Quality Management And Practices In Mechanised Construction Of Multi-Storeyed Buildings

M. Sankaraiah [1], E. Rambabu [2], C. Eswara Reddy [3]

[1] Research Scholar, Dept. of Mechanical Engg, S. V. U. College of Engg.,Tirupati-517502, India.

[2] General Manager, A. P. Rajiv Swagruha Corpn. Ltd., Jawahar Nagar, Hyderabad, India

[3] Professor of Mech. Engg., Sri Venkateswara University,Tirupati - 517502, India.

ABSTRACT

Mechanical Handling and Material Handling go together as that of hand-in glove in the modern construction of the Dams, Roads, Bridges, Buildings, Over Head Water Tanks, Towers, High-rise buildings having many stories, etc.

An attempt is made in this paper discusses the **Quality Management and Practices on** Reinforced Cement Concrete(RCC) where the Mechanical Handling equipment like Concrete Batching Plant **(CBP)** and Transit Concrete Mixer **(TCM)** are involved in the construction of multistoried buildings / High-rise buildings due to difficulties in the manual handling and time constraint.

The Cement Concrete (**CC**) is prepared in the CBP and transmitted to the Pre-casting yard by TCM for casting of RCC columns and RCC beams.

The compressive strength of CC is measured with samples (cubes) at different types of water curing methods. The duration for reaching required strength are found. The differences of compressive strength are studied and found that the continuous water curing has maintained for a period of 28 days so as to gain the compressive strength of 34 K/mm2 as per the code IS 456:2000 of the Buerow of Indian Standards.

***Key words*:** Quality, RCC, Material handling, Mechanical handling, Compressive strength,,

1. INTRODUCTION

Quality Management and practices are the collection, analysis and interpretation of data for use in quality control activities. Quality control is the use of techniques and activities to achieve sustain and improve the quality of product. Time saving, Cost saving and Reputation saving are the main objectives for the Project Planning and Construction Projects. Concrete Batching Plant (CBP) are being used in Constructions and they play a key role particularly in the construction of multi storeyed buildings / commercial complex in thick populated urban areas. The additional area required for yards of raw materials, installation of concrete plants and go-downs mat not be available in such areas. Therefore, mixing of concrete has to be maintained at separate locations away from the construction area. The M30 grade CC of required design is prepared in CBP by mechanical process and controls. The ready mix CC is collected and transported to the required place of work though TCM. The TCM having collecting drum which is revolving continuously upto the end of the delivery of CC so as to maintain in the uniform standards. The ready mix CC is used in

Pre-casting yard for casting of RCC hollow columns and RCC beams as per the required sizes with reinforcement as per bar bending schedule.

This paper investigates the Quality Management and Practices on Compressive strength of CC in different water curing methods and durations on the same Cubes(samples). **The water curing has to maintained for a period of 28 days so as to gain the compressive strength of 34 N/sqmm as per the BIS codes**, The gaining of compressive strength and Quality management of CC by Mechanical handling and material handling processes is found at better performance. This is the representation of strength coming in to the particular RCC components.

2. LITERATURE SURVEY

Quality has nine different dimensions such as Performance, Features, Conformance, Reliability, Durability, Service, Response, Aesthetics and Reputation [1]. The history of Q.C is undoubtedly as old as industry itself. During the middle ages, quality is a large extent controlled by the long periods of training required by the guides. Such training has instilled pride in workers for quality of a product.

The concept of specialization of labour was introduced during the Industrial revolution [2]. As a result, a worker no longer made the entire production, only a portion. Such change has brought about a decline in workmanship(3). Since, most products manufactured during the early period were not complicated and hence quality was not greatly affected. In fact increase in production, leads to decrease in cost. Thus, satisfying the customer expectation as for as cost is involved. But, products have became more complicated and jobs more specialized. Therefore, has it become necessary to inspect products after manufacture.

The issues of improving production performance with shortening construction time, reducing costs, etc. are the topics for researchers since a long time due to the urban growth. In realizing the goal of adequate 'shelter for all', the utilization of local materials as well as agro-industrial wastes could made a crucial contribution. In India, the shortage of traditional materials in which cement claims a share of 17 million tons, brick 54,898 millions, timber 13.34 million cubic meter, steel 2.70 million tons sand aggregate for concrete 286 million tons [4]. Many projects of building materials based on imported technologies closed down with colossal financial losses as they proved to be highly energy intensive and incompatible with the physical properties of local materials. Therefore, it is necessary to develop technology for construction of multi storeyed buildings from local resources which could provide sustained housing growth [5].

The productivity investigation as well as the analysis of planning and scheduling techniques are studied in [6,]. The effect of managerial action on the objectives of reducing time, cost and improving quality are investigated in [7]. The technological improvements, refers to using different materials, tools and / or equipment and to adopt new construction methods [8]. Pre-fabrication, being one of the greatest technological improvements in construction, the industrialization has long been recognized as the major way to achieve a quantum leap in productivity improvements in the Building Industry.

Accordingly, the multi storeyed building construction in Hyderabad is taken as a Case Study the construction of ground Floor [2].

Therefore, the Quality Controle and Management [9] on compressive strength of RCC components have to be compared with International Standards [10]. Therefore, Mechanical handling and Material handling of preparation of RCC is taken up for the Research pertaing high rise Building constructions..

3. METHODOLOGY

The methodology consists of curing and monitoring of M30 grade CC samples used in RCC works. The process flow chart for monitoring and measurement of incoming material from quality control laboratory is shown in Figure : - 1.

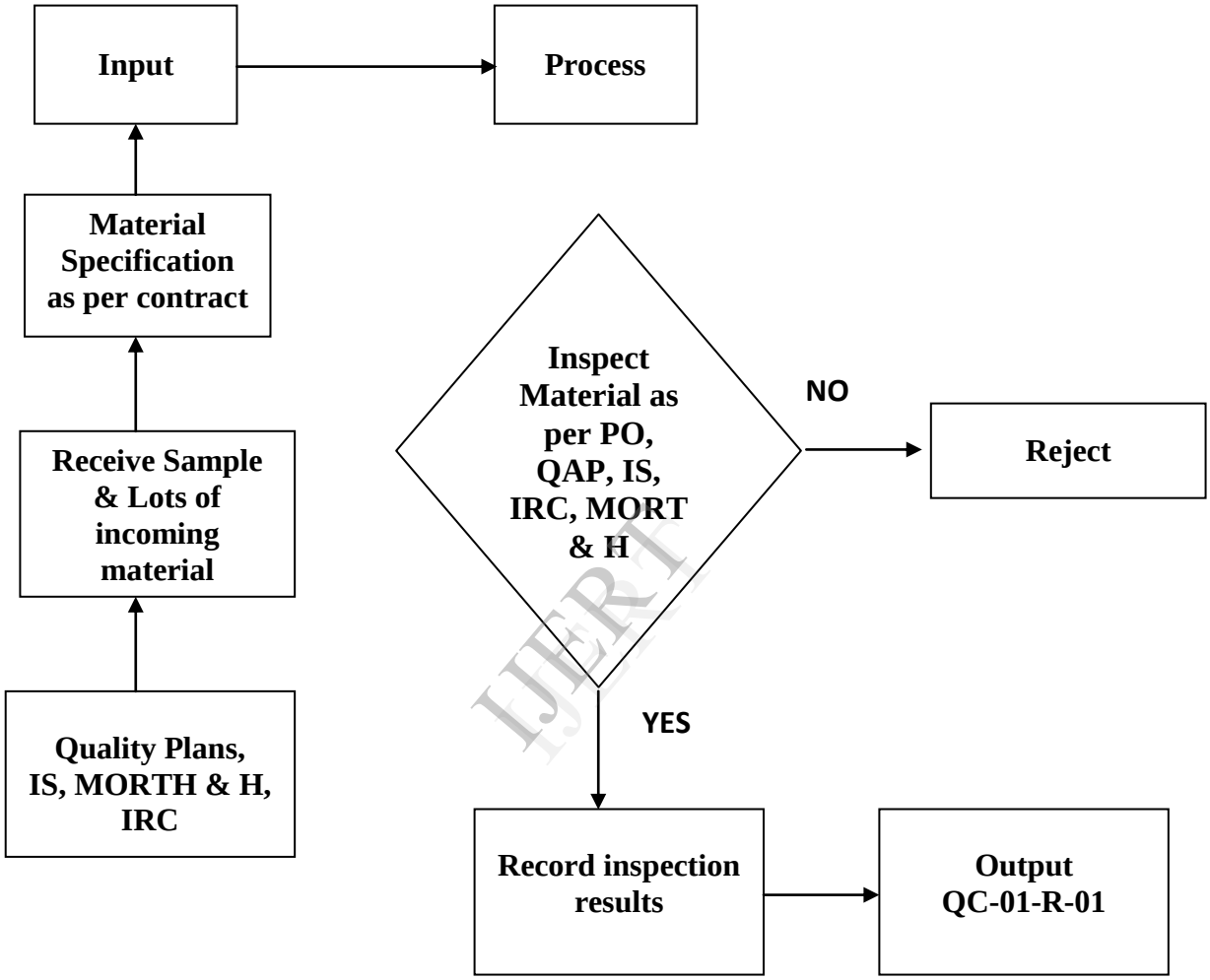


Figure 1.Process flow chart for monitoring and measurement of incoming material

The process of monitoring and measurement of quality control are explained below.

The CC of M30 grade is designed as per the requirement. The raw materials such as River sand, Robo sand, 12.50mm HBG metal, 20mm HBG metal are collected from various places , tested to required standards and ready stocked at the convenient place (Back side) of the CBP. The mini water tank is located at the top of the mixing chamber with automatic gate valve system and Cement through pipe from the bunkers with hydraulic system. The CC of 0.50 cum is prepared at one cycle of duration and loaded in TCM by chain conveyor system. The CBP is controlled by electrical motors, wire ropes, conveyors and hydraulic systems.

Stage – 1.

The CC of M30 grade is collected and transported by TCM for casting RCC footings, RCC columns, RCC beams, Grade slab etc. in multistoreyed buildings of G+14 floors, 17 blocks in the construction site. The samples of CC are collected and filled in the Iron moulds of size 150 mm x 150 mm x 150 mm. **The cubes prepared are places under water for curing. The compressive strength of cubes are tested after 7th day and 28th day as per the guidelines of IS 456:2000 of Buerow of Indian Standards. The results are tabulated in the Table No. 1.**

Stage – 2.

For further analysis, the similar type of cubes of 18 No. are prepared at the columns location and another 18 cubes at beams location.

The cubes are de-moulded after minimum setting time of 30 minutes and numbered for sub division into 4 groups as shown in Figure -. 2.

Group I : BCW (B-type Columns under Water curing) : RCC cubes are immersed in water pond for 28 days and kept out side without water curing upto 63 days.

Group II : BCS (B-type Columns under Water curing) : RCC cubes placed for water curing at the yard by mechanically(sprinkling) for 28 days and kept out side without water curing upto 63 days.

Group III : BBCW (B-type Beams under Water curing) : RCC cubes are immersed in water upto 63 days.

Group VI : BBCS(B-type Beams under Water curing) : RCC cubes placed for water curing at the yard by mechanically(sprinkling) up to 63 days.

The RCC cubes of Group I (9No) are designated BCW1 to BCW9 with date of casting and completely immersed in the water pond as shown in Fig.ure -3.

The RCC cubes of Group II (9No) are designated BCS1 to BCS9 with date of casting and placed over the Pre-casting Columns n the yard. The water sprinkling device is fixed for spreading over the surfaces of cubes.

The RCC cubes of Group III (9No) are designated BBCW1 toBBCW9 with date of casting and completely immersed in the water pond at separate location.

The RCC cubes of Group IV (9No) are designated BBCS1 to BBCS9 with date of casting and placed over the surface of the Beams at the yard. The water sprinkling device is fixed for spreading over the surfaces of cubes.

After 7 days of curing time, the No.1 cube of individual Groups (4) are being tested their compressive strength in Compression Testing Machine as shown in Figure – 5.

The specifications of the Compressive testing machine is shown Figure – 5.:

Sl.No. : Electrical & Digital – HT – 1654/A
Capacity : 200 KN
Proving Ring : Span: 0 – 2000 div.
Dial Gauge : 1 div = 0.002 mm = 10 KN

Dial Gauge Sl No and make : K 0430, Baker

Simultaneously, the other cubes of No.2,3,4,5,6,7,8,9 of individual groups are tested on 14,21,28,35,42,49,56,63 day respectively. The results are tabulated in the Tables 2 to 5 respectively.

4. RESULTS AND DISCUSSIONS

The minimum compressive strength of CC cubes of M 30 grade for 28 days = 34.00 N/^{mm2}. The target compressive strength of CC M30 grade cubes for 28 days = 38.30 N/mm^2 .

The standard Division for the samples are found by using the following formulas.

(A) From the Table 1.

$$s = \sqrt{\frac{\sum_{i=1}^{n} x_i - \bar{x}^2}{n-1}}$$

Sx = Standard deviation of average values.
X_i = Observed value
$\bar{x}$ = Average of Xi
n = Number of observation value
Sr= Standard deviation of the Ranges
Ri= Observed ranges
R= Average of Ri
n= number of ranges

(A) From the Table 1.
X=38.98
n=25
Sx=0.299

R=0.568
N=25
Sr=0.299

(B) From table 6.

$$s = \sqrt{\frac{\sum_{i=1}^{n} x_i - \bar{x}^2}{n-1}}$$

$$\therefore s = \sqrt{\frac{0.79}{3}} = 0.510$$

(C) From Table . 7

$$s = \sqrt{\frac{\sum_{i=1}^{n} x_i - \bar{x}^2}{n-1}}$$

$$\therefore s = \sqrt{\frac{0.048}{3}} = 0.126$$

(D) Determine the trail central line and control charts.

The central lines for the $\bar{x}$ and R charts are obtained using formulas

$$\bar{\bar{x}} = \frac{\sum_{i=1}^{g} x_i}{g} \quad \text{and} \quad \bar{R} = \frac{\sum_{i=1}^{g} R_i}{g}$$

Where $\bar{\bar{x}}$ = average of the observations

$\bar{x}_i$ = value of the i^{th} sample

g = number of samples

$\bar{R}$ = average of the sample ranges

R_i = range of the i^{th} sample

Trial control limits of the charts are established at ± standard deviations from the central value as shown by the formulas.

$$UCL_{\bar{x}} = \bar{\bar{x}} + 3\sigma_x \; ; \; UCL_R = \bar{R} + 3\sigma_R$$

$$LCL_{\bar{x}} = \bar{\bar{x}} - 3\sigma_x \; ; \; LCL_R = \bar{R} - 3\sigma_R$$

$$\bar{\bar{X}} = \frac{\sum_{i=1}^{g} \bar{x}}{g} \; ; \; \bar{R} = \frac{\sum_{i=1}^{g} R}{g}$$

UCLx=38.98+3x0.299 = 39.877
LCLx=38.98-3x0.299 = 38.083

UCLr = 0.568+3x0.299 = 1.465
LCLr = 0.568-3x0.299 = -0.329

Figure – 2: CC cube

Figure – 3: CC cubes under water

Figure – 4 : Compressive Testing Machine

Figure – 5: CC cube under Compression

Table : -1 Compressive strength of M30 grade CC under wter curing period of 28 days

S.No.	Date of Casting	Date of Testing	Compressive strength N/mm2	(Xi-X)	(Xi-X)2	Ri	(Ri-R)	(Ri-R)2
1	2	3	4	5	6	7	8	9
1	03.01.2011	31.01.2011	38.96	-0.02	0.0004	0.59	0.022	0.0005
2	04.01.2011	01.02.2011	39.55	0.57	0.3249	0	-0.568	0.3226
3	05.01.2011	02.02.2011	38.51	-0.47	0.2209	1.04	0.472	0.2228
4	06.01.2011	03.02.2011	38.96	-0.02	0.0004	0.59	0.022	0.0005
5	07.01.2011	04.02.2011	39.11	0.13	0.0169	0.44	-0.128	0.0164
6	08.01.2011	05.02.2011	39.25	0.27	0.0729	0.30	-0.268	0.0718
7	10.01.2011	07.02.2011	38.96	-0.02	0.0004	0.59	0.022	0.0005
8	11.01.2011	08.02.2011	38.66	-0.32	0.1024	0.89	0.322	0.1037
9	12.01.2011	09.02.2011	38.95	-0.03	0.0009	0.60	0.032	0.0010
10	13.01.2011	10.02.2011	38.96	-0.02	00004	0.59	0.022	0.0005
11	14.01.2011	11.02.2011	39.55	0.57	0.3249	0.00	-0.568	0.3226
12	17.01.2011	14.02.2011	38.96	-0.02	0.0004	0.59	0.022	0.0005
13	18.01.2011	15.02.2011	38.66	-0.32	0.1024	0.89	0.322	0.1037
14	19.01.2011	16.02.2011	38.66	-0.32	0.1024	0.89	0.322	0.1037
15	20.01.2011	17.02.2011	38.96	-0.02	0.0004	0.59	0.022	0.0005
16	21.01.2011	18.02.2011	39.41	0.43	0.1849	0.14	00.428	0.1832
17	22.01.2011	19.02.2011	38.96	-0.02	0.0004	0.59	0.022	0.0005
18	24.01.2011	21.02.2011	39.11	0.13	0.0169	0.44	-0.128	0.0164
19	25.01.2011	22.02.2011	39.25	0.27	0.0729	0.30	-0.268	0.0718
20	27.01.2011	24.02.2011	39.11	0.13	0.0169	0.44	-0.128	0.0164
21	28.01.2011	25.02.2011	39.26	0.28	0.0784	0.29	-0.278	0.0772
22	29.01.2011	26.02.2011	38.66	-0.32	0.1024	0.89	0.322	0.1037
23	31.01.2011	28.02.2011	38.96	-0.02	0.0004	0.59	0.022	0.0005
24	01.02.2011	01.03.2011	38.36	-0.62	0.3844	1.19	0.622	0.386
25	02.02.2011	02.03.2011	38.81	-0.17	0.0289	0.74	0.172	0.029

Table- 2 Compressive strength of CC cubes which are immersed in water pond in 28 days and kept outside without water upto 63 days.

S.No	Cube ID NO.	Location	Date of Casting	Date of testing	Curing Duration in days	Weight of the Cube inKgs	Load in Tones	Compressive strength in N/mm2
1	2	3	4	5	6	7	8	9
1	BCW1	Pre-casting yard	03.03.11	10.03.11	7	8.17	620	27.56
2	BCW2	-do-	03.03.11	17.03.11	14	8.21	640	28.44
3	BCW3	-do-	03.03.11	24.03.11	21	8.24	680	30.22
4	BCW4	-do-	03.03.11	31.03.11	28	8.25	800	35.56
5	BCW5	-do-	03.03.11	07.04.11	35	8.20	820	36.44
6	BCW6	-do-	03.03.11	14.04.11	42	8.14	840	37.33
7	BCW7	-do-	03.03.11	21.04.11	49	8.28	880	39.11
8	BCW8	-do-	03.03.11	28.04.11	56	8.32	880	39.11
9	BCW9	-do-	03.03.11	05.05.11	63	8.22	880	39.11

Table: 3 Compressive strength of CC cubes which are in water curing at the yard by mechanical(sprinkling) in 28 days and without water upto 63 days.

S.No	Cube ID NO.	Location	Date of Casting	Date of testing	Curing Duration in days	Weight of the Cube inKgs	Load in Tones	Compressive strength in N/mm2
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	BCS1	Pre-casting yard	03.03.11	10.03.11	7	8.16	600	26.67
2	BCS2	-do-	03.03.11	17.03.11	14	8.24	620	27.56
3	BCS3	-do-	03.03.11	24.03.11	21	8.20	680	30.22
4	BCS4	-do-	03.03.11	31.03.11	28	8.18	780	34.67
5	BCS5	-do-	03.03.11	07.04.11	35	8.22	800	35.56
6	BCS6	-do-	03.03.11	14.04.11	42	8.23	810	36.00
7	BCS7	-do-	03.03.11	21.04.11	49	8.20	840	37.33
8	BCS8	-do-	03.03.11	28.04.11	56	8.30	860	38.22
9	BCS9	-do-	03.03.11	05.05.11	63	8.24	880	39.11

Table: 4 Compressive strength of CC cubes which are immersed in water pond upto 63 days.

S.No	Cube ID NO.	Location	Date of Casting	Date of testing	Duration in days	Weight of the Cube inKgs	Load in Tones	Compressive strength in N/mm2
1	2	3	4	5	6	7	8	9
1	BBCW1	Pre-casting yard	03.03.11	10.03.11	7	8.21	610	27.11
2	BBCW2	-do-	03.03.11	17.03.11	14	8.24	650	28.89
3	BBCW3	-do-	03.03.11	24.03.11	21	8.22	720	32.00
4	BBCW4	-do-	03.03.11	31.03.11	28	8.20	800	35.56
5	BBCW5	-do-	03.03.11	07.04.11	35	8.20	820	36.44
6	BBCW6	-do-	03.03.11	14.04.11	42	8.22	860	38.22
7	BBCW7	-do-	03.03.11	21.04.11	49	8.21	870	38.67
8	BBCW8	-do-	03.03.11	28.04.11	56	8.30	880	39.11
9	BBCW9	-do-	03.03.11	05.05.11	63	8.28	880	39.11

Table: 5 Compressive strength of CC cubes which are in water curingat the yard mechanically(sprinkling) upto 63 days.

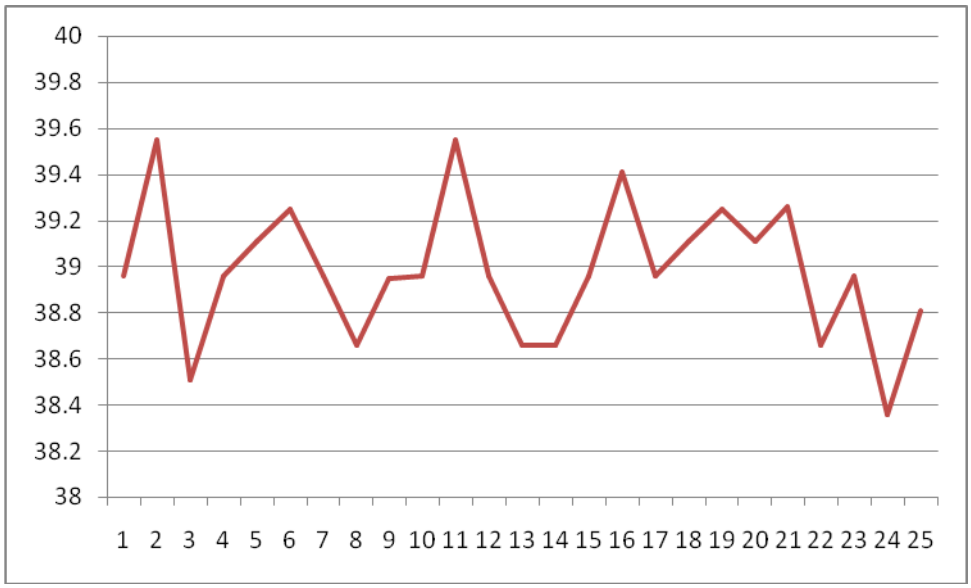
S. No.	Cube ID NO.	Location	Date of Casting	Date of testing	Duration in days	Weight of the Cube in Kgs	Load in Tones	Compressive strength in N/mm2
1	2	3	4	5	6	7	8	9
1	BBCS1	Pre-casting yard	03.03.11	10.03.11	7	8.24	620	27.56
2	BBCS2	-do-	03.03.11	17.03.11	14	8.22	640	28.44
3	BBCS3	-do-	03.03.11	24.03.11	21	8.26	680	30.22
4	BBCS4	-do-	03.03.11	31.03.11	28	8.28	780	34.67
5	BBCS5	-do-	03.03.11	07.04.11	35	8.20	820	36.44
6	BBCS6	-do-	03.03.11	14.04.11	42	8.25	830	36.89
7	BBCS7	-do-	03.03.11	21.04.11	49	8.26	860	38.22
8	BBCS8	-do-	03.03.11	28.04.11	56	8.30	880	39.11
9	BBCS9	-do-	03.03.11	05.05.11	63	8.25	880	39.11

Table: 6 Compressive strength of CC cubes after curing of 28 days.

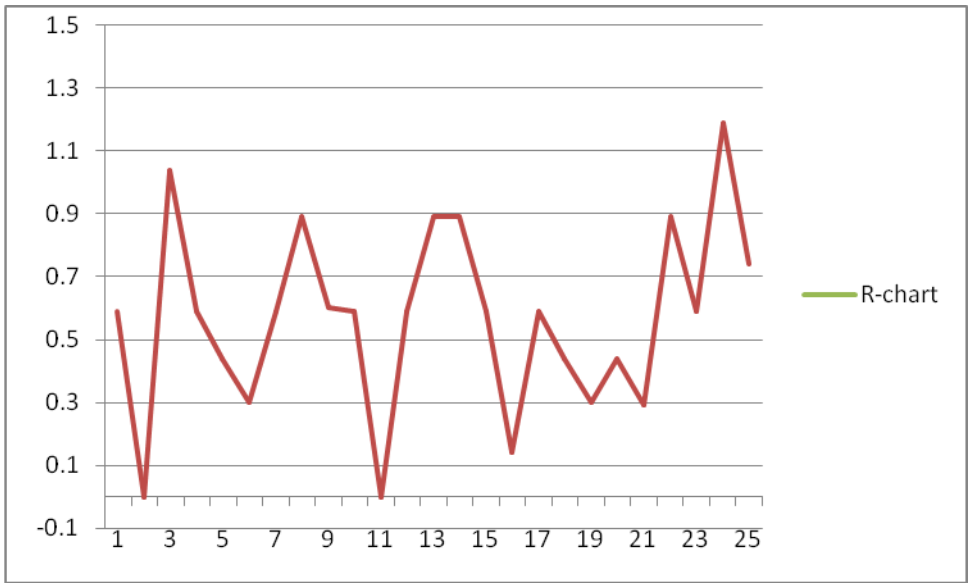
S.No.	Cube ID No.	Stress N/mm2	Xi-X	(Xi-X)2
1	BCW4	35.56	0.45	0.202
2	BCS4	34.67	-0.44	0.193
3	BBCW4	35.56	0.45	0.202
4	BBCS4	34.67	-0.44	0.193
Total		140.46	0.02	0.790

Table: 7 Compressive strength of CC cubes after curing of 42 days.

S.No.	Cube ID No.	Stress N/mm2	Xi-X	(Xi-X)2
1	BCW4	37.33	0.45	0.202
2	BCS4	36.00	-0.44	0.193
3	BBCW4	38.22	0.45	0.202
4	BBCS4	36.89	-0.44	0.193
Total		148.44	0.00	0048



X-Chart Samples



R-Chart Samples

5. CONCLUSIONS

The compressive strength of M30 grade CC is vary in different water curing methods. It is found that the water curing in water pond is getting more values than the other methods.

FURTHER WORK

Line balance techniques will be studied .

ACKNOWLEDGEMENT

The authors expresses their sense of gratitude for the help and cooperation extended by A. P. Rajiv Swagruha Corporation Limited, Jawahar Nagar, Hyderabad, India.

REFERENCES

1) Dale H.Besterfield, Quality control
2) Sankaraiah M, Rambabu E, Eswara Reddy C. Mechanical Handling of Materials in the construction of Multi storeyed buildings – a case study. ICAME-2010,S.V.National Institute of Technology, Surat,Gujarat, India.Proceedings; 2010, p. 42 (832-836)
3) Sankaraiah M, Rambabu E, Eswara Reddy C. Role of Material Handling Equipment in construction of High - Rise Buildings. 2nd A.P. Science Congres National Conference, S.V.University, Tirupati,India.
4)V.K.Mathur, Central Building Research Onstitute,Roorkee , India,Composite materials from local resources.Construction and Building materials 20(2006) 470-477.
5)V.K.Mathur, Central Building Research Onstitute,Roorkee , India,CSIRtask force programme, Roorkee,12th July,2002.High-rise commercial building projects. Construction Management and Economics 1985;3(1):59-87.
6)Rosenfield Y, Navon R, Cohen L, Methodology for prioritizing cost-effective construction technologies. Journal of construction Engineering and Management, ASCE 1998:124(3): 176-84.
7)Rosenfeld y. Innovative construction methods. Construction Management and Economics 1994;12(6):521-41.

8)Dietz AGH, Cuttler LS, editors. Industrialised building systems and housing. Cambridge, MA: MIT Press.1971.
9)Warszawski A. Industrialisation and robotics in building: amanagerial approach. New York: Happer and Row,1990.
10) IS : 456 : 2000 of Beurow of Indian Standards.