

Impact Analysis

DiamondWall Extruded PVC Panel

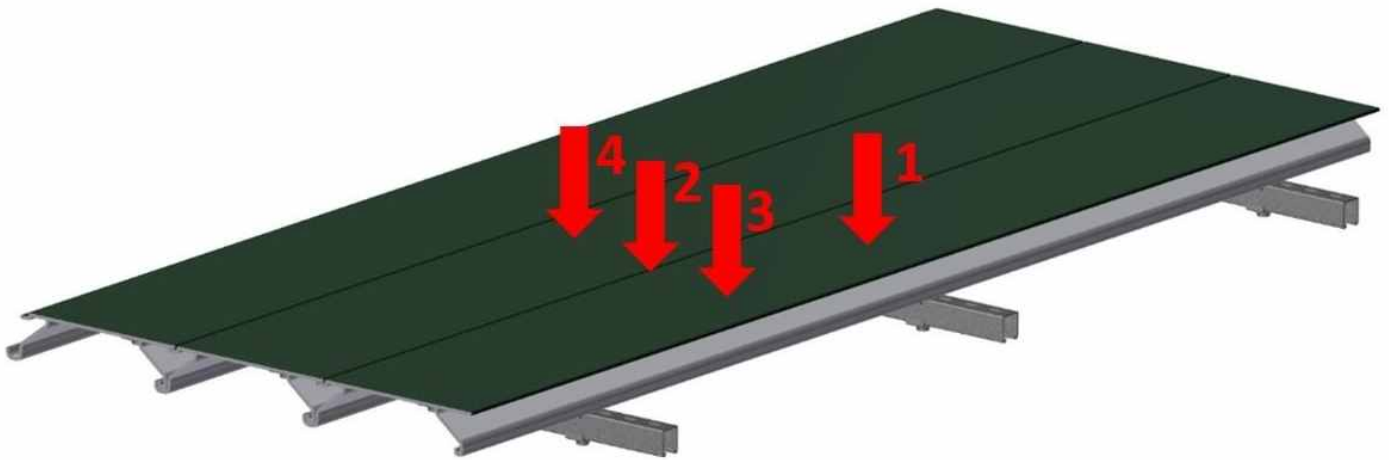
Date: 05/29/2024

Report By: Jenn Seuss

Test #1 - G'Max and Head Injury Criteria

Summary: Testing was conducted per ASTM F2440-18, Impact Attenuation for Indoor Wall / Feature Padding, in order to assess the impact attenuating capabilities of the DiamondWall Extruded PVC Panel System.

Test Method: The panels were tested in a temperature-controlled area using the TRIAX Touch “E” – a 10 lbs., hemispheric impacting missile - was dropped from a height of 48” onto the panel at probable impact locations (refer to Figure 1). The impacting missile contains an accelerometer sensor that measures the magnitude of deceleration (g’s) for the duration of impact. The peak deceleration is referred to as the “G’max”. The maximum allowable G’max is 200 g’s per ASTM F1292. The impacting missile also calculates the probability of a potential head injury with the Head Injury Criteria (HIC) value. The maximum HIC value is 1000 per ASTM F1292. Refer to Chart 1 for more information on the HIC



Location	Drop #	Drop Height (ft)	Impact Velocity (ft/s)	Theoretical Drop Height (ft)	Gmax	HIC	Results	
							Gmax	HIC
1 On waler; Center of Panel	1	4	16.0	4.0	90	289	68	287
	2	4	16.0	4.0	68	287		
	3	4	16.0	4.0	67	287		
2 Between Walers; Panel Seam	1	4	16.0	4.0	53	230	68	236
	2	4	16.0	4.0	64	235		
	3	4	16.0	4.0	72	237		
3 Between Walers; Center of Panel	1	4	16.0	4.0	54	207	52	204
	2	4	16.0	4.0	51	203		
	3	4	16.0	4.0	53	204		
4 Between Walers; Panel Leg	1	4	16.0	4.0	65	269	65	268
	2	4	16.0	4.0	65	267		
	3	4	16.0	4.0	65	268		

Table 1 – Results per Firefly Sports Testing (5-28-2024)

Impact Analysis DiamondWall Extruded PVC Panel

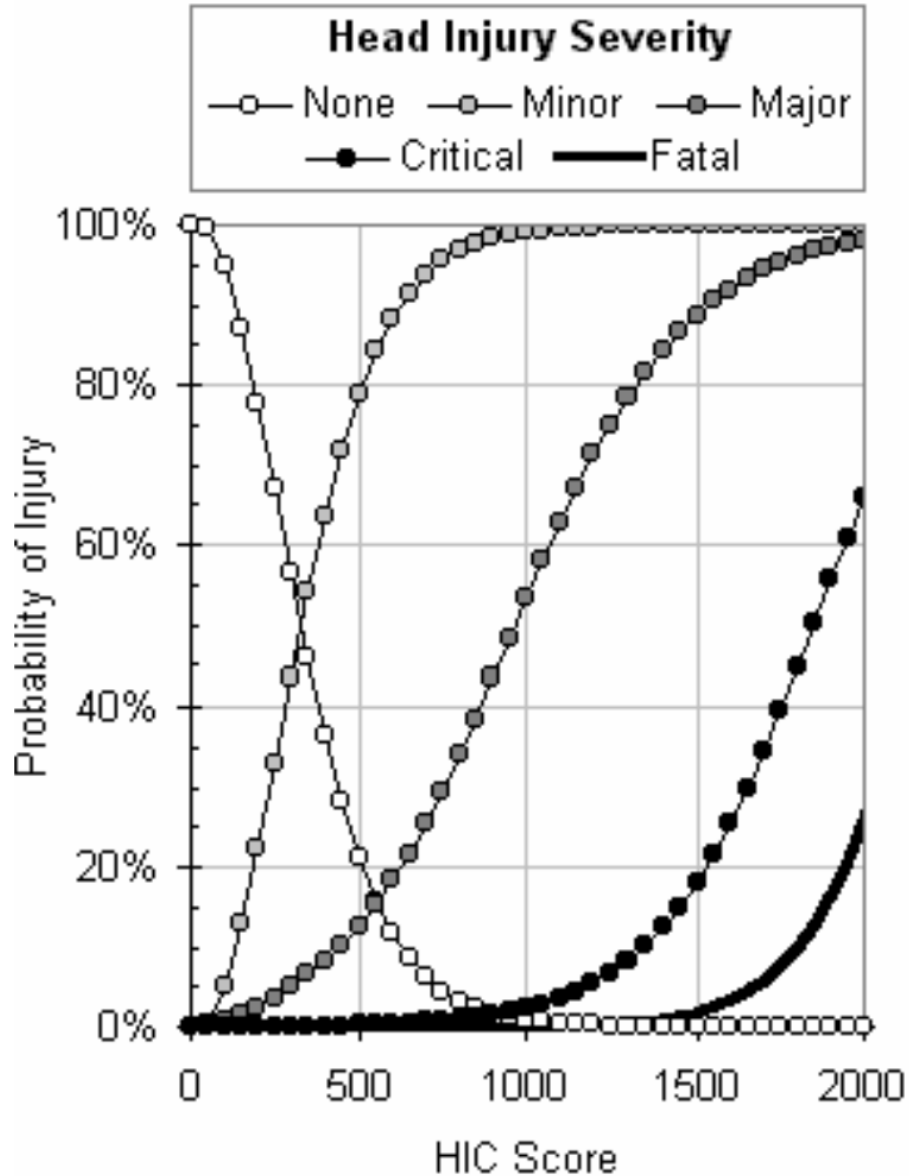


Chart 1 - Expanded Prasad-Mertz Curve

Source – “Sports surfaces and the risk of traumatic brain injury” By Martyn R. Shorten, PhD and Jennifer A. Himmelsbach, MS

Conclusions: The G’max average must be under 200 g’s. The test results show an average G’max of 61 g’s. The HIC score must be under 1000. The maximum HIC score came in at 208. The panel preforms well under the recommended G’max and HIC rating with less than a 5% chance of a major head injury.

Impact Analysis DiamondWall Extruded PVC Panel

Test #2 – Outfield Baseball Velocity

Summary: Testing was conducted to determine the velocity of an off the bat baseball at the point of impact of the outfield wall.

Test Method: The baseballs were shot at varying speeds using a pneumatic impact test launcher. The speeds were recorded 200ft from the launch site. The test was conducted on a cloudy, 65-degree day.

Results:

Ball #	Launcher Exit Velocity (mph)	Velocity at 200ft (mph)	Deceleration (mph)
1	92	81	11
2	92	84	8
3	92	85	7
4	100	96	4
5	101	90	11
6	101	84	17
7	106	80	26
8	107	87	20
9	107	85	22
10	107	87	20
11	119	92	27
12	119	81	38
13	119	86	33
14	119	95	24
15	119	87	32
16	127	97	30

Table 2

Impact Analysis DiamondWall Extruded PVC Panel

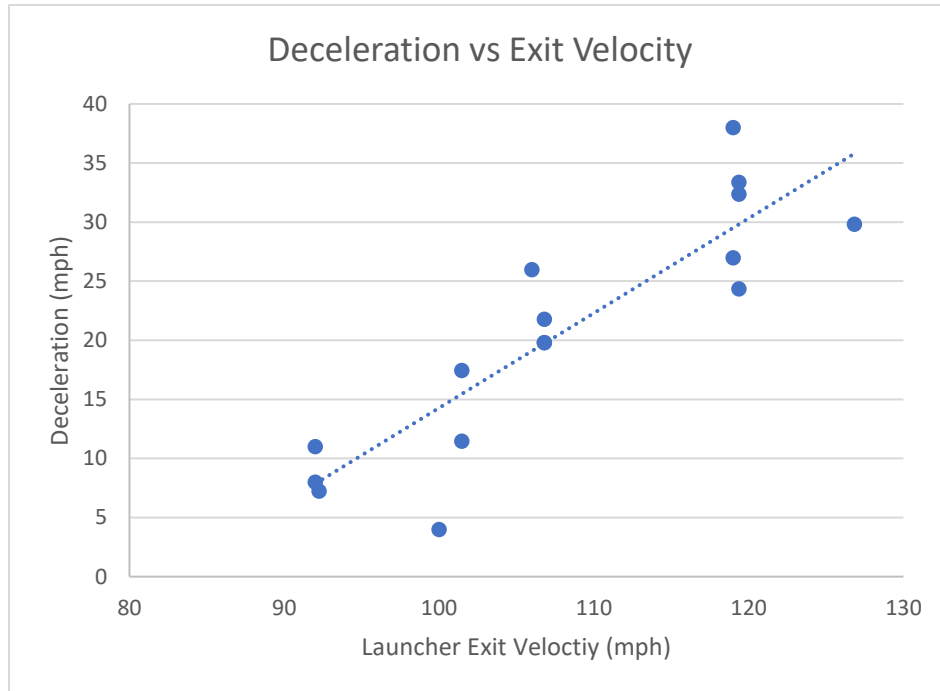


Chart 2 – Deceleration @ 200’ vs Exit Velocity

Ball #	Launcher Exit Velocity (mph)	Velocity at 245ft (mph)	Deceleration (mph)
1	127	68	59
2	135	80	55
3	135	77	58
4	135	80	55
5	135	76	59

Table 3

Conclusions: On average, the baseball decelerated by 19% at 200ft. The maximum recorded velocity at 200ft was 97 mph. At 245 ft, the baseball decelerated to a maximum of 80 mph.

Impact Analysis DiamondWall Extruded PVC Panel

Test #3 – Maximum Panel Velocity

Summary: Test was conducted to determine the velocity at which the panel fails when hit with a baseball.

Test Method: Baseballs shot at a varying speed using a pneumatic impact test launch at a panel 2 ft away. Exit speeds were recorded for each shot and the panel was inspected for signs of failure. See Image 1.



Image 1

Results:

Panel	Ball #	Velocity (mph)	Break?
A	1	100	No
	2	118	No
	3	135	No
	4	140	No
B	1	100	No
	2	118	No
	3	135	No
	4	140	No
C	1	100	No
	2	118	No
	3	135	No
	4	140	No

Table 4

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Image 2

Conclusions: The panels withstood impact speeds in excess of 140 mph, with no failure/damage. The off the bat velocity of a softball typically ranges from 65 – 73 mph¹. The off the bat velocity of a Major League Baseball typically ranges from 96-103 mph, with the 2016 record being 123 mph¹. Test #2 indicates that a 119-mph off the bat baseball would decelerate to about 88 mph at 200 ft. The outfield wall of a baseball stadium ranges from 300 to 420 ft from the home plate. It can be concluded that an off the bat baseball will not have enough velocity to break the outfield wall panels.

¹“Understanding Exit Speed.” *The Hitting Vault*, <https://thehittingvault.com/exit-speed-in-baseball-and-softball/>