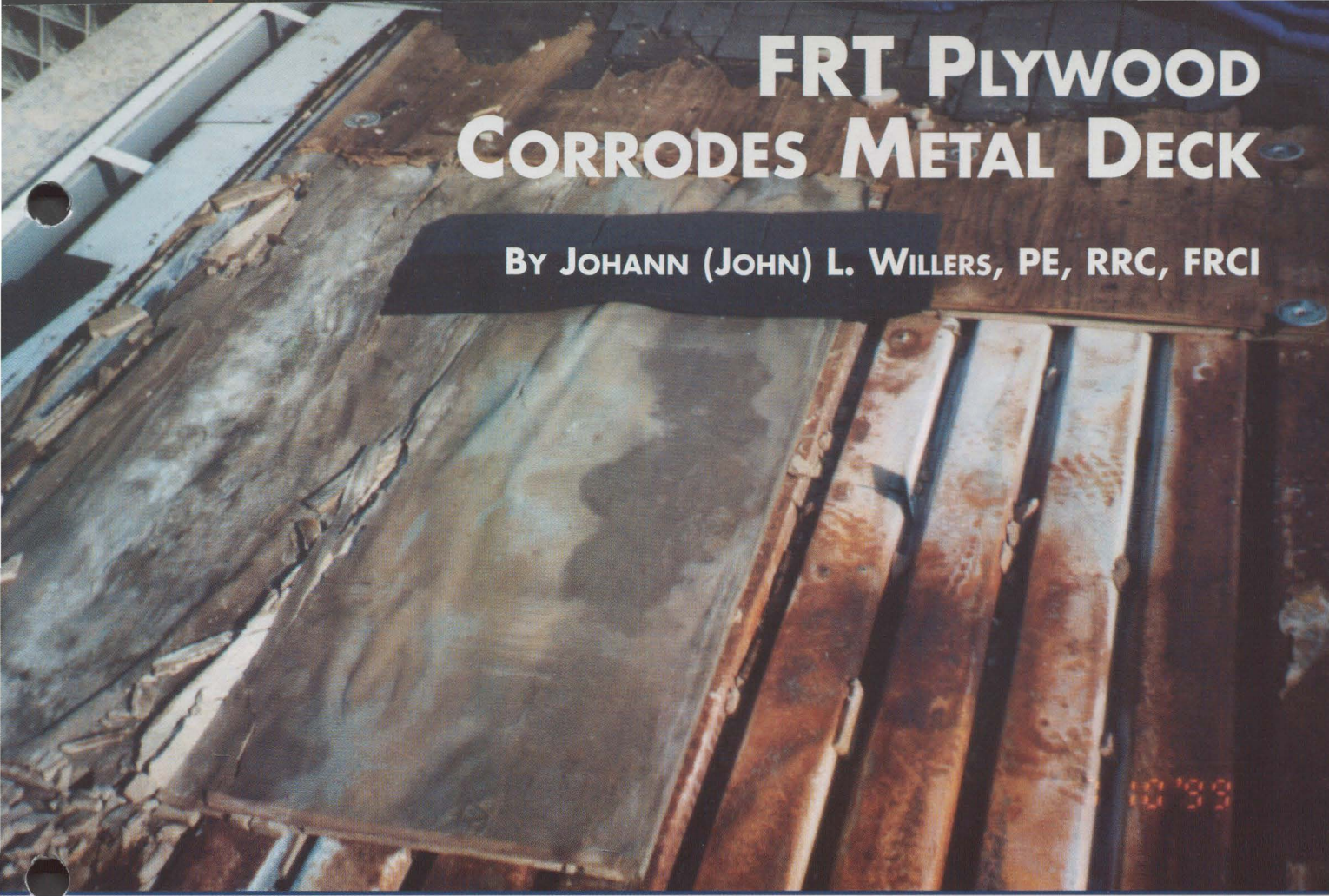


FRT PLYWOOD CORRODES METAL DECK

BY JOHANN (JOHN) L. WILLERS, PE, RRC, FRCI



Solar heating destroyed the FRT plywood. The acids in the activated FRT plywood and moisture entry from split shingles destroyed the metal roof deck. Moisture destroyed the gypsum board.

The metal roof deck of a school was found to be severely corroded and had to be replaced. School officials were dismayed by the impact this would have on the annual budget. Causes of this corrosion were the combined effects of the acids in the fire retardant treated plywood (FRT) and, after water entry, due to the splitting of the asphalt shingles.

How was this discovered?

The shingles had split, the school district had reached a settlement with the shingle manufacturer, and a local roofing contractor had been authorized to remove the defective split shingles and install new shingles. Aside from the very visible splits, there were no other known problems with the roof. A few leaks had been reported during the eight- or nine-year life of the new school building; however, these were attributed to flashings and had been replaced. The superintendent anticipated that this would be a simple shingle replacement project.

The contractor began removing the shingles, scraping them from the surface of the plywood with spades, and finding nothing unusual. However, the foreman quickly noticed that many of the screws and plates which secured the plywood to the metal deck were being removed with the shingles. Perhaps the crew was being too energetic in their removal work. This would be no

big problem, as replacement screws and washers would be installed. However, they discovered that the replacement screws did not engage the deck.

To investigate, a sheet of plywood was removed. They found that the plywood was weak and brittle, the underlying gypsum board was wet to the touch, and the surface of the metal deck was completely covered with rust. Holes were visible through the metal deck and it appeared dangerously flexible.

Initial investigation

The roofing contractor notified school officials who contacted the design architect and a structural engineer. The structural engineer contacted me, and a meeting was arranged to examine the metal deck.

A brief visual examination convinced the structural engineer that the roof deck needed to be replaced. I field-tested the deck by striking it with a hammer. The deck that was not rusted sustained a dent, and at the rusted area of the deck, the hammer easily broke through the deck. I had seen the effects of corrosion due to phenolic foam insulation, and this was equally severe. Some sheets of the deck had been removed and were lying on the ground. When I walked this deck, the flutes would easily flatten under my feet.



Corroded metal roof deck being removed and replaced with new metal roof deck.

Construction components

The roof had a slope of 4 on 12. The structure consisted of steel beams and columns which supported steel bar joists extending from eave to ridge. The joists supported the 22 gauge, Type B, galvanized steel roof deck with flutes parallel to the ridge. A gypsum board fire barrier was placed over the metal deck, and FRT plywood was placed over the gypsum board. Deck screws and galvanized plates were used to secure both of these components to the metal roof deck. Underlayment and three-tab, asphalt shingles were nailed to the FRT.

Below the deck was an air space, approximately 6 inches, and below the air space was foil-faced, fiberglass, batt insulation. The insulation was supported by chicken wire hung from the bottom chords of the steel joists, and the foil face was on the bottom side of the insulation. Eave and ridge ventilation was provided in the form of perforated metal and a continuous ridge vent respectively.

Characteristics of FRT plywood

Fire Retardant Treated (FRT) plywood is plywood which has been impregnated with water-borne, fire-retardant chemicals. Fire retardants work by altering the combustion chemistry of wood. When FRT wood is subjected to high temperatures, the fire-retardant chemicals react with the wood to increase the amount of char and reduce the amount of volatile, combustible vapors. Thus, they reduce the flammability of wood by decreasing the rate of heat release and the rate at which flames spread across the surface, thereby eliminating progressive combustion.

Elevated temperatures initiate this chemical reaction, which not only elimi-



Shingles had split at many locations throughout the roof, both vertically and horizontally. Vertical splits are shown here.



Salvaged FRT plywood failed the field test.

time, resulting in the severe corrosion of the metal deck. All of the necessary ingredients were present: chemicals, heat, moisture, and time.

Combined effects of shingles and FRT plywood

nates progressive combustion, but also has the effect of degrading the strength of FRT wood. Elevated temperatures may be the result of a fire or the result of solar radiation. Threshold temperatures for degradation vary among the chemical treatments utilized; however, temperatures in excess of 150° F can initiate the chemical reaction in some formulations. Temperature readings taken on the surface of the black shingles used on this school roof registered 157° F at noon the day I was on site. The high temperature that day was approximately 95° F.

The degradation process is the result of a mechanism called "acid hydrolysis" which has the effect of breaking down the cell structure of the wood. When sufficient heat is applied to FRT wood in the presence of moisture (which is naturally present in wood), some components of the treatment salts are broken down into an acid which begins degrading the wood. The degree of degradation will depend on the particular fire-retardant formulation used, the temperature levels attained in the roof system, the presence of moisture, and time. On this school, the temperature level was high, moisture was present both in a natural form and from the split shingles, and a significant amount of time had passed since the school was constructed in 1992.

Based on my observations of the construction components, it was clear that moisture from rainfalls during the past years had combined with the acids in the FRT plywood, had then saturated the underlying gypsum board, and finally remained in contact with the surface of the galvanized metal deck for an extended

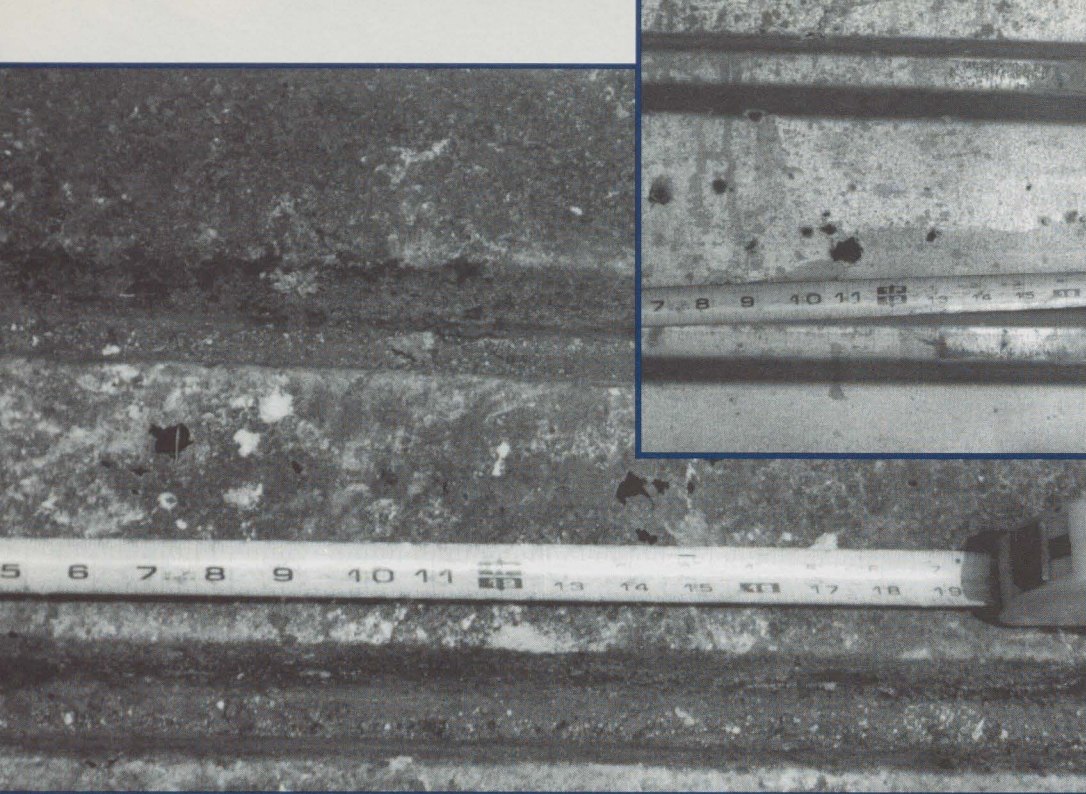
The shingles had split both vertically and horizontally, allowing moisture to enter the roof system. However, leaks were not reported because of the roof slope and the many barriers to moisture actually entering the classrooms below.

These combined effects caused the metal deck to be rendered structurally deficient. The repair work was much more costly than initially estimated due to the need to remove and replace the plywood, gypsum board, and metal deck (in addition to replacing the shingles). Also, a wing of the school had to be closed during construction due to deck removal and replacement overhead.

Conclusion

The construction components of this roof system formed many barriers to moisture actually entering the classrooms where it would have been discovered. These barriers concealed the fact that the roof was leaking. The combined effects of these concealed leaks, the presence of FRT plywood, solar heating, and time destroyed the galvanized metal roof deck, resulting in a very expensive reshingling project.

Owners and consultants should be wary not only of the heating effects on FRT plywood, but also the effects that moisture may have in forming an acid solution and transporting this acid to other components of the roof system where severe corrosion may occur. ■



Bottom face of corroded, galvanized metal roof deck.

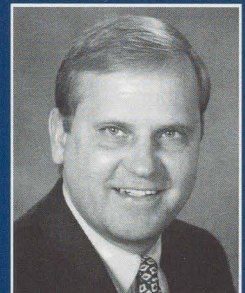
Top face of corroded, galvanized metal roof deck. White residue is from gypsum board placed over the metal deck.

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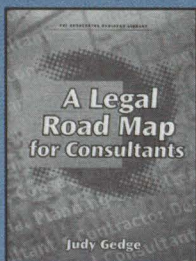
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