Cement Treated Base in Rigid and Flexible Aircraft Pavements– A Practitioner's Experience


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AGENDA

1. Cement Treated Base Typical Properties
2. Pros and Cons in Flexible and Rigid Pavement
3. Benchmarking at Various Airports
4. Recommendations
5. Case History 1 – Flexible Pavement
6. Case History 2 – Rigid Pavement
7. Key Items to Consider in Design and Construction

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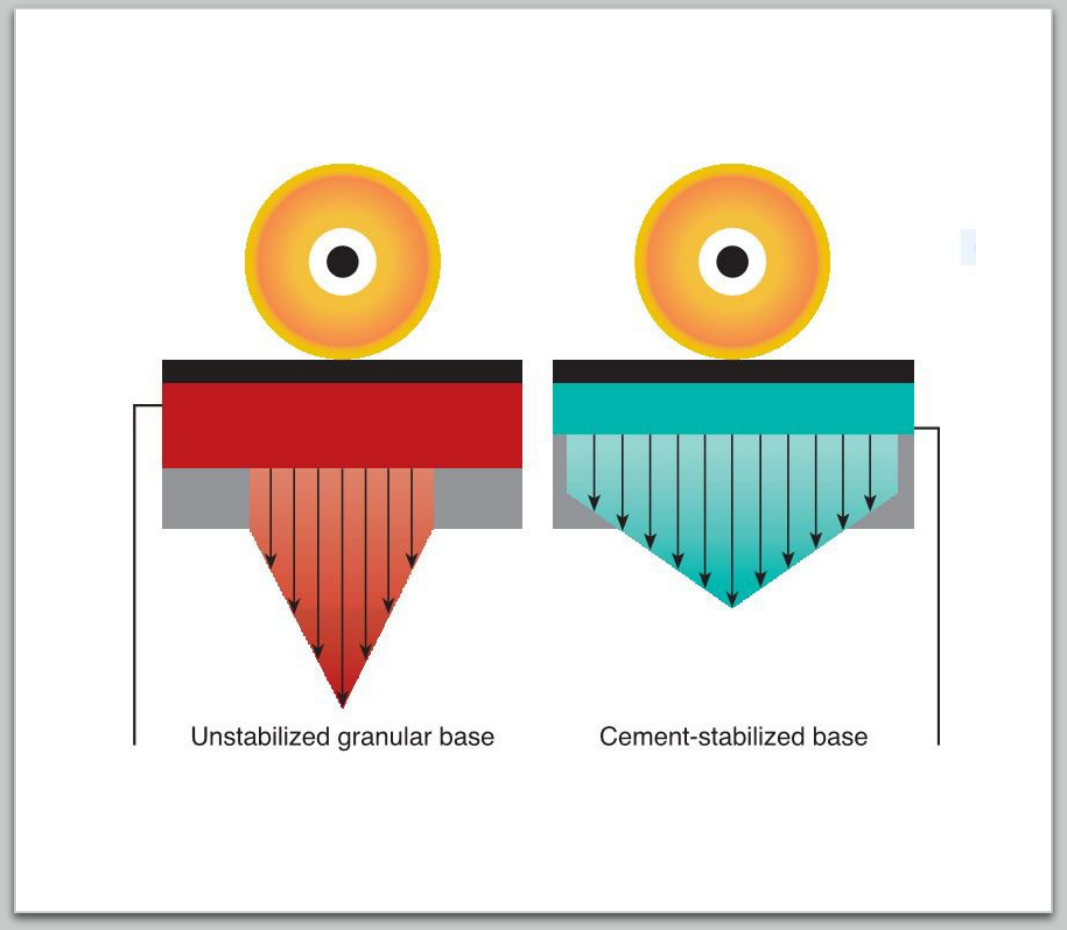
CTB Properties compared to Unstabilized Base

- Superior load distribution
- Modulus of Elasticity about 3500 MPa vs. 20000 MPa for granular, so thinner layer
- Stabilized Layer required by FAA for aircraft loading exceeding 45,359 kg (100,000 lbs.)
- Much less permeable and low loss of strength due to high water table or percolation



CTB Guiding Principles of Mix Design

- CTB is NOT lean Concrete – keep CTB strengths low – less than 5MPa compressive strength at 7 days (2 to 3.5 MPa).
- Compaction is primary goal in successful placement not compressive strength – the cement only locks in your compaction.
- Best results achieved by using a well graded granular base gradation. Always think of it as “granular base course” with a small amount of cement added (~2% by weight).
- Uniformity of mix and placement is very important – use pug mill for mixing and asphalt paver for spreading and keep water content at optimum for compaction.

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Cement Treated Base in Flexible and Rigid Pavemen

- Flexible Pros and Cons
  - Cheaper and faster than asphalt stabilization of layers
  - Possible reflective cracking if too strong and in severe climates (shrinkage cracking)
  - Enhances rutting performance compared to asphalt stabilization
  - Better support for lighting fixtures and other subsurface structures
- Rigid Pros and Cons
  - PCC Joints perform well into long term
  - Very strong CTB layer increases slab curling stresses
  - Must ensure debonding of CTB and PCC.
  - Provides enhanced load distribution to subsurface piping and other structures

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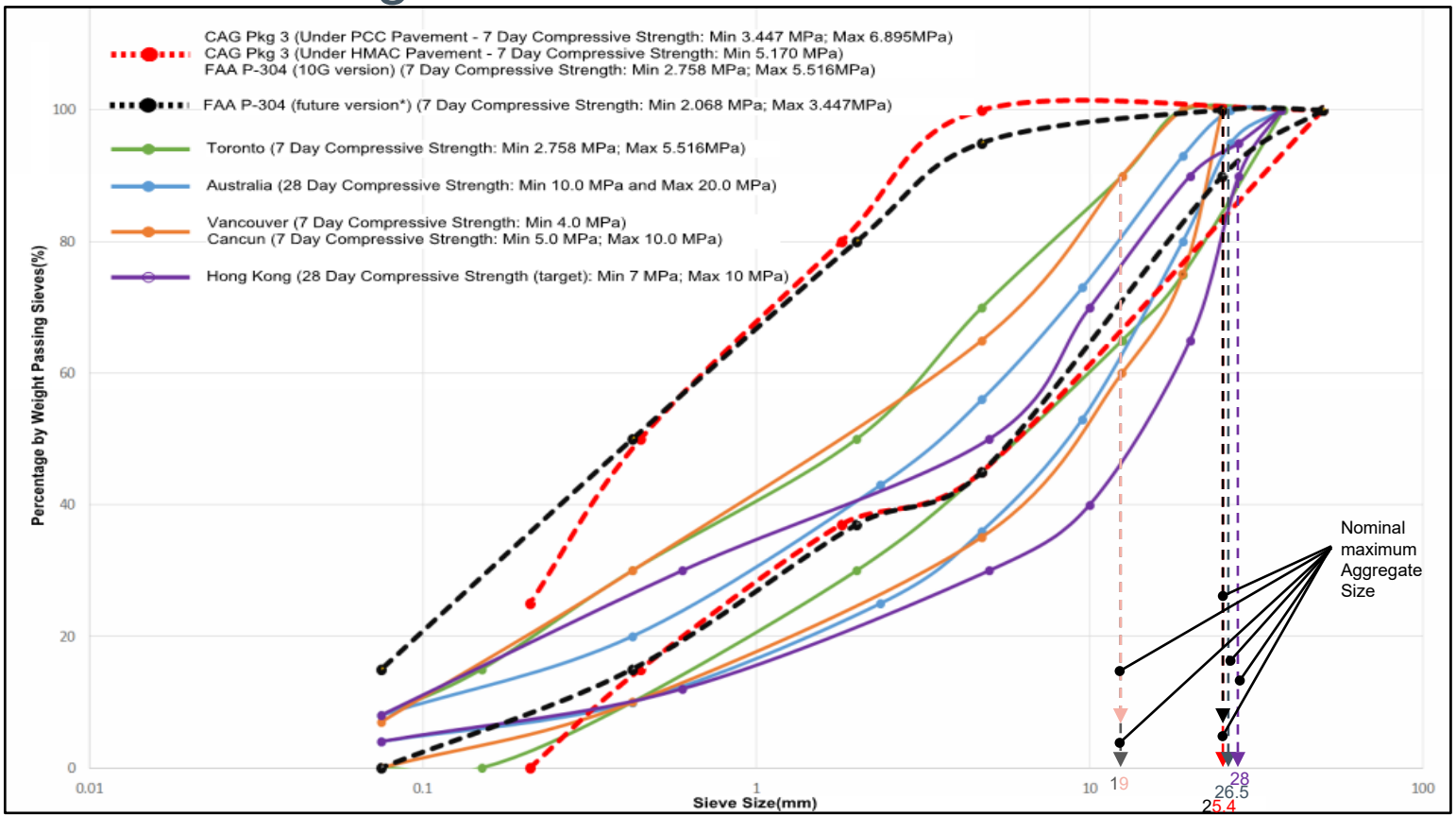
Benchmarking of CTB

Cement Treated Base Course - Key Properties	FAA P-304 (10G)	FAA P-304 (current 10H)	CAG	Toronto	Vancouver	Hong Kong	Australia	Cancun
Cement Type	Site Specific		ASTM C150	Normal Type 10	Normal Type 10	Ordinary BS	GP Cement	Type I Normal
Supplementary Cementitious	Max 6%		Max 6%	None	Type F – 25% Max.	10-25% Max.	N/A	25% max.
Aggregate Type	Granular, crushed/un, recycled PCC		Granular, crushed/un, recycled PCC	Crushed stone or gravel or recycled PCC	Crushed Stone or Gravel 60% crushed faces	100% Crushed Rock only – same as CABC	Crushed Basalt Rock only	Crushed Stone or Gravel 60% crushed faces
Aggregate Gradation mm	A: 50.0 to 0.210	A: 50.0 to 0.075	A: 50.0 to 0.210	38.1 to 0.075	25.0 to 0.075	37.5 to 0.075	37.5 to 0.075	25.0 to 0.075
Aggregate Strength Surface	LA 40% Max		LA 40% Max	LA 40% Max	LA 50% Max	LA 25% Max	LA 25% Max	L 45% Max
Magnesium Sulphate Soundness coarse/fine	15		13	10/13	12/16	5	5 (sodium Sulphate)	12/16
Compressive Strength Minimum 7 day	2.758 MPa	2.068 MPa	3.447 MPa under PCC /5.17MPa under HMAC	4.0MPa	4.0 MPa	N/A	TBD	5.0 MPa
Compressive Strength Maximum 7 Day	5.516 MPa	3.447 MPa	5.516 MPa	N/A	N/A	N/A	TBD	10.0 MPa
Compressive Strength Maximum 28 days	6.895 MPa	N/A	6.895 MPa	6.5 MPa +/- 0.5 MPa	N/A	Target 7.0 to 10.0 MPa	Min. 10.0 MPa and Max. 20.0	N/A
Minimum Compaction Required Mod. Proctor	98% MDD within 2% of optimum		98% MDD within 2% of optimum	97% MDD	97% MDD	100% MDD – same as CABC	97%	97% MDD

Benchmarking of CTB (Cont'd)

Cement Treated Base Course - Key Properties	FAA P-304 (10G)	FAA P-304 (current 10H)	CAG	Toronto	Vancouver	Hong Kong	Australia	Cancun
Watering During Placement	Water fog sprayers		Water fog sprayers	As Required	As Required	As Required + cure until Prime	N/A	Fine water spray as required
Curing Compound under PCC	White Pigment like PCC		White Pigment like PCC	RS-1	SS-1h	Prime Coat Typ. SS-1, SS-1h	Emulsion	Not Specified
Curing Compound under HMAC	Emulsion RS-1		Emulsion RS-1	RS-1	SS-1h	Prime Coat SS-1, SS-1h	Not Specified	SS-1h
Curing Compound Coverage Requirements PCC	0.2 L/m2	0.409 L/m2	0.2 L/m2	1.2 L/m2	1.2 L/m2	0.5 to 1.5 L/m2 trials	0.25l/m2 + same before PCC	Not Specified
Curing Compound Coverage Requirements HMAC	0.7 to 1.4 L/m2		0.7 to 1.4 L/m2	1.2 L/m2	1.2 L/m2	0.5 to 1.5 L m/2 Trials	Not Specified	1.35L/m2
Type of Plant Requirements	Central		Central	Central	Central	Pug Mill	Central	Central
Spreader Requirements	Mechanical		Mechanical	Not Specified	Mechanical	Mechanical	Mechanical	Mechanical
Pre-Cracking Requirements	None	CTB joint offset 600mm from asphalt joint/ no offset for PCC	3.5 x 3.5m	None	None	Post Micro Crackiing 24 hrs	Same as PCC but 600mm offset	3.5 x 3.5 m before/after comp
Compaction Completion and Curing Compound Application	45 min and max 2 hrs plus water before curing compound	Within 2 hrs	45 min and max 2 hrs plus water before curing compound	Curing compound must be on 2 hrs plus water before	Placement within 45 minutes from plant	30 min. from cement to site and 90 min to compaction	60 minutes to final compaction in summer	120 minutes from mixing to full compaction and prime

Benchmarking of CTB



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Case History 1 – New Parallel Runway at Cancun International Airport, Mexico

Flexible Pavement and CTB

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Cancun New Parallel Runway and Taxiway Bridge

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New Parallel Runway– Cancun Mexico

- FAA LEDFAA/FAARFIELD Design
- 2800 m parallel runway used primarily for arrivals
- HMAC over Cement Treated Base Course
- Lowest Cost Pavement Structure as compared to asphalt stabilized
- Aggregates in Yucatan are mostly coral limestone– relatively weak. Stabilized to increase strength.
- Runway opened in 2009

Cancun Runway Subgrade Repair (143 sinkholes)

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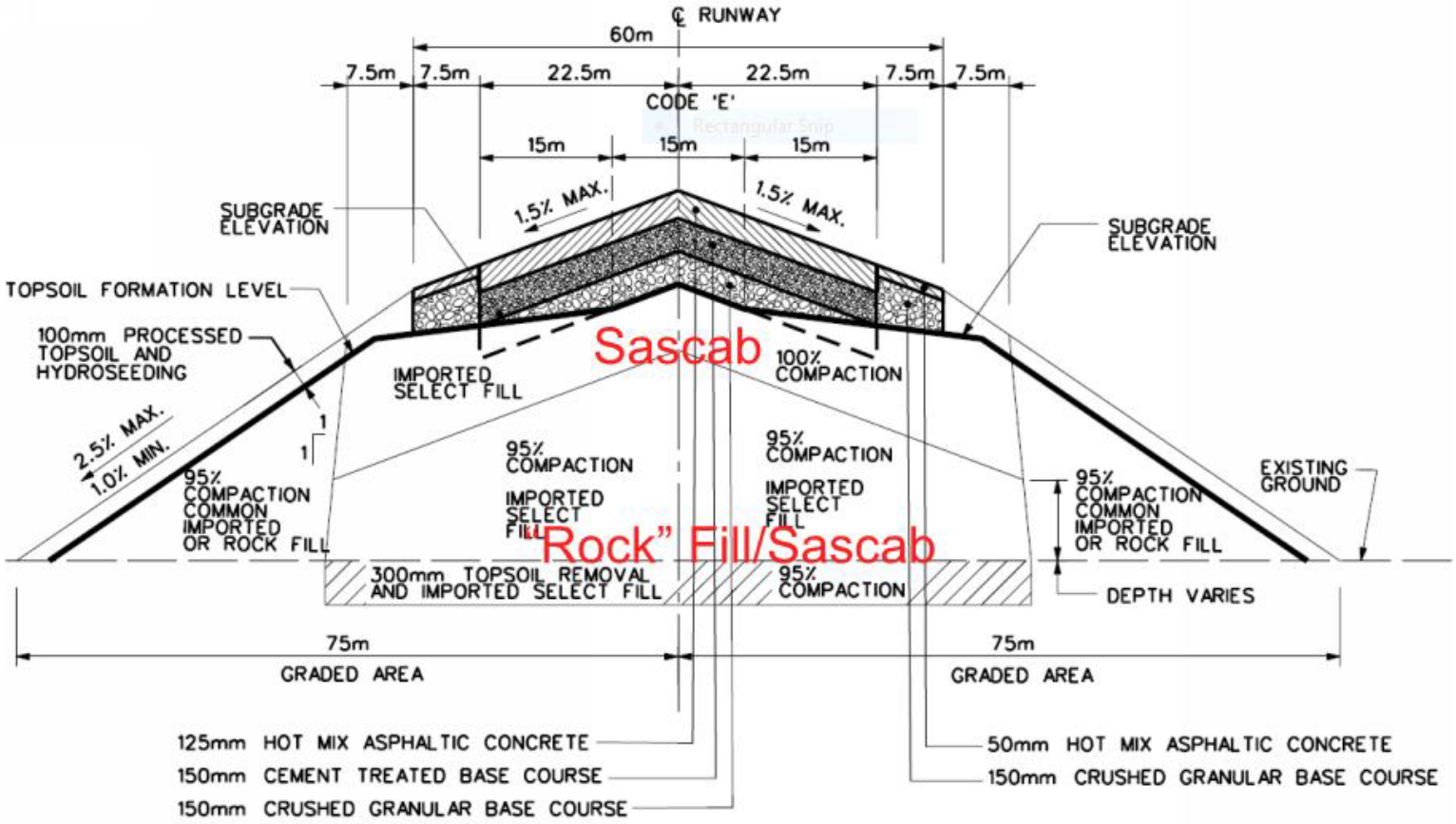
Cancun Pavement Design

- Flexible Design only as per contract, same as existing Runway
- FAA LEDFAA 1.3 and FAARFIELD initial version (2005/6)
- CBR on Repaired Subgrade and “Sascab” fill was maximum allowed: 28.5
- Final Recommended Section:
  - 125 mm HMAC
  - 150 mm Cement Treated Base (100 mm calculated)
  - 150 mm Crushed Granular Base (100 mm calculated)
  - 100% Modified Proctor Compaction (1000 mm below finished surface)
  - 95% Modified Proctor Compaction below 1000 mm
  - Expected Service Life (CDF) = 40 years (40 years left on concession agreement)

Cancun Typical Runway Section



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Inducing Cracks in Cement Treated Base Paving

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Case History 2 – New Parallel Runway at Calgary International Airport, Canada

Rigid Pavement and CTB

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New Calgary International Parallel Runway Fall 2014

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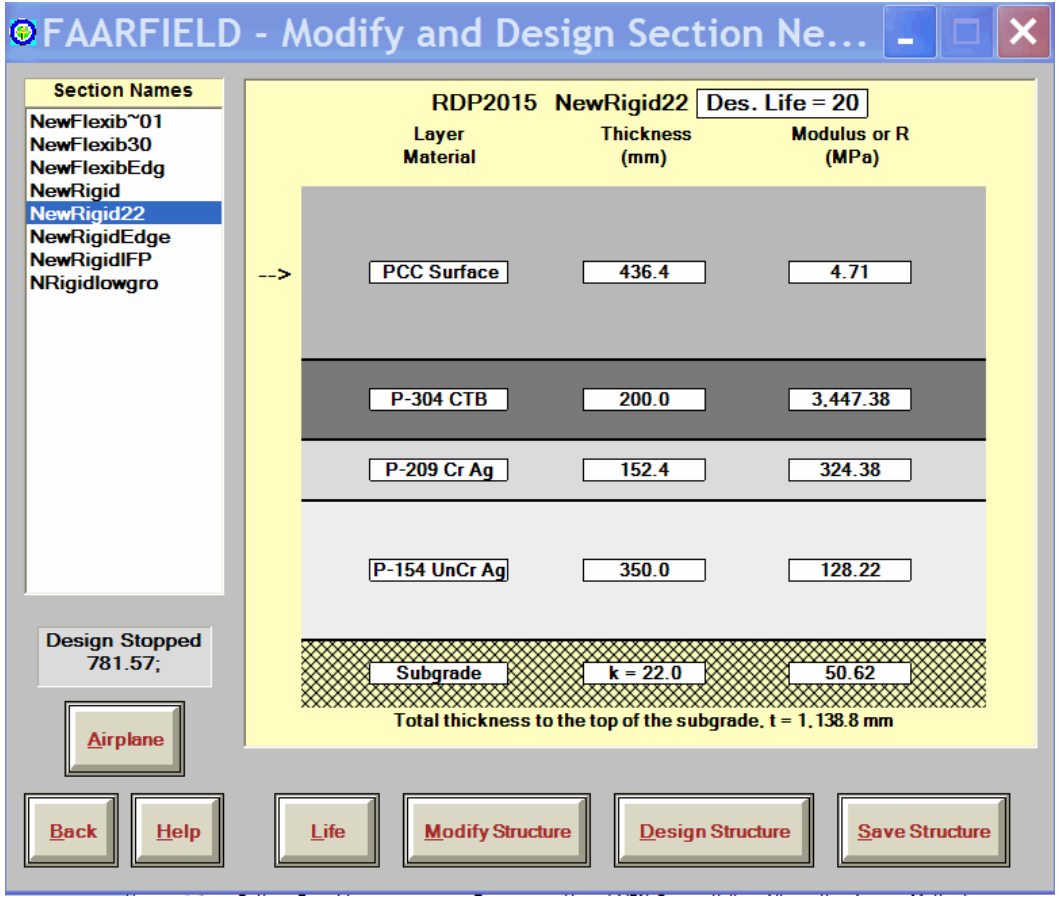
New Calgary Parallel Runway Data

- 4267 metres long (14,000 feet) – longest runway in Canada. CAT III for commercial attraction of Transpacific customers. Calgary is 1084 m above sea level.
- All Rigid Pavement
- Selection of Rigid Pavement during LCCA in Preliminary Design. Rigid was 12% less costly than Flexible Option for 40-year life.
- Followed both FAA and Canadian Transport Canada mandatory requirements to use cement stabilized base under PCC.

Calgary Runway FAA Rigid Pavement Section



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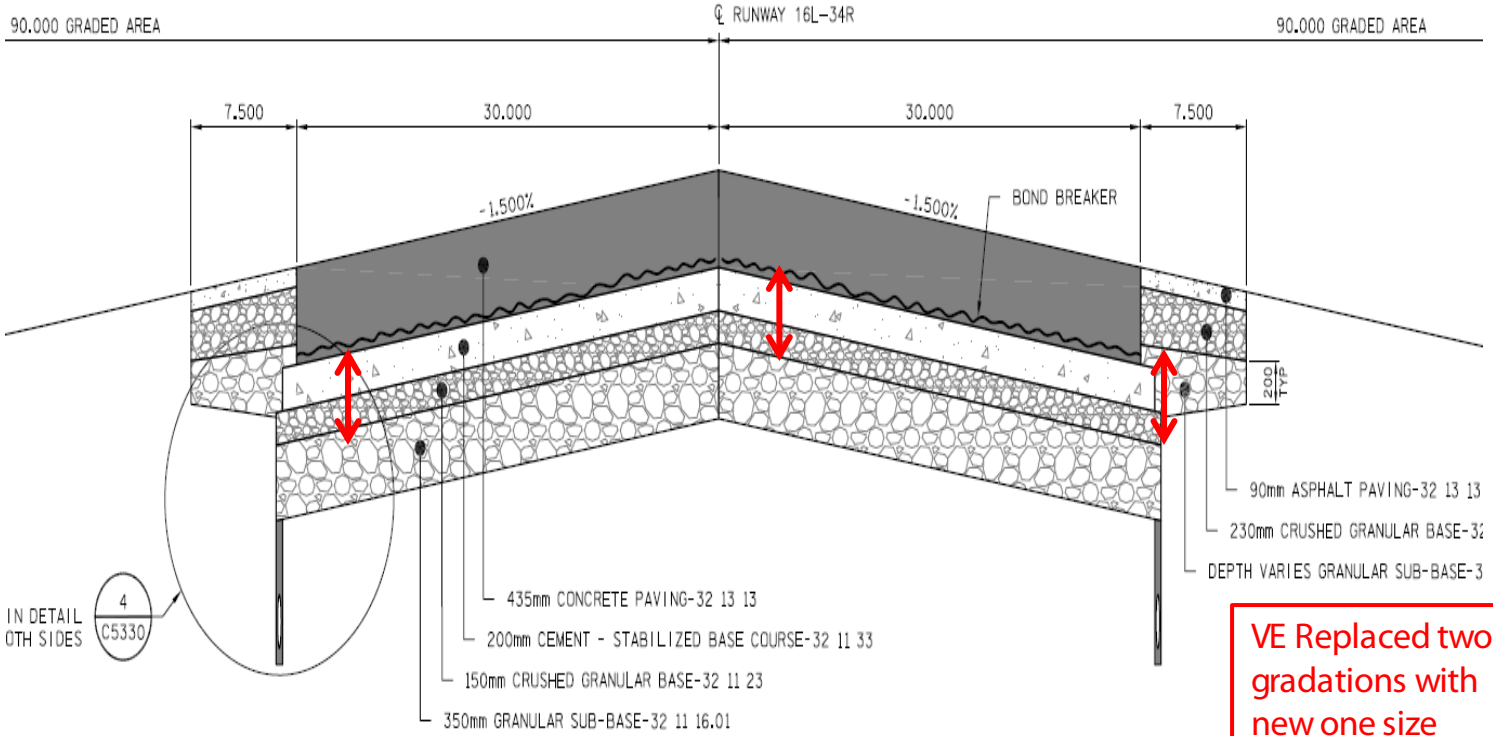
Calgary Pavement Details and Construction



VE Replaced two gradations with new one size Crushed Base

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Calgary Paving in 2013

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Calgary RWY Dowels and TDZ Can Installation on C

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Calgary Paving Trials – Good from the Start

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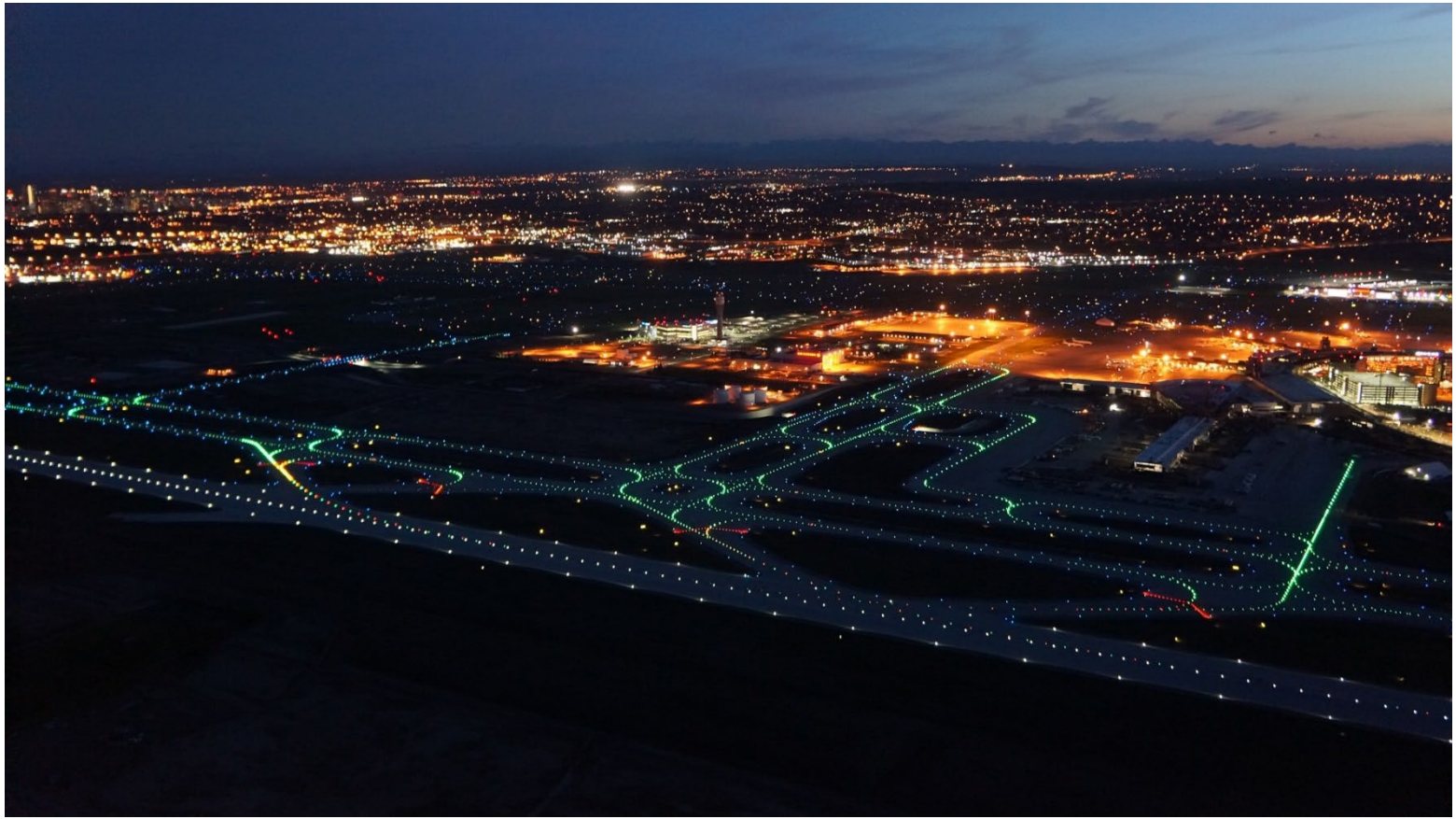
Calgary Runway All CAT III Lighting Turned On



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Recommended Properties of CTB

- Use a dense well-graded aggregate envelope – "banana" curve
- Limit 7-day compressive strength to 5 MPa (2 to 3.5 MPa)
- Induce joints if reflective cracking/excessive shrinkage an issue or strengths increasing significantly
- Obtain 98% modified proctor compaction as soon as possible – the cement is NOT your compaction agent.
- Apply adequate curing compound as soon as possible and re-spray to provide good prime coat or HMAC paving or de-bonding coverage prior to PCC paving

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