Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Date: 24-Jun-15

Place: Waipahu, Hawaii

Veh One:
2003 Ford Crown Vic

OL:	212.00 in
OW:	78.40 in
WB:	114.30 in
FOH:	42.60 in
ROH:	54.80 in
Weight:	4150.00 lb
Hood H:	2.58 in

Searle (Angle):

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

Searle Maximim:

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

Searle (Mass & Carry):

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

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 (ft):	5.33	5.33	5.33	5.33	5.33	5.33	5.33	5.33	5.33	5.33
Ped C/M Ht (ft):	3.33	3.50	3.42	3.17	3.83	3.42	3.03	3.04	3.17	3.42
Ped Slide D (ft):	11.60	17.20	25.30	18.67	34.78	35.00	30.20	37.30	32.42	14.17
Airborne D (ft):	30.00	32.60	34.60	27.58	57.80	59.00	36.40	56.20	61.83	45.83
Ped f-Value:	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
Throw D (ft):	41.60	49.80	59.90	46.25	92.58	94.00	66.60	93.50	94.25	60.00
Takeoff (Min):	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Takeoff (Max.):	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
1st Evid. (ft):	N/A	34.00	N/A	21.25	N/A	8.00	8.25	N/A	75.50	N/A
Ped Weight (lb):	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Vehicle Data:										
Hood Height (ft):	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.58
C/M - Hood Change (ft):	0.75	0.92	0.83	0.58	3.83	3.42	0.45	0.46	0.58	0.83
Braking (Yes=Y/No=N):	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Skid Total (ft):	38.90	42.50	43.90	33.70	90.10	81.80	75.20	90.00	86.30	80.20
Skid to Impact (ft):	10.80	12.90	7.90	7.29	N/A	5.80	29.95	11.60	20.30	N/A
Road f-Value:	0.82	0.82	0.80	0.79	0.80	0.80	0.81	0.80	0.81	0.81
Impact Spd (mph):	26.84	26.94	29.44	24.95	47.10	43.53	32.71	44.05	41.08	43.90
Radar (Start Braking):	N/A	N/A	N/A	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	N/A	N/A	N/A
Speed Acquired (%)	90%	98%	99%	102%	77%	84%	94%	82%	89%	66%

Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Test 1

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	26.63	mph
Searle (20 Degree) Takeoff:	25.01	mph
Searle Minimum Formula:	**24.18**	mph
Searle Maximum Formula:	29.44	mph

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	31.40	mph
Vehicle Speed - Impact:	26.84	mph
Radar Speed - Start of Braking:	N/A	mph
Radar Speed - Impact:	N/A	mph
IMPACT SPEED To Be Used:	**26.84**	**mph**

Other Calculations:

Speed (With Adjusted Data):	26.85	mph
Throw Minus Carry Distance:	38.63	feet
Location of First Evidence:	N/A	feet
% of Speed Attained (Ped):	90%	
Difference (C/M vs. Hood H):	0.8	feet
Takeoff From Video (Degrees):	5	Degrees
Carry Distance:	2.97	feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	4,150.00	lb
Pedestrian Weight: (m)	36	lb
Ped C/M Height: (H)	3.33	feet

Searle Minimum Analysis: (1993, 2009)

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

= 18.80 mph

Searle Minimum Analysis: (2009)

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

= 18.80 mph

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

Disclaimer: Documentaion is provided to supplement IPTM Crash Testing.
Additional training required to fully understand the technical analysis.

Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Test 2

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	29.14	mph
Searle (20 Degree) Takeoff:	27.36	mph
Searle Minimum Formula:	**26.46**	mph
Searle Maximum Formula:	32.21	mph

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	32.30	mph
Vehicle Speed - Impact:	26.94	mph
Radar Speed - Start of Braking:	N/A	mph
Radar Speed - Impact:	N/A	mph
IMPACT SPEED To Be Used:	**26.94**	**mph**

Other Calculations:

Speed (With Adjusted Data):	29.11	mph
Throw Minus Carry Distance:	46.33	feet
Location of First Evidence:	34.0	feet
% of Speed Attained (Ped):	98%	
Difference (C/M vs. Hood H):	0.9	feet
Takeoff From Video (Degrees):	6	Degrees
Carry Distance:	3.47	feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	4,150.00	lb
Pedestrian Weight: (m)	36	lb
Ped C/M Height: (H)	3.50	feet

Searle Minimum Analysis: (1993, 2009)

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

= 25.80 mph

Searle Minimum Analysis: (2009)

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

= 25.74 mph

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

Disclaimer: Documentaion is provided to supplement IPTM Crash Testing.
Additional training required to fully understand the technical analysis.

Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Test 3

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	31.96	mph
Searle (20 Degree) Takeoff:	30.01	mph
Searle Minimum Formula:	**29.02**	mph
Searle Maximum Formula:	35.33	mph

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	32.50	mph
Vehicle Speed - Impact:	29.44	mph
Radar Speed - Start of Braking:	N/A	mph
Radar Speed - Impact:	N/A	mph
IMPACT SPEED To Be Used:	**29.44**	**mph**

Other Calculations:

Speed (With Adjusted Data):	32.03	mph
Throw Minus Carry Distance:	56.09	feet
Location of First Evidence:	N/A	feet
% of Speed Attained (Ped):	99%	
Difference (C/M vs. Hood H):	0.8	feet
Takeoff From Video (Degrees):	6	Degrees
Carry Distance:	3.81	feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	4,150.00	lb
Pedestrian Weight: (m)	36	lb
Ped C/M Height: (H)	3.42	feet

Searle Minimum Analysis: (1993, 2009)

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

= 28.44 mph

Searle Minimum Analysis: (2009)

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

= 28.32 mph

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

Disclaimer: Documentaion is provided to supplement IPTM Crash Testing.
Additional training required to fully understand the technical analysis.

Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Test 4

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	28.08	mph
Searle (20 Degree) Takeoff:	26.37	mph
Searle Minimum Formula:	**25.50**	mph
Searle Maximum Formula:	31.04	mph

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	28.20	mph
Vehicle Speed - Impact:	24.95	mph
Radar Speed - Start of Braking:	N/A	mph
Radar Speed - Impact:	N/A	mph
IMPACT SPEED To Be Used:	**24.95**	**mph**

Other Calculations:

Speed (With Adjusted Data):	28.83	mph
Throw Minus Carry Distance:	42.74	feet
Location of First Evidence:	21.3	feet
% of Speed Attained (Ped):	102%	
Difference (C/M vs. Hood H):	0.6	feet
Takeoff From Video (Degrees):	3	Degrees
Carry Distance:	3.51	feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	4,150.00	lb
Pedestrian Weight: (m)	36	lb
Ped C/M Height: (H)	3.17	feet

Searle Minimum Analysis: (1993, 2009)

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

= **24.88 mph**

Searle Minimum Analysis: (2009)

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

= **24.72 mph**

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

Disclaimer: Documentaion is provided to supplement IPTM Crash Testing.
Additional training required to fully understand the technical analysis.

Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Test 5

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	39.73	mph
Searle (20 Degree) Takeoff:	37.31	mph
Searle Minimum Formula:	**36.07**	mph
Searle Maximum Formula:	43.92	mph

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	47.10	mph
Vehicle Speed - Impact:	47.10	mph
Radar Speed - Start of Braking:	N/A	mph
Radar Speed - Impact:	N/A	mph
IMPACT SPEED To Be Used:	**47.10**	**mph**

Other Calculations:

Speed (With Adjusted Data):	39.17	mph
Throw Minus Carry Distance:	89.97	feet
Location of First Evidence:	N/A	feet
% of Speed Attained (Ped):	77%	
Difference (C/M vs. Hood H):	1.3	feet
Takeoff From Video (Degrees):	10	Degrees
Carry Distance:	2.61	feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	4,150.00	lb
Pedestrian Weight: (m)	36	lb
Ped C/M Height: (H)	3.83	feet

Searle Minimum Analysis: (1993, 2009)

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

= 35.55 mph

Searle Minimum Analysis: (2009)

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

= 35.87 mph

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

Disclaimer: Documentaion is provided to supplement IPTM Crash Testing.
Additional training required to fully understand the technical analysis.

Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Test 6

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	40.03	mph
Searle (20 Degree) Takeoff:	37.59	mph
Searle Minimum Formula:	**36.35**	mph
Searle Maximum Formula:	44.25	mph

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	45.10	mph
Vehicle Speed - Impact:	43.53	mph
Radar Speed - Start of Braking:	N/A	mph
Radar Speed - Impact:	N/A	mph
IMPACT SPEED To Be Used:	**43.53**	**mph**

Other Calculations:

Speed (With Adjusted Data):	42.29	mph
Throw Minus Carry Distance:	89.94	feet
Location of First Evidence:	8.0	feet
% of Speed Attained (Ped):	84%	
Difference (C/M vs. Hood H):	0.8	feet
Takeoff From Video (Degrees):	2	Degrees
Carry Distance:	4.06	feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	4,150.00	lb
Pedestrian Weight: (m)	36	lb
Ped C/M Height: (H)	3.42	feet

Searle Minimum Analysis: (1993, 2009)

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

= 28.71 mph

Searle Minimum Analysis: (2009)

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

= 28.69 mph

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

Disclaimer: Documentaion is provided to supplement IPTM Crash Testing.
Additional training required to fully understand the technical analysis.

Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Test 7

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	33.70	mph
Searle (20 Degree) Takeoff:	31.64	mph
Searle Minimum Formula:	**30.60**	mph
Searle Maximum Formula:	37.25	mph

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	42.40	mph
Vehicle Speed - Impact:	32.71	mph
Radar Speed - Start of Braking:	N/A	mph
Radar Speed - Impact:	N/A	mph
IMPACT SPEED To Be Used:	**32.71**	**mph**

Other Calculations:

Speed (With Adjusted Data):	35.34	mph
Throw Minus Carry Distance:	61.38	feet
Location of First Evidence:	8.3	feet
% of Speed Attained (Ped):	94%	
Difference (C/M vs. Hood H):	0.5	feet
Takeoff From Video (Degrees):	1	Degrees
Carry Distance:	5.22	feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	4,150.00	lb
Pedestrian Weight: (m)	36	lb
Ped C/M Height: (H)	3.03	feet

Searle Minimum Analysis: (1993, 2009)

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

= **30.11 mph**

Searle Minimum Analysis: (2009)

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

= **29.63 mph**

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

Disclaimer: Documentaion is provided to supplement IPTM Crash Testing.
Additional training required to fully understand the technical analysis.

Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Test 8

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	39.93	mph
Searle (20 Degree) Takeoff:	37.49	mph
Searle Minimum Formula:	**36.25**	mph
Searle Maximum Formula:	44.14	mph

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	47.10	mph
Vehicle Speed - Impact:	44.05	mph
Radar Speed - Start of Braking:	N/A	mph
Radar Speed - Impact:	N/A	mph
IMPACT SPEED To Be Used:	**44.05**	**mph**

Other Calculations:

Speed (With Adjusted Data):	41.13	mph
Throw Minus Carry Distance:	88.86	feet
Location of First Evidence:	N/A	feet
% of Speed Attained (Ped):	82%	
Difference (C/M vs. Hood H):	0.5	feet
Takeoff From Video (Degrees):	4	Degrees
Carry Distance:	4.64	feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	4,150.00	lb
Pedestrian Weight: (m)	36	lb
Ped C/M Height: (H)	3.04	feet

Searle Minimum Analysis: (1993, 2009)

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

= 35.84 mph

Searle Minimum Analysis: (2009)

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

= 35.65 mph

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

Disclaimer: Documentaion is provided to supplement IPTM Crash Testing.
Additional training required to fully understand the technical analysis.

Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Test 9

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	40.09	mph
Searle (20 Degree) Takeoff:	37.64	mph
Searle Minimum Formula:	**36.40**	mph
Searle Maximum Formula:	44.31	mph

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	46.70	mph
Vehicle Speed - Impact:	41.08	mph
Radar Speed - Start of Braking:	N/A	mph
Radar Speed - Impact:	N/A	mph
IMPACT SPEED To Be Used:	**41.08**	**mph**

Other Calculations:

Speed (With Adjusted Data):	41.68	mph
Throw Minus Carry Distance:	91.25	feet
Location of First Evidence:	75.5	feet
% of Speed Attained (Ped):	89%	
Difference (C/M vs. Hood H):	0.6	feet
Takeoff From Video (Degrees):	4	Degrees
Carry Distance:	3.00	feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	4,150.00	lb
Pedestrian Weight: (m)	36	lb
Ped C/M Height: (H)	3.17	feet

Searle Minimum Analysis: (1993, 2009)

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

= 35.97 mph

Searle Minimum Analysis: (2009)

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

= 36.12 mph

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

Disclaimer: Documentaion is provided to supplement IPTM Crash Testing.
Additional training required to fully understand the technical analysis.

Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Tony Becker

Test 10

Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	31.98	mph
Searle (20 Degree) Takeoff:	30.03	mph
Searle Minimum Formula:	**29.04**	mph
Searle Maximum Formula:	35.36	mph

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	43.90	mph
Vehicle Speed - Impact:	43.90	mph
Radar Speed - Start of Braking:	N/A	mph
Radar Speed - Impact:	N/A	mph
IMPACT SPEED To Be Used:	**43.90**	**mph**

Other Calculations:

Speed (With Adjusted Data):	32.01	mph
Throw Minus Carry Distance:	56.00	feet
Location of First Evidence:	N/A	feet
% of Speed Attained (Ped):	66%	
Difference (C/M vs. Hood H):	0.8	feet
Takeoff From Video (Degrees):	6	Degrees
Carry Distance:	4.00	feet

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	4,150.00	lb
Pedestrian Weight: (m)	36	lb
Ped C/M Height: (H)	3.17	feet

Searle Minimum Analysis: (1993, 2009)

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

= 28.50 mph

Searle Minimum Analysis: (2009)

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

= 28.30 mph

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

Disclaimer: Documentaion is provided to supplement IPTM Crash Testing.
Additional training required to fully understand the technical analysis.