THERMAL RESTRAINT EFFECTS ON THE FIRE RESISTANCE OF STEEL AND COMPOSITE STEEL AND CONCRETE COLUMNS

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INTRODUCTION

Fire resistance of columns is influenced by the restraint to their axial thermal elongation. Two types of tests, one at the Faculty of Sciences and Technology of the University of Coimbra (FCTUC) and onother at the BAM Federal Institute for Materials Research an Testing, have been executed. While at FCTUC the restraint effect is realized by means of a real restraining frame located outside the furnace, the BAM test facility makes use of a hybrid sub-structuring system, where the column specimen is tested inside a furnace and the remaining structure is numerically simulated by a computer model.

1. EXPERIMENTAL SET-UP – FCTUC (s. Fig. 1)

Realization of elastic restraint of thermal elongation by restraining frame of variable stiffness (1)

Application of load by hydraulic jack (2) controlled by servo hydraulic system with 1 MN load cell (6)

Application of thermal action through modular electric furnace (3) closely following the ISO 834 curve

Measurement of restraining forces via load cell of 3 MN (4)

Measurement of displacements and rotations by LVDT's (5) orthogonally arranged in three different points

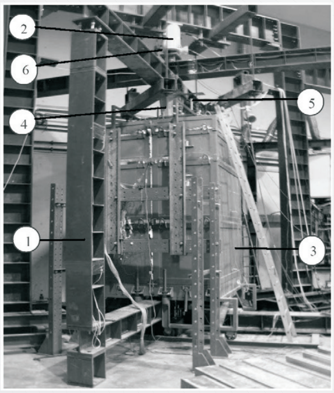

Fig. 1: Experimental Set-Up at FCTUC

2. EXPERIMENTAL CONCEPT – BAM (s. Fig. 2)

Realization of elastic restraint of thermal elongation via substructuring method:

1. Read measured forces
2. Compute target displacements via simulated substructure
3. Impose target displacements

Application of mechanical and thermal actions through column furnace

Thermal set point known function of time (ISO 834 curve)

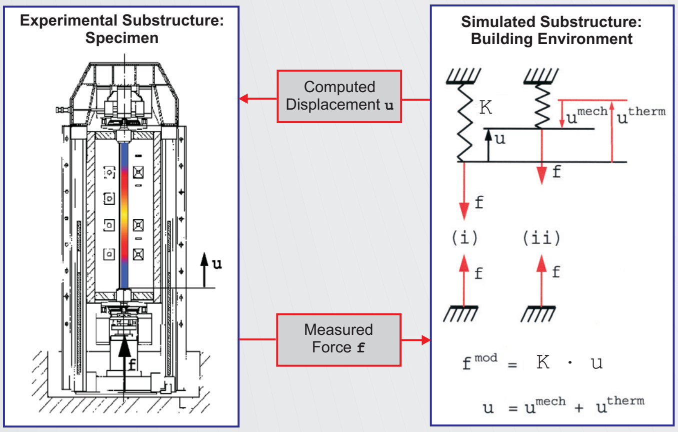

Fig. 2: Experimental Set-Up at BAM

3. SPECIMENS (s. Table 1 and Fig. 3)

Purpose: Comparison of the performance of experimental systems at FCTUC and BAM through fire resistance tests (4 tests at FCTUC, 4 tests at BAM) on steel and composite steel and concrete columns

Table 1: Test Parameters

Reference	FCTUC1	FCTUC2	FCTUC3	FCTUC4	BAM1	BAM2	BAM3	BAM4
Type	steel		composite		steel		composite	
Section	HEA160	HEA200	HEA160	HEA200	HEA140	HEB180	HEA200	HEA200
Stiffness kN/mm	68.07	68.07	68.07	68.07	46.98	69.54	11.08	58.97
Initial load kN	606.69	885.58	591.36	1022.84	492.38	1052.00	1202.78	1199.71

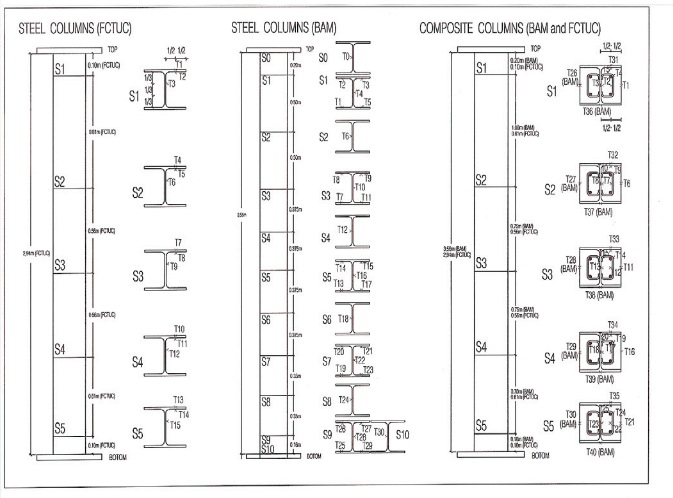

Fig. 3: Specimens in FCTUC and BAM Tests

5. RESULTS - TEMPERATURES (s. Fig. 4, 5, 6 and 7)

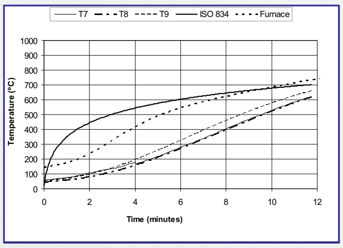

Fig. 4: FCTUC2 -Section S3

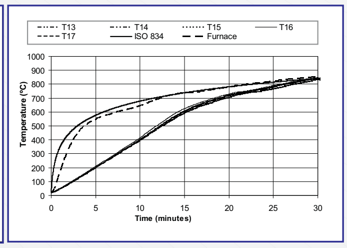

Fig. 5: BAM2 - Section S5

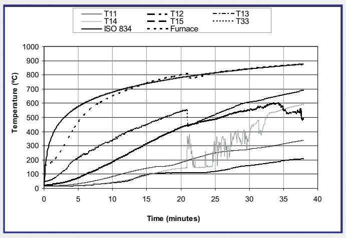

Fig. 6: FCTUC4 -Section S3

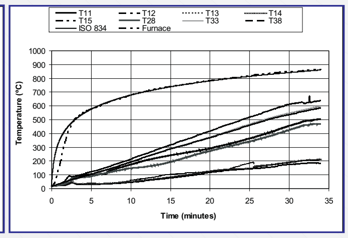

Fig. 7: BAM3 - Section S5

6. RESULTS - RESTRAINING FORCES (s. Figures 8 and 9)

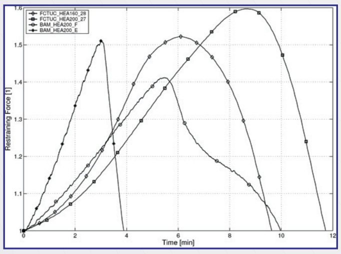

Fig. 8: Restraining Forces - Steel

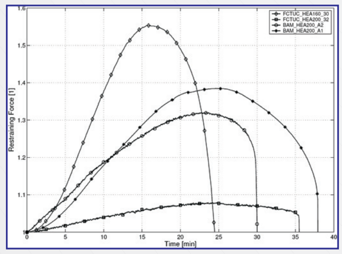

Fig. 9: Restraining Forces - Composite

7. CONCLUSIONS

- More insight into the behaviour of steel and composite steel and concrete columns subjected to fire
- The higher the surrounding structure stiffness the higher the restraining forces and less fire resistance for steel and compostite columns
- The lower the slendernes the higher the fire resistance for steel and compostite columns

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