# EFFECT OF INDUCED CARBONATION ON THE MECHANICAL PROPERTIES OF M30 AND M35 GRADE CONCRETE BY USING PPC

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***Abstract*:** An experimental work was carried to find the mechanical properties of M30 and M35 grade concrete using Pozolona Portland Cement. In this study, water cement ratio of 0.42 for M30 and 0.40 for M35 were used. A comparative study was done to know the effect of carbonation on mechanical properties of carbonated concrete and normal concrete. The test was carried out in the accelerated carbonation chamber having the level of 5% in $CO_2$ and 98% in humidity. The samples were tested at 3, 7 and 28 days.

***Keywords- Carbonation, Concrete, Humidity, Carbon dioxide, Pozolona Portland etc.***

## I. INTRODUCTION

Concrete is mostly used material in the world. About 5 billion cubic yard of concrete is used widely for constructing various types of buildings, road pavements, pile foundation, bridges, retaining structures, pipes and conduits, bunkers, chimney, communication towers and tunnels. Concrete is the mixture of cement, coarse aggregate, fine aggregate and water in fixed proportion; in some cases admixtures are also used. Among these constituents; cement and water are the active component of the concrete whereas fine and coarse aggregate are the inactive components. These four ingredients has important role in the composite mix of concrete. The coarse aggregate present in the mix act as a filler material and the fine aggregate used to fill the voids which are formed between the coarse aggregate, cement react with water to produce binder. The concrete when placed in form and allowed to cure hardens into a rock like mass known as concrete. The hardening of concrete is caused due to chemical reaction between cement and water, which causes concrete, grows stronger with age. Concrete is the most important building material because it having a good compressive strength which is ranging from M10 to M140 MPa and its workability ranges from 0 to 150 mm slump or more. In other words we can say that concrete is the main base for all type of construction in construction industry.

## II. EXPERIMENTAL WORK

***Specifications of material:-***

1. Ambuja PPC cement conforming BIS:1489 was used.
2. Fine aggregates conforming to zone II having specific gravity 2.65 was used.
3. Coarse aggregates of 20 mm maximum size and 12.5 mm down size having specific gravity 2.71 was used in the ratio of 1:1 to make them well graded as per requirement of mix design.
4. Water-cement ratio was 0.42 for M30 and 0.40 for M35.

***Casting And Curing:-***

Pan mixture was used to prepare the homogeneous mixture of concrete for the sample preparations. All samples i.e. beams, cubes and cylinders were cast in a standard mould of required size. Samples were vibrated on vibrator table for few minutes to reduce the formation of air bubbles in the concrete. To determine the compressive strength of concrete of M35 and M30 grade potable water, test cubes of size 15cm were cast. Specimens were prepared for testing at 3, 7 and 28 days of curing. Cylinders having 200mm height and 100 mm dia. were used to determine the split tensile strength. Concrete cylinders were prepared for testing at 3, 7 and 28 days. For the determination of flexural strength of concrete beam sample of size 100 × 100 × 500 mm, For determining abrasion value of concrete of M40 grade cubes were cast with variable proportions of water for 7, 14 and 28 days of curing. These specimens were cured in the curing tank for the specified time period.

## III. RESULTS

***1.Compressive Strength of M30 and M35 grade:-***

TABLE 1

Average Compressive Strength of M30 grade with and without carbonation N/mm$^2$

| S.NO. | Curing Age(days) | Without carbonation | With carbonation |
|---|---|---|---|
| **1** | **3** | 20.44 | 31.77 |
| **2** | **7** | 33.11 | 36.67 |
| **3** | **28** | 51.99 | 64.88 |

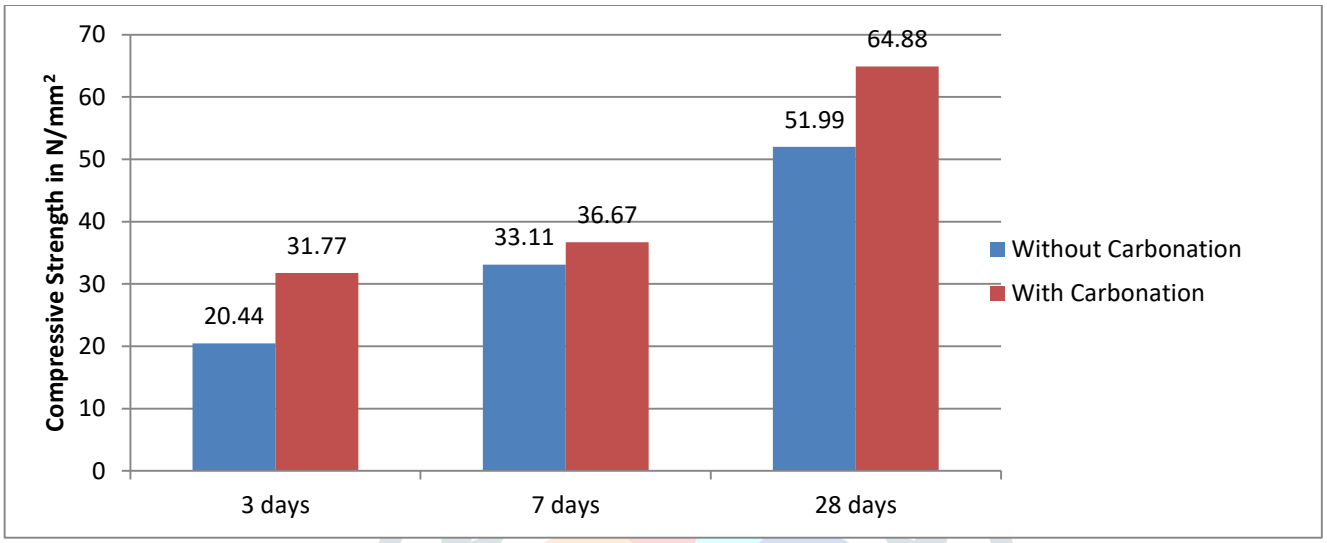


Fig. 1: Comparison of compressive strength of M30 grade with or without Carbonation

TABLE 2

Average Compressive Strength of M35 grade with and without carbonation N/mm$^2$

| S.NO. | Curing period (days) | Compressive strength in N/mm$^2$ Without carbonation | Compressive strength in N/mm$^2$ With carbonation |
|---|---|---|---|
| **1** | **3** | 23.55 | 34.88 |
| **2** | **7** | 34.18 | 39.78 |
| **3** | **28** | 55.78 | 62.88 |

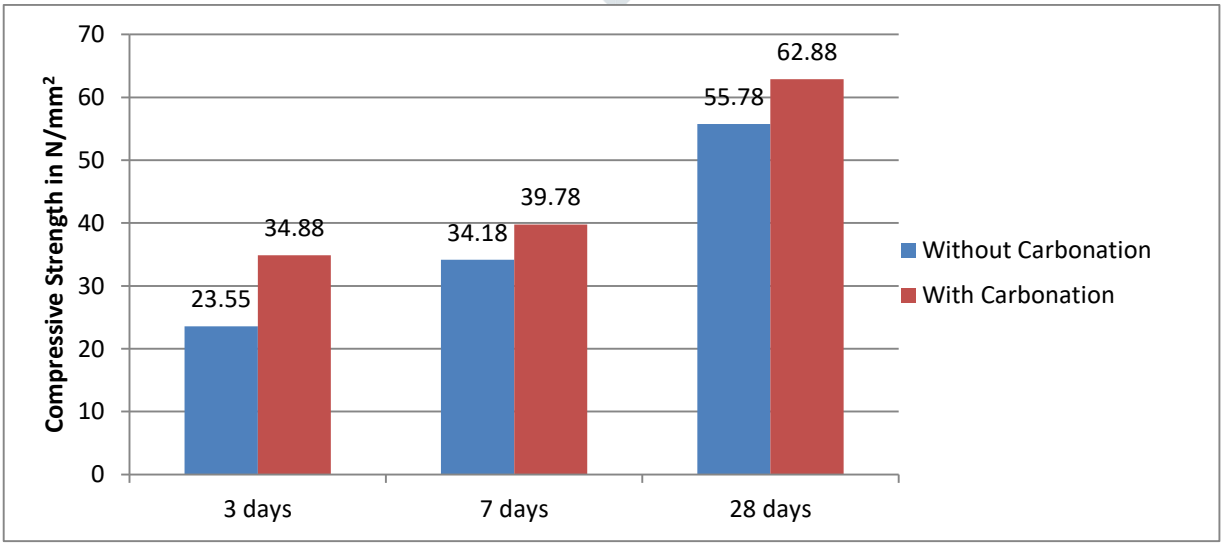


Fig. 2: Comparison of compressive strength of M35 grade with or without Carbonation

***2.Split Tensile Strength of M30 and M35 grade of concrete:-***

TABLE 3

Split tensile strength of M30 grade concrete without and with carbonation

| S.NO. | Curing period (days) | Split tensile strength in N/mm$^2$ Without carbonation | Split tensile strength in N/mm$^2$ With carbonation |
|---|---|---|---|
| **1** | **3** | 1.67 | 2.55 |
| **2** | **7** | 2.71 | 3.20 |
| **3** | **28** | 4.46 | 5.09 |

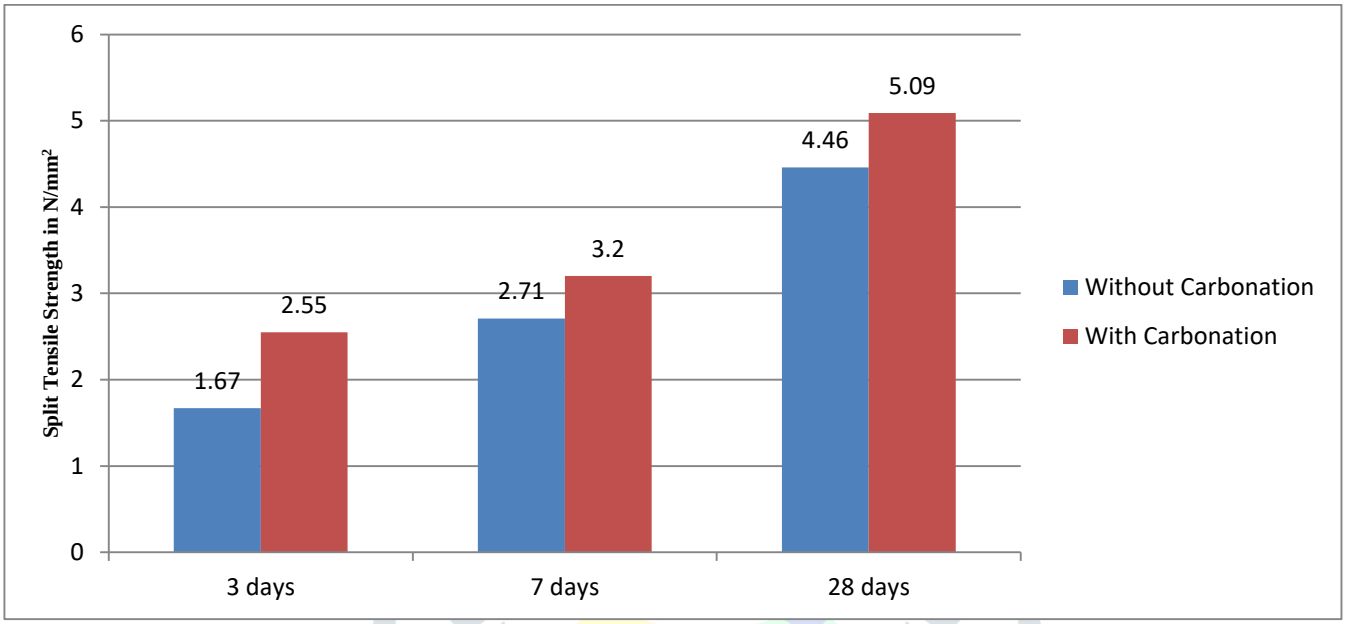


Fig. 3: Comparison of split tensile strength of M35 grade with or without Carbonation.

TABLE 4

Split tensile strength of M35 grade concrete without and with carbonation

| S.NO. | Curing period (days) | Split tensile strength in N/mm$^2$ Without carbonation | Split tensile strength in N/mm$^2$ With carbonation |
|---|---|---|---|
| **1** | **3** | 1.91 | 2.7 |
| **2** | **7** | 3.02 | 3.52 |
| **3** | **28** | 4.93 | 5.57 |

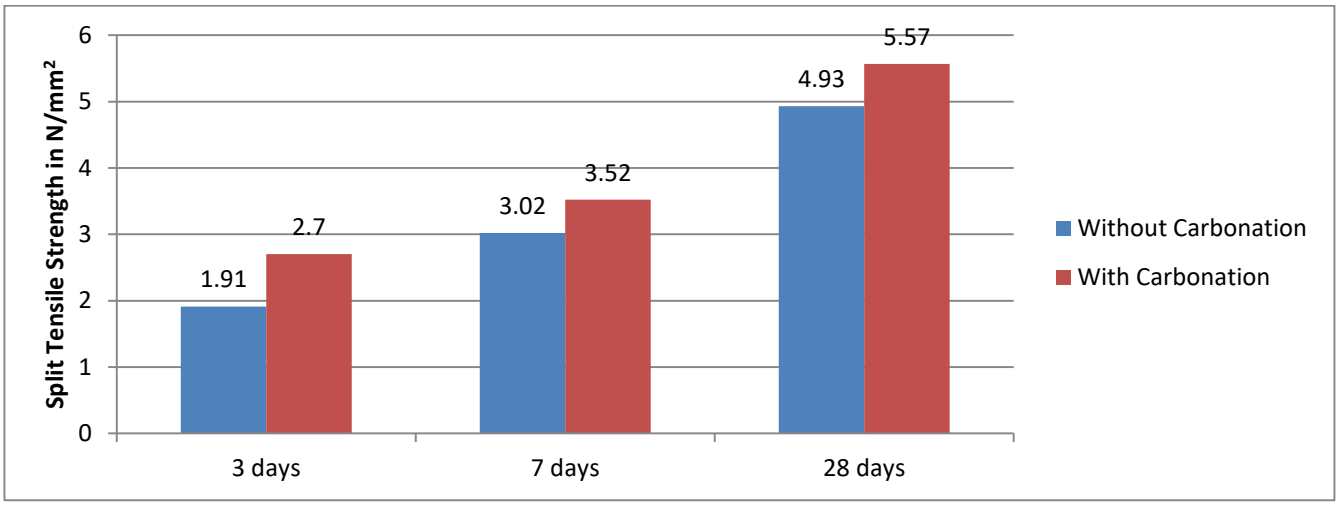


Fig. 4: Comparison of split tensile strength of M35 grade with or without Carbonation.

***3. Flexural strength of M30 and M35 grade of concrete:-***

TABLE 5

Flexural Strength of M30 grade of concrete with and without carbonation in N/mm$^2$

| S.NO. | Curing Period(days) | Flexural strength without carbonation N/mm$^2$ | Flexural strength with carbonation N/mm$^2$ |
|---|---|---|---|
| **1** | **3** | 4.19 | 5.50 |
| **2** | **7** | 5.65 | 7.16 |
| **3** | **28** | 8.88 | 10.92 |

TABLE 6

Flexural Strength of M35 grade of concrete with and without carbonation in N/mm$^2$

| S.NO. | Curing Period(days) | Flexural strength without carbonation N/mm$^2$ | Flexural strength with carbonation N/mm$^2$ |
|---|---|---|---|
| **1** | **3** | 4.85 | 6.28 |
| **2** | **7** | 6.25 | 7.53 |
| **3** | **28** | 9.16 | 10.88 |

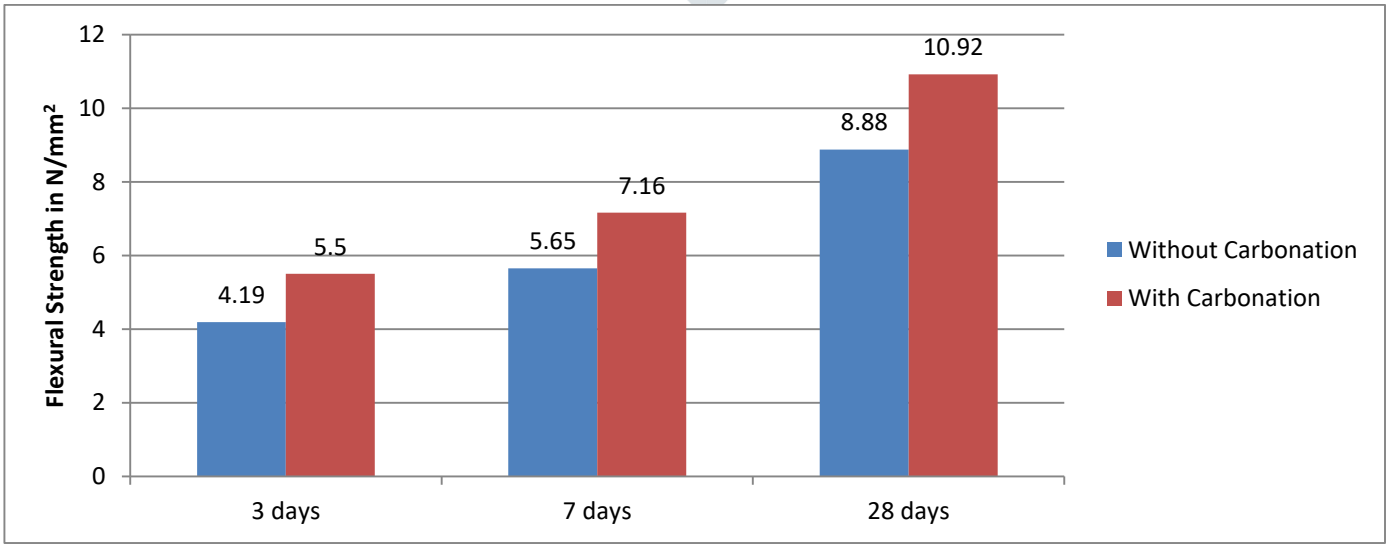


Fig. 5: Comparison of Flexural strength of M30 grade with or without Carbonation in N/mm$^2$.

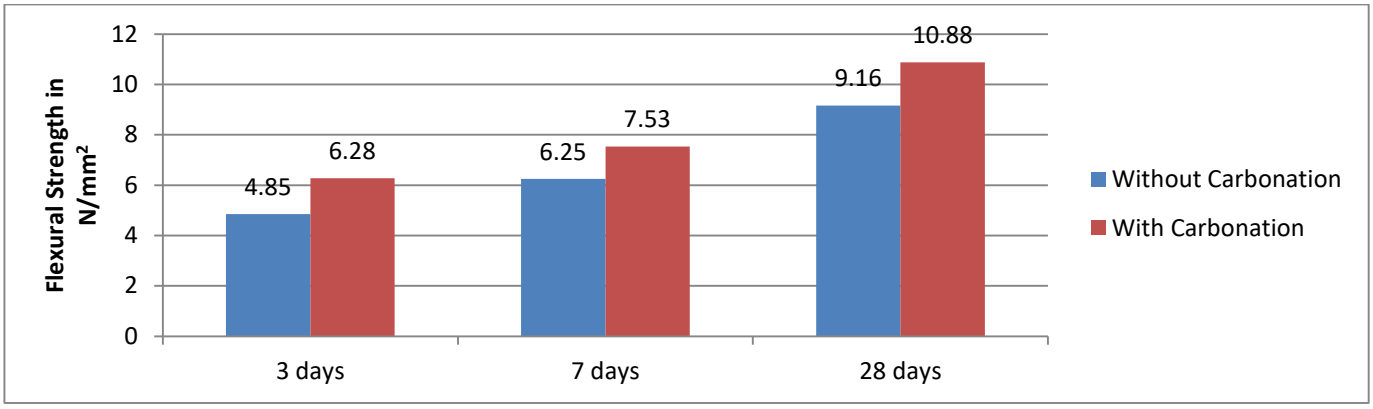


Fig.6: Comparison of Flexural strength of M35 grade of concrete with or without Carbonation in N/mm$^2$.

***4. Carbonation Test Results*:-**

In actual carbonation is very gradual process hence it does not cause any damage to concrete structure in the initial stage of its service life. Rate of carbonation depends on the humidity and exposure conditions of concrete. In this research work the test was conducted in the accelerated carbonation chamber for a period of 3, 7 and 28 days. Depth of carbonation was determined by spraying 0.2% of phenolphthalein solution on the splitting surface of the sample. The results of this test were assessed by the change in color. If the colour sprayed on the surface changes into pink then that means there was no carbonation of the concrete sample and if there is no change in colour it indicates that concrete got carbonated on its surface. In order to simulate the effect of atmosphere on the health of concrete in real life, the cubes were placed in carbonation chamber set the Temperature 30˚C, Humidity 98%, Carbon dioxide 5% for a period of 3$^{rd}$ ,7$^{th}$ and 28th day. The carbonation test was done afterwards, and the observations were noted as per ISO 1920- 12: 2015.

TABLE 7

Result of carbonation test M30 and M35 grades.

| Sr .no. | Age (days) | Carbonation depth Without carbonation | Carbonation depth With carbonation |
|---|---|---|---|
| 1. | 3 | NIL | NIL |
| 2. | 7 | NIL | NIL |
| 3. | 28 | NIL | NIL |

**INFERENCES**

There was no carbonation observed for any of the grades owing to the fact that carbonation is actually a very slow process and it takes a lot of years in a concrete of good quality to get carbonated. Though the carbonation test chamber helps to simulate the long term effect of carbonation, but results may be reflected if carbonation pressure is increased to higher levels than recorded to in the present study. Carbonation in the present test below may have been there, but in decrease manner which actually have or been able to capture using a test phenolphthalein test.

Fig.7: Carbonated Concrete Sample

## IV. DISCUSSION AND CONCLUSIONS

- From the results it can be concluded that the compressive strength of M30 and M35 grade of concrete with carbonation is more as compared to samples without carbonation.
- It has been observed that as the curing age increased, compressive strength also increased in both cases with or without carbonation.
- The test result shows that the compressive strength of carbonated concrete samples had increased by 35.66% for three day samples, 9.7% for seven days and 19.86% for 28 days test samples with respect to normal concrete sample of M30 grade of concrete.
- The test result shows that the compressive strength of carbonated concrete samples had increased by 32.48% for three day samples, 14.07% for seven days and 11.29% for 28 days test samples with respect to normal concrete sample of M35 grade of concrete.
- The test result shows that the split tensile strength of carbonated concrete samples had increased by 34.50% for three day samples, 15.31% for seven days and 12.37%for 28 days test samples with respect to normal concrete sample ofM30 grade of concrete.
- The test result shows that the split tensile strength of carbonated concrete samples had increased by 29.26% for three day samples, 14.20% for seven days and 11.50%for 28 days test samples with respect to normal concrete sample ofM35 grade of concrete.
- From the results it was also concluded that split tensile strength of samples with carbonation was more as compared to the samples of without carbonation.
- The test result shows that the flexural strength of carbonated concrete samples had increased by 23.81% for three days samples, 21.09% for seven days and 18.68%for 28 days test samples with respect to normal concrete sample of M30 grade of concrete.
- The test result shows that the flexural strength of carbonated concrete samples had increased by 22.77% for three day samples, 17% for seven days and 15.80% for 28 days test samples with respect to normal concrete sample ofM35 grade of concrete.
- From the results it can be concluded that flexural strength of samples of M30 and M35 grade with carbonation was more as compared to samples without carbonation.

## V. LIMITATIONS

- The change in the physical and chemical properties of raw materials such as cement, water, coarse and fine aggregates may give variable results.

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