

## Appendix 2: Tests results and simulations by SAFIR

### A2.1 Test FRFC 1A

*Profile 1* (Figure A2.1):

External profile: Circular hollow section 219.1 x 5

Internal profile: Circular hollow section 139.7 x 10

Concrete cover thickness: ~ 35 mm

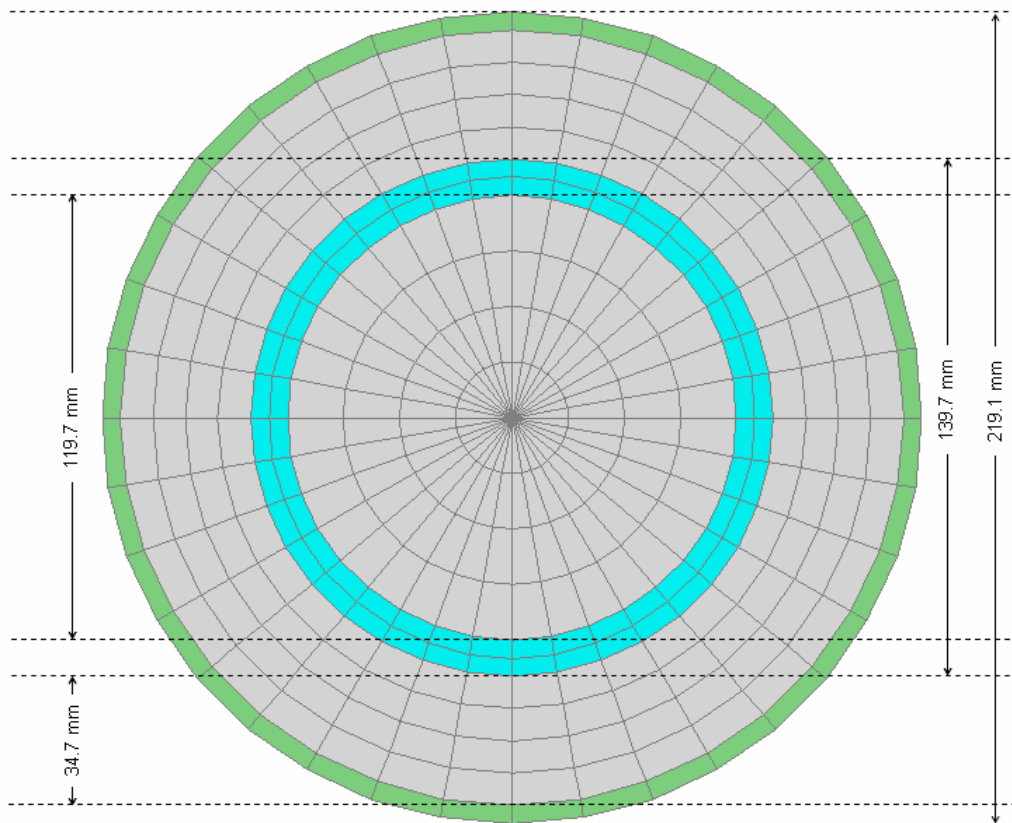


Figure A2.1. Cross-section of profile 1

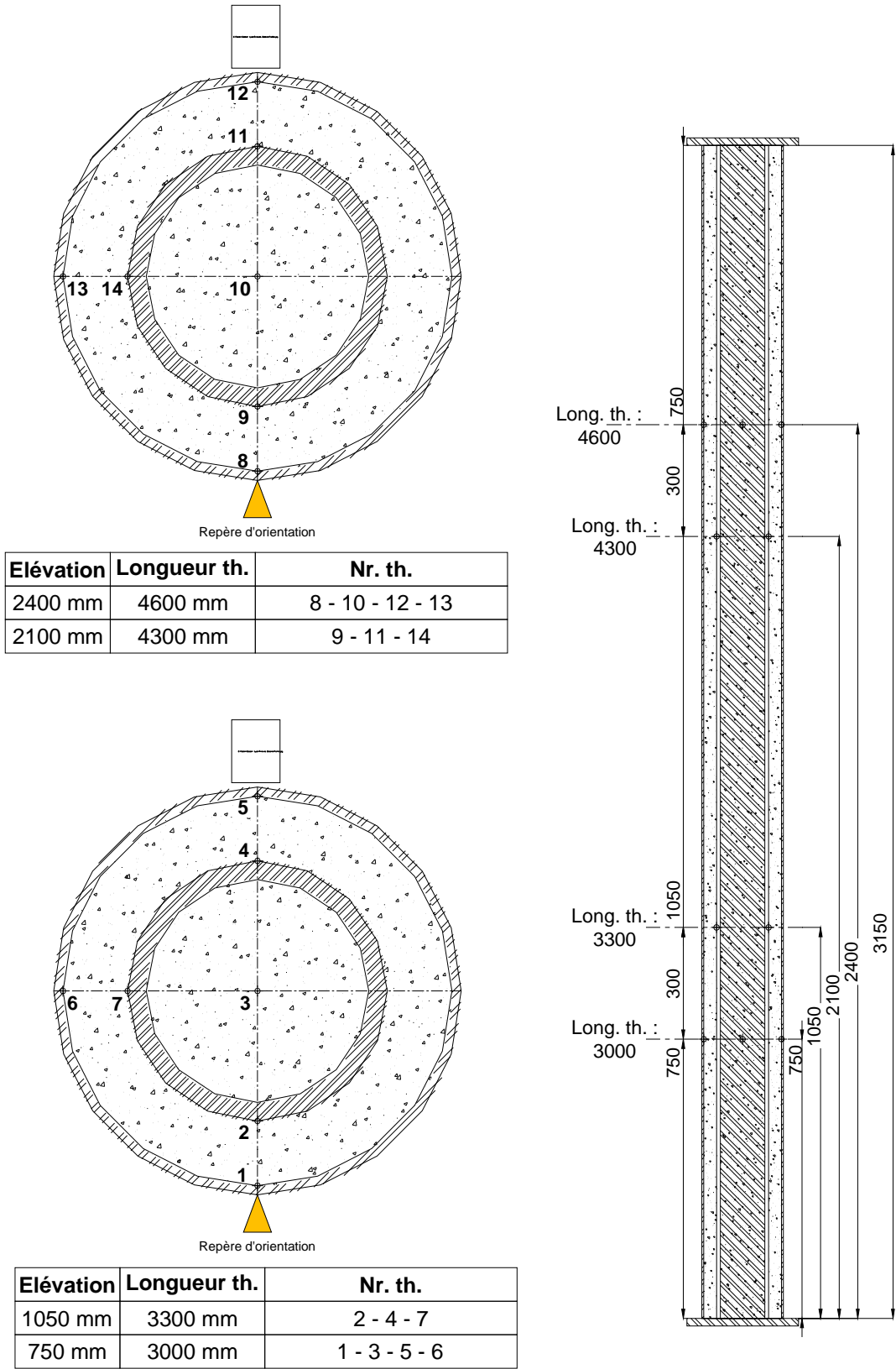


Figure A2.2. Location of thermocouples in the test FRFC 1A and 1B

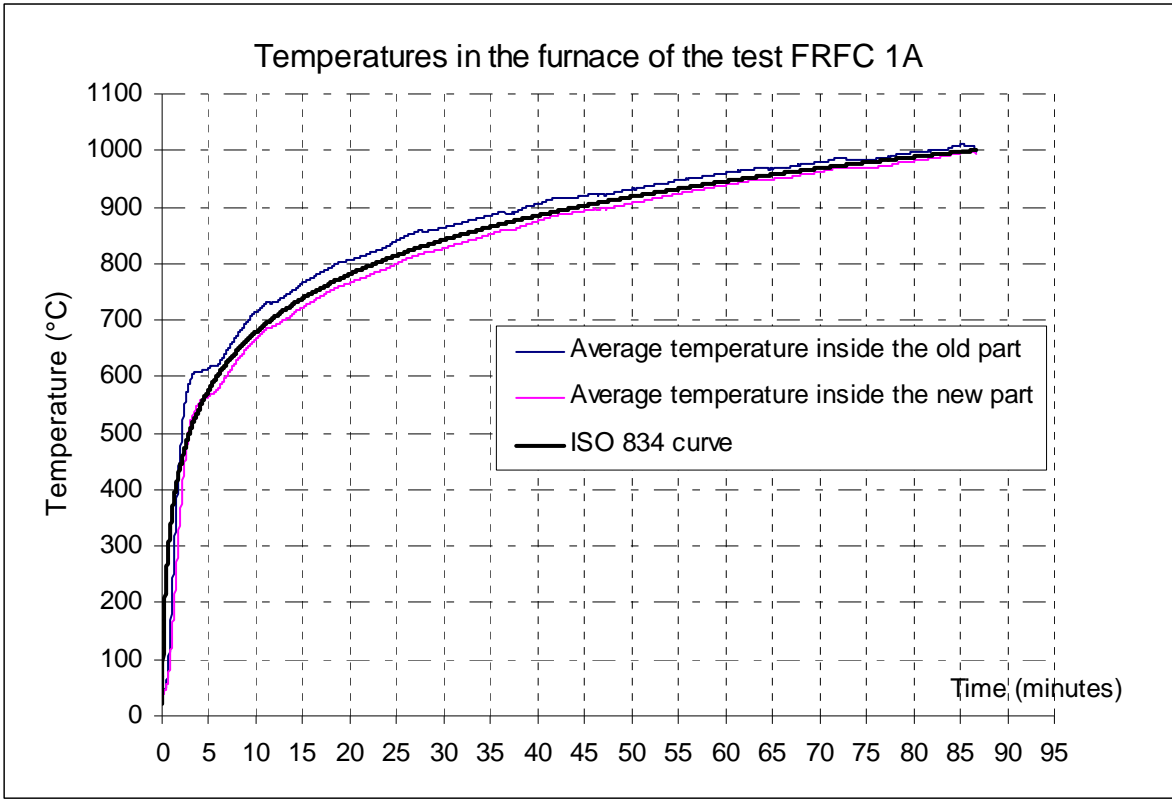


Figure A2.3. Temperatures in the furnace of the test FRFC 1A

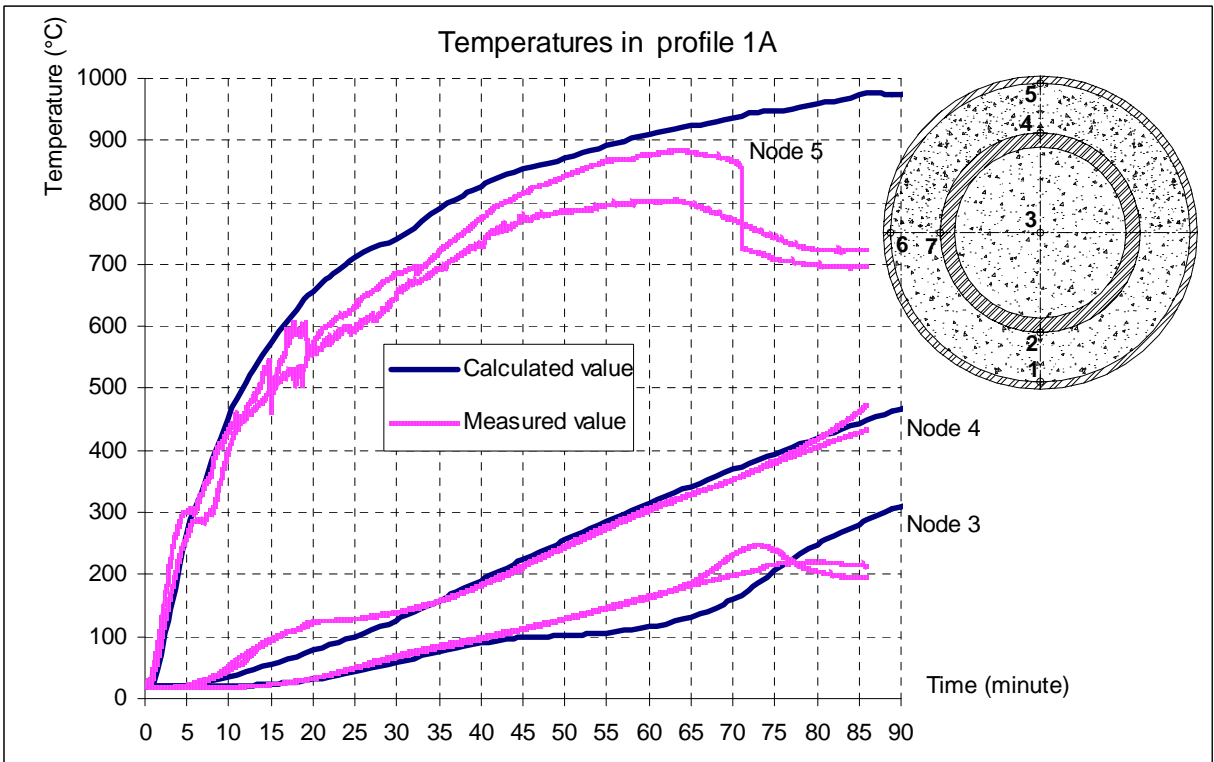


Figure A2.4. Temperatures in the section of the test FRFC 1A

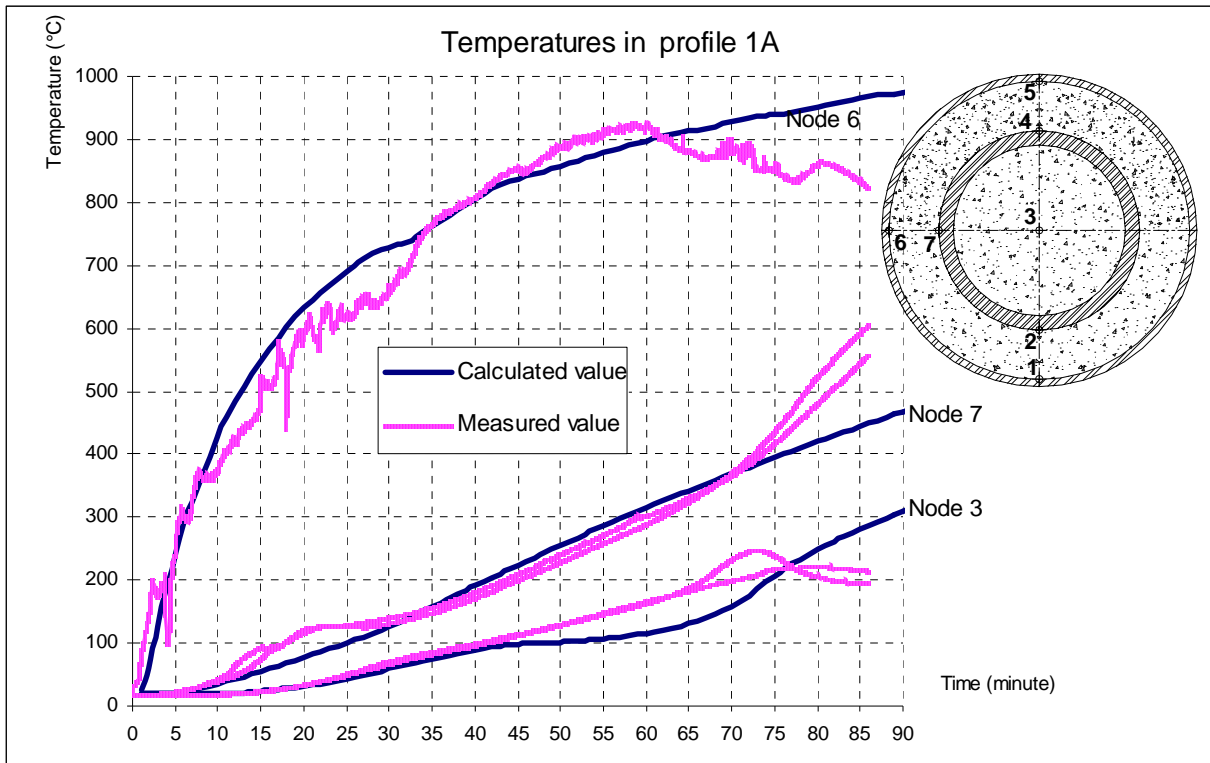


Figure A2.5. Temperatures in the section of the test FRFC 1A

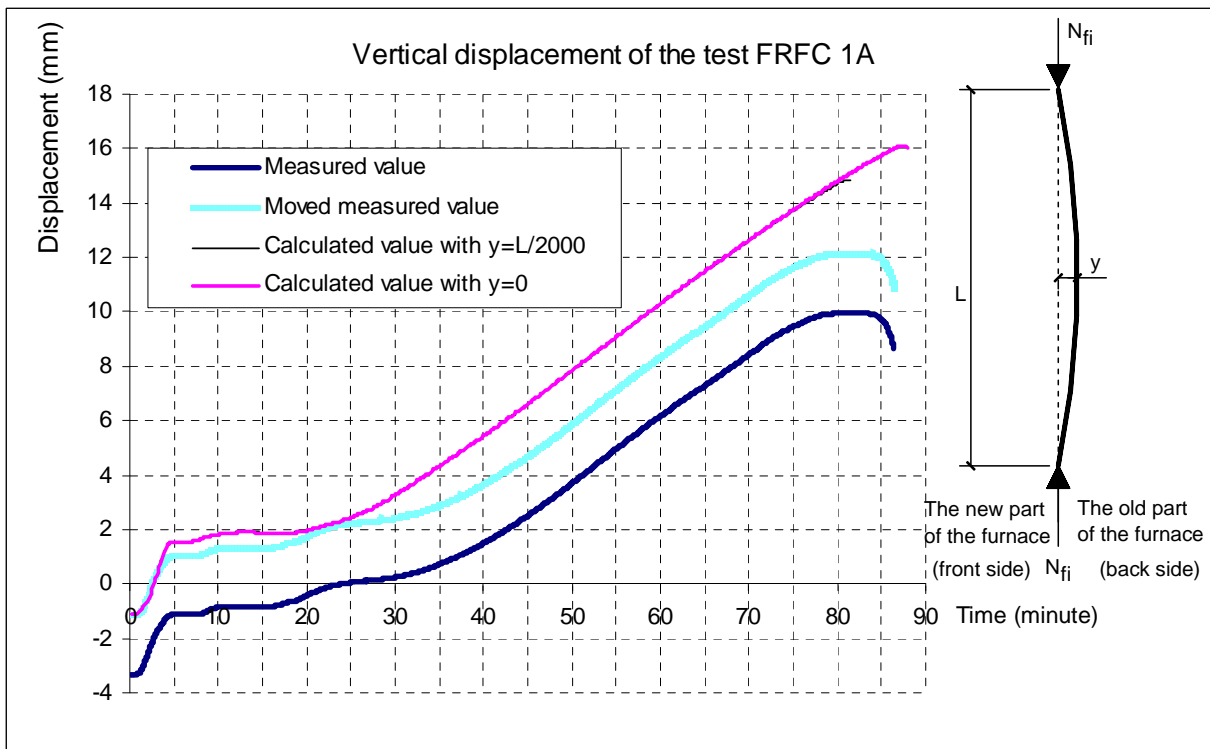


Figure A2.6. Vertical displacement of the test FRFC 1A

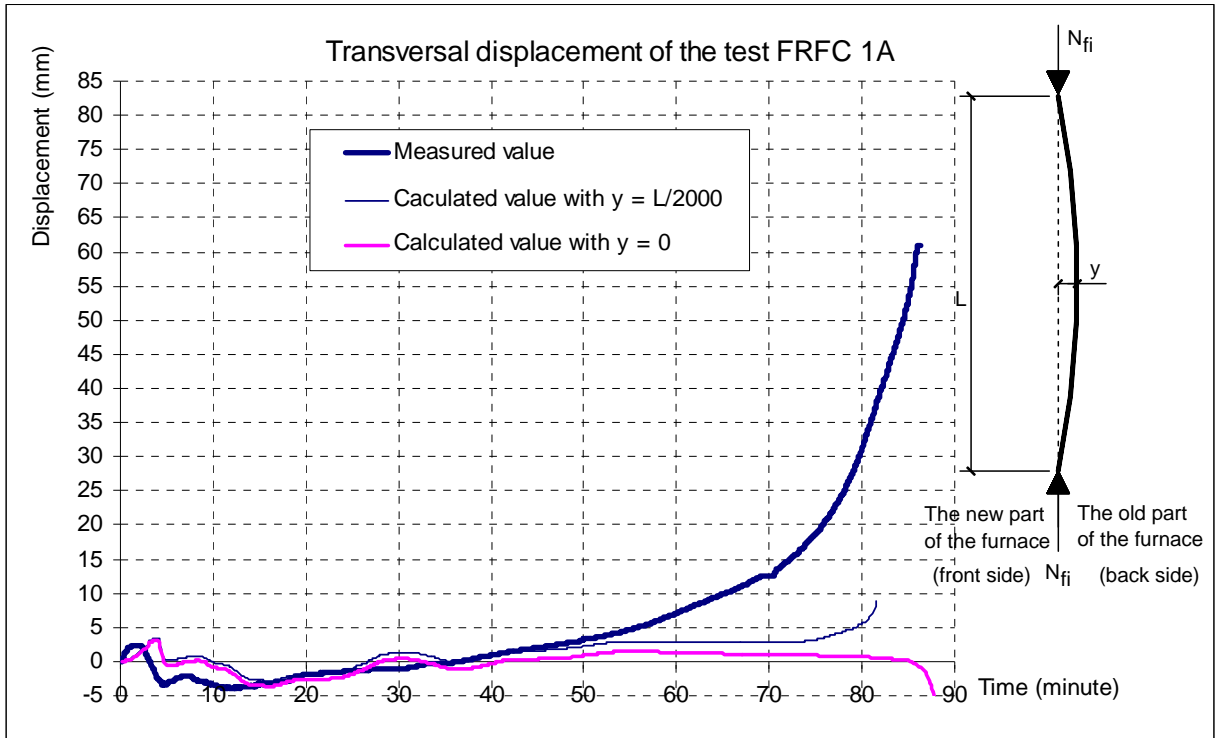


Figure A2.7. Transversal displacement at the middle height of the test FRFC 1A



Picture A2. 1 Column FRFC 1A after the test

## **A2.2 Test FRFC 1B**

*Profile 1* (Figure A2.1):

- External profile: Circular hollow section 219.1 x 5
- Internal profile: Circular hollow section 139.7 x 10
- Concrete cover thickness: ~ 35 mm

Location of thermocouples in the test FRFC 1B is shown in Figure A2.2

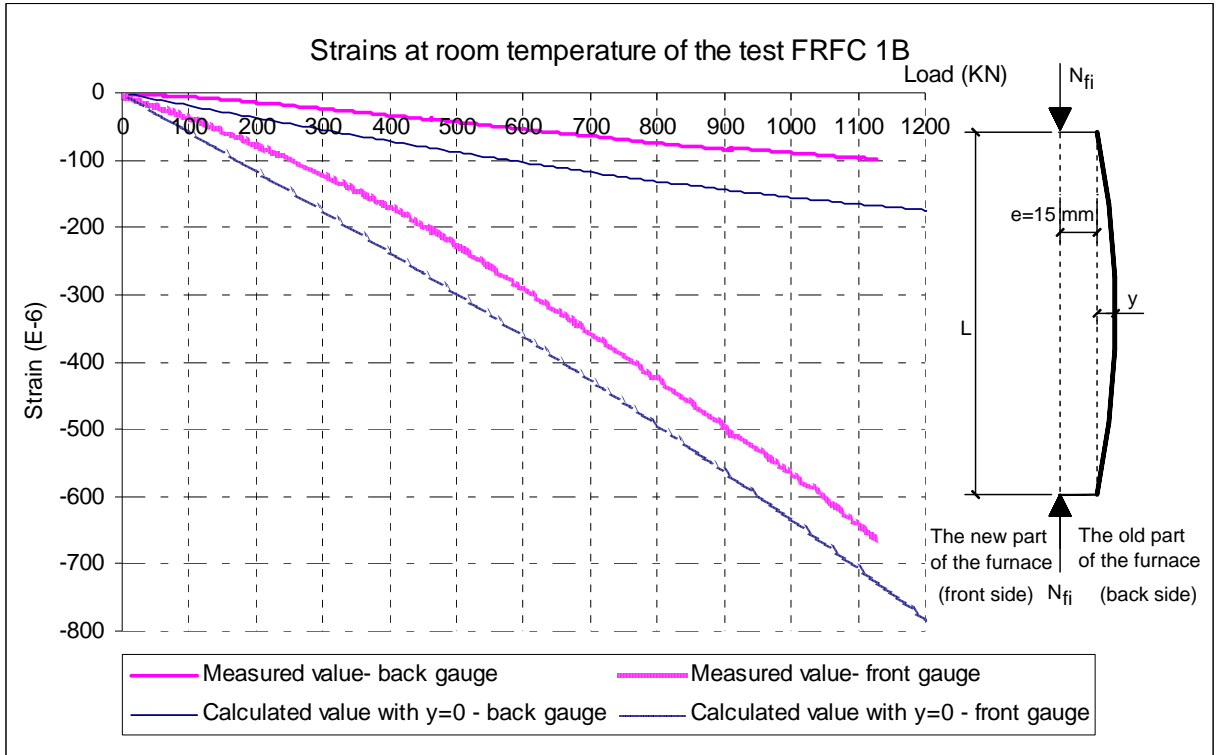


Figure A2.8. Strains at room temperature of the test FRFC 1B

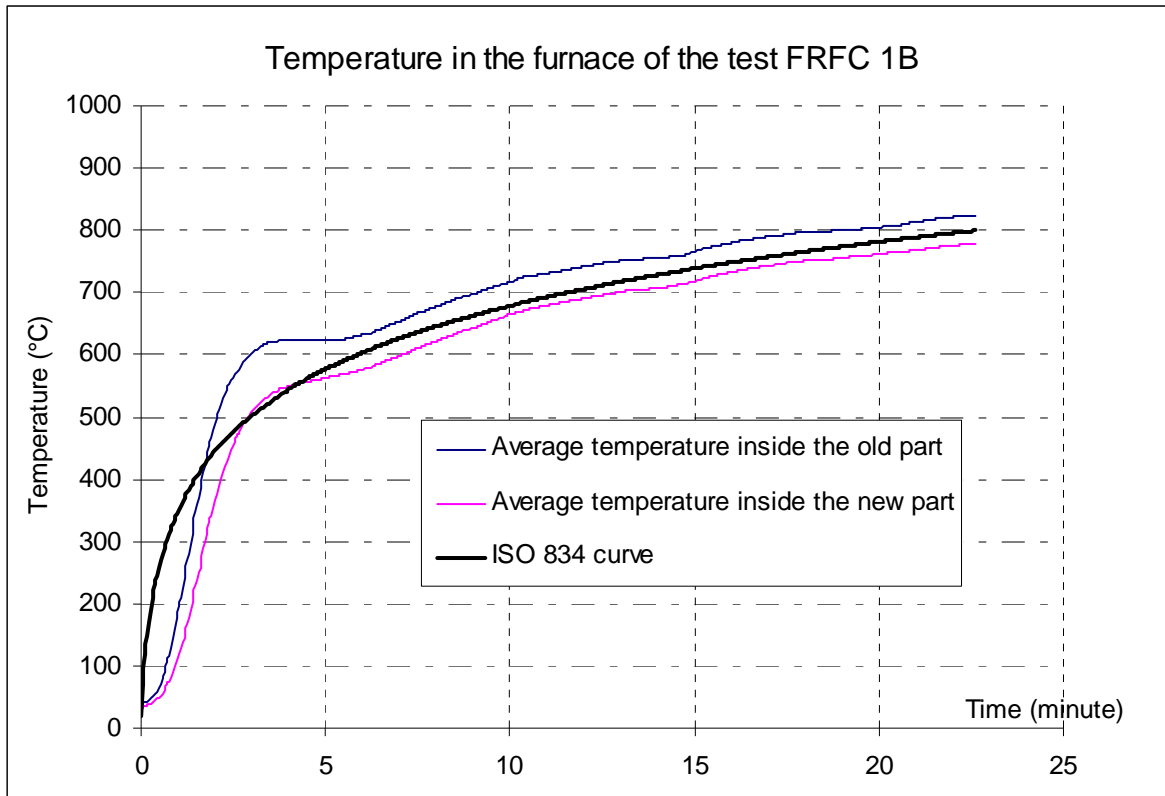


Figure A2.9. Temperatures in the furnace of the test FRFC 1B

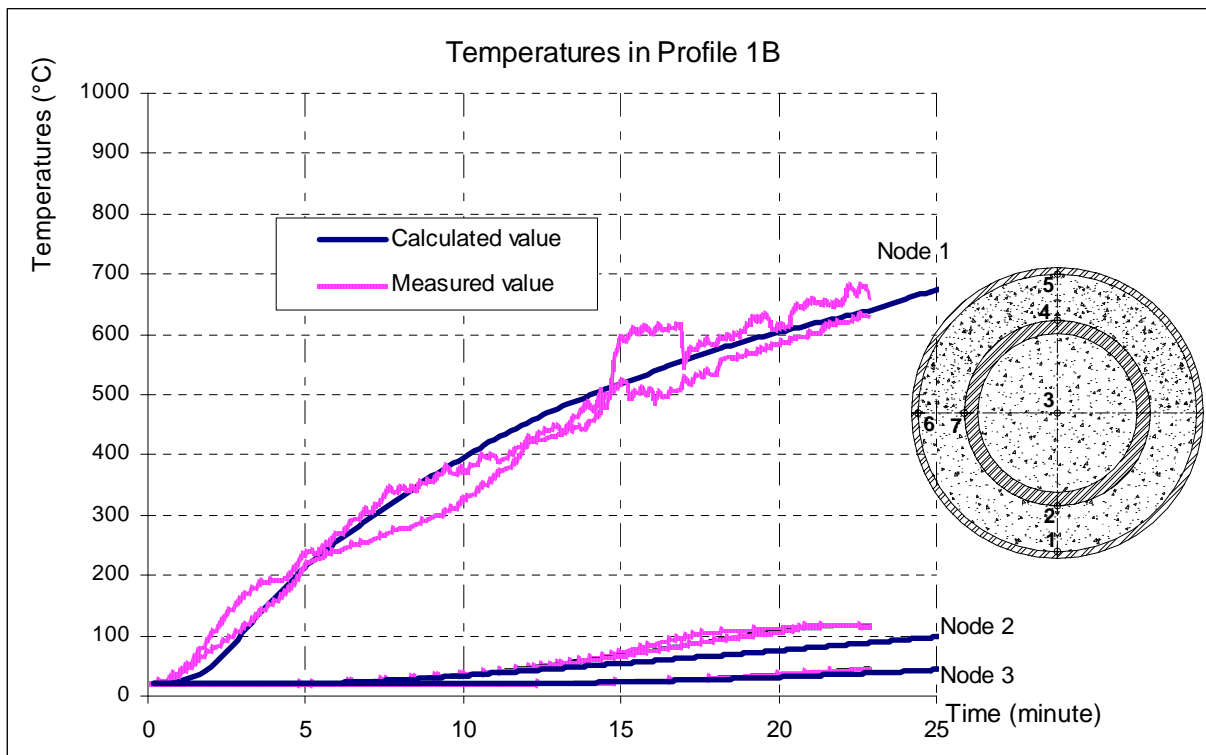


Figure A2.10. Temperatures in the section of the test FRFC 1B



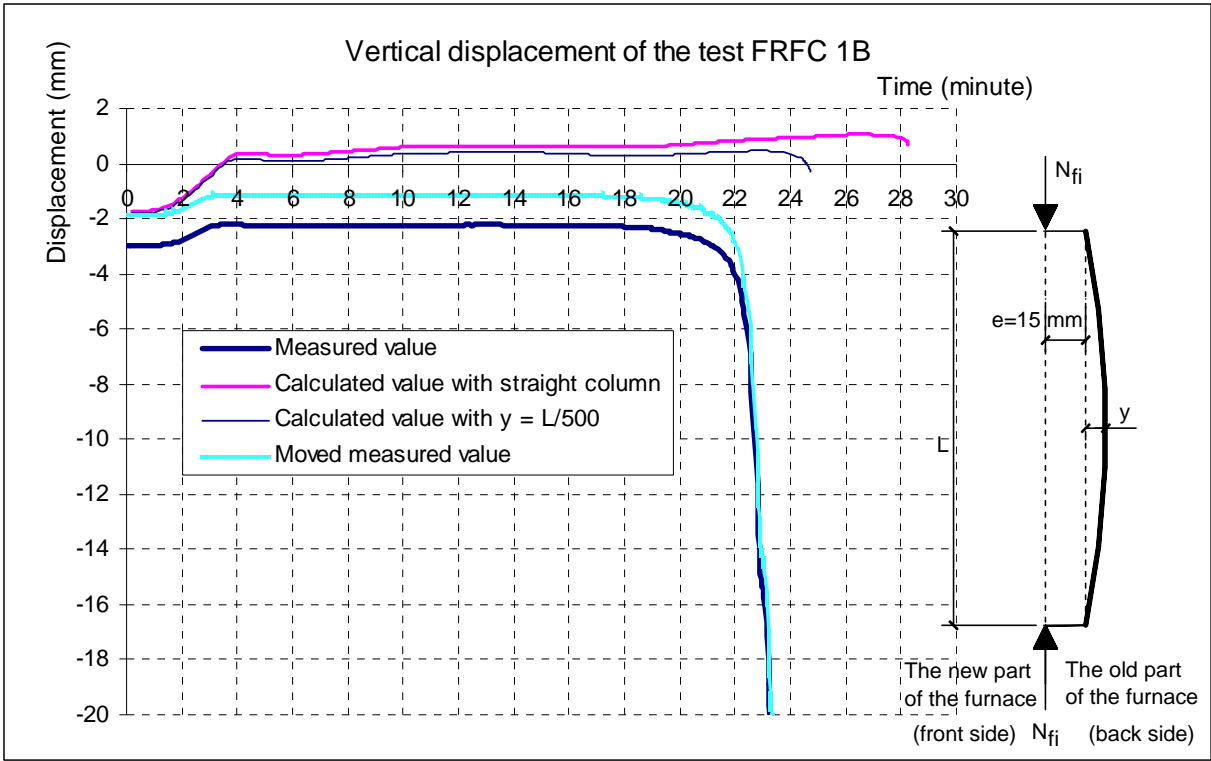


Figure A2.11. Vertical displacement of the test FRFC 1B

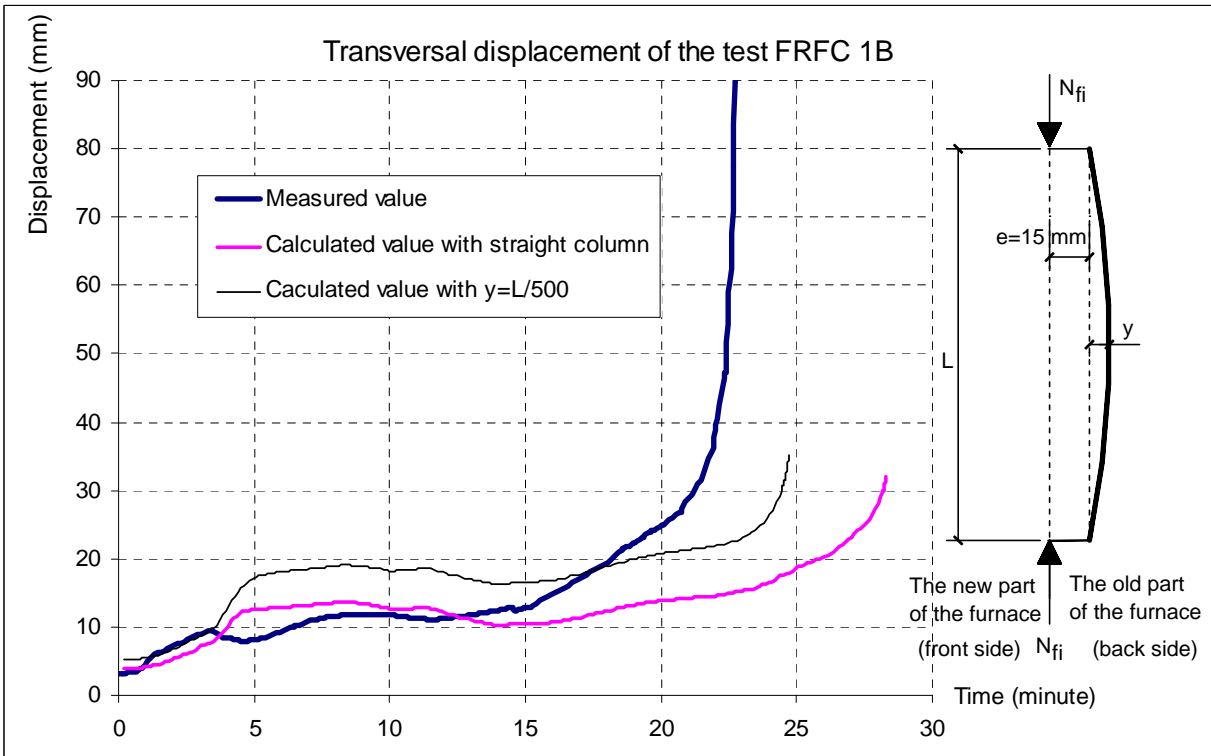


Figure A2.12. Transversal displacement at the middle height of the test FRFC 1B



Picture A2. 2. Column FRFC 1B after the test

### A2.3 Test FRFC 2A

Profile 2 (Figure A2.13): External profile: Circular hollow section 219.1 x 5  
Internal profile: Square hollow section 120 x 10

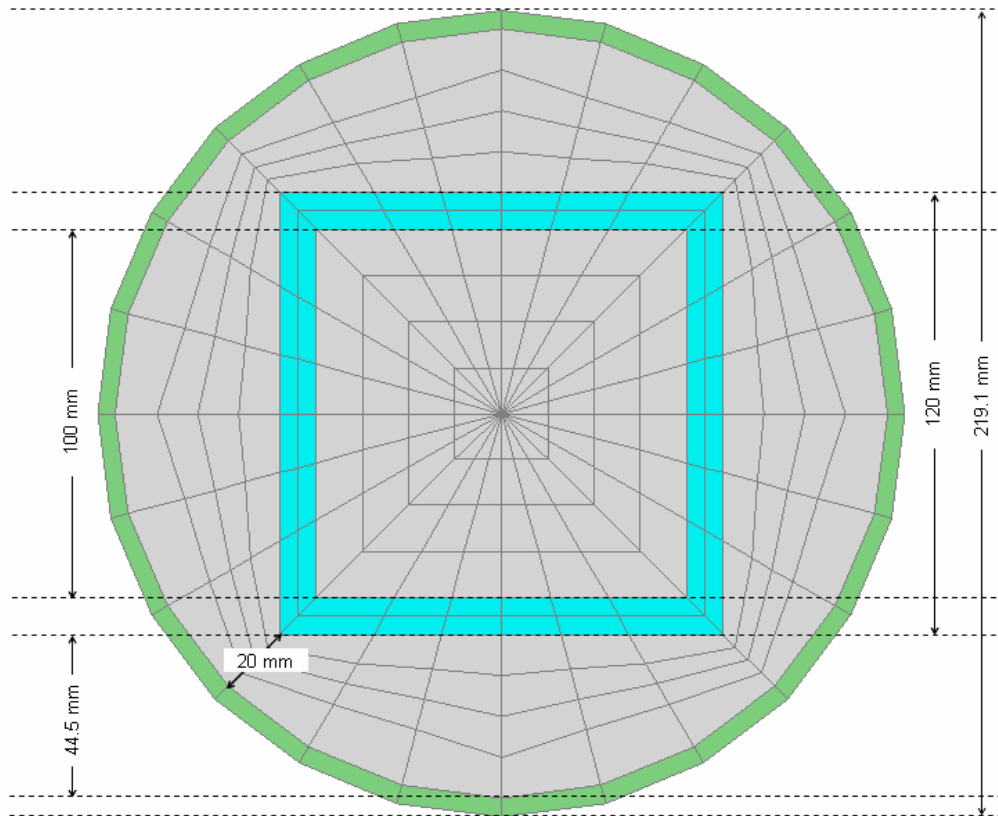


Figure A2.13. Cross-section of profile 2

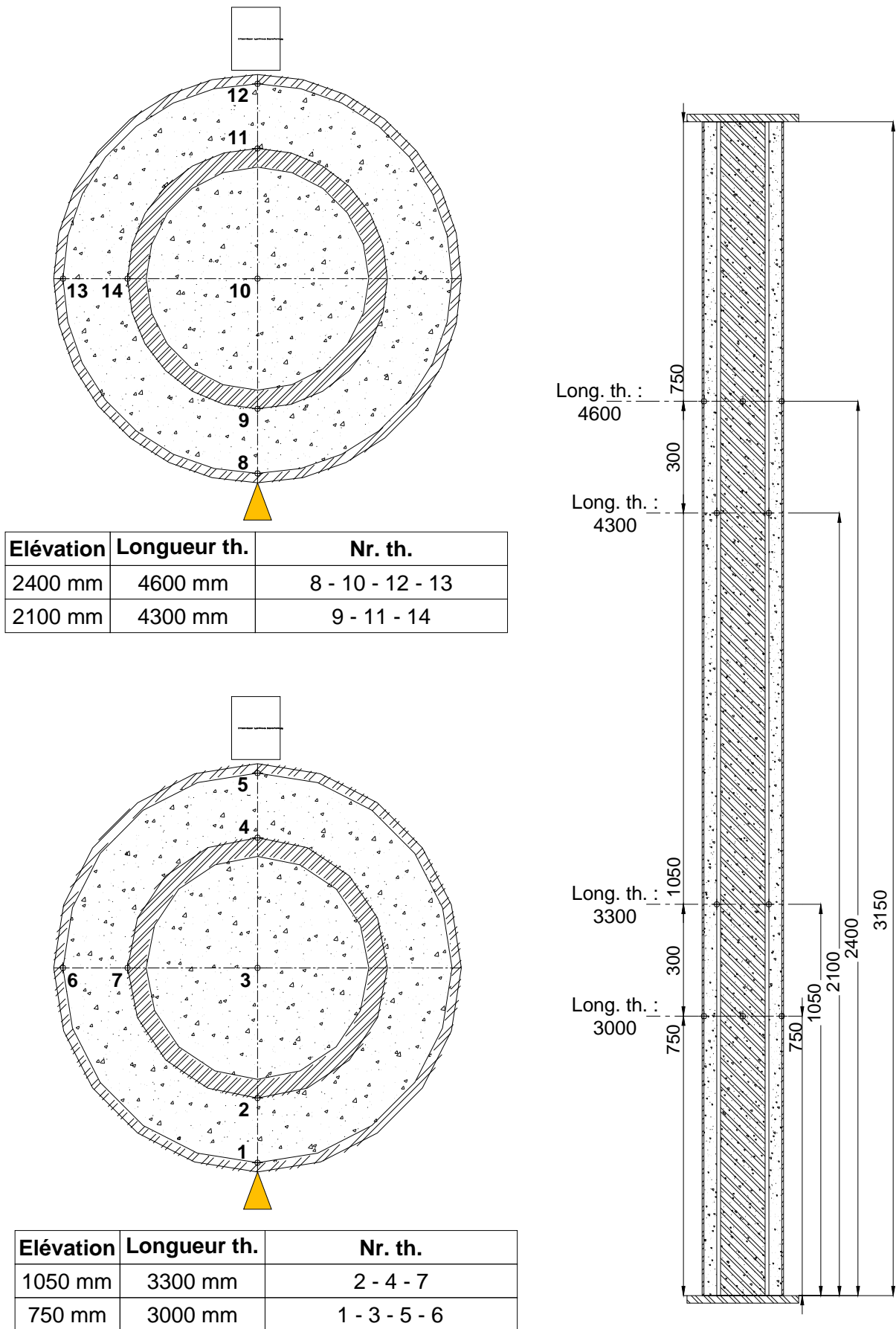


Figure A2.14. Location of thermocouples in the test FRFC 2A and 2B

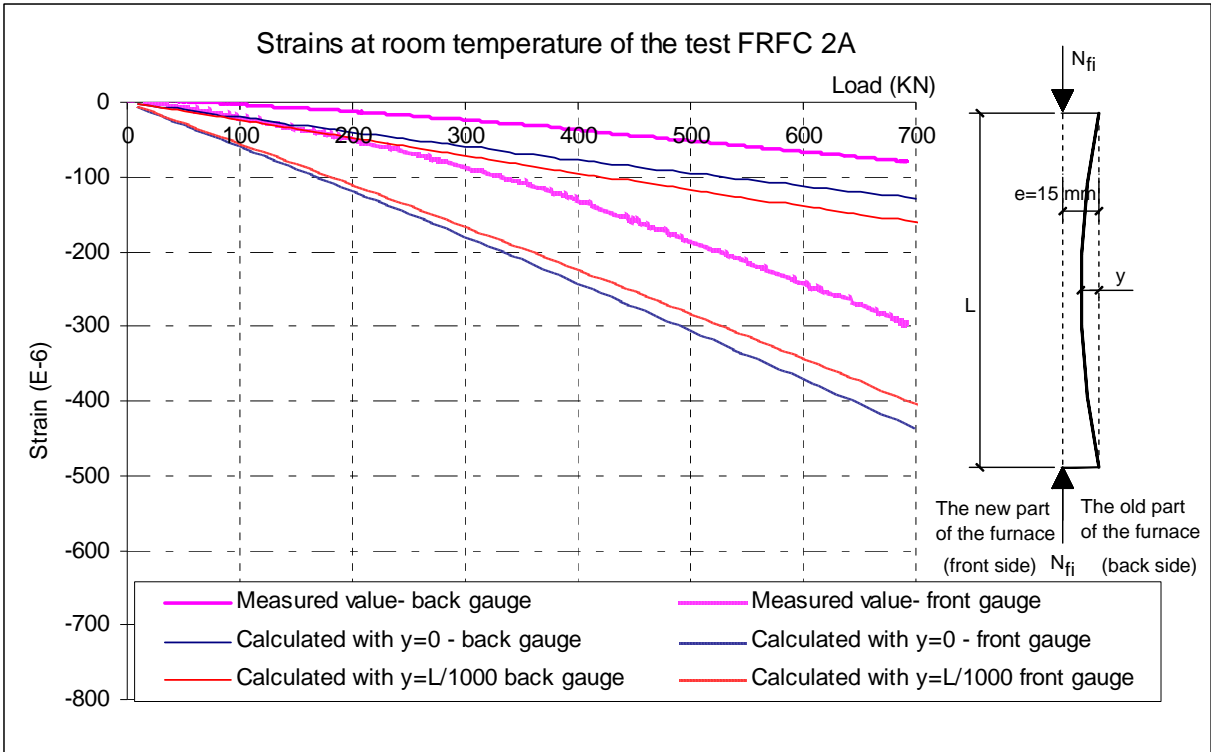


Figure A2.15. Strains at room temperature of the test FRFC 2A

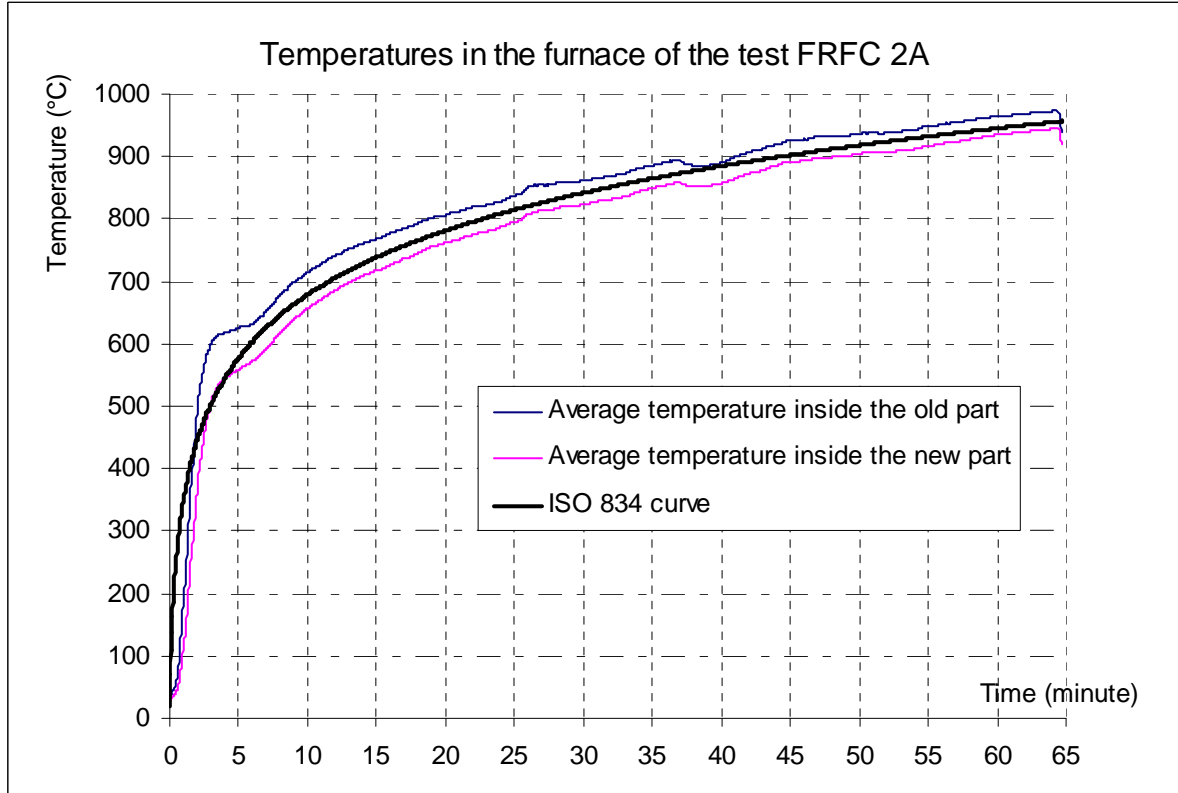


Figure A2.16. Temperatures in the furnace of the test FRFC 2A

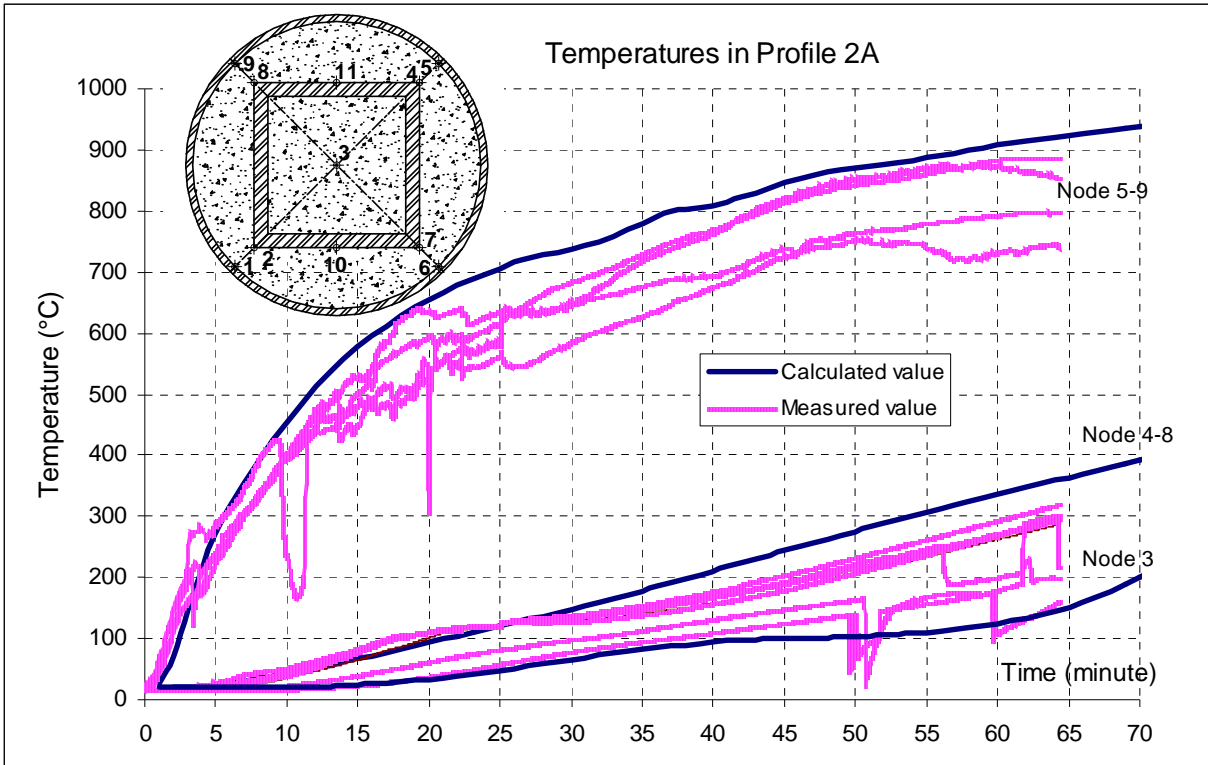


Figure A2.17. Temperatures in the section of the test FRFC 2A

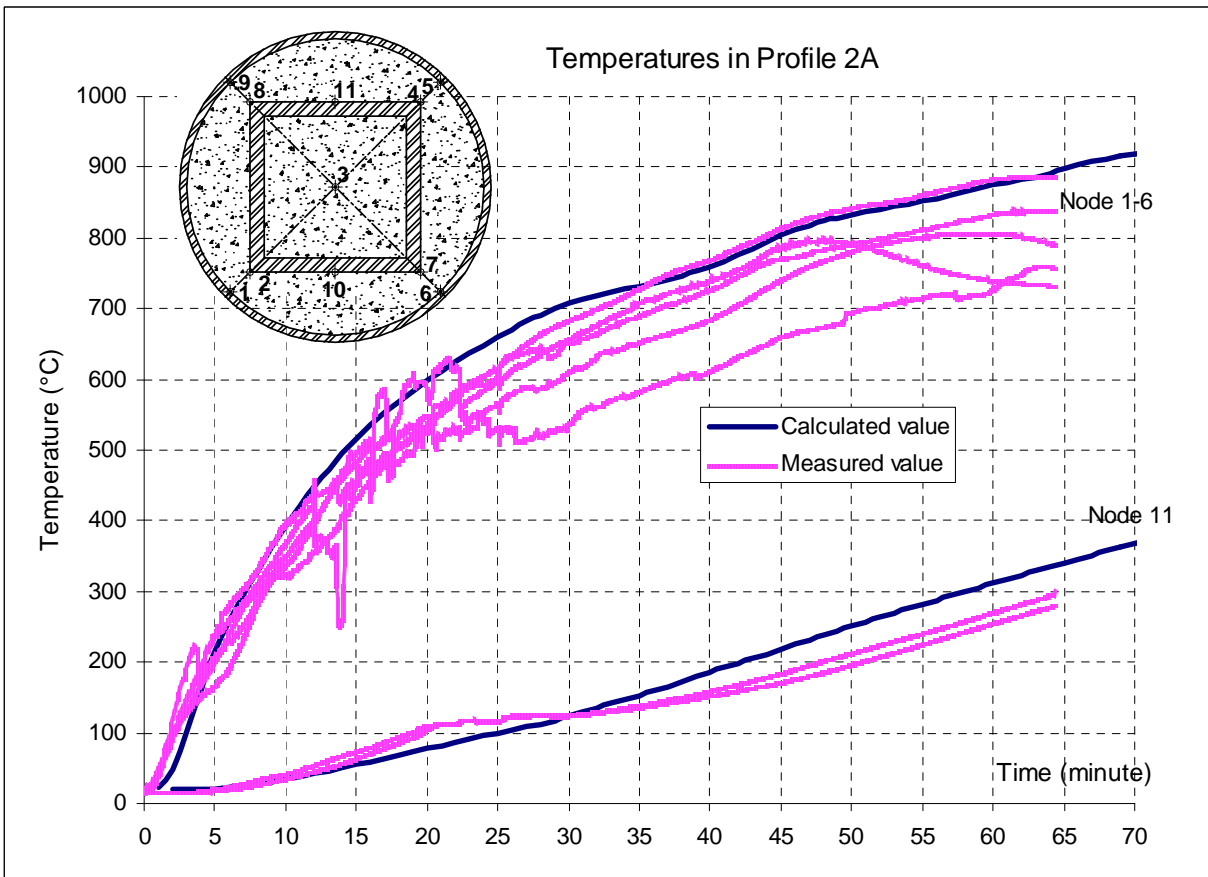


Figure A2.18. Temperatures in the section of the test FRFC 2A

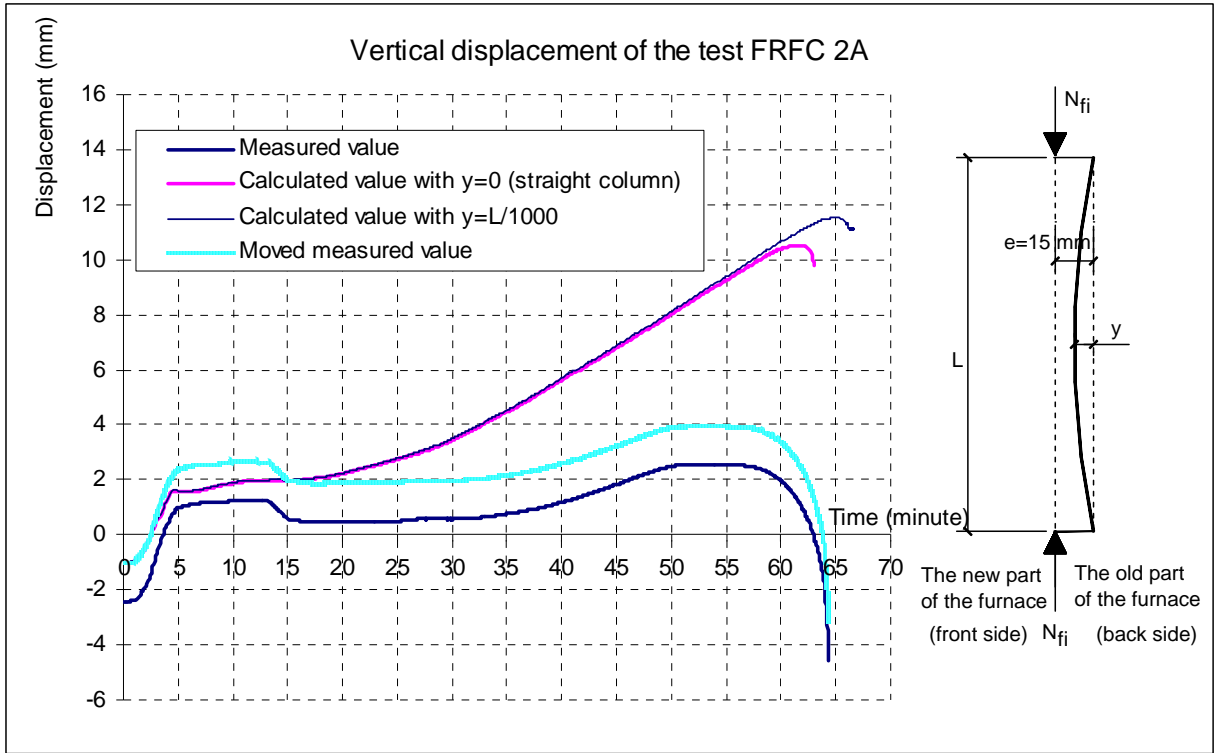


Figure A2.19. Vertical displacement of the test FRFC 2A

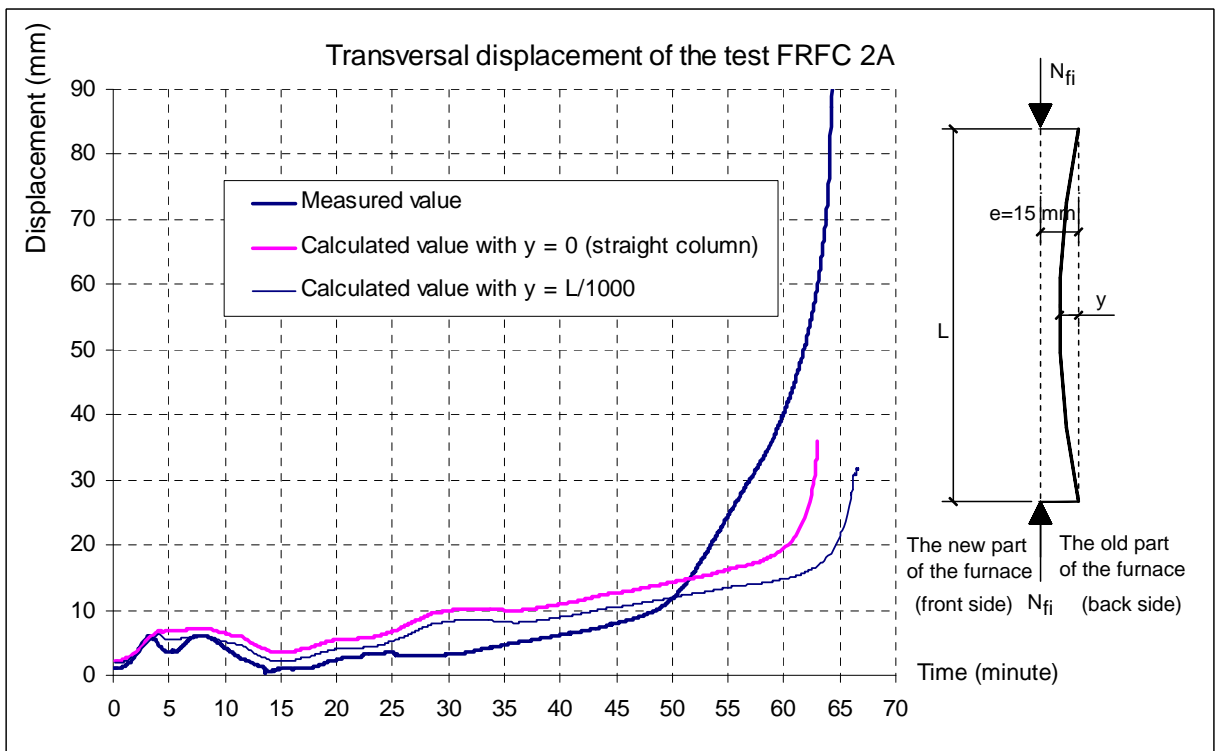


Figure A2.20. Transversal displacement at the middle height of the test FRFC 2A

## A2.4 Test FRFC 2B

Profile 2 (Figure A2.13):

External profile: Circular hollow section 219.1 x 5

Internal profile: Square hollow section 120 x 10

Concrete cover thickness: from 26 to 45 mm

Location of thermocouples in the test FRFC 2A is shown in Figure A2.14

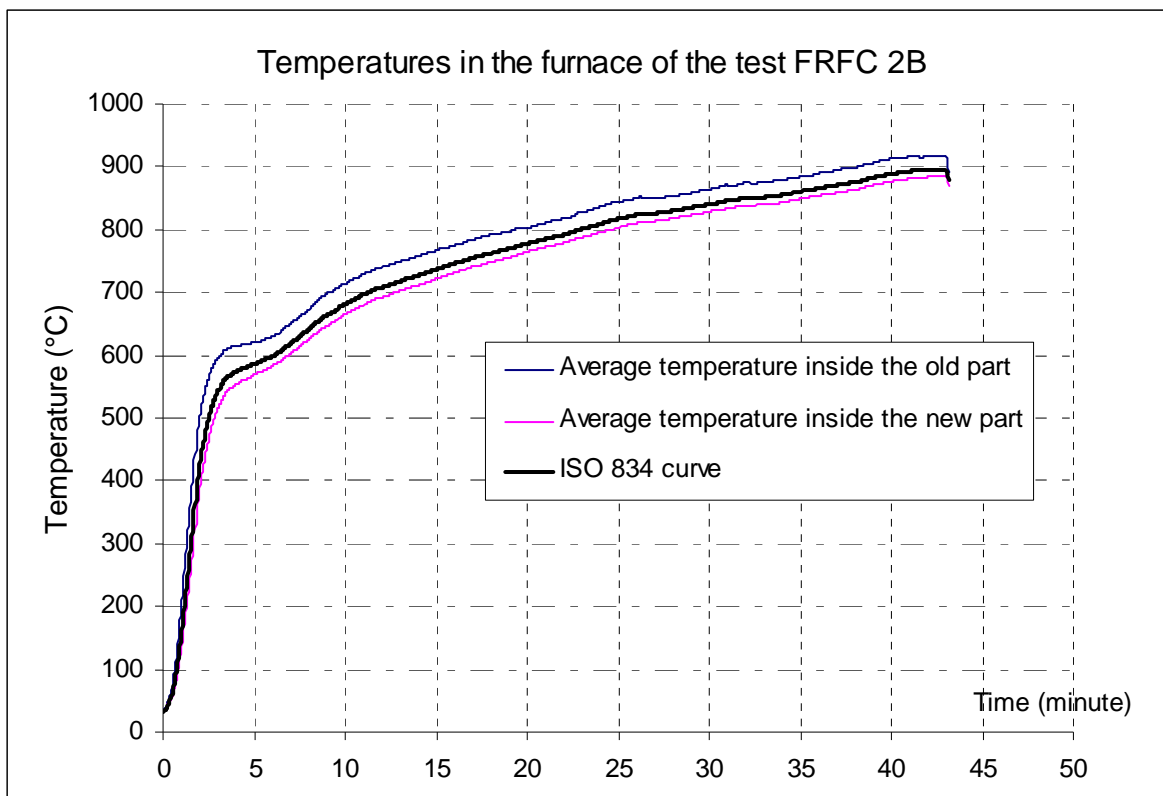


Figure A2.21. Temperatures in the furnace of the test FRFC 2B



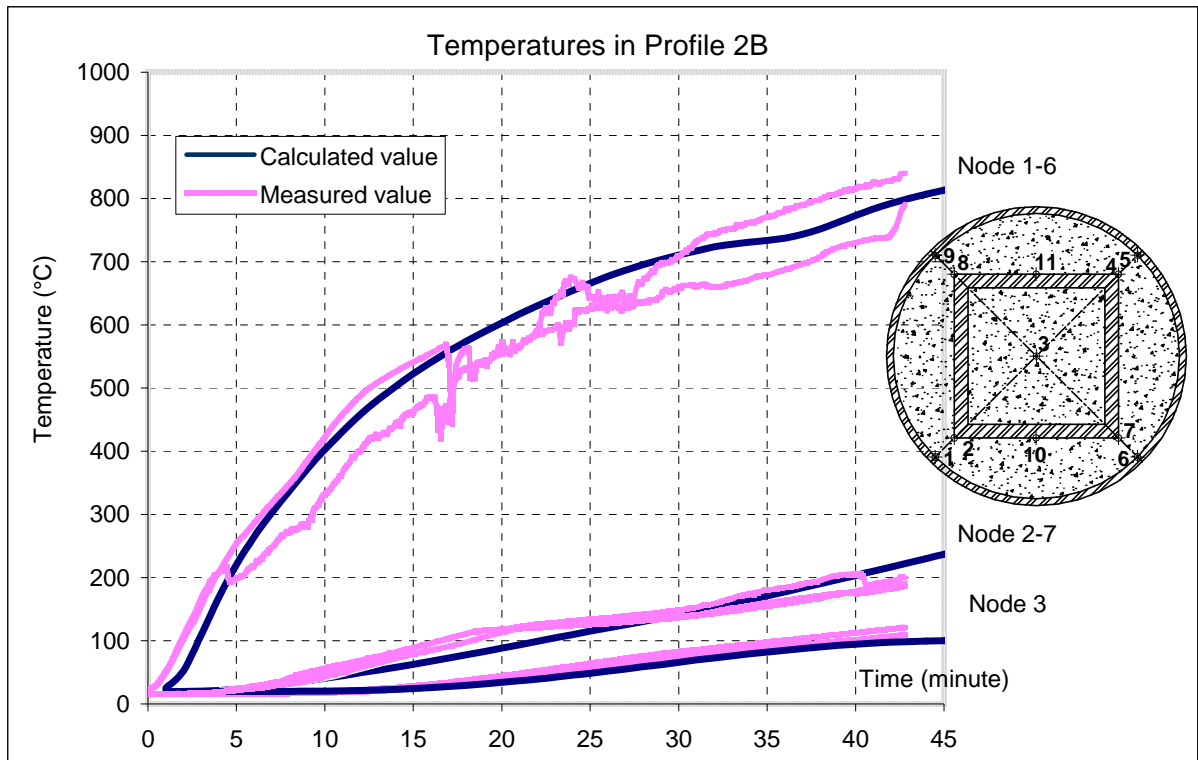


Figure A2.22. Temperatures in the section of the test FRFC 2B

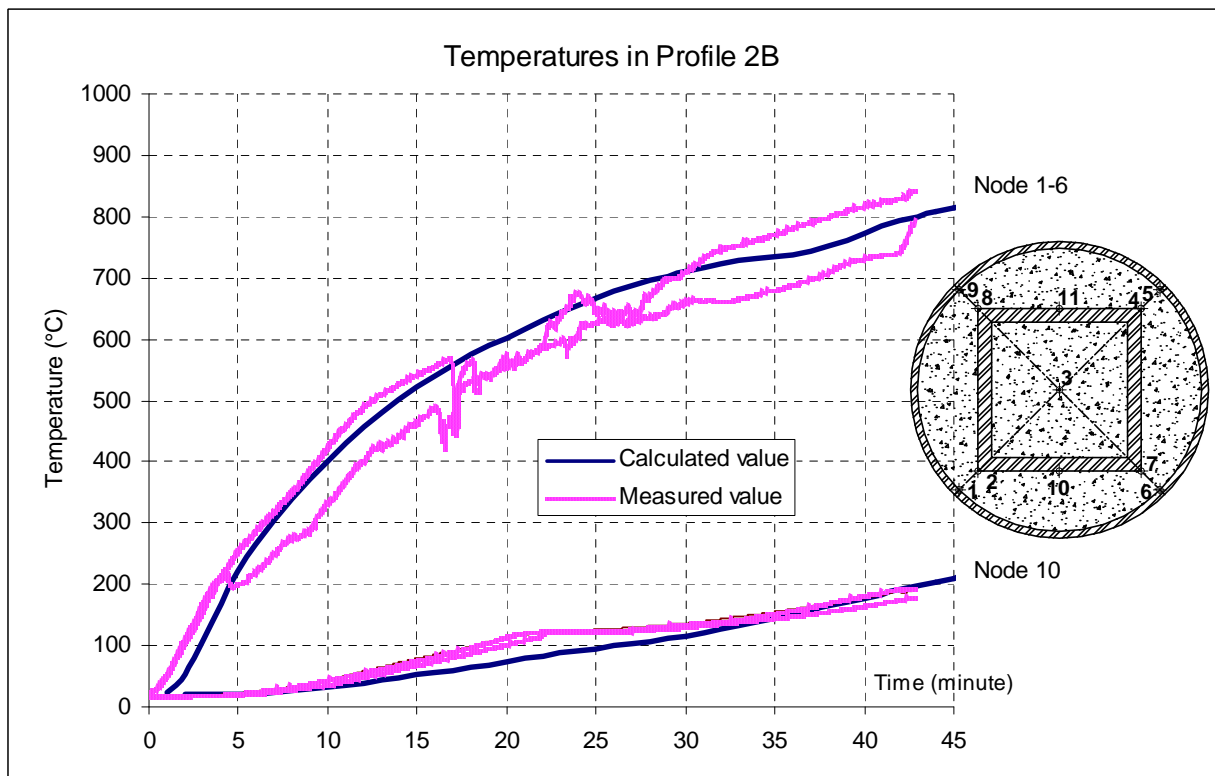


Figure A2.23. Temperatures in the section of the test FRFC 2B

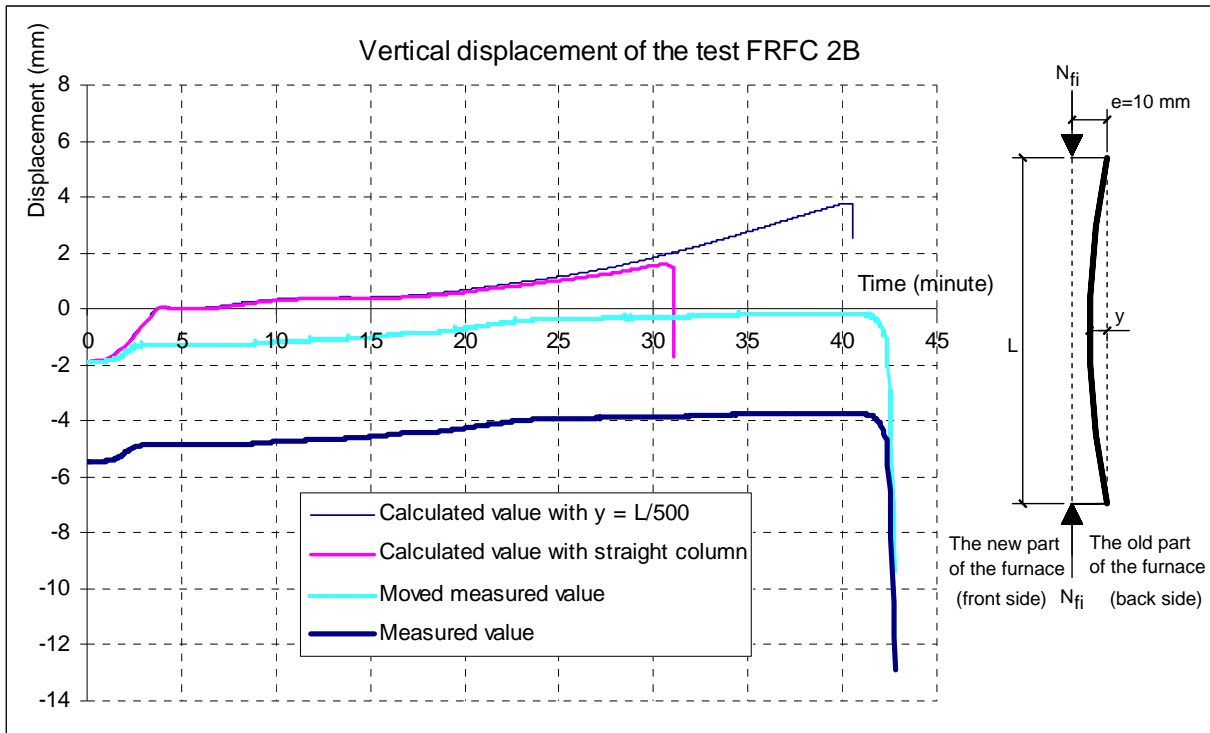


Figure A2.24. Vertical displacement of the test FRFC 2B

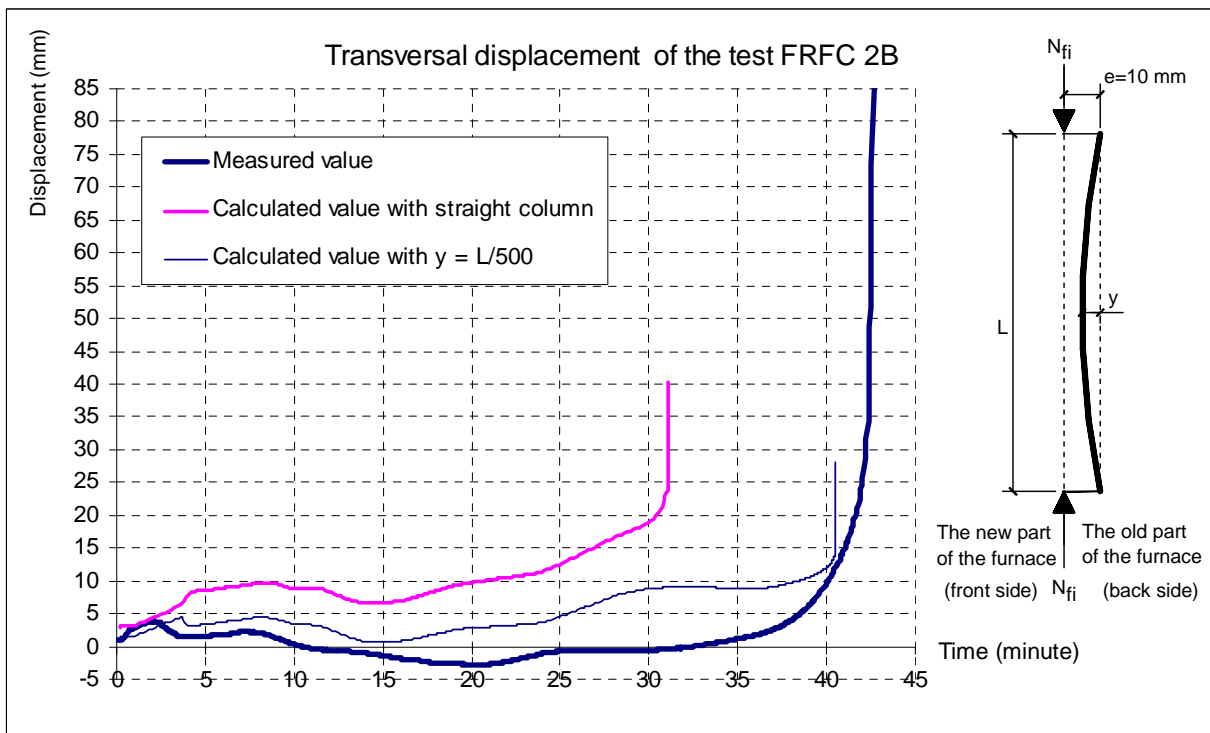


Figure A2.25. Transversal displacement at the middle height of the test FRFC 2B

## A2.5 Test FRFC 3A

Profile 3 (Figure A2.26):

External profile: Circular hollow section 219.1 x 5

Internal profile: H profile HEB120

Location of thermocouples in the test FRFC 3A is shown in Figure A2.27

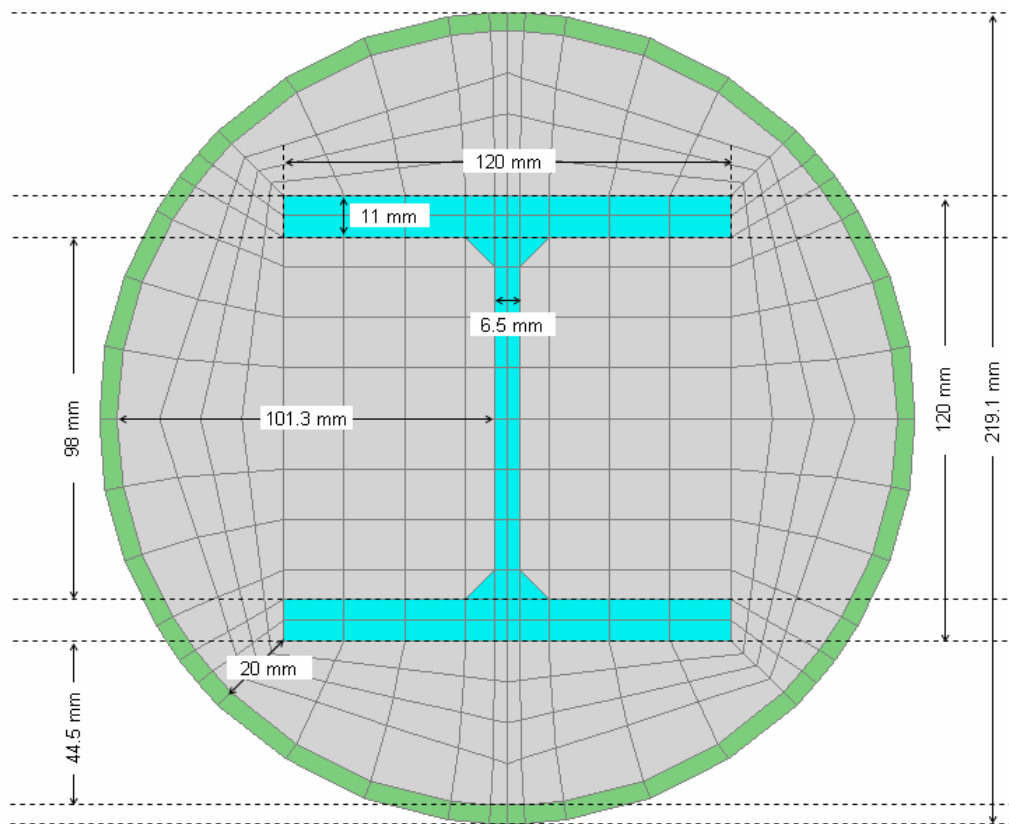


Figure A2.26. Cross-section of profile 3A

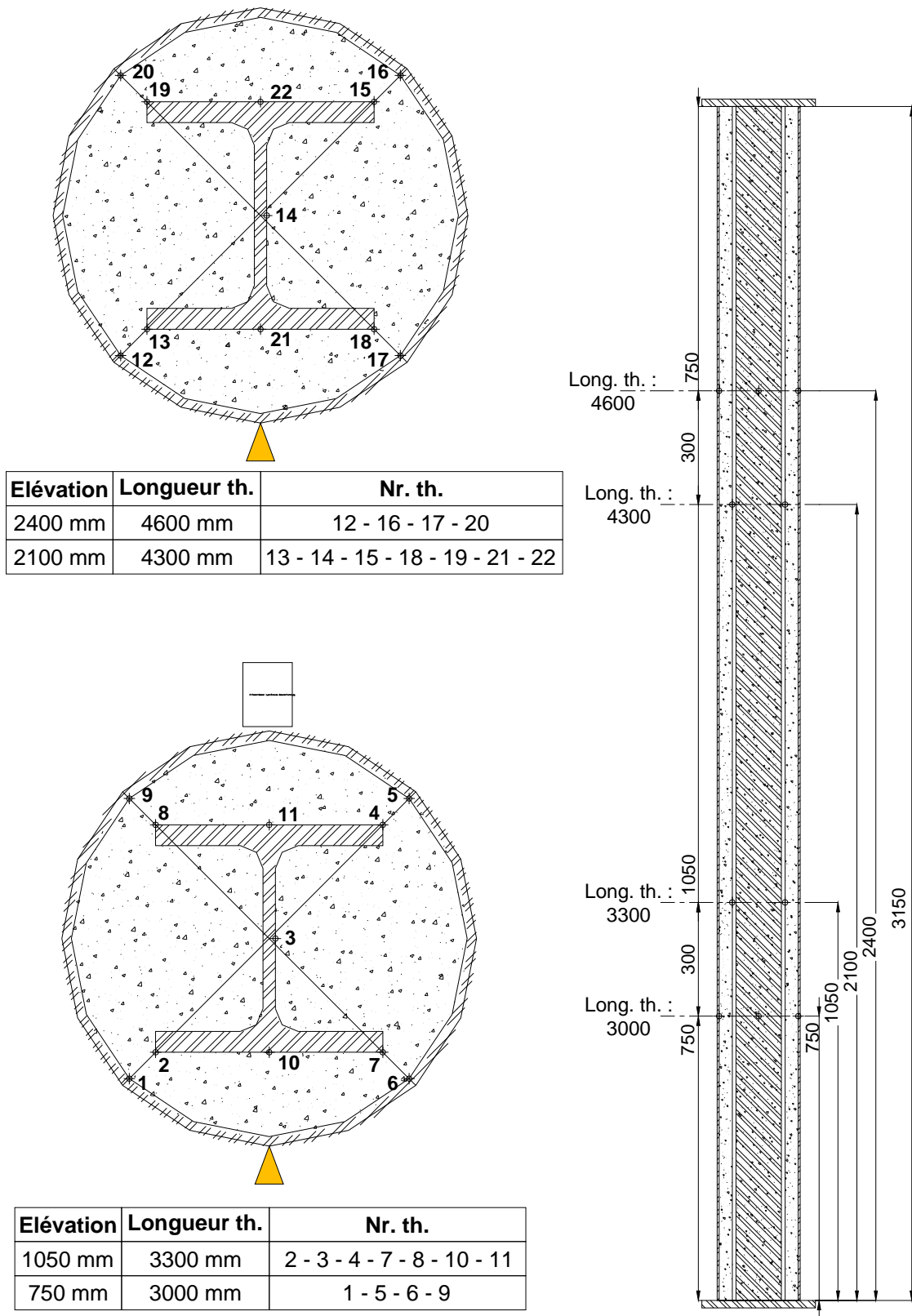


Figure A2.27. Location of thermocouples in the test FRFC 3A

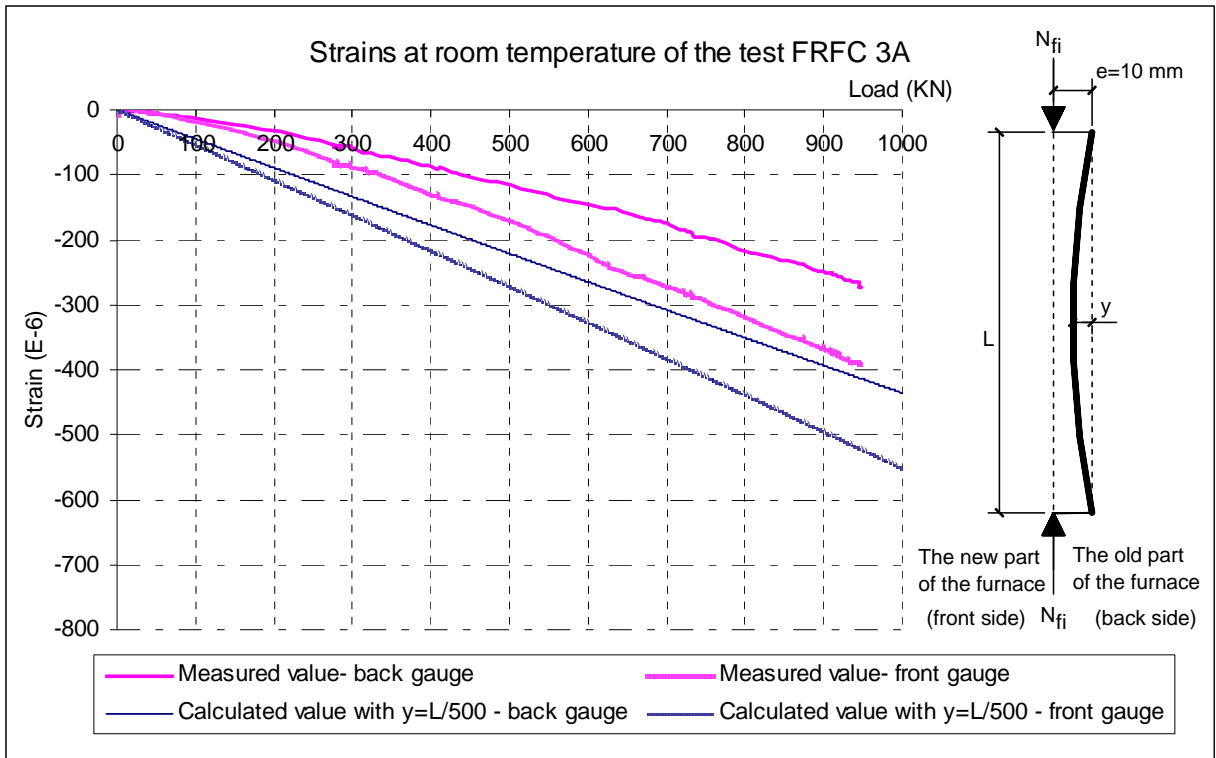


Figure A2.28. Strains at room temperature of the test FRFC 3A

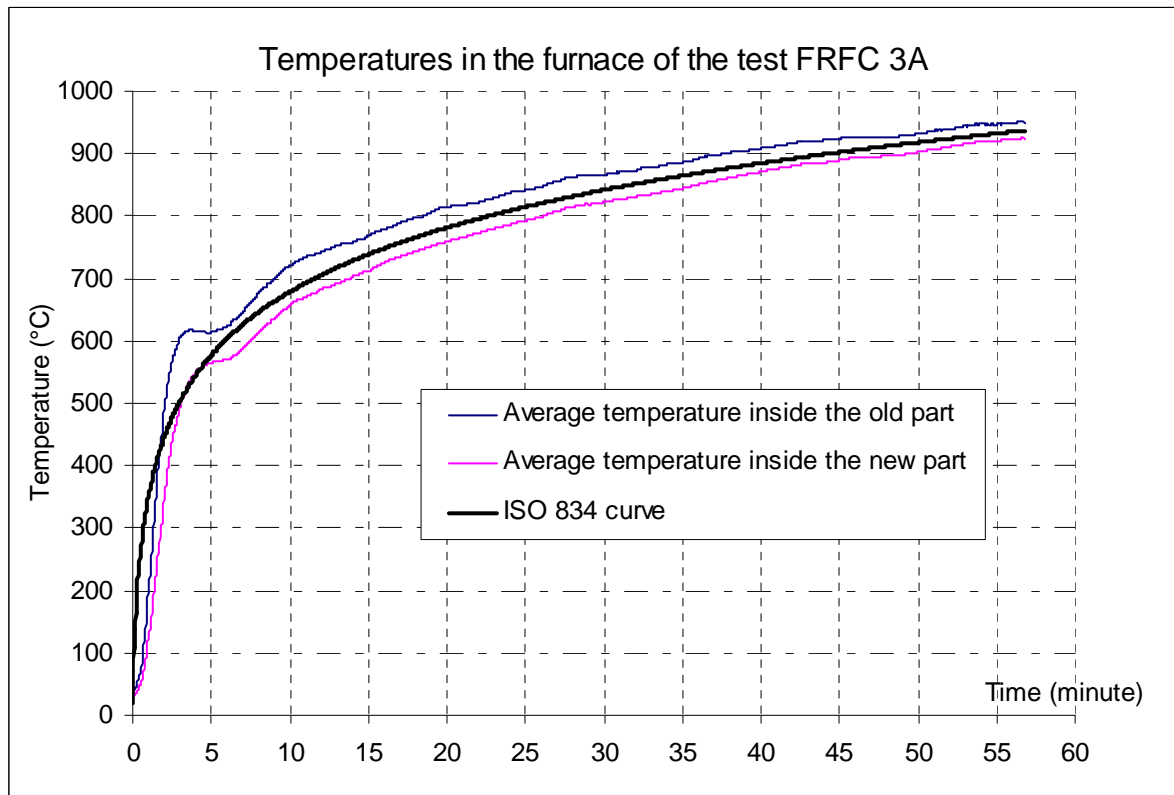


Figure A2.29. Temperatures in the furnace of the test FRFC 3A

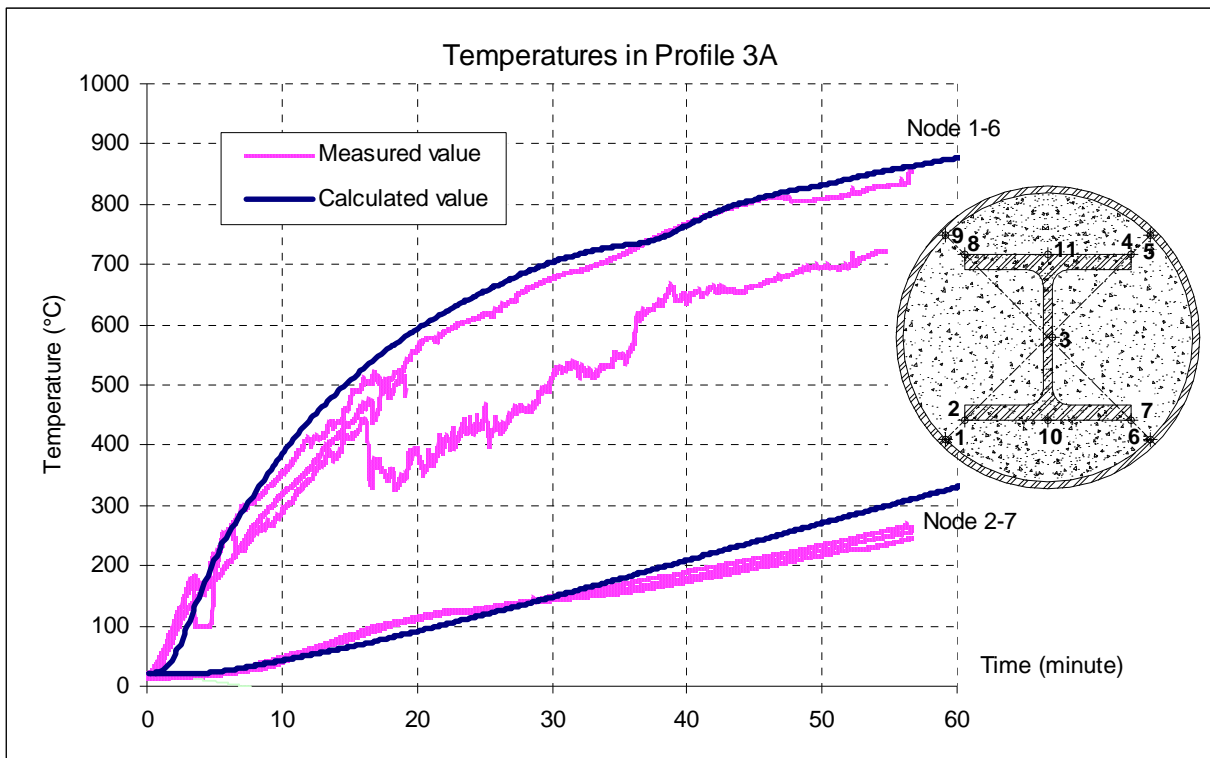


Figure A2.30. Temperatures in the section of the test FRFC 3A

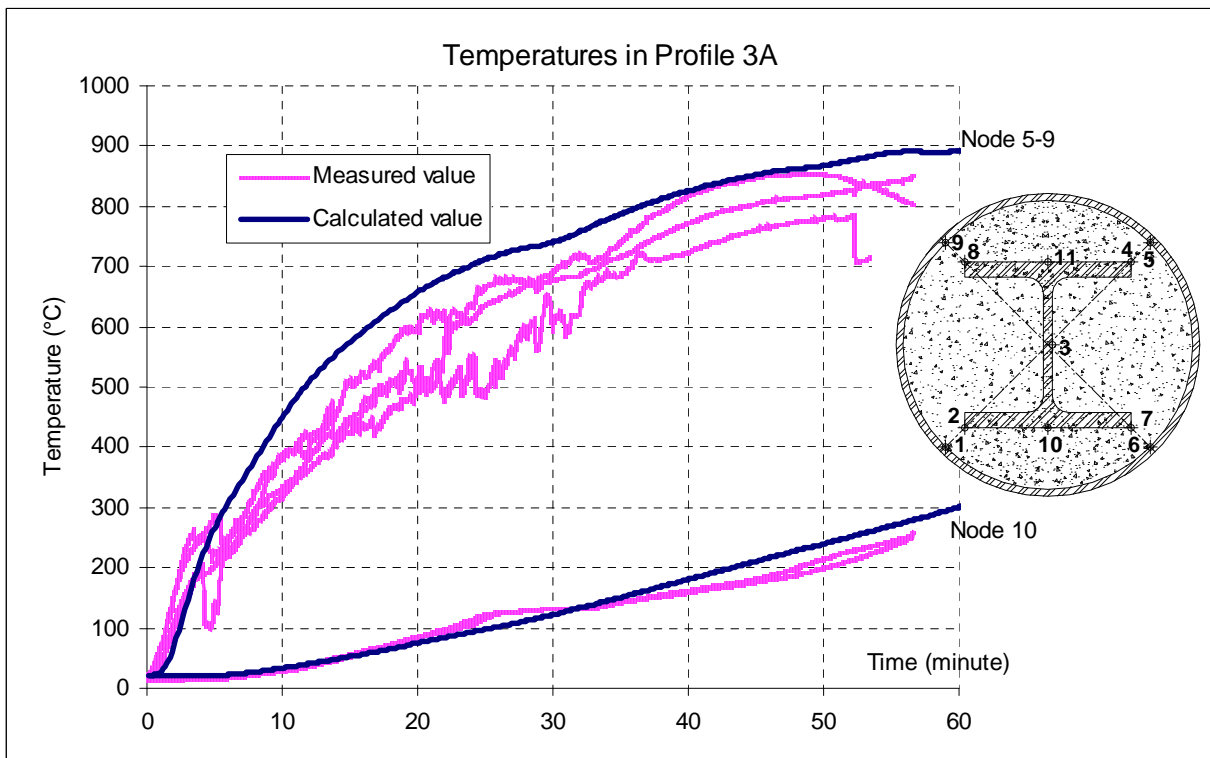


Figure A2.31. Temperatures in the section of the test FRFC 3A

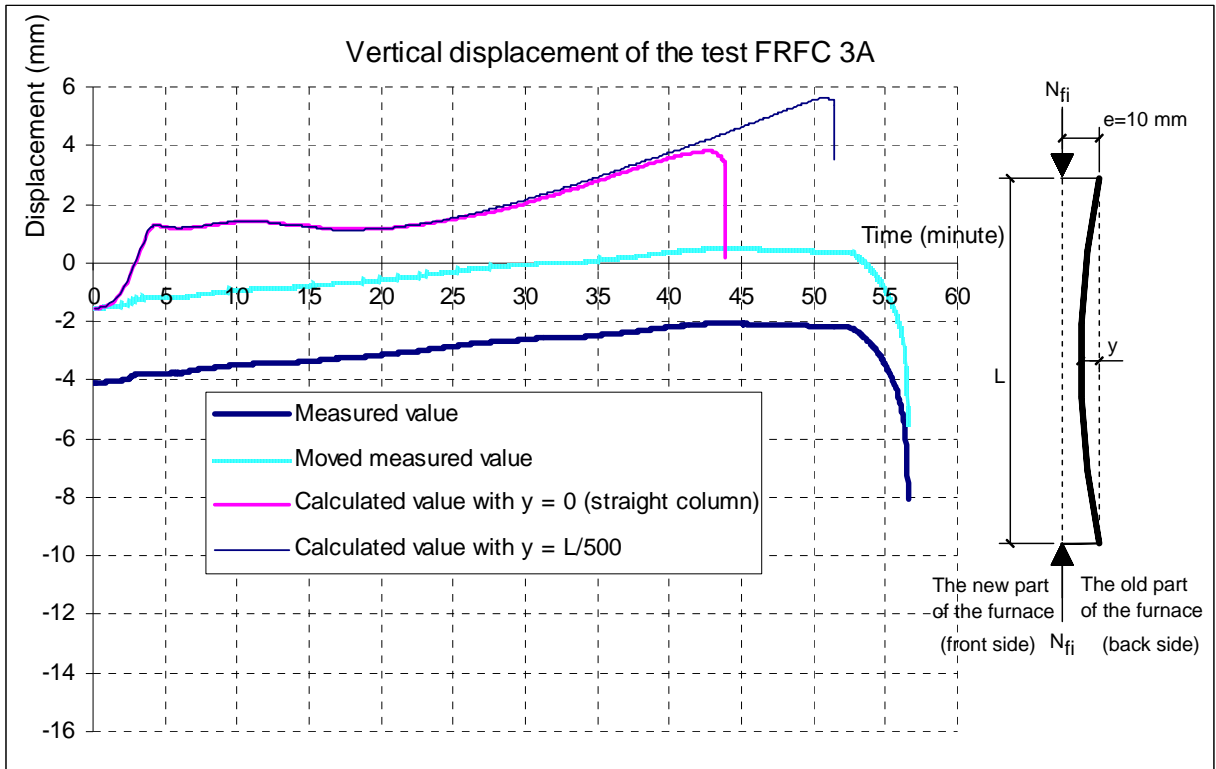


Figure A2.32. Vertical displacement of the test FRFC 3A

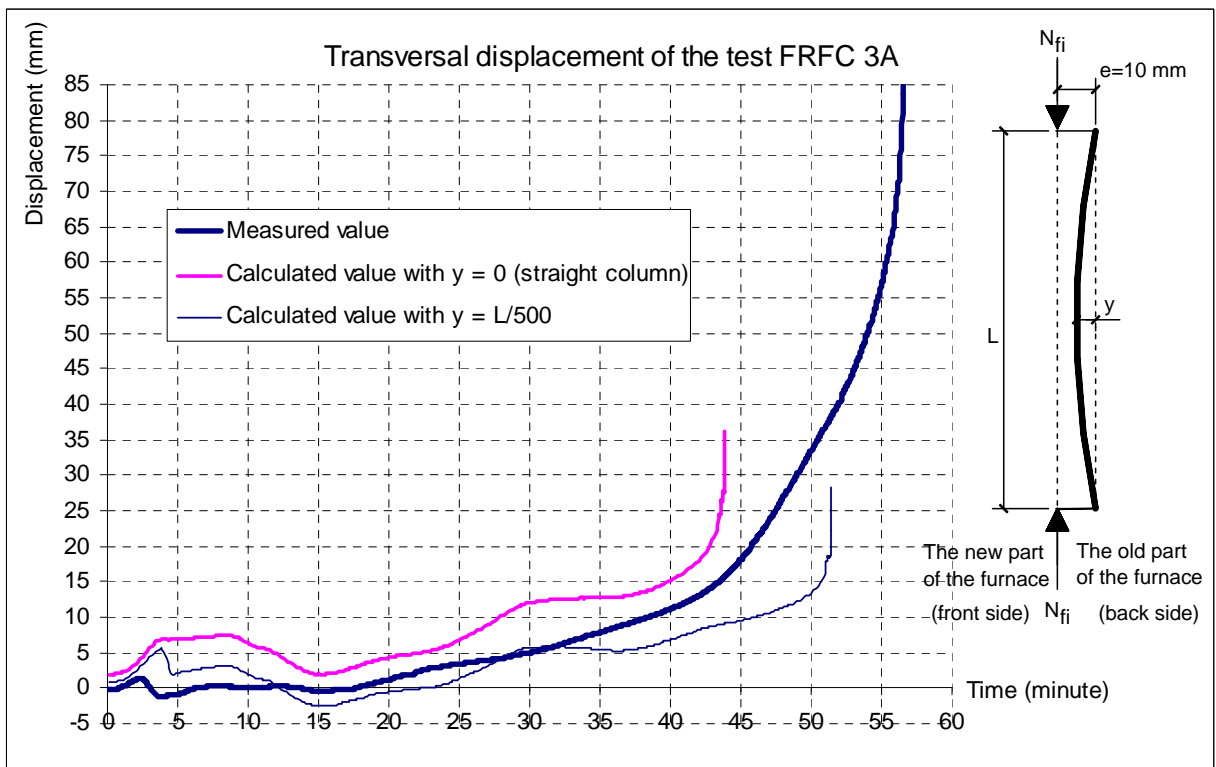


Figure A2.33. Transversal displacement at the middle height of the test FRFC 3A

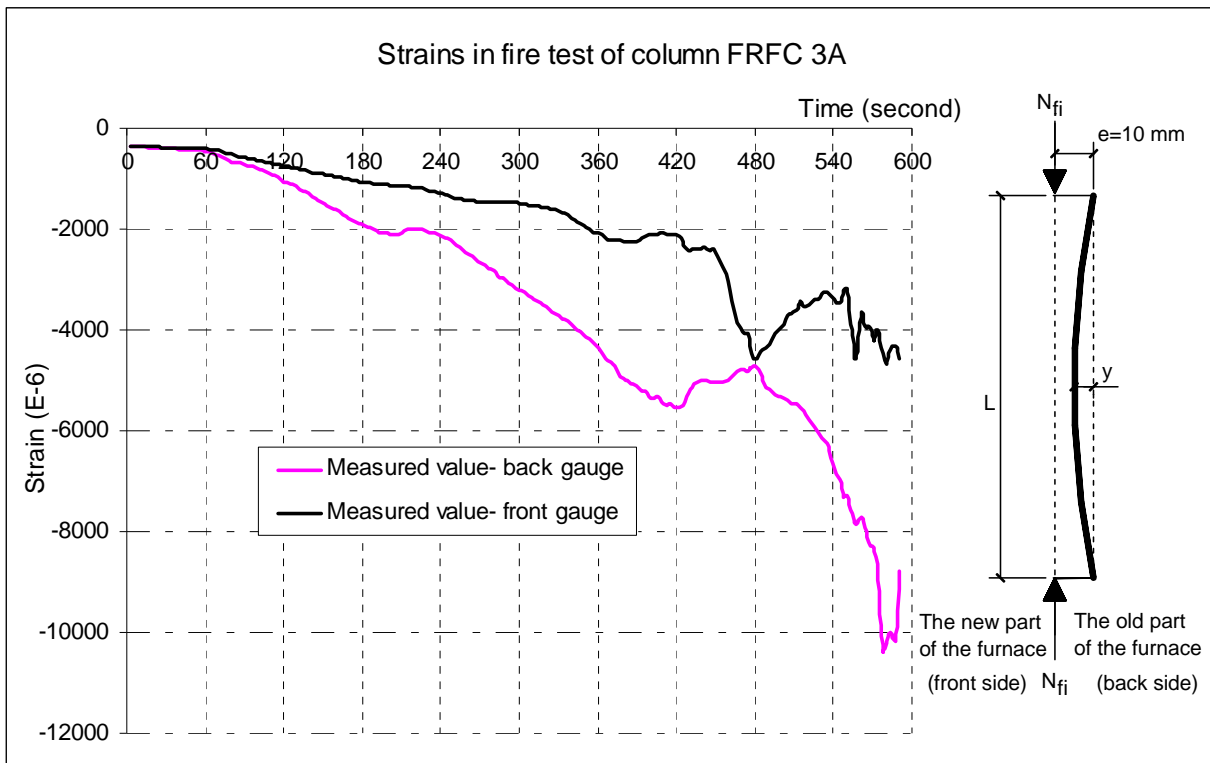


Figure A2.34. Strains in fire test of column FRFC 3A



## A2.6 Test FRFC 3B

Profile 3 (Figure A2.35):

External profile: Circular hollow section 219.1 x 5

Internal profile: H profile HEB120

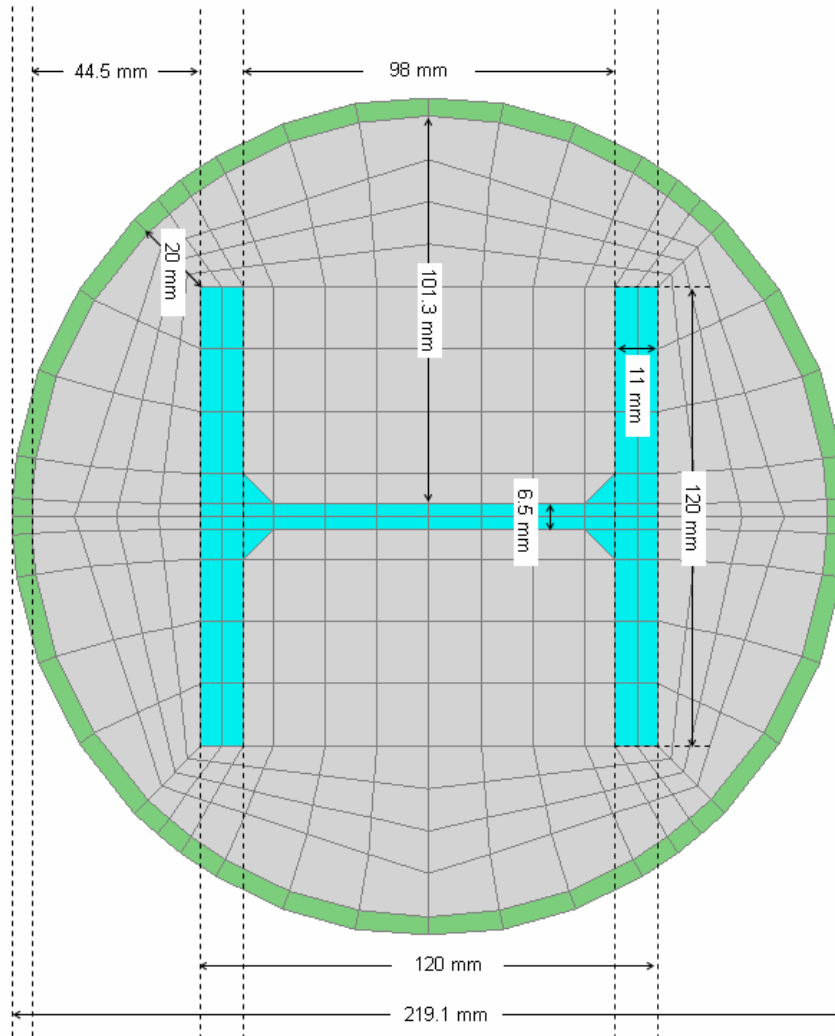


Figure A2.35. Cross-section of profile 3B

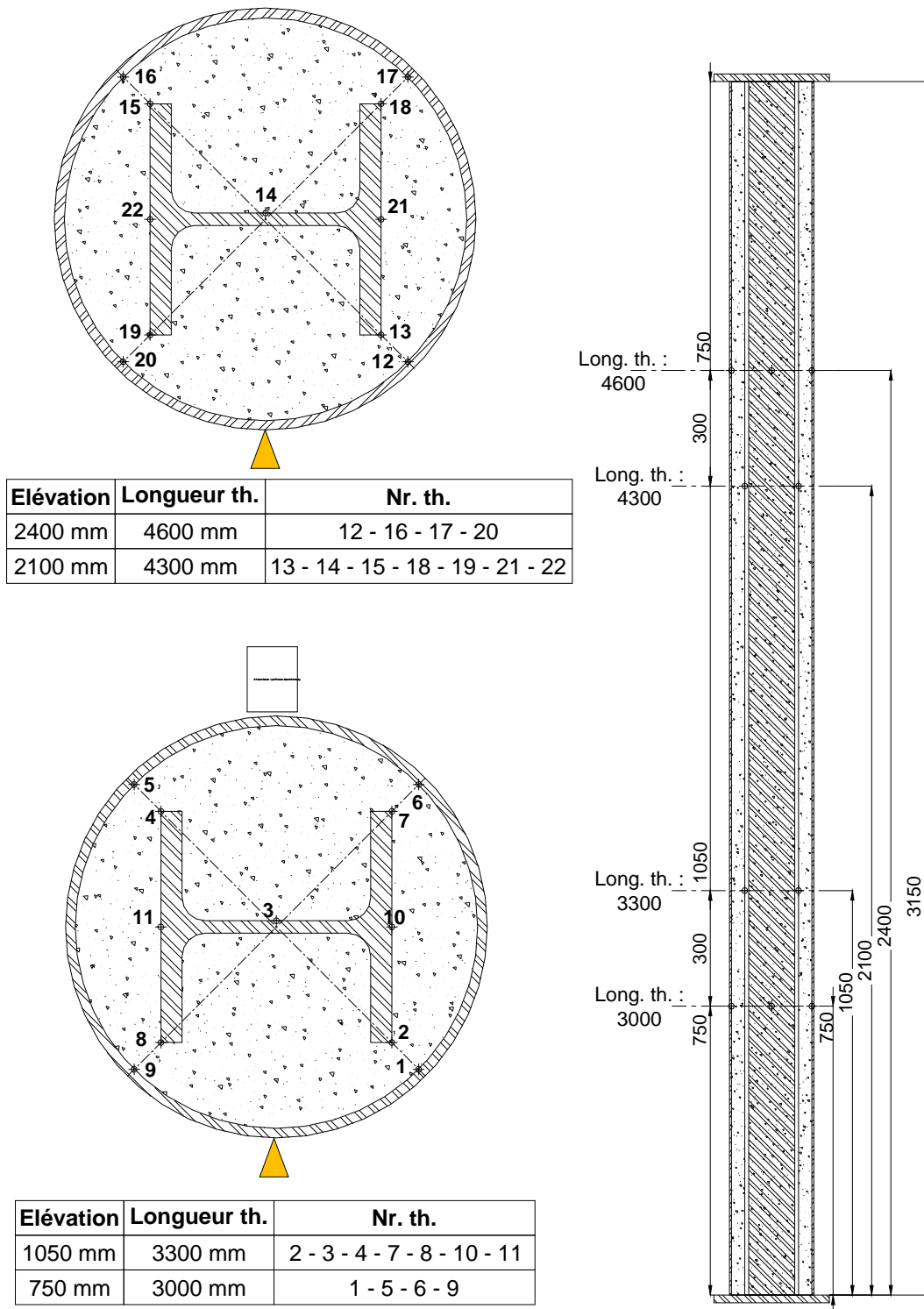


Figure A2.36. Location of thermocouples in the test FRFC 3B

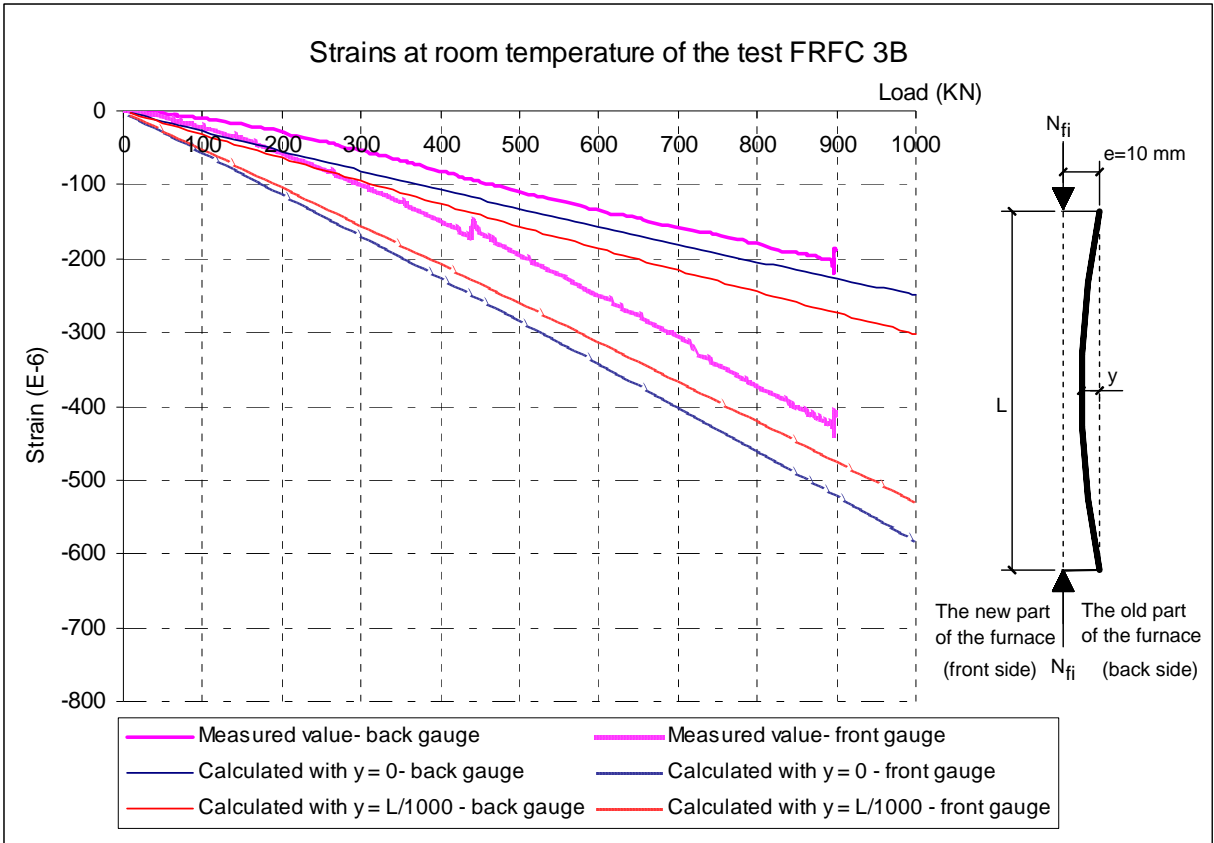


Figure A2.37. Strains at room temperature of the test FRFC 3B

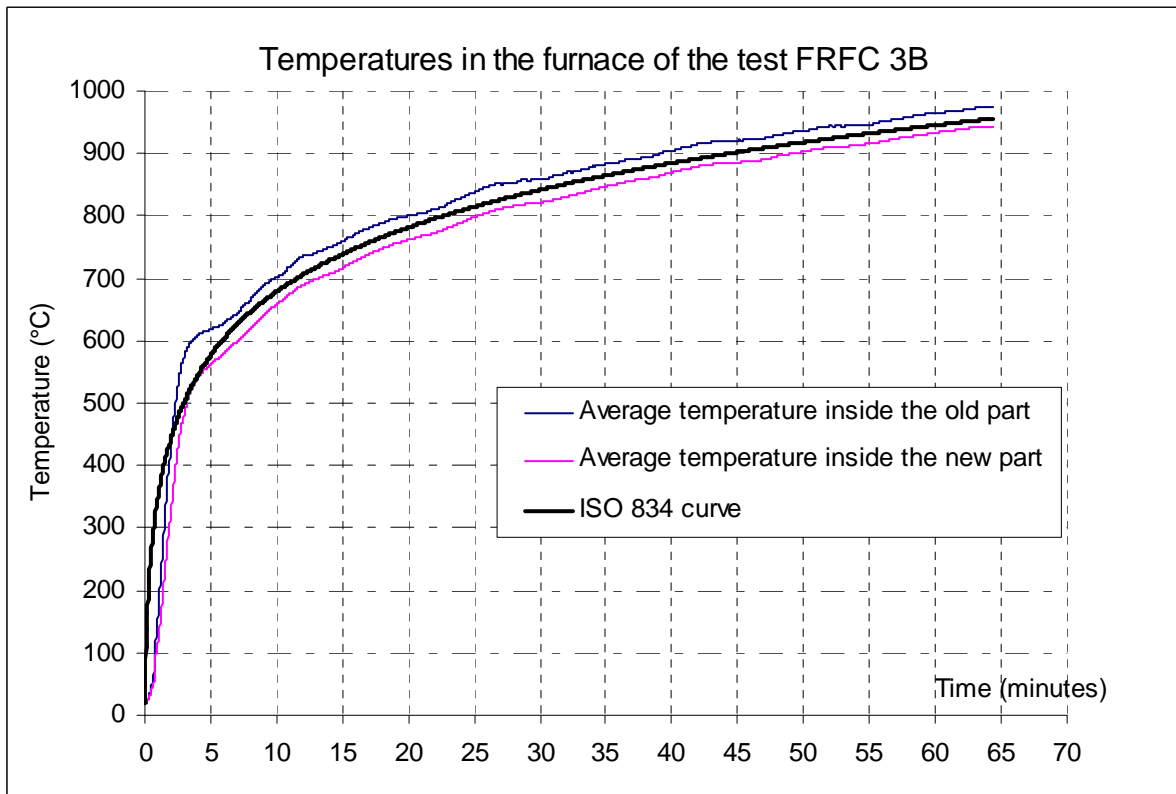


Figure A2.38. Temperatures in the furnace of the test FRFC 3B

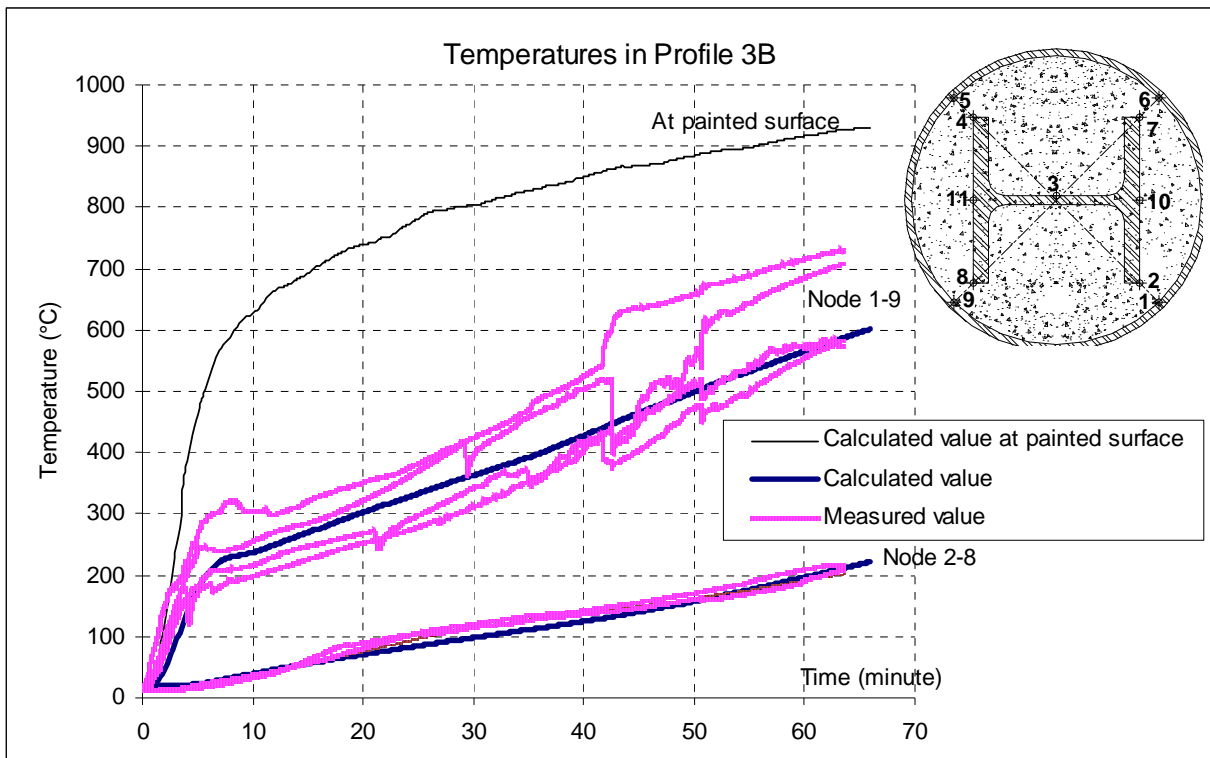


Figure A2.39. Temperatures in the section of the test FRFC 3B

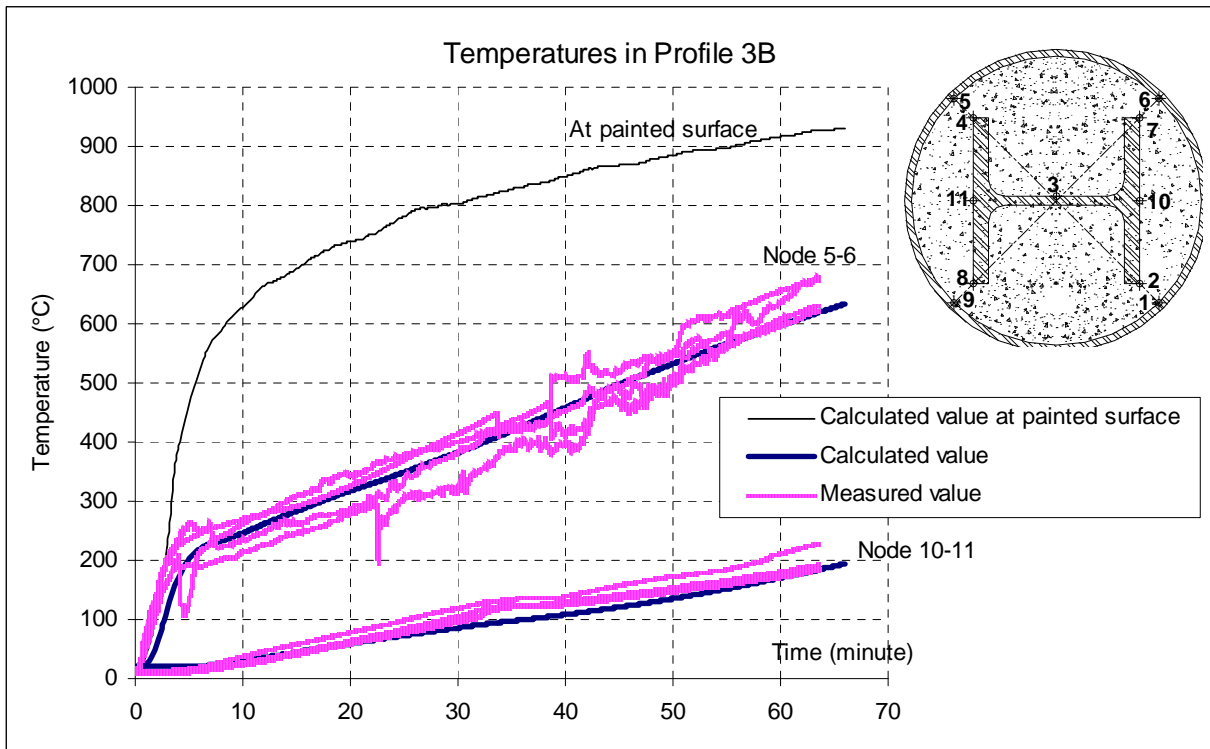


Figure A2.40. Temperatures in the section of the test FRFC 3B

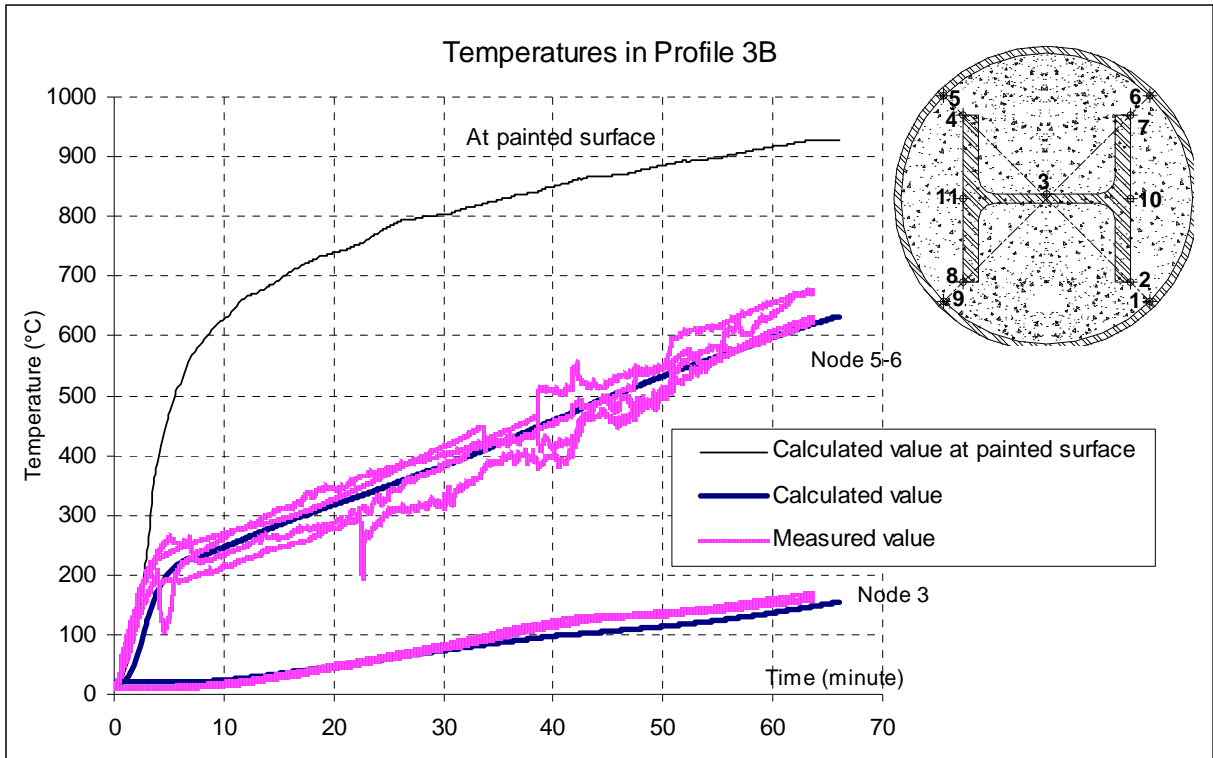


Figure A2.41. Temperatures in the section of the test FRFC 3B

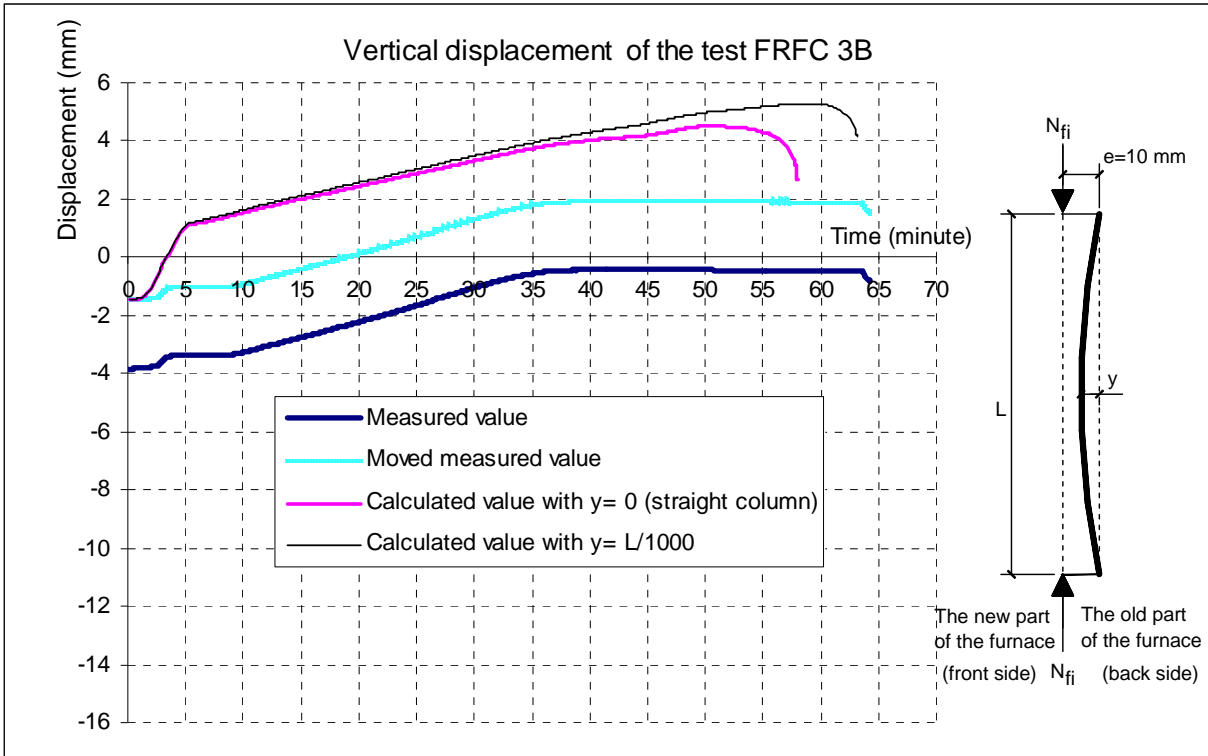


Figure A2.42. Vertical displacement of the test FRFC 3B

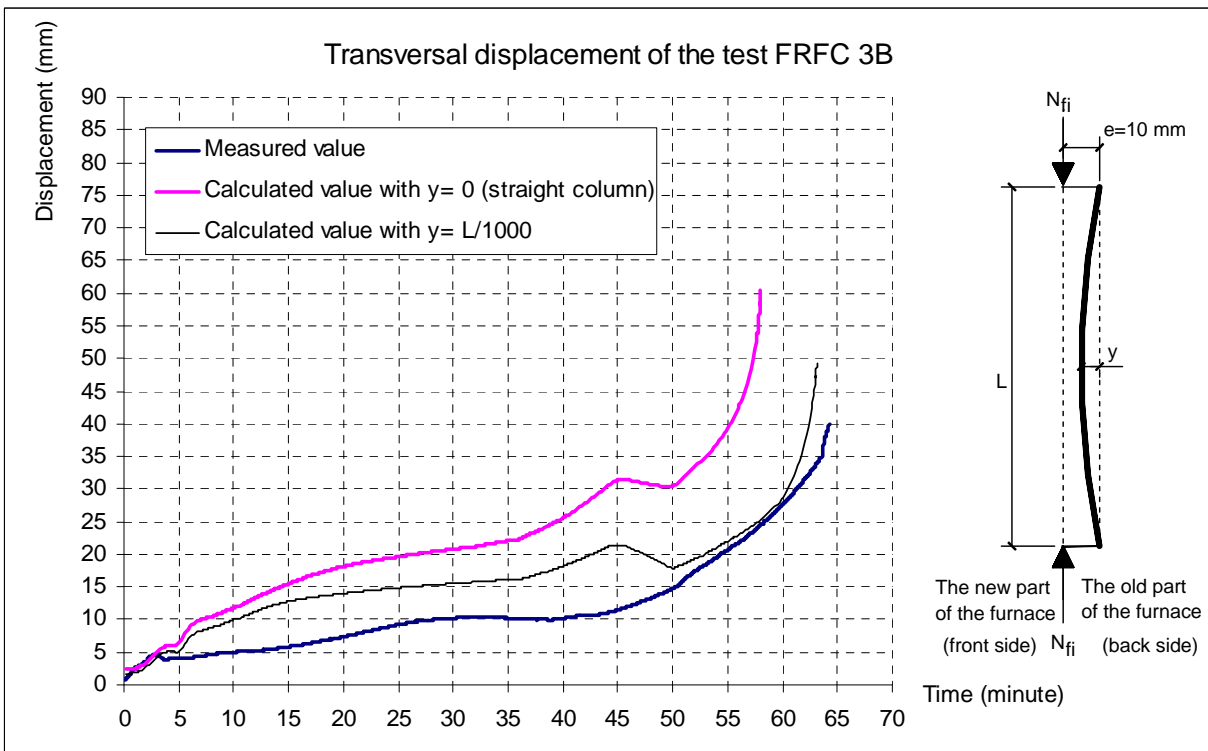


Figure A2.43. Transversal displacement at the middle height of the test FRFC 3B



Picture A2. 3. The intumescent paint after the test of FRFC 3B

## A2.7 Test FRFC 4A

Profile 4 (Figure A2.44):

External profile: Square hollow section 200 x 5

Internal profile: H profile HEB120

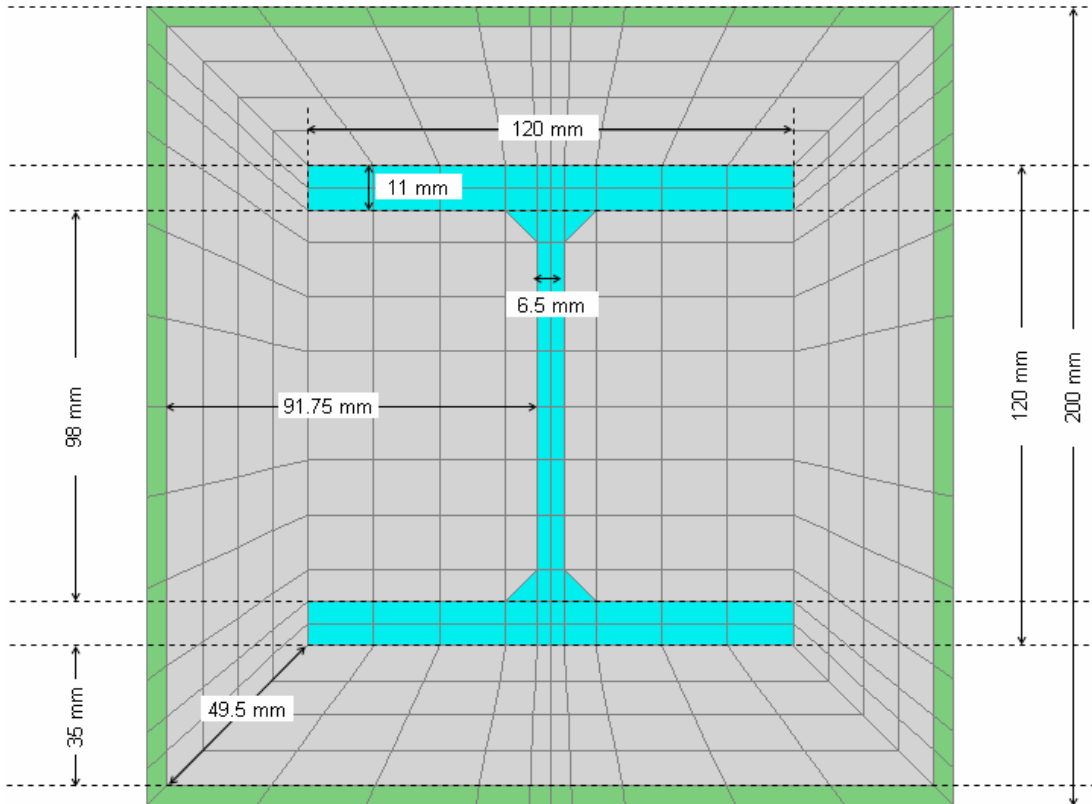


Figure A2.44. Cross-section of profile 4A



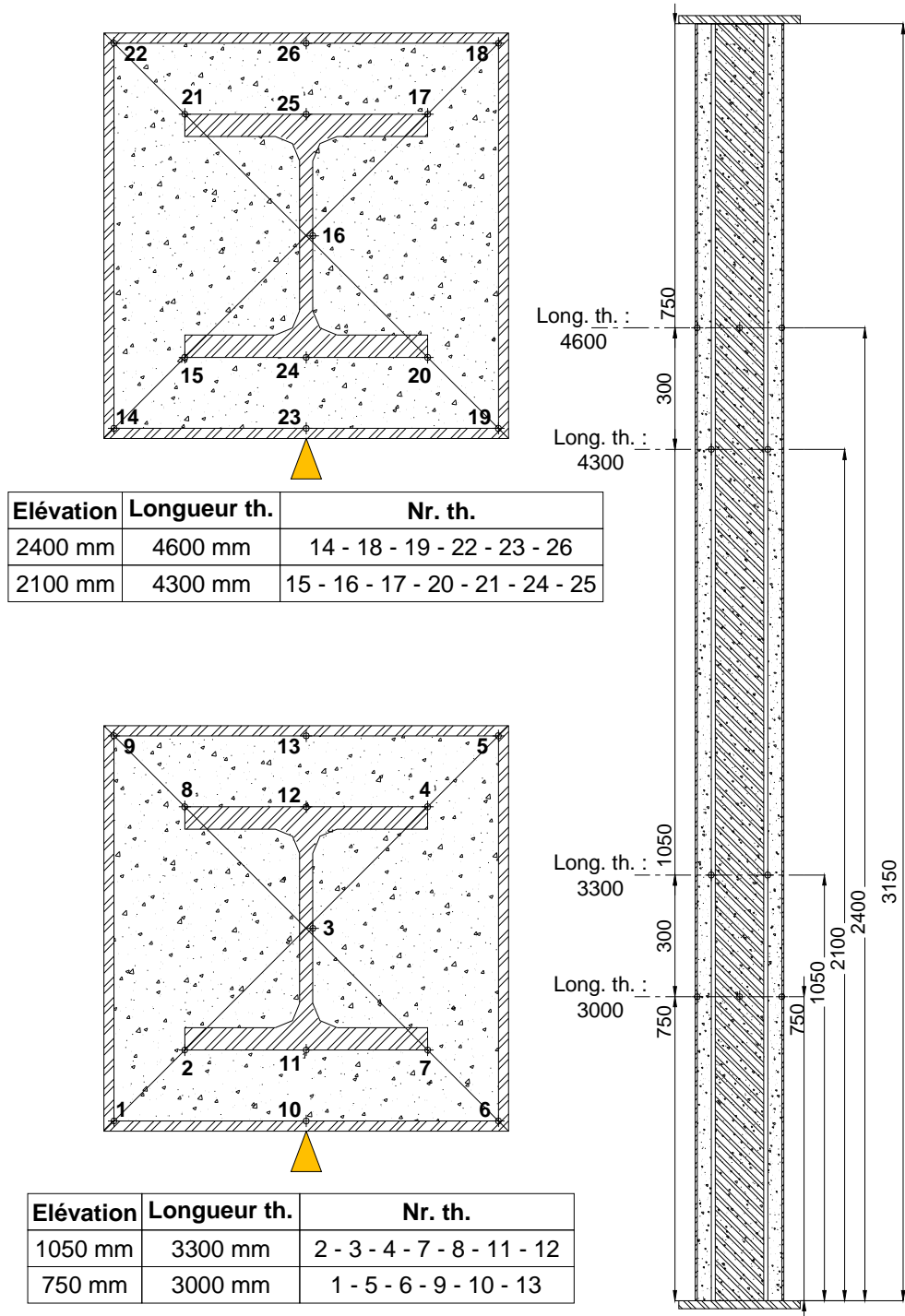


Figure A2.45. Location of thermocouples in the test FRFC 4A

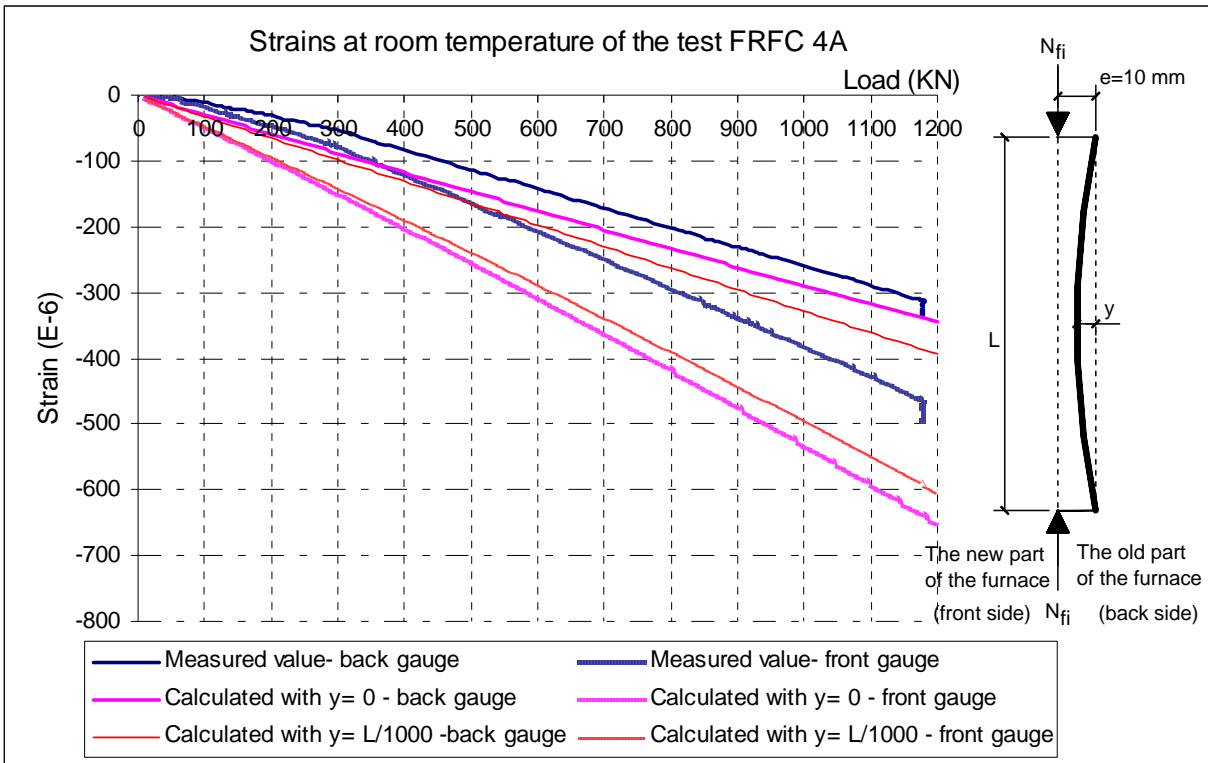


Figure A2.46. Strains at room temperature of the test FRFC 4A

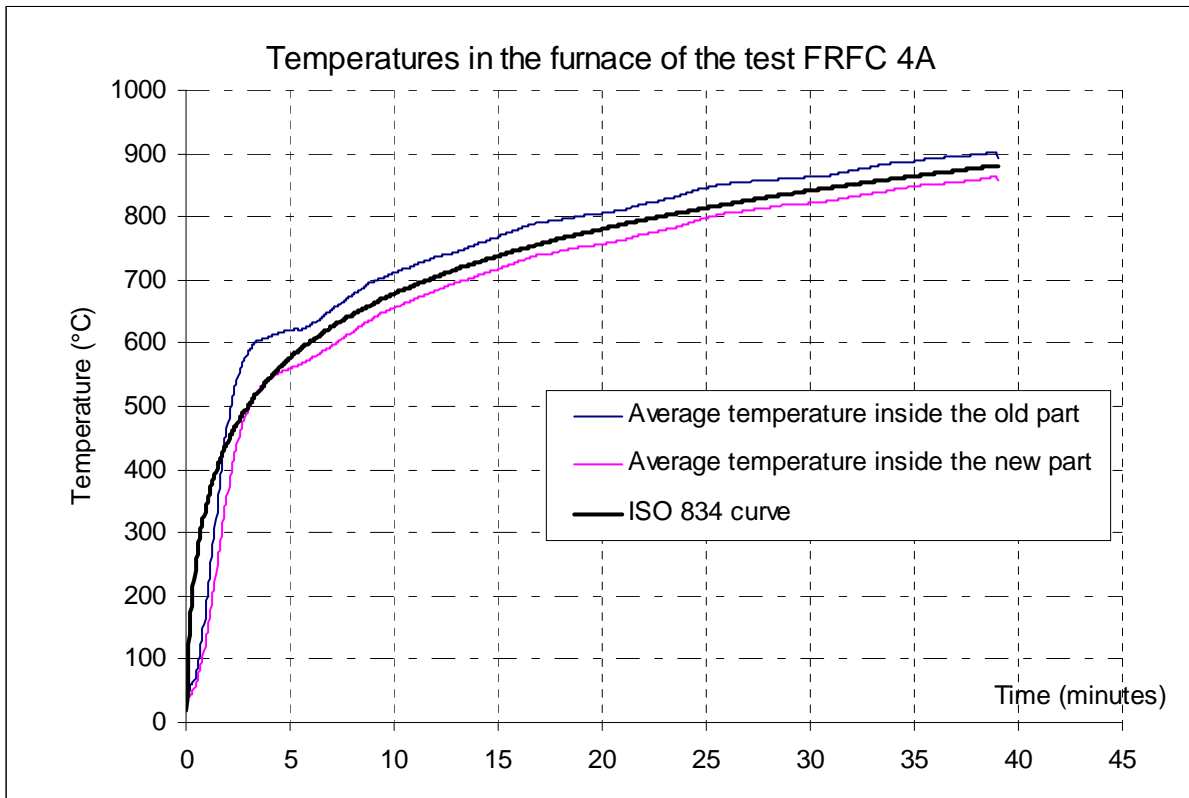


Figure A2.47. Temperatures in the furnace of the test FRFC 4A

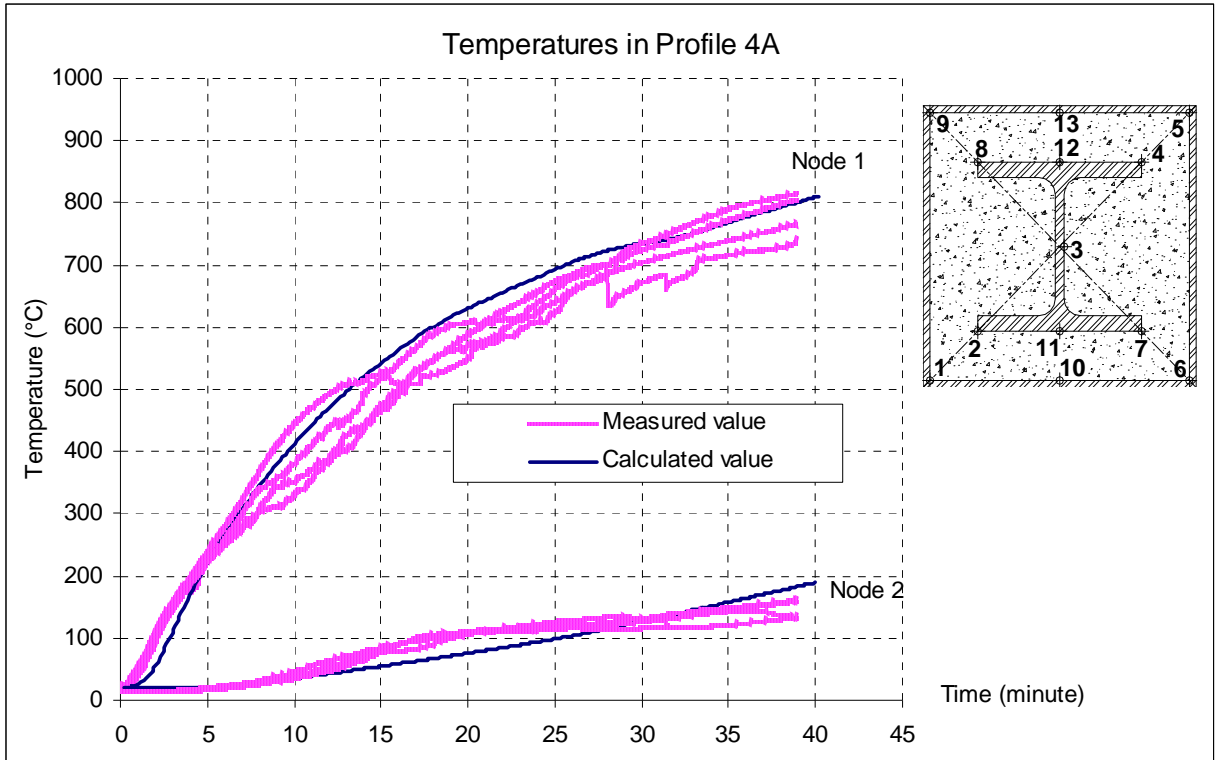


Figure A2.48. Temperatures in the section of the test FRFC 4A

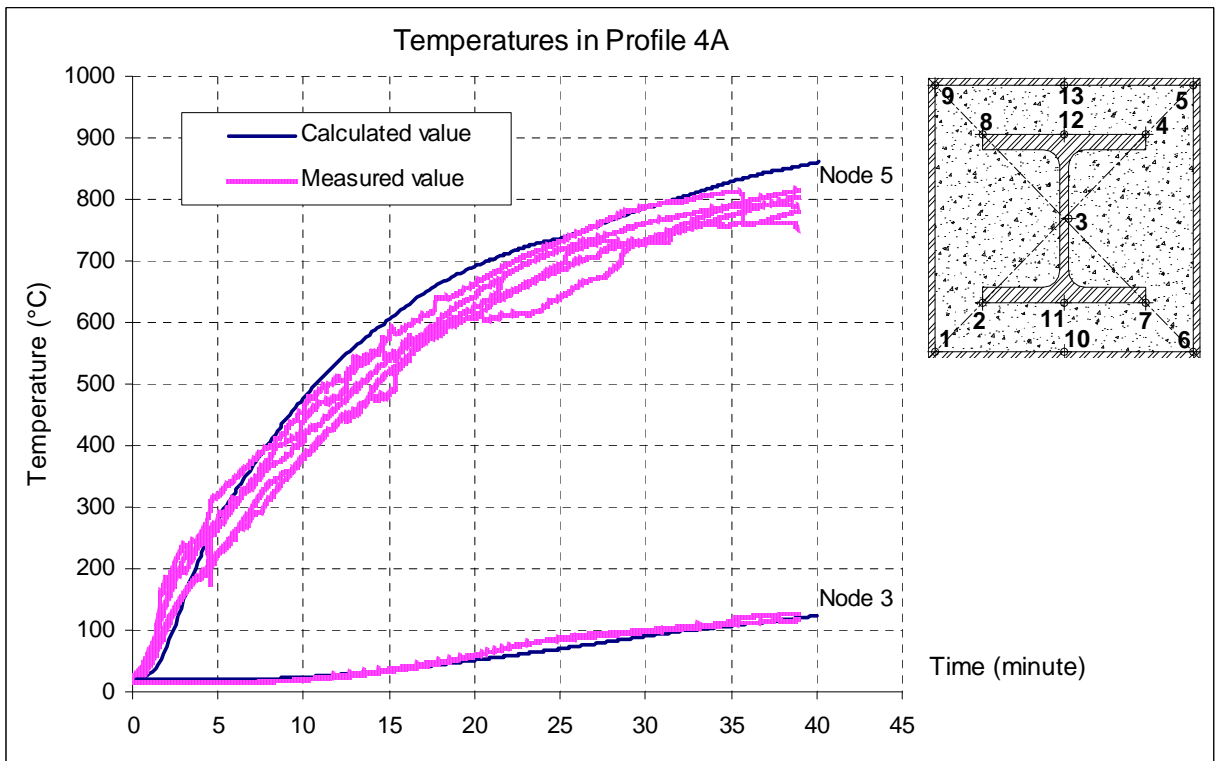


Figure A2.49. Temperatures in the section of the test FRFC 4A

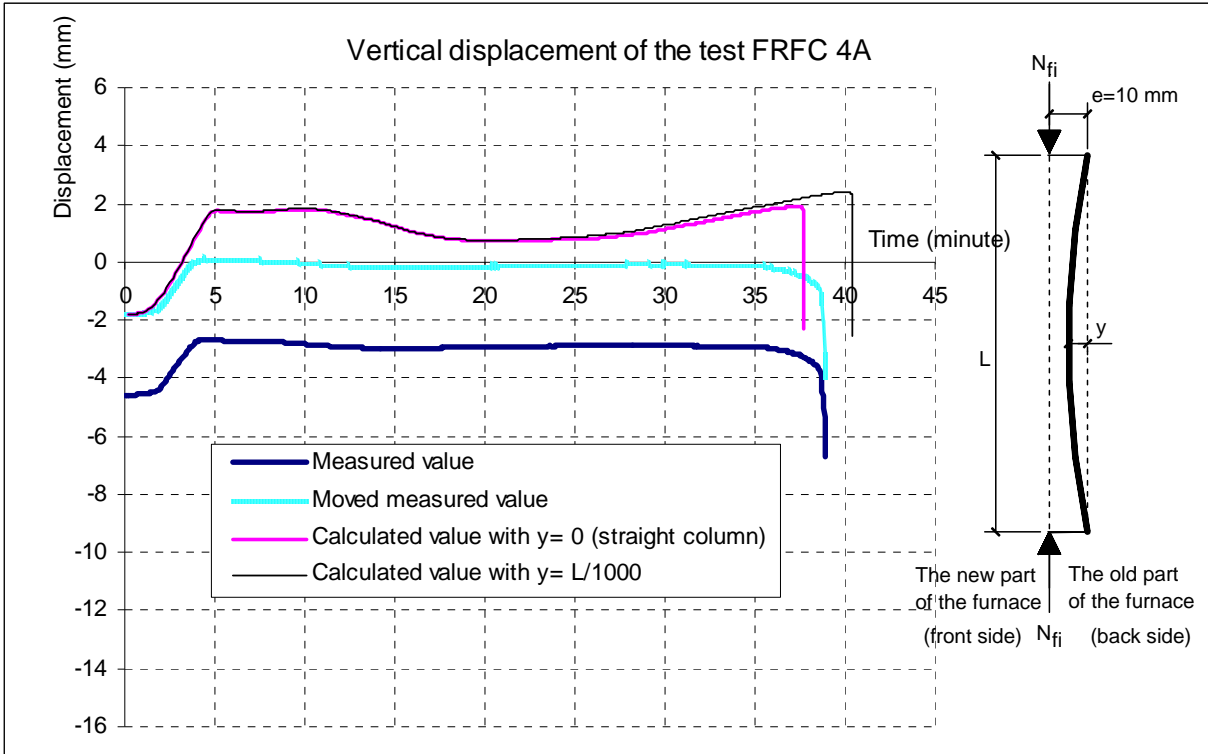


Figure A2.50. Vertical displacement of the test FRFC 4A

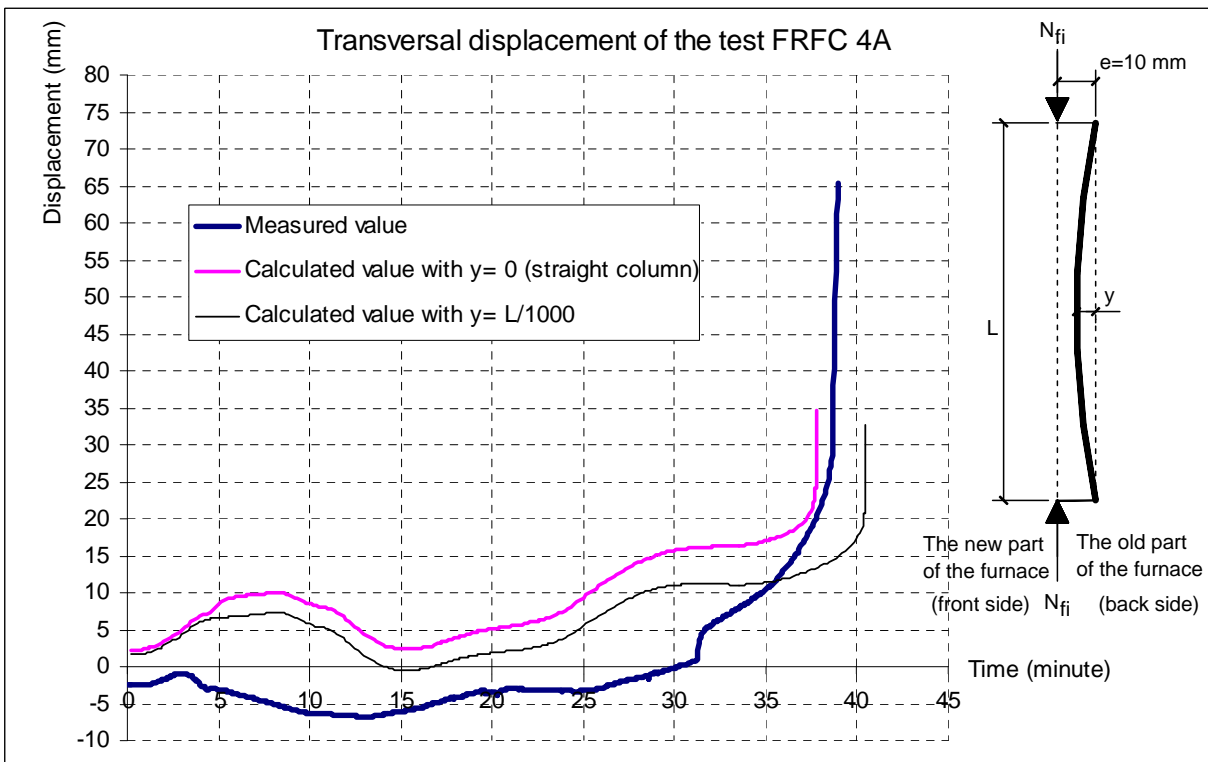


Figure A2.51. Transversal displacement at the middle height of the test FRFC 4A



Picture A2.4. Column FRFC 4A after the test



Picture A2.5. Local buckling of the test FRFC 4A

## A2.8 Test FRFC 4B

Profile 4 (Figure A2.44):

External profile: Square hollow section 200 x 5

Internal profile: H profile HEB120

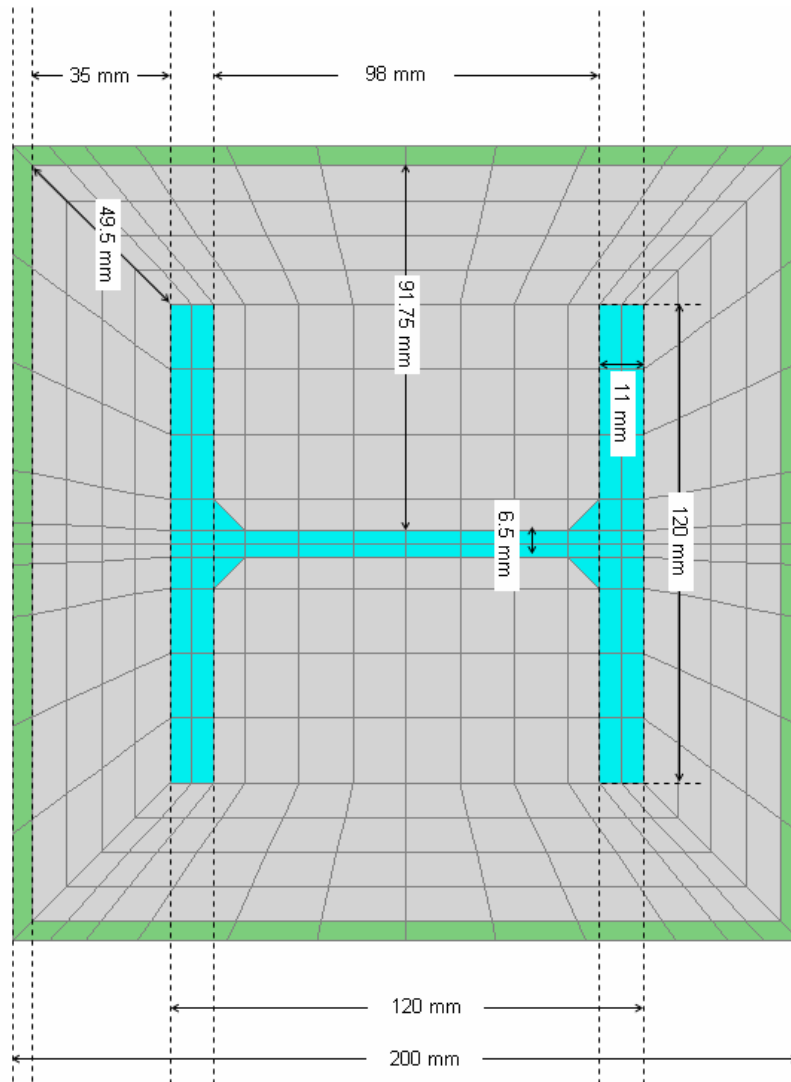


Figure A2.52. Cross-section of profile 4B

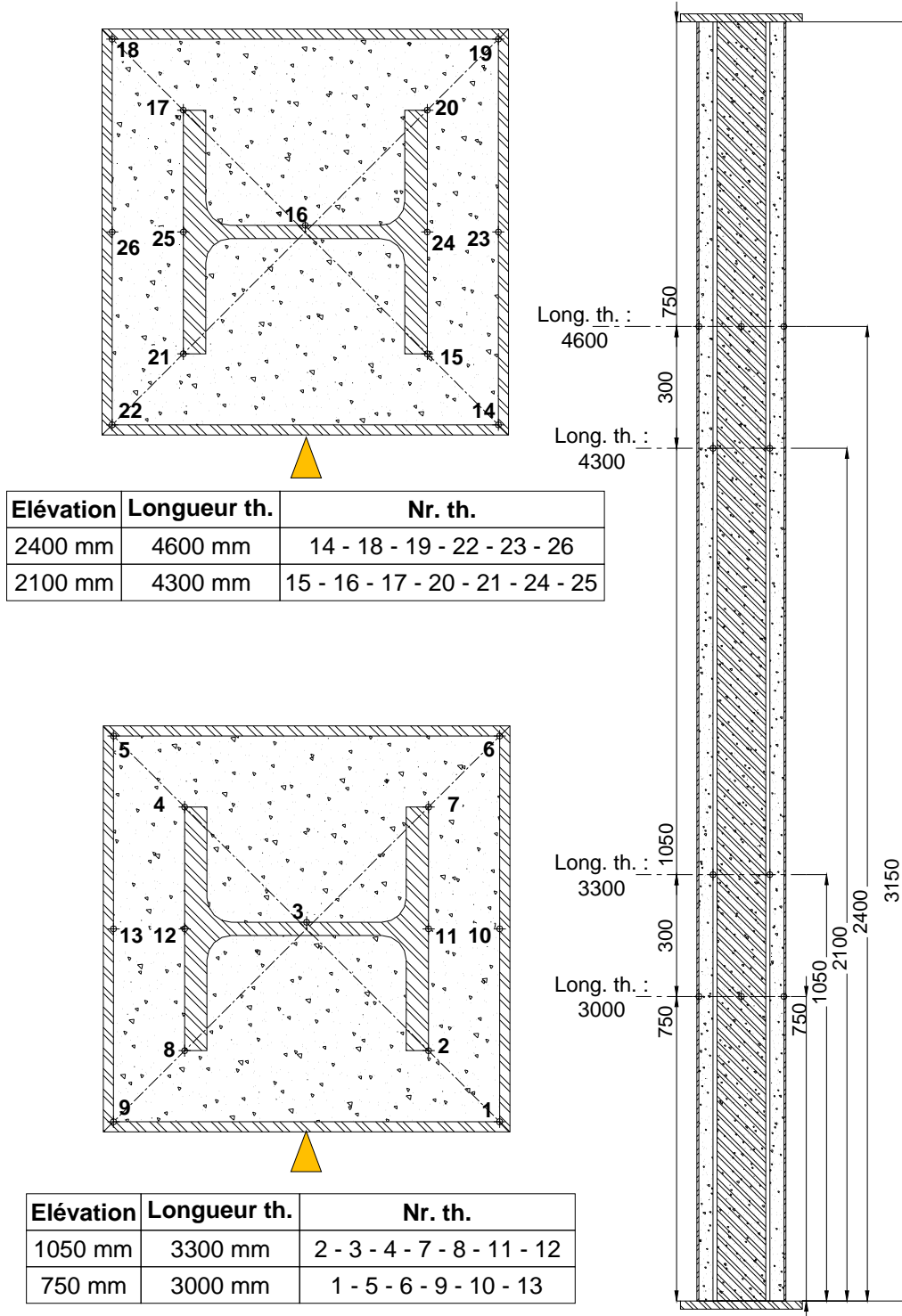


Figure A2.53. Location of thermocouples in the test FRFC 4B



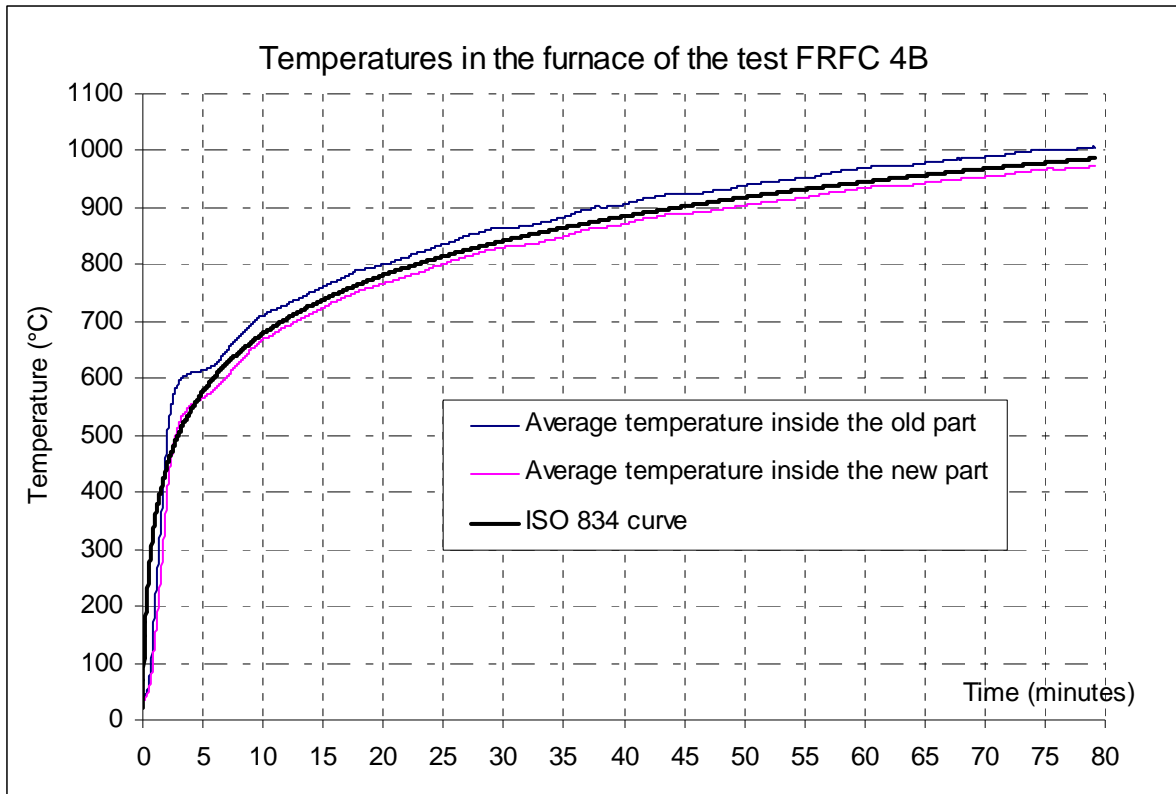


Figure A2.54. Temperatures in the furnace of the test FRFC 4B

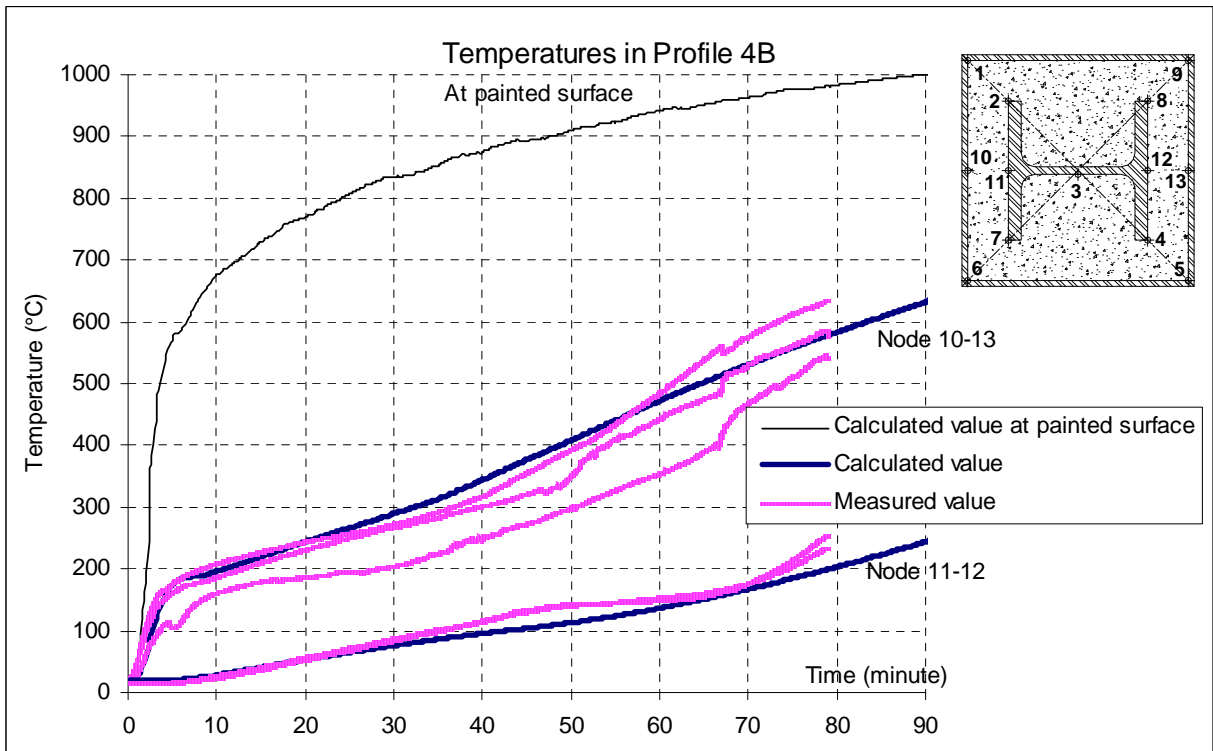


Figure A2.55. Temperatures in the section of the test FRFC 4B

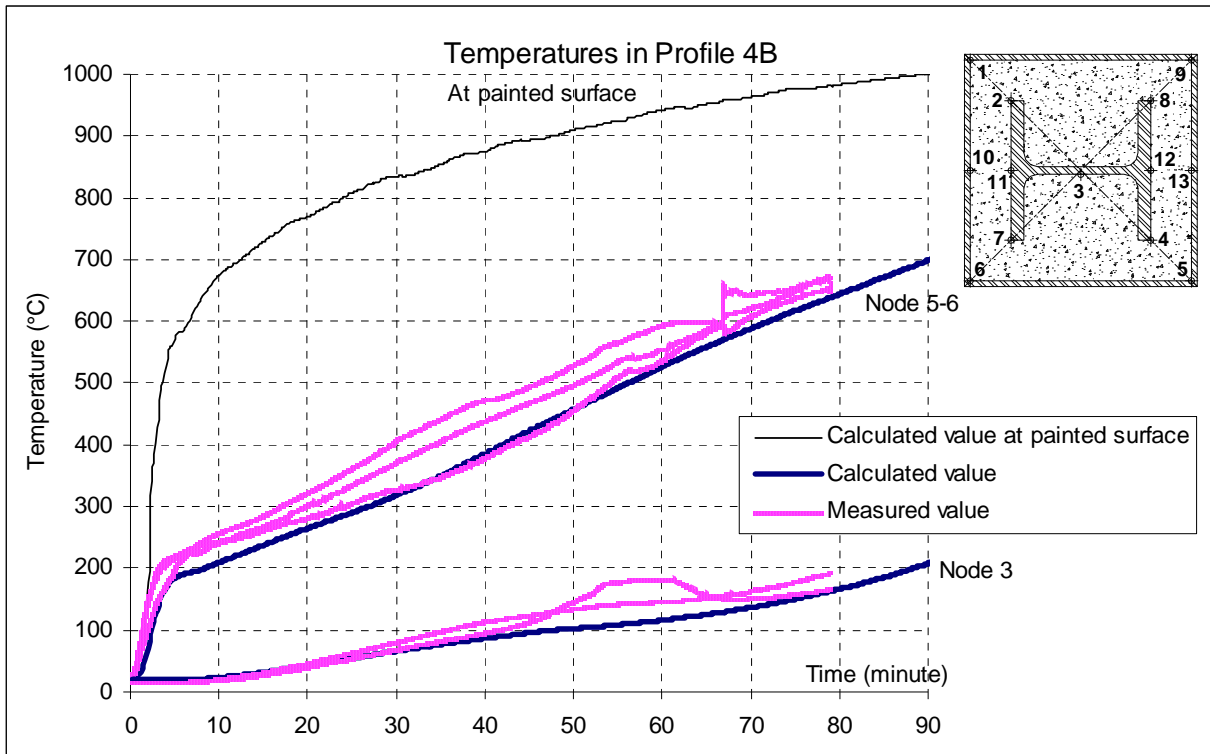


Figure A2.56. Temperatures in the section of the test FRFC 4B

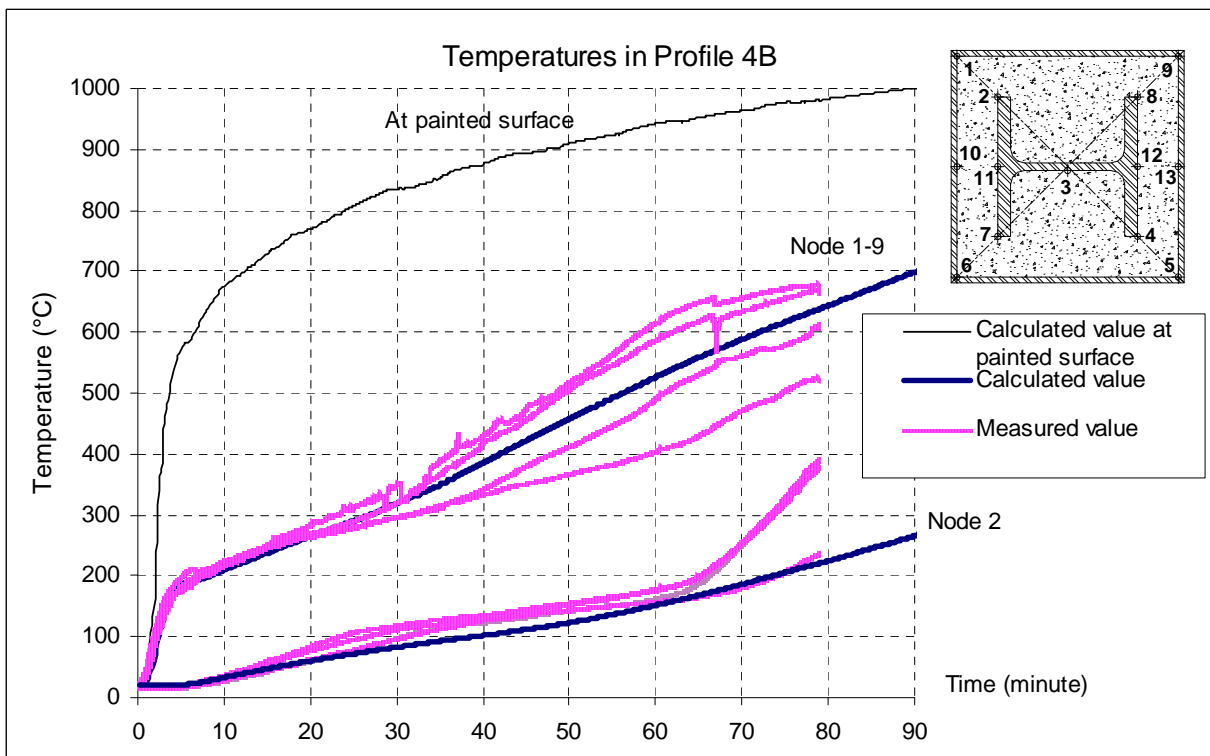


Figure A2.57. Temperatures in the section of the test FRFC 4B

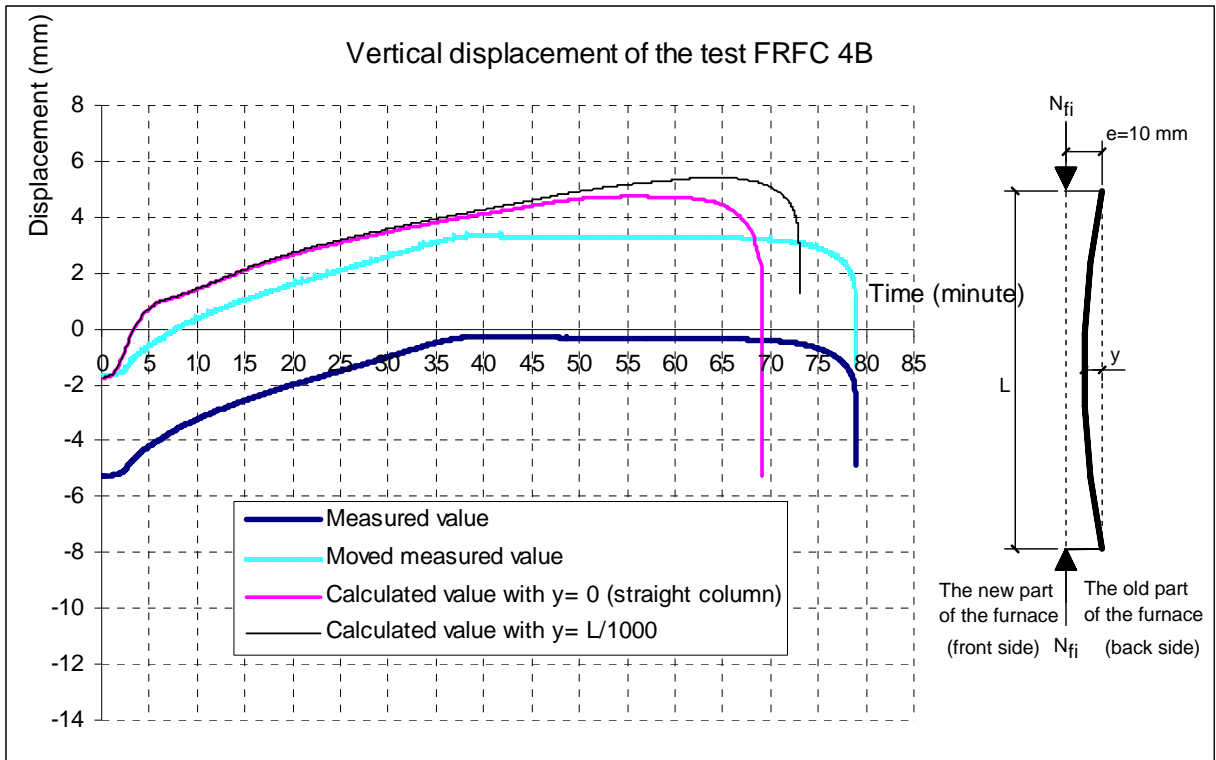


Figure A2.58. Vertical displacement of the test FRFC 4B

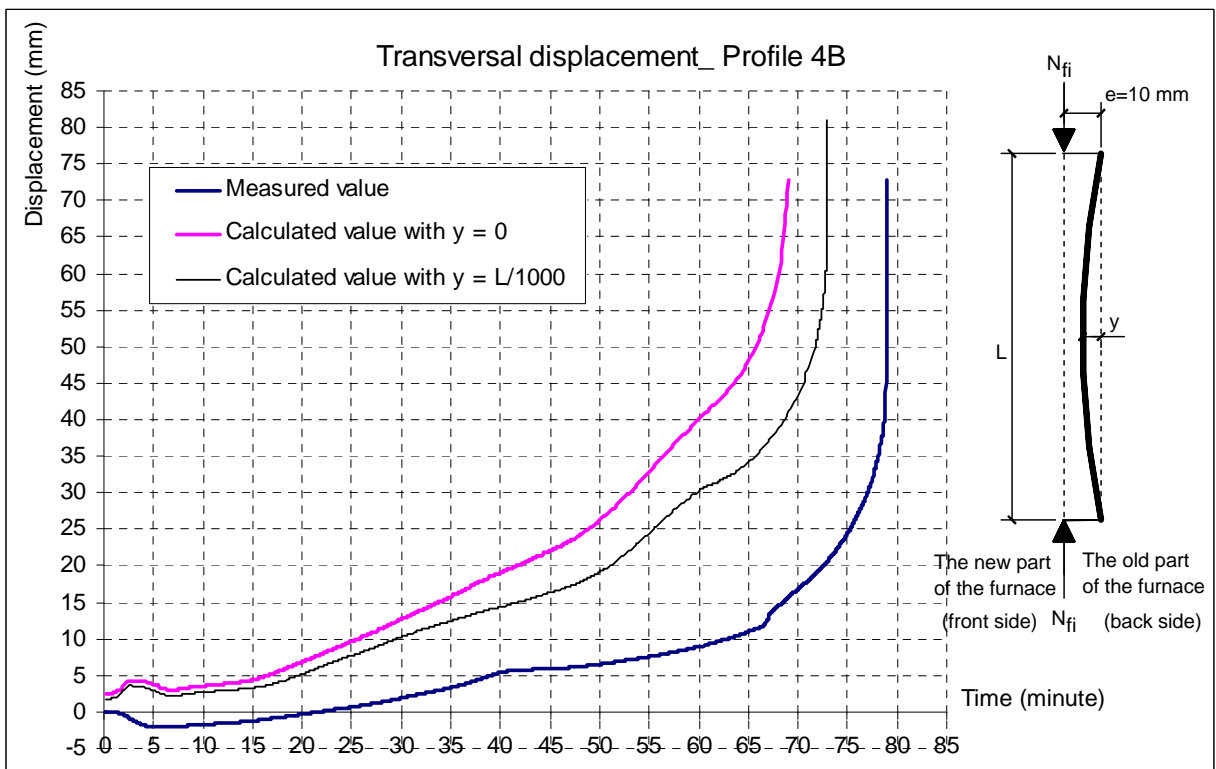


Figure A2.59. Transversal displacement at the middle height of the test FRFC 4B



Picture A2.6. Column FRFC 4B after the test



Picture A2.7. Local buckling of the test FRFC 4B

## A2.9 Test FRFC 5A

*Profile 5* (Figure A2.60): External profile: Circular hollow section 273 x 5  
Internal profile: Circular hollow section 168.3 x 10  
Concrete cover thickness: ~ 47 mm

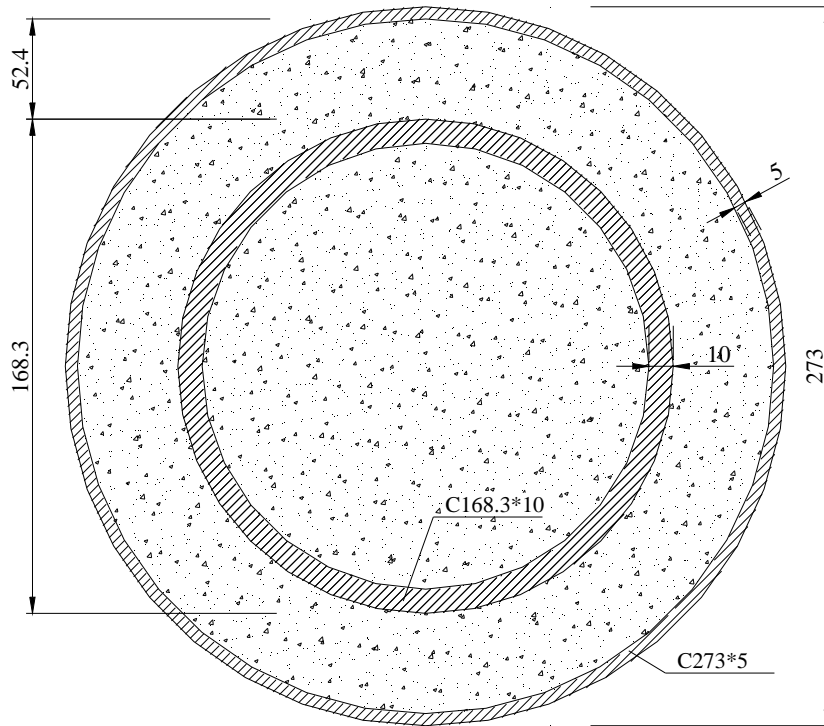


Figure A2.60. Cross-section of profile 5

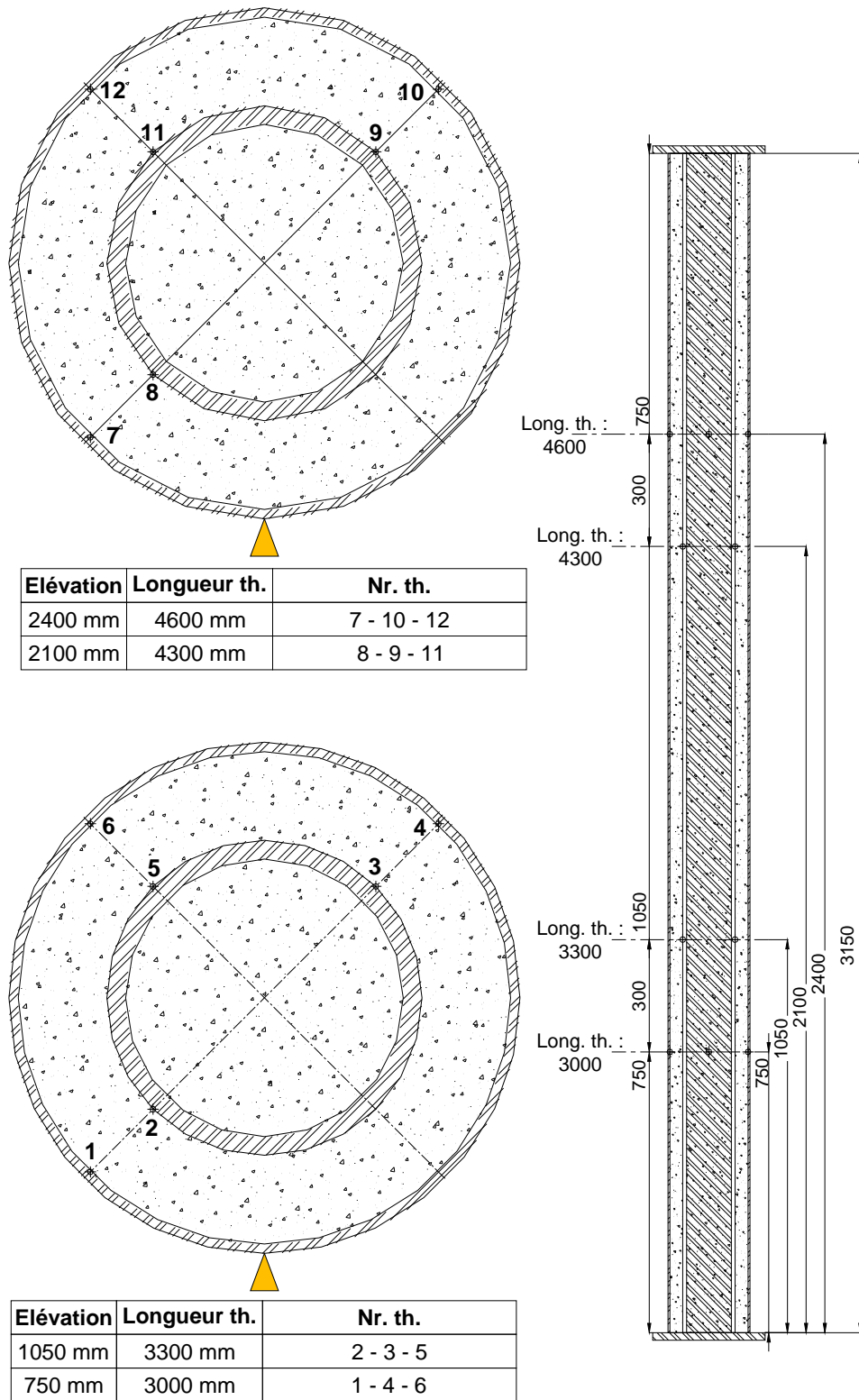


Figure A2.61. Location of thermocouples in the test FRFC 5A and 5B

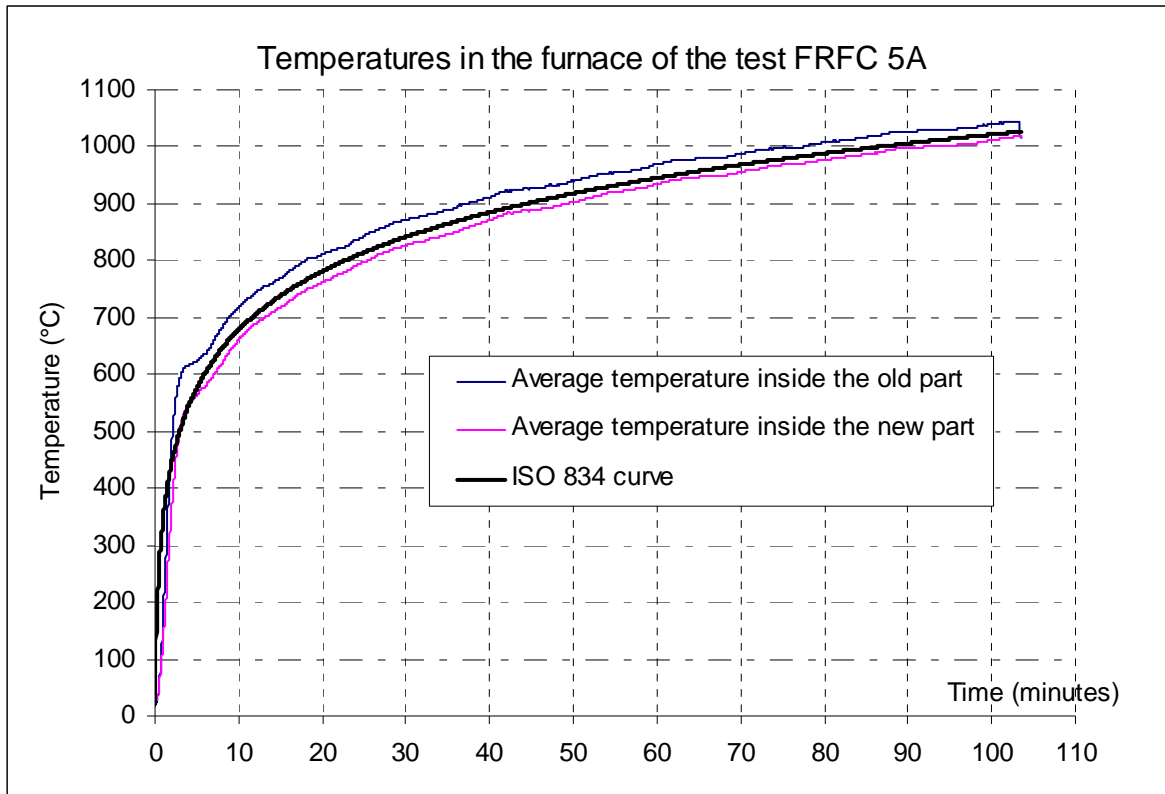


Figure A2.62. Temperatures in the furnace of the test FRFC 5A

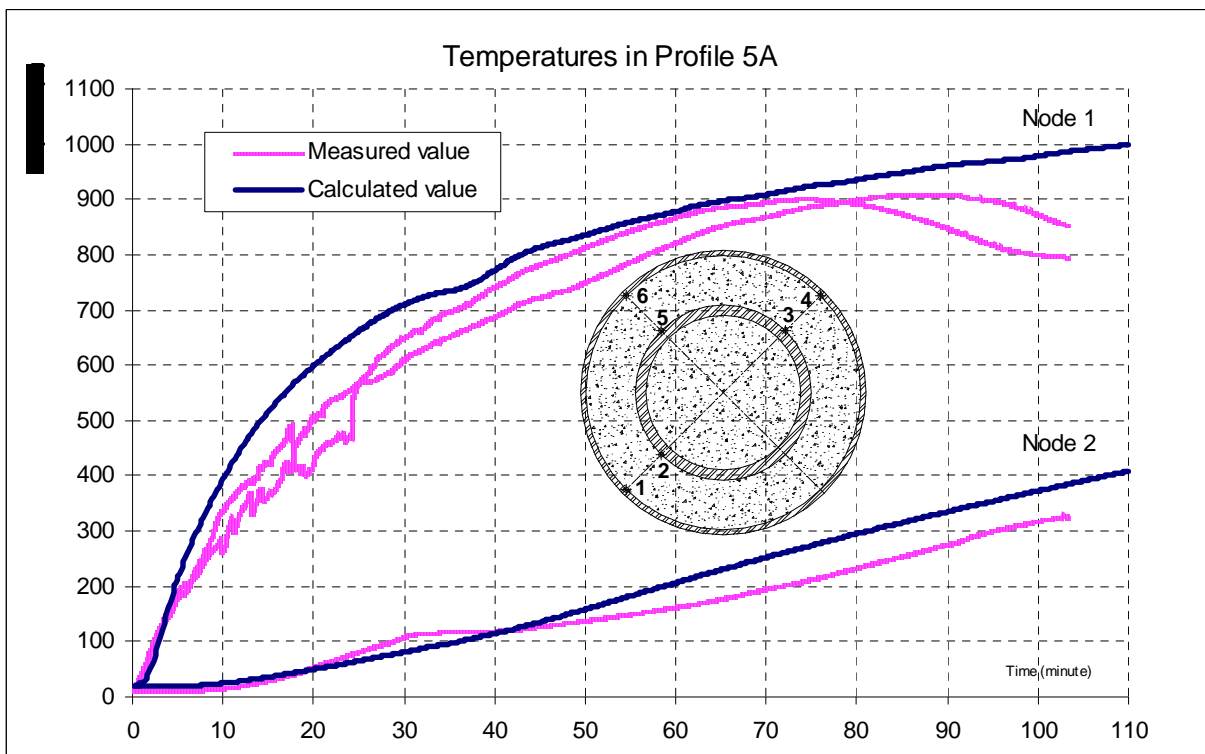


Figure A2.63. Temperatures in the section of the test FRFC 5A



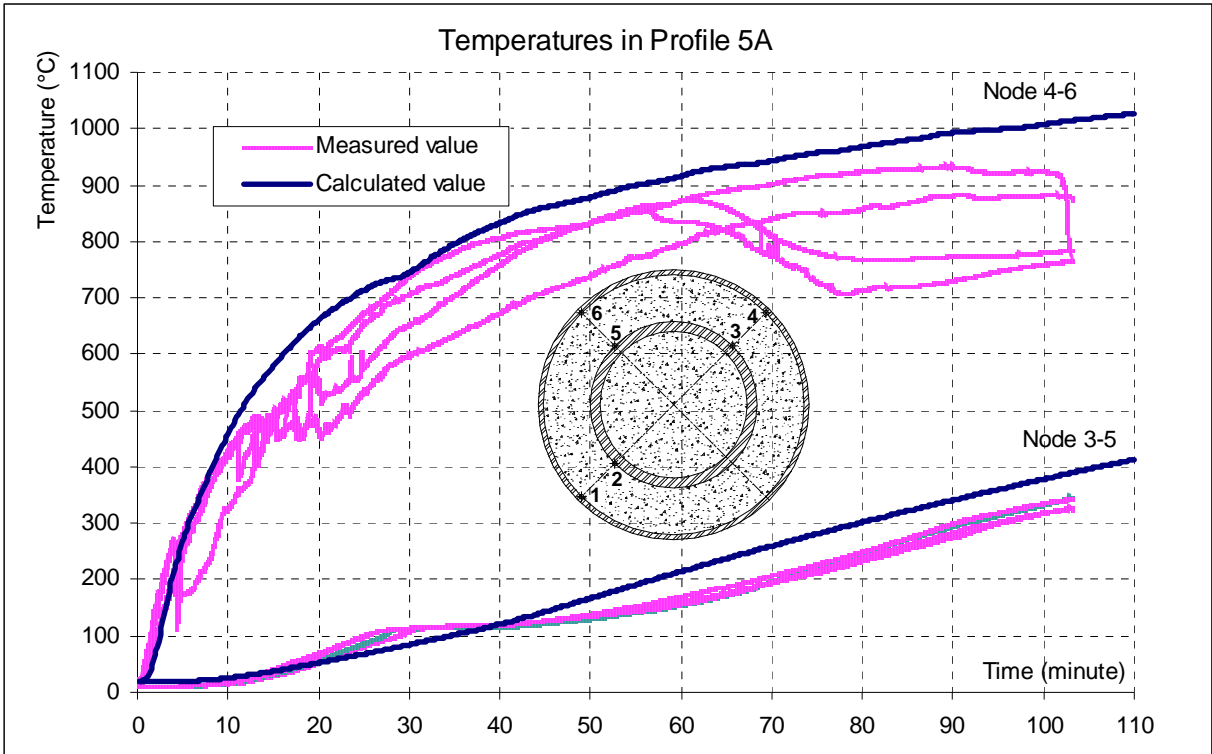


Figure A2.64. Temperatures in the section of the test FRFC 5A

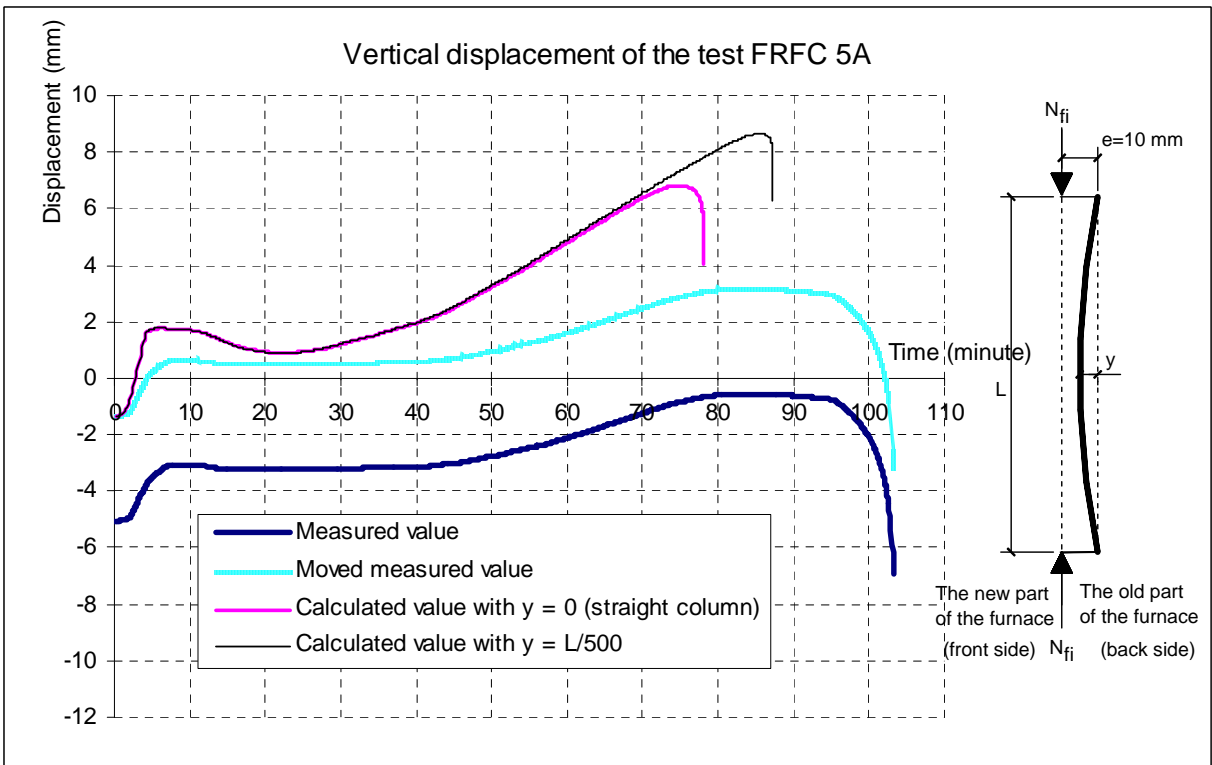


Figure A2.65. Vertical displacement of the test FRFC 5A

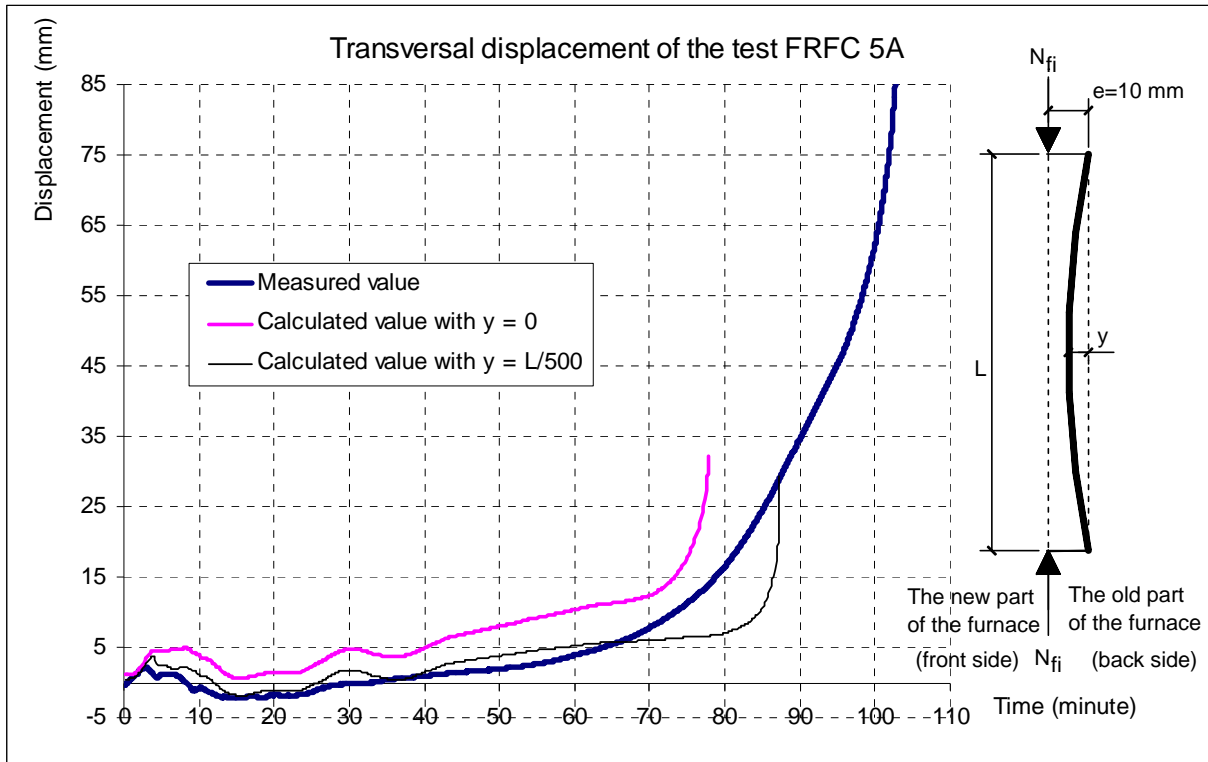


Figure A2.66. Transversal displacement at the middle height of the test FRFC 5A

## A2.10 Test FRFC 5B

Profile 5 (Figure A2.60)

Location of thermocouples in the test FRFC 5B is shown in Figure A2.61

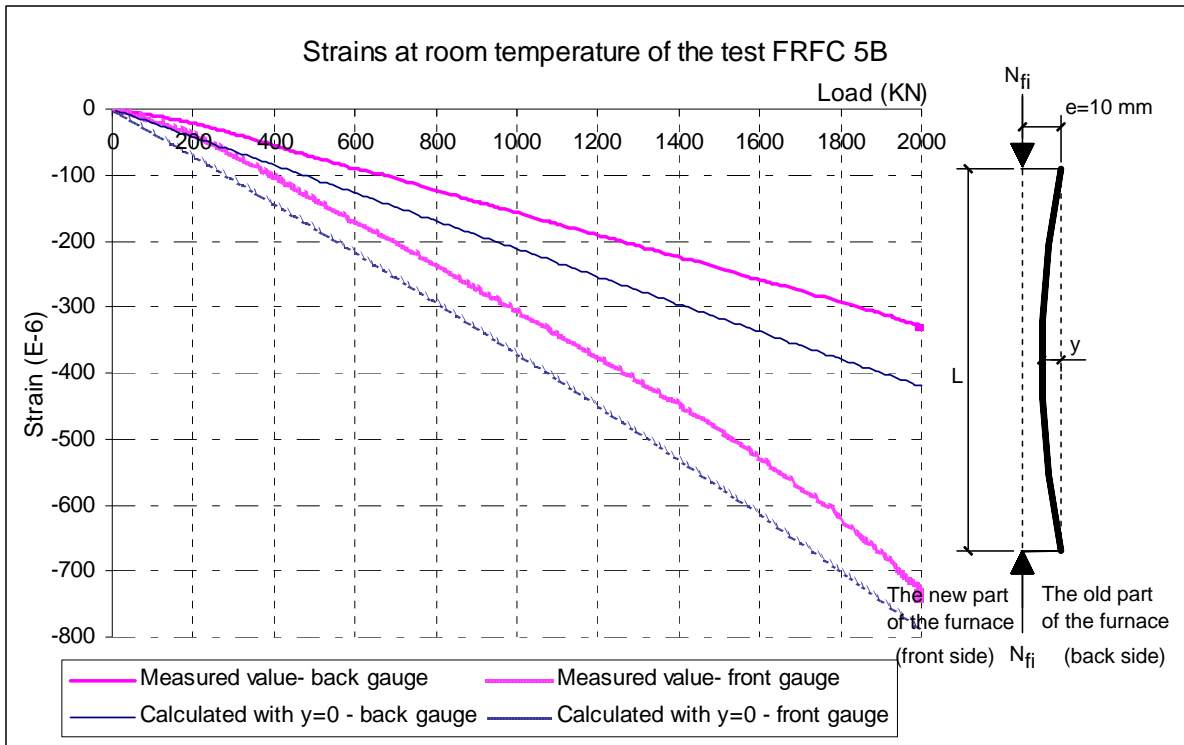


Figure A2.67. Strains at room temperature of the test FRFC 5B

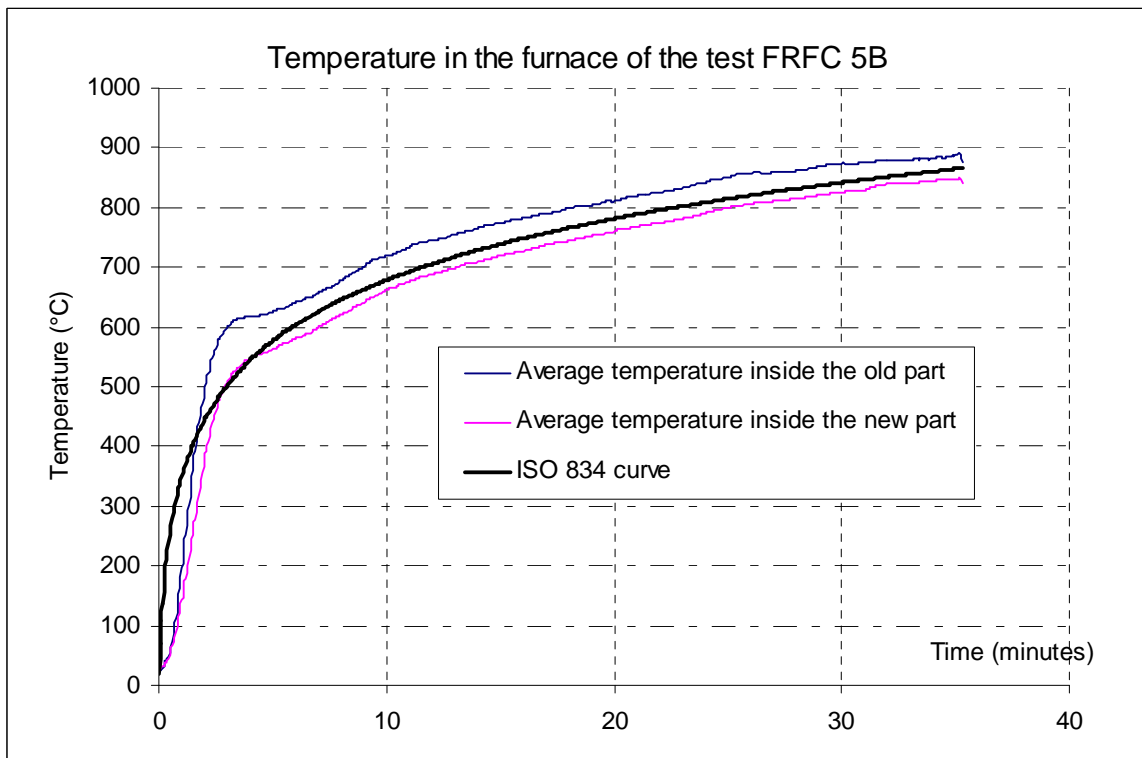


Figure A2.68. Temperatures in the furnace of the test FRFC 5B

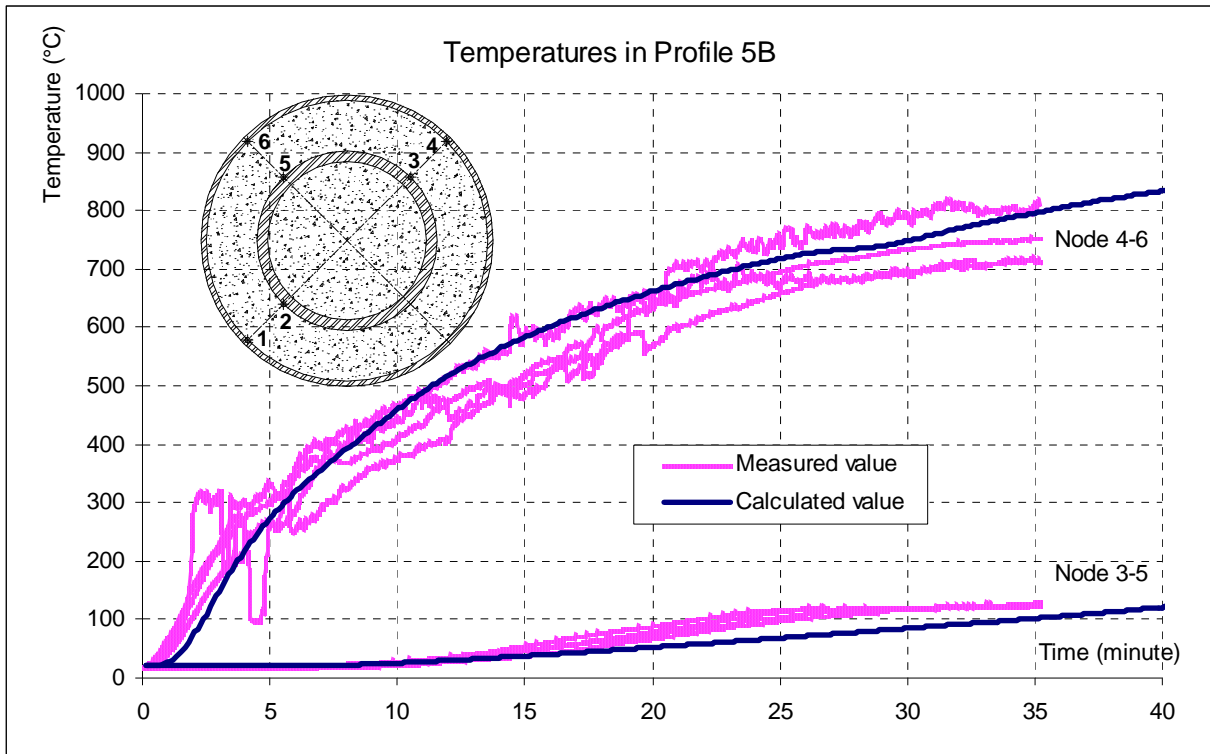


Figure A2.69. Temperatures in the section of the test FRFC 5B

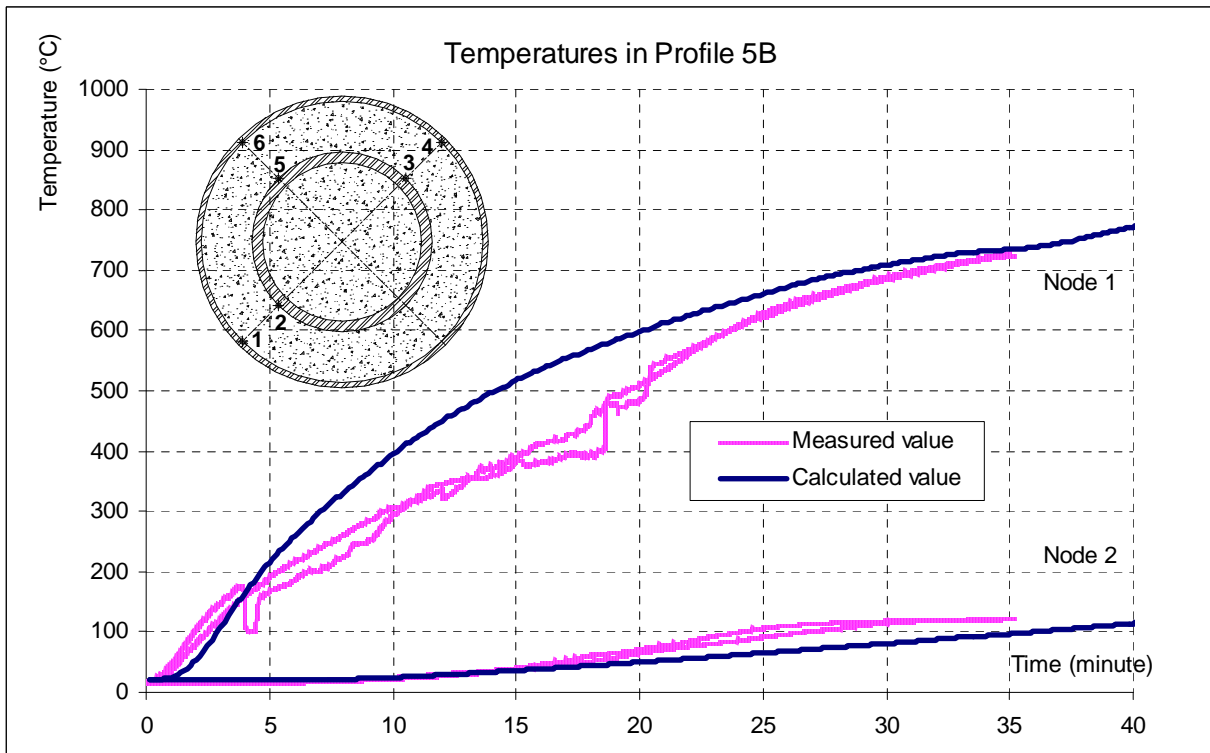


Figure A2.70. Temperatures in the section of the test FRFC 5B

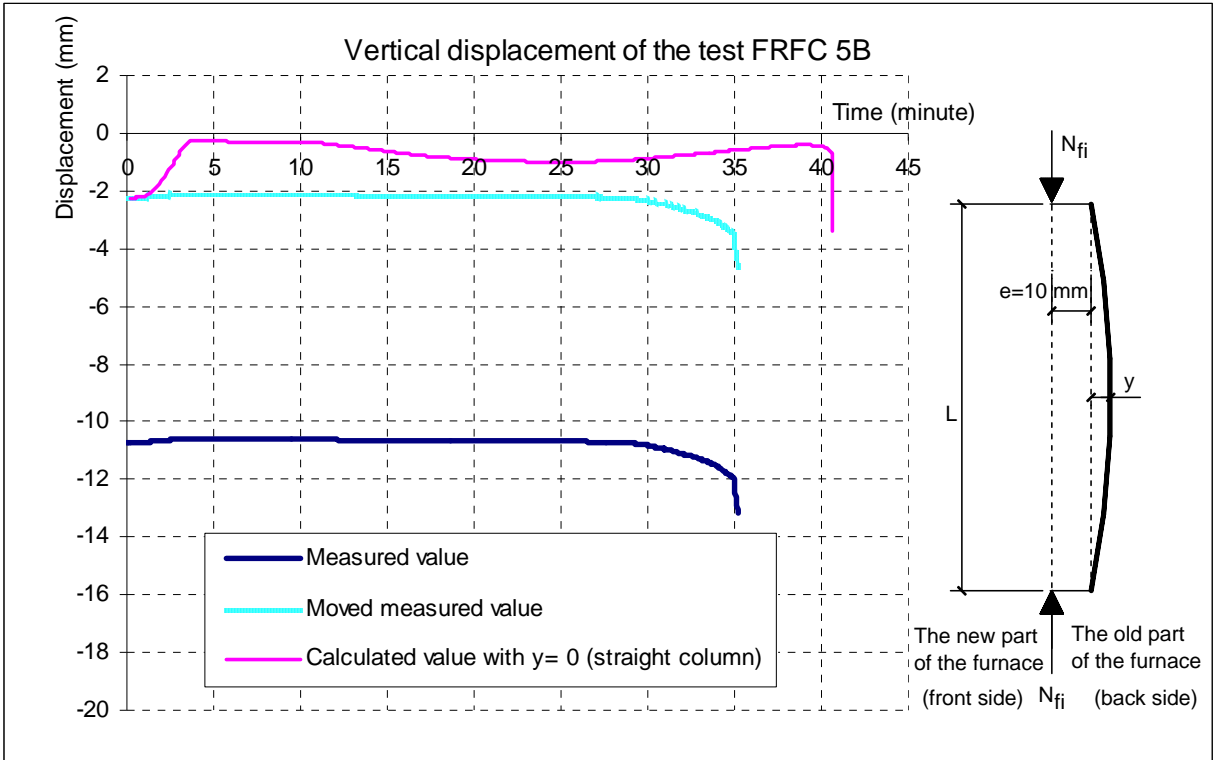


Figure A2.71. Vertical displacement of the test FRFC 5B

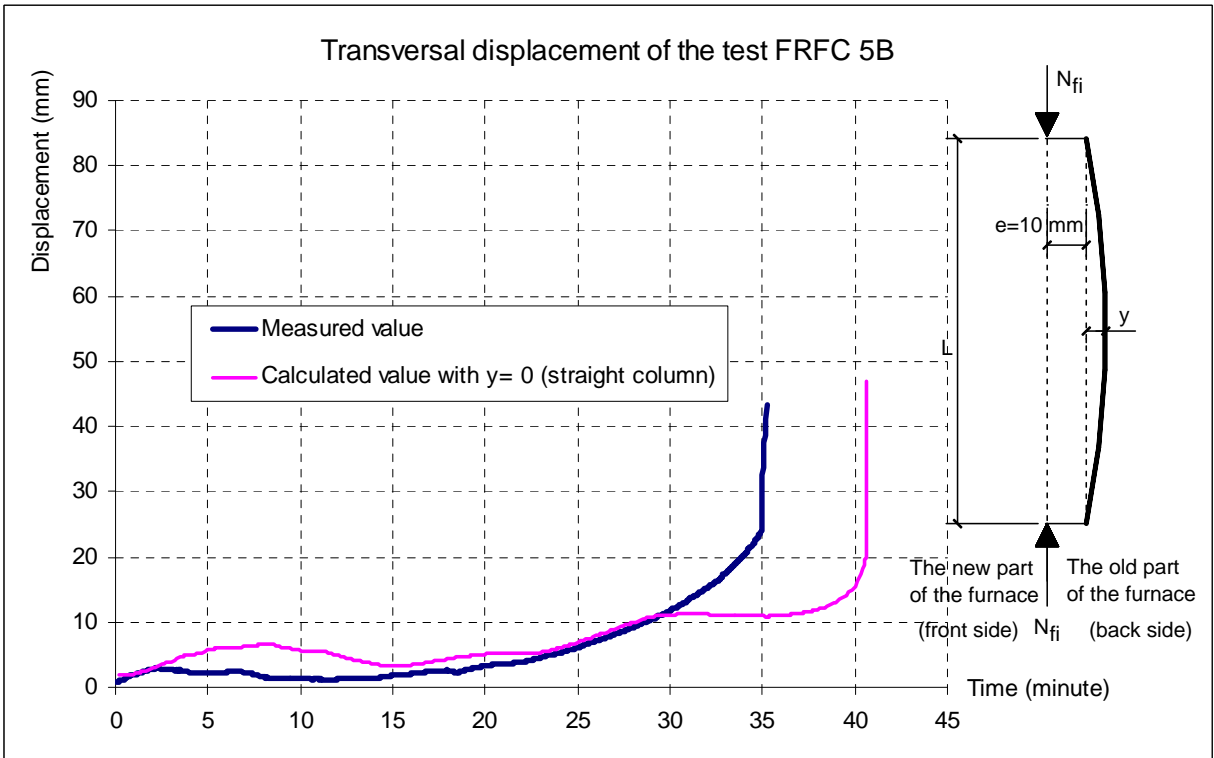


Figure A2.72. Transversal displacement at the middle height of the test FRFC 5B



Picture A2.8. Local buckling of the test FRFC 5B



Picture A2.9. The upside of the column FRFC 5B after the test



Picture A2.10. The upside of the column FRFC 5B after the test



Picture A2.11. The movement of the mark in concrete at the steam vent.

### A2.11 Test FRFC 6

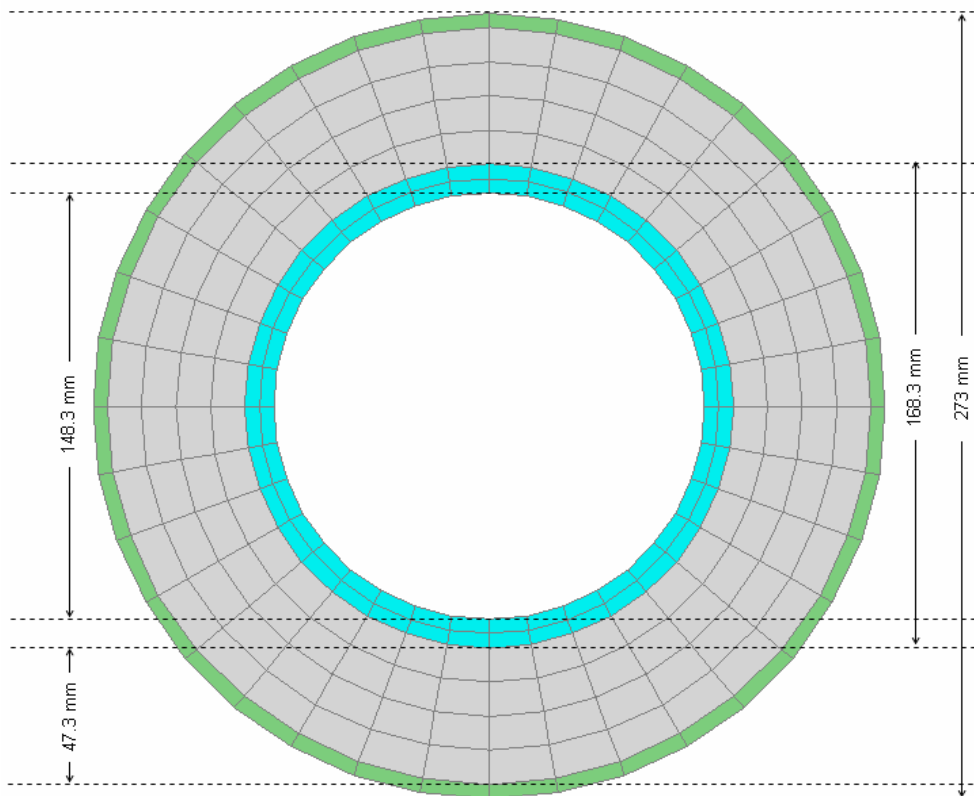


Figure A2.73. Cross-section of profile 6



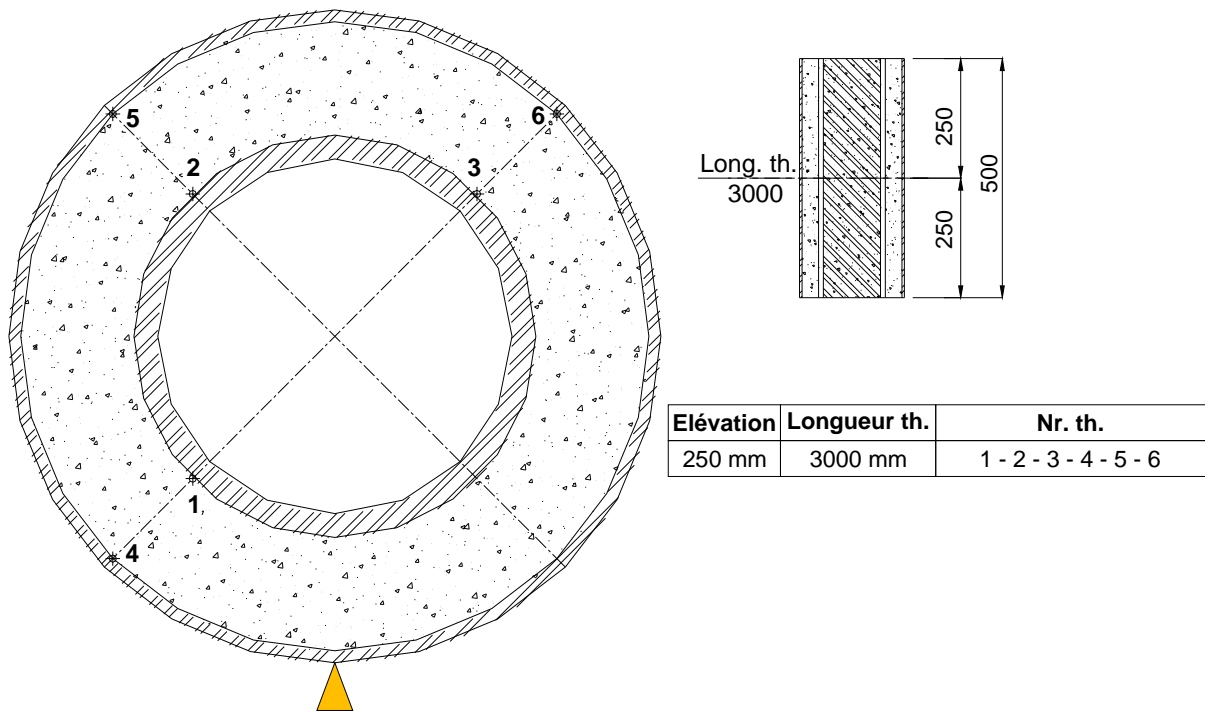


Figure A2.74. Location of thermocouples in the test FRFC 6

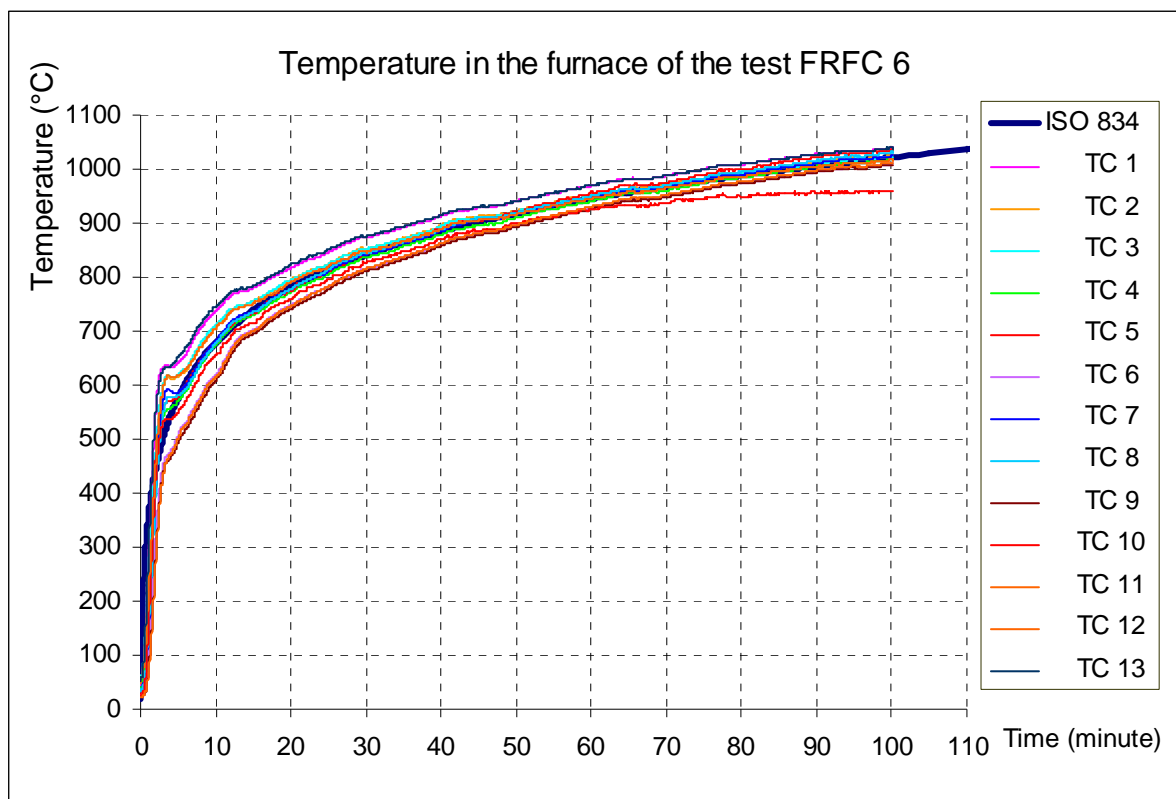


Figure A2.75. Temperatures in the furnace of the test FRFC 6

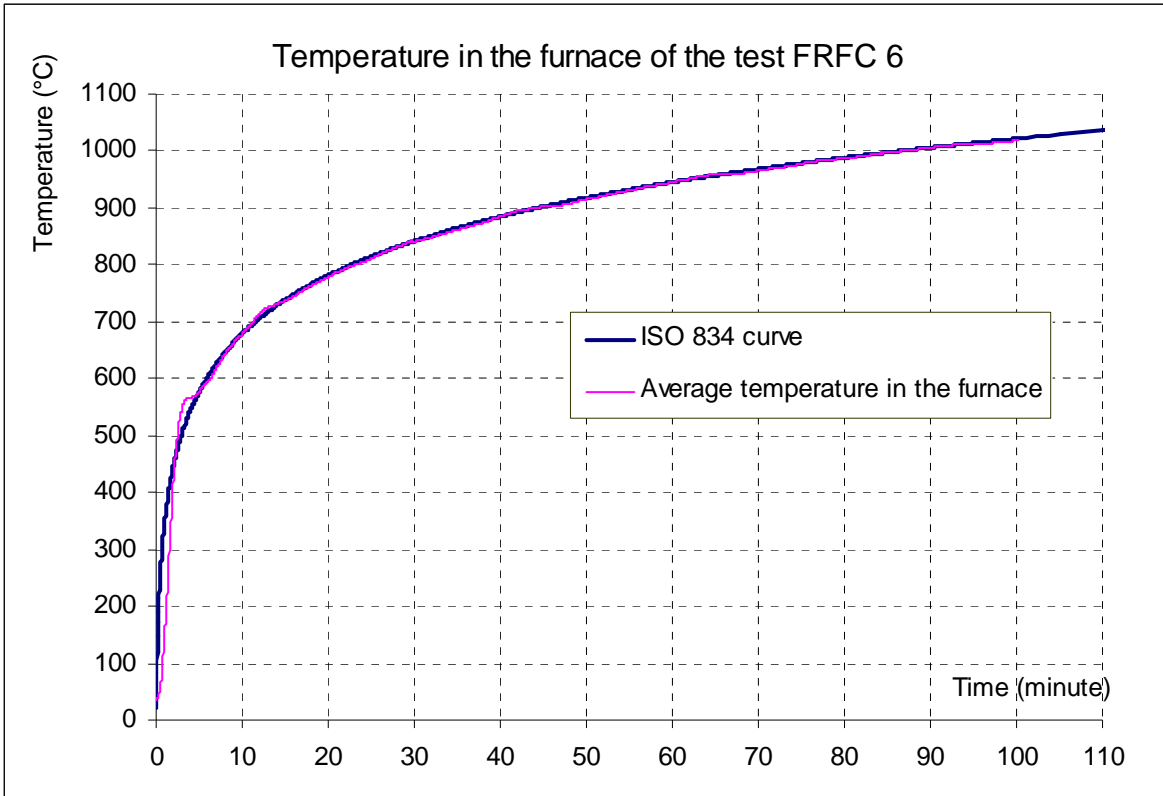


Figure A2.76. Temperatures in the furnace of the test FRFC 6

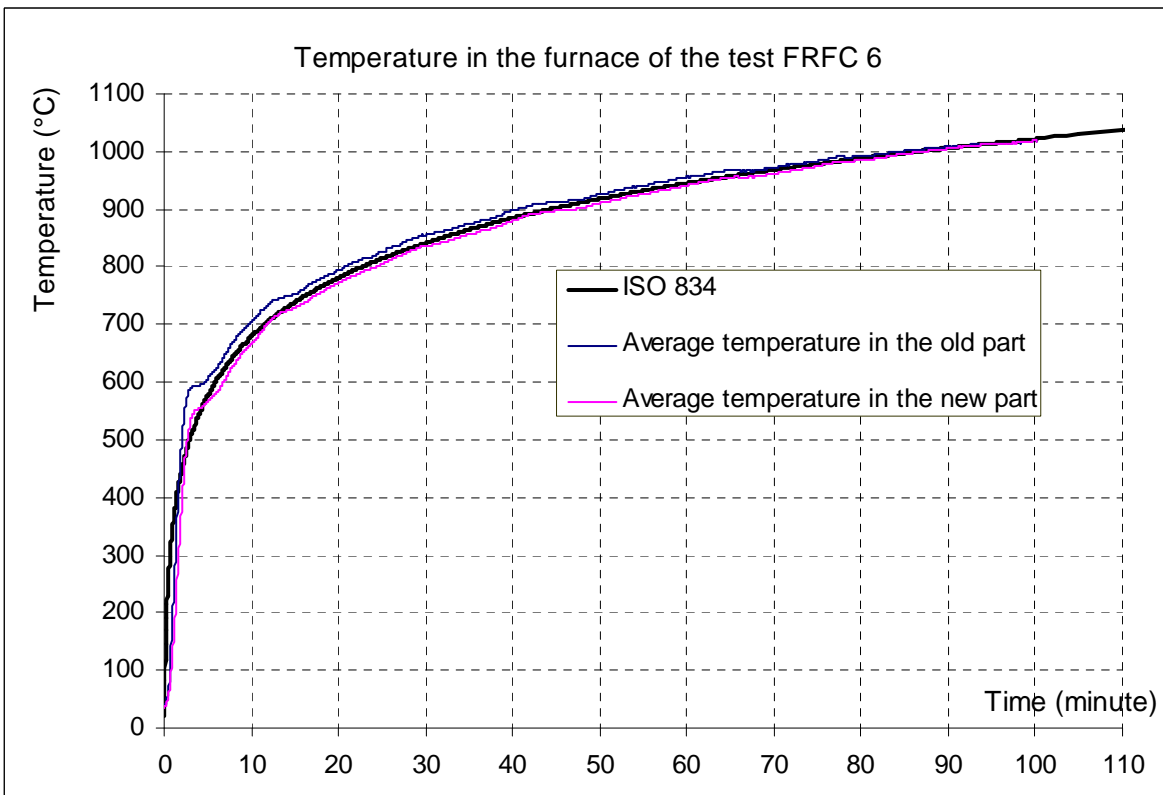


Figure A2.77. Temperatures in the furnace of the test FRFC 6

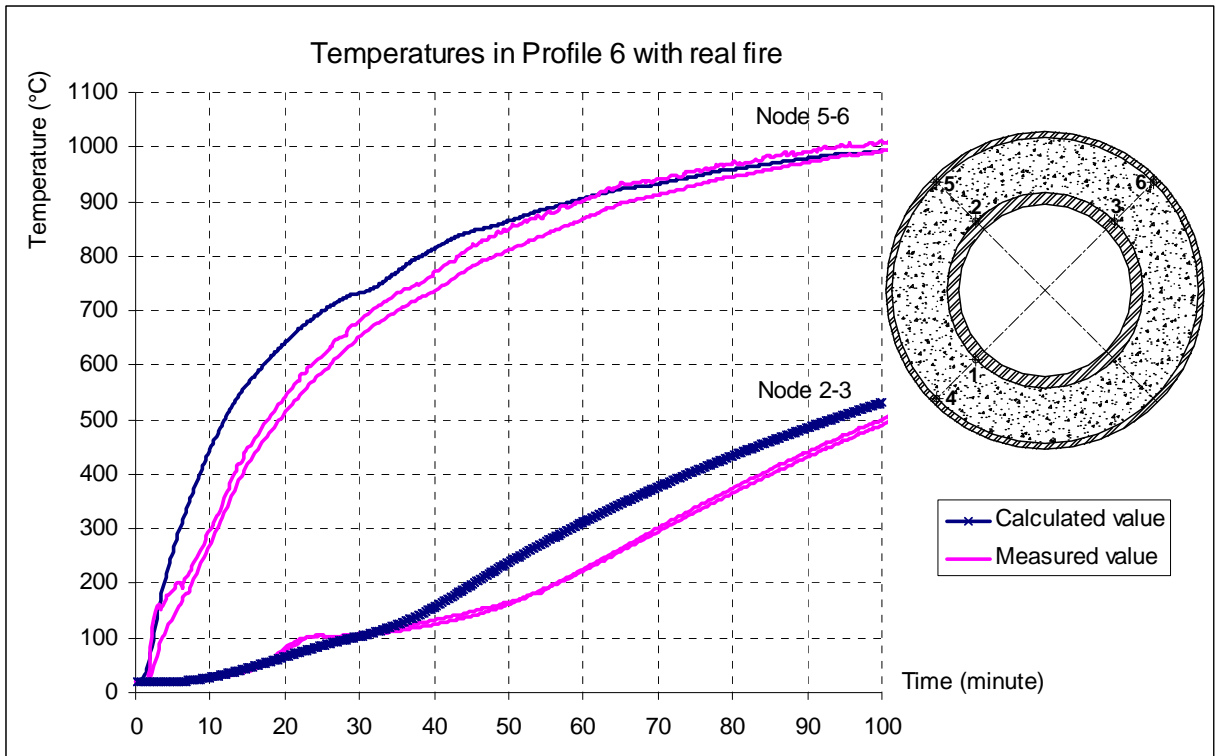


Figure A2.78. Temperatures in the section of the test FRFC 6 with the value of water content in concrete is 6% in weight

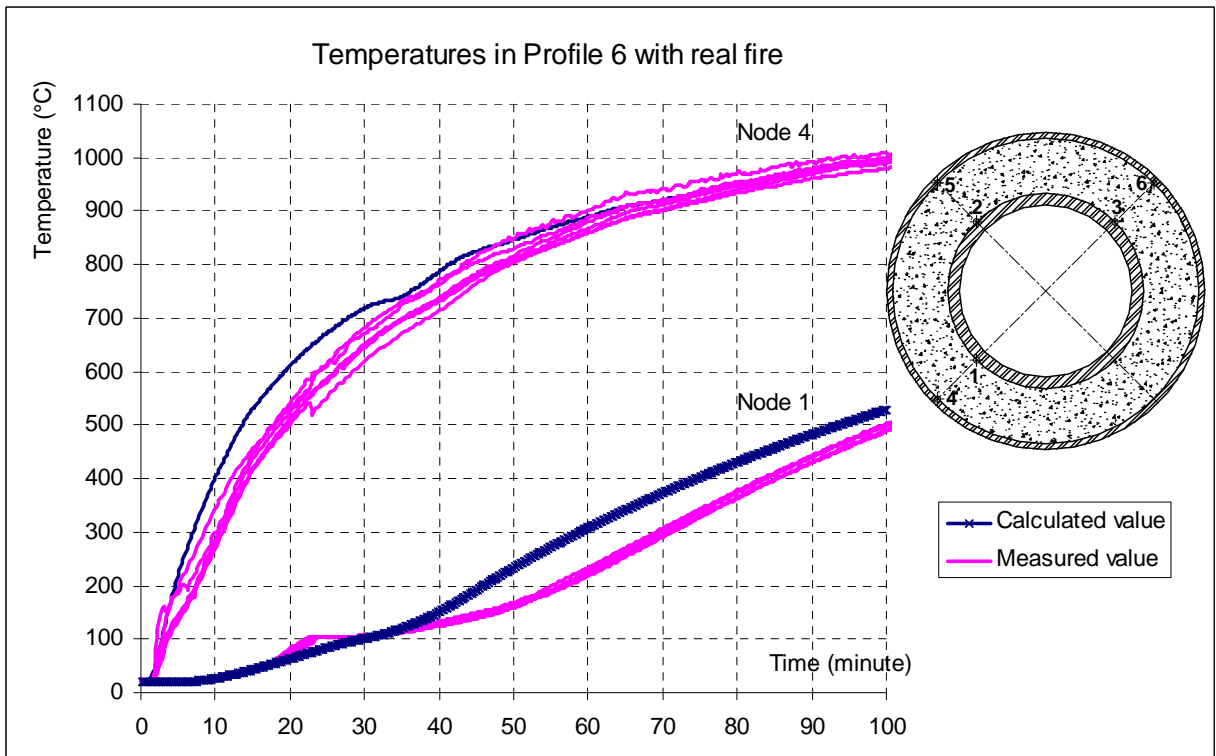


Figure A2.79. Temperatures in the section of the test FRFC 6 with the value of water content in concrete is 6% in weight

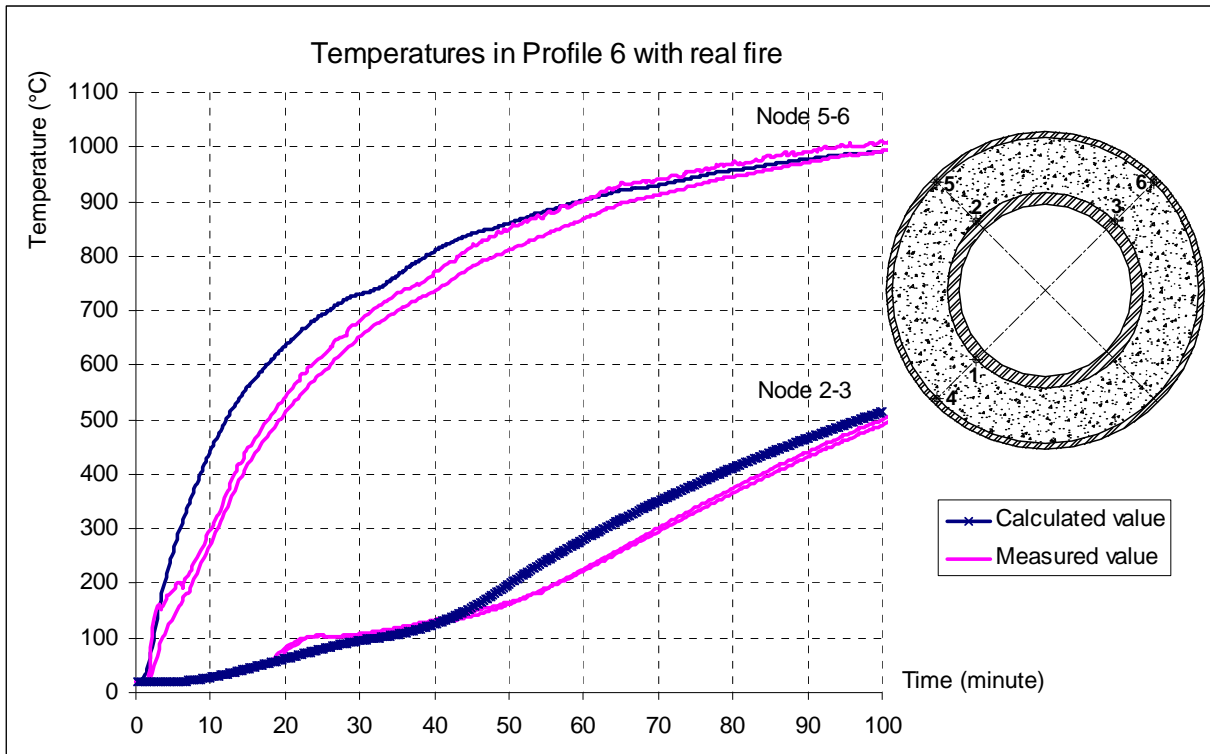


Figure A2.80. Temperatures in the section of the test FRFC 6 with the value of water content in concrete is 9% in weight

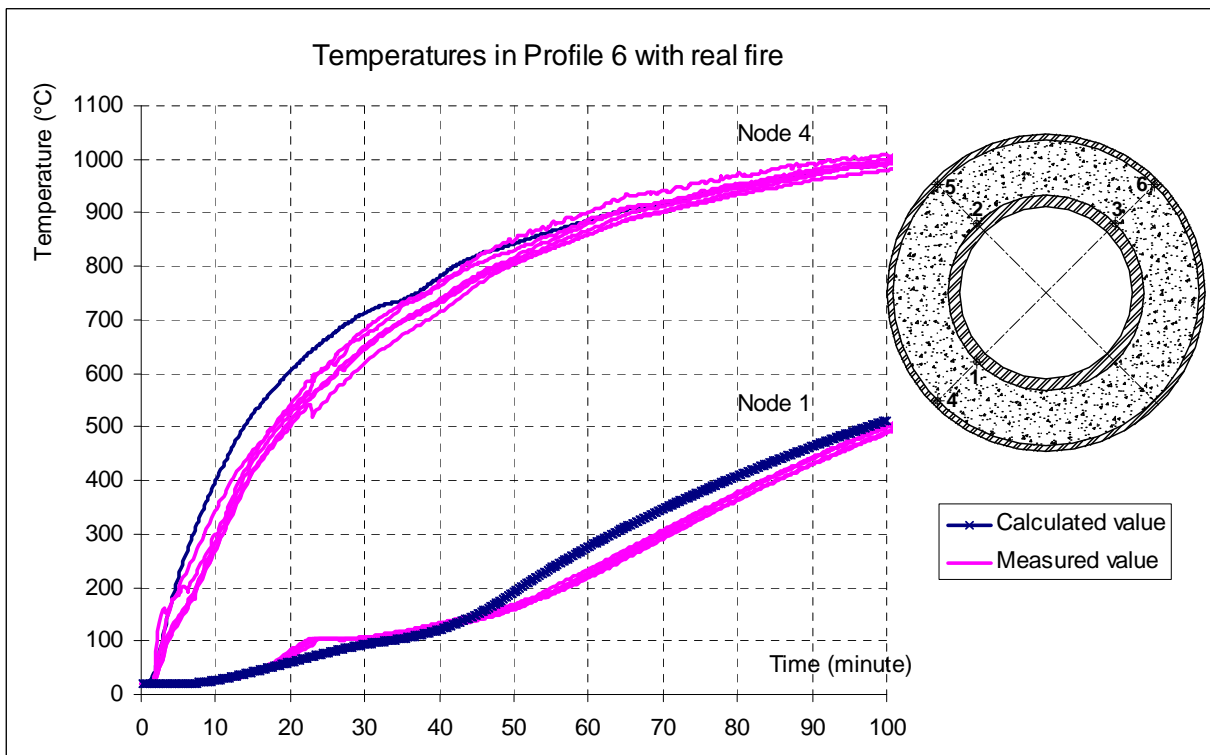


Figure A2.81. Temperatures in the section of the test FRFC 6 with the value of water content in concrete is 9% in weight



Picture A2.12. The columns FRFC 6 after the test



Picture A2.13. The upper end of the column FRFC 6 after the test.