

PATTULLO BRIDGE

Concrete Deck Rehabilitation & Service Life Extension



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HISTORY

- Originally opened in 1937;
- First toll bridge in British Columbia.

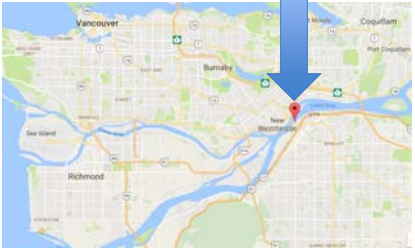



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LOCATION

- Four lane arterial connection between Surrey and New Westminister, BC;
- First major river crossing for vehicles to connect Metro Vancouver to Fraser Valley;
- Originally built by the Province of British Columbia as part of Highway 1A;



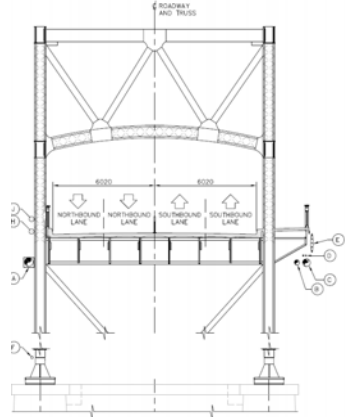



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CONFIGURATION

- Four narrow lanes (3.0 m each);
- Limited by width of truss opening (12.04 m);
- Centre two lanes closed each night from 10pm to 5am; (provides additional separation for impaired drivers).





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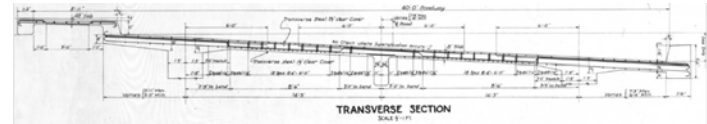
CONFIGURATION

- North and South approach spans supported by concrete-encapsulated steel trusses;
- Main river crossing spans supported by structural steel spans;
- Camel back truss spans navigable channel;
- Spans supported by steel trusses are FAR more dynamic than approach spans.



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REINFORCED CONCRETE BRIDGE DECK



- Nominally 200 mm thick;
- 50 mm asphalt pavement overlay;
- Waterproofing membrane was originally installed;
- Removed in 1982 and asbestos-modified asphalt overlay placed;



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REINFORCED CONCRETE BRIDGE DECK

- Issues related to concrete deterioration were known to BC MoTI in 1982;
- Deferred rehabilitation until 1985 until construction of a new 6-lane crossing was completed downstream;
- With new crossing came population explosion south of the Fraser River;
- Unable to undertake rehabilitation due to perceived major impact on traffic flow;
- Average traffic volume is 70,000 vehicles per day.

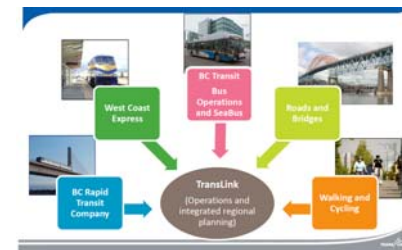


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PROVINCE OF BC CREATES



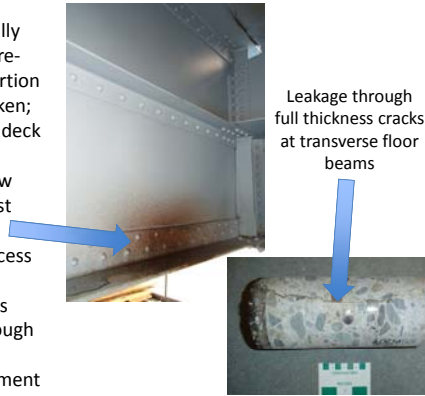
- Bridge operations limped along through 1980s and 1990s as concrete deterioration worsened with time;
- South Coast Regional transportation Authority (TransLink) created by Province of BC in 1998.
- In 1999, Province of BC “gifts” three bridges to TransLink;
- Downloaded responsibility for operation and maintenance onto the regional transportation authority.



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TransLink FIRST NOTICES DECK CONDITION IS POOR

- Extent of deterioration not fully understood until 2003 when re-coating of the below-deck portion of steel truss span is undertaken;
- Scaffolding installed beneath deck for re-painting work;
- Confused as to why brand new blue paint is being stained rust brown;
- Scaffold provides close-up access to deck soffit for first time;
- Identified full-thickness cracks and major water leakage through deck;
- First limited condition assessment undertaken at soffit;



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TransLink FIRST NOTICES DECK CONDITION IS POOR

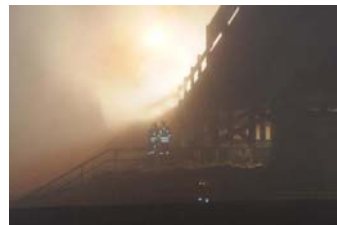
- Widespread condition assessment undertaken in 2006;
- Bridge closed for a weekend;
- Top surface of deck exposed by milling of asphalt overlay to expose reinforced concrete bridge deck at select locations;
- Condition Assessment included:
 - Delamination survey;
 - Cover depth measurement;
 - Half-cell corrosion potentials;
 - Chloride profiles;
 - pH profiles;
 - Corrosion rate measurements;
- Condition of superstructure and substructure elements also reviewed;



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TransLink STARTS TO REALIZE HOW BAD IT IS...

- In 2009, a fire started by homeless people destroyed the timber superstructure supporting the final span of the South Approach;
- Extended deck closure while repairs are undertaken;
- Access provided to remaining area of deck;
- All asphalt pavement overlay removed and replaced;
- Deck condition assessed in detail;
- **RESULTS ARE HORRIFYING**



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TransLink STARTS TO REALIZE HOW BAD IT IS...

- Signage installed beneath bridge deck to warn of risk of falling concrete.
- Nets are installed to catch falling concrete at areas of bridge spanning:
 - Roads;
 - Railroad tracks; and
 - Navigable river channel.



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EXTENT OF DETERIORATION IMPACTS RIDEABILITY

- Widespread spalling of concrete deck caused by chloride-induced corrosion begins to disrupt asphalt pavement overlay;
- Major potholes frequently result;
- Periodic weekend closures implemented to target problem areas;
- Select areas exposed by milling;
- Spalls removed by chipping;



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EXTENT OF DETERIORATION IMPACTS RIDEABILITY

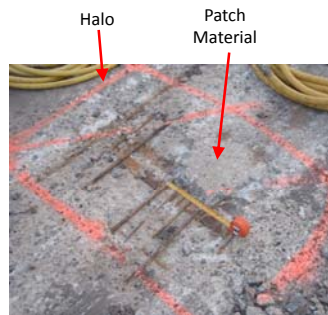
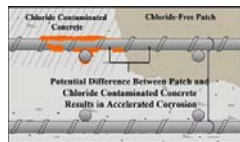
- Weekend closures undertaken two to three times annually from 2009 to 2015;
- Not enough time for proper repairs, cleaning rebar, substrate preparation, patching, etc.;
- Only had sufficient time to patch spalls and re-pave in order to minimize traffic disruption;
- No time allowed for efforts to arrest or mitigate corrosion.



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EXTENT OF DETERIORATION IMPACTS RIDEABILITY

- Periodic repairs actually made things worse due to the ring-anode effect and forced anodic corrosion into concrete surrounding patch repairs;
- Deterioration accelerated and worsened with time.



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MULTIPLE DECK CONDITION ASSESSMENTS UNDERTAKEN

- Findings:
 - Widespread delaminations;
 - Up to 32% in some spans;
 - Major soffit spalling at steel truss spans;



MULTIPLE DECK CONDITION ASSESSMENTS UNDERTAKEN

- Findings:
 - Extreme chloride concentrations
 - > 10x threshold concentration required to initiate and support corrosion at depth of rebar;
 - Surprisingly minimal alkalinity depression due to carbonation at top and soffit surfaces;

Sample No. Plan/Change: (m)/Offset (m)	Depth (mm)	Chloride Ion Content (% by mass of concrete)	pH
1 - 3 to 4104.040.0	0.20	5.124	11.7
	40.00	5.103	11.7
	80.00	5.272	11.4
2 - 3 to 4129.202.3	0.20	5.274	11.5
	40.00	5.274	11.5
	80.00	5.209	11.5
3 - 4 to 5178.846.8	0.20	5.209	11.5
	40.00	5.209	11.5
	80.00	5.209	11.5
4 - 4 to 5223.051.1	0.20	5.348	11.7
	40.00	5.281	11.5
	80.00	5.224	11.5
5 - 5 to 6250.511.0	0.20	5.224	11.4
	40.00	5.224	11.4
	80.00	5.224	11.4
6 - 5 to 6285.051.0	0.20	5.424	11.4
	40.00	5.272	11.4
	80.00	5.207	11.4
7 - 5 to 6290.717.0	0.20	5.207	11.4
	40.00	5.207	11.4
	80.00	5.207	11.4
8 - 5 to 6291.011.2	0.20	5.207	11.4
	40.00	5.207	11.4
	80.00	5.207	11.4
9 - 5 to 7044.346.6	0.20	5.204	11.5
	40.00	5.193	11.7
	80.00	5.204	11.5
10 - 6 to 7070.211.2	0.20	5.204	11.7
	40.00	5.223	11.7
	80.00	5.204	11.7
11 - 7 to 8407.448.0	0.20	5.224	11.8
	40.00	5.223	11.9
	80.00	5.224	11.8
12 - 7 to 8430.618.3	0.20	5.224	11.9
	40.00	5.223	11.9
	80.00	5.224	11.9
13 - 8 to 9430.022.2	0.20	5.102	11.7
	40.00	5.204	11.8
	80.00	5.223	11.9
14 - 10 to 11541.816.8	0.20	5.194	11.9
	40.00	5.194	11.9
	80.00	5.194	11.9
15 - 3 to 4447.819.4	0.20	5.348	11.9
	40.00	5.274	11.9
	80.00	5.204	11.9
16 - 12 to 13596.371.5	0.20	5.204	11.9
	40.00	5.222	11.9
	80.00	5.440	12.0
17 - 15 to 16561.515.0	0.20	5.274	12.0
	40.00	5.274	11.9
	80.00	5.274	11.9
18 - 17 to 16714.071.2	0.20	5.274	12.0
	40.00	5.274	11.9
	80.00	5.274	11.9
19 - 21 to 22799.003.0	0.20	5.204	11.9
	40.00	5.194	11.8
	80.00	5.204	11.8
20 - 25 to 22863.0111.5	0.20	5.204	11.8
	40.00	5.274	11.7

Note: *Change: 0.0 to 0.1 at Pier 3. Offset from Case Study
Values above the corrosion initiation threshold of 0.05% are shown in bold



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MULTIPLE DECK CONDITION ASSESSMENTS UNDERTAKEN

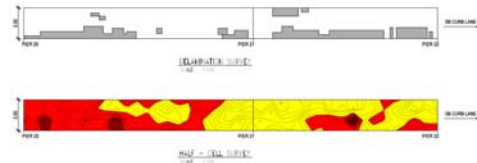
- Findings:
 - Major rebar section-loss occurring;
 - Complete rebar section-loss at isolated areas;



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MULTIPLE DECK CONDITION ASSESSMENTS UNDERTAKEN

- Findings:
 - Extreme half-cell potentials (more electronegative than -350 mV_{CSE} at widespread areas);
 - Widespread full thickness cracking.

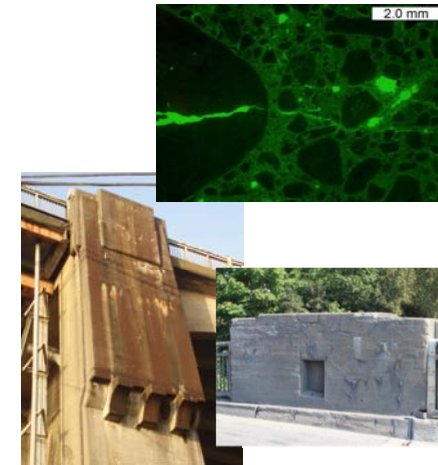


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OTHER CHALLENGES

- The deck is not this bridge's only issue...

SUBSTRUCTURE IS EXHIBITING WIDESPREAD CRACKING DUE TO ALKALI-SILICA REACTIVITY;




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OTHER CHALLENGES

- The deck is not this bridge's only issue...

WIDESPREAD CRACKING AND SPALLING IS PRESENT AT APPROACH SPAN SUPERSTRUCTURE




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OTHER CHALLENGES


- The deck is not this bridge's only issue...

STEEL SUPERSTRUCTURE EXHIBITS COMPLETE SECTION LOSS AT SOME AREAS DUE TO CORROSION;



CORROSION JACKING OCCURRING AT UPPER FLANGES.




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OTHER CHALLENGES

- The deck is not this bridge's only issue...

BEARINGS ARE SEISMICALLY DEFICIENT




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OTHER CHALLENGES

- The deck is not this bridge's only issue...

PIER NO. 5 ALMOST COMPLETELY UNDERMINED BY SCOUR



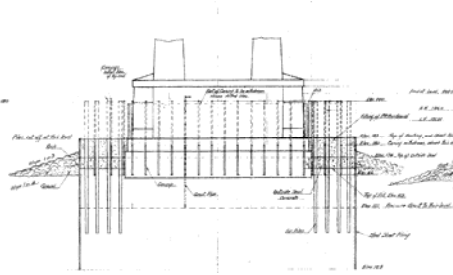
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OTHER CHALLENGES

- The deck is not this bridge's only issue...

PILES DO NOT EXTEND THROUGH FULL-DEPTH OF LIQUIFIABLE SOILS INTO SOLID GROUND



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OTHER CHALLENGES

- The deck is not this bridge's only issue...

BRIDGE DECK IS TOO NARROW DUE TO WIDTH OF TRUSS OPENING;



WIDTH OF EACH LANE IS LESS THAN CURRENT DESIGN CODE OF ≥ 3.6 metres



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SEISMIC RETROFIT & REHABILITATION PROJECT

- TransLink issues an RFP for Seismic Retrofit and Rehabilitation Project in 2013;
- Preliminary Design Requirements:
 - Extend service life by 30 years;
 - Widen deck to current design requirements (i.e. widen truss opening);
 - Must mitigate impact of work on traffic flow (so... widen truss while bridge is open to traffic);
 - Bearing replacement;
 - Deck rehabilitation;
 - Substructure repairs and strengthening;
 - Seismic retrofit for 1-in-2,475 year return period earthquake;
 - Ground densification for foundations;
 - Armouring of in-river piers with riprap;
 - Consultation with six First Nations bands claiming land rights;
 - Archaeological assessment;
 - Preliminary cost estimate and construction schedule;
 - **Capital budget for construction is \$299M (Maximum);**



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SEISMIC RETROFIT & REHABILITATION PROJECT

- Winning team lead by Buckland & Taylor (now COWI Bridge North America)



- Determined that list of deliverables cannot be completed for TransLink's maximum allowable budget of \$299M (surprise!);
- TransLink removes various scope items;
- Reduce seismic requirements to 1-in-475 return period earthquake;
- **Requests design team to evaluate second option to extend service life of bridge deck for an additional 10 years;**
- **A 10 year rehab is VERY different than a 30 year rehab;**
- **Project now requires two parallel designs.**



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OPTIONS CONSIDERED FOR REHABILITATION PROJECT

10 year Service Life Extension:

- Remove asphalt overlay;
- Remove top 50 mm of concrete bridge deck by milling to top of rebar;
- Target areas exhibiting spalling for deep concrete removal past rebar;
- Clean rebar by grit blasting;
- Reinstate all removed areas with a high-performance CIP C-1 concrete overlay;
- No soffit spill repairs;
- Not expected to stop corrosion, but rate of corrosion slowed down to allow for additional ten years of service.

30 year Service Life Extension:

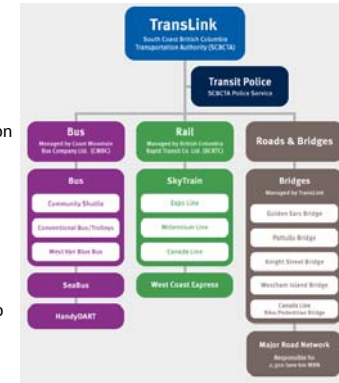
- Complete removal and replacement of two worst spans with precast units;
- Remove asphalt overlay;
- Remove top 50 mm of concrete bridge deck by milling to top of rebar;
- Remove concrete past rebar to ~100 mm depth by hydro-demolition;
- Arrest corrosion by installation impressed current cathodic protection system;
 - Considered distributed anode system too...
- Reinstate all areas with a high-performance CIP C-1 concrete overlay;
- Repair soffit spalls;



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TransLink Governance

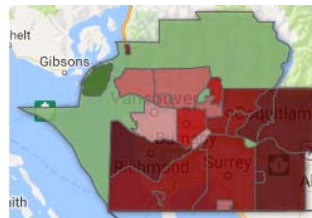
- Governed by Mayors of 14 cities and municipalities that comprise Metro Vancouver;
- Only consolidated regional transportation authority in North America;
- Developed a 30 year vision for transportation of people and goods within Greater Vancouver region;
- Needed to find a way to pay for it;
- Situation was a political hot potato;
- BC Government won't allow new taxes without public input;
- BC Government would not allow tolling of the Pattullo Bridge as they had deemed it to be the "toll-free alternative" to recently constructed upstream \$4B Gateway / Port Mann Bridge Project (toll);
- Held a plebiscite in May 2014 re tax increase.



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Plebiscite on Regional Transportation Tax of 0.5%

- Message regarding the vote was largely misconstrued by public;
- Unfairly became a referendum on TransLink's past spending transgressions;
 - This was never the intent;
- Received minimal vocal support from provincial or federal governments due risk of public backlash for raising taxes;
- "No" campaign led by taxpayer advocacy group;
- Soundly defeated by ~62-38 split;
- TransLink had no way to pay for elaborate rehabilitation project;



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REPLACEMENT (TOLLED) STRUCTURE NOW PLANNED



- An upstream replacement structure is being planned.
- New span won't be completed until 2023 to 2025.
- Costs to be split:
 - 33.3% Federal Government;
 - 33.3% BC Government;
 - 33.3% TransLink



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EXTENT OF BRIDGE DECK DETERIORATION IS SEVERE

- Public perception of TransLink spending habits was already bad;
- Cannot justify spending millions of dollars rehabilitating the bridge when it is likely to be replaced on a 7 to 10 year horizon;



BUT

- Current deck condition is so badly deteriorated, that it is **PAST the end of its service life.** It will not last until new structure is completed;
- No longer an exercise of nursing the deck along... we are in a full-blown protection of public safety exercise.**



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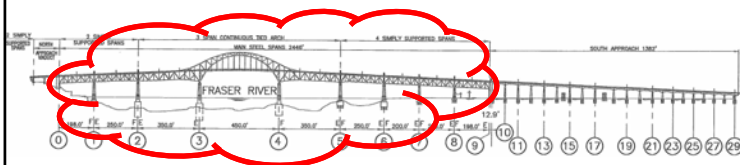
DO-MINIMUM REHABILITATION PROJECT

- Scope of rehabilitation project evolves to a “**DO MINIMUM**” approach to minimize cost and traffic disruption;
- Project objectives are:
 - To mitigate the risk of full thickness breach occurring while open to traffic;
 - Minimize costs;
 - Mitigate impact on traffic disruption; and
 - Do just barely enough for bridge to remain in service until 2023.
- Other functional improvements are abandoned (lane-widening, foundation improvements, seismic upgrades, etc.)



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DO-MINIMUM REHABILITATION PROJECT



- Extent of deterioration at top surface of bridge deck is widespread at all areas;
- However, while **extent of soffit deterioration is major at steel truss spans (> 100 m²), it is minimal at approach spans (~ 1 m²);**
- Focus of rehab is deck at Piers 0 to 9 (steel truss spans).
- Maintenance burden of asphalt overlay disruption due to unabated corrosion of approach span decks will continue; however, minimal risk of full thickness breach at these areas.



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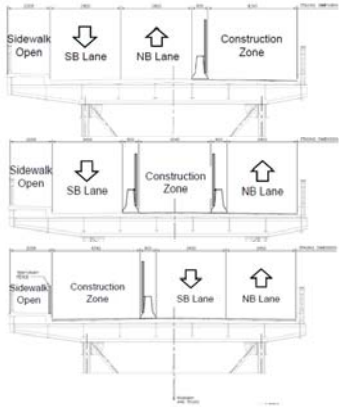
DO-MINIMUM REHABILITATION PROJECT

- Scope largely similar to 10 year rehab option presented earlier.
- Limited to ~750 m of 1,300 m total length of deck
 - Remove asphalt overlay;
 - Remove top 50 mm of concrete bridge deck by milling to top of rebar;
 - Target areas exhibiting spalling for deep concrete removal past rebar;
 - Clean rebar by grit blasting;
 - Reinstate all removed areas with a high-performance CIP C-1 concrete overlay;
 - Wire mesh to span areas of full thickness cracks and repair patches for augmentation of rebar.




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DO-MINIMUM REHABILITATION PROJECT




- Commenced in April 2016;
- Completed in three phases;
- Traffic reduced to one lane in each direction for each phase;
- Occasional full closures on weekends and overnight;
- Large Ontario barriers installed to separate traffic from work zone;
- Install scaffold to access bridge deck soffit.



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CONCRETE REMOVAL BY MILLING





- Removed asphalt overlay and top 50 mm of concrete to within 10 mm of top mat of rebar by milling.
- Probed deck and measured cover with GPR to minimize milling damage to rebar.

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REBAR COVER CONSISTENCY WASN'T GOOD IN 1937

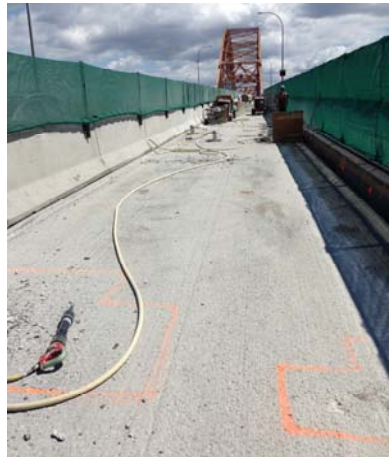


- Some bars damaged, mangled, or ripped right out of the deck despite best efforts;
- Damaged bars augmented with new bars.

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DELAMINATION SURVEY



- Chain drag survey (ASTM D4580) to identify areas of deeper delamination;
- Identify areas for additional concrete removal to ~25 to 30 mm past upper mat of rebar;

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CONCRETE REMOVAL BY CHIPPING

- Additional concrete removal to ~25 to 30 mm past upper mat of rebar;



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CONCRETE REMOVAL

- Deterioration at some areas coincident with soffit spalls resulting in removal to full thickness of deck.



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REBAR AUGMENTATION

- Remove corrosion residue by grit blasting to SSPC-6.
- Use wire mesh to span full thickness cracks and patches.



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CONCRETE PATCHING

- Augment areas of rebar with > 15% cross-section loss;
- Patch areas of deep and full thickness repairs.
- Target Traffic Patch (Coarse) repair mortar;
- Roughen surface;
- Moist cure;
- Install wire mesh at top surface.



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PREPARE SUBSTRATE SURFACE

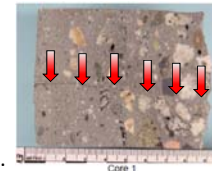
- High pressure water blasting to remove laitance, dust, and bruised concrete from milling (minimum pressure = 20,000 psi);
- Application of a cement-paste scrub coat bonding agent immediately before concrete placement.



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CONCRETE OVERLAY

- TransLink owns another bridge, built circa 2007-2009;
- Precast deck panels with high-performance silica fume-modified 50 mm thick overlay (C-XL exposure class);
- Widespread cracking soon after placement;
- EFFECTIVE cover depth is now 20 mm;
- 100 year Service Life?
- Did not want a recurrence of this issue.



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CONCRETE OVERLAY PERFORMANCE REQUIREMENTS

- Project specification based upon BC MoTI Standard Specification with special provisions;
- Special provisions included:
 - C-1 exposure class;
 - Compressive strength = 35 MPa at 28 days (minimum);
 - Completely **FORBID THE USE OF SILICA FUME** to mitigate shrinkage challenges;
 - Specified drying shrinkage performance < 0.035% per CSA A23.2-11C;
 - Maximum plastic temperature = 17 C;
 - Required night placements and batching with ice;
 - Minimum moist curing period = 7 days; and
 - Minimum adhesion strength = 0.9 MPa at 7 days per CSA A23.2-6B.

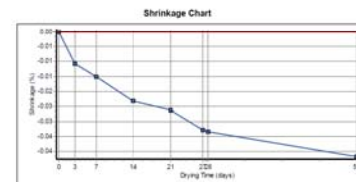


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CONCRETE OVERLAY TRIAL MIXES UNDERTAKEN

- Concrete supplier undertook laboratory trials to prove mix performance prior to construction;
- Complete disclosure (in confidence) of mix proportions (i.e. amounts expressed in kg per m³... not simply a “Yes” sheet)

Test Age (days)	Reading Date	Curing History	Shrinkage %			Avg Shrinkage %	Humidity %	Temp (deg C)	Tester
			GOL796-01	GOL796-02	GOL796-03				
0	4-12-2016	TDS					54	22	Green Path
3	4-19-2016	TDS-30A	-0.0100	-0.0100	-0.0120	-0.0107	54	22	Green Path
7	4-19-2016	TDS-70A	-0.0160	-0.0160	-0.0170	-0.0160	56	22	Green Path
14	4-26-2016	TDS-140A	-0.0230	-0.0210	-0.0260	-0.0233	56	22	Green Path
21	5-3-2016	TDS-210A	-0.0260	-0.0240	-0.0260	-0.0253	52	23	Green Path
27	5-9-2016	TDS-270A	-0.0270	-0.0260	-0.0270	-0.0267	50	23	Green Path
28	5-12-2016	TDS-280A	-0.0250	-0.0250	-0.0260	-0.0253	50	23	Green Path
88	6-7-2016	TDS-880A	-0.0360	-0.0370	-0.0480	-0.0417	63	23	Green Path



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CONCRETE OVERLAY MOCKUP SECTION

- Constructed off-site to represent deck rehabilitation conditions.



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CONCRETE OVERLAY PLACEMENT

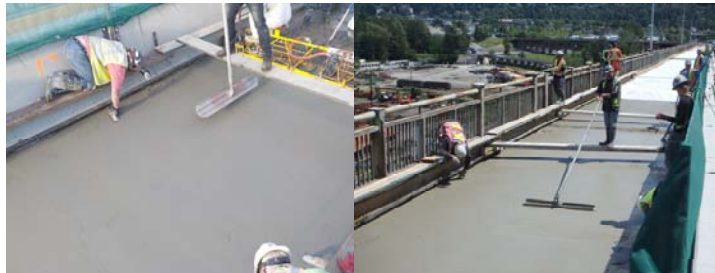
- After all areas of deep repairs were completed, overlay placement was undertaken;
- Restored deck profile to original asphalt overlay elevation;
- Multiple placements undertaken;
- Mostly at night or on weekends during full deck closures;



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CONCRETE OVERLAY PLACEMENT

- Concrete struck off using truss vibratory screed;
- Surface closed with a bull float and steel trowel;
- Was not ideal scenario due to narrow work area (~4 m wide);
- Surface profile ended up being somewhat bumpy at 30 km/hr (but not bad at higher speeds of > 60 km/hr).



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CONCRETE OVERLAY PLACEMENT

- Tined surface texture applied in transverse direction



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CONCRETE OVERLAY CURING

- Curing blankets applied as soon as possible such that blankets would not mar concrete surface.
- Concrete maintained 100 percent saturated for seven days.



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CONCRETE OVERLAY CURING

- Curing regime STRICTLY enforced for duration of curing period.



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CONCRETE OVERLAY TESTING

- 41 individual adhesive bond tests completed. Not one failure.
- All but three failed within substrate concrete or at top surface of overlay.



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CONCRETE OVERLAY TESTING

Compressive Strength:

- 238 f_c cylinders were cast for quality control purposes;
- 35 MPa achieved at 28 days in all cases;
 - Adequate strength achieved by 7 days in most cases;



Drying Shrinkage:

- Two quality assurance spot tests to confirm drying shrinkage performance;
- Both results show shrinkage less than 0.040%;
- Expected a slight increase (0.005%) from lab to field-scale production;

AVERAGE AGE	PERCENT LENGTH CHANGE			AVERAGE PERCENT LENGTH CHANGE	SPECIFIED MAXIMUM AT 28 DAYS
	1A	1B	1C		
Sample ID					
1	-0.004	-0.007	-0.005	-0.005	
4	-0.014	-0.015	-0.012	-0.014	
7	-0.008	-0.002	-0.008	-0.001	
14	-0.027	-0.027	-0.026	-0.027	
21	-0.030	-0.030	-0.030	-0.030	
28	-0.030	-0.037	-0.037	-0.037	0.025



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CONCRETE OVERLAY – CRACKING REVIEW

- All areas of constructed overlay were reviewed for cracking at end of warranty period;
- Minimal evidence of cracking that is not related to full thickness cracks reflecting through overlay;
- Minimal cracking thought to be related to restraint of drying shrinkage;
- Crack widths mostly narrower than 0.25 mm;
- Deck had been exposed to extreme winter weather prior to reviews;
- Wider cracks will be sealed with a methyl methacrylate sealer in May 2017 during maintenance closure and delamination survey.



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SOFFIT REPAIRS

- Project was ahead of schedule and under budget;
- TransLink elected to proceed with soffit repairs at some areas;
- Chip out loose concrete;
- Saw-cut edges;
- Clean rebar;
- Patched with overhead repair mortar.



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CHALLENGES

- Unpredictable weather from May to mid-July;
- Deck closures had to be coordinated weeks in advance in order to adequately notify public and minimize disruption.



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CHALLENGES

- Unpredictable weather from May to mid-July;
- Closures had to go ahead as planned;
- Intense rainfall commenced during some pours;
- Fresh concrete was sheltered from rain as well as possible.



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CHALLENGES - RAIN

- It rained A LOT from May to mid-July;
- Some concrete got a bit wet...
- Was removed and replaced.



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CHALLENGES – INCOMPLETE MIXING = LUMPS

- Batch plant literally right next to bridge;
- Short haul times;
- 80% batch water replacement with ice;
- Occasional challenges with incomplete mixing and lumps in concrete.



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CHALLENGES – ACCESS TO WORK AREA

- Second phase was between northbound and southbound lanes.



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CHALLENGES – ACCESS TO SOFFIT

- Scaffolding erected, albeit somewhat slowly...



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CHALLENGES – IMPAIRED DRIVERS

- Illicit drugs may have been involved...



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PROJECT FACTS

- Total volume of asphalt and concrete milled from deck – 960 m³
- Total area of partial depth repairs – 1160 m²
- Total area of full depth repairs – 111 m²
- Total volume of concrete placed for deck overlay – 963 m³
- Total number of formed deck soffit repair locations – 103
- Total area of deck soffit spall repairs – 46 m²
- Total area of deck soffit scaling – 28 m²
- Length of Ontario Barriers – 2.1 km
- Area of scaffold sub-deck – 3.6 Acres



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LESSONS LEARNED

- Thorough preparation – no major unknowns prior to construction.
- Contractor early involvement.
- Create team ethos.
- Combined site office for contractor and consultants.
- Understand/respect all participants’ priorities.
- Communicate – Regular, timely, bad/good news.
- Financial penalties and incentives in contract.
- Appropriate response when things do not go to plan.
- Very disciplined application of special provisions produced a high quality overlay.



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FOLLOW-UP / FUTURE

- Bi-weekly bridge deck condition monitoring inspections;



Photo 5: Large hole out of wheel path, concrete deck has been exposed. Location: S02E in South of Pier 8 (Piers 8B to 8E).



Photo 6: Hole in S02E in the P8E. Location: S02E in South of Pier 8 (Piers 8B to 8E).




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FOLLOW-UP / FUTURE

- Monthly bridge deck soffit inspections;
- Annual chain-drag of bridge deck from Pier 0-9;
- Anticipate localized repair of delaminations in the bridge deck approach spans every 12-18 months;
- Annual freshet/winter hydrographic surveys;
- Ongoing railing inspection and repairs;
- Monitoring for wind and seismic events;
- Other repairs as-and-when required; and
- New Bridge – 2022/23 ?



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QUESTIONS?

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