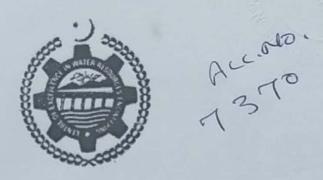M.Sc. THESIS

STABILITY AND DESIGN ANALYSIS OF WATERCOURSES IN SAND DUNE AREAS OF THAL REGION

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ABSTRACT

Earthen trapezoidal watercourses are often considered as water channels that are easy to design, construct and operate however they are not so simple. This is particularly the case for earthen channels in sand dune areas of Thal region of Pakistan where they are subjected to a cycle of wetting and drying associated with release of water in Greater Thal Canal.

Greater Thal canal is actually a flood canal off-takes at RD 180+222 from the Chashma - Jheulm (CJ) link canal near Adhi Kot in district Khushab being operated during kharif season from 15 April to 15 September. Therefore, watercourses in sand dune areas have to undergo stability analysis in dry and wet condition. One of the major parameter to be taken into account for stability is the side slope of earthen trapezoidal channel. In this respect small change in side slope of earthen trapezoidal watercourse lead to significant differences in stability, hydraulic efficiency and cut/fill volume.

The stability of earthen trapezoidal channels in sand dune areas is influenced by various factors and field conditions. The precise design of earthen channels is also one of the important aspects for a stable and hydraulically efficient section. There are two ways to design an earthen channel. One is the use of empirical methods and other is the theoretical method.

The main purpose of this research is to work out factor of safety for various side slopes of earthen trapezoidal channel in order to select a stable slope and selection of appropriate design method for sand dune areas.

Geo5 Slope Stability model was used for stability analysis and Micro Soft Excel for watercourse design. Geo5 Slope Stability software was used to compute

factor of safety by circular slip surface and polygonal slip surface. In circular slip surface factor of safety was computed using Bishop, Fellenius/Petterson, Spencer, Janbu and Morgenster-Price method, whereas in polygonal slip surface Sarma, Spencer, Janbu and Morenster-Price methods were employed to work out factor of safety.

Slope stability analysis was performed on upstream face and downstream face under dry and wet conditions. The stability increased when the side slope (Horizontal to Vertical) of the earthen trapezoidal water channel increased leading to an increase in cut/fill volume. On the other hand hydraulic efficiency decreased with the increase in side slope. It is important to select a suitable and stable side slope without compromising hydraulic efficiency. The reduction in velocity as compared to most efficient hydraulic section vary from 5.89% to 7.92% by varying side slope from 1.75:1 to 2:1 whereas factor of safety is at margin in some cases for side slope 1.75:1 but for 2:1 side slope is quite stable in each case.

Hydraulic radius was worked out for the scenario of different design methods with side slope of 2:1 (Horizontal to Vertical). The values thus obtained were compared for different design methods and finally this study revealed that tractive force method is the most suitable design method.

Factor of safety computed for Bishop, Fellenius/Petterson, Spencer, Janbu, Sarma and Morgenster-Price method under different scenario; these values were much close for each case. It was concluded that earthen trapezoidal watercourses inner face side slope must not be less than 1.75:1 in sand dune areas on the other hand outer face side slope may be 1.5:1 to minimize the earthwork; and the designing of such channels should be accomplished using tractive force method.