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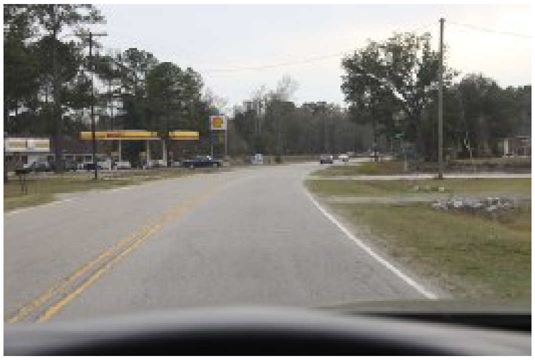
Perception/Reaction Time In Accident Reconstruction



Observing a pedestrian on a semi rural road in the daytime should be easy providing a rapid response

Detecting a pedestrian at night on the same road is more difficult

Even relatively close, a dark clad pedestrian at night may evade detection

In accident reconstruction we are frequently presented with a situation where the driver's perception/reaction (P/R) time to respond to a traffic situation is critical to the assessment of speed, visibility, attentiveness etc. It has become common to take one of three different approaches to assess the perception/reaction time. These are:

1. Use a set value, for example, 1.5 seconds
2. Use a range of values, for example, 1.0 to 2.0 second
3. Attempt to refine the P/R time based on the circumstances

Different authors and researchers have varying definitions of perception and reaction with some references subdividing the times into five or more defined phases. You can define reaction time as simply the time associated with physical movement, such as, moving the foot from the accelerator to the brake pedal. Other researchers include the decision-making process to initiate the maneuver as well as the physical motion in the total reaction time. A typical breakdown for P/R time would put detection and recognition into the perception category. The reaction category would then include both the decision making and the actual motion.

In real life, the nature of the circumstances in the detection, recognition, decision-making and execution all influence the amount of time required. At the low end, a reflex response such as removing your hand from a hot surface can occur very quickly. P/R values as low as 0.1 – 0.2 seconds can be obtained from this type of reflexive response. This very rapid response could occur in accident reconstruction where a "startled" driver was involuntarily responding to a loud noise or sudden vibration. A reflexive jerk of the steering wheel could occur very quickly. A more considered reaction takes longer.

Moving up the ladder in terms of both time and complexity is a situation that is fully expected with the range of potential responses very limited. These "respond to the buzzer" situations are easy to test and show up frequently in literature. A single potential stimulus and single response can produce a very short P/R time. Values of 0.2 – 0.3 seconds are typical.

Increasing the complexity to expected but varying response possibilities increases the P/R. An example is a baseball batter at home plate. In this situation, the focus is intense and there is the preparatory motion of the pitcher to assist with the timing. The batter is fully aware that a ball is being pitched, but has to decide if it will be a ball or strike and whether or not to swing the bat. If the batter decides to swing he has to judge where the bat can make contact with the ball. The batter will typically have a little more or less than 0.5 second to make the decisions and execute the swing. With training and practice most people can execute this maneuver with some degree of success.

Most accident situations are less predictable. For example, approaching a green traffic signal, you will be fully aware that it could turn yellow but generally have no specific timing mechanism. Situations where the problem is anticipated, readily visible, readily identifiable and the action required is relatively simple produce the lowest P/R reaction values typically used in accident reconstruction approximately ½ to ¾ of a second. However, longer times could reasonably be expected. Longer times could be associated with drivers who were not focused on the light at the moment it changed. Driving requires many actions approaching an intersection. Good drivers are monitoring their speed, the mirrors and side streets for approaching vehicles and pedestrians. Drivers who were focused on anything other than directly at the light would likely respond somewhat slower than the minimums. Drivers could also respond slower if they did not deem the situation urgent, that is, they were far enough away that a moderate response time would be adequate. Drivers could also respond slower if there was some indecision, that is, stop or proceed through.

In situations where drivers are not anticipating a problem but are somewhat surprised, the P/R times increase. Imagine if you were to come over a hill in daylight and observe a truck overturned on its side across the roadway. It would be a surprise but the problem would be obvious. The solution would also be relatively obvious, that is, get your vehicle slowed or stopped as rapidly as required or as possible. For clear situations where the problem and the solution are obvious, the P/R times range from approximately 3/4 up to 2 seconds with the 80 – 90th percentile values occurring around 1.5 seconds. This forms the basis for the typical 1.5 seconds used in accident reconstruction.

Many situations in accident reconstructions have a "problem" that either develops slowly or is not immediately obvious. Take the same situation where the truck is not overturned but simply stopped in the travel lane. It will generally take more time to perceive that the stopped truck is a problem and there may be more solutions, come to a stop or steer around. Complexity in the perception phase adds to the P/R time. Complexity in the solution phase also adds to the P/R time. Now imagine the situation at night. The overturned truck may not be nearly as visible. It may take considerably longer to identify and recognize as an overturned truck. It is for these reasons that some authors have recommended an increase in P/R times for nighttime accidents. However, it is really a detection and identification time increase. Once it is recognized, P/R proceeds at the same general times as during daylight. No one advocates increasing yellow light times at night. The reason is nighttime does not reduce the light visibility or recognition time. In general, the P/R cannot start until the problem is recognized then the rest of the P/R time proceeds the same as if the problem was easily detected.

Recently, there has been a trend to try to quantify P/R times by adding up all the factors that can be readily accounted for day vs. night, rural vs. urban, angle from directly ahead, etc. This work is largely based on comparison with test data and the assumption that each of the factors can be added independently to come up with a result. One author found, for example, the P/R average for response to a stationary pedestrian to be 1 second in daytime, but 3 seconds at night. Here again, it appears that the primary difference is whether the hazard is readily identifiable rather than day vs. night.

So what should be used in Accident Reconstruction? If an analyst is simply trying to quantify a travel distance between initial observation of a hazard and a reaction, then a fixed value P/R can be a reasonable approach. A value of 1.5 seconds is the value typically chosen. A range is probably a better way to approach the variation. For most simple situations, the “surprise” range is typically taken as 1 to 2 seconds or something similar. For other circumstances involuntary reactions on the short end or hard to detect situations on the long end, then P/R values outside of the typical range may be justified. Regardless of what is used, it should be recognized that there is a range of values and that more difficult conditions or situations may expand the upper end of the range.

Automobile struck in the passenger side in intersection collision

Pickup with right of way collided into the side of the automobile

Did the automobile driver stop at the stop sign or or enter the intersection without stopping? Insufficient time for an evasive response by approaching driver suggested that the automobile driver did not stop.

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