# EFFECTS OF FLAME RADIATION ON TEMPERATURE ELEVATION OF STEEL MEMBERS IN LARGE SPACE BUILDING FIRES

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- Temperature fields are non-uniform in large space building fires and lower than small compartment fires generally, given as

$$T_g(t)-T_g(0)=T_g^{\max}\left[1-0.8e^{(-\beta t)}-0.2e^{(-0.1\beta t)}\right]\cdot\left[\eta+(1-\eta)e^{\left(\frac{b-x}{\mu}\right)}\right]$$

- Heat transfer between flame, smoke and steel members is given as

$$\frac{\Delta T_{sf}}{\Delta t}=\frac{\varepsilon_r\varepsilon_s c_0 F\left[(T_g+273)^4-(T_{sf}(t)+273)^4\right]+\varepsilon_f\varepsilon_s\varphi_{sf}\xi F(1-\varepsilon_g)c_0\left[(T_f+273)^4-(T_{sf}(t)+273)^4\right]+F\varepsilon_c(T_g-T_{sf}(t))}{V\rho_s c_s}$$

- $T_{sf}'$ temperature of the steel member generated by the flame radiation alone is depend on follows

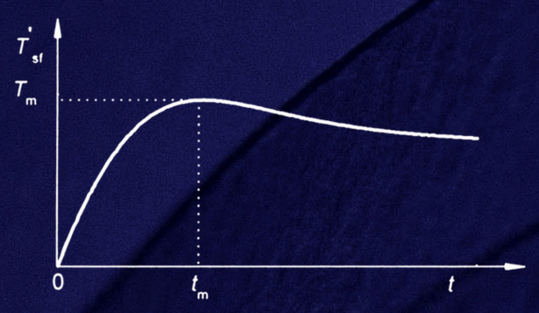


*Fig. 1.* Typical temperature course of steel members caused by flame radiation alone

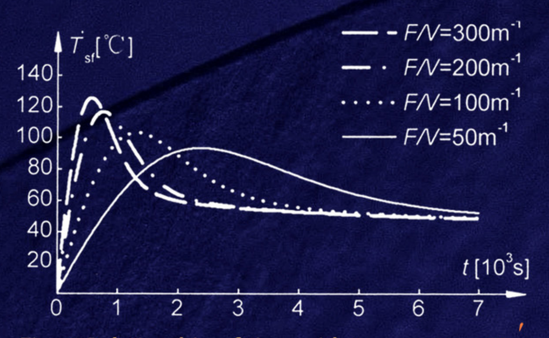


*Fig. 2.* Relationship of time with temperature $T_{sf}'$ for factor F/V

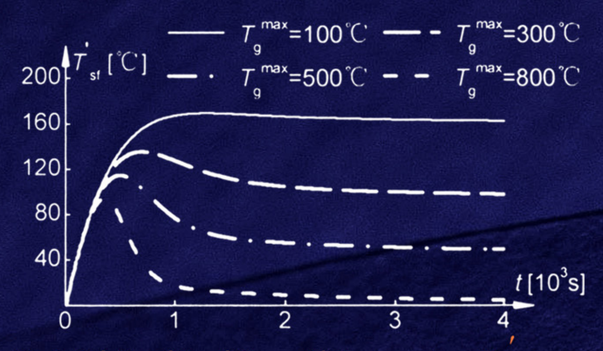


*Fig.3.* Relationship of time with temperature $T_{sf}'$ for factor $T_g^{max}$

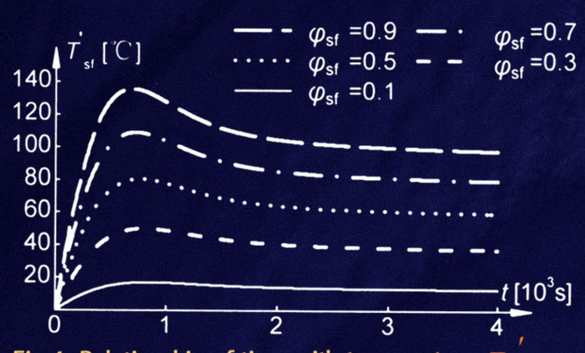


*Fig.4.* Relationship of time with temperature $T_{sf}'$ for factor $\varphi_{sf}$

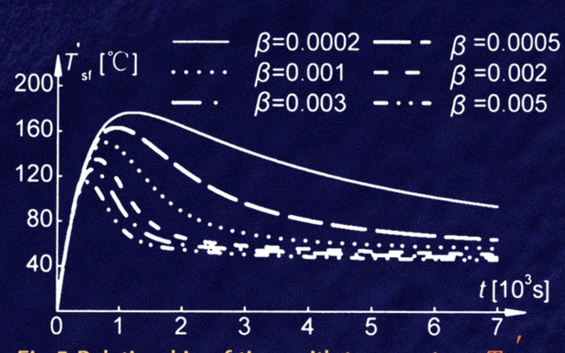


*Fig.5.* Relationship of time with temperature $T_{sf}'$ for factor $\beta$

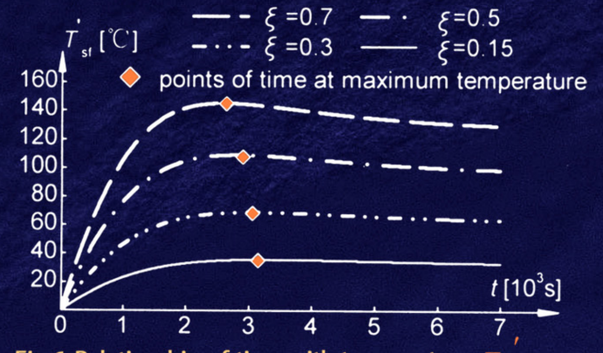


*Fig.6.* Relationship of time with temperature $T_{sf}'$ for factor $\xi$

- Simple expression for typical temperature course of $T_{sf}'$ shown in *Fig.1* is given by

$$T_{sf}'=T_m\left(k_1e^{-k_2\lg^2(t/t_m)}+k_3e^{-k_4\lg^2(t/t_m)}\right)$$

$$T_m=A+Be^{-T_g^{\max}/C}$$

$$\begin{cases}A=a_1+a_2\xi^2+(a_3+a_4\xi)\varphi_{sf}\\B=b_1+b_2\xi^2+(b_3+b_4\xi)\varphi_{sf}\\C=c_1+c_2\xi^2+(c_3+c_4\xi)\varphi_{sf}\end{cases}$$

$$t_m=A'+B'e^{-T_g^{\max}/C'}$$

$$\begin{cases}A'=a_1'-a_2'\xi\\B'=b_1'-b_2'\xi\\C'=c_1'-c_2'\xi\end{cases}$$

- A very good prediction of steel member temperatures caused by flame radiation alone