The Shortcomings of Using Prescriptive Specifications with Emerging Roofing Technologies

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Implementation of emerging technologies into time-tested, proven roof systems can result in some unintended consequences.
Problems observed

• Moisture migration from the buildings’ interiors
• Condensation forming within roof systems
• Loss of adhesion within roof systems
• In Northern climates, ice formation underneath roof membranes
Research

Research
Concrete types:

- Structural concrete
  - 150 lbs/ft$^3$
- Lightweight structural concrete
  - 85–120 lbs/ft$^3$
- Lightweight insulating concrete
  - 20-40 lbs/ft$^3$

Water Tower Place (1975)
Chicago, IL
859 feet tall
Concrete Aggregates
60-80% of Concrete Mix Design

• Normal-weight aggregates (stone):
  – Dense
  – Absorb about 2% by weight

• Light-weight aggregates (expanded shale):
  – Porous
  – Absorbs from 5 - 25% by weight

Lightweight structural concrete inherently contains more moisture
When is it OK to roof?

Historical guidelines

- After 28 days
- Plastic film test
- Application of hot bitumen

These are not appropriate for current generations of concrete
Flooring industry
ASTM Committee F06—Resilient Floor Coverings

- ASTM F1869, “Standard Test Method for Measuring Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride”
ASTM F2170 apparatus

Measure relative humidity (RH %) and temperature

Connector for the HM41 indicator

Protective cover (19268HM)

Plastic sleeve is sealed with a rubber plug (19267HM).

Plastic sleeve (19266HM)

The humidity can be measured at the desired depth (min. 30 mm, max. 90 mm).

The tip of the probe is in contact with the air that is in equilibrium with the concrete.

Probe diameter 12 mm
Bore hole diameter 16 mm
Trial ASTM F2170 tests
Existing lightweight structural concrete roof decks

<table>
<thead>
<tr>
<th></th>
<th>Roof 1</th>
<th>Roof 2</th>
<th>Roof 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof age (yrs)</td>
<td>4</td>
<td>7</td>
<td>7</td>
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<tr>
<td>Area (ft(^2))</td>
<td>13,200</td>
<td>23,840</td>
<td>14,760</td>
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<tr>
<td>Thickness (in.)</td>
<td>6.5</td>
<td>7.5</td>
<td>7.3</td>
</tr>
<tr>
<td>No. of readings</td>
<td>13</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>High reading</td>
<td>99% RH</td>
<td>99% RH</td>
<td>99% RH</td>
</tr>
<tr>
<td>Low reading</td>
<td>63% RH</td>
<td>96% RH</td>
<td>84% RH</td>
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<tr>
<td>Median reading</td>
<td>97% RH</td>
<td>99% RH</td>
<td>99% RH</td>
</tr>
<tr>
<td>Mean reading</td>
<td>89% RH</td>
<td>99% RH</td>
<td>95% RH</td>
</tr>
</tbody>
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Values of 65-85% RH are considered acceptable in the flooring industry depending upon the specific floor covering type.
75% internal RH can be achieved:

- Normal weight structural concrete
  - Less than 90 days
- Lightweight structural concrete
  - Almost 6 months
Acceptable values for roof systems?

Aren’t currently known
Conclusions

• Adapting emerging technologies can present some unexpected challenges
• Controlling moisture and its movement are increased concerns
• Concrete presents unique challenges
• We currently don’t have all the answers
Recommendations

- Using ASTM F2170 for concrete roof decks appears reasonable… but roofing-specific criteria needs to be developed.
Recommendations – cont.

“…when in doubt, we better figure it out…”

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2011 International Roofing Symposium
September 7, 2011
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Questions?