

SCENIC BRIDGE PRESERVATION

BIG SUR HWY 1 BRIDGES
2013



Bridge No. 44-0019

05-MON-001-59.4

Built 1932

Bixby Creek



Bridge No. 44-0036

05-MON-001-60.1

Built 1932

Rocky Creek



Bridge No. 44-0018

05-MON-001-63

Built 1931

Garrapata Creek



Bridge No. 44-0012
05-MON-001-64.33
Built 1932

Granite Canyon Bridge



Bridge No. 44-0017

05-MON-001-67.85

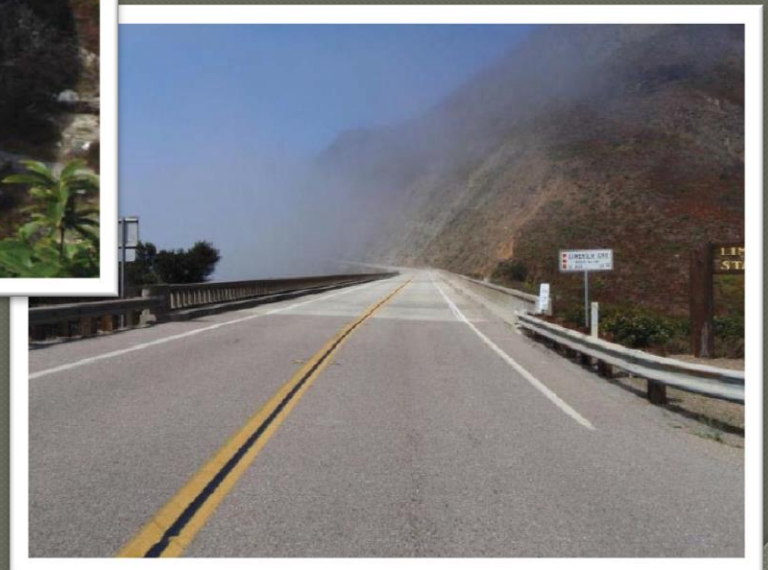
Built 1935

Malpaso Creek Bridge

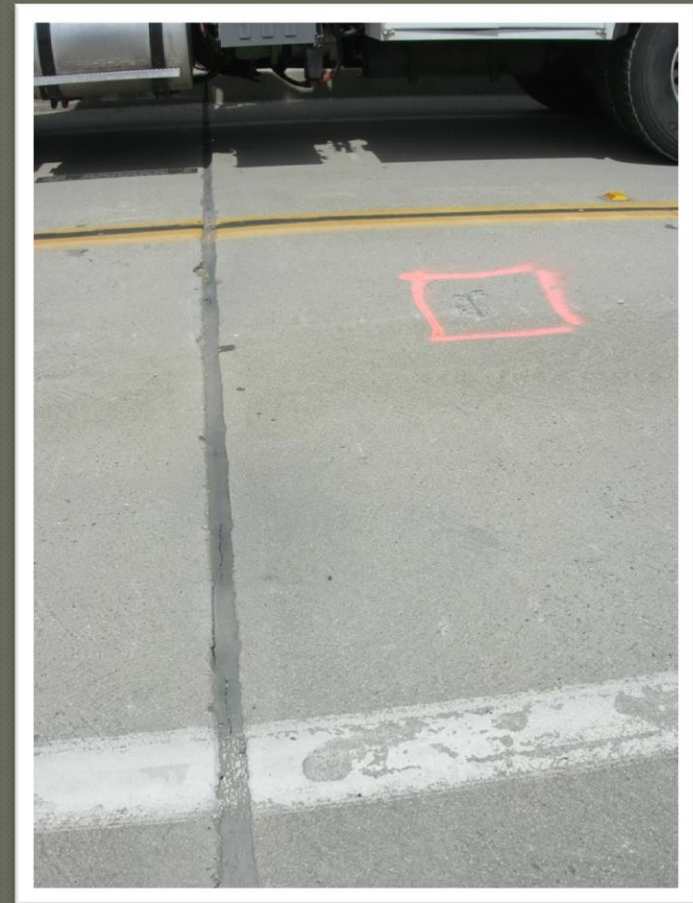
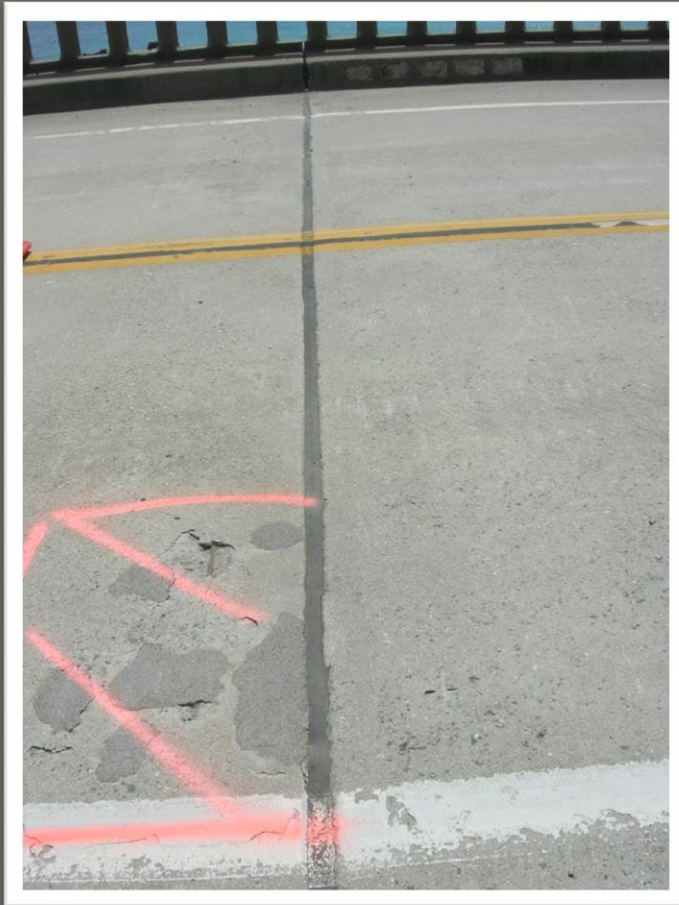


Bridge No. 44-0058
05-MON-001-20.95
Built 1957

Limekiln Creek



Limekiln Creek Deck



Limekiln Creek Restrainer Cable



Limekiln Creek Rocker Bearing



Limekiln Creek Girders



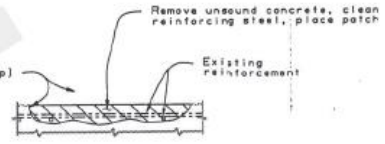
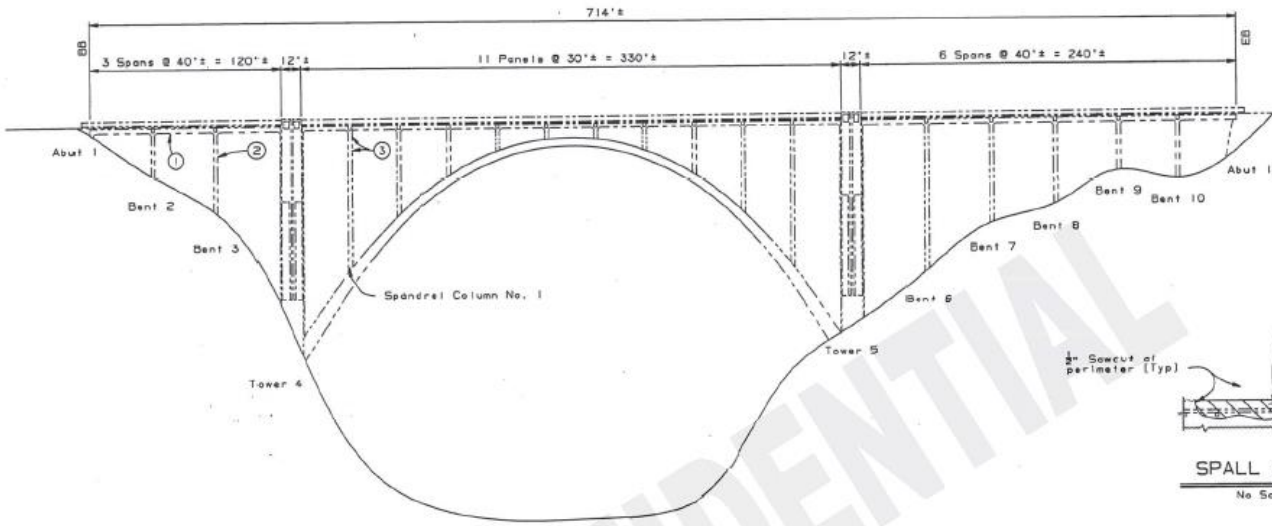
Bixby Creek General Plan

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DIST.	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	Men	1	\$9.9/59.6	21	21

Michael J. Leel
 REGISTERED ENGINEER - CIVIL
 CIVIL ENGINEER LICENSE NO. 42082
 EXPIRES 8-30-98
 STATE OF CALIFORNIA

6-26-98
 PLANS APPROVAL DATE
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NO AS BUILT CORRECTIONS
AS BUILT (KT)
 CORRECTIONS BY JIM O'HALLORAN
 CONTRACT NO. 03-308104
 DATE 1-21-97 (12-4-97)

AREA OF CONCRETE REPAIR

- Approximate Spalled Surface Areas
- ① Span 2: 12' along waffle of right girder 26 SF
 - ② Bent 3: top right side of column strut 2 SF
 - ③ Spandrel Column No. 1-Right: column face of top and just above strut 12 SF

Notes:
 - - - - - Indicates existing structure.

ELEVATION
1"=30'

PLAN
1"=30'

NOTE:
 THE CONTRACTOR SHALL VERIFY ALL CONTROLLING FIELD DIMENSIONS BEFORE ORDERING OR FABRICATING ANY MATERIAL.

DESIGNER <i>Michael J. Leel</i> DESIGN ENGINEER	DESIGN	Mike Hilling 9-94	DRAWING	Ju Kim 11-94	LAYOUT	Manuel Comacho 9-94	CHECKED	Ju Kim 11-94	STATE OF CALIFORNIA	DIVISION OF STRUCTURES	STRUCTURE MAINTENANCE	PROJECT NO.	64-0019	POST MILES	59.4	SPALL REPAIR
	DETAILS	Manuel Comacho 9-94	DRAWING	Ju Kim 11-94	SPECIFICATIONS	Germa Schickel	DATE	11-94	DEPARTMENT OF TRANSPORTATION	CU 05-220	E.A. 365101	SPALL REPAIR				BIXBY CREEK
	QUANTITIES	Mike Hilling 11-94	DRAWING	Ju Kim 11-94								GENERAL PLAN				

Bixby Creek 44-0019

Built 1932



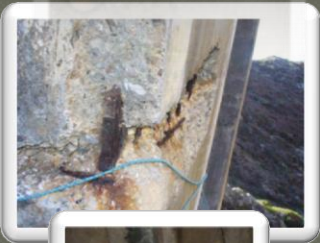
- Rail

- Severe cracking with unsound concrete and spalls with exposed rusted rebar.



- Deck

- Pattern cracks spaced less than 1' apart throughout.
- 1% of the deck area is spalled or unsound.
- Chloride concentration up to 5.5 LB/CY in 0 – 1" depth; up to 2.43 LB/CY in 1" – 2" depth.



- Superstructure/Substructure

- Numerous spalls and areas of unsound concrete due to rebar corrosion scattered throughout superstructure and substructure elements.

- Chloride concentration in the arch ribs:

❖ 0 – 1" depth	: 1.95 LB/CY to 3.77 LB/CY
❖ 1" – 2" depth	: 0.23 LB/CY to 5.2 LB/CY
❖ 2" – 3" depth	: 2.02 LB/CY to 3.59 LB/CY
❖ (Concrete cover is approximately 3")	



Bixby Creek Rail

14



Garrapata Creek Rail

15



Garrapata Creek Rail

16



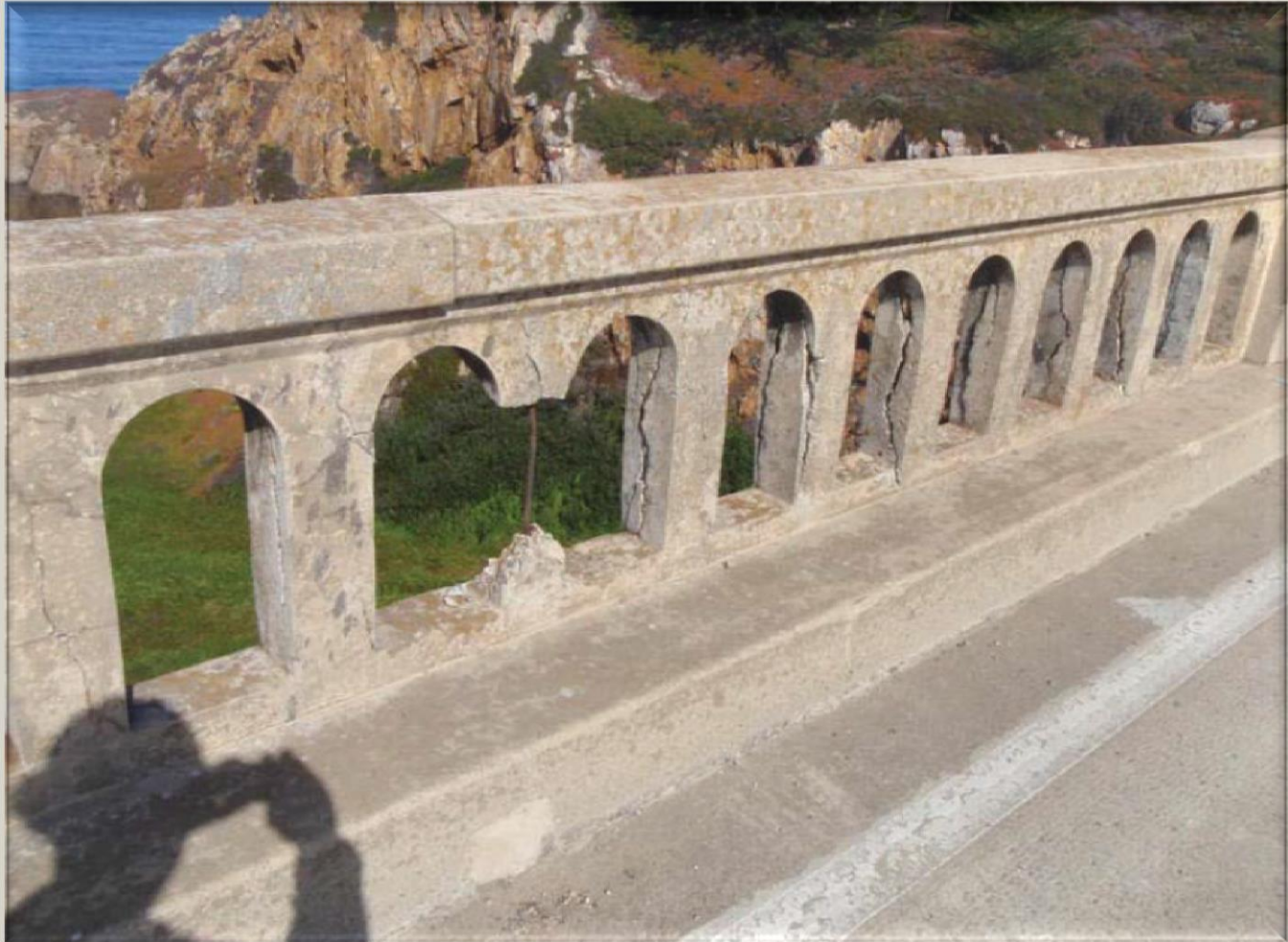
Garrapata Creek Rail

17



Garrapata Creek Rail

18



Rocky Creek Rail

19



Malpaso Creek Rail

20



Bixby Creek Deck

21



Granite Canyon Deck

22



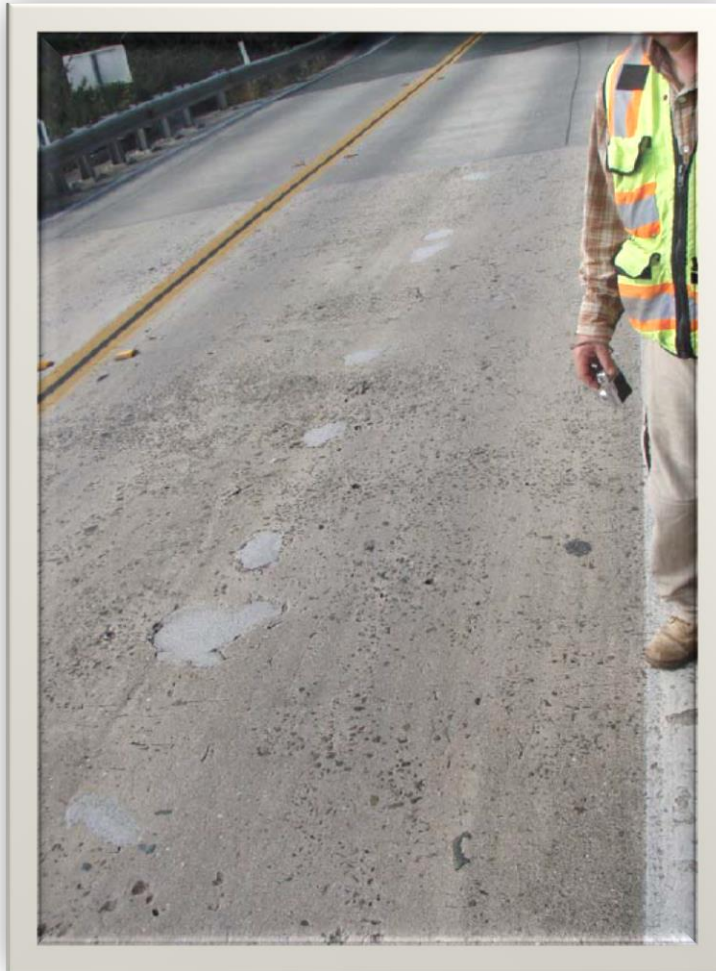
Granite Canyon Soffit

23



Malpaso Creek Deck

24



Bixby Creek Arch Ribs

25



Spall on right arch, south end



Bixby Creek Girders

26



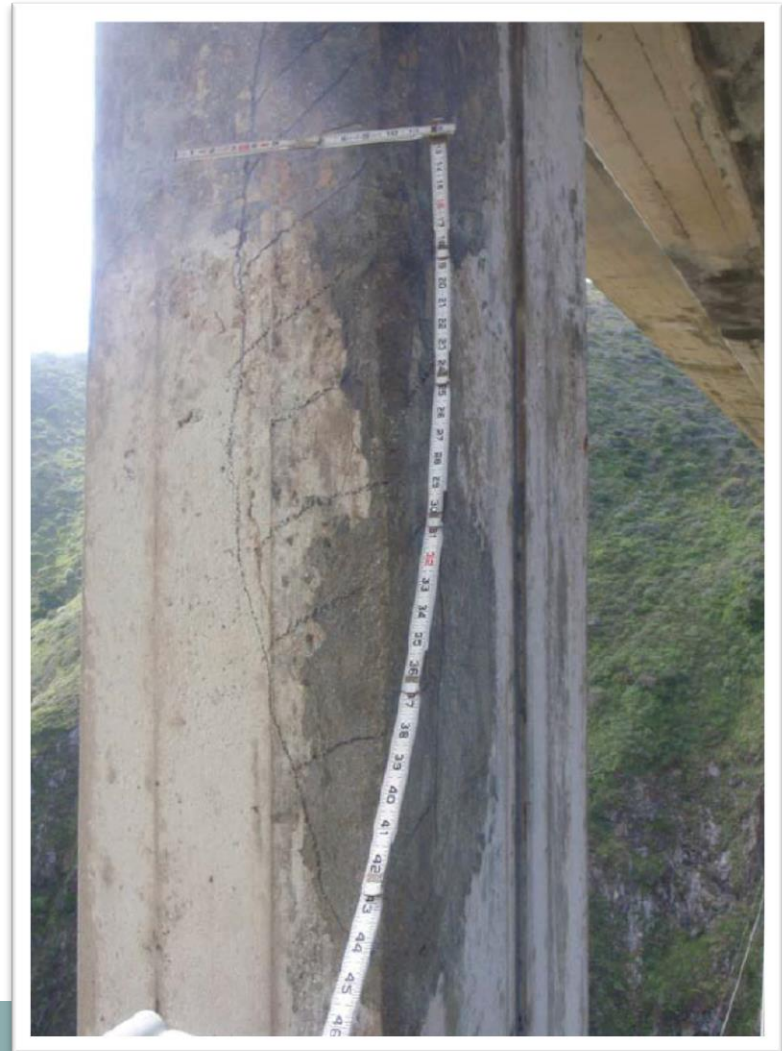
Bixby Creek Bent Caps

27



Bixby Creek Columns

28



Garrapata Creek Arch Ribs

29



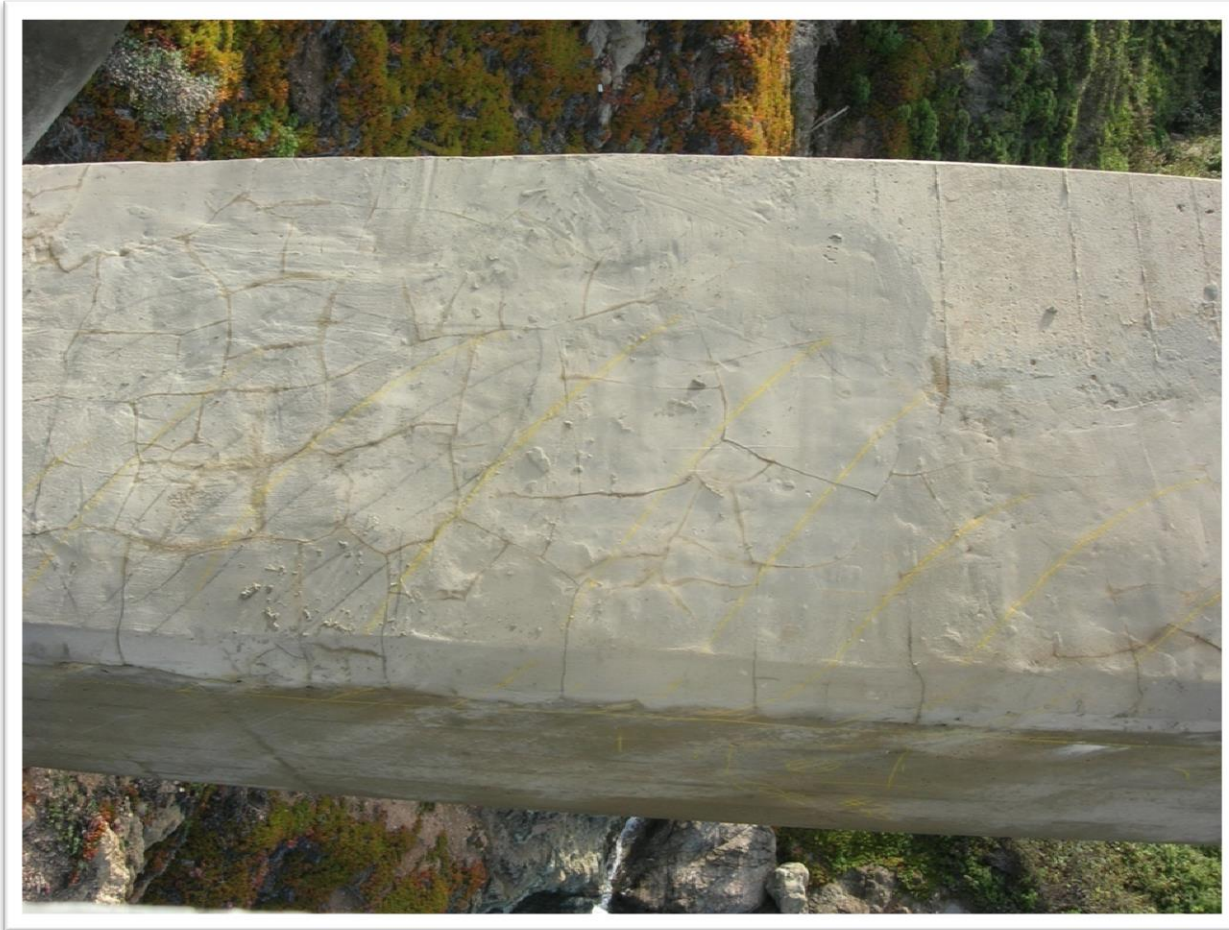
Garrapata Creek Columns

30



Granite Canyon Arch Ribs

31



Granite Canyon Arch Ribs

32



Granite Canyon Girders

33



Granite Canyon Columns

34



Granite Canyon Bent Caps

35



Malpaso Creek Arch Rib

36



Malpaso Creek Strut

37



Malpaso Creek Columns

38



Rocky Creek Arch

39



Rocky Creek Columns

40



Rocky Creek 44-0036

Built 1932

● Rail

- The concrete barrier rail posts are deteriorated along left and right barrier rail length. The deterioration includes large cracks, unsound concrete and spalls with exposed reinforcement.

● Deck

- Polyester concrete overlay in good condition.

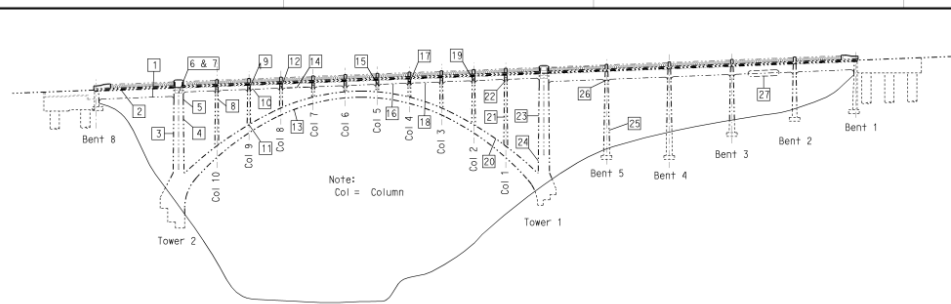
● Superstructure/Substructure

- There are numerous spalls and areas of unsound concrete scattered throughout the superstructure and substructure elements.
- Chloride concentration in the arch ribs:
 - ❖ 0 – 1" depth : 5.62 LB/CY
 - ❖ 1" – 2" depth : 6.82 LB/CY
 - ❖ 2" – 3" depth : 8.74 LB/CY
 - ❖ (Concrete cover is approximately 2.5")
 - ❖ 6,200 psi concrete strength

Rocky Creek Spall Locations

TRANSFER BUILT TO 30-2002 FIELD CORRECTION BUILT TO 30-2002
 CORRECTIONS TRANSFERRED BY: BG JIM WATTS
 CORRECTIONS TRANSFERRED BY: BG JIM WATTS

AS BUILT CORRECTIONS



ROCKY CREEK - LEFT SIDE ELEVATION SPALL MAP
NO SCALE

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	Mon	1	1.5/192.0	20	21
REGISTERED CIVIL ENGINEER			DATE	8-25-10	
11-29-10			PLANS APPROVAL DATE		
THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.					

NOTES: (APPLY TO THIS SHEET ONLY)

See "CONCRETE SPALL REPAIR DETAIL" on MISCELLANEOUS DETAILS sheet for spall repair details.



ROCKY CREEK - TYPICAL SECTION
NO SCALE

ROCKY CREEK SPALL REPAIR TABLE (LEFT SIDE OF BRIDGE)					
LOCATION	DESCRIPTION	APPROXIMATE LENGTH (feet)	APPROXIMATE WIDTH (feet)	APPROXIMATE DEPTH (inches)	APPROXIMATE VOLUME (cubic feet)
1	Bottom of girder	4.0	3.00	1.0	1.00
2	Decorative haunch	2.0	3.00	2.0	1.00
3	Tower 2, left leg, backside face closest to abutment	2.0	2.00	2.0	0.67
4	Tower 2, inside corner	6.0	2.00	2.0	2.00
5	Tower 2, left leg, front face	3.0	1.50	2.0	0.75
6	Tower 2, left deck overhang	1.5	1.50	2.0	0.38
7	Tower 2, deck overhang	0.8	7.50	2.0	0.94
8	Column 10, outside face (ocean side)	1.0	1.00	1.0	0.08
9	Left exterior girder, inner face	6.0	0.33	3.0	0.50
10	Near Column 9, underside of girder	4.0	1.00	2.0	0.67
11	Column 9, backside, corner	6.0	0.33	4.0	0.66
12	Column 8, top, (prior repair)	4.0	1.00	2.0	0.67
13	Arch haunch	1.0	0.50	6.0	0.25
14	Mid-span, left exterior girder corner	10.0	2.00	0.3	0.42
15	Mid-span, left exterior girder, top of haunch, corner	2.0	0.17	2.0	0.06
16	Between Columns 4 & 5, corner	5.0	0.50	2.0	0.42
17	Between Columns 3 & 4, left exterior girder, corner	2.0	2.00	3.0	1.00
18	Between Columns 3 & 4, left exterior girder, corner	3.0	1.00	2.0	0.50
19	Adjacent to Columns 2, bottom of exterior girder, bottom face	2.0	2.00	2.0	0.67
20	Between Columns 1 & 2, adjacent to Column 1, top of arch rib	2.0	2.00	2.0	0.67
21	Column 1, link beam haunch, bottom face	3.0	1.00	2.0	0.50
22	Column 1, left exterior girder, bottom face	2.0	2.00	2.0	0.67
23	Tower 1, 40' above the top of the arch, creek side face	3.0	1.00	1.0	0.25
24	Tower 1, inside face (3 at this location)	8.0	1.00	2.0	1.33
25	Bent 5, top of link beam corner	1.0	0.50	6.0	0.25
26	Bent 5, top of column girder intersection, corner (3 at this location)	4.0	0.33	4.0	0.44
27	Span 2, left exterior girder corner (3 at this location)	22.0	1.00	6.0	11.00

Total Volume = 83.38
See attached Quantity Sheet/CC004

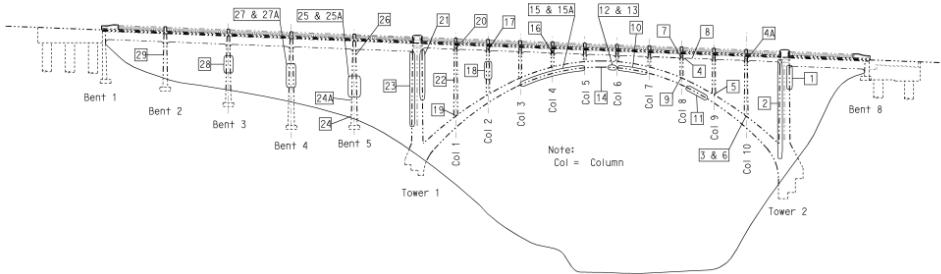
DESIGN	** Tim Powell	CHECKED	H. Dang	STATE OF CALIFORNIA	DIVISION OF MAINTENANCE	PROJECT NO.	ROUTE 1 BRIDGES
DETAILS	G.F. Bladwell	CHECKED	H. Dang	DEPARTMENT OF TRANSPORTATION	STRUCTURE MAINTENANCE DESIGN	PROJECT MILE	ROCKY CREEK SPALL LOCATION TABLE NO. 2
QUANTITIES	** Tim Powell	CHECKED	H. Dang			VARIES	
ORIGINAL SCALE IN INCHES FOR REPRODUCED PLANS				CU 05	EA 058801	DATE PLOTTED: 07-29-2010 11:05:33 AM	
STRUCTURES MAINTENANCE GENERAL PLAN & DETAIL SHEET (ENGLISH) (REV. 10/17/2011)						DATE PLOTTED	13 14

Rocky Creek Spall Locations

CONTRACT NO. 05-0304
 DRAWING DATE: 05-24-04
 FIELD CORRECTION DATE: 05-25-04

PREPARED BY: M. W. WINTER
 FIELD CORRECTIONS BY:

AS BUILT CORRECTIONS



ROCKY CREEK - RIGHT SIDE ELEVATION SPALL MAP
NO SCALE

ROCKY CREEK SPALL REPAIR TABLE (RIGHT SIDE OF BRIDGE)					
LOCATION	DESCRIPTION	APPROXIMATE LENGTH (feet)	APPROXIMATE WIDTH (feet)	APPROXIMATE DEPTH (inches)	APPROXIMATE VOLUME (cubic feet)
1	Tower 2, top of tower down, interior corner	15.0	0.25	3.0	0.9
2	Tower 2, top of tower down, creek side, interior corner	100.0	0.25	3.0	6.3
3	Column 10, near top of arch corner	4.0	0.33	4.0	0.4
4	Column 8, underside of girder face	4.0	0.33	4.0	0.4
4A	Column 10, underside of girder face	4.0	0.33	3.0	0.3
5	Column 9, corner	10.0	0.25	3.0	0.6
6	Column 10, corner	25.0	0.33	4.0	2.8
7	Column 6, underside of girder face	2.0	2.00	3.0	1.0
8	Between Columns 8 & 9, girder corner	3.0	0.25	3.0	0.2
9	Column 8, near top of arch rib, corner	2.0	0.25	3.0	0.1
10	Between Columns 6 & 7, underside of arch rib face	5.0	5.00	3.0	6.3
11	Between Columns 8 & 9, underside of arch rib face	3.0	5.00	3.0	6.3
12	Between Columns 5 & 6, near Column 6, underside of arch rib face	2.0	2.00	3.0	1.0
13	Column 6, underside of arch rib face	3.0	3.00	3.0	2.3
14	Between Columns 5 & 6, underside of arch rib corner	10.0	0.50	3.0	1.3
15	Column 5, underside of arch rib face	10.0	3.00	3.0	7.5
15A	Column 3 to Column 5, entire underside of arch rib face	45.0	3.00	3.0	33.8
16	Column 4, top of column, on both sides of girder [2' x 2' x 2'-sides]	4.0	2.00	2.0	1.3
17	Column 2, top of column, on both sides of girder [2' x 2' x 2'-sides]	4.0	2.00	2.0	1.3
18	Column 2, creek side corner	15.0	1.00	3.0	3.8
19	Column 1, top of arch corner	2.0	0.25	3.0	0.1
20	Column 1, top of column, on both sides of girder [2' x 2' x 2'-sides]	4.0	2.00	2.0	1.3
21	Tower 1 corner, (cumulative visual estimate)	10.0	0.33	4.0	1.1
22	Column 1, mountain side below link beam, corner	3.0	1.00	3.0	0.8
23	Tower 1, mountain side corner	40.0	0.50	6.0	10.0
24	Bent 5, lower link beam corner (creek side = 3', mountain side = 2')	5.0	0.50	3.0	0.6
24A	Bent 5, 10' above link beam corner	1.5	0.50	3.0	0.2
25	Bent 5, at upper link beam corner	3.0	1.00	3.0	0.8
25A	Bent 5, upper link beam haunch, corner	2.0	1.0	3.0	0.5
26	Bent 5, link beam haunch corner	5.0	0.5	3.0	0.6
27	Bent 4, mountain side of link beam corner	5.0	1.0	3.0	1.3
27A	Bent 4, mountain side of link beam corner	2.0	1.0	3.0	0.5
28	Bent 3, at link beam corner	3.0	0.5	6.0	0.8
29	Bent 2, at link beam, 10' from ground, corner	10.0	1.0	3.0	2.5

Total Volume = 98.7 + 59.96 + 95.42 (CC044)
See attached Quantity Sheet/CC044

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	Mon	1	1.5/192.0	19	21

REGISTERED CIVIL ENGINEER DATE: 8-25-10
 11-29-10
 PLANS APPROVAL DATE: 12-31-10
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NOTES: (APPLY TO THIS SHEET ONLY)
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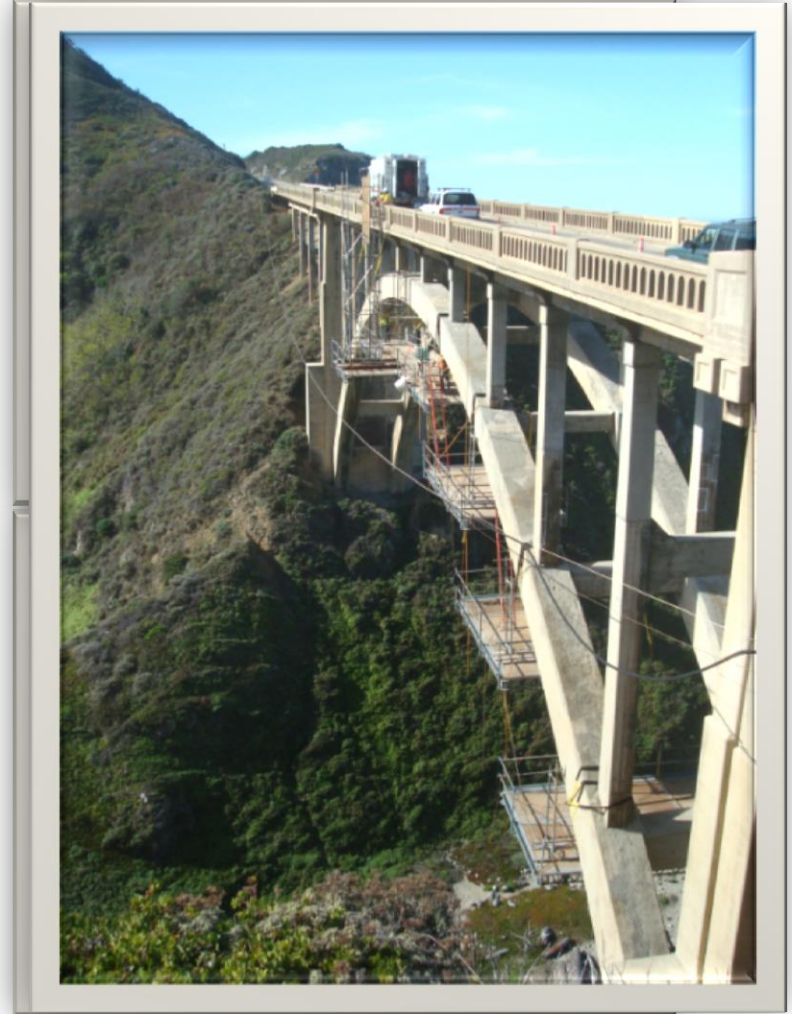
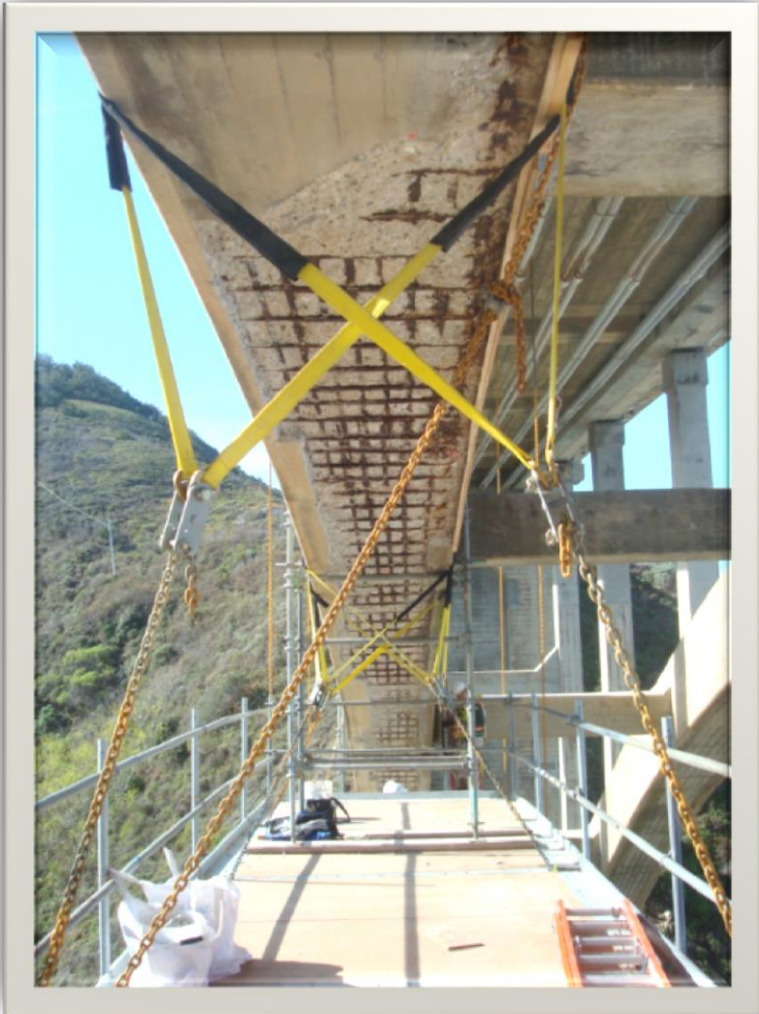


ROCKY CREEK - TYPICAL SECTION
NO SCALE

DESIGN	BY Tim Powell	CHECKED H. Dang	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF MAINTENANCE STRUCTURE MAINTENANCE DESIGN	ROUTE NO. VARIOUS	ROUTE 1 BRIDGES
DETAILS	BY G.F. Bidwell	CHECKED H. Dang	CU OS EA 059801	DATE 05/24/04	POST MILES VARIES	ROCKY CREEK SPALL LOCATION TABLE NO. 1
QUANTITIES	BY Tim Powell	CHECKED H. Dang	ORIGINAL SCALE IN INCHES FOR REDUCED PLANS	DATE 05/24/04	DATE 05/24/04	12 14

Rocky Creek Bridge

44



Lessons Learned

Rocky Creek Bridge Repair

- Unsound concrete removed was twice the original assessment.
- Sounding did not locate all the unsound areas.
- Have flexible funding to allow for changes in scope of work.
- There is a prevailing need to apply corrosion mitigation measures to all Big Sur spandrel arch bridges.

Corrosion Mitigation Alternatives

46

- **1. GALVANIC ANODES**
- **2. FLAME SPRAYED ZINC**
- **3. NORCURE CHLORIDE EXTRACTION**

Corrosion Mitigation Alternatives

47

- **1. GALVANIC ANODES**

- ❖ Numerous cored holes over the entire bridge.
- ❖ Patched holes would mar the appearance.
- ❖ Galvanic anodes have a limited life.
- ❖ Highest cost of the three alternatives.
- ❖ Alternative not selected.

Corrosion Mitigation Alternatives

48

- **2. FLAME SPRAYED ZINC**
 - ❖ Alters the appearance of the bridge.
 - ❖ Alternative not selected.

Corrosion Mitigation Alternatives

49

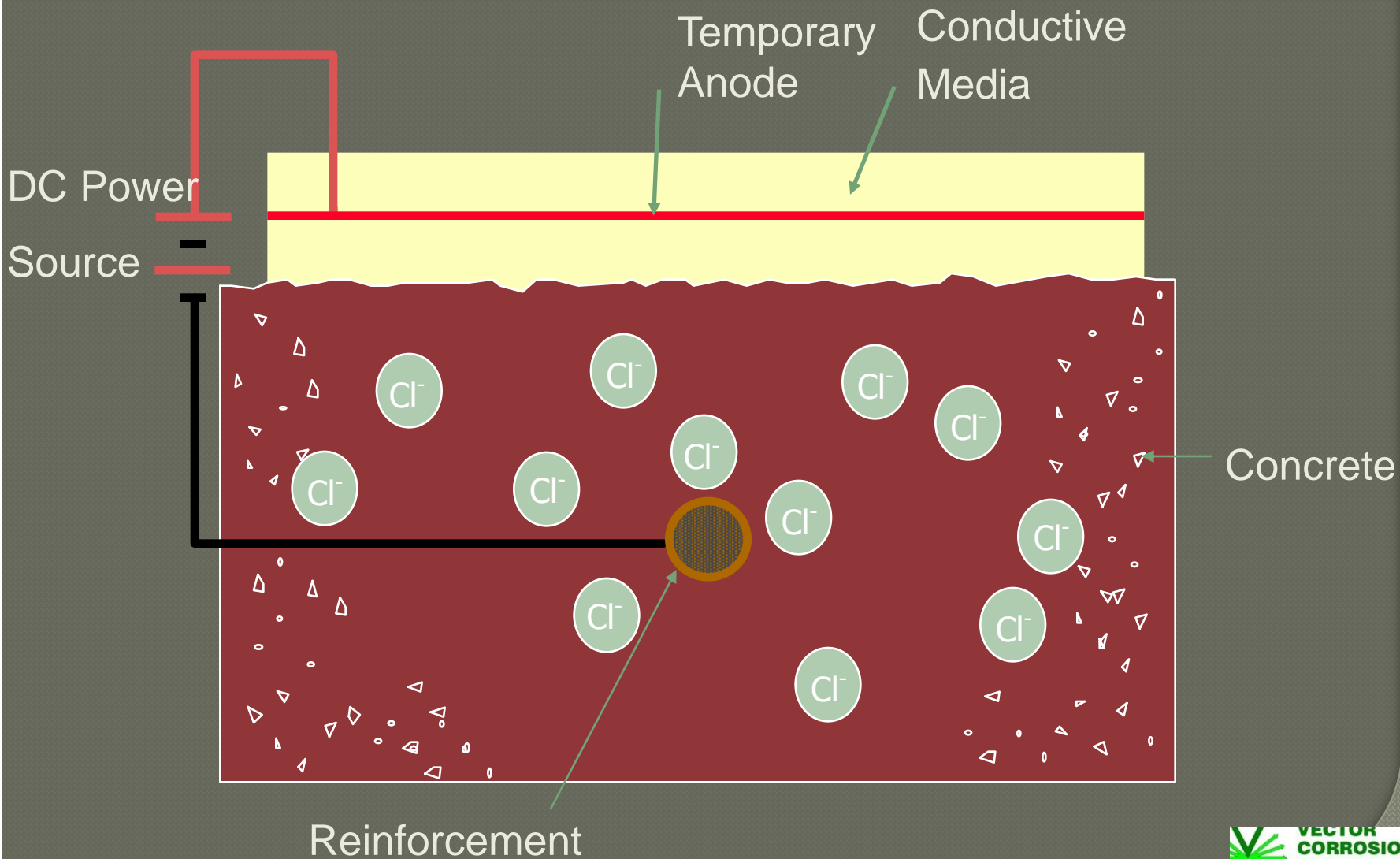
- **3. NORCURE CHLORIDE EXTRACTION**
 - ❖ Addresses the cause of the corrosion.
 - ❖ Chloride levels are significantly reduced.
 - ❖ Alkalinity is increased around the reinforcement.
 - ❖ Reinforcing steel is returned to a passive state.
 - ❖ Approx. cost \$38/sqft, excluding concrete repair and containment.
 - ❖ Alternative selected.

Concrete Repair Strategy

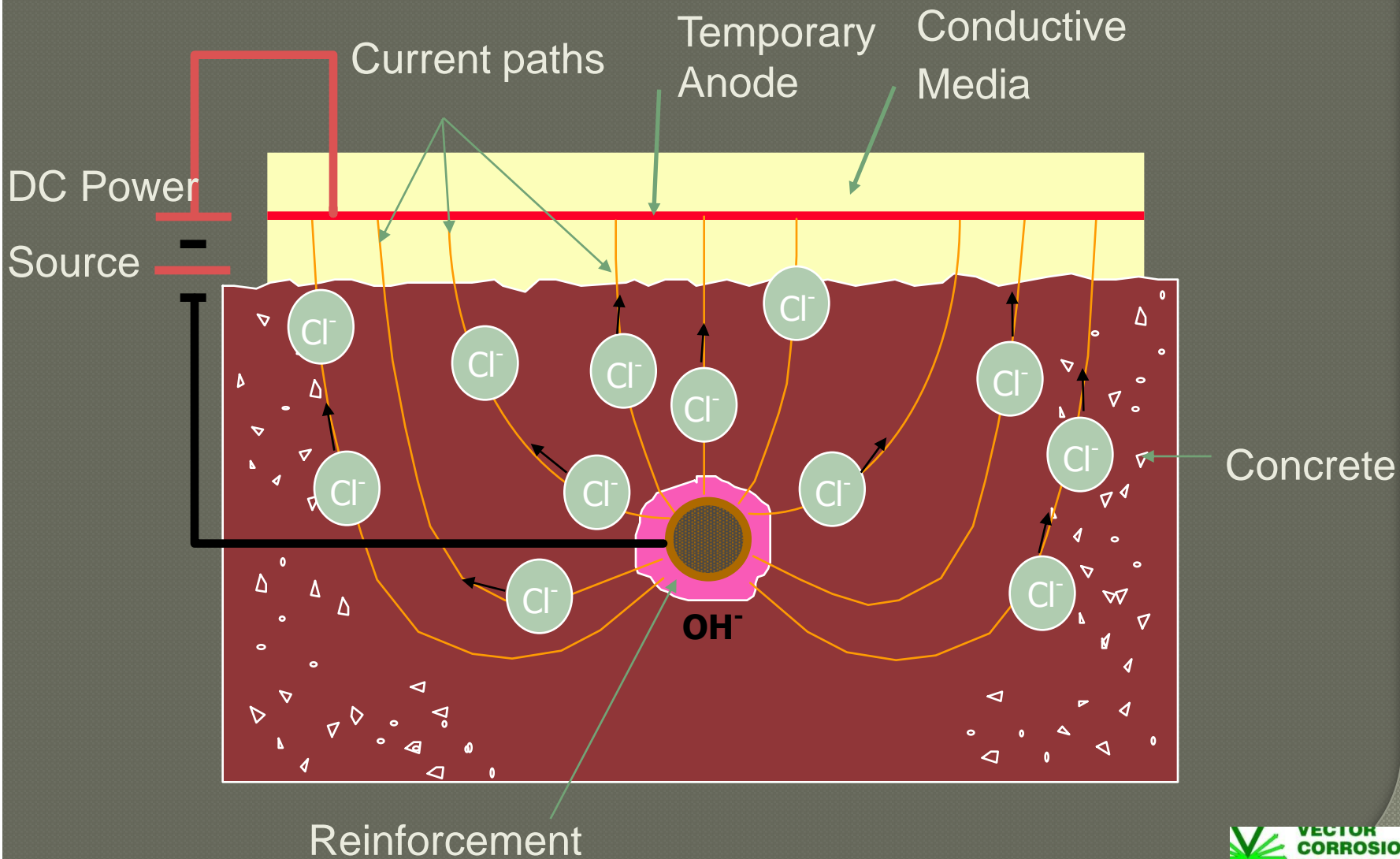
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- Large Areas
 - ❖ Shotcrete or cast-in-place with portland cement concrete.
 - ❖ Add synthetic microfibers to mix.
 - ❖ 7 day water cure.
- Small Areas
 - ❖ High quality patch material formulated for overhead applications.
 - ❖ Compatible with galvanic anodes.
- Install galvanic anodes at all repaired areas.

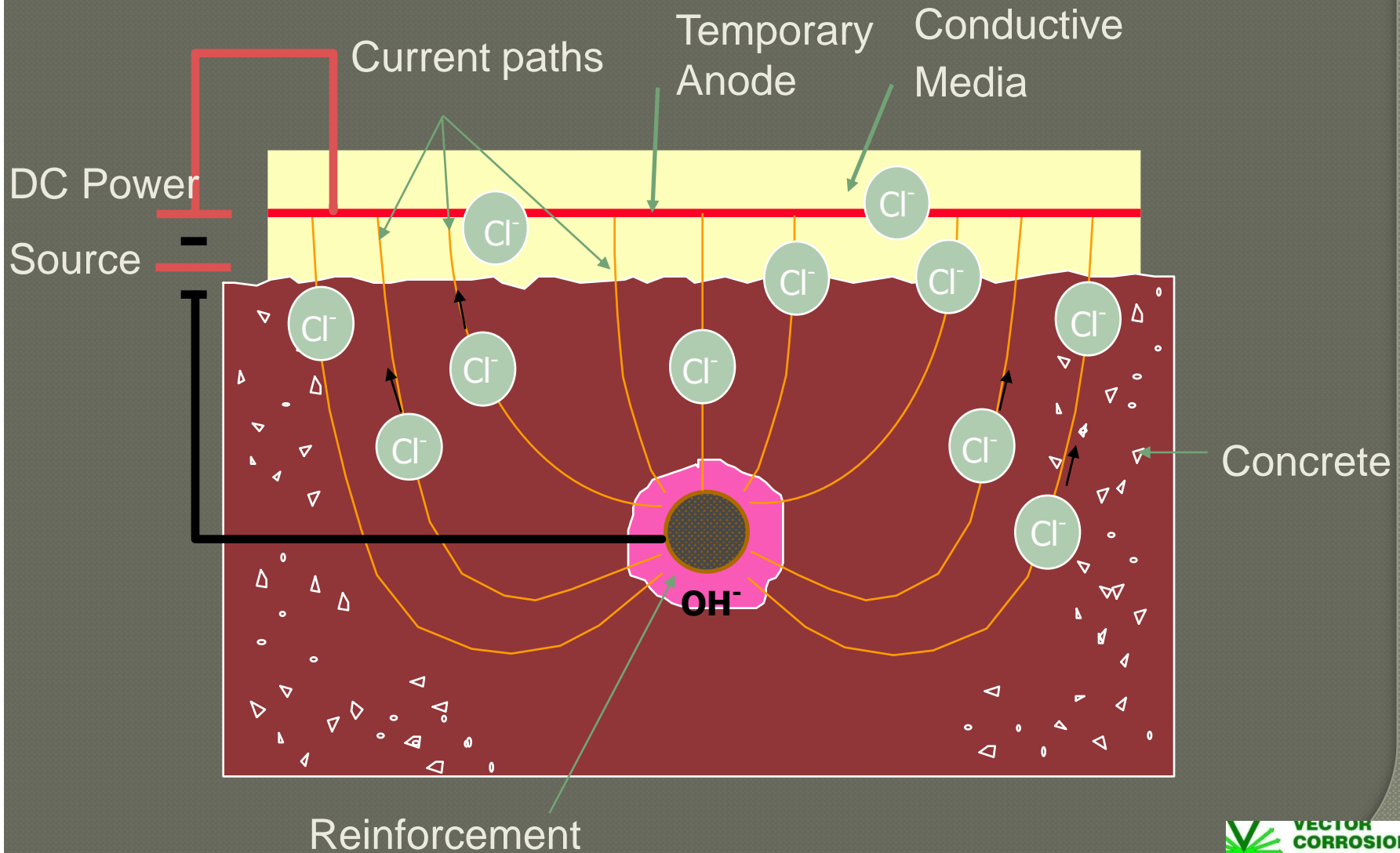
Electrochemical Chloride Extraction (ECE) From Salt Contaminated Concrete



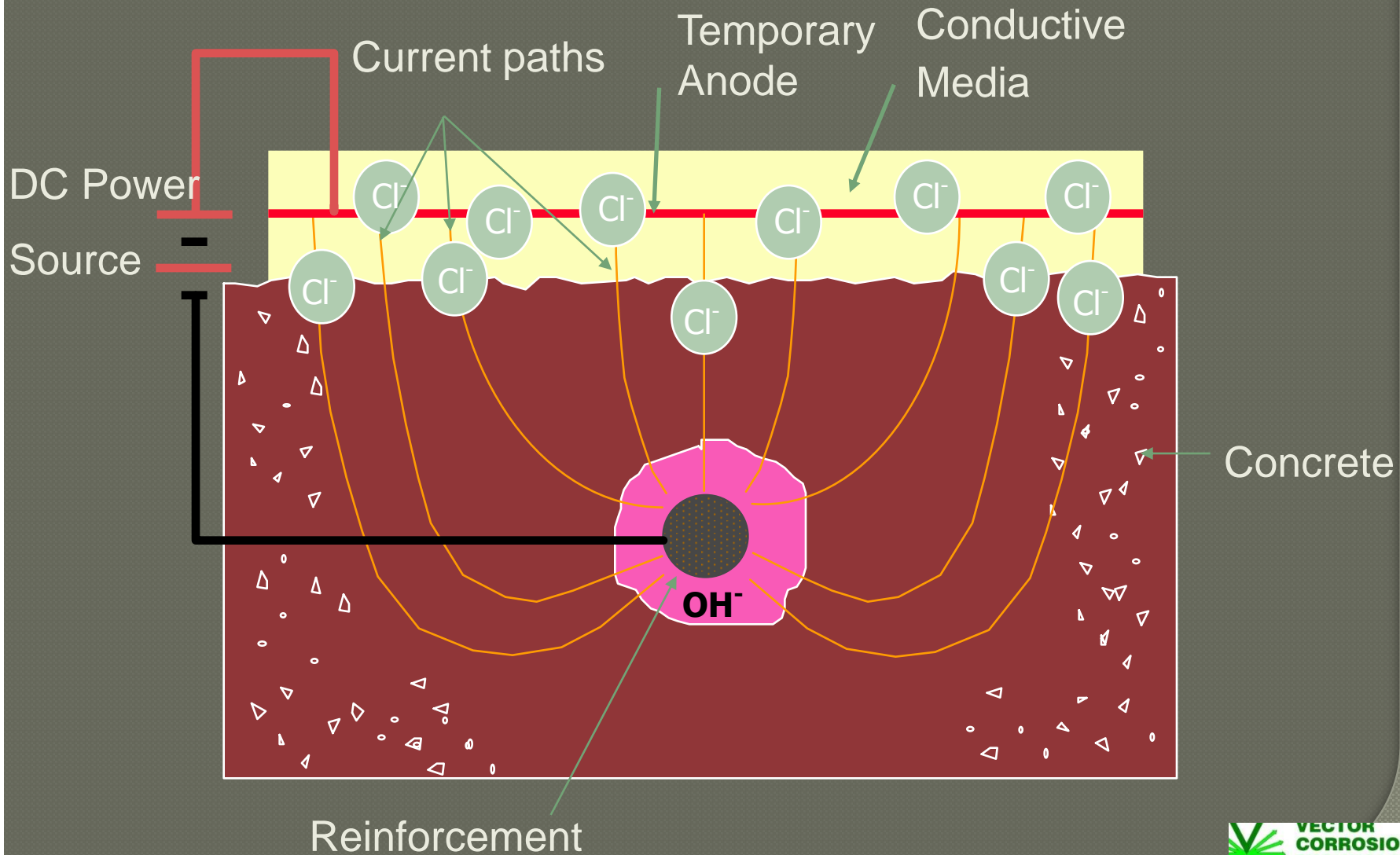
Electrochemical Chloride Extraction (ECE) From Salt Contaminated Concrete



Electrochemical Chloride Extraction (ECE) From Salt Contaminated Concrete



Electrochemical Chloride Extraction (ECE) From Salt Contaminated Concrete



Norcure[®] ECE Treatment Process I-480 Substructure Omaha, NE











Cellulose Fiber Serves as Electrolyte



**Installation Complete
Ready to Start Treatment**



**Piers after ECE Treatment
Cleaned and Sealed**

Rainbow Bridge- Idaho

(chloride extraction performed on arch ribs)



Rainbow Bridge- Idaho

(chloride extraction performed on arch ribs)



Rainbow Bridge- Idaho

(chloride extraction performed on arch ribs)



Caltrans Action Plan

- Perform chloride extraction at Malpaso Creek Bridge as a trial.
- Easiest access. Lowest risk of construction and environmental problems.
- Apply lessons learned from Malpaso project to the remaining Big Sur spandrel arch bridges.

Performance Measures

- Perform half-cell survey before and after treatment to measure reinforcement corrosion potential
- Take concrete cores to measure before and after chloride levels.

Concerns

- Access

- ❖ Steep gorge with no access from the ground.

- Containment

- ❖ Full containment required. No electrolyte or construction debris can fall into the gorge.

- Structure Capacity

- ❖ Weight of scaffolding and chloride extraction system may require staging.
- ❖ Highway 1 must be kept open to sightseeing busses.

Questions?