the hearing officer. The Office of the Attorney General or a Special Assistant Attorney General, appointed by the Attorney General, *shall* assist in providing advice to the DPW Director when matters of law arise. The hearing process *shall* be subject to the procedures of Chapter 9 of Title 5, Guam Code Annotated, with the exception noted above, to § 9220 of the same. The findings of the Director, upon the delivery to the respondent, *shall* fulfill the requirements of § 9201 of Chapter 9 of Title 5, Guam Code Annotated.

(D) In the event that the DPW Director affirms the finding of a third violation is valid, or if no hearing is requested in writing within fifteen (15) calendar days from the date of receipt of the findings by the respondent, the DPW Director may request, in writing, that the appropriate licensing entity revoke the respondent's license to do business on Guam immediately, for a period of up to three (3) years, as determined by the Director. Upon receipt of the DPW Director's written recommendation, the appropriate licensing entity may suspend such license to do business on Guam in accordance with the recommendation of the DPW Director. The hearing required of this Subsection *shall* fulfill the requirements to suspend a business license found in Chapter 9 of Title 5 GCA.

(4) Any person found to be in violation of the dimensional limitations established by this Chapter *shall* be guilty of a civil violation and subject to the following:

If the excess dimension (length or width) is as follows, the fine *shall* be:

Up to 5 feet	$ 50.00
Over 5 feet and up to 10 feet	$100.00
Over 10 feet and up to 15 feet	$150.00
Over 15 feet	$200.00,

plus $10.00 for each additional foot.

(5) Any person who commits any of the acts prohibited by this Section or any rules adopted to enforce this Chapter where no penalty is provided for *shall* be guilty of a civil violation and *shall* be fined *not less than* Five Hundred Dollars ($500.00), as determined by the DPW Director.

(b) All fines levied by a DMV/MCSAP inspector in accordance with the applicable provisions of this Chapter *shall* be deposited in the Better Public Service Fund of the Department of Revenue and Taxation, to be used by the Division of Motor Vehicles in accordance with § 16101 of Chapter 16, Title 11, Guam Code Annotated.

(c) All fines levied by a DPW/TESS inspector and any permits and administrative fees collected by the Department of Public Works in accordance with this Chapter *shall* be deposited in the TESS Facility Fund and *shall* be expended in accordance with § 5118 of this Chapter.

(d) Responsible Party.

(1) Import Shipping Containers Under Seal. Any importer or consignee, whether an individual or an entity, organization, or company, whose shipping container placed under seal has been determined to be in violation of § 5107 of this Chapter *shall* be responsible for any fine, penalty, handling, additional transportation or other associated cost (including storage).

(2) Export Shipping Containers Under Seal. Any exporter, whether an individual or an entity, organization, or company, whose shipping container placed under seal has been determined to be in violation of § 5107 of this Chapter *shall* be responsible for any fine,

penalty, handling, additional transportation or other associated cost (including storage).

(3) Local Containers Under Seal. Any individual and any organization, entity, or company loading a shipping container under seal not designated for export that has been determined to be in violation of § 5107 of this Chapter *shall* be responsible for any fine, penalty, handling, additional transportation or other associated cost (including storage).

(4) All Other Local Transport Not Under Seal. Any individual or any cargo transporting entity, organization, or company determined to be in violation of § 5107 of this Chapter *shall* be responsible for any fine, penalty, handling, additional transportation or other associated cost (including storage) prescribed in this Section.

(e) The fine schedules of the Superior Court of Guam and the Commercial Vehicle Safety Alliance (CVSA) for violations cited during roadside inspections, and the method for penalty assessment outlined in the Federal Uniform Fine Assessment (UFA) Program, specifically for violations identified as a result of a Compliance Review, are hereby adopted pursuant to fines and fees as applicable to Guam.

(f) For the purposes of this Section, *person* means the driver of the vehicle, unless the driver is an employee and is operating the vehicle in the scope and course of employment, in which case *person* means the employer of the driver. In the case of the transportation of a sealed container or transportation by flatrack, *person* means:

(1) the individual or company the cargo is consigned to; or

(2) the individual or company located on Guam shipping the cargo.

The owner of the vehicle or combination of vehicles may request the operator be held harmless and the citation be transferred to that owner of the vehicle or combination of vehicles. The consignee or the shipper *shall not* be cited if the power units' (tractors') drive axle group is overweight, and the weight is *not more than* that allowed for a tandem axle with any applicable tolerances.

(g) All permit and administrative fees, fines and reimbursements generated under this Chapter (applicable to the Department of Public Works) *shall* be deposited in the Tess Facility Fund, and *shall not* lapse at the end of the fiscal year, but *shall* roll over into the next fiscal year or until expended in accordance with § 5118 of this Chapter."

Section 7. § 5114 of Chapter 5, Title 16, Guam Code Annotated, is hereby *amended* to read as follows:

"**§ 5114. Permits for Excess Size and Weight.**

(a) A surety bond in a minimum amount of Five Hundred Dollars ($500.00), or proper evidence of adequate insurance, must be filed with the Director of Public Works before a permit will be issued for transporting over-width, over-length or over-weight loads on the highway, except when the applicant is a territorial or federal government agency.

(b) The Director of Public Works, or his authorized representative, may in his discretion, upon application in writing and good cause being shown therefore, issue a special permit in writing authorizing the applicant to operate or move a vehicle or combination of vehicles of a size or weight exceeding the maximum specified in this Chapter, or otherwise not in conformity with the provisions of this Chapter, upon the highways of Guam. A permit issued under this Section *shall not* authorize the operation or moving of any vehicle or combination of vehicles without the compliance with Chapter 7 of this Title.

(c) The application for any such permit *shall* specifically describe the vehicle or combination of vehicles and load to be operated or moved, and the particular highways for which the permit to operate is requested, and whether such permit is requested for a single trip, or for continuous operation for a designated period of time.

(d) The Director of Public Works, or his authorized representative, is authorized to issue or withhold such permit at his discretion, or, if such a permit is issued, to limit the number of trips or to establish time limitations within which the vehicles described may be operated, or to prescribe the conditions of the operations of such vehicle or vehicles when necessary to assure against undue damage to the highway foundations, surfaces or structures, and may require such undertaking or other security as may be deemed necessary to compensate for any injury to any such highway foundations, surfaces or structure. Each permit *shall* be valid only for a designated number of consecutive calendar days as specified in the permit, but in no event shall a permit be granted for a period longer than ten (10) days.

(e) At the discretion of the Director of Public Works or his authorized representative, blanket permits will be issued for over-sized vehicles presently on island, and said over-sized vehicles may be subject to time-of operations restrictions.

(f) Every such permit *shall* be carried in the vehicle or combination of vehicles to which it refers and *shall* be open to inspection by any police officer. It *shall* be unlawful for any person to violate any of the terms or conditions of such permits.

(g) All permitted vehicle or combination of vehicles to which it refers must display two (2) warning signs in addition to the permit number. Each warning sign *shall* consist of black letters at least twelve inches (12") high and not less that one and a half inches (1½") wide on a yellow background. The sign *shall* state "OVERSIZED LOAD" or "WIDE LOAD," as provided in the permit, and include the permit number. One sign will either be bumper-mounted or roof-mounted. If one of the signs is roof-mounted, then the other sign must be at the rear of the towed unit or at the rear of the load. The permit number shall consist of black letters at least ten inches (10") high and not less than one and a half inches (1½") wide. Clearance lights are also required during night time travel. Voids (holes) may be cut in the warning signs, as the signs must not cover any vehicle light or reflector.

(h) A fee *shall* be charged for each permit issued by the DPW Director as follows:

(1) Single trip permit for oversize and overweight loads: Fifty Dollars ($50.00).

(2) Continuous trip permit for oversize and overweight loads: One Hundred Dollars ($100.00).

All permits may include date, time and route restrictions as determined by the DPW Director. Such fees *shall* be deposited in the TESS Facility Fund of the Department of Public Works, and *shall* be expended in accordance with § 5118 of this Chapter.

(i) Any vehicle issued with a permanent special equipment license or requiring a special permit, as required under this Chapter, *shall* be prohibited from operating on the highways during the hours of 7:00 to 9:00 a.m., 12:00 to 1:00 p.m., and 4:00 to 6:00 p.m., Mondays through Fridays, except in cases of emergencies or at the direction of the Director of Public Works."

Section 8. A new § 5118 is hereby *added* to Chapter 5, Title 16, Guam Code Annotated, to read as follows:

"**§ 5118. Truck Enforcement Screening Station (TESS) Facility Fund.**

Notwithstanding any law to the contrary, a revolving fund, designated as the TESS Facility Fund (Fund), *shall* be established separate and apart from other funds of the government of Guam, and separate records *shall* be kept therefore. The Director of Public Works *shall* administer the Fund and *shall* issue vouchers properly certifying the use of the Fund's monies. The DPW Director is authorized to use revenues in the Fund and any interest derived therefrom for the operation and maintenance of the TESS Facility, or to establish, operate and maintain similar compliance facilities or programs. All monies in the Fund are hereby appropriated and are *not* subject to *I Maga'låhi's* transfer authority."

Section 9. Severability. If any provision of this law or its application to any person or circumstance is found to be invalid or contrary to law, such invalidity *shall not* affect other provisions or applications of this law that can be given effect without the invalid provisions or application, and to this end the provisions of this law are severable.

Section 10. Effective Date. This Act *shall* become effective sixty (60) days after enactment.

Exhibit 8

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DEPARTMENT OF LABOR

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- **Part Number:** 1926
- **Part Title:** Safety and Health Regulations for Construction
- **Subpart:** CC
- **Subpart Title:** Cranes & Derricks in Construction
- **Standard Number:** 1926.1408
- **Title:** Power line safety (up to 350 kV)--equipment operations.
- **GPO Source:** e-CFR

1926.1408(a)

Hazard assessments and precautions inside the work zone. Before beginning equipment operations, the employer must:

1926.1408(a)(1)

Identify the work zone by either:

1926.1408(a)(1)(i)

Demarcating boundaries (such as with flags, or a device such as a range limit device or range control warning device) and prohibiting the operator from operating the equipment past those boundaries, or

1926.1408(a)(1)(ii)

Defining the work zone as the area 360 degrees around the equipment, up to the equipment's maximum working radius.

1926.1408(a)(2)

Determine if any part of the equipment, load line or load (including rigging and lifting accessories), if operated up to the equipment's maximum working radius in the work zone, could get closer than 20 feet to a power line. If so, the employer must meet the requirements in Option (1), Option (2), or Option (3) of this section, as follows:

1926.1408(a)(2)(i)

Option (1)--Deenergize and ground. Confirm from the utility owner/operator that the power line has been deenergized and visibly grounded at the worksite.

1926.1408(a)(2)(ii)

Option (2)--20 foot clearance. Ensure that no part of the equipment, load line, or load (including rigging and lifting accessories), gets closer than 20 feet to the power line by implementing the measures specified in paragraph (b) of this section.

1926.1408(a)(2)(iii)

Option (3)--Table A clearance.

1926.1408(a)(2)(iii)(A)

Determine the line's voltage and the minimum approach distance permitted under Table A (*see* § 1926.1408).

1926.1408(a)(2)(iii)(B)

Determine if any part of the equipment, load line or load (including rigging and lifting accessories), while operating up to the equipment's maximum working radius in the work zone, could get closer than the minimum approach distance of the power line permitted under Table A (*see* § 1926.1408). If so, then the employer must follow the requirements in paragraph (b) of this section to ensure that no part of the equipment, load line, or load (including rigging and lifting accessories), gets closer to the line than the minimum approach distance.

1926.1408(b)

Preventing encroachment/electrocution. Where encroachment precautions are required under Option (2) or Option (3) of this section, all of the following requirements must be met:

1926.1408(b)(1)

Conduct a planning meeting with the operator and the other workers who will be in the area of the equipment or load to review the location of the power line(s), and the steps that will be implemented to prevent encroachment/electrocution.

1926.1408(b)(2)

If tag lines are used, they must be non-conductive.

1926.1408(b)(3)

Erect and maintain an elevated warning line, barricade, or line of signs, in view of the operator, equipped with flags or similar high-visibility markings, at 20 feet from the power line (if using Option (2) of this section) or at the minimum approach distance under Table A (*see* § 1926.1408) (if using Option (3) of this section). If the operator is unable to see the elevated warning line, a dedicated spotter must be used as described in § 1926.1408(b)(4)(ii) in addition to implementing one of the measures described in § § 1926.1408(b)(4)(i), (iii), (iv) and (v).

1926.1408(b)(4)

Implement at least one of the following measures:

1926.1408(b)(4)(i)

A proximity alarm set to give the operator sufficient warning to prevent encroachment.

1926.1408(b)(4)(ii)

A dedicated spotter who is in continuous contact with the operator. Where this measure is selected, the dedicated spotter must:

1926.1408(b)(4)(ii)(A)

Be equipped with a visual aid to assist in identifying the minimum clearance distance. Examples of a visual aid include, but are not limited to: A clearly visible line painted on the ground; a clearly visible line of stanchions; a set of clearly visible line-of-sight landmarks (such as a fence post behind the dedicated spotter and a building corner ahead of the dedicated spotter).

1926.1408(b)(4)(ii)(B)

Be positioned to effectively gauge the clearance distance.

1926.1408(b)(4)(ii)(C)

Where necessary, use equipment that enables the dedicated spotter to communicate directly with the operator.

1926.1408(b)(4)(ii)(D)

Give timely information to the operator so that the required clearance distance can be maintained.

1926.1408(b)(4)(iii)

A device that automatically warns the operator when to stop movement, such as a range control warning device. Such a device must be set to give the operator sufficient warning to prevent encroachment.

1926.1408(b)(4)(iv)

A device that automatically limits range of movement, set to prevent encroachment.

1926.1408(b)(4)(v)

An insulating link/device, as defined in § 1926.1401, installed at a point between the end of the load line (or below) and the load.

1926.1408(b)(5)

The requirements of paragraph (b)(4) of this section do not apply to work covered by subpart V of this part.

1926.1408(c)

Voltage information. Where Option (3) of this section is used, the utility owner/operator of the power lines must provide the requested voltage information within two working days of the employer's request.

1926.1408(d)

Operations below power lines.

1926.1408(d)(1)

No part of the equipment, load line, or load (including rigging and lifting accessories) is allowed below a power line unless the employer has confirmed that the utility owner/operator has deenergized and (at the worksite) visibly grounded the power line, except where one of the exceptions in paragraph (d)(2) of this section applies.

1926.1408(d)(2)

Exceptions. Paragraph (d)(1) of this section is inapplicable where the employer demonstrates that one of the following applies:

1926.1408(d)(2)(i)

The work is covered by subpart V of this part.

1926.1408(d)(2)(ii)

For equipment with non-extensible booms: The uppermost part of the equipment, with the boom at true vertical, would be more than 20 feet below the plane of the power line or more than the Table A of this section minimum clearance distance below the plane of the power line.

1926.1408(d)(2)(iii)

For equipment with articulating or extensible booms: The uppermost part of the equipment, with the boom in the fully extended position, at true vertical, would be more than 20 feet below the plane of the power line or more than the Table A of this section minimum clearance distance below the plane of the power line.

1926.1408(d)(2)(iv)

The employer demonstrates that compliance with paragraph (d)(1) of this section is infeasible and meets the requirements of § 1926.1410.

1926.1408(e)

Power lines presumed energized. The employer must assume that all power lines are energized unless the utility owner/operator confirms that the power line has been and continues to be deenergized and visibly grounded at the worksite.

1926.1408(f)

When working near transmitter/communication towers where the equipment is close enough for an electrical charge to be induced in the equipment or materials being handled, the transmitter must be deenergized or the following precautions must be taken:

1926.1408(f)(1)

The equipment must be provided with an electrical ground.

1926.1408(f)(2)

If tag lines are used, they must be non-conductive.

1926.1408(g)

Training.

1926.1408(g)(1)

The employer must train each operator and crew member assigned to work with the equipment on all of the following:

1926.1408(g)(1)(i)

The procedures to be followed in the event of electrical contact with a power line. Such training must include:

1926.1408(g)(1)(i)(A)

Information regarding the danger of electrocution from the operator simultaneously touching the equipment and the ground.

1926.1408(g)(1)(i)(B)

The importance to the operator's safety of remaining inside the cab except where there is an imminent danger of fire, explosion, or other emergency that necessitates leaving the cab.

1926.1408(g)(1)(i)(C)

The safest means of evacuating from equipment that may be energized.

1926.1408(g)(1)(i)(D)

The danger of the potentially energized zone around the equipment (step potential).

1926.1408(g)(1)(i)(E)

The need for crew in the area to avoid approaching or touching the equipment and the load.

1926.1408(g)(1)(i)(F)

Safe clearance distance from power lines.

1926.1408(g)(1)(ii)

Power lines are presumed to be energized unless the utility owner/operator confirms that the power line has been and continues to be deenergized and visibly grounded at the worksite.

1926.1408(g)(1)(iii)

Power lines are presumed to be uninsulated unless the utility owner/operator or a registered engineer who is a qualified person with respect to electrical power transmission and distribution confirms that a line is insulated.

1926.1408(g)(1)(iv)

The limitations of an insulating link/device, proximity alarm, and range control (and similar) device, if used.

1926.1408(g)(1)(v)

The procedures to be followed to properly ground equipment and the limitations of grounding.

1926.1408(g)(2)

Employees working as dedicated spotters must be trained to enable them to effectively perform their task, including training on the applicable requirements of this section.

1926.1408(g)(3)

Training under this section must be administered in accordance with § 1926.1430(g).

1926.1408(h)

Devices originally designed by the manufacturer for use as: A safety device (*see* § 1926.1415), operational aid, or a means to prevent power line contact or electrocution, when used to comply with this section, must meet the manufacturer's procedures for use and conditions of use.

TABLE A—MINIMUM CLEARANCE DISTANCES

Voltage (nominal, kV, alternating current)	Minimum clearance distance (feet)
up to 50	10
over 50 to 200	15
over 200 to 350	20
over 350 to 500	25
over 500 to 750	35
over 750 to 1,000	45
over 1,000	(as established by the utility owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution).

Note: The value that follows "to" is up to and includes that value. For example, over 50 to 200 means up to and including 200kV.

[75 FR 48142, August 9, 2010]

Next Standard (1926.1409)

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