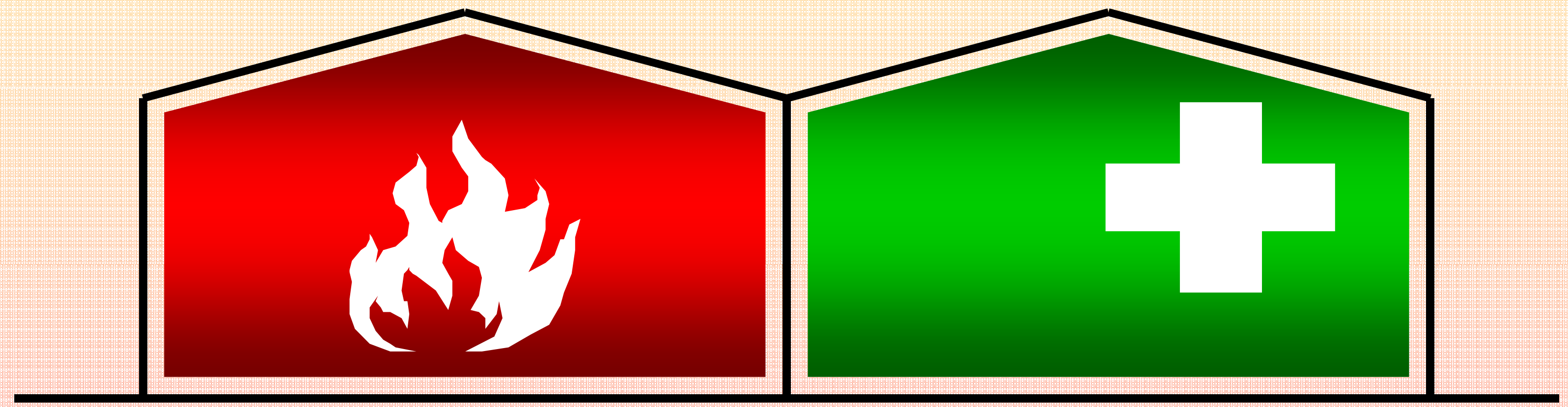
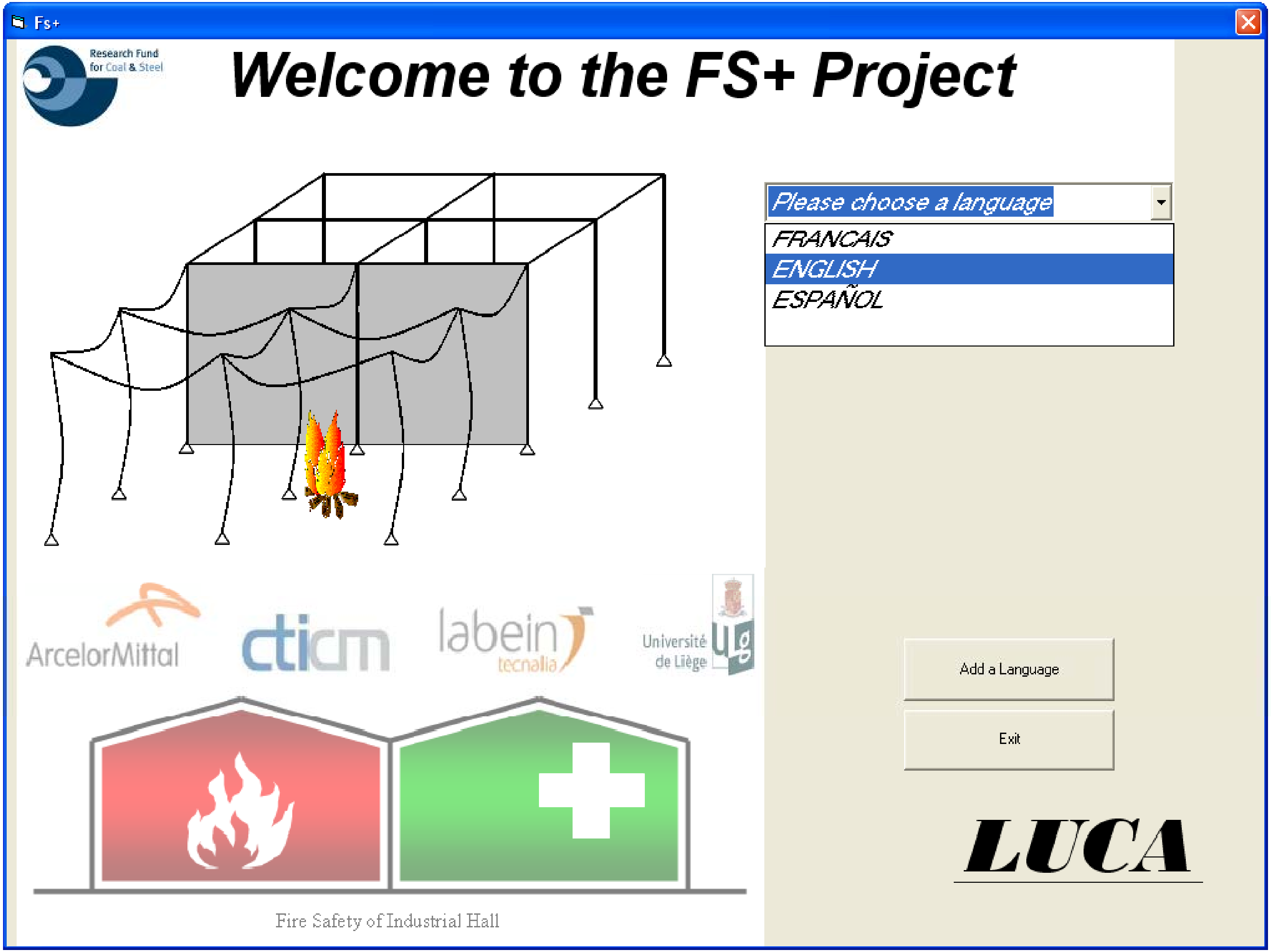
Présentation du software LUCA

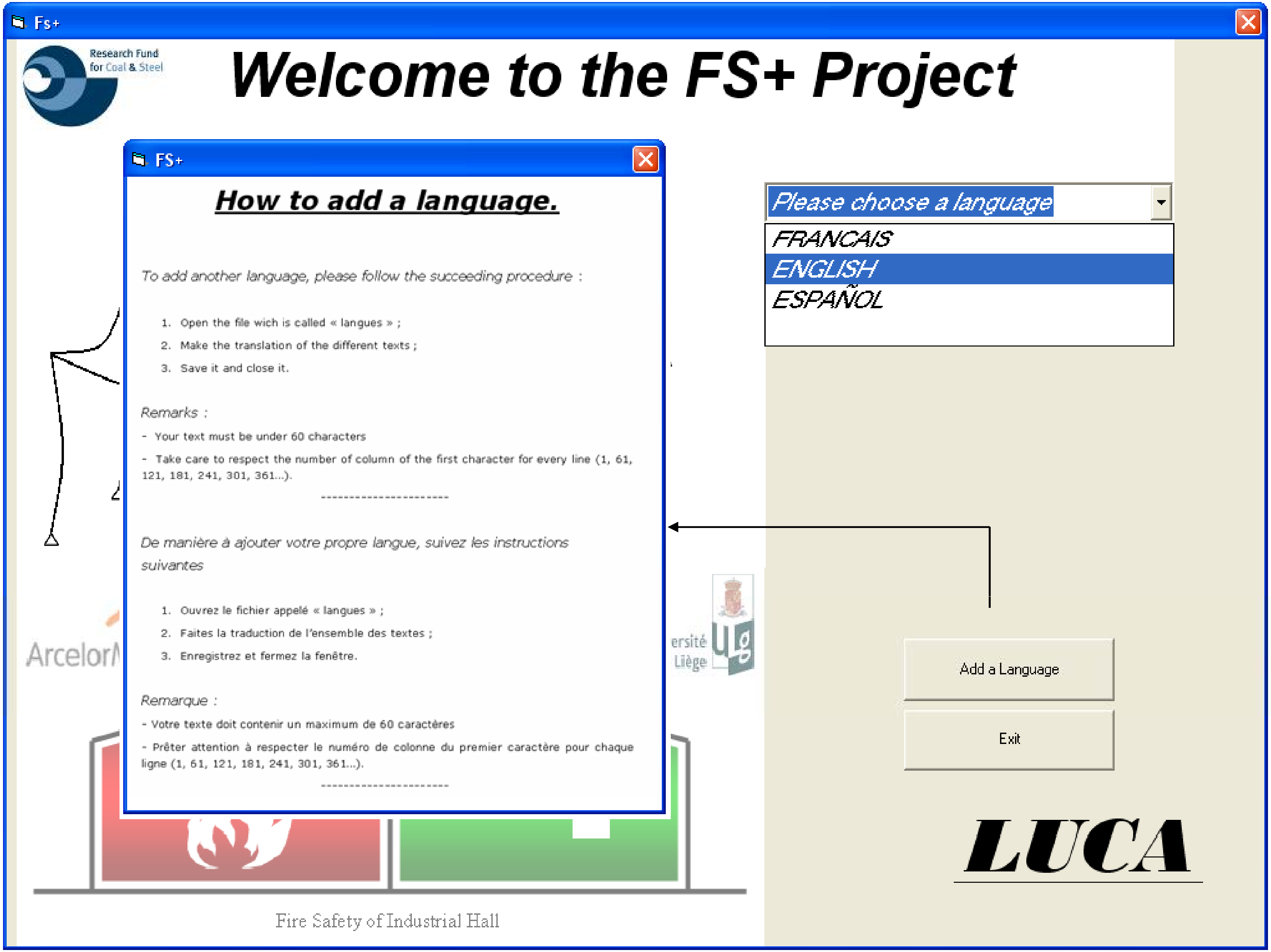


Sécurité incendie des halls industriels

ArcelorMittal   cticm   labein tecnalia   Université de Liège

RFS2-C2-2007-00032


Fs+
Research Fund for Coal & Steel
Welcome to the FS+ Project
Please choose a language
FRANCAIS
ENGLISH
ESPAÑOL
ArcelorMittal
cticm
labein
tecnalia
Université de Liège
Add a Language
Exit
LUCA
Fire Safety of Industrial Hall


Fs+
Research Fund for Coal & Steel
Welcome to the FS+ Project
FS+
How to add a language.
To add another language, please follow the succeeding procedure :
1. Open the file wich is called « langues » ;
2. Make the translation of the different texts ;
3. Save it and close it.
Remarks :
- Your text must be under 60 characters
- Take care to respect the number of column of the first character for every line (1, 61, 121, 181, 241, 301, 361...).

De manière à ajouter votre propre langue, suivez les instructions suivantes
1. Ouvrez le fichier appelé « langues » ;
2. Faites la traduction de l'ensemble des textes ;
3. Enregistrez et fermez la fenêtre.
Remarque :
- Votre texte doit contenir un maximum de 60 caractères
- Prêter attention à respecter le numéro de colonne du premier caractère pour chaque ligne (1, 61, 121, 181, 241, 301, 361...).

Please choose a language
FRANCAIS
ENGLISH
ESPAÑOL
Add a Language
Exit
LUCA
Fire Safety of Industrial Hall

FS+

Introduction

Field of application

This Software is applicable to industrial halls the fulfill the following conditions:

- Buildings with steel structure, either steel portal frames with cross section in standard H or I hot rolled profiles or equivalent welded plate giders, or steel frames based on lattices beams with columns in H or I ;

- Buildings divided in one or several compartments separated one from another by fire walls. These walls can be either parallel to the steel frames, or perpendicular to the steel frames.

The sizes considered in the project are as listed :

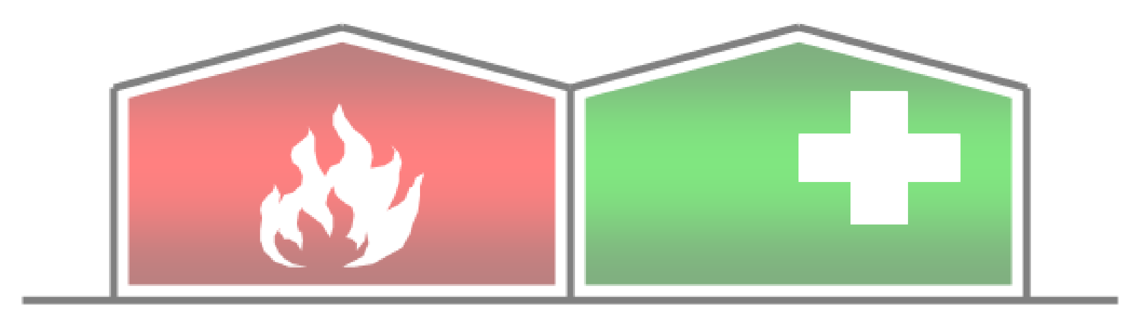
Length of a span for simple bay : 15 m, 20 m and 30 m
Length of a span for multiple bay : 20 m, 30 m and 40 m
Height - simple bay : 5 m, 7.5 m, and 12.5 m
Height - multiple bay : 7.5 m, 12.5 m and 20 m
(H < 20 m [Collapse towward the inside])
Slope of the roof : 5°
Number of bays : 1, 3 and 5
Lattice beam : equal angles 50x50x5 till 120x120x12

Design beyond the scope of analysis will not be recommended unless treated as preliminary design, which will be farther validated.

How to treat the results

The displacements that will be obtained must be used to verify the stability of the interior and exterior walls ;

The force that will be obtained in stage of pull must be used to verify the stability of the cold part (force located at the top of the column).

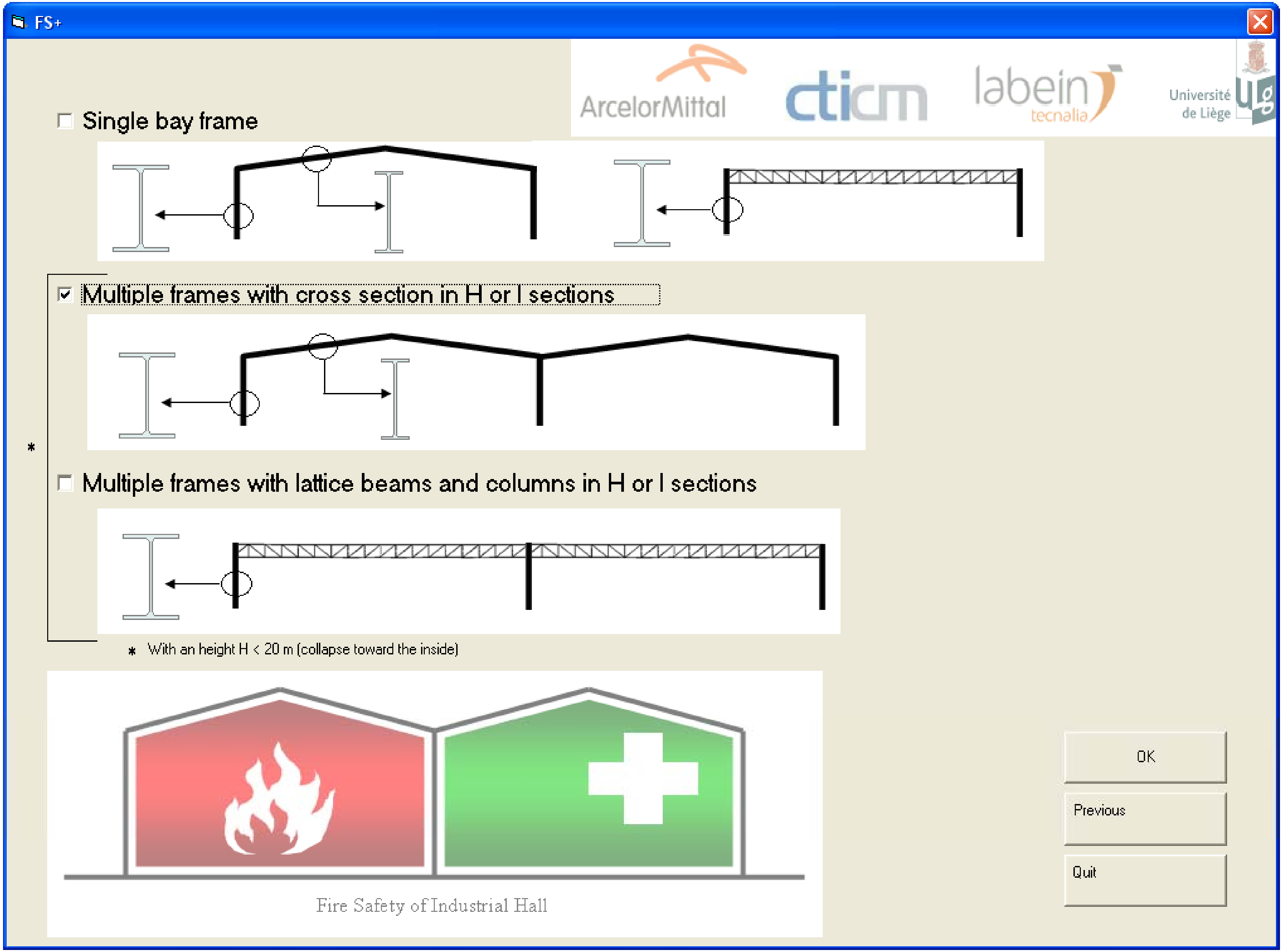


Fire Safety of Industrial Hall

OK

Previous

Quit


FS+
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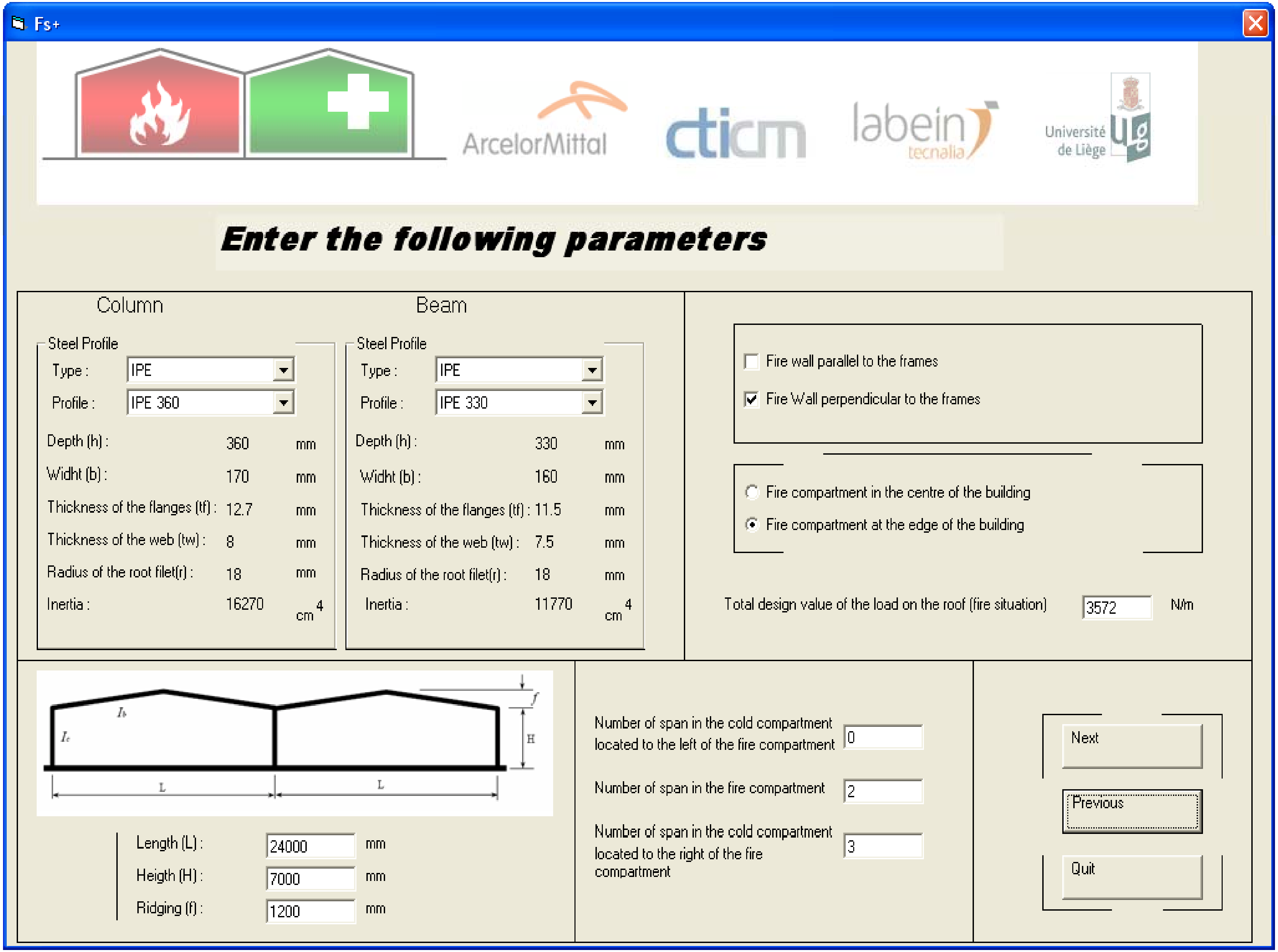
labein
tecnalia
Université de Liège
Single bay frame
Multiple frames with cross section in H or I sections
*
Multiple frames with lattice beams and columns in H or I sections
* With an height H < 20 m (collapse toward the inside)
Fire Safety of Industrial Hall
OK
Previous
Quit


Fs+
ArcelorMittal
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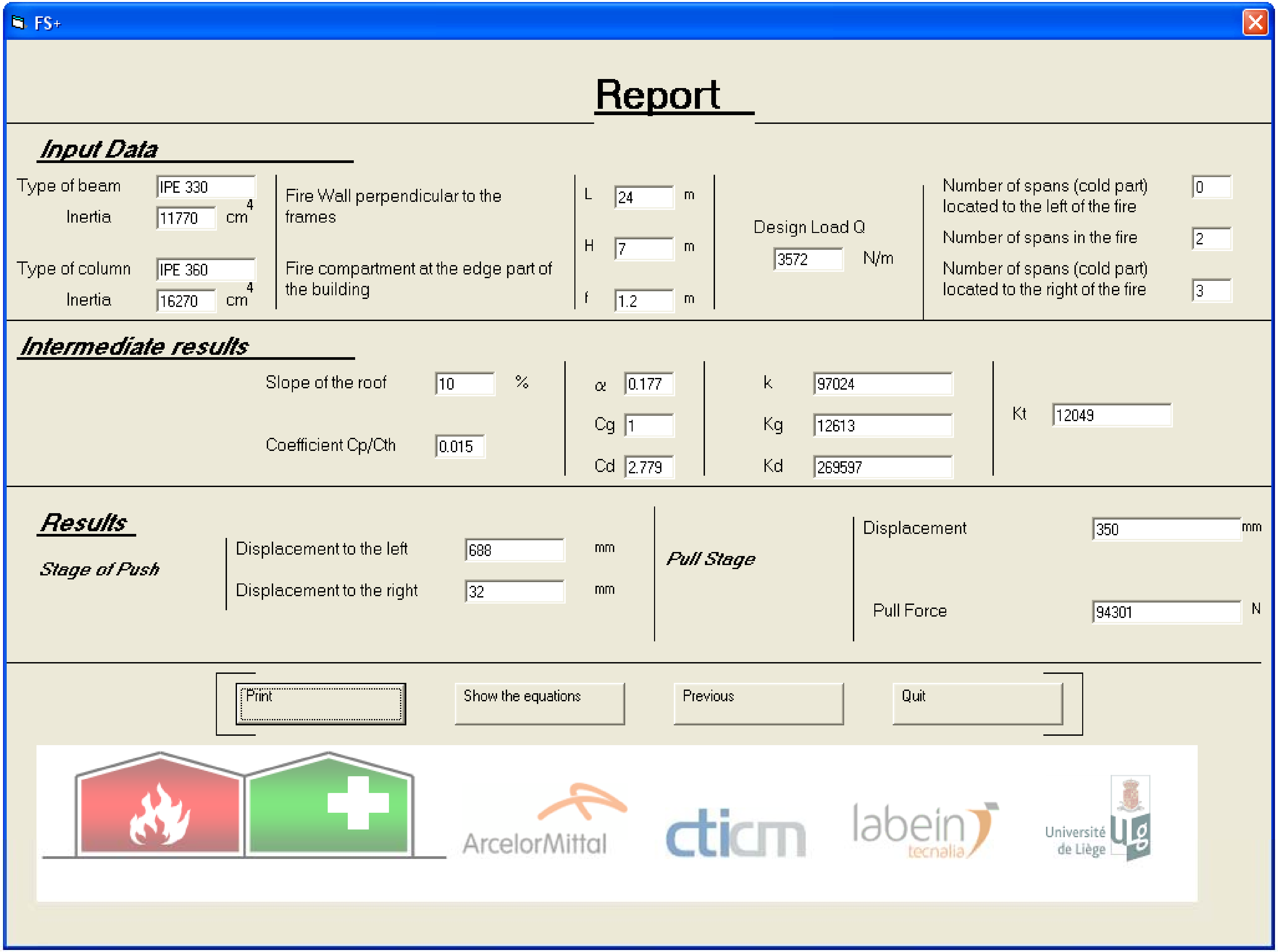
labein
tecnalia
Université de Liège
Enter the following parameters
Column
Steel Profile
Type : IPE
Profile : IPE 360
Depth (h) : 360 mm
Widht (b) : 170 mm
Thickness of the flanges (tf) : 12.7 mm
Thickness of the web (tw) : 8 mm
Radius of the root filet(r) : 18 mm
Inertia : 16270 cm 4
Beam
Steel Profile
Type : IPE
Profile : IPE 330
Depth (h) : 330 mm
Widht (b) : 160 mm
Thickness of the flanges (tf) : 11.5 mm
Thickness of the web (tw) : 7.5 mm
Radius of the root filet(r) : 18 mm
Inertia : 11770 cm 4
Fire wall parallel to the frames
Fire Wall perpendicular to the frames
Fire compartment in the centre of the building
Fire compartment at the edge of the building
Total design value of the load on the roof (fire situation) 3572 N/m
Ib
Ic
f
H
L
L
Length (L) : 24000 mm
Heigth (H) : 7000 mm
Ridging (f) : 1200 mm
Number of span in the cold compartment located to the left of the fire compartment 0
Number of span in the fire compartment 2
Number of span in the cold compartment located to the right of the fire compartment 3
Next
Previous
Quit


FS+
Report
Input Data
Type of beam
IPE 330
Inertia
11770
cm4
Type of column
IPE 360
Inertia
16270
cm4
Fire Wall perpendicular to the frames
Fire compartment at the edge part of the building
L
24
m
H
7
m
f
1.2
m
Design Load Q
3572
N/m
Number of spans (cold part) located to the left of the fire
0
Number of spans in the fire
2
Number of spans (cold part) located to the right of the fire
3
Intermediate results
Slope of the roof
10
%
Coefficient Cp/Cth
0.015
α
0.177
Cg
1
Cd
2.779
k
97024
Kg
12613
Kd
269597
Kt
12049
Results
Stage of Push
Displacement to the left
688
mm
Displacement to the right
32
mm
Pull Stage
Displacement
350
mm
Pull Force
94301
N
Print
Show the equations
Previous
Quit
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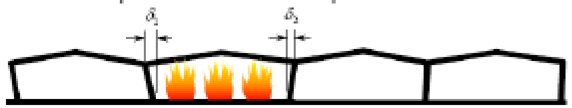
Case 1 : Fire in a compartment located at the middle of the Hall

Stage of Push : displacements at fire compartment ends



Displacements $\delta_i\ [m]$:

$$\delta_i = \frac{C_p\, n.q.l}{K_i}$$

(*)

Roof slope	Cp
0%	1,19
5%	1,16
10%	1,1

C_p is an empirical coefficient (function of the slope of the roof) (*) linear interpolation may be used

n is the span number of the compartment submitted to fire ($n \leq 2$)

q is the linear load on roof (fire situation)

l is the span length [m]

K_i are the equivalent lateral stiffness of the steel frames of cold compartments [N/m]

m_i is the span number of the neighboring cold compartments

$$\begin{cases} K_i = k \ \ for \ \ m_i = 1 \ [1] \\ K_i = c.k \ \ for \ \ m_i \geq 2 \ [2] \end{cases}$$

With,

$$\begin{cases} k = \dfrac{\alpha}{1+2.\alpha} \cdot \dfrac{12.E.I_c}{(h+f)^3} \quad [N/m] \\ \alpha = \dfrac{I_b}{I_c} \cdot \dfrac{h+f}{l} \left(1 - \dfrac{f}{0.6\,h}\right) \\ c = 1 + \displaystyle\sum_{i=2}^{m} \frac{i}{2} \cdot \frac{2.\alpha+1}{1+2.i.\alpha} \end{cases} \quad [3]$$

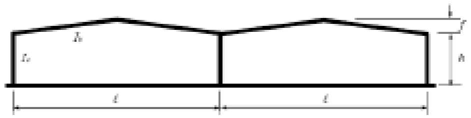
h height of the portal frame [m]

f ridging [m]

I_b second moment of area of the beam [m⁴]

I_c second moment of area of columns [m⁴]

E modulus of elasticity of steel [N/m²]



Stage of Traction : Stability of the cold part of the structure and displacement at fire compartment end

Horizontal tensile force F at the compartment ends

$$F = C_p.n.q.l$$

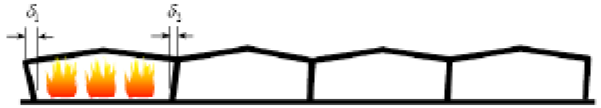
Maximum displacements induced at the top of columns

$$\delta_{max,i} = \frac{F}{K_i}$$

K_i given by [1]

Case 2 : Fire compartment at edge part of the storage building

Stage of Push : displacements at fire compartment ends



Displacements $\delta_i\ [m]$:

$$\delta_i = \frac{K_t}{K_i} n.C_{th}.l$$

With, $K_t = \dfrac{K_1 K_2}{K_1 + K_2}$

Roof slope	Cth
0%	0,01
5%	0,011
10%	0,015

K_1 et K_2 equivalent lateral stiffness of the steel frames

l is the span length [m]

n is the span number of the compartment submitted to fire

C_{th} empirical coefficient (function of the slope of the roof) linear interpolation may be used

K_2 given by [1] or [2]

$$\begin{cases} K_1 = 0{,}065.k \ \ for \ \ n = 1 \\ K_1 = 0{,}13.k \ \ for \ \ n = 2 \\ K_1 = 0{,}13.c.k \ \ for \ \ n > 2 \end{cases}$$

c and k given by [3] with $m = n - 1$

Stage of Traction : Stability of the cold part of the structure and displacement at fire compartment end

Horizontal tensile force F at the compartment ends

$$\begin{cases} F = 0{,}5.C_p.q.l \ \ pour \ \ n = 1 \\ F = C_p.q.l \ \ pour \ \ n \geq 2 \end{cases}$$

Maximum displacements induced at the top of columns

$$\delta_{max,i} = \frac{F}{K_i}$$

K_i given by [1]

ArcelorMittal cticm labein tecnalia Université de Liège

Report
FS+

1] Introduction

Multiple frames with cross section in H or I sections

1.1] Field of application

This Software is applicable to industrial halls the fulfill the following conditions:

- Buildings with steel structure, either steel portal frames with cross section in standard H or I hot rolled profiles or equivalent welded plate giders, or steel frames based on lattices beams with columns in H or I ;

- Buildings divided in one or several compartments separated one from another by fire walls. These walls can be either parallel to the steel frames, or perpendicular to the steel frames.

The sizes considered in the project are as listed :

Length of a span for simple bay : 15 m, 20 m and 30 m
Length of a span for multiple bay : 20 m, 30 m and 40 m
Height - simple bay : 5 m, 7.5 m, and 12.5 m
Height - multiple bay : 7.5 m, 12.5 m and 20 m
(H < 20 m [Collapse towward the inside])
Slope of the roof : 5°
Number of bays : 1, 3 and 5
Lattice beam : equal angles 50x50x5 till 120x120x12

Design beyond the scope of analysis will not be recommended
unless treated as preliminary design, which will be farther validated.

1.2] How to treat the results

The displacements that will be obtained must be used to verify the stability of the interior and exterior walls ;

The force that will be obtained in stage of pull must be used to verify the stability of the cold part (force located at the top of the column).

2] Input Data

2.1] Type and inertia of the columns and beams of the frames

Type of beam
IPE 330
Inertia
11770 cm4

Type of column
IPE 360
Inertia
16270 cm4

2.2] Position of the fire wall and location of the fire in the building :

Fire Wall perpendicular to the frames

Fire compartment at the edge part of the building

2.3] Geometry of the frames :

Length :
L = 24 m
Heigth :
H = 7 m
Ridging :
f = 1.2 m

0 : Number of spans (cold part) located to the left of the fire
2 : Number of spans in the fire compartent
3 : Number of spans (cold part) located to the right of the fire

2.4] Design Load Q

q = 3572 N/m

3] Intermediate results

3.1] Slope of the roof, Coefficient (function of the slope)

10 % : Slope of the roof
0.015 : Coefficient Cp/Cth

3.2] Coefficients a and c :

a : 0.177
Cg : 1
Cd : 2.779

3.3] Equivalent stiffness for lateral displacements :

k : 97024 N/m
Kg : 12613 N/m
Kd : 269597 N/m
Kt : 12049 N/m

4] Results

4.1] Stage of Push

Horizontal displacements in the top of the columns :

688 mm : Displacement to the left
32 mm : Displacement to the right

4.2] Pull Stage

Maximum horizontal force in the top of the columns :

94301 N : Pull Force

Horizontal displacements in the top of the columns :

350 mm : Displacement

Made with the Software LUCA

Case 1 : Fire in a compartment located at the middle of the Hall

Stage of Push : displacements at fire compartment ends

Displacements δ_i [m] :

$$\delta_i = \frac{C_p \, n \, q \, l}{K_c}$$

Roof slope	Cp
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

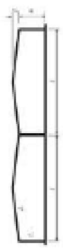
C_p is an empirical coefficient (function of the slope of the roof) (*) linear interpolation may be used
n is the span number of the compartment submitted to fire ($n \leq 2$)
q is the linear load on roof (fire situation)
l is the span length [m]
K_c are the equivalent lateral stiffness of the steel frames of cold compartments [N/m]
m_c is the span number of the neighboring cold compartments

$$\begin{cases} K_c = k \ \text{for} \ m_c = 1 \ [1] \\ K_c = c.k \ \text{for} \ m_c \geq 2 \ [2] \end{cases}$$

With.

$$\begin{cases} k = \frac{\alpha}{1+2\alpha} \cdot \frac{12 E I_c}{(h+f)^3} \ [N/m] \\ \alpha = \frac{I_b}{I_c} \cdot \frac{h+f}{l} \left(1 - \frac{f}{0.6 h}\right) \\ c = 1 + \sum_{i=2}^{n} \frac{i}{2} \frac{2\alpha+1}{1+2\lambda\alpha} \end{cases} \quad [3]$$

h height of the portal frame [m]
f ridging [m]
I_b second moment of area of the beam [m⁴]
I_c second moment of area of columns [m⁴]
E modulus of elasticity of steel [N/m²]



Stage of Traction : Stability of the cold part of the structure and displacement at fire compartment end

Horizontal tensile force F at the compartment ends

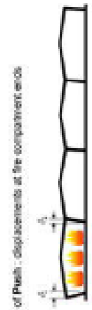
$$F = C_p \, n \, q \, l$$

Maximum displacements induced at the top of columns

$$\delta_{max} = \frac{F}{K_c} \qquad K_c \text{ given by [1]}$$

Case 2 : Fire compartment at edge part of the storage building

Stage of Push : displacements at fire compartment ends



Displacements δ_i [m] :

$$\delta_i = \frac{K_c}{K_t} n \, C_d \, l$$

With. $K_t = \frac{K_1 K_2}{K_1 + K_2}$

Roof slope	Cd
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

K_1 et K_2 equivalent lateral stiffness of the steel frames
l is the span length [m]
n is the span number of the compartment submitted to fire
C_d empirical coefficient (function of the slope of the roof) linear interpolation may be used

K_2 given by [1] or [2]

$$\begin{cases} K_1 = 0{,}065.k \ \text{for} \ n = 1 \\ K_1 = 0{,}13.k \ \text{for} \ n = 2 \\ K_1 = 0{,}13.c.k \ \text{for} \ n > 2 \end{cases}$$

c and k given by [3] with m = n − 1

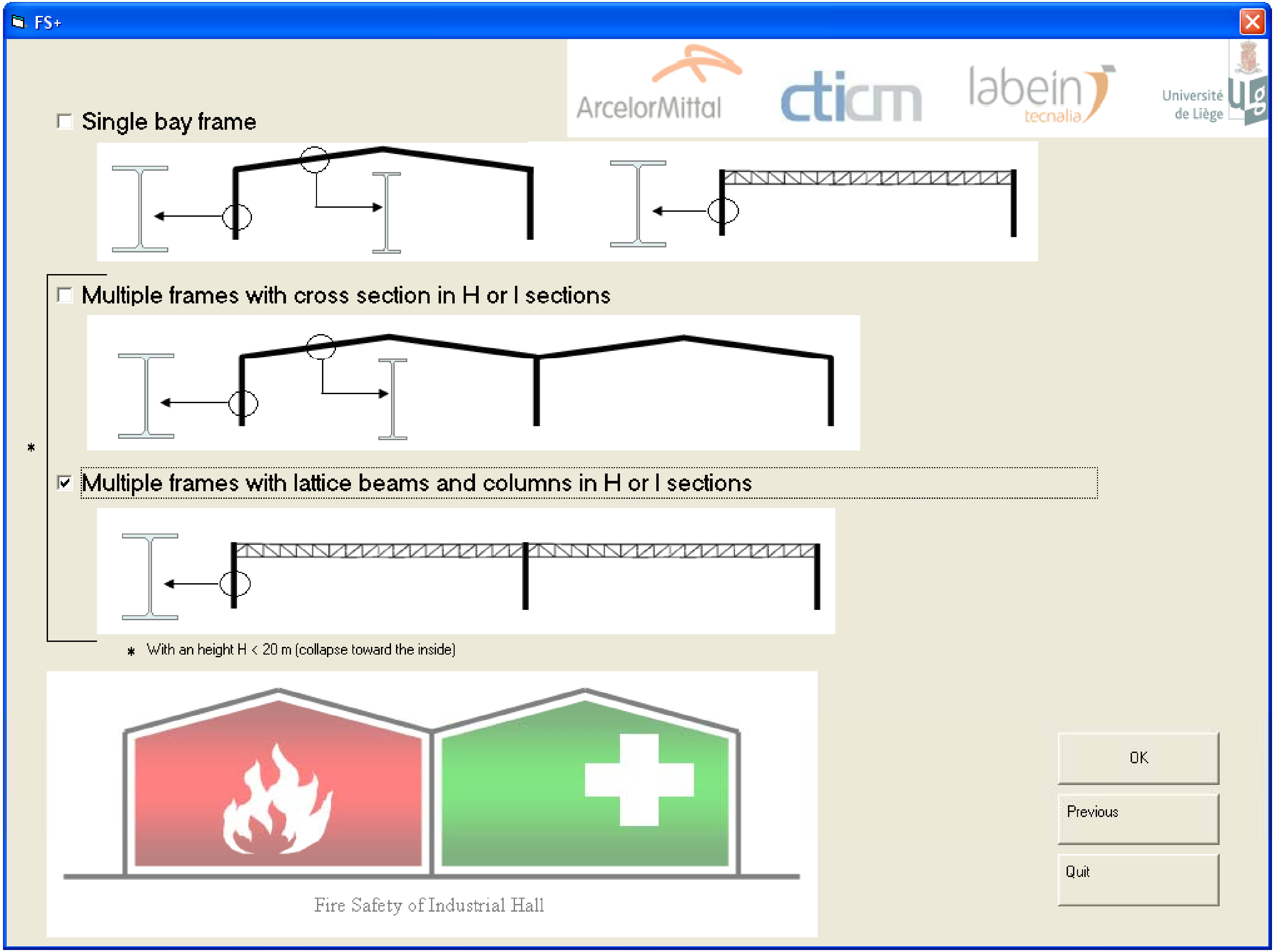
Stage of Traction : Stability of the cold part of the structure and displacement a fire compartment end

Horizontal tensile force F at the compartment ends

$$\begin{cases} F = 0{,}5 \, C_p . q \, l \ \text{pour} \ n = 1 \\ F = C_p . q \, l \ \text{pour} \ n \geq 2 \end{cases}$$

Maximum displacements induced at the top of columns

$$\delta_{max} = \frac{F}{K_c} \qquad K_c \text{ given by [1]}$$


FS+
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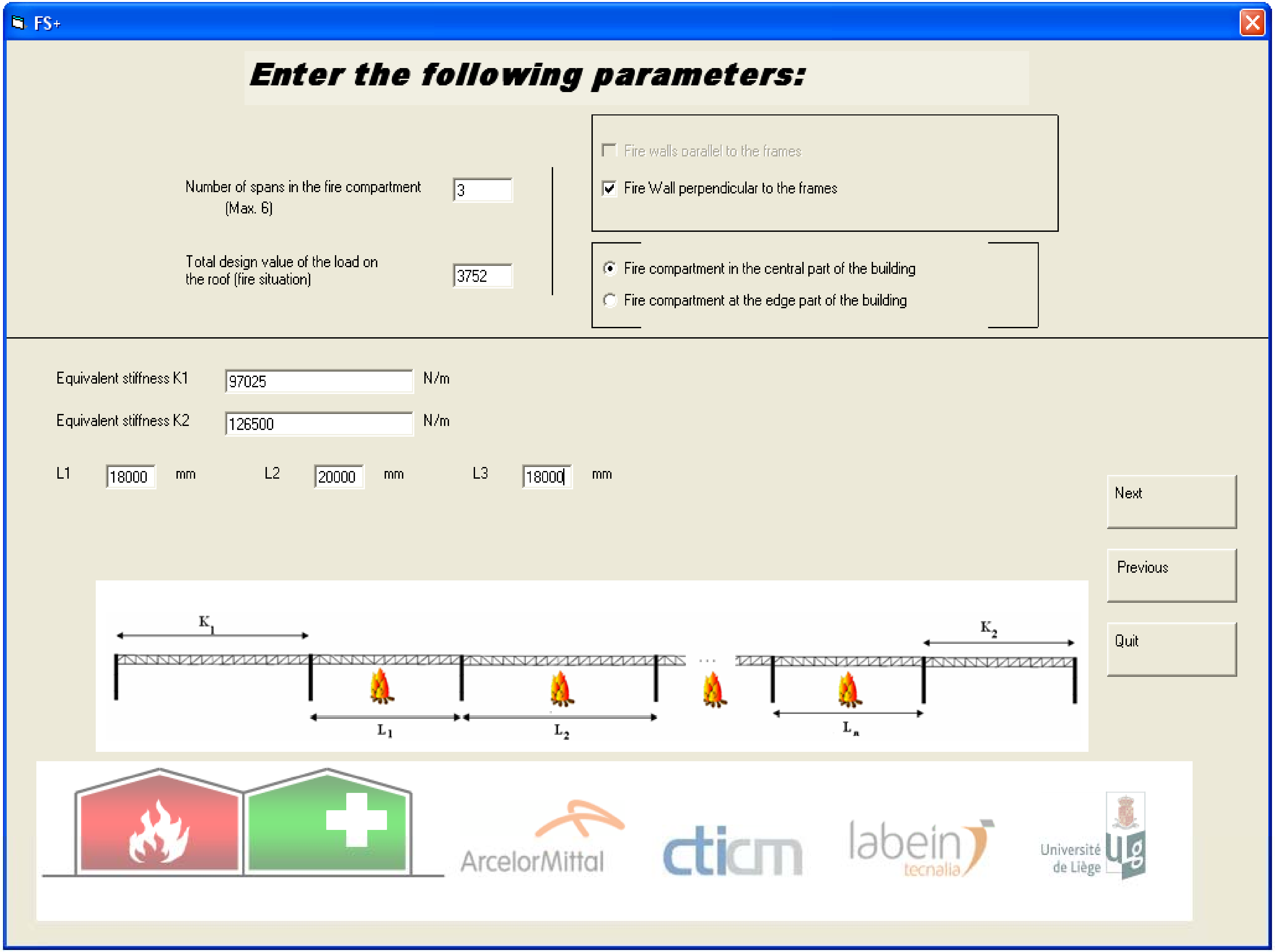
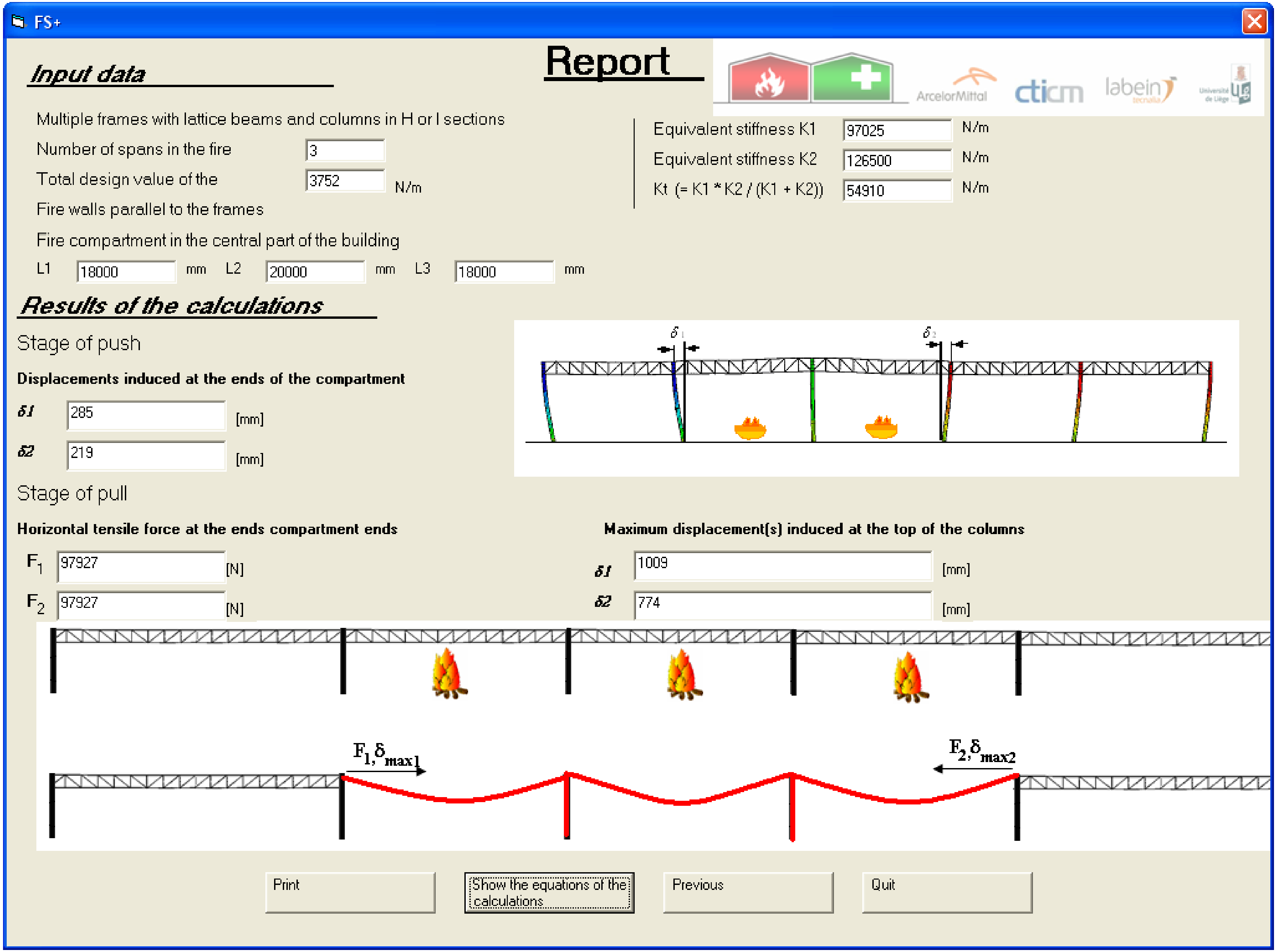
Single bay frame
Multiple frames with cross section in H or I sections
*
Multiple frames with lattice beams and columns in H or I sections
* With an height H < 20 m (collapse toward the inside)
Fire Safety of Industrial Hall
OK
Previous
Quit


FS+
Enter the following parameters:
Number of spans in the fire compartment (Max. 6)
3
Total design value of the load on the roof (fire situation)
3752
Fire walls parallel to the frames
Fire Wall perpendicular to the frames
Fire compartment in the central part of the building
Fire compartment at the edge part of the building
Equivalent stiffness K1
97025
N/m
Equivalent stiffness K2
126500
N/m
L1
18000
mm
L2
20000
mm
L3
18000
mm
Next
Previous
Quit
K1
K2
L1
L2
Ln
ArcelorMittal
cticm
labein
tecnalia
Université de Liège
ulg


FS+
Report
ArcelorMittal
cticm
labein
Input data
Multiple frames with lattice beams and columns in H or I sections
Number of spans in the fire 3
Total design value of the 3752 N/m
Fire walls parallel to the frames
Fire compartment in the central part of the building
L1 18000 mm L2 20000 mm L3 18000 mm
Equivalent stiffness K1 97025 N/m
Equivalent stiffness K2 126500 N/m
Kt (= K1 * K2 / (K1 + K2)) 54910 N/m
Results of the calculations
Stage of push
Displacements induced at the ends of the compartment
δ1 285 [mm]
δ2 219 [mm]
Stage of pull
Horizontal tensile force at the ends compartment ends
F1 97927 [N]
F2 97927 [N]
Maximum displacement(s) induced at the top of the columns
δ1 1009 [mm]
δ2 774 [mm]
F1, δmax1
F2, δmax2
Print
Show the equations of the calculations
Previous
Quit