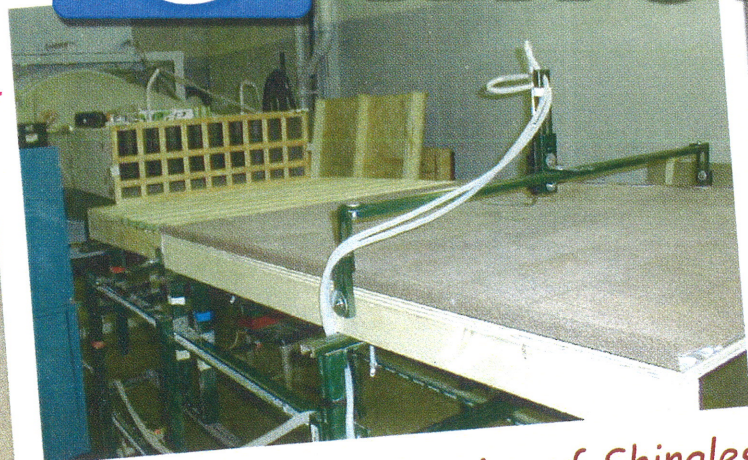




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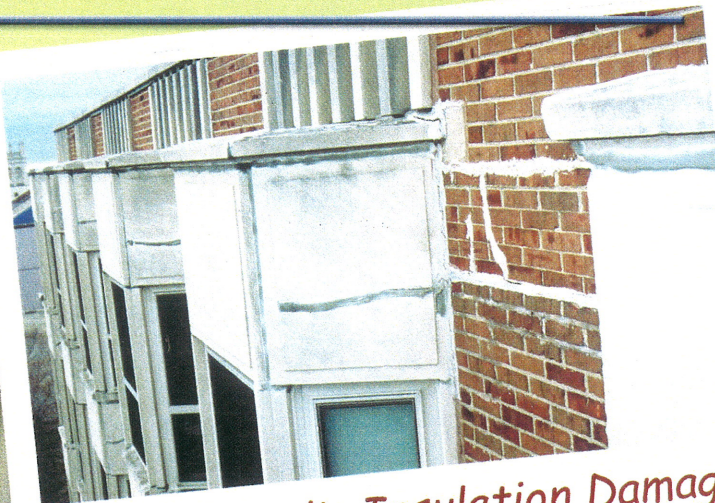


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Phenolic Insulation and the Building Envelope

By Don Kilpatrick and Michael G. Taylor, Esq.

This article discusses recent findings suggesting that, in the presence of phenolic insulation, the integrity of structural steel components such as shelf angles and brick ties may be compromised. The sampling and subsequent testing of these materials has established a chemical link between the phenolic insulation and the observed volumetric expansion, corrosion, and failure of these building envelope support mechanisms. As a result, costly wall repairs may sometimes be required in conjunction with re-roofing. Also presented are the legal effects of these findings and the potential recourse against the manufacturers of phenolic insulation that may still be available to building owners.

REVIEW

Most are aware of the well-documented, less-than-desirable characteristics of phenolic insulation when interfaced with structural steel roof decking. Millions of square feet of existing roof systems have been removed to facilitate steel deck remediation, overlay, and in some instances, replacement, due to the corrosion that has occurred because of the known acidic properties of the insulation.

In recognition of the problem, the two manufacturers of the product initiated class action settlements to accommodate the anticipated flood of claims. Due notice was provided through a media blitz that included newspapers, magazines, and television ads, educating and advising building owners of the potential problems associated with phenolic products. Both manufacturers presented case studies demonstrating the varied levels of corrosion that could be expected. They also offered economic data suggesting that the financial burden of the costly re-roofing should acknowledge depreciation or useful life of the existing assembly. Their efforts satisfied the court, and an agreement or settlement class was derived.

Building owners who were fortunate enough to opt out of the class put themselves at an advantage, such that they could potentially improve their settlements beyond that offered within the class. The settlement terms are clear in presentation as they relate to eligibility requirements. These requirements are largely based on the type and arrangement of roof system components in the assembly. For example, phenolic-installed, direct-to-steel deck in either built-up or single-ply configurations would be considered an eligible claim (Photos 1 and 2). In contrast, the manufacturers have turned a blind



Photos 1 and 2 – A contrast in conditions is apparent and can be expected when phenolic insulation is installed over structural steel decking.

eye to some steel deck installations that incorporated a vapor retarder. The presence of the vapor retarder is cited as providing adequate protection for the steel deck. Moreover, specific to discussion in the body of this paper, the settlement terms state in part that, "the following persons are not included in the settlement classes:...(b) persons whose roof system and roof deck are entirely non-metal."

It is widely accepted that, in the presence of moisture, the corrosion is decidedly worse. This suggests that the moisture is the vehicle or transport mechanism for the acid from the insulation to the underlying steel deck. Those familiar with the phenomenon are quick to recognize the broad spectrum and wide variability of corrosion that can be expected. A sharp contrast of conditions, ranging from severe rust to near pristine conditions, has been observed adjacent to one another in the field of the roof (Photo 3). In most instances, the insulation installed in areas of severe localized corrosion is laden with moisture. As would be expected, the level of corrosion varies as the insulation component moves toward its equilibrium moisture content, or that determined by the service environment and ambient conditions.

The following discussion presents our observations and findings made on two phenolic projects. The first project was initially con-



Photo 3 – The protection offered by a vinyl vapor retarder at this inspection opening is questionable, as the deck conditions presented no more than one foot apart ranged from near pristine to severely corroded.

sidered a routine, "within-the-class" claim with phenolic insulation installed over steel deck, vapor retarder inclusive. The second project began as a façade inspection required by municipal code.

PROJECT NO. 1

On a recent re-roofing project, driven by the presence of phenolic insulation, it was noted that some above-roof sheet metal accessories were exhibiting

varied levels of corrosion. More specifically, galvanized cap and counter-flashing (items not in direct contact with the offending material) were corroding. These components of the assembly were installed in conjunction with the built-up roof system as part of the original 1989 construction. The measured interior relative humidity of the manufacturing facility was 62%, and the building was pressurized. The roof system consisted of the following components from the deck up:



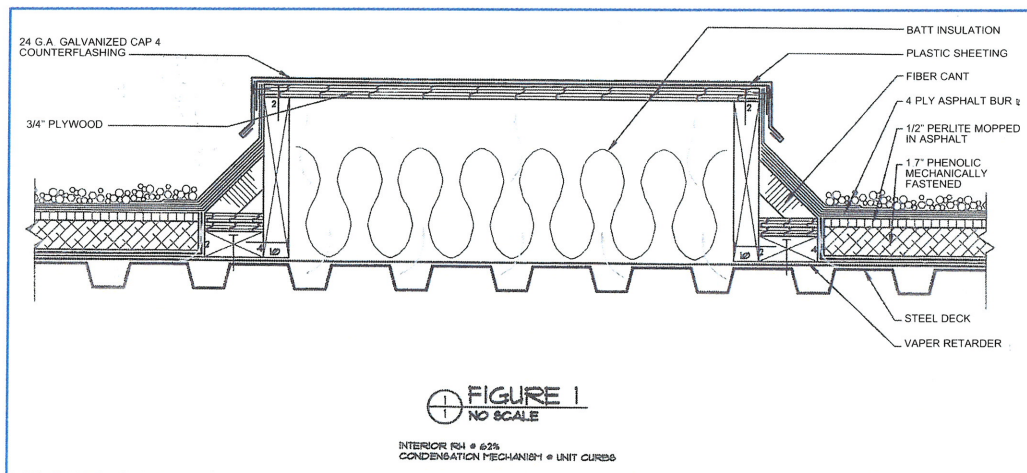


Figure 1

Roof deck:	Fluted steel
Vapor retarder:	Reinforced paper laminate
Base layer insulation:	Mechanically fastened 1.7 in. phenolic
Top layer:	1/2 in. perlite mopped in asphalt
Membrane:	Four-ply asphalt, fiberglass felts with aggregate surfacing
Square footage:	Approximately 300,000

Observations

The expansion joint wood blockings ran perpendicular to the direction of the steel deck, centered over a 3/4-in. gap in the deck. The sheet metal cap and counterflashing covering the expansion joint were rusting. At the inspection opening, a wash of warm air came out of the building, and condensation was noted on the vinyl draped over the top of the wood blocking. The insulation adjacent

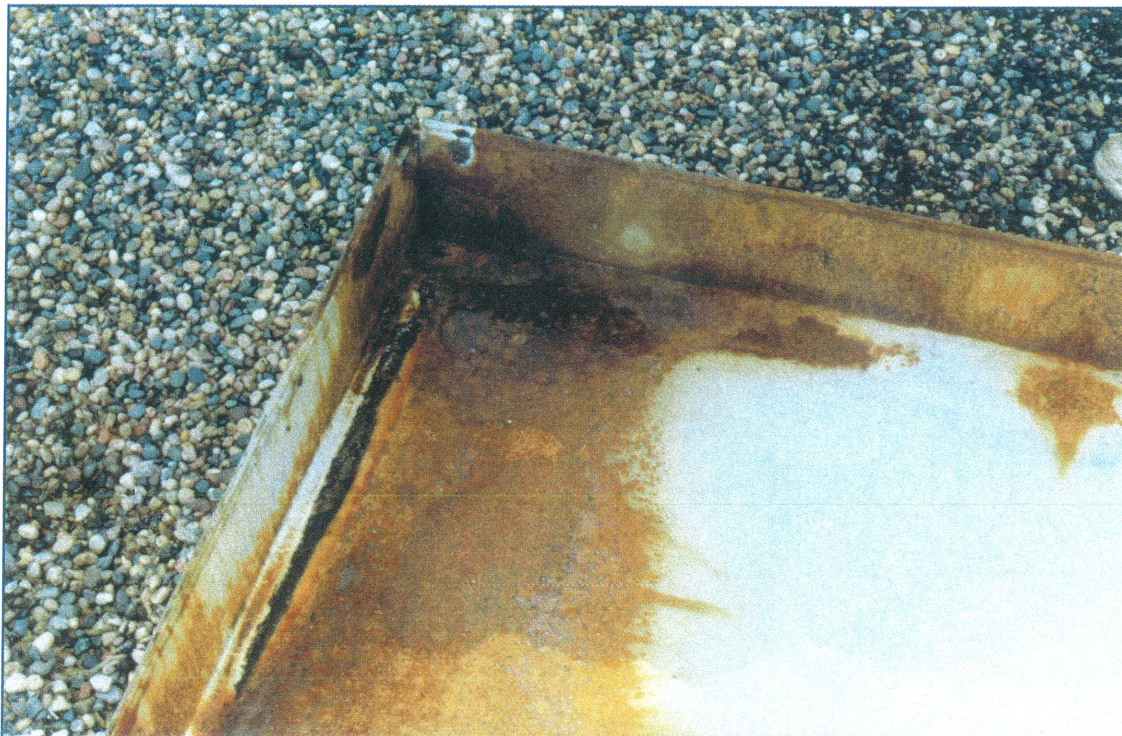


Photo 4 – Excessive corrosion of sheet metal accessories (cap flashing) not in direct contact with phenolic insulation. Free moisture, attributed to condensation, was present within the confines of the curb.

to the inspection opening was dry.

Another roof system feature was the numerous curbs, installed as part of the original construction, intended to accommodate the owners' needs relative to the predictable changes in occupancy. These curbs were wood framed and mechanically attached to the deck. The steel deck and vapor retarder were continuous through the confines of the curb, with the base and top layer of insulation terminating at the outside face of the curb. The curbs were in-filled with fiberglass batt insulation, covered with 3/4-in. plywood, a single layer of plastic sheeting, and a 24-gauge galvanized

metal cap (Figure 1). Severe corrosion was observed on the underside of the sheet metal cap (Photo 4). Condensation was also noted at these locations. The insulation around the curb was essentially dry.

These observations suggest that movement of air through the building envelope (more specifically, the steel deck flutes discharging into deck openings at the expansion joint and curbs) may be a sufficient avenue for the released acids from the adjacent, essentially dry insulation. In this instance, the acids have migrated to locations subject to condensation due to breaches in the roof system components. This is supportive of the theory that essentially dry phenolic insulation may contribute to the corrosion of steel in contact with and close proximity to the offending materials. The moisture content of phenolic insulation – that identified as the

transport mechanism for the known acidic properties of the material – need not be in excess of equilibrium or that established by the service environment of the installation.

It is worth mentioning that the insulation manufacturer dispatched its claim specialist to this project a number of years before the owner decided to move forward with the remediation. Their expert reportedly made one inspection opening, witnessed the presence of the vapor retarder, and left the project. The manufacturer's complacency worked to the owner's advantage in successfully negotiating more favorable settlement terms.

PROJECT NO. 2

The author's firm was retained to perform a critical examination of façade components on a building in the upper midwest. The structure was ten stories with the exterior cladding consisting of a single wythe of brick tied to CMU back-up wall. An insulated cavity wall was present. A brick parapet wall extended approximately 3 ft. 6 in. above the horizontal plane established by the poured concrete roof deck. A series of limestone-clad, bay window assemblies was present at regular intervals across each elevation (Figure 2).

Observations

During the façade inspection, it became evident that the brick veneer was exhibiting concentrated levels of distress and out-of-plane conditions at the juncture of the roof deck and outside face of the parapet wall (Photos 6 and 7). Similar distress conditions were observed across the cut-limestone cladding at the window heads (Photo 8).

A series of inspection openings in areas of localized distress confirmed significant corrosion of the shelf angles (Photos 9 and 10). The conditions were most prominent at the tenth-floor roof slab and parapet interface, with conditions improving at the juncture of the eighth-floor slab and brick veneer (Figure 3). On the remaining similar floor slab interfaces with the brick veneer, the deflection was present but not as pronounced as that of the tenth floor. The subsequent shift of loads from the upper limits of floors 10-8 was distributed to the remainder of the shelf angles mechanically fastened to the outside face of the floor slabs on floors 7-3. As a result, the integrity of the anchorage mechanisms was compromised. It was determined that replacement of the shelf angles and brick veneer would be required on floors 3-10.

Upon completion of the façade inspection in the fall of 2002, a report was issued in which the conditions were described as "safe with maintenance and repair," subject to repairs by 2003-04. Extending the repair window anything beyond the 2003-04 construction season would have presented an "unsafe and imminently hazardous condition," as upwards of 60-70% section loss had occurred at isolated locations in the shelf angles on the upper limits of the building.

As part of the design survey required to develop bidding documents for subject wall repairs, it was determined that the roof construction consisted of the following components from the deck up:

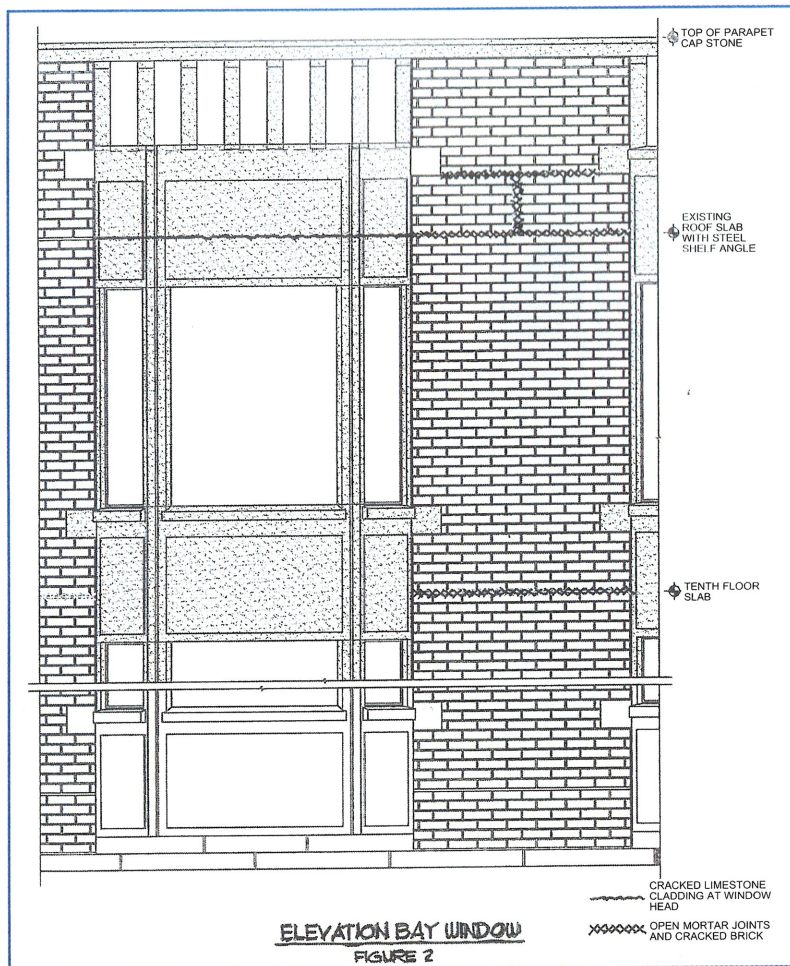


Figure 2

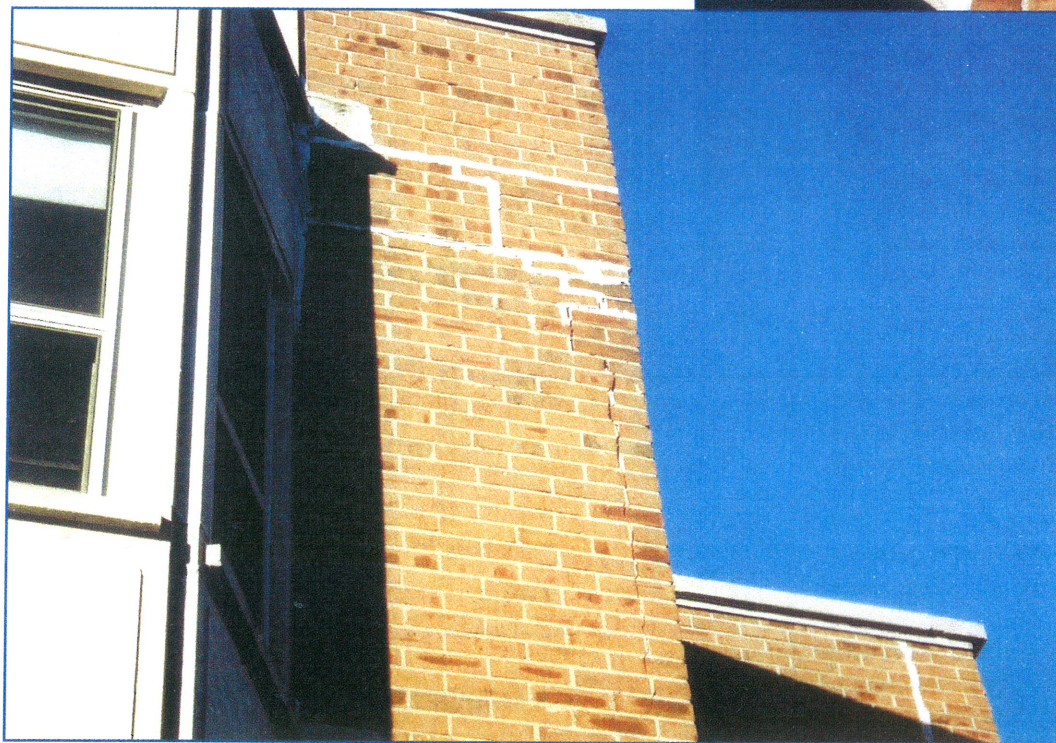
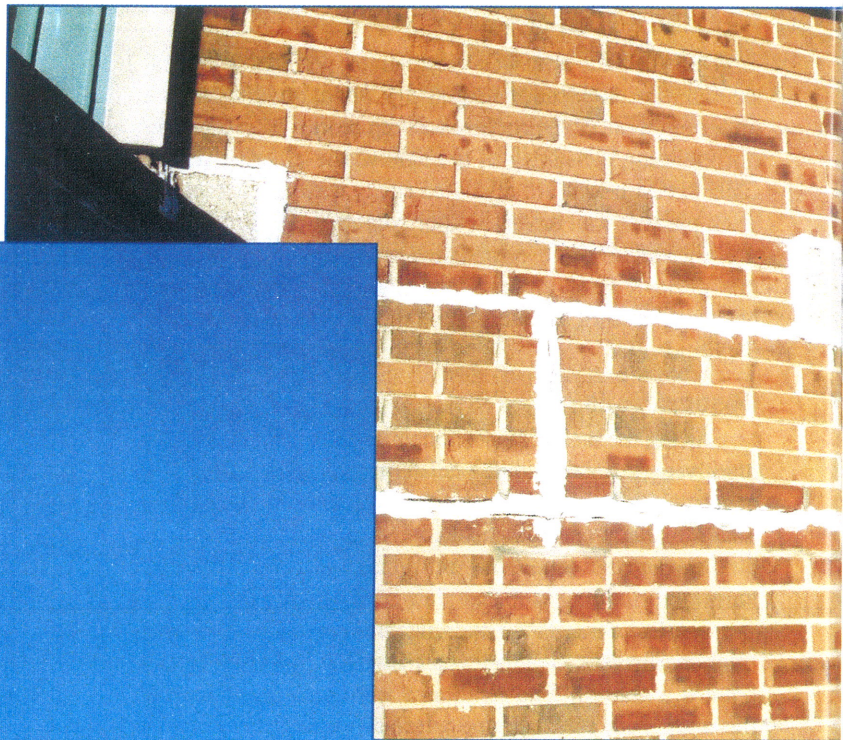


Photo 5 – Wall system movement at the parapet/roof slab interface resulted in the meandering upper limits of the balustrade capstones.

Roof deck:	Poured concrete
Vapor retarder:	Two-ply fiberglass set in asphalt
Base layer insulation:	1.2 in. phenolic
Top layer:	1/2-in. wood fiber
Membrane:	Four-ply fiberglass in asphalt with aggregate surfacing

Photo 6 – Previous caulking repairs at open joints and cracks of the brick in-fill between the window bays.

Photo 7 – At outside corners, the established horizontal pattern of caulking repairs at open joints was supplemented by additional vertical cracks.



Given accelerated levels of corrosion observed on the shelf angles at the roof slab interface, the discovery of phenolic insulation as a component of the building envelope resulted in further investigation. As a result, samples of corroded steel (rust pack) and phenolic insulation were obtained from inspection openings at the cut limestone clad window head of the tenth floor and at the shelf angle mid-span, between the window bays. The samples were submitted to a forensic lab for chemical analysis.

Samples of both the insulation and steel (rust pack) were extracted in deionized water. Through Fourier Transform Infrared (FTIR) Spectroscopy, used to analyze the extracts, it was determined that the IR spectra were a match for para-toluene sulfonic acid (PTSA). The measured pH of the extracts ranged from 3.5-3.8. The results of the testing concluded that the presence of the PTSA on the corroded steel and in the residues was a clear indicator that the phenolic insulation contributed to corrosion of the steel. The low pH and conductivity of the extract supports the findings that acids were involved in the corrosion.

In contrast, a similar group of severely corroded steel samples from window head lintels and fire escape connections was obtained from a nearby building known not to include phenolic insulation as a component of the roof assembly. This group of samples was subjected to the same series of tests to determine if acids contributed to the corrosion process. The measured pH of the extracts ranged from 6 to 7 (basically neutral), with no evidence to suggest that acids (more specifically PTSA), contributed to the corrosion.


Based on the above-mentioned lab results and the apparent

role of the phenolic insulation as a catalyst for the corrosion, leaving the phenolic in place was considered an unacceptable risk. It was determined that complete removal of the phenolic would be required prior to introducing the new steel shelf angles that would be necessary as part of the wall repair contract.

A temporary roof covering consisting of a torch-applied modified was specified. The temporary roof included a four-foot band of 1/8-in.-per-ft. tapered material at the outside parapet roof edge. This feature directed water to the interior roof drains, significantly reducing the likelihood that water would be retained in the work area soon to be occupied by the masonry contractor.

The removal of the existing roof provided the opportunity to gather additional information related to as-built conditions of the roof assembly and its relationship to the masonry features of the parapet. As previously mentioned, there was a two-ply, fiberglass vapor retarder mopped in asphalt to the concrete deck. The felt plies of the vapor retarder were turned up at the parapet wall approximately 1.5-2.0 in. A large quantity of the phenolic insulation





was saturated, primarily to the north, south, and east of the centrally located penthouse, with moisture content in excess of 650% by dry weight. That to the west of the penthouse was essentially dry.

It could be argued that the vapor retarder, installed over a concrete deck, would provide adequate protection for any steel that might be in close proximity to phenolic insulation, wet or dry. However, on this project it was determined that the portion of the vapor retarder that continued through the transition from the horizontal plane of the roof deck up the vertical surface established by the interior of the parapet was largely void of mopping asphalt.

The lack of mopping asphalt, in conjunction with the porous fiberglass felts, results in a felt-ply envelope in a critical location that is less than watertight. It is at this location that the soluble acids carried by the excess moisture that could no longer be retained in the insulation made its way into the wall cavity, resulting in the accelerated corrosion of the shelf angles (Photo 11). At no time since the roof was installed has the owner reported disruption of

occupancy due to water leakage into the building interior, in spite of the large quantities of wet insulation. Free moisture that could no longer be retained in the saturated insulation moved laterally, discharging into the wall cavity and making contact with structural steel support mechanisms for the limestone cladding and brick veneer (Photos 12, 13, and 14).

Photo 8 - Repetitive pattern of horizontal cracks across the limestone-clad window heads. The distress conditions presented were typical of the building's four primary elevations.



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Photo 9 – A severely corroded shelf angle, and subsequent rust jacking, was determined to be the apparent cause for the out-of-plane conditions observed at the brick in-fill between the window bays.

Photo 10 – Volumetric expansion of the steel shelf angles at the parapet/roof slab interface.



The results of this investigation are supported by sound mechanics and the industry-accepted, less-than-desirable performance characteristics of phenolic insulation in the presence of moisture. As such, the larger question is, what happens beyond discovery? Do these findings challenge the terms, conditions, and potentially, the accepted limits of product liability? Is there any recourse for an owner of a building currently exhibiting wall distress conditions that can be attributed to the presence of phenolic insulation? The following discussion on legal issues will explore options that may be available to building owners under current law.

LEGAL ISSUES

The History of Phenolic Foam Litigation

From 1980 through early 1992, two companies manufactured, distributed, and sold phenolic foam roof insulation to roofing wholesalers, contractors, and property owners in the United States. Beazer East, Inc., formerly known as Koppers Company, Inc. (Beazer), manufactured, distributed, and sold phenolic foam roof insulation from 1980 through January 17, 1989. Schuller International, Inc., now known as Johns Manville Corporation (JM), manufactured, distributed, and sold phenolic foam roof insulation from January 17, 1989, through approximately March 31, 1992. From 1980 through early 1992, Beazer or JM phenolic insulation was installed on literally thousands of commercial, industrial, and apartment buildings throughout the United States.

By the early 1990s, some building owners who had installed phenolic foam insulation over metal roof decks began to notice corrosion problems on their metal decks. The costs of replacing the

roofing systems and repairing or replacing the supporting metal decks were significant. Roof consultants and experts hired by the building owners began to link the corrosion to the phenolic foam insulation. However, early on, Beazer and JM often either denied that the roof deck corrosion problem was caused by their phenolic foam insulation or simply refused to adequately compensate the owners for their repair or replacement costs. The inevitable lawsuits against Beazer and JM followed.

The Phenolic Foam Class Action Lawsuit and Settlement

In the mid 1990s, some of these separate lawsuits were consolidated by a Massachusetts federal judge into a single class action captioned *Sebago, Inc. and Flint Village, LLC v. Beazer East Inc. f/k/a/ Koppers Company, Inc, Johns Manville Corporation, et al*, 18 F.Supp.2d 70 (D.Mass. 1998). Interestingly enough, while the original lawsuits that were consolidated contained many "state law" claims against Beazer and JM for negligent representation, negligence, strict products liability, fraud, and breach of implied and express warranties, many of these claims were actually dismissed or limited by the federal judge. The judge, however, did allow the

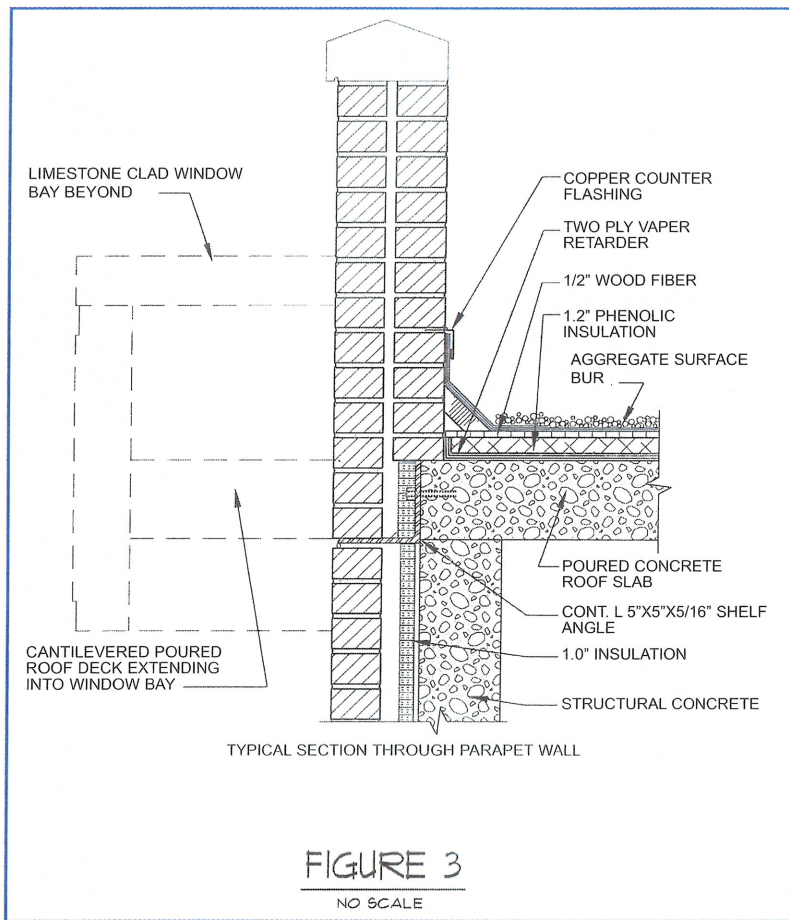


Figure 3

class action plaintiffs to proceed with their claims under a federal statute known as the Racketeer Influenced and Corrupt Organizations Act ("RICO"), based upon alleged mail or wire fraud committed by Beazer and JM in sending out "misleading" brochures and information.

In mid-June, 2000, the federal judge entered an

Photo 11 - Apparent breach in the two-ply vapor retarder at the transition from the horizontal plane of the roof deck and adjacent wall. The tear in the felt plies and gap between the roof slab and parapet wall are present due to the corrosion of the shelf angle, subsequent rust jacking, and upward movement of the wall section. It is at these locations that free moisture carried water soluble acids from the wet phenolic insulation into the wall cavity.



order granting preliminary approval of a proposed settlement. Building owners who would otherwise be included in the class for settlement purposes were given until November 22, 2000, to "opt out" and pursue claims on their own. In mid-December, 2002, the proposed settlement was given final approval. For purposes of the settlement, the class members were all persons or entities who had not opted out and who, as of June 30, 2000, owned an "Eligible Property," which was defined as a building on which the phenolic insulation was installed over a metal roof deck and within a built-up roofing system, a single-ply roofing system, or a shingled roofing system. The class members, for settlement purposes, did not include any building owners who had installed phenolic foam over non-metal deck or owners who had included phenolic foam within a metal roof system whose exterior membrane was all metal.

Those who participated in the class action settlement ended up signing global releases absolving Beazer and JM from any liability whatsoever with respect to the phenolic foam on their buildings. For example, in the Beazer settlement agreement and release, the release language broadly states:

Roof Owner does hereby release and forever discharge Beazer... from any and all claims, liabilities, rights, demands, suits, matters, obligations, damages, losses or costs, actions or causes of action, of every kind and description, in law or in equity, that the Roof Owner has, had or may have against Beazer... whether known or unknown, foreseen or unforeseen, accrued or which may hereafter accrue, asserted or unasserted, latent or patent, that is, has been, could reasonably have been or in the future might reasonably be, asserted by the Roof Owner against any Beazer party, either in this Action, or in any other action or proceeding, in this Court or



Photo 12 – Relationship of segmented shelf angle providing support for the limestone cladding, outside face of poured concrete deck, phenolic insulation, and related roof system components.

any other court or forum, regardless of the legal theory, and regardless of the type or amount of relief or damages claimed arising from or in any way relating to the design, manufacture, distribution, sale, handling, written or oral instructions, specifications, marketing, use, performance or any defects or alleged defects of Beazer, PFRI, and any replacement, repair, treatment, remedial work, removal or disposal of the Roofing System or Deck at the Building, or any part thereof which have accrued or will accrue as a result of having Beazer PFRI on the Roof Owner's Eligible Property ("Settled Claim")...

The form class action JM settlement agreement and release contains similarly broad language.

Accordingly, building owners who settled with Beazer or JM under the terms of the class action settlement are possibly barred from bringing any claim for the new building envelope corrosion phenomenon identified earlier in this paper. This is true even though arguably the damage to the building envelope, as discussed in the earlier portion of this paper, was not known at the time of the settlement or even contemplated by any of the plaintiffs in the class action. To be successful in any new legal action against Beazer or JM, a building owner who already released claims pursuant to the class action settlement would first have to prevail on an argument that the class action settlement should be voided or reopened, or, in spite of the express language of the signed release, that the settlement and release did not cover damages for the new claims.

Claims Against Beazer or JM by Building Owners Who Opted Out of the Class Action or Who Were not Covered by the Class Action

For the most part, building owners who opted out of the class action, but who settled with Beazer or JM on their own, signed settlement agreements and releases provided by Beazer and JM that also contained very broad release language, which arguably bars any new claims. The only building owners who do not face the broad release language problem are those who have yet to settle any claims with Beazer or JM, either inside or outside the class action lawsuit.

Applicable Statutes of Limitation and Repose

In addition to the release language issue, another hurdle to a possible recovery against Beazer and JM for the



Photo 13 – Overall poor condition of cast-in-place receiver and anchor bolt for shelf angles at outside face of poured concrete roof deck.

phenomenon discussed earlier in this paper is state law statutes of limitation and repose. Many, if not most, states have statutes that will bar a building owner from bringing a lawsuit for damage resulting from negligent design, faulty construction, or defective materials after a certain amount of time has passed. In Nevada, for example, the applicable statute of limitations provides that any lawsuit based on a construction defect must be commenced within three years after the defect is discovered (NRS 11.190[3]). Further, the Nevada statutes of repose provide that regardless of when (or even if) the defect is discovered, any lawsuit based upon a patent (or obvious) defect must be brought within six years after substantial completion of the construction, and any lawsuit based upon a latent (or hidden) defect must be brought within eight years after substantial completion (NRS 11.204-205).

Most states have similar statutes of limitation or repose, although the time periods will vary somewhat from state to state. In

some states, claims otherwise time barred by an applicable statute of limitation or repose will be allowed to proceed if the owner can show fraud or fraudulent concealment on the part of the defendant. The legal point is that even if claims against Beazer or JM have not been expressly released in a settlement, they may be barred by the applicable state statute of limitations and repose. Roofing contractors and consultants who discover conditions with the building envelope similar to those discussed in this paper should recommend that the building owner immediately consult with a lawyer to determine whether a timely claim could be brought.

THIRD PARTY ISSUES

Depending upon the severity of the problem, a building owner who discovers conditions with the building envelope similar to those described in the first sections of this paper may have to immediately initiate costly repairs, whether or not there is a potential recovery from the phenolic manufacturer(s) or others responsible for the construction or design of the roofing system. A failure to initiate repairs could result in significant additional damage to the building in the future. Further, if portions of the building envelope crumble or fall away, this could result in catastrophic loss or injury to third parties, either in the form of third-party property damage, injury, or death. If this were to occur in a situation where a building owner knew or should have known about the problem but did nothing, significant additional (and uninsured) liability could attach. Roof consultants who continue to discover phenolic foam on buildings should immediately alert their clients (in writing) to the possibility of problems beyond the corrosion of metal roof decks. Under certain conditions, it should also be recommended that structural members that may have been exposed to the water soluble acids known to be present in the phenolic insulation be inspected as well.

SUMMARY

The findings of this investigation suggest that difficulties associated with phenolic insulation may reach much further than that

accepted by the industry and so far acknowledged and recognized by the manufacturers. The manufacturers are quick to discount the claim, stating they have never



Photo 14 – Cracks in the outside face of the limestone cladding were caused by the rust jacking of both the horizontal and vertical legs of the steel shelf angle.

heard of their product resulting in the described conditions/loss. Lack of previous knowledge alone is not just cause to dismiss a claim. With most product-related claims resulting in loss, there is a discovery phase that is a precedent-setting, defining moment, supported by fact that drives reaction to and acceptance of the phenomenon as real.

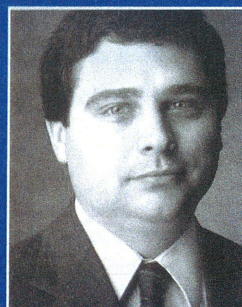
The conditions described in this paper are driven by special circumstances (high interior relative humidity, saturated insulation). It is not being suggested that all buildings with phenolic insulation will exhibit similar problems. However, the testing performed to date indicates the release of para toluene sulfonic acid (PTSA) is a continual process, supplemented by extreme service conditions. The soluble acids are distributed to susceptible areas of the building through the movement of free moisture and perhaps by moisture-laden air moving across the building envelope to condense elsewhere. The migration of acids through the building envelope results in corrosion of steel elements that would typically be thought of as not susceptible to damage. Buildings with concrete decks and wall cavities are more likely to be subjected to damage, as leakage to the building interior may not occur due to the monolithic nature of the roof deck. ■

ABOUT THE AUTHORS

Donald W. Kilpatrick has been employed with INSPEC, Inc., since 1985. During his tenure in the laboratory environment, he has evaluated a broad range of roofing systems and components, with an emphasis on construction defects. Don's observations and analysis of these components and assemblies has been utilized in compliance and workmanship testing on both new and existing construction and failure investigations. Most recently, he has been assisting building owners with their specific needs related to compliance with façade ordinance inspections.



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Michael G. Taylor is a shareholder and chair of the Construction Law Group of Leonard, Street & Daimond, Minneapolis, MN. He has extensive experience negotiating engineering, design, construction management, and design/build contracts, and he has represented architectural, engineering, roof consultant, construction manager, developer, owner and contractor clients in construction-related litigations, arbitrations, and mediations throughout the country. Mike is active in the litigation and construction insurance sections of the American Bar Association. He has written and lectured extensively on various construction, litigation, and insurance issues, and is an active member of AIA, RCI, AGC, and ABC.