Journal of Engineering Sciences, Assiut University, Vol. 35, No. 2, pp. 323-335 , March 2007

A MATHEMATICAL EXPRESSION FOR SPLIT TENSILE STRENGTH OF STEEL FIBER REINFORCED CONCRETE

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(Received November 11, 2006 Accepted February 5, 2007)

Use of fiber reinforced concrete is increasing recently, brought forth by the enhancements of concrete matrix engineering properties upon adding fiber. The resulting material possesses higher tensile strength, consolidated response and better ductility, which ultimately minimize immature failures.

Thus it is beneficial to comprehend more the engineering properties of the material. Accordingly, this study moves toward deriving a mathematical expression that relates fiber reinforced concrete compressive strength to split cylinder tensile strength.

Literature survey is carried out to collect data, pertinent to split cylinder tensile strength versus compressive strength values, for fiber reinforced concrete. Gathered data comprise compressive strengths from 20 MPa to 102 MPa.

Regression analysis is performed; a mathematical expression that predicts split cylinder tensile strength of steel fiber reinforced concrete is eventually derived. The predicted values fit well with experimental data. The findings of this study shed more light on the tensile strength of fiber reinforced concrete.

KEYWORDS: *Steel Fiber Reinforced concrete, composite concrete*

1- INTRODUCTION

The addition of steel fibers to concrete mixes improves the properties of the obtained steel fiber reinforced concrete (SFRC). Symptoms of the improved properties comprise tensile strength, shear strength as well as ductility and toughness of the SFRC.

Such enhancements render using steel fibers attractive especially in high strength concrete. The addition of steel fibers also reduces the concrete brittleness, which increases with higher concrete strengths. Such improvements in concrete properties support the use of SFRC in many structural applications such as airports, highway paving layers, industrial floorings, and bridge decks. Let alone its use as a repairing material.

Utilizing steel fibers as a technique for improving the properties of concrete has been the issue of many studies on structural behavior of such material, steered to acquire better understanding of the behavior of SFRC both in linear and nonlinear stages, and to attain detailed authenticated provisions for the design of such materials.

Few studies have been targeted towards investigating the relationship between the split tensile strength and the compressive strength of SFRC. The available relationships are either based on limited number of specimens or narrow range of fiber content or fiber aspect ratio. Ashour *et al.* [1] suggested the following equation for high strength concrete specimens of a single aspect ratio, *l/d* of 75

$$f_{sp} = 4.95 - 2.13\, v_f \qquad (1)$$

where v_f is fiber content.

More parameters are presented within the expression addressed by Ashour *et al.* [2], as follows:

$$f_{sp} = \frac{f_{cuf}}{(20 - \sqrt{F})} + 0.7 + \sqrt{F} \qquad (2)$$

where f_{cuf} is the cube strength of fiber reinforced concrete [MPa].

f_{sp} is the splitting strength of fiber reinforced concrete [MPa].

F is fiber reinforcement index = *(l/d).* v_f *.D_f*, where *l* and *d* are steel fiber length and diameter respectively. D_f is a bond factor that equals 0.5 for round fibers, 0.75 for crimped fibers, and 1.0 for indented fibers.

In order to derive a credible mathematical relationship, based on a wide range of fiber contents (v_f), compressive strengths, and fiber aspect ratios *(l/d)*, this study is carried out; it embodies a large number of experimental data collected from literature. The independent predictors comprise specimens of different sizes, various concrete grades and aggregate types in addition to multiple values of the fiber reinforcement index $(v_f * \frac{l}{d})$.

2- RESEARCH SIGNIFICANCE

The importance of the study is that it employs a large number of experimental data of SFRC, based on test specimens that cover a variety of factors of significant effect on the SFRC split strength. The main goal is to present a reliable mathematical expression that relates SFRC split strength with concrete cylindrical compressive strength and fiber reinforcement index. It is hoped that such expression could be ultimately employed in formulating appropriate design provisions for fibrous concrete members, under shear, torsion and tension.

3- DATA ANALYSIS

An experimental data pertinent to values of compressive strength f'_c, splitting tensile strength, f_{sp}, volumetric fiber content, v_f, and fiber aspect ratio, l/d of 358 SFRC cylindrical specimens are listed in Table (3). These data are gathered from several research papers, (Batson [3], Craig *et al.* [4], Sharma [5], Robert and Victor [6], El-Niema [7], Ashour *et al.* [2], Ashour and Wafa [8], Ghosheh [9], Padmarajaiah [10], Marar and Celik [11], Kwak [12], Ayish [13], Bani-Yasin [14], Rjoub and Rasheed [15], and Aqaileh [16]). Gathered data contain compressive strength values from 20.65 MPa to 102 MPa. Also data include concrete without fibers and concrete with fiber reinforcement indices. All the compressive strength values presented in Table (3) are either for cylinders of standard dimensions (150x300mm) or converted to standard cylindrical strengths using conversion factors presented in Table (2). Regression analysis is carried out with the split strength, f_{sp} as the predicted dependent variable. The scatter plot of experimental values of f_{sp} versus f'_c indicates that the expected relation could take the general expression

$$f_{sp} = \alpha + \beta \times ((v_f \times \frac{l}{d})^{\chi}) \times \sqrt{f'_c} \tag{3}$$

Parameters that are statistically insignificant are discarded, and the model coefficients are eventually determined. The values of calculated regression coefficients (α, β and χ) are found to be (0.614, 0.4 and 1.029) respectively. Ultimately, the mathematical expression that predicts split cylinder tensile strength of fiber reinforced concrete f_{sp} is concluded as follows

$$f_{sp} = (0.614 \ + 0.4 \ (v_f \times \frac{l}{d})^{1.029}) \times \sqrt{f'_c} \tag{4}$$

The P-values for the coefficients of regression analysis (α, β and χ) are illustrated in Table (1).Their values are less than 0.001. Such low p-values indicate that the predictor has a significant effect on the response variable. Thus the predictors illustrated in Eq. (4) are statically significant, and have a definite significant effect on the predicted values. Also, the adjusted coefficient of determination, R^2 is 0.840, implying that the regression predicted values are acceptably close to the observed data.

Equation (4) can be normalized by dividing its two sides by the term $\sqrt{f_c^{'}}$ as follows

$$\frac{f_{sp}}{\sqrt{f'_c}} = (0.614 \quad + 0.4 \quad (v_f \times \frac{l}{d})^{1.029}) \tag{5}$$

Equation (5) could be further simplified as follows

$$\frac{f_{sp}}{\sqrt{f'_c}} = (0.6 + 0.4 \times \quad (\% FRI)) \tag{6}$$

Where $FRI = v_f . l/d$

Figure (1) illustrates the scatter plot of %FRI versus the experimental split strength divided by $\sqrt{f_c^{'}}$, for the data listed in Table (3). The plot illustrates an upper and lower bounds derived by regression analysis. Figure (2) also illustrates the experimental split strength values versus the predicted values according to Eq. (7). It indicates that the predicted values are close to test result values. The plot of the data in both figures (Figs. 1 and 2) confirms the reliability of the derived expression. Equation (6) may be written in the following form

$$f_{sp} = (0.6 + 0.4 \quad (v_f \times \frac{l}{d}) \ ) \times \sqrt{f'_c} \tag{7}$$

Table 1: Estimated parameters using regression analysis

	$\alpha = 0.614$	$\beta = 0.4$	$\chi = 1.029$	$R^2 = 0.841$	adjusted $R^2 = 0.840$
P value	< 0.001	< 0.001	< 0.001		

Table 2: Conversion factors to standard cylindrical strength [15]

Cylinders 7.5x150 mm	0.95	Cylinders 100x200 mm	0.97	cylinders 150x300 mm	1
Cubes 100x100x100mm	0.78	Cubes 150x150x150mm	0.8	Cubes 200x200x200mm	0.83

Table 3: Compressive strength, fiber reinforcement index and split cylinder strength

<table>
<tr><td colspan="8">Marar and Celic [11]
(Compression, splitting, Cylinders 150x300)</td></tr>
<tr><td>no</td><td>FRI</td><td>f'c (Mpa)</td><td>f_{sp} (MPa)</td><td>no</td><td>FRI</td><td>f'c (Mpa)</td><td>f_{sp} (MPa)</td></tr>
<tr><td>1</td><td>0</td><td>32.06</td><td>3.2</td><td>20</td><td>0</td><td>73.5</td><td>5.13</td></tr>
<tr><td>2</td><td>30</td><td>32.66</td><td>3.93</td><td>21</td><td>30</td><td>76.02</td><td>5.68</td></tr>
<tr><td>3</td><td>60</td><td>34.11</td><td>4.72</td><td>22</td><td>60</td><td>78.48</td><td>6.95</td></tr>
<tr><td>4</td><td>75</td><td>36.28</td><td>5.35</td><td>23</td><td>75</td><td>80.09</td><td>8.26</td></tr>
<tr><td>5</td><td>90</td><td>37.46</td><td>5.9</td><td>24</td><td>90</td><td>84.63</td><td>8.93</td></tr>
<tr><td>6</td><td>105</td><td>39.27</td><td>6.1</td><td>25</td><td>105</td><td>86.22</td><td>9.97</td></tr>
<tr><td>7</td><td>120</td><td>39.85</td><td>6.84</td><td>26</td><td>120</td><td>88.97</td><td>10.83</td></tr>
<tr><td>8</td><td>37.5</td><td>33.73</td><td>4.12</td><td>27</td><td>37.5</td><td>76.96</td><td>6.94</td></tr>
<tr><td>9</td><td>75</td><td>34.63</td><td>5.24</td><td>28</td><td>75</td><td>78.85</td><td>8.14</td></tr>
<tr><td>10</td><td>93.75</td><td>36.61</td><td>6.18</td><td>29</td><td>93.75</td><td>84.48</td><td>9.12</td></tr>
<tr><td>11</td><td>112.5</td><td>38.31</td><td>6.53</td><td>30</td><td>112.5</td><td>87.4</td><td>10.03</td></tr>
<tr><td>12</td><td>131.25</td><td>39.63</td><td>7.15</td><td>31</td><td>131.25</td><td>89.52</td><td>11.16</td></tr>
<tr><td>13</td><td>150</td><td>41.17</td><td>7.87</td><td>32</td><td>150</td><td>91.49</td><td>11.74</td></tr>
<tr><td>14</td><td>41.5</td><td>33.99</td><td>4.36</td><td>33</td><td>41.5</td><td>78.02</td><td>7.51</td></tr>
<tr><td>15</td><td>83</td><td>35.26</td><td>5.94</td><td>34</td><td>83</td><td>80.95</td><td>8.89</td></tr>
<tr><td>16</td><td>103.75</td><td>37.09</td><td>6.54</td><td>35</td><td>103.75</td><td>86.21</td><td>10.71</td></tr>
<tr><td>17</td><td>124.5</td><td>39.73</td><td>7.07</td><td>36</td><td>124.5</td><td>89.19</td><td>11.5</td></tr>
<tr><td>18</td><td>145.25</td><td>41.27</td><td>7.86</td><td>37</td><td>145.25</td><td>91.73</td><td>12.54</td></tr>
<tr><td>19</td><td>166</td><td>42.87</td><td>8.33</td><td>38</td><td>166</td><td>93.56</td><td>13.16</td></tr>
<tr><td colspan="8">Craig et al [4]</td></tr>
<tr><td>no</td><td>FRI</td><td>f'c (Mpa)</td><td>f_{sp} (MPa)</td><td>no</td><td>FRI</td><td>f'c (Mpa)</td><td>f_{sp} (MPa)</td></tr>
<tr><td>39</td><td>0.00</td><td>40.69</td><td>3.45</td><td>43</td><td>120.00</td><td>28.97</td><td>4.55</td></tr>
<tr><td>40</td><td>42.00</td><td>40.00</td><td>5.72</td><td>44</td><td>200.00</td><td>47.59</td><td>6.00</td></tr>
<tr><td>41</td><td>100.00</td><td>43.45</td><td>6.34</td><td>45</td><td>120.00</td><td>40.00</td><td>6.07</td></tr>
<tr><td>42</td><td>90.00</td><td>35.86</td><td>5.31</td><td>46</td><td>160.00</td><td>45.52</td><td>7.10</td></tr>
<tr><td colspan="8">Sharma [5]</td></tr>
<tr><td>no</td><td>FRI</td><td>f'c (Mpa)</td><td>f_{sp} (MPa)</td><td>no</td><td>FRI</td><td>f'c (Mpa)</td><td>f_{sp} (MPa)</td></tr>
<tr><td>47</td><td>0</td><td>42.3</td><td>4.55</td><td>51</td><td>72</td><td>48.6</td><td>7.16</td></tr>
<tr><td>48</td><td>0</td><td>43.2</td><td>4.6</td><td>52</td><td>67.5</td><td>47.7</td><td>6.96</td></tr>
<tr><td>49</td><td>0</td><td>47.7</td><td>4.83</td><td>53</td><td>67.5</td><td>43.2</td><td>6.62</td></tr>
<tr><td>50</td><td>0</td><td>46.8</td><td>4.79</td><td></td><td></td><td></td><td></td></tr>
</table>

Batson [3]

no	FRI	f'c (Mpa)	f_{sp} (MPa)	no	FRI	f'c (Mpa)	f_{sp} (MPa)
54	44	40.19	5.71	63	61.6	39.71	6.18
55	44	40.19	5.71	64	61.6	39.71	6.18
56	44	40.19	5.71	65	61.6	39.71	6.18
57	44	40.19	5.71	66	61.6	39.71	6.18
58	30.8	40.19	5.71	67	61.6	39.71	6.18
59	30.8	40.19	5.71	68	61.6	39.71	6.18
60	30.8	40.19	5.71	69	61.6	39.71	6.18
61	30.8	40.19	5.71	70	61.6	39.71	6.18
62	61.6	39.71	6.18				

Ghosheh [9]

no	FRI	f'c (Mpa)	f_{sp} (MPa)	no	FRI	f'c (Mpa)	f_{sp} (Mpa)
71	0	42.49	4.56	78	75	42.67	5.69
72	0	41.9	4.53	79	56.25	40.47	6.62
73	0	41.9	4.53	80	93.75	40.85	6.11
74	26.6	42.49	5.4	81	37.5	40.47	7.17
75	35	39.7	5.49	82	75	40.11	5.51
76	70	41.42	6.7	83	0	41.42	6.7
77	37.5	40.11	5.24				

Bani-Yasin [14]

no	FRI	f'c (Mpa)	f_{sp} (Mpa)	no	FRI	f'c (Mpa)	f_{sp} (Mpa)
84	0.00	23.83	2.62	99	0.00	51.90	5.66
85	0.00	23.57	2.49	100	0.00	49.64	5.23
86	0.00	23.27	2.54	101	0.00	52.13	5.64
87	0.00	24.20	2.49	102	0.00	53.80	5.73
88	0.00	23.75	2.46	103	0.00	52.94	5.86
89	0.00	23.82	2.51	104	0.00	52.89	5.94
90	30.00	25.83	2.86	105	30.00	54.25	6.44
91	30.00	24.66	3.02	106	30.00	55.54	6.12
92	30.00	24.90	2.97	107	30.00	54.72	6.13
93	60.00	27.39	3.44	108	60.00	55.72	7.42
94	60.00	26.41	3.15	109	60.00	55.85	7.28
95	60.00	25.99	3.01	110	60.00	56.80	7.29
96	75.00	26.68	3.88	111	75.00	55.26	7.65
97	75.00	25.63	3.64	112	75.00	55.88	7.55
98	75.00	26.19	3.58	113	75.00	55.58	7.48

Ayish[13]

no	FRI	f'c (Mpa)	f_{sp} (Mpa)	no	FRI	f'c (Mpa)	f_{sp} (Mpa)
114	0	20.1	3.1	119	60	22.78	2.94
115	30	21.37	3.23	120	60	24.65	2.76
116	60	22.753	3.67	121	60	23.02	2.79
117	60	22.91	3.53	122	90	24.65	3.58
118	0	20.65	3.14	123	90	25.45	3.63
124	60	22.15	4.08	140	90	24.73	3.68
125	0	32.76	3.84	141	30	53.52	5.96
126	30	34.48	4.15	142	30	52.03	6.08
127	60	35.72	4.66	143	30	53.66	5.91
128	60	36.43	4.36	144	60	51.74	5.73
129	0	32.60	3.74	145	60	52.74	5.86
130	60	35.96	4.64	146	60	53.35	5.94
131	30	21.73	2.48	147	30	54.52	6.26
132	30	22.07	2.31	148	30	53.66	6.57
133	30	21.55	2.47	149	30	54.29	6.45
134	60	22.33	2.49	150	60	54.85	6.89
135	60	22.08	2.46	151	60	56.68	7.3
136	60	22.16	2.51	152	60	54.14	7.13
137	30	22.72	2.6	153	90	56.64	8.56
138	30	22.32	2.66	154	90	56.03	8.34
139	30	22.25	2.54	155	90	56.72	8.63

Kwak [12]

no	FRI	f'c (Mpa)	f_{sp} (Mpa)	no	FRI	f'c (Mpa)	f_{sp} (Mpa)
156	0.00	60.72	4.32	158	46.88	66.54	6.08
157	31.25	61.89	5.88	159	31.25	29.88	3.83

Craig [4]

no	FRI	f'c (Mpa)	f_{sp} (Mpa)	no	FRI	f'c (Mpa)	f_{sp} (Mpa)
160	0	40.69	3.45	164	120	28.97	4.55
161	42	40.00	5.72	165	200	47.59	6.00
162	100	43.45	6.34	166	120	40.00	6.07
163	90	35.86	5.31	167	160	45.52	7.10

El-Neima [7] (Comp, splitting, cylinders 150x300mm)

no	FRI	f'c (Mpa)	f_{sp} (Mpa)	no	FRI	f'c (Mpa)	f_{sp} (Mpa)
168	0.00	22.34	1.96	186	25.00	61.70	6.39
169	51.08	26.19	4.50	187	25.00	39.90	5.14

(cont) El-Neima [7]

no	FRI	f'c (Mpa)	f_{sp} (MPa)	no	FRI	f'c (Mpa)	f_{sp} (MPa)
170	89.39	28.57	4.60	188	66.50	61.70	7.88
171	127.70	29.73	4.74	189	133.00	67.20	10.70
172	38.30	24.62	3.60	190	25.00	61.70	6.39
173	67.03	25.24	3.88	191	25.00	39.20	5.09
174	95.75	25.38	4.07	192	66.50	61.70	7.88
175	25.35	23.79	3.12	193	150.00	76.70	12.11
176	44.37	24.76	3.64	194	200.00	79.50	14.36
177	63.38	25.17	4.01	195	250.00	77.20	16.14
178	25.00	61.70	6.39	196	300.00	75.80	17.98
179	25.00	39.90	5.14	197	66.50	42.30	6.52
180	66.50	61.70	7.88	198	100.00	41.40	7.43
181	133.00	67.20	10.70	199	66.50	55.70	7.48
182	50.00	59.30	7.14	200	66.50	42.30	6.52
183	100.00	60.00	8.95	201	133.00	71.90	11.07
184	150.00	67.00	11.32	202	150.00	67.00	11.32
185	200.00	55.90	12.04				

Robert [6]

no	FRI	f'c (Mpa)	f_{sp} (MPa)	no	FRI	f'c (Mpa)	f_{sp} (MPa)
203	0.00	54.15	2.90	206	42.75	56.72	5.90
204	14.25	55.96	5.60	207	57.00	54.15	5.60
205	28.50	59.47	6.00	208	57.00	51.40	6.20

Rjoub and Rasheed [15]

no	FRI	f'c (Mpa)	f_{sp} (MPa)	no	FRI	f'c (Mpa)	f_{sp} (MPa)
209	0	55.22	4.96	284	0	59.76	5.18
210	0	63.71	5.11	285	0	65.65	5.26
211	0	71.06	5.71	286	0	74.69	5.91
212	0	80.87	6.34	287	0	84.84	6.74
213	0	91.85	6.62	288	0	94.78	6.77
214	40	59.76	5.18	289	40	63.07	6.1
215	40	65.65	5.26	290	40	78.66	6.79
216	40	74.69	5.91	291	40	88.3	7.36
217	40	84.84	6.74	292	40	93.94	8.81
218	40	94.78	6.77	293	40	97.06	8.95
219	60	62.51	7.13	294	60	65.21	7.32
220	60	76.71	7.8	295	60	80.42	7.95

(cont) Rjoub and Rasheed [15]

no	FRI	f'c (Mpa)	f_{sp} (MPa)	no	FRI	f'c (Mpa)	f_{sp} (MPa)
221	60	85.62	8.62	296	60	90.17	8.9
222	60	92.98	9.64	297	60	94.97	9.75
223	60	97.03	9.83	298	60	98.11	9.92
224	80	64.73	8.12	299	80	67.31	8.41
225	80	78.91	8.93	300	80	81.14	9.15
226	80	88.01	9.69	301	80	92.93	10.04
227	80	94.67	10.96	302	80	96.62	11.1
228	80	99.21	11.47	303	80	99.98	11.5
229	120	66.81	9.22	304	120	69.08	9.71
230	120	80.82	9.98	305	120	82.29	10.74
231	120	91	10.73	306	120	94.17	11.23
232	120	96.73	11.68	307	120	96.35	12.04
233	120	100.18	12.27	308	120	100.2	12.63
234	0	65.25	5.28	309	0	51.22	3.95
235	0	70.21	5.47	310	0	60.85	4.1
236	0	79.51	6.12	311	0	69.39	4.42
237	0	89.27	6.58	312	0	80.11	4.75
238	0	98.92	6.93	313	0	86.48	4.98
239	40	66.23	6.32	314	40	54.71	4.94
240	40	79.42	6.97	315	40	67.91	5.94
241	40	90.79	7.92	316	40	79.31	6.28
242	40	94.13	8.92	317	40	89.76	6.63
243	40	99.94	9.02	318	40	93.62	6.91
244	60	67.37	7.8	319	60	55.84	6.41
245	60	82.66	8.37	320	60	69.42	7.04
246	60	91.89	9.2	321	60	81.61	7.68
247	60	95.62	9.95	322	60	90.31	8.2
248	60	99.98	10.31	323	60	94.28	8.57
249	80	69.71	8.81	324	80	57.88	7.23
250	80	84.31	9.42	325	80	73.07	7.92
251	80	93.76	10.72	326	80	82.60	8.45
252	80	96.2	11.63	327	80	92.61	9.57
253	80	100.12	11.92	328	80	95.31	9.92
254	120	71.23	9.85	329	120	59.12	8.21
255	120	85.21	10.84	330	120	74.24	9.00
256	120	94.78	11.93	331	120	84.63	9.64
257	120	98.71	12.78	332	120	93.11	10.36
258	120	101.3	13.08	333	120	96.72	10.74
259	0	48.74	3.8	334	0	57.87	4.08
260	0	58.81	4.01	335	0	64.08	4.25

(cont) Rjoub and Rasheed [15]							
No	FRI	f'c (Mpa)	f_{sp} (MPa)	No	FRI	f'c (Mpa)	f_{sp} (MPa)
261	0	67.31	4.34	336	0	75.31	4.63
262	0	74.92	4.63	337	120	84.42	4.82
263	0	80.77	4.81	338	120	93.64	4.15
264	40	52.63	4.68	339	120	52.63	4.68
265	40	61.27	4.97	340	0	61.72	4.97
266	40	74.67	5.51	341	0	74.67	5.51
267	40	82.89	6.15	342	0	82.89	6.15
268	40	91.07	6.26	343	40	91.07	6.26
269	60	54.01	6.05	344	60	54.01	6.05
270	60	62.89	6.48	345	60	62.89	6.48
271	60	76.63	7.08	346	60	76.63	7.08
272	60	84.62	7.91	347	60	84.62	7.91
273	60	92.86	8.08	348	60	92.82	8.08
274	80	55.22	6.83	349	80	52.2	6.83
275	80	64.73	7.44	350	80	64.73	7.44
276	80	78.98	8.12	351	80	78.98	8.12
277	80	87.03	8.97	352	80	87.03	8.97
278	80	93.91	9.2	353	80	93.91	9.2
279	120	56.77	7.68	354	120	56.77	7.68
280	120	66.82	7.94	355	120	66.82	7.94
281	120	80.11	8.72	356	120	80.11	8.72
282	120	88.18	4.98	357	120	88.18	4.98
283	120	94.22	10.3	358	120	94.22	10.33

Note: FRI = $(v_f * \frac{l}{d})$ s

4- CONCLUSIONS

The following conclusions can be drawn from this study

1- A suggested expression that predicts the split cylinder tensile strength of steel fiber reinforced concrete is presented.

2- The outcomes of descriptive statistical analysis confirm the credibility of the derived expression.

3- Concrete compressive strength, fiber content and the fiber aspect ratio are the major effectual parameters in specifying the tensile strength of fiber concrete.

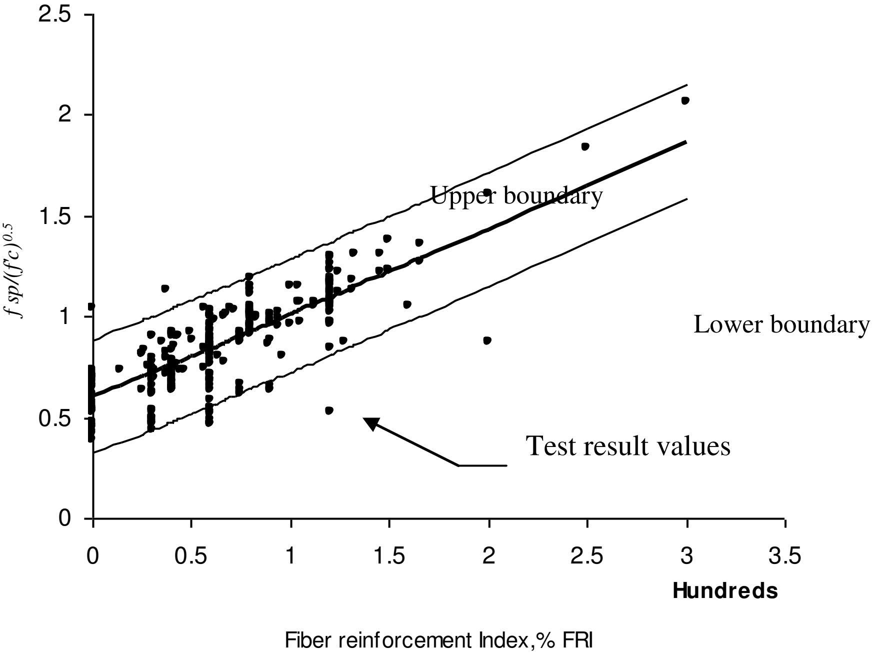

Figure 1: Effect of steel fiber reinforcement index, % FRI versus $f_{sp}/(f'_c)^{0.5}$

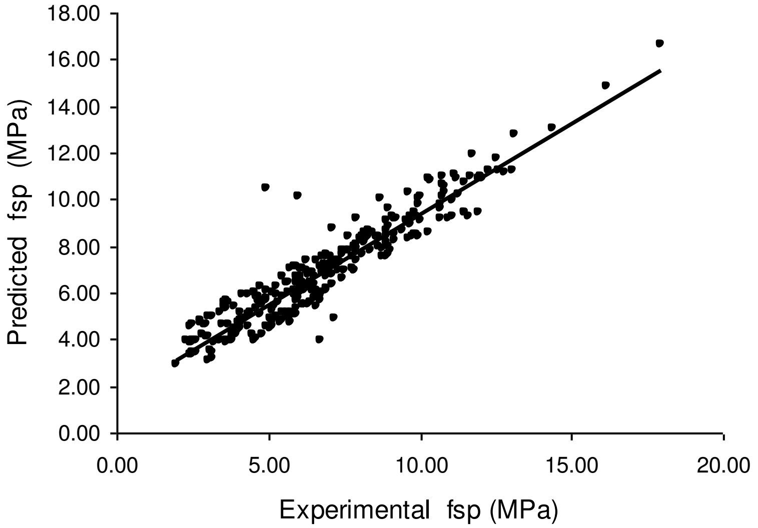

Figure 2: Experimental versus predicted split strength.

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حساب مقاومة شد الانفلاق للخرسانة بالألياف

أصبح استخدام الألياف المعدنية بالخرسانة بتزايد مستمر في الوقت الحالي، و ذلك بسبب تحسن خصائص الخرسانة عند إضافة الألياف المعدنية. و تمتلك الخرسانة بالألياف المعدنية مقاومة أعلى لاجهادات الشد، بالإضافة إلى استجابة و متانة أفضل و إلى تحسن في الممطولية مما يؤدي في النهاية إلى سلوك و استجابة أفضل عند التعرض لتأثير القوى. و عليه أضحى من الضروري التعرف على الخصائص الهندسية للخرسانة بالألياف المعدنية. و عليه تتجه هذه الدراسة إلى إيجاد نموذج رياضي يحكم علاقة مقاومة الخرسانة للشد باستخدام فحص الانفلاق بمقاومة الخرسانة للضغط. و بناء على ذلك تم دراسة بيانات تتضمن مقاومة الخرسانة للشد و القيم المناظرة لها لمقاومة الخرسانة للضغط. و قد شملت الدراسة على خرسانة بإجهاد كسر من 20.65 نيوتن/مم^2 إلى 102 نيوتن/مم^2. وتم عمل تحليل إحصائية لكافة البيانات و تم استنتاج علاقة رياضية تتناول علاقة مقاومة الخرسانة للشد باستخدام فحص الانفلاق بمقاومة الخرسانة للضغط لنفس الخلطات.

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