

A Not-So-Perfect Storm: The Convergence of Large Buildings, Wood Decks, and Mechanically Attached Low-Slope, Single-Ply Roofing Systems

By Richard Gustin; Rob Hughes, CDT

INTRODUCTION

Construction materials, techniques, and needs are ever evolving, driven by a multitude of factors. OSB has become a common building material due to its availability and favorable cost. In the western US, wood decking has long been a preferred roofing substrate in commercial construction, with plywood being common for the last 50 years. More recently, OSB decking has started replacing traditional plywood while, simultaneously, mechanically attached single-ply roof systems continue to gain popularity for similar reasons. At the same time, how Americans purchase and receive products has evolved significantly, with exceptionally large distribution warehouses becoming a standard part of the retail supply chain. Significantly larger structures, wood decks, and mechanically attached single-ply systems have all been part of the construction industry for many years; however, the intersection of all three on a common project is a relatively new practice.

Given the growing perception of OSB as a cost-effective alternative to plywood decking, there are recent signs to suggest that in some situations, mechanically attached single-ply systems over OSB decking may encounter issues related to fastener withdrawal. Additional design considerations are necessary for the emerging environmental and dynamic challenges of these structures. This white paper discusses recent research regarding fastener performance in OSB decking for these specific warehouse applications and makes recommendations to effectively design and install a dependable roof system tailored to these buildings' needs.

REGIONAL CONSTRUCTION PRACTICES

Traditional/Typical Methods vs. Western Practices

Traditionally, across much of the US, roof systems have been installed with rigid foam board insulation in multiple layers, sometimes with a cover board over steel or concrete decking. The use of multiple insulation layers distributes stresses more evenly and provides increased thermal performance, which is necessary in much of the country.¹ Over this substrate, rigid bituminous systems or adhered single-ply roof systems have been installed with good results across a variety of different environments. Large temperature swings and cold winters throughout much of the country established the need to control vapor drive. Given that proper vapor-barrier installation requires installation over the roof deck, the vapor barrier often serves dual purposes as a temporary roof and a seal for the interior from the outside environment. Most importantly, for the purposes of this paper, vapor barriers can control airflow and help prevent the interior environment from interacting with the roof assembly.²

In the Western US, environmental conditions are much milder, and the access to and tradition of using wood from the Pacific Northwest in

Interface articles may cite trade, brand, or product names to specify or describe adequately materials, experimental procedures, and/or equipment. In no case does such identification imply recommendation or endorsement by the International Institute of Building Enclosure Consultants (IIBEC).

lieu of steel or concrete has largely remained common practice. While early construction used solid-wood boards through the 1950s, it was successfully replaced with plywood over time. Acknowledging that plywood is not as strong as steel, it has proven sufficient for the needs of applications in the western region, where built-up roofing (BUR) remained popular well after other parts of the country started migrating to single-ply systems.³ These BUR systems utilized mechanically fastened base sheets with evenly distributed points of contact at a relative high density. Given the rigidity of multi-ply fiberglass built-up roofs and the low wind speeds generally associated with most of the western region, performance was more than adequate, with long service life being the norm.

Given a milder climate, buildings in this region often used little to no insulation, and vapor barriers were not needed. As energy codes evolved, it became common to use fiberglass batt insulation in the joist space and occasionally a cover board or fanfold on the deck for industrial or warehouse applications.⁴ Even as single-ply systems became more common, this building practice remained in place with cover boards installed on the roof deck and thermal efficiency accommodated using fiberglass insulation. While vapor barriers have more recently been employed, it is often to serve a different purpose, such as controlling construction-generated moisture, protecting the structure from high moisture-generating activities, or serving as a temporary roof during construction.⁵

PROBLEM: WIND UPLIFT AND BUILDING PRESSURIZATION ISSUES ON LARGE WAREHOUSES

It's worth noting that the evolution of building construction practices based on regional differences is not uncommon in the construction industry as building requirements, materials, and techniques change. While there is nothing new about large tilt-up construction warehouses, OSB wood decks, mechanically attached single-ply roof systems, or proven traditional Western design and installation techniques, they appear to have come together under evolving environmental factors, resulting in some notable instances of fastener performance issues, even under moderate wind speeds. The following section will examine this further.

Environment

Throughout the US, large warehouses are currently being built outside of urban centers. These peripheral locations are advantageous for businesses because they offer proximity to major

cities and infrastructure at a much lower price than real estate within the city.⁶

These locations tend to experience more wind exposure because there aren't other buildings or obstacles nearby to help moderate or obstruct wind exposure. For isolated warehouses with large footprints and little to no buffer, this exposure subjects the roof system to heightened dynamic pressures regularly.

Building codes and designs are tailored to account for regional weather patterns. Significant anomalies in the weather can place buildings in environments that codes haven't accounted for and that building components were not designed to withstand. Consider the Texas power crisis in 2021, when major winter weather caused significant damage to buildings and refineries in the Gulf region because infrastructure was not designed to withstand such extreme weather events.⁷ These weather anomalies are occurring with increasing frequency and intensity, challenging codes and standards with weather extremes that are becoming the new normal.⁸ Ultimately, material and installation practices that may have been sufficient for historical weather patterns may now be insufficient for the type of extreme weather conditions more recently witnessed.

Structure

In tilt-up construction, structural components supporting the roof deck are bolted to the precast walls. This attachment detail typically leaves a gap between the deck and the wall that can allow air to flow through. Since there is little to no partitioning in a warehouse, bay doors can channel a substantial amount of unobstructed airflow into the warehouse when left open. The path of least resistance for this air to escape is through the gaps between the roof deck and wall and at penetrations in the structural deck.

In this scenario, the warehouse acts as a large common plenum, allowing air pressure within the structure to build up. The air could exploit gaps in the roof deck, resulting in air pressure building against the roof membrane.

Insulation

Rigid polyisocyanurate insulation (ISO), which is typically installed in two offset layers, has a substantially greater ability to moderate airflow and provide resistance to air pressure than fiberglass batt insulation. ISO not only serves as an insulator but also provides airflow restriction. Comparatively, the composition and typical installation method of fiberglass allows for less obstructed internal air pressure to reach the roof membrane.

Materials and Attachment

Typically, BUR roofs installed over wood decking utilize a 3 ft wide base sheet. The base sheet is attached with four to five rows of fasteners evenly spaced across the sheet, creating thousands of points of contact with friction acting as a glue, dispersing forces evenly on the OSB deck; asphalt bleed-through in the base sheet adds a minor adhesive bond. With this type of installation, OSB has demonstrated successful capability as a roofing substrate.

Since OSB had a long history in building construction and performed effectively in BUR systems, one may assume that replacing plywood with OSB would have similar results with single-ply systems. However, most single-ply systems utilize sheets that are 8 ft wide or more and are fastened with only one row of fasteners per sheet.⁹ As a result, each fastener is required to withstand substantially more uplift force. Additionally, over-torquing or over-tightening fasteners, which can occur with all deck types, can reduce fastener pullout resistance.

Design and Construction

Steel deck construction benefits from the availability of thousands of different roof systems that have been tested and approved by independent agencies. Wood decks, often being used for light commercial applications or in the western region where lower wind speeds are common, have not been similarly vetted. As a result, there are few plywood- or OSB-specific assemblies that have been tested, leaving many designers to extrapolate required fastening rates from existing steel deck codes and approvals.¹⁰ The different material properties between steel and wood can lead to fastening rates that may not match project requirements in certain applications. The performance capability of steel, coupled with the availability of tested systems, leads both installers and designers to sometimes use systems that far exceed the actual wind uplift requirements of the building; this, however, may not always be the case with OSB when examining its performance in large warehouse applications.

The warehouses in question utilizing these roof systems have also grown tremendously in size. The guideline of using two or three half sheets as a perimeter/corner enhancement has worked well on traditional projects, generally less than 350 squares. Now, with projects commonly reaching a 5,000- or even exceeding 10,000- square size, enhancements typical for smaller buildings are inadequate. ASCE 7 calculations would dictate perimeter widths out to 16 to 30 ft, with four to six sheets being a typical requirement. Considering pressure resulting from open warehouse dock doors,

the required enhancement zone could be greater still.

Large warehouse roofs, like most roof installations, are installed progressively, sometimes leaving wide areas of exposed decking subject to inclement weather during installation. As an "Exposure 1" classified material, OSB can be affected by long-term exposure to moisture during the construction process.¹¹

Moisture and subsequent drying can potentially cause OSB to become less resilient after prolonged exposure.¹² Specifically, it has been observed that pullout values can be degraded after extensive exposure of the decking to the outside environment and that fastening patterns based on new material may be suspect.¹³

Coupled together, external wind uplift forces and internal pressure from the large warehouse building structure can cause a combined effect where the wind is pulling the roof membrane away from the structure while the building pressure is simultaneously pushing it away.

Ideally, these combined forces are sufficiently managed by the materials and methods used in the construction process. However, in the western US, the shift to using OSB in conjunction with traditional wide-sheet in-lap mechanically attached single-ply fastening patterns may be more challenging to a roof system's wind uplift performance. The combined characteristics of the fastener and decking material may be insufficient to withstand the uplift forces on the

fasteners at the typical attachment rates. The supplemental safeguards that could offset this in the form of resilient steel decking, overdesign for uplift with tested assemblies, air control through vapor barriers, and multiple layers of insulation are routinely not present. In certain observed instances, roofs exhibited visual signs of being overstressed in the form of varying degrees of failure under what would typically be considered normal conditions.

RECENT OBSERVATIONS OF WIND- AND PRESSURE-RELATED FAILURES OF SINGLE-PLY ROOF SYSTEMS ON DISTRIBUTION CENTERS

In the western US, it has been observed that relatively new commercial warehouses with mechanically attached single-ply roof systems with OSB decking sometimes reveal damage (requiring repair or replacement) that cannot be attributed to any single significant weather event. More concerning is that these specific projects are not 15 to 20 years old with aged materials that have been repeatedly cycled, but rather relatively new projects less than 5 years old that have not seen many, if any, significant weather events. Damage specific to both external wind uplift and internal pressurization has been observed, as well as roof systems exhibiting failures related to both. The observed damage in these instances has varied from facility to facility and included a variety of different failure modes, such as fastener withdrawal, membrane

blowoffs, delaminated wall flashings, curbs separated from the deck, and holes in the deck.

The most noteworthy thing about several of these instances of system failure is that they could not be attributed to a major weather event. The observed damage occurred in environments that experienced wind speeds that are less than 75 mph and, in some cases, at wind speeds less than 55 mph. The damage has included four to five significant blow-offs in the southwest region (California, Arizona, Nevada), including a 2,400-square loss in North Central California that occurred at wind speeds under 55 mph. Intermittent fastener withdrawal has also been observed, with one location reporting over 4,000 fasteners partially withdrawn on a single roof.

Observations of fastener withdrawal include multiple groupings of 20 to 50 fasteners per membrane lap and frequently the first 3 to 5 fasteners at the leading edge of the perimeter "finger" enhancements. It is possible that wind flutter on the 10 ft wide sheet under moderate winds may, over time, diminish pullout capacity at these enhancements. This issue has not been observed in steel decks with the same finger-style enhancement.

One specific project stood out and was the impetus to begin additional research on how fasteners are driven in the field. A three-building complex in the Southwest with induction-welded TPO exhibited varying levels of damage on each building, from nearly none to extensive loss of cover board and membrane (**Fig. 1**). The damage was not consistent with wind direction or any



FPO
High-res images to come



FIGURE 1. Extensive fastener withdrawal with no corresponding wind event.

FIGURE 2. Curb and skylight separation from the deck.

building features, and no evidence of a wind event was present on the surrounding grounds. The fastening pattern was relatively robust, with perimeter and corner enhancement present. The areas of damage were random, with the field, perimeter, and corners all affected. While maximum wind speeds were recorded as only 45 mph, certain sections lost all their fasteners, and no spalling damage was evident in the OSB decking. The fasteners pulled out cleanly.

Some large warehouses also sustained roof system damage that suggested that building pressure was a contributing factor. In these facilities, the warehouse is generally a large, unconditioned space with numerous dock doors. To improve temperature conditions within the facility, workers frequently leave the dock doors open. Under the right circumstances, this can cause the warehouse to pressurize, even under light to moderate winds.

A 3,900-square facility in North Central California was documented with skylights, HVAC, and various smaller curbs separated from the deck (Figs. 2 and 3). The membrane did not appear to cause this damage. Holes were observed in the OSB decking at numerous locations as if internal pressure had pushed through it. Backed-out fasteners were observed not at the perimeter or corners where pressures are highest but rather in the field of the roof.

Another 1,670-square facility in the Southwest had wind damage to the interior, including a garage door that was distorted and bent towards the interior of the building (Fig. 4). Winds were

recorded at 64 mph. No obvious causes were evident at the building or roof level, and the door was rated to withstand wind speeds over 100 mph.

While not a mechanically fastened system over OSB wood decking, a 1,000-square facility in South Central California with an adhered PVC roof over a steel deck experienced approximately 30 squares of damage in the field of the roof (Fig. 5). The membrane was bonded to ISO insulation, which fractured, leaving the fasteners intact; the membrane was still adhered to the boards. These observations are not consistent with a typical wind-related failure, which would generally initiate at the building perimeter or edge. In addition, the membrane would typically peel the facer off the board, leaving the boards otherwise intact. Investigation revealed that the facility had recently eliminated one passive gravity vent in the failure area. Additionally, the facility representative admitted that one bay door was often left open. These scenarios illustrate that real-world, daily building operations should be a material consideration when designing a roof system and the potential power of internal pressure in large warehouse structures.

Fastener Efficacy for Mechanically Fastened Single-Ply Roofing on Wood Decks

Wood structural sheathing choices for roof decking in West Coast warehouse building applications consist of either plywood or OSB.

Plywood is composed of multiple laminations of softwood veneers (plies) glued together under pressure with adhesive.¹⁴ OSB is composed of thin slices of rectangularly shaped wood strands pressed together in cross-oriented layers using heat-cured resin polymers.¹⁵ In the mid-twentieth century, plywood replaced solid-wood decking as the structural sheathing of choice. Similarly, OSB supplanted plywood in the late twentieth century, largely due to cost efficiency and wide availability.

While plywood and OSB are intended for the same applications and have similar properties, it is fair to conclude that the industry broadly adopted OSB based on the assumption of equivalent performance.¹⁶

The generally accepted minimum pullout resistance for mechanically attached membrane systems over any structural deck is 400 lbs. This standard applies to qualification for a manufacturer's typical guarantee of up to a 55-mph wind speed and should not be conflated with building code compliance or FM requirements.

Given the apparent lack of publicly available testing, research, or FM assembly approvals for mechanically attached membrane systems over OSB and plywood structural decks, our third-party testing sought to better understand the factors that may be contributing to observed fastener withdrawal failures.

Two types of tests were conducted:

- Fastener withdrawal testing per FM Approvals, Section 4.0: *Pull Out Tests for Fasteners/Roof*



FIGURE 3. Loss of rooftop curb due to possible internal pressurization.



FIGURE 4. Garage door damage showing distortion from winds at or below 64 mph.



FIGURE 5. Fractured ISO with fasteners and membrane intact.



FIGURE 6. Instron tensile testing machine.

Deck and Fasteners/Stress Plate or Batten Bar Combination Using Tensile Loading.

- Cyclic/dynamic wind testing per CSA A123.21:20: *Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems*

Fastener withdrawal was conducted on 4 x 4 in. samples to determine pullout values sorted by decking material, weathering of decking, fastener type, and properly torqued vs. over-torqued fasteners (**Fig. 6**)

The fastener withdrawal testing utilized the following sample types:

1. 1/2 in. OSB*
2. 15/32 in. CDX plywood
3. HD ISO over 1/2 in. OSB
4. Aged/weathered samples of the same 1/2 in. OSB, 15/32 in. CDX plywood, HD ISO over 1/2 in. OSB

*Testing involved one OSB material from a major manufacturer.

The overall goal of the test protocol was to account for several known variables encountered in roof installation.

- 15/32 in. CDX plywood samples were tested to provide a comparative reference point for the OSB.

- OSB combined with a cover board was tested because it is a commonly installed assembly in West Coast systems second only to OSB without a cover board.
- Testing of weathered/aged samples was conducted to determine what effect precipitation during construction may have on fastener performance.
- Fastener types. While #15 fasteners are recommended for use in wood decking, #14 fasteners are acceptable and commonly used; each sample type was tested with a #14 and a #15 fastener to gauge if there was any difference in performance based on the fastener type.
- Each sample and fastener type was tested to an overturned or over-driven condition to assess the impact of improperly calibrated screw guns on fastener withdrawal.

RESULTS

Results indicate that decking type and torque during fastener installation could have a significant impact on fastener withdrawal (**Table 1**). In the limited testing, only the 15/32 in. plywood exceeded the 400 lb. minimum when paired with the recommended #15 fasteners. In the limited testing, OSB fell well below

the minimum in both fastener scenarios. Additionally, the limited testing indicated that fastener choice may matter. Broadly, #15 fasteners outperform #14 fasteners in most cases.

It is important to note that **all** of the sample types we tested, with the exception of 1/2 in. OSB yielded pullout values with a maximum of 20% deviation within the three-sample test protocol. In the limited testing, OSB often required four or more samples to meet the required data set. As such, preliminary testing suggested that there may be inconsistencies in the properties of the OSB material tested.

Curiously, the limited testing indicated that aging of the OSB had the opposite effect than expected—it actually improved pullout resistance test results. Additional testing, however, is needed to further understand how OSB properties are affected by weather events.

The increased pullout values observed in the limited testing between HD ISO over 1/2 in. OSB compared with 1/2 in. OSB are notable, and this observation lends itself to additional investigation to determine whether the HD ISO acts as a cushion or positive stop, preventing even minor overturning of the fastener.

Finally, the limited testing data suggests that over-driving fasteners may be problematic

TABLE 1. Comparison of withdrawal values for various fastener/torque/deck combinations

Fastener	Fastener Torque	Substrate	Maximum Load (lbf)					
			1	2	3	Avg.	Sd Dev	CoV
JM All-Purpose Fastener	Proper	15/32" CDX Plywood	390	310	393	364	47	13
		1/2" OSB	206	179	206	197	16	8
		HD ISO over 1/2" OSB	380	297	416	365	61	17
		Aged 15/32" CDX Plywood	245	313	235	264	43	16
		Aged 1/2" OSB	260	205	281	249	39	16
		Aged HD ISO over 1/2" OSB	399	373	283	351	61	17
JM High-Load Fastener	Proper	15/32" CDX Plywood	462	447	455	455	8	2
		1/2" OSB	221	273	229	241	28	12
		HD ISO over 01/2" OSB	326	397	382	368	37	10
		Aged 15/32" CDX Plywood	346	347	463	385	67	17
		Aged 1/2" OSB	314	403	387	368	47	13
		Aged HD ISO over 1/2" OSB	278	315	345	313	34	11
JM All-Purpose Fastener	Overturn	15/32" CDX Plywood	162	154	164	160	5	3
		1/2" OSB	153	142	99	131	29	22
		HD ISO over 01/2" OSB	220	129	167	172	46	27
		Aged 15/32" CDX Plywood	226	198	217	213	14	7
		Aged 1/2" OSB	157	131	166	151	18	12
		Aged HD ISO over 1/2" OSB	181	129	164	158	26	17
JM High-Load Fastener	Overturn	15/32" CDX Plywood	415	400	525	447	68	15
		1/2" OSB	129	141	107	126	17	13
		HD ISO over 01/2" OSB	183	130	142	152	28	18
		Aged 15/32" CDX Plywood	169	218	166	184	29	16
		Aged 1/2" OSB	51	126	74	83	39	46
		Aged HD ISO over 1/2" OSB	256	344	216	272	66	24

in OSB, and screw guns in the field should be regularly and properly calibrated to avoid over-driving.

Both cyclic and static testing were performed on a 60 mil TPO membrane mechanically fastened over a 1/2 in. OSB deck.

Cyclic or dynamic wind uplift testing was conducted to simulate wind gusts to investigate the fastener withdrawal-induced failure point for a mechanically attached TPO membrane and to gauge the effect on fastener pullout values over time under cyclic wind loading. The testing was

conducted using the CSA A123.21 test apparatus over a 12 x 24 ft specimen of mechanically fastened 60 mil TPO over a 1/2 in. OSB deck. The attachment rate was set to simulate a 10 ft sheet fastened 6 in. on center, a typical system for the west region. Nine baseline pull values were

TABLE 2. Withdrawal resistance of JM TPO membrane fasteners in OSB decking

Gust Loading Interval	Cycle Count	Target Pressure	Maximum Load (lbf)			
			Row A	Row B	Row C	Avg.
1	500	0-25 PSF	290	561	346	399
2	500	0-28 PSF	174 ¹	341	35 ²	183
3	500	0-30 PSF	309	383	370	354
4	500	0-32 PSF	328	417	292	346
5	500	0-35 PSF	267	96 ²	330	231
6	3	0-40 PSF	356	222	Fail ³	289

Notes: 1) Plate deformation observed
2) Fastener visually withdrawn, incompletely from deck
3) Complete detachment of fastener row observed; test terminated prior to completing 500 cycles

TABLE 3. ANSI/FM 4474 wind uplift results

Target Pressure	Duration of Loading	Results
15 PSF	60s	Pass
30 PSF	38s	Fail ¹

Notes: 1) Fastener withdrawal observed during loading

harvested from sample fasteners driven into the sample OSB deck prior to the start of testing, which averaged 294 lbs.

Five complete gust loading intervals of 500 cycles each were conducted. The target pressure for the first interval was 25 PSF, with pressure increased incrementally to a target of 35 PSF for interval #5. The failure occurred three cycles into Interval #6, with a target pressure of 40 PSF. At the conclusion of each interval, visual observations were recorded, and pull values were harvested from one fastener from each of the three center seams utilizing a different fastener location per seam per interval.

Table 2 above shows the observations and pull values for each cycle.

A static test, ANSI/FM 4474, was also conducted on an identically constructed specimen to establish a reference point. In the limited testing, the failure occurred below the FM testing standard of 60 PSF for mechanically attached single-ply membrane roof systems (Table 3).

The results from each of these three tests suggest that cyclic wind loading can be a contributing factor that can compromise fastener pullout resistance. Additionally, OSB

material variability in our testing sample is evident from the wide range of pull values throughout testing and the number of cycles specific fasteners could withstand.

DESIGN CONSIDERATIONS, INSTALLATION BEST PRACTICES, AND REPAIR PROTOCOLS TO REINFORCE ROOF SYSTEM RELIABILITY

Our limited testing and observation suggest that mechanically fastened single-ply systems on an OSB deck may require special considerations for roof design and planning.

Design

Building design is central to the success of every roof installation. In light of our limited test results for mechanical fastening in OSB decks, it is our view that design professionals should consider utilizing the following steps during the design process:

- Increasing the perimeter width: Designing in accordance with ANSI-SPRI RP-4 Wind Design Standard for Ballasted Single-Ply Roofing Systems increases the perimeter of the roof further into the field in areas with

dock doors. Install half-sheet enhancements in accordance with ASCE 7 calculated perimeter width.

- Reducing sources of flutter: Designers should look for areas where they can reduce flutter and stress on the individual fasteners. For example, avoiding finger-style enhancements in favor of traditional picture framing reduces the loads on the individual fasteners caused by sheet flutter.
- Control for unwanted air movement: Finding ways to use the design to preemptively address unwanted air movement in large, open buildings may prove to be an effective approach for reducing the internal pressure on the roof itself. Sealing the perimeter roof-to-deck interface and penetrations throughout the roof area should be considered. Another example of this could be one-way vents at the roof level to relieve over-pressurization.

Materials & Installation

Selecting appropriate materials for the application and using installation methods that work best with those selected materials will have an impact on the long-term success and resiliency of a roof system:

- Sheet width: Consider narrow sheets to reduce membrane flutter; 8 ft sheets put less stress on the fasteners.
- Attachment rates: Use induction-welded systems with equally spaced plates and screws throughout in lieu of in-seam linear fastening. Traditional in-seam fastening with large-width sheets (10 ft) should not be done with OSB.
- Fasteners: Select the best fastener for the materials and ensure that fasteners are not over- or under-tightened. The use of #15 fasteners appears to enhance pullout resistance.
Fastener design: There is likely an opportunity for a dedicated fastener with thread depth and pitch to reflect the needs of plywood and potentially OSB substrates.
- Cover board: An additional layer can moderate airflow to the membrane and reduce the risk of overdriven fasteners.

Best Practices

- Conservative calculations: Exercise caution when using steel deck-based system assembly information for projects with OSB decking.
- Facility operations: Facilities should be cognizant of the impact that open bay doors can have on the building pressure and the potential damage it can cause to the roof.

- Pullout testing: Every project should have pullout testing once the deck has been installed and again if it has been weathered during the construction process. Perform fastener withdrawal testing at the point of installation and adjust fastening rates based on actual pullout values.
- Testing: The industry needs more wind testing that reflects today's construction methods.

Damage Remediation

If or when damage occurs, it's important to revisit the design standards and best practices outlined above. Each failure is unique and requires rigorous review and input by all stakeholders, such as consultant, owner, manufacturer, and contractor, before embarking on repairs to ensure safety and to reestablish roof system performance.

CONCLUSION

That old saying, assume nothing and question everything, might be the best place to start when considering mechanical fastening in OSB roof decking for large warehouse structures. Weather and building dynamics are evolving. Whereas oversized systems installed over steel decking might allow for a less rigorous review before installation, the decision to use mechanical fastening in OSB requires close attention by all parties from planning through installation. Balancing design and value engineering is especially important. In particular:

- Future weather extremes must be considered. Attention to system selection, fastening rate, and layout is imperative.
- Extrapolation based on other tested systems should be especially conservative and always validated with actual withdrawal testing results.
- Controlling airflow within the structure by sealing gaps in the roof deck and ensuring the OSB is not left exposed during construction should be considered standard practice.
- Ensuring that roofing mechanics are trained and attentive to proper fastener torque is critical to successful installation.

Large warehouses with mechanically attached single-ply roofs and OSB decks are here to stay. It is incumbent on the roofing community to apply the skills, experience, and judgment we already possess to ensure delivery of resilient, high-performance results. 

REFERENCES

- 1 Marcin Pazera, Ph.D. "Improved Commercial Roofing Performance with Staggered Insulation Layers." Roofing Magazine. 2019. <https://roofingmagazine.com/improve-commercial-roof-performance-with-staggered-insulation-layers/>
- 2 Baskaran, B.A., Molleti, S., Booth, R.J. "Understanding Air Barriers in Mechanically Attached Low Slope Roofing Assemblies for Wind Uplift." Proceedings of the 3rd International Building Physics Conference. NRC Publication. 2006. <https://nrc-publications.canada.ca/eng/view/accepted?id=b6d07dd5-96d0-4901-b70c-e4d2e31a6a84>
- 3 Fricklas, Richard. "It All Starts with The Roof Deck." Buildings Magazine. 2010. <https://www.buildings.com/industry-news/article/10191305/it-all-starts-with-the-roof-deck>
- 4 Taylor, Thomas. "Cool Roofs on The West Coast: Has Roofing Science Been Up to The Task?" IIBEC. 2017. <https://iibec.org/cool-roofs-west-coast-roofing-science-task/>
- 5 Hutchinson, Thomas. "Vapor Barrier" Roofing Magazine. 2014. <https://roofingmagazine.com/vapor-retarders/>
- 6 Allegro Realty. "The 3 Most Common Locations for Logistics Commercial Properties." 2023. <https://allegrorealty.com/articles/the-3-most-common-locations-for-logistics-commercial-properties>
- 7 Lee, CC., Maron, M. & Mostafavi, A. "Community-scale big data reveals disparate impacts of the Texas winter storm of 2021 and its managed power outage." Humanit Soc Sci Commun 9, 335.2022. <https://doi.org/10.1057/s41599-022-01353-8>
- 8 Price, Asher. Sechler, Bob. "Winter Storm Blackouts Plagued Texas in 2011, Too. Recommendations Made Afterwards Went Unenforced." USA Today. 2021. <https://www.usatoday.com/story/news/nation/2021/02/18/state-energy-winter-protections-lacking-reports-have-suggested/4490501001/> <https://www.sciencedirect.com/science/article/pii/S2214629621001997>
- 9 Fisher, James. Sputo, Thomas. "Are Your Roofing Membranes Overstressed?" Interface Magazine. 2018. <https://iibec.org/wp-content/uploads/2018-07-fisher-sputo.pdf>
- 10 FM Approvals. Roof Nav Assembly Search. 2005-2023
- 11 Fisette, Paul. "Choosing Between Oriented Strandboard and Plywood." University of Massachusetts Amherst. Department of Environmental Conservation. <https://bct.eco.umass.edu/publications/articles/choosing-between-oriented-strandboard-and-plywood/>
- 12 EPA. "Moisture Control Guidance for Building Design, Construction, and Maintenance." 2013. <https://www.epa.gov/sites/default/files/2014-08/documents/moisture-control.pdf>
- 13 Graham, Mark. "Plywood or OSB?" NRCA Professional Roofing. 2021. <https://www.professionalroofing.net/Articles/Plywood-or-OSB-04-01-2021/4853>
- 14 Scalisi, Tom. Franco, Michael. "13 Things All DYIers Should Know About Plywood." Bob Villa. 2021. <https://www.bobvila.com/articles/plywood-sizes-and-types/>
- 15 NA. "Oriented Strand Board (OSB). The Fabrication, Uses, Performance and Sustainability of Oriented Strand Board (OSB)." Naturally Wood. 2023. <https://www.naturallywood.com/products/oriented-strand-board/>
- 16 Groom, Sean. "Plywood Vs. OSB" Green Building Advisor. 2005. https://www.greenbuildingadvisor.com/app/uploads/sites/default/files/Plywood-vs-OSB_FHB169.pdf

ABOUT THE AUTHORS



RICHARD GUSTIN
JOHNS MANVILLE,
DENVER, COLORADO

Rick Gustin started his career as a roofing contractor before coming to Johns Manville (JM) in 1998, where he served as a field technical representative. He then held various roles, including technical services specialist, Six Sigma Black Belt, and application engineer before assuming responsibility as manager of Guarantee Services. In 2013, he became the EPDM product manager focusing on developing JM's offering. Today, Rick is the Owner Services Technical Manager responsible for large claims and technical marketing support. He holds a degree in mechanical engineering from Rensselaer Polytechnic Institute.



ROB HUGHES, CDT
JOHNS MANVILLE,
DENVER, COLORADO

Rob Hughes, CDT, joined Johns Manville (JM) in 2019, building on 25 years in the general contracting and commercial roofing industries. His roofing career has included estimating, operations, roof evaluation, contract administration, and project management. As part of JM's Owner Services team, he provides internal technical training and support. Externally, Rob engages directly with building owners and property managers related to the lifecycle of the installed JM-guaranteed roof systems. Rob holds a CDT certification from CSI, 10- and 30-hour OSHA safety certifications, and is pursuing his Registered Roof Consultant accreditation from IIBEC.