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(تاریخ دریافت ۸۵/۱۲/۲۶، تاریخ دریافت روایت اصلاح شده ۸۷/۲/۷، تاریخ تصویب ۸۷/۶/۵)

MPa
 mm / mm

MPa

N/m

MPa

(FRC)

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HPFRCC

[] [-] (HPFRCC) FRC
[] Reinhardt Naaman HPFRCC
() HPFRCC HPFRCC FRC
HPFRCC FRC

: $G_f, f_y, f_{sp}, \sigma_c, D_f, L_f, \nu_f$ HPFRCC

.HPFRCC

FRC

.HPFRCC

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Material	Reference No.	v_f (%)	L_f (mm)	D_f (mm)	σ_c (MPa)	f_{sp} (MPa)	f_r (MPa)	G_f (N/m)
CARDIFRC®	[3-5]	6	6(5%) & 13(1%)	0.16	207	25	-	21000
Densit	[1]	6	12	0.4	140	-	-	-
Ductal	[1]	2	13-15	0.2	160-240	-	-	-
RPC	[7]	4	6	0.16	200-800	-	60	45000
SIFCON	[1]	12	30	0.5	56-120	41	90	134000
Torex-HPFRCC	[1]	2	30	0.3	84	-	-	-

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Seko Dense NSF PCE

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/ mm - MPa



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	Agg/C	SF/C	Fine Quartz Sand				W/(C+SF)	SP/(C+SF)
			0-300 μm	0-0.25 mm	0.25-1 mm	1-4 mm		
RPC	1.1	0.25	100%	---	---	---	0.22	0.019
DSP	1.58	0.25	---	14%	29%	57%	0.15	0.06

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		MIX-A1	MIX-A2	MIX-A3	MIX-A4	MIX-A5
AGGREGATE	AGG/C	1.1	2	1.1	1.1	1.34
	S.F/C	0.25	0.25	0.15	0.25	0.25
	50% (0.1-0.25mm)	50% (0.1-0.25mm)	50% (0.1-0.25mm)	50% (0.1-0.25mm)	100% (0-0.6mm)	50% (0-0.3mm)
	50% (0-0.3mm)	50% (0-0.3mm)	50% (0-0.3mm)	50% (0-0.3mm)	----	50% (0.3-1.2mm)
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(MPa) 7days-20°C		88	61	72	73	73
		MIX-A6	MIX-A7	MIX-A8	MIX-A9	MIX-A10
AGGREGATE	AGG/C	1.58	1.58	2.5	2.9	2.9
	S.F/C	0.25	0.15	0.15	0.15	0.15
	14% (0-0.3mm)	14% (0-0.3mm)	14% (0-0.3mm)	14% (0-0.3mm)	10% (0-0.3mm)	7% (0-0.3mm)
	28.5% (0.3-1.2mm)	28.5% (0.3-1.2mm)	28.5% (0.3-1.2mm)	28.5% (0.3-1.2mm)	25% (0.3-1.2mm)	10% (0.3-1.2mm)
	57.5% (1.2-4.75mm)	57.5% (1.2-4.75mm)	57.5% (1.2-4.75mm)	65% (1.2-4.75mm)	10% (1.2-2.4mm)	
	----	----	----	----	73% (2.4-4.75mm)	
(MPa) 7days-20°C		128	84	70	90	76

(Planar Mixer)

(MIX-A1...10)

× × cm

(MIX-A6)

[] RPC

FRC

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[] DSP

(Drum Mixer)

/ PCE

% / - /

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(°C)

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MPa MPa

°C

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MPa

MIX-A6

W/(C+SF)

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SP/(C+SF)

.(MIX-A6)

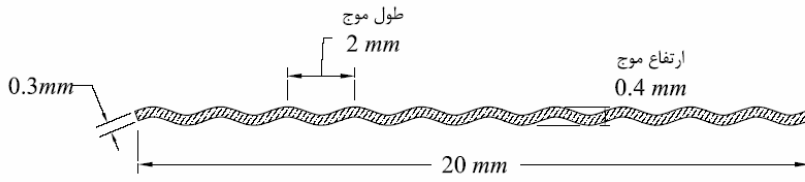
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Constituents (kg/m^3)		Properties		
Portland Cement	813		7days-20°C	128 MPa
Fine Quartz Sand(0-0.3mm)	183		28days-20°C	154 MPa
Fine Quartz Sand (0.3-1.2mm)	367		7days-90°C	169 MPa
Fine Quartz Sand (1.2-4.75mm)	734			0.3-0.4 %
Silica Fume	203			7.6 MPa
Superplasticizer(PCE)	15.2		(28days-	7.7 MPa
Water	175			5×10⁴ MPa
W/C	0.215		(G_r)	60 N/m
W/(C+S.F)	0.172			20-25 cm
S.P/(C+S.F)	1.5%			2500 kg/m³

cm

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(mm)	(kgf)	
0.9	11.73	
0.75	11.40	
0.55	11.35	
0.40	13.00	
0.0	6.32	



mm / mm)

(/ mm / mm /

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FRC

/ mm

%

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(

(× × cm)

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(× × cm)

/ mm

mm

mm

(

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(× × cm)

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MIX-A6

(Pull-out)

SFRC-5

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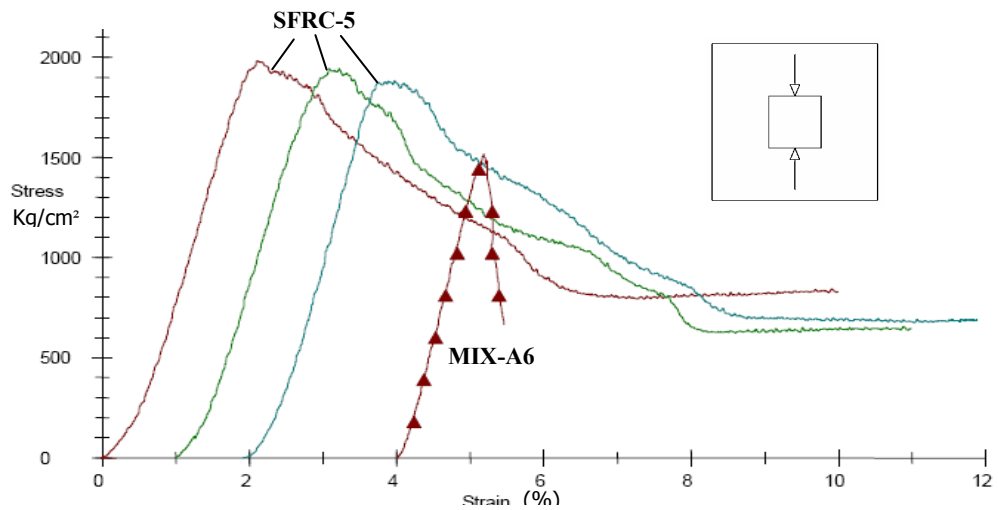
(kg/m^3)

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	MIX-A6	SFRC-1	SFRC-2	SFRC-3	SFRC-4	SFRC-5
Portland Cement	813	796	791	787	782	777
Fine Quartz Sand(0-0.3mm)	183	180	179	178	176	175
Fine Quartz Sand (0.3-1.2mm)	367	359	357	355	353	351
Fine Quartz Sand (1.2-4.75mm)	734	719	715	710	706	702
Silica Fume	203	199	198	197	195	194
Superplasticizer (PCE)	15.2	14.9	15.8	16.7	17.6	18.5
Water	175	171	170	169	168	167
Steel Fiber(volume percent)	Without fiber	157(2%)	196(2.5%)	236(3%)	275(3.5%)	314(4%)
W/C	0.215	0.215	0.215	0.215	0.215	0.215
W/(C+S.F)	0.172	0.172	0.172	0.172	0.172	0.172
S.P/(C+S.F)	1.5%	1.5%	1.6%	1.7%	1.8%	1.9%

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	MIX-A6	SFRC-1	SFRC-2	SFRC-3	SFRC-4	SFRC-5
(MPa)	151.3	176.2	175.9	179	180.7	193.6
$(N.m) \%$	686	8035.4	8144.6	8648.7	9442.9	10065.2



SFRC-5

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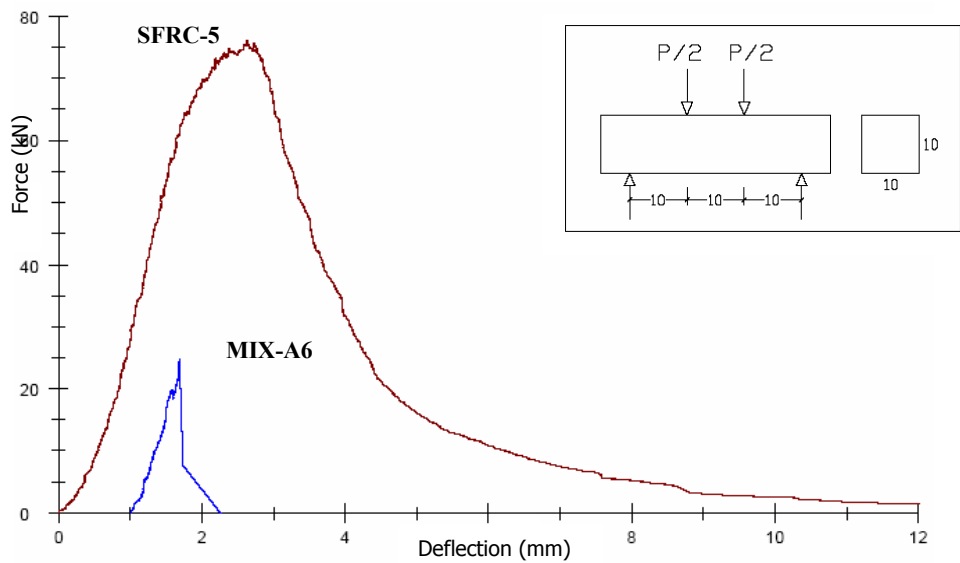
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SFRC-5 ()
(MIX-A6)

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	MIX-A6	SFRC-1	SFRC-2	SFRC-3	SFRC-4	SFRC-5
(Mpa)	77	17.7	17.9	19.4	19.2	23.3
(mm)	0.75	1.01	1.42	1.76	2.07	2.64
(N.m)	7.9	29.4	38.4	54.1	63.8	108.6
(N.m)	7.9	75.4	97.2	131.7	157.9	247.2



(MIX-A6) SFRC-5 :

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	MIX-A6	SFRC-1	SFRC-2	SFRC-3	SFRC-4	SFRC-5
(MPa)	7.7	18.9	20	20.4	20.7	23.2

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MIX-A6

SFRC-5

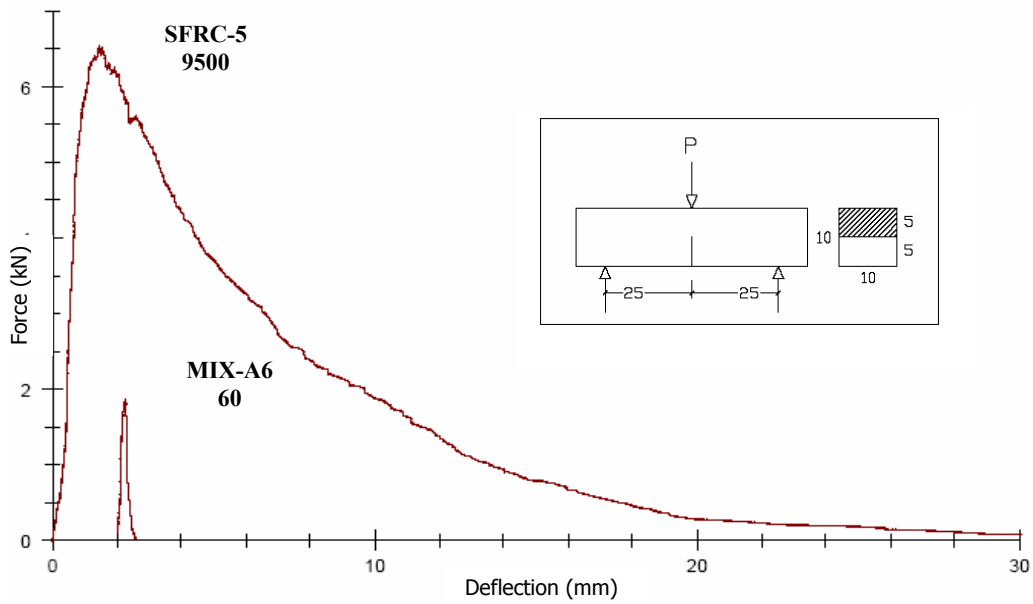
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o C

SFRC-5

	MIX-A6	SFRC-1	SFRC-2	SFRC-3	SFRC-4	SFRC-5
(N.m)	0.3	16.1	30	39	39.2	47.5
(G _f) (N/m)	60	3220	6000	7800	7840	9500

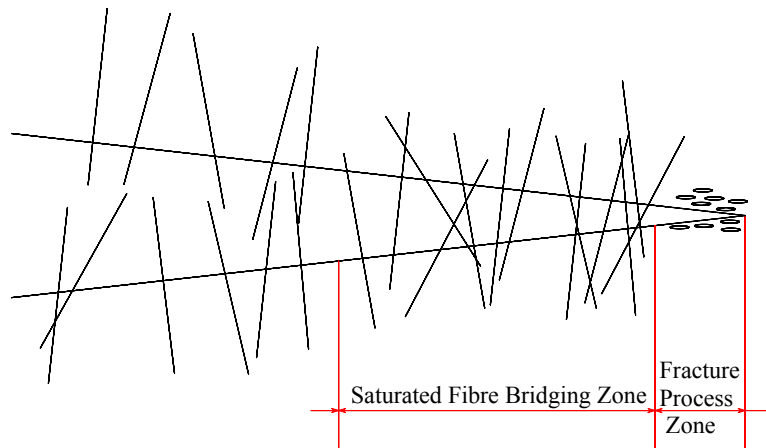


(MIX-A6)

SFRC-5

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.(SFRC-5)		:	
Constituents(kg/m^3)		Properties	
Portland Cement	777	SFRC-5	
Fine Quartz Sand(0-0.3mm)	175	(MPa)	193.6
Fine Quartz Sand (0.3-1.2mm)	315	(N.m)%	10065
Fine Quartz Sand (1.2-4.75mm)	702	(MPa)	23.3
Silica Fume	194	(mm)	2.64
Superplasticizer(PCE)	18.5	(N.m)	108.6
Water	167	(N.m)	247.2
Steel Fiber(volume percent)	314(4%)	(N/m)(G _r)	9500
W/C	0.215	(MPa)	23.2
W/(C+S.F)	0.172		
S.P/(C+S.F)	1.9%		



[] :

°C MPa
MPa

mm
/ mm mm / mm

MIX-A6

MIX-A6 .

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% / (
% /

)

MPa

SFRC-5

) / MPa

() N/m

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- 1 - Fiber Reinforced Concrete (FRC)
 - 2 - Matrix
 - 3 - High Performance Fiber Reinforced Cementitious Composite (HPRCC)
 - 4 - Strain Hardening
 - 5 - Fracture Energy
 - 6 - First Crack Strength
 - 7 - Pseudo Strain Hardening
 - 8 - Damping
 - 9 - Reactive Powder Concrete (RPC)
 - 10 - Densified System Containing Homogeneously Arranged Ultra Fine Particles (DSP or Densit)
 - 11 - Notched Beam
 - 12 - Bridging Action
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