Figure 10.2. Amber Cycle versus Legal Speed

Hence the speed is zero when \( t = t_0 = v_0/g \). Integrating (2) subject to \( x(0) = 0 \) gives

\[
x = -gt^2/2 + v_0 t.
\]

The value of \( x \) when \( t = t_0 \) is

\[
x(t_0) = D_0 = \frac{v_0^2}{2g}.
\]

Caution with units must be used at this point: we are dealing with a distance \( D_0 \) which is measured in feet by traffic engineers, and a speed \( v_0 \) which is usually measured in miles per hour. The reader should convert miles to feet before making any calculations.

Let us plunge ahead to computing the amber phase:

\[
A = \frac{D_0 + l + L}{v_0} + T,
\]

where \( T \) is the driver reaction time. Thus

\[
A = \frac{v_0}{2g} + \frac{l + L}{v_0} + T.
\]

If we sketch the graph of \( A \) versus \( v_0 \), it looks like Figure 10.2.

We shall assume that \( T = 1 \) s, \( L = 15 \) ft, and \( l = 30 \) ft. Moreover, we shall accept the word of a highway engineer that \( f = 0.2 \) is representative. (See Exercise 1.) The amber cycles for \( v_0 = 30, 40, \) and \( 50 \) mi/h are shown in Table 1, along with the rule of thumb values.

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<thead>
<tr>
<th>( v_0 ) (mi/h)</th>
<th>( A ) (s)</th>
<th>Rule of Thumb</th>
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<tbody>
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<td>5.46</td>
<td>3 s</td>
</tr>
<tr>
<td>58.67</td>
<td>6.35</td>
<td>4 s</td>
</tr>
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<td>73.53</td>
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Note that the rule of thumb is consistently shorter than our predicted amber phases. This suggests that many intersections are designed so that it is quite possible that vehicles will be in the intersection when the light changes to red.

Even given adequate stopping time, many motorists will attempt to accelerate and try to beat the light. Most do not know (and some do not even care) when the light will turn red. A partial solution may lie in a "countdown" type of traffic light, where during the last few seconds of amber a countdown sequence of digits superimposed on the amber light warns the drivers exactly when the light will change. A system like this one was tried several years ago in Houston with some success in lowering accident rates. See Exercise 6.

Exercises

1. A vehicle traveling on dry, level pavement at 40 mi/h has the brakes applied. The vehicle travels 270 ft before stopping. Compute the coefficient of friction.

\[
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