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Study on Effect of Traditional and Accelerated Curing Method on Compressive Strength of Concrete Incorporating with Industrial Waste

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Abstract - ***All of the beneficial properties of precast concrete, including compressive strength, durability and water tightness are enhanced through proper curing techniques. Unfortunately, the curing of precast concrete products is one of the last and perhaps most neglected steps in the manufacturing process, especially in a rapid production environment. Curing takes place immediately after concrete placing and finishing, and involves maintenance of desired moisture and temperature conditions.***

Aim of study is to determine efficient method of curing which gives better compressive strength of concrete incorporating industrial waste. For further investigation the cubes of different grades of concrete with different proportion of industrial waste are to be casted and their Compressive strength will be determined with method of traditional and accelerated curing. Cost analysis for a ROB bridge at surendranagar with a concrete incorporating industrial waste are carried out.

Keywords - Precast concrete, Curing, Traditional Curing, Accelerated Curing, Compressive Strength

INTRODUCTION

Indian realty majors are adopting precast technology in building their latest projects. The main advantages of precast technology are quality, speed of construction, and a value-for-money product. Precast concrete is advantageous for reduce shrinkage and creep, control dead-load deflections, improve quality control, material availability can be improved and for steel erection methods are similar to in-situ concrete and thus total construction time is significantly reduced. The use of such technology helps in saving up to 64% of the time taken for similar projects using normal construction methods and technology. In other words, if normal brick-and-mortar method takes one year to complete a project, the precast method takes about four months. But the curing of precast concrete products is one of the last and perhaps most neglected steps in manufacturing process, especially in a rapid production environment.

Curing is the maintenance of a satisfactory moisture content and temperature in concrete for a period of time immediately following placing and finishing so that the desired properties may develop. The need for adequate curing of concrete cannot be overemphasized. Curing has a strong influence on the properties of hardened concrete; proper curing will increase durability, strength, water tightness, abrasion resistance, volume stability, and resistance to freezing and thawing and deicers.

Traditional conditions for curing involve by spraying or ponding the concrete surface with water. Additional common curing methods include wet burlap and plastic sheeting covering the fresh concrete. For higher-strength applications, accelerated curing techniques may be applied to the concrete. One common technique involves heating the poured concrete with steam, which serves to both keep it damp and raise the temperature, so that the hydration process proceeds more quickly and more thoroughly.

I. OBJECTIVES

Following are the main objectives of the research work.

- To study of Traditional and Accelerated curing method for concrete and its effect at various environment.
- To study the effect of different curing techniques on Compressive strength of concrete and concrete incorporating industrial waste.
- To evaluate Mechanical properties of Hardened Concrete by Compression Test (at 3, 7 and 28 days).
- To study the effect of curing method on Time, Quality and Cost.

II. RESEARCH METHODOLOGY

In order to compare accelerated curing strength with traditional curing strength, an experiment work has been carried out. The cube of various grade of concrete are casted from same properties of materials with glass powder and curing is done by traditional and accelerated curing methods. After 3, 7 and 28 days the compressive strength of concrete are tested and compare result. Casting and curing of concrete cube are as per IS codes.

III. ACCELERATED CURING METHODS

Boiling water method (100° C)

In this method after specimens have been made, they shall be stored in vibration free place and humidity of room is maintained 90% at a 27 ± 2° C for 23 hours ± 15 minutes from the mixing of water with cement. Specimen shall be cured in curing tank for 3.5 hours at a 100° C for 2 days. The temperature of curing tank at boiling period should not drop more than 3°.

Warm water method (60° C)

After the specimen have been made, they kept in place free from vibration at 27 ± 2° C for two hours and then immersed in curing tank with the mould and curing it at 60° C for 72 hours. The specimen shall then be removed from the mould placed for saturated surface dry (SSD) condition.

IV. MATERIAL AND EXPERIMENTAL WORK

TABLE 1: Physical properties of Cement and Glass Powder

property	Property of Cement	Property of Glass Powder
Specific Gravity	3.16	3.01
Fineness by seiveing	1.36	
Consistency	30.5	31.5
Initial Setting Time	105	140
Final Setting Time	295	305
Compressive Strength		
3 days	31.0	32.0
7 days	43.0	43.5
28 days	56.0	56.0

TABLE 2: Mix Proportion

Mix Proportion						
Concrete Grade		Cement	Water	F.A	C.A.(10mm)	C.A.(20mm)
M20	Proportion	1.000	0.480	1.669	1.125	2.089
	Per m^3	392	188	654	441	818
M25	Proportion	1.000	0.430	1.400	1.004	1.865
	Per m^3	445	178	623	447	830
M35	Proportion	1.000	0.360	1.207	0.881	1.636
	Per m^3	494	178	596	435	808
M40	Proportion	1.000	0.380	1.178	0.794	1.475
	Per m^3	516	196	608	410	761

Table 3: Concrete compressive strength incorporating Glass Powder

7 Day testing (M-20) (1:1.88:2.83 & w/c=0.5)							
Cube	Date of Casting	Date of Testing	Mix Proportion		Weight of Cube	Strength	
			Cement	GP		All	Avg
Cube 1	21-12-2017	29-12-2017	100	0	8.05	18.31	17.085
Cube 2	21-12-2017	29-12-2017	100	0	8.15	15.86	
Cube 1	01-01-2018	09-01-2018	90	10	8.3	17.33	17.13
Cube 2	01-01-2018	09-01-2018	90	10	8.15	16.93	
Cube 1	02-01-2018	10-01-2018	80	20	8.4	18.95	18.605
Cube 2	02-01-2018	10-01-2018	80	20	8.45	18.26	
Cube 1	02-01-2018	10-01-2018	70	30	8.65	16.22	16
Cube 2	02-01-2018	10-01-2018	70	30	8.7	15.77	
28 Day testing (M-20) (1:1.88:2.83 & w/c=0.5)							
Cube	Date of Casting	Date of Testing	Mix Proportion		Weight of Cube	Strength	
			Cement	GP		All	Avg
Cube 1	21-12-2017	18-01-2018	100	0	8.3	24.62	22.42
Cube 2	21-12-2017	18-01-2018	100	0	8.25	20.22	
Cube 1	01-01-2018	29-01-2018	90	10	8.4	24.67	23.53
Cube 2	01-01-2018	29-01-2018	90	10	8.35	22.4	
Cube 1	02-01-2018	30-01-2018	80	20	8.4	26.8	24.82
Cube 2	02-01-2018	30-01-2018	80	20	8.5	22.84	
Cube 1	02-01-2018	30-01-2018	70	30	8.2	19.24	20.705
Cube 2	02-01-2018	30-01-2018	70	30	8.25	22.17	

From the pilot study of Glass Powder as an industrial waste in concrete with a different proportion of cement replacement we get a good result at a 7 days as well as at 28 days. From that study conclusion is made that the replacement content of GP with the cement is optimum at a 20%. Testing of compressive strength of normal concrete with a different curing methods (Traditional curing method and accelerated curing method) at a 28 days. For accelerated curing method strength of concrete are predicted by the help of IS 9013.

Regression Equation for prediction of compressive strength at 28 days of concrete which are cured with accelerated curing for 1 day is

$$R_{28} = 1.64 * R_a + 8.09$$

Where, R_a = compressive strength of concrete at a day 1 by accelerated curing method

TABLE 4: Compressive strength of a concrete with traditional and accelerated curing of different grade

Grade	Normal Curing By immersion		Accelerated Curing		
	Compressive strength at 28th day		R_a	Compressive strength at 28th day (R28=1.64*Ra+8.09)	
M20	28.51	28.83	14.27	31.5	31.38
	28.86		13.71	30.57	
	29.12		14.62	32.06	
M25	35.1	34.15	17.81	37.3	35.92
	34.25		16.74	35.55	
	33.1		16.35	34.9	
M35	44.8	46.48	23.12	46	47.54
	45.55		23.80	47.12	
	49.1		25.25	49.5	
M40	50.1	48.97	26.53	51.6	50.08
	48.6		25.25	49.5	
	48.2		25.04	49.15	

From the result of above experiment we found that we can get a better result in less duration with the help of accelerated curing for further study we merge both above experiment of GP concrete and Accelerated curing.

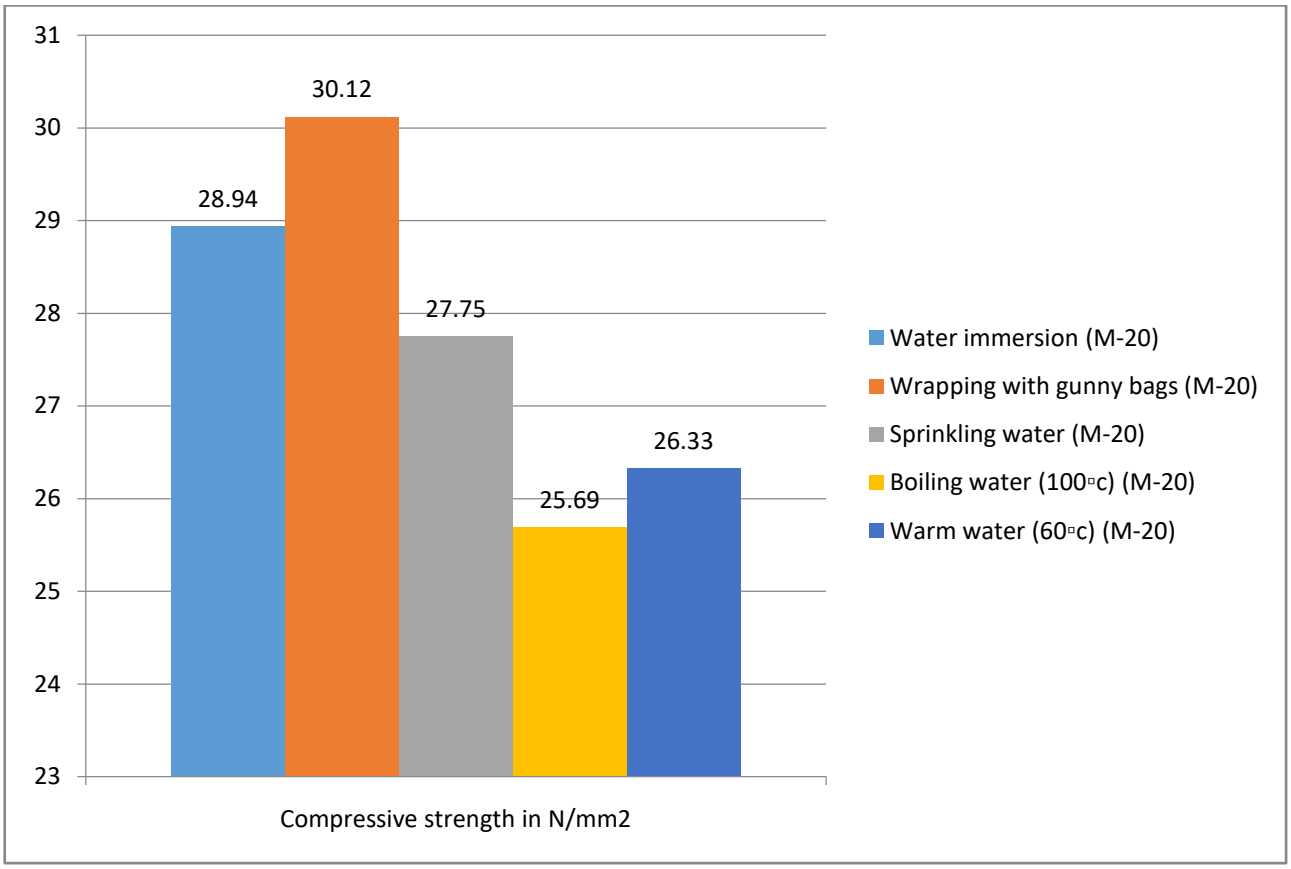

Figure 1 Comparison of compressive strength of M-20 grade concrete with different curing method

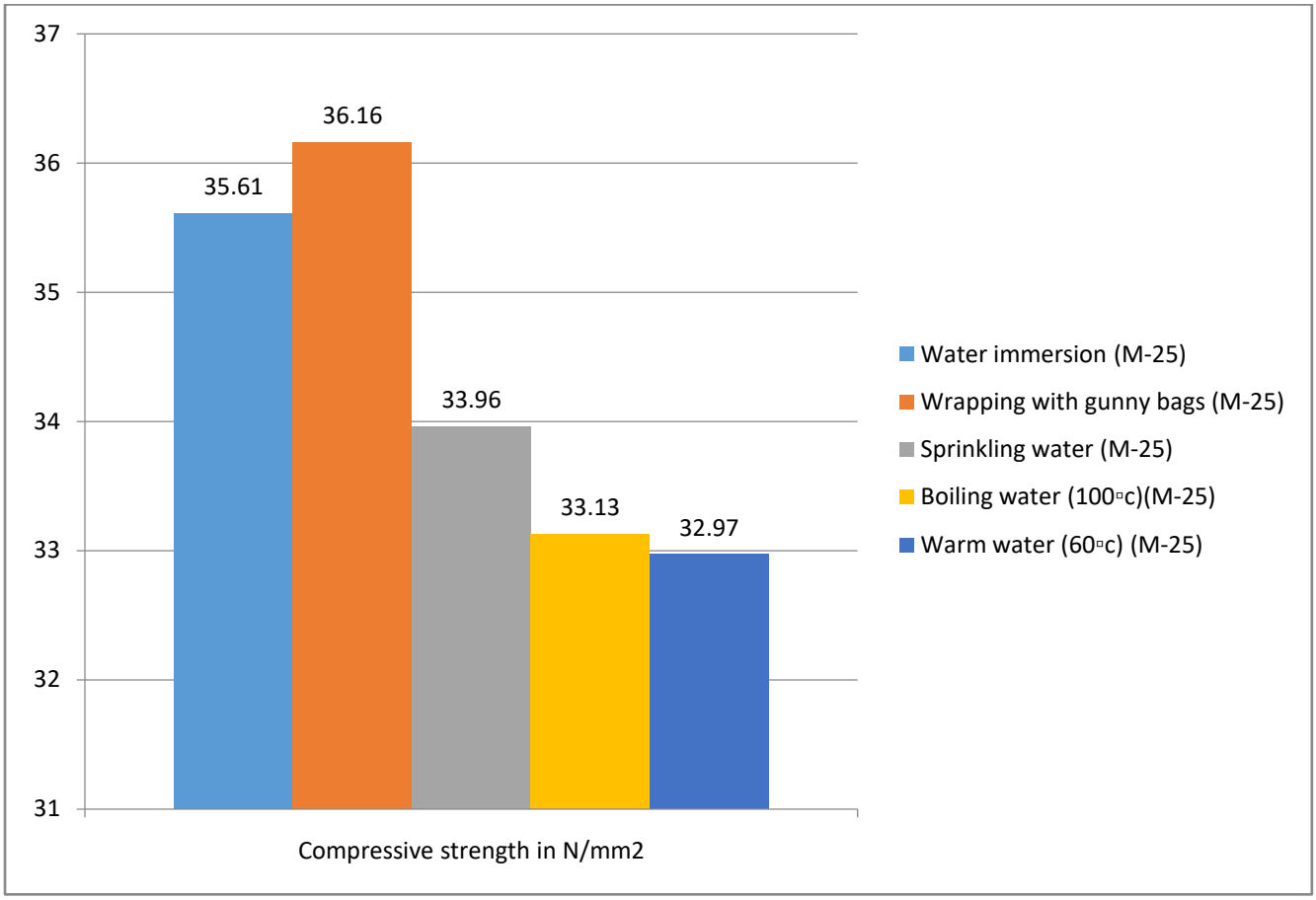

Figure 2 Comparison of compressive strength of M-25 grade concrete with different curing method

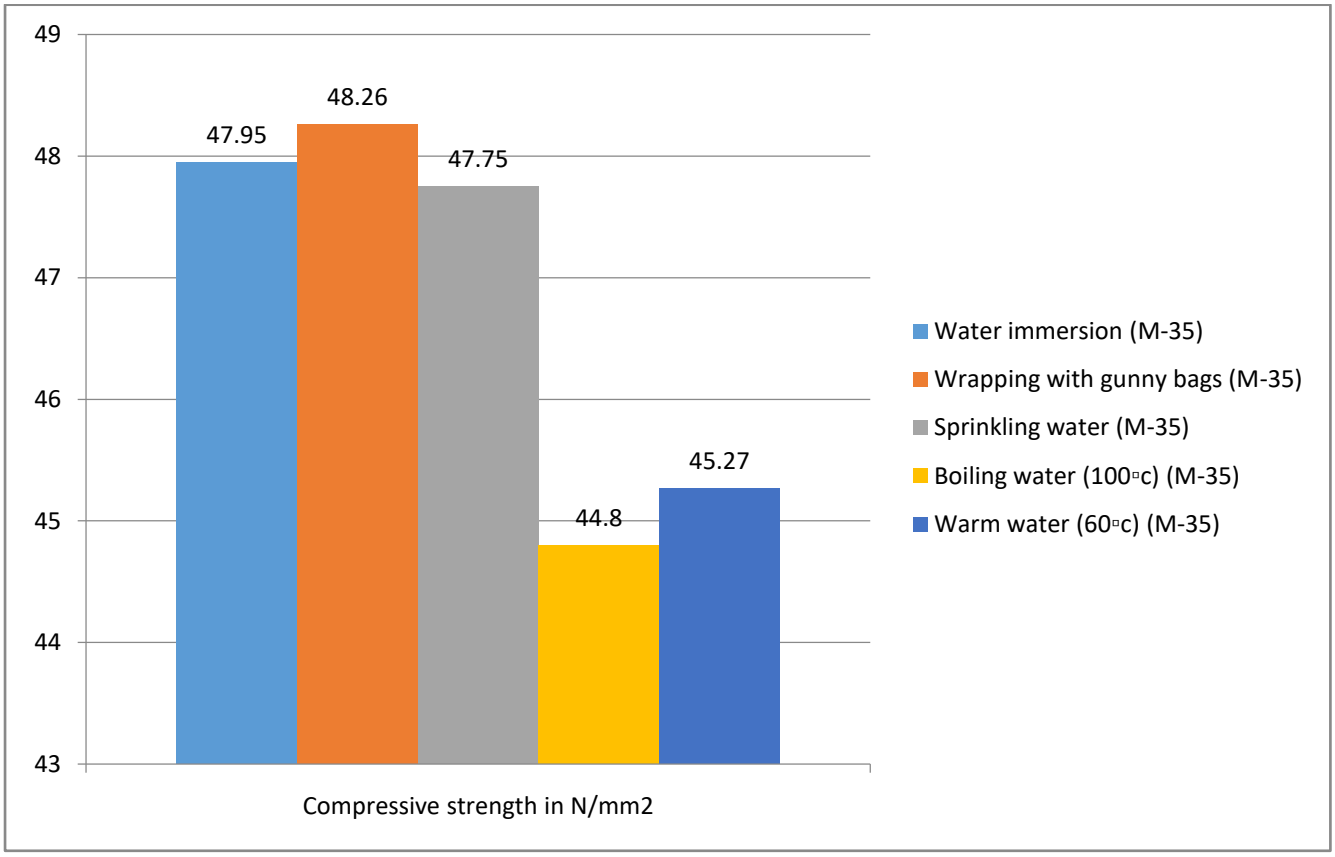

Figure 3 Comparison of compressive strength of M-35 grade concrete with different curing method

Table 5: Cost analysis for an M-20 grade concrete

Sr. No.	Materials	Quantity (kg)	Cost
1	Cement	314	2010
2	Glass Powder	78	117
3	Fine Aggregeate	654	392
4	Coarse Aggregeate (6-10 mm)	441	309
5	Coarse Aggregeate (10-20 mm)	818	654
6	Water	188	19

Total Quantity of Materials = 2493

Total Cost of Materials = 3,501

Cost of 1 cubic meter Normal M20 grade concrete = 3,883

Benefits per cubic meter = 382

Benefits per cubic meter for M-20 = 382/-

Benefits per cubic meter for M-25 = 437/-

Benefits per cubic meter for M-35 = 485/-

Benefits per cubic meter for M-40 = 505/-

From the BOQ of the ROB bridge tender at surendranagar are detaile studied. Quantity of concrete with different grades are find out and from the above cost analysis the total amount of the saving in bridge by GP replacement with cement are calculated.

Table 6: Cost Saving in ROB Surendranagar

Surendranagar ROB		
Grade of concrete	Quantity (cmt)	Saving
M20	188.61	72,049.02/-
M25	1729.50	7,55,791.50/-
M35	12247.83	59,40,197.55/-
M40	3348.10	16,90,790.50/-
	Total Saving	84,58,828.57/-

V. CONCLUSION

This experimental work has established the feasible way for using industrial waste such as Glass Powder as a replacement of cement substitute to produces concrete. Compressive strength of the concrete incorporating Glass Powder increase compare to traditional concrete. Accelerated curing also increase the strength of the concrete in shorter duration. Based on experimental research concerning Slump Test, Compressive Strength for concrete incorporating Glass Powder and cured by various curing methods we get that the strength achieved by traditional curing method at 28 days and strength achieved by accelerated curing at 3 days have does not much difference. Concrete cured by accelerated curing method get a satisfactory result as per grade of concrete. In lower grade concrete Glass Powder increase strength by 20-25%. When in high strength concrete increase in strength of concrete is by 15-20%. But in the high strength concrete heat of hydration are controlled by a Glass Powder so it is used for mass concreting in Bridge, Dam etc. Concrete incorporating Glass Powder and cured by accelerated curing can used for a manufacturing of precast element. This research increase productivity of element by delivered manufactured element as soon as possible. Rate of concrete incorporating Glass Powder for $1m^3$ are lower than the traditional concrete. Rate of concrete incorporating Glass Powder for $1m^3$ are same as a traditional concrete but it gives better result in short duration.

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