

THESIS

**EVALUATION OF DRAINAGE MODELS FOR TILE
DRAINAGE PROJECTS IN PAKISTAN**

Submitted by

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ABSTRACT

A number of drainage equations are available for calculating the drain spacing of pipe drainage system. Each drainage equation has its limitations to calculate the drain spacing and thus may or may not be used for the drainage design for a particular project depending upon the project conditions.

This study was conducted to determine the applicability of and effect of various drainage equations, which were used in Pakistan in past on drain spacing for different pipe drainage projects. The drainage equations evaluated for this purpose include: Hooghoudt, Ernst, Modified Donnan and Kirkham-Toksoz drainage equations. Three drainage projects were selected for study: Fourth Drainage Project, Faisalabad, Khushab SCARP and Swabi SCARP. The soils of these projects consisted of different strata. The Fourth Drainage Project consisted of two layered soil and the Khushab SCARP consisted of two and three layers with heterogenous and stratified soils. The Swabi SCARP consisted of homogenous soil with single layer.

The drainage equations were used according to the limitations of the drainage equations and the hydro-geologic conditions of the projects. For this purpose, spread sheets on Lotus 123 package were developed to calculate the drain spacing for Hooghoudt, Ernst and Modified Donnan equations whereas for the Kirkham-Toksoz equation a computer model was used.

In view of the hydro-geologic conditions of different projects it was found that the drainage design for Fourth Drainage Project could be based on Modified Donnan, Ernst and Kirkham-Toksoz equations. For Khushab SCARP drainage design could be based on Modified Donnan, Ernst and Kirkham-Toksoz equations. For Swabi SCARP drainage design could be based on Hooghoudt, Ernst and Kirkham-Toksoz equations. Due to the limitations of the drainage equations the Modified Donnan equation, the Ernst equation and the Kirkham-Toksoz equation could be used for two layer soils whereas for

single and homogenous soils the Hooghoudt equation the Ernst equation and the Kirkham-Toksoz equations could be used for drainage design. The Modified Donnan Equation could not be used for single layer soil and when the drain is on the interface of the two layered soil.

For Fourth Drainage Project, Faisalabad (two layered soils), the relative difference between drain spacing calculated by Modified Donnan equation, Ernst equation and Kirkham-Toksoz equations increases with decrease of depth from drain level to the interface of the two layered soil. The drain spacing calculated by the Ernst equation increases upto some limit due to the limitations of the Ernst equation. This difference can be ignored due the uncertainty of the data used. The relative difference between drain spacing calculated by three drainage equations for Khushab SCARP is very small and is within the acceptable limits. For Swabi SCARP (homogenous soils), the relative difference between drain spacing calculated by Hooghoudt equation, Ernst equation and Kirkham-Toksoz equation is very small. In view of this it is concluded that any of the applicable drainage equations for a project can be used for drainage design without any significant error.