2.4. The Dilemma Zone

Up to this point in the session, we have considered the stop line only in terms of its capacity, i.e., its ability to move traffic. We must also remember that the stop line also has the function of stopping traffic, and it is important that this function be carried out safely.

The MUTCD provides that a green interval must be properly terminated by a yellow interval. In addition, it is common practice to include an all-red interval to create an additional buffer to clear the intersection. In textbook terminology, the yellow interval is referred to as the “change interval” and the all-red is referred to as the “clearance” interval.

The sum of these two intervals does not have a name that is universally used, and the result is often a misuse of the terminology. Proper use of these terms is important to understanding their meaning, and therefore the European definition of the change plus clearance intervals as the “intergreen” will be used here.

At issue here is the proper length for the intergreen. Too much time devoted to this interval will increase the lost time and compromise the efficiency of the operation. On the other hand failure to provide sufficient warning time could create a safety hazard. The computational method described here is often referred to as the Institute of Transportation Engineers (ITE) method.

Consider the time-space diagram to the left. The roadway is shown in its full width with some approach distance on the horizontal axis. Time is shown on the vertical axis.
Now, assume that the phase for the movement on this approach must end at an arbitrary time as shown at the left. There can be no vehicles from this approach left in the intersection because a conflicting movement will be given the green at this point. The problem is to determine when the yellow must begin to provide adequate warning to drivers.

There will be no conflict within the intersection if a driver elects to proceed through and clear the intersection before the beginning of the conflicting green. The trajectory for this vehicle is shown as a line of constant slope, which reflects the speed on the approach.

There will also be no conflict if the driver elects to stop before entering the intersection. If a constant deceleration is used, the trajectory will be represented by a parabola. To maintain a safe operation, there must exist a point in time and space that is common to both trajectories from which the driver may execute either choice successfully. That point is indicated as the “decision point” on the figure.
So, given a specified time to end the phase the latest time to begin the yellow and avoid trapping any drivers in the dilemma zone, as indicated here, determines the minimum length of the intergreen.

Note that, past the decision point, there is a region in time and space between the two trajectory lines in which neither choice may be executed successfully. This region is known as the “dilemma zone.” While it is not possible to ensure that no drivers will enter this zone inadvertently because of indecision, it is very important that the intergreen timing not be so short as to trap any driver in the zone at the beginning of yellow. This means that the yellow may not begin before the time of the decision point.

In fact, the yellow may not begin before the driver has also had time to react and make a clear choice before the decision point.

So, given a specified time to end the phase the latest time to begin the yellow and avoid trapping any drivers in the dilemma zone, as indicated here, determines the minimum length of the intergreen.
Note that the minimum intergreen time may be represented as the sum of three time components indicated on the “time” axis of the figure.

1. The reaction time, generally considered to be in the range of one second. This is represented by Tr on the figure.

2. The time required to travel the distance required to stop. There is no simpler way to describe this, other than to say that it is often mistaken for the time required to stop. The time required to stop is of no significance here. Drivers who elect to stop before the intersection do not have to stop before the end of the phase. They have to stop before they get to the stop line.

The distance required to stop is represented on the figure by the horizontal distance from the decision point to the stop line. The time required to travel this distance is represented by Tsd

A constant value for deceleration, a, must be assumed to compute the stopping distance, d, from the basic kinematic formula:

\[ d = \frac{v^2}{2a} \]

The time required to travel the stopping distance, Tsd, may now be computed by dividing the stopping distance by the speed.

3. The time required to clear the intersection totally, Tc, (i.e., the rear of the vehicle). This is simply the width of the intersection plus the length of the vehicle, all divided by the speed.

**Example**

Let’s say we have an approach speed of 30 mph (44 ft/sec), a deceleration rate of 11 ft/sec², an intersection width of 60 ft, and a vehicle length of 28 ft.

Applying the computations just described, the minimum intergreen time would be 5 sec, 2 of which should go to the all-red clearance. This would only leave 3 sec for the yellow change interval. Remember, this is the minimum time to avoid the dilemma zone. Many agencies also have policies regarding the minimum times based on driver expectancy. For example, some agencies would increase the yellow time computed above to 4 sec for this reason.