

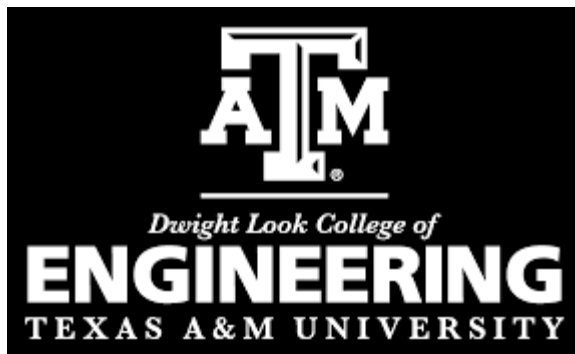
2015

STORM SHELTER & SAFE ROOM PANEL COMPONENT TESTING

PERFORMED FOR:



PERFORMED BY:



Texas A&M Engineering Extension
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EXECUTIVE SUMMARY

Forever Safe Shelters (Forever Safe) is a developer of an above ground “Safe Shelter.” Forever Safe’s wind resistant structural technology system serves as a tornado shelter/safe room. Additionally, Forever Safe’s shelters are precast, modularized components that allow for significant advantages in budget and installation. To determine the pressure bearing capabilities of Forever Safe’s primary component panels, two static load tests were performed: out-of-plane bending and punch-through tests.

Hurricane Category	Wind Speed
Category 1	74-95 mph
Category 2	96-110 mph
Category 3	111-129 mph
Category 4	130-156 mph
Category 5	157 mph
Tornado Classification	Wind Speed
F-0	40-72 mph
F-1	73-112 mph
F-2	113-157 mph
F-3	158-206 mph
F-4	207-260 mph
F-5	261-318 mph

It was decided to use static load tests after reviewing the testing provisions of ICC/NSSA Standard for the Design and Construction of Storm Shelters (2008). These testing provisions, which are based on ASTM E330 (Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference) and E1886 (Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, Doors, Skylights and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differential’s), were determined to be inadequate to evaluate storm shelter components from loading resulting from tornadic winds and debris. Catastrophic tornado events can result in structural loads that far exceed those imposed by ICC 500. The fastest wind speed ever recorded on earth is 318 mph in Moore, Oklahoma during the 1999 storm season. Table 1 provides wind speeds and classifications of storms.

Table 1: Wind Speed by Storm

As an example, Figure 1 is a view of tornado damage at an elementary school at Eagle Pass, TX on April 24, 2007. The structural damage is the result of a manufactured home being picked up and thrown over 100 yards into the side of the school building. The tornado was subsequently classified as EF3.



Forever Safe Shelter Testing

When it came time to test Forever Safe Shelters’ panels it was determined to perform static pressure test that far exceeded existing codes and standards. Whereas ICC 500 calls for 2”x4” missile testing we used a 145% larger pressure area with an 8” steel plate to represent debris similar to a telephone pole. Using hydraulic pressure, a **concentrated load** was converted to **uniform pressure loading** which corresponds to equivalent **wind speed** by converting net wind pressure to wind speed $p_{net} = 0.00256V^2$.

Panel Component/Test	Concentrated Load	Uniform Pressure	Wind Speed
4’x12’/ Bending	17,300 lbs	720 psf	530 mph
4’x12’/Punch-Through	17,300 lbs	720 psf	530 mph
4’x8’/Bending	22,300	1425 psf	746 mph
4’x8’/Punch-Through	24,100	1506 psf	767 mph
4’x8’ Door Punch-Through	25,000	1562 psf	781 mph