



Achieving Maximum Roof Performance at the Lowest Installed Cost With Invinsa® Roof Board

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Executive Summary

Commercial roof reliability, strength and durability are some of the primary considerations for today's commercial building owner, contractor and specifier.

During its life span, a roof will endure damage as a result of natural elements such as high winds during storms, wide swings in temperature and humidity, and hail, as well as mechanical damage from traffic due to maintenance and installations.

With these environmental considerations in mind, enhancing a roof's performance and extending the life of a roof system may prove challenging. Cover boards are commonly used to provide mechanical and thermal enhancements to a roof system, and there are several options available. How do you choose one that optimizes performance and installed costs? This paper presents the results of field applications and laboratory investigations that demonstrate how Invinsa Roof Board by Johns Manville (JM) offers compelling reductions in weight and cost while still allowing for ideal performance and a variety of installation efficiencies.

A Case for Cover Boards

Cover boards have historically been used in bituminous roofing primarily as a substrate for hot applications. Approximately 95% of all BUR and SBS roofing include a cover board. NRCA Technical Bulletin 9 and 2000-3 recommends the use of a cover board in all low-slope membrane roof systems to protect underlying insulation. With single ply growth, cover boards took on an additional purpose and have an increased importance. The single ply membrane is thin and flexible, and it lacks the multiple layers and structural integrity that protect against the elements, particularly external mechanical stresses.

Thus, cover boards are still a best practice for improving roof durability and performance for the life of the roof.

Invinsa and Invinsa® FR: Time-Tested Reliability and Expertise

In 2005, JM began commercializing Invinsa, a revolutionary product based on the company's 20 years of history and expertise in polyisocyanurate manufacturing.

Invinsa is comprised of high-density (HD) polyisocyanurate (polyiso) combined with coated glass facers (CGF) in a new form. It was developed to provide a lightweight alternative to gypsum cover boards.

Architects, specifiers and contractors generally agree that adding a cover board enhances the long-term performance of single ply roof systems, as well as cold-applied and self-adhering bituminous roof systems.

Invinsa FR, an extension of Invinsa, is the first of its kind in the HD polyiso product category and is capable of achieving a UL® Class A fire rating over a combustible roof deck in single ply roof systems.

Invinsa and Invinsa FR offer customers several advantages, including:

- Extended long-term performance of single ply systems with greater impact resistance and durability
- At less than one-third the weight of gypsum cover boards, Invinsa keeps five tons of dead weight off the roof for every 100 SQs compared to the same thickness of gypsum
- Faster, easier and more cost-efficient installation with lower adhesive usage and no priming required

- Mineral-surfaced, fiber glass-reinforced facers for excellent water resistance
- Easy and (virtually) dust-free cutting
- Ergonomic design for convenient handling during installation
- Lower transportation costs with over 900 SQs of Invinsa per truckload compared to less than 400 SQs per truckload for the same-thickness gypsum

Ron Malekow, contractor and vice president of Howard Roofing Company, Inc., needed an energy-efficient, fire-resistant system for his company's new facility, so he turned to JM for the solution. "The Invinsa FR Roof Board provided the strength, flexibility and light weight we needed, while also giving me the peace of mind knowing we were achieving a Class A fire rating," Malekow said.

Understanding ASTM C1289 for Cover Boards

As of 2012, HD polyiso cover boards received their own Type, Class and Grade designation under ASTM C1289. This ASTM is the Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board. The roofing design community now has a standard to reference in their specifications for HD polyiso boards.

Invinsa is part of ASTM C1289 Type II, Class 4, Grade 3. The grades refer to various compressive strength minimums. Grade 1 is a minimum 80 psi compressive strength. Grade 2 is a minimum 110 psi compressive strength. Grade 3 is a minimum of 140 psi compressive strength. Because these are minimum compressive strength requirements, Grade 3 meets the requirements of Grades 1 and 2, and Grade 2 meets the requirements of Grade 1.

Invinsa is the only HD polyiso cover board that meets the requirements for Grades 1, 2 and 3. Invinsa provides the right amount of compressive strength to protect a roof from fracture caused by hail, damage from foot traffic and heavily loaded carts, and to provide puncture resistance from dropped hammers and other tools. Invinsa remains the leader for HD polyiso cover boards in terms of protection, with an average compressive strength of 150 psi. See the table below for details on additional ASTM physical property requirements for HD polyiso cover boards.

HD Polyiso Cover Boards – ASTM C1289 Type II, Class 4

Property	Grade 1	Grade 2	Grade 3	Invinsa 1/4"
Compressive Strength - psi, min.	80	110	140	140 min (150 avg.)
Dimensional Stability - % Linear Change, max	1.0	1.0	1.0	<0.6
Dimensional Stability - % Thickness Change, max	4.0	4.0	4.0	<4.0
Flexural Strength - psi, min.	400	400	400	1500
Break Load - lbf, min.	20	20	20	25
Tensile Strength - psf, min.	2000	2000	2000	>2000
Water Absorption - % Vol, max	2.0	2.0	2.0	2.0
Water Vapor Transmission - perm, max	1.5	1.5	1.5	<1
Minimum Thermal Resistance @ 75 +/- 2°F	1/4" - 1.0 1/2" - 2.0	1/4" - 1.0 1/2" - 2.0	1/4" - 1.0 1/2" - 2.0	1.2 avg.

See Reference 1.

It may appear cumbersome for the roof designer to use the full ASTM designation (Type, Class and Grade) for a product. However, doing so ensures that the designer will actually get the products and performance required.

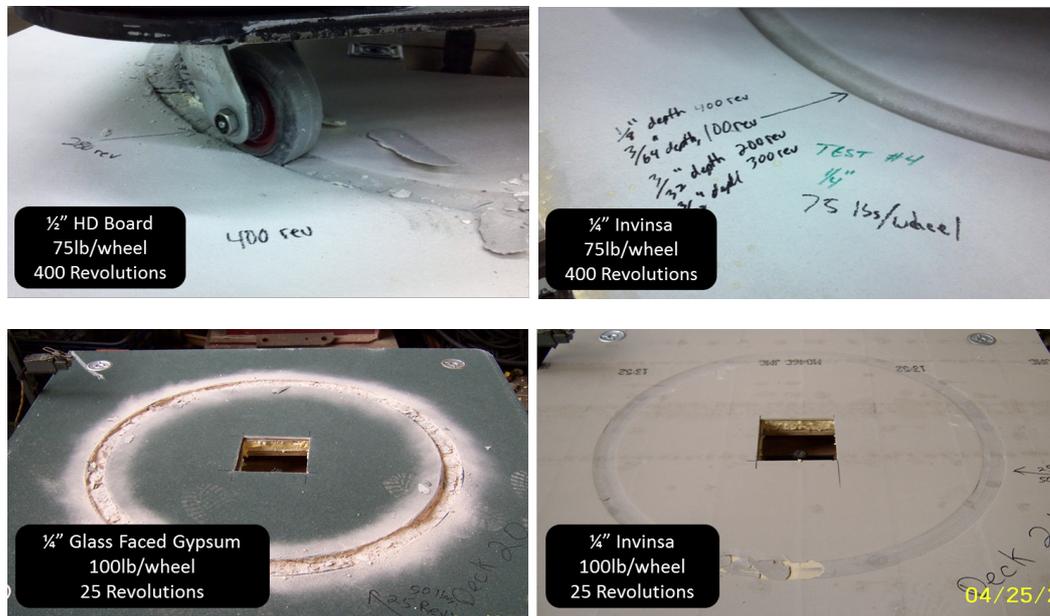
Advantages for Building Owners and Specifiers

For building owners as well as specifiers, architects and consultants (owner representatives), the challenge is finding technically superior, reliable materials to maximize the life of the roof system.

Strength and Durability: In order to differentiate between HD polyiso and gypsum cover boards, JM went outside the roofing industry to the experts in the flooring industry for an applicable test method to evaluate the ability of the boards to withstand rigorous traffic.

To differentiate between cover boards, an independent third party from the flooring industry conducted the Robinson-type floor tester test method on Invinsa, gypsum and other HD polyiso boards. The Robinson-type floor tester is an ASTM test method (C627) performed in the flooring industry to test the ability of flooring systems to withstand traffic.

NTA, Inc., in Nappanee, Ind., performed this test on Invinsa, ½" HD polyiso, and ¼" glass-faced gypsum. The results show Invinsa resisted damage 2.4 times longer than ½" Grade 2 HD polyiso at 75 pounds per wheel, and seven times longer than ¼" glass-faced gypsum at 100 pounds per wheel. Grade 3 Invinsa provides greater protection and durability against foot traffic and heavily loaded carts than other HD polyiso and gypsum cover boards.



See Reference 2.

Grade 3, 140 psi minimum compressive strength is a key differentiator for Invinsa HD polyiso cover board, providing greater protection and durability from the damaging effects of traffic compared to other HD polyiso and glass-faced gypsum cover boards.

Puncture Resistance: An important factor affecting the performance of roofing systems is the ability to resist puncture loads, as demonstrated using ASTM D5635-04 Standard Test Method Dynamic Puncture Resistance of Roofing Membrane Specimens. This test method covers the evaluation of the maximum puncture load that roofing system samples can withstand, without allowing the passage of water, when subjected to impact from a rigid object having a sharp edge. The test method involves a roofing membrane test specimen, set on a thermal insulation substrate, including a cover board, and is subjected to an increasing impact load until maximum energy is reached before failure. A rigid, falling puncture head creates the load. Puncture of the test specimen is assessed by visual examination and verified by conducting a water-tightness test.

PRI Construction Materials Technologies, LLC, in Tampa, Fla., a third-party testing lab, evaluated how various HD polyiso boards stood up to puncture loads under JM PVC and JM TPO membranes. See the table below for comparisons on how Invinsa performed under this test versus other HD polyiso boards.

Membrane	Thickness (mil)	Board	Compressive Strength (psi)	Puncture Resistance (J)
JM TPO	60	Polyiso	20	12.5
		½" HD Polyiso	100	20
		Invinsa	140 (min.)	22.5
	80	Polyiso	20	20
		½" HD Polyiso	100	22.5
		Invinsa	140 (min.)	37.5
JM PVC	60	Polyiso	20	15
		½" HD Polyiso	100	15
		Invinsa	140 (min.)	27.5
	80	Polyiso	20	22.5
		½" HD Polyiso	100	20
		Invinsa	140 (min.)	35

See Reference 3.

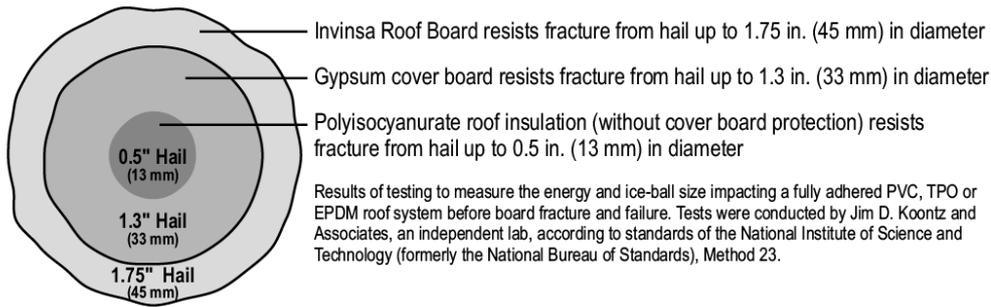
The data clearly shows that in every case, Invinsa, at Grade 3 with the highest compressive strength of HD polyiso boards, improves the durability of the membrane. The results also show that Invinsa provides the greatest impact performance of HD polyiso cover boards.

Impact Resistance: True impact protection is the result of achieving the right balance between compressive and flexural strength from a polymeric, non-brittle material. In the drive to make roofs last longer and provide better protection, JM used its knowledge of the science of integrating roofing system components to become the first to market with a cover board material unlike any other.

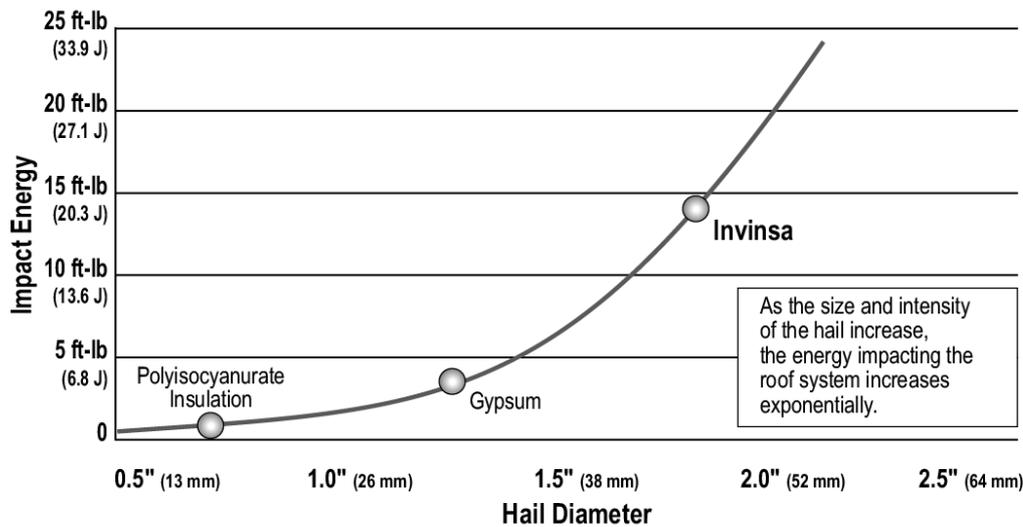
Invinsa's flexibility allows it to withstand environmental impacts such as hail. The driving force of this element can compromise the integrity and performance of the entire system, especially if the material beneath the membrane is fragile or subject to cracking, cratering or shattering upon impact.

In a hail impact resistance test conducted at Jim D. Koontz & Associates, Inc., an independent testing laboratory in Hobbs, N.M., Invinsa resisted fracture from hail up to 1.75" in diameter better than gypsum and low-density polyiso boards.

The right cover board increases a roof's ability to resist fracture from impact of hail.



System performance in fully adhered JM Single Ply Roofing Systems



See Reference 4.

Adjusting for the Elements: Invinsa provides long-term durability by adding a stabilizing component to the roof system. Invinsa works with fully adhered and mechanically fastened JM PVC, JM TPO and JM EPDM systems, as well as cold-applied and self-adhering bituminous systems, to meet certain FM Global® 1A-90 roof constructions. Invinsa will not rot. It will not dissolve. It will not support mold. What it will do is maintain its integrity under adverse weather conditions for the long-term enhancement of the roof system.

Water Absorption: With its mineral-coated, fiber glass-reinforced facers, Invinsa provides excellent water resistance. Invinsa's extremely low water absorption (a maximum of 2.0% by volume when tested according to ASTM C209) means fewer weather concerns during staging.

	1/4" Invinsa	1/4" Invinsa FR	1/4" Gypsum	1/2" Gypsum	5/8" Gypsum
Water Absorption – % vol Invinsa, % wt Gypsum	2% Max	4% Max	10% Max	10% Max	10% Max
Water Absorbed per 4' x 8' board – lbs	0.8	1.7	3.8 - 5.2	6.4 - 8.8	8.0 -10.2
Water Weight per 100 SQs – lbs	260	519	1,188 - 1,625	2,000 - 2,750	2,500 - 3,188

See Reference 5.

Gypsum absorbs and holds more water, so its weight, along with the added weight of the board, adds a lot of additional weight and unnecessary stress on the roof structure.

Weight/Roof Load Concerns: At less than one-third the weight of standard gypsum cover boards, every 100 squares of Invinsa keeps nearly five tons of dead weight off the roof when compared to the same thickness of gypsum. This is especially important on older buildings or re-covers where overall weight may be a concern.

	1/4" Invinsa	1/4" Invinsa FR	1/4" Gypsum	1/2" Gypsum	5/8" Gypsum
4' x 8' Board Weight – lbs	12	13	38 - 50	64 - 88	80 - 102
Weight per 1,000 SQs – lbs	37,500	40,630	118,750 - 157,000	200,000 - 275,000	250,000 - 318,750
Additional Weight on Roof			3x - 4x	5x - 7x	6x - 8x

See Reference 6.

Specifier John Hesslink’s Story: “There is now a far better way to get maximum performance out of your roof,” according to John Hesslink, president of Division 7 Design, Inc., and specifier of the Basalt Elementary School’s new JM EPDM roof system. “I was pleased to find a cover board that stands up to moisture as well as Invinsa does.”

For a project at Basalt Elementary School in Basalt, Colo., an Invinsa cover board provided an extra layer of protection between their thermal investment and the waterproofing membrane. Invinsa means peace of mind and long-term roof performance.

Advantages for Contractors and Distributors

For contractors and distributors, material cost isn’t the only thing that should be considered. Total installed cost is just as important a factor, and Invinsa is less expensive than gypsum from an installed-cost perspective. Invinsa’s light weight provides savings at every step of the project. From labor and installation to transportation, lighter cover boards mean greater ease of use, which translates to crucial cost savings.

Weight: A 4' x 8' (1.22 m x 2.44 m) sheet of 1/4" Invinsa weighs only 12 pounds (5.4 kg). That’s less than one-third the weight of the same-size sheet of 1/4" gypsum cover board. The benefit of being lightweight, combined with the other advantages of Invinsa, generates a host of installation cost savings.

Labor and Installation Efficiencies: Invinsa’s high-impact and flexural strength offers less breakage during handling, compared to gypsum, and increased resistance to damage from various sources, including foot traffic during the installation process. The need for oversized and more expensive equipment is eliminated due to the lighter weight material.

User Friendly: Invinsa’s board composition requires no additional priming and also provides a low-dust environment and smooth surface for better adhesion through a more even bond. Also, Invinsa’s closed surface requires less adhesive usage, while easy scoring and snapping permits fast and tight fabrications around roof penetrations. The Invinsa product is also easier to cut than gypsum, using just a standard blade, without additional instructions or tools.

Transportation Efficiencies: At a lighter weight than gypsum, Invinsa provides more squares per truckload. Fewer truckloads mean lower fuel costs. When loading the product, Invinsa’s weight makes it much easier to load than gypsum, resulting in less crane rental time and charges.

Cost Review: The following chart shows that despite Invinsa and Invinsa FR’s higher material cost in comparison to gypsum, gypsum’s overall transportation and equipment costs result in a more expensive job.

1,000 SQ Mechanically Fastened Single Ply System

	1/4" Invinsa	1/4" Invinsa FR	1/4" Gypsum	1/2" Gypsum	5/8" Gypsum
Material Cost SQ	\$46	\$52	\$43	\$54	\$56
Job Material Cost	\$46,200	\$51,920	\$42,900	\$53,900	\$56,100
Trucks	2	2	4	6	8
Fuel Charge	\$350	\$350	\$700	\$1,050	\$1,400
Number Pallets	104	104	63	104	130
Hoisting - Forklift/Crane Hrs.	5	5	17	28	35
Boom Truck/Crane Cost	\$900	\$900	\$3,060	\$5,040	\$6,300
Loading Person/Hrs.	9.26	9.26	33.33	55.56	69.44
Loading Cost	\$556	\$556	\$2,000	\$3,333	\$4,167
Staging Person/Hrs.	13.89	13.89	50.00	83.33	104.17
Staging Cost	\$833	\$833	\$3,000	\$5,000	\$5,417
Installation Person/Hrs.	65.00	65.00	120.00	120.00	120.00
Installation Cost	\$3,900	\$3,900	\$7,200	\$7,200	\$7,200
Detail Person/Hrs.	20.00	20.00	26.60	26.60	26.60
Detail Cost	\$1,200	\$1,200	\$1,596	\$1,596	\$1,596
Waste Cleanup Person/Hrs.	20.00	20.00	26.60	26.60	26.60
Waste Cleanup Cost	\$1,200	\$1,200	\$1,596	\$1,596	\$1,596
Total Cost	\$55,139	\$60,859	\$62,052	\$78,715	\$83,775

**This chart denotes the typical distributor costs and \$60/hr. labor costs.*

This chart clearly shows that Invinsa can save \$7 per SQ on total installed cost.

Conclusion

JM's history in roofing and the data provided in this article demonstrate that Invinsa provides a durable, low-risk solution for reducing the cost and weight of roofing applications. Invinsa provides compelling high performance and durability, as well as cost, time, labor and weight reductions compared to alternative cover board materials. Additionally, there is added peace of mind in knowing Invinsa is backed by the JM heritage of innovation and more than 150 years of product expertise and support. Owners, owner representatives, distributors and contractors alike are assured that Invinsa FR, an extension of Invinsa, is also the first of its kind in the HD polyiso product category. Invinsa FR is capable of achieving a UL Class A fire rating over a combustible roof deck in single ply roof systems, providing an alternative to gypsum cover boards in these applications.

For owners and owner representatives such as specifiers, architects and consultants, the Invinsa product line offers a technically superior material and advantages such as:

- Strength and durability
- Impact resistance
- Water absorption
- Less weight per board versus gypsum, alleviating weight/load concerns

The benefit is a more durable roof that will ensure maximum value over the life of the roofing investment.

For distributors and contractors, Invinsa offers cost savings and ease of use at every step of the project. Key advantages include:

- Long-term performance
- Less weight per board
- Labor and installation efficiencies
- User friendly
- Transportation efficiencies

The benefit is easier and faster installation, with lower installed costs.

Quite simply, Invinsa's properties result in easier installation, transport and better roof performance in the long term.

References

1. ASTM C1289-12 Standard Specification for Type II, Class 4 Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
2. The Robinson-Type Floor Tester Test. Testing performed at Smith-Emery Labs in Los Angeles, Calif., April 2006, and NTA, Inc., in Nappanee, Ind., March 2013.
3. Puncture Load Test, PRI Construction Materials Technologies, LLC, in Tampa, Fla. (test method ASTM D5635), September 2013.
4. Hail Impact Resistance Test, Jim D. Koontz and Associates, Inc., (independent lab), August 2005.
5. Water Absorption: Data sourced from manufacturers' technical data sheets.
6. Roof Load Concerns Chart: Data sourced from manufacturers' technical data sheets.
7. Job Size Cost Chart: Howard Roofing analysis (side-by-side job comparison study from the University Avenue project and Hathaway projects in California), August and September 2013.

To learn more about Invinsa and Invinsa FR, and to review supporting materials such as installation details, data sheets, application instructions and specifications, please visit the Commercial Roofing [page](#) on the JM website (www.jm.com).



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