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Quality Control between theory and practice in Building Industry.

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الخلامة :

THEORY AND PRACTICEIN BUILDING INDUSTRY

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نم التخطيط لهذا البحث لدراسة وتقبيم بعض العناصر التي تؤثر في جودة الخرسانية ، امتناز عدد ستمائة مكعب خرساني يمثلون مائة عينة ثم اخدهم من عشرين موقع عمل مختلف في محافظة الدفيلية وثم اختبار مقاومتهم للففط في اعمار لا أيام و ٢٨ يوم ، ثم حسباب منوسط مقاومة الففط للخرساسة والاسحراف المعياري ومعامل الاختلاف للعبنات المختلفة كما تسم توقيع بعض العلاقات التي تباعد على تقبيم جودة الخرسانة ، ولقد دلت الدراسة على ان جسبودة الخرسانة تتوقف الى حد كبير على كفاءة العنمر البشري ومقدار فهمه وتطبيقة لامول فيسلسط العودة ، كما اوضفت الدراسة الحاجة الى زيادة العناية بشبط جودة الخرسانة على المستسبوي

ABSTRACT

This research was conducted to investigate and assess some of the factors affecting the quality of concrete. Six hundred concrete cubes out of one hundred samples were taken from twenty different sites at different locations in El-Dakahlia governmente. They were tested in compression. Average compression strength values, the standard deviation and the coefficient of variation were computed and correlations were made.

The study indicated that the human factor is very significant and the quality control in general is deficient and needs to be reviewed.

INTRODUCTION

In the last few years failures in buildings due to the poor quality of concrete increased with high frequancy in Egypt Fig. (1). This fenomina was investigated by different research workers in different countries (1 - 5). In Egypt extensive research has been started either in the laboratory or in the field (7-9)

The present study was planned to investigate the quality of concrete in the governerate of El-Dakahlia. Six hundard concrete cubes out of one hundred samples were taken from twenty different sites and tested in compression. These samples were provided by the inspectors authorised for quality control in the different construction sites and tested at the Strength of Materials laboratory in El-Mansoura University.

EXPERIMENTAL WORK

Compression test was carried out on 600 concrete cubes representing mainly two groups. The first group consisted of fifty two sets each of six cubes taken from the same batch, cured in water and tested at 7 days age. The second group consisted

of forty eight sets of six cubes each tested at 28 days age. Tests were carried out in accordance with the British Standard Specifications 8.S. 1881.

For each set of concrete cubes tested in compression at 7 days age or 28 ⁻¹ days age, the mean strength, the standard deviation and the coefficient of variation were computed and correlations were made.

To evaluate the concrete quality, certain procedure was carried out into the test results of the first group of cubes tested at 7 days age (312 cubes) as well as the second group of cubes tested at 28 days age (288 cubes). For each group the cubes were arranged in desending order according to their strength then devided into sets with equal class interval with a range of 30 Kg/cm². The average strength value of each set was calculated as well as the frequency which is the number of cubes with strength lies within the boundries of each set.

Check sheets, histograms and Ogive comulative curves were plotted from which the mode and the median values were determined.

The standerd deviation for each set of cubes was evaluated according to the A.C.I. classification. An overall veiw was carried out to evaluate the general situation of the cubes tested at 7 days age as well as those tested at 28 dyas age.

An analytical relationship was determined between the compressive strength of the concrete cubes recived from the different construction sites of El-Dakahlia provence and tested at 7 days age and those tested at 28 days age.

ANALYSIS AND DISCUSSIONS

Tables (1 and 2) show the test results of the different sets for concrete cubes tested at 7 days age and for those tested at 28 days age, respectivelly. Generally speaking, it is clear that there is a great difference between the strength of the different cubes within the same set. However, table (1) shows that the average compressive strength of the 312 concrete cubes tested at 7 days age is 215.59 kg/cm², while, the average standard deviation is 54.12. The coeffecient of variation varied between 4.17 and 54.34. Table (2) shows that the average compressive strength of the 288 concrete cubes tested at 28 days age 1s 280.12 kg/cm², while, the average standard deviation is 64.21. The coefficient of variation varied between 6.73 to 30.44. These results indecate that good effort was done by the inspectors which led to concrete of reasonable average strength, however, these inspectors need more training on the quality control and inspection applications.

Tables (3 and 4) show the concrete compressive strength of the cubes tested at 7 days age and those tested at 28 days age respectively as arranged in desending order. Tables (5a and 5b) show the classification of concrete strength into sets with definite limits. However, the range of each set and the frequency of test results are also indicated. The check sheets and the histograms shown in Figs. (2 and 3) indicate that the highst frequency (the mode) of the 7 days and the 28 days concrete compressive strength are at 225 kg/cm² and 205 kg/cm², respectively.

Table (6) and Fig. (4) show that the median of the 7 days age test specimens is 217 kg/cm². However, table (7) and Fig. (5) show that the median of the 28 days age test specimens is 270 kg/cm^2 .

The Egyptian Code of Practice stated that the strength of concrete used in reinforced concrete structures should not be less than 120 kg/cm². However, about 1.0 % of the tested cubes were of strength less than 120 kg/cm² at 28 days age. The Code of Practice stated also that the strength of the hand mixed concrete with 300 kg/m² cement should not be less than 160 kg/cm². However, about 5 % of the tested cubes were of strength less than 160 kg/cm² at 28 days age.

Tables (8 and 9) show the evaluation of the different concrete mixes tested at 7 days and 28 days age respectively with respect to the standard deviation and taking the classification of the A.C.I. Code into consideration.

Table (10) and Fig. (6) show the evaluation of the whole status of the quality of concrete tested at 7 days age, while, table (11) and Fig. (7) show the evaluation of those cubes tested at 28 days age.

A summery of the whole situation as classified according to the A.C.I. Oode is shown in Fig. (8).

The relationship between the 7 days and the 28 days concrete compressive strength is plotted in Fig. (9). Big agreement is found between the expression drived through a computer program for curve fitten ($f_{\rm C28} = 1.3 f_{\rm C7} - 15.049 \ {\rm kg/cm^2}$) and the imperical expression ($f_{\rm C28} = 1.26 \ f_{\rm C7}$).

CONCLUSIONS

This research study led to the following conclusions:

- In quality control the human factor is very significant, thus, the inspectors should be given extensive training courses in such field and its application in the laboratory and in the site.
- 2. More care should be taken for the quality control of concrete as a product,
- 3. The expression drived through a computer program for curve fitting of the experimental test results obtained in this research is $f_{\text{C28}} = 1.3 \, f_{\text{C7}}$ -15.049. This expression is in a good agreement with the imperical expression $f_{\text{C78}} = 1.26 \, f_{\text{C7}}$ which relates the concrete compressive strength at the age of 28 days to that at 7 days age.

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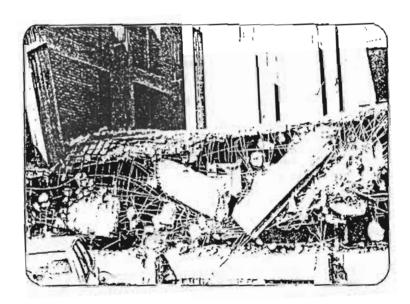


Fig. (1) Building Failure

Table (1)

Table (2)

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78.00	187.10	121.04	270. 04	117 64	210.04 1171 29	212.70	19. M	42.11
11.60	117.31	113 64	530 04	131 04		177 11	4.41	36.41
17.10	127 14	311.07	121 14	111 5	77.24 7133 M	14: 17	42.24	11.11
						221.15	11.21	12.45
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14.14	271.14	111 10	184 80	311 47	\$10.00 1101 PR	250.47	(4.31	11.77
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17.00	249.20	211.10	343 00	307 44	#13,44 1118 PA	220. 07	11.29	1.11
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12 62	253 Deb	218 90	141 04	244. 09	213 PO 1"41.PS	172.00	22 11	14 11
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		17.71										
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1								289, 24	214 00	711. CO		37.00
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1. 1									113.20	347.20	*34. 73	
										200.70		
									242 20	171.60	311. 00	
1								410.00		147.04	123. 44	
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77 en 118 en 401 en 101 en 175. en 144. on 2017. en 146.45 30. 40												77.10
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Table (3)

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214, 40	349.20	341 10	201.40	236.40	112
221.22	331.20	117.00	170.00	210 00	210
378.00	271.40	111.00	170.00	317.00	316
313.10	111.00	T13.00	112.40	314.40	317
310.00	339, 10	301. DO	202. 80	203.40	301
277.10	127.00	177.00	173.00	251.20	245
211.00	283. 80	711.00	213.30	273.40	113
213. 10	271. 60	777 *0	177.40	371.70	772
217.00	277.00	177.00	173.00	275.00	7/1
273.80	270. 40	270. 60	170.40	270.60	110
319.30	789. 40	741. 60	144.70	\$44.70	140
200.00	254.00	131,10	137.40	331 40	117
1255.10	133.90	133.10	171.00	337.00	212
222.00	213.0d	110.40	220.80	250.00	127
249 00	245. 40	214. +0	214.20	200.20	714
142.00	212.00	717 00	2 80. pg	369.641	121
237.70	229.00	237 10	>>7.40	237 45	723
222.00	723.00	222 20	:33.30	212.20	737
177.79	233. 20	222 20	113.30	211.00	721
221.50	230.00	1:4.20	228. 80	217 27	774
221.10	213. od	771.40	714.40	321 44	771
272. 22	727.00	220.00	270.00	370.00	119
270.00	720.00	224.00	170.00	310.00	717
317.10	317.00	211.20	212.20	314.00	111
217.40	237.40	713.10	213.40	211.00	715
311.20	211.00	719.00)	207 99	201.00	121
307.00	200.80	701.00	100.60	794.70	104
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194.00	181.00	141.10	184.40	(\$1.30	112
123.40	103.40	(17-10		100.00	110
177.20	119.20	177.20	176.00	171-00	1.74
174.00	114.00	171.00	172.40	117-10	110
179.09	173.80	113.20	107.40	127.50	117
147.20	197. 20	117.10	117.39	111.00	102
147.90	103.40	141.40	167.30	111.40	1+0
15F. 50	131. 10	131.10	154.20	131.00	174
122.00	111.90	131.00	147 40	111.00	117
147.40	143.20	111.40	143.14	111.00	110
149.30	179.40	117.50	(11.20	114.20	111
122.00	129. 25	137.40	111.10	127.60	16
113.10	177.20	122.00	121.90	112.19	11.6
113.23	114.00	117,70	116.00	115.40	111
110.40	112.90	110.00	197.90	107.19	101
103.19	10.00	PP. 700	11.00	72 10	100
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213. 10	113.10	344 00	143.20	217.84	326.40
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277. ED	774. 10	321 40	115.40	373 40	317.40
3:1. 40	170.00	7:0 00	311.00	218.60	214.60
314 40	334.60	313 60	330 70	31.9 40	207. 20
274. 20	307.20	351.40	351 10	100.00	200.10
203.90	287.30	344 50	221.40	217 00	177.00
177. 70	145 DO	174 40	711.60	172 50	177.40
141 14	127.20	3+0 4D	710 00	311 :0	300.70
189. 60		191.70	154 60	: 01 00	117.00
277.40	213.20	201 60	200 10	\$30 log	317.00
277. 63	277.30	277.10	271. 10	1/5 20	171.00
119.00	312 BO	759.40	220.00	110.10	179-10
244. 10	54 WD	260.30	284.10	241.40	311.10
21.00	210.00	120,00	237.40	2:1 10	713,40
21.10	7:7-10	255,00	223 00	7:1 64	711.04
713.00	250.00	349. 60	217.00	347.40	716.00
212 00	211.00	244.70	344 50	241 00	217 00
777 10	137.40	141,00	2 10 00	2 .0	110.00
20 00	121, 10	129.40	113.40	223 40	333.00
31. 50	110 CD	273.70	123.20	111.10	213.00
24 10	336 40	229-23	\$ 21 . 00	151 00	121 20
111.00	720.00	710.00	24.40	274.40	:10 00
1. 10	117.00		170.00	120. N	149.30
15 40	213.10	217 15	711 00	31 k. 10	313.10
21 22	211.22		21.00	711.00	311 20
00 10	707.00	111.00	100.00	710.00	797.00
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Table (5)

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7	130-110	143	117
•	170-110	177	71
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16	310-320	2:3	30
	300.310	719	1 10
- 11	210-740	313	1 17
12	160-100	371	1
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6. PRINCHES SAME

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Table (6)

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10	i .	104	219	14.35
	i	210	l i a	19.11
	i	710	123	1 55.76
7	i	140	1	**.11
	•	784	76	10.77
7		130	37	10.17
4	,	114	14	14.25
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Table (7)

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11	4.0	211	11.17
1.1	110	2/2	24.11
17	100	222	\$7.41
"	110	100	17,20
14	J 310	/ iii	11.40
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	230	} iii	11.03
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,	110	1 55 1	11.11
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	110	1 7 1	1.51
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ATTER T-0419

Table (9)

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Table (10)

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Greed) - (- 1 - j - L] - LI-11-41-30-71	10	19.33	
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Table (11)

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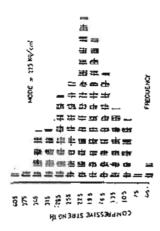


Fig. (3-a) Check Sheet for 7 Days

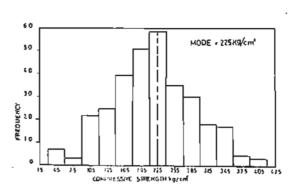


Fig. (2-b) Histogram for 7 Days

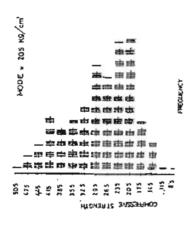
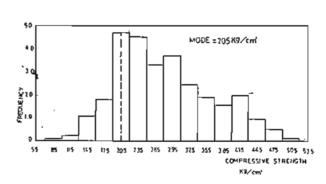


Fig. (3-a) Check Sheet for 28 Days



1

Fig. (3-b) lüstogram for 28 Days

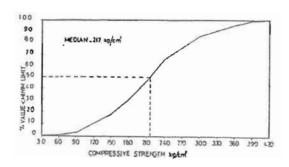
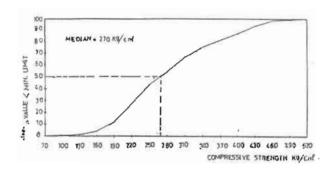


Fig. (4) Ogive Curve for 7 Days



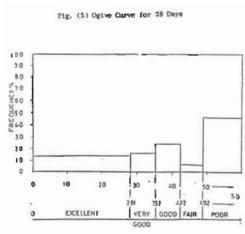


Fig. (6) Mistogree for 7 Days

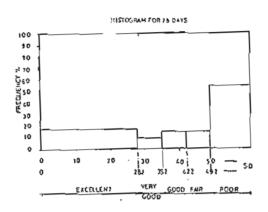


Fig. (?) Ristogram for 28 Days

mg. (8) CLASSIFICATION OF CONCRETE QUALITY ACCORDING TO A C I

