Window & Door Buck Keyway Pullout from Concrete

INTRODUCTION

Prebuck Window & Door Buck Frames have been thoroughly tested using finite element analysis (FEA). This analysis specifically evaluated the holding strength and resistance to pull-off from the concrete, provided by the keyway in the backside of the buck.

FEA is a computer simulation tool that allows for material strength values to be input and various scenarios of force to be evaluated. By leveraging this technology, Prebuck aims to provide comprehensive data that can be utilized by the Architecture, Engineering, and Construction (AEC) community. These data points will aid in specifying and supporting the use of Prebuck for projects.

Prebuck Window & Door Buck Frames are designed to integrate directly with concrete, eliminating the necessity for additional mechanical anchors. The dual keyway spanning the entire length of the board further enhances the contact surface area and bolsters the resistance to torsional forces. Prebuck leverages the use of engineered Laminated Strand Lumber (LSL) to ensure heightened strength, impeccable straightness, and the elimination of common weak points found in dimensional materials such as knots, cracks, and wanes.

This technical bulletin is provided to equip professionals in the AEC industry with the required information to confidently specify and employ Prebuck on projects.

TEST METHODOLOGY

While conducting the finite element analysis (FEA), specific parameters were established to accurately represent real-world scenarios.

All contact points between the wood and concrete were set as frictionless, except at the areas of interest, specifically within the dual keyways. Within these keyways a frictional contact was established with a static coefficient of friction of 0.2. This setup aimed to mimic the realistic interaction between the Prebuck Window & Door Buck and the concrete at crucial points.

To replicate the pullout process, a uniform pressure was evenly applied on the Prebuck. This ensures consistent force distribution across the entire surface. This approach facilitated a comprehensive assestment of the frame's resistance to pullout forces.

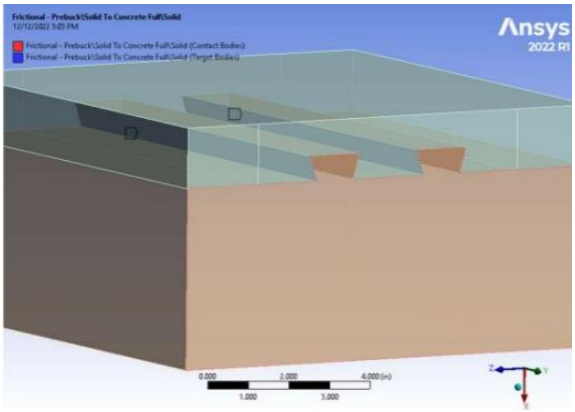


Figure 2: Contact Setup

TEST PROTOCOL

The holding strength and resistance to pull-off of the Prebuck Window & Door Buck was tested in accordance with FEA Static Structural.

TEST RESULTS

The force required to start breaking the contact point between the keyway and the flat concrete surface began at 1,561 psf (74.74 kPa).

Figure 3 illustrates that the maximum stress occurs at the edge of the contact between the concrete and the Prebuck. The stress required for failure was not reached during the simulation.

Figure 4 shows that the Prebuck does not reach sufficient shear stress needed to break in the contact region, allowing for pullout of the board.

The ultimate failure occurred at 3,904 psf (186.92 kPa). At this critical point, the force exerted caused the edges of the Prebuck to uplift until the material snapped at the center point. Figure 5 illustrates that the maximum deformation occurs along the sides of the Prebuck (shaded red).

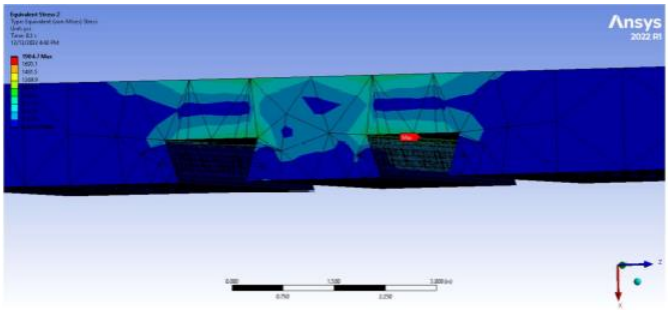


Figure 3: Stress Experienced by Prebuck Window

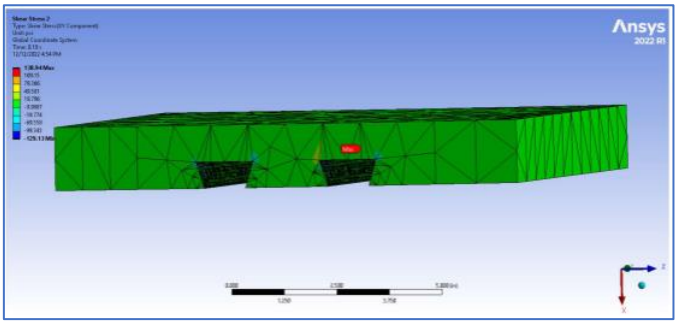


Figure 4: Shear Stress Experienced by Prebuck Window

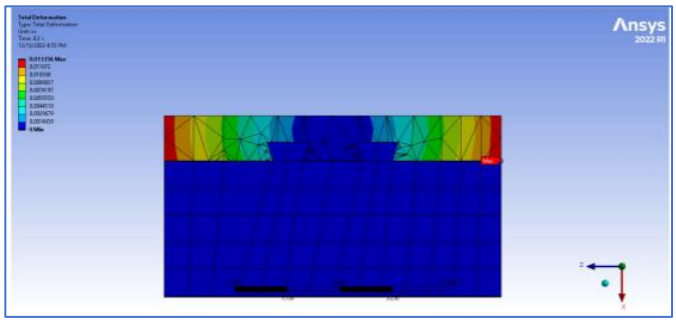


Figure 5: Deformation Experienced by Prebuck Window

PREBUCK PUT TO THE TEST

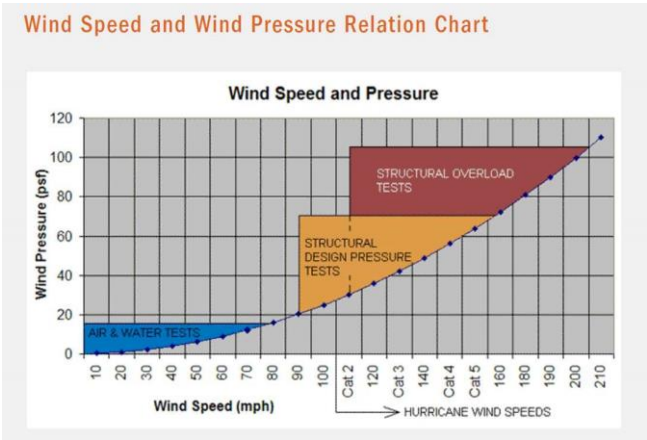
Researchers at Prebuck conducted testing to evaluate the holding strength and resistance to pull-off from concrete of the Prebuck Window & Door Buck Frames, focusing on the keyway in the backside of the buck. The finite element analysis (FEA) simulated various force scenarios to assess the material's performance.

Shear Strength Assessment

The Prebuck Buck Frame demonstrated significant resilience. At 1,561 psf (74.74 kPa), the frame began to break at the contact point of the keyway and the flat concrete surface.

Design Service Load

The ultimate failure of the Prebuck Buck Frame occurred at 3,904 psf (186.92 kPa), when the force caused the edges of the frame to uplift, and the material snapped at the center point. This critical load is substantially higher than the initial breaking point, indicating that the Prebuck Buck Frames can endure significant stress before failing.



In assessing the durability of Prebuck, our research explored the dynamics of wind resistance. To ensure thorough evaluation, we selected a range of sample window opening sizes and applied the wind load requirements outlined by the Miami-Dade Building Code, setting our wind speed of 175 miles per hour (282 km/h). This resembles real-world conditions in high-risk areas prone to hurricanes and tropical storms. As demonstrated in the chart below, our findings reveal the FEA Analyzed load capacity of Prebuck under a wind pressure of 80 psf (3.83 kPa).

Wind Pressure	Window Opening Size	Maximum Potential Load	Maximum Load on Total Buck Area	Percentage of FEA Structural capacity
80 lbs (119 kg)	3' x 2'	480 lbs	51.2 lbs/ft^2	**3.28%**
	0.915m x 0.61m	66.45 kg	76.18 kg/m^2	
	5' x 3'	1,200 lbs	80 lbs/ft^2	**5.12%**
	1.52m x 0.92m	166.12 kg	119.03 kg/m^2	
	4' x 5'	1,600 lbs	94.81 lbs/ft^2	**6.07%**
	1.22m x 1.52m	221.50 kg	141.07 kg/m^2	
	6' x 4'	1,920 lbs	102.4 lbs/ft^2	**6.56%**
	1.83m x 1.22m	265.80 kg	152.35 kg/m^2	

It was concluded that the Prebuck Buck Window & Door Buck Frames provides superior resistance to pull-off forces and maintains structural integrity under high-stress conditions, making it a reliable choice.

CONCLUSION

Based on the FEA testing that was performed, the Prebuck Window and Door Buck can sustain tensile stresses trying to pry or tear the buck from the concrete up to a maximum of 1,561 psf (74.74 kPa) before cracking begins. The FEA analysis also indicated that even more stress could be exerted on the buck before the board will fully fail or snap out of the concrete keyways.

We welcome any inquiries into this testing and would appreciate any feedback on additional testing that you would like to see performed. Additionally, we extend the ability to evaluate your specific assembly or project-specific assembly at the Tremco Building Science lab so that we can incorporate your window, façade anchors or adhered veneer, below grade to wall, and roof to wall connection. Other tests associated with Prebuck can be found at www.prebuckproducts.com.

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