Convergence in EXTRAN

The iterative method uses an under-relaxation factor of w for the first iteration and subsequent iterations until the convergence criteria is satisfied.

The notation used in the iterative process is listed in the Variable Notation table in the Partial Differential Equations section. The first iteration estimate of $Y^{n+1/2}$ and $Q^{n+1/2}$ are Y^n and Q^n, respectively. Typical ranges of w are 0.5 to 0.75. The new estimate of Qn+1 at each iteration is:

Equation 22: $Qn+1 = (1-w)\cdot Qn+1/2 + w\cdot Qn+1$

and the estimated new junction depth at each iteration is:

Equation 23: $Yn+1 = (1-w)\cdot Yn+1/2 + \cdot wYn+1$

The new time step solution is deemed solved when all the estimated conduit flows and junction depths satisfy their convergence criterion (parameters Maximum Head Change (**SURTOL**) and Maximum Flow Change (SURJUN) on the Job Control dialog). Reasonable values for SURTOL are 0.001 and 0.005 for most simulations. The convergence criteria for conduit flows and junction depths are:

Equation 24: $|Q_{n+1} - Q_{n+1/2}|/Q_{n+1} \leq SURTOL$

Equation 25: $|A_{n+1} - A_{n+1/2}|/A_{n+1} \leq SURTOL$

Equation 26: $|Y_{n+1} - Y_{n+1/2}|/Y_{n+1} \leq SURTOL$

Equation 27: $|V_{n+1} - V_n|/V_{n+1} \leq SURTOL$

Qref, the reference full conduit flow, is defined by the user in the Job Control dialog and allows a more realistic convergence criteria for large conduits.

The convergence of the conduit cross section area as well as the conduit flow is tested to prevent the decoupling of A and Q, since the estimate of A is based on the last iteration value of the connecting node depths. Please note that the magnitude of Aref is assumed equal to the magnitude of Qref and is not entered in a dialog.

An additional bound on the iterated values of junction head and conduit flows is used in EXTRAN version 5. The change in H is restricted $\leq$1 percent in any one iteration, and the change in Q is restricted $\leq$10 percent in any one iteration.

This depth computation is based on the current net inflows to each node and the average nodal surface areas computed for the last time step and the current iteration. The new water surface elevation in the junction must be within the limits defined by the ground and invert elevations. The new junction elevation is calculated by weighting the last and current iteration using an under-relaxation parameter (w). The change in depth is additionally constrained to be less than 1 percent in any one iteration. Larger changes are adjusted to 105 or 95 percent of the calculated depth.

The continuity equation at the nodes is tested for convergence using the global parameter, SURJUN (Maximum Flow Change), defined in the JOB CONTROL dialog. The nodal convergence check constrains the error in the nodal continuity equation divided by the crown depth (Node ground elevation minus invert elevation) to be less than the value of SURJUN. Typical values of SURJUN are 0.005 and 0.001 (ft or m).