# Pedestrian/Bicycle Crash Analysis

Instructors: Tony Becker / Mike Reade

Date: 10-Jun-09

Place: Augusta, ME

Vehicle: 1999 PLY. GRAND VOYAGER SE
VIN: 1P4GP44G9XB508597
OL: 200 Inches
OW: 76 Inches
WB: 119 Inches
FOH: 34 Inches
ROH: 47 Inches
Weight: 4,186.00 lb
Hood H: 30 Inches

**Searle (Angle):**

$$V = \frac{\sqrt{2 \times \mu \times g \times d}}{[\cos\theta + (\mu \times \sin\theta)]}$$

**Searle (Mass & Carry):**

$$V_{min} = \frac{M + m}{M}\sqrt{\frac{2\mu g(d - Carry)}{1 + \mu^2}}$$

**Searle Maximim:**

$$V_{max} = \sqrt{2 \times \mu \times g \times d}$$

**Searle Minimum:**

$$V_{min} = \sqrt{\frac{2 \times \mu \times g \times d}{1 + \mu^2}}$$

The above vehicle data was collected from Expert AutoStats a product of 4N6XPRT Systems.

| Crash Data: | Test 1 | Test 2 | Test 3 | Test 4 | Test 5 | Test 6 | Test 7 | Test 8 | Test 9 | Test 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ped Ht (in.):** | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | |
| **Ped C/M Ht (in.):** | 40 | 40 | 41.5 | 40 | 42 | 41 | 40 | 40 | 26 | |
| **Ped Slide D (ft.):** | 12.8 | 15.5 | 16.9 | 22.4 | 22.9 | 6.1 | 8.5 | 14.55 | 68 | |
| **Airborne D (ft.):** | 31.7 | 40.7 | 34.2 | 36.4 | 46.4 | 14.9 | 31 | 29.65 | 0 | |
| **Ped f-Value:** | 0.5 | 0.5 | 0.5 | 0.5 | 0.56 | 0.5 | 0.5 | 0.5 | 0.5 | |
| **Throw D (ft.):** | 44.5 | 56.2 | 51.1 | 58.8 | 69.3 | 21 | 39.5 | 44.2 | 68 | |
| **Takeoff (Min):** | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 0 | |
| **Takeoff (Max.):** | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 0 | |
| **1st Evid. (ft):** | 7.5 | 11.4 | 8.4 | 7.8 | 21.0 | 12.4 | 7.2 | 31.5 | 46.2 | |
| **Ped Weight (lb):** | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 30 | |
| **Vehicle Data:** | | | | | | | | | | |
| **Hood Height (in.):** | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | |
| **C/M - Hood Change (in.):** | 10 | 10 | 11.5 | 10 | 12 | 11 | 10 | 10 | -4 | |
| **Braking (Yes=Y/No=N):** | Y | Y | Y | Y | Y | Y | Y | Y | Y | |
| **Skid Total (ft.):** | 55 | 54.9 | 56.8 | 46.9 | 60.7 | 54.3 | 44.5 | 77 | 90.9 | |
| **Skid Impact (ft.):** | 24.3 | 10.2 | 13.4 | 10 | 14 | 23 | 18.9 | 48.1 | 24 | |
| **Road f-Value:** | 0.71 | 0.72 | 0.71 | 0.67 | 0.64 | 0.74 | 0.68 | 0.72 | 0.73 | |
| **Vericom (Impact):** | 25.57 | 31.07 | 30.4 | 27.23 | 29.94 | 26.36 | 22.85 | 24.98 | 38.28 | |
| **Radar (Start Braking):** | | | | | | | | | | |
| **Radar (Impact):** | 34 | 35 | 35 | 32 | 35 | 28 | 30 | 36 | | |

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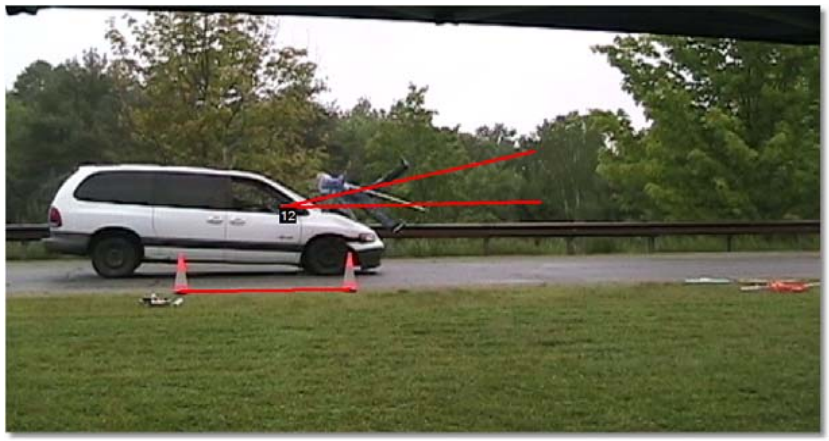
Test 1



**Searle Analysis: (1983)**

| | |
|---|---|
| Searle (10 Degree) Takeoff: | 24.11 mph |
| Searle (20 Degree) Takeoff: | 23.26 mph |
| Searle Minimum Formula: | 23.11 mph |
| Searle Maximum Formula: | 25.84 mph |

**Vehicle Speed Analysis:**

| | |
|---|---|
| Speed - Start of Braking (Skid): | 34.23 mph |
| Speed - Impact (Skid): | 25.57 mph |
| Speed - Start of Braking (Radar): | N/A mph |
| Speed - Impact (Radar): | 34.00 mph |
| Speed - Impact (Vericom): | 25.57 mph |

**Other Calculations:**

| | |
|---|---|
| Speed (With Adjusted Data): | 23.29 mph |
| Throw Minus Carry Distance(ft): | 42.34 feet |
| Location of First Evidence (ft.): | 7.5 feet |
| % of Speed Attained (Ped): | 90% |
| Difference (C/M vs. Hood H (in.): | 10 inches |
| Takeoff From Video (Degrees): | 12 Degrees |
| Carry Distance (ft.): | 2.16 feet |

**NEW Searle Formulae Analysis:**

| | |
|---|---|
| Voyager Weight: (M) | 4,186.00 lb |
| Pedestrian Weight: (m) | 55 lb |
| Ped C/M Height: (H) | 3.33 feet |

**Searle Minimum Analysis: (1991, 2009)**

$$V_{min} = \sqrt{\frac{2\mu g(d - \mu H)}{1 + \mu^2}}$$

= **22.67 mph**

**Searle Minimum Analysis: (2009)**

$$V_{min} = \frac{M + m}{M}\sqrt{\frac{2\mu g(d - Carry)}{1 + \mu^2}}$$

= **22.84 mph**

*(Percentage is determined by dividing Searle Minimum result by Vehicle Impact Speed)*

# Pedestrian/Bicycle Crash Analysis

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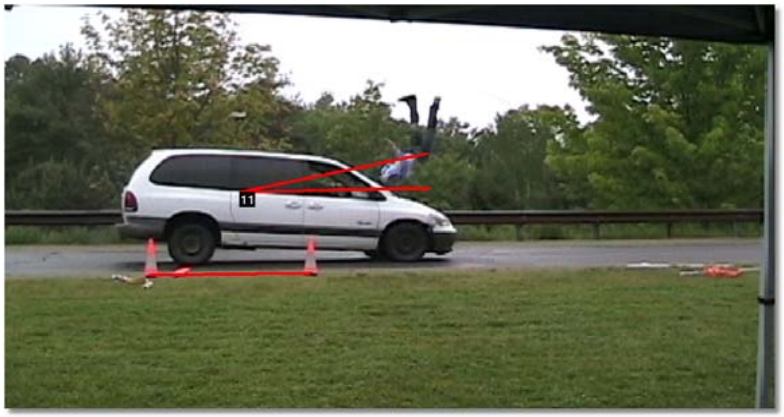
Test 2



**Searle Analysis: (1983)**

| | |
|---|---|
| Searle (10 Degree) Takeoff: | 27.09 mph |
| Searle (20 Degree) Takeoff: | 26.14 mph |
| Searle Minimum Formula: | 25.97 mph |
| Searle Maximum Formula: | 29.03 mph |

**Vehicle Speed Analysis:**

| | |
|---|---|
| Speed - Start of Braking (Skid): | 34.44 mph |
| Speed - Impact (Skid): | 31.07 mph |
| Speed - Start of Braking (Radar): | N/A mph |
| Speed - Impact (Radar): | 35.00 mph |
| Speed - Impact (Vericom): | 31.07 mph |

**Other Calculations:**

| | |
|---|---|
| Speed (With Adjusted Data): | 26.45 mph |
| Throw Minus Carry Distance(ft): | 54.09 feet |
| Location of First Evidence (ft.): | 11.4 feet |
| % of Speed Attained (Ped): | 84% |
| Difference (C/M vs. Hood H (in.): | 10 inches |
| Takeoff From Video (Degrees): | 11 Degrees |
| Carry Distance (ft.): | 2.11 feet |

**NEW Searle Formulae Analysis:**

| | |
|---|---|
| Voyager Weight: (M) | 4,186.00 lb |
| Pedestrian Weight: (m) | 55 lb |
| Ped C/M Height: (H) | 3.33 feet |

**Searle Minimum Analysis: (1991, 2009)**

$$V_{min} = \sqrt{\frac{2\mu g(d - \mu H)}{1 + \mu^2}}$$

= **25.58 mph**

**Searle Minimum Analysis: (2009)**

$$V_{min} = \frac{M + m}{M}\sqrt{\frac{2\mu g(d - Carry)}{1 + \mu^2}}$$

= **25.81 mph**

*(Percentage is determined by dividing Searle Minimum result by Vehicle Impact Speed)*

# Pedestrian/Bicycle Crash Analysis

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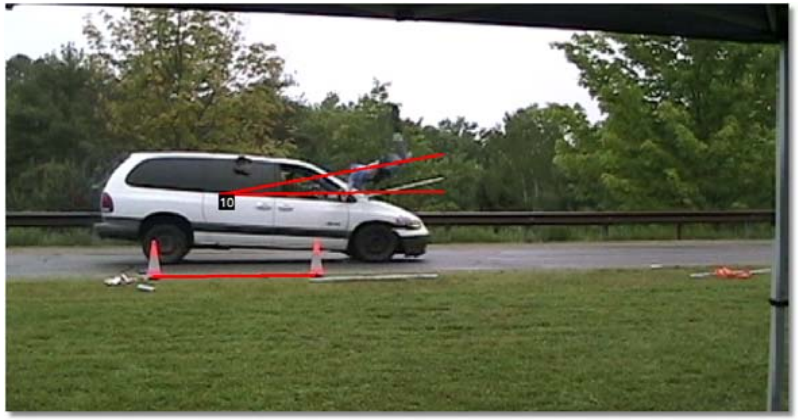
Test 3



**Searle Analysis: (1983)**

| | |
|---|---|
| Searle (10 Degree) Takeoff: | 25.84 mph |
| Searle (20 Degree) Takeoff: | 24.93 mph |
| Searle Minimum Formula: | 24.76 mph |
| Searle Maximum Formula: | 27.69 mph |

**Vehicle Speed Analysis:**

| | |
|---|---|
| Speed - Start of Braking (Skid): | 34.78 mph |
| Speed - Impact (Skid): | 30.40 mph |
| Speed - Start of Braking (Radar): | N/A mph |
| Speed - Impact (Radar): | 35.00 mph |
| Speed - Impact (Vericom): | 30.40 mph |

**Other Calculations:**

| | |
|---|---|
| Speed (With Adjusted Data): | 25.39 mph |
| Throw Minus Carry Distance(ft): | 49.37 feet |
| Location of First Evidence (ft.): | 8.4 feet |
| % of Speed Attained (Ped): | 81% |
| Difference (C/M vs. Hood H (in.): | 11.5 inches |
| Takeoff From Video (Degrees): | 10 Degrees |
| Carry Distance (ft.): | 1.73 feet |

**NEW Searle Formulae Analysis:**

| | |
|---|---|
| Voyager Weight: (M) | 4,186.00 lb |
| Pedestrian Weight: (m) | 55 lb |
| Ped C/M Height: (H) | 3.33 feet |

**Searle Minimum Analysis: (1991, 2009)**

$$V_{min} = \sqrt{\frac{2\mu g(d - \mu H)}{1 + \mu^2}}$$

= **24.36 mph**

**Searle Minimum Analysis: (2009)**

$$V_{min} = \frac{M + m}{M}\sqrt{\frac{2\mu g(d - Carry)}{1 + \mu^2}}$$

= **24.66 mph**

*(Percentage is determined by dividing Searle Minimum result by Vehicle Impact Speed)*

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Additional training required to fully understand the technical analysis.

# Pedestrian/Bicycle Crash Analysis

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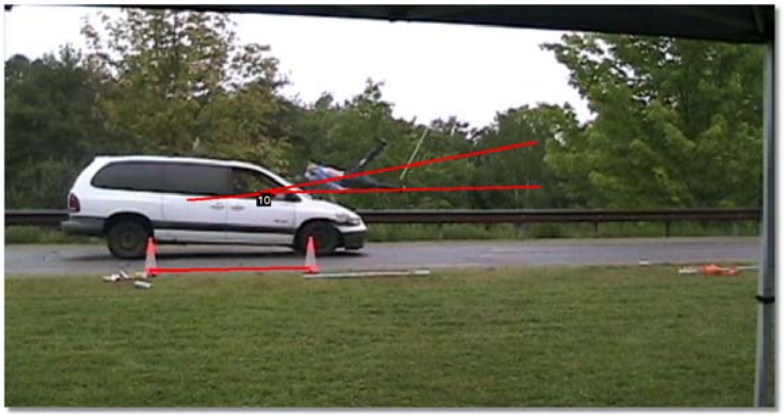
Test 4



**Searle Analysis: (1983)**

| | |
|---|---|
| Searle (10 Degree) Takeoff: | 27.71 mph |
| Searle (20 Degree) Takeoff: | 26.74 mph |
| Searle Minimum Formula: | 26.56 mph |
| Searle Maximum Formula: | 29.70 mph |

**Vehicle Speed Analysis:**

| | |
|---|---|
| Speed - Start of Braking (Skid): | 30.70 mph |
| Speed - Impact (Skid): | 27.23 mph |
| Speed - Start of Braking (Radar): | N/A mph |
| Speed - Impact (Radar): | 32.00 mph |
| Speed - Impact (Vericom): | 27.23 mph |

**Other Calculations:**

| | |
|---|---|
| Speed (With Adjusted Data): | 27.06 mph |
| Throw Minus Carry Distance(ft): | 56.08 feet |
| Location of First Evidence (ft.): | 7.8 feet |
| % of Speed Attained (Ped): | 98% |
| Difference (C/M vs. Hood H (in.): | 10 inches |
| Takeoff From Video (Degrees): | 10 Degrees |
| Carry Distance (ft.): | 2.72 feet |

**NEW Searle Formulae Analysis:**

| | |
|---|---|
| Voyager Weight: (M) | 4,186.00 lb |
| Pedestrian Weight: (m) | 55 lb |
| Ped C/M Height: (H) | 3.33 feet |

**Searle Minimum Analysis: (1991, 2009)**

$$V_{min} = \sqrt{\frac{2\mu g(d - \mu H)}{1 + \mu^2}}$$

= **26.18 mph**

**Searle Minimum Analysis: (2009)**

$$V_{min} = \frac{M + m}{M}\sqrt{\frac{2\mu g(d - Carry)}{1 + \mu^2}}$$

= **26.28 mph**

*(Percentage is determined by dividing Searle Minimum result by Vehicle Impact Speed)*

# Pedestrian/Bicycle Crash Analysis

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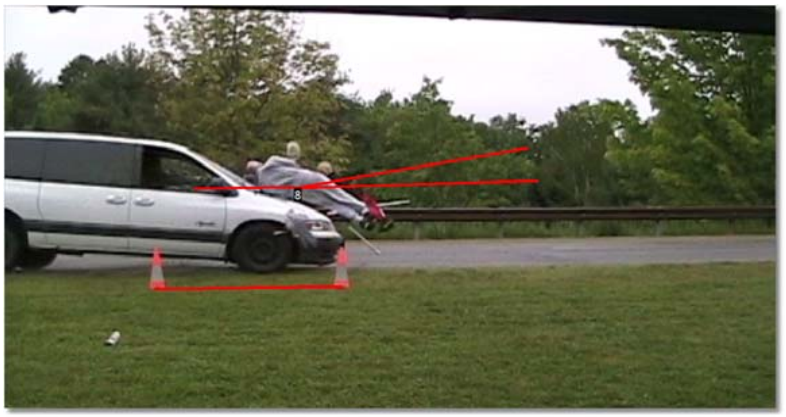
Test 5



**Searle Analysis: (1983)**

| | | |
|---|---|---|
| Searle (10 Degree) Takeoff: | 31.53 | mph |
| Searle (20 Degree) Takeoff: | 30.16 | mph |
| Searle Minimum Formula: | 29.77 | mph |
| Searle Maximum Formula: | 34.12 | mph |

**Vehicle Speed Analysis:**

| | | |
|---|---|---|
| Speed - Start of Braking (Skid): | 34.14 | mph |
| Speed - Impact (Skid): | 29.94 | mph |
| Speed - Start of Braking (Radar): | N/A | mph |
| Speed - Impact (Radar): | 35.00 | mph |
| Speed - Impact (Vericom): | 29.94 | mph |

**Other Calculations:**

| | | |
|---|---|---|
| Speed (With Adjusted Data): | 30.98 | mph |
| Throw Minus Carry Distance(ft): | 66.04 | feet |
| Location of First Evidence (ft.): | 21.0 | feet |
| % of Speed Attained (Ped): | 99% | |
| Difference (C/M vs. Hood H (in.): | 12 | inches |
| Takeoff From Video (Degrees): | 9 | Degrees |
| Carry Distance (ft.): | 3.26 | feet |

**NEW Searle Formulae Analysis:**

| | | |
|---|---|---|
| Voyager Weight: (M) | 4,186.00 | lb |
| Pedestrian Weight: (m) | 55 | lb |
| Ped C/M Height: (H) | 3.33 | feet |

**Searle Minimum Analysis: (1991, 2009)**

$$V_{min} = \sqrt{\frac{2\mu g(d - \mu H)}{1 + \mu^2}}$$

= **29.37 mph**

**Searle Minimum Analysis: (2009)**

$$V_{min} = \frac{M + m}{M}\sqrt{\frac{2\mu g(d - Carry)}{1 + \mu^2}}$$

= **29.44 mph**

*(Percentage is determined by dividing Searle Minimum result by Vehicle Impact Speed)*

# Pedestrian/Bicycle Crash Analysis

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Test 6

**Searle Analysis: (1983)**

| | | |
|---|---|---|
| Searle (10 Degree) Takeoff: | 16.56 | mph |
| Searle (20 Degree) Takeoff: | 15.98 | mph |
| Searle Minimum Formula: | 15.87 | mph |
| Searle Maximum Formula: | 17.75 | mph |

**Vehicle Speed Analysis:**

| | | |
|---|---|---|
| Speed - Start of Braking (Skid): | 34.72 | mph |
| Speed - Impact (Skid): | 26.36 | mph |
| Speed - Start of Braking (Radar): | N/A | mph |
| Speed - Impact (Radar): | 28.00 | mph |
| Speed - Impact (Vericom): | 26.36 | mph |

**Other Calculations:**

| | | |
|---|---|---|
| Speed (With Adjusted Data): | 15.85 | mph |
| Throw Minus Carry Distance(ft): | 19.04 | feet |
| Location of First Evidence (ft.): | 12.4 | feet |
| % of Speed Attained (Ped): | 60% | |
| Difference (C/M vs. Hood H (in.): | 11 | inches |
| Takeoff From Video (Degrees): | 9 | Degrees |
| Carry Distance (ft.): | 1.96 | feet |

**NEW Searle Formulae Analysis:**

| | | |
|---|---|---|
| Corsica Weight: (M) | 3,015.00 | lb |
| Pedestrian Weight: (m) | 55 | lb |
| Ped C/M Height: (H) | 3.33 | feet |

**Searle Minimum Analysis: (1991, 2009)**

$$V_{min} = \sqrt{\frac{2\mu g(d - \mu H)}{1 + \mu^2}}$$

= **15.23 mph**

**Searle Minimum Analysis: (2009)**

$$V_{min} = \frac{M + m}{M}\sqrt{\frac{2\mu g(d - Carry)}{1 + \mu^2}}$$

= **15.39 mph**

*(Percentage is determined by dividing Searle Minimum result by Vehicle Impact Speed)*

# Pedestrian/Bicycle Crash Analysis

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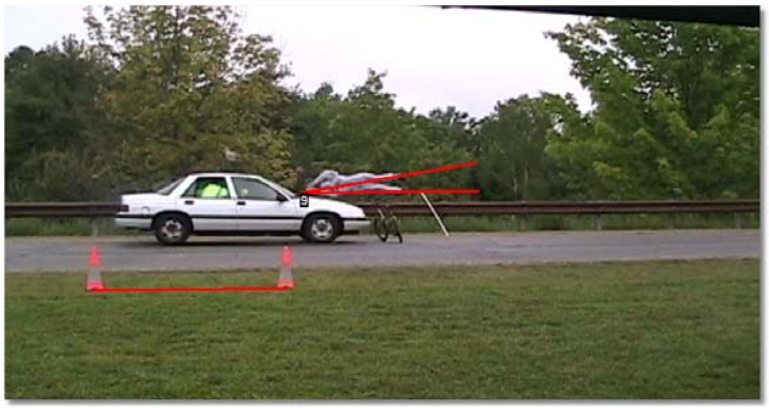
Test 7



**Searle Analysis: (1983)**

| | |
|---|---|
| Searle (10 Degree) Takeoff: | 22.71 mph |
| Searle (20 Degree) Takeoff: | 21.92 mph |
| Searle Minimum Formula: | 21.77 mph |
| Searle Maximum Formula: | 24.34 mph |

**Vehicle Speed Analysis:**

| | |
|---|---|
| Speed - Start of Braking (Skid): | 30.13 mph |
| Speed - Impact (Skid): | 22.85 mph |
| Speed - Start of Braking (Radar): | N/A mph |
| Speed - Impact (Radar): | 30.00 mph |
| Speed - Impact (Vericom): | 22.85 mph |

**Other Calculations:**

| | |
|---|---|
| Speed (With Adjusted Data): | 22.22 mph |
| Throw Minus Carry Distance(ft): | 37.39 feet |
| Location of First Evidence (ft.): | 7.2 feet |
| % of Speed Attained (Ped): | 95% |
| Difference (C/M vs. Hood H (in.): | 10 inches |
| Takeoff From Video (Degrees): | 9 Degrees |
| Carry Distance (ft.): | 2.11 feet |

**NEW Searle Formulae Analysis:**

| | |
|---|---|
| Corsica Weight: (M) | 3,015.00 lb |
| Pedestrian Weight: (m) | 55 lb |
| Ped C/M Height: (H) | 3.33 feet |

**Searle Minimum Analysis: (1991, 2009)**

$$V_{min} = \sqrt{\frac{2\mu g(d - \mu H)}{1 + \mu^2}}$$

= **21.31 mph**

**Searle Minimum Analysis: (2009)**

$$V_{min} = \frac{M + m}{M}\sqrt{\frac{2\mu g(d - Carry)}{1 + \mu^2}}$$

= **21.57 mph**

*(Percentage is determined by dividing Searle Minimum result by Vehicle Impact Speed)*

# Pedestrian/Bicycle Crash Analysis

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Test 8

**Searle Analysis: (1983)**

| | |
|---|---|
| Searle (10 Degree) Takeoff: | 24.03 mph |
| Searle (20 Degree) Takeoff: | 23.18 mph |
| Searle Minimum Formula: | 23.03 mph |
| Searle Maximum Formula: | 25.75 mph |

**Vehicle Speed Analysis:**

| | |
|---|---|
| Speed - Start of Braking (Skid): | 40.78 mph |
| Speed - Impact (Skid): | 24.98 mph |
| Speed - Start of Braking (Radar): | N/A mph |
| Speed - Impact (Radar): | 36.00 mph |
| Speed - Impact (Vericom): | 24.98 mph |

**Other Calculations:**

| | |
|---|---|
| Speed (With Adjusted Data): | 24.09 mph |
| Throw Minus Carry Distance(ft): | 42.39 feet |
| Location of First Evidence (ft.): | 31.5 feet |
| % of Speed Attained (Ped): | 92% |
| Difference (C/M vs. Hood H (in.): | 10 inches |
| Takeoff From Video (Degrees): | 6 Degrees |
| Carry Distance (ft.): | 1.81 feet |

**NEW Searle Formulae Analysis:**

| | |
|---|---|
| Voyager Weight: (M) | 4,186.00 lb |
| Pedestrian Weight: (m) | 55 lb |
| Ped C/M Height: (H) | 3.33 feet |

**Searle Minimum Analysis: (1991, 2009)**

$$V_{min} = \sqrt{\frac{2\mu g(d - \mu H)}{1 + \mu^2}}$$

= **22.59 mph**

**Searle Minimum Analysis: (2009)**

$$V_{min} = \frac{M + m}{M}\sqrt{\frac{2\mu g(d - Carry)}{1 + \mu^2}}$$

= **22.85 mph**

*(Percentage is determined by dividing Searle Minimum result by Vehicle Impact Speed)*

# Pedestrian/Bicycle Crash Analysis

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Test 9

**Searle Analysis: (1983)**

| | | |
|---|---|---|
| Searle (10 Degree) Takeoff: | 31.94 | mph |
| Searle (20 Degree) Takeoff: | 31.94 | mph |
| Searle Minimum Formula: | 28.57 | mph |
| Searle Maximum Formula: | 31.94 | mph |

**Vehicle Speed Analysis:**

| | | |
|---|---|---|
| Speed - Start of Braking (Skid): | 44.62 | mph |
| Speed - Impact (Skid): | 38.28 | mph |
| Speed - Start of Braking (Radar): | N/A | mph |
| Speed - Impact (Radar): | N/A | mph |
| Speed - Impact (Vericom): | 38.28 | mph |

**Other Calculations:**

| | | |
|---|---|---|
| Speed (With Adjusted Data): | 30.60 | mph |
| Throw Minus Carry Distance(ft): | 62.41 | feet |
| Location of First Evidence (ft.): | 46.2 | feet |
| % of Speed Attained (Ped): | 75% | |
| Difference (C/M vs. Hood H (in.): | N/A | inches |
| Takeoff From Video (Degrees): | 0 | Degrees |
| Carry Distance (ft.): | 5.59 | feet |

**NEW Searle Formulae Analysis:**

| | | |
|---|---|---|
| Voyager Weight: (M) | 4,186.00 | lb |
| Pedestrian Weight: (m) | 55 | lb |
| Ped C/M Height: (H) | 3.33 | feet |

**Searle Minimum Analysis: (1991, 2009)**

$$V_{min} = \sqrt{\frac{2\mu g(d - \mu H)}{1 + \mu^2}}$$

= **28.21 mph**

**Searle Minimum Analysis: (2009)**

$$V_{min} = \frac{M + m}{M}\sqrt{\frac{2\mu g(d - Carry)}{1 + \mu^2}}$$

= **27.73 mph**

*(Percentage is determined by dividing Searle Minimum result by Vehicle Impact Speed)*

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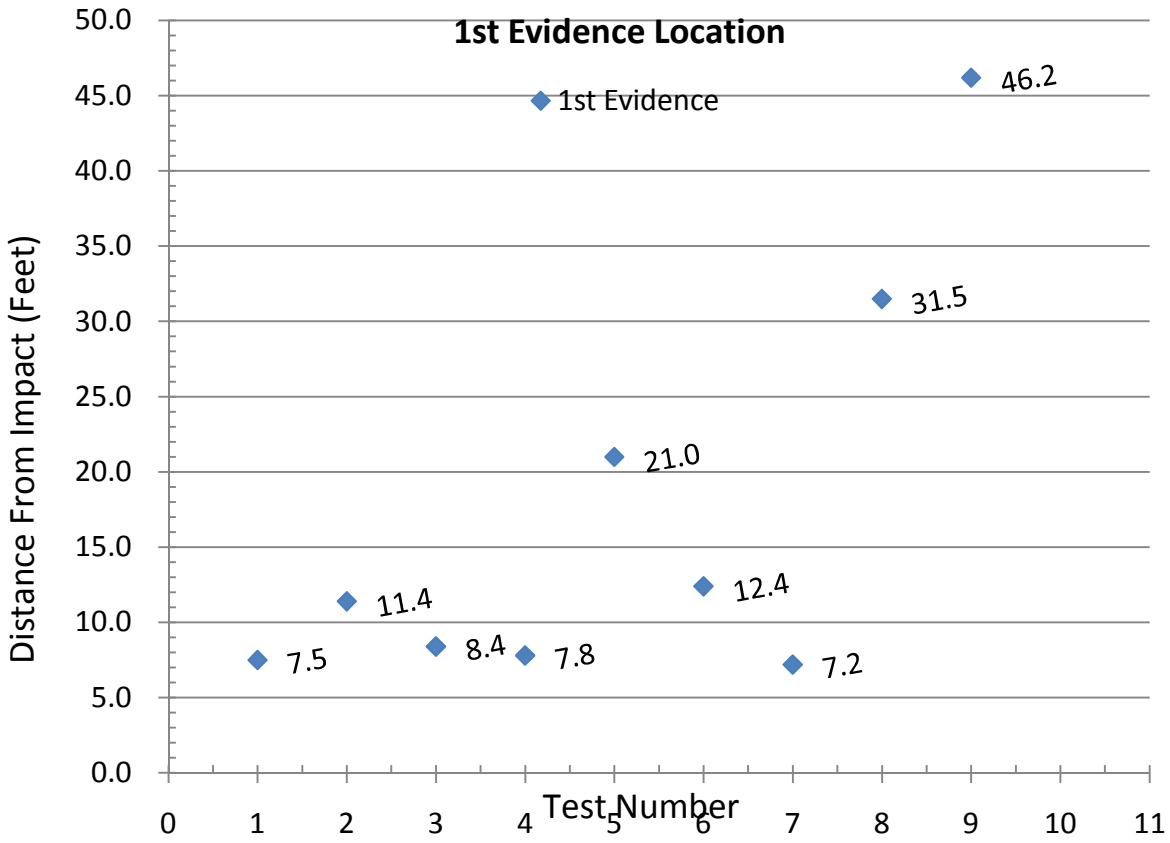


The above graph represents the location of the "1st" Evidence after impact. The longitudinal distance was measured from the impact location either forward or backward. In cases where the 1st Evidence lands before impact, the value is shown as a "RED" negative number.

# Pedestrian/Bicycle Crash Analysis

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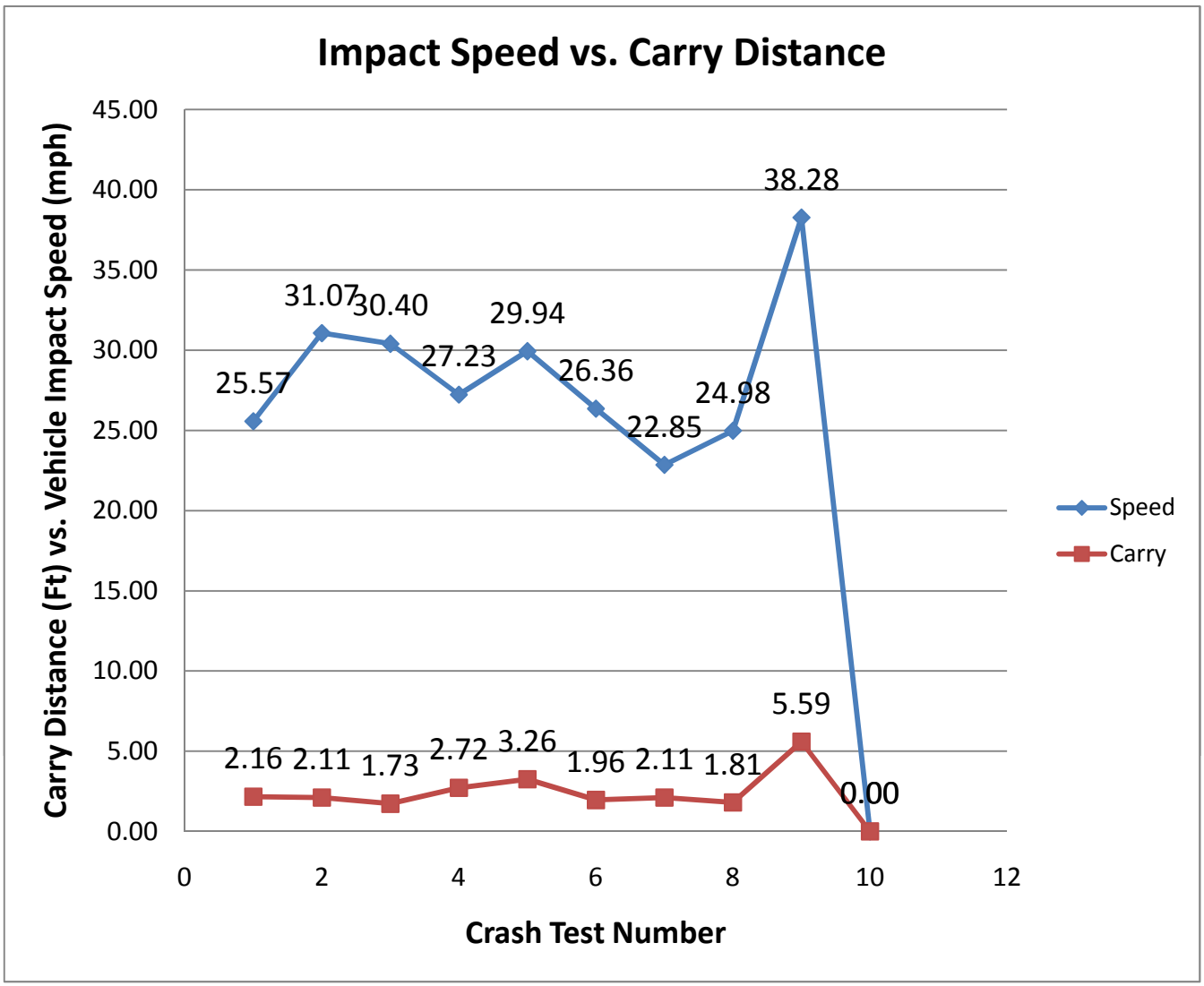


| Data | Speed | Carry |
|---|---|---|
| Test 1: | 25.57 | 2.16 |
| Test 2: | 31.07 | 2.11 |
| Test 3: | 30.40 | 1.73 |
| Test 4: | 27.23 | 2.72 |
| Test 5: | 29.94 | 3.26 |
| Test 6: | 26.36 | 1.96 |
| Test 7: | 22.85 | 2.11 |
| Test 8: | 24.98 | 1.81 |
| Test 9: | 38.28 | 5.59 |
| Test 10: | 0.00 | 0.00 |