ACCIDENT ANALYSIS SERVICE

Crash Facts – Scenario 1 – Pedestrian Accident - Solution - May 2006

Well, we got the first scenario under our belt and I received an excellent analysis from an old friend Bill Hamilton. I have not heard from Bill since the mid-eighties. Although some of his answers were a little different from mine, for the most part, he was right on! Most of his analysis was by *logical deduction* the main tool of the adjustor.

Bill's analysis:

- The driver was going 27 mph.
- Speed at impact estimated 25 mph.
- Driver was 15.84' from POI when he saw the pedestrian.
- The pedestrian was 3' from the POI when the driver saw the person.
- There was no direction given for the pedestrian but from the injuries he was walking from the drivers right to his left, and never saw the car coming.
- The brakes all worked and the tires would have had good tread.
- The new asphalt was dry (.74) for these facts to be true.
- The last point this accident could have been avoided was 52' from POI.

Scenario No 1:

A skidding vehicle struck a pedestrian in the middle of a 12-foot lane. The vehicle skidded 35 feet coming to rest with the pedestrian's body in front of it. The driver stated that he observed the pedestrian in the middle of the roadway, but did not have time to avoid the accident. He stated that his speed was 25 mph in a 25 mph zone. A witness stated that the pedestrian was, "just walking across the street and got run over." The pedestrian's fatal injuries involved the left leg, hip and the left side of his head.

Assignment:

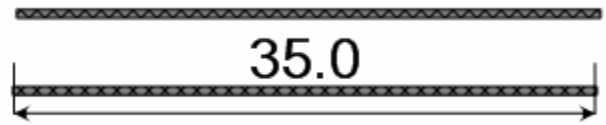
Explain as much as you can regarding what happened in this accident. Including:

1. What was the speed of the vehicle?
2. What was the speed at impact?
3. Where was the driver relative to *point of impact* (POI) when he recognized the pedestrian as a hazard?
4. Where was the pedestrian when the driver recognized him as a hazard?
5. What can you say about the vehicles brakes?
6. Where was the *point of last avoidance*?

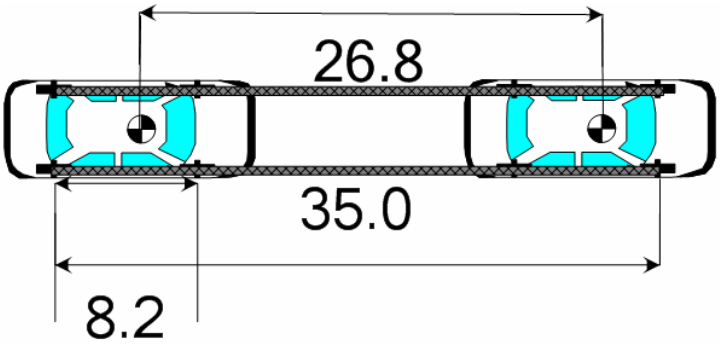
Let us begin with the skidmarks. When you examine an accident scene and observe four distinguishable tire skidmarks (caused when a vehicle yaws left or right), it is easy to measure them. By the way, measure all four, skidmarks, but use the longest skidmark for speed calculations. Do not use the average – that is the old way.

What if you only see two parallel skidmarks? Well here, we have the *crux of the problem* when measuring skidmarks. In the overwhelming majority of cases, two parallel skidmarks are overlapping skidmarks (rear over front). You must adjust your measurement for wheelbase from the longest skidmark.

The scenario stated that the vehicle skidded 35 feet, but wheelbase was not mentioned.



When the wheelbase is subtracted from the skidmarks the vehicle actually skids 26.8 feet.



For this scenario, I have assumed 35 feet of skidmarks after adjustment for the wheelbase.

Formula 1:

$$\text{Energy eqivalent speed in mph} = \sqrt{30 \bullet d \bullet f + g}$$

Where:

30 = gravitational constant
d = skidding distance
f = coefficient of friction
g = grade factor (disregarded if less than .03 or 3%)

Formula -1 is used to determine the speed of the vehicle based upon a skid to a stop (35 feet). I used a coefficient of friction of .74 with no grade factor. The vehicles speed was approximately 27.87 mph.

Formula 2 is used to calculate the speed at impact:

Formula 2:

$$\text{Speed based on skid to impact} = \sqrt{s^2 - 30 \bullet ds \bullet f + g}$$

Where:

s^2 = Speed base upon full skidmark measurement
ds = skid to impact measurement

NOTE: This formula gives you speed at any distance along a skidmark

The speed at 5 feet into the skid is 25.81 mph. This is the approximate change in velocity (Delta-V) of the pedestrian.

Now let us try to find out where the pedestrian and the vehicle were when the driver perceived him. The driver stated that he first saw the pedestrian in front of him.

The literature identifies 5 fps (3.4 mph) velocity for an average walking adult.

Formula 3 is used to convert mph to fps:

Formula 3:

$$\text{Feet per Second (fps)} = 1.47 \bullet mph$$

The conversion of 27.87 mph to fps yields 40.98 fps for the vehicle at perception.

The .75 seconds perception and .75 seconds reaction times are acceptable for an alert driver. This is the common time the vehicle and pedestrian had as they moved to the *point of impact.* Every second the vehicle gets 40.98 feet closer to impact as the pedestrian gets 5 feet closer.

To determine how far each moved toward impact during the driver's *perception + reaction time*, multiply 1.5 seconds times their respective speed in fps. The vehicle moved 40.98 x 1.5 or 61.46 feet toward impact as the pedestrian walked 5 x 1.5 or 7.5 feet.

Formula 4 is for locating the vehicle at perception:

Formula 4:

Perception to impact = Speed in fps x (perception time + reaction time + skid to impact time)

We have everything needed for Formula 4 but the *skid to impact time*. Of course, there is a formula that also:

Formula 5:

$$\text{Total skid time} = \frac{S_f - S_0}{21.95 \bullet f + g}$$

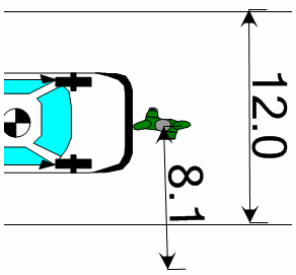
Where:

S_f = Final speed or speed based on skidding to a stop
S_0 = Speed after partial skid
f = coefficient of friction
g = grade factor

The final speed of the vehicle (after 35 feet of skidding) is 27.87 mph. After skidding 5 feet to impact, the speed is 25.81 mph. Formula 5 yields .13 seconds of pre impact skid time. To get the total time from perception to impact, add 1.5 seconds (Perception + Reaction) to .13 seconds skid time = 1.63 seconds. When the driver first perceived the pedestrian, they were **both** 1.63 seconds from impact.

To locate the vehicle relative to impact just add the perception/reaction distance to the pre-impact skid (61.46 + 5 = 66.46). The location of the pedestrian is 1.61 x 5 fps or 8.13 feet from impact.

The pedestrian's injuries were on his left side. Logical deduction dictates that he was coming from the driver's right.



The width of the lane is 12 feet and the pedestrian was struck in the center of the lane and vehicle. This means that the pedestrian was at least 2.13 feet off the roadway when the driver first saw him.

The last thing you were asked to determine is the driver's *Point of Last Avoidance*. This involves the additional distance the pedestrian needed to walk to clear the impact zone (front of vehicle). I assumed the pedestrian needed walked an additional 3 feet to clear the impact zone. The time required to walk 3 feet is:

Formula 6:

Walking Time = Walking distance (feet) ÷ Walking speed (fps)

3 ÷ 5 fps = .6 seconds

Now we need to determine the additional braking distance needed to slow the vehicle down just enough to allow the pedestrian to clear the impact zone.

Formula 7:

$$Da = Dt - (16.1 \bullet f + g \bullet (St - Et)^2)$$

Where:

Da = additional skidding distance to impact
d_t = Total skidding distance
16.1 = gravitational constant
f = Coefficient of friction
S_t = Total time to skid to a stop
E_t = Addition walking time escape hazard zone

The only information that we do not have for Formula 7 is the total skidding time. We can use Formula 5 to determine this. Simply assign 0 to S_0 and you get 1.72 seconds for a full skid to a stop. Plug this time into Formula 7 and you get 20.17 feet. Add this to the *Point of Perception* distance (66.46 feet) and you get 86.64 feet or the *Point of Last Avoidance* by braking.

There we have done it. I hope that this analysis can be useful in the real world. If you have any questions please email them to me. I have developed an Excel spreadsheet that applies to the scenario's solution. It calculates formulas step by step. I plan to develop a similar spreadsheet for each of the **Accident Facts** scenarios. When we are done, you will have a library of spreadsheets to assist you in your investigations.

My thanks to Bill Hamilton for being the first to jump in. I hope to hear from more of you with your answer to the next scenario. If you have any suggestion to make this article better, please let me know.

Crash Facts

Ran off Roadway Accident Investigation Scenario 2

You are investigating a single car accident where a vehicle ran off the road and struck a tree. The vehicle skidded 35 feet on a wet asphalt road, 15 feet on a wet gravel shoulder and 60 feet on wet grass before impacting a 6 foot diameter Douglas fir. The airbags deployed upon impact. After impact, the vehicle rotated 90 degrees and skidded another 25 feet on wet grass before coming to rest. The surfaces were level.

The speed limit was 55 mph. The driver stated that he was traveling the speed limit. The Airbag Control Module was downloaded showing a Delta-V of 20.3 mph.

What was the speed of the vehicle when it first began to skid?

What was the speed when the vehicle t impacted the tree?

You are invited to address any other issues that you feel are important and that you can support.

Email your answers to Don Webb at donwebb@crashspeed.com. Those with the best answers will be featured in the next Crash Facts article.