Pedestrian/Bicycle Crash Analysis

Instructors: Mike Reade & Patrick Robins

Date: 21-Aug-13

Place: Calgary, Alberta

	Veh One: 00 Malibu	Veh Two: 03 Taurus
OL:	484 cm	502 cm
OW:	176 cm	185 cm
WB:	272 cm	276 cm
FOH:	101 cm	106 cm
ROH:	112 cm	121 cm
Weight:	1384 kg	1521 kg
Hood H:	70 cm	75 cm

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 (m):	1.58	1.58	1.58	1.58	1.58	N/A	N/A	N/A	N/A	N/A
Ped C/M Ht (m):	0.98	0.90	0.94	1.02	1.07	N/A	N/A	N/A	N/A	N/A
Ped Slide D (m):	11.42	7.66	11.75	9.86	5.53	N/A	N/A	N/A	N/A	N/A
Airborne D (m):	8.68	13.94	13.85	14.21	11.49	N/A	N/A	N/A	N/A	N/A
Ped f-Value:	0.64	0.64	0.64	0.64	0.64	N/A	N/A	N/A	N/A	N/A
Throw D (m):	20.10	21.60	25.60	24.07	17.02	N/A	N/A	N/A	N/A	N/A
Takeoff (Min):	4.00	4.00	4.00	4.00	4.00	N/A	N/A	N/A	N/A	N/A
Takeoff (Max.):	10.00	10.00	10.00	10.00	10.00	N/A	N/A	N/A	N/A	N/A
1st Evid. (m):	1.88	4.30	3.30	4.54	4.48	N/A	N/A	N/A	N/A	N/A
Ped Weight (kg):	16.36	16.36	16.36	16.36	16.36	N/A	N/A	N/A	N/A	N/A
Vehicle Data:										
Hood Height (m):	0.70	0.70	0.70	0.70	0.70	N/A	N/A	N/A	N/A	N/A
C/M - Hood Change (m):	0.28	0.20	0.24	0.32	0.32	N/A	N/A	N/A	N/A	N/A
Braking (Yes=Y/No=N):	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A
Skid Total (m):	14.18	18.90	24.50	19.80	19.70	N/A	N/A	N/A	N/A	N/A
Skid to Impact (m):	2.56	3.65	4.20	5.08	4.73	N/A	N/A	N/A	N/A	N/A
Road f-Value:	0.84	0.84	0.84	0.84	0.80	N/A	N/A	N/A	N/A	N/A
Impact Spd (km/h):	49.79	56.82	65.81	55.70	54.96	N/A	N/A	N/A	N/A	N/A
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):	55.00	63.00	69.00	58.00	62.00	N/A	N/A	N/A	N/A	N/A

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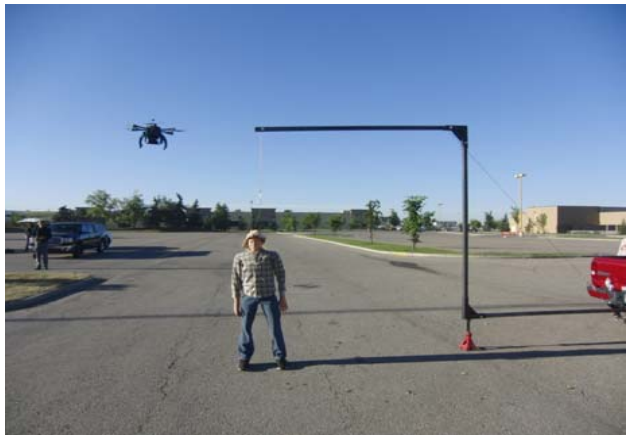
Test 1



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	54.85	km/h
Searle (20 Degree) Takeoff:	52.16	km/h
Searle Minimum Formula:	**48.15**	km/h
Searle Maximum Formula:	57.16	km/h

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	55.00	km/h
Vehicle Speed - Impact:	49.79	km/h
Radar Speed - Start of Braking:	N/A	km/h
Radar Speed - Impact:	55.00	km/h
IMPACT SPEED To Be Used:	**49.79**	**km/h**

Other Calculations:

Speed (With Adjusted Data):	50.71	km/h
Throw Minus Carry Distance:	19.00	meters
Location of First Evidence:	1.9	meters
% of Speed Attained (Ped):	97%	
Difference (C/M vs. Hood H):	0.3	meters
Takeoff From Video (Degrees):	10	Degrees
Carry Distance:	1.10	meters

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	1,482.00	kg
Pedestrian Weight: (m)	16.36	kg
Ped C/M Height: (H)	0.98	meters

Searle Minimum Analysis: (1993, 2009)

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

= **47.39 km/h**

Searle Minimum Analysis: (2009)

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

= **47.33 km/h**

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

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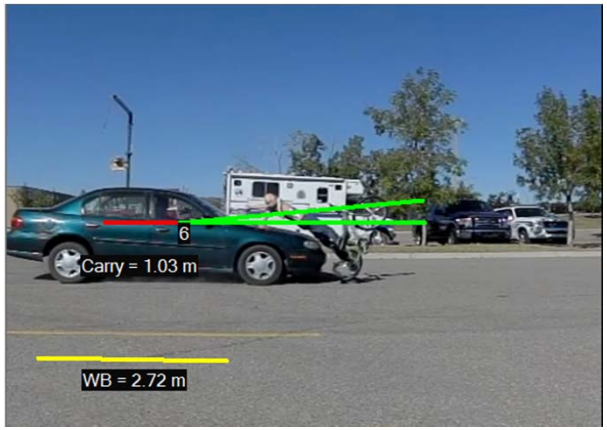
Test 2



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	56.86	km/h
Searle (20 Degree) Takeoff:	54.07	km/h
Searle Minimum Formula:	**49.91**	km/h
Searle Maximum Formula:	59.26	km/h

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	63.30	km/h
Vehicle Speed - Impact:	56.82	km/h
Radar Speed - Start of Braking:	N/A	km/h
Radar Speed - Impact:	63.00	km/h
IMPACT SPEED To Be Used:	**56.82**	**km/h**

Other Calculations:

Speed (With Adjusted Data):	54.48	km/h
Throw Minus Carry Distance:	20.57	meters
Location of First Evidence:	4.3	meters
% of Speed Attained (Ped):	88%	
Difference (C/M vs. Hood H):	0.2	meters
Takeoff From Video (Degrees):	6	Degrees
Carry Distance:	1.03	meters

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	1,482.00	kg
Pedestrian Weight: (m)	16.36	kg
Ped C/M Height: (H)	0.90	meters

Searle Minimum Analysis: (1993, 2009)

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

= **49.24 km/h**

Searle Minimum Analysis: (2009)

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

= **49.24 km/h**

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

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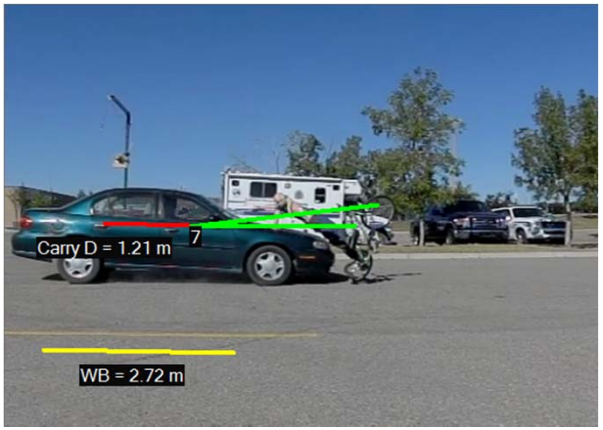
Test 3



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	61.90	km/h
Searle (20 Degree) Takeoff:	58.86	km/h
Searle Minimum Formula:	**54.33**	km/h
Searle Maximum Formula:	64.51	km/h

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	72.30	km/h
Vehicle Speed - Impact:	65.81	km/h
Radar Speed - Start of Braking:	N/A	km/h
Radar Speed - Impact:	69.00	km/h
IMPACT SPEED To Be Used:	**65.81**	**km/h**

Other Calculations:

Speed (With Adjusted Data):	58.82	km/h
Throw Minus Carry Distance:	24.39	meters
Location of First Evidence:	3.3	meters
% of Speed Attained (Ped):	83%	
Difference (C/M vs. Hood H):	0.2	meters
Takeoff From Video (Degrees):	7	Degrees
Carry Distance:	1.21	meters

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	1,482.00	kg
Pedestrian Weight: (m)	16.36	kg
Ped C/M Height: (H)	0.94	meters

Searle Minimum Analysis: (1993, 2009)

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

= **53.69 km/h**

Searle Minimum Analysis: (2009)

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

= **53.62 km/h**

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

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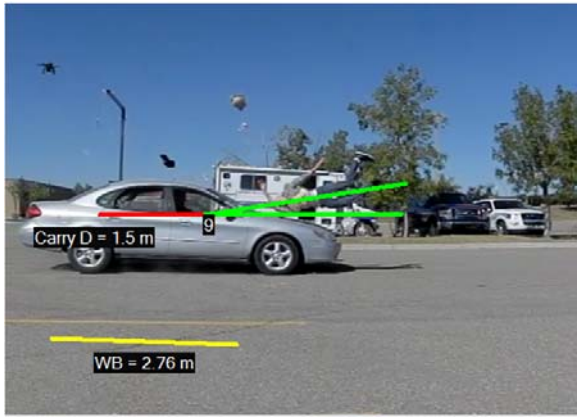
Test 4



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	60.02	km/h
Searle (20 Degree) Takeoff:	57.08	km/h
Searle Minimum Formula:	**52.69**	km/h
Searle Maximum Formula:	62.55	km/h

Vehicle Speed Analysis:

VC Speed - Start of Braking:	64.70	km/h
VC Speed - Impact:	55.70	km/h
Radar Speed - Start of Braking:	N/A	km/h
Radar Speed - Impact:	58.00	km/h
IMPACT SPEED To Be Used:	**55.70**	**km/h**

Other Calculations:

Speed (With Adjusted Data):	55.68	km/h
Throw Minus Carry Distance:	22.57	meters
Location of First Evidence:	4.5	meters
% of Speed Attained (Ped):	95%	
Difference (C/M vs. Hood H):	0.3	meters
Takeoff From Video (Degrees):	9	Degrees
Carry Distance:	1.50	meters

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	1,619.00	kg
Pedestrian Weight: (m)	16.36	kg
Ped C/M Height: (H)	1.02	meters

Searle Minimum Analysis: (1993, 2009)

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

= **51.97 km/h**

Searle Minimum Analysis: (2009)

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

= **51.53 km/h**

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

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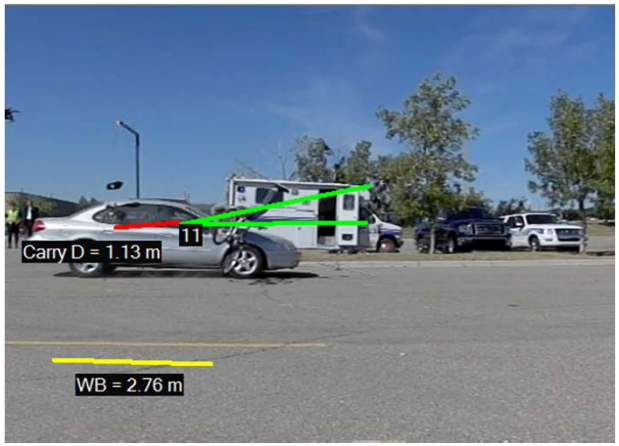
Test 5



Searle Analysis: (1983)

Searle (10 Degree) Takeoff:	50.47	km/h
Searle (20 Degree) Takeoff:	48.00	km/h
Searle Minimum Formula:	44.30	km/h
Searle Maximum Formula:	52.60	km/h

Vehicle Speed Analysis:

Vehicle Speed - Start of Braking:	63.10	km/h
Vehicle Speed - Impact:	54.96	km/h
Radar Speed - Start of Braking:	N/A	km/h
Radar Speed - Impact:	62.00	km/h
IMPACT SPEED To Be Used:	**54.96**	**km/h**

Other Calculations:

Speed (With Adjusted Data):	46.05	km/h
Throw Minus Carry Distance:	15.89	meters
Location of First Evidence:	4.5	meters
% of Speed Attained (Ped):	81%	
Difference (C/M vs. Hood H):	0.4	meters
Takeoff From Video (Degrees):	11	Degrees
Carry Distance:	1.13	meters

NEW Searle Formulae Analysis:

Vehicle Weight: (M)	1,619.00	kg
Pedestrian Weight: (m)	16.36	kg
Ped C/M Height: (H)	1.07	meters

Searle Minimum Analysis: (1993, 2009)

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

= **43.40 km/h**

Searle Minimum Analysis: (2009)

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

= **43.24 km/h**

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