

**Update on Frozen Soil and Ground Settlement in Vicinity of Ventilation
Building #1
July 25, 2011**

SUMMARY OF ISSUE

The I-90 Connector Tunnel between the South Bay Interchange and Ventilation Building #1 is located beneath the railroad tracks to and from South Station. To construct this tunnel, a method known as Ground Freezing was proposed in 2000 to stabilize the surrounding ground as a portion of the tunnel was excavated. For the duration of construction, soil within the tunnel footprint was frozen, to depths as great as 130 feet below the ground surface. In 2002 the freeze plant was shut down and the slow and expected process of thawing the frozen soil mass began. While some ground settlement was expected, the thawing of the frozen soil during the past nine years has resulted in greater settlement than originally predicted. The settlement experienced beneath the railroad tracks suggests a potential void beneath the I-90 connector tunnel base slab. However, regular inspections to date of the reinforced concrete tunnel structure have not shown any signs of excessive stress.

To ensure that the tunnel structure is stable, MassDOT contracted with STV Parsons, an independent engineering firm, to evaluate the tunnel. [STV Parsons' preliminary analysis](#) found that, "While some sections (of the tunnel structure) have factors of safety lower than as specified by AASHTO (American Association of State Highway and Transportation Officials), the fact that they are over 1.0 indicates that these tunnel sections still have a capacity greater than the stresses they are experiencing." The full report is attached.

To date, the settlement has impacted existing highway utility and railroad infrastructure including a 42-inch-diameter concrete force main drainage pipe, which conveys storm water runoff from the ramps of the South Bay Interchange. The 345-foot long pipe runs beneath the railroad tracks at an approximate depth of 50 feet and connects to storm water pump station #8 located in Ventilation Building #1. The drainage pipe has settled up to approximately 8 feet from its original position.

The frozen soil settlement issue, its impact on MBTA rail lines and remedial efforts taken by the MBTA was raised at a February 3, 2010 Board of Directors meeting which subsequently appeared in the Boston Globe.

Engineering and geotechnical consultants continue to review data and perform analysis to track and ultimately project the degree of settlement. Current estimates show that ground settlement could continue to occur through 2014. Approximately \$3.5 million has been spent to date on mitigation actions and it is expected that an additional \$11.5 million will be spent in the near future. Planned engineering reviews will determine the full extent of the necessary remediation and the cost associated with this issue. Costs incurred to date and future remedial costs will be drawn from the \$408 million Central Artery Trust Fund.

IMMEDIATE ACTIONS

The MassDOT Highway Division, MassDOT Rail & Transit Division and Amtrak have been sharing data and monitoring the situation regarding the ground settlement.

Monitoring points on the railroad tracks and in the soil and utilities adjacent to the tracks continue to be surveyed on a regular basis. Coordination meetings are held among the affected parties every six to eight weeks, depending on the issues that arise. As necessary the tracks are tamped with additional ballast to maintain track elevations.

This item will remain ongoing until the thaw is complete.

Separation at the concrete drainage pipe joints has been detected. A limited grouting program and special gaskets were installed inside the pipe to address this. This work was completed under a \$332,000 contract using approved CA/T Trust Fund request CRC11A. The plan is to continue to monitor the pipe condition and joints.

This item is complete.

In the event that the concrete drainage pipe is damaged due to excessive ground settlement, an emergency bypass pumping system has been installed. The temporary emergency bypass pumping system has been constructed to convey storm water coming from the South Bay interchange to the Boston Water and Sewer Commission (BWSC) storm water system, using temporary pipes and pumps. The bypass cost was \$1.2 million and the work was also performed using CA/T trust fund request CRC11A.

This item is complete.

An electrical duct bank conveying high power (13.8kv) for the MBTA Redline subway was underpinned to prevent ground settlement-related failure due to elongation or sag.

This item is complete.

Settlement in the back corner of the United States Postal Service parking lot has caused interruptions in access.

The area is repaved as necessary to maintain property usage.

NEXT STEPS

At one location, the railroad tracks near South Station have been tamped approximately eight feet over the last eight years. Consequently the thickness of the ballast now exceeds track design standards. To address this, Amtrak will have a Contractor remove and replace the excessive “ballast pocket” with sand and gravel this summer.

Contract is at 100% and procurement of a contractor is underway.

The settlement data suggests that a void may have formed beneath the I-90 connector tunnel base slab, due to thawing of the underlying clay soils. As settlement of the clay soils continues, potential voids beneath the tunnel base slab may increase in depth. MassDOT has surveyed and inspected the tunnel, and has yet to find any indicators that the tunnel is stressed in excess of its capacity. As noted, an initial review by STV Parsons has determined, “Based on monitoring data provided to date, it is not anticipated the ongoing settlement below the tunnel will significantly increase the lateral extent of the potential void area or influence the subgrade modulus of the tunnel foundation soils. Therefore, assuming the loading conditions remain constant, it is expected the results of the structural model would not be significantly impacted by the continued settlement in the former deep freeze area below the tunnel.”

MassDOT will continue to monitor and STV Parsons will continue to evaluate the condition of the tunnel sections while final plans are developed to delineate and mitigate the potential voids. In addition to routine inspection procedures, the following initiatives will be undertaken to ensure the structural integrity of the tunnel:

1. Locate concrete placement (construction) joints in the structural roof, roadway slabs and walls between stations 21+59.74 and station 25+30.24 and continuing to station 26+90.
2. Inspect construction joints for signs of movement, distress and leakage. This includes joints identified in Item 1 above and those shown on the plans, particularly the horizontal joints in the side walls near the base slab and roof slab. One method to monitor and record movement across the joints would be to install strain gages or digital crack gauges.
3. Inspect joints at the intermediate jacking stations for signs of movement, distress and leakage.
4. Inspect joints at the interface of jacked tunnel and cut and cover tunnels for signs of movement, distress and leakage.
5. Inspect the walls and roof slab for cracks, movement, distress and leakage. Pay particular attention for any longitudinal cracks within the middle two-thirds of the walls and slabs.

6. Inspect the infill concrete and pavement for evidence of cracks, movement, distress and leakage in the underlying base slab.
7. Survey roadway elevations along both curb lines to monitor vertical displacement of the tunnel. Follow the existing protocol or establish an alternate protocol that will allow for reestablishing stable control and survey points. Survey points should include intermediate jacking stations and intermediate points at 25 foot intervals.
8. Inspect ventilation ducts, walkway railings, tiles and components of mechanical and electrical systems, particularly in areas of intermediate jacking stations, for signs of movement.
9. Attachments by the use of expansion/drilled anchors to the underside of the roof slab and walls should be inspected. The concrete adjacent to the anchors should be inspected to verify its integrity and identify any signs of deterioration.

LONG TERM SOLUTIONS

The 42" pipe will need to be replaced due to damage from the settlement. This will involve jacking a new pipe parallel to the original pipe location. This will be done after the frozen soil has thawed and the settlements are normalized.

Further investigation and analysis may result in proposed permanent repairs to the area below the I-90 tunnel box. This work would also be completed after the ground has finished thawing. Interim repairs would be performed as necessary based upon the analysis.

CA/T TRUST FUND REQUESTS

Trust Fund Request CRC 11, which included the South Station Rail Yard Ground Freezing issue, was approved on 12/24/08, for \$600,000. The scope of this request was investigation, monitoring, and design; it was anticipated a subsequent request would be developed as the scope was further defined.

Additional funding requested in Trust Fund Request CRC 11A was approved on 12/08/09 for \$7.3 million. This provided funding for the continuation of the monitoring and investigation, as well as utility remediation and ballast repair. It was agreed with FHWA that should any funds be recovered (for example, from insurance) they would be deposited back into the Trust Fund. Any additional funding necessary to implement remediation of identified issues was to be requested via a subsequent Trust Fund Request (i.e. CRC 11B)

COST RECOVERY

The parties have spent significant time negotiating resolution of the ground settlement issue with the General Contractor that designed and performed the freezing, Slattery, Interbeton, White and Perini, JV (SIWP). As early as 2008, CA/T put SIWP on notice about potential backcharge for this issue. While progress has been made to negotiate a credit from the contractor, specific terms have not yet been agreed upon or incorporated in an executed contract modification. The parties have continued to negotiate in an attempt to resolve this issue.

Any settlement agreement with the Contractor is expected to allow each party to pursue recovery from insurance sources.

The general liability carrier for the CA/T Project Owner Controlled Insurance Program (OCIP) has been put on notice. MassDOT has submitted a Proof of Loss to the CA/T Builders Risk carrier. MassDOT and MBTA have also submitted a claim to the MBTA's Railroad Protective carrier. At this time, there is no forecast concerning the amount or timing of any insurance recovery as the carriers are still in the process of investigating the claim, and MassDOT is responding to various requests for information from the carriers.