

Monitoring and Assessment of Polymer Materials in Civil Works Infrastructure Applications

ERDC
Engineer Research and
Development Center

Monitoring Completed Navigation Projects
(MCNP)

Lock Maintenance Workshop

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ERDC / CERL, Champaign, IL

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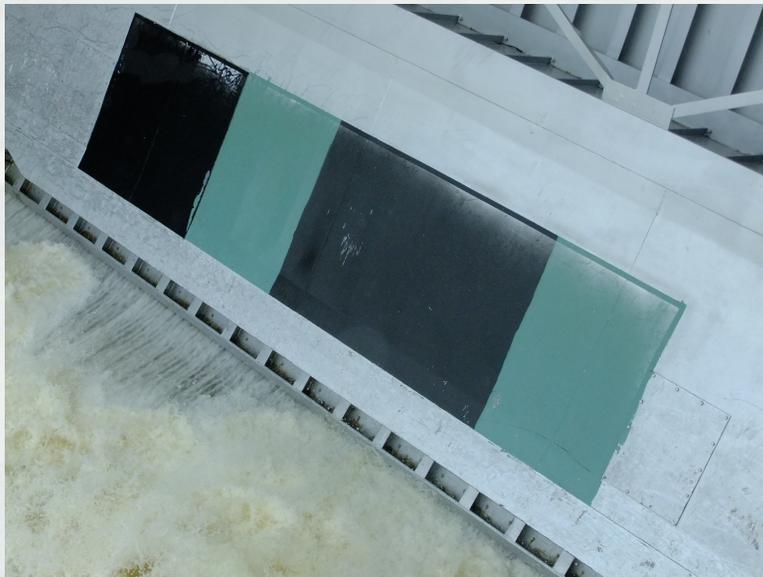


US Army Corps
of Engineers®



Impact / Abrasion Resistant Coatings

- Howell Heflin Dam, AL
- Adhesively applied UHMWPE
- 2 different ceramic epoxy coatings
- Vinyl 3-A-Z system



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12 Month Field Evaluation



- **Inspection Techniques**
- Visual Observation
 - ▶ Rust
 - ▶ Blister
 - ▶ Undercutting
 - ▶ Impact Damage
 - ▶ Delamination
 - ▶ Cracking
- Dry Film Thickness



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12 Month Field Evaluation

- UHMWPE
- Good Adhesion
- Few areas with 1-2 cm deep gouging
- Some corrosion on edges
 - ▶ Due to poor painting



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12 Month Field Evaluation

- **Ceramic Epoxy Coatings**
- **Impact/abrasion down to substrate**
- **No blistering or rust undercutting**
- **No chalking**



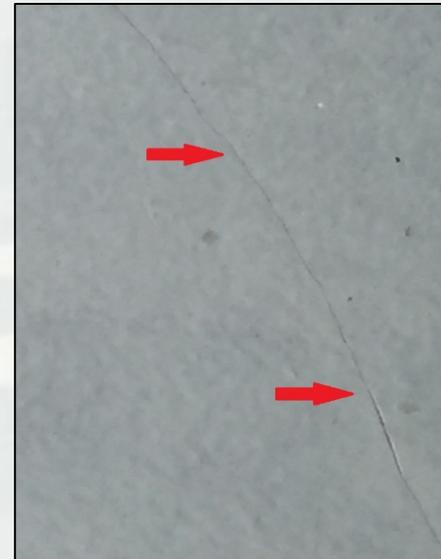
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12 Month Field Evaluation

- Ceramic Coatings on Vinyl 3-A-Z
- Impact/abrasion damage
- Vinyl 3-A-Z showing
- Cracking due to differences in thermal expansion coefficients



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12 Month Field Evaluation

- Vinyl 3-A-Z System
- Extensive impact/abrasion damage
- White intermediate and zinc primer showing
- Substrate corroding



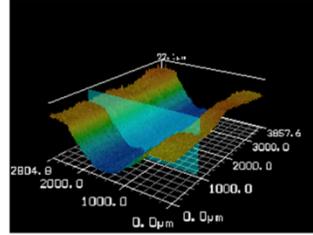
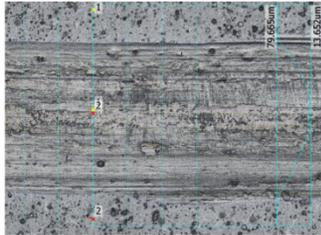
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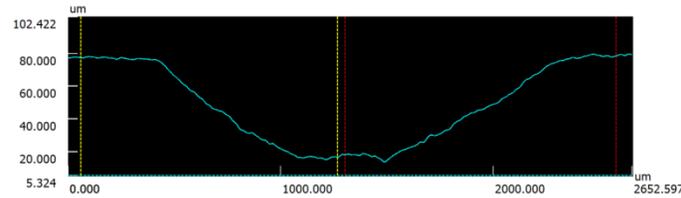
Laboratory Testing

Laser-optical image



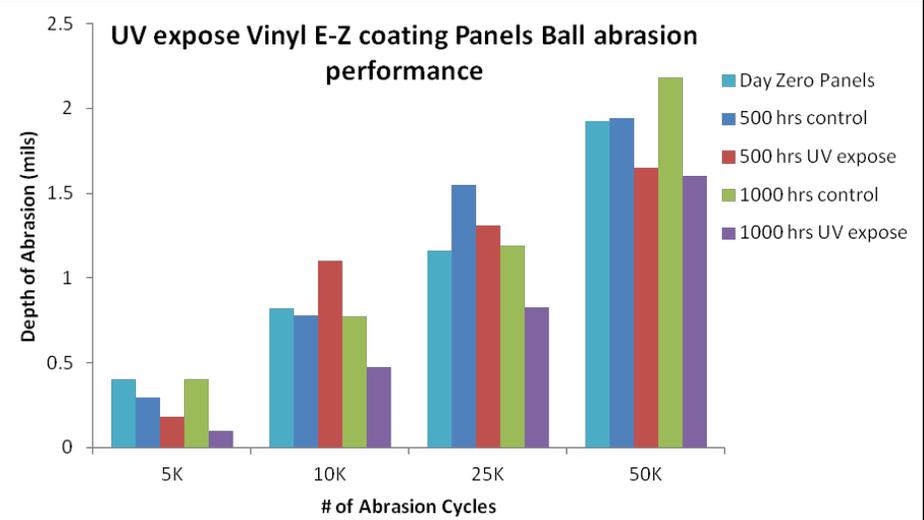
3D profile

Scan length vs surface profile



Profile1	Horz. dist.	Hght. diff.	Hght. ave.	Angle	C.S. length	C.S. area	R	Comment
All	2652.597um	1.923um	48.982um	0.042°	2661.429um	115986.803...		
Seg.1	1204.751um	60.708um	48.971um	2.885°	1209.068um	52773.522u...		
Seg.2	1272.675um	60.212um	46.581um	2.709°	1276.919um	52597.754u...		
Seg.3								
Seg.4								
Seg.5								
Seg.6								
Seg.7								
Seg.8								
Seg.9								
Seg.10								
Total	2477.425um	120.920um	95.552um	5.593°	2485.987um	105371.276...		
Max.	1272.675um	60.708um	48.971um	2.885°	1276.919um	52773.522u...		
Min.	1204.751um	60.212um	46.581um	2.709°	1209.068um	52597.754u...		
Ave.	1238.713um	60.460um	47.776um	2.797°	1242.994um	52685.638u...		
Std. DV	33.962um	0.248um	1.195um	0.088°	33.926um	87.884um2		
3sigma	101.886um	0.744um	3.586um	0.264°	101.777um	263.651um2		

Profile1
Line type : Set 2pt.
Ave: Range 3 lines, Filter: Skip 100 lines
Correction : Smooth intensity None, DCL/BCL None, Smooth height #2 Simple average, Correct tilt Straight line(auto)
Ref. value1 : 102.422um
Ref. value2 : 5.324um
Step : 97.099um



# Abrasion cycles	Average abraded depth(mils)				
	Control			UV exposed	
	Day Zero	500hrs	1000hrs	500hrs	1000hrs
5K	0.403771	0.293648	0.402392	0.177446	0.098796
10K	0.822081	0.777488	0.774316	1.100619	0.475666
25K	1.158557	1.548223	1.188726	1.307371	0.825105
50K	1.924887	1.942578	2.180357	1.648378	1.603866



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Composite Pile Repair



- East Lynn Lake, WV
- FRP Shell
- Epoxy Grout
- FRP Wrap
- Self Consolidating Concrete



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20 Month Field Evaluation



- **Inspection Techniques**
- Visual Observation
 - ▶ Cracking
 - ▶ Swelling
 - ▶ Brooming
 - ▶ Impact Damage
- Digital Tap Hammer
 - ▶ Quantitative
 - ▶ Probes Delaminations



20 Month Field Evaluation



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20 Month Field Evaluation



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20 Month Field Evaluation

- Scour / Erosion
- Bare Steel Exposed
- Repair
 - ▶ Restore Mudline
 - ▶ New, Larger Riprap



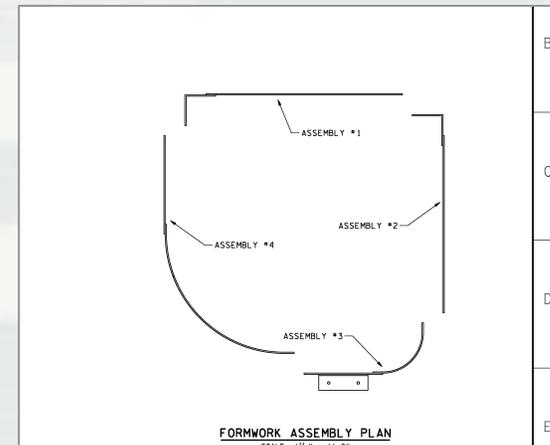
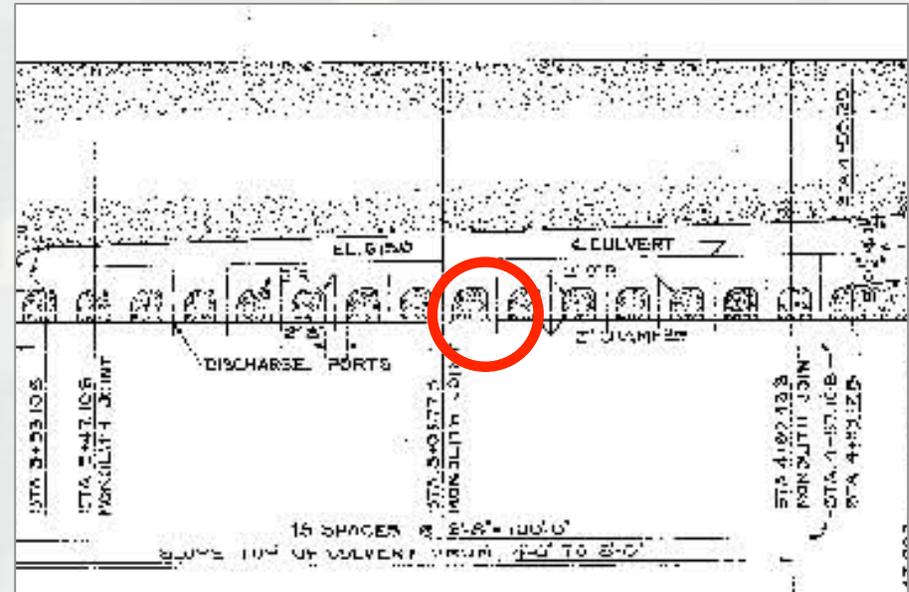
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FRP Wrap Concrete Repair

- Chickamauga Lock – Chattanooga, TN
- FRP Wrap
- Primer
 - ▶ Promotes Adhesion



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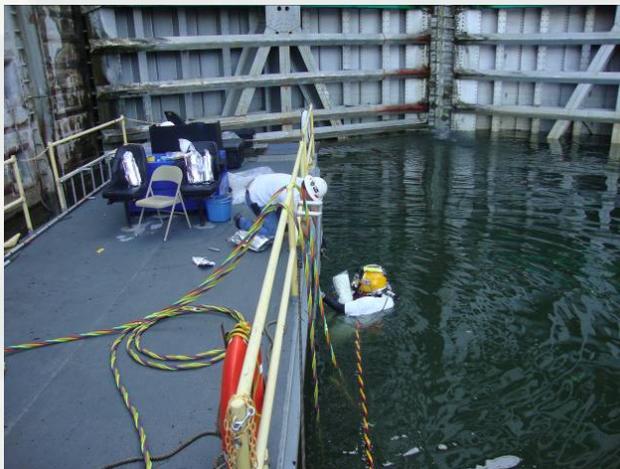
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12 Month Field Evaluation

- **Inspection Techniques**

- Visual Observation - Divers

- ▶ Cracking
- ▶ Disbonding
- ▶ Swelling



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Laboratory Testing

- Accelerated Weathering
 - ▶ Immersion
 - ▶ UV
 - ▶ Atmospheric
- Compression Testing
 - ▶ Wrapped Concrete Cylinders
- Tensile Testing



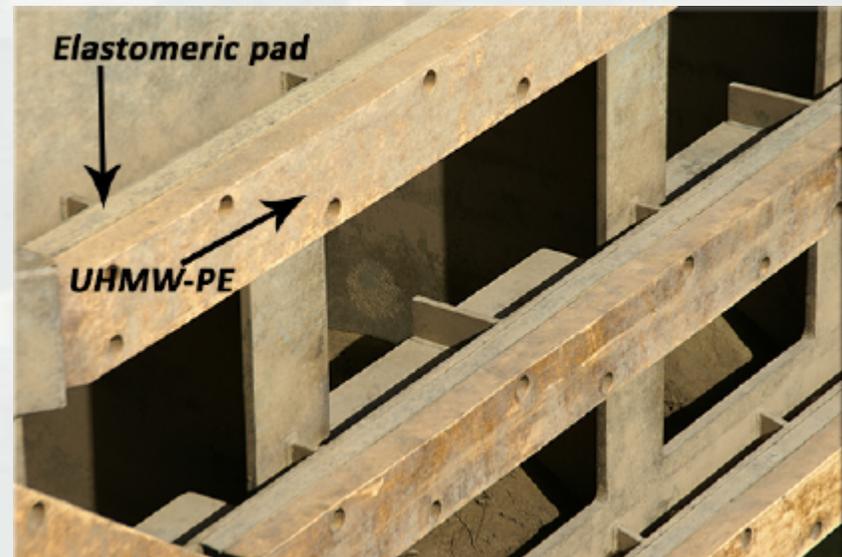
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Composite Timbers

- Bumpers
 - ▶ Many locks across USACE
- Wall Armor
 - ▶ Lock and Dam 52



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Polymer Slides

- Bankhead Dam, AL
- Iteration #1
 - UHMW-PE
 - ▶ Mechanically Fastened
- Iteration #2
 - PTFE
 - ▶ Mechanically Fastened
 - UHMW-PE
 - ▶ Adhesively Applied



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Polymer Slides

- Iteration #3
 - Imbedded Steel Plate
Badly Corroded
 - Belzona R-Metal Repair
 - Superglide Topcoat
- Iteration #4
 - Stainless Steel Plate
 - ▶ Imbedded in Composite
Sheet



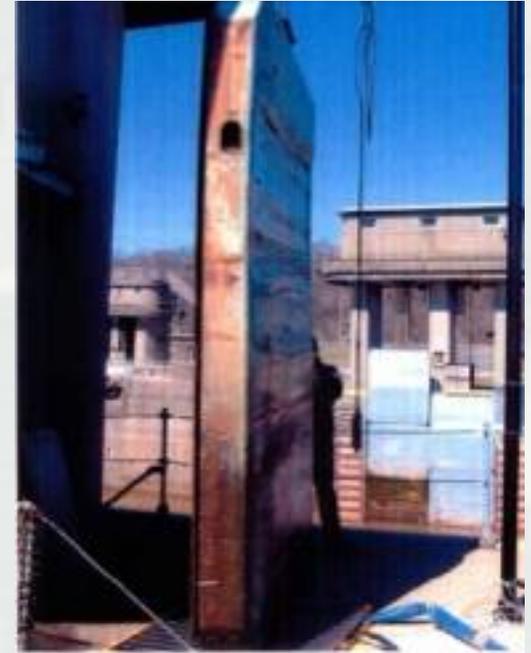
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Composite Recess Panels

- Willow Island Lock, OH
- **Inspection Techniques**
- Visual Observation
 - ▶ Cracking
 - ▶ Swelling
 - ▶ Brooming
 - ▶ Abrasion
 - ▶ Impact Damage
- Digital Tap Hammer
 - ▶ Quantitative
 - ▶ Probes Delaminations



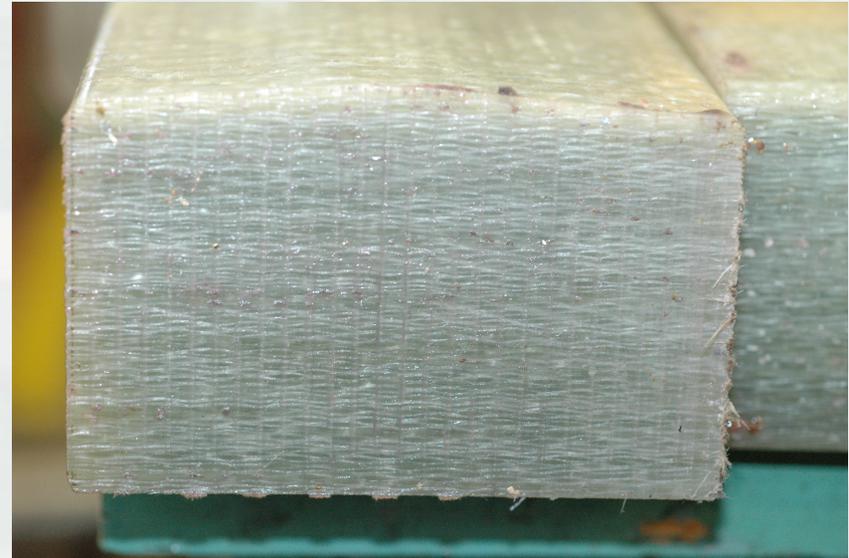
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Composite Miter Blocks

- Hiram Chittenden Locks, WA
- **Inspection Techniques**
- Visual Observation
 - ▶ Cracking
 - ▶ Swelling
 - ▶ Brooming
 - ▶ Abrasion
 - ▶ Impact Damage
- Digital Tap Hammer
 - ▶ Quantitative
 - ▶ Probes Delaminations



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Composite Wicket Gate

- Peoria Dam, IL



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Questions ???



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