TABLE OF CONTENTS

1. INTRODUCTION 1
1.1. BACKGROUND 2
1.1.1. Practical applications 4
1.1.2. Advantages of SR-CFST columns 6
1.2. FIRE BEHAVIOUR OF SR-CFST COLUMNS 7
2. STATE OF THE ART 9
2.1. GENERAL 10
2.2. NUMERICAL MODELS 11
2.3. EXPERIMENTAL INVESTIGATIONS 12
2.3.1. Post-fire experimental investigations 12
2.3.2. Thermo-mechanical experimental investigations 14
2.4. AVAILABLE CALCULATION METHODS 15
3. AIM AND SCOPE OF THIS THESIS 19
3.1. AIM OF THIS THESIS 20
3.1.1. Specific objectives 20
3.2. SCOPE AND LIMITATIONS OF THIS THESIS 21
4. EXPERIMENTAL PROGRAM 23
4.1. SPECIMEN PREPARATION 24
4.2. POST-FIRE STUB COLUMNS TESTS 25
4.2.1. Test specimens 25
4.2.2. Thermal test set-up 26
4.2.3. Mechanical test set-up 27
4.2.4. Test procedure 28
4.2.5. Results 28
4.2.6. Proposed design procedures 38
4.3. THERMO-MECHANICAL STUB COLUMN TESTS 42
4.3.1. Test specimens 42
4.3.2. Test set-up 44
4.3.3. Results 46
5. DEVELOPMENT OF THE NUMERICAL MODEL 55
5.1. CHARACTERISTICS OF THE NUMERICAL MODEL 56
5.1.1. Geometry and finite element mesh 56
5.1.2. Material properties at elevated temperatures 58
5.1.3. Thermal contacts 59
5.1.4. Mechanical contacts 60
5.1.5. Analysis procedure 60
5.2. SECTIONAL THERMAL MODEL 63
5.2.1. Validation 63
5.2.2. Sensitivity analysis 68
5.3. THREE-DIMENSIONAL THERMO-MECHANICAL MODEL 71

5.3.1. Validation 71
5.3.2. Sensitivity analysis 74

6. PARAMETRIC STUDIES 81

6.1. THERMAL PARAMETRIC STUDIES 82
6.1.1. Cases of the parametric studies 82
6.1.2. Sectional integration for computing plastic resistance and stiffness 83
6.1.3. Analysis of results 83

6.2. THERMO-MECHANICAL PARAMETRIC STUDIES 88
6.2.1. Cases of the parametric studies 88
6.2.2. Analysis of results 89

7. DEVELOPMENT OF A SIMPLIFIED CALCULATION METHOD FOR SR-CFST STUB COLUMNS EXPOSED TO FIRE 95

7.1. REVIEW OF EXISTING DESIGN GUIDANCE 96
7.2. A NEW THERMAL CALCULATION METHOD FOR FIRE EXPOSED SR-CFST COLUMNS 97
7.2.1. Simplified cross-sectional temperature field proposal for SR-CFST columns 97
7.2.2. Applicability limits of the proposed method 107

7.3. A NEW THERMO-MECHANICAL CALCULATION METHOD FOR AXIALLY LOADED SR-CFST STUB COLUMNS EXPOSED TO FIRE 108
7.3.1. Simplified thermo-mechanical proposal for axially loaded SR-CFST columns 108
7.3.2. Applicability limits of the proposed method 111

8. CONCLUSIONS 113

8.1. SUMMARY AND GENERAL CONCLUSIONS 114
8.2. SPECIFIC CONCLUSIONS 115
8.3. FUTURE WORK 117

REFERENCES 119
ANNEX I: COMPENDIUM OF PUBLICATIONS 129