Pedestrian/Bicycle Crash Analysis

Instructors: Tony Becker / Chris Sanchez

Date: 7-Jun-12

Place: Raleigh, NC

Vehicle: 2003
VIN:
OL:
OW:
WB:
FOH:
ROH:
Weight: 4,620.00 lb
Hood H: 34

Searle (Angle):

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

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:

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

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.):	66	66	66	66	66	66	66	66	0	66
Ped C/M Ht (in.):	39	39	39	39	39	39	39	39	39	39
Ped Slide D (ft.):	24.33	10.8	23.16	10.6	N/A	20.08	32.16	22.5	37	35.33
Airborne D (ft.):	37	31.45	45.17	32.4	N/A	66.42	46	58	28	62.25
Ped f-Value:	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Throw D (ft.):	61.33	42.25	68.33	43	99.16	86.5	78.16	80.5	65	97.58
Takeoff (Min):	10	10	10	10	10	10	10	10	10	10
Takeoff (Max.):	20	20	20	20	20	20	20	20	20	20
1st Evid. (ft):	7	18.5	6	23.58	0	0	0	7.33	0	3
Ped Weight (lb):	55	55	55	55	55	55	0	0	55	55
Vehicle Data:										
Hood Height (in.):	34	34	34	34	34	34	34	34	34	34
C/M - Hood Change (in.):	5	5	5	5	5	5	5	5	5	5
Braking (Yes=Y/No=N):	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skid Total (ft.):	39.1	39.2	47.41		108.33	75.81	69.96	67.75	67.75	121.5
Skid Impact (ft.):		17.7				9.73	4.96			
Road f-Value:	0.77	0.74	0.72		0.68	0.7	0.77			0.72
Vericom (Impact):	31.40	21.85	33.03		47.00	37.25	38.75			51.23
Radar (Start Braking):				28.6				37.7	37.7	
Radar (Impact):				28.6				37.7	37.7	

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Test 1

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	31.70	mph
Searle (20 Degree) Takeoff:	29.90	mph
Searle Minimum Formula:	**29.08**	mph
Searle Maximum Formula:	34.85	mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	30.05	mph
Speed - Impact (Skid):	31.40	mph
Speed - Start of Braking (IDrive):	33.00	mph
Speed - Impact (Vericom):	31.40	mph

Other Calculations:

Speed (With Adjusted Data):	31.97	mph
Throw Minus Carry Distance(ft):	57.33	feet
Location of First Evidence (ft.):	7.0	feet
% of Speed Attained (Ped):	93%	
Difference (C/M vs. Hood H (in.):	5.0	inches
Takeoff From Video (Degrees):	5	Degrees
Carry Distance (ft.):	4.00	feet

NEW Searle Formulae Analysis:

Veh Weight: (M)	4,620.00	lb
Pedestrian Weight: (m)	55	lb
Ped C/M Height: (H)	3.25	feet

Searle Minimum Analysis: (1993, 2009)

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

= **28.57 mph**

Searle Minimum Analysis: (2009)

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

= **28.45 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:	26.31	mph
Searle (20 Degree) Takeoff:	24.82	mph
Searle Minimum Formula:	24.14	mph
Searle Maximum Formula:	28.92	mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	32.00	mph
Speed - Impact (Skid):	32.00	mph
Speed - Start of Braking (IDrive):	32.00	mph
Speed - Impact (iDrive):	32.00	mph

Other Calculations:

Speed (With Adjusted Data):	25.88	mph
Throw Minus Carry Distance(ft):	38.25	feet
Location of First Evidence (ft.):	18.5	feet
% of Speed Attained (Ped):	75%	
Difference (C/M vs. Hood H (in.):	5.0	inches
Takeoff From Video (Degrees):	6	Degrees
Carry Distance (ft.):	4.00	feet

NEW Searle Formulae Analysis:

Veh Weight: (M)	4,620.00	lb
Pedestrian Weight: (m)	55	lb
Ped C/M Height: (H)	3.25	feet

Searle Minimum Analysis: (1993, 2009)

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

= 23.52 mph

Searle Minimum Analysis: (2009)

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

= 23.24 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:	33.46	mph
Searle (20 Degree) Takeoff:	31.56	mph
Searle Minimum Formula:	**30.70**	mph
Searle Maximum Formula:	36.78	mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	32.00	mph
Speed - Impact (Skid):	33.03	mph
Speed - Start of Braking (IDrive):	31.00	mph
Speed - Impact (Vericom):	33.03	mph

Other Calculations:

Speed (With Adjusted Data):	34.05	mph
Throw Minus Carry Distance(ft):	65.03	feet
Location of First Evidence (ft.):	6.0	feet
% of Speed Attained (Ped):	93%	
Difference (C/M vs. Hood H (in.):	5.0	inches
Takeoff From Video (Degrees):	5	Degrees
Carry Distance (ft.):	3.30	feet

NEW Searle Formulae Analysis:

Veh Weight: (M)	4,620.00	lb
Pedestrian Weight: (m)	55	lb
Ped C/M Height: (H)	3.25	feet

Searle Minimum Analysis: (1993, 2009)

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

= **30.21 mph**

Searle Minimum Analysis: (2009)

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

= **30.30 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:	26.54	mph
Searle (20 Degree) Takeoff:	25.04	mph
Searle Minimum Formula:	24.35	mph
Searle Maximum Formula:	29.18	mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	28.57	mph
Speed - Impact (Skid):	28.57	mph
Speed - Start of Braking (IDrive):	29.00	mph
Speed - Impact (Vericom):	28.57	mph

Other Calculations:

Speed (With Adjusted Data):	26.20	mph
Throw Minus Carry Distance(ft):	37.00	feet
Location of First Evidence (ft.):	23.6	feet
% of Speed Attained (Ped):	85%	
Difference (C/M vs. Hood H (in.):	5.0	inches
Takeoff From Video (Degrees):	3	Degrees
Carry Distance (ft.):	6.00	feet

NEW Searle Formulae Analysis:

Veh Weight: (M)	4,620.00	lb
Pedestrian Weight: (m)	55	lb
Ped C/M Height: (H)	3.25	feet

Searle Minimum Analysis: (1993, 2009)

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

= 23.74 mph

Searle Minimum Analysis: (2009)

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

= 22.86 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:	40.30	mph
Searle (20 Degree) Takeoff:	38.02	mph
Searle Minimum Formula:	**36.98**	mph
Searle Maximum Formula:	44.31	mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	47.01	mph
Speed - Impact (Skid):	47.00	mph
Speed - Start of Braking (Radar):	N/A	mph
Speed - Impact (iDrive):	40.00	mph
Speed - Impact (Vericom):	47.00	mph

Other Calculations:

Speed (With Adjusted Data):	41.03	mph
Throw Minus Carry Distance(ft):	96.16	feet
Location of First Evidence (ft.):	0.0	feet
% of Speed Attained (Ped):	79%	
Difference (C/M vs. Hood H (in.):	5.0	inches
Takeoff From Video (Degrees):	6	Degrees
Carry Distance (ft.):	3.00	feet

NEW Searle Formulae Analysis:

Veh Weight: (M)	4,620.00	lb
Pedestrian Weight: (m)	55	lb
Ped C/M Height: (H)	3.25	feet

Searle Minimum Analysis: (1993, 2009)

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

= **36.58 mph**

Searle Minimum Analysis: (2009)

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

= **36.85 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:	37.64	mph
Searle (20 Degree) Takeoff:	35.51	mph
Searle Minimum Formula:	**34.54**	mph
Searle Maximum Formula:	41.38	mph

Vehicle Speed Analysis:

Speed - Start of Braking (IDrive):	37.00	mph
Speed - Impact (Skid):	39.90	mph
Speed - Impact (Vericom):	39.90	mph

Other Calculations:

Speed (With Adjusted Data):	38.36	mph
Throw Minus Carry Distance(ft):	82.50	feet
Location of First Evidence (ft.):	0.0	feet
% of Speed Attained (Ped):	87%	
Difference (C/M vs. Hood H (in.):	5.0	inches
Takeoff From Video (Degrees):	5	Degrees
Carry Distance (ft.):	4.00	feet

NEW Searle Formulae Analysis:

Veh Weight: (M)	4,620.00	lb
Pedestrian Weight: (m)	55	lb
Ped C/M Height: (H)	3.25	feet

Searle Minimum Analysis: (1993, 2009)

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

= **34.11 mph**

Searle Minimum Analysis: (2009)

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

= **34.13 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:	35.78	mph
Searle (20 Degree) Takeoff:	33.76	mph
Searle Minimum Formula:	**32.83**	mph
Searle Maximum Formula:	39.34	mph

Vehicle Speed Analysis:

Speed - Start of Braking (IDrive):	37.00	mph
Speed - Impact (Skid):	38.75	mph
Speed - Impact (Vericom):	38.75	mph

Other Calculations:

Speed (With Adjusted Data):	35.79	mph
Throw Minus Carry Distance(ft):	73.16	feet
Location of First Evidence (ft.):	0.0	feet
% of Speed Attained (Ped):	85%	
Difference (C/M vs. Hood H (in.):	39.0	inches
Takeoff From Video (Degrees):	6	Degrees
Carry Distance (ft.):	5.00	feet

NEW Searle Formulae Analysis:

Veh Weight: (M)	4,620.00	lb
Pedestrian Weight: (m)	55	lb
Ped C/M Height: (H)	3.25	feet

Searle Minimum Analysis: (1993, 2009)

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

= **32.38 mph**

Searle Minimum Analysis: (2009)

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

= **32.14 mph**

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

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Test 8 2 Ped Hit

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	36.31	mph
Searle (20 Degree) Takeoff:	34.26	mph
Searle Minimum Formula:	**33.32**	mph
Searle Maximum Formula:	39.92	mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	37.71	mph
Speed - Impact (Skid):	37.71	mph
Speed - Start of Braking (IDrive):	36.00	mph
Speed - Impact (Vericom):	37.71	mph

Other Calculations:

Speed (With Adjusted Data):	36.03	mph
Throw Minus Carry Distance(ft):	75.50	feet
Location of First Evidence (ft.):	7.3	feet
% of Speed Attained (Ped):	88%	
Difference (C/M vs. Hood H (in.):	39.0	inches
Takeoff From Video (Degrees):	7	Degrees
Carry Distance (ft.):	5.00	feet

NEW Searle Formulae Analysis:

Veh Weight: (M)	4,620.00	lb
Pedestrian Weight: (m)	55	lb
Ped C/M Height: (H)	3.25	feet

Searle Minimum Analysis: (1993, 2009)

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

= **32.87 mph**

Searle Minimum Analysis: (2009)

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

= **32.65 mph**

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

Pedestrian/Bicycle Crash Analysis

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Test 9 2 Ped Hit

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	32.63 mph
Searle (20 Degree) Takeoff:	30.78 mph
Searle Minimum Formula:	**29.94** mph
Searle Maximum Formula:	35.87 mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	37.71 mph
Speed - Impact (Skid):	37.71 mph
Speed - Start of Braking (IDrive):	36.00 mph
Speed - Impact (Vericom):	37.71 mph

Other Calculations:

Speed (With Adjusted Data):	33.35 mph
Throw Minus Carry Distance(ft):	62.38 feet
Location of First Evidence (ft.):	0.0 feet
% of Speed Attained (Ped):	79%
Difference (C/M vs. Hood H (in.):	5.0 inches
Takeoff From Video (Degrees):	5 Degrees
Carry Distance (ft.):	2.62 feet

NEW Searle Formulae Analysis:

Veh Weight: (M)	4,620.00 lb
Pedestrian Weight: (m)	55 lb
Ped C/M Height: (H)	3.25 feet

Searle Minimum Analysis: (1993, 2009)

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

= **29.44 mph**

Searle Minimum Analysis: (2009)

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

= **29.68 mph**

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

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Test 10

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	39.98	mph
Searle (20 Degree) Takeoff:	37.72	mph
Searle Minimum Formula:	**36.69**	mph
Searle Maximum Formula:	43.96	mph

Vehicle Speed Analysis:

Speed - Start of Braking (Skid):	51.23	mph
Speed - Impact (Skid):	51.23	mph
Speed - Start of Braking (IDrive):	45.00	mph
Speed - Impact (Vericom):	51.23	mph

Other Calculations:

Speed (With Adjusted Data):	39.69	mph
Throw Minus Carry Distance(ft):	91.58	feet
Location of First Evidence (ft.):	3.0	feet
% of Speed Attained (Ped):	72%	
Difference (C/M vs. Hood H (in.):	5.0	inches
Takeoff From Video (Degrees):	7	Degrees
Carry Distance (ft.):	6.00	feet

NEW Searle Formulae Analysis:

Veh Weight: (M)	4,620.00	lb
Pedestrian Weight: (m)	55	lb
Ped C/M Height: (H)	39.00	feet

Searle Minimum Analysis: (1993, 2009)

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

= **31.48 mph**

Searle Minimum Analysis: (2009)

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

= **35.96 mph**

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