# GEOPHYSICAL ANALYSIS OF PERMEABLE PAVEMENT INFILTRATION DURING SIMULATED RAINFALL EVENTS

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As flooding events increase in frequency and intensity in response to climate change, permeable pavement offers a method of flood mitigation that can reduce surface runoff in developed areas as well as promote direct aquifer recharge. The reduction of surface runoff helps to limit erosion, pollution, demands on waste-water treatment, and potential hazards. In 2021, an infiltration test station was developed in Storrs, Connecticut to evaluate the relative efficacy of permeable pavement relative to natural soil during simulated rainfall events, and to demonstrate remote and autonomous geophysical methods to continuously monitor long-term infiltration. The test site consisted of four plots: two with permeable pavement pads, one natural soil, and one impermeable control plot. Each plot was approximately 2.5 meters squared and had electrical resistivity probes installed to depths of approximately 1 meter. To replicate precipitation, three watering wands were connected to a constant water source, secured to a fixed structure, and centered above each plot at a height of approximately 0.75 meter. Three of the plots were watered for a three-hour period while the covered control plot was not. Before each test, desired flow rates were calibrated by collecting a targeted volume of water over a set time interval from each wand. Predetermined flow rates were calculated to approximately span the range of local rainfall rates. A 0.5-inch/hour flow rate was used to emulate light rainfall, a 2-inch/hour flow rate for moderate rainfall, and a 4-inch/hour flow rate for torrential downpour. Relatively minimal ponding was observed on the porous pads during testing, but as simulated precipitation rates increased, so did surface runoff. Modifications were made to accommodate the higher test rates, reduce surface runoff, and ensure vertical flow through the pads. A challenge of assessing permeable pavement efficacy is understanding the recharge impact within the subsurface. To overcome this challenge, time-lapse electrical resistivity probes were installed below each plot. The data collected from these probes were automatically uploaded to Subsurface Insights for processing and visualization. During the test, the probes recorded sudden drops in apparent resistivity, which were interpreted as infiltration in direct response to the simulated rainfall. As these probes measured resistivity along the length of the probe itself, a 1-dimensional profile of infiltration over time was observed. As contact resistance varies between probes, data were plotted relative to a temporal datum to compare infiltration responses between pavement plots. The data exhibited a sharp decrease in resistivity within a few minutes after the artificial recharge events began, followed by a sudden rebound in resistivity at the conclusion of each test, which lasted several hours, and then a gradual attenuation to pre-test values within approximately 1-1.5 days. The rapid response times indicate that both concrete pads have high permeability and similar attenuation rates to the natural soil, which demonstrates the permeable pavements have a comparable rate of infiltration and do not retain water for a longer period than the natural soil. These results suggest that infiltration through permeable pavements reasonably simulates infiltration through natural soils and may have promising applications as an alternative to impermeable pavements and structures as the demand for flood mitigation technology increases with the increase in flooding events. Additionally, these results demonstrate the successful application of remote autonomous resistivity probes to monitor recharge beneath permeable pavements. Such monitoring technology is important for municipalities and stakeholders to evaluate permeable pavement effectiveness and inform maintenance cycles.