# Distribution of temperature in steel and composite beams and joints under natural fire

F. Hanus (B.E.S.T. design office) & J.-M. Franssen (Univ. of Liege)

Motivation: analysis of connections in cooling phase => calculation of temperatures in steel beam and in joints.

Existing « lumped capacitance » method:

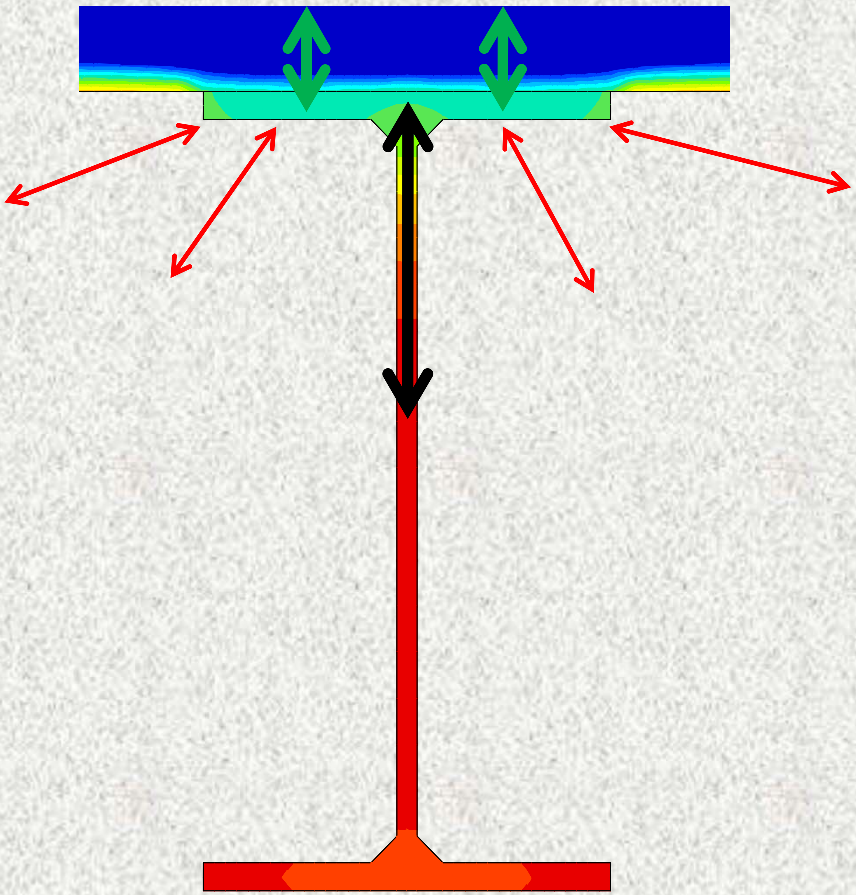
$$\Delta Q_{transferred} = \dot{h}_{net,d}\ k_{sh}\ A_m\ \Delta t = c_a\ \rho_a\ V\ \Delta\theta_{a,t} = \Delta Q_{heating}$$

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.

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



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## $\Delta Q_{concrete}$

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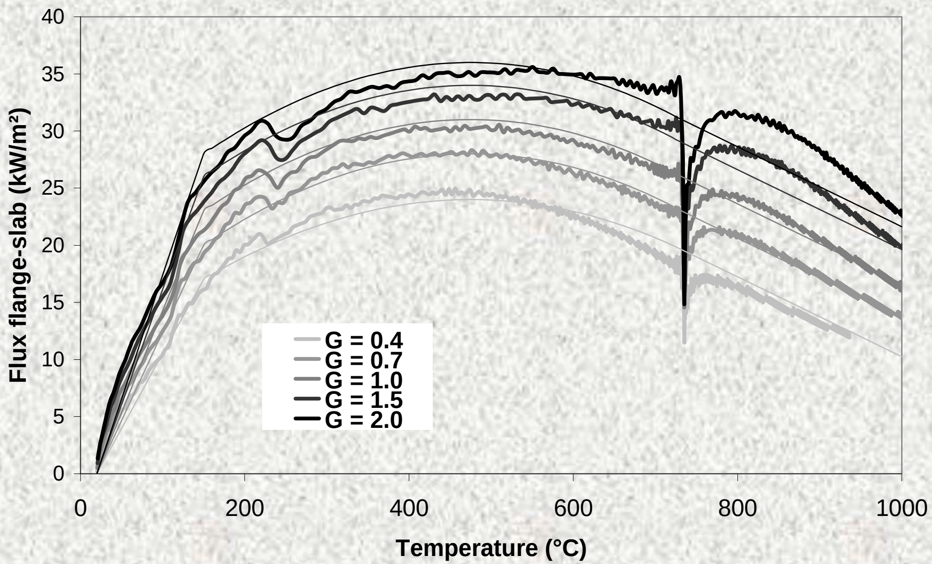
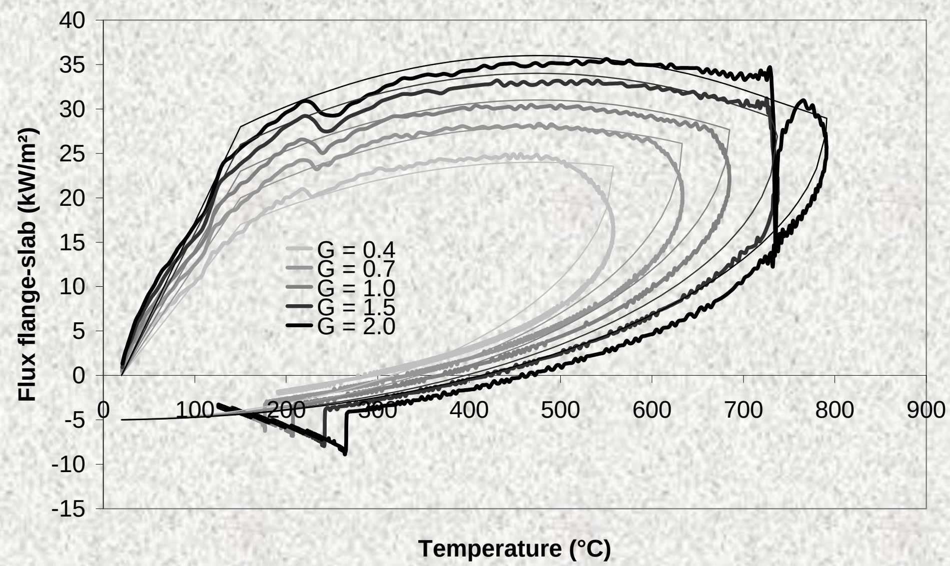
Given by an equation obtained from curve fitting
- with numerical results
- based on Annex A of EN 1991-1-2 parametric fire curves

Contains 2 parameters

| | $\Gamma$ = 0.4 | $\Gamma$ = 0.7 | $\Gamma$ = 1 | $\Gamma$ = 1.5 | $\Gamma$ = 2 |
|---|---|---|---|---|---|
| | Flux (kW/m²) | Flux (kW/m²) | Flux (kW/m²) | Flux (kW/m²) | Flux (kW/m²) |
| 20 | 0 | 0 | 0 | 0 | 0 |
| 150 | 17 | 20 | 23 | 26 | 28 |
| 475 | 24 | 28 | 31 | 34 | 36 |




During heating




During heating and cooling

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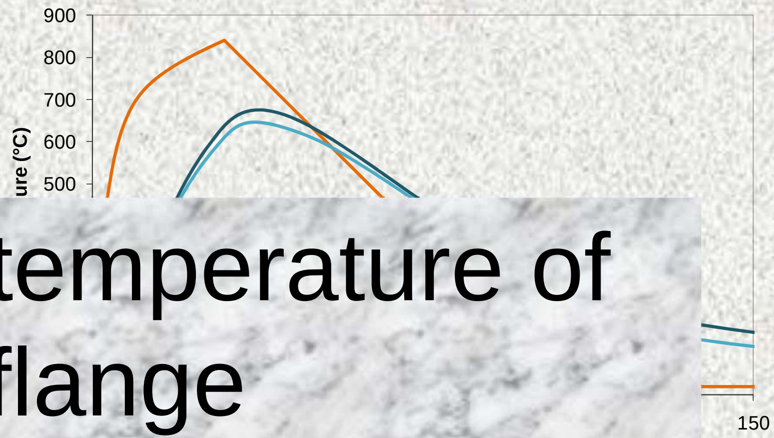
IPE300

IPE550


30’ fi

Works also for the temperature of the upper flange in the joint region

60’ fire