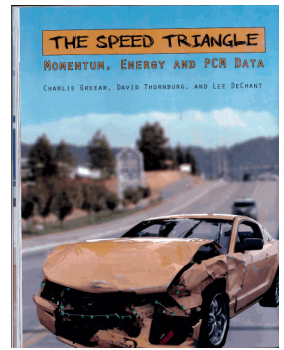


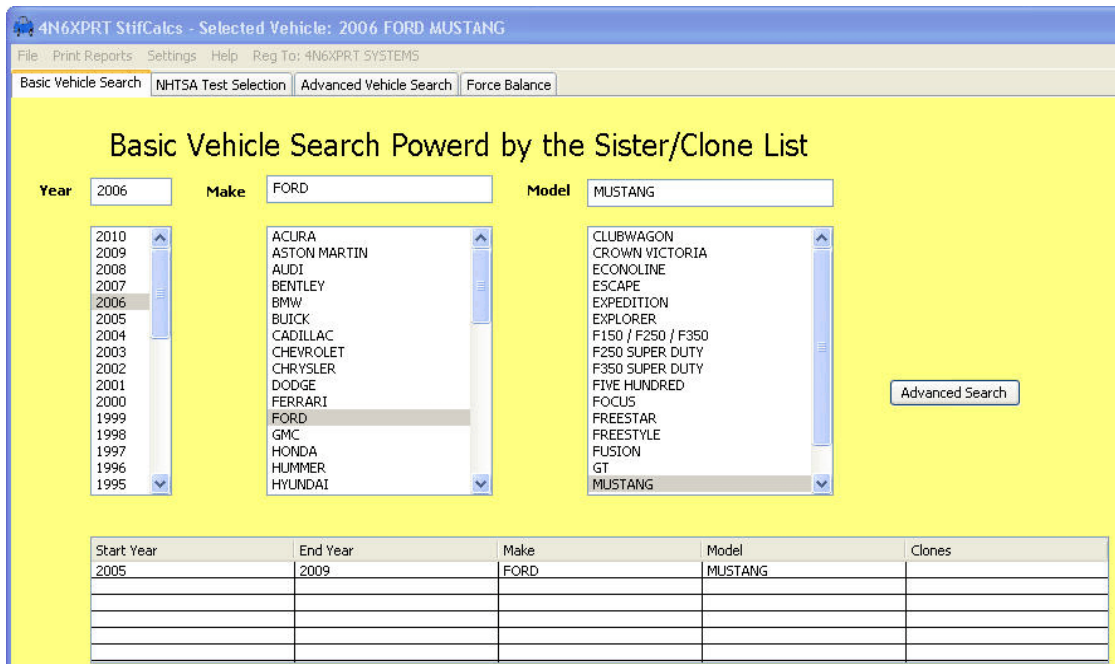
Force Balance Example - Step By Step



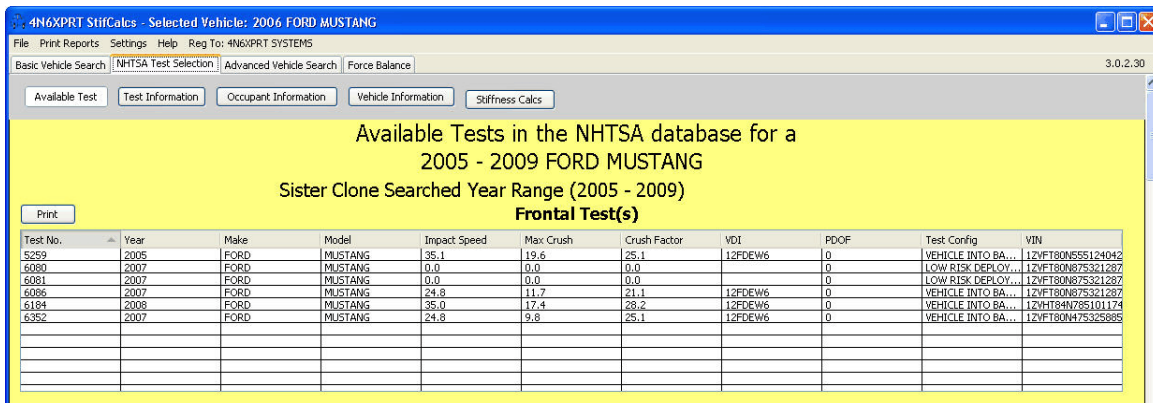
This example is taken from a case study **The Speed Triangle - Momentum, Energy, and PCM Data** by *Charlie Greear, David Thornburg, and Lee DeChant* published in COLLISION magazine, Volume 6, Issue #1, page 48.

In this collision, a Ford Mustang was racing a Subaru Impreza WRX, and ended up T-boning a 1987 Chevrolet Caprice. There are no side impact tests for the Chevrolet Caprice in the NHTSA Crash Test database, so the authors chose to use a Force-Balance approach to derive the Stiffness values for the Caprice. This example shows how the Force Balance module in the 2011 version of 4N6XPRT StifCalcs® can be used to quickly and easily perform the calculations with the added bonus of obtaining the KE Equivalent Speed, delta-v, and Closing speed based strictly upon the damage to each vehicle.

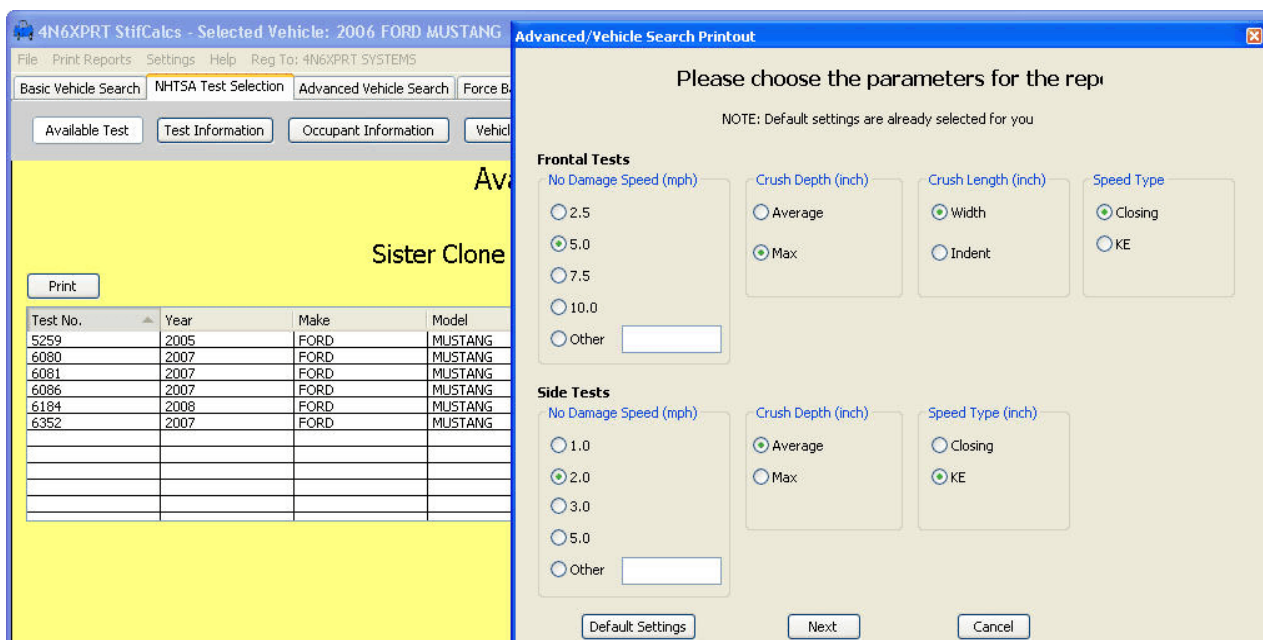
The Bullet vehicle in this case was a 2006 Ford Mustang. Using the 4N6XPRT StifCalcs® BASIC SEARCH, we click on 2006 - FORD - MUSTANG



At this point, we click on the NHTSA TEST SELECTION tab to see what tests are available.



When we click on the PRINT button above the FRONTAL TEST(S) box, we get the Test Summary Test Criteria box where we designate the NO DAMAGE SPEED, Crush Depth to use, Crush Length to use, and Speed to use.



When this has been set (in this example, 5.0 mph, Maximum Crush, Vehicle Width, Closing Speed) click NEXT

Test No	Year	Make	Model	Body Style	No Damage Speed	Crush Distance	Closi...	Stiffness A	Stiffness B	Stiffness G	Kv
5259	2005	FORD	MUSTANG	TWO DOOR COUPE	5.0	19.6	35.1	328.4	100.7	535.7	136
6086	2007	FORD	MUSTANG	TWO DOOR COUPE	5.0	11.7	24.8	351.5	119.4	517.3	187
6184	2008	FORD	MUSTANG	CONVERTIBLE	5.0	17.4	35.0	379.0	130.9	548.7	178
6352	2007	FORD	MUSTANG	TWO DOOR COUPE	5.0	9.8	24.8	419.3	169.3	519.2	265

	A	B	G	Kv	CF
Average	369.6	130.1	530.2	192.0	24.9
Minimum	328.4	100.7	517.3	136.9	21.1
Maximum	419.3	169.3	548.7	265.7	28.2
Std Dev	39.1	29.0	14.8	53.8	2.9

Number of Tests 4

Clicking the SEND ALL VALUES TO FORCE BALANCE imports the A-B Stiffness values to the Force Balance module. Before continuing with the Force Balance example, lets quickly examine the crush measurements to be used.

The Authors of the article showed the following crush profiles, and used 10 equally spaced crush measurements for their Force Balance Calculation. The profiles and the Force Balance results were as follows:

Caprice Crush Profile - Measured Front to Rear

Mustang Crush Profile

Crush Measurements and Force Balance Results

Vehicle #1	Crush Measurements	Vehicle #2
Mustang	Make	Caprice
25.99 in	C1	0.0 in
10.42 in	C2	3.08 in
10.78 in	C3	7.67 in
15.71 in	C4	13.47 in
13.57 in	C5	18.81 in
12.64 in	C6	21.43 in
13.27 in	C7	19.77 in
23.87 in	C8	13.18 in
19.24 in	C9	6.66 in
22.35 in	C10	0.0 in
	C11	
	C12	
15.96 in	Average Crush	11.56 in

63.21 in	Damage Width	84.0 in
2.6°	PDOF	11.7°
3555 lbs	Vehicle Weight	3950 lbs

Stiffness Coefficients		
383.83 lb/in	A stiffness	152.42 lb/in
137.41 lb/in ²	B stiffness	154.08 lb/in ²
536.08 lbs	G stiffness	75.39 lbs

When you examine the two Crush Profiles, you can see the following:

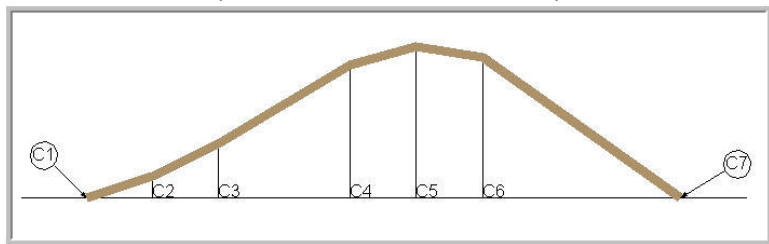
Caprice Profile - The profile from C3 to C5 and from C7 to C10 is essentially a straight line in each case. Therefore while the inclusion of the C4 and the C8 & C9 measurements are in line with crush measurement protocol, they are in essence meaningless measurements as far as the average crush for the Caprice is concerned.

Mustang Profile - The red dotted line overlaying the Authors Crush Profile illustrates the crush profile described by the 10 equally spaced crush measurements. In this instance, by using equally spaced crush measurements, a number of "critical points" of the profile are missed, most significantly between C1 and C2. This in turn affects the average crush depth that is used for calculating the force applied to the Mustang to create its damage.

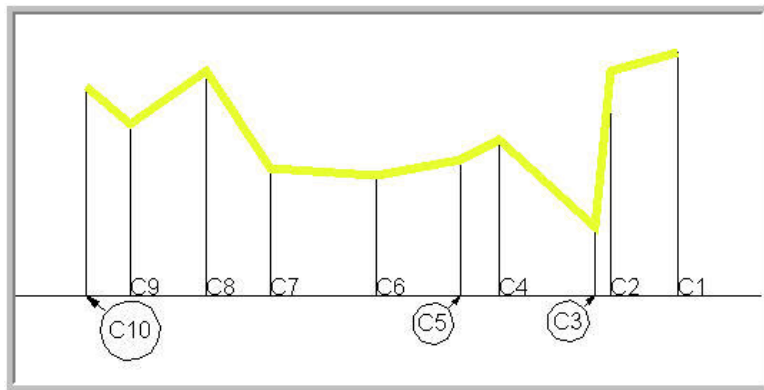
The problems noted for both profiles are NOT a “fault” of the Authors, but ARE a problem which is inherent with a protocol that requires equal spacing between measurements.

When you compare the crush profiles used by the Authors with the NON-EQUAL spacing crush measurements used in 4N6XPRT StifCalcs® for this same Force Balance example, you can see that in the case of the Caprice the same profile can be depicted with fewer measurements, and in the case of the Mustang profile, the measurements more closely mirror the actual crush profile of the vehicle.

**Caprice Crush - Unequal Spacing
(Measured Front to Rear)**



Mustang Crush - Unequal Spacing



Continuing with the Force Balance example, you can see that after entering the vehicles from the AS Lite, and entering the Crush Profile for both vehicles (for this example the NON-EQUAL spacing was used, but EQUAL SPACING is also permitted within the module, and is, in fact, the default), all that is left to do is print and review the results. Sample output can be seen on the next page.

4N6XPRT StifCalcs

File Print Reports Settings Help Reg To: 4N6XPRT SYSTEMS

Basic Vehicle Search NHTSA Test Selection Advanced Vehicle Search Force Balance 3.0.2.30

Load previously saved comparison Save current comparison Force Re-Calculations Print

Select Vehicle 1 From AS Lite Vehicle 1 Manual Input

2006 FORD MUSTANG

Curb Weight (pounds): 3300
 Occupant + Cargo Weight (pounds): 255
 Total Weight (pounds): 3555
 Angle Coll Force to Normal (degrees): 0
 No Damage Speed (mph): 5
 Energy Crush Depth (inches): 16.82
 Auto-Calculate Energy Crush Depth

PDOF
 Lever Arm Distance (inches): 0
 Yaw Moment of Inertia (lb-ft-sec²): 2455.65
 Auto-Calculate Yaw Moment

Impact Location
 Front Side Rear Other

Vehicle 1 Crush Measurements

	A	B
Average	369.6	130.1
Minimum	328.4	100.7
Maximum	419.3	169.3
Std. Deviation	39.1	29

Crush Spacing
 Equal Non-Equal

	Spacing	Zone Area	Zone Depth(x) (inches)	Area Depth(x) (inches ²)	Zone Depth(y) (inches)	Area Depth(y) (inches ²)
C1 (in.)	25.99					
C2 (in.)	7.17	179.32	12.51	2243.57	3.54	634.47
C3 (in.)	1.63	25.54	8.58	219.11	2.30	58.75
C4 (in.)	10.26	123.27	6.31	778.42	26.32	3244.52
C5 (in.)	4.07	63.76	7.84	500.13	14.20	905.30
C6 (in.)	8.96	122.93	6.87	844.49	40.22	4944.68
C7 (in.)	11.40	150.88	6.62	998.75	62.76	9468.89
C8 (in.)	6.84	128.83	9.66	1244.04	44.77	5768.35
C9 (in.)	8.15	172.66	10.66	1839.87	60.94	10522.21
C10 (in.)	4.72	96.03	10.21	980.01	40.20	3860.10

Average Crush (inches): 16.82

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (mph)
Minimum	328.4	100.7	63910.67	112883.11	30.9	29.8	56.6
Avg - 2 Std. Deviations	291.4	72.1	47537.39	86890.65	27.1	26.0	49.4
Avg - 1 Std. Deviations	330.5	101.1	64189.67	113415.61	30.9	29.9	56.7
Average	369.6	130.1	80841.95	140116.81	34.4	33.3	63.3
Avg + 1 Std. Deviations	408.7	159.1	97494.23	166897.81	37.5	36.4	69.2

Select Vehicle 2 From AS Lite Vehicle 2 Manual Input

1987 CHEVROLET CAPRICE

Curb Weight (pounds): 3775
 Occupant + Cargo Weight (pounds): 175
 Total Weight (pounds): 3950
 Angle Coll Force to Normal (degrees): 0
 No Damage Speed (mph): 2
 Energy Crush Depth (inches): 11.53
 Auto-Calculate Energy Crush Depth

PDOF
 Lever Arm Distance (inches): 0
 Yaw Moment of Inertia (lb-ft-sec²): 2862.50
 Auto-Calculate Yaw Moment

Impact Location
 Front Side Rear Other

Vehicle 2 Crush Measurements

	A	B
Average	134.7	120.3
Minimum	134.7	120.3
Maximum	134.7	120.3
Std. Deviation	134.7	120.3

Crush Spacing
 Equal Non-Equal

	Spacing	Zone Area	Zone Depth(x) (inches)	Area Depth(x) (inches ²)	Zone Depth(y) (inches)	Area Depth(y) (inches ²)	
C1 (in.)	0						
C2 (in.)	3.08	9.33	14.37	1.03	14.75	6.22	89.37
C3 (in.)	7.67	9.33	50.15	2.85	142.97	14.66	735.13
C4 (in.)	18.81	18.66	247.06	7.01	1732.01	47.96	11848.52
C5 (in.)	21.43	9.33	187.72	10.07	1891.13	32.76	6148.99
C6 (in.)	19.77	9.33	192.20	10.31	1980.71	41.92	8057.39
C7 (in.)	0	28.02	276.98	6.59	1825.28	149.44	41391.55
C8 (in.)							
C9 (in.)							
C10 (in.)							

Average Crush (inches): 11.53

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	bSub1
Minimum	134.7	120.3	63910.67	87454.62	25.8	26.8	31.4
Avg - 2 Std. Deviations	115.4	88.2	47537.39	65576.41	22.3	23.4	26.9
Avg - 1 Std. Deviations	135.1	120.8	64189.67	87826.83	25.8	26.9	31.5
Average	152.3	153.7	80841.95	110014.51	28.9	30.0	35.5
Avg + 1 Std. Deviations	167.9	186.8	97494.23	132158.21	31.7	32.8	39.2

The Authors found that the Mustang had a speed of 54-62 mph at impact with the Caprice. Compare this speed range with the Closing Speed calculated FROM DAMAGE ONLY by the Force Balance module, concentrating on the values between the **Average** and **Average - 1 Std Deviation** (56-63 mph) that were derived from the four NHTSA frontal crash tests on Ford Mustangs. Be sure to also compare the calculated Average Crush for each vehicle and the derived A-B values for the Caprice, which would then be used in a CRASH 3 analysis to further refine your opinions.

4N6XPRT StifCalcs®

FORCE BALANCE OUTPUT

Non-Equal Spacing Crush Profile

Stiffness Values calculated using MAXIMUM CRUSH from NHTSA Crash Test Database

2006 FORD MUSTANG - Front Impact

Curb Weight (pounds): **3300**
 Occupant + Cargo Weight (pounds): **255**
 Total Weight (pounds): **3555**

PDOF Lever Arm Distance (inches): **0.00**
 Yaw Moment of Inertia (lb-ft-sec²): **2455.65**

Angle Coll Force to Normal (degrees): **0.0**

No Damage Speed (mph): **5.0**
 Energy Crush Depth (inches): **16.82**
 Damage Length (inches): **63.2**

Crush Profile Measurements: **10**

	"Known" Stiffness Values	
	A	B
Average	369.6	130.1
Minimum	328.4	100.7
Maximum	419.3	169.3
Std. Deviation	39.1	29.0

Unequal Spacing (inches)	Zone Area (inches ²)	Zone Depth(x) (inches)	Area Depth(x) (inches ²)	Zone Depth(y) (inches)	Area Depth(y) (inches ²)
C1 (inches)	25.99	7.17	179.32	12.51	2243.57
C2 (inches)	24.03	1.63	25.54	8.58	219.11
C3 (inches)	7.31	10.26	123.27	6.31	778.42
C4 (inches)	16.72	4.07	63.76	7.84	500.13
C5 (inches)	14.61	8.96	122.93	6.87	844.49
C6 (inches)	12.83	11.40	150.88	6.62	998.75
C7 (inches)	13.64	6.84	128.83	9.66	1244.04
C8 (inches)	24.03	8.15	172.66	10.66	1839.87
C9 (inches)	18.34	4.72	96.03	10.21	980.01
C10 (inches)	22.35				

Average Crush (inches): **16.82**

Results

	A		B		Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (WPH)
	Minimum	Average	Minimum	Average					
Avg - 2 Std. Deviations	291.4	72.1	47537.39	86890.65	27.1	26.0	49.4		
Avg - 1 Std. Deviations	330.5	101.1	64189.67	113415.68	30.9	29.9	56.7		
Average	369.6	130.1	80841.95	140116.83	34.4	33.3	63.3		
Avg + 1 Std. Deviations	408.7	159.1	97494.23	166897.80	37.5	36.4	69.2		
Avg + 2 Std. Deviations	447.8	188.1	114146.51	193721.66	40.4	39.3	74.6		
Maximum	419.3	169.3	103251.62	176008.06	38.5	37.4	71.1		
Damage Centroid Depth (x) (inches)									K ² 3202.91
Damage Centroid Depth (y) (inches)									Eff. Mass Ratio (gamma) 1.00
Area of Damage (inches ²):									1063.22

1987 CHEVROLET CAPRICE - Side Impact

Curb Weight (pounds): **3775**
 Occupant + Cargo Weight (pounds): **175**
 Total Weight (pounds): **3950**

PDOF Lever Arm Distance (inches): **0.00**
 Yaw Moment of Inertia (lb-ft-sec²): **2862.50**

Angle Coll Force to Normal (degrees): **0.0**

No Damage Speed (mph): **2.0**
 Energy Crush Depth (inches): **11.53**
 Damage Length (inches): **84.0**

Crush Profile Measurements: **7**

Unequal Spacing (inches)	Zone Area (inches ²)	Zone Depth(x) (inches)	Area Depth(x) (inches ²)	Zone Depth(y) (inches)	Area Depth(y) (inches ²)
C1 (inches)	0.00	9.33	14.37	1.03	14.75
C2 (inches)	3.08	9.33	50.15	2.85	142.97
C3 (inches)	7.67	18.66	247.06	7.01	1732.01
C4 (inches)	18.81	9.33	187.72	10.07	1891.13
C5 (inches)	21.43	9.33	192.20	10.31	1980.71
C6 (inches)	19.77	28.02	276.98	6.59	1825.28
C7 (inches)	0.00				
C8 (inches)					
C9 (inches)					
C10 (inches)					

Average Crush (inches): **11.53**

Results

	A		B		Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (WPH)	B Sub
	Minimum	Average	Minimum	Average						
Avg - 2 Std. Deviations	134.7	120.3	63910.67	87454.62	25.8	26.8	31.4			
Avg - 1 Std. Deviations	115.4	88.2	47537.39	65576.41	22.3	23.4	26.9			
Average	135.1	120.8	64189.67	87926.83	25.8	26.9	31.5			
Avg + 1 Std. Deviations	152.3	153.7	80841.95	110014.55	28.9	30.0	35.5			
Avg + 2 Std. Deviations	167.9	186.8	97494.23	132158.22	31.7	32.8	39.2			
Maximum	182.2	219.9	114146.51	154268.76	34.2	35.3	42.5			
Damage Centroid Depth (x) (inches)									K ² 3360.21	
Damage Centroid Depth (y) (inches)									Eff. Mass Ratio (gamma) 1.00	
Area of Damage (inches ²):									968.47	

4N6XPRT StifCalcs®

Available Test Results
Front Impact Test Summary

Report Filter Settings

Year Range: 2005 - 2009
 Make: FORD
 Model: MUSTANG

Test Number	Vehicle Info	No Damage Speed (mph)	Max Crush (inch)	Closing Speed (mph)	Vehicle Width Stiffness Values				Crush Factor
					A	B	G	Kv	
5259	2005 FORD MUSTANG TWO DOOR COUPE	5.0	19.6	35.1	328.4	100.7	535.7	136.9	25.1
6086	2007 FORD MUSTANG TWO DOOR COUPE	5.0	11.7	24.8	351.5	119.4	517.3	187.3	21.1
6184	2008 FORD MUSTANG CONVERTIBLE	5.0	17.4	35.0	379.0	130.9	548.7	178.2	28.2
6352	2007 FORD MUSTANG TWO DOOR COUPE	5.0	9.8	24.8	419.3	169.3	519.2	265.7	25.1
Average (AVG)					369.6	130.1	530.2	192.0	24.9
Minimum (MIN)					328.4	100.7	517.3	136.9	21.1
Maximum (MAX)					419.3	169.3	548.7	265.7	28.2
Standard Deviation (STDev-sample)					39.1	29.0	14.8	53.8	2.9
Number of Tests (n)				4					

2006 FORD MUSTANG - Front Impact

Curb Weight (pounds): **3300**
 Occupant + Cargo Weight (pounds): **255**
 Total Weight (pounds): **3555**

PDOF
 Lever Arm Distance (inches): **0.00**
 Yaw Moment of Inertia (lb-ft-sec²): **2455.65**

Angle Coll Force to Normal (degrees): **0.0**
 No Damage Speed (mph): **5.0**
 Energy Crush Depth (inches): **16.82**
 Damage Length (inches): **63.2**
 Crush Profile Measurements: **10**

"Known" Stiffness Values

	A	B
Average	369.6	130.1
Minimum	328.4	100.7
Maximum	419.3	169.3
Std. Devation	39.1	29.0

	Unequal Spacing (inches)	Zone Area (inches ²)	Zone Depth(x) (inches)	Area Depth(x) (inches ²)	Zone Depth(y) (inches)	Area Depth(y) (inches ²)	
C1 (inches)	25.99	7.17	179.32	12.51	2243.57	3.54	634.47
C2 (inches)	24.03	1.63	25.54	8.58	219.11	2.30	58.75
C3 (inches)	7.31	10.26	123.27	6.31	778.42	26.32	3244.52
C4 (inches)	16.72	4.07	63.76	7.84	500.13	14.20	905.30
C5 (inches)	14.61	8.96	122.93	6.87	844.49	40.22	4944.68
C6 (inches)	12.83	11.40	150.88	6.62	998.75	62.76	9468.89
C7 (inches)	13.64	6.84	128.83	9.66	1244.04	44.77	5768.35
C8 (inches)	24.03	8.15	172.66	10.66	1839.87	60.94	10522.21
C9 (inches)	18.34	4.72	96.03	10.21	980.01	40.20	3860.10
C10 (inches)	22.35						

Average Crush (inches): **16.82**

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (MPH)
Minimum	328.4	100.7	63904.32	112883.12	30.9	29.6	56.3
Avg - 2 Std. Deviations	291.4	72.1	47532.85	86890.65	27.1	25.9	49.1
Avg - 1 Std. Deviations	330.5	101.1	64183.30	113415.68	30.9	29.7	56.4
Average	369.6	130.1	80833.75	140116.83	34.4	33.1	62.9
Avg + 1 Std. Deviations	408.7	159.1	97484.21	166897.80	37.5	36.2	68.8
Avg + 2 Std. Deviations	447.8	188.1	114134.66	193721.66	40.4	39.1	74.2
Maximum	419.3	169.3	103240.96	176008.06	38.5	37.2	70.7
Damage Centroid Depth (x) (inches)	9.07				k ²	3202.91	
Damage Centroid Depth (y) (inches)	37.06				Eff. Mass Ratio (gamma)	1.00	
Area of Damage (inches ²):	1063.22						

1987 CHEVROLET CAPRICE - Side Impact

Curb Weight (pounds): **3775**
 Occupant + Cargo Weight (pounds): **175**
 Total Weight (pounds): **3950**

PDOF
 Lever Arm Distance (inches): **0.00**
 Yaw Moment of Inertia (lb-ft-sec²): **2862.50**

Angle Coll Force to Normal (degrees): **0.0**

No Damage Speed (mph): **2.0**

Energy Crush Depth (inches): **11.00**

Damage Length (inches): **84.0**

Crush Profile Measurements: **10**

	Unequal Spacing (inches)	Zone Area (inches ²)	Zone Depth(x) (inches)	Area Depth(x) (inches ²)	Zone Depth(y) (inches)	Area Depth(y) (inches ²)
C1 (inches)	0.00					
	25.24	185.89	4.91	912.73	16.83	3127.95
C2 (inches)	14.73					
	3.48	56.71	8.17	463.44	5.28	299.17
C3 (inches)	17.86					
	2.82	52.25	9.27	484.35	7.07	369.28
C4 (inches)	19.20					
	7.62	156.21	10.26	1603.30	26.75	4178.70
C5 (inches)	21.80					
	7.40	153.81	10.40	1599.73	33.24	5112.58
C6 (inches)	19.77					
	9.36	155.56	8.41	1308.21	51.18	7962.40
C7 (inches)	13.47					
	9.36	98.94	5.42	535.99	60.41	5976.87
C8 (inches)	7.67					
	9.36	50.31	2.85	143.42	69.53	3498.25
C9 (inches)	3.08					
	9.36	14.41	1.03	14.80	78.00	1124.32
C10 (inches)	0.00					

Average Crush (inches): **11.00**

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	B Sub
Minimum	137.8	125.8	63904.32	85211.22	25.4	26.7	32.1
Avg - 2 Std. Deviations	117.9	92.2	47532.85	63879.31	22.0	23.3	27.5
Avg - 1 Std. Deviations	138.1	126.4	64183.30	85574.17	25.5	26.7	32.2
Average	155.8	160.8	80833.75	107210.79	28.5	29.8	36.3
Avg + 1 Std. Deviations	171.7	195.4	97484.21	128806.50	31.3	32.6	40.0
Avg + 2 Std. Deviations	186.4	230.1	114134.66	150371.43	33.8	35.1	43.5
Maximum	176.9	207.4	103240.96	136265.48	32.2	33.5	41.3
Damage Centroid Depth (x) (inches)	7.65				k ²	3360.21	
Damage Centroid Depth (y) (inches)	34.25			Eff. Mass Ratio (gamma)		1.00	
Area of Damage (inches ²):	924.10						

4N6XPRT StifCalcs®

Available Test Results
Front Impact Test Summary

Report Filter Settings

Year Range: 2005 - 2009
 Make: FORD
 Model: MUSTANG

Test Number	Vehicle Info	No		Closing Speed (mph)	Vehicle Width Stiffness Values				Crush Factor
		Damage Speed (mph)	Average Crush (inch)		A	B	G	Kv	
5259	2005 FORD MUSTANG TWO DOOR COUPE	5.0	16.8	35.1	383.5	137.3	535.7	186.6	29.3
6086	2007 FORD MUSTANG TWO DOOR COUPE	5.0	10.2	24.8	400.9	155.3	517.3	243.7	24.1
6184	2008 FORD MUSTANG CONVERTIBLE	5.0	16.1	35.0	408.2	151.8	548.7	206.7	30.4
6352	2007 FORD MUSTANG TWO DOOR COUPE	5.0	8.4	24.8	486.9	228.4	519.2	358.3	29.1
Average (AVG)					419.9	168.2	530.2	248.8	28.2
Minimum (MIN)					383.5	137.3	517.3	186.6	24.1
Maximum (MAX)					486.9	228.4	548.7	358.3	30.4
Standard Deviation (STDev-sample)					45.9	40.9	14.8	76.7	2.8
Number of Tests (n)				4					

2006 FORD MUSTANG - Front Impact

Curb Weight (pounds): **3300**
 Occupant + Cargo Weight (pounds): **255**
 Total Weight (pounds): **3555**

PDOF
 Lever Arm Distance (inches): **0.00**
 Yaw Moment of Inertia (lb-ft-sec²): **2455.65**

Angle Coll Force to Normal (degrees): **0.0**
 No Damage Speed (mph): **5.0**
 Energy Crush Depth (inches): **16.82**
 Damage Length (inches): **63.2**
 Crush Profile Measurements: **10**

"Known" Stifness Values

	A	B
Average	419.9	168.2
Minimum	383.5	137.3
Maximum	486.9	228.4
Std. Devation	45.9	40.9

	Unequal Spacing (inches)	Zone Area (inches ²)	Zone Depth(x) (inches)	Area Depth(x) (inches ²)	Zone Depth(y) (inches)	Area Depth(y) (inches ²)	
C1 (inches)	25.99	7.17	179.32	12.51	2243.57	3.54	634.47
C2 (inches)	24.03	1.63	25.54	8.58	219.11	2.30	58.75
C3 (inches)	7.31	10.26	123.27	6.31	778.42	26.32	3244.52
C4 (inches)	16.72	4.07	63.76	7.84	500.13	14.20	905.30
C5 (inches)	14.61	8.96	122.93	6.87	844.49	40.22	4944.68
C6 (inches)	12.83	11.40	150.88	6.62	998.75	62.76	9468.89
C7 (inches)	13.64	6.84	128.83	9.66	1244.04	44.77	5768.35
C8 (inches)	24.03	8.15	172.66	10.66	1839.87	60.94	10522.21
C9 (inches)	18.34	4.72	96.03	10.21	980.01	40.20	3860.10
C10 (inches)	22.35						

Average Crush (inches): **16.82**

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	Closing Speed (MPH)
Minimum	383.5	137.3	85100.14	147193.21	35.2	33.9	64.5
Avg - 2 Std. Deviations	328.1	86.4	56293.71	101819.64	29.3	28.0	53.2
Avg - 1 Std. Deviations	374.0	127.3	79484.46	138383.89	34.2	32.9	62.5
Average	419.9	168.2	102675.21	175202.55	38.5	37.1	70.5
Avg + 1 Std. Deviations	465.8	209.1	125865.97	212126.34	42.3	40.9	77.7
Avg + 2 Std. Deviations	511.7	250.0	149056.72	249103.66	45.8	44.4	84.3
Maximum	486.9	228.4	136791.60	229514.54	44.0	42.6	80.9
Damage Centroid Depth (x) (inches)			9.07			k ²	3202.91
Damage Centroid Depth (y) (inches)			37.06	Eff. Mass Ratio (gamma)		1.00	
Area of Damage (inches ²):	1063.22						

1987 CHEVROLET CAPRICE - Side Impact

Curb Weight (pounds): **3775**
 Occupant + Cargo Weight (pounds): **175**
 Total Weight (pounds): **3950**

PDOF
 Lever Arm Distance (inches): **0.00**
 Yaw Moment of Inertia (lb-ft-sec²): **2862.50**

Angle Coll Force to Normal (degrees): **0.0**

No Damage Speed (mph): **2.0**

Energy Crush Depth (inches): **11.00**

Damage Length (inches): **84.0**

Crush Profile Measurements: **10**

	Unequal Spacing (inches)	Zone Area (inches ²)	Zone Depth(x) (inches)	Area Depth(x) (inches ²)	Zone Depth(y) (inches)	Area Depth(y) (inches ²)
C1 (inches)	0.00					
	25.24	185.89	4.91	912.73	16.83	3127.95
C2 (inches)	14.73					
	3.48	56.71	8.17	463.44	5.28	299.17
C3 (inches)	17.86					
	2.82	52.25	9.27	484.35	7.07	369.28
C4 (inches)	19.20					
	7.62	156.21	10.26	1603.30	26.75	4178.70
C5 (inches)	21.80					
	7.40	153.81	10.40	1599.73	33.24	5112.58
C6 (inches)	19.77					
	9.36	155.56	8.41	1308.21	51.18	7962.40
C7 (inches)	13.47					
	9.36	98.94	5.42	535.99	60.41	5976.87
C8 (inches)	7.67					
	9.36	50.31	2.85	143.42	69.53	3498.25
C9 (inches)	3.08					
	9.36	14.41	1.03	14.80	78.00	1124.32
C10 (inches)	0.00					

Average Crush (inches): **11.00**

Results

	A	B	Average Force (pounds)	Damage Energy (ft*lbs)	KE Speed (mph)	Delta V (mph)	B Sub
Minimum	160.0	169.7	85100.14	112747.72	29.3	30.5	37.3
Avg - 2 Std. Deviations	128.9	110.1	56293.71	75303.13	23.9	25.2	30.1
Avg - 1 Std. Deviations	154.4	158.0	79484.46	105459.13	28.3	29.6	36.0
Average	176.4	206.2	102675.21	135532.60	32.1	33.4	41.1
Avg + 1 Std. Deviations	196.0	254.6	125865.97	165550.46	35.5	36.8	45.7
Avg + 2 Std. Deviations	213.9	303.2	149056.72	195527.54	38.5	40.0	49.9
Maximum	204.7	277.5	136791.60	179677.70	36.9	38.3	47.7
Damage Centroid Depth (x) (inches)	7.65				k ²	3360.21	
Damage Centroid Depth (y) (inches)	34.25			Eff. Mass Ratio (gamma)		1.00	
Area of Damage (inches ²):	924.10						