

Thermomechanical behaviour of Steel-Timber Composite beams

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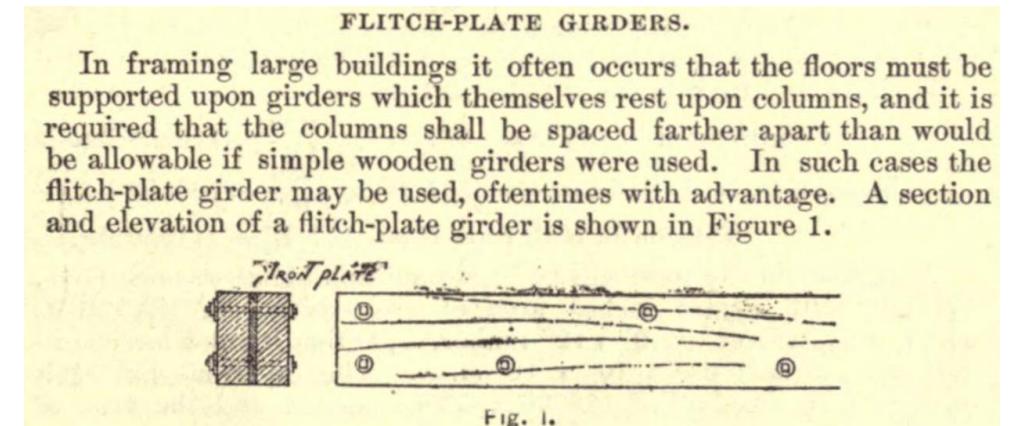


Steel + Timber



- Optimisation of material
- Effective solutions at both ambient and fire conditions
- Architectural benefits (well being in wooden interiors)

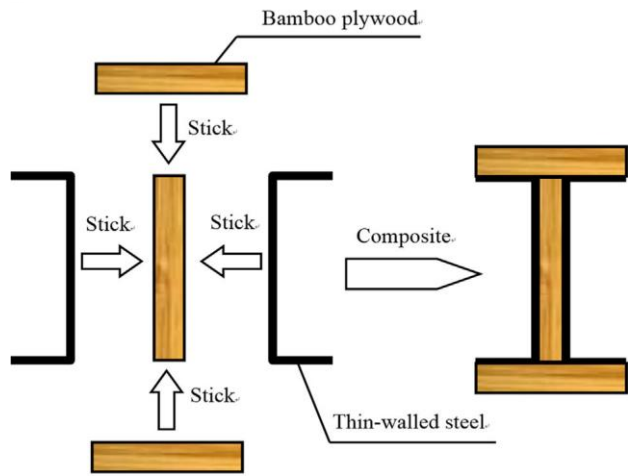
An old idea : flitched beams
⇒ Strengthen timber with steel



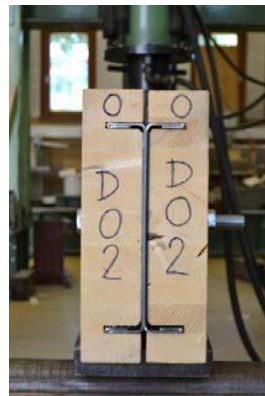
[The American architect and building news, 1883]

Existing works on mechanical behavior of STC (steel timber composite) beams :
 Winter et al. (2016), Palermo et al. (2006), Bori et al. (2003), Bulleit et al. (1984), ...

Strengthening timber elements with steel

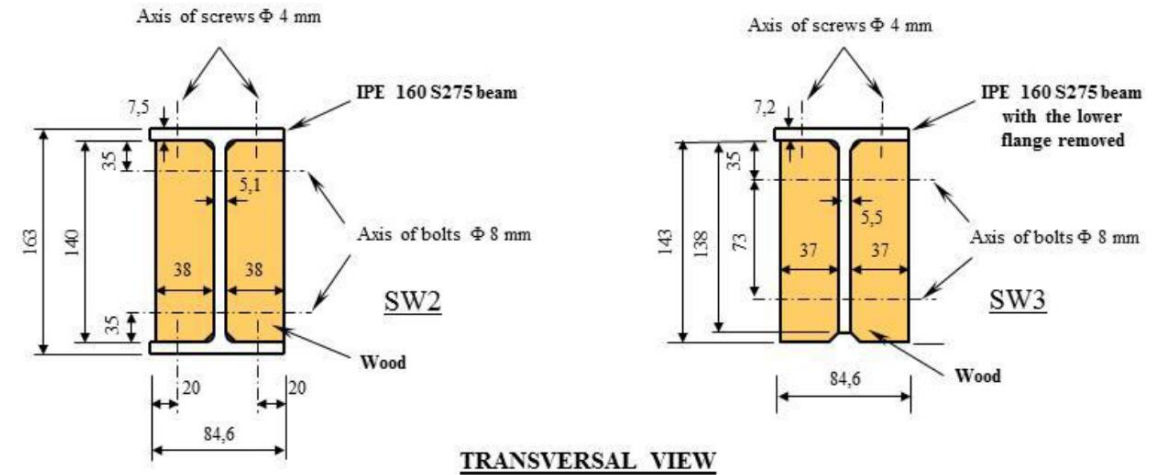


Strengthening bamboo sections with steel cold formed sections
 Li et al., 2015



Winter et al.
 WCTE, 2016

Strengthening steel with timber

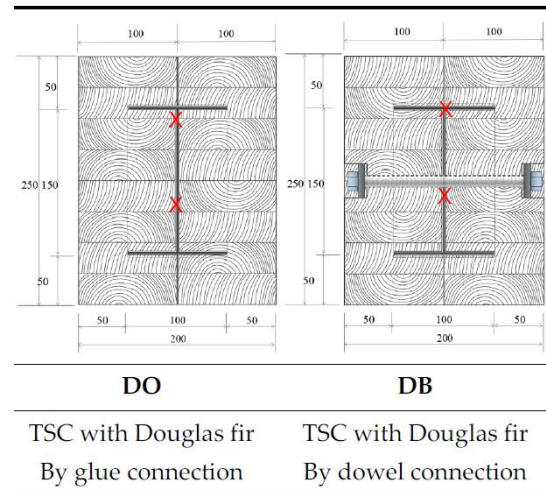


Jurkiewicz, Durif et al.
 Eurosteel, 2017

Existing works on thermal behavior of STC (steel timber composite) beams



Winter et al.
WCTE 2016



Di Ha Le & Tsai, 2019



Bihina et al, Eurosteel 2020

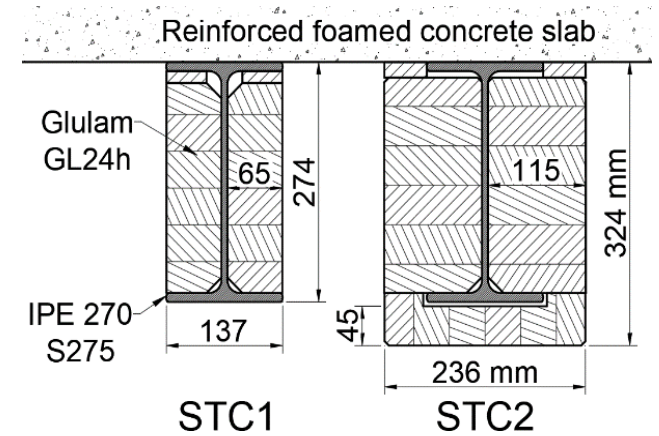
Mainly thermal tests aim to evaluate the charring rate of timber, the increase of temperature in steel, the influence of connection system but no thermomechanical studies have been led for beams under bending

Experimental tests at normal conditions

Présentation du montage et des charges ultimes obtenues

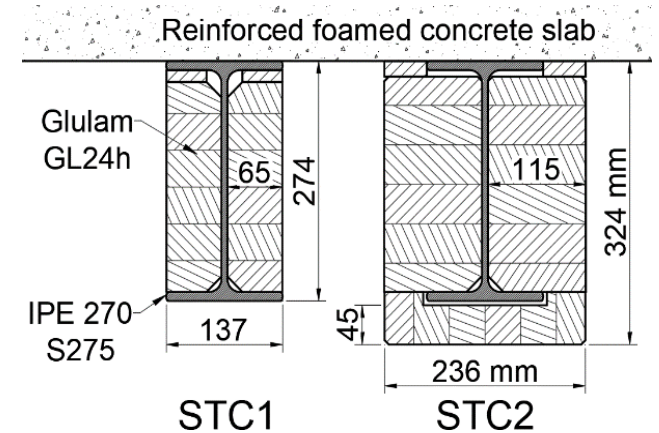
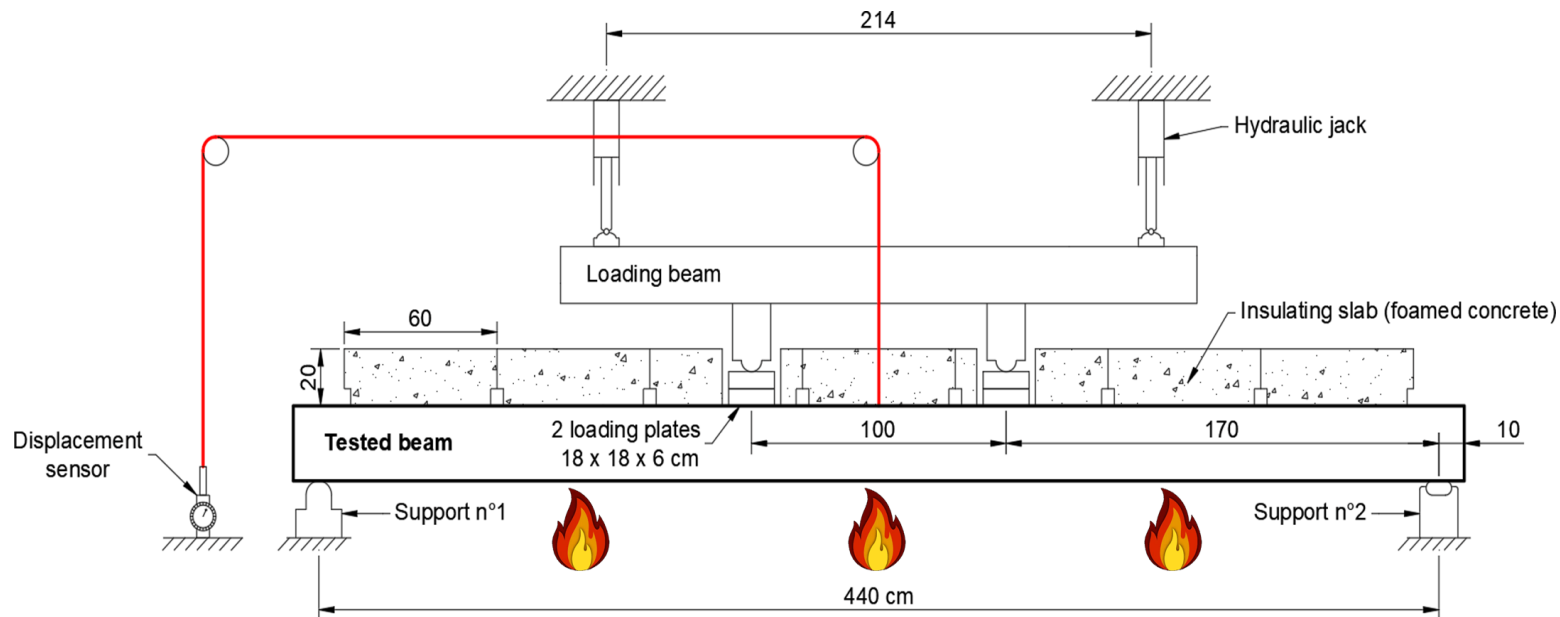
Experimental tests under fire conditions

- 2 configurations tested with and without loading (1m long)
- Applied load : 43% of the ultimate load obtained at normal condition
- 3 sides ISO fire exposure



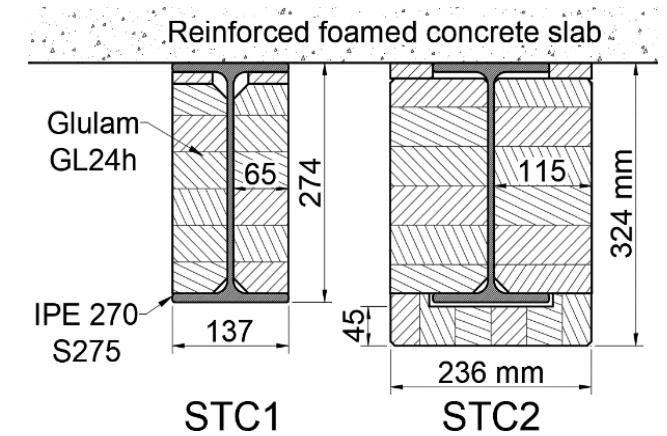
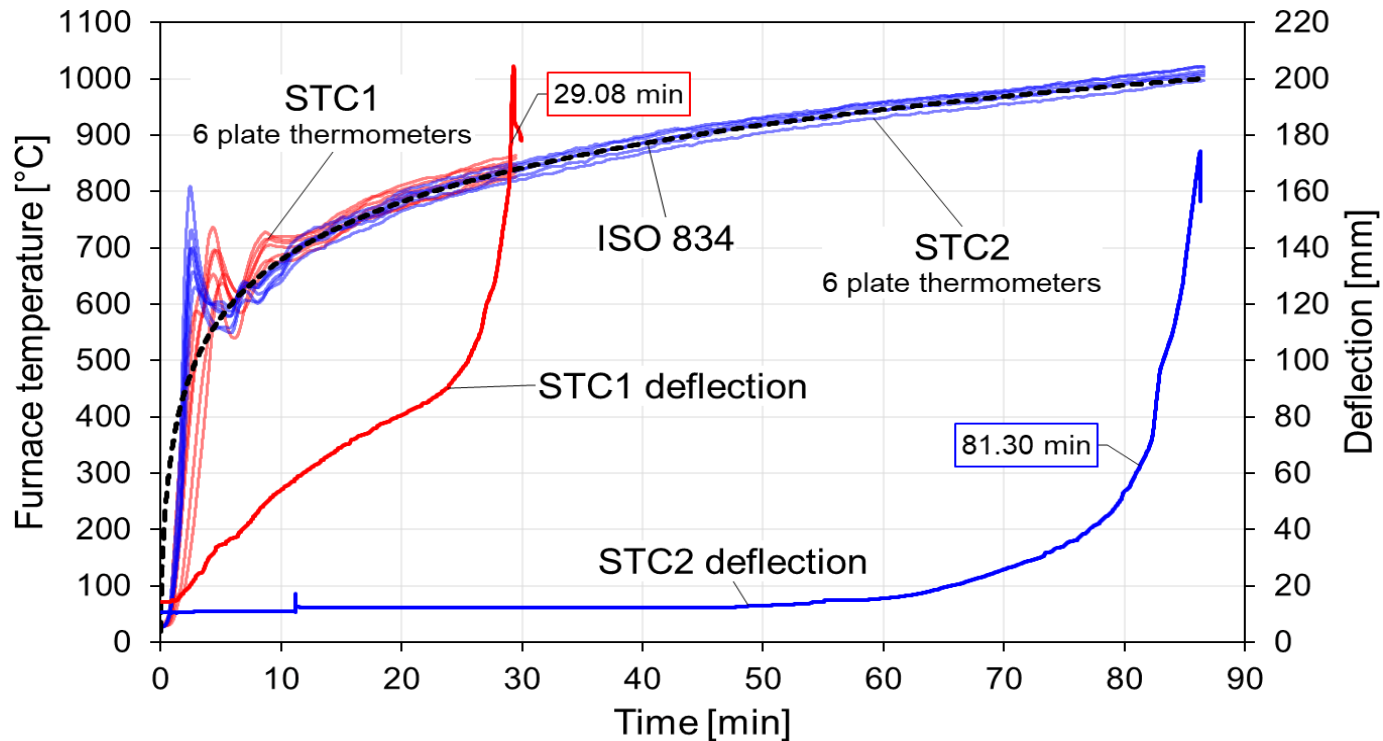
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Experimental tests under fire conditions

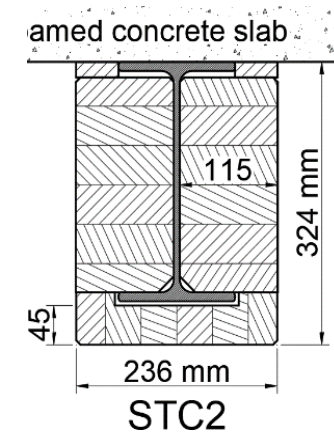
- Time – displacements results



- Failure time for STC1 : 29 minutes
- Failure time for STC2 : 81 minutes

Experimental tests under fire conditions

- Observations : progressive fall of the bottom flange timber protection for STC2

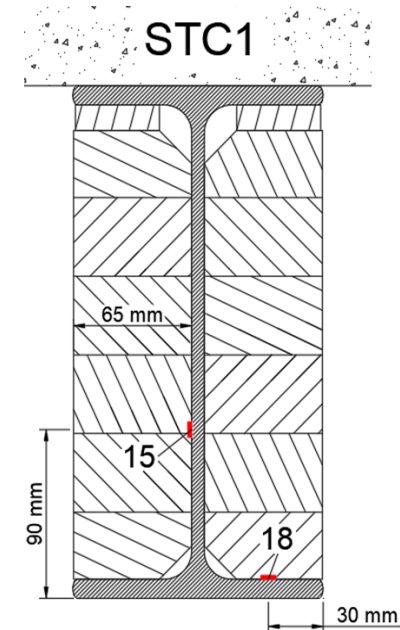
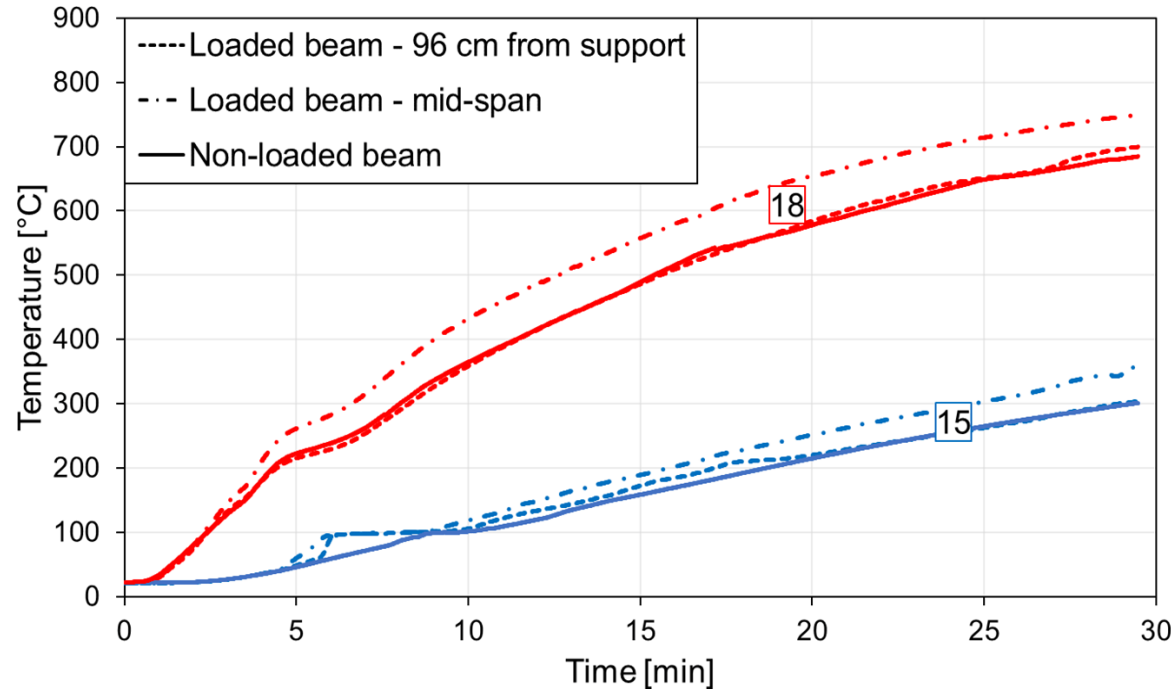


Experimental tests under fire conditions

- Thermocouples disposal

Experimental tests under fire conditions

- Temperature results and influence of mechanical loading



Experimental tests under fire conditions

- Temperature results and influence of mechanical loading

IDEM POUR STC2

Numerical model and analysis

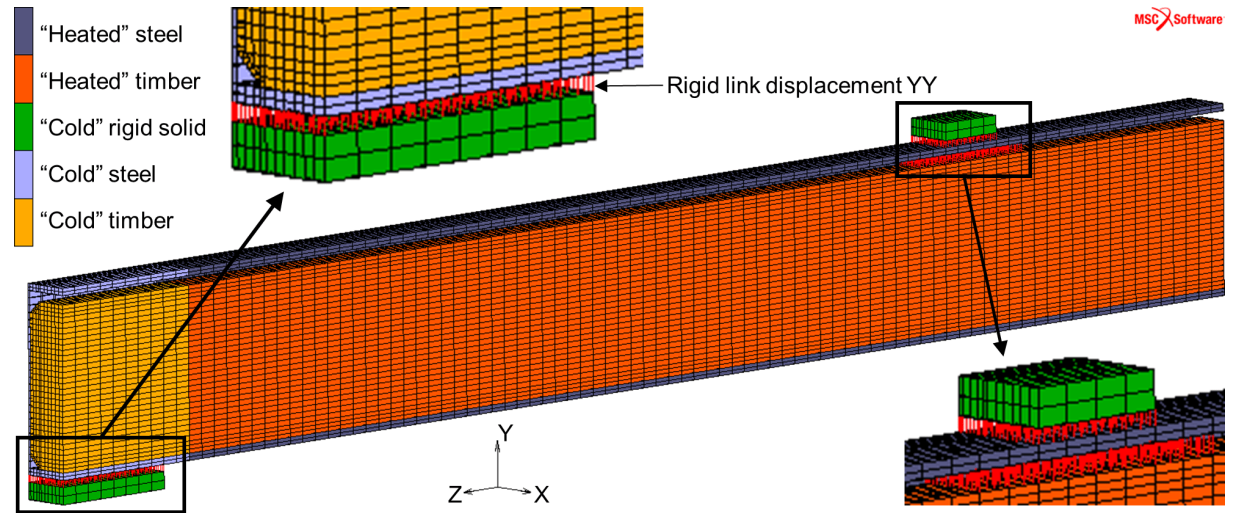
Descriptif du modèle :

Calcul thermomécanique non couplé

Taille maillage

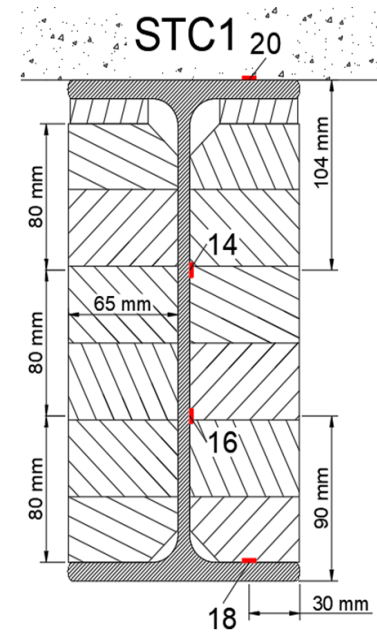
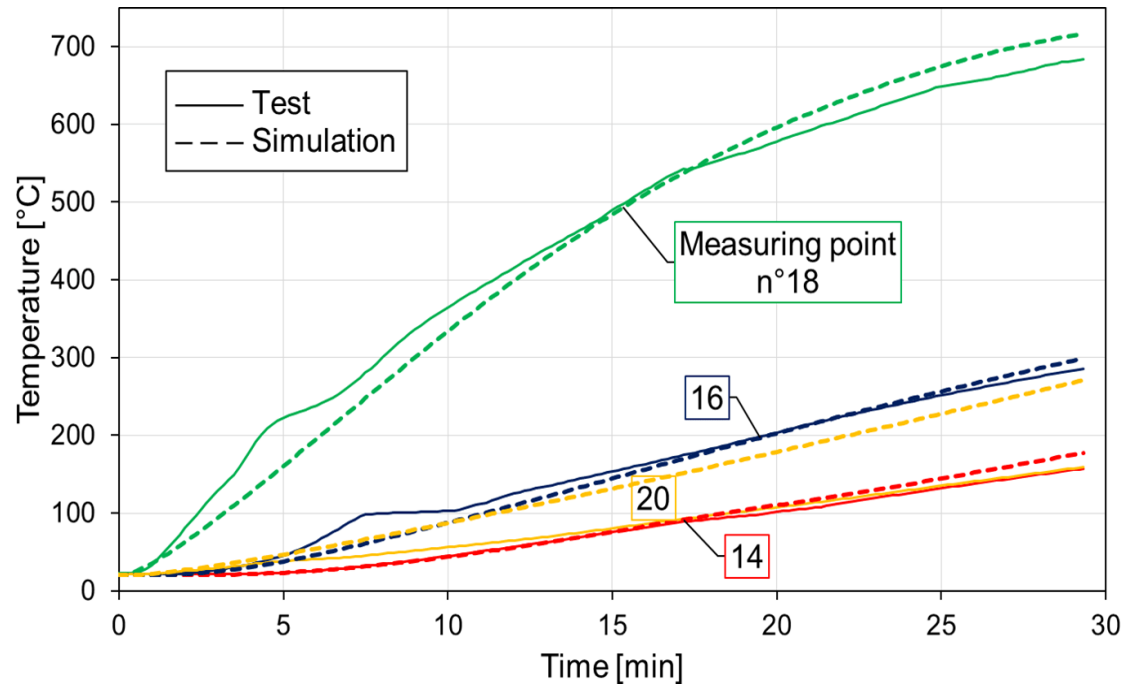
Modèle bois

Modèle acier



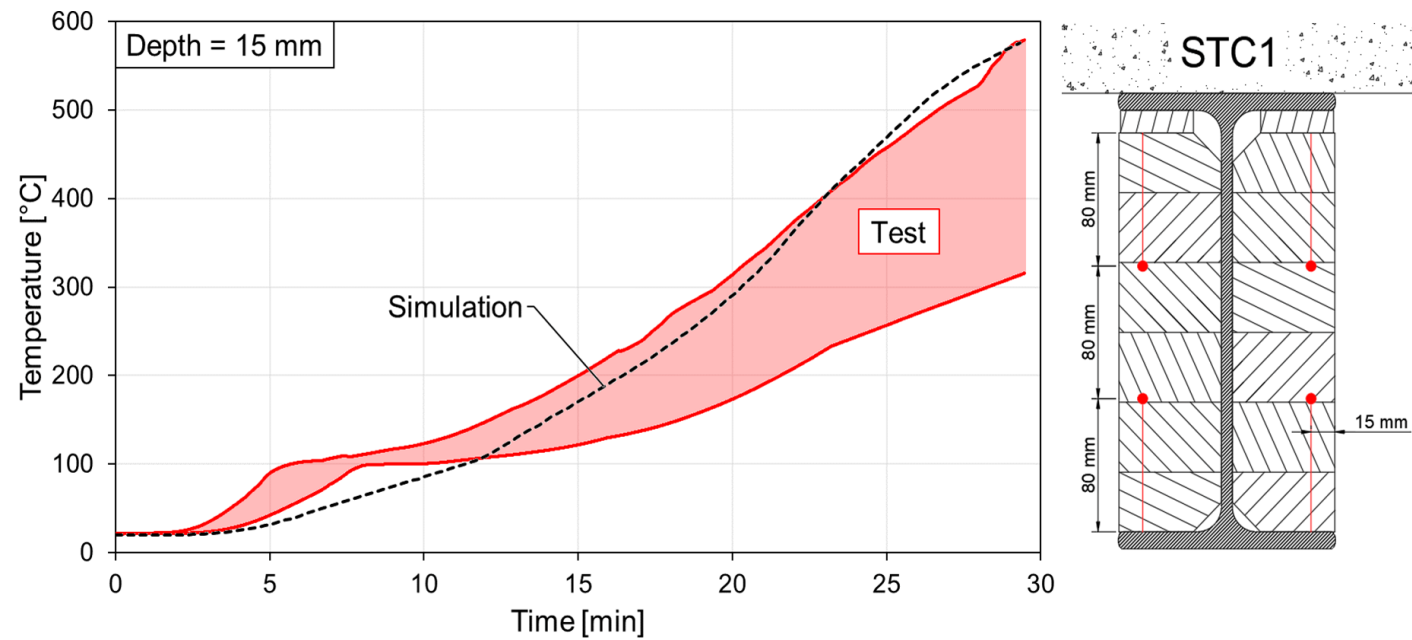
Numerical model and analysis

Results and comparison with tests :



Numerical model and analysis

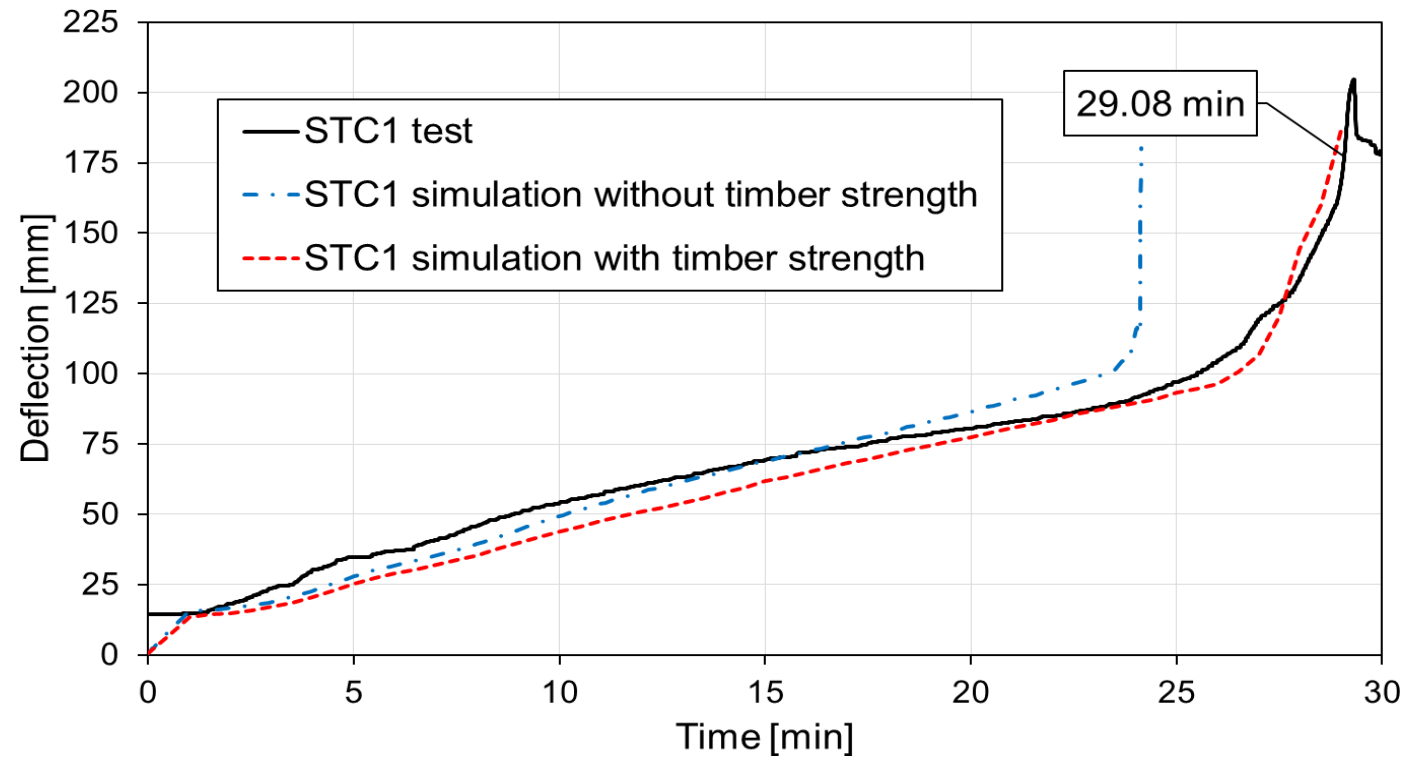
Results and comparison with tests :



Numerical model and analysis

Results and comparison with tests :

Those results show the importance to consider timber in the mechanical strength of the hybrid section, allowing an **increase of 5 minutes** of fire resistance



Numerical model and analysis

Results and comparison with tests :

Comparaison avec acier seul pour un taux de chargement de 43% et un niveau de chargement identique à la poutre STC1



Conclusions



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Thanks for your attention

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