



PLR calculation for a remote Runway in the Alberta Oil Sands.

Ray Clement, P. Eng CBR Technology Inc.



SWIFT Conference | September 22nd, 2016 | Minneapolis, Minnesota

Outline

Background

- Site history
- CBR Technology's Boeing Penetrometer
- Initial geotechnical investigation & resulting report
- Misinterpretation of Geotechnical Information

Associated Engineering Investigation

• Concerns raised about the subgrade values

Attempt to re-confirm the original data using BP



Final Results

Alberta Oil Patch





Site "X" Paved Runway



Current predominant aircraft in use at the site

Dash 8 Q400

BAe 146





What the site wants to upgrade to



- Passengers, 108 132
- Cruise speed, 530 mph
- Range 3511 miles
- Max takeoff wght. 139,090lbs
- Length 102 ft.



Site Goals (2012)

- Looking for options on maintenance and rehabilitation
- 25 year old runway
- CBR Tech initiates a borehole testing



2012 CBR CORING PROGRAM



Boeing Penetrometer

September 14, 2012

CBR Geotechnical Investigation

TEST POSITION	Blo Coring Lcn on Rwy Avg CBR	Thickness (Asphalt Sa Depth G	in inches) andy Sandy iravel Clay	Fine Sand	Moisture	Top of Undisturbed Soil (TUS) 6 " blo TUS & 12" blo TUS CBR's	South Rwy Edge Avg CBR	North Rwy Edge Avg CBR		
East of West Turn Bay On Rwy Center Line	29,7	3,5	12" 29"	18"	16% N/A 7% to 13%	22 - 24 - 25 15 - 16 - 21 26 - 29 - 34	23,7	17,3		
1/4 distance east of west end North of cntr line	26,0	3,75	12" 38"	8"	20% 7% 15% to 17%	15 - 14 - 16 14 - 15 - 19 25 - 25 - 28	15,0	16,0		
1/2 distance east of west end on Rwy Center Line	23,7	3,75	18" 30"	10"	N/A 17% 16% to 18%	22 - 21 - 23 25 - 26 - 24 22 - 24 - 25	22,0	25,0	Avg CDD	20.9
3/4 distance east of west end South of cntr line	40,0	3,5	12" 0	44°	14% N/A 15% to 17%	25 - 24 - 26 15 - 18 - 17 40 - 40 - 40	25,0	16,7	Less stnd de	29.8 ev. 6.2
West of east Turn bay on Rwy Center Line	29,7	3,0	12" 29"	18"	N/A N/A	22 - 24 - 26 15 - 16 - 19 26 - 29 - 34	24,0	16,7	Valid CBR	23.6
MINIMUM CBR AVERAGE CBR LESS STD DEV VALID CBR	23.7 29,8 6,2 23,6	3,0 0,3 3,2					15,0 21,9 4,0 17,9	16,0 18,3 3,8 14,6	CB	GY INC.

APMS REPORT Oct 2012

Prepared on behalf of CBR Technology applying Transport Canada Manuals and Standards

Field CBR 23.6 – (25% spring reduction factor) = 18

- (CBR 18 translates to a Subgrade Bearing Strength (S value) = 206
- S = 206 kN

• EGT = 420 cm (t = 80x1,5 + 300 = 420 mm)

T.C. Design Curves

S = 206 EGT = 42 cm.

<u>PLR = 11</u>

PLR = 10.3

2012 -The world is good

- The Canadian PLR rating system goes from 1 -13, so;
- With a PLR of 11 you can land most types of aircraft on this airfield, but particularly in the clients case, 737's.

2015 Associated Engineering Study

- Identifies some concerns while reviewing previous reports.
- CBR Tech (Ray) asked to review their numbers.
- Review of APMS report shows that using the values provided, the numbers work out fine.
- However, a closer review of the borehole values from two separate geotechnical studies (CBR Tech and AMEC) may support AE's concerns.
- there is a sandy-clay layer within the base construction which may be the limiting strength factor.

TEST POSITION	Blo Coring Lcn on Rwy Avg CBR	Thickness Asphalt Depth	s (in inc Sand Gravi I	les) Sandy Clay	Ane Sand	Moisture	Top of Undisturbed Soil (TUS) 6 " blo TUS & 12" blo TUS CBR's	South Rwy Edge Avg CBR	North Rwy Edge Avg CBR
East of West					_	16%	22 - 24 - 25	23,7	1
Turn Bay On						N/A	15 - 16 - 21		17,3
Rwy Center Line	29,7	3,5	12*	29"	18**	7% to 13%	26 - 29 - 34		
1/4 distance east		1				20%	15 - 14 - 16	15,0	• • F.
of west end						7%	14 - 15 - 19	8	16,0
North of cntr line	26,0	3,75	12*	38"	8"	15% to 17%	25 - 25 - 28	6	ġ.
1/2 distance east						N/A	22 - 21 - 23	22,0	
of west end on						17%	25 - 26 - 24		25,0
Rwy Center Line	23,7	3,75	18"	30"	10"	16% to 18%	22 - 24 - 25		
3/4 distance east						14%	25 - 24 - 26	25,0	İ.
of west end						N/A	15 - 18 - 17		16,7
South of cntr line	40,0	3,5	12"	0	44"	15% to 17%	40 - 40 - 40		
West of east				-		N/A	22 - 24 - 26	24,0	
Turn bay on						N/A	15 - 16 - 19		16,7
Rwy Center Line	29,7	3,0	12*	29"	18"	20% to 12%	26 - 29 - 34		
MINIMUM CBR	23,7	3,0						15,0	16,0
AVERAGE CBR	29,8	3,5						21,9	18,3
LESS STD DEV	6,2	0,3						4,0	3,8
VALID CBR	23,6	3,2						17,9	14,6

Sandy-Clay 29 inches

September 14, 2012

38 inches

30 inches

0 inches

What happened?

- The CBR value used was for the bottom of the borehole at a depth of 5 feet.
- However, in the APMS report this value was used at the interface between the first sand layer and the top of the sandyclay layer.
- Therefore it was not indicative of the values for the sandy clay layer at a depth of approximately 1 below the surface.
- Objective: I would like to have an opportunity to use the BP to establish a CBR value at this depth

Fall 2014, I walked the runway

- Raveling (loss of surface aggregate)
- Weathering (loss of surface matrix)
- Iron Stone Pop-outs
- Fatigue cracking
- Rutting (hydroplaning potential)
- Alligator cracking (loss of support)
- Settlement
- Transverse cracking
- Longitudinal cracking
- Patching
- Map cracking
- Bleeding

CBR Technology follow up

Overall Assessment

- A 'qualitative' assessment of the runway condition is estimated at poor to fair.
- In order to provide a 'quantitative' evaluation a more detailed inspection would be required using ASTM Standard D5340.
- Subsequently, AE hired to provide a PCI, structural evaluation and rehabilitation options

Typical Oil patch Gravel Runway

2015, Exposing the base material layers

Exposing the base material layers

Making the repair

Site # 1

Typical smaller cut & repair

One year later (2016)

Site #1

One year later (2016)

Site #3

One year later (2016)

Site #5

2016 CBR results at top of sandy-clay layer

			CBR (Boeing Penetrometer)							
			/ # /	#2	#3	#4-	#5	# 6		
N4" A.C.	{	A. `A.`	A.C.	A.C. removed	k.c.removed	A.C. removed	A.C. removed	A.C. removed.	0	
	-3"	0	Carave removed	32	42	44 45	49	35	3″	
Gravel	6"	·			· · ·		43		6"	
а. Ф	.)''.	2' '	∇	. <u>-</u> .	· · ·	-			12."	
	15"		26	17	19		26	33	15''	
	18''		- 17	12	20	23	20	30	18"	
N 30"	21"		21		× • • • •		g e		21"	
Clay	24" 27"		20			Recall 20	12 value			
	30"	///	(8)			was 23.6				
	33"	1			- 				-	
		///								

AE / LVM HWD report

 For this assignment, the HWD test data and analysis provides a more reliable <u>method</u> for the pavement strength and subgrade value calculations primarily due to the number and frequency of test locations on the entire runway surface

LVM HWD

illustration of runway strength contours

Final Results (AE Report)

• "After the field testing and initial analysis was completed, discussions were held between AE, LVM and CBR to review the results. During the review it was agreed that a PLR of 7.2 is appropriate for (this) runway. There was considerable variation in the test results both between testing methods as well as in various locations on the runway. The average PLR value for HWD testing completed on the centreline of the runway is 7.4 and for the 3m offset on each side of the runway centreline it is 7.0"

Final Results (AE Report)

"Pavement structural capability is best determined through the combination of field observations, loadbearing tests and engineering judgement."

QUESTIONS

Oil Sands / Ft. McMurray

ALBERTA

Edmonton

SASKATCHEWAN

Canada

T. C. PLR to PCN conversion

Flexible Pavements

ICAOSubgrade Strength Category Code Letter Flexible Pavement Subgrade Strength – S (kN) – Range and Nominal Value

Canadian	A (High)	B (Medium)	C (Low)	D (Ultra Low)
PLR	>160	160 - 110	110 - 70	<70
Value	180	130	90	50
	Equivalent ICAOPa	vement Classification Number PC	CN	
2				4
3				6
4				9
5			12	13
6			16	19
7		16	21	27
8		23	29	37
9	24	32	39	50
10	38	43	51	64
11	53	57	66	81
12	68	72	83	101
13	80	88	103	124

For Category A: $PCN = 100.000 - (46.9401 * PLR) + (6.0420 * PLR^2) - (0.1963 * PLR^3)$ For Category B: $PCN = 75.0000 - (24.7528 * PLR) + (2.7623 * PLR^2) - (0.0603 * PLR^3)$ For Category C: $PCN = 15.0000 - (3.7769 * PLR) + (0.5096 * PLR^2) + (0.0230 * PLR^3)$ For Category D: $PCN = 5.0000 - (1.3799 * PLR) + (0.4657 * PLR^2) + (0.0264 * PLR^3)$

