THERMALLY ACTIVATED BUILDING STRUCTURES CPD
CREATING ENERGY EFFICIENT ENVIRONMENTS
TABS CPD Agenda

• TABS Principles
• Benefits & energy savings
• Installation methods
• Key components
• Design Considerations
• Installation process
• Case Studies
The REHAU Group

20,000 employees worldwide – experts in polymer manufacturing.

Founded in 1948 in Germany.

5 divisions in the following sectors:
- Window solutions
- **Building solutions**
- Industrial solutions
- Furniture solutions
- Automotive solutions
New commercial buildings are facing the combined challenge of meeting sustainability requirements, avoiding overheating whilst creating a comfortable environment for the occupants.
Benefits of radiant heating & cooling

- More energy efficient compared to air-based systems
- Higher comfort level for building occupants
- Greater design freedom
- Reduced air movement (better for allergy sufferers)
- Low maintenance
Thermal comfort of a person is determined by:

- The person’s activity
- The person’s clothes
- Air temperature
- Air speed
- Air humidity
- Surface Temperature

Why is radiant heating & cooling more comfortable?
Historical buildings have typically very thick walls. These walls act as gigantic thermal accumulators.
How does TABS work?

The building’s concrete mass is utilized to store heat energy.

This allows heating and cooling operations to be carried out at low, energy-saving temperatures.

Cooling units can therefore be smaller than conventional air conditioning equipment.
Concrete vs screed as a thermal store

SCREED
Density: 1,200 kg/m³*
Specific heat capacity: 840 J/kgK or 0.233 Wh/kgK*
Screed Thickness: 75 mm anhydride screed @thermal conductivity = 1.2 W/mK**
⇒ Thermal storage capacity: 20.97 Wh/m²K

CONCRETE
Density: 2,000 kg/m³*
Specific heat capacity: 1,000 J/kgK or 0.278 Wh/kgK*
Concrete Thickness: 150 mm concrete slab @thermal conductivity = 2.1 W/mK**
⇒ Thermal storage capacity: 83.40 Wh/m²K
Benefits of TABS

• Up to 50% lower operating costs
• Up to 30% lower investment costs
• Ideal for renewable energy sources (e.g. heat pumps)
• Comfortable environment for occupants
• No sick building syndrome or draughts
• No need for suspended ceilings
Many of the UK TABS projects achieve BREEAM ‘Excellent’ or ‘Very Good’ ratings. Some have also achieved Passivhaus certification.
Energy saving benefits of TABS

Air conditioning:
- Reduced air volumes when combined with TABS so smaller plant and fan size required
- Reduced electrical consumption

Chillers:
- TABS uses closer to ambient temperatures (15-18°C) versus typical chiller temperatures of 6-12°C
- This increases the COP of the chiller
Combination of TABS and heat pumps

- Heat pumps work better with radiant heating temperatures (<45°C)
- Can provide renewable cooling via a heat pump
- Air, ground and water source heat pumps all work with TABS
- Receive Renewable Heat Incentive payments
When can you use TABS?

- Buildings with an exposed soffit
- Concrete construction
- Multi storey buildings
- Open plan designs works better
- High focus on energy efficiency
TABS applications include:
- Offices
- Hospitals
- Retail
- Museums / galleries
- Transport hubs / stations
- Sport centres / arena
- Education
There are 3 TABS installation methods available:
1. In-situ concrete slabs
2. Pre-fabricated mesh
3. Precast concrete planks
1. In-situ concrete slabs

- Large circuits possible
- Minimal connections within structure
- Around 300m² installed per day (2 people)
- Can sit anywhere within structural slab
2. Pre-fabricated mesh

- Fast Installation
- Can be used for PT Slab applications
- Smaller circuits
- Better outputs when located near slab surface
- Ideal for Tichelmann Loops
- Two options available – **sTABS or TABS Module**
- **sTABS for prefabricated modules underneath the lower reinforcement layer**
  - For within slabs at least 200mm high
  - 75mm or 150mm pipe spacing
  - Integrated spacers for installation
  - Up to 90W/m² possible

- **TABS modules for prefabricated modules between the lower and upper reinforcement layer**
  - Variable, project related modules
  - 150mm pipe spacing
  - Double or Single meander
  - Up to 70W/m² possible
3. Precast concrete planks

- Off site construction methods
- Quick to install on site
- Easy connections into building services
- High cooling capacity of up to 90W/m²
PE-Xa compression sleeve jointing technology

- Only 2 components – fitting and sleeve
- 10 year comprehensive warranty within the slab
- Easy to repair in concrete
- Tools comprise of pipe expander and clamping jaws
- Fast and simple installation
All brass compression sleeve joints must be protected by tape when installed directly in concrete.
Cross-linked polyethylene (PE-Xa) pipework

- Excellent thermal and chemical resistance
- Can withstand 6 bar at 95°C
- Pipe ‘kinks’ do not damage the pipe and still maintains 98% strength
Commissioning Box

- Sits flush with the concrete finish
- Allows for commissioning of large TABS circuits
- Connected to the distribution pipework using compression sleeve fittings
- Solution is buried within the slab
Soft-Spot Isolation Box

- Compact design
- Allows for isolation of ‘soft spots’ within the slab
- Connected using compression sleeve fittings
Booster Boxes

- Compact design
- Allows for future connections of additional cooling units (AHU etc.)
- Connected using compression sleeve fittings
Booster Boxes with Chilled Ceilings

- Chilled ceiling panels can be suspended from soffit for increased cooling output
- Quick and easy connections
- Available in standard or acoustic versions
- Excellent low-energy alternative to FCU/AHU
All TABS projects should involve design support from a specialist supplier due to the key differences to conventional radiant heating & cooling systems.
KEY DESIGN CONSIDERATIONS

• Primary function is cooling
• Covers only ca. 50% of typical heating
• Slow reacting system
• Condensation management required
• Controls strategy & interfacing with other building services
• No zoning
• Exclusion zones where no pipes are allowed, e.g.
  – Structural columns etc.
### EXAMPLE OF TABS OUTPUTS

<table>
<thead>
<tr>
<th>Ceiling design</th>
<th>Design [mm]</th>
<th>Room temperature</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCT with cavity floor</td>
<td>RAUTHERM S 20 x 2.0 VA 15 Pipe cover 130 mm</td>
<td>°C</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>CCT with composite screed</td>
<td>RAUTHERM S 20 x 2.0 VA 15 Pipe cover 130 mm</td>
<td>°C</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>10 Carpet</td>
<td>°C</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>35 Screed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 Wooden board</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>130 Floor cavity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>280 Reinforced concrete ceiling</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Performance (active area)

<table>
<thead>
<tr>
<th>Floor</th>
<th>W/m²</th>
<th>W/m²</th>
<th>W/m²</th>
<th>W/m²</th>
<th>W/m²</th>
<th>W/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average T on surface</td>
<td>24.8</td>
<td>24.7</td>
<td>24.6</td>
<td>24.5</td>
<td>20.7</td>
<td></td>
</tr>
<tr>
<td>Ceiling</td>
<td>39</td>
<td>42</td>
<td>44</td>
<td>49</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Average T on surface</td>
<td>22.4</td>
<td>22.2</td>
<td>22.0</td>
<td>21.5</td>
<td>23.5</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>51</td>
<td>54</td>
<td>60</td>
<td>29</td>
<td></td>
</tr>
</tbody>
</table>

#### Performance (active area)

<table>
<thead>
<tr>
<th>Floor</th>
<th>W/m²</th>
<th>W/m²</th>
<th>W/m²</th>
<th>W/m²</th>
<th>W/m²</th>
<th>W/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average T on surface</td>
<td>23.4</td>
<td>23.3</td>
<td>23.1</td>
<td>22.8</td>
<td>21.5</td>
<td></td>
</tr>
<tr>
<td>Ceiling</td>
<td>38</td>
<td>40</td>
<td>43</td>
<td>47</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Average T on surface</td>
<td>22.6</td>
<td>22.4</td>
<td>22.1</td>
<td>21.7</td>
<td>23.3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>59</td>
<td>63</td>
<td>69</td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>
### EXAMPLE OF TABS OUTPUTS

#### Ceiling design

### Design [mm]

<table>
<thead>
<tr>
<th>Room temperature</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>[°C]</td>
<td>26</td>
<td>26</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow temperature</th>
<th>[°C]</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>[°C]</td>
<td>16</td>
<td>16</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Return temperature</th>
<th>[°C]</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>[°C]</td>
<td>20</td>
<td>19</td>
<td>18</td>
</tr>
</tbody>
</table>

#### CCT with INI and screed

**RAUTHERM S 20 x 2.0 VA 15**

Pipe cover 130 mm

<table>
<thead>
<tr>
<th>10</th>
<th>Carpet</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>Screed</td>
</tr>
<tr>
<td>30</td>
<td>Impact noise insulation</td>
</tr>
<tr>
<td>280</td>
<td>Reinforced concrete ceiling</td>
</tr>
</tbody>
</table>

#### Performance (active area)

<table>
<thead>
<tr>
<th>Floor</th>
<th>[W/m²]</th>
<th>Average T on surface [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>25.2</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>25.1</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>24.9</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>20.4</td>
</tr>
</tbody>
</table>

#### CCT on the lower reinforcement layer with INI and screed

**RAUTHERM S 20 x 2.0 VA 15**

Pipe cover 55 mm

<table>
<thead>
<tr>
<th>10</th>
<th>Carpet</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>Screed</td>
</tr>
<tr>
<td>30</td>
<td>Impact noise insulation</td>
</tr>
<tr>
<td>280</td>
<td>Reinforced concrete ceiling</td>
</tr>
</tbody>
</table>

#### Performance (active area)

<table>
<thead>
<tr>
<th>Floor</th>
<th>[W/m²]</th>
<th>Average T on surface [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>25.2</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>25.2</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>25.1</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>20.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ceiling</th>
<th>[W/m²]</th>
<th>Average T on surface [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
<td>22.4</td>
</tr>
<tr>
<td></td>
<td>42</td>
<td>22.2</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>21.9</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>21.5</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>23.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
<th>[W/m²]</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>46</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>52</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>
### EXAMPLE OF TABS OUTPUTS

#### Ceiling design

<table>
<thead>
<tr>
<th>Design [mm]</th>
<th>10 Carpet</th>
<th>60 Screed</th>
<th>30 Impact noise insulation</th>
<th>280 Reinforced concrete ceiling</th>
</tr>
</thead>
</table>

**sCCT with INI and screed**

**RAUTHERM S 14 x 1.5 VA 7.5**

Pipe cover 17 mm

<table>
<thead>
<tr>
<th>Room temperature [°C]</th>
<th>26</th>
<th>26</th>
<th>26</th>
<th>26</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow temperature [°C]</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>15</td>
<td>28</td>
</tr>
<tr>
<td>Return temperature [°C]</td>
<td>20</td>
<td>19</td>
<td>18</td>
<td>17</td>
<td>24</td>
</tr>
</tbody>
</table>

#### Performance (active area)

<table>
<thead>
<tr>
<th>Surface</th>
<th>[W/m²]</th>
<th>6</th>
<th>7</th>
<th>7</th>
<th>8</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td></td>
<td>25.1</td>
<td>25.1</td>
<td>25.0</td>
<td>24.9</td>
<td>20.5</td>
</tr>
<tr>
<td>Ceiling</td>
<td></td>
<td>19.9</td>
<td>19.5</td>
<td>19.1</td>
<td>18.4</td>
<td>25.1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>73</td>
<td>78</td>
<td>83</td>
<td>92</td>
<td>36</td>
</tr>
</tbody>
</table>

#### Tab. 2-1  Average static performance in W/m² (active area)

- **Carpet**  
  \( R = 0.08 \)

- **Screed**  
  \( \lambda = 1.2 \text{ W/(mk)} \) to EN 15377

- **Wooden board**  
  \( R = 0.13 \)

- **Floor cavity**

- **Impact noise insulation**  
  \( R = 0.040 \)

- **Reinforced concrete ceiling**  
  \( \lambda = 1.9 \text{ W/(mk)} \) to EN 15377

- **RAUTHERM S pipe**

- Thermal resistance of the air layer in the false floor in accordance with EN 15377

- Thermal resistance on the surface in accordance with EN 15377

- At flow temperature +16 °C:
  - rel. room humidity 50 %, 26 °C room temperature

- At flow temperature +15 °C:
  - rel. room humidity 45 %, 26 °C room temperature
Hydraulic option 1: Tichelmann loops

Fig. 2-10  Schematic illustration of a two-line system
1  Flow
2  Return
3  Balancing and shut-off valve
4  Shut-off valve
5  CCT circuit
Hydraulic option 2: Manifolds

Fig. 2.9  Schematic illustration of manifold connection
1  Flow
2  Return
3  Balancing and shut-off valve
4  Compression sleeve manifold
5  Shut-off valve
6  CCT circuit
Manifolds allow each circuit to be shut off separately.
## Hydraulic options compared

**Tichelmann**

**Pros:**
- Self-balancing
- No balancing valves or manifolds required
- Less pipe breaking through concrete

**Cons:**
- Joints in the concrete
- Larger header pipe

**Manifolds**

**Pros:**
- No joints in the concrete
- Individual circuits can be controlled via manifold

**Cons:**
- Higher costs of manifolds / valves
- More pipe breaking through concrete
Installation Process

1. Shuttering – Assemble mounting parts such as connection boxes, TABS Extension box

2. Installation –
   - Installation of the lower reinforcement
   - Installation of pipe / modules with spacers to assembly plan with subsequent pressure test
   - Install connecting line and lead into connection box
   - Visual Inspection

3. Concrete –
   - Installation of the upper reinforcement
   - Monitor concreting process
   - After removal of the ceiling shuttering, carry out second pressure test
TABS case studies
Examples of UK & European installations
Tate Modern, London

- TABS installation in 10 storey project
- 24,000m of PE-Xa pipework
- BREAM ‘Very Good’ rating
- £260 million extension
Centre of Medicine, University of Leicester

- Largest non-residential Passivhaus project in UK
- Combination of TABS and industrial floor heating
- 7km of REHAU PE-Xa pipe in total
- Project also used AWADUKT Thermo ground-air heat exchanger
White Collar Factory, London

- Installation began March 2015
- 20,000m² of REHAU TABS Pipework
- Derwent London project
- Largest TABS project in Europe
University of Northampton

- 40,000m of 20mm REHAU PE-Xa pipe
- Completed in Spring 2017
- £330 million Waterside Campus
- Aiming for BREEAM Excellent
THANK YOU FOR YOUR ATTENTION
ANY QUESTIONS?