Errata 2011-10

SKB R-09-19

Groundwater flow modelling of the excavation and operational phases – Forsmark

In the earlier distributed report, there are errors that have now been corrected. The corrected page 92 is enclosed. The changed text is marked with a vertical line in the page margin. An updated pdf version of the report, dated 2011-10, can be found at www.skb.se/publications.

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B.3 Comparison with an analytical solution

For steady-state flow towards a circular tunnel in a semi-infinite isotropic and homogeneous aquifer the inflow rate per unit length of the tunnel, q [m³/s], may be derived from well function provided by /Thiem 1906/:

$$q = 2\pi\, K\, d\left[\ln\left(\frac{2d}{r}\right)\right]^{-1} \qquad \text{(B-2)}$$

where K is the hydraulic conductivity of the porous medium, r is the radius of the tunnel and d is the depth below a constant-head boundary, e.g. a fixed groundwater table. Equation (B-2) is valid for $\frac{d}{r} >> 1$. If $\frac{d}{r} \approx 10$, the error in q is of the order of 1%.

An outline of the flow model setup in DarcyTools is shown in Figure B-2. The hydraulic properties used for the flow simulation are shown in Table B-1.

The comparison with the analytical solution is shown in Figure B-3. /El Tani 2003/ provides means to calculate correction factors for finite values of r/d. For the present setup variants of r/d, it is found that the calculated correction factors are insignificant. Moreover, a sensitivity study with focus on the discretisation of the computational grid in proximity to the tunnel showed that grid independent solutions are achieved when the cell size is of the same size as the tunnel radius or smaller, see Table A-2.

It is found, however, that the horizontal size of the domain needed to be quite large (4,000 m) to achieve correct solutions. A smaller size (2,000 m) affected the inflow rates with several percent.

Table B-1. Parameters values for simulations of inflow to an open tunnel.

Domain size	4,000 m (horizontal), 2,000 m (vertical)
Grid (cell) size	Tunnel: Max(Δx, Δz) = 0.1 m
	Near field: Max(Δx, Δz) = 0.5 m
	Far field: Max(Δx, Δz) = 8 m
Hydraulic conductivity	10^{-8} m/s
Boundary conditions	Bottom: no flow
	Vertical: no flow
	Top: atmospheric pressure
	Tunnel: atmospheric pressure
Tunnel data	Depth: 500 m
	Radius: 1 m, 2 m and 4 m

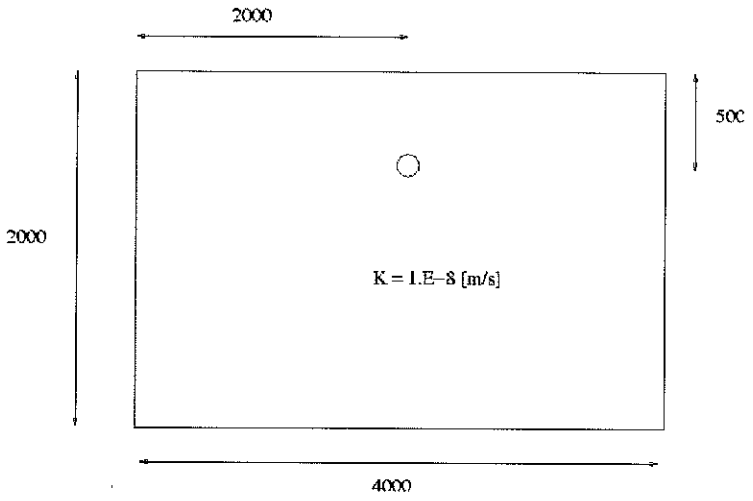

Figure B-2. Illustration of the studied situation.