TRE

Improvement of computation of travel times of hypercritical speed measures

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Currently, in case a hypercritical speed measure is received, it implements two effects:

1. The FD hypocritical branch is modified so that the travel time along the link coincides with the one at the measured speed.
2. The link exit capacity bottleneck is set to the flow value at the intersection between the FD hypercritical branch and the speed secant.

The combination of the two, plus any possible more severe bottleneck as spillback from downstream, makes so that if any of the downstream bottlenecks constraints the flow once it has travelled the wished travel time, there is an additional queue delay and the travel time is higher than the measured one.

1.1 Hypercritical speed correction

The speed exported to the database results is computed as the average between hypocritical and hypercritical speed weighted by the number of vehicles in hypocritical and hypercritical state; the objective is to match the measured and result speed values:

$$\boldsymbol{V_{results} = V_{hypo} \cdot (1 - quen) + V_{hype} \cdot quen = V_{measure}} \tag{1}$$

Where:

- $V_{hypo} = Q^0(k^0)/k^0$
- $V_{hype} = Q^+(k^+)/k^+$
- $k^0 = \frac{nveh \cdot (1-quen)}{L \cdot (1-quel)}$
- $k^+ = \frac{nveh \cdot quen}{L \cdot quel}$

It follows:

$$\boldsymbol{V_{results} = Q^0(k^0) \cdot \frac{L \cdot (1 - quel)}{nveh} + Q^+(k^+) \cdot \frac{L \cdot quel}{nveh} = V_{measure}} \tag{2}$$

Where:

- $quel = \frac{queu}{queu+stor}$
- $nveh = F - E + D$
- $stor = G_t - F + D$
- $queu = H_t - E + D$

If flows are constant, we have that $Q^0(k^0) = Q_t^0$ and $Q^+(k^+) = Q_t^+$; if they are not constant, for a generic fundamental diagram, we have:

$$\boldsymbol{Q^0(k^0) = Q \cdot \left[1 - \left(1 - \frac{k^0 \cdot V}{Q \cdot \gamma^0}\right)^{\gamma^0}\right]} \tag{3}$$

$$\boldsymbol{Q^+(k^+) = Q \cdot \left[1 - \left(1 + \frac{(k^+ + J) \cdot W}{Q \cdot \gamma^+}\right)^{\gamma^+}\right]} \tag{4}$$

In case of constant flows, we can easily solve Equation (2) with respect to D:

$$\boldsymbol{D = \frac{(F - E) \cdot V \cdot L - Q_t^0 + (H_t - E) \cdot \left(\frac{Q_t^+ - Q_t^0}{H_t - E + G_t - F}\right)}{\left(\frac{Q_t^+ - Q_t^0}{H_t - E + G_t - F}\right) - V \cdot L}} \tag{5}$$

If the flows are not constant, the explicit solution of Equation (2), substituting Q^0 and Q^+ with equations (3) and (4), is harder, and a simple iterative algorithm is used instead.