EN 1991-1-5: Eurocode 1: Actions on structures: General Actions: Part 1.5: Thermal Actions

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THERMAL ACTIONS - CLASSIFICATION

- **VARIABLE ACTION**
  (in the combinations of actions)

- **INDIRECT ACTION**

- **Characteristic value of thermal actions: annual probability of being exceeded of 0,02 (equivalent to 50 year return), on which National maps of maximum and minimum temperatures are based**

EN 1991-1-5 - Design situations

- **Thermal actions need to be determined for each relevant design situation identified in accordance with EN 1990.**

- **The elements of a loadbearing structure need to be checked to ensure that thermal movement will not cause overstressing of the structure, either by the provision of movement joints or by including the effects in the design.**

EN 1991-1-5: Representation of actions

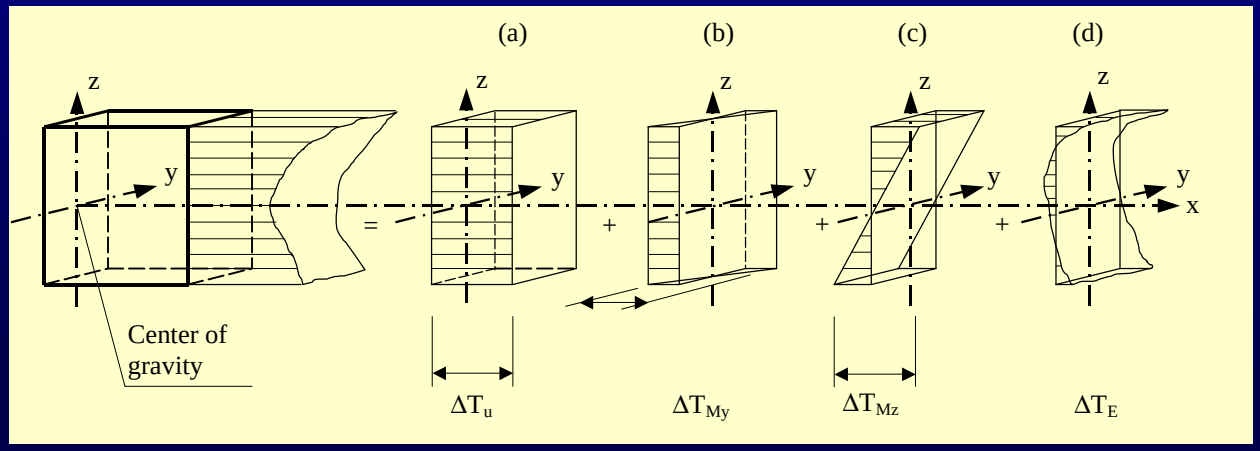
- Daily and seasonal changes in
  - Ø shade air temperature,
  - Ø solar radiation,
  - Ø re-radiation, etc.,

will result in variations of the temperature distribution within individual elements of a structure.

- The magnitude of the thermal effects is dependent on
  - Ø local climatic conditions, together with
  - Ø the orientation of the structure, its overall mass, finishes (e.g. cladding in buildings), and
  - Ø in the case of building structures, heating and ventilation regimes and thermal insulation.

EN 1991-1-5:Representation of constituent components of a temperature profile

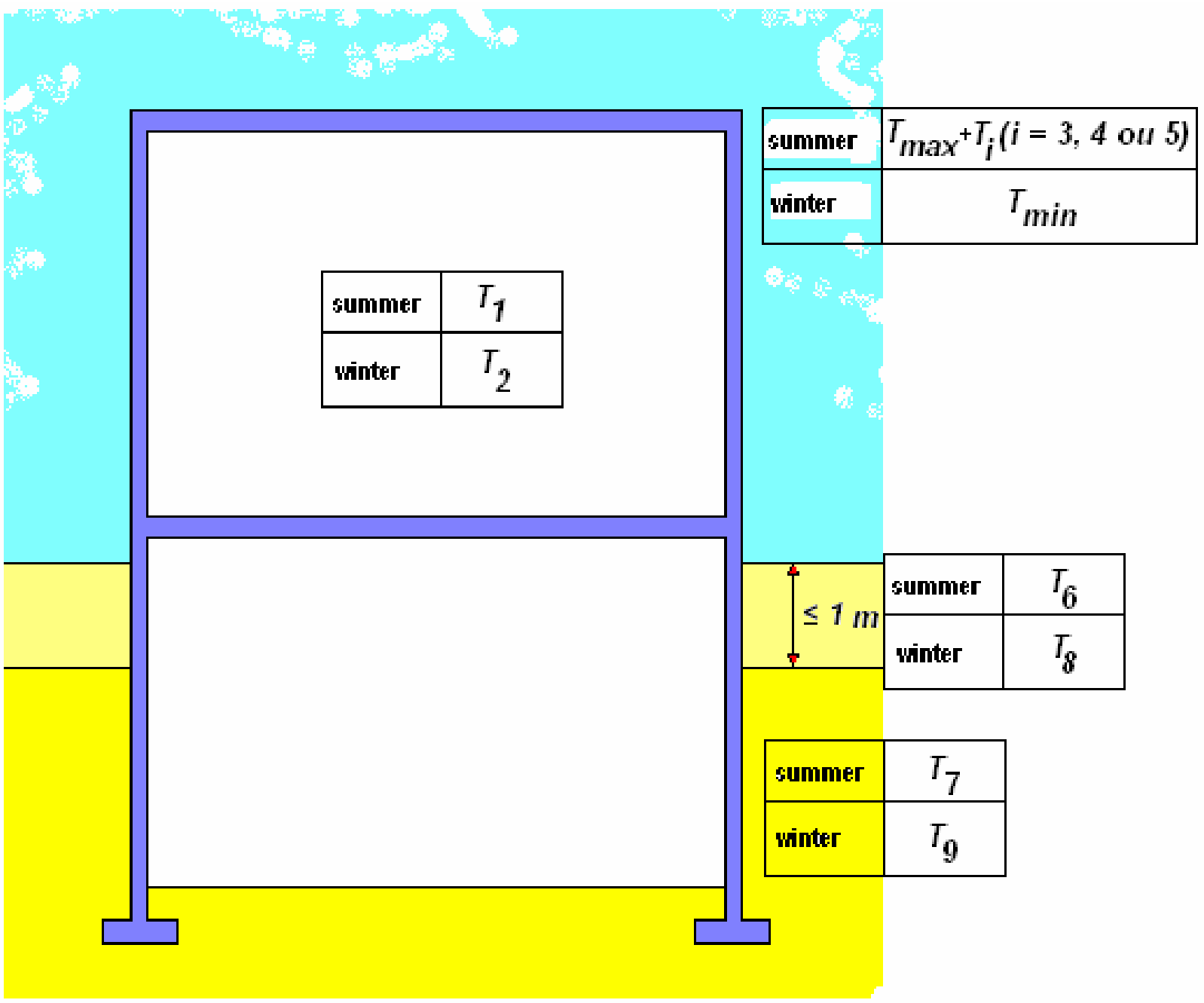
The temperature distribution within an individual structural element is split into the following four essential constituent components:
(a) A uniform temperature component, ΔT_u;
(b) A linearly varying temperature difference component about the *z-z* axis, ΔT_{My};
(c) A linearly varying temperature difference component about the *y-y* axis, ΔT_{Mz};
(d) A non-linear temperature difference component, ΔT_E. This results in a system of self-equilibrated stresses which produce no net load effect on the element.



EN 1991-1-5: Temperature changes in buildings

- Thermal actions on buildings due to climatic and operational temperature changes need to be considered in the design of buildings where there is a possibility of the ultimate or serviceability limit states being exceeded due to thermal movement and/or stresses.

- Volume changes and/or stresses due to temperature changes may also be influenced by:
  - shading of adjacent buildings,
  - use of different materials with different thermal expansion coefficients and heat transfer,
  - use of different shapes of cross-section with different uniform temperature.


summer
$T_{max}+T_i$ (i = 3, 4 ou 5)
winter
T_{min}
summer
T_1
winter
T_2
≤ 1 m
summer
T_6
winter
T_8
summer
T_7
winter
T_9

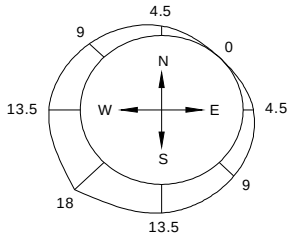
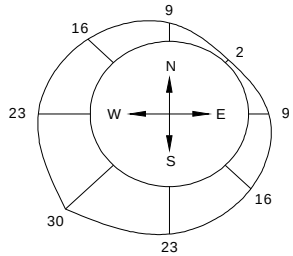
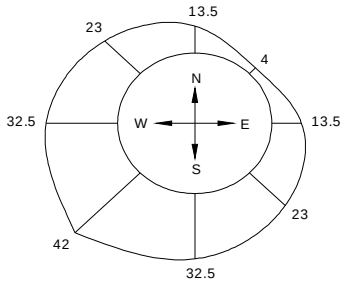
Indicative values of inner environment (T_1 and T_2) And T_{out} (i.e.T_{max} + T_1,T_2 or T_3) for buildings above ground, for regions between latitudes *45°N and 55°N*

T	Season	Characteristic Values of the temperature (°C)	CommentsCommentaires
T_1	Summer	20	
T_2	Winter	25	
T_3	Summer	Relative absorption depends on surface colour. (bright light surface)	
		0	Elements facing North-East
		18	Elements facing South-West
T_4		Relative absorption depends on surface colour. (light coloured surface)	
		2	Elements facing North-East
		30	Elements facing South-West
T_5		Relative absorption depends on surface colour. (dark surface)	
		4	Elements facing North-East
		42	Elements facing South-West

Indicative temperatures T_{out} for underground parts of buildings For regions between latitudes 45°N and 55°N

T_6	**Summer**	**8**	**Temperature for depth below the ground level, less than 1 m.**
T_7	**Summer**	**5**	**Temperature for depth below the ground level, more than 1 m.**
T_8	**Winter**	**-5**	**Temperature for depth below the ground level, less than 1 m.**
T_9	**Winter**	**-3**	**Temperature for depth below the ground level, more than 1 m.**

EN 1995-1-1: Solar radiation effects *T*3, *T*4, and *T*5 for different building orientations

Building Surface	Solar radiation effect	Building temperatures
Bright light surface	T_3	
Reflective light coloured surface	T_4	
Dark surface	T_5	

EN 1991-1-5: Temperature changes in buildings

- **The uniform temperature component of a structural element $D\boldsymbol{T}_{\mathbf{u}}$ is defined as:**

  $$D\boldsymbol{T}_{\mathbf{u}} = \boldsymbol{T} - \boldsymbol{T}_{\mathbf{0}}$$

  where:

  - Ø $\boldsymbol{T}$ **is an average temperature of a structural element due to climatic temperatures in winter or summer season and due to operational temperatures.**
  - Ø $\boldsymbol{T}_{\mathbf{0}}$ **is the temperature of a structural element at the relevant stage of its restraint (on completion)**

- **When elements of one layer are considered and when the environmental conditions on both sides are similar, $\boldsymbol{T}$ may be approximately determined as the average of inner and outer environment temperature $\boldsymbol{T}_{\mathbf{in}}$ and $\boldsymbol{T}_{\mathbf{out}}$.**

THANK YOU FOR YOUR ATTENTION