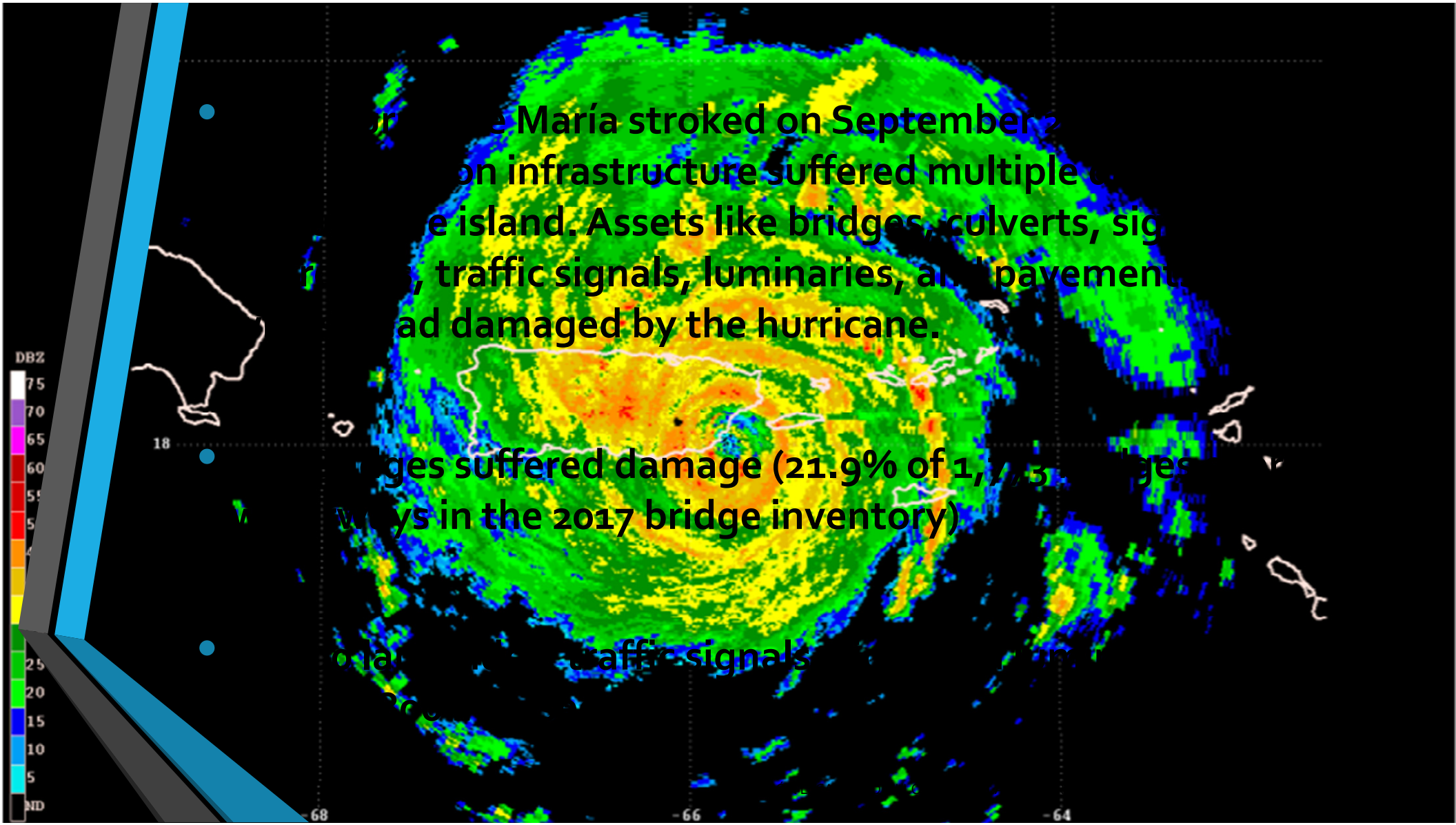
CONCRETE ROLE ON THE RECONSTRUCTION OF THE TRANSPORTATION PROJECTS AFTER HURRICANE MARÍA

DR. RAMÓN L. CARRASQUILLO PE
SCHOLARSHIP PROGRAM FUNDRAISING
ANNUAL CONFERENCE 2021

Presented by:
José M. López Pérez P.E. MSCE
Carlos R. Matos Concepcion P.E. MECE

APC
ASOCIACIÓN PUERTORRIQUEÑA DEL CONCRETO

SNC·LAVALIN
ATKINS
Member of the SNC-Lavalin Group


María stroked on September
on infrastructure suffered multiple
e island. Assets like bridges, culverts, sig
, traffic signals, luminaries, a pavemen
ad damaged by the hurricane.
ges suffered damage (21.9% of 1,
ys in the 2017 bridge inventory)
traffic signals
DBZ
75
70
65
60
25
20
15
10
5
18
-68
-66
-64

We can't forget the lessons that Maria taught us!

Mayor Emergency Recovery Phases:

Timed Elapsed

- Initial response
  - Initial damage assessment
  - Debris removal and reestablishment of essential traffic for emergency response
- Emergency Response
  - Detailed Damage assessment
  - Initial Emergency repairs
  - Permanent Emergency Repairs
- Final recovery phase
  - Permanent repairs
  - Resiliency

Basic / Simple / Ready-Available

Gradual Transition

Standard Design / Construction

Emergency Response

- Management - Standard Procedure
- Concrete specifications employed
  - Payment of Concrete
  - Applications
  - Technical requirements
  - Operational Challenges
- Response Project Examples - Role and evolution of Concrete on the post hurricane response
- Other aspects

Standard Procedure

- Detailed Damage Inspection Report (DDIR) –
  - Form used by FHWA to estimate damages
- Task Order –
  - General description of the work (scope of work)
  - Task amount
  - Duration of the work
  - Agreed and signed by the PRHTA Representative and the Contractor

- List of Fixed Unit Prices – FHWA
- PRHTA Standard Drawings (or Emergency Design Drawings)
- PRHTA Standard Specifications For Road And Bridge Construction
- PRHTA Material Testing Schedule (MTA)

DETAILED DAMAGE INSPECTION REPORT
(Title 23, Federal-aid Highways)

Report Number

Sheet 1 of 1

Location (Name of Road and Milepost)
PR-853 FROM KM 7.7, Municipality of Carolina

FHWA Disaster Number
PR201701

Inspection Date
October 10, 2017

Description of Damage
Landslide in Highway PR-853, Km 7.7
Length: 20.00 LnM Width: 3.00 LnM Height: 3.00 LnM
Stabilization of roadway with gabion wall construction and placing borrow material.

Federal-aid Route Number
PR-853

State: PR
County: Carolina

Cost Estimate

	Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost: Completed	Cost: Remaining
Emergency Repairs	Mobilization	LS	$99.33	100.00		$9,933.16
	Temporary Concrete Barrier	LnM	$165.60	25.00		$4,140.00
	Construction Signs	SqM	$284.60	20.00		$5,692.00
	Drums	Ea	$103.50	25.00		$2,587.50
	Removal of Structures and Obstructions	LS	$51.00	100.00		$5,100.00
	Borrow Class B	CuM	$35.70	35.00		$1,249.50
	Unclassified Excavation for Structures	CuM	$40.80	142.00		$5,793.60
	Subbase Course	CuM	$35.70	65.00		$2,320.50
	Aggregate Base Course	CuM	$56.15	20.00		$1,123.00
	Hot Mix Bituminous S(75)(12)	Ton	$220.00	20.00		$4,400.00
	Hot Mix Bituminous B-1(75)	Ton	$220.00	40.00		$8,800.00
	Guard Rail Single Face	LnM	$120.60	30.00		$3,618.00
	Unclassified Excavation	CuM	$20.40	50.00		$1,020.00
	Gabions	CuM	$419.60	120.00		$50,352.00
	Concrete Paved Waterway	SqM	$68.15	4.00		$272.60
	Thermoplastic Pavement Markings	LnM	$7.24	60.00		$434.40
	Concrete Curb and Gutter Type F	LnM	$68.15	30.00		$2,044.50
	Straw Bales	Each	$12.00	12.00		$144.00
	Silt Fence	LnM	$8.00	30.00		$240.00
	Method: __ Local Forces __ State Forces _X_ Contract			Subtotal		$109,264.76
				PE/CE		
				Emergency Repair Total		$109,264.76
Permanent Repairs						$0.00
						$0.00
						$0.00
						$0.00
	Method: __ Local Forces __ State Forces __ Contract			Subtotal		$0.00
				PE/CE		$0.00
				Right-of-way		
				Perm. Repair Total		$0.00

Environmental Assessment Recommendation
_X_ Categorical Exclusion ___ EA/EIS

Estimated Total $109,264.76

Recommendation: ✓ Eligible ___ Ineligible
FHWA Engineer: [signature] Date: 01/17/2018

Concurrence: ✓ Yes ___ NO
State Engineer: Eng. Carlos Céspedes Gómez Date: 8/dic/17

Concurrence: ___ Yes ___ No
Local Agency Representative Date

Form FHWA-1547(Rev. 4-98)

- Detailed Damage Inspection Report (DDIR) – Form used by FHWA to estimate damages

GOVERNMENT OF PUERTO RICO
Puerto Rico Highway and Transportation Authority

EMERGENCY WORKS - HURRICANE IRMA/MARIA

Emergency Repair
PR-853 Km 7.7 Carolina

Contract No. 2018-0000-79 **AC- No:** AC-806536 **Oracle No.** L069999536
Task Work No. 15 **Contractor:** L.P.C. & D., Inc.

As part of this task order of the Contract, the Contractor shall perform the works mentioned as follows or indicated in the referenced document, according the Unit Prices for ER Projects included in Exhibit A of the Contract:

ITEM NO.	SPEC NO.	DESCRIPTION OF WORK	% FEDERAL PARTICIPATION	FINAL ESTIMATE			
				QTY	UNIT	UNIT PRICE	TOTAL COST
A. Emergency Repairs							
1	151	Mobilization		100	LS	$ 99.33	$ 9,933.00
2	202	Removal Structures and Obstructions		1	LS	$ 5,100.00	$ 5,100.00
3	203	Borrow Class B		35	CUM	$ 35.70	$ 1,249.50
4	203	Unclassified Excavation		50	CUM	$ 20.40	$ 1,020.00
5	206	Unclassified Excavation Structures		142	CuM	$ 40.80	$ 5,793.60
6	301	Subbase Coures		65	CuM	$ 35.70	$ 2,320.50
7	304	Aggregate Base Course		20	CuM	$ 56.15	$ 1,123.00
8	401	HPM Bituminous S(75)(12) - 0 to 99 Tons		20	Tons	$ 220.00	$ 4,400.00
9	401	HPM Bituminous B(75) - 0 to 99 Tons		40	Tons	$ 220.00	$ 8,800.00
10	606	Guardrail (Single Face)		30	LnM	$ 120.60	$ 3,618.00
11	609	Concrete Curb and Gutter Type F		30	LnM	$ 68.15	$ 2,044.50
12	614	Gabions		120	CuM	$ 419.60	$ 50,352.00
13	617	Concrete Paved Waterway		4	SqM	$ 68.15	$ 272.60
14	618	Thermoplastic Pavt Marking (All Colors)		60	LnM	$ 7.24	$ 434.40
15	638	Drums		25	Each	$ 103.50	$ 2,587.50
16	638	Construction Signs		20	SqM	$ 284.60	$ 5,692.00
17	638	Temporary Conc Barriers		25	LnM	$ 165.60	$ 4,140.00
18		Silt Fence		30	LnM	$ 8.00	$ 240.00
19		Straw Bales		12	Each	$ 12.00	$ 144.00
20							
		Emergency Repairs Sub-Total					$ 109,264.60
B. Permanent Restoration							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
		Permanent Restoration Sub-Total					$ -
		TOTAL AMOUNT					$ 109,264.60

Accepted by:
Contractor's Representative Signature

Tomás Montalvo Torres, Vicepresident, LPC&D, Inc.
Contractor's Name and Title (print)

March 3, 2018.
Signature Date

Notice to Proceed: III/5/18

Duration: 90 days

Recommended by:
Regional Director Signature

Regional Director's Name (Print)

Approved by:
PRHTA's Representative Signature

Eng. Eduardo F. Ruiz Vélez - Construction Area Director
PRHTA's Representative Name and Title (print)

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- Task Order

GOVERMENT OF PUERTO RICO
PUERTO RICO HIGHWAY AND TRANSPORTATION AUTHORITY
ESTIMATES AND BIDS OFFICE

Rev. Sep 27, 2018

FIXED UNIT PRICES FOR ER PROJECTS

Item No.	Spec No.	Description	Unit	Avg Price	Labor Level	Labor Adjusted Price
1	151	Mobilization	LS	10%	N/A	
2	201	Clearing and Grubbing	Cda	5,000.00	L	5,100.00
3	202	Removal Structures and Obstructions	LS	5,000.00	L	5,100.00
4	202	Debris Removal	CuM Truck Measure	50.00	H	52.45
5	203	Backfill Material	CuM Truck Measure	25.00	L	25.50
6	203	Borrow Class B	CuM Truck Measure	35.00	L	35.70
7	203	Borrow Class D	CuM Truck Measure	15.00	L	15.30
8	203	Unclassified Excavation	CuM Truck Measure	20.00	L	20.40
9	205	Trench Excavation	CuM Truck Measure	25.00	L	25.50
10	206	Unclassified Excavation Structures	CuM Truck Measure	40.00	L	40.80
11	209	Sheathing	CuM Truck Measure	55.00	L	56.15
12	301	Subbase Coures	CuM Truck Measure	35.00	L	35.70
13	304	Aggregate Base Course	CuM Truck Measure	55.00	L	56.15
	401	HPM Bituminous S(75)(12)				
14		0 to 99 Tons	Tons	220.00	N/A	220.00
15		100 to 399 Tons	Tons	175.00	N/A	175.00
16		400 and over	Tons	135.00	N/A	135.00
	401	HPM Bituminous B(75)				
17		0 to 99 Tons	Tons	220.00	N/A	220.00
18		100 to 399 Tons	Tons	175.00	N/A	175.00
19		400 and over	Tons	135.00	N/A	135.00
20	403	Cold Milling Bitum Conc Pavement	CuM	85.00	N/A	85.00
21	601	Class A Concrete	CuM	650.00	H	681.85
22	601	Rubble Concrete	CuM	525.00	H	550.70
23	602	Reinforcing Steel	Lbs	2.00	H	2.10
24	603	18"RC Pipe Class III	LnM	125.00	H	131.10
25	603	24" RC Pipe Class III	LnM	150.00	H	157.35
26	603	30" RC Pipe Class III	LnM	200.00	H	209.80
27	603	36" RC Pipe Class III	LnM	250.00	H	262.25
28	603	42" RC Pipe Class III	LnM	400.00	H	419.60
29	603	54" RC Pipe Class III	LnM	600.00	H	629.40
30	603	60" RC Pipe Class III	LnM	1,000.00	H	1,050.00
31	603	Prefab Box Sect 1.83x1.83 Mt	LnM	5,000.00	H	5,245.00
32	603	Prefab Box Sect 2.5x2.5 Mt	LnM	7,000.00	H	7,340.00

1 OF 4

- List of Fixed Unit Prices – FHWA

PRHTA Standard Drawings

PUERTO RICO HIGHWAY AND TRANSPORTATION AUTHORITY
Materials Testing Schedule (MTS)
July 2017

Material Specification/Property	Acceptance Sampling Frequency	Sampling Responsability[1]	Testing Responsability[1]	Sampling and Testing Procedures (AASHTO or ASTM)
603 – PIPE CULVERTS				
Reinforcing Concrete Pipes (603-RCP)				
Three Edge Bearing Loading	1 per Lot (Lot = 50) (See Note 15)	MTAO	MTAO	**Sampling:** D 3665 and R 60 (C 172) **Testing:** T 280 (M170)
610 – CONCRETE BARRIER				
Class A Concrete				
Temperature	1 Set daily/100 LnM or fraction.	CAP	CAP	**Sampling:** D 3665 and R 60 (C 172) **Testing:** T 309 (C 1064)
Slump	When strength specimen is taken or consistency is questionable.	CAP	CAP	**Sampling:** D 3665 and R 60 (C 172) **Testing:** T 119 (C 143)
Air Content	When strength specimen is taken or consistency is questionable see note.	CAP	CAP	**Sampling:** D 3665 and R 60 (C 172) **Testing:** T 152 (C 271) or T 196 (C 173)
Compressive Strength	1 set daily/100 LnM or fraction (6 cylinders per set).	CAP	MTAO	**Sampling:** D 3665, T 23 (C 31) **Testing:** T 22 (C 39)

[1] CAP- Construction Area Personnel, MTAO – Material Testing Advisory Office, CP-Contractor Personnel.

PRHTA Material Testing Schedule (MTA)

CONCRETE SPECIFICATIONS EMPLOYED

- Concrete Payment (From ***Item –3 of ARTICLE VIII "Concrete pay items on ER Projects "*** - Standard Operation Procedure Documentation for Monthly Progress Payment of Emergency Relief Projects (Irma/María Hurricanes) , 2018)
  - 100% - if at (7) days compression test ≥ 75% f'c
  - If if at (28) days compression test ≤ 75% f'c - deduction (Spec. 601 or 934 of the PRHTA Standard Specifications)
  - Resident Engineer/Inspector will provide a summary of test results (7 and 28 days) per task once they become available
- PRHTA's Material Testing Office (OPM) Labs
- PRHTA's Construction Director Directive #6 of 2019 – Contractor Quality Control Certification (CQCC)

CONTRACTOR'S QUALITY CONTROL CERTIFICATION

WE HEREBY CERTIFY that: _____

_____

_____

_____

Furnished by: _____

To be incorporated in the Project with: AC Number _____

Federal-Aid Number: _____ Oracle Number _____

In the quantity of: _____

Incorporated in: _____

Conforms to: _____

PRHTA Standard Specifications for Road and Bridge Construction

As contractor, we have established and maintained a quality control system (QCS) as required in the contract documents for the subject material. This QCS includes all personnel, equipment, supplies and facilities necessary to obtain samples, perform tests, evaluate test results and adequately control his work. All the testing equipment used as part of the quality control system is properly calibrated and will meet the specifications applicable for the specified test procedures. All workmanship used in the above-mentioned project/ material meet the contract requirements. Assures that the subject material and completed construction conform to Contract requirements. Has available all supporting documentation.

Signed by:

_____ _____

Contractor: Title

_____ Date: _____

Signature month/day/year

Sworn and signed before me by _____, _____occupatioin, of legal age, _____ (civil status) and resident of _____, Puerto Rico, whom I personally know or have identified by _____, in _____, Puerto Rico, this ____ day of _____, 20__.

NOTARY PUBLIC (signature)

Affidavit # _____

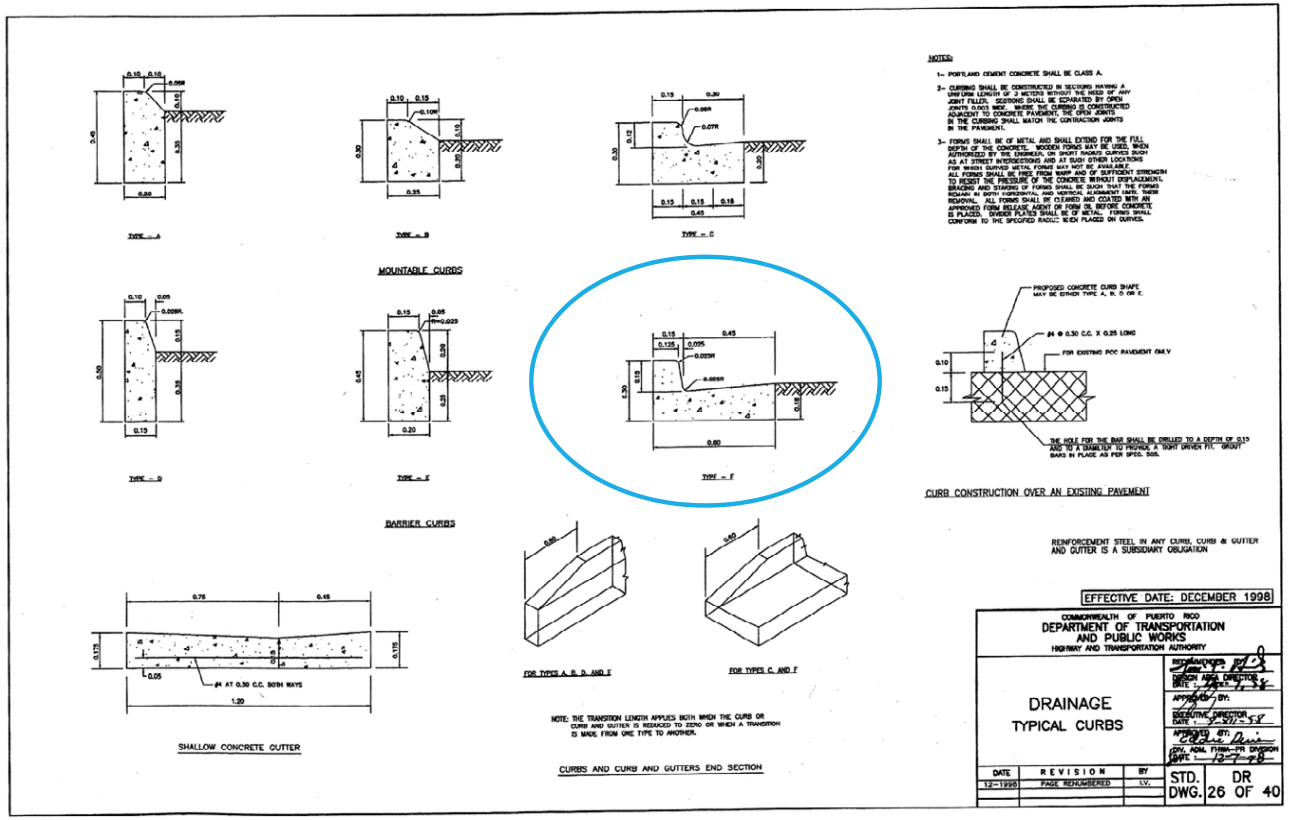
Notary Address and Phone Number:

- Contractor Quality Control Certification (CQCC)

CONCRETE SPECIFICATIONS EMPLOYED

- PRHTA Standard Specifications For Road And Bridge Construction – Spec. 601
  - Class A Concrete - 28 days f'c – 3000 psi – Slump 2-4 inches
    - Concrete Curbs and Gutters (All Types) – Spec. 609
      - Most used Type D & F
    - Shallow Concrete Gutter – Spec. 609
    - Concrete Paved Waterway – Spec. 617
  - Concrete Barriers – Spec. 610
    - Most used Type B & C
  - For any other structure as specified in the drawings (Emergency Drawings)
  - For any other structure - on site design

CONCRETE CURB AND GUTTER TYPE F



CONCRETE CURB AND GUTTER TYPE F

AC-827536 TO #15 PR-146 Km. 9.3 Construction of a Stone Filter and Road Embankment to repair a land slide with various underground springs at 20 ft depth

CONCRETE CURB AND GUTTER TYPE F

AC-827536 TO #15 PR-146 Km. 9.3 Construction of a Stone Filter and Road Embankment to repair a land slide with various underground springs at 20 ft depth

CLASS A CONCRETE - LABORATORY RESULTS

original

Puerto Rico Highway and Transportation Authority
Materials Testing Office

FINAL REPORT ON COMPRESSIVE STRENGTH OF CONCRETE

Lab Sample ID: 1-C001-11-075-1 **Field ID:** 0001-B

Report Printed: 02/27/2020
Report Date:

Project ID : L279999536-15 AC-827536 **Federal ID:** ER-9999(270)

Project Name : EMERGENCIA PR-146 KM 9.3 CIALES
Project Administrator: Ing. Darymar Hernández Ginés
Region : Norte
Contractor : SANTA & CO. CORP
Amount Represented By Sample: 4 Cu.M.
Supplier : BTA CONCRETE

Date Sampled: 01/14/2020
Date Received: 01/16/2020
Date Tested: 02/11/2020

Sample Taken At: Encintado Lt.
PRHTA Specification: 601-A **Class:** Structural Concrete, Class A
Governing AASHTO Specification: T-22(ASTM-C-39) & T119/C143 C-1231
Req. Strength :3,000

	CYL-1	CYL-2	CYL-3	CYL-4	CYL-5	CYL-6	AVG
Load (lb)	75,170	73,120	69,670				
Diameter (in)	4.00	4.00	3.99				4.00
Area (in^2)	12.57	12.57	12.50				12.57
Strength (psi)	5,980	5,820	5,570				5,790
Break Type	1/(a)	1/(a)	3/(e)				

Age 28 days
Slump 3.00 in

Sketches of Typical Fracture Patterns

Remarks:
Field:
Lab:

Acceptance Result: Set Met Requirements, Verify Moving Average

Sampled By: Julio E. Perez TTCP ID: 00081
Tested By: Eileen Tamara Baez TTCP ID: 00024
Laboratory Head: Miguel Ortiz Gonzalez

Autoridad de Carreteras y Transportación
OFICINA ASESORA
PRUEBAS DE MATERIALES
Revisado por: Fecha:
Director

Batch: 002365

Rev. Dec. 2011

5,790 psi

CLASS A CONCRETE - LABORATORY RESULTS

Class A - Concrete (3000 psi)			
TO	F'c (PSI)		Feature
	7 Days	28 Days	
8	**	5050	Concrete Curb & Gutter
	**	7730	Concrete Curb & Gutter
10	**	4950	Concrete Curb & Gutter
12	3740	**	Headwall
13	**	4850	Concrete Curb & Gutter
15	4550*	4550	Concrete Paved Water Way
	5260	5790	Concrete Curb & Gutter
	5060	5710	Concrete Curb & Gutter
	4240	4670	Concrete Curb & Gutter
17	3450	4220	Concrete Curb & Gutter
	**	3830	Concrete Curb & Gutter

*** 20 days Result**

**** Results Not Received From Lab**

CONCRETE SPECIFICATIONS EMPLOYED

- Class B Concrete - 28 days f'c – 2200 psi – Slump 1-4 inches
  - Concrete Barriers - Spec. 610
  - Sidewalks - Spec. 608
    - BR-1130AC-014515/Modular Bridge Installation Over Rio Grande de Manati, PR-145 Km. 0.1

- Class D Concrete - 28 days f'c – 5000 psi – Slump 1-3 inches
  - For structures specified in the drawings (Emergency Design)
  - BR-1130 Abutments – AC-014515/Modular Bridge Installation Over Rio Grande de Manati, PR-145 Km. 0.1

SIDEWALKS

AC-014515/ Modular Bridge Installation Over Rio Grande de Manati PR-145 Km. 0.1- Replacement of an existing two span concrete bridge (Bridge 1130 collapsed by hurricane Maria) with a single span temporary bridge (ACROW) of 250 ft long and protection of the new bridge embankment.

SIDEWALKS

AC-014515/ Modular Bridge Installation Over Rio Grande de Manati PR-145 Km. 0.1- Replacement of an existing two span concrete bridge (Bridge 1130 collapsed by hurricane Maria) with a single span temporary bridge (ACROW) of 250 ft long and protection of the new bridge embankment.

CLASS B CONCRETE - LABORATORY RESULTS

AC-014515 - Sidewalks		
Class B Concrete (2,200psi)		
	F'c (psi)	
	7 Days	28 Days
	5,100	6140
	4460	5310
	4680	5470

BR-1130 Abutments

AC-014515/ Modular Bridge Installation Over Rio Grande de Manati PR-145 Km. 0.1- Replacement of an existing two span concrete bridge (Bridge 1130 collapsed by hurricane Maria) with a single span temporary bridge (ACROW) of 250 ft long and protection of the new bridge embankment.

BR-1130 Abutments

AC-014515/ Modular Bridge Installation Over Rio Grande de Manati PR-145 Km. 0.1- Replacement of an existing two span concrete bridge (Bridge 1130 collapsed by hurricane Maria) with a single span temporary bridge (ACROW) of 250 ft long and protection of the new bridge embankment.

BR-1130 Abutments

AC-014515/ Modular Bridge Installation Over Rio Grande de Manati PR-145 Km. 0.1- Replacement of an existing two span concrete bridge (Bridge 1130 collapsed by hurricane Maria) with a single span temporary bridge (ACROW) of 250 ft long and protection of the new bridge embankment.

BR-1130 Abutments

AC-014515/ Modular Bridge Installation Over Rio Grande de Manati PR-145 Km. 0.1- Replacement of an existing two span concrete bridge (Bridge 1130 collapsed by hurricane Maria) with a single span temporary bridge (ACROW) of 250 ft long and protection of the new bridge embankment.

BR-1130 Abutments

AC-014515/ Modular Bridge Installation Over Rio Grande de Manati PR-145 Km. 0.1- Replacement of an existing two span concrete bridge (Bridge 1130 collapsed by hurricane Maria) with a single span temporary bridge (ACROW) of 250 ft long and protection of the new bridge embankment.

CLASS D CONCRETE - LABORATORY RESULTS

AC-014515 - Abutments		
Class D - Concrete (5000 psi)		
	F'c (PSI)	
	7 Days	28 Days
	4250	5530
	**	7520
	5740*	**
	6200	**
	5820	**
	4400	**
	6890	**
	7500	8680
	6950	8090
	**	8370
	6650	7710
	5540*	6580
	**	7010
	6370	7480

* Resultado de 8 dias

** Results Not Received From Lab

AC-014515/ MODULAR BRIDGE INSTALLATION OVER RIO GRANDE DE MANATI PR-145 KM. 0.1- BEFORE AND AFTER

- ACROW 700XS Panel Bridge 76.2 m (250 ft) x 2 Lanes 7.35 m x QDR4H (**Q**uadruple **D**oble **R**einforced **Four** **H**eavy) Bridge with Footwalk . HS-25-44 load.
- **Longest Available Single Span ACROW Panel Bridge in the USA**

CONCRETE SPECIFICATIONS EMPLOYED

- Lean Concrete Base - Spec. 305 - 28 days f'c – 1000 psi – Slump 1-3 inches
  - Used as roadway base in the TOs in substitution of the pavement box.
  - Example ***AC-827536 TO #15 PR-146 Km. 9.3 Ciales – (Limon-2Bocas)***
    - 2 underground springs at 20 ft depth
      - No Geotechnical Study
    - L Shape Stone Filter
    - New Storm Sewer System
      - 16ft depth Inlet
      - RCP
      - Headwall
    - Borrow Material Backfill

LEAN CONCRETE BASE

AC-827536 TO #15 PR-146 Km. 9.3 Ciales

LEAN CONCRETE BASE

AC-827536 TO #15 PR-146 Km. 9.3 Ciales

AC-827536 TO #15 PR-146 KM. BEFORE AND AFTER

Other Hurricane Maria Emergency Projects

Atkins/KCI JV & PRHTA

Significant Sites completed North Region

AC-014080/ Landslide Correction / PR-140 KM 29.9, Utuado - Construction of a Gravity Wall with Reinforced Soil Slope (RSS) to repair an over 30 m depth land slide with multiple underground springs and a creek.

AC-014080/ Landslide Correction / PR-140 KM 29.9, Utuado - Construction of a Gravity Wall with Reinforced Soil Slope (RSS) to repair an over 30 m depth land slide with multiple underground springs and a creek.

AC-014080/ Landslide Correction / PR-140 KM 29.9, Utuado - Construction of a Gravity Wall with Reinforced Soil Slope (RSS) to repair an over 30 m depth land slide with multiple underground springs and a creek.

Nov. 12, 2018
18.335889 N , -66.464184 W
PR-145 Km. 0.4
AC-014515

AC-014515

AC-827536 TO #8 - PR-146 Km. 10.6, Ciales

- Construction of an L Shape stone filter and road Embankment

AC-827536 TO #12 PR-149 Km. 14.6, Ciales

- 42 m long by 10 m deep Landslide correction
- Gabion wall
- Improvements to the drainage systems
  - Concrete Curb & Gutter
  - Drop Manhole
  - RCP
  - Headwall
- improvements to the safety

AC-827536 TO #17 PR-146 Km. 4.1, Ciales

- Repair of a land slide with Borrow Material & Grouted Rip-Rap

AC-824536 – Orocovis TO #18 (PR-157 km. 0.9), TO #23 (PR-157 km. 0.7) TO #24 (PR-157 km. km. 0.4)

- Three consecutive landslides
  - km. 0.4 - landslide correction - combination of stone embankment with a gabion wall.
  - km. 0.7 - landslide correction - construction of a 12 ft Cantilever Retaining Wall.
  - km. 0.9 - land slide correction - combination of a stone embankment encased with concrete and a small gabion wall

AC-824536 - TO #24 (PR-157 km. 0.4) Orocovis

Stone embankment with a gabion wall and grouted rip-rap

AC-824536 – TO #23 (PR-157 km. 0.7) Orocovis

- **12 ft Cantilever Retaining Wall**
- **Design by Atkins Structural Engineer**

AC-824536 – TO #18 (PR-157 km. 0.9) Orocovis

Stone embankment encased with concrete (grout) and a small gabion wall

AC-848536 - TO #5, PR-830 km. 1.6 Bayamón

- Landslide correction with the construction of a Concrete Gravity Retaining Wall

Significant Sites completed East Region

AC-811536 – TO #10, PR-919 km. 0.5 San Lorenzo

- Landslide correction with the construction of a Concrete Gravity Retaining Wall

Significant Sites completed Metro Region

AC-806536 TO #8 (PR-181 Km 59.6) and #10 (PR-181 Km 60.2), Trujillo Alto

- Km 59.6 - Small landslide - construction of a gabion wall and grouted riprap to mitigate slope erosion.
- Km 60.2 - Small landslide - construction of a gabion wall.

Significant Sites completed West Region

AC-802536 TO #10 (PR-110 14.9 –15.1), Moca

- Scenic route with major landslide and rock fall
  - Gabion wall
  - Type F Concrete Barrier with Expanded Metal Fence for rock fall mitigation
  - Type C concrete barrier to protect pedestrians that use the sidewalk leading to the "Merendero", an iconic place of the Municipality.

Significant Sites completed South Region

AC-015107 Modular Bridge #1962 Over Jacaguas River (PR-151 Km 0.17), Villalba

- Removal of a collapsed bridge
- Installation of a modular Acrow Bridge with a pedestrian sidewalk
- Construction of a retaining wall
- Installation of 24" PRASA water main pipe

AC-015107 Modular Bridge #1962 Over Jacaguas River (PR-151 Km 0.17), Villalba

AC-813536 TO #11 (PR-179 Km 13), Guayama

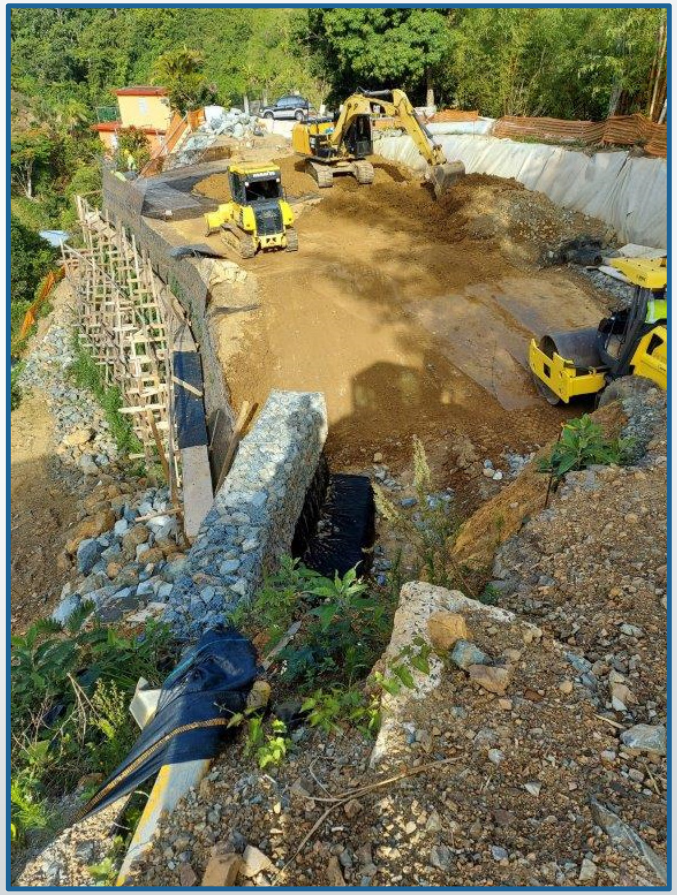
- Landslide correction using a Maccaferri's - Green Terra Mesh System.
- Designed by the PRHTA
  - FHWA Research Center – Consultant
  - Atkins/KCI – Geotechnical Consultant & Inspection
- First time this system is used for an ER project in PR.

AC-813536 TO #11 (PR-179 Km 13), Guayama

AC-012329 Various Landslide Corrections (PR123 Km's 30.8, 34.8, 37.4, 37.8, 42, 43, 44.1 and 44.3), Adjuntas

- 8 landslide corrections along PR-123
- Restoration included
  - Rubble concrete walls
  - Guard rail installation and other safety devices.
- **Km 30.8** is a mayor landslide
  - Macaferri's Green Terra Mesh system.
  - Under construction by July 30 2021

AC-012329 Landslide Correction PR123 Km 30.8, Adjuntas



CONCRETE ROLE ON THE RECONSTRUCTION OF THE TRANSPORTATION PROJECTS AFTER HURRICANE MARÍA

QUESTIONS?

THANKS, YOU ALL!

Presented by:
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