THESIS

SUBSURFACE DRAINAGE DESIGN FOR CONTROLLED DRAINAGE CONDITIONS

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ABSTRACT

Excessive recharge disturbs the subsurface hydrologic balance and cause waterlogging. To reclaim the productive lands, subsurface drainage systems are designed on the basis of Hooghoudt's equations. Water table fluctuates through the year depending on recharge. During the period of low recharge in Rabi season, water table drops below the design water levels at bottom of root zone leading to over drainage. Controlled drainage can be adopted by providing water afflux at pipe laterals. This study was done to determine drain afflux requirements for varying recharge. A laboratory scale sand tank model was used to determine water surface profiles under normal and with controlled drainage conditions to determine water afflux. Numerical modeling of subsurface drains was done under controlled drainage to simulate laboratory experiment and extended the findings to typical field scale conditions of the drain spacing 250 m, recharge 2.5 mm/day and drain depth 2.5 m.

A scaled sand tank model was constructed 2.2 m long, 1 m wide and 1.30 m high with bricks and inner sidewalls were plastered, painted and protected by plastic sheet placed on bed and sidewalls. Two lateral perforated drains of 1.9 cm dia wrapped with a fabric geotextile were installed in physical model at one wall at height of 1 m from bed. Model was filled with sand and saturated with water up to 1.0 m. Recharge of 2.0, 1.5, 1.0, and 0.5 mm/day was provided as rain fall by drippers. Model was calibrated and operated for field scale recharges without and with controlled drainage conditions; controlled drainage conditions were created by providing afflux at drain laterals. Water levels were measured in observation wells by electric probe. Groundwater Vista 6 (GV6) was used for the numerical modeling to reproduce results of physical model and extended to typical field drainage design.

Maximum water table elevation of 5.5, 3.5, 2.5 and 1.5 cm was found in physical model at recharge of 2, 1.5, 1.0 and 0.5 mm/day under normal drainage conditions. Maximum water level was achieved by providing afflux of 1.5, 3.5 and 4.5 cm for recharges of 1.5, 1.0 and 0.5 mm/day and inverse linear relationship was found between afflux and recharge. GV6 simulated water levels compared well with lab model results with error of 0.8, 0.4, 0.3 cm for the recharges of 1.5, 1.0, and 0.5 mm/day. GV6 faithfully reproduced lab measured results for controlled drainage. In typical field design analysis, GV6 simulated maximum water levels under without controlled drainage conditions were found as 1.5, 1.22, 0.95 and 0.66 m for the recharge of 2.5, 2.0, 1.5, 1.0 and 0.5 mm/day respectively. GV6 model provide afflux of 0.3, 0.6, 0.9 and 1.2 m respectively for the recharges of 2.0, 1.5, 1.0 and 0.5 mm/day. An inverse liner relationship was also found between afflux and recharges.

Numerical modeling provides sound technique to analyze performance of selected drainage design under without and with controlled drainage conditions. Controlled drainage may be adopted to maintain the water table near root zone for period of low recharges to conserve the water and save from adverse effect of over drainage. Water table may be maintained at the desirable design levels by providing afflux of 0.3, 0.6, 0.9 and 1.2 m at 80, 60, 40 and 20 % of the design recharge under typical field conditions and layout design.