HLWYM HEmails

From: Hakan Basagaoglu
Sent: Wednesday, January 10, 2007 7:13 PM
To: Scott Painter; David Pickett
Cc: Paul Bertetti; Jude Mcmurry; Chandrika Manepally; Olufemi Osidele
Subject: water saturation
Attachments: saturation curve.wpd

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Jude,

I have attached a brief write-up on the calculation of water saturations in fracture and matrix in each layer as the infiltration rate changes.
I have included a plot on the second page (for matrix flow in CHnv).

I was initially thinking about including two different graphs, but I guess this single graph will be more informative and useful.

Hakan

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Water Saturations

Water saturation, S_W, in fractures and matrix changes as the infiltration rate varies with time. S_W affects the calculations of interstitial velocity, the travel time in hydrostratigraphic units, and the retardation coefficients in the transport equations for both fractures and matrix. In TPA, the saturation values between 0 and 1 is divided into increments as shown in Fig. XX. The same curve is used for fractures and matrix in all layers. The relative hydraulic conductivity is computed for matrix and fracture in each layer by using the water saturation (for each increment) and layer-specific van Genucten parameters, λ, (specified in tpa.inp) using the van Genuchten relation given below:

$$K_r = \sqrt{S_w}\left[1-\left(1-S_w^{1/\lambda}\right)^{\lambda}\right]^2 \quad \textbf{(1)}$$

where

K_r — Relative hydraulic conductivity [unitless]

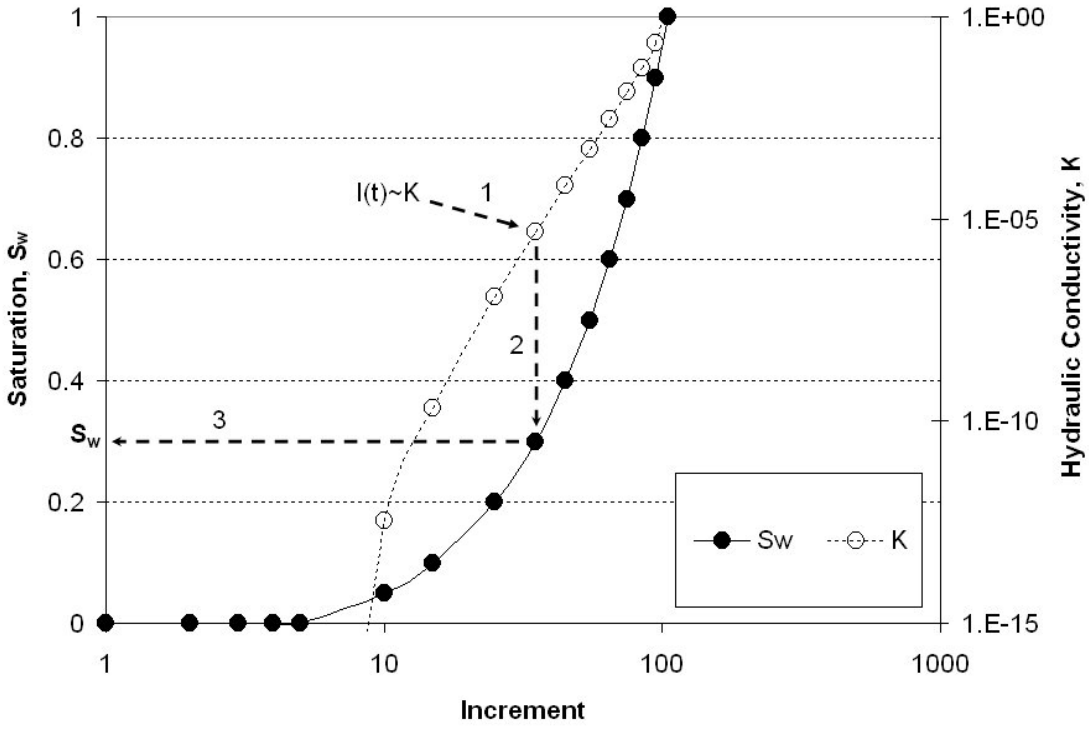
Sw — Water saturation [dimensionless]

λ — 1-1/β

β — fitting parameter [unitless] specified in the tpa.inp file.

Next, the hydraulic conductivity of matrix/fracture in each layer is calculated by multiplying the saturated hydraulic conductivity (layer and medium specific input parameter in tpa.inp) and the relative hydraulic conductivity (computed via Eq. 1) of the matrix/fracture. Although the saturation curve in Fig. XX is the same for matrix and fracture in each layer, the hydraulic conductivity of matrix and fracture will be different for each layer. In TPA, these curves are set up before the simulation starts. The saturation curve and the matrix hydraulic conductivity for Chnv is shown in Fig. XX (the matrix permeability was set to 1.8×10^{-14} m^2), as an example.

Once the simulation starts, the hydraulic conductivity nearly equal to the infiltration rate, I(t), is chosen from the hydraulic conductivity curve (denoted by 1 on the graph). Then, the corresponding hydraulic conductivity is chosen from the graph by moving vertically to the hydraulic conductivity curve (denoted by 2). The corresponding saturation reads from the vertical axis (denoted by 3). This procedure is repeated for all layers in each simulation time step to calculate water saturation in fractures and matrix.


1
0.8
0.6
0.4
0.2
0
Saturation, S_w
1.E+00
1.E-05
1.E-10
1.E-15
Hydraulic Conductivity, K
1
10
100
1000
Increment
I(t)~K
1
2
3
S_w
Sw
K