

Table of contents

Acknowledgements.....	5
Zusammenfassung.....	10
Abstract	12
1 Introduction.....	14
2 Literature review.....	17
2.1 The separation of architecture and engineering.....	17
2.1.1 Theory and design of structures	17
2.1.2 Structure and form in modern and post-modern architecture.....	19
2.2 Concrete shell structures built between the 1920s and the 1970s.....	20
2.2.1 Tile vaulting.....	21
2.2.2 Design	22
2.2.3 Construction.....	25
2.3 Recent concrete shell structures	26
2.3.1 Crematorium in Kakamigahara	27
2.3.2 Rolex Learning Center	27
2.3.3 The Jubilee Church	29
2.4 Recent developments	29
2.4.1 Architectural geometry	30
2.4.2 Computational structural design.....	30
2.4.3 Digital fabrication.....	31
2.5 The CASTonCAST system.....	33
2.5.1 Fabrication technique	34
2.5.2 Geometric method.....	35
3 Scope of research	36
3.1 Research objectives.....	36
3.2 Research approach.....	37
4 Prototype	38
4.1 Design.....	39
4.1.1 Geometry.....	40
4.1.2 Structure.....	41
4.2 Fabrication	42
4.3 Construction	45

5	Method for the design of CASTonCAST shell structures	49
5.1	Concept	49
5.2	Process	50
5.3	Version 1	51
5.4	Version 2	55
	5.4.1 Structural analysis	55
	5.4.2 Results	56
6	Load path network method.....	58
6.1	Introduction.....	58
6.2	Method	60
	6.2.1 Static determinacy of a single-node three-dimensional structure.....	60
	6.2.2 Construction of three-dimensional load paths	62
6.3	Analysis	65
	6.3.1 Load path.....	65
	6.3.2 Form.....	72
	6.3.2 Load.....	73
6.4	Design of post-tensioned shell structures.....	73
	6.4.1 Prestressing.....	75
	6.4.2 Method.....	78
6.5	Modelling.....	79
7	Method for the design of CASTonCAST shell structures	
	based on load path network method	83
7.1	Introduction	83
7.2	Analysis approach	84
	7.2.1 Influence of the form	88
	7.2.2 Influence of the load path.....	90
7.3	Form-finding approach	92
7.4	Design exploration	94
8	Conclusions	97
8.1	Overview	97
8.2	Prototype.....	97
	8.2.1 Limitations and future work.....	98
8.3	Design of CASTonCAST shell structures	99
	8.3.1 Limitations and future work.....	100
8.4	Load path network method.....	100
	8.4.1 Limitations and future work.....	101
8.5	Final remarks	101
	Bibliography.....	104