Micro Climates and Moisture Induced Damage to Paintings

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Smithsonian Museum Conservation Institute
Washington, D.C.

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The Smithsonian Institution is the National Museum System of the United States

James Smithson's Gift

"I then bequeath the whole of my property...
to the United States of America, to found at Washington,
under the name of the Smithsonian Institution,
an Establishment for the increase & diffusion of knowledge..."
James Smithson (1765-1829)

The Smithsonian Institution has 19 Museums and 9 Research Centers including:

The Anacostia Community Museum
The Arts and Industries Building
Cooper-Hewitt National design Museum
Free Gallery of Art and Arthur M. Sackler Gallery
Hirshhorn Museum and Sculpture Garden
National air and Space Museum and the Udvar-Hazy Center
National Museum of African Art
National Museum of American History, Behring Center
National Museum of Natural History
National Museum of the American Indian
National Portrait Gallery
National Postal Museum
National Zoological Park
Smithsonian American art Museum and its Renwick Gallery

As such the Smithsonian maintains over 600 buildings with 33 “monumental” buildings.

Maintaining the buildings is also a “monumental” task

There are a total of 8,426,000 square feet (782,775 sq. m)

The total energy costs for FY 2006 was $32,800,000 US.

And the tightly controlled environments in the buildings was causing considerable damage.

The Smithsonian “Castle”

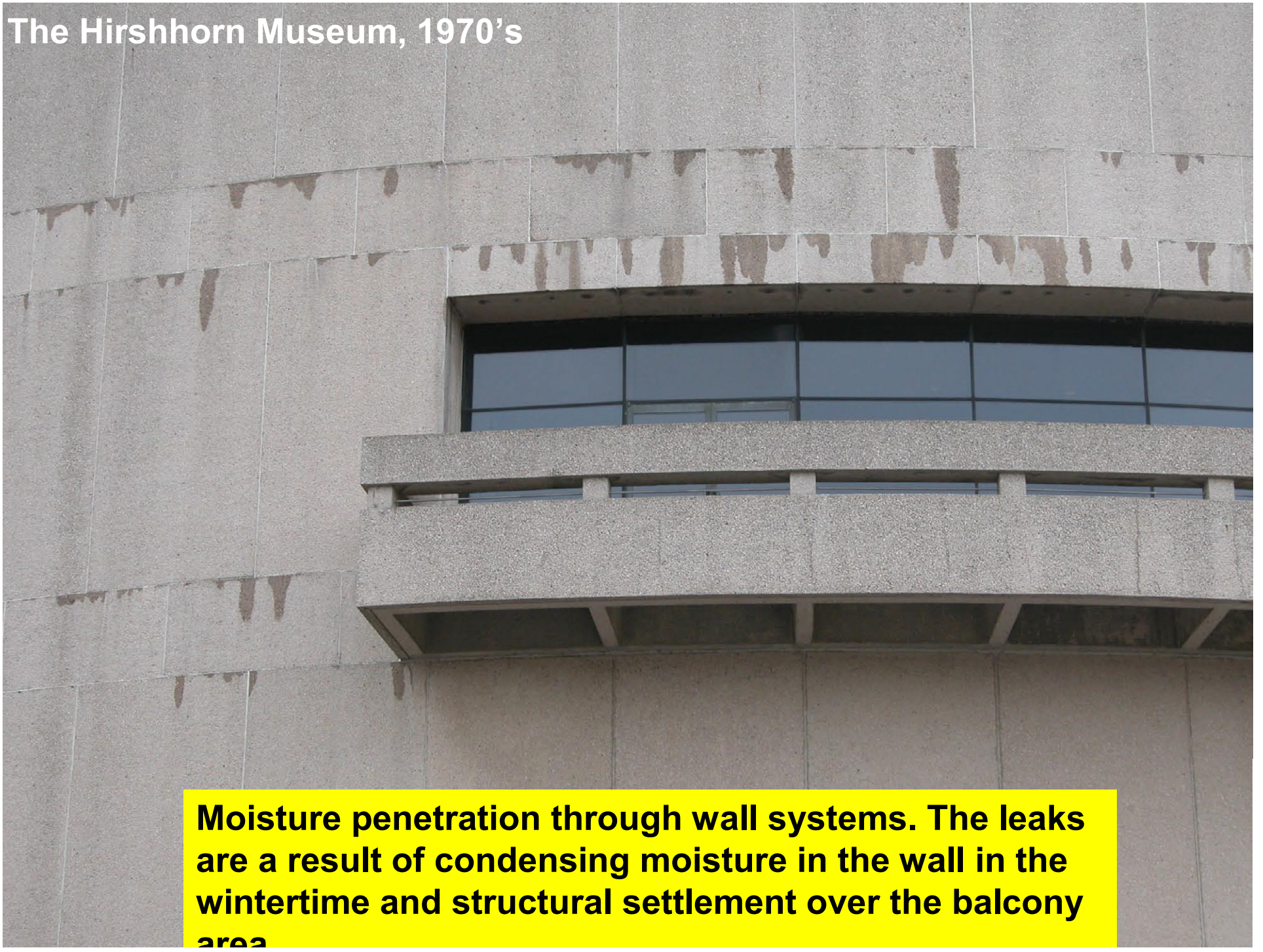
This is the first building for the Smithsonian institution (1855)

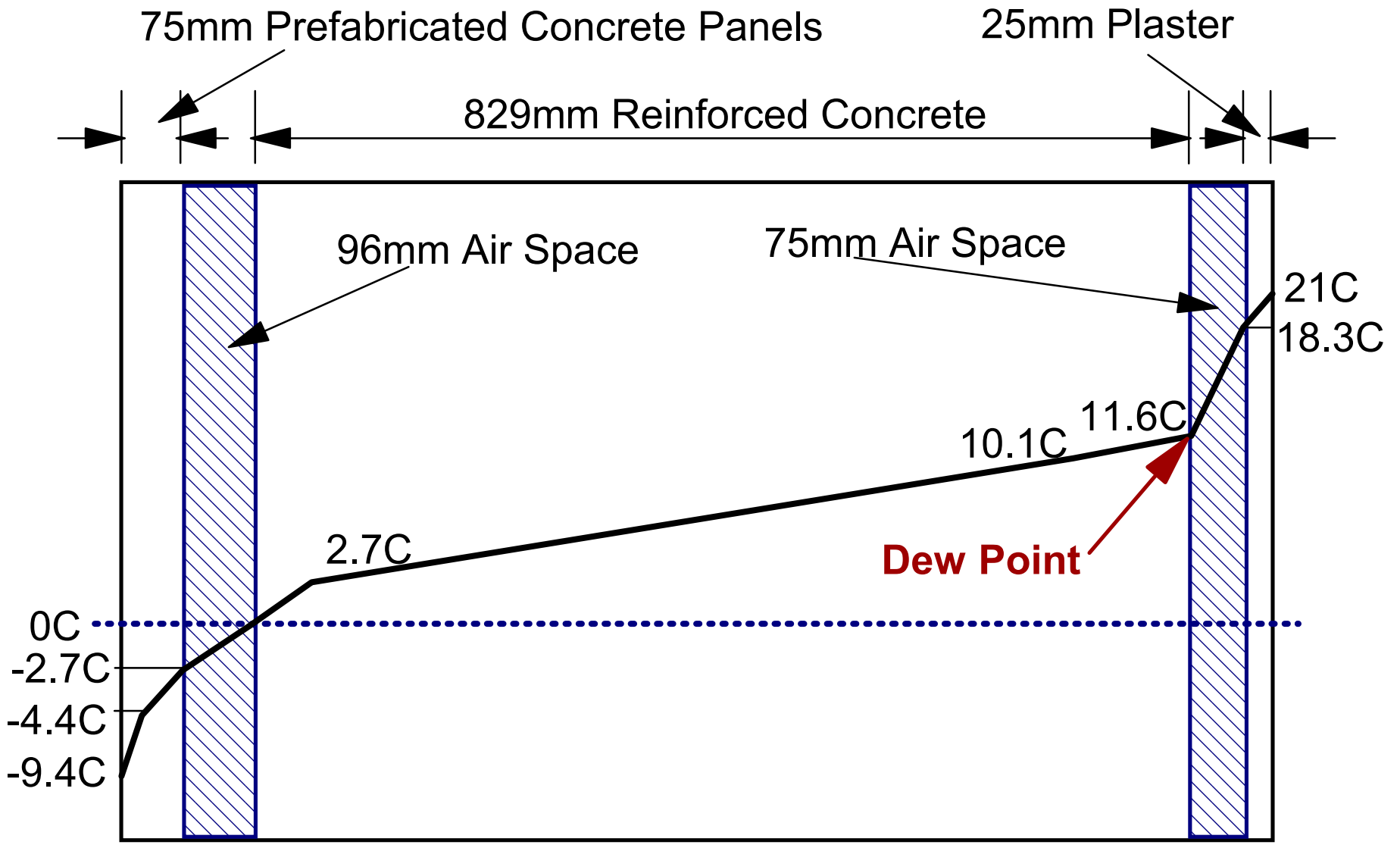
But there were growing problems with the buildings resulting from tightly controlled interior environments.

The National Museum of American History, c 1960's

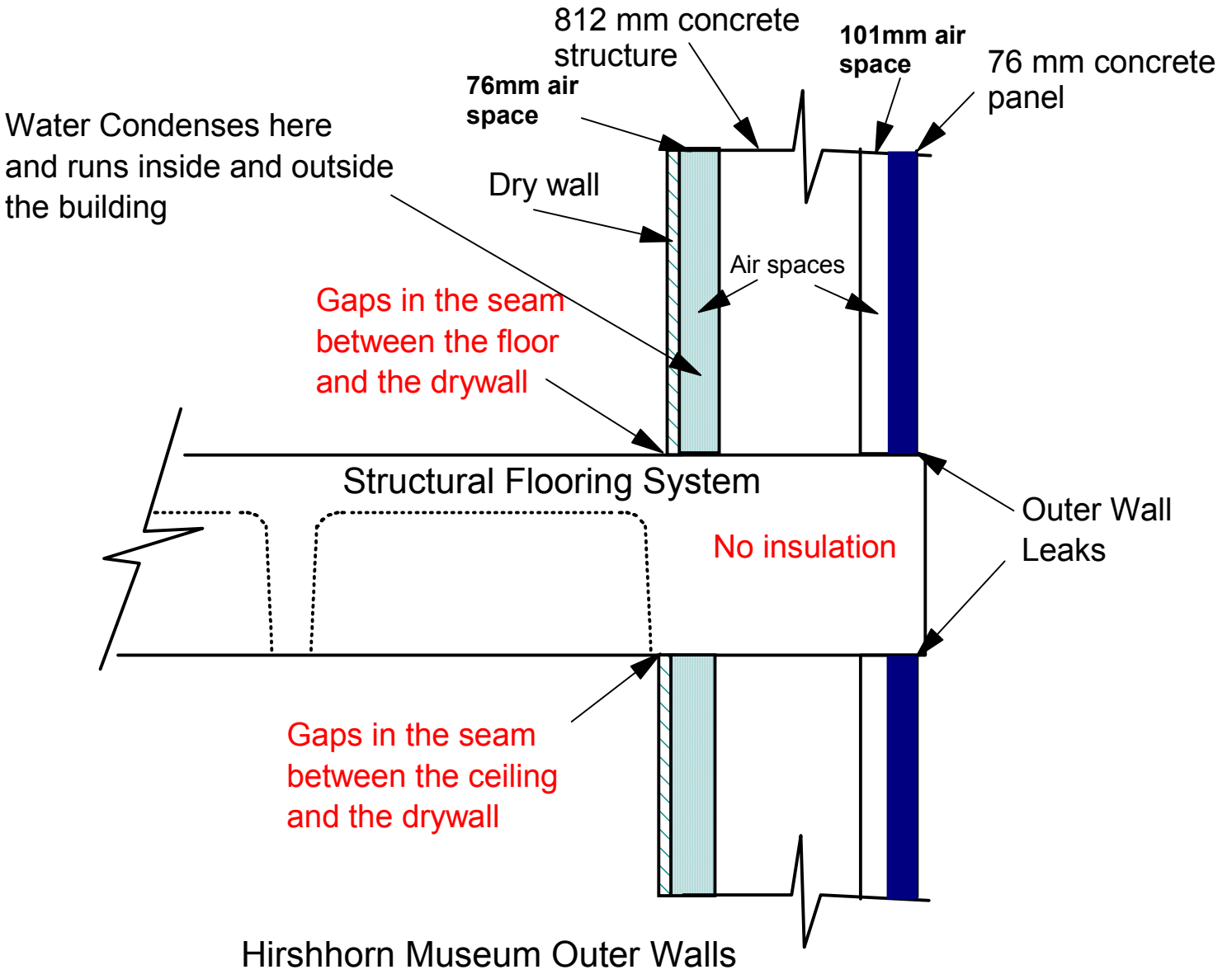

The National Museum of American History, c 1960's
Condensing moisture due to high relative humidity
(50%) In the wintertime.

The Hirshhorn Museum, 1970's


The Hirshhorn Museum, 1970's
Moisture penetration through wall systems. The leaks are a result of condensing moisture in the wall in the wintertime and structural settlement over the balcony area



Outer Wall of the Hirshhorn Museum



Hirshhorn Museum Outer Walls

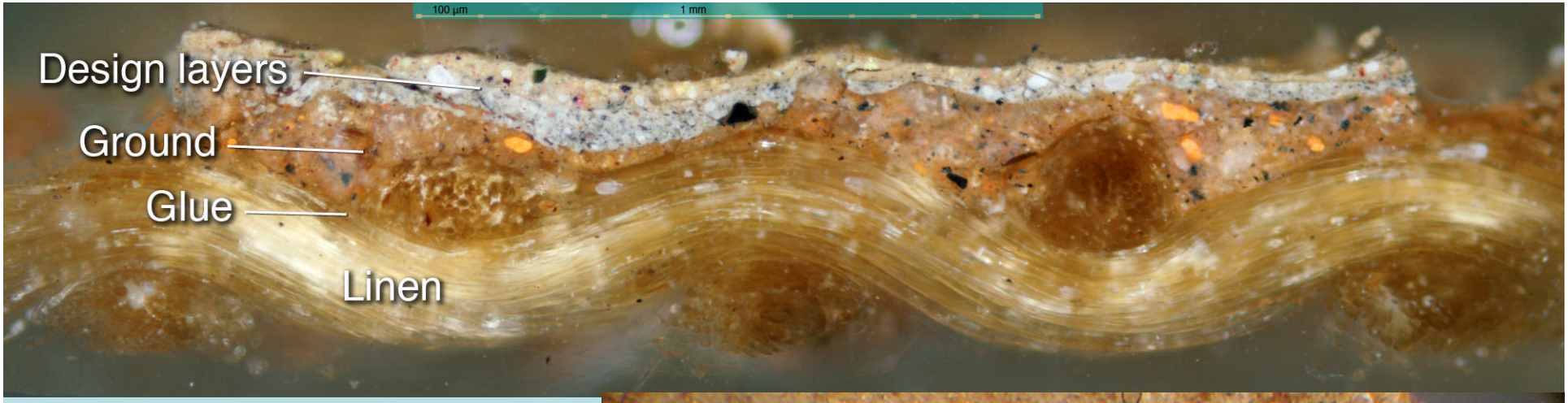
These were not the only buildings with problems due to the environmental control

The Renwick Gallery, c. 1860

The Renwick Gallery, c. 1860

Moisture condensation on the walls in cold winters. Indoor ambient relative humidity was 50%. In the hot summertime RH drop to 35% behind the painting.

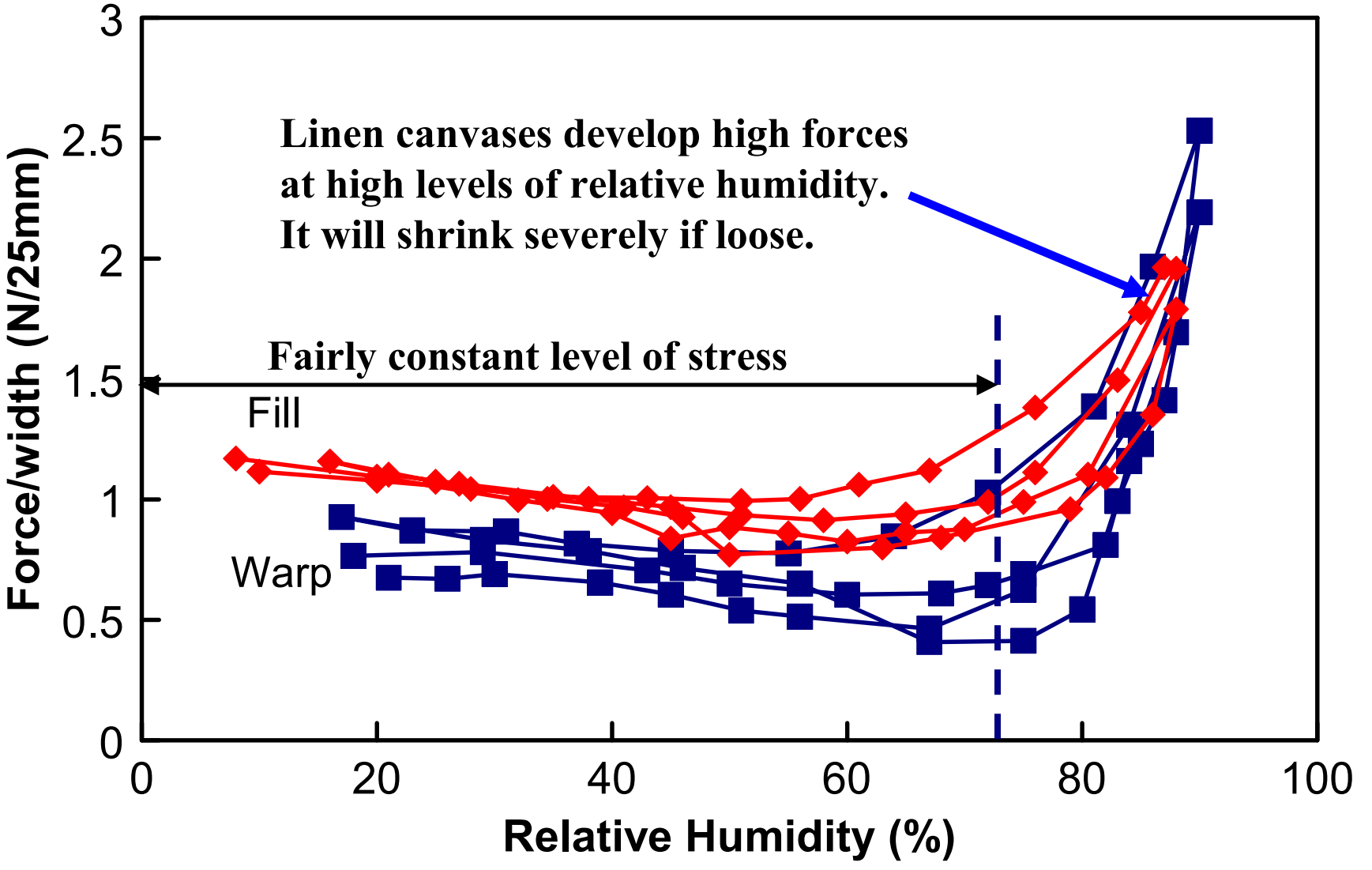
The damage potential is significant.

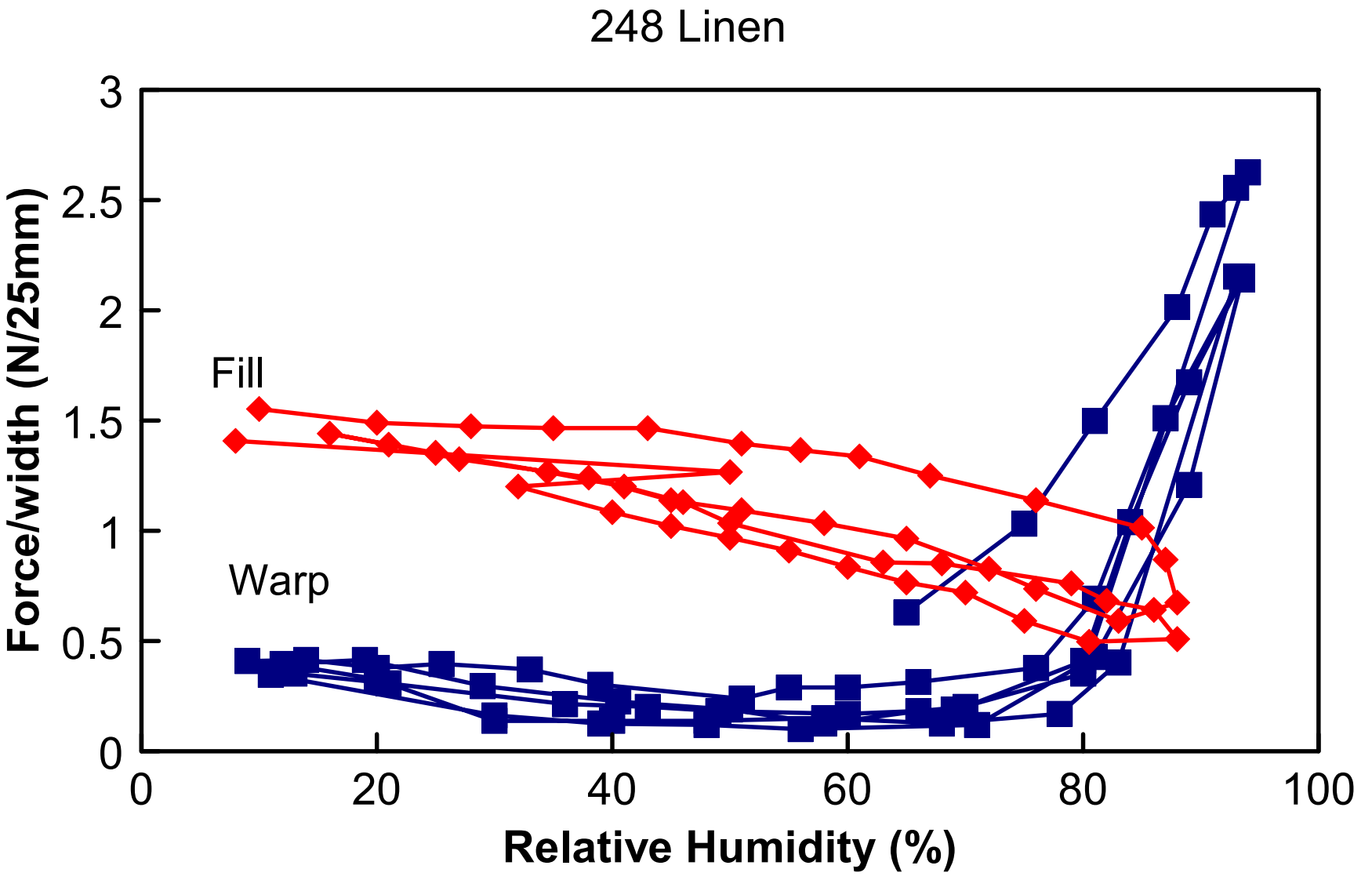


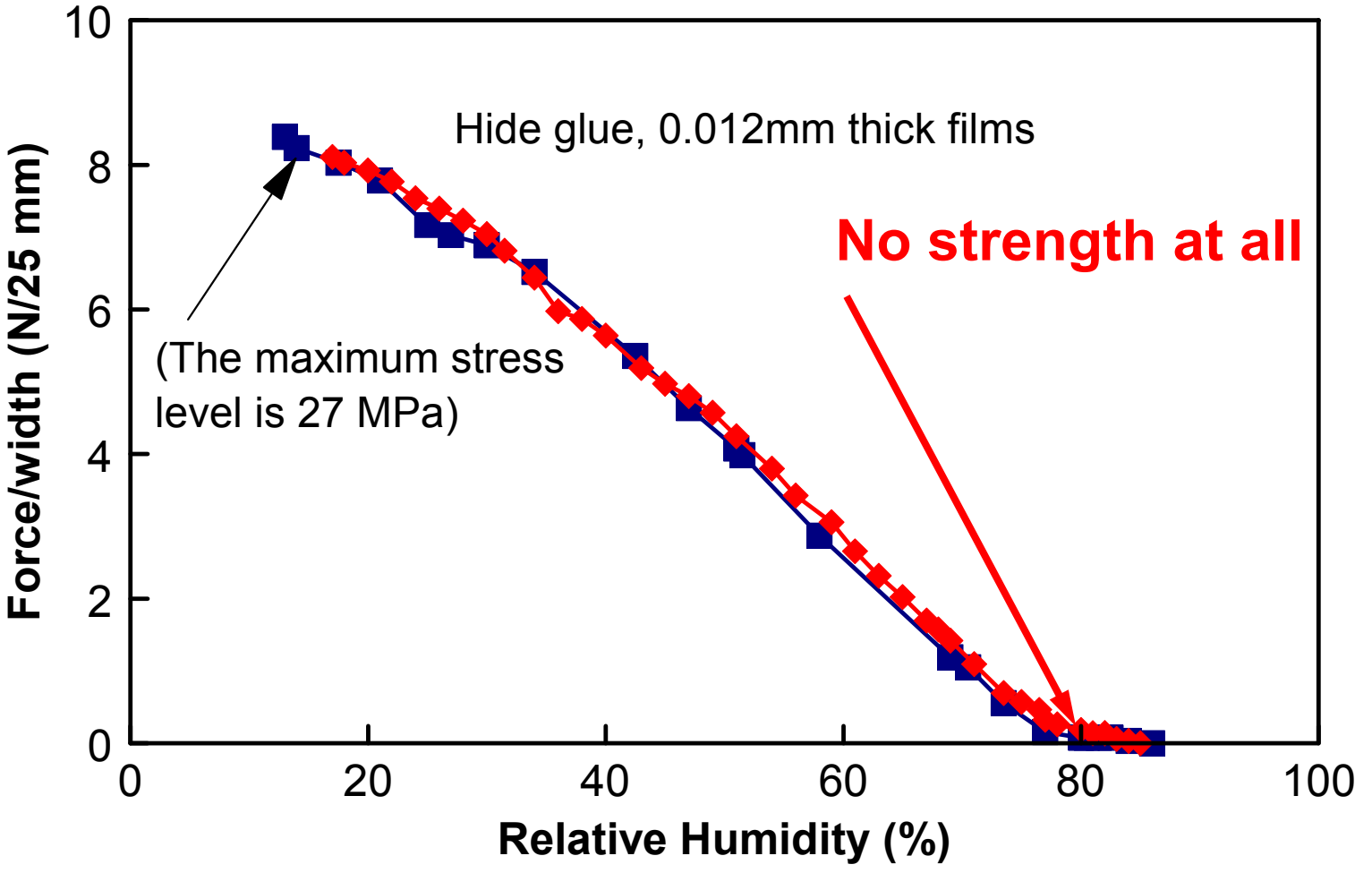
19th century Italian oil on canvas.

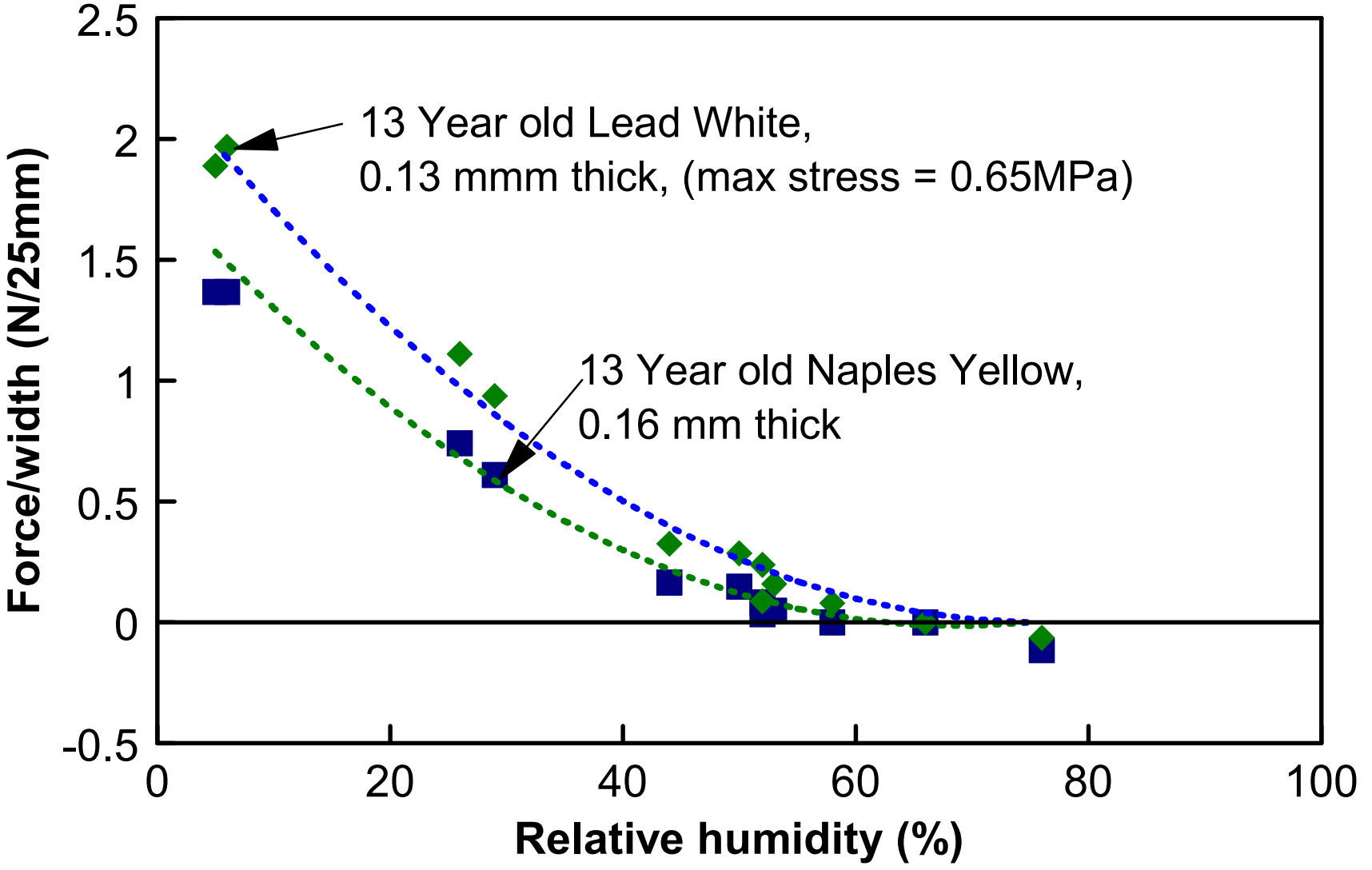
The composite behavior of restrained canvas paintings in an environment of changing relative humidity.

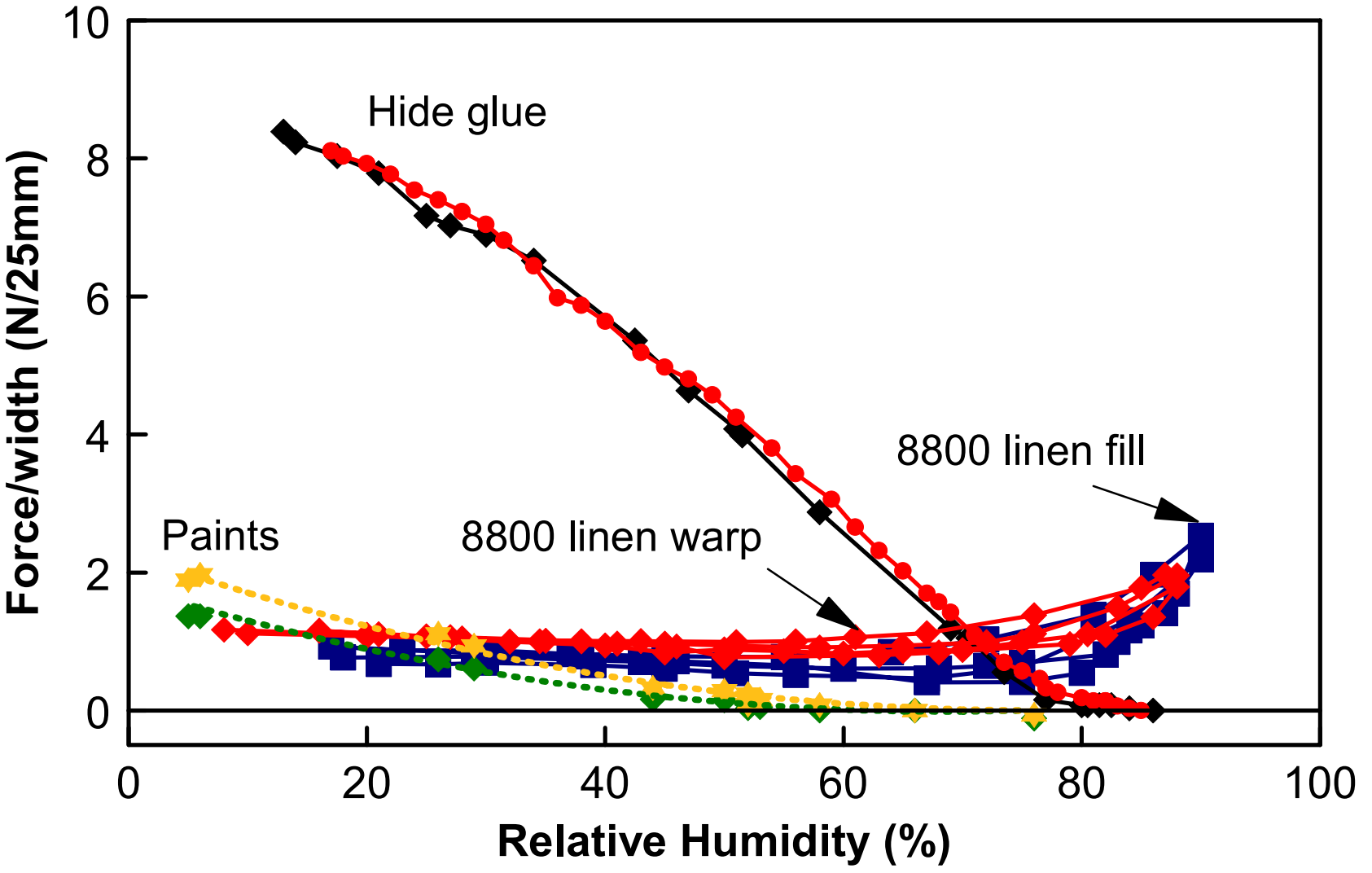
Restrained testing and the principle of superposition. All layers of canvas painting are under stress nearly all of the time.

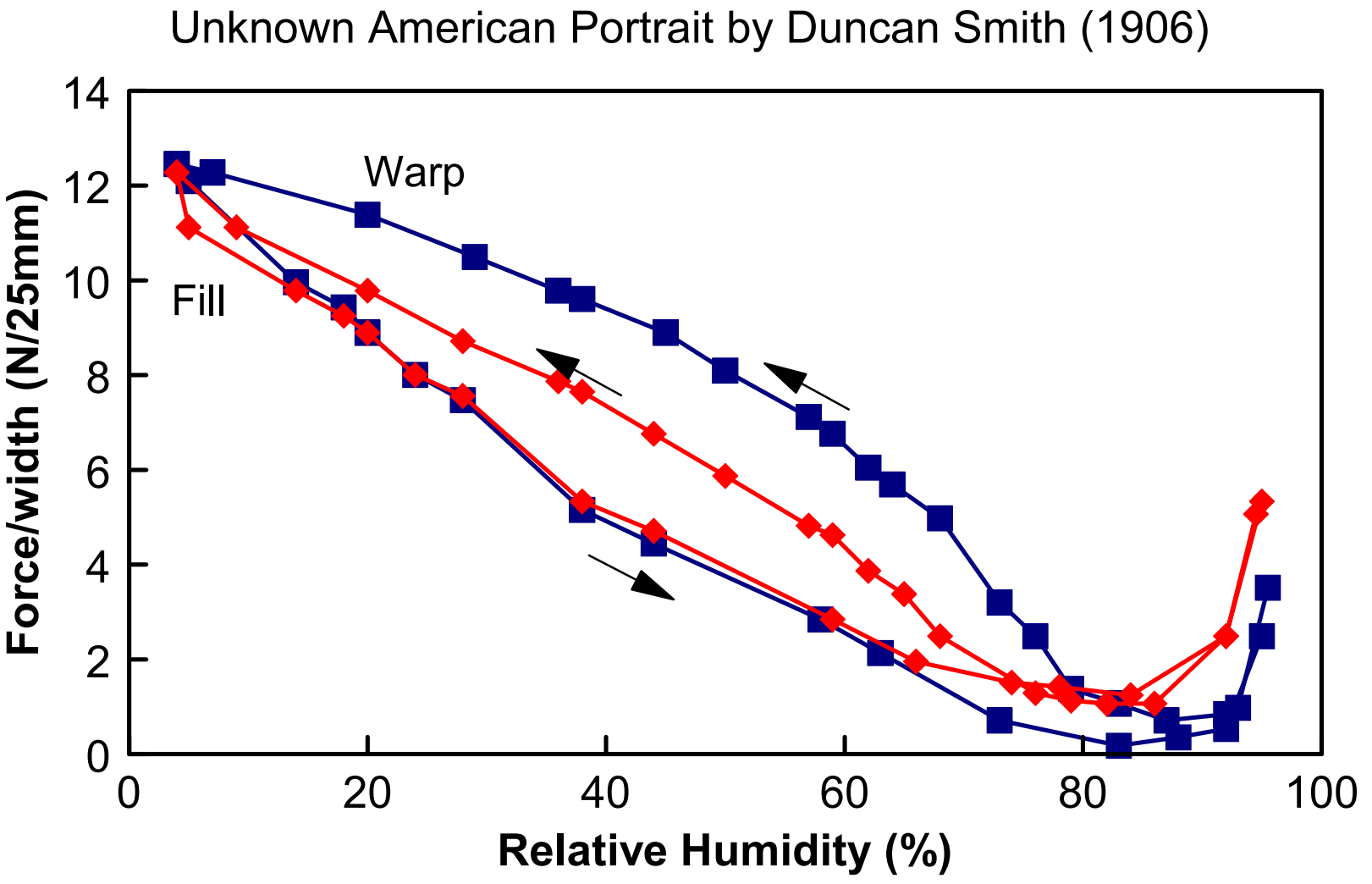


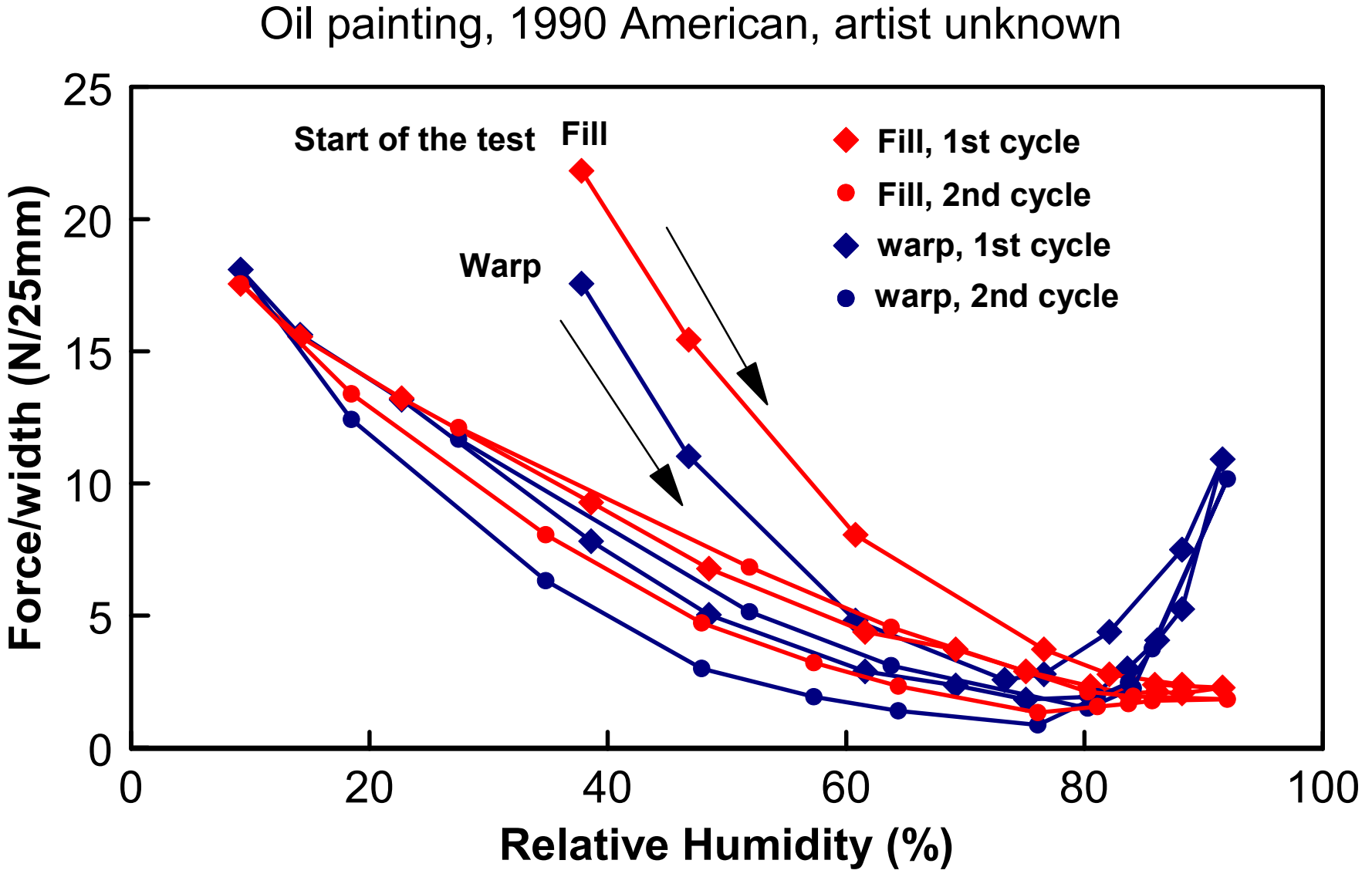

248 Linen
Force/width (N/25mm)
Relative Humidity (%)
Fill
Warp
0
0.5
1
1.5
2
2.5
3
0
20
40
60
80
100


Hide glue, 0.012mm thick films
No strength at all
(The maximum stress level is 27 MPa)
Force/width (N/25 mm)
Relative Humidity (%)
0
2
4
6
8
10
0
20
40
60
80
100


2.5
2
1.5
1
0.5
0
-0.5
0
20
40
60
80
100
Force/width (N/25mm)
Relative humidity (%)
13 Year old Lead White,
0.13 mmm thick, (max stress = 0.65MPa)
13 Year old Naples Yellow,
0.16 mm thick

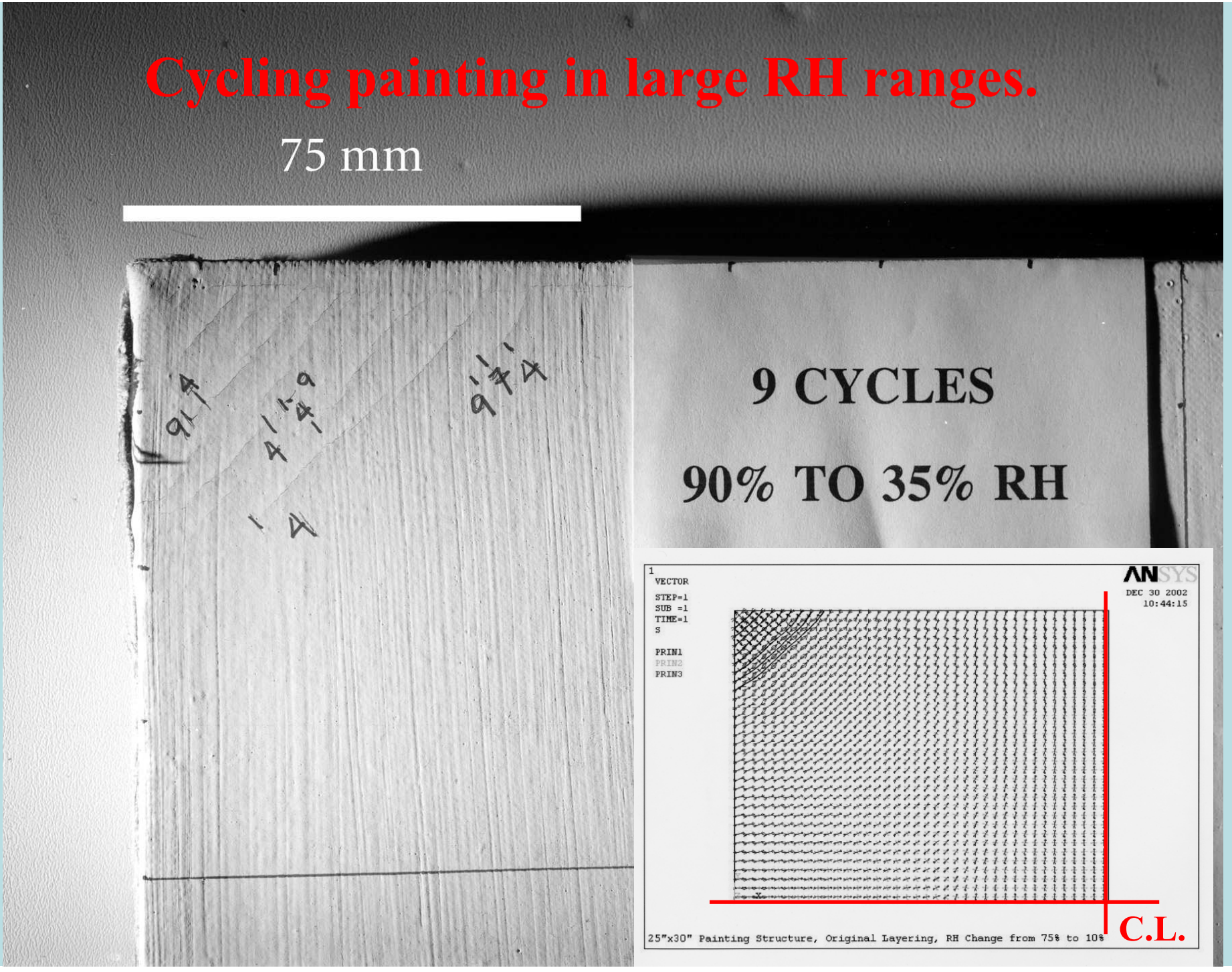

Force/width (N/25mm)
Relative Humidity (%)
Hide glue
8800 linen fill
8800 linen warp
Paints
0
2
4
6
8
10
0
20
40
60
80
100


Unknown American Portrait by Duncan Smith (1906)
Warp
Fill
Force/width (N/25mm)
Relative Humidity (%)
0
2
4
6
8
10
12
14
0
20
40
60
80
100

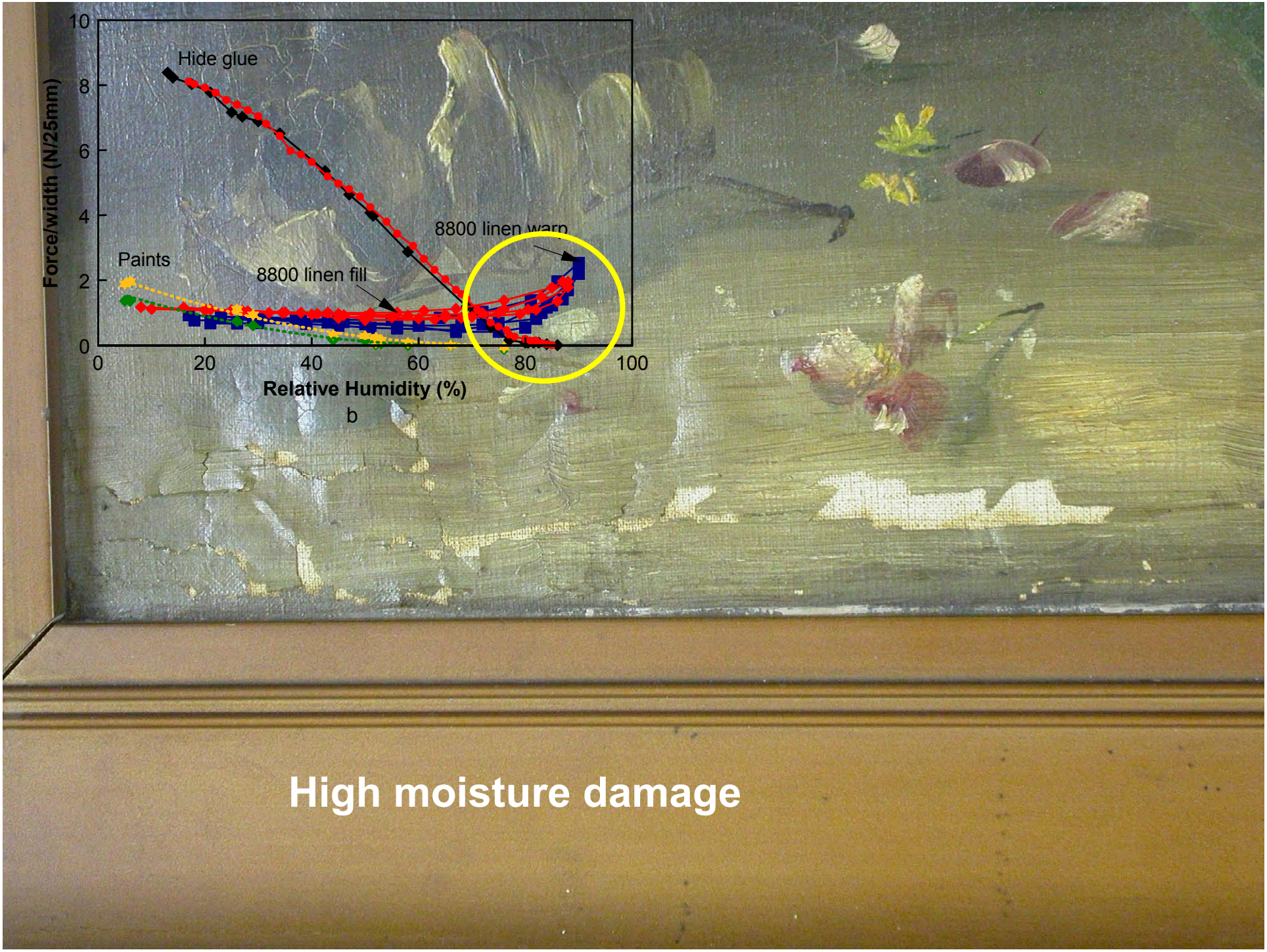

Oil painting, 1990 American, artist unknown
Start of the test
Fill
Warp
Fill, 1st cycle
Fill, 2nd cycle
warp, 1st cycle
warp, 2nd cycle
Force/width (N/25mm)
Relative Humidity (%)
0
5
10
15
20
25
0
20
40
60
80
100

Cycling painting in large RH ranges.

75 mm

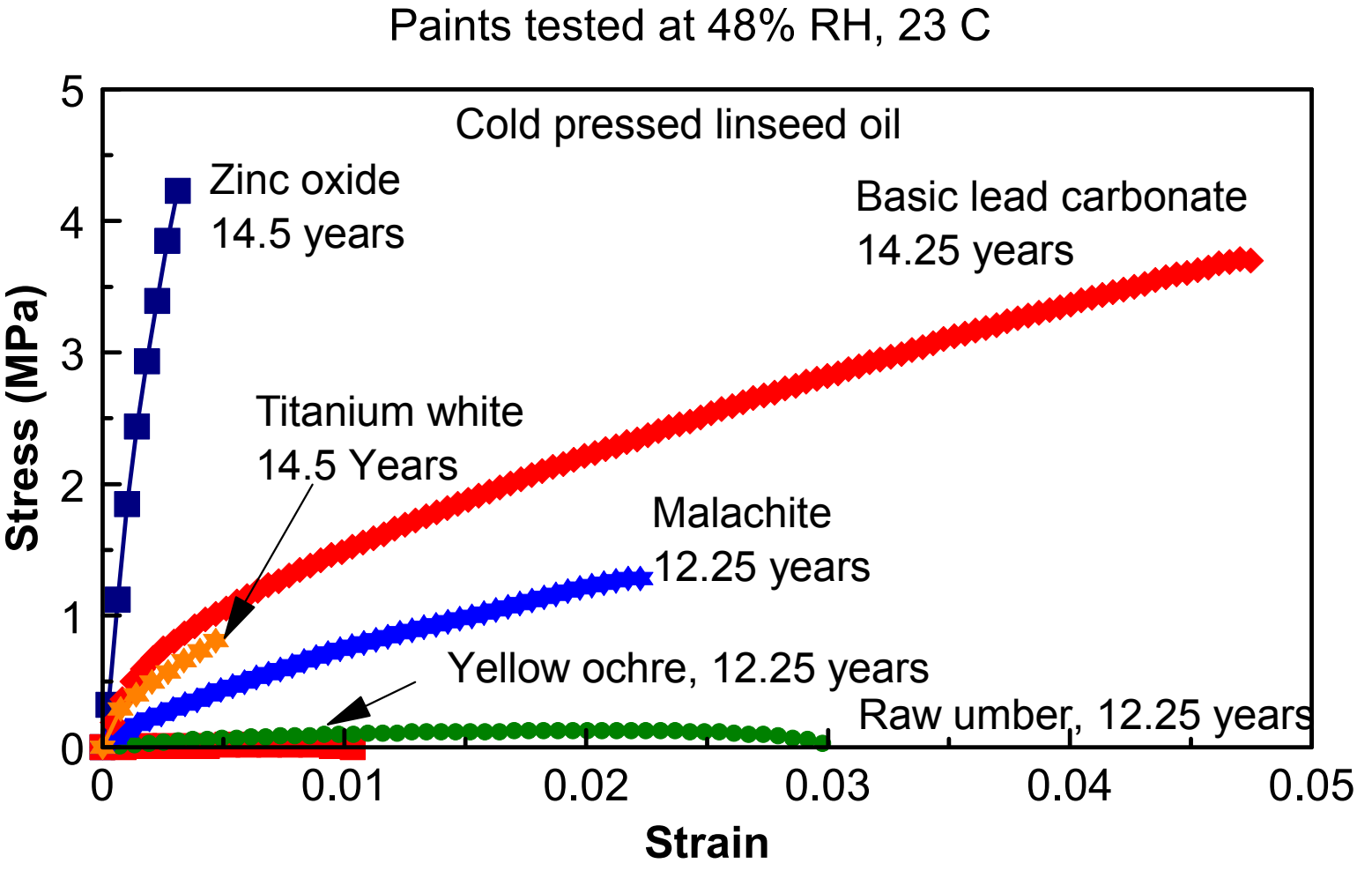


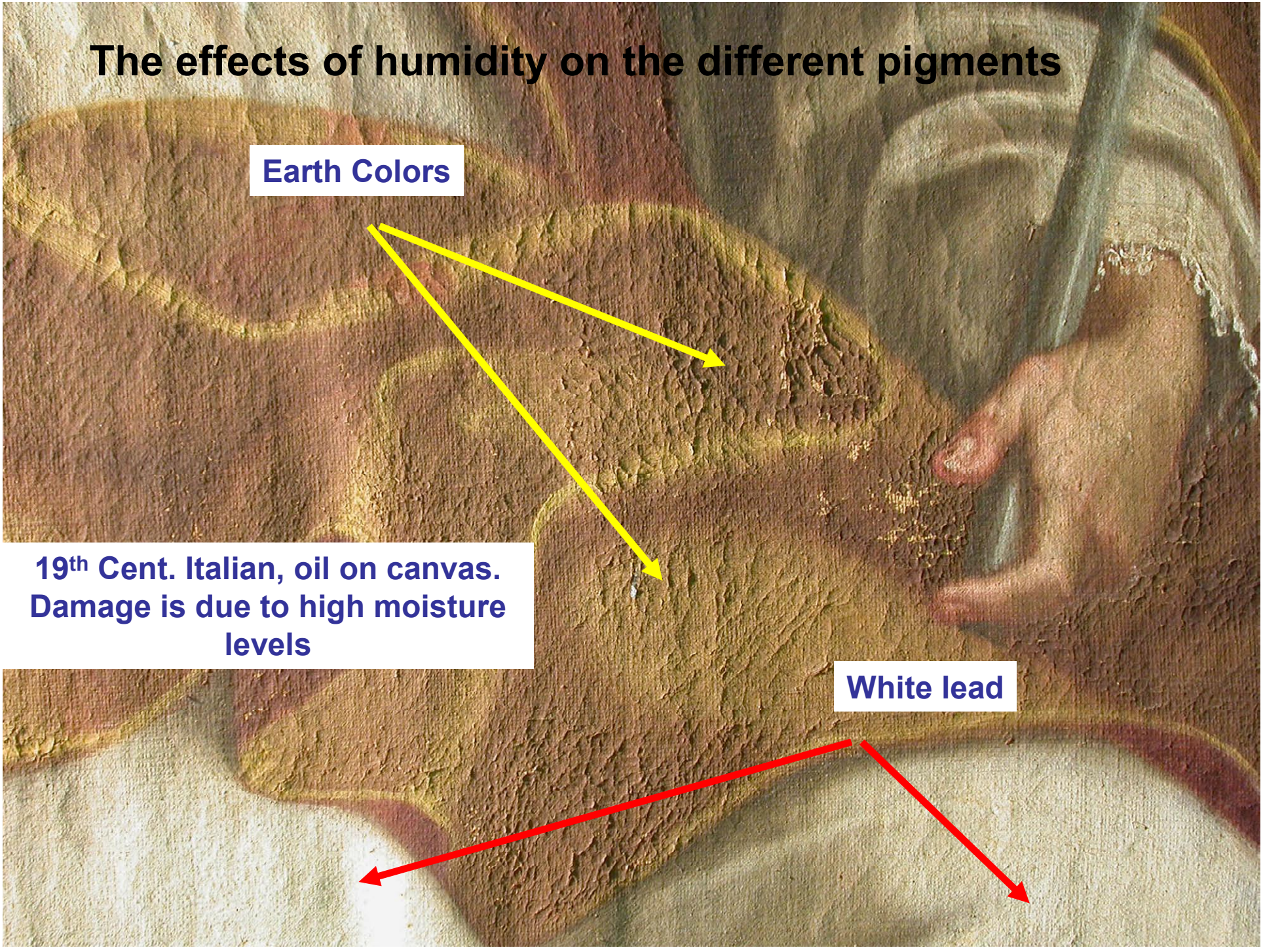

Buckling from loose keys and over expansion
Cracking from low RH
Key out cracking



High moisture damage

The strength of the oil paints made with different pigments




The effects of humidity on the different pigments
Earth Colors
19th Cent. Italian, oil on canvas. Damage is due to high moisture levels
White lead

Correcting the problems

- Reset the museum environment, lower the RH in the wintertime to 37% RH - 40% RH

- Provide backing boards to all paintings

- Provide a 25mm - 50mm airspace behind all paintings on the inside of exterior walls.

Benefits of the changes

- Maintain the collection stability
- Lower building maintenance costs
- Lower energy consumption

Contact information

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