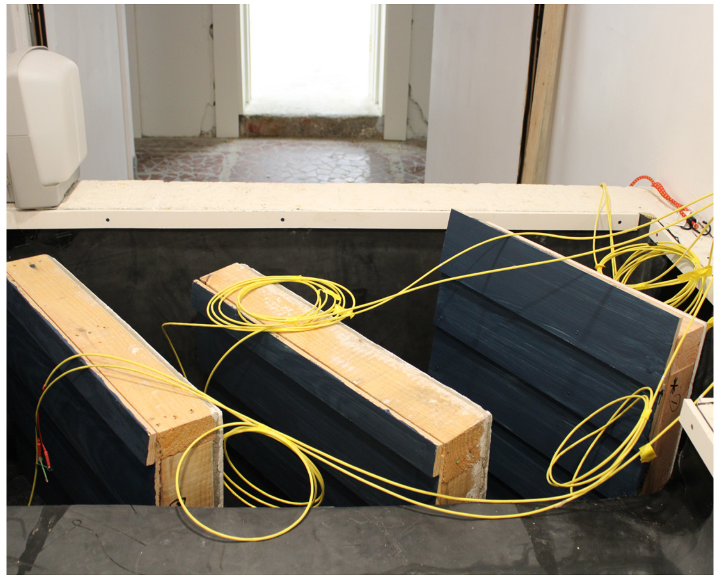
THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY - TEST 1.2

Testing the Flood Resiliency of Historic Exterior Wall Systems, Plaster Using Test Protocol BRS 2-22

JANUARY 2023

Testing the Flood Resiliency of Historic Exterior Wall Systems, Plaster, Using Test Protocol BRS 2-22 was undertaken to study the survivability of historic plaster wall assemblies and exterior cladding materials that have been exposed to limited duration water inundation, as is commonly experienced during tidal flooding events. The tests were performed in accordance with "BRS 2-22: Test Protocol for Flood Testing of Exterior Wall Systems," developed by Georg Reichard, Ph.D., P.E. for BRS to create a consistent assessment method regarding the durability and re-workability of wall assemblies after flooding events.



Wall assemblies in test chamber pre-flooding

CONCLUSIONS & FUTURE TESTING

In general, the results of this test indicate that a wall assembly constructed with plaster on wood or wire lath, like many of the wall assemblies found in pre-1970 structures in the Tidewater region of Virginia, are highly survivable in a flood scenario. Further testing will help us better analyze the comparisons between these traditional, historic materials and the modern materials that have replaced them in more recent construction as well as guiding us on building a protocol around post-storm recovery of wall assemblies that show high rates of survivability.

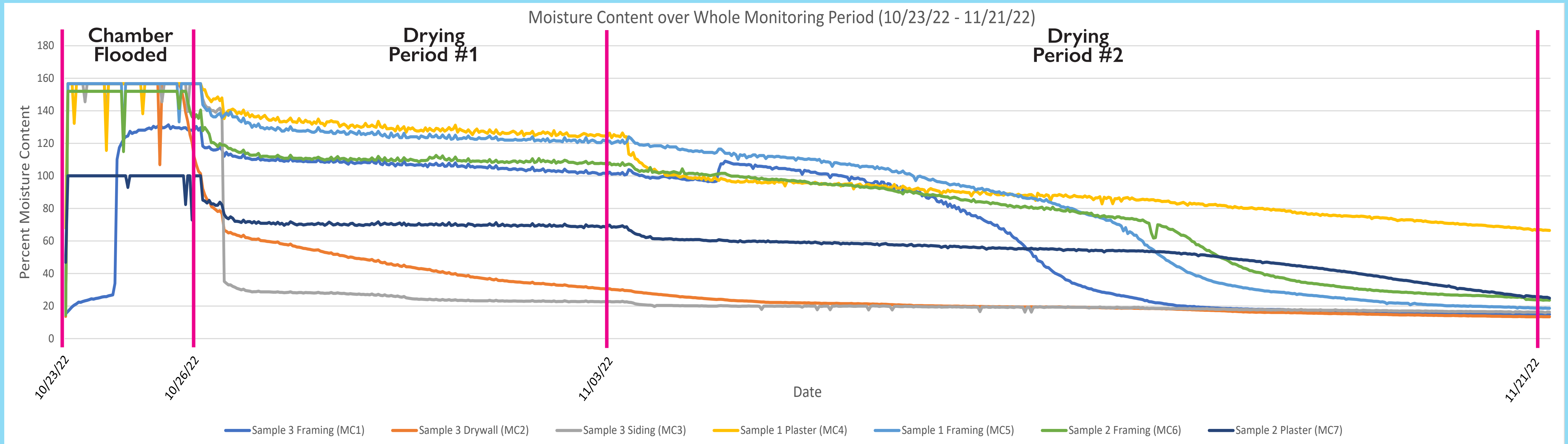
Detail of wood lath and plaster wall assembly

ABOUT BUILDING RESILIENT SOLUTIONS:

Building Resilient Solutions (BRS) is a joint venture between Commonwealth Preservation Group (CPG) and Museum Resources Construction and Millwork (MRCM) that was formed to address the growing number of existing buildings that are vulnerable to damage from recurrent flooding. Through a combination of field monitoring equipment, data collection, lab testing, and experience, the BRS team is dedicated to analyzing the flood resiliency of building materials and systems in pre-1970s buildings in the Tidewater region of Virginia and providing on-site monitoring and retrofit designs for individual properties. In 2022, BRS opened the first research laboratory in the United States dedicated to testing the flood resiliency of building materials and systems. The BRS lab includes an enclosed flood test chamber that allows for controlled, repeatable testing of building materials and assemblies, which in turn provide the opportunity for analysis and retrofit testing.

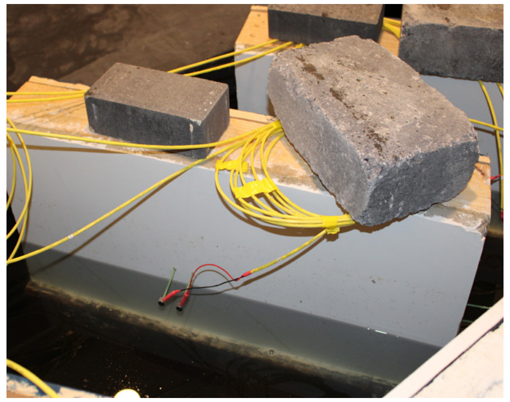
COMPARATIVE RESULTS ACROSS TESTING ASSEMBLIES

This graph shows the moisture contents of each of the three wall assemblies throughout the testing period. The chamber was flooded October 23rd – 26th, and the first drying period lasted until November 3rd. Since moisture contents had not yet returned to pre-testing levels, a second drying period with an increased temperature ran until November 21st. Moisture contents were monitored with a Lignomat monitoring system with monitoring probes placed below the waterline. Due to equipment sensitivities, the probes read very high when fully saturated; however, the significant results are related to the change in moisture content (rather than exact percentage).

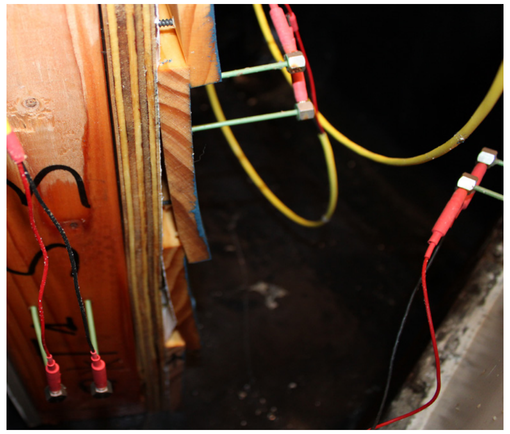


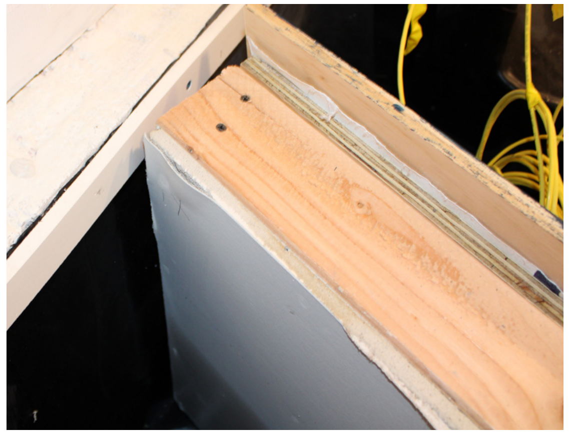
TESTING INTENT

This Protocol, specifically, was intended to replicate flood events and drying periods typical to the conditions seen in Tidewater, Virginia to analyze their affect on exterior wood cladding, plaster, and lath applied using traditional historic methods and materials. Although siding was included in the wall assemblies, it was done so as an add-on to the test; the test's primary intent did not include analyzing the impacts of inundation on the siding materials. Due to limitations in available testing equipment, only the moisture content of the siding on the modern drywall assembly was monitored. The consistent testing methods and observations made during the Protocol 2 testing will establish a replicable means of testing the survivability of historic wall assembly materials during a flood event as well as an assessment of the effect of drying processes on materials. Assemblies were submerged in treated tap water for 72 hours and allowed to dry in a controlled environment for seven days, followed by an additional 14 day drying period. Specific length, width, thickness, weight, and moisture content (with pinless meter) measurements were taken at 4 times: immediately before inundation, when the flood chamber was drained, after the seven day drying period, and again after the 14 day drying period.


Wall Assembly 1 (Wood Lath & Plaster) during flooding


Wall Assembly 2 (Wire Lath & Plaster) showing split siding post-drying


Wall Assembly 3 (Drywall) showing warped siding during draining


Wall Assembly 3 (drywall) peeling at edges post flooding

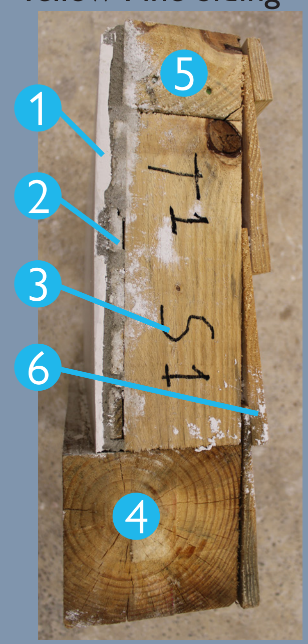
KEY FINDINGS

- When combined, modern materials such as plywood, a water-resistive barrier, and fiberglass insulation resulted in increased moisture retention compared to traditional materials in a wall assembly.
- Plaster samples survived with little to no changes in measured values or deformations.
- The drywall surface, while a little rough, had little to no change in the measured thickness of the wall framing and siding.
- Drywall edges where water could easily penetrate the joint between the paper and gypsum performed poorly.
- Plaster on wood lath performed the best, expanding the least in cross section and returning closest to pre-testing values. Performance was based on a sample's ability to return to its pre-testing size, form, and appearance.
- Plaster on wood lath, plaster on wire lath, and modern drywall all performed to a level to be considered survivable wall assemblies under controlled drying conditions.

WALL ASSEMBLIES USED IN TESTING

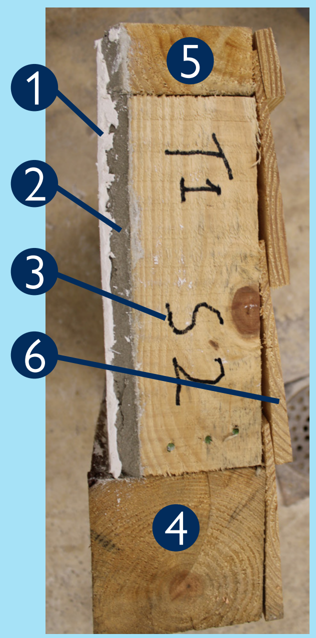
Samples were chosen to represent some of the most common wall assemblies utilized in pre-1970 structures in the Tidewater area of Virginia as well as the modern materials that have replaced them in later construction. The wall assemblies tested included a makeup of:

SAMPLE 1
Plaster on Wood Lath with taper sawn Southern Yellow Pine Siding



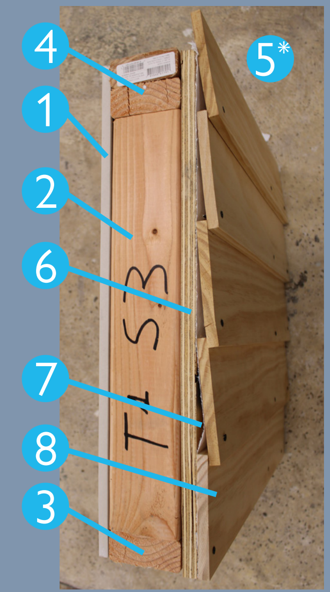
1. Plaster (consisting of three layers)
2. Wood Lath
3. Stud
4. Bottom plate (sill plate)
5. Top plate
6. Siding

SAMPLE 2
Plaster on Wire Lath with taper sawn Southern Yellow Pine Siding



1. Plaster (consisting of three layers)
2. Wire Lath
3. Stud
4. Bottom plate (sill plate)
5. Top plate
6. Siding

SAMPLE 3
Modern Drywall with taper sawn Southern Yellow Pine Siding



1. Drywall
2. Stud
3. Bottom plate (sill plate)
4. Top plate
5. R-13 faced fiberglass insulation *not visible
6. Oriented Strand Board
7. Tyvek house wrap
8. Siding

RISE

BRS's second test, Protocol 2: Testing the Flood Resiliency of Historic Exterior Wall Systems, Plaster, Using Test Protocol BRS2-22, was made possible and funded through a partnership with RISE: Resilience Innovations.

THIS PAGE INTENTIONALLY LEFT BLANK