

February 27, 2019

Version 1.0
Matrix 5635-522

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Subject: Town of Golden Kicking Horse River Dike Improvement Project – Ice Loading Clarifications

Dear Ms. Anderson:

1 INTRODUCTION

This letter report has been prepared to provide the requested ice loading clarifications per the email query from Kieran Gaston (B.Eng., P.Eng., Design Engineer) of Read Jones Christoffersen Ltd. sent to Matrix on December 11, 2018 (as shown in italics throughout this letter). The ice loads discussed herein are applicable to the concrete dike wall design of the Kicking Horse River Dike Improvement Project, located in the Town of Golden, British Columbia. The information contained herein clarifies and is supplemental to information contained within the Hydrotechnical Design Report (Matrix 2018).

1.1 Static Ice (Thermal Expansion Loading)

CSA S6 indicates a 1500 kPa value. Do you have an estimate for the ice thickness in this case? It enables us to estimate the restraint on the opposite earthen embankment and thus reduce the 1500 kPa value.

Static ice is ice that forms in a continuous sheet due to cooling of the water surface. This ice can exert thermal expansion loads when a continuous ice cover forms across the river width or between structural elements, such as between bridge piers. Static ice loading is not expected along the concrete wall for the following reasons:

- The bank opposite the concrete wall is relatively shallow and along a low elevation island (Gould's Island). A complete ice cover would tend to slide up the island bank when expanding and not have a solid surface from which to exert pressure.
- Static ice cover would form at a low elevation on the riprap slope below the concrete wall. Again, the ice would not have a solid surface from which to exert pressure.

1.2 Ice Jam (Lateral Thrust Due to Arching Ice)

No recommended value indicated. CSA S6 indicates a 10 kPa lateral pressure for ice jams.

Ice jams are a common occurrence on the Kicking Horse River. The recommended design ice jam elevation and thickness was provided in the Hydrotechnical Design Report (Matrix 2018). The recommended lateral pressure of an ice jam is 10 kPa per the Canadian Highway Bridge Design Code (CSA Group 2017, Section 3.12.4).

1.3 Ice Impact (Dynamic Forces)

Given the description of this case as dynamic flood waves of ice and water (brash ice jam), would this case actually exert a lateral thrust on the wall that relates to the ice's crushing strength? It is our understanding that the wall would only need to resist a 'small' thrust to redirect the 1.5 m/s flow from a ~10 degree angle?

Impact of ice on the concrete wall can occur during ice jam formation, ice jam breakup, and intermittently throughout the winter as the result of ice javes (dynamic flood waves of ice and water). It is recommended that the concrete wall be designed to resist the dynamic force resulting from an impact and redirection of a 3 m thick ice floe (a floating mass of free ice) at a velocity of 1.5 m/s at an angle of 10 degrees to the wall (e.g., a velocity of 0.26 m/s perpendicular to the wall face). Because of the shallow angle of the flow to the concrete wall face, ice floes would not be crushed before being redirected.

2 CLOSURE

We trust that this letter report suits your present requirements. If you have any questions or comments, please call either of the undersigned at 403.237.0606.

Yours truly,

MATRIX SOLUTIONS INC.



David Kushner, P.Eng.
Hydrotechnical Engineer

DK/tmh

February 27, 2019

Reviewed by



Katy Curtis, P.Eng.
Senior Hydrotechnical Engineer

February 27, 2019

copy: Kieran Gaston, B.Eng., P.Eng., Design Engineer, Read Jones Christoffersen Ltd., Calgary Alberta

VERSION CONTROL

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V0.1	23-Jan-2019	Draft	5635-522 LR 2019-01-23 draft V0.1.docx	Issued to client for review
V1.0	27-Feb-2019	Final	5635-522 LR 2019-02-27 final V1.0.docx	Issued to client

REFERENCES

CSA Group. 2017. *Canadian Highway Bridge Design Code*. Reprinted July 2017. This reprint is being issued to incorporate Update No. 1 (April 2016) and Update No. 2 (July 2017) into the original 2014 Code. Mississauga, Ontario. July 2017.

Matrix Solutions Inc. (Matrix). 2018. *Kicking Horse River Dike Improvement Project, Hydrotechnical Design Report, Town of Golden, British Columbia*. Prepared for the Town of Golden. Calgary, Alberta. October 2018.

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