Distribution of temperature in steel and composite beams and joints under natural fire
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Motivation: analysis of connections in cooling phase => calculation of temperatures in steel beam and in joints.

Existing « lumped capacitance » method:

$$\Delta Q_{\text{transferred}} = \dot{h}_{\text{net},d} k_{\text{sh}} A_m \Delta t = c_a \rho_a V \Delta \theta_{a,t} = \Delta Q_{\text{heating}}$$

OK for unprotected steel sections (heating and cooling)
OK for protected steel sections (heating)
OK for lower half of a steel beam with a slab on the upper flange
Not OK for the upper part of the steel beam with a slab

More info on http://hdl.handle.net/2268/66090
New « Heat exchange » method for T in the upper flange.

\[ \Delta Q_{\text{transferred}} = \Delta Q_{\text{gas}} + \Delta Q_{\text{top-bottom}} + \Delta Q_{\text{concrete}} = c_a \rho_a V \Delta \theta_{a,t} = \Delta Q_{\text{heating}} \]

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\[ \Delta Q_{\text{concrete}} \]

Given by an equation obtained from curve fitting
- with numerical results
- based on Annex A of EN 1991-1-2 parametric fire curves

Contains 2 parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Flux (kW/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Gamma = 0.4 )</td>
<td>0</td>
</tr>
<tr>
<td>( \Gamma = 0.7 )</td>
<td>17</td>
</tr>
<tr>
<td>( \Gamma = 1.0 )</td>
<td>24</td>
</tr>
<tr>
<td>( \Gamma = 1.5 )</td>
<td>34</td>
</tr>
<tr>
<td>( \Gamma = 2.0 )</td>
<td>33</td>
</tr>
</tbody>
</table>

During heating During heating and cooling
Works also for the temperature of the upper flange in the joint region

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