INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: A Study on Soil-Plant-Atmosphere Interaction for Green Infrastructure

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The presence of vegetation in the upper layer of vadose zone results in complex moisture dynamics (soil-plant-atmosphere interaction) due to the combined effects of transpiration and soil water evaporation. Unsaturated soil-root composite hydraulic properties, transpiration and soil water evaporation and effect of plant parameters (i.e., leaf area index (LAI), grass density, shoot length (SL) and stomatal conductance) on soil property are keys for understanding this complex moisture dynamics. Plant parameters and unsaturated soil properties were not considered holistically by previous researchers to understand soil-plant-atmosphere interaction. The main objective of this study is to explore the soil-plant-atmosphere interaction by considering the soil (cracks, suction and hydraulic conductivity) and plant parameters (vegetation density, LAI and stomatal conductance) together. Effect of crop and non-crop species growth on crack intensity factor (CIF) were investigated in the current study. In addition, effect of plant parameters on evapotranspiration induced suction was numerically analyzed. It is evident that large number of sensors are usually installed to monitor the suction in geotechnical infrastructure. Therefore, a non-intrusive and economical technique was developed to differentiate the 1) mix grass cover under tree shade (MUT); 2) mix grass cover under self-shade (MUS) and 3) mix grass cover without shade (MWS) in relatively large areas. Changes in stomatal conductance and surface area of vegetation at high suction ((high suction; > 100 kPa) were rarely investigated previously. Hence, effect of suction on stomatal conductance and surface area was investigated in this study. Furthermore, spatial and temporal heterogeneity of hydraulic conductivity in green space was rarely focused. Field monitoring was conducted in an urban green space to understand the spatial and temporal heterogeneity of surface hydraulic conductivity

during the life period of mix grass. It is known that suction and surface hydraulic conductivity are interpreted from soil surface water content. Non-invasive and cost effective technique is vital to interpret soil surface water content. Therefore, colour analysis technique was demonstrated to interpret soil surface water content. This study on soil-plant-atmosphere interaction helps to analyze the performance of green infrastructure accurately. Correlations were found between shoot parameters (SL, LAI, vegetation density) and CIF for the selected crop and non-crop species. Numerical analysis revealed that changes in shoot and root parameters could alter the suction by 11 % - 300 %. In addition, time required to attain wilting point was found to depend on plant parameters. Two new relationships i.e., Stomatal conductance characteristic curve (SCCC) and surface area characteristic curve (SACC) were found. The elementary hypothesis of spatial uniformity of surface hydraulic conductivity during life span of mix grass was not found to be true from the present study. The spatial and temporal heterogeneity of surface hydraulic conductivity was found mainly due to non-uniformity in grass growth and tree shade.