2.1 Saturation Flow Rate

The saturation flow rate crossing a signalized stop line is defined as the number of vehicles per hour that could cross the line if the signal remained green all of the time. It is not practical to measure this quantity directly in the field because the signal does not usually remain green for more than a minute or so on each cycle. The units of saturation flow rate are “vehicles per hour of green” (vphg). This is sometimes expressed on a per-lane basis as “vehicles per hour of green per lane.”

The saturation flow rate (satflow for short) may be derived from the steady-state headway, which is defined as the average elapsed time between the passage of successive vehicles over the stop line in the same lane. The Highway Capacity Manual (HCM) suggests recording the time of passage of the fourth and tenth vehicles over several cycles to determine this value. This assumes that the initial queue at the start of green is at least ten vehicles long. The first few vehicles are excluded because of the transient effect of starting up the queue. Vehicles beyond the tenth are excluded because they may represent the arrival rate instead of the departure rate.

A typical value for the steady state headway is approximately two seconds per vehicle in each lane. In other words, each vehicle requires 2 seconds of the available green time. This yields a typical saturation flow rate of approximately 1800 vphgpl.

**Example**

Consider an example of a two lane approach to a signal. Assume that a study conducted over several cycles indicates that the average time for the fourth vehicle to cross the stop line is 11.1 seconds after the start of green. The corresponding time for the tenth vehicle is 22.9 seconds.

This means that the average time to accommodate six successive vehicles is 11.8 seconds, and that each vehicle required an average of 1.97 seconds of green time, producing an estimated saturation flow rate of 1827 vphgpl, or 3654 vphg for the whole approach.

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\begin{align*}
\text{s} & = \text{saturation flow rate} \\
& = \text{vphg} \\
& \text{or (vphgpl)} \\
\text{h} & = \text{steady state headway (sec/veh)} \\
& = \frac{\text{t(10)} - \text{t(4)}}{6} \\
\text{s} & = \frac{3600}{h}
\end{align*}
\]

\[
\begin{align*}
\text{t(10)} &= 22.9 \text{ sec} \\
\text{t(4)} &= 11.1 \text{ sec} \\
\text{Diff} &= 11.8 \text{ sec} \\
\text{h} &= \frac{11.8}{6} = 1.97 \text{ sec} \\
\text{s} &= \frac{3600}{1.97} = 1827 \text{ vphgpl} \\
\text{or } 1827 \times 2 &= 3654 \text{ vphg}
\end{align*}
\]