Preliminary Research on Plastic Based Materials (PBM)
Plastic based material (PBM) flooring

• Resilient Floor Coverings
• Luxury Vinyl Tile (LVT)
• Luxury Vinyl Plank (LVP)
• Wood Polymer Composite (WPC) Flooring
• Stone Polymer Composite (SPC) Flooring
• Clay Polymer Composite (CPC) Flooring
• Rigid Core Board (RCB)

• Common Denominator - Plastic
Why is PBM flooring popular?

• Top reasons consumers are choosing PBM flooring (preliminary results from independent market research):
  • Belief of scratch resistance
  • Belief of wet area usage
  • Belief of durability, in general
  • Assumption of competitive pricing
  • Assumption of health and safety
  • Assumption of comparability to ceramic tile
Surface Durability: Discrepancies between ads and warranty exclusions

- “Worry-proof,” “scratch-proof,” “life-proof,” “pet-proof,” and many claims

- Yet, warranties examined for products tested excluded:
  - Scratching, indentation, and/or pet damage

- Also, manufacturers recommend the use of furniture pads which are not depicted in advertisements
Waterproof??

• Advertisements for products tested for water intrusion:
  • “100% Waterproof”
  • Depicted bathrooms and wet areas, spills, leaks, etc.

• Warranties exclude for example:
  • All water damage resulting from water passing through or around floor covering to the sub-floor and other structural elements of the building

• Claim “Unaffected by water”
Waterproof??

• “Unaffected by Water”
• Merriam-Webster online: waterproof is defined as “impervious to water”
• Cambridge dictionary online: waterproof is defined as “not allowing water to go through.”

• Merriam Webster adds: “especially: covered or treated with a material (such as a solution of rubber) to prevent permeation by water”.

Moisture (or Lack of Moisture): Damages caused by moisture (such as leaking pipes, spills, wet mopping, pets, relative humidity, subfloor moisture etc.) are excluded. Moisture (and dryness) can cause issues such as checks, cupping, crowning, warping, buckling, peeling, twisting, seam swelling or gapping. In addition, moisture intrusions from concrete hydrostatic pressure, flooding, or plumbing leaks, along with high levels of alkalinity, can affect flooring and subflooring over time and moisture can be trapped below the flooring and/or underlayment and create mildew or mold. Damage from such conditions, including to the floor and subfloor, is not covered under this warranty.
Ad for product with warranty exclusion in prior slide
(video depicts water running on the floor)
Preliminary Testing/Research of “Waterproof”

• Initial sampling of 10 PBM products from a lot of nearly 40 brands/product lines

• Products chosen:
  • Major market presence/high popularity with consumers
  • Advertised claims of “waterproof”

• Spectrum of products tested:
  • 7 RCB, 2 SPC, 1 WPC
  • All click system “LVT or LVP” products
Two test methods used

• No information on water penetration test method found from product manufacturers

• EN 13553 European specification for resilient floor coverings – polyvinyl chloride floor coverings for use in special wet areas

• ASTM D4068 Standard specification for chlorinated polyethylene sheeting for concealed water-containment membranes (used in tile industry)
EN 13553 Methodology

• Box filled with water to level of 20 cm, approximately 30 Liters

• Per the standard, any drop in water level within 24 hours deemed a failure

• Clear assembly and substrate to facilitate observation of water movement above and beneath the floor covering
Initial Observations

• Water penetration into seams within seconds of making contact with the flooring, then:
  • Resurfacing on the outside of the container\(^1\)
  • Dripping from the edges of the seams\(^2\)
  • Also trapped between floor covering and substrate\(^3\)
## EN 13553: Preliminary Results

<table>
<thead>
<tr>
<th>Sample</th>
<th>Water lost per hour in Liters (gal) over 0.15 m²</th>
<th>Water lost per hour in Liters (gal) over 3.7 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3</td>
<td>6.13 (1.62)</td>
<td>151.21 (40.25)</td>
</tr>
<tr>
<td>S6</td>
<td>2.43 (0.64)</td>
<td>59.94 (15.90)</td>
</tr>
<tr>
<td>S8</td>
<td>2.25 (0.59)</td>
<td>55.50 (14.66)</td>
</tr>
<tr>
<td>S10</td>
<td>7.54 (1.99)</td>
<td>185.99 (49.44)</td>
</tr>
<tr>
<td>S14</td>
<td>2.54 (0.37)</td>
<td>62.65 (9.19)</td>
</tr>
<tr>
<td>S15</td>
<td>4.81 (1.27)</td>
<td>118.65 (31.55)</td>
</tr>
<tr>
<td>S17</td>
<td>1.91 (0.50)</td>
<td>47.11 (12.42)</td>
</tr>
<tr>
<td>S20</td>
<td>0.49 (0.13)</td>
<td>12.09 (3.23)</td>
</tr>
<tr>
<td>S21</td>
<td>4.22 (1.11)</td>
<td>104.09 (27.58)</td>
</tr>
<tr>
<td>S23</td>
<td>4.75 (1.25)</td>
<td>117.17 (31.06)</td>
</tr>
</tbody>
</table>
ASTM D4068 Methodology

- Used in ceramic tile industry
- 2" diameter pipe, 24" water column
- Samples sealed to water column outlet
- The drop in water measured
- Samples observed for leaks through seams
ASTM D4068 Results

- All samples tested began leaking immediately through the seam
- Within a few seconds water began to appear on top of the samples
- Results reported for water leaking out of 2” seam

<table>
<thead>
<tr>
<th>Sample</th>
<th>Water lost (mL) per 10 minutes over 2” seam</th>
<th>Water lost Liters (gal) per hour (2”)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3</td>
<td>166</td>
<td>0.99 (0.26)</td>
</tr>
<tr>
<td>S6</td>
<td>320</td>
<td>1.92 (0.51)</td>
</tr>
<tr>
<td>S8</td>
<td>320</td>
<td>1.92 (0.51)</td>
</tr>
<tr>
<td>S10</td>
<td>405</td>
<td>2.43 (0.64)</td>
</tr>
<tr>
<td>S14</td>
<td>190</td>
<td>1.14 (0.30)</td>
</tr>
<tr>
<td>S15</td>
<td>315</td>
<td>1.89 (0.50)</td>
</tr>
<tr>
<td>S17</td>
<td>190</td>
<td>1.13 (0.30)</td>
</tr>
<tr>
<td>S20</td>
<td>100</td>
<td>0.60 (0.15)</td>
</tr>
<tr>
<td>S21</td>
<td>64</td>
<td>0.38 (0.10)</td>
</tr>
<tr>
<td>S23</td>
<td>100</td>
<td>0.60 (0.16)</td>
</tr>
</tbody>
</table>
“Waterproof” . . . in summary

• All products tested are from “name brands,” claim to be 100% waterproof and advertise explicitly or implicitly that they can be used in wet areas.

• Warranties exclude water damage to the sub-floor, walls, or other structural elements of the home where the floor covering is installed.

• Substantial leakage through seams for both methods.
Ad for product with warranty excluding problems due to excessive moisture
(video depicts water spraying on the floor)
If a floor covering is advertised as “waterproof,” but water leaks through seams:

• Failures are possible that are not covered by the product warranty

• Unanticipated water penetration into the substrate
  • Mold and structural damage are a possibility on wood subfloors
Mold Growth
Where does mold grow?

- Areas that are damp
  - PBM flooring may not prevent moisture intrusion, as already established

- Nutrition source
  - Water trapped beneath flooring and within the flooring itself
    - May be favorable environment for fungi to grow
  - Organic chemicals in plastics may be a ready source of carbon and nutrition supporting mold growth
Research on PBM flooring for mold resistance

- Tests on 22 samples
  - All “waterproof” research specimens were included

- Ceramic tile also tested for reference

- Samples exposed to five fungi common to buildings per ASTM G21 test method
Mold growth results

- 90% of plastic flooring samples tested supported growth
- Growth varied from small amounts to profuse growth
- No growth observed on ceramic tile
Why is mold bad?

• Possible structural damage, discoloration, and unpleasant odors

• Major health concerns
  • According to a WHO report, non-visible mold growth (i.e. underneath the flooring) is a leading hidden cause for sickness
  • Common ailments: respiratory and allergic affects
  • In some cases, more severe ailments are possible
Mold growth in buildings – Allergies

• Spores pushed into indoor air from “squishy” flooring or sub-flooring by simple day-to-day walking

• Some molds are known to release toxic substances that can cause rashes, hives, joint pain, depression and chronic fatigue
Mold growth in buildings – VOCs

• Growth of fungi releases VOCs

• According to literature, mold growth can accelerate release of phthalate plasticizers
  • According to CDC, certain phthalates are known to cause reproductive disorders
Slip Resistance
Plastic flooring usage in wet areas: slip resistance?

• Many plastic floorings are advertised as waterproof, water resistant, or suitable for wet areas.

• Of products examined, manufacturers did not specify wet Dynamic Coefficient of Friction (DCOF).

• Using hard surface flooring standards, what are the numbers for plastic flooring?
Tests: Wet DCOF of plastic flooring

• Research on a sampling of products to determine which pass/fail 0.42 wet DCOF limit specified in ANSI A326.3.

• 22 products tested
  • All advertise wet area applications
Preliminary Findings

- 81.8% of tested products measured below 0.42 in all or some directions
- 18.2% of tested products were above 0.42 in all directions
- Conclusion: Per ANSI A326.3 hard surface criteria, majority of PBM flooring products fall below criteria to be specified for wet applications, despite:
  - Advertised wet area usage

<table>
<thead>
<tr>
<th>Measured below 0.42 wet DCOF</th>
<th>Measured below 0.42 along “long edge,” above 0.42 along “short edge”</th>
<th>Measured above 0.42 wet DCOF</th>
<th>Total number of products tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>2</td>
<td>4</td>
<td>22</td>
</tr>
</tbody>
</table>
PBM flooring in wet areas, summary of testing:

• Claimed to be waterproof
  • A top reason for purchase cited by consumers
• Confirmed water leakage on all products tested
• Majority of products grew mold
• Majority of products had wet DCOF below 0.42
Scratch Resistance
Warranty exclusions for scratches/scratching

• **Product A**
  • “What is not covered by this limited warranty?”
    • “Loss of gloss/scratching”

• **Product B**
  • “The following are not covered by this Limited Warranty:”
    • “Damage caused by fire, burns, abuse, flooding, spills, scratches, abrasive scouring pads, scuffing, staining, construction or installation.”
    • “Damage caused by vacuum cleaner beater bar, indentations or damage caused by spiked heeled shoes, improper rolling loads, caster wheels, chairs or other furniture without proper floor protectors and cuts from sharp objects.”

• **Product C**
  • “We warrant to the original purchaser that the wear layer on our flooring will not wear through the decorative surface. Scratches, indentation or reduction in gloss level is not considered wear.”
How hard is plastic flooring?
A traditional approach

• Attempt to scratch the surface of the sample using minerals of known hardness

• Simple and quick test to check sample hardness
Preliminary Results

- Sampling of 22 plastic flooring samples
  - All claiming durability/abrasion resistance
  - All exclude scratching from their warranty

- All samples scratched with hardness picks 3 and above (scale 1 to 10)
Scratch hardness of plastic flooring vs. ceramic tile relevant to other scales and abrasives

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Mohs relative Hardness</th>
<th>Scratch Test</th>
<th>Rosiwal absolute Hardness</th>
<th>Vickers kp / mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talc</td>
<td>1</td>
<td>scrapeable with fingernail</td>
<td>0.03</td>
<td>2.4</td>
</tr>
<tr>
<td>Gypsum</td>
<td>2</td>
<td>scratchable with fingernail</td>
<td>1.25</td>
<td>36</td>
</tr>
<tr>
<td>Calcite</td>
<td>3</td>
<td>scr. with copper coin</td>
<td>4.5</td>
<td>109</td>
</tr>
<tr>
<td>Fluorite</td>
<td>4</td>
<td>easily scr. with knife</td>
<td>5</td>
<td>189</td>
</tr>
<tr>
<td>Apatite</td>
<td>5</td>
<td>still scr. with knife</td>
<td>6.5</td>
<td>536</td>
</tr>
<tr>
<td>Orthoclase</td>
<td>6</td>
<td>scr. with steel file</td>
<td>37</td>
<td>795</td>
</tr>
<tr>
<td>Quartz</td>
<td>7</td>
<td>scratches window glass</td>
<td>120</td>
<td>1,120</td>
</tr>
<tr>
<td>Topaz</td>
<td>8</td>
<td>scratches quartz</td>
<td>175</td>
<td>1,427</td>
</tr>
<tr>
<td>Corundum</td>
<td>9</td>
<td>scratches topaz</td>
<td>1,000</td>
<td>2,060</td>
</tr>
<tr>
<td>Diamond</td>
<td>10</td>
<td>scratches corundum</td>
<td>140,000</td>
<td>10,060</td>
</tr>
</tbody>
</table>
The durability of PBM flooring products?

• Surface wear resistance is another commonly advertised benefit
  • Another reason consumers cited for purchase

• All warranties for products tested exclude damage due to scratching
  • Exclusions also caution against pets, furniture legs, etc.

• Scratching is a concern for PBM products based on warranty exclusions and these test results
For more information

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