Ref.	Specimen	b_w (mm)	d (mm)	A_s (mm^2)	A_{sw} (mm^2)	i_{sw} (mm)	Fabric	n_f	t_f (mm)	s_f (mm)	w_f (mm)	f_{cm} (MPa)	E_f (MPa)	ε_{fu} (%)	V_{uexp} (kN)	V_{fexp} (kN)	ε_{feexp} (%)
ESC [25]	V-GPHDM-01	300	254	603	50	500	glass	1	0.042	500	500	34.07	90	2.90	102.22	39.33	0.720
	V-BR3-01	300	254	603	50	500	basalt	1	0.053	500	500	33.78	95	3.15	98.48	36.12	–
	V-BR3-02	300	254	603	50	500	basalt	1	0.053	500	500	33.78	95	3.15	60.69	-	0.200
	V-CONTROL	300	254	603	50	500	-	-	-	-	-	40.85	-	–	75.41	-	–
GOL [30]	S1-FRCM-F3-UN	150	250	2124	50	300	carbon	1	0.047	750	750	15.30	240	1.80	142.40	27.20	0.482
	S1-FRCM-F4-UN	150	250	2124	50	300	steel	1	0.270	750	750	15.30	190	1.60	149.70	44.39	0.173
	S1-CONTROL	150	250	2124	50	300	-	-	-	-	-	15.30	-	–	115.20	-	–
TET [20]	CON	102	177	402	-	-	-	-	-	-	-	21.60	-	–	29.68	-	–
	UW_M1	102	177	402	-	-	carbon	1	0.095	460	460	23.80	225	1.80	44.80	12.10	0.16
	UW_M2	102	177	402	-	-	carbon	2	0.095	460	460	23.80	225	1.80	68.86	36.16	0.23
	UW_M3	102	177	402	-	-	carbon	3	0.095	460	460	22.60	225	1.80	75.11	44.06	0.19
AZA [33]	C-N	150	307.5	998	-	-	-	-	-	-	-	37.50	-	–	61.75	-	–
	UW-GT	150	307.5	998	-	-	glass	1	0.095	2000	2000	37.50	75	2.80	90.10	28.35	0.647
	UW-CT1	150	307.5	998	-	-	carbon	1	0.047	2000	2000	37.50	230	1.60	75.90	14.15	0.213
	UW-CT2	150	307.5	998	-	-	carbon	1	0.047	2000	2000	37.50	230	1.60	126.70	64.95	0.977
CON [31]	R30	150	225	942	28	200	-	-	-	-	-	30.80	-	–	79.00	-	–
	C-UJ-HI-TRC(5)	150	225	942	28	200	glass	1	0.055	500	500	30.80	80	2.90	109.50	30.88	0.156
	S-UJ-HI-TRC(5)	150	225	942	28	200	glass	1	0.055	40	246	31.30	80	2.90	85.00	5.11	0.159
	R40	150	225	942	28	200	-	-		-	-	42.30	-	–	114.50	-	–
	C-UJ-HI-TRC(5)	150	225	942	28	200	glass	1	0.055	100	266	42.30	80	2.90	125.50	11.00	0.148
	S-UJ-HI-TRC(5)	150	225	942	28	200	glass	1	0.055	500	500	42.30	80	2.90	117.50	3.00	0.152
BOU [28]	CON_20	102	177	402	-	-	-	-	-	-	-	21.60	-	–	29.79	-	–
	UW_MCL3_20	102	177	402	-	-	carbon	3	0.062	460	460	20.80	225	1.60	67.60	38.91	0.263
	UW_MG7_20	102	177	402	-	-	glass	7	0.044	460	460	20.00	74	1.60	82.50	54.91	0.681
	CON	200	385	2513	-	-	-	-	-	-	-	14.00	-	–	93.38	-	–
	CH4_20	200	385	2513	-	-	carbon	4	0.095	880	880	14.00	225	1.60	225.73	132.3	0.201

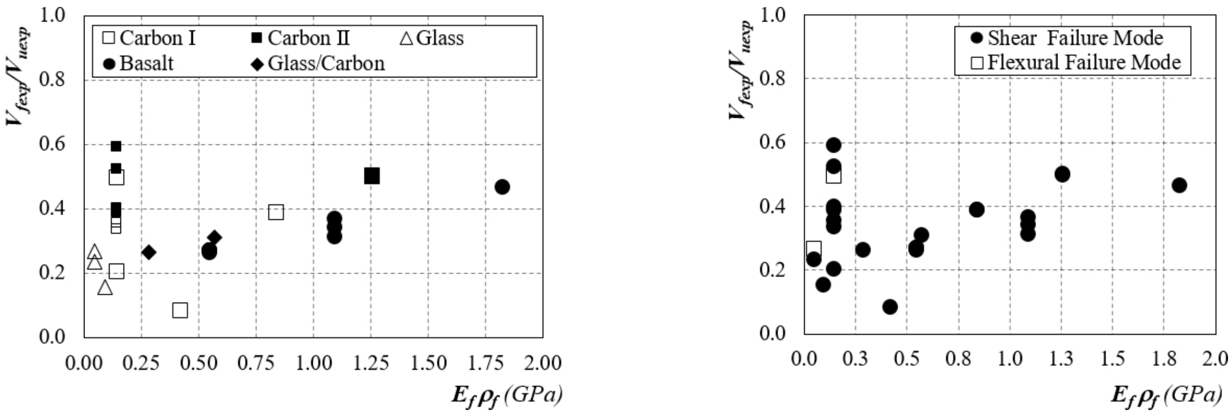
Ref.	Specimen	b_w (mm)	d (mm)	A_s (mm^2)	A_{sw} (mm^2)	i_{sw} (mm)	Fabric	n_f	t_f (mm)	s_f (mm)	w_f (mm)	f_{cm} (MPa)	E_f (GPa)	ε_{fu} (%)	V_{uexp} (kN)	V_{fexp} (kN)	ε_{feexp} (%)
TKB [21]	CON	200	385	2513	-	-	-	-	-	-	-	14.00	-	–	124.23	-	–
	CH2	200	385	2513	-	-	carbon	2	0.095	880	880	15.20	225	1.60	169.96	35.08	0.107
	CL3	200	385	2513	-	-	carbon	3	0.062	880	880	13.80	225	1.60	180.63	58.17	0.181
	G7	200	385	2513	-	-	glass	7	0.044	880	880	13.80	74	1.60	217.22		0.540
TRI [4]	C	150	272	603	24	230	-	-	-	-	-	30.50	-	–	58.25	-	–
	M1	150	272	603	24	230	carbon	1	0.047	690	690	30.50	225	1.60	100.05	41.80	0.727
	M2	150	272	603	24	230	carbon	2	0.047	690	690	30.50	225	1.60	121.90	63.65	–
SIL [29]	CONTROL	150	198	226	28	270	-	-	-	-	-	33.00	-	–	69.00	-	–
	INORGANIC	150	198	226	28	270	glass	1	0.055	530	530	33.00	73	1.60	116.50	47.50	2.30
	MORTAR	150	198	226	28	270	glass	1	0.055	530	530	33.00	74	1.60	81.00	12.00	0.74
JUN [8]	CONTROL	150	270	402	-	-	-	-	-	-	-	28.00	-	–	52.50	-	-
	W50-N4	150	270	402	-	-	glass/carbon	1	0.107	50	180	28.00	240	1.75	58.50	6.00	0.156
	W50-N5	150	270	402	-	-	glass/carbon	1	0.107	50	137.5	28.00	240	1.75	61.50	9.00	0.178
	W50-N6	150	270	402	-	-	glass/carbon	1	0.107	50	110	28.00	240	1.75	63.50	11.00	0.175
	W100-N4	150	270	402	-	-	glass/carbon	1	0.107	100	250	28.00	240	1.75	60.50	8.00	0.144
	W100-N5	150	270	402	-	-	glass/carbon	1	0.107	100	166.7	28.00	240	1.75	72.00	19.50	0.234
	W100-N6	150	270	402	-	-	glass/carbon	1	0.107	600	600	28.00	240	1.75	81.00	28.50	0.206
TZO [19]	C	150	315	763	-	-	-	-	-	-	-	20.20	-	–	57.13	-	–
	L1	150	315	763	-	-	carbon	1	0.062	700	700	20.85	225	1.60	67.69	8.72	0.010
	L2	150	315	763	-	-	carbon	2	0.062	700	700	21.64	225	1.60	70.56	9.35	0.053
	H1	150	315	763	-	-	carbon	1	0.095	700	700	23.35	225	1.60	81.30	15.26	0.113
	H2	150	315	763	-	-	carbon	2	0.095	700	700	23.12	225	1.60	94.18	28.79	0.107
BAG [41]	C	150	300	1413	28	180	-	-	-	-	-	42.00	-	–	111.50	-	-
	Beam_4	150	300	1413	28	180	glass	1	0.055	200	275	42.00	80	1.60	147.00	35.50	1.070
BRU [18]	CONTROL	120	400	1884	50.24	200	-	-	-	-	-	32.70	-	–	295.00	-	-
	PB-1/1	120	400	1884	50.24	200	glass	2	0.095	1800	1800	28.00	80	1.75	277.00	39.58	0.326
	PB-1/2	120	400	1884	50.24	200	glass	4	0.095	1800	1800	28.00	80	1.75	277.50	40.08	0.165
	PB-1/3	120	400	1884	50.24	200	glass	6	0.095	1800	1800	28.00	80	1.75	293.00	55.58	0.112
ASK [42]	TRM-1		182.7	226	-	-	steel	1	0.254	76	126	20.68	205	1.75	31.00	1.15	0.010
	SM-1	152	182.7	226	-	-	steel	1	0.254	76	126	20.68	205	1.75	31.15	1.30	0.012
	TRM-2	152	182.7	226	-	-	steel	1	0.254	76	126	20.68	205	1.75	34.00	2.25	0.022

[1 mm = 0.0394 in; 1 kN = 224.820 lb; 1MPa=145.038 psi; 1 m^2=10.764 ft^2]

Table 2—Side bonded FRCM shear strengthened specimens

Ref.	Specimen	b_w (mm)	d (mm)	A_s (mm^2)	A_{sw} (mm^2)	i_{sw} (mm)	Fabric	n_f	t_f (mm)	s_f (mm)	w_f (mm)	f_{cm} (MPa)	E_f (GPa)	ε_{fu} (%)	V_{uexp} (kN)	V_{fexp} (kN)	ε_{feexp} (%)
TET [20]	CON_20	102	177	402	-	-	-	-	-	-	-	21.60	-	–	29.79	-	–
	SB_MCH2_20	102	177	402	-	-	carbon	2	0.095	460	460	22.60	225	1.60	50.99	19.82	0.130
	SB_MCH3_20	102	177	402	-	-	carbon	3	0.095	460	460	22.60	225	1.60	62.44	31.28	0.138
TBK [21]	CON	102	177	402	-	-	-	-	-	-	-	21.60	-	–	29.68	-	–
	SB_M1	102	177	402	-	-	carbon	1	0.095	460	460	21.60	225	1.60	32.43	2.75	0.036
	SB_M2	102	177	402	-	-	carbon	2	0.095	460	460	22.60	225	1.60	50.82	19.77	0.130
	SB_M3	102	177	402	-	-	carbon	3	0.095	460	460	22.60	225	1.60	62.39	31.34	0.138
AWA [32]	C-B	150	250	1885	-	-	-	-	-	-	-	36.00	-	–	60.30	-	–
	S0-FRCM_1	150	250	1885	-	-	carbon	1	0.047	750	750	36.00	230	2.80	126.82	66.53	1.230
	S0-FRCM_2	150	250	1885	-	-	carbon	1	0.047	750	750	36.00	230	2.80	147.52	87.22	1.613
	C-B	150	250	1885	-	-	-	-	-	-	-	36.00	-	–	107.62	-	–
	S1-FRCM_1	150	250	1885	28	150	carbon	1	0.047	750	750	36.00	230	2.80	176.02	68.40	1.265
	S1-FRCM_2	150	250	1885	28	150	carbon	1	0.047	750	750	36.00	230	2.80	179.70	72.08	1.333
	C-B	150	250	1885	-	-	-	-	-	-	-	36.00	-	–	133.28	-	–
	S2-FRCM_1	150	250	1885	28	75	carbon	1	0.047	750	750	36.00	230	2.80	200.92	67.65	1.251
	S2-FRCM_2	150	250	1885	28	75	carbon	1	0.047	750	750	36.00	230	2.80	206.85	73.58	1.361
CON [31]	R30	150	225	942	28	200	-	-	-	-	-	22.80	-	–	79.00	-	–
	S-SB-P-TRC(10)	150	225	942	28	200	glass	1	0.055	120	100	22.80	80	2.90	107.50	28.88	1.75
	S-SB-P-TRC(5)	150	225	942	28	200	glass	1	0.055	120	100	23.30	80	2.90	104.50	24.61	1.49
JUN [8]	CONTROL	150	270	402	-	-	-	-		-	-	28.00	-	–	52.50	-	–
	W600-L1	150	270	402	-	-	glass/carbon	1	0.107	2000	2000	28.00	240	1.75	71.50	19.00	0.164
	W600-L2	150	270	402	-	-	glass/carbon	2	0.107	2000	2000	28.00	240	1.75	76.00	23.50	0.102
AZA [33]	C-N	150	307.5	998	-	-	-	-	-	-	-	37.50	-	–	61.75	-	–
	SB_G	150	307.5	998	-	-	glass	1	0.095	2000	2000	37.50	75	2.80	73.15	11.40	0.260
	SB_FRCM_1	150	307.5	998	-	-	carbon	1	0.047	2000	2000	37.50	230	1.60	77.80	16.03	0.241
	SB_FRCM_2	150	307.5	998	-	-	carbon	1	0.047	2000	2000	37.50	230	1.60	122.70	60.95	0.917
ALS [27]	BS-1	150	180	314	-	-	-	-	-	-	-	20.00	-	–	30.40	-	–
	BS-2	150	180	314	-	-	basalt	2	0.064	400	400	20.00	319.4	1.75	41.33	10.93	0.074
	BS-3	150	180	314	-	-	basalt	2	0.064	400	400	20.00	319.4	1.75	41.76	11.36	0.077
	BS-4	150	180	314	-	-	basalt	4	0.064	400	400	20.00	319.4	1.75	44.37	13.97	0.047
	BS-5	150	180	314	-	-	basalt	4	0.064	400	400	20.00	319.4	1.75	46.27	15.87	0.054
	BS-6	150	180	314	-	-	basalt	2	0.064	400	400	20.00	319.4	1.75	41.69	11.29	0.077
	BS-7	150	180	314	-	-	basalt	2	0.064	400	400	20.00	319.4	1.75	41.69	11.29	0.077
	BS-8	150	180	314	-	-	basalt	4	0.064	400	400	20.00	319.4	1.75	48.13	17.73	0.060
	BS-9	150	180	314	-	-	basalt	4	0.107	400	400	20.00	319.4	1.75	57.05	26.65	0.054

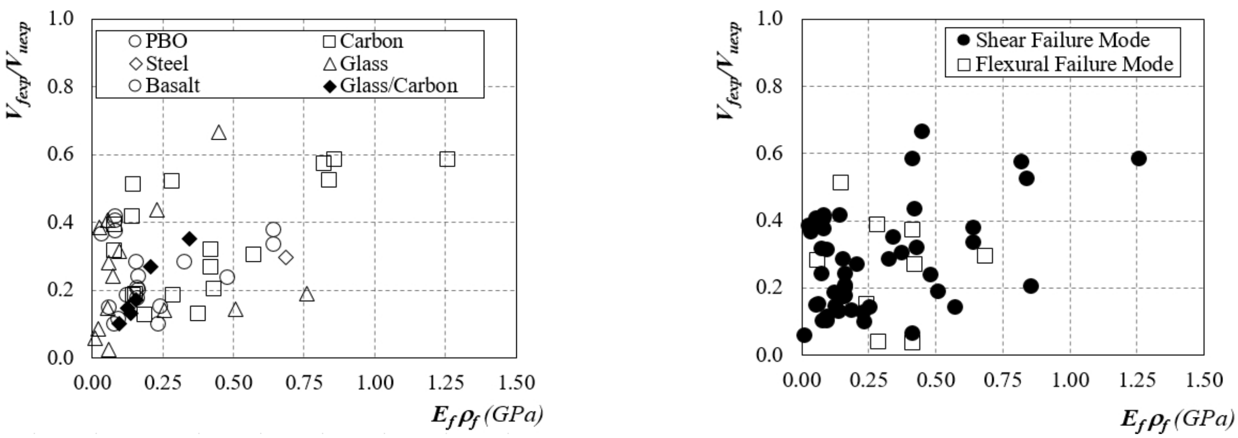
[1 mm = 0.0394 in; 1 kN = 224.820 lb; 1MPa=145.038 psi; 1 m^2=10.764 ft^2]



(a) (b)

[1 GPa = 0.145 psi]

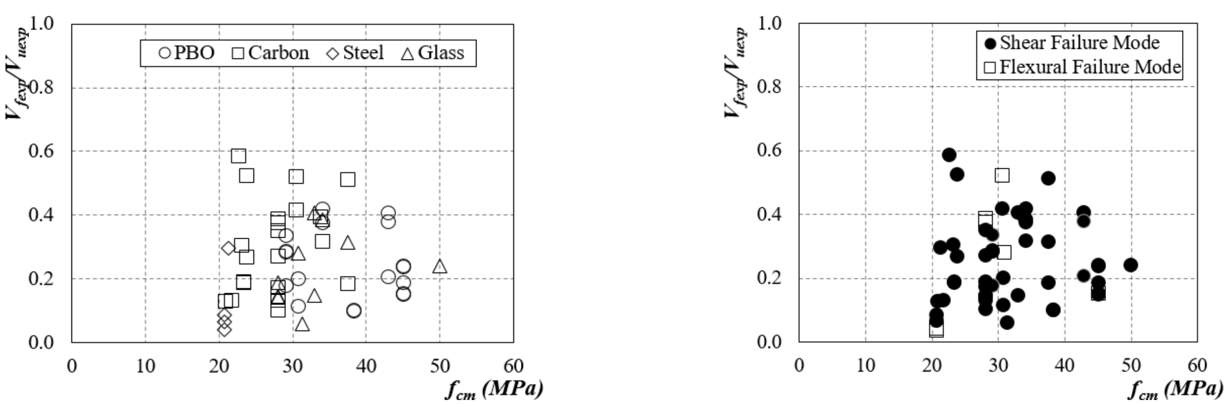
Fig. 1—Side bonded specimens: (a) variation of the ratio; (b) failure mode



(a) (b)

[1 GPa = 0.145 psi]

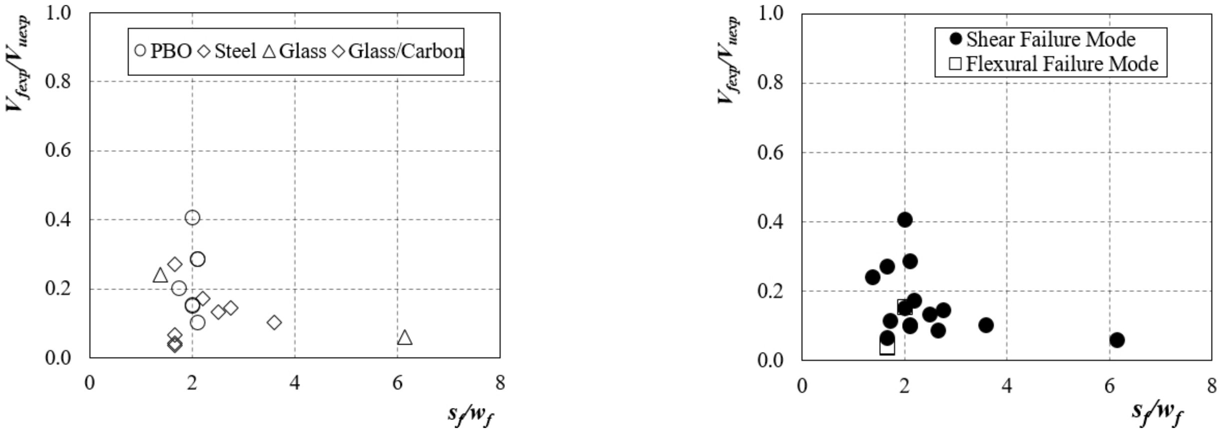
Fig. 2—U-shaped shear wraps: (a) variation of the ratio V_{fexp}/V_{uexp} with $E_f\rho_f$; (b) failure mode



(a) (b)

[1 MPa = 145.038 psi]

Fig. 3—Specimens shear strengthened with U-shaped FRCM *wraps:* (a) V_{fexp}/V_{uexp} *versus* s_f/w_f; (b) failure mode



(a) (b)

Fig. 4—Specimens shear strengthened with U-shaped FRCM wraps: (a) V_{fexp}/V_{uexp} *versus* s_f/w_f ; (b) failure mode

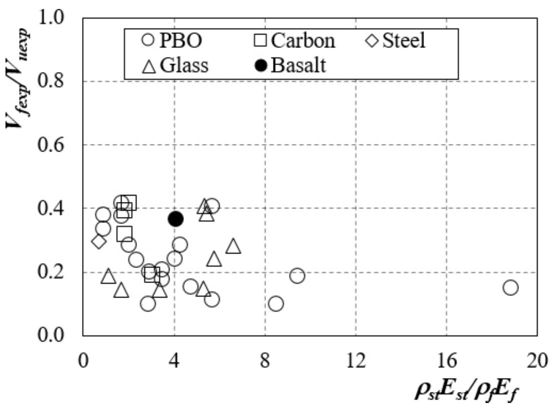


Fig. 5—Specimens strengthened in shear with U-shaped FRCM wraps: V_{fexp}/V_{uexp} versus $\rho_{st}E_{st}/\rho_f E_f$

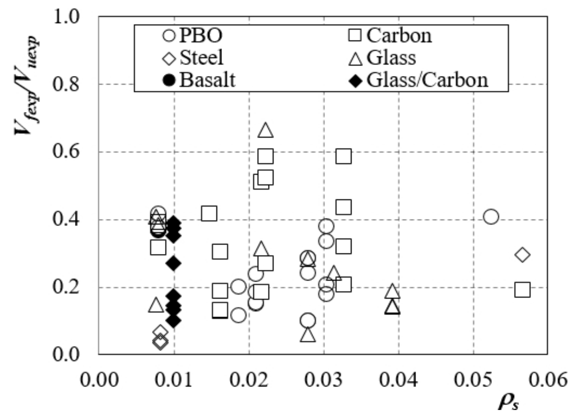
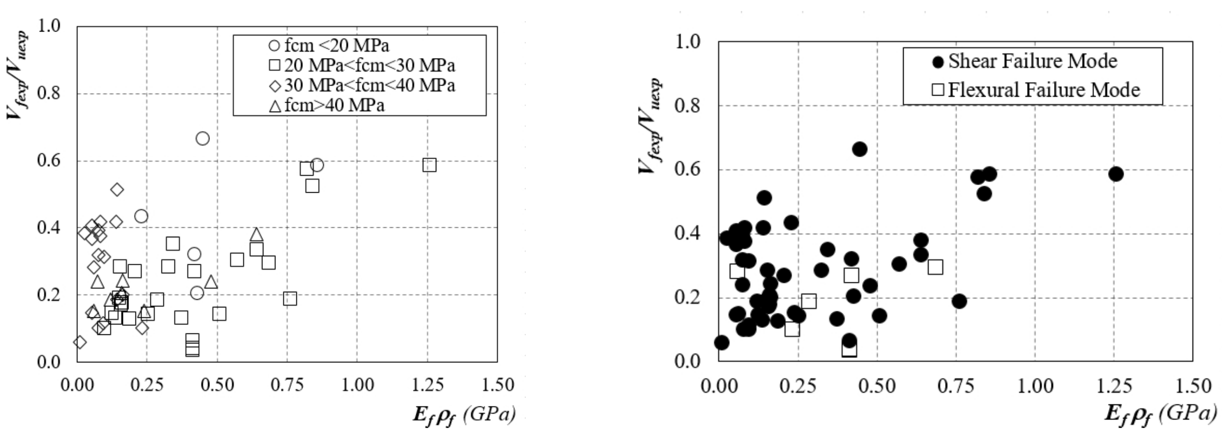


Fig. 6—Specimens strengthened in shear with U-shaped FRCM wraps: V_{fexp}/V_{uexp} versus ρ_s



(a) (b)

[1 GPa = 0.145 psi]

Fig. 7—Specimens shear strengthened with U-shaped FRCM strips: (a) variation of V_{fexp}/V_{uexp} versus $E_f\rho_f$ varying f_{cm} ; (b) failure mode

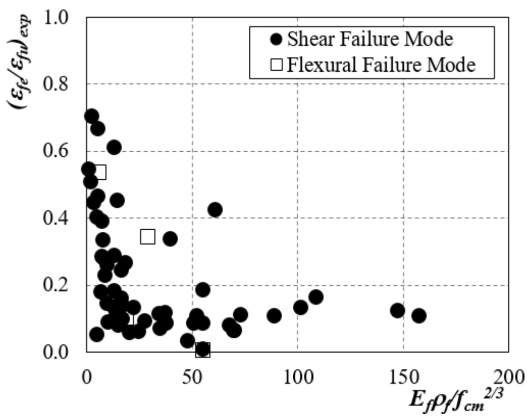


Fig. 8—Specimens shear strengthened with U-shaped FRCM wraps: $(\varepsilon_{feFRCM}/\varepsilon_{fu})_{exp}$ versus $E_f\rho_f/f_{cm}^{2/3}$

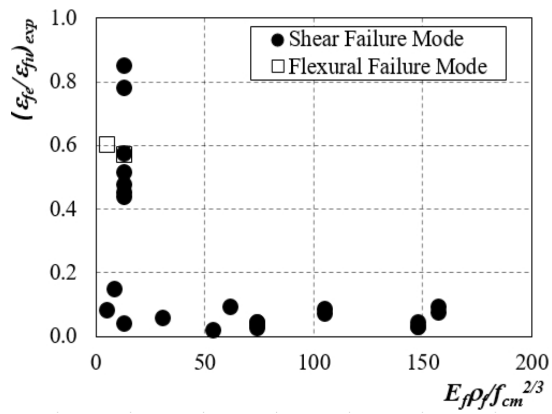


Fig. 9—Specimens shear strengthened with side bonded FRCM wraps: $(\varepsilon_{feFRCM}/\varepsilon_{fu})_{exp}$ versus $E_f\rho_f/f_{cm}^{2/3}$

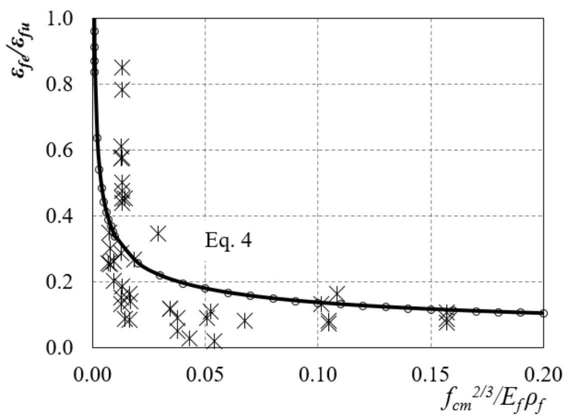


Fig. 10—Specimens strengthened with non-coated fibers: comparison between predicted and experimental results

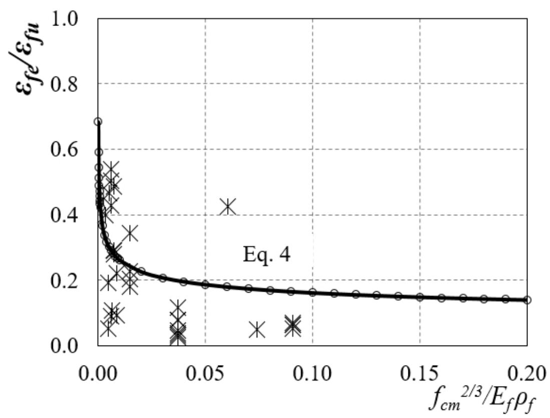
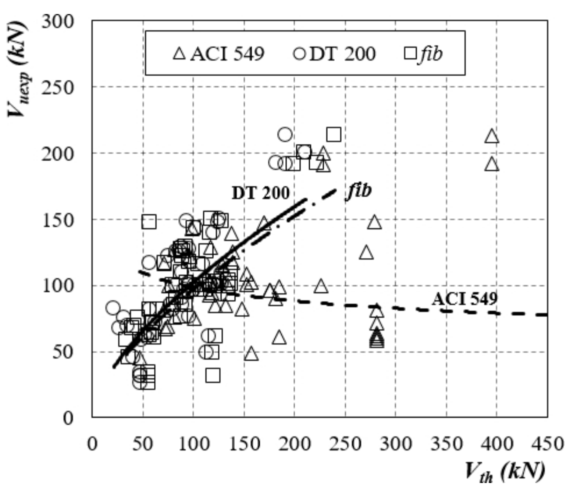
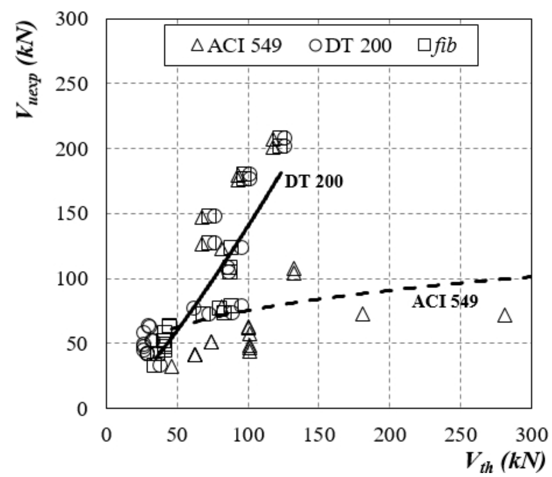


Fig. 11—Specimens shear strengthened with coated fibers: predictions and experimental comparison



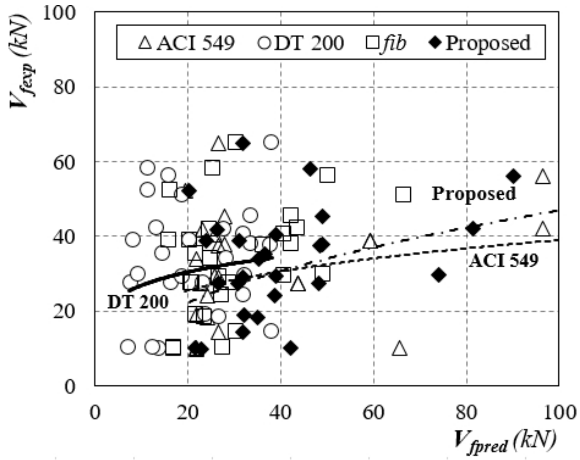
[1 kN = 224.820 lb]

Fig. 12—Comparison between predictions of models and experimental values: U-shaped FRCM



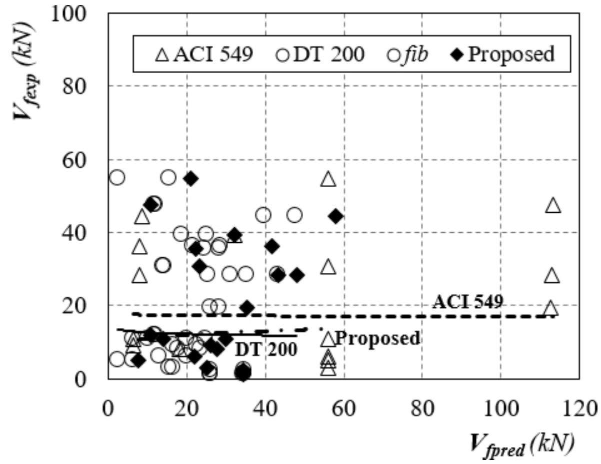
[1 kN = 224.820 lb]

Fig. 13—Comparison between predictions of models and experimental values: side bonded FRCM



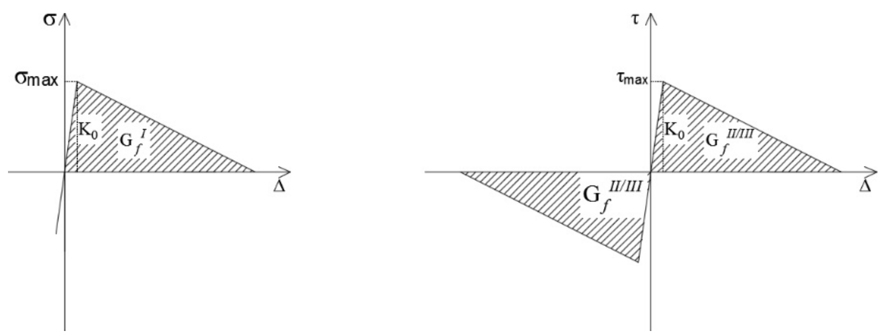
[1 kN = 224.820 lb]

Fig. 14—Comparison between predictions of models and experimental values U-shaped FRCM.un-coated fibers



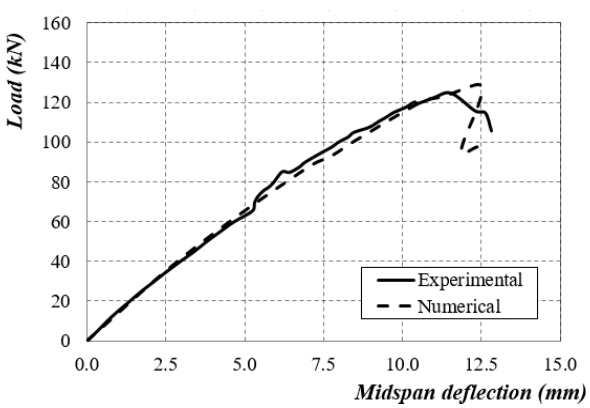
[1 kN = 224.820 lb]

Fig. 15—Comparison between predictions of models and experimental values U-shaped FRCM coated fibers



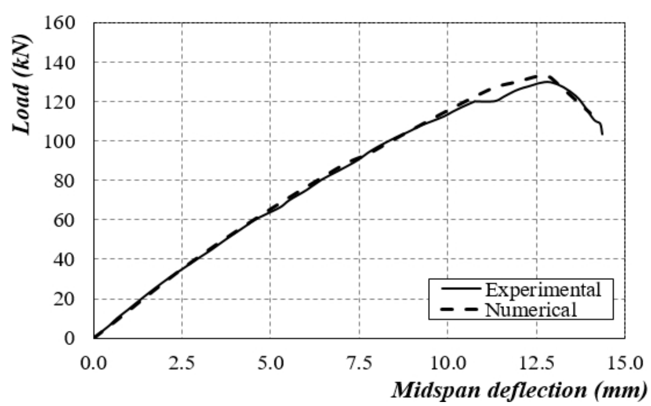
(a) (b)

Fig. 16—Traction-reparation approach: (a) mode I; (b) modes II and III



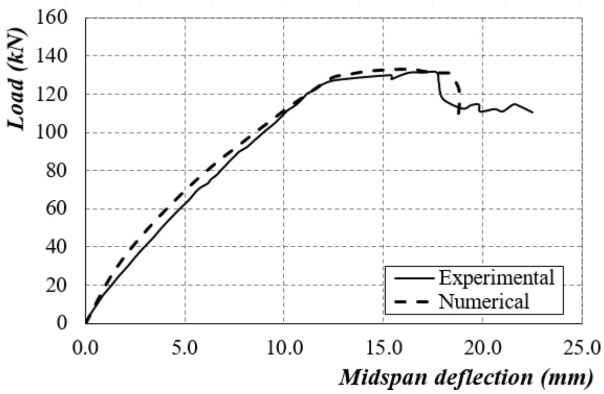
[1 mm = 0.0394 in; 1 kN = 224.820 lb]

Fig. 17—TRB3 beam: numerical and experimental comparison



[1 mm = 0.0394 in; 1 kN = 224.820 lb]

Fig. 18—TRB5 beam: numerical and experimental comparison



[1 mm = 0.0394 in; 1 kN = 224.820 lb]

Fig. 19—TRB4 beam: numerical and experimental comparison

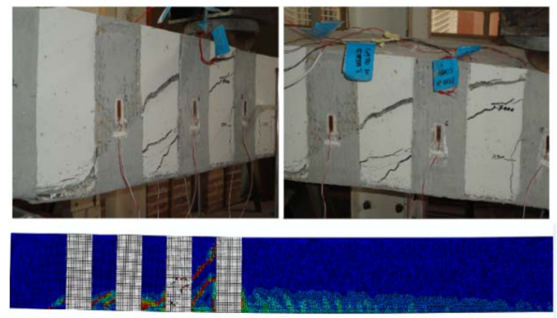


Fig 20—TRB4 beam: numerical and experimental comparison

Confinement of Concrete Columns with SRG

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Synopsis: in this study, the behavior of concrete compressive members confined by steel reinforced grout (SRG) is investigated. An experimental study was carried out to understand the behavior of short concrete prisms with a square cross-section confined by SRG subjected to a monotonic concentric compressive load. Test parameters considered in this study are the density of steel fibers, number of layers, corner condition, number of overlapping faces, and length of the reinforcement. The effectiveness of the confinement is evaluated in terms of peak stress with respect to unconfined prisms. SRG confinement is shown to improve the compressive strength of concrete prisms relative to the unconfined condition. An increase in the number of confinement layers results in an increase in the compressive strength and energy absorption.

Keywords: Composites, Concrete, Steel reinforced grout, Confinement.