I. FINITE DIFFERENCE EQUATIONS

Before applying a numerical analysis procedure, it is necessary to express the appropriate flow equation in finite difference form. The following example will illustrate the procedure. Consider a saturated soil for which the hydraulic conductivity $K$ is both isotropic and uniform. For two-dimensional, steady-state flow in the $x,y$ plane, the appropriate expression is

$$\frac{\partial}{\partial x} \left( \frac{\partial H}{\partial x} \right) + \frac{\partial}{\partial y} \left( \frac{\partial H}{\partial y} \right) = 0,$$

[6]

this being a special case of Eq. [2]. Now let us assume that spatial changes in $H$ are approximately linear between adjacent points, the latter being separated by finite, but small, distances as shown in Fig. 22–2A. Accordingly, the first term in Eq. [6] is given approximately by

$$\frac{\partial}{\partial x} \left( \frac{\partial H}{\partial x} \right)_{x,y} \approx \frac{\left( \frac{\partial H}{\partial x} \right)_{x+\frac{\Delta x}{2},y} - \left( \frac{\partial H}{\partial x} \right)_{x-\frac{\Delta x}{2},y}}{\Delta x}.$$  

[7]

Similarly, the first term on the right side of Eq. [7] is approximated by

$$\frac{\partial H}{\partial x}_{x+\frac{\Delta x}{2},y} \approx \frac{H_{x+\Delta x,y} - H_{x,y}}{\Delta x}$$

while the second term is given by

$$\frac{\partial H}{\partial x}_{x-\frac{\Delta x}{2},y} \approx \frac{H_{x,y} - H_{x-\Delta x,y}}{\Delta x}.$$