

*Test II Report on*

**INVESTIGATION OF WIND PROJECTILE  
RESISTANCE OF ROYAL BUILDING SYSTEMS  
SHELTER WALL PANELS**

*Submitted to*

**Mr. John Todd  
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*Testing Performed by*

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*Investigators*

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*Date Submitted*

**June 14, 2001**

## **Investigation of Wind Projectile Resistance of American Plywood Association Wood Laminated Panel**

### **Overview of Project**

Mr. John Todd of Royal Building Systems (Cdn) Limited contacted the Wind Science and Engineering (WISE) Research Center at Texas Tech University to assess the ability of their wall system to resist tornado forces and debris impacts. Tests were conducted on June 12, 2001. The specifics about each test, results and conclusions follow.

Royal Building Systems has developed a wall system utilizing extruded PVC. The PVC extrusions are approximately 5 ½-in. wide and 8 1/8-in. wide. The extrusions are joined by tongues and grooves with the different widths alternating position. Voids in the system's cells allow the concrete to flow from cell to cell and also permit the placement of reinforcing bars to placed vertically and horizontally. The concrete placed in the test samples had an allowable compressive strength of 3000 psi with pea gravel aggregate and was reinforced with Grade 60 reinforcing steel. Un-reinforced, vertically reinforced, and vertical + horizontal reinforced 4' x 4' wall samples for testing included the following:

RBS4 4" thickness

RBS6 6" thickness

RBS8i 8" thickness (6" concrete + 2" polyurethane insulation)

RBS8 8" thickness

The missile criterion used for the tests was a 15-lb. 2x4-in. wood board traveling along the board's longitudinal axis, striking the panel perpendicular to the panel face. The tornado test criterion uses this missile traveling at 100-mph which corresponds to a 250-mph ground wind speed storm and is the criterion used in designing for occupant protection. Additional factors of safety are inherent in the criterion since there is a very small probability that a missile will be traveling along its axis and will strike a wall perpendicular to its surface.

## Testing From June 12, 2001

The RBS4 test panel was placed in front of the reaction frame for testing.



**Target Placed in Front of Reaction Frame**



**RBS4 Test Panel Clamped to Reaction Frame**

**Missile Shot I – 102 mph**

The un-reinforced RBS4, 4-in. thick, was impacted in the center of the panel near a tongue and grooved joint. The impact caused no structural damage to the panel, however, a small piece of the vinyl was broken at the point of impact.



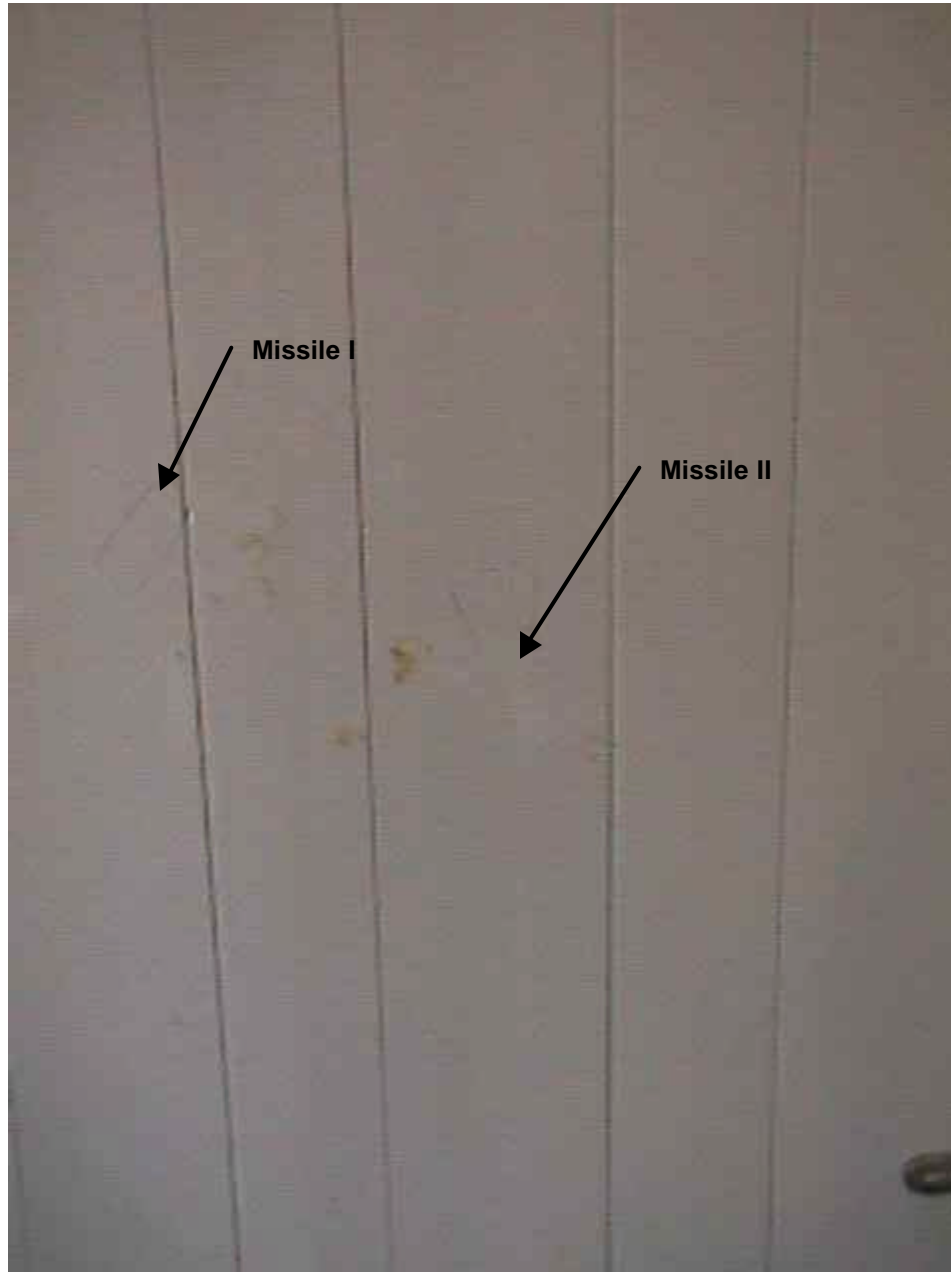
**Front of impacted Test Panel**



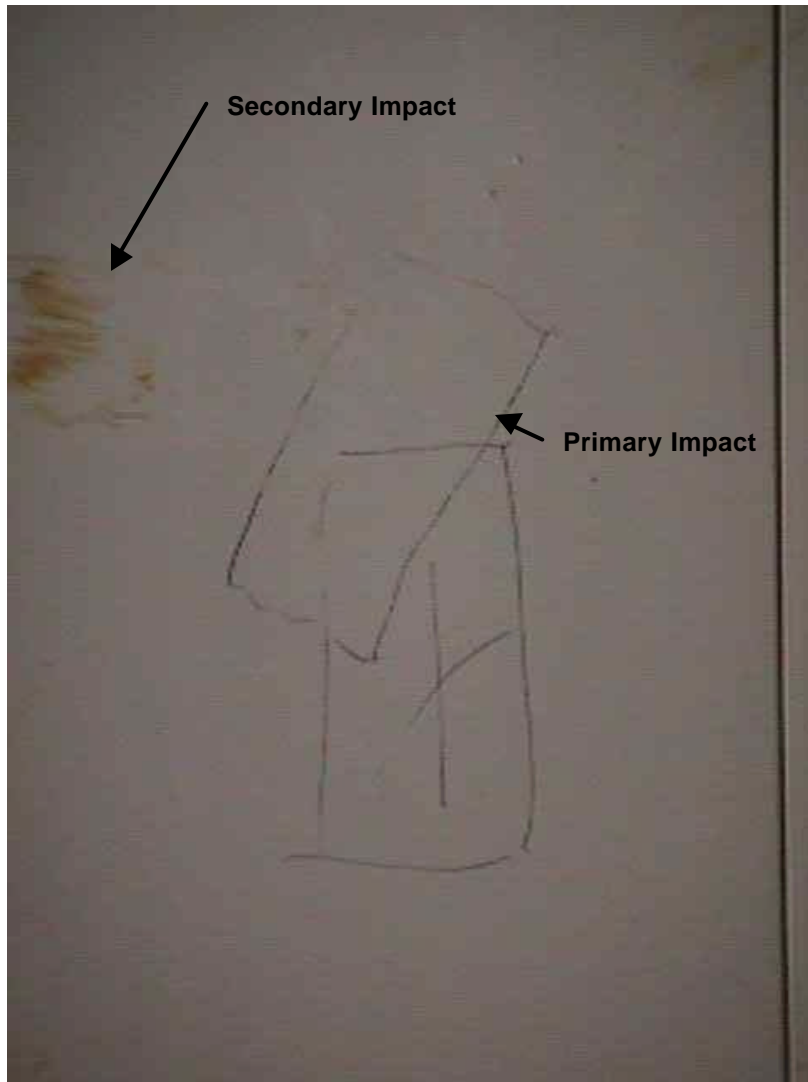
**Point of Impact**

### **Missile Shot II –102 mph**

The test panel was impacted a second time striking the center of the 8-in. extrusion. The impact caused the missile to shear, thereby allowing a secondary impact on the panel by the trailing portion of the missile. No visible damage resulted from either the primary or secondary missile impact.



**Target Impacted by Missile II**



**Target Impacted by Test Missile II**

## **Conclusions**

*Within the bounds of reasonable engineering and technical certainty, and subject to change if additional information becomes available, the following is my professional opinion:*

The 4' x4' un-reinforced RBS4 test panel resisted the 100 mph, 15-lb. 2x4 missile. The missile speed correlates to a 250 mph ground wind speed tornado. The tested panel thereby meets the criteria as established by FEMA #320, "Taking Shelter From The Storm" for debris impact resistance. The other test samples, un-reinforced and reinforced (RBS4-reinforced, RBS6, RBS8i, and RBS8), though not tested, are also considered FEMA 320 compliant, since they represent stronger systems by virtue of their reinforcing and increased concrete thickness. However, it is recommended that an engineering analysis be conducted on the un-reinforced wall system for resistance to the storm wind pressures. Bending in walls is produced by these pressures and is normally best resisted by reinforcing steel.

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Larry J. Tanner, P.E.

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