Although a little more complicated, ICPR basically calculates stages at nodes as follows:

$$z_{t+dt} = z_t + dz$$

$$dz = (\Sigma Q / A_s)\, dt$$

where, z_{t+dt} is the stage at the next time increment (in ft.)
z_t is the stage at the current time increment (in ft.)
dz is the calculated change in stage (in ft.)
ΣQ is equal to the sum of all inflows minus the sum of all outflows (in cfs)
A_s is the total wetted surface area (in sq. ft.)
dt is the computational time increment (in sec.)

The time increment has a direct affect on dz. Furthermore, if dz changes too abruptly, instability in the link flow calculations can occur. Therefore, guidelines must be established to control dz by limiting dt. This is accomplished by setting the following five parameters on the "routing control" data form:

1. Min Calc. Time
2. Max Calc Time
3. Max Delta Z
4. Delta Z Factor
5. Time Step Optimizer

The first two parameters define the range of computational time increments that ICPR is allowed to work within. The program will never allow dt to drop below the minimum value nor will it ever exceed the maximum value. Typically, the minimum is set to 0.5 seconds. Occasionally, you may need to lower it to about 0.25 seconds if you are working with storm sewer systems. A typical maximum computational time increment is 60 seconds. This can be increased substantially if you are working with highly storage-oriented systems such as large lakes. Normally, the program is less sensitive to the maximum computational time increment.

The absolute maximum change in stage for any node in the model is established by setting the "Max Delta Z" parameter. If your model goes unstable, the change in stage (dz) can jump dramatically, and if left unchecked, the instability will grow and the program will eventually lock up. The "Max Delta Z" parameter generally keeps the model running and prevents the program from crashing, but some or all of your results may be erroneous. A typical value for this parameter is 1.0 foot. This means that if the calculated dz value exceeds 1.0 foot, ICPR will automatically limit the change to 1.0 foot. Continuity is violated when this happens and water will be lost from the system (see "Analyzing ICPR's Mass Balance Report" for more information on this subject. You can also check the node maximum conditions report to insure that the maximum delta z does not equal the "Max Delta Z" parameter that you set in the routing control data form. It is important that you check into the cause of this potential instability should it occur during a simulation.

ICPR will automatically adjust the computational time increment between the user-specified minimum and maximum values based on changes in stage at each node in the system and certain criteria established by the user. If the "change in stage" at every node in your model is at or below the allowable value, then ICPR will attempt to increase the time increment by a factor of 1.25, but never above the maximum allowable computational time increment. Likewise, if the change in stage at any node exceeds the allowable value, then ICPR will reduce the computational time increment by a factor of 1.25, but never lower than the minimum allowable.

The allowable "change in stage" criterion is defined as the product of the "Max Delta Z" and the "Delta Z Factor". This value is 0.005 feet for a typical "Delta Z Factor" of 0.005 and a "Max Delta Z" of 1.0 foot.

ICPR will not always increase the time increment when the computed change in stage at every node is at or below the "change in stage criteria". The "Time Step Optimizer" establishes the number of consecutive times the criteria must be met before ICPR will increase the computational time increment. The default value is 10 unless the user indicates otherwise.

To illustrate these concepts, assume that the following parameters have been set on the routing control data form:

1. Minimum Calc. Time 0.5 seconds
2. Maximum Calc. Time 60. seconds
3. Max Delta Z 1.0 foot
4. Delta Z Factor 0.005
5. Time Step Optimizer 10

The "change in stage" criterion is equal to (1.0 x 0.005 = 0.005 feet). Assume that the current time increment is 10 seconds and that the maximum computed change in stage for all of the nodes in your model is 0.015 feet. Since this exceeds the "change in stage" criteria of 0.005 feet, ICPR will automatically reduce the computational time increment to (10/1.25 = 8.00 seconds) and re-compute stages.

If the maximum computed change in stage for all nodes is less than or equal to the "change in stage" criteria of 0.005 feet for 10 consecutive time steps, ICPR will increase the computational time step by a factor of 1.25 and continue the simulation.

The computational time increment will never fall below 0.5 seconds and it will never increase above 60 seconds since these are the minimum and maximum values set for this example.