Transportation Safety Board of Canada | Bureau de la sécurité des transports du Canada

REASSESSMENT OF THE RESPONSE TO RAIL SAFETY RECOMMENDATION R07-03 – R04Q0040

ROADBED STABILITY

Background

At approximately 1440 eastern daylight time on 17 August 2004, 18 tank cars of Canadian National train U-781-21-17, a petroleum product unit train travelling from the Ultramar Canada Inc. refinery in Lévis, district of Saint-Romuald, Quebec, and bound for Montréal, Quebec, derailed at Mile 3.87 of the Lévis Subdivision, in the marshy area of the Grande Plée Bleue, near Saint-Henri-de-Lévis. Approximately 200 000 litres of gasoline and diesel fuel spilled into the marshy area, but the spilled product was recovered. There were no injuries.

A subgrade failure had occurred suddenly and without warning when all indications were that the track was in good condition and that there were no early signs of distress. The railway inspection technologies and procedures, mainly based on evaluations of track conditions at surface level, were not effective to assess the condition and the behaviour of the subgrade and detect the impending risk of collapse.

Many miles of Canadian railway tracks are built along rivers or across marshy areas where peat is present. Therefore, these locations are exposed to the conditions encountered in this occurrence. Given these circumstances, a better understanding of the failure mechanism and the effect of railway loading on peat subgrade is needed to mitigate the risks inherent to these types of organic soils.

The Board recognizes the efforts by the railway and the regulator to address the issues related to soil and rock slope stability. Industry has taken important initiatives such as the Railway Ground Hazard Research Program to better understand, identify, and mitigate risks relating to geology and the behaviour of railway track subgrade. These initiatives were focused mainly on slope stability and on the behaviour of soils of glaciolacustrine origin, even though the recent development of ground penetrating radar technology could potentially apply to peat areas.

The study commissioned by the TSB and carried out by the Civil Engineering Department of Université Laval determined punching shear as a failure mechanism. It also indicated that the areas where the tracks were built on saturated peat, and where surfacing work is required regularly to maintain the profile of the track, are areas susceptible to punching. The shear punching mechanism was consistent with site observations and integrated results from tests performed in the laboratory and in the field. However, additional research efforts are required to enhance understanding of their phenomena and reduce risk. Therefore, the Board recommends that:

> The Department of Transport and the railway industry conduct in-depth studies on the behaviour of saturated organic materials under cyclic loading.
>
> R07-03

Canada

Transport Canada's Response to R07-03 (April 2008)

In response to TSB Recommendation R07-03, CN has a project underway on the Edson Subdivision dealing with the behavior of peat under cyclic loading. The results are being shared with the Railway Ground Hazard Working Committee. In addition to this, TC is planning to conduct an in-depth study of the behavior of saturated organic materials under cyclic loading as recommended.

Board Assessment of Response to R07-03 (June 2008)

TC has acknowledged the deficiency and indicated that an in-depth study of the behavior of saturated organic materials under cyclic loading will be conducted. As it is too soon to evaluate the outcome of TC's efforts, the Board assesses the response to Board Recommendation R07-03 as having **Satisfactory Intent.**

Additional Response to R07-03 (June 2010)

TC has acknowledged the deficiency and indicated that TC is part of the Railway Ground Hazard Research Program Working Group and is completing research in this area.

Board Reassessment of Response to R07-03 (June 2010)

TC has indicated that research is underway, however, no details have been forthcoming. Therefore the Board reassesses the response to recommendation R07-03 to remain as having **Satisfactory Intent.**

Additional Response to R07-03 (December 2010)

The University of Alberta, under the direction of Prof. Derek Martin, is carrying out studies on soft soils. Two sites have been instrumented on CN lines, one near Edson at Mile 102.0 and the other one at Anzac on the Lac la Biche Subdivision Mile 286.9. A large amount of work has been done. Some remedial measures have been studied and seem to work reasonably well. However, there is still a lot of work ahead to better understand the issues and come up with operational criteria such as, "allowable car weight" and "allowable speed". "The Canadian Railway Research Laboratory", financed by TC, CN, CP and the Transportation Technology Centre Inc. (TTCI) and affiliated with TTCI and the University of Alberta, is conducting research focusing on cold weather operations and soft soils.

Board Reassessment of Response to R07-03 (February 2011)

Transport Canada and the railway industry are conducting in depth studies on the behavior of saturated organic materials under cyclic loading. The study is obtaining some positive results. In the meantime, the Board maintains the response to recommendation R07-03 as **Fully Satisfactory.**

Additional response to R07-03 (February 2012)

The Ground Hazard Research Team indicated that it is progressing on the project. However, an updated progress report is not available at this time.

Board reassessment of response to R07-03 (February 2012)

The Ground Hazard Research Project is ongoing. However, the research results have not yet advanced sufficiently to address the safety risks. Therefore, the Board maintains the response to Recommendation R07-03 as **Satisfactory Intent.**

Additional response to R07-03 (August 2012)

The Ground Hazard Research Team (i.e., TC, CN, CP and University of Alberta) has completed its study on vertical rail deflection under heavy axle loads (HAL). This study used a motion capture instrumentation system called the Shape Accel Array (SAA) to obtain measurements of deformations within the underlying saturated organic materials (peat) under the cyclic loading of a passing train. The chosen sites were along a rail embankment built in the 1920s over a peat mire formation in Alberta. The SAA indicated that there was deformation of the subgrade which did not recover before the passing of the next train.

The study results were used to develop a track rehabilitation strategy for locations involving saturated organic materials. At the test locations, timber piles were driven down through the peat approximately one metre into the underlying material for both sides of every second tie. Instrument measurements indicated that the majority of the load was effectively transferred through the piles to the underlying silty-clay material. It was concluded that the installation of piles within peat is an effective method of reducing the loading carried by the peat and thereby reducing the potential for degradation of the soft peat foundation. The research results have been published in a number of industry journals and the study reports have been circulated to the team members for field implementation.

Board reassessment of response to R07-03 (September 2012)

The Ground Hazard Research Project has conducted an in-depth study on the behavior of saturated organic materials under cyclic loading. The study results have been used to assess the foundation performance at various soft soil sites in Western Canada. With the development of a method for reducing the load carried by the saturated organic materials, the risk of derailments caused by the degradation of this type of subgrade material can be reduced. Therefore, the Board reassesses the response to Recommendation R07-03 as **Fully Satisfactory**.

Next TSB action

This deficiency file is **Closed**.