



Pedestrian/Bicycle Crash Analysis



Instructors: Tony Becker / Mike Reade

Date: 14-May-09

Place: Bayamon, Puerto Rico

Vehicle: 1995 Mitsubishi Expo Mini Van

VIN: JA3AD59G0SZ001121

OL: 169 inches

OW: 67 inches

WB: 99 inches

FOH: 32 inches

ROH: 38 inches

Weight: 3,059.00 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):

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

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.):	64	64	64	64	64	64	64	64		
Ped C/M Ht (in.):	39	39	39	39	40	39	30			
Ped Slide D (ft.):	25.2	26	19.4	8.45	31.7	18.3	45			
Airborne D (ft.):	42.3	40	32.3	27.8	29.8	18.3	42.5			
Ped f-Value:	0.7	0.7	0.7	0.7	0.7	0.7	0.7			
Throw D (ft.):	67.5	66	51.7	36.25	61.5	18.3	87.5			
Takeoff (Min):	10	10	10	10	10	10	10			
Takeoff (Max.):	20	20	20	20	20	20	20			
1st Evid. (ft):	N/A	8.0	6.0	3.0	-6.0	0.5	10			
Ped Weight (lb):	45	45	45	45	45	45	45			
Vehicle Data:										
Hood Height (in.):	30	30	30	30	30	30	30			
C/M - Hood Change (in.):	9	9	9	9	10	9	0			
Braking (Yes=Y/No=N):	Y	Y	Y	Y	Y	Y	Y			
Skid Total (ft.):	59.7	58.5	55.8	49.9	82.1	82.1	95.5			
Skid Impact (ft.):	10	11.3	19.5	10	23.3	0.15	34.5			
Road f-Value:	0.66	0.656	0.67	0.652	0.648	0.631	0.67			
Vericom (Impact):	31.49	30.48	27.01	27.62	33.81	39.38	35.01			
Video (Impact):	N/A	24.5	25.4	26.4	26.2	35.1	29.31			
Radar (Start Braking):	N/A	N/A	N/A	N/A	N/A	N/A	N/A			
Radar (Impact):	N/A	N/A	N/A	N/A	N/A	N/A	N/A			

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Additional training required to fully understand the technical analysis.



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Test 1



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	34.03 mph
Searle (20 Degree) Takeoff:	31.93 mph
Searle Minimum Formula:	30.84 mph
Searle Maximum Formula:	37.65 mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	34.38 mph
Speed - Impact (Skid):	31.37 mph
Speed - Start of Braking (Radar):	N/A mph
Speed - Impact (Radar):	N/A mph
Speed - Impact (Vericom):	31.49 mph

Other Calculations:

Speed (With Adjusted Data):	35.04 mph
Throw Minus Carry Distance(ft):	64.00 feet
Location of First Evidence (ft.):	0.0 feet
% of Speed Attained (Ped):	98%
Difference (C/M vs. Hood H (in.):	9 inches
Takeoff From Video (Degrees):	4 Degrees
Carry Distance (ft.):	3.50 feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	3,059.00 lb
Pedestrian Weight: (m)	45 lb
Ped C/M Height: (H)	3.25 feet

Searle Minimum Analysis: (1991, 2009)

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

$$= 30.32 \text{ mph}$$

Searle Minimum Analysis: (2009)

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

$$= 30.48 \text{ mph}$$

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

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Test 2



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	33.65 mph
Searle (20 Degree) Takeoff:	31.57 mph
Searle Minimum Formula:	30.50 mph
Searle Maximum Formula:	37.23 mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	33.93 mph
Speed - Impact (Skid):	30.48 mph
Speed - Start of Braking (Radar):	N/A mph
Speed - Impact (Radar):	N/A mph
Speed - Impact (Vericom):	30.48 mph

Other Calculations:

Speed (With Adjusted Data):	35.39 mph
Throw Minus Carry Distance(ft.):	62.50 feet
Location of First Evidence (ft.):	8.0 feet
% of Speed Attained (Ped):	100%
Difference (C/M vs. Hood H (in.):	9 inches
Takeoff From Video (Degrees):	2 Degrees
Carry Distance (ft.):	3.50 feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	3,059.00 lb
Pedestrian Weight: (m)	45 lb
Ped C/M Height: (H)	3.25 feet

Searle Minimum Analysis: (1991, 2009)

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

$$= 29.97 \text{ mph}$$

Searle Minimum Analysis: (2009)

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

$$= 30.12 \text{ mph}$$

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

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Test 3



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	29.78 mph
Searle (20 Degree) Takeoff:	27.94 mph
Searle Minimum Formula:	26.99 mph
Searle Maximum Formula:	32.95 mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	33.49 mph
Speed - Impact (Skid):	27.01 mph
Speed - Start of Braking (Radar):	N/A mph
Speed - Impact (Radar):	N/A mph
Speed - Impact (Vericom):	27.01 mph

Other Calculations:

Speed (With Adjusted Data):	30.53 mph
Throw Minus Carry Distance(ft.):	48.60 feet
Location of First Evidence (ft.):	6.0 feet
% of Speed Attained (Ped):	100%
Difference (C/M vs. Hood H (in.):	9 inches
Takeoff From Video (Degrees):	4 Degrees
Carry Distance (ft.):	3.10 feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	3,059.00 lb
Pedestrian Weight: (m)	45 lb
Ped C/M Height: (H)	3.25 feet

Searle Minimum Analysis: (1991, 2009)

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

$$= 26.39 \text{ mph}$$

Searle Minimum Analysis: (2009)

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

$$= 26.56 \text{ mph}$$

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

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Test 4



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	24.94 mph
Searle (20 Degree) Takeoff:	23.40 mph
Searle Minimum Formula:	22.60 mph
Searle Maximum Formula:	27.59 mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	31.24 mph
Speed - Impact (Skid):	27.94 mph
Speed - Start of Braking (Radar):	N/A mph
Speed - Impact (Radar):	N/A mph
Speed - Impact (Vericom):	27.62 mph

Other Calculations:

Speed (With Adjusted Data):	24.42 mph
Throw Minus Carry Distance(ft.):	31.75 feet
Location of First Evidence (ft.):	3.0 feet
% of Speed Attained (Ped):	81%
Difference (C/M vs. Hood H (in.):	9 inches
Takeoff From Video (Degrees):	5 Degrees
Carry Distance (ft.):	4.50 feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	3,059.00 lb
Pedestrian Weight: (m)	45 lb
Ped C/M Height: (H)	3.25 feet

Searle Minimum Analysis: (1991, 2009)

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

$$= 21.88 \text{ mph}$$

Searle Minimum Analysis: (2009)

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

$$= 21.46 \text{ mph}$$

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

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Test 5



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	32.48 mph
Searle (20 Degree) Takeoff:	30.48 mph
Searle Minimum Formula:	29.44 mph
Searle Maximum Formula:	35.94 mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	39.95 mph
Speed - Impact (Skid):	33.81 mph
Speed - Start of Braking (Radar):	N/A mph
Speed - Impact (Radar):	N/A mph
Speed - Impact (Vericom):	33.81 mph

Other Calculations:

Speed (With Adjusted Data):	33.85 mph
Throw Minus Carry Distance(ft.):	55.90 feet
Location of First Evidence (ft.):	-6.0 feet
% of Speed Attained (Ped):	87%
Difference (C/M vs. Hood H (in.):	10 inches
Takeoff From Video (Degrees):	1 Degrees
Carry Distance (ft.):	5.60 feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	3,059.00 lb
Pedestrian Weight: (m)	45 lb
Ped C/M Height: (H)	3.25 feet

Searle Minimum Analysis: (1991, 2009)

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

$$= 28.89 \text{ mph}$$

Searle Minimum Analysis: (2009)

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

$$= 28.48 \text{ mph}$$

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

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Test 6



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	17.72 mph
Searle (20 Degree) Takeoff:	16.63 mph
Searle Minimum Formula:	16.06 mph
Searle Maximum Formula:	19.60 mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	39.42 mph
Speed - Impact (Skid):	39.39 mph
Speed - Start of Braking (Radar):	N/A mph
Speed - Impact (Radar):	N/A mph
Speed - Impact (Vericom):	39.38 mph

Other Calculations:

Speed (With Adjusted Data):	19.06 mph
Throw Minus Carry Distance(ft.):	17.30 feet
Location of First Evidence (ft.):	0.5 feet
% of Speed Attained (Ped):	41%
Difference (C/M vs. Hood H (in.):	9 inches
Takeoff From Video (Degrees):	0 Degrees
Carry Distance (ft.):	1.00 feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	3,059.00 lb
Pedestrian Weight: (m)	45 lb
Ped C/M Height: (H)	3.25 feet

Searle Minimum Analysis: (1991, 2009)

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

$$= 15.03 \text{ mph}$$

Searle Minimum Analysis: (2009)

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

$$= 15.84 \text{ mph}$$

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

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Test 7



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	38.75 mph
Searle (20 Degree) Takeoff:	36.35 mph
Searle Minimum Formula:	35.12 mph
Searle Maximum Formula:	42.87 mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	43.81 mph
Speed - Impact (Skid):	35.02 mph
Speed - Start of Braking (Radar):	N/A mph
Speed - Impact (Radar):	N/A mph
Speed - Impact (Vericom):	35.01 mph

Other Calculations:

Speed (With Adjusted Data):	41.50 mph
Throw Minus Carry Distance(ft.):	82.00 feet
Location of First Evidence (ft.):	10.0 feet
% of Speed Attained (Ped):	100%
Difference (C/M vs. Hood H (in.):	0 inches
Takeoff From Video (Degrees):	0 Degrees
Carry Distance (ft.):	5.50 feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	3,059.00 lb
Pedestrian Weight: (m)	45 lb
Ped C/M Height: (H)	3.25 feet

Searle Minimum Analysis: (1991, 2009)

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

$$= 34.66 \text{ mph}$$

Searle Minimum Analysis: (2009)

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

$$= 34.50 \text{ mph}$$

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

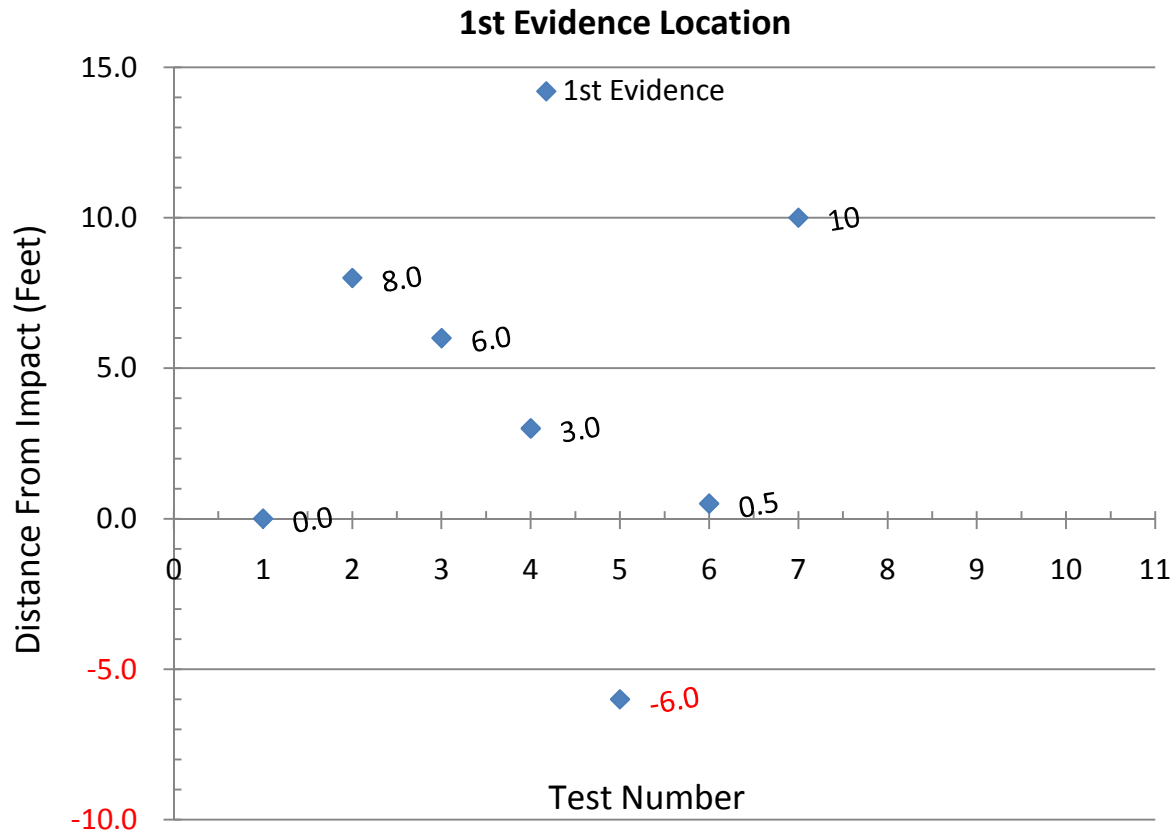
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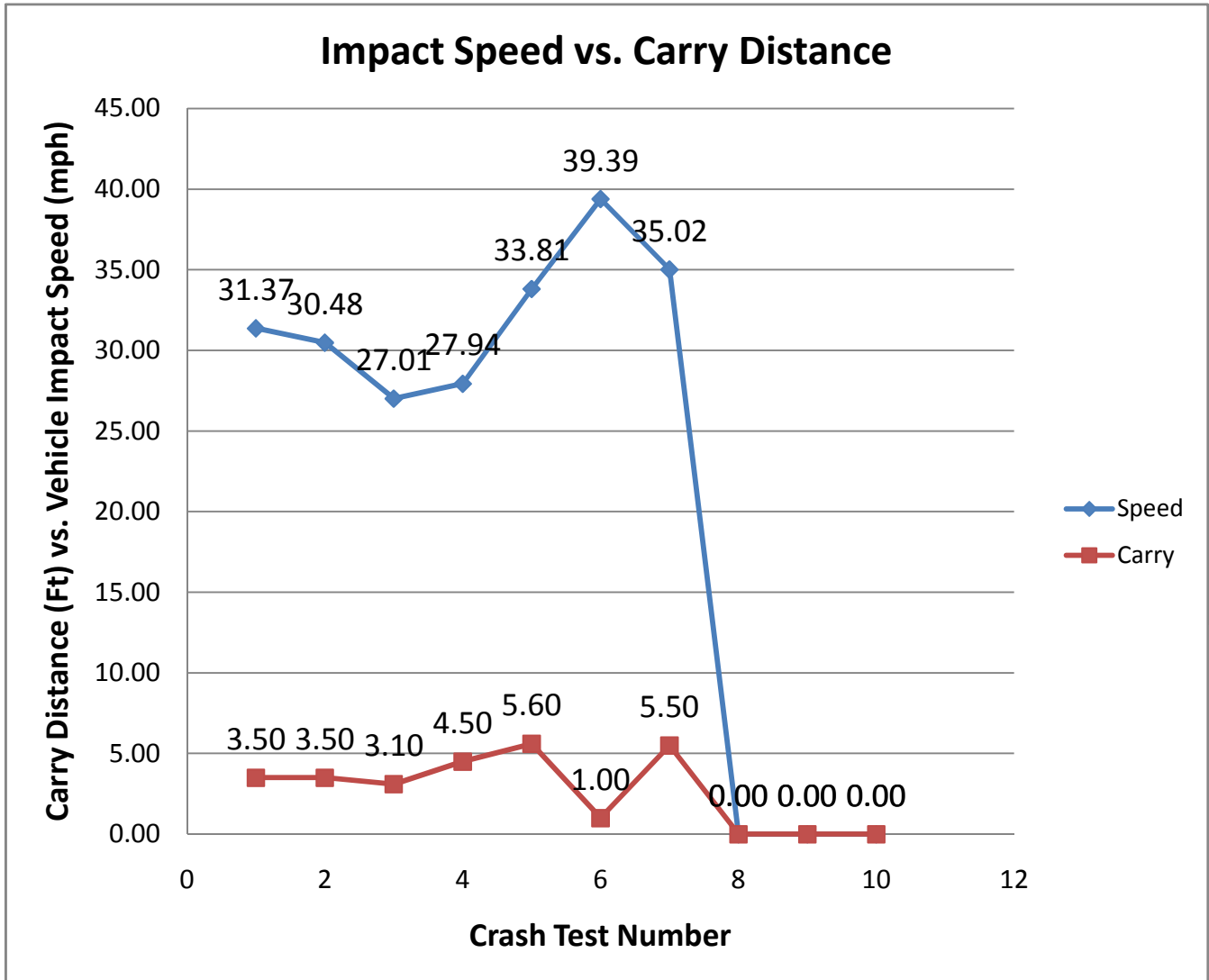
The above graph represents the location of the "1st" Evidence after impact. The longitudinal distance was measured from the impact location either forward or backward. In cases where the 1st Evidence lands before impact, the value is shown as a "RED" negative number.



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Data	Speed	Carry
Test 1:	31.37	3.50
Test 2:	30.48	3.50
Test 3:	27.01	3.10
Test 4:	27.94	4.50
Test 5:	33.81	5.60
Test 6:	39.39	1.00
Test 7:	35.02	5.50
Test 8:	0.00	0.00
Test 9:	0.00	0.00
Test 10:	0.00	0.00

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