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# A STUDY ON MECHANICAL PROPERTIES OF M40 GRADE CONCRETE WITH FOSROC ADMIXTURE

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**Abstract:**

The construction industry is consisting of unorganized companies working as subcontractors making significant contribution to national economy both by increased GDP as well as in providing employment. In construction sector there are three segments like real estate is combined with residential and commercial constructions.

In the construction industry, in the presence of concrete elements depending on work inherent nature of the infrastructure or capital formation industry, capital goods are used directly and indirectly with all other types of resources.This study is aimed to find whether FOSROC admixture is suitable as usage of admixture in concrete mix, and whether FOSROC admixture results in providing durability to M40 grade concrete and to compare the compressive strength of conventional concrete sample with and without FOSROC admixture.

## 1. Introduction

Concrete is combination of material made from sand, gravel and cement. The cement is a mix of various minerals which when mixed with water, hydrate and roughly become strong binding the sand and gravel into a solid mass.

There are three basic components in the concrete mix:

- Portland cement
- Water
- Aggregates

The water and cement forms a paste that coats the aggregate and sand in the mix. The paste hardens and binds the both aggregate and sand together. Water is used to chemically react with the cement (hydration) and to produce workability in the concrete. The amount of cement is compared with the amount of water in the mix in pounds is called the water/cement ratio.

The low the w/c ratio, the stronger the concrete (Less permeability and higher strength). Sand is the fine aggregate. Crushed stone and gravel is the coarse aggregate in most of the mixes [1-5].

Plasticizers are chemical admixtures that can be added to concrete mixtures to improve workability. They are manufactured from pop lingo suffocates a by-product of paper industry. Addition of plasticizers reduces the requirement of water content for concrete mixture. Generally 1-2% of Plasticizers per unit weight of cement is sufficient [6-12].

## 2. Review of Literature

According to **Sravana Kumar (2016)**, Mechanical properties of Recycled Aggregate Concrete (RAC) such as compressive strength, split tensile strength and Flexural strength is observed and durability of concrete using recycled aggregate treated with H2SO4 and HCL are performed for M40 grade of concrete and compressive strength of cubes samples are tested at an age of 7days and 28days and for Split tensile strength and Flexural strength of concrete cylinders and beams are tested at an age of 28 days. Recycled course aggregate (RCA) is replaced with Natural course aggregate (NCA) in percentage basis like 0%, 20%, 40%, 60%, 80% and 100%. The test results will show that up to 20 to 40% replacement of RCA which will give better results. The usage of recycled aggregate will gives a better choice for constructions. And the wastage of natural resources is reduced to a little extent.

According to **Lakshmi Kumar Minapaet (2014),** an attempt has been made to study the Mechanical Properties of a structural grade light weight concrete of M30 grade using Pumice stone and mineral admixture materials like Fly Ash and Silica Fume are adopted. By using 20% of light weight aggregate as a partial replacement to natural coarse aggregates the compressive strength results are promising. According to **Gumma Soumya (2018),** this work intended to study the impact of concrete by partially replacement of cement with silica fume and fine aggregate with quartz sand. From this study it has been observed that maximum compressive strength is noted for 10% replacement of cement with silica fume and the values are higher than those of normal concrete. The optimum percentages of substitution of silica fume and quartz sand in concrete was found to be 10% and 60%.According to **Dilip Kumar (2012),** the silica fume had greater influence on the properties of fresh and hardened concrete. From this study it was observed that maximum compressive strength is noted for 10% replacement of cement with silica fume and the values are higher than those of normal Concrete where as split tensile strength and flexural strength of the silica fume concrete are increased by about 38.58% and 21.13% of the normal concrete. According to **Muthupriya. P (2016)** the impact of fly ash and metakolin content material on compressive strength of concrete for 7 and 28 days is phenomenal. Compressive strength, split tensile strength and flexural strength increases and the required strength is achieved with the replacement of 15% fly ash and 15% metakolin when compared to nominal mix concrete. According to **Mukesh (2012),** this study a comprehensive effort was made to partially replace the natural river sand by stone quarry dust and cement by fly ash as an alternative in combination with mineral admixture, for concrete ingredients which shall lead to global sustainable development and lowest possible environmental impact and will also reduce cost of construction as well. It was observed that the flexural strength and split tensile strength for mix designations ( 100% cement and 0% fly

ash) is about 35-40% higher than the conventional concrete. The increase in replacement of cement with fly ash results in gradual decrease in the strength of concrete. According to **Asshad Imam (2018),** the compression strength of concrete was increased with increase in replacement level of silica fume in a range of 8-12% below which no significant change in compressive strength can be expected. The split tensile strength of concrete shows an increasing tendency up to a limit of 10%-15%. The durability Parameters are higher in case of concrete blended with silica fume as compared to normal OPC concrete. According to **Dr D.V. Prasad Rao (2016),** this study combined influence of quarry dust and silica fume on compressive strength, split tensile strength, flexural strength and modulus of elasticity of M30 grade of concrete is investigated. Finally they found that the various strength characteristics of concrete can be improved by the addition of 10% of silica fume and 60% of quarry dust content. According to **Shanmugapriya Vijay (2013),** they made an experimental study on the properties of silica fume in high performance concrete and came out with finding that at 7.5% cement replaced by silica fume using super plasticizer are investigated and results are promising. According to **Lakhan Nagpal (2013)** the crushed stone dust waste can be used effectively used to replace natural sand in concrete.

Here an attempt to understand the Strength and durability properties of concrete with and without plasticizer.

1. To find whether FOSROC admixture is suitable as usage of admixture in concrete mix.

2. To study the durability of M40 grade concrete with FOSROC admixture first of its kind.

3. To compare the compressive strength of conventional concrete sample with and without FOSROC admixture.

## 3. Materials and Methods

### Materials:

Materials used include Ordinary Portland Cement-53 grade, Fine aggregate (River Sand.), Coarse aggregate, Water, Admixture (Plasticizer)

### Cement:

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. As it is commonly known, it is a mixture of compounds made by burning limestone and clay together at very high temperatures ranging from 1400 to 1600°C. Although there are other cements for special purposes, this module will focus solely on Portland cement and its properties. The production of Portland cement begins with the quarrying of limestone, $CaCO_3$. Huge crushers break the blasted limestone into small pieces. The crushed limestone is then mixed with clay (or shale), sand, and iron ore and ground together to form a homogeneous powder. However, this powder is microscopically heterogeneous.Cements used in construction are usually inorganic often lime or calcium silicate based, and can be characterized as either hydraulic or non-hydraulic, depending on the ability of the cement to set in the presence of water.The OPC (53 grade) which is used in the

study is ultra tech cement of 53 grade and the cement used in casting of cubes and cylinders meet the following specifications as per IS: 12269-1987.The Portland cement of 53 grade was selected for the experimentation. It was dry, and in the form of powder and was not having lumps, because it was not exposed to moisture [13, 14].

**Table 3.1 Basic composition of cement:**

| S.no | Contents | Percentage |
|---|---|---|
| 1. | CaO | 60-67 |
| 2. | $SiO_2$ | 17-25 |
| 3. | $Al_2O_3$ | 3-8 |
| 4. | $Fe_2O_3$ | 0.5-6.0 |
| 5. | MgO | 0.5-4.0 |
| 6. | Alkalies | 0.3-1.2 |
| 7. | $SO_3$ | 2.0-3.5 |

(Source: www.uobabylon.edu.iq)

**Table 3.2 Properties of cement:**

| S.NO | Properties | Results | Permissible Limits as per IS 12269-1987 |
|---|---|---|---|
| 1 | Specific gravity | 3.15 | 3.10-3.25 |
| 2. | Fineness of modulus | 2.1% | <10% |
| 3. | Normal consistency | 27% | - |
| 4. | Initial setting time | 32 minutes | 30 minutes (minimum) |
| 5. | Final setting time | 271 minutes | 600 minutes (maximum) |

(Source: Tests conducted in Laboratory)

**Fine aggregate:**

Fine aggregate is a material which is used in concrete mixture and generally which is passing through 4.75mm IS sieve and retained on 0.15mm IS sieve is called as fine aggregate. Properties of concrete like durability, creep, thermal properties, strength, shrinkage, surface friction, and modulus of elasticity are depending upon the properties of fine aggregate. Fine aggregate consists silt, clay and river sand particles and this fine aggregate play a crucial role in the construction industry. River sand is used in the plastering of the walls.

**Table 3.3 Properties of fine aggregate:**

| S.NO | Properties | Results | Permissible Limits as per IS |
|---|---|---|---|
| 1 | Specific gravity | 2.48 | 2.5-3.0 |
| 2 | Bulking of sand | 18 at 6% | - |
| 3 | Fineness of modulus | 3.48 | 2-3.5 |
| 4 | Grade | Zone-I | |
| 5 | Size | <4.75mm | |

(Source: Tests conducted in Laboratory)

**Coarse aggregate:**

Coarse aggregate is a material which is used in concrete making. Generally aggregate which have size above 4.75mm is called coarse aggregate. Commonly used coarse aggregate sizes are 6mm, 12mm, 20mm, 40mm and 60mm. And 6mm, 12mm and 20mm sizes coarse aggregates are used in construction functions. 40mm size course aggregate is used as railway ballast.

**Table 3.4 Properties of coarse aggregate**:

| S.NO | Properties | Results | Permissible Limits as per IS 383-1970 |
|---|---|---|---|
| 1 | Specific gravity (20mm) | 2.64 | 2.5-3.0 |
| 2 | Flakiness index | 17.96% | 35% maximum |
| 3 | Elongation index | 12.19% | 35% maximum |
| 4 | Aggregate impact value | 12.98% | 45% maximum |
| 5 | Fineness modulus | 2.59 | |
| 6 | Shape | Angular or flaky | |

(Source: Tests conducted in Laboratory)

**Plasticizers**

Plasticizers, additionally called high vary water reducers, are chemical admixtures used wherever well-dispersed particle suspension is needed. These polymers are used as dispersants to avoid particle segregation, and to enhance the flow characteristics of suspensions like in concrete applications. Their addition to concrete or mortar permits the reduction of the water to cement quantitative relation while not negatively poignant the workability of the mixture, and allows the assembly of self-consolidating concrete and high performance concrete. This result drastically improves the performance of the hardening contemporary paste. The strength of concrete will increase once the water to cement quantitative relation decreases. However, their operating mechanisms lack a full understanding, revealing in bound cases cement-super plasticizer incompatibilities.

In the present study we have used CONPLAST SP430 at 1.5% to the unit weight of cement used.

**Water:**

This is the material which carries great work in construction and it is used in the preparing of mortar, mixture of concrete and curing. The quality of water used has a direct impact on the strength of the mortar and concrete in the construction work. The water used for curing and mixing must be free from high quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth, etc that might be deleterious to bricks, concrete.

**Tests on Cement:** Specific gravity, Fineness modulus, Normal consistency, Initial settingtime and final setting time and Soundness test

**Test on Fine aggregate:** Specific gravity of sand, Bulking of sand and Fineness modulus of sand

**Test on coarse aggregate:** Specific gravity, Sieve analysis, Elongation index& Flakiness

index and Aggregate impact value

**Test on fresh concrete:** Slump cone test

**Details of mixes:**

In the present study chemical admixture super plasticizer was used to gain a strength at early ages for all mixes.

Mix proportions for M-40 grade concrete: cement/cement: F.A/cement: C.A/cement

$$= \quad (405/405) :( 745/405) :( 1090/405)$$

$$= \quad 1 \quad : \quad 1.83 \quad : \quad 2.69$$

**Casting of Concrete cubes:**

Cubes with dimension of 150mm × 150mm × 150mm was used for compression test. All these specimens were cast in iron moulds conforming to relevant codes of Indian standards. Prior to casting of specimen, mould were cleaned, lubricated with oil and all the bolts are fastened tightly so that there is no leakage in the mould.

**Strength Test:**

**a) Compressive Strength:**

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, and quality control during production of concrete etc. Test for compressive strength is carried out on cube. Various standard codes recommend concrete cube as the standard specimen for the test. American Society for Testing Materials ASTM C39/C39M provides Standard Test Method for Compressive Strength of Cubical Concrete Specimens. For cube test two types of specimens either cubes of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15cm x 15cm x 15cm are commonly used. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of this specimen should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen. These specimens are tested by compression testing machine after 7 days curing or 28 days curing in water. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

**DURABILITY TEST**

**a) Water Absorption for 24 Hour Tested as per ASTM D570**

Water absorption is used to determine the amount of water absorbed under specified conditions. Factors affecting water absorption include: type of plastic, additives used, temperature and length of exposure. The data sheds light on the performance of the materials in water or humid environments. The Procedure includes, for the water absorption test, the specimens are dried in an oven for a specified time and temperature and then placed in a desiccators to cool. Immediately upon cooling the specimens are weighed. The material is then emerged in water

at agreed upon conditions, often 23°C for 24 hours or until equilibrium. Specimens are removed, patted dry with a lint free cloth, and weighed. The size of specimen is two inch diameter disks, 0.125" or 0.250" thick. Water absorption is expressed as increase in weight percent.

Percent Water Absorption = [(Wet weight - Dry weight)/ Dry weight] x 100

## 4. Results & Discussion

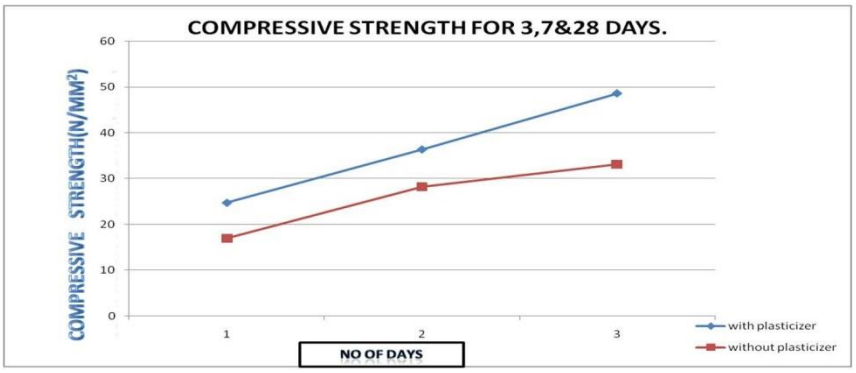
### COMPRESSIVE STRENGTH COMPRESSIVE STRENGTH OF CONCRETE CUBES AFTER 3, 7 and 28 DAYS FOR W/C 0.38 WITH AND WITHOUT PLASTICIZER:

The Compressive Strength test on Concrete cubes is done after 3, 7 and 28 days for W/C 0.38 and the results are given in the below table.

**Table 4.1: Compressive strength of concrete cubes after 3, 7and 28 days for W/C 0.38 with and without plasticizer:**

| S.NO | Number of days | Compressive strength ($N/mm^2$) | |
|---|---|---|---|
| | | With plasticizer | Without plasticizer |
| 1. | 3 | 24.75 | 17.02 |
| 2. | 7 | 36.36 | 28.31 |
| 3. | 28 | 48.58 | 33.2 |

In this study we can observe that there is a more compressive strength by using plasticizer and less compressive strength by using without plasticizer for W/C 0.38




**Graph: 4.1 Variation of compressive strength for W/C 0.38 with and without plasticizer**

### COMPRESSIVE STRENGTH COMPRESSIVE STRENGTH OF CONCRETE CUBES AFTER 3, 7 and 28 DAYS FOR W/C 0.37 WITH AND WITHOUT PLASTICIZER:

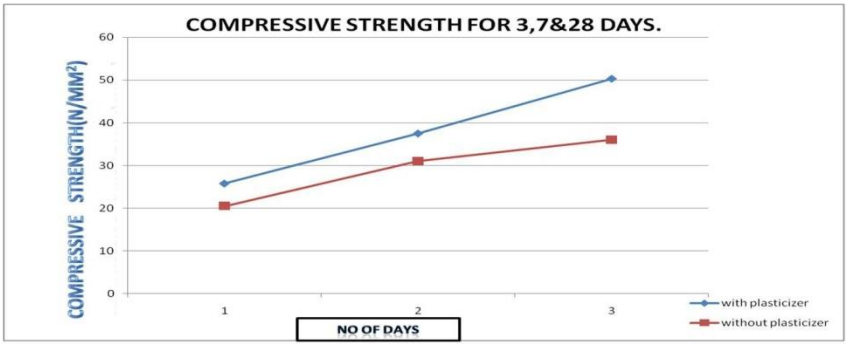
The Compressive Strength test on Concrete cubes is done after 3, 7 and 28 days for W/C 0.37 and the results are given in the below table.

**Table 4.2: Compressive strength of concrete cubes after 3, 7 and 28 days for W/C 0.37**

**with and without plasticizer:**

| S.NO | Number of days | Compressive strength ($N/mm^2$) | |
|---|---|---|---|
| | | **With plasticizer** | **Without** |
| 1. | 3 | 25.8 | 20.5 |
| 2. | 7 | 37.5 | 31 |
| 3. | 28 | 50.3 | 36 |

In this study we can observe that there is a more compressive strength by using plasticizer and less compressive strength by using without plasticizer for W/C 0.37



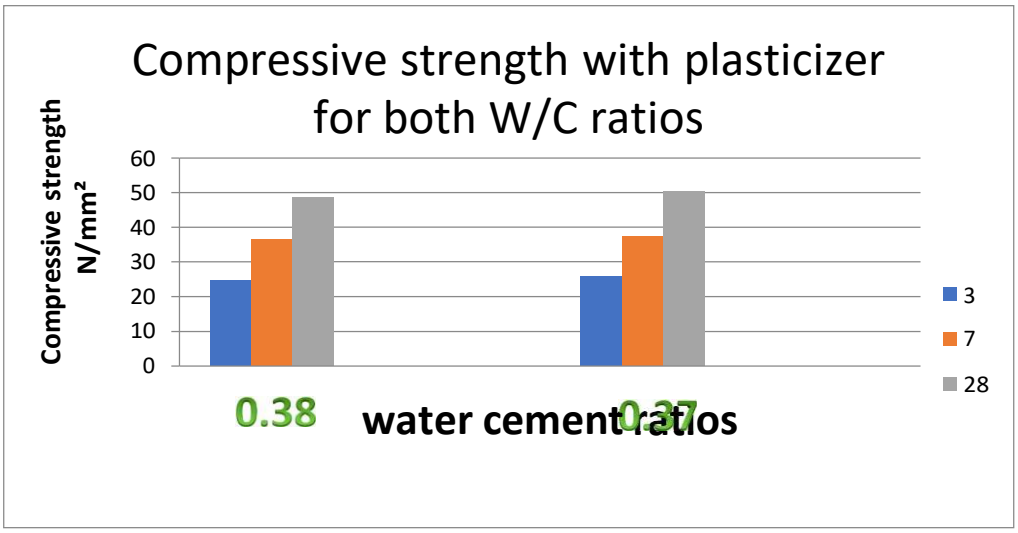

**Graph: 4.2 Variation of compressive strength for W/C 0.37 with and without plasticizer**

**4.2 COMPARISON OF COMPRESSIVE STRENGTH BOTH W/C RATIOS AT 3, 7 AND 28 DAYS WITH PLASTICIZER:**

**Table 4.3 Comparison of compressive strength of both W/C ratios with plasticizer**

| S.NO | Number of days | Compressive strength ($N/mm^2$) | |
|---|---|---|---|
| | | **W/C=0.38** | **W/C=0.37** |
| 1. | 3 | 24.75 | 25.8 |
| 2. | 7 | 36.36 | 37.5 |
| 3. | 28 | 48.58 | 50.3 |

In this study comparing both W/C for compressive strength of 3, 7 & 28 days is more for 0.37 W/C ratio by using plasticizer. By decreasing the W/C ratio the strength will be high.



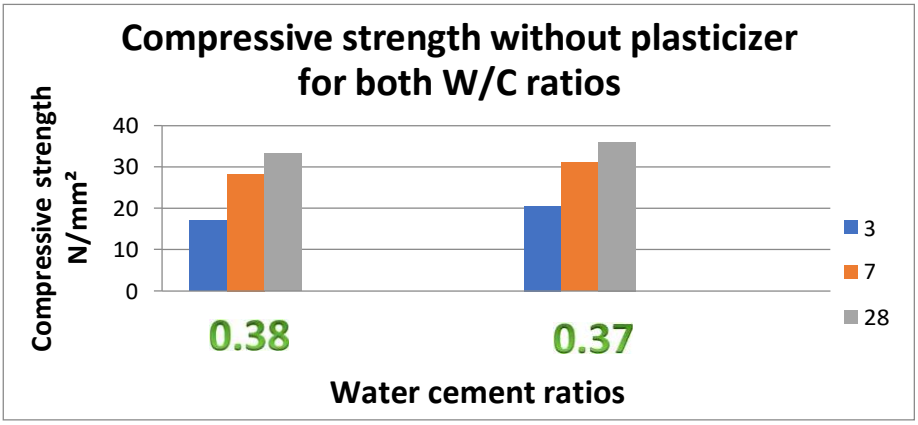

**Graph: 4.3 Variation of compressive strength for both W/C 0.37&0.38 with plasticizer**

**COMPARISON OF COMPRESSIVE STRENGTH BOTH W/C RATIOS AT 3, 7 AND 28 DAYS WITHOUT PLASTICIZER:**

**Table 4.4 Comparison of compressive strength both W/C ratios without plasticizer**

| S.NO | Number of days | Compressive strength (N/mm$^2$) | |
|---|---|---|---|
| | | W/C=0.38 | W/C=0.37 |
| 1. | 3 | 17.02 | 20.5 |
| 2. | 7 | 28.31 | 31 |
| 3. | 28 | 33.2 | 36 |

In this study comparing both W/C for compressive strength of 3, 7 & 28 days is more for 0.37 W/C ratio by using without plasticizer. By decreasing the W/C ratio the strength will be high.




**Graph: 4.4 Variation of compressive strength for both W/C 0.37&0.38 without plasticizer**

Compressive strength test was conducted and results were promising when plasticizer was used.28 days results are better when compared with 3&7 days, With plasticizer when compared without plasticizer at W/C 0.38. It is true even for W/C 0.37.

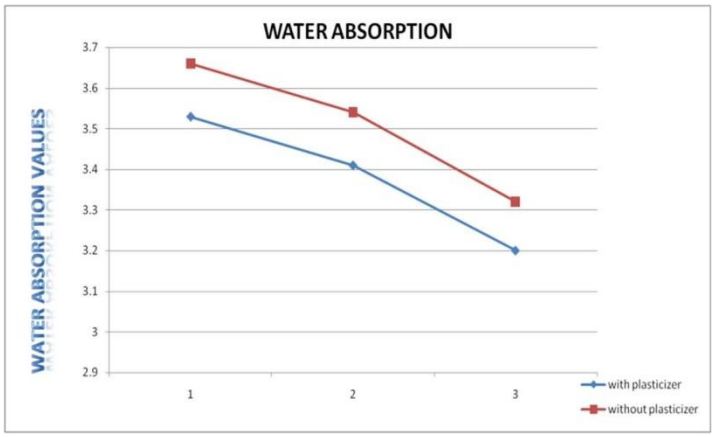
**WATER ABSORPTION TEST VALUES FOR BOTH W/C RATIO 0.38 WITH AND WITHOUT PLASTICIZER:**

The water absorption test on Concrete cubes after 28 days and the results are given in the below table for 0.38 W/C ratio with and without plasticizer.

**Table 4.5: Water absorption values for 0.38 W/C ratios with and without plasticizer:**

| S.NO | Water absorption values | |
|---|---|---|
| | **With plasticizer** | **Without plasticizer** |
| 1. | 3.53 | 3.66 |
| 2. | 3.41 | 3.54 |
| 3. | 3.20 | 3.32 |

In this study water absorption values will be increased without plasticizer and decreased with plasticizer.




**Graph: 4.5 Variation of water absorption for with and without plasticizer**

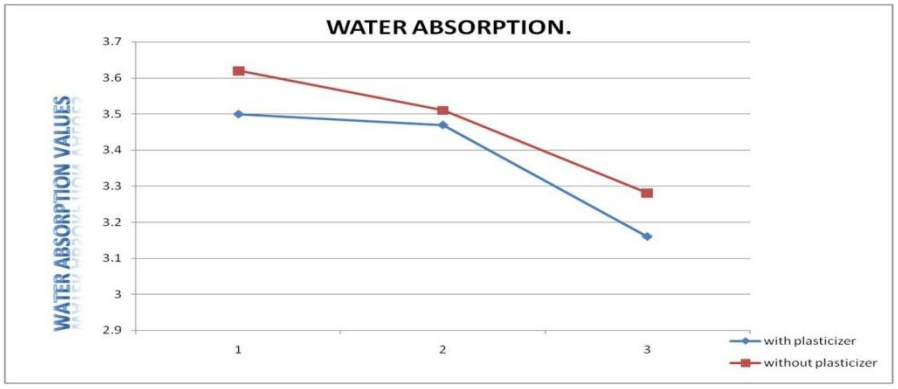
**WATER ABSORPTION TEST VALUES FOR BOTH W/C RATIO 0.37 WITH AND WITHOUT PLASTICIZER:**

The water absorption test on Concrete cubes after 28 days and the results are given in the below table for 0.37 W/C ratio with and without plasticizer.

**Table 4.6: Water absorption valuesfor 0.37 W/C ratios with and without plasticizer:**

| S.NO | Water absorption values | |
|---|---|---|
| | **With plasticizer** | **Without plasticizer** |
| 1. | 3.50 | 3.62 |
| 2. | 3.47 | 3.51 |
| 3. | 3.16 | 3.28 |

In this study water absorption values will be increased without plasticizer and decreased with plasticizer.




**Graph: 4.6 Variation of water absorption for with and without plasticizer**

When water absorption values recorded high when plasticizer was not used. When compared with usage of plasticizer when plasticizer is there is almost 15% reduction in water absorption values. When compared with specimens made without usage of plasticizer.

## 5. Conclusion of study

Plasticizer is usage resulted in increase of compressive strength and reduces water absorption values. Whereas specimens without usage of plasticizer resulted in reduction in compressive strength around 10% when compared with that of usage of plasticizer.When plasticizer was used water absorption values around 15% lesser when compared with that of no plasticizer.This study is limited in conduction of compressive strength test and water absorption test where as in future the study can be extend for resistance to acid attack and alkali attack. The other W/C ratios other than 0.37&0.38 can be adopted in future.

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