Taxiway Lima Rehabilitation at YVR Airport
Lessons Learned from Different Perspectives

Stantec

YVR International Airport
South Airfield Pavement Rehabilitation 2023 (Taxiway L, L2, L4, L6, D3)

Today's Panel

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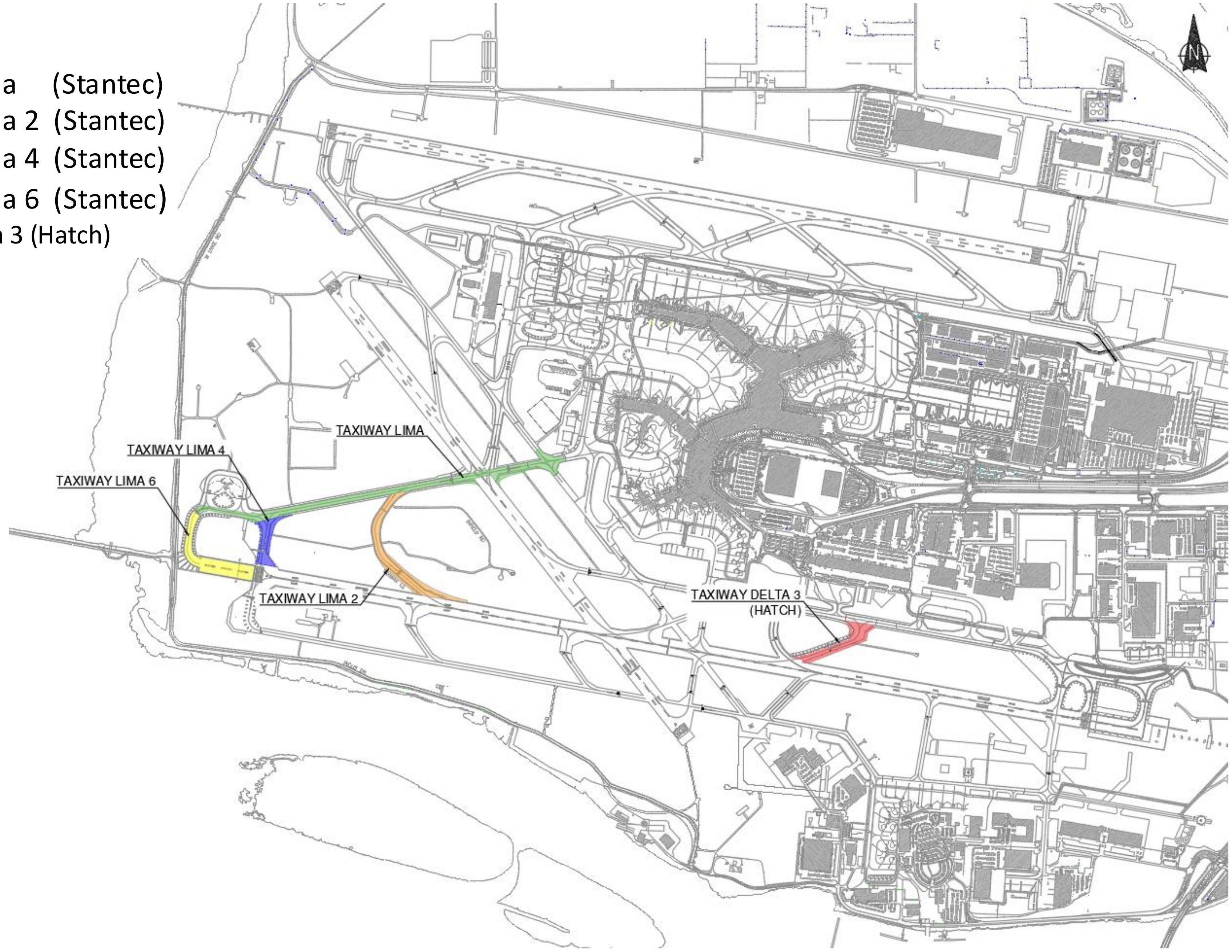
Project Overview

Areas of Work

- Taxiway Lima (Stantec)
- Taxiway Lima 2 (Stantec)
- Taxiway Lima 4 (Stantec)
- Taxiway Lima 6 (Stantec)
- Taxiway Delta 3 (Hatch)



Project Overview – Scope of Work (Civil)

Taxiway Lima

- 185 mm Asphalt Mill and Inlay
- Full Depth PCC Pavement Reconstruction West of TWY L4
- Full Depth PCC Pavement Reconstruction (TWY L / RWY 1331 Intersection)
- New Fillet Construction (TWY L / RWY 1331 Intersection)

Taxiway Lima 2

- Full Depth Asphalt Pavement Reconstruction
- New Subdrain Installation

Taxiway Lima 4

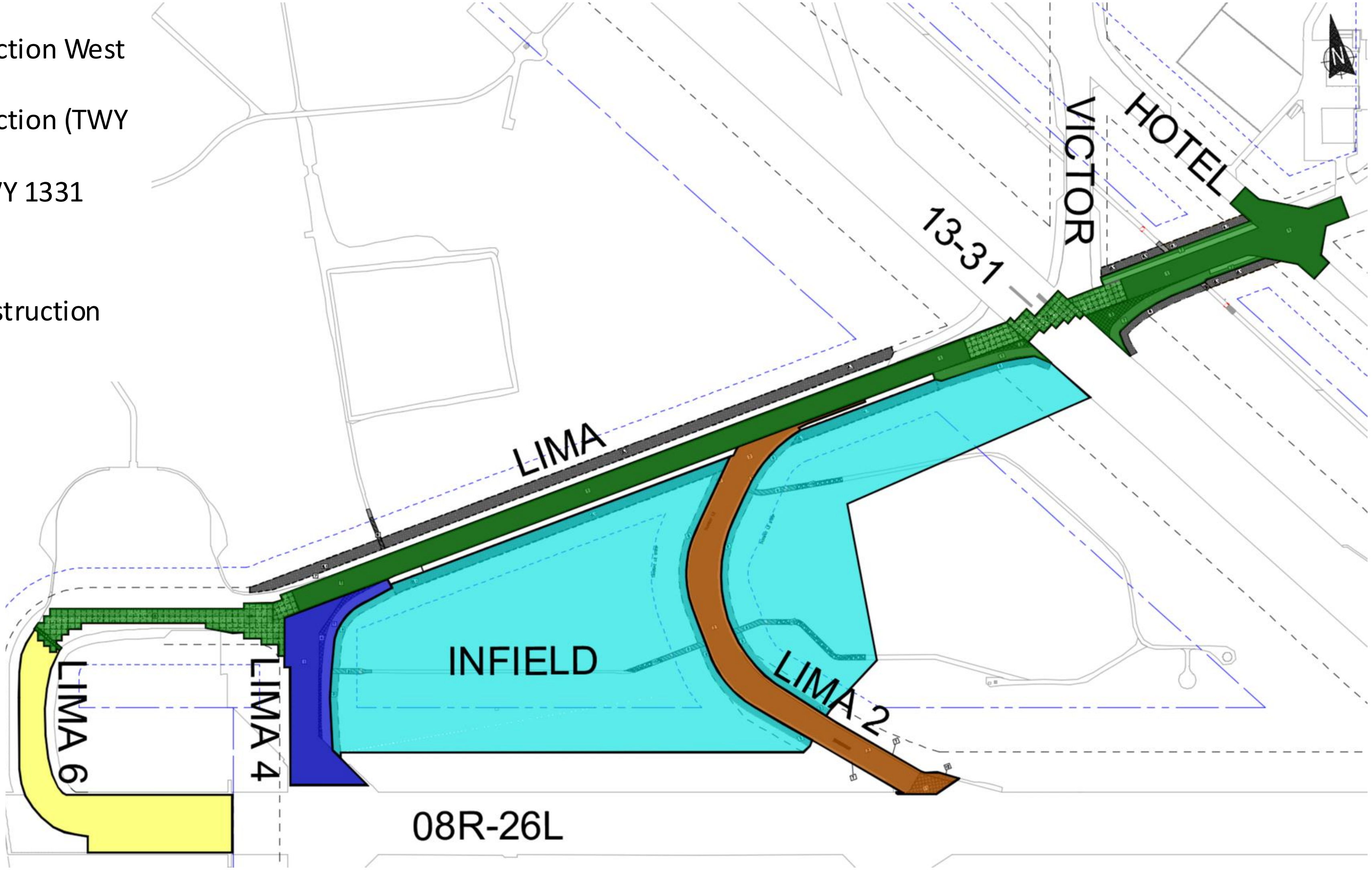
- 185 mm Asphalt Mill and Inlay
- Widening of the TWY L / L4 Fillet
- New Subdrain Installation

Taxiway Lima 6

- Localized PCC Pavement Repairs

Taxiway Lima 2 / Lima 4 Infields

- Localized Regrading and Drainage Improvements
- Infield Road Relocation

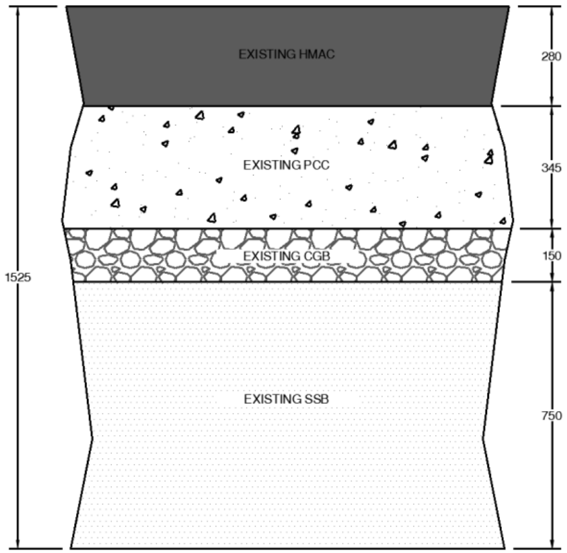


HMAC Pavement Design – TWY Lima from TWY Lima 4 to TWY Hotel

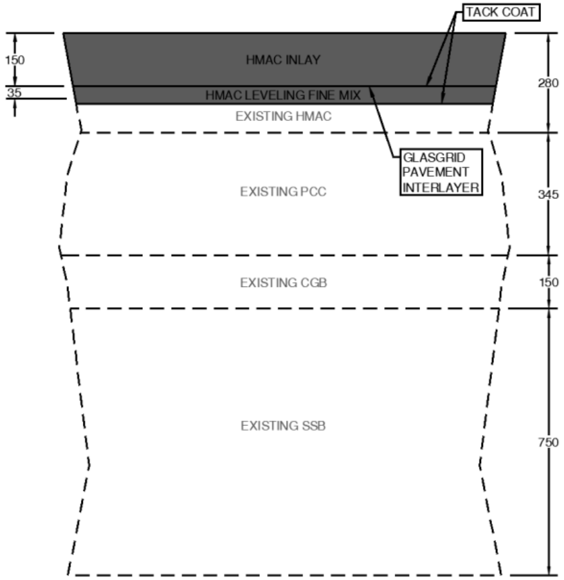
Design Notes

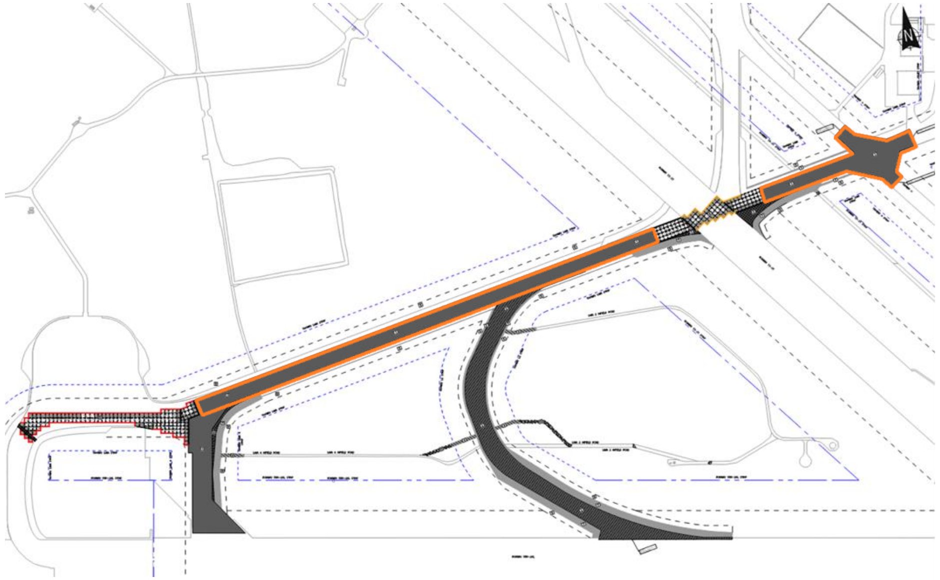
- A 185mm mill and inlay was used as a temporary solution for to extend the life of pavement.
- The resulting surface will accomplish the project objective in avoiding any taxiway closures during rehabilitation of the north runway.

Existing Structure



Final Pavement Structure



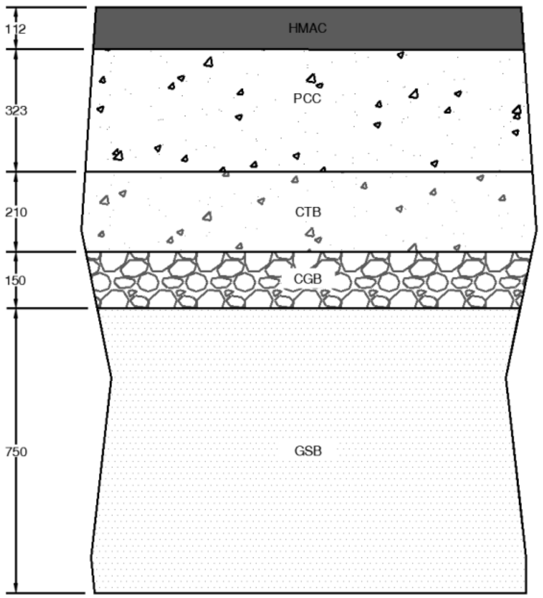


PCC Pavement Design – TWY Lima RWY 1331 Intersection

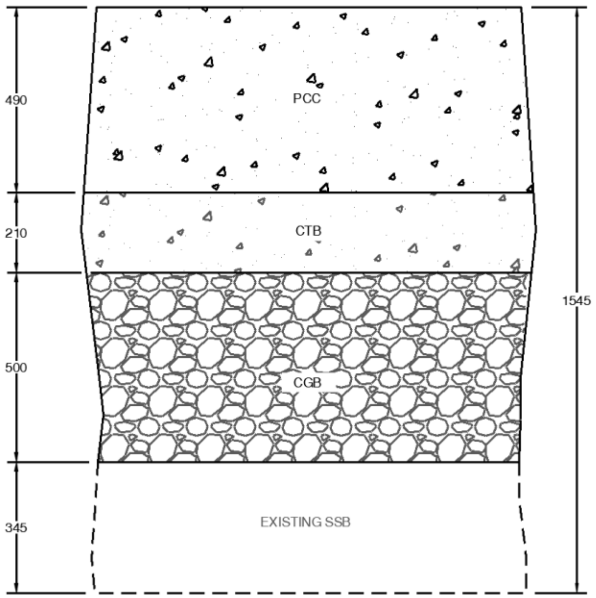
Design Notes

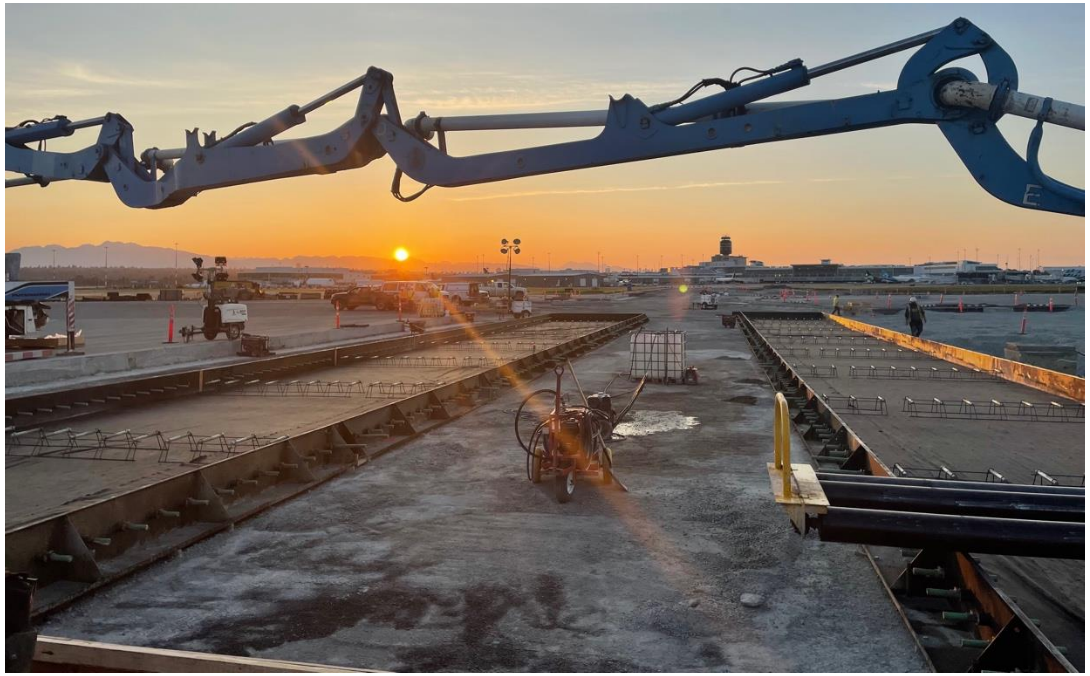
- Taxiway Lima at the Runway 13-31 intersection is designed with the same loading criteria as the rest of Taxiway Lima as the requirements for Taxiway Lima are more restrictive than those for Runway 13-31.
- The new pavement structure takes advantage of the existing sand sub-base, which allows for a thinner pavement structure.

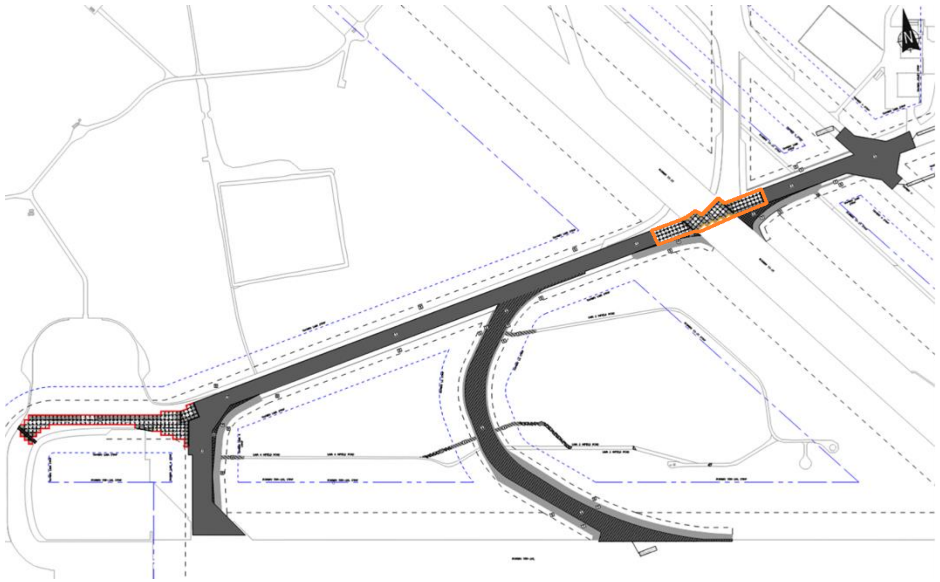
Existing Structure



Final Pavement Structure



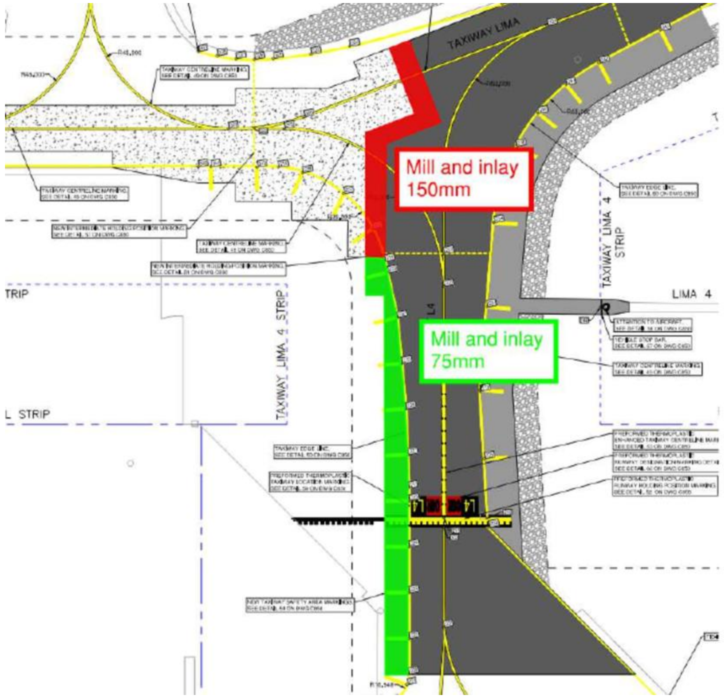


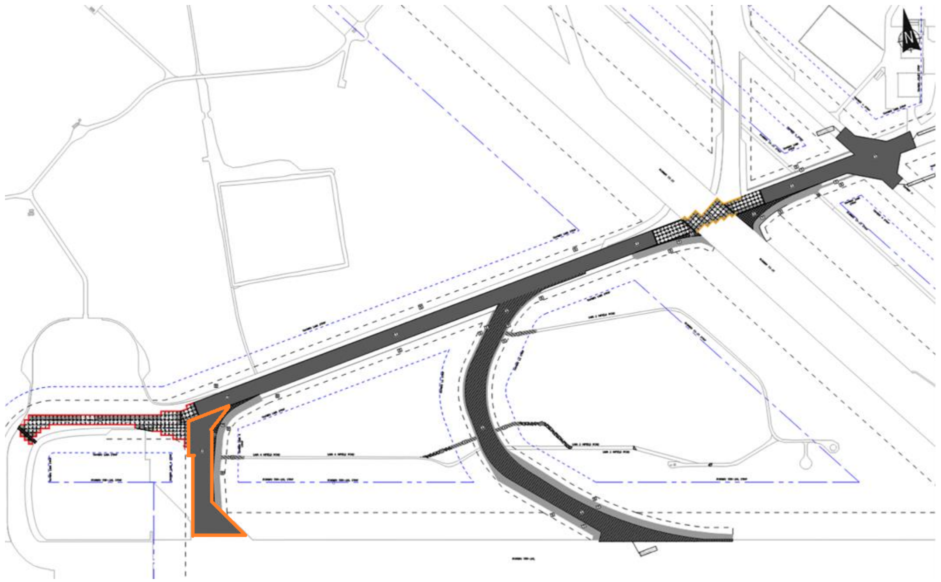


HMAC Pavement Design – TWY Lima 4

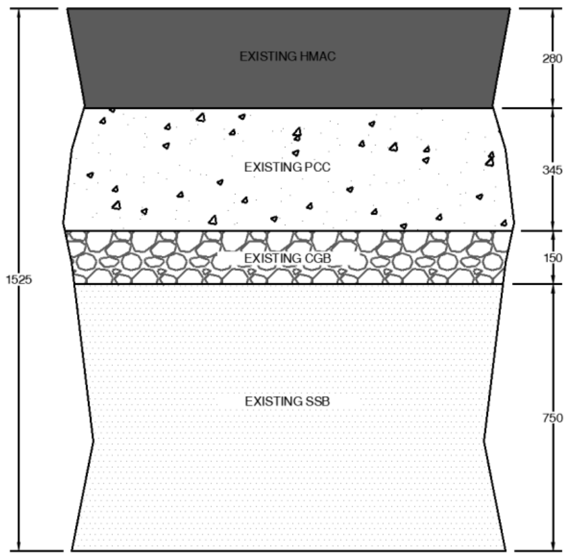
Design Notes

- Taxiway Lima 4 was designed on the same design criteria as Taxiway Lima.
- During construction, it was discovered that the existing HMAC is not a consistent depth across the whole taxiway and is only full thickness at the crown.

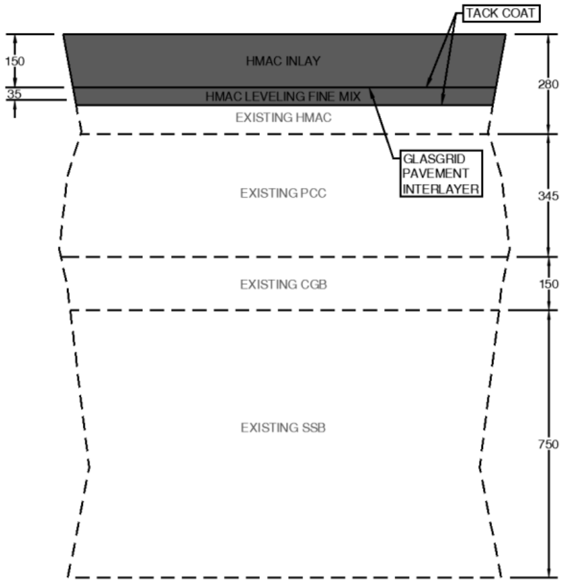




Existing Structure



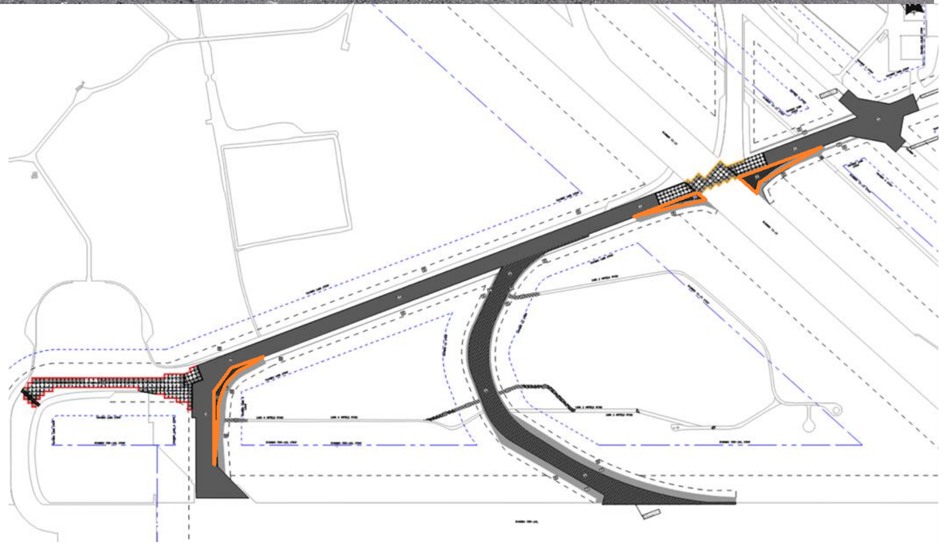
Final Pavement Structure



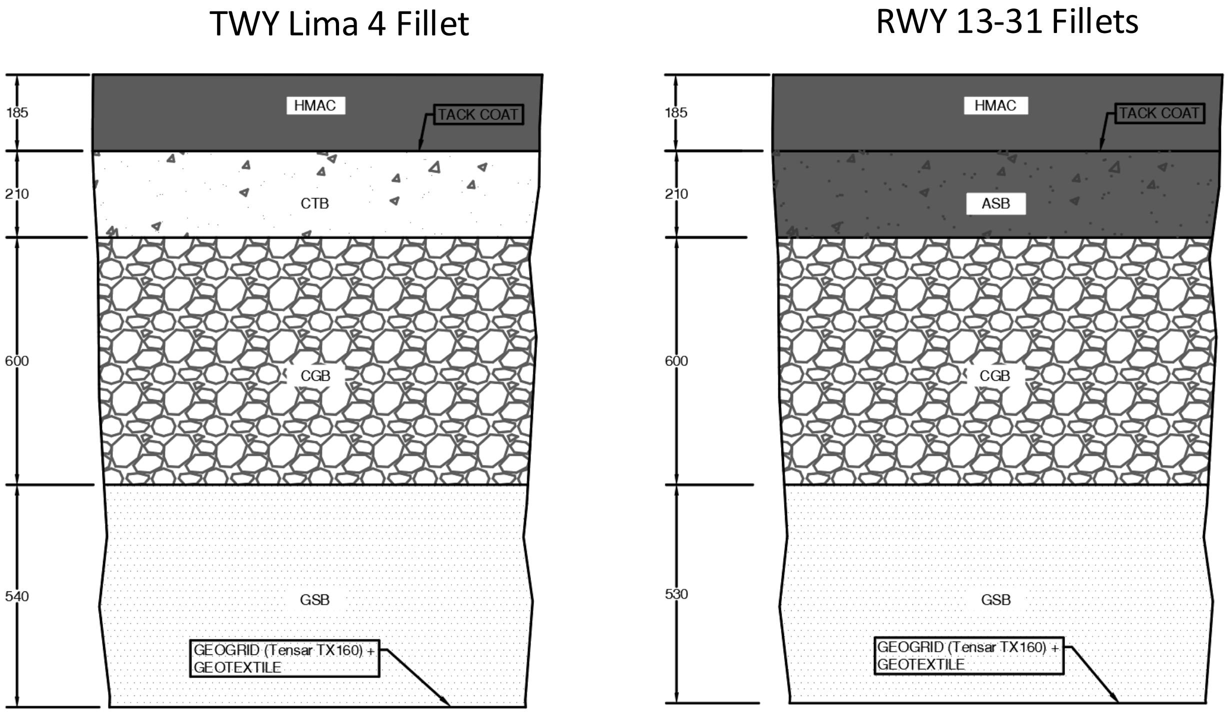
HMAC Pavement Design – TWY Lima 4 and RWY 13-31 Fillets

Design Notes

- The fillet pavement was designed with a traffic loading of **40%** of fleet mix annual departures.
- During construction the use of Asphalt Stabilized Base (ASB) was approved by YVR to facilitate the project schedule.



Final Pavement Structures

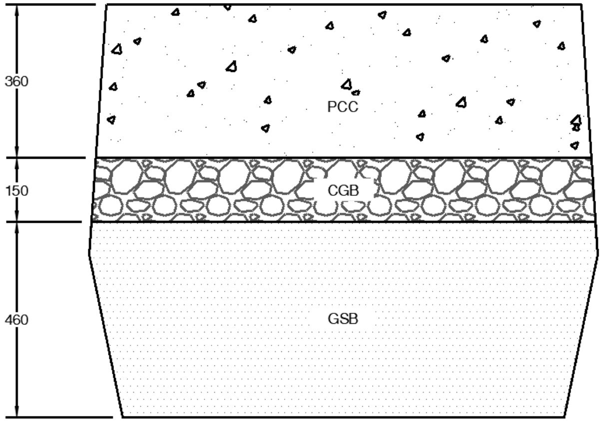


HMAC Pavement Design – TWY Lima 2

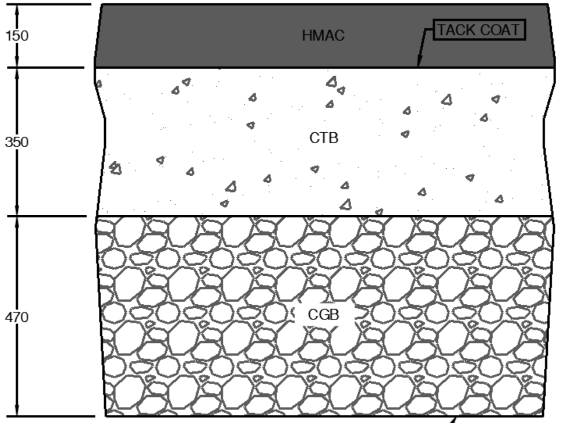
Design Notes

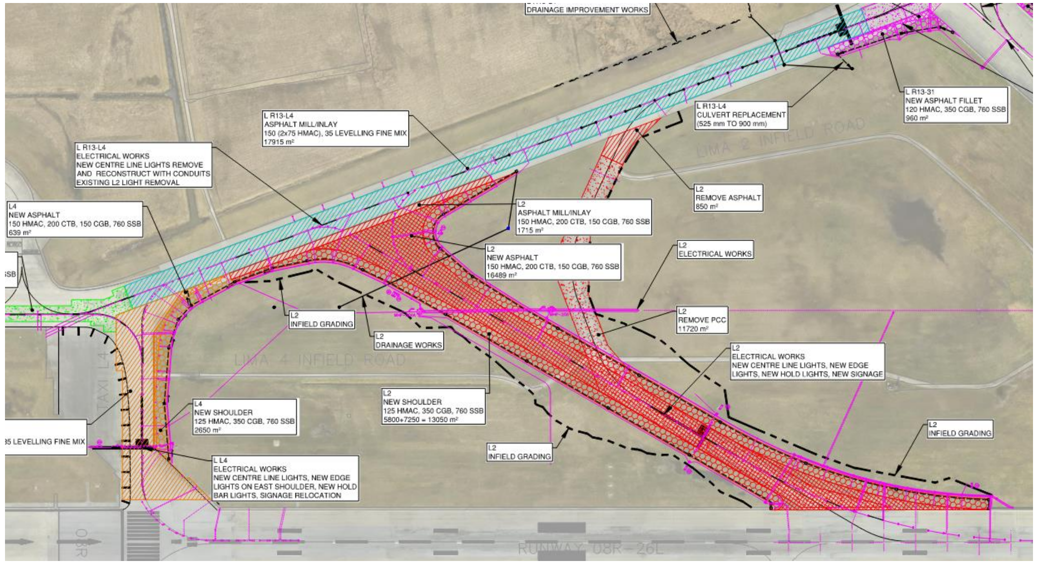
- Taxiway Lima 2 is used exclusively for arrivals.
- The Lima 2 taxiway pavement structure uses a layer of Cement Treated Base (CTB) to strengthen the flexible pavement structure given a limited maximum pavement depth.

Existing Structure

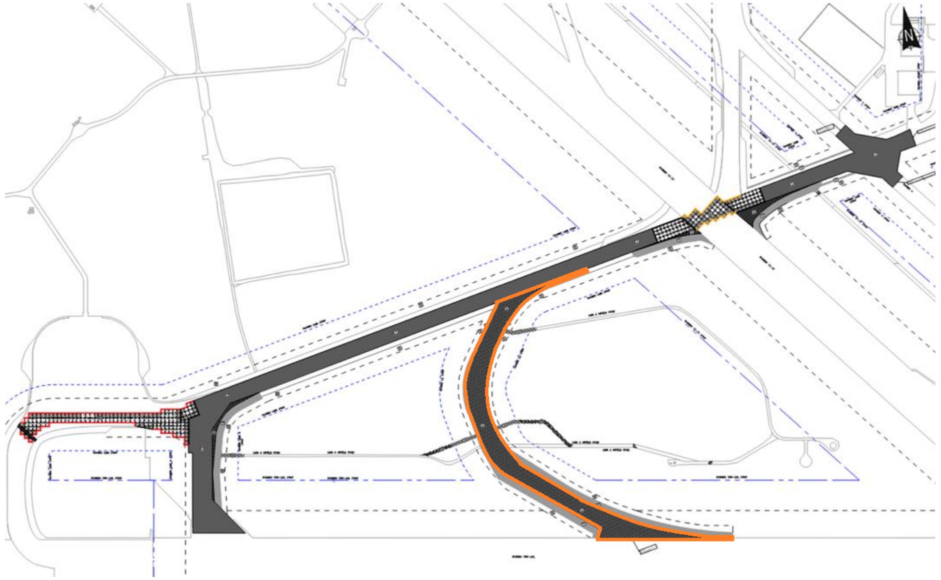


Final Pavement Structure





Original L2 RET Redesign Alignment

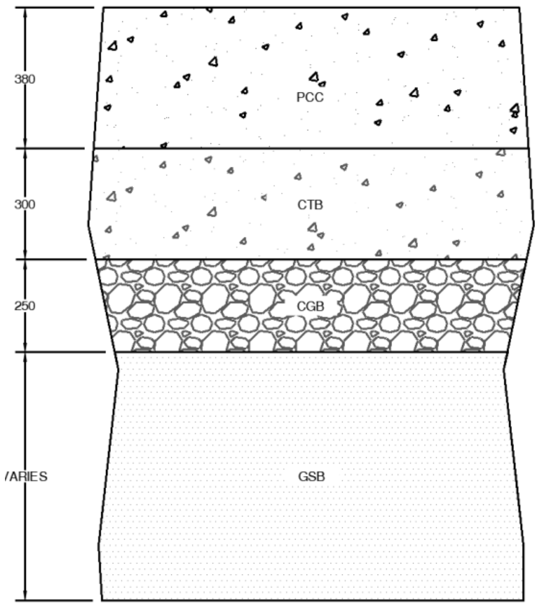


PCC Pavement Design – TWY Lima West of TWY Lima 4

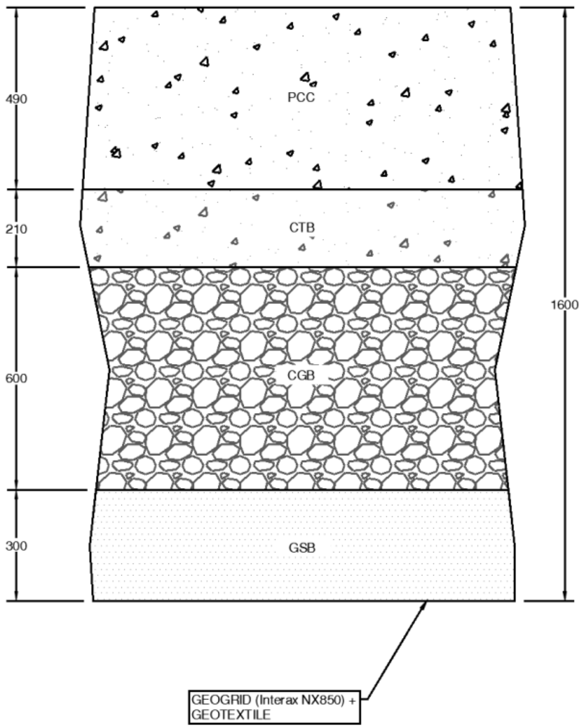
Design Notes

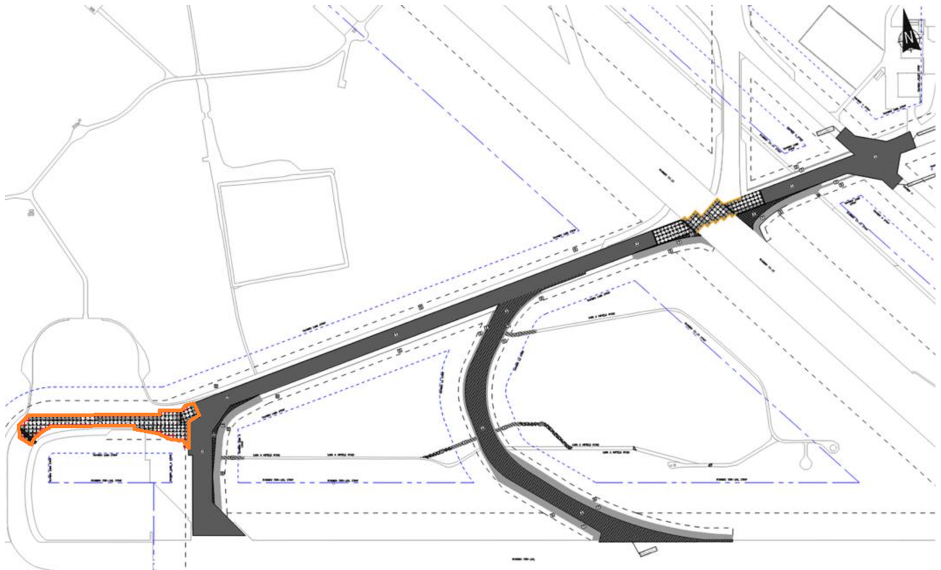
- Taxiway Lima between Lima 4 and Lima 6 was designed on the same design criteria as Taxiway Lima with an assumed 10% reduction in traffic.
- As the new pavement structure is thicker than existing, this area constitutes full depth pavement reconstruction down to subgrade.

Existing Structure



Final Pavement Structure





HMAC Pavement Design – Paved Taxiway Safety Areas

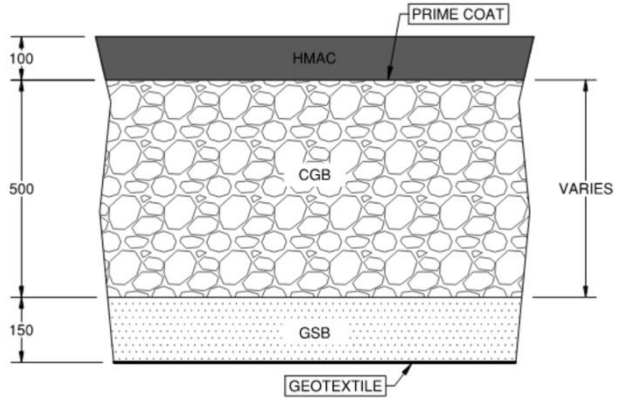
Design Notes

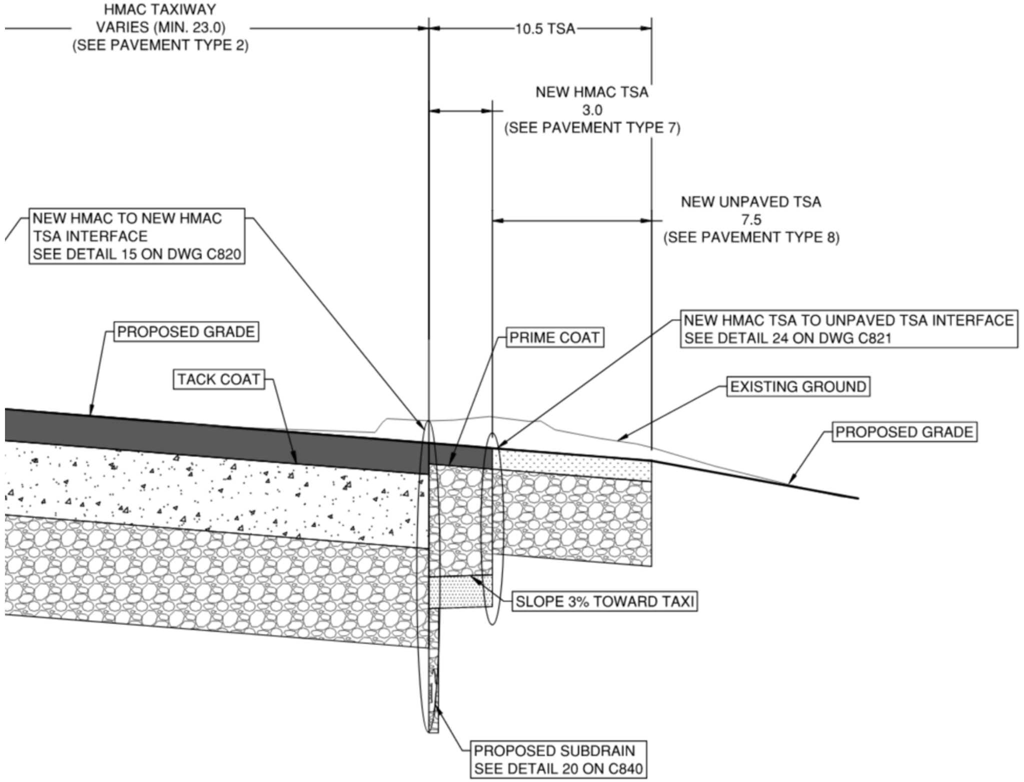
- The shoulder pavement was designed with a traffic loading of one pass of the critical aircraft per year for 15 years.
- The depth of the CGB increases towards the edge of the taxiway to provide for subsurface drainage.

	Material	Thickness (mm)	E (MPa)	CBR
	P-401/P-403 HMA Surface	100	1378.95	
	P-209 Crushed Aggregate	500	415.08	
-->	P-154 Uncrushed Aggregate	147	72.43	
	Subgrade		41.37	4

Example Pavement Cross-Section (TWY L2)

Final Pavement Structure





Pavement Design – Traffic Loading

Design Process

- The current and projected fleet mix at YVR shows that all but a rounding error of pavement damage is from the combination of the B777 and B787 traffic.
- The fleet mix and growth projections were used in conjunction with FAARFIELD pavement design software to determine design recommendations and expected lifespan of repairs.

Additional Airplane Information

No.	Name	CDF Contribution	CDF Max for Airplane	P/C Ratio
1	A300-600 Std Bogie	0.00	0.00	3.38
2	A310-200	0.00	0.00	3.69
3	A330-200 WV022	0.00	0.00	1.87
4	A330-300 WV022	0.00	0.00	1.87
5	A350-900	0.00	0.00	2.25
6	A380-800 WV006	0.00	0.00	3.78
7	A380-800 WV006 Belly	0.00	0.00	4.2
8	B737-8/8-200/BBJ MAX 8	0.00	0.00	3.47
9	B737-9 MAX	0.00	0.00	3.39
10	B737-600	0.00	0.00	3.7
11	B737-700	0.00	0.00	3.68
12	B737-800	0.00	0.00	3.53
13	B737-900 ER	0.00	0.00	3.53
14	B747-400	0.00	0.00	3.47
15	B747-400 Belly	0.00	0.00	3.47
16	B757-200	0.00	0.00	3.92
17	B767-200	0.00	0.00	3.73
18	B767-300 ER	0.00	0.00	3.63
19	B777-200 ER	0.00	0.00	4.05
20	B777-200 LR	0.10	0.10	3.86
21	B777-300 ER	0.71	0.71	3.84
22	B777-9	0.18	0.18	3.84
23	B787-10	0.00	0.00	4.05
24	B787-8	0.00	0.00	3.77
25	B787-9	0.01	0.01	4.05

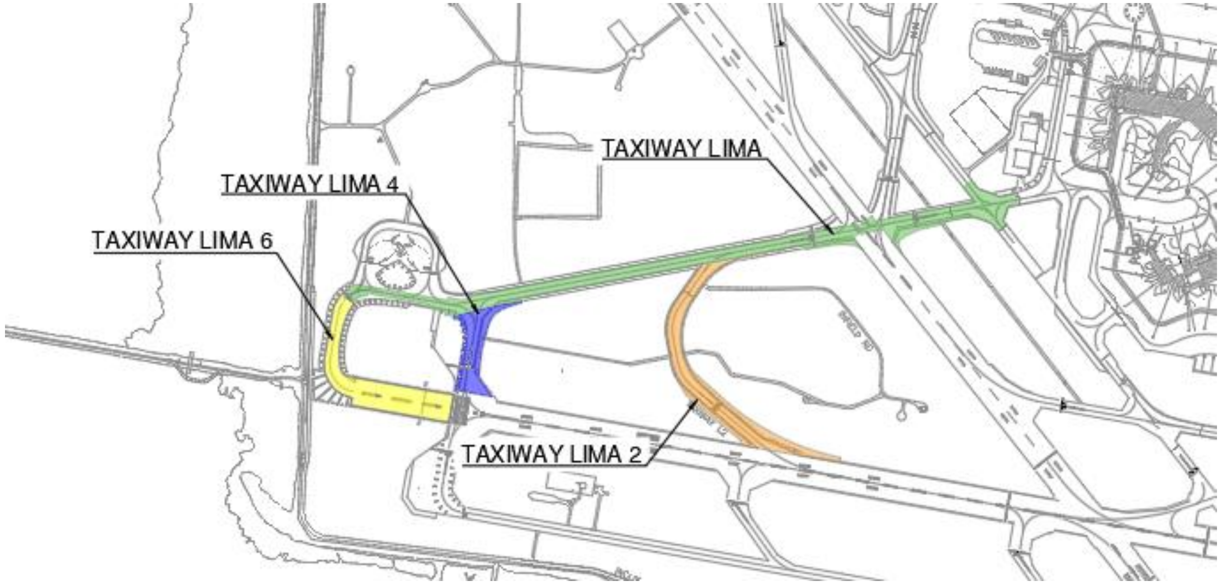
Project Constraint – Schedule

Taxiway Lima / Lima 4 Closure

- Taxiway Lima is a primary taxiway surface, providing the main access for takeoff from Runway 08R and landing on Runway 26L.
- Any unplanned closure of another primary taxiway within the project timetable would present a significant operational disruption.
- The planned closure was 16 weeks.
- Some buffer was included within the schedule, but the overall timeline was tight and any issues would need to be resolved within that time period.

Taxiway Lima 2 Closure – End of Construction Season

- Taxiway Lima 2 must be completed and returned to service before the end of the 2023 construction season in time for holiday traffic.

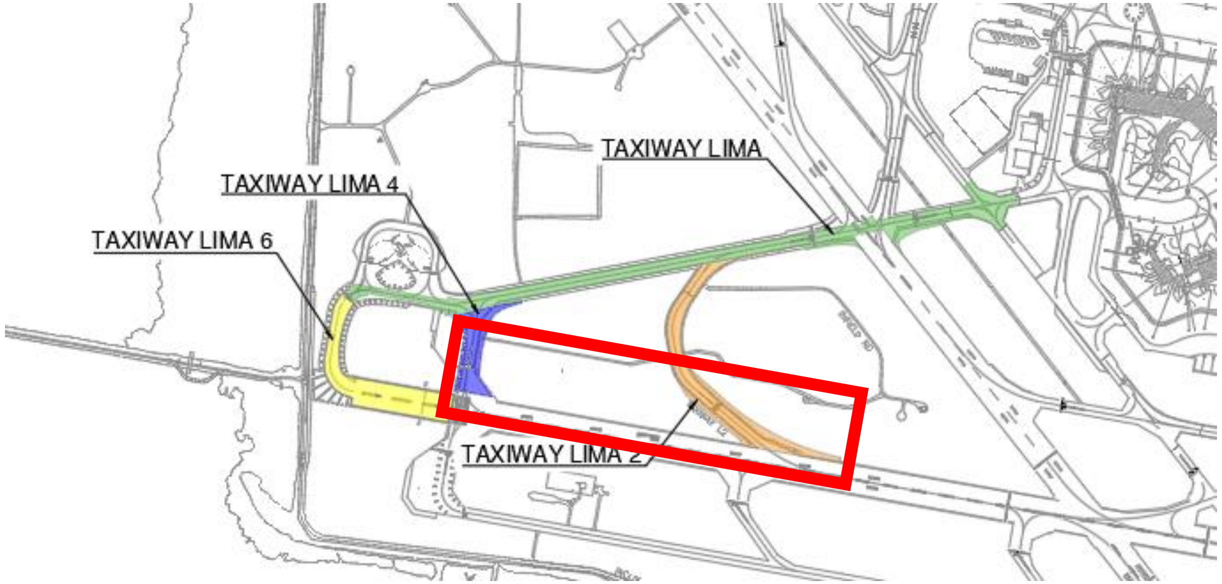


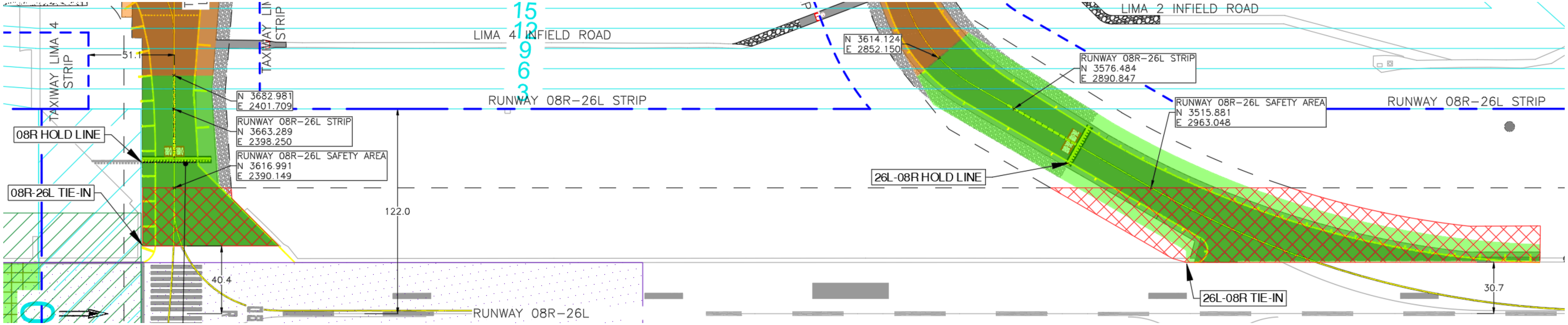
Project Constraint – Working Adjacent to an Active Runway

Work Restrictions Adjacent to an Active Runway

- No stockpiles within the runway strip and safety area.
- Terrain within the strip and safety area comply with finished grades as per TP-312 5e. This includes filling in any excavations made during the night.
- No equipment can be left within the runway strip or safety area.
- Due to excavation works, temporary ramps must be built for any abrupt changes in surface elevations.
- All debris and material must be removed from active surfaces.

These requirements must be satisfied by the end of each night.

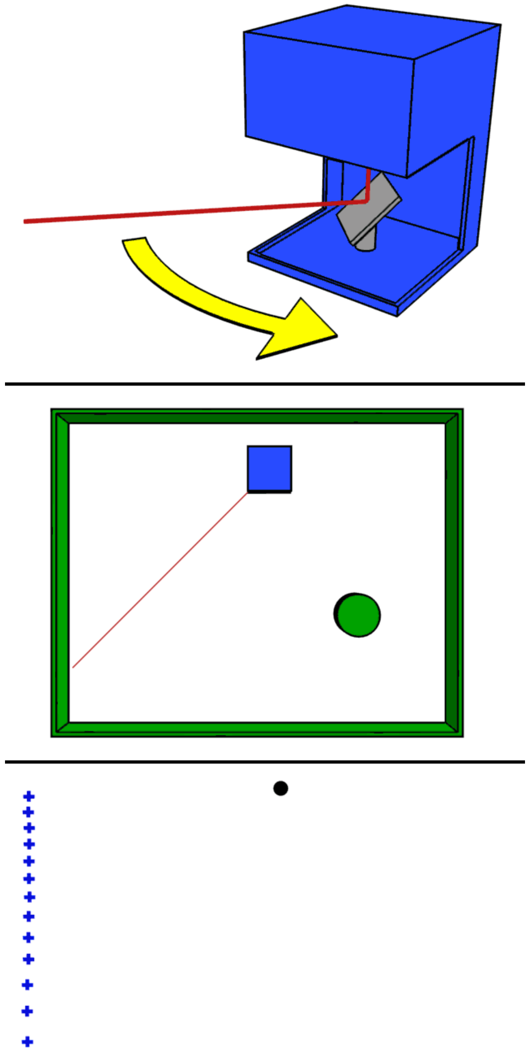




Project Challenges – LiDAR Survey

What Is a LiDAR Survey?

- LiDAR surveys are aerial surveys completed by using a LASER to create a topographical cloud of points.
- A LiDAR survey must be "processed" to turn it into a standard topographic surface suitable for design.



Benefits of Using a LiDAR Survey

- LiDAR surveys cost effective ways to survey a large area in a short period of time.

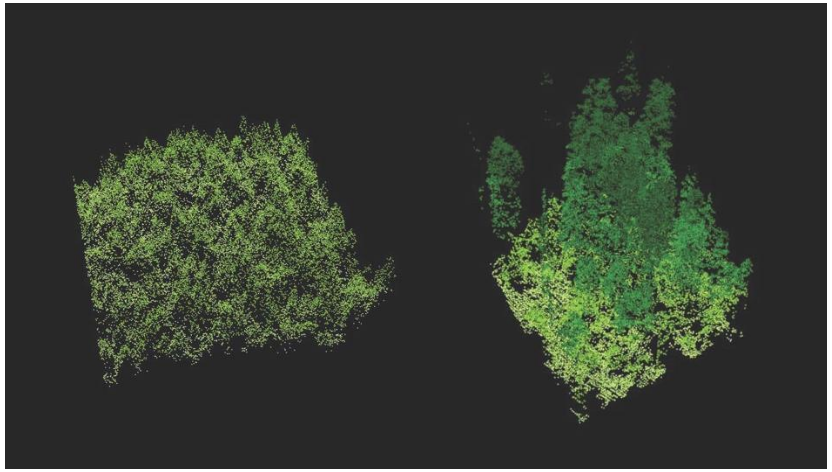
Limitations of a LiDAR Survey

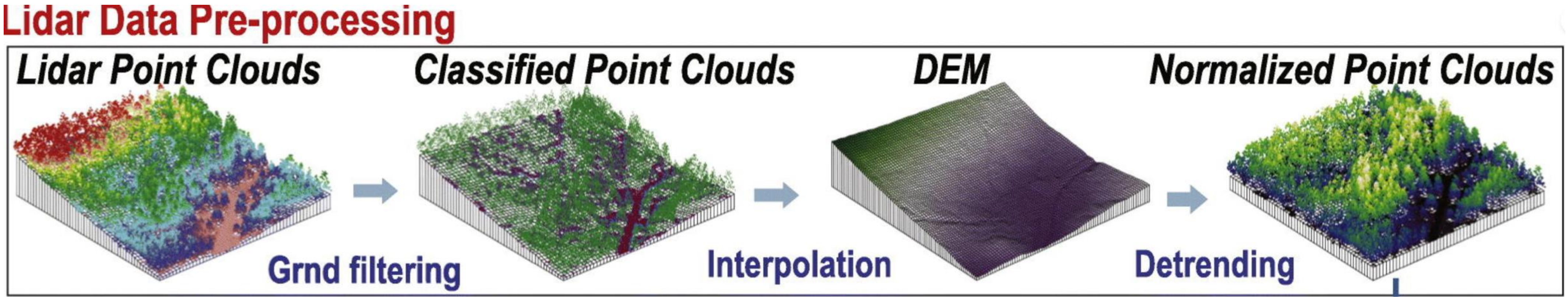
- LiDAR surveys are aerial surveys completed by using a LASER to create a topographical cloud of points.
- LiDAR surveys are agnostic of what each point corresponds to (paint, asphalt, grass, trees, buildings, etc.).

Project Challenges – LiDAR Survey

LiDAR Challenges

- The provided LiDAR had not been adequately weeded for design purposes.
- The elevations of the pavement were [+/- 50mm] of the actual, unprocessed raw data is inappropriate for detailed design purposes.





Solution

- A topo survey was completed on the entire paved area within the project scope.
- The pavement surface was redesigned based on the new topo survey while demolition works were underway.

Project Challenges – Subgrade Bearing Strength

Geotechnical Boreholes

- Boreholes are an effective method to determine subsurface conditions using a representative sample.
- Initial investigations showed a very weak subgrade that would require strengthening and consolidation.
- Subgrade material was largely clay and silt.
- Large masses of organic material were found in the subgrade.

Project Challenges – Subgrade Bearing Strength

Challenges

- Perched water
- Agitated silty clay

Project Challenges – Subgrade Bearing Strength

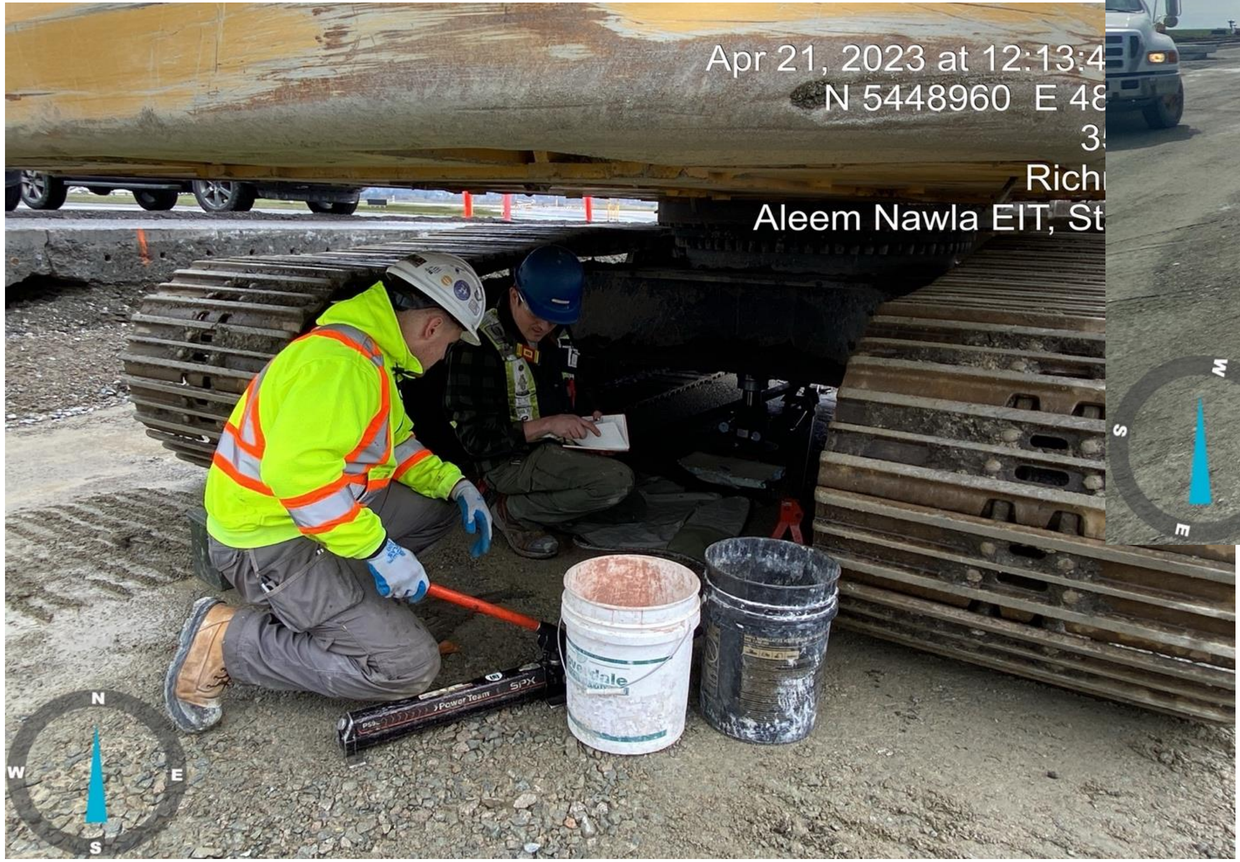
Solution – Subgrade Improvement

- Addition of lime
- Over-excavation to 300 mm below the designed subgrade depth. Place and compact a 300 mm layer of granular material, wrapped in geotextile to prevent migration of fines.
- Tensar TX160

Project Challenges – Subgrade Bearing Strength

Solution – Reinforce Subgrade

- Apply geogrid above the new subbase material
- Place and compact sub-base and base layers as per original design and proof roll.
- Any areas failing the proof roll to be excavated to the bottom of the base layer and reinforced with geogrid.
- Plate load test to check subgrade improvement from CBR 4 to CBR 6



Project Challenges – Cement Treated Base

Challenge

- Design mix resulted in some segregation of the coarse aggregate at the surface and poor adhesion due to cure times and ambient temperatures.

Solution

- Team quickly remedied the deficient surface and worked to fine tune the mix for the site conditions.

Result

- Further CTB placement during the project occurred without issue

Project Challenges – Cement Treated Base

Challenge

- CTB used in flexible pavements tends towards shrinkage cracking which can reflect up through the asphalt layers similar to Joint Reflection Cracking from Asphalt paved over PCC slabs.

Solution

- 2 separate methods in place to address shrinkage and reflective cracking.
- Team jointly reviewed methodology on TSA pavement at TWY L as a trial.
- Surface pre-cracked using a vibratory roller within 24-72h of placement during curing period.
- Measured timing and optimal number of roller passes to achieve desired surface cracking.

Result

- Induced hairline cracks help mitigate effects localized shrinkage cracking.
- Thickness of HMAC layer intended to bridge any discontinuity.

Project Challenges – Drainage

Design Constraints

- A high water table and perched water above the silty subgrade leaves very little room between the bottom of the pavement structure and the elevation of the ground water, especially in rain.
- Long pipe runs compress the ability to add adequate slope to the pipes.
- Aging base plans (Tie-ins, Slopes, Inverts) lead to lost data that is rediscovered in the field.
- YVR is built on Musqueam traditional territory and respecting areas of archaeological importance is a high priority.

Panel Questions