

Table of contents

Acknowledgements	3
Abstract	5
Resumen	7
Resum	9
Doctoral Thesis Modality	11
Table of contents	13
List of notations and acronyms	19
Chapter 1. Introduction	21
1. Background	22
2. Motivation and problem statement	23
3. Current status	25
3.1. General framework for residual prestress assessment	25
3.2. Destructive testing methods	27
3.3. Minimally invasive concrete-based testing methods	28
3.4. Method selection framework	29
3.5. Conceptual and mechanical basis of the Saw-Cut Test	30
3.6. Research gap and positioning of this Doctoral Thesis	33
4. Objectives	34
5. Structure of the document	35
6. References	37

Chapter 2. Conceptual Basis and Evaluation of Concrete Strain Changes by Saw-Cutting [1st paper]	43
Abstract	47
1. Introduction	48
2. General aspects	51
2.1. Specimens and testing set-up	51
2.2. Equipment and instrumentation devices	53
3. Preliminary experimental works	56
3.1. Prototype 1	56
3.2. Prototype 2	57
3.3. Prototype 3	58
4. Basis for improving sct implementation and methodology	60
4.1. Rationale of the measurement approach	60
4.2. Specific cutting support device	64
5. Experimental program and results	66
5.1. PCB-1: validating SCT through redundancy	66
5.2. PCB-2: validating SCT through reproducibility	75
5.3. PCB-3 and PCB-4: validating SCT through repeatability	77
6. Conclusions	81
Acknowledgment	81
References	82
Appendix A – List of acronyms	87
Appendix B – List of notations	87
B.1. General	87
B.2. Displacements	88
B.3. Measurements	88
Appendix C – Additional figures	89
Chapter 3. Saw-Cut Testing Procedure, Equipment, Instrumentation, and Implementation [2nd paper]	93
Abstract	97
1. Introduction	98
2. Saw-cut method	100

3. Experimental test	102
3.1. Specimen design and materials	102
3.2. Test equipment and measuring devices	104
3.3. Instrumentation layout	108
3.4. Casting and prestressing of the specimen	113
3.5. Saw-cutting test development	114
3.6. Detensioning of specimen	116
4. Experimental results	116
4.1. Absolute displacements	116
4.2. Relative displacements	117
4.3. Strain changes	122
5. Conclusions	126
Acknowledgments	128
References	128
List of notations and acronyms	132
Chapter 4. Experimental and Numerical Validation of the Saw-Cut Method [3rd paper]	133
Abstract	137
1. Introduction	138
2. Experimental test	140
2.1. Specimen design and materials	140
2.2. Measurement methodology and instrumentation layout	141
2.3. Casting and prestressing the specimen	143
2.4. SCT methodology	145
3. Modelization and validation	146
3.1. Geometry	146
3.2. Constitutive models	149
3.3. Finite element classes	151
3.4. Loads and boundary conditions	152
3.5. Mesh	152
3.6. Analysis procedure	153
4. Results and discussion	154
4.1. Displacements at the top surface	154
4.2. Displacements at the lateral surface	159
4.3. Strain changes at the top surface	165
4.4. Strain changes at the lateral surface	168
4.5. Stress changes at the top surface	171
4.6. Stress changes at the lateral surface	174

4.7. Discussion	177
5. Conclusions	178
Acknowledgments	179
References	180
List of notations and acronyms	184
Chapter 5. Comprehensive Experimental Program Reproducing Various Stress States [4th paper]	185
Abstract	189
1. Introduction	190
2. Experimental program	192
2.1. Specimens	192
2.2. Materials	193
2.3. Experimental campaign	193
3. Saw-cut methodology	194
3.1. Fundamentals	194
3.2. Instrumentation	195
3.3. Measurement procedures	197
3.4. Test procedure	198
4. Results and analysis	200
4.1. Prestressing stage	200
4.2. Saw-cut stage	203
4.3. Prestress removal stage and recovery results	209
5. Discussion	211
5.1. Complete concrete strain profile	211
5.2. Concrete stress-release profile	213
5.3. SCT reliability	215
6. Conclusions	216
Acknowledgments	218
References	218
List of notations and acronyms	223

Chapter 6. Probabilistic Framework for Interpreting Saw-Cut Tests	
[5th paper]	225
Abstract	229
1. Introduction	230
2. Experimental database	233
3. Statistical independence of experimental variables	237
3.1. Statistical independence of experimental variables	237
3.2. Statistical characterization of stress-release measurements	239
3.3. Exceedance probability analysis	242
3.4. Log-log regression and uncertainty quantification	244
4. Probabilistic analysis of the stress-release	250
4.1. Probabilistic analysis procedure	250
4.2. Results	251
5. Discussion	255
6. Conclusions	257
Acknowledgments	258
References	259
Chapter 7. General Discussion of the Results	265
1. Introduction	266
2. Methodological basis to experimentally characterize the Isolated Concrete Block	266
2.1. Redefinition of the measurement strategy	266
2.2. The Reference Point (RP)	267
2.3. Multi-Gauge-Length Evaluation	268
3. Saw-Cut Testing implementation	269
3.1. Validation of the external reference point	269
3.2. Mechanical interpretation of the strain-relief mechanism	270
3.3. Methodological robustness of the cutting configuration	270
3.4. Mechanical evolution of the ICB	271
4. Experimental-Numerical validation of the SCT	272
4.1. Consistency of the reference framework	272
4.2. Unloading-controlled decompression	273
4.3. Through-depth stress redistribution	274
4.4. Mechanical representation of the SCT response	275

5. Robustness and generalization of the SCT	277
5.1. Stress-states variability	277
5.2. Stability of the measurement framework	277
5.3. Decompression and normalized interpretation	278
6. Probabilistic approach for the SCT interpretation	280
6.1. Statistical foundation of the probabilistic model	280
6.2. Independence from prestress history variables	280
6.3. Governing stochastic law of stress release	281
6.4. Fragility-based interpretation and decision support	282
7. Domain of validity and identified limitations	284
7.1. Geometric scope of validation	284
7.2. Measurement resolution and small-base limitations	286
8. Integrative closing remarks	286
9. References	287
Chapter 8. Conclusions and Further Research	291
1. Conclusions	292
2. Further research	295
Appendix. Compilation of References [in alphabetical order]	299