Blue-Green Algae and its Effect on Fiber-cement Roofing Within a Microclimate

An Investigation of Biodeterioration of Fiber-Cement Roofing by Cyanobacteria and its Implications for the Roofing Industry in Hawaii

By Colin Murphy, RRC, FRCI

EXECUTIVE SUMMARY

The author was commissioned to conduct an investigation on the island of Oahu at a major residential complex re-roofed during 1993 to 1995 with fiber-cement "shake" look-alike elements. The referenced "Project" consists of 82 wood-framed, two-story, residential townhomes constructed in the early 1980s. The original roofing on all structures consisted of red cedar medium shakes installed approximately ten years prior to the re-roof. The fiber-cement shakes were installed over the original "skip sheathing" and a 30# organic underlayment. The conditions observed at the project prompted the author to review other fiber-cement roof installations throughout the island.

Inspections of fiber-cement roofing assemblies installed throughout Oahu revealed very extensive areas of blackish "algae" growth at all roofs. Only areas under cover (i.e., below overhangs and trees) were void of surface growth.

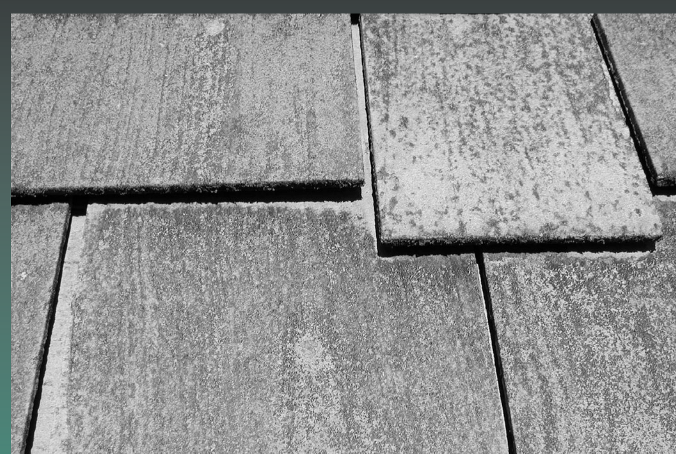


Photo 1 – Typical blackish algae growth observed throughout the project complex .

sRepresentative samples were collected from the Project site and shipped to this firm's laboratory in Seattle, Washington, for testing and analysis. Additional testing of the shakes and the "algae" growth was conducted by independent laboratories in Seattle.

Testing revealed the bacterial growth sampled from the Project primarily consisted of species of the cyanobacteria Scytonema.

- As further discussed below, the phyla of Cyanobacteria (often generically named "blue-green algae") are bacteria that differ from all other forms of "algae" due to their photoautotrophic nature – i.e., cyanobacteria, like green plants, are capable of synthesizing their own food from inorganic substances using light as an energy source.
- The Scytonema cyanobacteria are found from the Arctic to the Antarctic, are common to Oahu and Maui[1], and "can commonly be mistaken for a fungus as it forms soot-like specks, dark brown to black in color."[2]

The investigation and testing confirmed the effect of this cyanobacteria growth on the fiber-cement roofing is biodeterioration of the cementitious elements. Due to the extent of the observed growth and deterioration, the author recommends a full examination of the suitability and long-term performance of fiber-cement roofing elements in the Hawaiian market.

INTRODUCTION

The fiber-cement elements used in the roofing industry are constructed from panels of fiber-reinforced cement. Proprietary mixes of Portland cement, ground silica, cellulose fiber, and mineral oxide pigments are built up in layers on rollers and then cured by high-pressure steam autoclaving. The fiber-cement product at all but two of the eleven Oahu projects visited was positively identified to be from a single manufacturer.

- The product was marketed with a "50-year transferable limited product warranty."
- While there appears to be no formal withdrawal of the product from the Hawaiian roofing market, no evidence of current marketing of the product can be found at the manufacturer's websites.
- Recently, the ICBO Evaluation Service ("ICBO ES") Evaluation Report supporting the use of the product in model building code jurisdictions has been allowed to expire.[3]

Water absorption rates for fiber-cement materials are naturally high, exceeding 25% on a dry-weight basis. Documentation submitted by a primary manufacturer to ICBO ES in 1988 states:

> "The … shakes demonstrated a water absorptive rate of 27.7 percent of their oven-dry weight. However, even with this high water absorption rate, the average weight of the … shake when installed as described in the manufacturer's installation procedures is approximately 6 pounds per square foot. This is well within allowable weight limits and does not require special structural supplementation."

In a February 15, 1989 letter to the Metro Dade County Building and Zoning Department ("MDCBZ"), a consultant to the manufacturer wrote:

> "Since this product is not classified as a "Cement and Clay Roof Tile," I do not believe that the water absorption issue is relevant. What we want to get across is that the product will perform the same function as the wood shake and shingles."

A similar letter, dated April 17, 1989, to the Product Control Supervisor of the MDCBZ Department from another consultant to the manufacturer, stated:

> "As you are aware, it is not possible to satisfy the water absorption requirements of SFBC (South Florida Building Code) under tiles for the subject roofing material. To classify these materials as tiles or shakes or shingles is also a question. In my opinion, higher water absorption is not a problem for the proper functioning of these materials because the water never leaks and is not detrimental to the underlayment."

Clearly, the focus of the efforts by the manufacturer's consultants regarding the high water absorption/retention properties of the fiber-cement product was to assure the Code authorities that the retained moisture did not add undue weight to the roof structure or pose a deterioration risk to roofing substrates. No review appears to have been conducted regarding the potential for the retained water to foster biological growth in environments within the Code jurisdiction.

Photo 3 – Crumbling deterioration at leading edge

Photo 2 – Typical blackish algae growth observed throughout the project complex

The findings of an ICBO ES Report issued in April 1988 stated, "…the…Shake and…Slate Roof Systems described in this report complies [sic] with the 1985 Uniform Building Code…"

Photo 4 – Blackish algae growth begins below eave-protected, shaded area

FIELD OBSERVATIONS

Field observations confirmed the Project's fiber-cement elements were installed over a 30# felt underlayment applied to the spaced "skip" sheathing substrate remaining after removal of an original cedar shake assembly. The inspected attic voids were hot. Minimal venting was observed at the roof eaves and field; no power vents were installed. No ridge or gable venting was observed. In general, the roof slopes are approximately 4:12, although areas of lower and steeper slope were observed throughout the complex.

The installation was found to be in general compliance with the manufacturer's published installation instructions. No fiber-cement shake loss was observed as a result of "blow-offs."

With varying degrees of severity, areas of blackish "algae" growth on the shakes were observed throughout the Project complex. At some localized areas, e.g., under eaves and at locations swept clean by tree branches, minimal algae growth was observed on the fiber-cement shakes. Generally, inspection revealed significant deterioration of the shakes, including cracking, crumbling and "leafing" at the leading edge, and delamination of the fiber-cement layers.

Samples of the installed fiber-cement shakes were extracted for testing. In addition, comparative samples of uninstalled shakes, which had been stored onsite and protected from the elements since the re-roofing installation, were secured.

TESTING

Physical Property Testing

Physical property testing of the sampled fiber-cement shakes was conducted at this firm's laboratory in Seattle. Additional testing and analysis of coating and core composition of the fiber-cement elements were conducted by Analytical Chemistry, Inc., of Seattle. Testing and analysis of the sampled algae were conducted by Lab/Cor, Inc., of Seattle. Visual inspection confirmed the fiber-cement elements had varying concentrations of blackish "algae" discoloration on the surface, except on those visually-acceptable samples that had been extracted from below eaves, where the shake elements had been protected to some degree from exposure to sun and water.

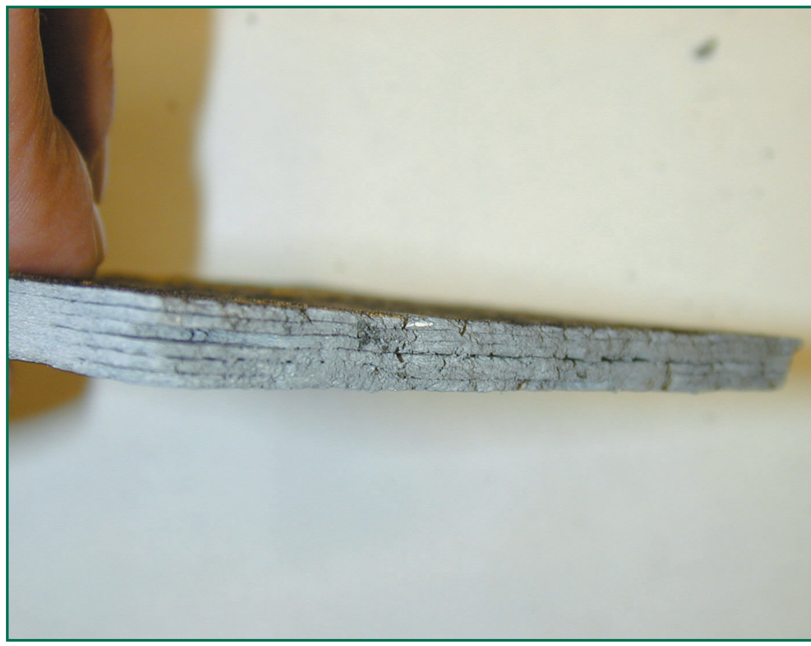


Photo 5 – Cohesive failure of the laminates

Cohesive failure (delamination) of the fiber-cement layers was observed on some samples. In several cases, the extent of the structural deterioration precluded testing of physical properties.

Testing for "flexural strength" per ASTM C-1185[4] standards found a reduction in flexural strength performance (see *Table 1*)

Table 1: Flexural Strength Test Results (psi)				
Sampling	Wet		Dry	
	Longitudinal	Transverse	Longitudinal	Transverse
Exposed (from site)	1851.2	1166.2	2959.1	1919.0
Unexposed (as new, from site)	2248.9	1300.5	3054.9	1911.1

Table 1: Flexural Strength Test Results (psi)

for the exposed samples relative to the unexposed ("as new") samples taken from storage at the Project. Both the "as new" and exposed samples met the minimum saturated modulus of rupture (798 psi) set forth in ASTM C-1225.[5]

Specimens were selected from the Project sampling to represent increasing degrees of severity of the blackened surface condition and then tested for water absorption per ASTM C-1185 standards. An increase in water absorption corresponded with the severity of the observed surface condition (see *Table 2*). While the sporadic and low conditions produce results similar to the "as-new" product, medium and high severity surface conditions result in an increased water absorption condition.

Table 2: Water Absorption Test Results (%)		
Sample Number	Severity of Condition	Water Absorption (%)
N/A	Uninstalled (new)	25.8%
01	Sporadic	23.8%
07	Low	25.3%
35	Medium	27.9%
06	High	31.3%

Table 2: Water Absorption Test Results (%)

Both exposed and unexposed shingle materials met ASTM and ICBO requirements for watertightness, showing no signs of droplet formation on the material underside.[6]

Coating and Core Composition

Representative specimens of the exposed and unexposed (i.e., the "as new" elements that had been stored under cover since construction) fiber-cement shakes were tested for determination of the surface coating and core composition and were examined for the presence of algaecide. (Note the manufacturer's published literature does not state the fiber-cement shakes were manufactured with an algaecide component.) The report issued by Analytical Chemistry concludes:

- Unexposed samples are "a calcium-aluminum-silicate/carbonate composite with a surface polymer coating."
- The compositions of all "samples are similar except that no polymer coating was detected on the surface of" the sample that had been exposed to weathering.
- No evidence of the presence of algaecides, tin, arsenic, or copper was detected on the unexposed samples.

"Algae" Testing

Testing by Lab/Cor identified the blackish algae growth as primarily consisting of the cyanobacteria *Scytonema sp.*, with secondary growth of the *Chroococus sp.*, *Gloeocapsa sp.*, *Aphanocapsa sp.*, and *Oscillatoria sp.*, and chance traces of the single-celled green alga *Trebouxia sp*. No significant algal or biological growth was found on unexposed (below-eave) samples.

A loose fungal sample scraped from the leading edge of a fiber-cement element was identified as lichen: composite organisms comprised of a fungus and an alga living in symbiotic association. The fungus absorbs water that is used by the alga in photosynthesis; the alga synthesizes and excretes a specific carbohydrate that the fungus can utilize as food.

- The algal component of the fungal symbiosis is usually a single-celled green alga (*Trebouxia, Coccomyxa*) or a blue-green alga (*Nostoc, Scytonema*).

DISCUSSION

As noted above, the phyla of Cyanobacteria (often generically named "blue-green algae") is bacteria that differs from all other forms of "algae" due to its photoautotrophic nature – i.e., cyanobacteria, like green plants, are capable of synthesizing their own food from inorganic substances using light as an energy source. Varieties of Cyanobacteria are observed in colorations that range from pink to blue to yellow to black. Cyanobacteria "are strikingly abundant in the humid tropics."[7]

- "Blue-green algae also grow in profusion in the tropics, frequently occurring on painted surfaces where they may be so dark in colour [sic] as to appear almost black. Scytonema is one of the commoner blue-greens on paint and is easily mistaken for a fungus as it forms soot-like specks, dark brown to black in colour. [sic]"[8]
- "Certain blue-green algae are also prevalent in tropical conditions, and commonly occurring species belong to *Oscillatoria* and *Scytonema*."[9]

The *Scytonema* cyanobacteria are well documented as common to Oahu and Maui. Much of the leading current research efforts worldwide to derive potent anti-cancer drugs from the *Scytonem*a cyanobacteria are being conducted at the University of Hawaii.

Generally, a regular supply of water is necessary for prolific growth of cyanobacteria, and the synergistic effect of such growth is to trap underlying moisture necessary for further growth.

- "The basic requirements for algal growth are a source of inoculum, nutrients, oxygen, carbon dioxide, light, suitable pH, and water, none of which is usually limiting. Normally, only in the case of fresh concrete or asbestos-cement, is pH limiting; otherwise, it is water supply which [sic] often offers scope for control."[10]
- "Details of building design affecting the shedding of water and minimizing its retention on critical building surfaces are important because it is the duration of the period of wetness that is crucial rather than the frequency of wetting itself in predisposing a surface to colonization."[11]
- "…the presence of extensive sheets of algal growth will trap water and retard subsequent drying which [sic] in turn will exacerbate water-induced damage of the underlying material."[12]

Studies conducted on concrete high-rise buildings in Singapore have found:

- "Algae are the first to appear on newly-completed building surfaces. These organisms grow profusely on the porous stonework and painted surfaces, especially where the supply of moisture and light are not limiting. …These growths contribute to the slow deterioration of the structures, besides being aesthetically objectionable."[13]

Studies have consistently found Scytonema on "stone, brick, and concrete walls (often associated with buildings), paint and limewash, roof tiles, and sandstone monuments."[14]

- Initially, "the surface of newly-prepared concrete or asbestos-cement is a deterrent to algal growth because of the high pH (often 11 or 12). The combined action of water and the changing of the hydroxides to carbonates results in the pH eventually falling sufficiently to allow algal growth."[15]
- "The ability of *Scytonema* and *Calothrix* to fix atmospheric nitrogen is an added advantage for these two filamentous blue-greens. Hence their high incidence of occurrences as compared to the other filamentous blue-green algae."[16]

Nitrogen fixation is a process whereby relatively inert dinitrogen (~ 79% of the Earth's atmospheric gas) is converted to ammonia. Nitrogen fixation is a critical process for the nitrogen cycle that supports life on our planet:

- Nitrogen cycle: nitrogen transformation from air and soil (to) nitrogen-fixing bacteria (to) **nitrifying bacteria** (to) plants (to) animals (to) decomposers (to) air and soil.
- "Multicellular life (plants, animals, and fungi) depend almost entirely on bacteria to obtain (or "fix") nitrogen from the air and transform it into a chemical form that plants can use."[17]

Some of the Cyanobacteria, including *Scytonema*, are key contributors to the nitrogen fixation conversion of dinitrogen to ammonia. The effects of this metabolic secretion of organic acid on cement and concrete materials can be significant — "Algae are considered corrosive."[18]

In the presence of water, the ammonium resulting from the nitrogen fixation process is oxidized by common nitrifying bacteria, forming highly corrosive nitric acid, which can also interact with "lime" (calcium oxide, a key component of Portland cement) to form highly soluble ammonium sulphates that attack the cement substrates via water migration. The higher the concentration of sulphate in solution, the more serious the resulting deterioration. The severity of the attack is increased if the sulphate-bearing water is in continual contact with the substrates.

"Microbially-induced concrete corrosion" (aka "microbiologically-induced corrosion") has been extensively studied for the pipeline and sewage treatment industries:

- "Microbially-induced Concrete Corrosion (MICC) is the process where biogenic sulfuric acid reacts with cementitious material to deteriorate the integrity of concrete pipe and other structures."[19]
- "Microbiologically-influenced corrosion or microbiologically-induced corrosion (MIC) refers to corrosion and ensuing loss of metal or concrete caused by biological organisms. …MIC results from the corrosive secretions of micro-organisms."[20]
- "Although having an initial alkalinity as high as a pH of 13 due to the formation of lime in the hydration of dicalcium and tricalcium silicates (Portland cement components), concrete surfaces could have a pH as low as 0.6 because of microbiologically-induced attack. …The sulfuric acid generated due to MIC directly attacks the underlying substrate and causes destruction of the infrastructure."[21]

For the fiber-cement shake elements, such attacks proceed along the lines of cracks in the shakes and between the fiber-cement layers, particularly when the movement of water is facilitated by one-side water pressure or evaporation from a free surface. Deterioration can occur from both crystallization and chemical reaction. The result is disintegration, expansion, and eventual delamination of the fiber-cement shingle.

In addition, the *Scytonema* cyanobacteria have filaments that are surrounded by mucilaginous (moist and sticky) sheaths that are negatively charged and hydrophilic. The sheaths absorb and store water and associated nutrients during periods of rain and from moisture found within the substrate. If the conditions (inorganic nutrients, pH, UV, temperature, and water) are appropriate, the filaments will grow, form new sheaths, and extend over larger and deeper areas. The effects of the shrinking and swelling of the hydrophilic sheaths during arid conditions and periods of moisture intake will accelerate the biodeterioration process.

- "The presence of mucilage sheaths around cells and filaments of blue-green algae probably assists them in the colonization of such habitats. The sheaths retain moisture and protect the cells from desiccation during periods of drought. The dust retained by the sheaths provides nutrients for the growth of the algae."[22]

Photo 6 – Microscopic view of Scytonema Endolithicum – mucilaginous sheaths cover the growing filaments (http://www.botany.hawaii.edu/faculty/webb/BOT311/Cyanobacteria/Cyanobacteria.htm)

The report issued by Lab/Cor for the Project sampling states:

- "*Scytonema sp.* has grown into tufted masses over much of the surface, and when these tufts are removed to expose the underlying surface, filaments of algae can be seen within the substrate below."
- "Sand or quartz are seen lying freely amongst the filaments of the organism. Presumably these grains originated in the matrix of the …shake, and as the cement deteriorated, these grains become disassociated from the product matrix and become entangled with and adhered to the gelatinous sheaths of the filaments of the growing *Scytonema sp.*"
- "Also, an opaque, white deposit is commonly seen on the surface of the *Scytonema sp.* tufts present on the deteriorated product. These deposits likely are the result of chemi-

cal altering of the cement matrix and the subsequent redeposition of minerals originating from the cement in the product."

SEM (scanning electron microscope) images produced by Lab-Cor[23] dramatically depict the effects of the expansion of these mucilaginous sheaths into the fiber-cement elements. *Photos* 7, 8, and 9 provide comparisons of a 150x cross-section of the surface of a fiber-cement sample (from below an eave) without algal growth and 100x and 1000x cross-sections of the biodegraded surface of a sample colonized by *Scytonema*.

In summary, Scytonema is feeding upon the rich, moist fiber-cement matrix. Grains of fiber-cement are continually being loosened from the substrate and adhered to the sticky, slimy sheaths to provide essential nutrients to the feeding cyanobacteria.

The resulting corrosive secretions work to loosen more grains from the product matrix. The swelling sheaths apply stress to the shake surface and core, resulting in stratification and "leafing."

Photo 8 – SEM Image (original mag = x100) of cross-section of surface of fiber-cement sample taken from area colonized by Scytonema

CONCLUSIONS

The sampled shakes consist of fiber-cement elements with an original polymer coating containing no algaecides. The condition of the sampled shakes varies significantly from as-new to extensive deterioration and cohesive failure (delamination). The condition has not yet compromised the overall integrity of the water-shedding assembly except in limited areas of significant degradation of individual fiber-cement elements; however, the service life of the roofing system has been compromised significantly.

The installed elements are colonized with species of the filamentous cyanobacteria *Scytonema* that are common to Hawaii and are known to grow prolifically in humid, tropical climates. The extent of the colonization varies. Unexposed shake materials and some areas of exposed shakes (e.g. at eaves or at locations wind-swept by overhanging tree branches) have no algae growth; however, most of the exposed shakes have 100% colonization. The algae initially form in

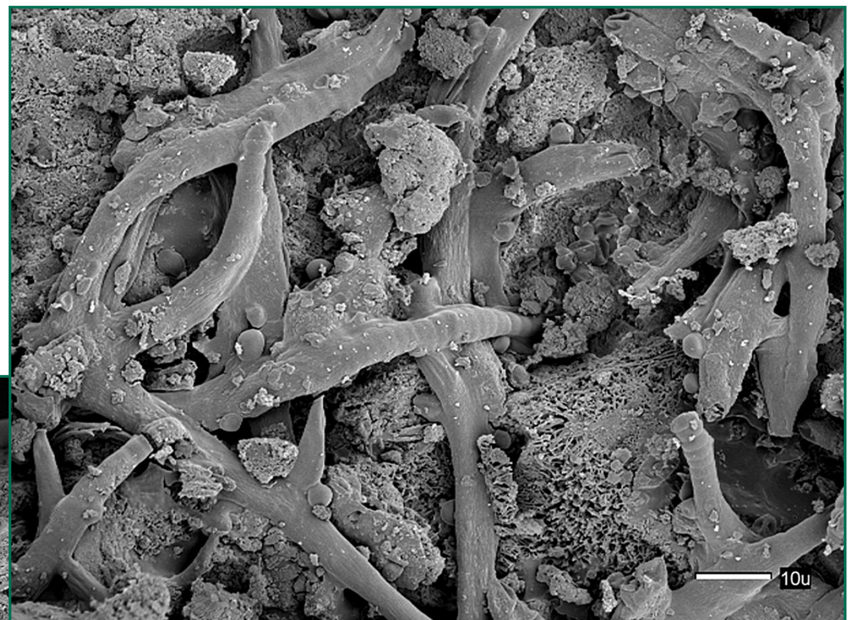


Photo 9 – SEM image (original mag = x1000) of cross-section of surface of fiber-cement shake. Grains have "… become disassociated from the product matrix and become entangled with and adhered to the gelatinous sheaths of the filaments of the growing Scytonema sp."

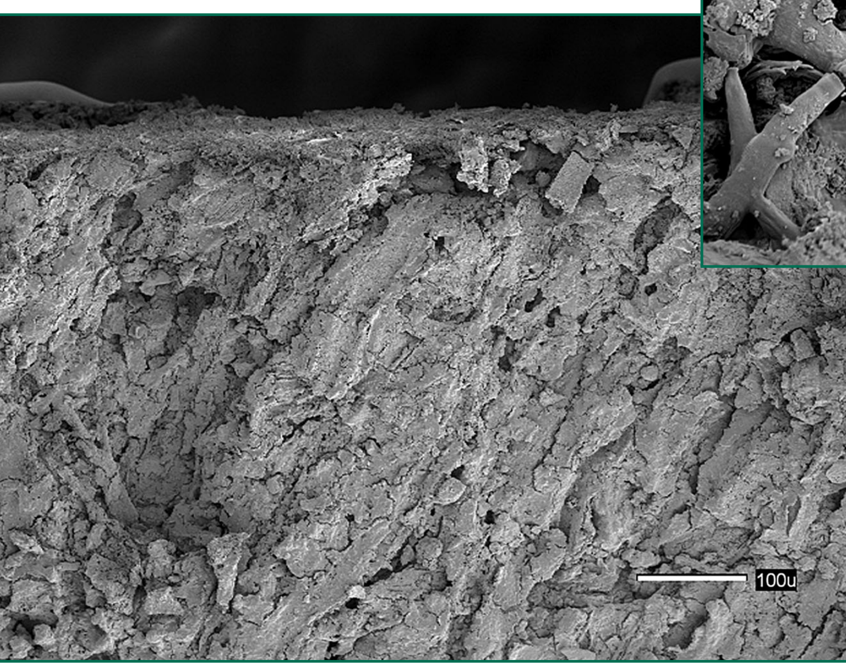


Photo 7 – SEM image (original mag = x150) of cross-section of surface of fiber-cement sample taken from under eave where no algal or bacterial colonization had occurred the troughs of the irregular, three-dimensional surface and eventually expand to cover the ridges.

As the *Scytonema* filaments grow, the mucilaginous outer sheaths become increasingly entangled with and adhered to the fiber-cement particulates, resulting in increased structural stresses to the shake substrate. In addition, the hydrophilic sheaths "shrink" when exposed to dry periods and re-expand when rewetted, resulting in further internal stress within the surface of the fiber-cement element.

Additional attacks on the structural integrity of the shakes come from the corrosive effects of *Syctonema's* production of organic acid (ammonium) as it "fixes" atmospheric nitrogen. The ammonium is then oxidized by commonly present "nitrifying bacteria," forming highly corrosive nitric acid, which can also interact with the lime component of the shake elements to form highly soluble ammonium sulphates that can attack the fiber-cement core via water migration.

Mechanical deterioration resulting from the movements of the sheathed filaments is supplemented by corrosive deterioration occurring from both crystallization and chemical reactions related to ongoing transformations of the organic and inorganic acids that are natural products of the nitrogen fixation process. The result is disintegration, expansion, and eventual delamination (leafing) of the fiber-cement elements.

As the original polymer coating is removed in areas of algae growth, more of the fiber-cement substrate is exposed, allowing increased moisture migration and water absorption, and deeper penetration of the *Scytonema* filaments. Loss of the polymer coating, either through the cyanobacterial attack or through other mechanical means (e.g., power washing), is not the primary cause of failure, but accelerates the condition. Use of an algaecide in the polymer coating would have delayed but not prevented the onset of the cyanobacterial growth.

Inspection revealed the installation of the fiber-cement product to be generally compliant with the installation requirements published by the manufacturer. There is no aspect of the application that would have resulted in promoting the extensive proliferation of *Scytonema* cyanobacteria.

Instead, the condition results from the natural phenomena of biocorrosion and biodeterioration: the fiber-cement shakes werre sold into a market where the physical properties of the cement substrate, combined with appropriate levels of moisture, temperature and pH, produced an excellent host for the proliferation of the locally common *Scytonema* cyanobacteria.

Due to the extent of the observed growth and resulting deterioration, the author recommends a full examination of the suitability and long-term performance of fiber-cement roofing elements in the Hawaiian market.

Written protocols for remediation of bacterial growth and resultant biodeterioration on stone walls date back to early human history. The Old Testament, for example, proscribes removal and replacement of the affected areas:

> "…if the disease is in the walls of the house with greenish or reddish spots, and if it appears to be deeper than the surface, then the priest shall go out of the house to the door of the house, and shut up the house for seven days. And the priest shall come again on the seventh day, and look; and if the disease has spread in the walls of the house, then the priest shall command that they take out the stones in which is the disease and throw them into an unclean place outside the city; and he shall cause the inside of the house to be scraped round about, and the plaster that they scrape off they shall pour into an unclean place outside the city; then they shall take other stones and put them in the place of those stones, and he shall take other plaster and plaster the house." - *Leviticus 14:37-42 (KJV)*

Remediation of the conditions observed in Hawaii may require similar full removal and replacement of fiber-cement roofing systems. ■

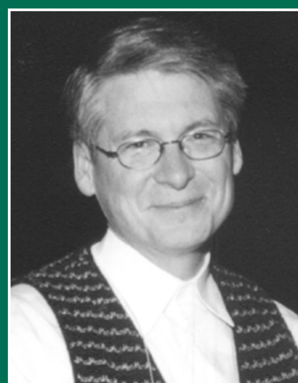
ENDNOTES

1. Eric B. Guinther, "List of Species from Aquatic Environments (Brackish and Fresh Water) in the Hawaiian Islands," http://home.hawaii.rr.com/cpie/Fwater1a.html
2. C.E. Skinner, "The Role of Algae in the Deterioration of Decorative and Marine Paints," Proceedings of the XI Congress of FATIPEC.
3. ICBO Evaluation Service is a subsidiary of the International Conference of Building Officials, www.icbo.org
4. ASTM C-1185-92, "Standard Test Methods for Sampling and Testing Non-Asbestos Fiber-Cement Flat Sheets, Roof and Siding Shakes, and Clapboards," American Society of Testing and Materials, July 1992.
5. ASTM C-1225-93, "Standard Specification for Non-Asbestos Fiber-Cement Roofing Shakes, Shakes, and Slates," American Society of Testing and Materials, June 1993.
6. Samples that had deteriorated to the point of significant leafing and crumbling were not tested due to the advanced state of deterioration.
7. D.M. John, "Algal Growths on Buildings: a General Review and Methods of Treatment," *Biodeterioration Abstracts*, Vol. 2 No. 2., 1988.
8. Ibid.
9. C. Grant, "Fouling of Terrestrial Substrates by Algae and Implications for Control," *International Biodeterioration Bulletin*, Autumn 1982.
10. Ibid.
11. Ibid.
12. Ibid.
13. Ibid.
14. John.
15. Ibid.
16. Ibid.
17. http://cgee.hamline.edu/see/questions/dp_cycles/dp_cycle_nutr.htm
18. Y.C. Wee and K.B. Lee, "Proliferation of Algae on Surfaces of Buildings in Singapore," *International Biodeterioration Bulletin*, Winter 1980.
19. Jeffrey Davis, Dana Nica, and Deborah Roberts, "Modeling Microbially Induced Concrete Corrosion in Sewers," University of Houston, http://gem1.cive.uh.edu/content/cigmina98/poster02.html
20. Shiwei Guan, Ph.D., "Synergistic Protection Against Microbiologically Influenced Corrosion Using A 100% Solids Polyurethane Incorporated with Anti-Microbial

Agents," http://www.geocities.com/~sguan/mic.htm
21. Ibid.
22. Grant.
23. Barbara Reine and Colin Murphy, "Characterization of Biodegradation of Fiber Cement Shingles by *Scytonema sp.* Using Optical and Scanning Electron Microscopy," *Microscopy and Microanalysis 7 (Supplement 2: Proceedings)*, pgs. 472-473. 2001. Barbara Reine is a Lab/Cor mycologist. This paper was presented by the authors at the annual meeting of the Microscopy Society of America on August 6, 2001.

About the Author

Colin Murphy, RRC, FRCI, founded Trinity Group Fastening Systems in 1981. In 1986, he established Trinity Engineering, focusing primarily on forensic analysis of roof systems, materials analysis, laboratory testing, and long-term analysis of in-place roof systems. The firm, formally known as Exterior Research & Design, LLC, Trinity Engineering, is based in Seattle, WA. Colin joined RCI in 1986 and became an RRC in 1993. In 1996, he was honored with the Richard Horowitz Award for excellence in technical writing for *Interface*. In 1998, RCI granted Colin the Herbert Busching Jr. Award for significant contributions to the general betterment of the roof consulting industry. In 2001, he was made a Fellow of RCI.



Colin Murphy, RRC, FRCI

ASTM Establishes Green Roof Standards Task Group

Michael F. Gibbons has been appointed as the head of a Green Roof Task Group at ASTM to investigate the possibility of creating a standard for green roof infrastructure in the U.S. The Task Group was set up under the E06.71 Subcommittee on Sustainability in Buildings, formed in 1946.

E-06 has approximately 850 members and currently has jurisdiction over 170 standards. These standards play a preeminent role in the building industry and address issues relating to the performance of buildings, their elements, components, and the description, measurement, prediction, improvement, and management of the overall performance of buildings and building-related facilities.

For more information on the task group, contact Michael F. Gibbons at 972-960-8726 or archsys1@aol.com.

—Green Roof Infrastructure Monitor

Roofers Too Close For Comfort on Sept. 11

There were about 30 roofers working on a building just one block from the World Trade Center when the hijacked planes crashed into the WTC on September 11. Employees of Conco Roofing, Brooklyn, NY, were reroofing 90 West, a 25-story building designed by Cass Gilbert, constructed in 1907 and designated as an historical landmark. When the second plane hit the South Tower, debris littered the roof of 90 West, and one worker was struck on the arm by what was thought to be a part of the plane. His injuries were not serious, and he has since recovered. Following the collapse of the towers, five floors of 90 west were damaged by fire. The building itself had other structural damage from falling debris, including the northwest corner parapet wall being torn off. The roofers' trucks were buried in the rubble.

—Roofing Contractor