Construction Materials

Threshold Testing

Prepared by

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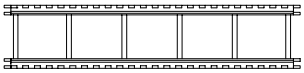
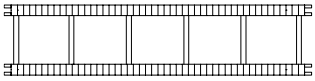
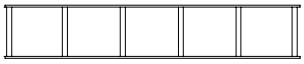
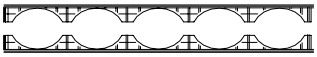
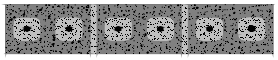
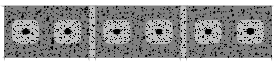
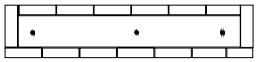
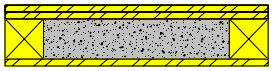
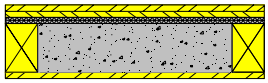
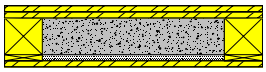
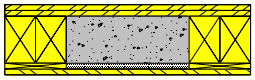
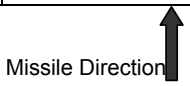
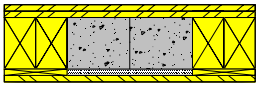
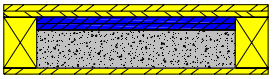
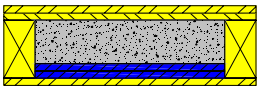
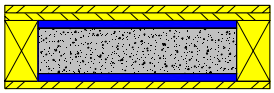
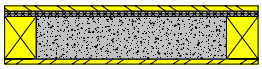
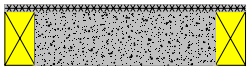
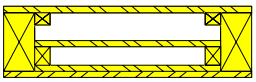
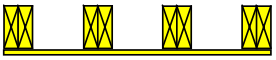
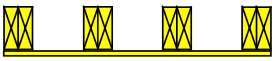
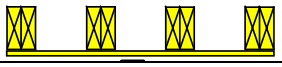
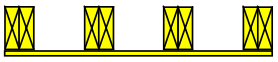
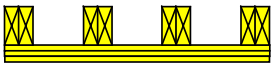
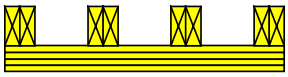
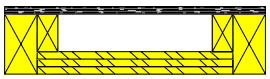
CONSTRUCTION MATERIALS THRESHOLD TESTING

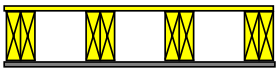
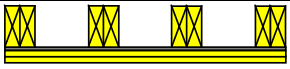
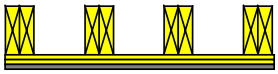
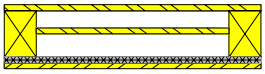
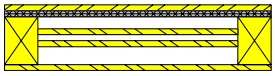
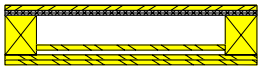
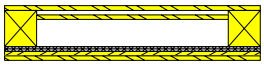
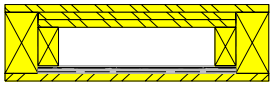
Section A- 15 lbf 2x4 board missile			
	Target Name	**Target Description**	**Threshold Missile Speed (MPH)**
A1-Reinforced Concrete			
	2 in. thick pea-gravel concrete with #4 rebar reinforcement 12 in. o.c. each way.		26.0
	3 in. thick pea-gravel concrete with #4 rebar reinforcement 12 in. o.c. each way.		102.0
	4 in. thick pea-gravel concrete with #4 rebar reinforcement12 in. o.c. each way.		162.0
	6 in. thick pea-gravel concrete slab with #4 rebar reinforcement12 in. o.c. vertically.		102.4
	6 in. thick pea-gravel concrete slab with #4 rebar reinforcement 24 in. o.c. vertically.		102.4
A2-Reinforced Concrete Walls Constructed using Insulating Concrete Forms (ICF)			
	6 in. thick GREENBLOCK ICF (Exterior finish consists of vinyl siding attached to ICF fastening strips.)		119.9
	6 in. thick BLUE MAXX ICF (Interior finish consists of 5/8 in gypsum board attached directly to ICF fastening strips. Exterior finish consists of 3 in. brick attached to ICF fastening strips with brick ties.)		99.0
	4 in. thick LITE FORM ICF (Interior finish consists of 5/8 in gypsum board attached directly to ICF fastening strips. Exterior finish consists of vinyl siding attached to ICF fastening strips.)		96.7
	6 in. thick POLYSTEEL (WAFFLE) ICF (Exterior finish consists of 1/4 in thick Exterior Insulation Finish System (EIFS) applied directly to ICF.)		103.8

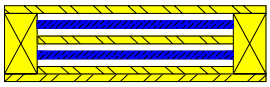
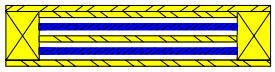
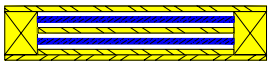
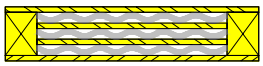
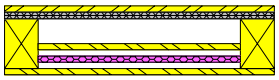
Section A- 15 lbf 2x4 board missile			
	Target Name	**Target Description**	**Threshold Missile Speed (MPH)**
A3-Reinforced Masonry Units (CMU)			
	8 in. CMU reinforced with concrete and #4 rebar in every cell; truss type horizontal reinforcement was placed every 16 in.		121.0
	6 in. CMU reinforced with concrete and #4 rebar in every cell; truss type horizontal reinforcement was placed every 16 in.		111.3
	6 in. CMU reinforced with concrete and #4 rebar in every cell; 8-gage truss horizontal reinforcement every other course.		130.0
A4-Reinfoced Brick Cavity Walls with Concrete Infill			
	Brick cavity wall reinforced with #4 rebar every 12 in. and concrete infill.		100.0
A5-Stud Walls with Concrete Block Infill			
	4x4 stud wall, containing 4 in. concrete block, and one layer of 3/8 in. CD grade plywood on the impact and two layers ¾ in. CD grade plywood non-impact faces.		103.8
	4 in. concrete block in a 2X4in. stud wall with two layers of ¾ in CD grade plywood.		< 103.9
	4 in. concrete block in a 2x4 in. stud wall with two layers of ¾ in. CD grade plywood and 14 ga. ½ in. expanded metal on the non-impact side, and one layer of plywood on the impact side.		106.7
	4x4 stud wall with 1x4's on the studs, containing 4 in. concrete block, gypsum board infill, and one layer of ¾ in. CD grade plywood on the impact face and two layers on the non-impact face.		106.5
	Double studded 2x4 wall with furring. Two layers of ¾ in. CD grade plywood on the non-impact face, one layer on the impact face, and a layer of 3/8 in. gyp. board. The wall is filled with 4 in. concrete block.		103.0

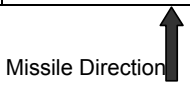


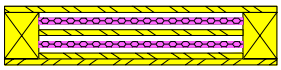
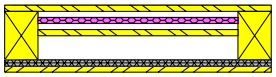
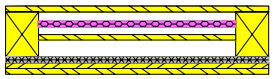
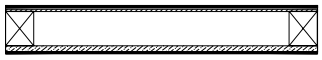
Section A- 15 lbf 2x4 board missile			
	Target Name	**Target Description**	**Threshold Missile Speed (MPH)**
	Double studded 2x4 wall with furring. Two layers of ¾ in. CD grade plywood on the non-impact face, one layer on the impact face, and a layer of 3/8 in. gyp. board. The wall is filled with 4 in. concrete block placed vertically in the cell.		101.9
	4 in. concrete block in a 2X6 in. wall with 1 ½ in. of polystyrene between block and one layer of ¾ in. CD grade plywood		111.3
	4 in. concrete block in a 2x6 in. stud wall with 1 ½ in. of polystyrene between the block and the impact face of ¾ in. CD grade plywood. There is also two layers of plywood on the non-impact face.		105.4
	4 in. concrete block in a 2x6 in. wall with 1 ½ in. of polystyrene on each side of the block, one layer of ¾ in. CD grade plywood on the impact side, and two layers on the non-impact face.		104.0
A6-Stud Walls with Concrete Infill			
	Stud wall with CD grade plywood, 14 ga. ½ in. expanded metal, and concrete infill.		106.1
	Stud wall filled with concrete with no plywood and 14 ga. ½ in. expanded metal on the non-impact face.		> 107.7
A7- Stud Walls with Plywood			
	2x8 in. stud wall with ¾ in. CD grade plywood inserts.		< 101.3
	4 layers of ¾ in. CD grade plywood.		< 85.4
	4 layers of ¾ in. CD grade plywood glued together and attached to the frame with screws.		< 82.0
	4 layers of ¾ in. BC grade plywood glued together and attached to the frame with screws.		< 78.9

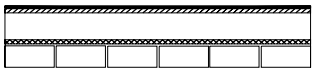
Section A- 15 lbf 2x4 board missile			
	Target Name	**Target Description**	**Threshold Missile Speed (MPH)**
	1 layer of 1/2 inch Plywood		< 52.0
	1 layer of 1/2 inch Plywood with Masonite Siding		< 52.0
	1 layer of 3/4 inch Plywood		< 53.0
	1 layer of ¾ in. plywood mounted with 3 in. #8 wood deck screws spaced 6 in on center to the double stud 4X4 ft. frame.		29.0
	2 layer of ¾ in. plywood mounted with 3 in. #8 wood deck screws spaced 6 in on center to the double stud 4X4 ft. frame.		41.0
	3 layer of ¾ in. plywood mounted with 3 in. #8 wood deck screws spaced 6 in on center to the double stud 4X4 ft. frame.		59.0
	4 layer of ¾ in. plywood mounted with 3 in. #8 wood deck screws spaced 6 in on center to the double stud 4X4 ft. frame. All plywood layers are rotated 90 degrees from the previous layer.		71.0
A8- Stud Walls with Plywood and Steel Plate			
	Double 2x4 stud wall with one layer of 12 ga. steel on the impact side and one layer of ¾ in. CD grade plywood on the non-impact side.		105.2
	2x8 stud wall with two layers of ¾ in. plywood and one layer of 14 ga. steel.		100.9
	Double stud wall with 4 layers of ¾ in. CD grade plywood and 14 ga. steel on the back face of the target.		107.0
	Stud wall with 2 layers of ¾ in. CD grade plywood with 16 ga. metal on non-impact side.		105.0
	Stud wall with 3 layers of ¾ in. CD grade plywood inserts with 14 ga. metal on the non-impact side.		105.7

Section A- 15 lbf 2x4 board missile			
	Target Name	**Target Description**	**Threshold Missile Speed (MPH)**
	2 layers of ¾ in. CD grade plywood with 14 ga. steel on the non-impact side, and gypsum board on both the impact and non-impact faces.		108.4
	1 layer of 12 ga. steel that was hot rolled A569 Grade 33 on top of the double stud frame followed by a layer of ¾ in. plywood on the non-impact side.		145.0
	2 layers of ¾ in. plywood, one layer of 14 ga. steel.		130.0
	2 layers of ¾ in. plywood, one layer of 14 ga. steel and the 4x4 ft, double stud frame.		< 112.8
A9- Stud Walls with Plywood and Expanded Metal			
	3 layers of ¾ in. CD grade plywood with 14 ga. ½ in. expanded metal on the impact side.		< 103.8
	4 layers of ¾ in. CD grade plywood with 14 ga. ½ in. expanded metal on the non-impact side.		< 99.2
	4 layers of ¾ in. CD grade plywood with 14 ga. ½ in. expanded metal on the non-impact side.		< 102.7
	3 layers of ¾ in. CD grade plywood with 14 ga. ½ in. expanded metal on the non-impact side.		< 100.9
	4 layers of ¾ in. CD grade plywood with 14 ga. ½ in. expanded metal on the impact side.		< 98.7
	4 layers of ¾ in. plywood with 14 Ga. steel insert with spacers between inserts and the back face of the target.		109.4

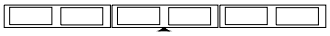
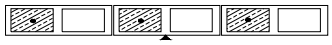
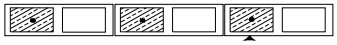
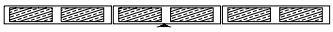
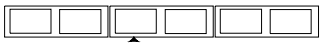
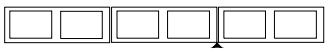
Section A- 15 lbf 2x4 board missile			
	Target Name	**Target Description**	
A10- Stud Walls with Inserts Between Studs			
	14 ga. steel insert with spacers between all the inserts and the back face has two layers of ¾ in CD grade plywood.		110.0
	4 layers of ¾ in. CD grade plywood with 14 ga. steel insert and spacers between all inserts.		104.5
A11- Stud Walls with Polystyrene Infill			
	4 layers of ¾ in. CD grade plywood with two layers of energy absorbing polystyrene as inserts.		105.4
	4 layers of ¾ in. CD grade plywood with two layers of energy absorbing polystyrene as inserts.		< 104.1
	4 layers of ¾ in. CD grade plywood with two layers of energy absorbing polystyrene as inserts.		< 100.0
A12-Stud Walls with Corrugated Infill Materials			
	3 layers of corrugated tin with four layers of ¾ in. CD grade plywood.		< 100.9
	1 layer of corrugated tin with four layers of ¾ in. CD grade plywood.		< 104.8
A13- Stud Walls with Combinations of Infill and Siding Materials			
	3 layers of ¾ in. CD grade plywood with 14 ga. ½ in. expanded metal on the non-impact side and bead-board infill.		< 90.8



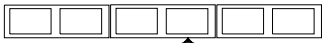
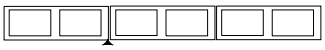
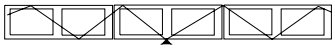
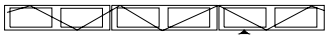
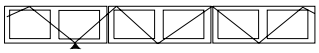
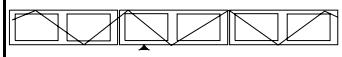
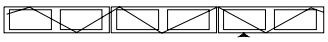
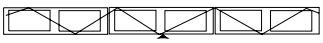
Section A- 15 lbf 2x4 board missile			
	Target Name	**Target Description**	**Threshold Missile Speed (MPH)**
	4 layers of ¾ in. CD grade plywood with two layers of energy absorbing bead board as inserts.		< 102.2
	3 layers of ¾ in. CD grade plywood with 14 ga. ½ in. expanded metal on the impact side and bead-board infill.		< 104.8
	4 layers of ¾ in. CD grade plywood with 14 ga. ½ in. expanded metal on the impact side and bead-board infill.		< 103.3
	Masonite siding wall; 7/16 in. masonite siding (rough finish) on the front face and 1/2 in. gypsum wallboard on the back face.		< 54.0
	Insulation Board / Masonite siding wall;1/2 in. insulating board and 7/16 in. masonite siding (rough finish) on the front face and 1/2 in. gypsum wallboard on the back face.		< 54.0
	Plywood / Masonite siding wall; 1/2-in. plywood sheeting and 7/16-in. masonite siding (rough finish) in the front face and 1/2-in. gypsum wallboard in the back face.		< 52.0.0
	Plywood wall; 1/2-in. plywood sheeting on the front face and 1/2-in. gypsum wallboard on the back face.		< 52.0
	plywood wall; 3/4-in. plywood sheeting on the front face and 1/2-in. gypsum wallboard on the back face.		< 53.0

Section A- 15 lbf 2x4 board missile			
	Target Name	**Target Description**	**Threshold Missile Speed (MPH)**
	Stucco wall; 1/2-in. plywood sheeting topped by 3 course stucco exterior on the front face and 1/2-in. gypsum wallboard on the back face.		< 53.0
	Lapboard siding wall; 3/4-in. plain lapboard siding on the front face and 1/2-in. gypsum wallboard on the back face.		< 53.0
	Insulation Board / Lapboard siding wall; 1/2-in. insulation board and 3/4-in. plain lapboard siding on the front face and 1/2-in. gypsum wallboard on the back face.		< 52.0
A14- Brick Veneer Walls			
	Brick veneer wall. (Interior finish consists of 5/8-in. gypsum board attached directly to the wood studs. 3 1/2-in. fiberglass batt insulation was placed between studs. Exterior finish consists of 3/4-in. plywood sheeting attached to the studs with a 3-in. brick veneer.)		< 69.4
	High wind speed design brick veneer*		‹ 51.0
	*Threshold speed appeared to be unaffected by the brick tie spacing for either the High Wind Design or the Normal Wind Design.		
A15- Doors			
	Hollow core door (wooden door).		< 54.0
	Solid-core door (particle board fill).		< 53.0

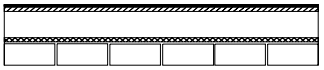
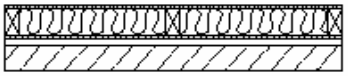
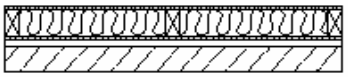
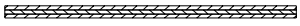
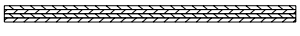
Missile Direction

Section B- 2x4 board missile with different weights			
	Target Name	**Target Description**	**Threshold Missile Speed (MPH) / Weight (lbf)**
B1-Reinforced Masonry Units (CMU)			
	8 in. CMU with no reinforcement.		60.0 (13.0)
	8 in. CMU with no reinforcement.		< 131.0 (11.0)
	8 in. CMU reinforced with #4 rebar at 16 in. on center cells with rebar filled with grout.		135.0 (11.0)
	8 in. CMU reinforced with #4 rebar at 16 in. on center cells with rebar filled with grout.		104.0 (11.25)
	8 in. CMU reinforced with #4 rebar at 16 in. on center cells with rebar filled with grout.		162.0
	8 in. CMU reinforced with grout filled in every cell.		98.0 (12.5)
	8 in. CMU with no reinforcement.		71.0 (13.75)
	8 in. CMU with no reinforcement.		100.0 (13.75)

Missile Direction

Section B- 2x4 board missile with different weights			
	Target Name	**Target Description**	**Threshold Missile Speed (MPH) / Weight (lbf)**
	12 in. CMU with no reinforcement.		< 120.0 (11.75)
	12 in. CMU with no reinforcement.		< 85.0 (12.0)
	12 in. CMU with steel trusses in horizontal joints.		125.0 (11.75)
	12 in. CMU with steel trusses in horizontal joints & no cell reinforcement.		124.0 (11.75)
	12 in. CMU with steel trusses in horizontal joints & no cell reinforcement.		< 86.0 (12.75)
	12 in. CMU with steel trusses in horizontal joints & no cell reinforcement.		121.0
	12 in. CMU with steel trusses in horizontal joints & no cell reinforcement.		72.0 (12.75)
	12 in. CMU with steel trusses in horizontal joints & no cell reinforcement.		< 85 (13.0)
	8 in. CMU with steel trusses in horizontal joints & no cell reinforcement.		104.0 (12.5)
	8 in. CMU with steel trusses in horizontal joints & no cell reinforcement.		< 89.0 (12.5)
B2 - Reinforced Concrete Slabs			
	4 in. thick reinforced concrete; #3 rebar at 6 inch o.c. each way in the middle of the slab		121.0 (13.5)
	4 in. thick reinforced concrete; #3 rebar at 6 inch o.c. each way in the middle of the slab		147.0 (14.0)
	4 in. thick concrete - NO Reinforcement		> 122.0 (14.25)
	6 in. thick reinforced concrete; #3 rebar at 6 inch o.c. each way in the middle of the slab		> 140.0 (13.75)

Missile Direction

Section B- 2x4 board missile with different weights			
	Target Name	**Target Description**	
B3 - Brick Veneer Walls			
	Brick veneer wall with 1/2-in. insulation board and 1/2-in. gypsum wallboard.		120.0 (12.5)
	High wind speed design Brick veneer*		80.0 (9.0)
	Normal wind speed design Brick veneer*		80.0 (9.0)
	*Threshold speed appeared to be unaffected by the brick tie spacing for either the High Wind Design or the Normal Wind Design.		
B4 - Plywood layers			
	1 layer of 3/4 inch Plywood		< 48.4 (14.0)
	2 layers of 3/4 inch Plywood		< 63.0 (14.0)
	3 layers of 3/4 inch Plywood		< 76.6 (14.0)
	4 layers of 3/4 inch Plywood		< 110.2 (14.0)
B5 - OSB layers			
	1 layer of 3/4 inch OSB		low speed
	2 layers of 3/4 inch OSB		low speed
	3 layers of 3/4 inch OSB		< 62.3 (14.0)
	4 layers of 3/4 inch OSB		< 74.3 (14.0)
	OSB Clad Stud Wall		22.0 (9.0)
B6 - Residential Stud Walls with OSB Sheathing, Insulation & 1/2-in. Gypsum Board			
	Fiber-cement Board Sided Stud Wall		22.0 (9.0)
	Vinyl Sided Stud Wall		< 26.0 (9.0)

Missile Direction