

Contents

1. Introduction	1
1.1. Background	1
1.2. Motivation	2
1.3. Objectives	3
1.3.1. Main Objective	3
1.3.2. Specific Objectives	3
2. Literature Review	4
2.1. FRC and concrete	4
2.1.1. Reinforced concrete and its properties	4
2.1.2. Fibers as reinforcement	5
2.2. PVA fiber reinforced concrete	7
2.2.1. Pullout test	8
2.2.2. Fiber's Distribution	9
2.2.3. Aggregate Size	10
2.2.4. Compressive Strength	12
2.2.5. Tensile Strength	16
2.2.5.1. Indirect Tensile Test	17
2.2.5.2. Direct Tensile Test	20
2.3. Water-cement ratio	24
2.4. 2D Digital Image Correlation	25
3. Analytical Model	27
3.1. Materials	27
3.1.1. Concrete	27
3.1.1.1. Unconfined concrete	27
3.1.1.2. Confined concrete	28
3.1.2. Steel	30
3.2. Beam modeling	33
3.2.1. E-SFI element	34
4. Experimental design	36
4.1. Mix design	36
4.1.1. Materials	36
4.1.2. Fibers used	37
4.1.3. Sieve Analysis	39
4.1.3.1. Fine sand	40
4.1.3.2. Coarse sand	41

4.1.3.3.	Gravel	43
4.1.3.4.	Mixture Sieve curve	44
4.2.	Tensile test of steel reinforcement bars	45
4.3.	Mixing procedure	46
4.4.	Test results	48
4.4.1.	Preliminary tests	48
4.4.2.	Results	49
4.4.3.	Concrete compression test	50
4.4.4.	Indirect tensile test	59
4.5.	Beam pushover test	65
4.5.1.	Ultimate and cracking strength	68
4.5.2.	DIC beam analysis	69
4.5.2.1.	Error analysis	69
4.5.2.2.	DIC strain data	71
4.5.2.2.1.	Shear beam	71
4.5.2.2.2.	Flexural beam	74
4.5.2.3.	DIC displacement data	77
4.5.3.	Physical instruments	80
4.5.3.1.	Flexural Beam	80
4.5.3.2.	Shear Beam	82
4.5.4.	Measurement comparison	83
5.	Beam analytical model	87
5.1.	Material calibration	87
5.1.1.	Reinforcing steel	87
5.1.2.	Concrete	89
5.2.	Sensitivity analysis	92
5.3.	Model's results	94
5.3.1.	Long beams	95
5.3.2.	Short beams	98
5.3.3.	Model strain fields	100
5.3.3.1.	Shear beam	101
5.3.3.2.	Flexural beam	104
6.	Conclusion	107
	List of terms	110
	Bibliography	112
	Appendix	116
A.	Preliminary tests	116
A.1.	Preliminary test #1	116
A.2.	Preliminary test #2	119
A.2.1.	Compression test	119
A.2.2.	Direct tensile test	121

B. Ncorr methodology	124
C. Detailed compression results	128
D. DIC analysis results	130
D.1. Long beam with plain concrete	130
D.2. Long beam with PVA fiber	132
D.3. Short beam with plain concrete	134
D.4. Short beam with PVA fiber	136
E. E-SFI strain field	138
E.1. Long beam with plain concrete	139
E.2. Long beam with PVA fiber	141
E.3. Short beam with plain concrete	143
E.4. Short beam with PVA fiber	145