Sustainable Building Materials for the Prevention of Corrosion

U.S. Army Corps of Engineers
2007 Infrastructure Systems Conference

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Outline

- Definitions
- Directives for Sustainability
- Benefits of Use
- Sustainable Project at Fort Lewis
  - Types of Materials
  - Project Status
  - Metrics for Evaluation
  - Expected Results
- Recycled Plastic Lumber
- Barriers to Use
- The Future

Definitions

- **Corrosion:** **"The deterioration of a material or its properties due to a reaction of that material with its environment……", draft DoD Instruction 5000.rr, *Prevention and Mitigation of Corrosion on DoD Military Equipment and Infrastructure.***
- **Sustainability:**
  - **"That which meets the needs of the present without compromising the ability of future generations to meet their own needs." 1987 UN World Commission on Environment and Development.**
  - **"Never let today use up tomorrow." ACSIM / USACE SPiRiT Brochure.**

Directives

- Executive Order 13423, 26 Jan 07, "Strengthening Federal Environmental, Energy, and Transportation Management"
  - Building Performance: *Construct or renovate buildings in accordance with sustainability strategies, including resource conservation, reduction, and use; siting; and indoor environmental quality*.
- Executive Order 13101, 14 Sep 98, "Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition."
- Engineering Technical Letter 1110-3-491, 1 May 01, "Sustainable Design for Military Facilities."
- "Sustainable Development and Design Policy Update", ASAI&E, 5 Jan 06 : minimum LEED rating of Silver. (Leadership in Energy and Environmental Design)

Expected Benefits

- Reduced wastes
  - ✓ no need to dispose of degraded materials
  - ✓ recycled content
- Extended service life
  - ✓ more durable, reduced degradation
- Reduced operational costs
  - ✓ more efficient energy use
  - ✓ less maintenance
- Overall reduced costs
  - ✓ initial cost of construction
  - ✓ lifecycle
- Increased quality of life

OSD Funded Corrosion Prevention and Control Project

Sustainable Materials Replacement at Fort Lewis

PROJECT OVERVIEW

- To renovate an existing building using sustainable products and material systems in order to reduce:
  - Installation costs (first & lifecycle)
  - Operational costs (energy, low-maintenance, more durable)
  - Extend service life (again more durable)
- To obtain a high LEED rating consistent with Army goals for *Sustainability*.

ENVIRONMENTAL EDUCATION & CONFERENCE CENTER

High-Maintenance & Low-Energy Efficient Old Chapel

Low-Maintenance, High-Energy Efficient, and Sustainable Environmental Education and Conference Center

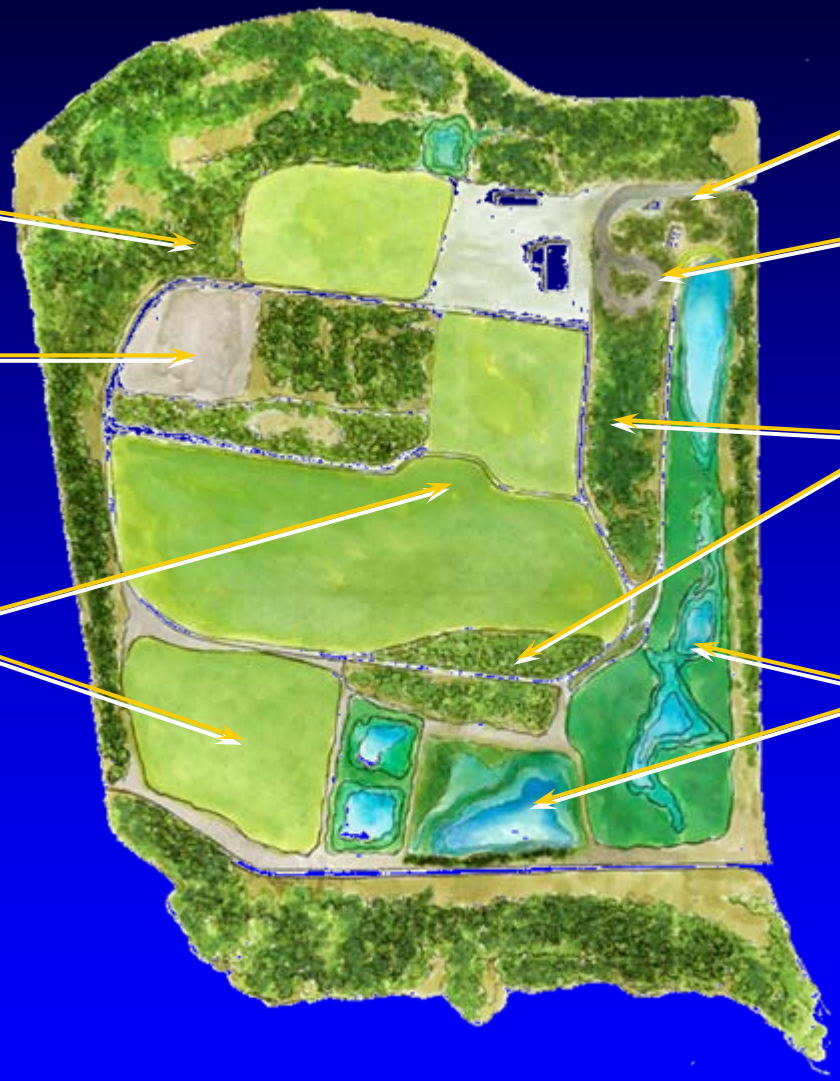
REUSE VS. BUILDING NEW

- Existing chapel building has:
  - 9,300 board feet lumber
  - 2,600 square feet wood flooring
  - 4,500 square feet fiberboard panels
  - 560 square feet windows and doors
- To build a replacement facility of same size and function would take approx. 23 large trees (@ 400 board feet per tree)

LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED)

- U.S. Green Building Council Rating System
- Five Major Categories
  - Sustainable Sites
  - Water Efficiency
  - Energy & Atmosphere
  - Materials & Resources
  - Interior Environmental Quality
- Target Platinum Rating; high Gold current design rating level

SEQUALITCHEW LANDFILL SITE

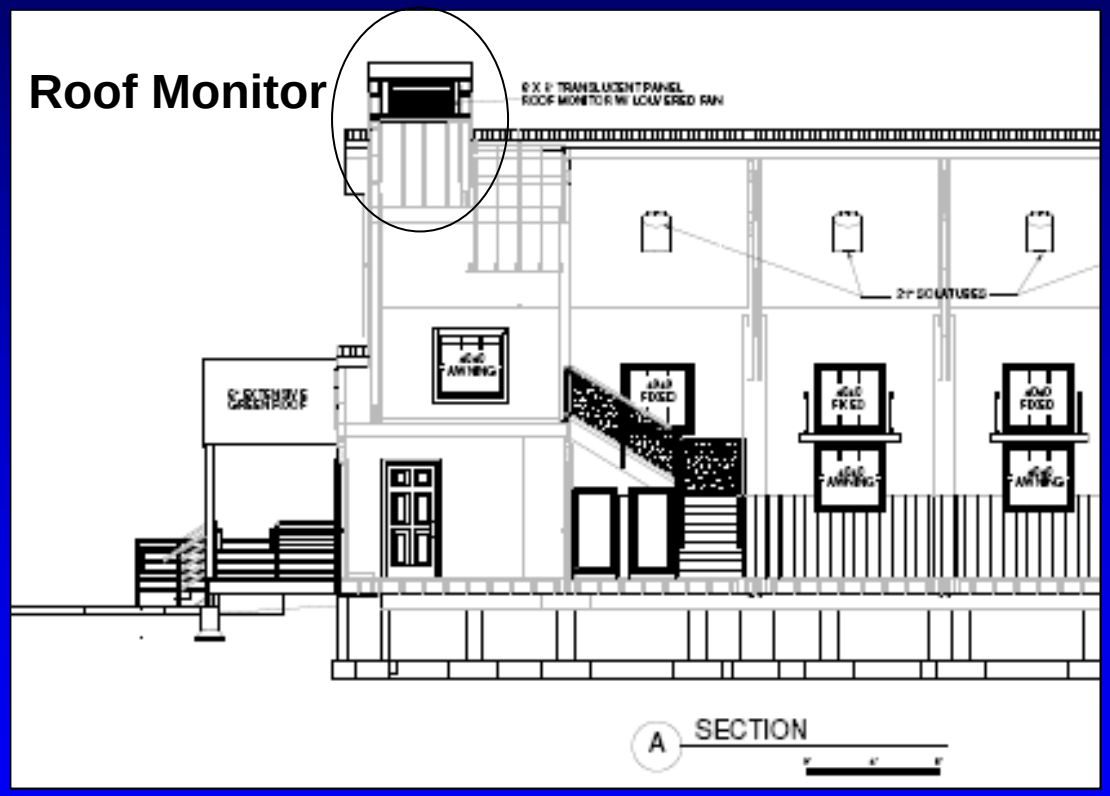


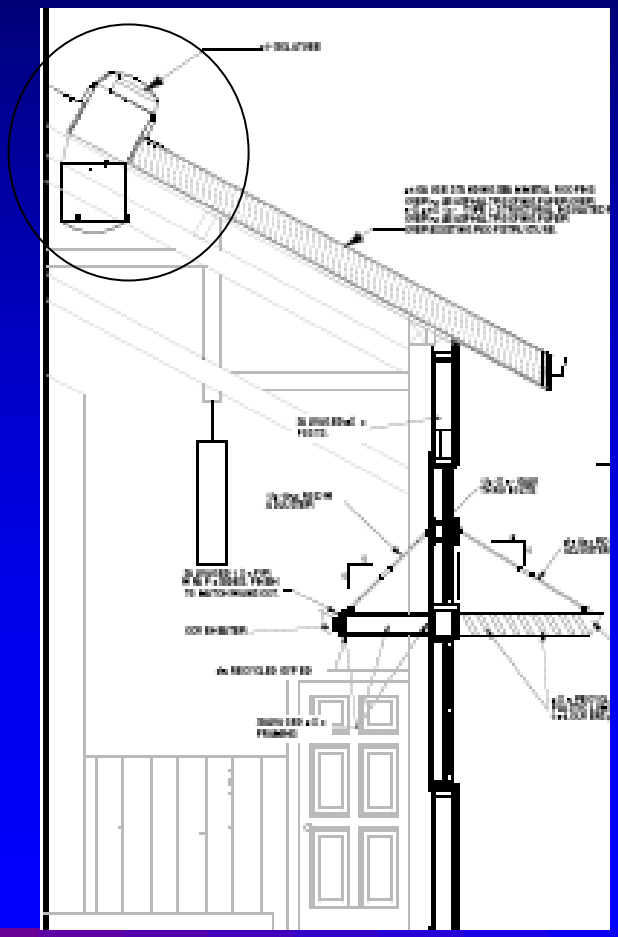
ORIENTATION & SUNSHADING

Building sited in its new location in an East-West Orientation

Light Tubes and Monitor

- For indirect lighting, reduced energy





ENERGY EFFICIENCY

- Upgrade Building Envelope
  - R25 Walls (Cotton Batting)
  - R30 Floor (Cotton Batting)
  - R38 Roof (SIPs)
- Based on energy modeling, the insulated structure will use 75% LESS energy for heating

Types of Sustainable Building Materials

- Foundation and Walls
- Walls and Insulation
- Exterior Claddings
- Roofing
- Recycled Materials
- Utilities
- Coatings, Finishes, and Adhesives

Foundations & Walls

- Insulated concrete forms
- Green concrete – fly ash content

Walls and Insulation

- Structural insulated panel systems (SIPs)

Exterior Cladding

Considerations

- Drainable exterior insulation systems
- Polymeric cladding (e.g., PP)
- Coated fiber cement siding
  - High durability, low-maintenance
  - Reuse / Recyclability, if ever removed

Roofing

Considerations

- Recycled rubber roofing
- "Green" roofing
- High-performance coated metal roofing
  - High-durability, low-maintenance
  - High reflectivity, reduce heat island effect

Recycled Materials

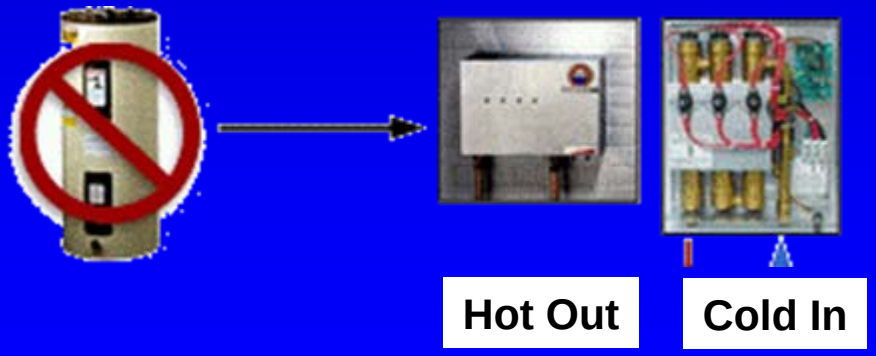
- Recycled Plastic Lumber for Sunshading & Decking

- Recycled Wood Siding, Wainscoting, & Doors

Utilities

- Composting Toilets

- On-Demand / Tankless Water Heaters

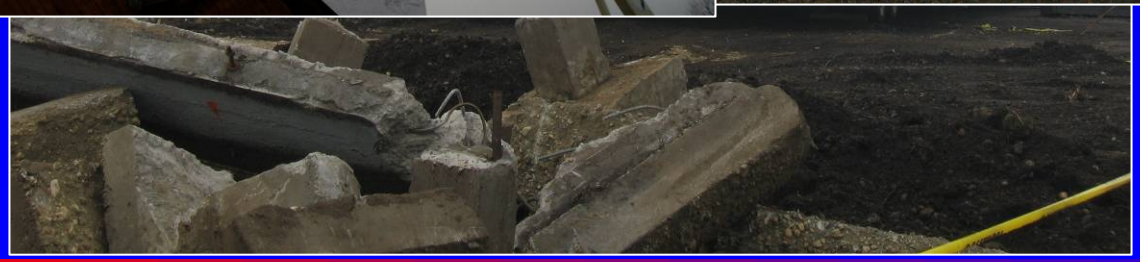


COATINGS, FINISHES, & ADHESIVES

- Use low VOC coatings, finishes, & adhesives, especially for interior use

THE WORK HAS BEGUN

- **Preparation Before the Move**



THE WORK HAS BEGUN

- The Move

THE WORK HAS BEGUN

- New “Green Concrete” Foundation

THE WORK HAS BEGUN

- **Installing SIPs Panels – Roofing & Siding to Follow (also note use of salvaged plywood panels)**

Metrics for Evaluation

- Cost of Implementation (i.e., to install)
- Reduction in Maintenance Costs
- Reduction in Energy Usage
- Longer Life Expectancy (i.e., before replacement)

Expected Results for Fort Lewis Project

- An award winning “showcase” of sustainable design and materials usage
- Minimum LEED rating of GOLD
- Meet or exceed the originally estimated ROI of 14.92 and associated savings of $16-plus million
- Fort Lewis to use experience and demonstrated sustainable materials/product systems in future renovations of existing facilities
- Development of design guidance and specs for implementation across DoD

Certainly Not Sustainable

- Approx. 11 billion pounds of plastic containers manufactured annually in the U.S.
- Nationally, <10 percent of the total is recovered for reuse
- And the rate of recycling is in a downward trend!
- The volume of plastics in landfills is estimated at almost 25 percent
- Plastics are made from fossil fuels which are in finite supply

Also Not Sustainable

- Chemically treated lumber can be hazardous to the environment and people (e.g., ban on consumer use of CCA-treated wood by USEPA)
- Most types of wood used in outdoor exposures need chemical treatments in order to be resistant to moisture, rot, and insects
- In some locations, creosote-treated wood is a hazardous material upon disposal

Marine piling all but gone due to marine borers

A Sustainable Solution

- The Birth of a Sustainable Industry – Plastic Lumber Industry Started by Making Use of Cheap Feedstock Materials Previous Considered a Waste

Recycled Plastics

Plastic Lumber Products

Advantages Of Plastic Lumber and Related Products

- Comparable Strength to Wood BUT Differences in Stiffness to Wood Require Special Design Considerations
- High Toughness
- Doesn't Rot and Not Attacked by Insects
- Not a Hazardous Material
  - Ban on CCA-Treated Wood
  - Is Creosote Next?
- Recyclable - Disposable
- Made from Otherwise Landfilled Materials
- Lower Lifetime Costs
- Properties Can Be Improved -- Engineered

Plastic Lumber Bridge at Fort Leonard Wood, MO

Failing Wood Timbers on Old Bridge to be Replaced

Plastic Lumber Bridge at Fort Leonard Wood, MO

Humvee Driving Across Completed Plastic Lumber Bridge

Benefits Of Using Plastic Lumber for Fort Leonard Wood Bridge

- USED 13,000 LBS POST-CONSUMER PLASTICS
  - 78,000 One-Gallon Milk Jugs (HDPE)
  - 335,000 8-oz. Foam Coffee Cups (PS)
- NO PRESERVATIVES / COATINGS NEEDED
- LIFE EXPECTANCY
  - Treated Wooden Bridge = 15 Years
  - Untreated Wooden Bridge = 5 Years
  - Plastic Lumber Bridge = 50 Years
- LIFECYCLE COST ANALYSIS
  - Break Even in Less Than 8 Years (bridge completed June 1998 with no-maintenance during that period)

Plastic Lumber Structures At Jackson Abbott Wetlands, Fort Belvoir, VA

Handicap Access Fishing Piers

Boardwalk/Observation Deck

Lessons-Learned for Plastic Lumber Structures at Fort Belvoir

- Similar use of materials and material costs as the bridge at Fort Leonard Wood
- Need To Account For Thermal Movement
  - In design (higher thermal expansion coefficient than wood but doesn't swell in presence of moisture like wood)
  - During construction (cut pieces left in the sun will "grow")
- Working Properties
  - Best if using carbide tipped saw blades
  - Best to pre-drill decking boards
- "Plastic Dust" Can Be Pollutant
- Initial costs were still higher than wood design – Need lifecycle consideration to justify first costs.

Plastic Lumber I-Beam Design

- Demonstration bridge at Wharton State Forest, NJ
- Designed & constructed as a cooperative effort between McLaren Engineering & Rutgers University, NJ
- Plastic lumber I-beam design equates to less material to carry the same load – another approach to reduce initial costs
- Interlocking members speeds construction – also to reduce costs

Innovative I-Beam Design

Nested I-Beams for Efficient Design and Rapid Construction

Innovative I-Beam Design

Initial test with pickup truck driving over bridge

Plastic Lumber I-Beam Design

- The success of this bridge is significant since it shows the concept works at both time and materials savings
- Preliminary analysis shows the plastic lumber I-beam design can be cost competitive on a first cost basis to a treated wood design
- The durability and low-maintenance requirements of the plastic lumber structure make life-cycle cost considerations a plus benefit

Related Recycled-Plastic Products -- Pilings and RR Ties

Recycled-Plastic Pilings as Replacement for Creosote-Treated Piles

Recycled-Plastic RR Cross Ties
10-15 Million Wood Ties Replaced Annually in U.S.

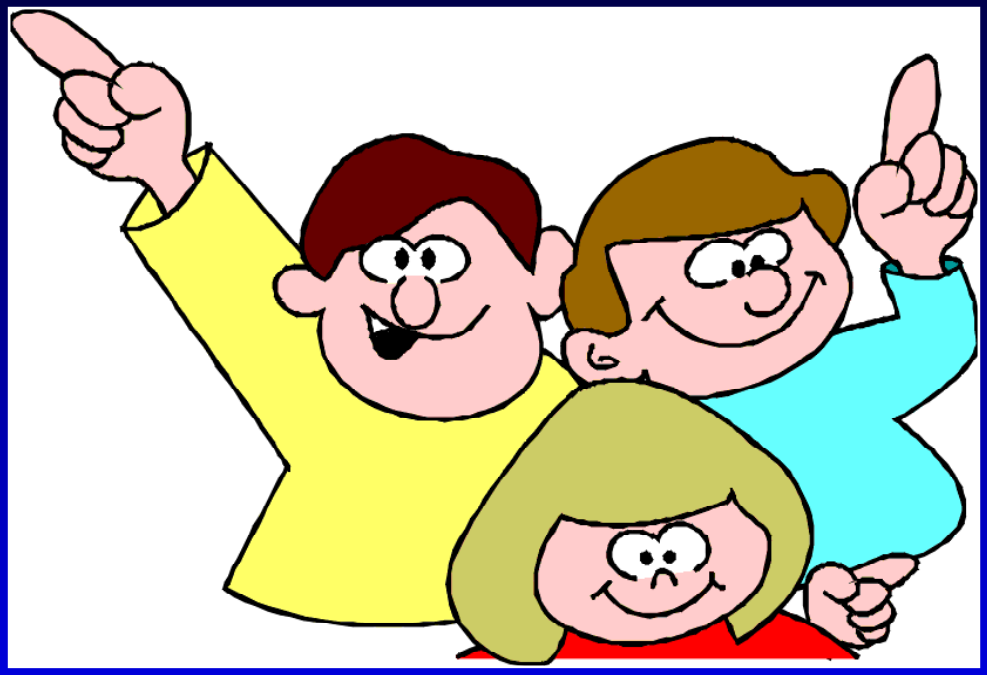
Barriers to Sustainability

- Lack of awareness
  - ✓ directives
  - ✓ products
  - ✓ potential benefits
- Afraid of something new
  - ✓ perceived risks
  - ✓ no experience
  - ✓ unknown long-term performance
  - ✓ are the advertised benefits *REAL*?
- Time constraints for implementing something new

So Do We Have a Sustainable Future Before Us?

- It Can Be!
- It Better Be!
- It Must Be!

Questions ???



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