Postprint on River Bed Parameter Calculation in Arid Regions

Authors: Jie Feilong, Feng Lihua, Li Sheng, Li Sheng

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Abstract

The primary source of groundwater recharge in arid regions is river water infiltration. Accurate evaluation of groundwater resources in such areas necessitates precise determination of riverbed parameters, including vertical hydraulic conductivity of the riverbed (K) and vertical infiltration rate of river water (V). This study presents a simplified permeameter and corresponding calculation formula for vertical hydraulic conductivity of riverbeds in arid regions; the method was applied to the northern piedmont of the Kunlun Mountains in southern Xinjiang to determine riverbed parameters for arid region rivers. The results demonstrate that this method can effectively determine the vertical hydraulic conductivity of riverbeds in arid regions, with values at 18 test sites ranging from 0.864 to 14.832 $\text{m} \cdot \text{d}^{-1}$. Based on the experimental results, the relationship between vertical infiltration rate of river water and river water depth in arid regions was summarized, and an empirical equation describing this relationship was proposed, which indicates that vertical infiltration rate of river water (V) is positively correlated with river water depth (M), the growth rate of infiltration rate (dV/dM) is negatively correlated with river water depth, and the growth rate approaches zero when river water depth is very large.

Full Text

Calculation of Streambed Parameters in Arid Area

JIE Fei-long, FENG Li-hua, LI Sheng
(College of Geology and Mineral Engineering, Xinjiang University, Urumqi 830046, China)

Abstract:
The primary source of groundwater recharge in arid regions is river water seepage. Accurate determination of streambed parameters is essential for evaluating groundwater resources in these areas. These parameters include vertical

streambed hydraulic conductivity (K) and vertical river water seepage rate (V). This paper describes a simplified seepage meter and derives the equation for calculating vertical streambed hydraulic conductivity in arid regions. The method was applied to measure streambed parameters in the northern piedmont of the Kunlun Mountains, an arid area in southern Xinjiang. Results from 18 tests showed that vertical streambed hydraulic conductivity ranged from 0.07 to 1.03 $cm \cdot min^{-1}$, demonstrating the method' s effectiveness for measuring streambed hydraulic conductivity in arid environments. Based on these results, the relationship between river water seepage rate and river water depth was characterized, and a formula describing this relationship was proposed. The findings indicate a positive correlation between vertical seepage rate V and river water depth M, but the rate of increase in seepage rate declines as depth increases, approaching zero at greater depths. This study provides valuable insights for groundwater resource evaluation in arid regions.

Keywords: Xinjiang; arid area; streambed; vertical seepage rate; vertical hydraulic conductivity

2. Methodology

2.1 Test Conditions

The study conducted 18 tests measuring vertical hydraulic conductivity of the streambed. The results showed that hydraulic conductivity ranged from 0.864 to 14.832 $m \cdot d^{-1}$, with an average value less than 4.936 $m \cdot d^{-1}$. When the water depth was less than 40 cm, the vertical seepage rate varied from 1.728 to 30.672 $m \cdot d^{-1}$, averaging less than 10.608 $m \cdot d^{-1}$. These measurements provide the basis for establishing the relationship between seepage rate and water depth.

2.2 Relationship Between Seepage Rate and Water Depth

Based on the test data, the relationship between vertical seepage rate V and river water depth M can be expressed by the logarithmic equation:

$$V = a \ln(bM + 1)$$

where a and b are empirical coefficients determined through regression analysis of measured data, with both values greater than zero. Statistical analysis of the 18 test datasets yielded correlation coefficients R^2 ranging from 0.793 to 1, indicating that the equation effectively captures the V-M relationship across different conditions. The results demonstrate that while seepage rate increases with water depth, the rate of increase diminishes as depth grows larger, approaching zero at greater water depths.

Figure 3 shows the piezometric tube reading curve, where the variables are defined as: t = time (min), h = water level change (cm), and V = seepage rate ($cm \cdot min^{-1}$).

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Note: Figure translations are in progress. See original paper for figures.