

Development of Design Tools for Convective Mitigation Techniques to Preserve Permafrost Under Northern Transportation Infrastructure



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Source: Fabrice Calmels, Yukon Research Centre



Differential Settlement









Embankment Spreading





It is essential to keep permafrost frozen underneath transportation infrastructure





To protect permafrost:

- Preventing heat intake
- Extracting heat from ground

It is essential to keep permafrost frozen underneath transportation infrastructure



• Preventing heat intake principle



7



• Preventing heat intake principle



8



• Heat extraction principle





• Heat extraction principle









Source: Modified from Ferell, 2010













Source: Modified from Ferell, 2010







1. Introduction -> Mitigation Techniques







Source: Modified from Ferell, 2010

1. Introduction -> Mitigation Techniques







2. Research Project -> Improve Knowledge on Mitigation Techniques



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2. Research Project -> Improve Knowledge on Mitigation Techniques







Project Goal:

Develop improved engineering tools for the design of convective protection systems

- Create a decision tool for selection of the most appropriate mitigation method, considering the local context and needs, from promising techniques already in use
- Develop design procedures for convective mitigation techniques, including heat drain and air convection embankment

2. Research Project -> Methodology





- One model to explore degradation, another to explore abilities of methods
- 4 field sites available to validate models

2. Research Project -> Methodology

Interface



Difference between temperature of permafrost and temperature at interface 'embankment / natural ground' Heat balance method will be used to :

- validate models (field data)
- test heat extraction ability of mitigation techniques

3. Preliminary Outcome -> Model Development





3. Preliminary Outcome -> Model Development





> A 2D thermal model was developed based on the control section at Beaver Creek, Yukon

3. Preliminary Outcome -> Model Development





A 2D thermal model was developed based on the control section at Beaver Creek, Yukon
The thermal model was well calibrated by the field data along the centerline

3. Preliminary Outcome -> Heat Balance





- > The chart of heat balance was obtained by sensitivity analysis
- > 2nd figure allows engineers to check if permafrost degradation is happening or not quickly

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- > 2nd figure allows engineers to check if permafrost degradation is happening or not quickly

3. Preliminary Outcome -> Validation From Another Site





The chart of heat balance was well validated by data at Tasiujaq, Quebec

4. Next Step





Heat extraction ability = f (controlling parameters)



Important to:

- Define field of application of mitigation techniques
- Develop a method for selection of mitigation techniques
- Propose design procedures for Heat drain & Air convection embankment
- Project schedule (this summer)
- Modeling study on going
- Analysis of field data on going
- Development of design criteria soon



QUESTIONS



