ICEFIELDS PARKWAY ROCK SLOPES

PRESENTATION TO CSCE CALGARY Henry Crawford, P.Eng. APRIL 21, 2011





One of several contracts to twin Highway 1 through the National Parks

Image © 2011 DigitalGlobe Image NASA © 2011 Google

Imagery Date: 9/14/2002 2003

9/3/2003

lat 51.443002* lon -116.205214* elev 1569 m



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A Design-Build Project



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Outline of Talk

- Overview of Project
- Investigation Phase
- Rock Slope Design
- Catchment Ditch Design
- Other Design Issues
- Commentary on D-B





Key Players Owner: Parks Canada General Contractor: Graham Construction Prime Consultant: <u>CH2M Hill</u> Geotechnical Consultant: Thurber Engineering

The Project Included:

3.16 km of new carnageway











New bridge at interchange



Leveloridge over Bow Rive



Bid Phase – Geotechnical Role

- Review data/reports provided by Owner
- Conduct preliminary site reconnaissance
- Provide preliminary design recommendations for contractor to price project
- Very stressful!!





After Project Award....







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Detailed Design Phase

- Conducted limited test pitting program
- Limited test hole drilling for the bridge structures
- No drilling of rock slopes
 Image: Solution of the slope state o

Detailed site reconnaissance / Geological mapping of bedrock exposures

SITE GEOLOGY

- Precambrian Miette Group
- Argillite (slatey), sandstone and conglomerate
- Strong bedding foliation in slate
- Dips range from 60° to 70° to 20° to 25°
- Some fold features observed

Rock Cut Slope Design

- Map structural geology
- Divide cut areas into segments with similar rock structure
- Kinematic stability analysis of each segment
- Determine optimum slope angles based on kinematically possible failure modes and risk tolerance / <u>Owner's criteria</u>

Owner's Criteria?

- Keep rock exposures as natural as possible
- No "half barrels"
- No rock bolts
- No wire mesh
- No shotcrete
- Low Maintenance

Do you remember stereo-nets?

(b)

(c)

North Slope Segment 5 Planar Failure

North Slope Segment 3 Toppling Failure

Rock Cut Ditch Catchment Design

Empirical Methods

- Ritchie
- Whiteside
- ODOT

Modelling

- Rocfall
- CRSP

Example Design Charts

Roll

1:1 1.25:

D=4

40

W = 10⁴

50

Figures taken from FHWA Manual 'Rock Slopes' November 1991. USDOT Chapter 12 Page 19.

Rock Fall Modelling (RocFall)

Avoid intermediate benches!

ODOT Study (1994)

ODOT Study

Table 1 - Recommended Rock Catchment Ditch Dimensions Compared with ODOT Criteria

Segment	Chainage		Slope	Slope	Min. Ditch Dimensions ³		Actual Ditch Dimensions		Meets ODOT
	From	То	(m)	Angle	B (m)	D (m)	B (m)	D (m)	Criteria ⁴
EB TCH	75+210	75+290	6 to 10	0.7H:1V	6	1.25	10.7	1.5	Yes
EB TCH	74+920	75+000	6 to 10	0.7H:1V	6	1.25	10.6	1.3	Yes
EB TCH	74+670	74+790	16 to 20	0.7H:1V	7.5	1.5	10.2	1.5	Yes
EB – NB Ramp	0+257	0+310	7 to 9	0.7H:1V	7	1.25	10.1	1.6	Yes
SB–EB Ramp (Lt)	3+710	3+760	7 to 8	0.7H:1V	6	1.25	10.4	1.5	Yes
SB–EB Ramp (Rt)	3+790	3+800	2 to 5	0.25H:1V	4.5	1.0	10.0	1.2	Yes
SB–EB Ramp (Rt)	3+840	3+890	6 to 12	0.7H:1V	6	1.25	10.5	1.5	Yes
SB–EB Ramp (Lt)	3+850	3+870	6 to 8	1.0H:1V	6	1.25	9.4	1.1	Yes
SB–EB Ramp (Rt)	3+890	3+946	15 to 20	0.7H:1V	7.5	1.5	10.5	1.5	Yes
WB – NB Ramp	1+202	1+370	11 to 25	0.5H:1V	8	1.5	8.3	1.5	Yes
WB TCH	74+780	74+860	5 to 22	0.5H:1V	8	1.5	8.2	1.5	Yes
WB TCH	74+540	74+650	2 to 7	0.5H:1V	4.5	1.25	8.2	1.25	Yes
WB TCH	74+340	74+490	8 to 10	0.5H:1V	6	1.25	7.5	1.25	Yes

³ Based on B.C. Ministry of Transportation and Infrastructure Technical Bulletin GMO2001
 ⁴ Oregon Department of Transport Rockfall Catchment Area Design Guide" (Report SPR-3(032), dated November, 2001)

Construction Inspection

- Periodic inspections only
- Blasting
- Scaling

Other Geotechnical Issues??

Piling Through Coarse River Gravels

Pavement design for new carriageway and overlay section

HAPPY EASTER!!

