Specific building-physical properties of ETICS on mineral-wool basis

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1. Introduction

IBP-Summary report stone wool ETICS on behalf of Rockwool

- Fraunhofer institute investigating ETICS since 1960

- Report give overview about hygrothermal performance and durability of exterior insulation with stonel wool

- Stone wool is non-combustible

- Stone wool thermal conductivity is between $\lambda = 0.035-0.04 \text{W/mK}$

- Stone wool has high water permeability; $\mu = 1$
2. Investigation of moisture behaviour and water resistance of stone wool in ETICS

IBP-report from 1989
weathering of stone wool behind facadeds with open joints

<table>
<thead>
<tr>
<th>Stone wool behind pads (20% open joints)</th>
<th>Density [kg/m³]</th>
<th>Outdoor exposure time [years]</th>
<th>Maximum moisture content [mass-%]</th>
<th>Maximum moisture content [Vol-%]</th>
<th>East side Insulation slots in [mm]</th>
<th>West side Insulation slots in [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFP 040</td>
<td>45</td>
<td>4</td>
<td>4,3</td>
<td>0,2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>RFP 035</td>
<td>65</td>
<td>4</td>
<td>5,6</td>
<td>0,4</td>
<td>2,5</td>
<td>5</td>
</tr>
<tr>
<td>RPO XII-F</td>
<td>100</td>
<td>4</td>
<td>4,7</td>
<td>0,5</td>
<td>0,3</td>
<td>2</td>
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</tbody>
</table>
2. Investigation of moisture behaviour and water resistance of stone wool in ETICS

**IBP-report from 1993**
moisture behavior of stone wool under practical use

- **Objective:** stone wool moisture behavior (cavity wall, perimeter, inverted roof, pitch roof), hydrophobic effect
- **Location:** Fraunhofer Institute, Holzkirchen
- **Insulation:** stone wool and reed
- **Direction:** 0° and 35°C, west side
2. Investigation of moisture behaviour and water resistance of stone wool in ETICS

IBP-report from 1993
moisture behavior of stone wool under practical use

- Measurement on exterior surface was taken at 12mm immersion depth (weather beathed surface), rest was taken at 3mm thickness

A: stone wool 175 kg/m³, 3,5 years weathered
B: stone wool 150 kg/m³, 6,0 years weathered
IBP-report from 1989
Rockwool thermal blocks under natural exposure

soley on the slanted edge weathering effects are evident

Lower three rows

Single layer with paint
Prefabricated surface primer

Sept. 1989
Oct 1984

Sept. 1989

3. Investigation of moisture behaviour and water resistance of stone wool in ETICS
## IBP-report from 1989
Rockwool thermal blocks under natural exposure

### 2. Investigation of moisture behaviour and water resistance of stone wool in ETICS

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Prefabricated surface primer</td>
<td>Center</td>
<td>1,3</td>
<td>0,7</td>
<td>0,3</td>
<td>0,2</td>
<td>1,6</td>
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<tr>
<td>Single layer with paint</td>
<td>Joint</td>
<td>1,7</td>
<td>0,4</td>
<td>0,4</td>
<td>0,2</td>
<td>--</td>
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<tr>
<td>Prefabricated surface primer</td>
<td>Center</td>
<td>1,2</td>
<td>0,6</td>
<td>0,3</td>
<td>0,3</td>
<td>1,9</td>
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<td>Joint</td>
<td>1,3</td>
<td>0,5</td>
<td>0,3</td>
<td>0,2</td>
<td>--</td>
</tr>
</tbody>
</table>
Conclusion

- Water absorption is low due hydrophobised stone wool

- The „straightend fibre orientation parallel to the surface – independent on hydrophobising- through redirection of striking water to reduction of water penetration depth („Reed pitch roof – effect“)

- Drying from moistened stone wool is fast in comparison to capillary-micorporous material. Its evaporation, as practically no transport resistance in stone wool exist (µ ≈ 1)

- Stone wool with surface primer, can stand alone for driving rain category II
3. Durability of stone wool in ETICS

IBP-report 1998 hygrothermal behaviour of ETICS

North
West

Sand-lime brick with EPS
With stone wool

Insulation

<table>
<thead>
<tr>
<th>WDVS</th>
<th>bez. Wärmestrom [W/m²K]</th>
<th>Wärmeleitfähigkeit des Dämstoffas in situ [W/mK]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Versuchswand</td>
<td>93/94</td>
<td>94/95</td>
</tr>
<tr>
<td>EPS, Sud</td>
<td>0.41</td>
<td>0.38</td>
</tr>
<tr>
<td>EPS, West</td>
<td>0.50</td>
<td>0.47</td>
</tr>
<tr>
<td>MWL, West</td>
<td>0.47</td>
<td>0.43</td>
</tr>
<tr>
<td>MW, West</td>
<td>0.45</td>
<td>0.42</td>
</tr>
<tr>
<td>MWL, Nord</td>
<td>0.40</td>
<td>0.38</td>
</tr>
<tr>
<td>MW, Nord</td>
<td>0.40</td>
<td>0.38</td>
</tr>
</tbody>
</table>

years
Insulation thickness 100 mm
3. Durability of stone wool in ETICS

IBP-report 2006
hygrothermal stress and long-time of ETICS

- Nr. 31 after 15 and 23 years
- Nr. 32 after 2,14 and 23 years
- Nr. 14 after 3 and 15 years

- Moisture [M-%] West, no crack
- Moisture [M-%] West, with crack
Impact of orientation and therefore of weathering is small. Only on slabs we found certain differences.

In the beginning some measurements show a lower and later a higher bond strength value.

During the test time both kind of insulation (slabs, lamella) coming to a sustained „stable“ bond strength.
Effects of rain water leakage on concrete sandwich panels retrofitted with exterior insulation systems

- **WUFI-climate date for Hannover (north of Germany), driving load class II**

- **Insulation thickness 100mm**

- **Within this construction and normal „application failures“ foam ETICS will increase the risk of corrosion of reinforcing steel**

Corrosion protection of concrete reinforcement (< 80% r.H.)
Fraunhofer Experience in ETICS more than 50 years

- 30 years approved Stone wool in ETICS
- EOTA damp-test gives reliable view of aged stone wool
- Extrem weathering tests prove no long-term change of thermal conductivity
- Mineral stone wool ETICS provide 50% faster drying time comparing with foam
- Stone wool ETICS are more forgivable due application failures especially for Concrete rain screen cladding system (refurb) and timber frame