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Cumulative economic damages in permafrost based on an example of a linear infrastructure (Railway Khanovey – Pesets)

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In permafrost zones, the deformations of railroad tracks is typically initiated during the construction processes and largely depends on the specific construction method used and the permafrost conditions encountered. The construction of a railway line modifies the heat transfer conditions at the surface. The change in the thermal state of the foundation caused by the construction further results in a modification of the physical characteristics and the mechanical properties of the soil and rock. However, settlements of the railroad embankment and tracks may also occur naturally in response to climate change. To prevent unwanted railroad deformations, foundation conditions must be known for the engineering design and for an accurate implementation of engineering solutions.

Vertical settlements are the dominant type of deformation of the roadbed that has been observed on the railway line between Khanovey and Pesets in Russia. Settlements begin to appear during late summer, but do mainly occur in September and October. The settlements are believed to be associated with permafrost degradation and gradual lowering of the permafrost table. The areas of settlement occur where the seasonal frost no longer reaches the permafrost table and a layer of continuously thawed ground form. Where large taliks are present and in areas where the seasonal frost depth equals or exceeds

the thaw depth in summer (active layer), generally, settlements do not occur.

The main reason for the permafrost degradation is the change in the thermal regime initiated by the construction of the railway. The construction of a railway in permafrost area affects the natural conditions of and the location of the permafrost table. Permafrost degradation can further be accelerated by using inadequate methods and procedures during the construction of the railroad bed, such as removal of peat. Drilling confirmed that the vegetation layer was removed during construction of the embankment.

These settlements may result in significant economic losses, which include, direct loss of material, structural damage to railroad infrastructure and indirect economic losses due to the interruption of railroad services. As highlighted, the permafrost in the area is affected by changes in seasonal freezing and thawing as well as human impacts. The standard depth of seasonal frost, according to the Building Regulations 2.01.01-82, for the soils encountered in the area is up to 2.5 m. Further, following the Manual for Designing Foundations of Buildings and Structures p.2.135., t39, the soil is classified as having a strong frost heaving potential. We present research that assessed the accumulated economic costs of long-term operation under a changing climate along the Khanovey - Pesets rail line.