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Durability of Traditional and Modified Limewashes

Mary F. Striegel
Sarah M. Jackson

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Who is NCPTT

- Legislation
- Location
- Federal Agency
- Programs
- Materials Research

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Established by congress in 1992

- The legislation created the Center, a Board, and a Grants program
- NCPTT advances the application of science and technology to historic preservation.
- Working in the fields of archeology, architecture, landscape architecture and materials conservation, the Center accomplishes its mission through training, education, research, technology transfer and partnerships.

- Legislation
- Location
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Natchitoches, Louisiana

- Legislation
- Location
- Federal Agency
- Programs
- Materials Research

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- Legislation
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Northwestern State University

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Lee H. Nelson Hall

- Legislation
- Location
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Part of the National Park Service

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- Legislation
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- Materials Research

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Four major program areas

- Archeology and Collections
- Architecture and Engineering
- Cultural Landscapes
- Materials Research

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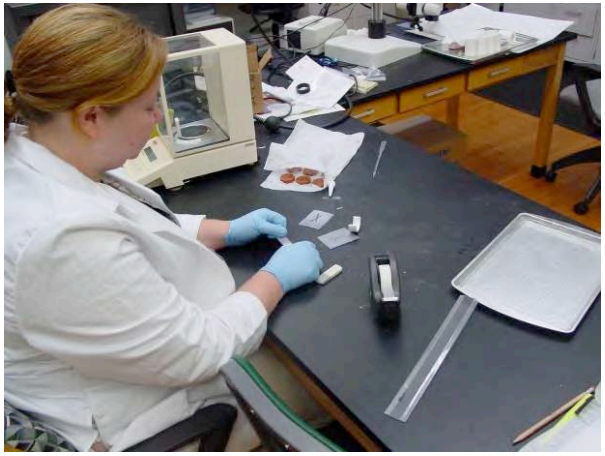
NCPTT Materials Research



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Cane River Creole National Historical Park

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Durability Study

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Limewash

- Definitions
- History
- Manufacture
- Uses
- Application
- Popularity

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What is Limewash?

- Limewash is a simple type of matt paint made from lime and water, with or without additives or pigments.

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History of Limewash

- Lime itself has a long history and was used by Egyptians as early as 4000 BC.
- Limewash was important in the 17th and 18th centuries
- The waning of Limewash was a result of
  - The introduction of Portland Cement in 1824
  - the development of modern more durable paints, and
  - the rise in cost of labor

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Manufacture

- Limewash is made from lime and water.
- The process involves three main steps.
  - Burning Lime
  - Slaking Lime
  - Preparing Wash with or without additives

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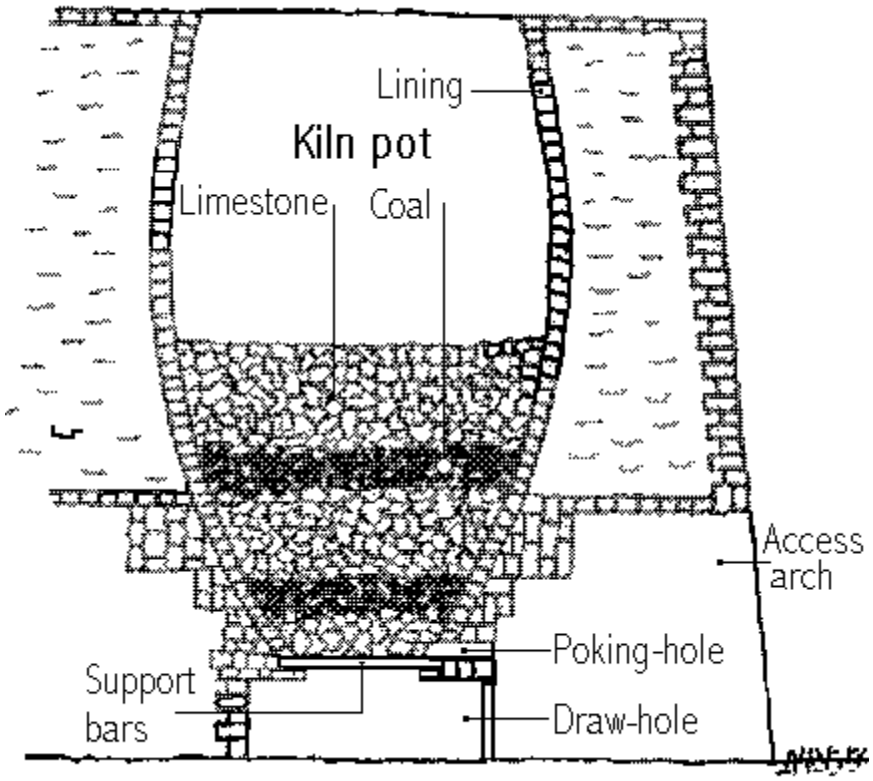
Burning Lime



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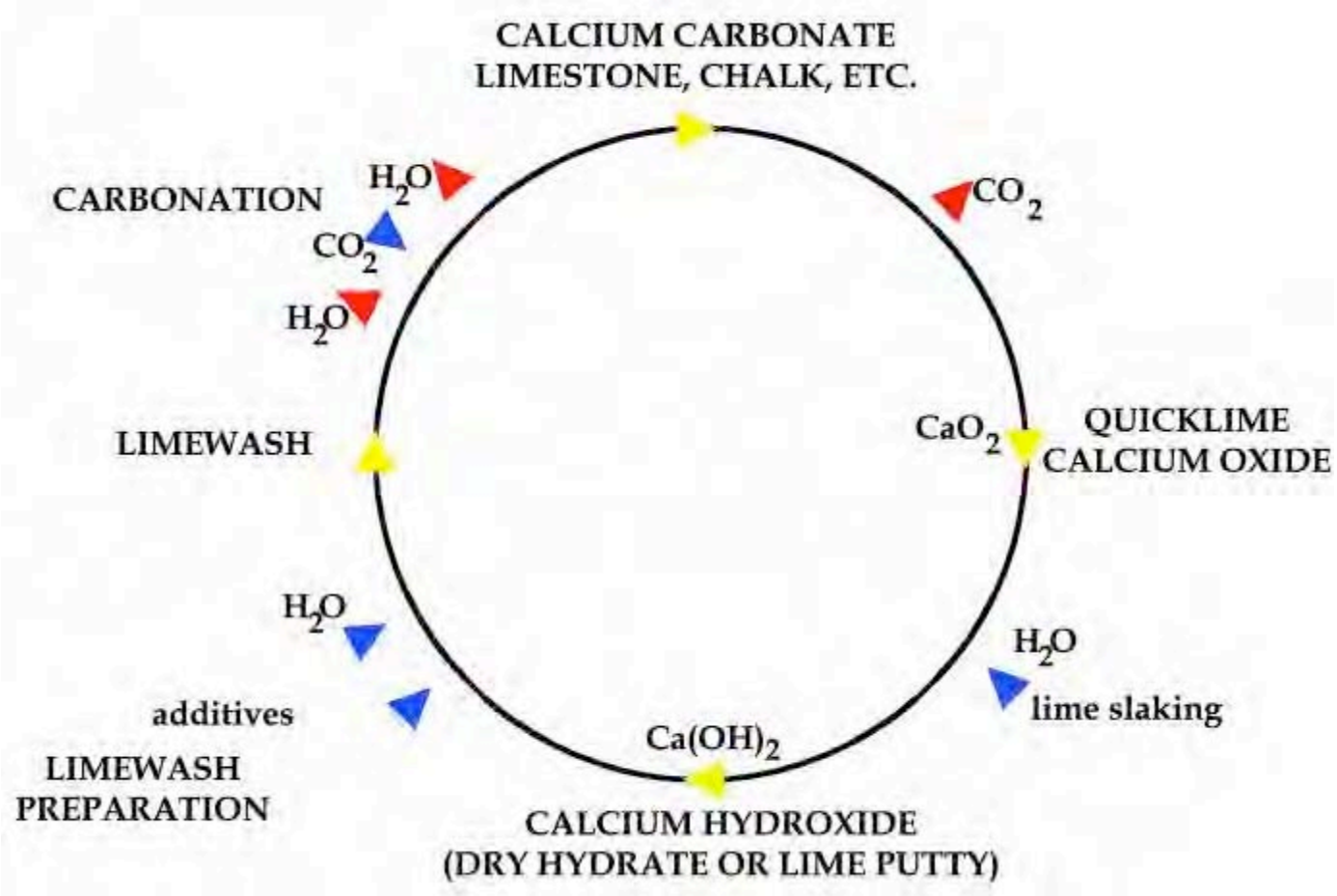
Lime Cycle



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Additives

Additive	Function
Lime	Basic covering medium
Tallow	Binder and waterproofing
Raw Linseed Oil	Weather-proofing
Casein	Improved resistance
Salt	Humectant, Emulsifier
Alum	Humectant, Emulsifier
Clove Oil	Biocide
Washing Blue	Add Brilliance

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Uses

- Applied to
  - Adobe
  - Brick
  - Waddle and Daub
  - Plaster
  - Wood
- A breathable coating
- A protectant
- A consolidant
- An insect repellent
- An antiseptic

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Application

- Surfaces are brushed down to clean then dampened normally with a hand-pumped spray
- Limewash is applied thinly
- Three or four coats are the minimum needed
- Each coat is allowed to dry thoroughly then dampened before applying the next coat.

Whitewash is easily applied. The materials required are inexpensive, yet a good finish can be obtained if the surface is properly prepared and the whitewash applied thin.

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Popularity

- Limewash popular in the 17th and 18th centuries in America
- It was used to whiten the walls of homes and applied annually.
- By the mid 19th century, it was used mostly on fences and the exteriors of cottages, barns and other outbuildings.
- It was largely replaced by the development of other paints.

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Details of the Study

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Substrates

Rough-sawn New Wood

Weathered Wood

Epoxy

Modern
Brick

Handmade
Brick

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Sample Preparation

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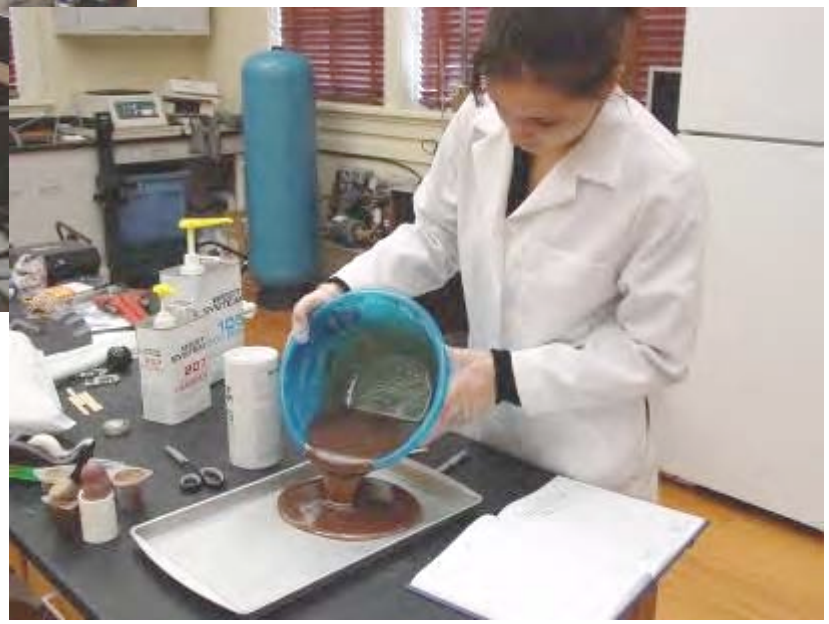
Sample Preparation



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Limes

- Graymont “Ivory Finish Lime” Hydrated Lime
- Graymont “Niagara” Mature Lime Putty
- Virginia Lime Works Lime Putty
- Mississippi Lime Architectural Lime Putty

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Recipes

	Lime	Part A	Part B	Mix
Wash A	Graymont Ivory hydrated lime.	1lb. Table salt, .5 oz alum, 1/3 cup unsulphured molasses, 1/12 tsp laundry bluing. Mix in 2 1/2 cups hot water.	4 1/4 cups hydrated lime mixed with 4 1/2 cups hot water let stand 12 hours	Mix parts A & B in equal parts. Viscosity 17 seconds at 70 degrees in #4 Ford cup.
Wash B	Graymont Niagara lime putty	1lb. Table salt, .5 oz alum, 1/3 cup unsulphured molasses, 1/12 tsp laundry bluing. Mix in 3 cups hot water.	Mix 8 1/2 cups Niagara putty with 4 cups hot water. Let stand 12 hours.	Mix parts A & B in equal parts. Viscosity 17 seconds at 70 degrees in #4 Ford cup.
Wash C	Virginia Limeworks lime putty	1lb. Table salt, .5 oz alum, 1/3 cup unsulphured molasses, 1/12 tsp laundry bluing. Mix in 2 1/2 cups hot water.	Mix 8 1/2 cups Virginia Limeworks with 4 3/4 cups hot water.	Mix parts A & B in equal parts. Viscosity 17 seconds at 70 degrees in #4 Ford cup.

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Recipes

	Lime	Part A	Part B	Mix
Wash D	Graymont Ivory hydrated lime.	1/3 cup unsulphered molasses, 1/12 tsp laundry bluing, ¼ tsp clove oil. Mix with 1 ½ cups of hot water.	4 1/4cups of hydrated lime mixed with 2 1/2 cups hot water. Let stand 12 hours.	Mix parts A & B in equal parts. Viscosity 17 seconds at 70 degrees in #4 Ford cup. Add 4 tsp Schmincke Binding Medium per 1 cup of limewash.
Wash E	Graymont Niagara lime putty	1/3 cup unsulphered molasses, 1/12 tsp laundry bluing, ¼ tsp clove oil. Mix with 1 ½ cups of hot water.	8 1/2 cups of putty lime mixed with 2 1/4 cups hot water. Let stand 12 hours.	Mix parts A & B in equal parts. Viscosity 17 seconds at 70 degrees in #4 Ford cup. Add 4 tsp Schmincke Binding Medium per 1 cup of limewash.
Wash F	Virginia Limeworks lime putty	1/3 cup unsulphered molasses, 1/12 tsp laundry bluing, ¼ tsp clove oil. Mix with 1 1/2 cups of hot water.	8 1/2 cups of putty mixed with 2 1/4 cups hot water. Let stand 12 hours.	Mix parts A & B in equal parts. Viscosity 17 seconds at 70 degrees in #4 Ford cup. Add 4 tsp Schmincke Binding Medium per 1 cup of limewash.

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Recipes

	Lime	Part A	Part B	Mix
Wash G	Graymont Ivory hydrated lime	4 1/4 cups hydrated lime mixed with 7 1/2 cups hot water. Let stand 12 hours.		Check viscosity 17 seconds at 70 degrees. For each 1 cup of limewash, add 2 tablespoons of Edison.
Wash H	Graymont Niagara lime putty	8 1/2 cups Niagara lime putty mixed with 5 cups hot water. Let stand 12 hours.		Check viscosity 17 seconds at 70 degrees. For each 1 cup of limewash, add 2 tablespoons of Edison.
Wash I	Virginia Limeworks lime putty	8 1/2 cups Virginia lime putty with 5 cups hot water. Let stand 12 hours.		Check viscosity 17 seconds at 70 degrees. For each 1 cup of limewash, add 2 tablespoons of Edison.

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Recipes

	Lime	Part A	Part B	Mix
Wash K	Virginia Limeworks lime putty	8 1/2 cups Virginia lime putty with 5 cups hot water. Let stand 12 hours		Check viscosity 17 seconds at 70 degrees.
Wash L	Graymont Ivory hydrated lime	4 1/4 cups hydrated lime mixed with 4 1/2 cups hot water. Let stand 12 hours.	Add sufficient water to achieve mix requirements. (We added 2 1/2 cups of water)	Check viscosity 12 seconds at 70 degrees.
Wash M	Graymont Niagara lime putty	8 1/2 cups Niagara lime putty mixed with 5 cups hot water. Let stand 12 hours.	Add sufficient water to achieve mix requirements. (We added 15 cups of water)	Check viscosity 12 seconds at 70 degrees.
Wash N	Mississippi Lime Company Lime Putty	8 1/2 cups Mississippi Lime Co. Lime Putty with 26 cups of hot water. Let stand 12 hours.	Add sufficient water to achieve mix requirements. (We added 21 cups of water)	Check viscosity 12 seconds at 70 degrees.

Applied to handmade and modern brick.

Applied to handmade brick and weathered wood.

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Limewash Application

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Testing Methods

- Documentation
- Color Change
- Solids Measurement
- Artificial Weathering
- Abrasion
- Adhesion

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EXPERIENCE YOUR AMERICA

Documentation

- Documentation
- Color Change
- Solids Measurement
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- Adhesion

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Colorimetry

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EXPERIENCE YOUR AMERICA

Solids

- Documentation
- Color Change
- Solids Measurement
- Artificial Weathering
- Adhesion
- Abrasion

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EXPERIENCE YOUR AMERICA

Artificial Weathering

- Documentation
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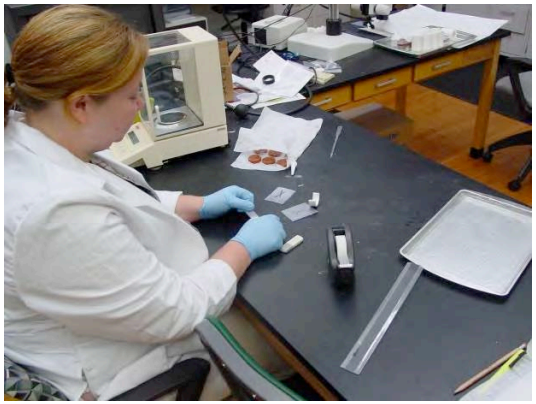
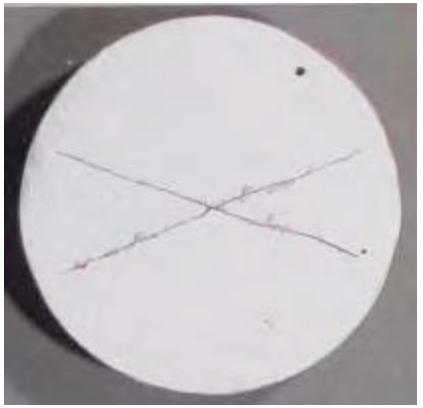
EXPERIENCE YOUR AMERICA

Adhesion





- Documentation
- Color Change
- Solids Measurement
- Artificial Weathering
- Adhesion
- Abrasion

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EXPERIENCE YOUR AMERICA

Abrasion

- Documentation
- Color Change
- Solids Measurement
- Artificial Weathering
- Adhesion
- Abrasion

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Results

- Handmade Brick
- Modern Brick
- Weathered and Rough-sawn New Wood
- Epoxy

Results on Handmade Brick

	Rating	QUV	Adhesion	QUV-Adhesion	Abrasion	QUV-Abrasion
Best	13	A, E, K, L	F	M	A	M
	12	M	H	C, E, G	B	A
	11	F, H	D	K	K	B
	10	D, G, I	E		C	L
	9	B	A		D	D
	8	N	K	F, H	L	E
	7	C	I		I	H
	6		C, G	I	G	K
	5			A	E	F
	4		B	D, L	M	C
	3		N		H	I, G
	2		M	B	F	
Worst	1		L	N	N	N

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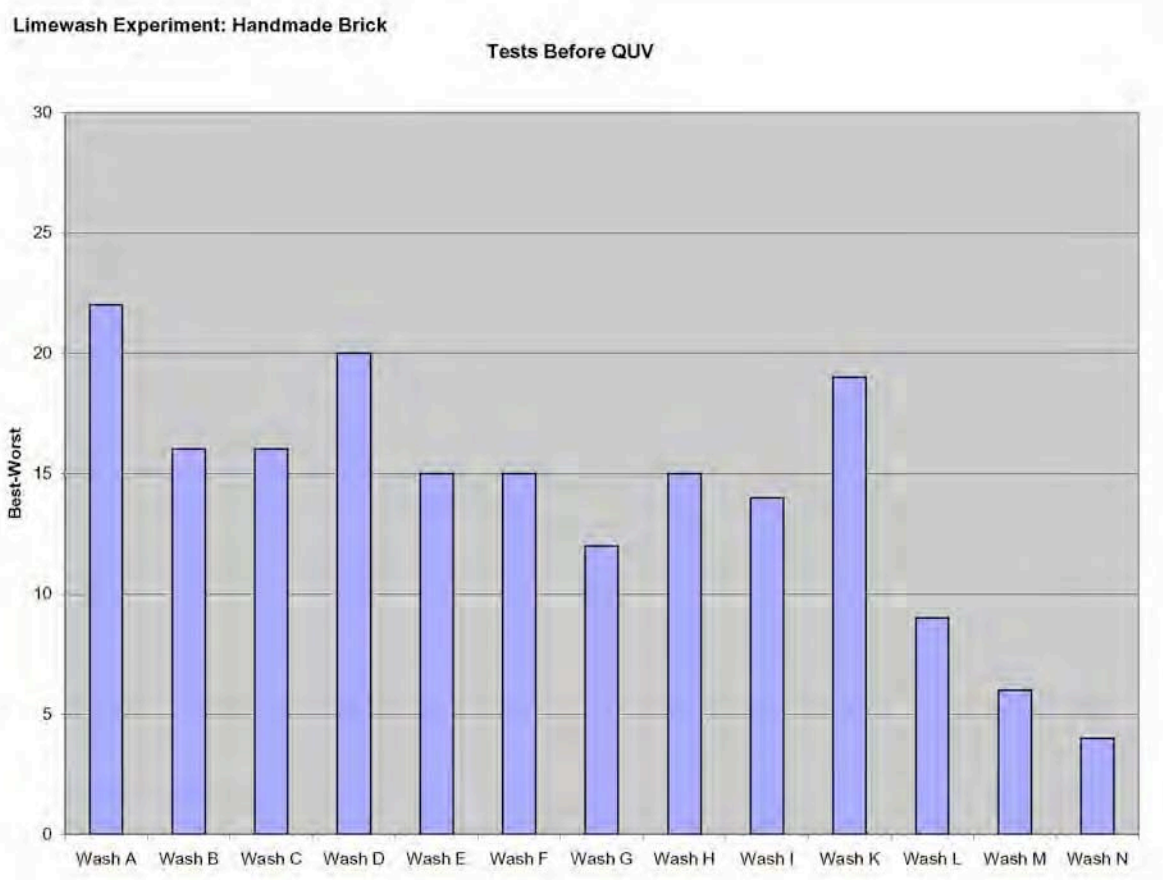
Results on Handmade Brick



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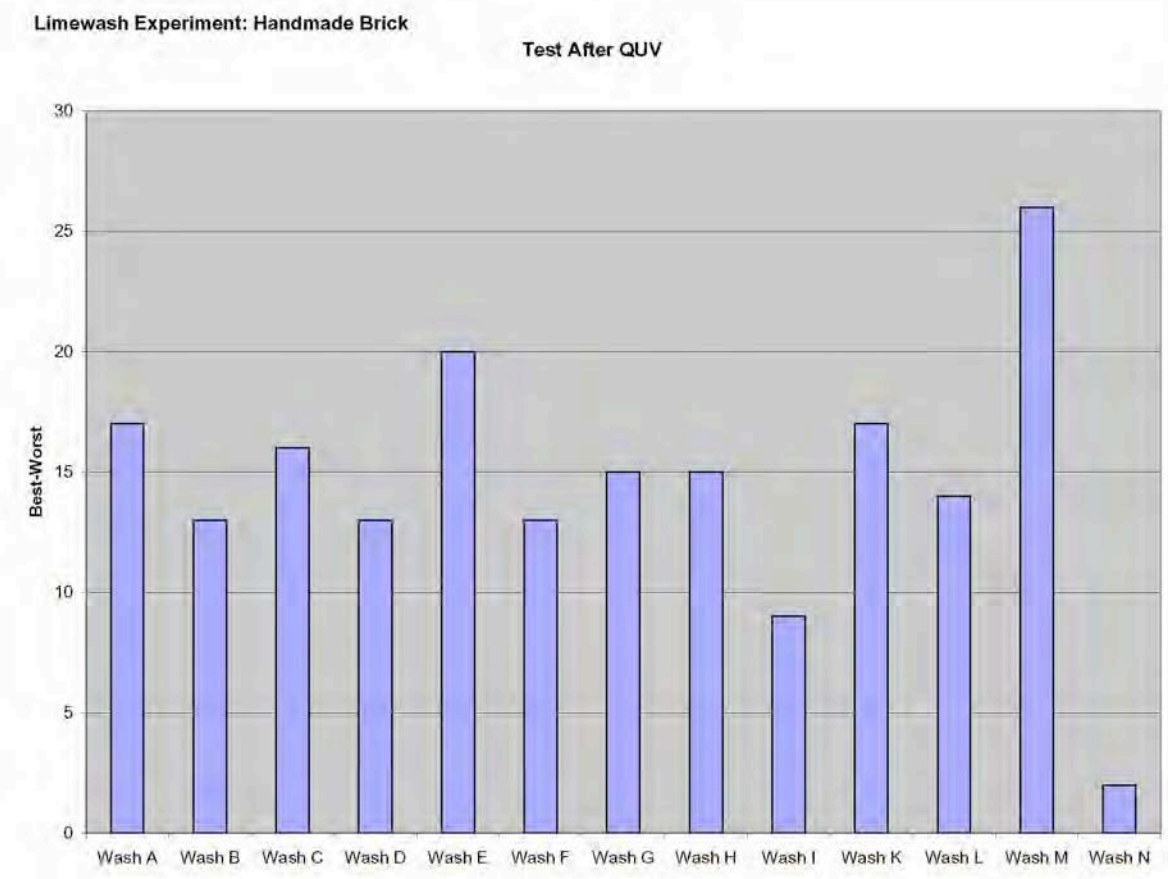
Results on Handmade Brick



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- Handmade Brick
  - Results
  - Before QUV
  - After QUV
  - Comparison
- Modern Brick
- Weathered and Rough-sawn New Wood
- Epoxy

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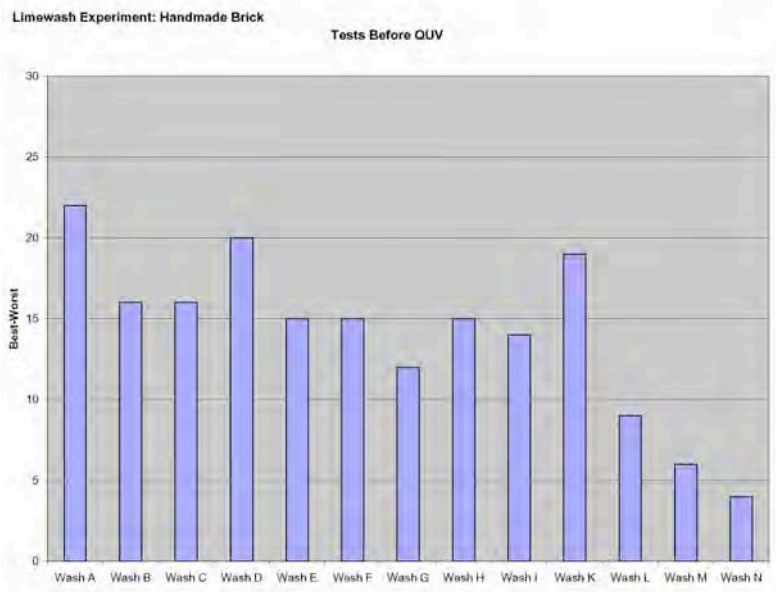
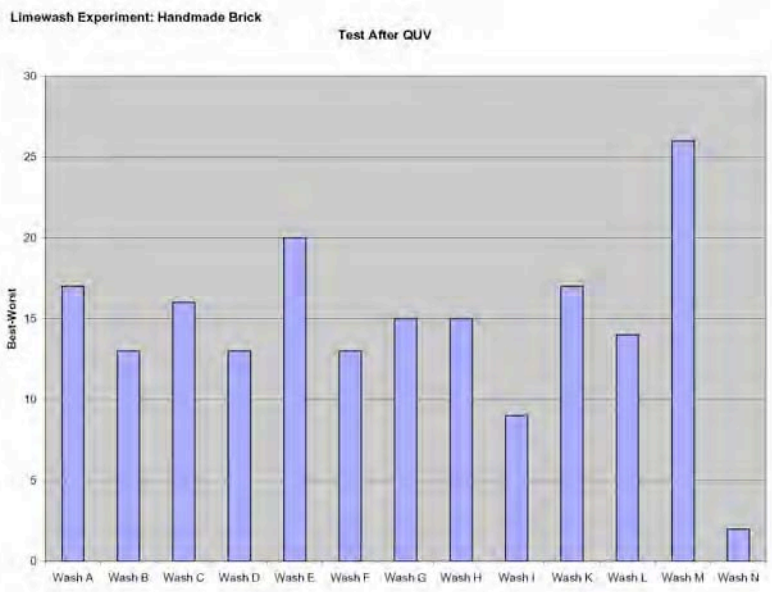
Results on Handmade Brick





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Results on Modern Brick

	Rating	QUV	Adhesion	Abrasion	QUV-Adhesion	QUV-Abrasion
Best	10	K	K	A	I	B
	9	D, H	F	B	H	E
	8		D	C	F	A
	7	B	B	K	C	D
	6	E, I	A	F	D	H
	5		G	G	A, E, G	G
	4	G	E	D		K
	3	A	C	E		C
	2	F	I	I	B	I
Worst	1	C	H	H	K	F

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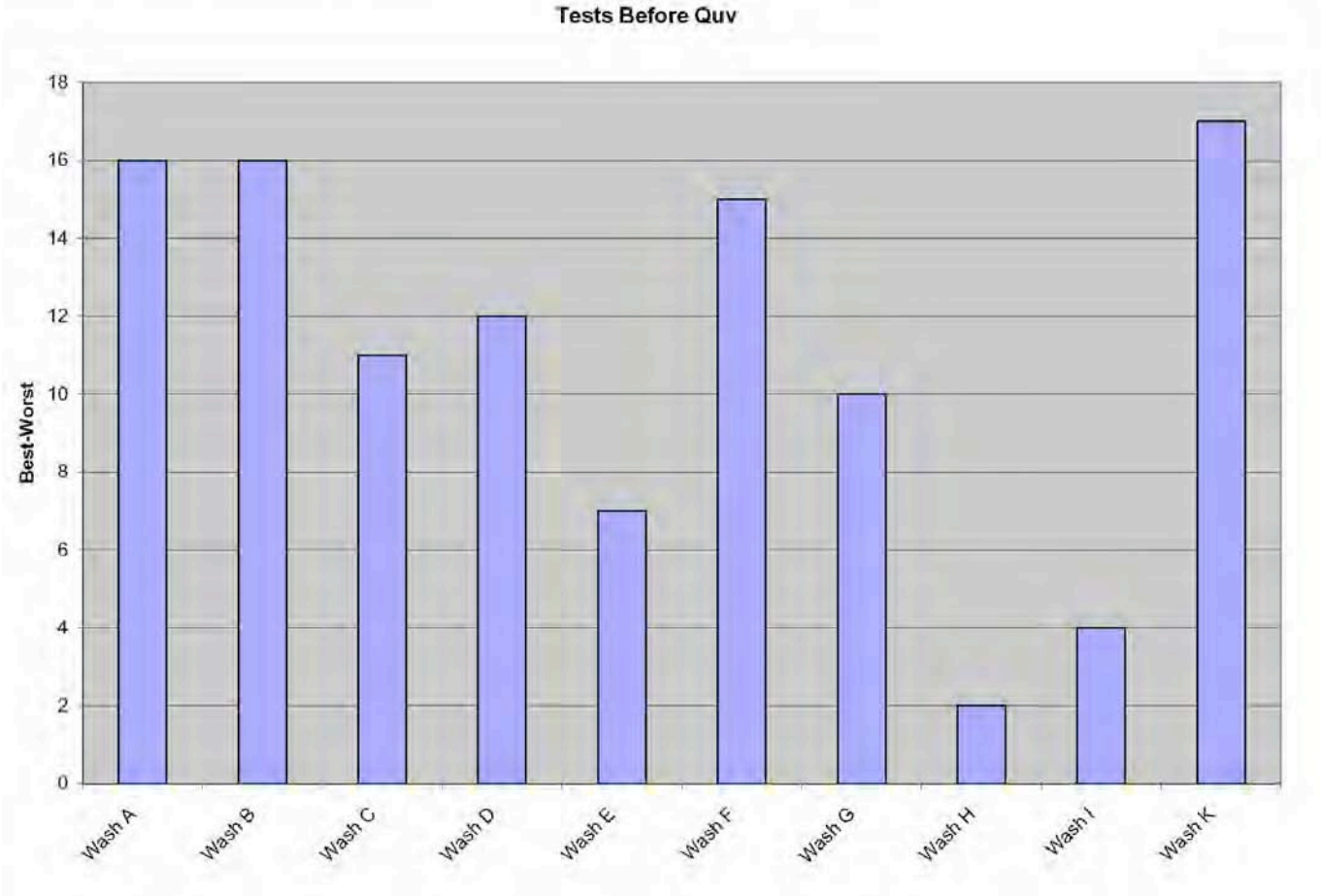
Results on Modern Brick



- Handmade Brick
- Modern Brick
  - Results
  - Before QUV
  - After QUV
  - Comparison
- Weathered and Rough-sawn New Wood
- Epoxy

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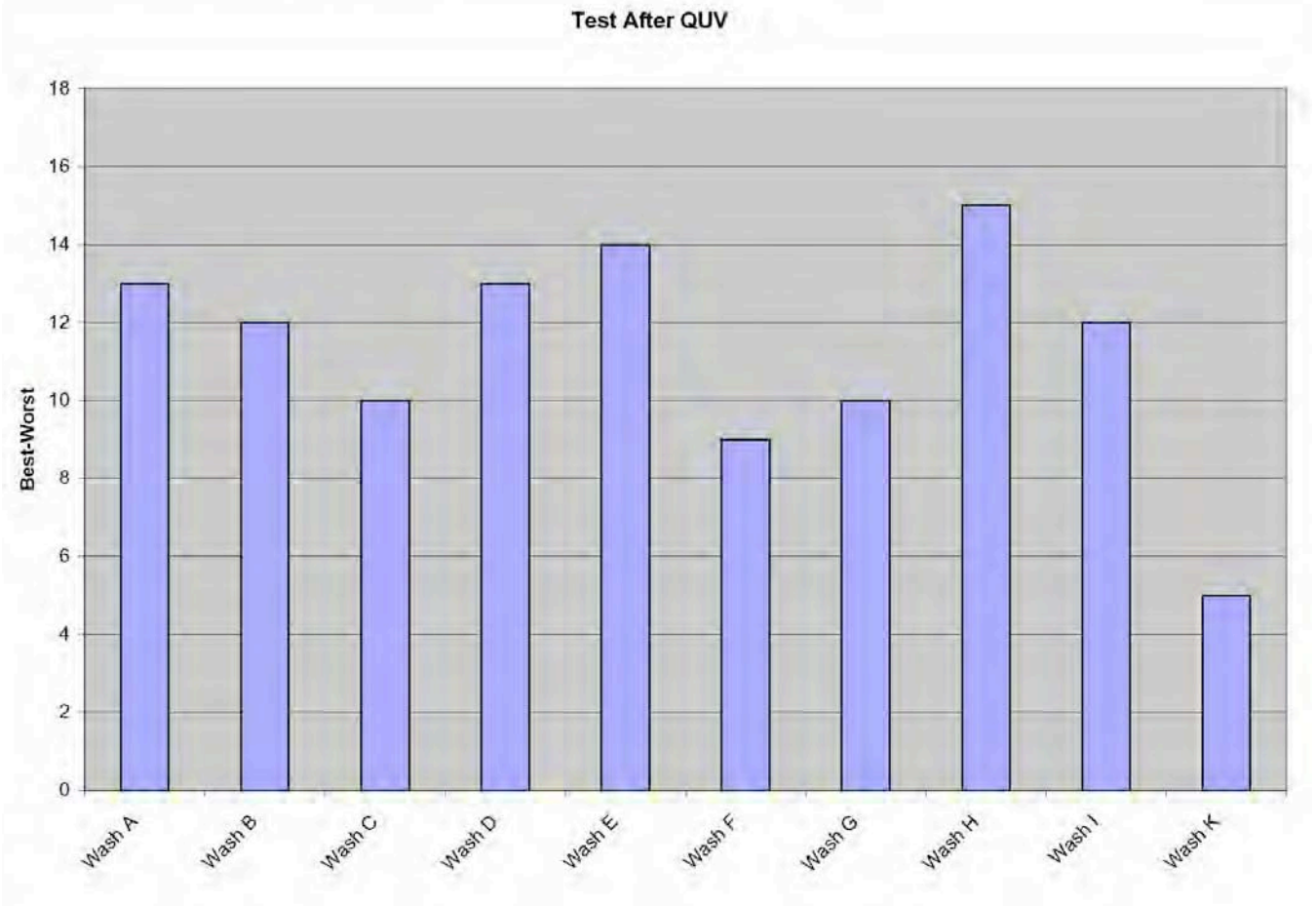
Results on Modern Brick



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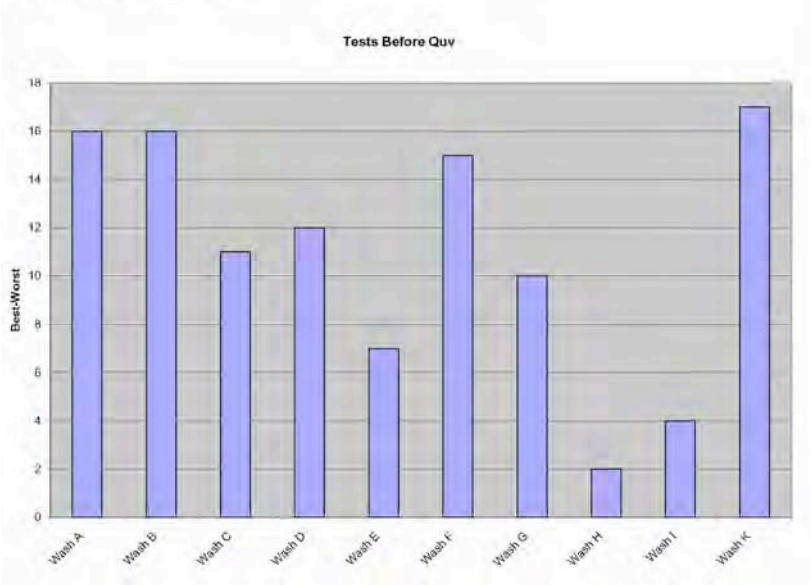
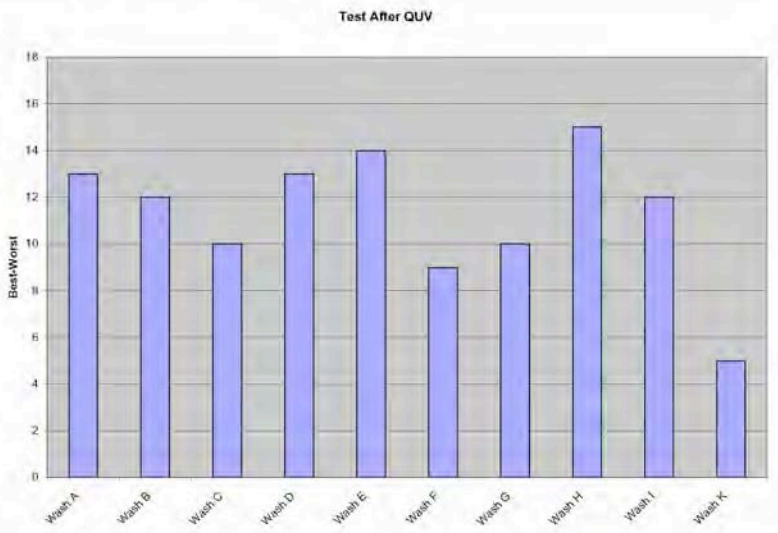
Results on Modern Brick





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Summary of Handmade and Modern Brick

- Wash B, made from Graymont Lime Putty and containing salt, molasses, alum, and laundry bluing, performed the best on both handmade and modern brick.
- However, the salt has the ability to recrystallize in the pores of brick which we saw in the samples. Thus we do not recommend this wash.
- Wash M, a basic Graymont Niagara lime putty and water, performed second best on handmade brick. It has not yet been tested on Modern Brick.
- Alternatives may include
  - Wash K, containing Virginia Limeworks Putty and water, which performed well on both handmade and modern brick
  - Or Wash D or Wash E made with different limes but containing Casein and clove oil

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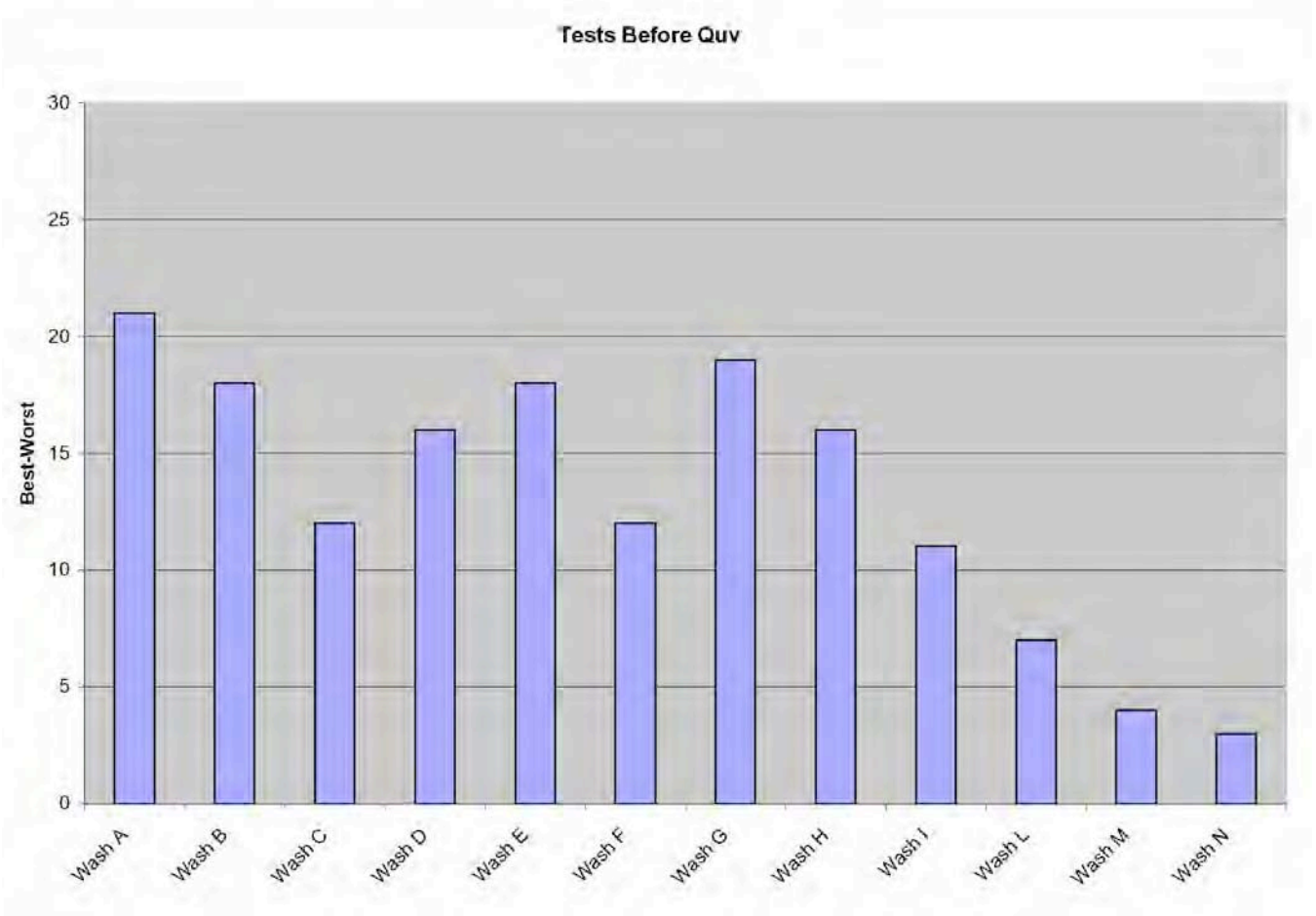
Results on Weathered Wood and Rough-sawn New Wood

	Rating	QUV	Adhesion	QUV-Adhesion	Abrasion	QUV-Abrasion
Best	12	D, E, I	E	E	B	E
	11		H	B	A	G
	10		A	G	G	F
	9	H	G	D	D	I
	8	F, G	F	C	C	D, H
	7		D	I	I	
	6	C	B	A	E	A
	5	A	L	H	H	B, C
	4	B	C, I	F	F	
	3	L		M	L	
	2	M	M	L, N	M	L, M, N
Worst	1	N	N		N	

Results on Weathered Wood and Rough-sawn New Wood



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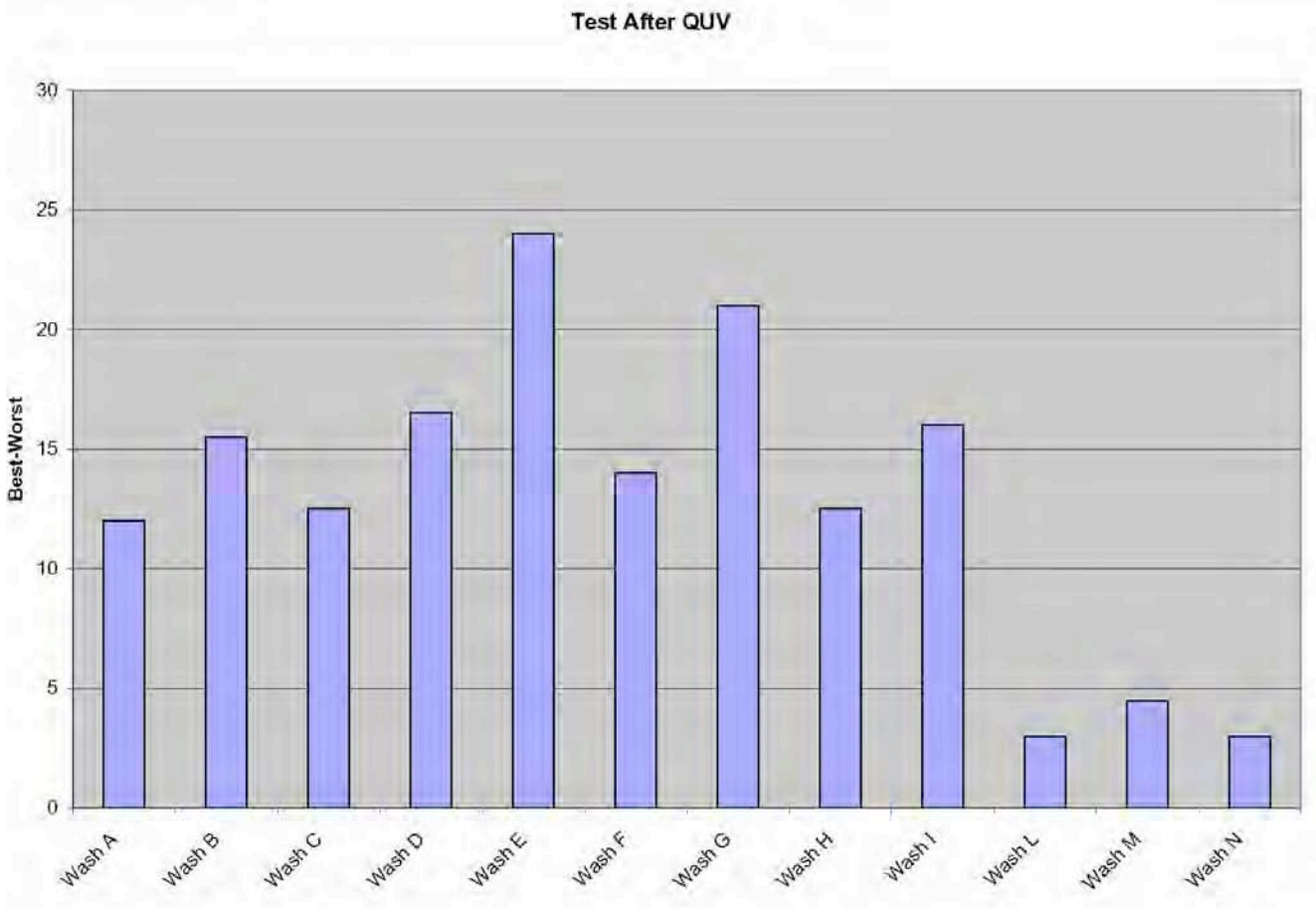
Results on Weathered Wood and Rough-sawn New Wood



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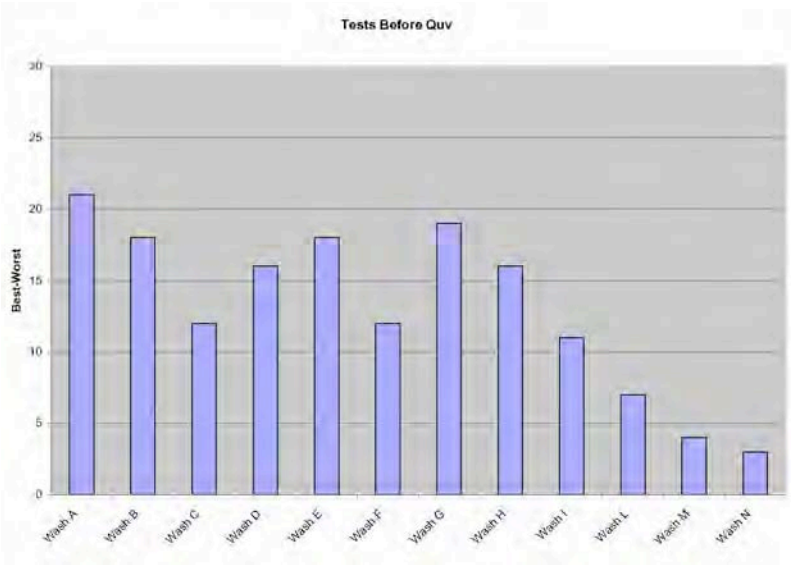
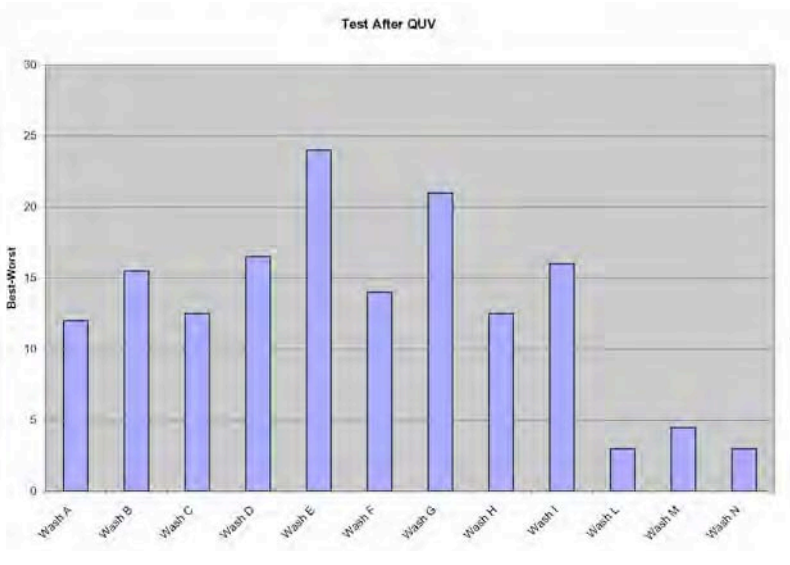
Results on Weathered Wood and Rough-sawn New Wood





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Results on Epoxy Fills

	Rating	QUV	Adhesion	QUV-Adhesion	Abrasion	QUV-Abrasion
Best	4	E	E	G	D	E
	3	D	G	E (w/o)	E (w/o)	D, G, E (w/o)
	2	E (w/o), G	E (w/o)	D	E	
Worst	1		D	E	G	

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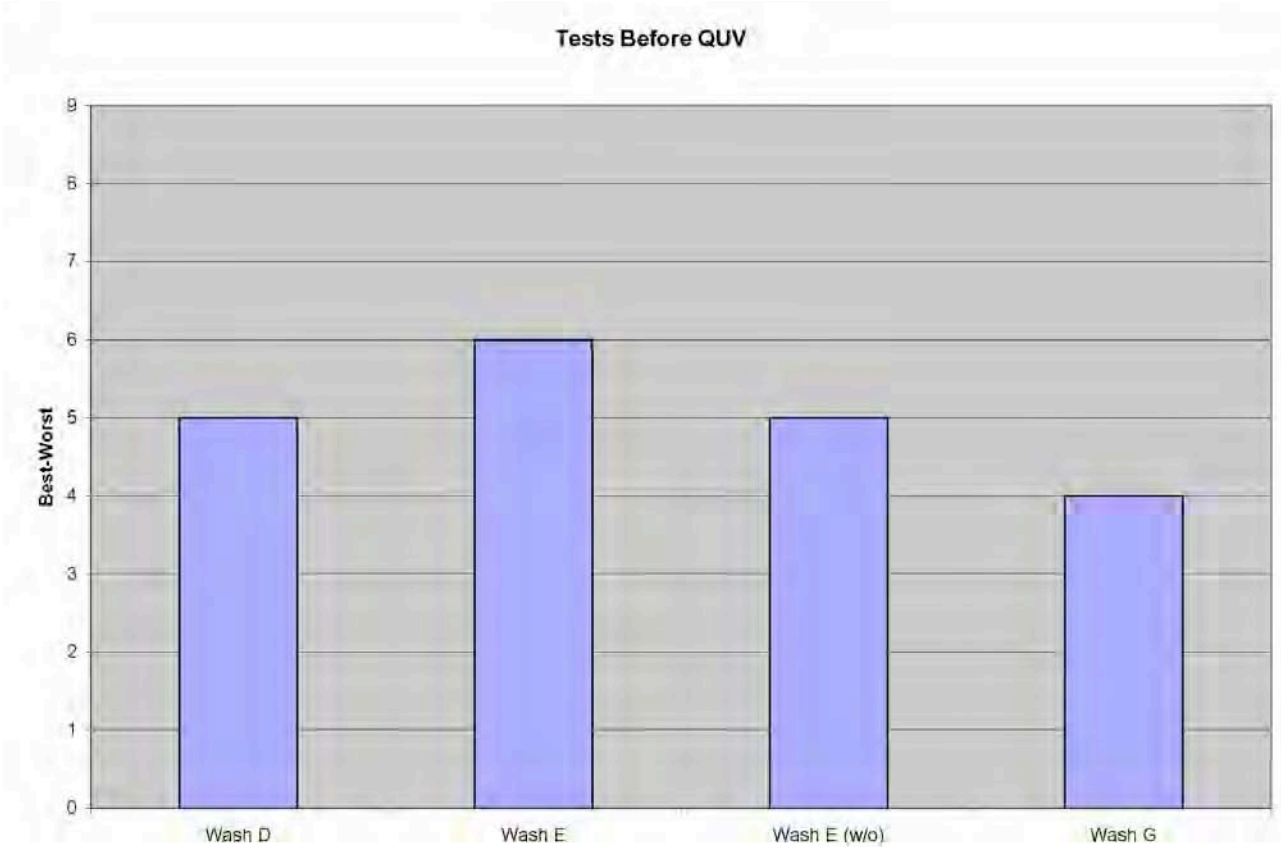
Results on Epoxy Fills



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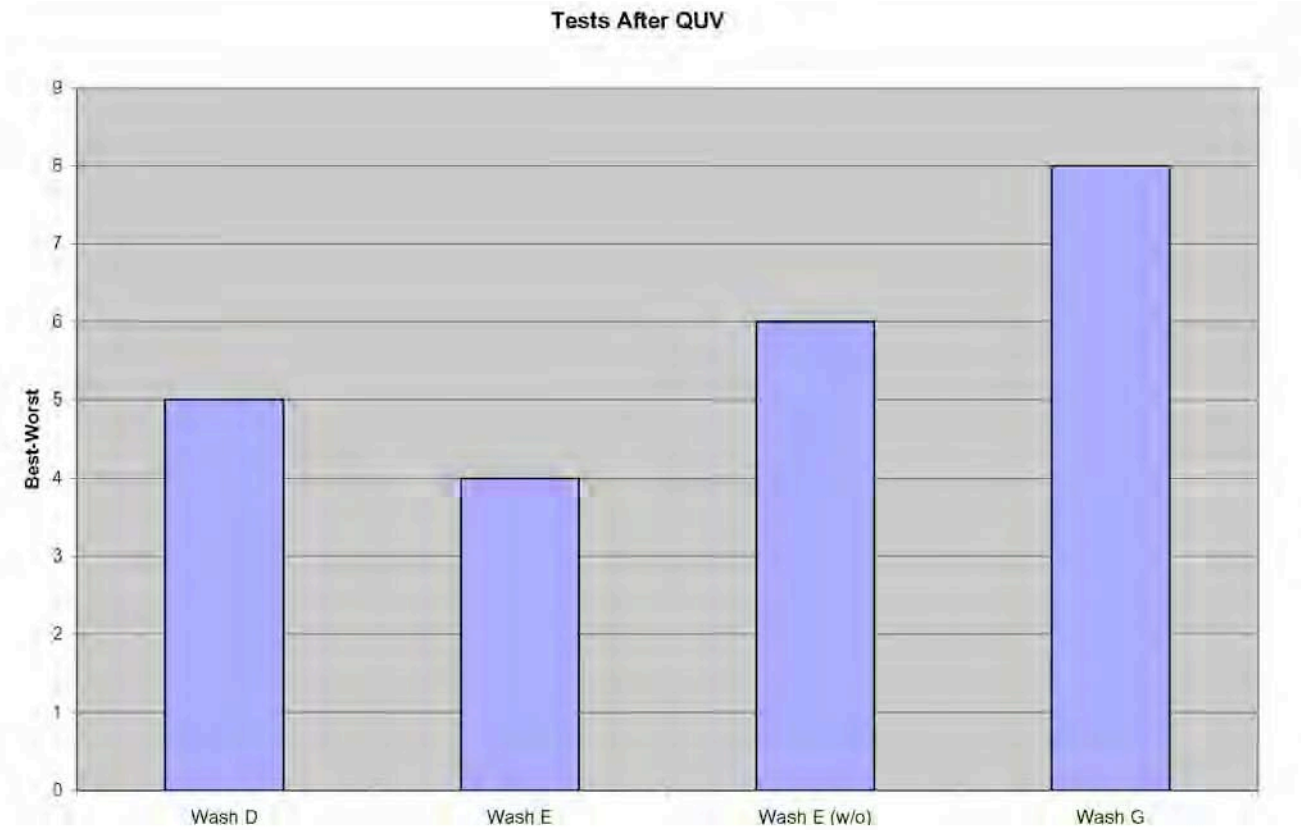
Results on Epoxy Fills



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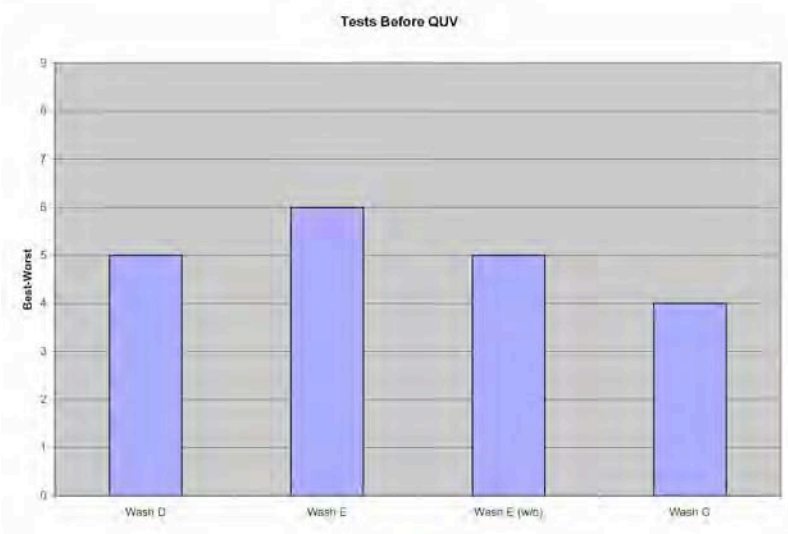

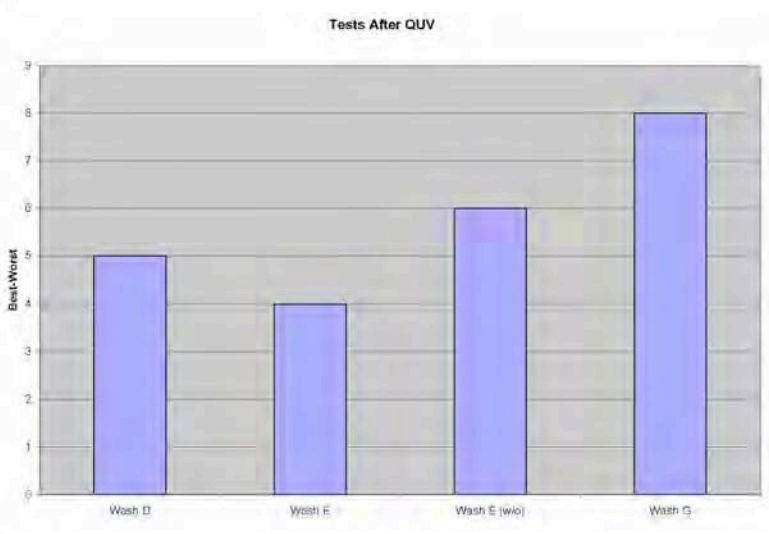

- Handmade Brick
- Modern Brick
- Weathered and Rough-sawn New Wood
- Epoxy
  - Results
  - Before QUV
  - After QUV
  - Comparison

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Summary of Results on Wood and Epoxy

- None of the limewashes we tested were durable on our wood samples.
  - There were only three coats of limewash applied to all wood samples.
  - Since these samples were more textured, more coats may be needed to adhere better to the surface.
- On wood samples the primer may be beneficial due to the cell structure of the material.
- Wash E, containing Graymont lime putty, casein, molasses, clove oil, and laundry bluing, was the best performing limewash on wood. It also performed well on epoxy.

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Further Testing Needed

- Applying heavier coats of limewash
- Applying a greater number of coats of thin coats
- Look at the effects of temperature and humidity on carbonation
- Look at Pozzalonic additives
- Look at effects of a primer on the limewash and the substrate

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Further Reading

- Ashurst, John &Nicola, **Practical Building Conservation/English Heritage Technical Handbook, Volume 3, 'Mortars, Plasters & Renders.'** Gower Technical Press, 1988.
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Acknowledgements

- Marcy Frantom, Quality Finish
- Max Turner, Quality Finish
- Eric Ford, Cane River Creole National Historical Park
- Laura Gates, Cane River Creole National Historical Park
- Greg Dugan, Cane River Creole National Historical Park
- Norman Weiss, Columbia University

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Acknowledgements

- Lina Burina, Louisiana School for Math, Sciences and the Arts
- Renaldo Webb, Louisiana School for Math, Sciences and the Arts
- Jansen Smith, Louisiana School for Math, Sciences and the Arts
- Shelly Hines, Louisiana School for Math, Sciences and the Arts
- Tye Botting, NCPTT
- Jason Church, NCPTT
- Cole Stevens, Northwestern State University
- Eric Broaddus, Northwestern State University

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