Carpet Tack Strips: Determining the Duration of a Water Loss

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ABSTRACT

Carpet tack strips offer an excellent tool to interpret the occurrence and duration of a water loss. Water losses are among the most common claims in the United States. When a water loss occurs in a carpeted home, the carpet tack strips offer a precise method to evaluate the duration of the event based on various characteristics of staining and deterioration. Research studies compared the sequential changes that occur when carpet tack strips are exposed to continuous moisture for one week periods of wetting and drying over a period in excess of 2 years. Research using carpet tack strips exposed to continuous and cyclical wet–dry periods of moisture exposure revealed visual and microbial clues that prove effective in differentiating the duration of a loss and whether the loss originated from a single or repeated event. Forensic engineers and scientists will discover that a carpet tack survey will expose the water release history of a structure and guide them to more accurate and defensible evaluations of a water damage claim.

INTRODUCTION

The duration of loss is a key element when insurance policy language states that coverage is limited to a particular duration. Only a few materials are consistently wetted after a water release. Wood flooring and sheathing, carpet and padding, gypsum wall board, cabinet particleboard and carpet tack strips offer opportunities to evaluate absorption patterns and sequences of deterioration when a water loss occurs. Among these materials, water damage to carpet tack strips is a consistent and time sensitive indicator. Nail stains, wood discoloration and microbial growth were observed to occur within a few days of a loss, while dark discolorations, composite wood delamination and the emergence of different fungal species occurred later. This research identified the response of carpet tack materials to continuous and cyclical (wet-dry cycles) over a period of 100 days with photos of gradual deterioration up to 958 days.

BACKGROUND

The carpet tack strip was invented in 1939 by Mr. Roy Roberts. His invention was inspired after observing his wife sewing precise pleats in window drapes by using small nails pounded through a wooden board to secure the fabric (Southern Cross Building Products). Prior to carpet tack strips, nails fastened carpets to the floor and over time wear produced ripples that required frequent reattachment. Carpet tack strips decreased the carpet installation time, resulted in a smoother appearing carpet and became integrated universally in all wall to wall carpet installations.

Carpet tacks strips are three or five layer plies of wood laminate. The number of plies is odd numbered with the outer plies oriented parallel to the length or long dimension of the panel. Alternating the grain direction in adjacent plies provides dimensional stability across the width (Youngquist, 1999). Tack strips are commonly made of birch, fir, or poplar and are cut into 7/8, 1, and 1 1/4 inch widths with the wider strips constructed with two rows of coated pins. The support nails are made of hardened high carbon steel (10-14 gauge) to penetrate wood and concrete floors and are coated to prevent rust stains.

MATERIAL AND METHODS

This laboratory research effort was intended to document the gradual stages of deterioration that carpet tack strips undergo under conditions of three (3) variables: (1) commonly used carpet tack material manufacturers (Halex, fir wood and Roberts, birch wood), (2) continuous moisture exposure and (3) cyclical moisture exposure. One set of 12 inch length samples (6 Halex and 6 Roberts) was exposed to continuous moisture while the second set (6 Halex and 6 Roberts) experienced cyclical wet-dry cycles lasting seven days wet and seven days dry for a total test period for both sample sets of 100 days.

The moisture content in the carpet tack strips was monitored and found to range from 7%-16% (dry cycle) to 23 to 38% (wet cycle). The relative humidity was maintained between 37-45% (dry cycle) and 63-84% (wet cycle). The temperature was held relatively constant between 73 ^{o}F and 76^{o}F. These experimental parameters are representative of conditions before and after a water loss based on field measurements. The changing appearance of the test strips was photographed and compared to controls (no moisture exposure). Moisture measurements were obtained using a Tramex Penetrating Moisture Meter. Sections of Olefin carpet covered the test strips and a cotton towel was placed beneath the strips with tap water added to

maintain moisture. During the dry cycle, the tack strips were removed from their covered plastic container and allowed to air dry.

RESULTS

The test results did not distinguish a difference between the performance of the Halex and Roberts carpet tack strips. Four elements of deterioration were documented. A summary of the results is presented in **Table 1** (Continuous) and **Table 2** (Cyclical).

1. Progressive Wood Discoloration

The carpet tack strips (Halex) exposed to continuous moisture exhibited gradual darkening from the initial appearance to near black after 100 days and became similarly black after 365 days (**Photographs 1-6**). Both sets experienced moisture saturation and gradual darkening from moisture exposure followed by a gradual increase in microbial growth. By comparison, carpet tack strips exposed to wet-dry cycles showed less discoloration after 100 days. The appearance of the carpet tack strips exposed to wet-dry cycles was similarly black after 365 days. In the field, diagnosis of duration would be accomplished by taking photographs of the affected carpet tack and comparing them to published exemplars.

2. Wood Delamination

Separation between the layers of wood laminate was a key distinction between the response of the continuous and cyclical exposures. Carpet tack exposed to continuous moisture did not separate while carpet tack exposed to four or more wet-dry cycles (repeated exposures) did.

3. Metal Oxidation

Rust on the pins and support nails was observed after the first day and rust on the adjacent wood the second day. In both exposure scenarios (continuous and cyclical), the nails exhibited gradual oxidation, rust staining and darkening to a black appearance after 100 days.

4. Microbial growth

Visible microbial growth (spots) was observed after three days of moisture exposure (**Table 1**). The initial microbial growth consisted of mycelia followed by *Aspergillus/Penicillium-like* spores. These fungal species predominated for the first 28 days. Sometime between Day 28 and Day 35, *Chaetomium* spores were identified and became the predominant fungal specie thereafter. Carpet tack strips exposed to

the wet-dry cycles responded similarly (**Table 2**). The dark discoloration observed at the end of the test period was primarily attributed to dense microbial growth.

DISCUSSION

It is not intuitively obvious for an investigator to pull back carpeting after a water loss to examine the carpet tack strips. This is because the appearance of the exposed carpet, base trim and wall may be visually unaffected. However, if the carpet is pulled back or the base trim removed, evidence of an historical and currently reported water release will be readily apparent (Nehrig and Moon, 2010). Changes in carpet tack strip appearance are remarkably sensitive to moisture exposure and can reveal the history and location of water losses in a structure.

Wood is hygroscopic; it absorbs water in the vapor form and when it contacts free water (Forest Product Laboratory, 1973). Under dry conditions, the durability of a wood-adhesive bond is dependent on the surface adhesion between the adhesive and the wood. Under continuous moisture conditions, adhesive durability and strength are not only affected by the surface adhesion, but more importantly by the dimensional strains that occur as the moisture content increases and the wood expands (Hofferber, *et. al.,* 2009).

When wood fibers swell, they expand in all directions. The expansion of wood creates tensile (expansion) strains between cellulose fibers located on the outside that are swelling as opposed to fibers that have not yet become wet. Similarly, when the wood begins to dry, shear stresses are created. Separation begins to occur when the outside wood fibers experience drying and begin to contract while those fibers that remain wet maintain their expanded size (Simpson, 1999). Repeated wet–dry cycles eventually tear the fibers apart, damaging the wood and the adhesive bond.

CONCLUSION

- Carpet tack strips that get wet for a short period of time (1 day) will show evidence of rust on or near the pin or nail.
- Carpet tack strips exhibit a progressive and predictive darkening the longer they are exposed to moisture.
- Carpet tack strips exposed to one long-term moisture release (up to 100 days) did not exhibit laminate separation. However, carpet tack strips exposed to repeated wet dry cycles (repeated events) will show delamination after completion of a minimum of four wet-dry cycles.
- Visible microbial growth can be observed within two to three days after continuous moisture contact.

- The first fungi to be observed are *Aspergillus-Penicillium*-like. After one month, *Chaetomium* will be detected and become the predominant specie.
- The two test groups (Halex and Roberts) responded similarly to continuous and cyclical moisture exposures.

The evaluation of carpet tack strip serve as supporting evidence when investigating a water loss. The appearance and condition of carpet tack strips provide one of several prongs in the interpretation of a water loss. Carpet tack evidence must be accompanied by interviews, examination of the source and extent of damage, review of appropriate service contractor invoices and other details related to the loss are essential to make a comprehensive and competent assessment of the duration and extent of the water loss.

REFERENCES

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Table 1. Continuous Moisture Exposure

Duration	Wood[1]	Nails	Microbial Growth
Day 1	Damp Appearance	Slight rust	None
Day 3	Saturated	Rust stains	Spots of mold growth
Day 5	Rust between nail & wood	Visible rust	
Day 7	Wood getting dark		
Day 8			
Day 14	Wood darker; Odor detected	Increasing rust	More mycelia (*Asp/Pen* -like growth)
Day 16	Gradual darkening; No separation[2]		Increased *Asp/Pe* n-like growth
Day 21			
Day 28			*Chaetomium* spores detected
Day 35			*Chaetomium* spores dense
Day 42			
Day 49			
Day 56			
Day 63			
Day 70			
Day 77			
Day 84			*Chaetomium* ; abundant mycelia
Day 91			
Day 100	Wood nearly black in color	Black nails	Dense *Chaetomium* and mycelium
Day 365	Added continouous moisture to box periodically to determine when disintegration of tack strips occur		
Day 652	Layers splitting linear and peeling away; few samples show layer split perpendicular; becoming fragile to pick up and prevent layer separation	Black nails with corrosion pitting	Dense microbial growth
Day 894	Layer thinning & disintegration observed due to lignin biodegradation		Dense growth on lower layers; less growth on top layer where microbial growth is in death phase and laminate is decomposing
Day 958	All samples have layer thinning & disintegration		

(1) Major visual milestones

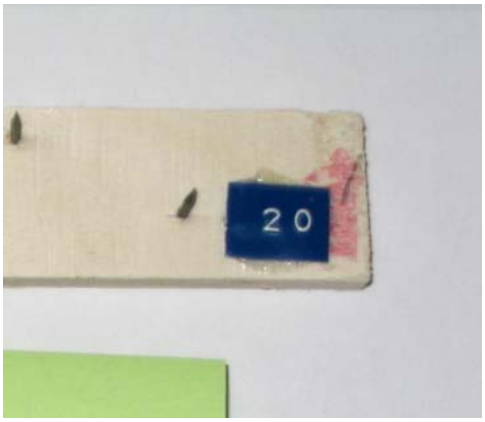
(2) Table reflects both Halex and Roberts Carpet tack strips

Table 2. Cyclical Moisture Exposure - 7 Days Wet/ 7 Days Dry[1]

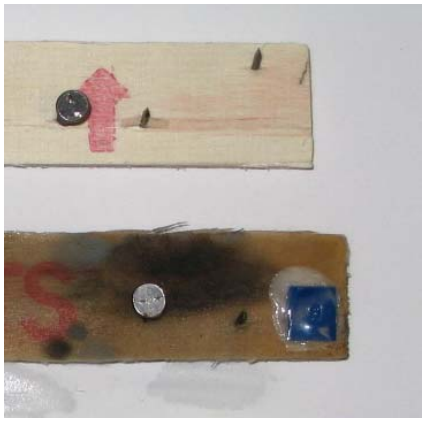
Duration	Wet-Dry Cycle Wood[2]	Nails	Microbial Growth
Day 1	Damp Appearance	Slight rust	None
Day 3	Saturated	Rust stains	Spots of mold growth
Day 5	Rust between nails & wood	Visible rust	Visible surface growth (*Asp/Pe* n-like)
Day 7	Wood getting dark		*Asp/Pen* -like and mycelia dominate
Day 8	Wood getting lighter		
Day 14	Wood getting lighter		
Day 16	Wood slightly darker		
Day 21	Slow wicking from base		
Day 28	Wood getting lighter		
Day 35	Wood darkening		*Chaetomium* spores predominate
Day 42	Growth darkening wood		
Day 49	Wood darkening		
Day 56	Layer separation		
Day 63	Wood dark		
Day 70	Distinct Layer Separation	Black nails	
Day 77			
Day 84			Dense *Chaetomium* and mycelium
Day 91			
Day 100			
Day 365	Added continouous moisture to box periodically to determine when disintegration of tack strips occur		
Day 652	Few samples show layers splitting linear and peeling away; not fragile to pick up	Black nails with corrosion pitting	Dense microbial growth
Day 894			
Day 958	Several samples were observed with layer thinning & disintegration due to lignin biodegradation		

(1) Table reflects both Halex and Roberts carpet tack strips
(2) Left column indicates major visual milestones

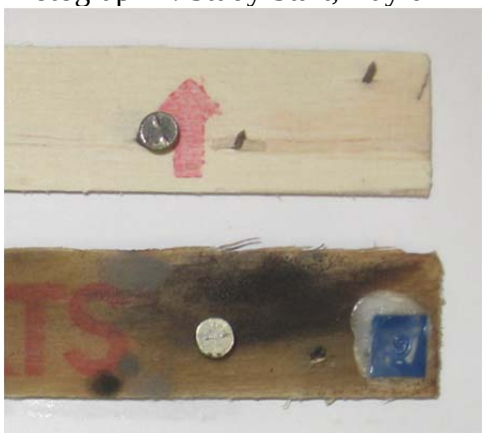
Carpet Tack Photo Succession: Continuous Moisture Exposure



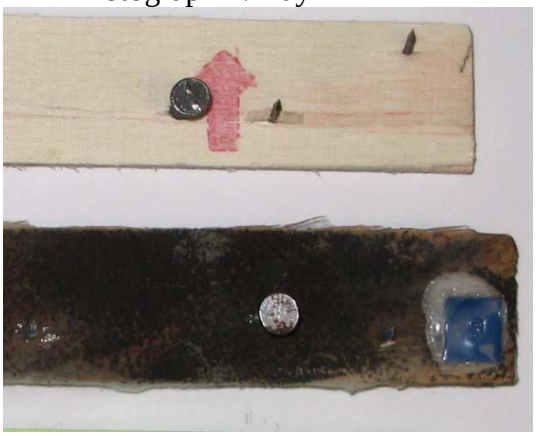
Photograph 1: Study Start, Day 0



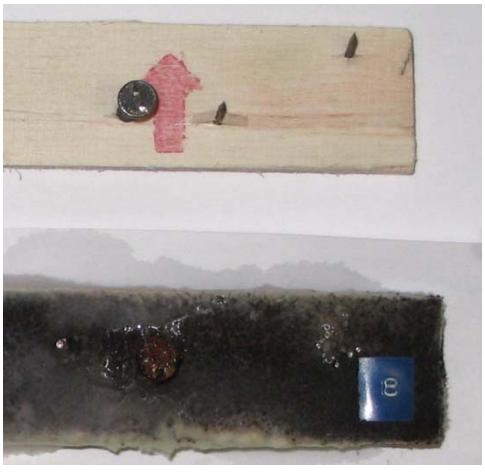
Photograph 2: Day 14



Photograph 3: Day 28



Photograph 4: Day 55



Photograph 5: Day 100

Photograph 6: Day 958