INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

In this work, an effort is being made to obtain an analytical solution to the problem of groundwater flow into a network of equally spaced ditch drains in a stratified soil underlain by an impervious barrier. The problem is being solved for a few of its variants resulting from different locations of water level in the ditches. All these solutions can tackle both a constant as well as a variable ponding distribution at the surface of the soil. Also, in the first instance, solutions to the problem and its variants are obtained by assuming the flow as two-dimensional in a defined drainage space; this supposition next is been relaxed and the problem with its variants are then solved by considering all the three components of flow in the defined flow space. The separation of variables method along with necessary Fourier expansions are being used to solve all the problems considered for study – the separation of variable method for obtaining solutions to the governing groundwater flow equation corresponding to a problem and the Fourier runs for satisfying the boundary and initial conditions pertaining to the problem. The accuracy of all the solutions is being checked by comparing with the works of others for specific situations; numerical checks on them have also been carried out. All the proposed steady state solutions are new, exact and are valid for all possible variations of parameters associated with them; however, the corresponding transient solutions are approximate in nature and are strictly valid only when the directional conductivities and specific storage of a multi-layered soil satisfy certain pre-defined relations among each other. As a large number of transient ponded drainage situations can be studied even with these imposed restrictions, the proposed transient solutions are also expected to find wide use in studying time dependent behavior of these situations as well. From the study it becomes clear that ponded drainage in a stratified soil is highly influenced by the directional conductivities and specific storage of the constituent layers and that neglecting the stratifications of a layered soil column (i.e., assuming a stratified soil as a single-layered one) may lead to a serious error in reading the hydraulics of flow associated with such a system. It has also become amply clear from the study that ponded drainage of a stratified soil is pretty sensitive to the water head of the recipient drains and also the nature of the ponding distribution at the surface of the soil. A uniform depth of ponding at the surface of the soil results in mostly unequal movement of water in a ponded drainage space with regions close to the ditch accounting for most of the flow to the drains and the regions away from the ditches accounting for a very low proportion of it into the drains. Thus, reclaiming a salt-affected soil with a uniform depth ponded drainage system

would mostly lead to non-uniform cleaning of the soil profile – regions adjacent to the drains will be unnecessarily more cleaned and regions away from the drains less cleaned. However, by providing a progressively increasing ponding head towards the half-way distance between the drains, the uniformity of water movement in a ponded drainage system can be greatly improved. Another important point that has come of the study is that the presence of a very lowly conductive soil layer (like, say, the presence of plow-sole layer in a paddy field) over that of relatively more pervious layer may help considerably in improving the uniformity of water movement in a ponded drainage system, even when the soil is being subjected to a constant depth of ponding at the surface of the soil. As soils in nature are mostly stratified and heterogeneous, it is hoped that the general ditch drainage theories provided here for stratified soils prove to be important tools towards understanding of subsurface water movement into open drains under water logged conditions.