Before the Fall: Lifecycle Maintenance of Plaster on Wood Lath Ceilings

Conference for Catholic Facility Management (CCFM)

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Course Description

This presentation will describe how wood lath and plaster ceilings were designed so that the plaster is suspended from – not adhered to – its wood lath substrate. As such, a wood lath and plaster ceiling functions as an interconnected, suspended system, and also deteriorates systemically. This presentation will focus on chronic deterioration and compare two methods of plaster assessment: (1) the traditional method of sounding; and (2) an advanced method, which numerically quantifies the structural integrity of an entire plaster ceiling system. Various traditional plaster treatment methods will then be compared to the advanced method of treatment called “Plaster Consolidation”, which also addressed the entire ceiling system.

Learning Objectives

1. By the end of the program, participants will learn how and why plaster on wood lath ceilings were designed to function as suspended systems, using case studies and examples.

2. By the end of the program, participants will learn how moisture transmission (from humidity) causes these systems to deteriorate and eventually break down, using case studies and examples.

3. By the end of the program, participants will learn about the various methods of assessing and treating distressed plaster on wood lath, using case studies and examples.

4. By the end of the program, participants will learn about the enduring benefits of “Plaster Consolidation”, using case studies and examples.

A Brief History of Plaster

- Dates back 25 centuries – i.e. book of Leviticus 14:42 in the Old Testament, describes re-plastering the interior of a house for sanitation and purging a plague.
- Traditionally, the cementitious material that binds the aggregate particles into a heterogeneous mass is one of three types:
  - Lime
  - Gypsum
  - Portland cement
- For our purposes today, we are addressing lime-based plaster.

Why Old Plaster is Important

- Original building fabric
- Density and durability
- Surface is fairly impervious to water
- Versatile – surface can be rounded or flat
- Superior sound barrier due to density
- Excellent acoustics
- More fire resistant than drywall

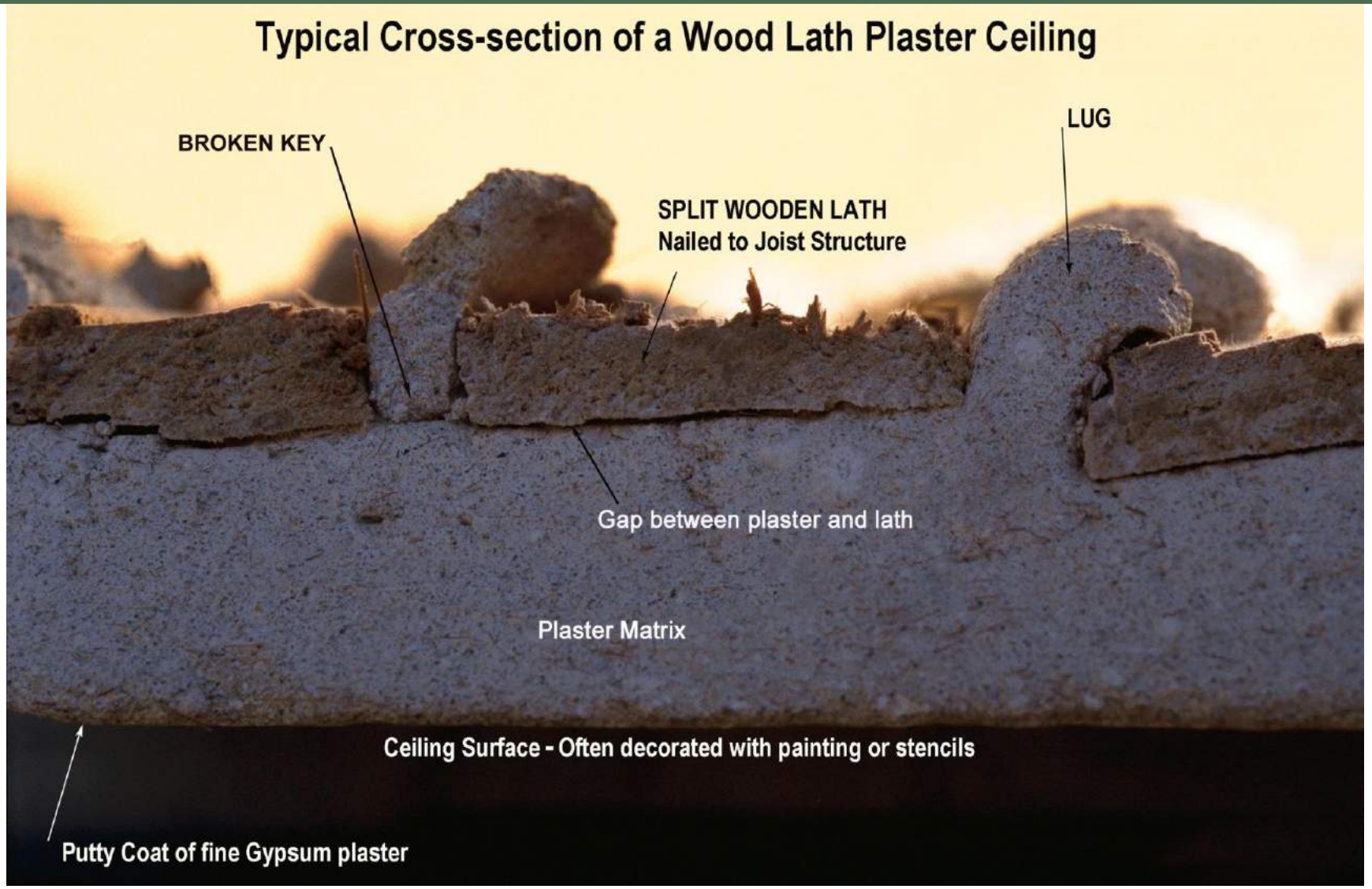
What makes a Good Plaster Job?

- Composition and quality of the plaster mix - the finer the grain the better the plaster.

- Craftsmanship – the plasterer’s his ability to consistently generate useful keys & lugs.

A plaster on wood ceiling functions as a suspended system held up by keys & lugs

Plaster on Wood Lath – a Suspended System



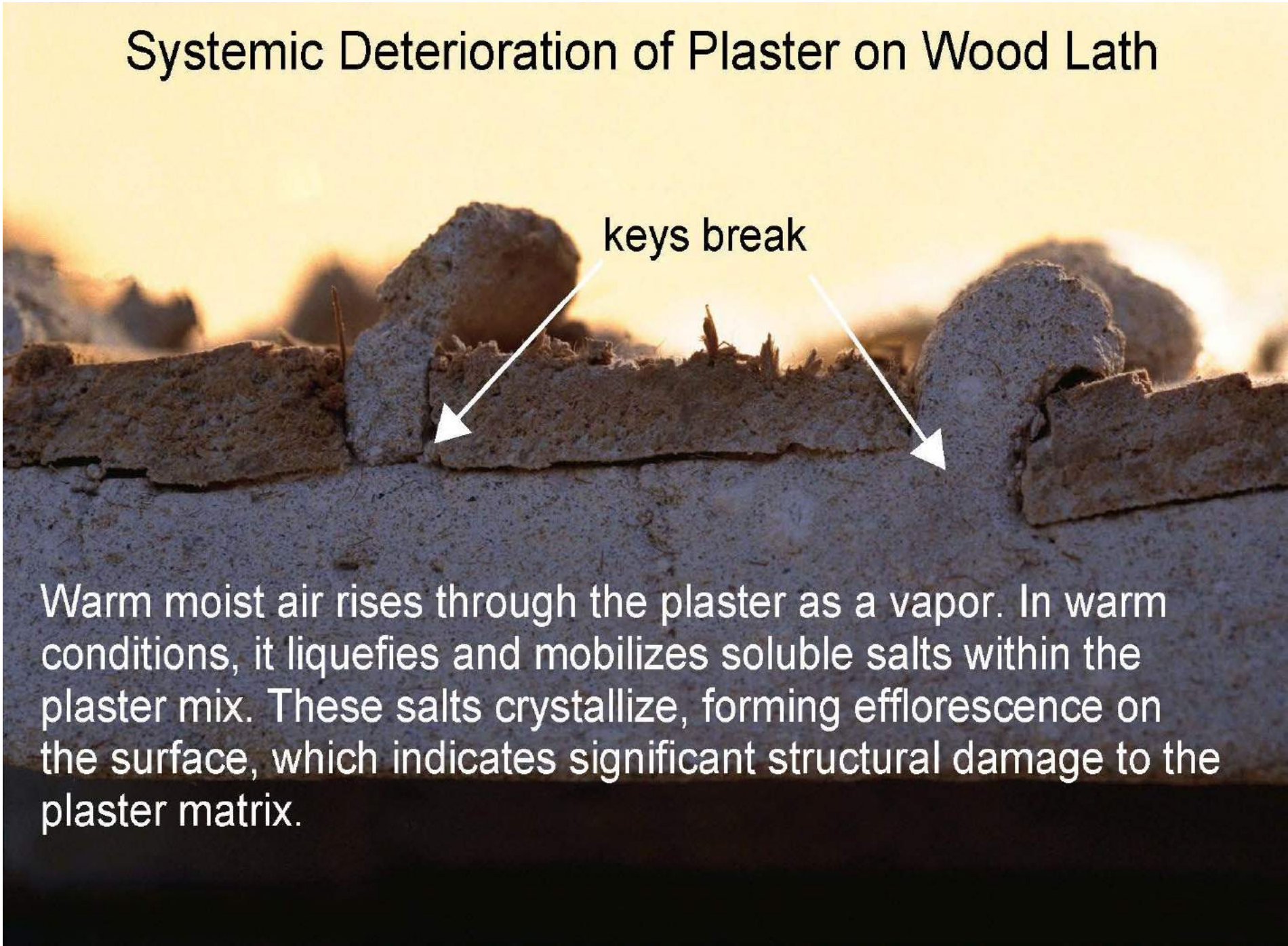
What Goes Wrong?

1. **Acute trauma** to an isolated area(s) – water infiltration and damage from mechanical installations are most common.

2. **Chronic deterioration** – gradual systemic breakdown of keys & lugs over 100+ years; plaster matrix becomes friable (powdery).

Major cause: moisture transmission

Systemic Deterioration of Plaster on Wood Lath



Warm moist air rises through the plaster as a vapor. In warm conditions, it liquefies and mobilizes soluble salts within the plaster mix. These salts crystallize, forming efflorescence on the surface, which indicates significant structural damage to the plaster matrix.

Insulation

- Properly installed insulation with air space between plaster is perfectly fine.

- However, insulation laid directly on top of the plaster will trap moisture and accelerate the deterioration.

Plaster on Wood Lath Assessment

A Piece of Unsolicited Advice

If you are responsible for a building with a plaster-on-wood-lath ceiling that is more than 100 years old, you should have the ceiling properly assessed.

Sounding: a traditional method of plaster assessment

- Tapping a rubber mallet against the ceiling surface:
  - Informal, unscientific variation of Impact Echo Testing.
  - Highly subjective, fundamentally unreliable and often misleading when applied to plaster on wood lath.
  - Useful in assessing plaster on masonry and cast plaster ornament.

Assessing Plaster on Wood Lath

The plaster is held up by thousands of keys & lugs hooked onto the wood lath.

Assessing those keys & lugs is essential to understanding the condition of the plaster.

Objective: to determine the structural integrity of the entire plaster ceiling system.

Analogy: sounding is like taking a pulse; a systematic assessment is like giving a physical.

Overview of a typical church attic (safety at all times)

Systematic Plaster Assessment

1. Sample test areas – 1% to 2% of total area
2. Measure all potentially good keys (in inches)
3. Record on test data card
4. Pull test and measure every broken or missing key in test area (in inches)
5. Record on test data card.
6. Tabulate and extrapolate numbers
7. Calculate condition of the plaster.

1. Sample Test Area
2. Measure all keys (inches)

3. Record on Sample Test Card

TEST LOCATION

____ of ____

TEST PHOTO ☐ Before Cleaning

TEST PHOTO ☐ After Cleaning

TEST PHOTO ☐ Final

Old St. Patrick's Cathedral

Mulberry St, NY

Ceiling Plaster Condition Assessment

conducted in the week of Feb 18 - 23, 2013

Test Area Dim. Length ____" X Width ____"

Area = _____ Sq. In. Area = _____ Sq. Ft.

Divide Sq. In. by 144

Width of Laths _____" Width of Key Space ___ "

A Total Inches of viable KEY space in sample _____"

This value excludes key spaces that are too narrow to function properly

B Total Inches of KEYS with LUGS remaining after testing ____"

C Percentage of LUGS remaining after testing ____ %

The percentage is value B divided by the value A multiplied by 100.

Assessment conducted by John Tiedemann Inc

Assessment designed by Historic Plaster Conservation Services Limited

Technician Signed _____

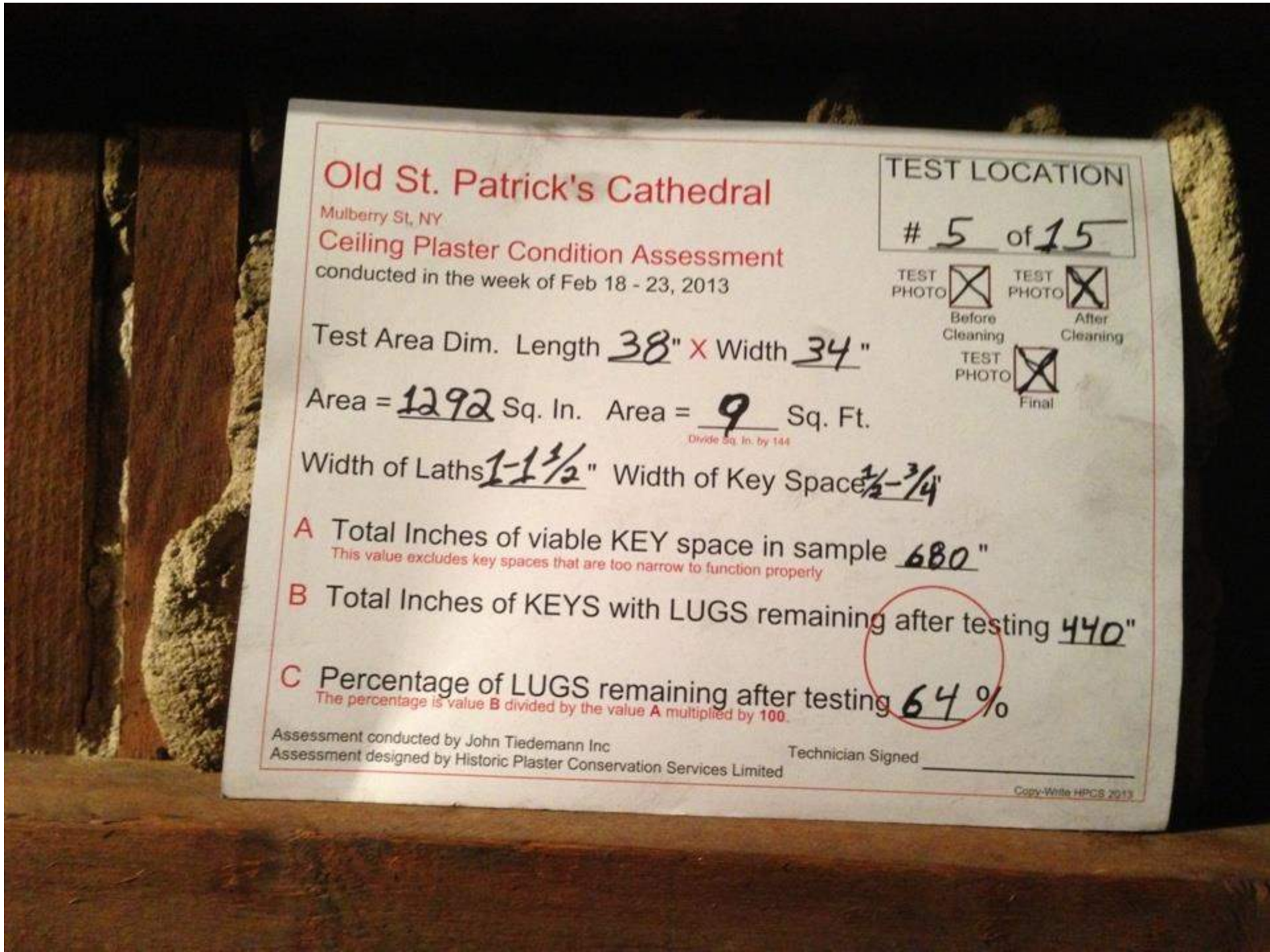
4. Pull-test and measure all missing and broken keys

Pull-testing plaster keys is an acquired skill

Note: every key and lug within the sample area ***must*** *be tested*

Remove broken keys or lugs from the test area, measure each and record total number of linear inches on Test Data Card.

Every key within sample area must be tested


Old St. Patrick's Cathedral
Mulberry St, NY
Ceiling Plaster Condition Assessment
conducted in the week of Feb 18 - 23, 2013
TEST LOCATION
5 of 15
TEST PHOTO X Before Cleaning
TEST PHOTO X After Cleaning
TEST PHOTO X Final
Test Area Dim. Length 38" X Width 34"
Area = 1292 Sq. In. Area = 9 Sq. Ft.
Divide Sq. In. by 144
Width of Laths 1-1 1/2" Width of Key Space 1/2-3/4"
A Total Inches of viable KEY space in sample 680"
This value excludes key spaces that are too narrow to function properly
B Total Inches of KEYS with LUGS remaining after testing 440"
C Percentage of LUGS remaining after testing 64 %
The percentage is value B divided by the value A multiplied by 100.
Assessment conducted by John Tiedemann Inc
Assessment designed by Historic Plaster Conservation Services Limited
Technician Signed
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6. Tabulate Test Data

Tabulation of Data Collected

Sample Number	Area in Square Inches.	Key Space	Lath Width	Inches of Key Space in Each Row	Number or Rows of Lath	Length of Keys "As Built"	Key Length After Pull Test	Inches of Deficient keys	% Remaining "as built" Strength	% Keys Deficient Because Too Narrow to Function
1	900	3/16"	1.1/4"	28	20	560"	386"	174	69%	50%
2	840	3/16"	1 1/4"	28	19	532"	372"	160	69%	45%
3	812	3/16"	1 1/4"	28	18	504"	266"	238	53%	60%
4	900	3/16"	1 1/4"	28	18	504"	335"	169	66%	47%
5	784	3/16"	1 1/4"	28	18	504"	266"	238	53%	75%
6	896	3/16"	1 1/4"	28	19	532"	256"	276	48%	70%
7	840	3/16"	1 1/4"	28	18	504"	275"	229	55%	79%
8	1080	3/16"	1 1/4"	28	22	616"	532	84	86%	50%
9	750	3/16"	1 1/4"	28	16	400"	276"	124	66%	80%
10	588	3/16"	1 1/4"	28	15	420"	234"	186	86%	50%
11	672	3/16"	1 1/4"	28	17	476"	328"	148	68%	60%
12	672	3/16"	1 1/4"	28	17	476"	328"	148	68%	60%

Fig 3 Chart of the results accumulated on site during the investigation of plaster conditions at Our Lady of the Assumption Church, Windsor

7. Calculate the condition of the plaster

$$\frac{\text{Key Length After Pull Test}}{\text{Length of Keys "As Built"}} \times 100 = \text{\% Remaining "As Built" Strength}$$

This method is repeatable and verifiable

Interpreting the Results
(subjective…based on experience)

Remaining structural integrity:

85%+ no need for treatment but monitor once a year.

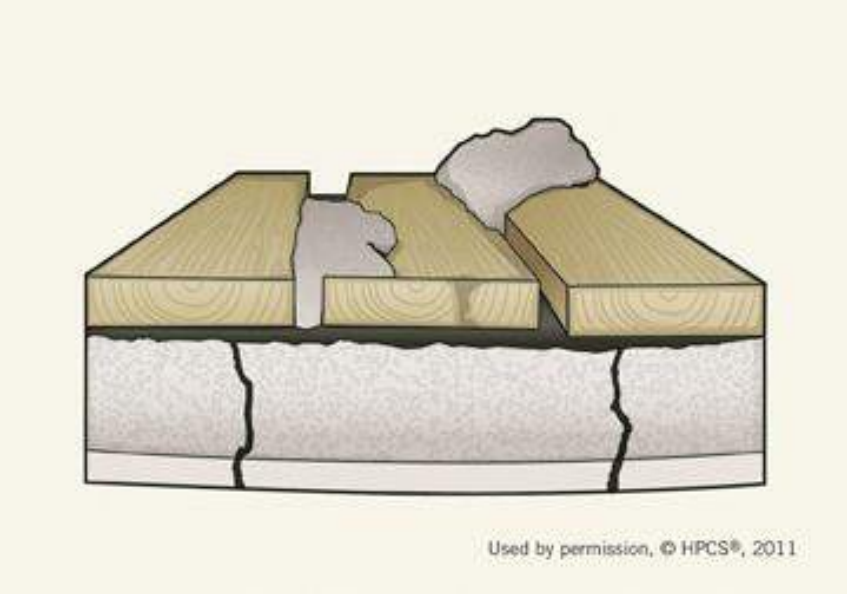
70-85% start considering treatment and monitor closely.

(Caveat: if building is undergoing a major renovation, plaster should be treated/upgraded like all other systems)

<70% could be a safety problem and treatment should be imminent.

Treating Distressed Plaster

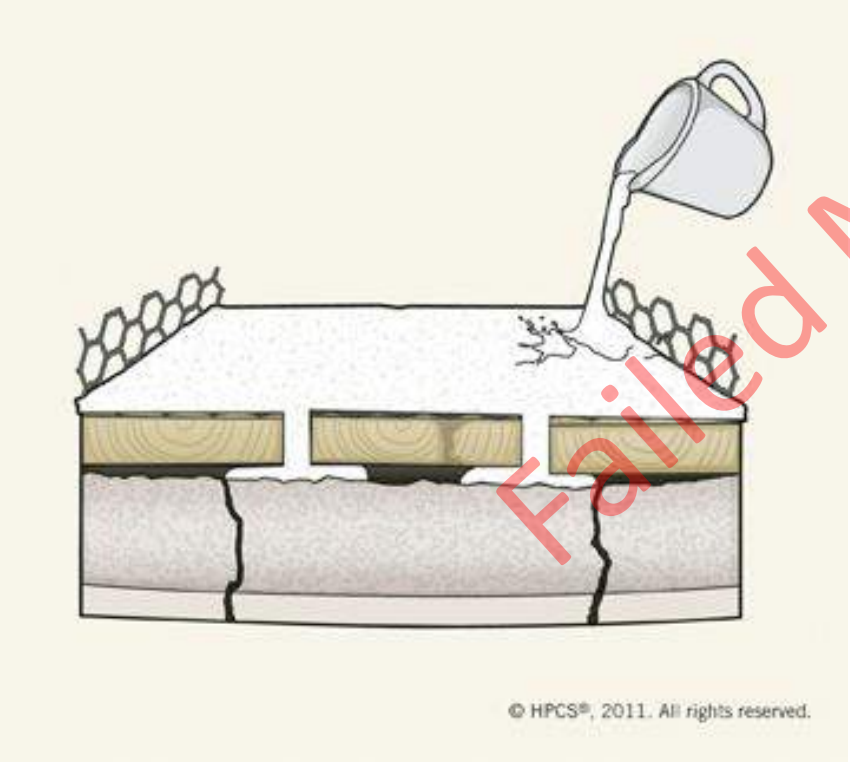
Example of Damaged Plaster



- Keys & lugs are either missing or broken.
- Cracks go all the way up to substrate.
- Plaster matrix is likely to be friable.
- Plaster is in state of apprehended collapse.

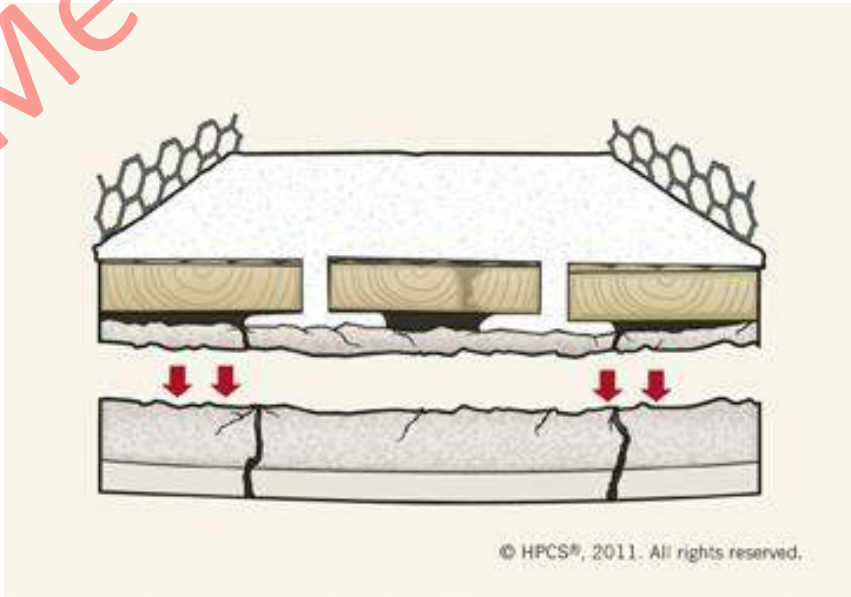
Traditional Treatment Method #1: Applying plaster to plaster ("like with like")

Plaster of Paris is poured over back of the existing plaster.



Before long a separation appears between new and original plaster.

Eventually plaster fails – i.e. Drayton Hall, Charleston, S.C.



Failed Method

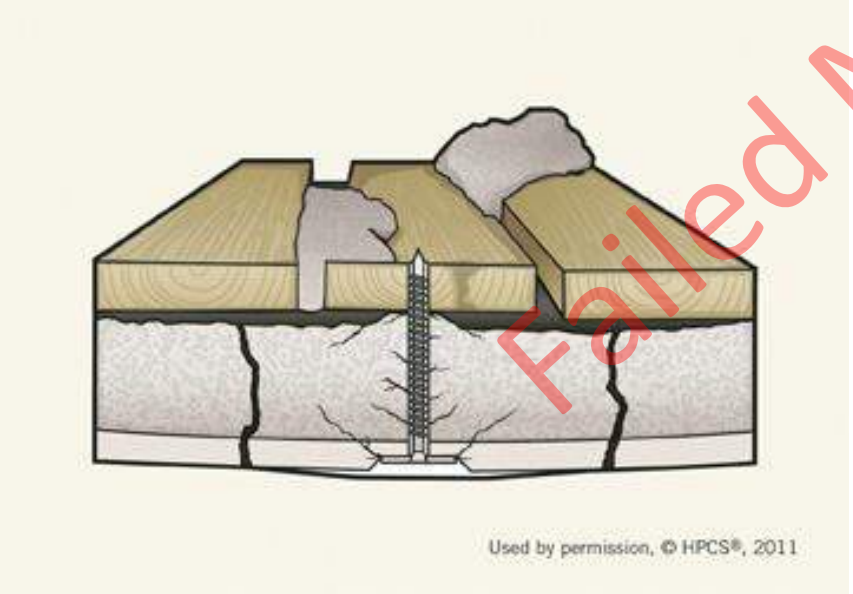
Traditional Treatment Method #2: Wood Screws & Washers

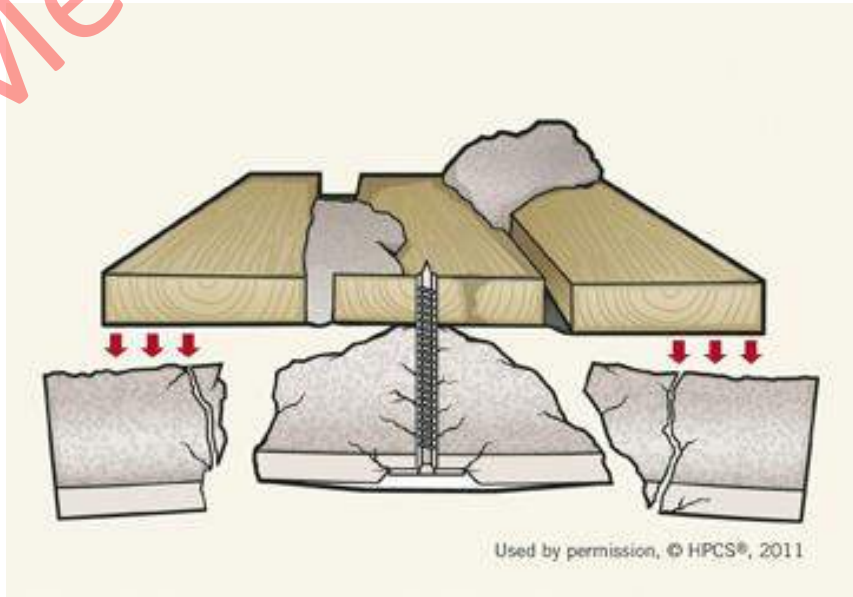
Wood screws & washers are installed across ceiling surface.

Wood screws & washers deface the ceiling surface.

The plaster continues to deteriorate around the points of contact.

Failed Method





Traditional Treatment Method #2: Wood Screws & Washers

Morgan Phillips

Materials scientist with National Parks Service.
1980 – published seminal article in APT Bulletin:

"Adhesives for the Reattachment of Loose Plaster."

Major Breakthrough in Plaster Treatment!

Traditional Treatment Method #3 (Morgan Phillips): Isolated applications of acrylic resin & paste

Hole drilled into wood lath above the plaster.

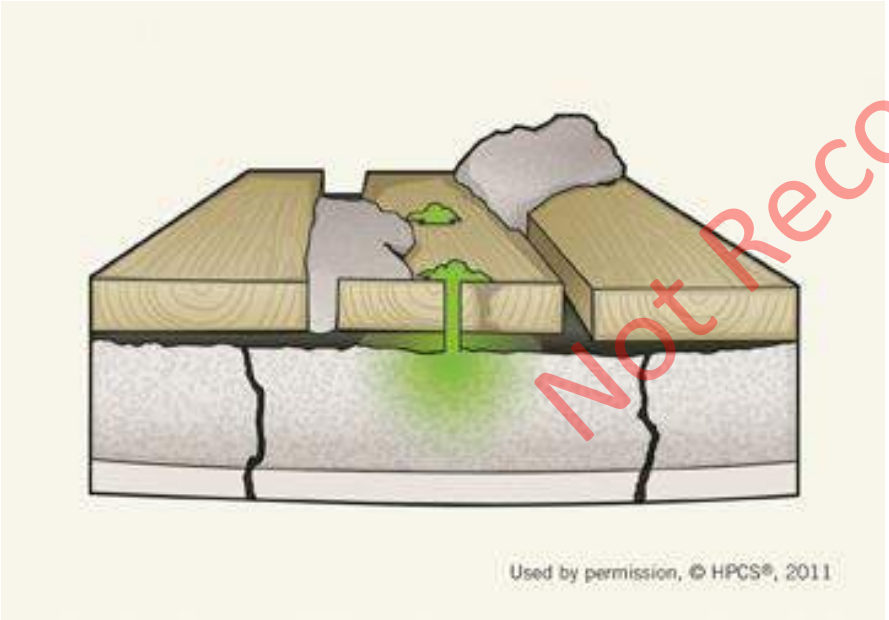
Acrylic resin (unfilled adhesive) sprayed into hole.

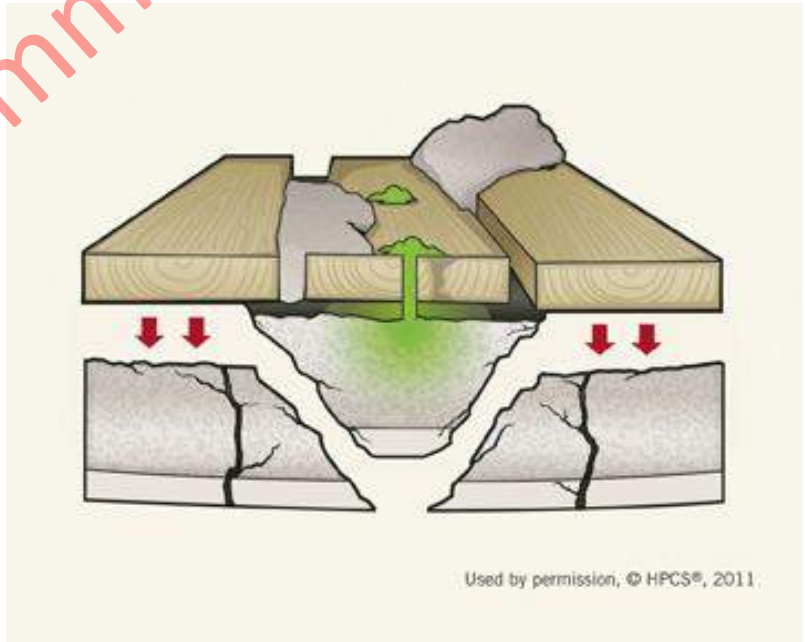
Acrylic paste (filled adhesive) then injected into hole

The acrylic paste bonds to and strengthens the plaster immediately below.

Most of the plaster remains untreated .

Treating whole ceiling this way is prohibitive.





Roderick (Rod) Stewart
Developer of Plaster Consolidation

Heritage Conservator and Materials Scientist

Rod Stewart's Epiphany

In 1981, while experimenting with the Morgan Phillips method and formulations to treat a distressed wood lath & plaster ceiling in the historic Barnum House, Mr. Stewart came to realize that:

Plaster on wood lath functions as a system and deteriorates systemically.

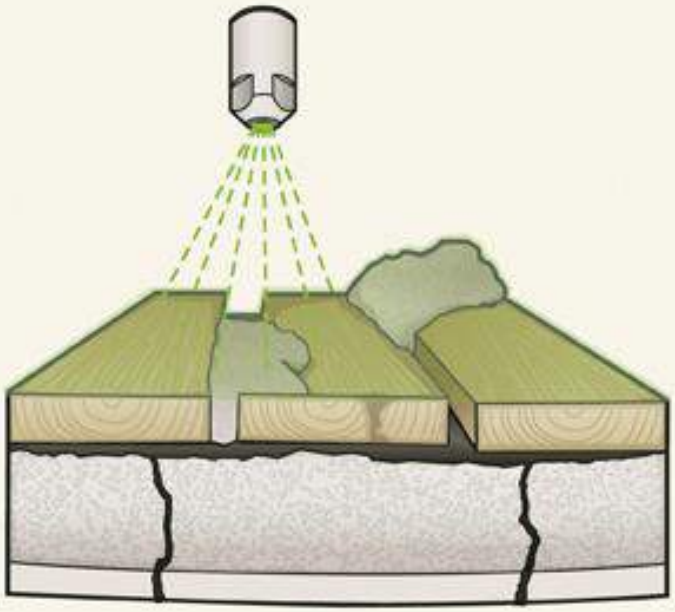
If possible and when necessary, the entire system should be treated.

"Plaster Consolidation"

Plaster Consolidation

Formulated acrylic resins are infused into the base coats with multiple applications across the entire ceiling.

1



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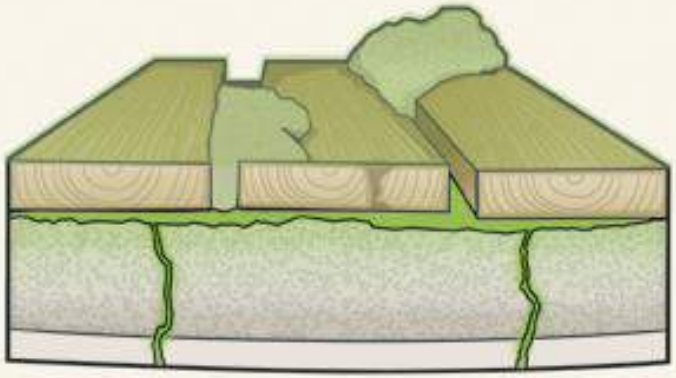
Decaying plaster matrix is penetrated and greatly strengthened.

Acrylic resins fill fissures and cracks.

Plaster is converted from being mechanically supported by the keys and lugs to being fully adhered to the wood lath substrate.

2



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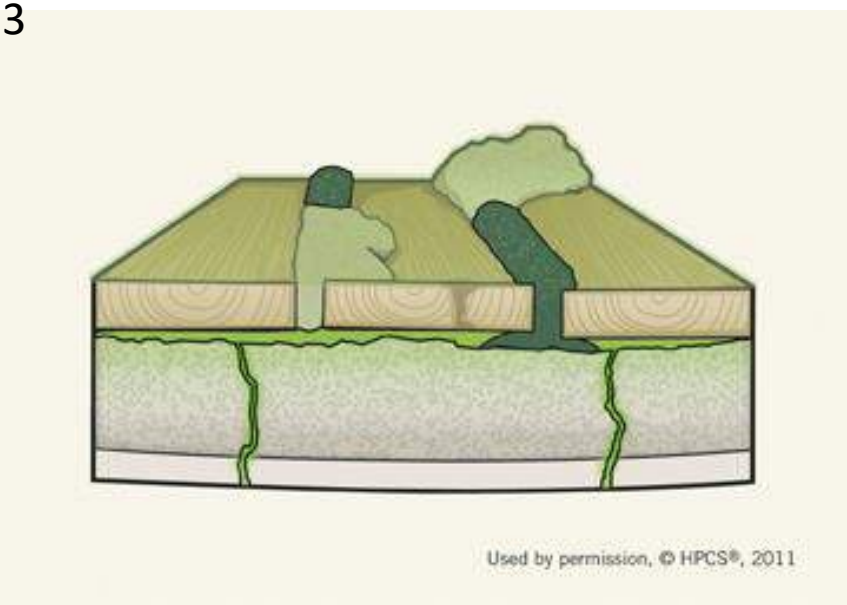
Plaster Consolidation (cont'd)

3



After consolidation, missing keys are replaced with a formulated acrylic-based filled adhesive.

This process begins a new era for the building.

In the absence of UV light, the resin component of this methodology will last and perform indefinitely.

The ceiling is as good as – perhaps even better than – new.

Tests-to-Failure on Consolidated Wood Lath & Plaster Ceilings

Engineering design load for successful test:

30 psf

(Weight of plaster (5lbs) + safety factor of 5 times)

Old St. Patrick's Cathedral, NYC

Test to failure: plaster gave way at **356 psf.**

Test conducted by Simpson, Gumpertz & Heger engineers

St. Stephen Our Lady of the Scapular Church, NYC

Test to failure: plaster gave way at **188 psf.**

Test conducted by Building Conservation Associates (BCA) and Quality Restoration Works

Results presented to the 2012 APT Conference in Charleston, S.C. – "*Field Testing Acrylic Adhesive Plaster Repairs*"

Benefits and Advantages of Consolidating Wood Lath and Plaster

- Addresses entire ceiling as a system.
- Strengthens the plaster matrix and maintains flexibility.
- Converts ceiling from a fragile suspended system to a strong, unified adhered system.
- Does not deface the ceiling surface.
- Addresses safety concerns.
- Does not require scaffolding.
- Greatly extends the plaster's useful service life - it lasts a very long time.

Plaster on Wood Lath Consolidation - Some Notable Church Projects

Old St. Patrick's Cathedral, New York

St. Ann & Holy Trinity, Brooklyn

St. Aloysius, Jersey City

Grace Church, New York

The Cathedral of the Immaculate Conception, Syracuse, NY

St. Stephen's, Croghan, NY

First United Methodist, Henderson, KY

Our Lady of Sorrows, New York

St. Stephen Our Lady of the Scapular, New York

St. Brigid's, New York

Plaster Consolidation Summary

More than 150 plaster consolidation projects.

Some are 35+ years old - no further deterioration, no additional cracking, no failures, no maintenance costs incurred, no warranties exercised, no insurance claims filed.

Plaster consolidation is not a temporary repair; it is a permanent upgrade to your plaster ceiling system.

Finally, A Bold Statement

If a way to treat systemic deterioration of plaster on wood lath was available 50 years ago, hundreds (perhaps thousands) of historic plaster ceilings would have been saved.

Questions?

Catholic Conference of Facility Management (CCFM)

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