

related test method	ENV 13381-4 Fire protection of steelwork by applied fire protection materials
subject	Determination of fire protection result when the fire protection fails on both loaded and unloaded reference beams at temperatures below 250°C
reference of original query	TC2 N265rev4 Helpdesk 2000-17

Problem

This relates to cases where the fire protection material falls off the loaded & unloaded reference beams [at low steel temperatures (i.e. below 250°C), much lower than the critical temperatures given in the standard (normally between 350 °C and 700 °C)], whilst the fire protection material does not fall off the unloaded columns.

According to ENV 13381-4, in such cases the correction factor will be 1 (because the fire protection material falls off both the unloaded and loaded beam at approximately the same time and with approximately equal temperature rise). The temperature on the columns will rise more steadily (because of their retained protection) and consequently their fire resistance will be better than for the beams and lead to a calculated fire resistance that is too high and give an unsafe result.

The phenomenon reported occurs mainly for gypsum based (residual water containing) fire protection products. As it is heated a dehydration front penetrates slowly through the fire protection layer. When this dehydration front reaches the fire protection / steel interface, the adhesion may be lost and the fire protection may fall off.

This will be especially so for the horizontally tested beams. For vertically tested short columns, edge effects and the different effect of gravity may help to keep the fire protection material in place.

The time at which the dehydration front reaches the fire protection / steel interface, has been found to coincide with an increase in the rate rise of steel temperature. This increase is more pronounced when the protection falls off (especially beams) than when it does not (especially columns).

Therefore, it is proposed to use the time at which a change in rate of steel temperature rise occurs (indicative of the arrival of the dehydration front at the steel surface), as the time at which the whole range of critical temperatures (350 °C / 700 °C) has been reached.



This is a safe approach, as the temperature at which a change in rate of steel temperature rise would be expected to occur is below 250 °C.

Recommendation

When testing fire protection products (especially gypsum based products and any other product which behaves similarly) to ENV 13381-4, where fire protection material falls off loaded and unloaded beams but remains adhered to the columns, the evaluation procedure shall be considered as leading to an unsafe conclusion and an alternative procedure shall be used for evaluation of the time to reach critical temperature.

In such cases, the time to reach the critical temperature - for all critical temperatures (350 °C / 700 °C) – shall be taken as being equal to the time when the dehydration front reaches the fire protection / steel interface on the columns.

This time shall be indicated for each short column as the time when the measured rate of temperature rise changes substantially. This shall be deduced by extrapolation from the temperature curve of the steel (see figure 1 below) and be taken as the point when a change in rate of temperature increase is observed.

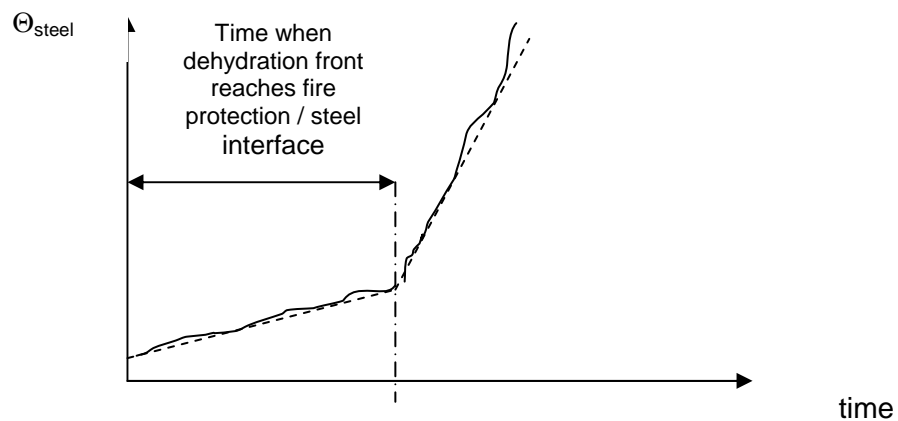


Figure 1