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Stabilized Engineered Wood Fiber for Accessible Playground Surfaces

Installation and Serviceability Results: Governor Nelson State Park, Wisconsin

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Abstract

Playground surfaces of sand, pea gravel, and engineered wood fiber (EWF) provide some level of impact protection for children. However, because these surfaces are soft and uneven, they can be difficult for those who use mobility aids such as wheelchairs and walkers. This study is the third phase of a research and development project in pursuit of a stable, smooth, and impact-attenuating surface based on wood materials to improve wheelchair and walker accessibility for playgrounds. Two EWF stabilizing binders, a non-foaming polyurethane (Vitri-Turf) and an acrylic and polyvinyl acetate polymer emulsion (Soil-Sement), were installed on a working playground at Governor Nelson State Park in Waunakee, Wisconsin. A soft impact-absorbing playground surfacing system was created through the use of a bonded top layer and a thick underlying layer of unbonded EWF. Cost estimates and a step-by-step guide are provided for installing SEWF on a playground.

Keywords: wood, fiber, surfacing, impact, accessibility, ADA, composite, polyurethane, playground, durability, installation, cushioning

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Zeager Bros. Inc. and Beneficial Designs, Inc. (Minden, Nevada), provided the apparatus for the impact test and the rotational penetrometer, as well as training in their use. Thanks to Zeager Bros. Inc. for the donation of EWF and Midwest Industrial Supply (Canton, Ohio) for the donation of Soil-Sement.

Our thanks to the Wisconsin Department of Natural Resources for offering the park playground as a development site for this study. We particularly note the guidance and support of Anthonette Gilpatrick, ADA Coordinator, Renee Lee, Park Manager, and the staff of Governor Nelson State Park for installing and monitoring the playground site. Volunteer groups who helped to install the playground surfacing included the Rotary Club of Waunakee, Madison Chapter of Telephone Pioneers of America, and Edgewood High School students. We could not have performed the study without the support of Steve Schmieding of the Forest Products Laboratory (FPL) and his wife Jane as well as other FPL staff, namely Carl Syftestad, Lloyd Currier, Ben Henderson, Tim Voelker, Vicki Herian, Nancy Keen, Tom Kuster, and Mary Collet.

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Background

Some engineered wood fiber (EWF) and chipped wood surfaces on playgrounds are difficult for those who use mobility aids, such as wheelchairs and walkers, because the surfaces are soft and uneven. This study is the third phase of a research project in pursuit of a stable, smooth, and impact-attenuating surface, based on wood materials, for playgrounds. In Phase I, processing techniques and material properties were evaluated in small bench-top and full-depth laboratory tests (Laufenberg and others 2003). Phase II involved 6 months of outdoor field testing (Laufenberg and Winandy 2003). In Phase III, reported here, we continued to develop the concept for stabilizing EWF to improve wheelchair and walker accessibility.

Phases I and II demonstrated that our new binder–EWF system can (a) enhance mobility, as related to the provisions of the Americans With Disabilities Act (ADA 1990), (b) meet test requirements for playground surface cushioning to reduce head impact injuries, and (c) perform in an outdoor environment. In Phase III, the two most promising EWF stabilizing binders were installed on a working playground. The concept was to mix a binder throughout the upper surface of EWF to create a stiff (firm) and scuff-resistant (stable) composite. The combination of a top layer of bonded EWF and a thick underlying layer of unbonded EWF creates a soft, impact absorbing playground surfacing system. In this report, the term SEWF refers to “stabilized” EWF and indicates the system with the bonded top layer of EWF.

Phase I

In previous work (Laufenberg and others 2003), numerous processing techniques and binders were evaluated for the development of wood–binder composite playground surfaces. Our goal was to improve accessibility for users of wheelchairs and walkers. Although traditional EWF performs well for nearly all expectations of a play surface, a pertinent shortcoming is the amount of energy required by a wheelchair user to maneuver over the surface, primarily because it is soft and uneven. Thus, the EWF–binder composite system needed to achieve two seemingly conflicting performance requirements: to promote accessibility and to retain adequate impact-energy absorption to preclude injuries. The composite systems developed consisted of the combination of a binder and EWF in a thin top surface layer over a layer of unmodified EWF.

The effort identified designs using compatible resin (e.g., latex, silicone, and polyurethane) binders and various species and textures of EWF. Adhesive binders were chosen for their inert and non-toxic nature in the playground environment and the retention of a natural look for the surface. Consideration was given to the need to add materials and to the possibility of patching the surfaces after damage from major impact. Use of a play surface for 3 to 5 years was considered adequate time for the binder to fulfill its function. The surface could then be renewed by adding EWF. Composite systems with EWF have not been used before in this application. Therefore, there is no guarantee or warranty that they will function for that extended period.

The preliminary evaluation included laboratory testing of energy absorption and surface stability (firmness) on trial surfaces in 0.5- by 0.5-m (18- by 18-in.) plywood boxes; the surfaces had a uniform depth of 0.3 m (12 in.). Seven systems were identified as having reasonable performance and were recommended for Phase II outdoor field evaluations.

Phase II

Phase II research focused on outdoor evaluation of binder and fiber combinations identified as minimally acceptable and promising in the Phase I evaluations. Seven surface treatments and a control surface were installed in a series of outdoor test beds in Madison, Wisconsin, to gather field experience on long-term performance and durability. The binders evaluated were (a) a synthetic latex emulsion, (b) a low molecular weight silicone, and (c) foaming and non-foaming resilient polyurethane. Systems were evaluated over a 6-month period, from April to October 2002.

Tests were performed at regular intervals to provide a quantitative measure of accessibility and impact attenuation. An impact test was performed after the 6-month exposure period. The results indicated that all the surfaces passed the existing specifications for impact attenuation of playground surfaces (Laufenberg and Winandy 2003). The results further indicated that 6 months of aging had changed the impact performance of all systems except the unsurfaced (no additive) EWF. The latex binder and both polyurethane binders consistently met the accessibility requirements for playgrounds. However, the foaming formulation produced a hard brittle shell that became even harder with exposure/age and would increase the injury rate for falls on the surface. The silicone system did not maintain adequate integrity during rain/dry cycles in this outdoor test. Moisture measurements indicated that the bonded surface retarded the drying of the underlying EWF. That finding might have long-term implications for the rate of decay for the systems, and alternative treatments might be used to retard decay.

Phase III

In Phase III, a few of the most promising SEWF systems were tested in a working playground. The desired binder–EWF system needed to provide impact safety and appropriate accessibility over a number of seasons. It needed to retain the performance characteristics of impact-energy absorption and surface resiliency. To accomplish this, the first order of business was to objectively assess the field-use requirements of any successful SEWF.

Acceptable SEWF Systems

Because of their reactivity, the stabilizing binders needed to be applied on site or mixed with EWF no longer than 1 h prior to placement on the ground surface. Accordingly, the technical issues considered were (a) cure/set time prior to surface use, (b) range of EWF moisture and temperature conditions acceptable for use, (c) emission of fumes or odors, workable exotherms, and toxic or other chemical release concerns related to the binder/EWF mixture, and (d) any post-installation deleterious effects of SEWF on users.

Any viable field system must meet two primary user needs: impact safety and accessibility. The Americans With Disabilities Act (ADA 1990) states that accessible surfaces shall be stable, firm, and slip-resistant. Each viable SEWF system must also be non-toxic to users. In addition, the SEWF system should be porous, to allow water to drain from both the upper bonded surface and the lower unbonded interior of the mats. This is critical in reducing the biodeterioration potential of the wood fiber and in maintaining the cushioning behavior of EWF during subfreezing temperatures.

Impact safety is quantifiable through the use of the consensus standard ASTM F1292 (ASTM 1999a). Preliminary portable impact tests provided an indication of the cushioning performance of the stabilizing binder. The ADA criteria for accessible surfaces have not been defined adequately within the ADA accessibility guidelines for quantitative measurement on any specific surface. Currently, the only objective method suitable for assessing the firmness and stability of a playground surfacing system is the rotational penetrometer, a portable measurement device that simulates a wheelchair caster negotiating the test surface. For our study, two cooperators (Zeager Bros. Inc., Middletown, Pennsylvania; Beneficial Designs, Inc., Minden, Nevada) provided the apparatus for the portable impact test and the rotational penetrometer, as well as training in their use.

Playground Study Site

An Access Board solicitation for potential study sites yielded numerous responses. Fortuitously, an accessibility coordinator for the Wisconsin State Parks offered a site close to the Forest Products Laboratory—a sand-surfaced playground at Governor Nelson State Park in Waunakee, Wisconsin.

Design

The playground was originally designed with some structural provisions for accessibility. A transfer point/platform was incorporated in the climbing structure; however, the surface leading to it was fine beach sand. Total fall height was determined to be 3.1 m (10 ft). Discussions with the park staff provided insight to the usage of this area. In response, the staff decided to retain sand on a portion of an adjacent (but not conjoining) playground. The remaining area of approximately 190 m^2 (2,020 ft^2) was converted to a full-depth EWF surface (Fig. 1).

Preparation of Playground Subsurface

Our efforts began by removing the existing sand surface to a depth of 0.38 m (15 in.) (Fig. 2). All roots, stones, and vegetation were removed. Much of the tonnage of sand was moved by two skid-steer loaders, but significant amount required handwork by a dedicated and hardworking volunteer crew from the Waunakee Rotary and a local chapter of Telephone Pioneers of America. The work crew also included employees of the park, the Wisconsin Department of Natural Resources, and the Forest Service. The majority of the clean sand was used to replenish the adjacent beach at the park and the remainder was piled in a wooded site nearby. Approximately 12 h of equipment time and 48 h of personnel time were required to remove the sand.

Installation of Drainage Base

Following industry standard EWF installation practices, we ensured that the excavated surface had a minimum of 1% slope for drainage. A lightweight landscaping geotextile

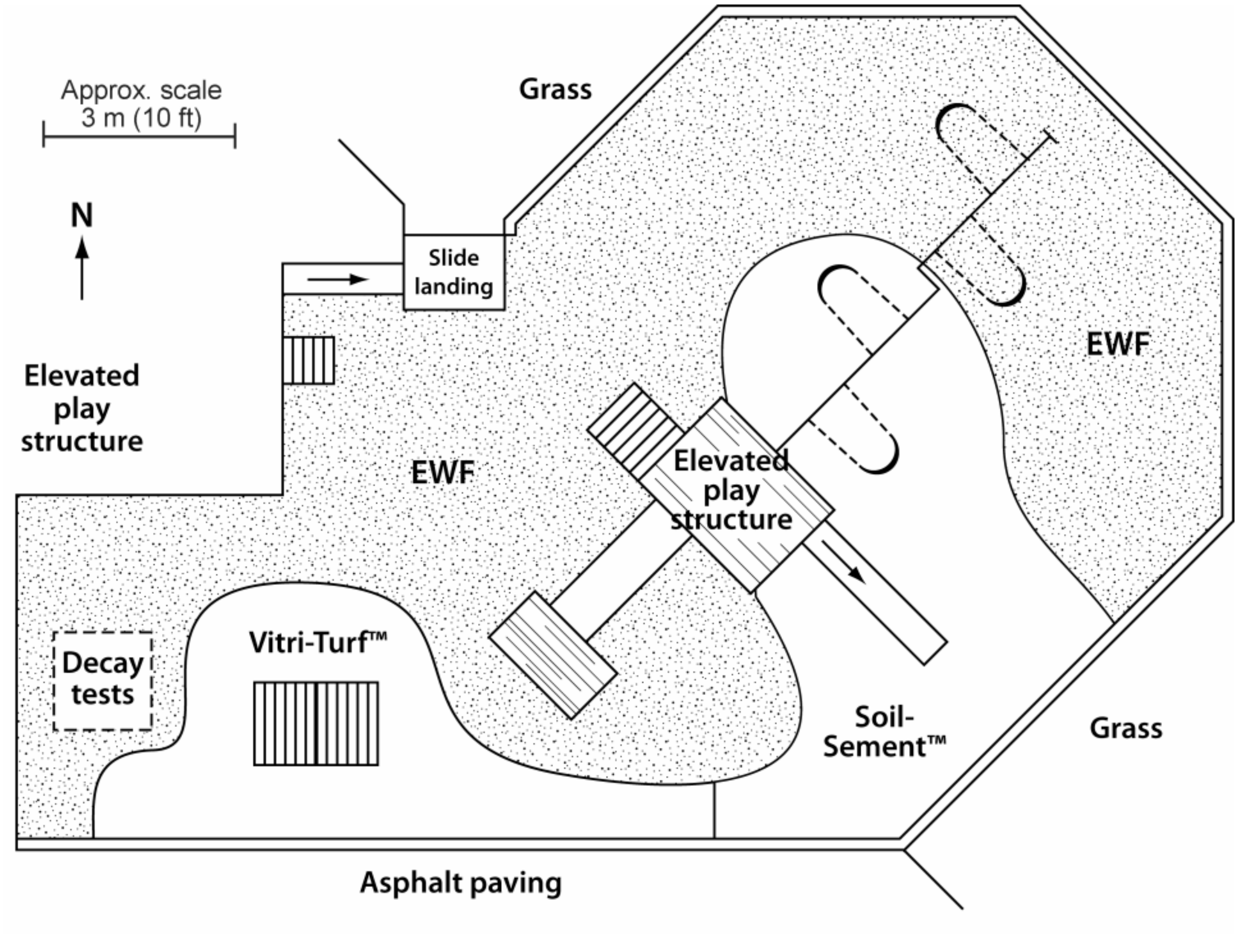

Figure 1—Schematic plan of playground site at Governor Nelson State Park.

fabric was placed on the surface, followed by a 0.08-m (3-in.) layer of 18-mm (3/4-in.) washed, angular drainage rock (Fig. 3). Half the rock was placed using a skid-steer loader and the other half was placed manually using wheelbarrows. All the rock was shoveled and raked by hand to a uniform depth. Another layer of geotextile fabric was laid on top of the rock layer (Fig. 4). Handfuls of rock were thrown on the fabric to keep the wind from blowing it out of place. The layers of geotextile fabric kept soil and fiber from clogging the rock and thus preserved the drainage quality of the rock layer. Approximately 25 metric tons (28 tons) of rock was used. Placing the rock and geotextile required 25 h of manual labor and 3 h of skid-loader use.

EWF Application

Fifty cubic meters (66 yd^3) of EWF, donated by a cooperator (Zeager Bros. Inc.), was obtained from BNB Bedding of Oskaloosa, Iowa, and delivered in a 75-m^3 (100-yd^3) live-bottom trailer (Fig. 5). The EWF was manually applied to a thickness of 0.3 m (12 in.). One week later, after the surface had been further compacted by usage, approximately 40 m^3 (53 yd^3) of EWF was added and compacted to return the surface to the full depth of 0.3 m (12 in.).

Bonded Surface Installation

Two weeks after applying the EWF, we returned to stabilize the upper surface. Considering that children had used the playground in the meantime, we had hoped the EWF was adequately compacted to support the stabilized layer. Our plan was to treat approximately 30% of the playground with the two binding systems and to leave the remainder as the untreated control (Fig. 1). The two binder systems used to fabricate these systems were

1. an acrylic and polyvinyl acetate polymer emulsion, Soil-Sement (Midwest Industrial, Canton, Ohio), mixed 30% by dry weight of solids to unit weight of dry EWF and applied 63 mm (2.5 in.) thick, and

2. a non-foaming polyurethane (Vitricon), Vitri-Turf (Polymer Plastics Corp., Commack, New York), mixed 30% by weight to unit weight of dry EWF and applied 37 mm (1.5 in.) thick.

Figure 2—Removal of sand from existing playground surface.

Figure 4—Completion of drainage system; second layer of fabric laid over drainage rock.

Figure 3—Placement of drainage fabric and rock on playground subsurface.

Figure 5—Application of engineered wood fiber (EWF).

If the EWF has 20% moisture content, that weight should be subtracted from the EWF weight prior to calculating the weight addition of the binder. The same procedure should be followed for the binder that does not contain 100% solids. The weight percentage should be calculated only on the solids content of the binder. Because the EWF was installed in the fall, we monitored the air temperature; both stabilizing binders required 4°C (40°F) for proper curing. On the date of installation, the overnight temperature had dipped to –2°C (28°F). The crew waited for the temperature to rise before mixing the EWF with the binders, which had been stored at room temperature. When the EWF was mixed with the binders, the temperature of the resultant mixture was well above 10°C (50°F).

A portion of EWF was removed from the play area for stabilization. For the polyurethane binder, 38 mm (1-1/2 in.) of EWF was removed and for the emulsion polymer, 64 mm (2-1/2 in.) of EWF. The EWF was placed in a 160-L (40-gal) portable mortar mixer (Fig. 6). The amount of binder added was determined as a proportion (30%) of EWF dry weight (volumetrically equivalent to 0.041 m^3, 1.45 ft^3) to 5.3 L (1.25 gal) of Vitri-Turf or 10.6 L (2.5 gal) of Soil-Sement. Weight proportion was 77:23. The EWF and binder were mixed for approximately 3 min. The mixture was transported by polyethylene tray wheelbarrows to the target pad and spread with hand tools to an even thickness (Fig. 7).

The area was then compacted and flattened with a 1.2-m by 1.2-m by 16-mm (4-ft by 4-ft by 5/8-in.) piece of plywood

Figure 6—Mixing of binder and EWF in mortar mixer.

Figure 7—Leveling and compaction of binder–EWF mixture.

covered with a polyethylene release sheet. To compact the cushioning pad to the full 0.3-m (12-in.) depth required for unbonded EWF, a 90-kg (198-lb) person slowly stepped on the plywood in each quadrant, applying firm pressure.

The two SEWF surfaces were allowed to cure or bond for 6 days prior to usage. The entire surface was covered with polyethylene sheeting for 3 days to protect it from rain. Within 2 h of placing the Vitri-Turf, the surface was somewhat rigid to slight hand pressure. The Soil-Sement surface did not begin to cure or cross-link until more than 48 h had passed; when the polyethylene sheeting was removed, the surface was still slightly tacky. The area was left open to the air for another 3 days prior to opening the play surface for use. Figure 8 shows the completed surface, with little notable differences between the three surface materials.

Test Procedures

Field Observation Reports

The playground site was not under direct supervision or observation by park staff or other responsible personnel. However, on-duty staff noted any public concerns and changes at the site. Forest Products Laboratory staff visited the site at least weekly for the first 2 months and at least monthly thereafter (if the ground was thawed) to perform the rotational penetrometer test and to observe and annotate any maintenance needs, use patterns, or other issues.

Accessibility Measures

All surfaces were measured with the rotational penetrometer periodically over the first 6 months of exposure (Fig. 9). This device subjects the surface to a low-speed rotational bearing test that simulates the weight and action of a front caster wheel on a wheelchair. The procedures are based on a draft national standard test method for the firmness and stability of ground and floor surfaces (RESNA 2000), which uses an average of five readings. This test provides objective measures of surface firmness and stability and has been correlated to the work measurement of ASTM F1951, “Accessibility of Surface Systems,” for a wide array of surfacing and floor coverings (ASTM 1999b). The RESNA test was performed 1 week after surface installation and as often as once a week in the first 2 months, using the rotational penetrometer and protocol for assessing bearing/rotational surface indentation (Axelson and Chesney 1999). The device was used on test areas selected as representative of the entire surface.

Impact Attenuation Tests

Impact tests were performed by a cooperator (Zeager Bros. Inc.) 7 weeks after EWF installation. ASTM F1292–99 test methods were used at a constant test drop height of 3.05 m (10 ft) (Fig. 10). Maximum *g* levels and head injury criteria (HIC) were measured.

Moisture and Durability

To learn more about biodeterioration of the EWF playground system, we sampled and ovendried packets of EWF material and buried them in the unsurfaced portion of the playground. Polyolefin geotextile fiber pouches were each filled with approximately 40 oven-dry grams of fiber (Fig. 11). These biodeterioration samples were placed so as to allow circulation of water and air. The EWF surface was excavated throughout its entire 0.3-m (12-in.) depth to determine the moisture profile of the surfacing system. The samples were buried at depths of 100, 150, 200, 250, and 300 mm (4, 6, 8, 10 and 12 in.) (Fig. 11). One-quarter of the samples was removed at 6 months to provide data on wood fiber moisture content and weight loss. After drying and weighing, the removed packets were reinserted and the area was restored.

Figure 8—Completed playground looking north: left, Vitri-Turf SEWF; right, Soil-Sement SEWF; top, EWF. Line of demarcation is below wheelchair footrest.

Figure 9—Measurement of accessibility with rotational penetrometer.

Figure 10—Impact test setup for drop height of 3.05 m (10 ft).

Figure 11—Biodeterioration samples on EWF surface.

Observations and Results

Field Observation

The park manager conducted a series of surveys of play surface users within 1 month of installation. Approximately 60 children in grades 4 and 5 (ages 9 to 11) were divided into three groups and then invited to play on each test surface. Feedback was solicited on features while the children performed unchoreographed activities, such as bouncing, running, falling, rolling, and jumping. After playing for several minutes on each surface, the children were asked to stand on the surface they preferred. In all three groups of children, more than 90% chose the urethane Vitri-Turf SEWF surface. The remainder had equal preference for the untreated EWF (5%) and the polymer emulsion Soil-Sement (5%) SEWF. The major comment was that the users liked the stiff bounce obtained from the Vitri-Turf and disliked the attenuation of the EWF and the Soil-Sement SEWF.

Accessibility Measures

During the 10-month period of the test, firmness and stability of the SEWF surfaces were measured with the rotational penetrometer (Figs. 12 and 13, respectively). The Soil-Sement SEWF showed poor binding early in the exposure period, compared to the unsurfaced EWF. Only the Vitri-Turf SEWF showed acceptable performance for accessibility during the entire trial installation.

Impact Attenuation

Impact testing (ASTM F1292) was conducted on the Vitri Turf SEWF and the unsurfaced EWF 7 weeks after installation. At this time, the Soil-Sement SEWF had not yet cured or cross-linked because of the rainy weather (see following section on durability). Average *g* readings for the second and third drop tests were 92 for Vitri-Turf and 83 for EWF. Average HIC readings were 507 for Vitri-Turf and 413 for EWF. These values are excellent for a play surface, which must have *g* readings of less than 200 and HIC readings of less than 1,000.

Durability

Measures of surface durability are usually quite subjective unless the loss of durability represents a dramatic failure. This was the case for the installation of the Soil-Sement SEWF. Curing, as evidenced by stiffening of the SEWF mixture, was slow and incomplete. Based on our experience with a previous exterior installation (Laufenberg and Winandy 2003), we assume that individual particles of this material had bonded poorly. Within 3 weeks of installation, the Soil-Sement SEWF showed detachment of top surface particles from the overall layer. The lack of stability and firmness of the Soil-Sement surface was reflected in the rotational penetrometer readings as well. When the impact

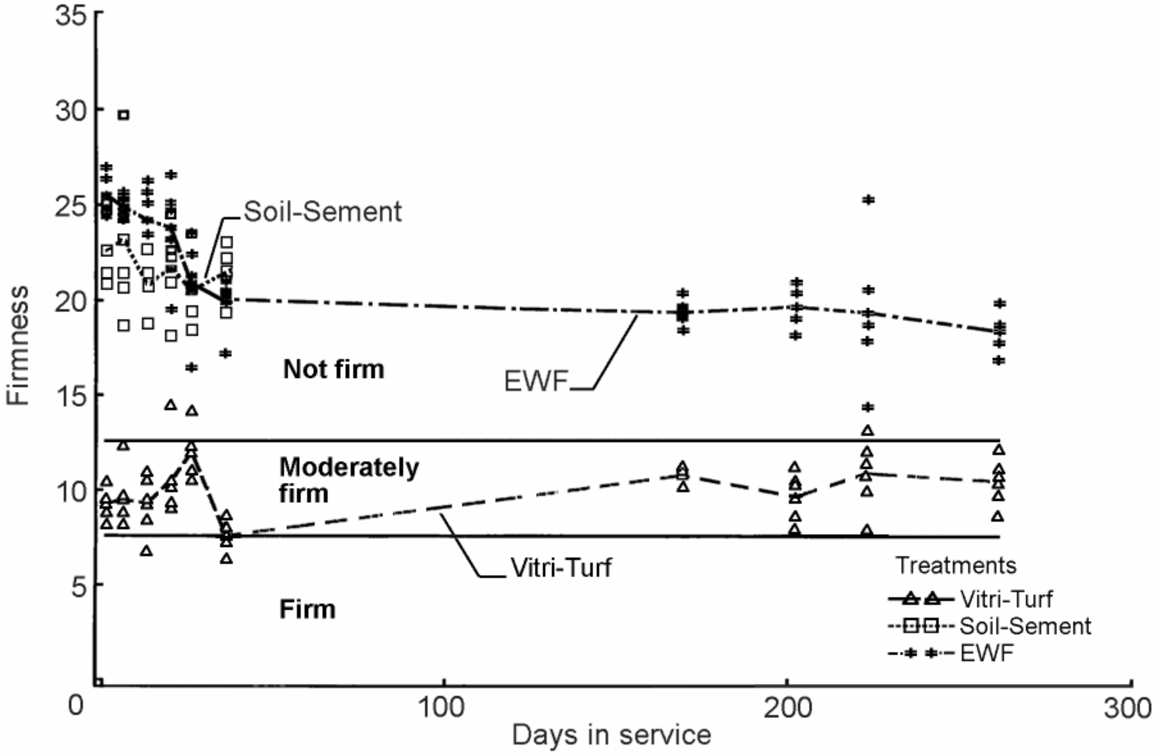

Figure 12—Firmness of playground surface, as measured by rotational penetrometer, over 9-month installation.

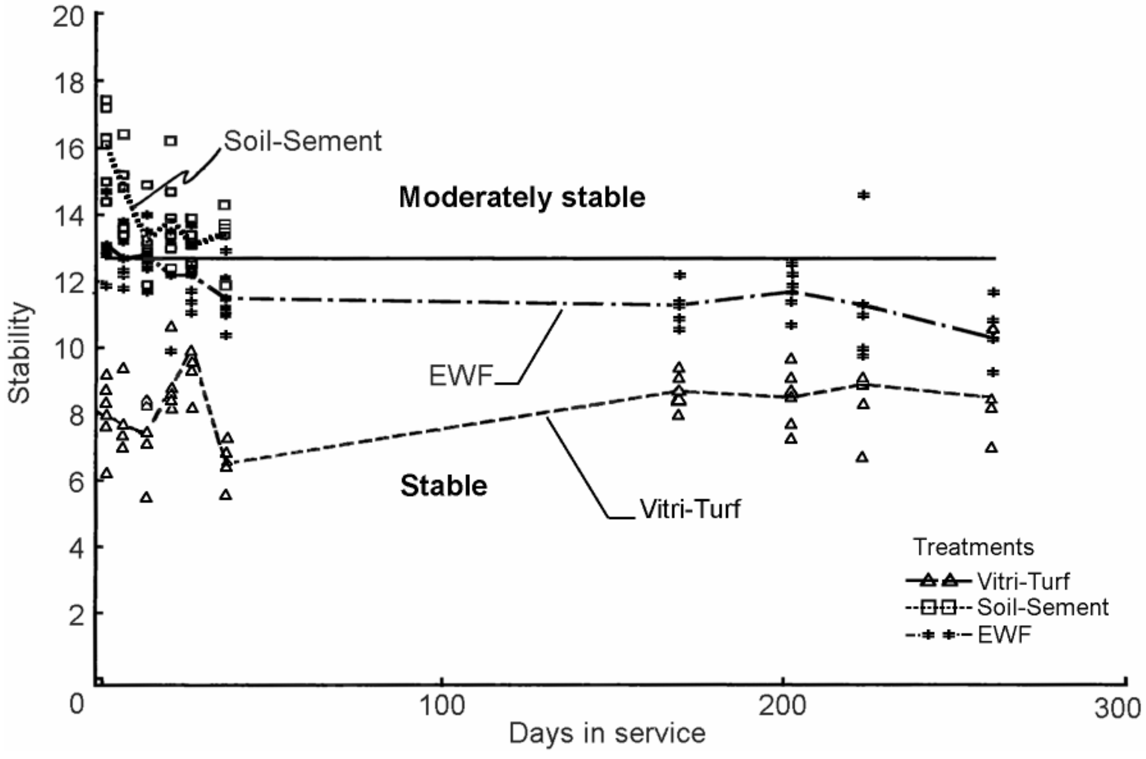

Figure 13—Stability of playground surface, as measured by rotational penetrometer, over 9-month installation.

tests were run (7 weeks after installation), the Soil-Sement surface had deteriorated and its performance was similar to that of unsurfaced EWF. Although we had intended to replace the Soil-Sement SEWF, the cold weather of fall and winter interceded, followed by a record-breaking wet spring and summer, which further precluded re-installation. In retrospect, the use of Soil-Sement may indeed be acceptable, but the conditions for such an installation would need to be fairly dry with relatively warm periods. Some dry and warm climates may lend themselves to the use of this binder. The wet and cool climate in southwestern Wisconsin during the fall 2003 to spring 2004 season was not conducive to the installation or curing of Soil-Sement.

The durability of Vitri-Turf SEWF with exposure to weather was good and reflected similar experience with a prior exterior installation (Laufenberg and Winandy 2003). The integrity of the Vitri-Turf SEWF surface was maintained for the first 9 months. We then found that the edge of the Vitri-Turf SEWF had been lifted and the material torn off in large (0.2- to 0.8-m^2, 2- to 8-ft^2) plates and tossed about on the play surface (Fig. 14). This damage occurred at the unprotected and unsecured interface with the unstabilized EWF. It did not occur at the edge of the playground where the Vitri-Turf had bonded to the wood landscape ties that surround the area. Differential settlement of the Vitri-Turf SEWF and the EWF (due to extensive rainfall) was approximately 38 mm (1.5 in.). As a result of the damage, the Vitri-Turf SEWF was removed 9 months after installation. The material showed little evidence of fungal propagation or insect infestation. The thickness of the removed material, measured at 24 locations, was an average of 30.4 mm (1.2 in.).

To test the durability of the EWF playground system, the biodeterioration samples were removed from various depths of the unsurfaced portion of the playground 6 months after installation. The samples were cleaned, ovendried, and reweighed; weight loss ranged from 1.4% to 1.9%. These values are consistent and reasonable for EWF. In spite of 4 months of freezing conditions above the surface, fungal hyphae were present at all levels (Fig. 15). If the EWF surface is maintained, further results will be gathered from this site at 6-month intervals.

Costs and Personnel Time for EWF Installation

The following summary of costs and time estimates is not meant to be definitive. Markup for contractors or other overhead and profits is not included. No costs were incurred for edging since treated wood edging was already installed. The estimates do not include the significant amount of personnel time required to remove the sand from the playground.

Figure 14—Exposed and torn edge of Vitri-Turf SEWF.

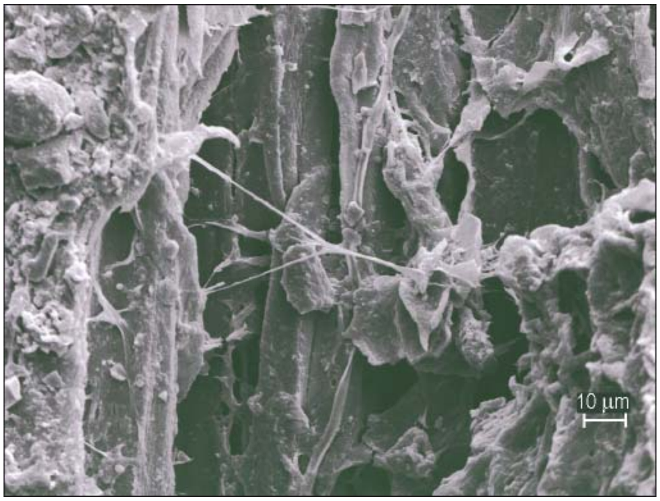

Figure 15—Hyphal growth on surface of wood chip from biodeterioration sample. Fungal growth was present at all depths of EWF surface after 6 months.

Quantity of material

EWF	120 yd^3 uncompacted
Vitri-Turf	35 gal
Soil-Sement	80 gal (45% solids)

Market value of material

EWF	$21/yd uncompacted (incl. shipping)	$2,520
Vitri-Turf	$18/gal (100% solids, 11 lb/gal)	630
Soil-Sement	$7/gal (45% binder/55% water)	560
Drainage system (rock, geotextile, and drainage)		800
		$4,510

Equipment and tool rental (market value) $1,500

Personnel time

Drainage system installation, 25 h @ $15/h	$375
Unbonded EWF installation, 60 h @ $10/h	600
Bonded surface installation, 24 h @ $15/h	360

Installation of the two surface treatments was completed during one work day. Approximate effort for installation of 300 ft^2 of each material (600 ft^2 total) was 24 h (four people for 6 h).

Summary of costs for 0.3-m- (12-in.-) depth surface treatment

	Cost ($/ft^2)			
			Play surface	
Component	Labor	Materials	Paid labor	Volunteer labor
Drainage system	0.20	0.40	—	—
EWF (0.3 m, 12 in.)	0.30	1.17	2.07	1.57
Vitri-turf (38 mm, 1.5 in.)	0.60	2.10	4.77	3.67
Soil-sement (63.5 mm, 2.5 in.)	0.60	1.87	4.54	3.44

Preliminary Guidelines for Vitri-Turf SEWF Installation

Follow manufacturer's instructions for storage and handling of the binder. Binder materials must be stored indoors in cool dry storage out of sunlight. Observe recommended limits on binder shelf life as reactivity will diminish after that time. Read material safety data sheets carefully prior to opening containers. Wear protective clothing and eye gear at all times. The EWF should be less than 30% moisture content for correct absorption and curing of SEWF.

Mixing of Binder With EWF

1. Mix Vitri-Turf binder with EWF at ratio of 77/23 by weight. This is approximately 1.25 gal of Vitri-Turf binder to 1.8 bushels of EWF (depending on density of EWF particles).
2. Use a mechanical drum mixer to mix binder and EWF. To mix a small batch for repairs, use a trough and hoe. Be sure that EWF particles are thoroughly coated. Adequate mixing takes about 2 min in a typical mortar or cement mixer. Check the mixer at the end of each mix to ensure that binder and fine wood particles are not accumulating on the paddles or drum.

Application of SEWF

1. Transport SEWF mixture to site in a wheelbarrow. Dump mixture onto site and apply binder–EWF mixture to a thickness (uncompacted) of about 75 mm (3 in.) using a screed bar or rake.
2. Compact and smooth the surface using a large trowel or a 1.2-m by 1.2-m by 16-mm (4-ft by 4-ft by 5/8-in.) piece of plywood covered with a heavy-mil sheet of polyethylene as a release. If the material sticks, lubricate the trowel or plywood with kerosene, diesel fuel, or soapy water. Do not saturate the surface with these lubricants. After compaction, thickness will be approximately 40 mm (1.6 in.).
3. Apply a moderate downward pressure onto the surface so that the mixture compacts tightly. If plywood is used to compact the surface, a 90-kg (200-lb) person stepping on the four quadrants of the panel should provide adequate compaction.
4. Allow the surface to cure for a minimum of 24 h.

Cleanup

Clean all tools and surface spots immediately with diesel fuel prior to drying. Once the binder has dried it will be extremely difficult to remove from tools, surfaces, or hands.

General Precautions

- Wear protective clothing and eye gear.
- Provide a minimum of 1% slope for all substrates for drainage.
- Ambient air temperature should be 4°C (40°F) or greater and rising when SEWF is applied. Air temperature remain at 4°C (40°F) or greater for at least 7 days after application.
- Protect surfaces from rain for minimum of 48 h after SEWF application.
- Read all material safety data sheets very carefully. If you do not understand the instructions, contact the manufacturer before applying SEWF.
- If binder accidentally comes in contact with eyes, immediately rinse with water and contact a physician.

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