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The Effects of Reclaimed Asphalt Pavement on the Frost Susceptibility of Soil

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Our roadways and pavements are an essential part of our daily lives. Quality road systems have raised the quality of life from the days of the Romans until this very day. Roads are vital parts of shipping, thereby providing us goods and services, of the military, thereby providing us protection, and of general transportation, thereby providing us with opportunities to expand both physically and mentally. Due to the importance of our roads and highways, it is very critical that our roads are kept in good functional condition. The pavement that makes our roads is the key to keeping them usable.

Frost can be very detrimental to pavements. In cold regions of the world, frost heave is one of the main mechanisms that can damage and reduce the usability of our roadways. Frost heave is simply the act of water freezing in the soil structure that is supporting the roadway. As the water in the soil freezes, the ice draws up more water through capillary action, and that water freezes as well. Soon, an ice lens forms in the soil and causes the soil to heave. In the spring the ice lenses thaw and saturate the underlying soil with water. This severely weakens the soil that is supporting the roadway, causing the roadway to experience distress and eventually complete failure. There are at least three conditions, all of which must exist before frost heaving can occur. These three conditions are: a sufficiently cold climate to allow freezing temperatures to penetrate below the road surface into the underlying soil, a supply of water from below, above, or laterally into the freezing zone, a soil material that is frost susceptible and is lying within the freezing zone.

Of these three conditions, typically none of them can be totally controlled. However, treating the underlying soil is the most feasible and cost effective method of limiting or eliminating frost heave problems in the pavement. Many treatments have been attempted and researched in the past including but not limited to replacing the soil, adding lime, and adding cement. My research focused on an additive that has not been researched until now.

Reclaimed asphalt pavement is simply old asphalt pavement that has been ground up. A typical practice in recycling this asphalt pavement is to add it to the roadbase, which is the soil directly beneath the asphalt. Because of this widespread practice, we looked at the effects that adding this reclaimed asphalt pavement would have on the frost susceptibility of the soil. Our hypothesis was that the soil would experience decreased frost heave with increased concentrations of reclaimed asphalt pavement.

Our experimental design was a full factorial design, which means that all levels of all factors were crossed. We tested three different types of materials. These materials included roadbase from UDOT, roadbase from Morgan, Utah, and silt from Sunroc. We also tested five different contents of reclaimed asphalt pavement. These concentrations included: 100% reclaimed asphalt pavement, 75% reclaimed asphalt pavement and 25% soil, 50% reclaimed asphalt pavement and

50% soil, 25% reclaimed asphalt pavement and 75% soil, and 100% soil. We also performed 2 repetitions of testing of each blend of soil and reclaimed asphalt pavement. In total this equals 30 different specimens tested.

Our testing procedures included creating specimens to simulate a roadway. Our specimens were approximately 6 inches in diameter and 9 inches in height. The specimens were compacted at their optimum moisture content. A surcharge weight was placed on top of the specimens in order to simulate the roadway on top of the soil. After the specimens were created, they were placed in a tank of shallow water, coming up about 2 inches on the specimen, thereby providing a water source for the frost heave to occur. The tank of water and the specimens spent 10 days in an environmental chamber that was kept at -7°C, thereby providing extended cold temperatures for freezing to occur. Thermocouples were placed in 3 specimens at one inch increments. The thermocouples recorded the temperature gradient the specimens experienced throughout the test. Also linear variable differential transformers (LVDT) measured and recorded the height changes of the specimen throughout the ten days of the test.

Our results generally supported our hypothesis. As the reclaimed asphalt pavement content increase, the frost heaving experienced by the soil decreased. These results are presented in figure 1.

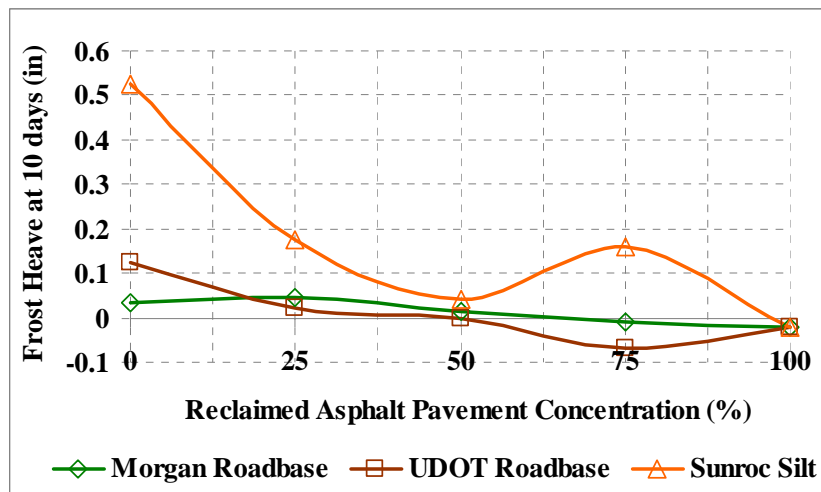


Figure 1. Frost heave experienced by varying reclaimed asphalt contents and soil types

This research has been a tremendous experience. It not only affects me and my decisions as a future civil engineer. This research has the capability of effecting decisions of other engineers, contractors, departments of transportation, and other public officials with regards to our roads and highways. There is also more research and different aspects of this research that we are looking at right now. For example we are looking at the strength of the soil after it experienced frost heave and thawing. I have discovered that this research project and the things that we have learned can affect our lives and the quality of life for those that follow us.