# Effect of Freeze-Thaw Cycles on Bank Erosion Rate of Bedrock

*Jagriti Mishra[1], Takuya Inoue[1]

1. Civil Engineering Research Institute for Cold Region, Sapporo - Hokkaido, Japan

Freeze-Thaw erosion happens when water penetrates through the cracks in rocks; freezes, and expands in volume, making the cracks bigger and eventually the rock weaker. Freeze-Thaw induced erosion accounts for 24% of the world land area and 55% of the total land area of the northern hemisphere making it the third major erosion type after water erosion and wind soil erosion. Even though, the effect of FT is massive, knowledge regarding how it effects rivers is scarce.

In this study, we have made an attempt to explore the change in the rate of erosion followed by a series of Freeze-Thaw cycles. We collected specimens from Rekifune river in Hokkaido, Japan. Each specimen was circular with a diameter of 220mm and height of 50mm. The specimens were immediately kept in air cushions to keep from drying, freezing or shock during transportation. In laboratory, until the test, the specimens were kept at room temperature, completely submerged in water to prevent the specimens from changes in water content.

Specimens were put through freeze-thaw cycle using a Freeze-Thaw Apparatus shown in Fig.1. The minimum temperature maintained to achieve freezing of the specimens was -18℃. The maximum temperature of the apparatus was maintained at 20℃ in order to achieve thawing of specimens. The time taken to achieve minimum and maximum temperatures was 3hours and 4hours respectively. The specimens were maintained at minimum and maximum temperature for 0.5 hours each. The total time taken for an entire cycle of freezing and thawing was 8 hours. After 1 cycle of FT, the surface layer peeled off; After 2$^{nd}$ cycle, the surface started getting flaky and peeling off; After 3$^{rd}$ cycle, a thin surface layer peeled off and the specimen disintegrated and couldn’ t be prepared for another FT cycle. The tensile strength of specimens decreased considerably after first FT cycle itself. The erosion rate of the specimens was measured using a rotation mill. The erosion rate of specimens decreased exponentially as shown in Fig.1. However, these samples were artificially frozen and thawed in a dry condition. In order to study the effect of FT cycles in wet conditions, we performed another set of experiments with specimens completely submerged in water. These specimens were kept outside the laboratory in order to study the effect of FT in natural conditions. The specimens were submerged under 400mm water depth. The top layer of the water was frozen within 1 night of setting up the specimens. After 1 month, the specimen was tested for its erosion rate. The erosion rate of the specimen became 2 times of specimen not put through FT cycle. Moreover, as shown in Fig.2; the specimens were flaking and disintegrating by itself due to FT. These results suggest that FT effects not only river banks, but river bed as well.

Keywords: Freeze-Thaw weathering, erosion rate, bedrock

 

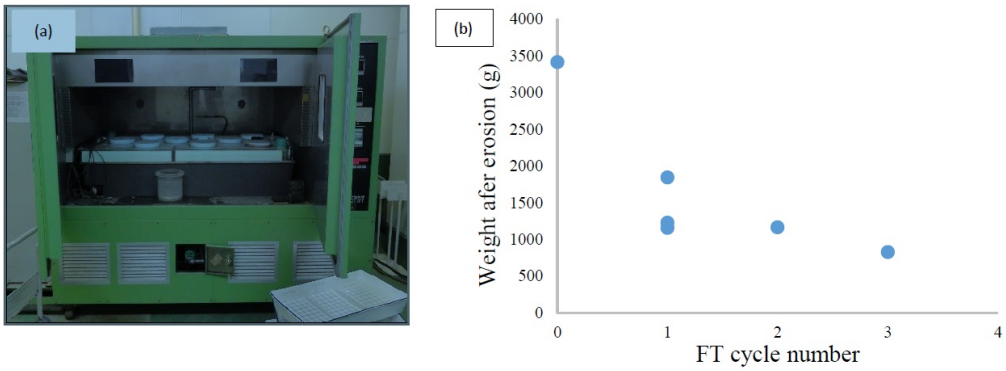


Fig.1 Experiment performed in dry conditions

(a) Apparatus used for mimicking FT cycle (b) Graph showing decrease erosion rate with respect to number of FT cycle.

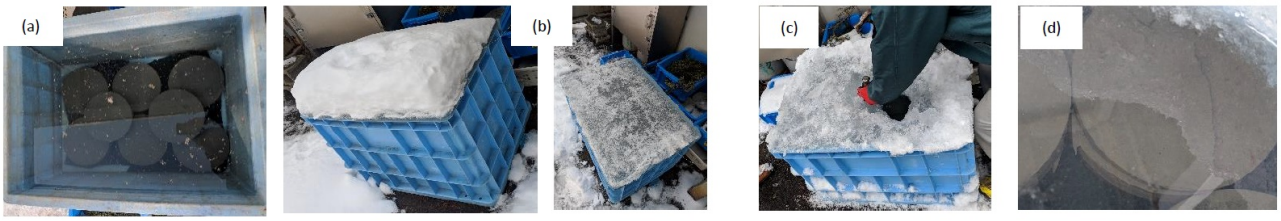


Fig.2 Completely submerged specimen in natural FT conditions

(a) Specimen submerged under 400mm water depth (b) The top layer of water is frozen (c) Breaking the top frozen layer using chisel and hammer to extract the specimen (d) It can be seen that the sample is flaking under water.

 