# AN EXPERIMENTAL STUDY ON FLEXURAL BEHAVIOR OF M30 GRADE RCC BEAMS WITH FLAX SEEDS AS PARTIAL REPLACEMENT OF CEMENT AND JAGGERY AS ADMIXTURE

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**Abstract -** *Flax seed is the natural forms of fiber possessing some binding properties like cement. It also has condescending mechanical properties where the young's modulus rate and tensile strength are in good range and it is eco-friendly. Hence, the flax seeds are powdered in a fine manner and it is used as the partial replacement of cement. This project leads to the retired traditional concept of additional admixture of concrete. This study helps the construction industry towards the sustainable development. This paper emphasizes the use of flax seeds as partial replacement of cement and jaggery as admixture in RCC beams. The flax seeds are replaced at 0%,0.5%,1%,1.5%,2% by weight of cement and the optimum percentage of flax seeds as partial replacement of cement is observed. Jaggery is replaced at 0%,0.05%,0.1%,0.15%,0.2% by weight of cementitious material for the optimum percentage of flax seeds. The flexure behavior of RCC beams casted using these materials is analyzed, tested at 28 days and compared with conventional RCC beams of M30 grade concrete.*

***Key Words***: *Flax seeds, Natural fibers, Jaggery, Workability, Natural admixtures.*

## 1. INTRODUCTION

Cement is said to be one of the most vital ingredient in the construction field. Day by day the growth of construction is enormous and the usage of cement has been increased at the epitome range. This huge amount of cement usage affects the environment in a worse manner. The carbon dioxide as which is not environmental friendly has been formed at condescending rate in the manufacture of cement and other green house gases were also emitted. This creates abiotic depletion, global warming, acidification and other hazardous impacts. Hence the replacement for cement is necessary for the current situation.

### 1.1 Objectives

- To use the locally accessible materials in the construction industry and to lessen the cost of development.
- To make the eco-friendly concrete for sustainable development.
- To increase the workability of concrete by using natural admixture.
- To enhance the properties of concrete by using natural materials like flax seeds powder and jaggery.

## 2. MATERIALS USED

### 2.1 Cement

The cement used in this project is an Ordinary Portland cement of 53- grade conforming to IS 12269-1987. The cement used in the project should be fresh and should have of uniform consistency. Where there is evidence of lumps or any foreign matter in the cement, it should not be used. The cement should be stored under dry conditions and for as short duration as possible.

**Table-1:** Physical Properties of cement

| S.No | Property | Value obtained |
|---|---|---|
| 1 | Normal Consistency | 30% |
| 2 | Fineness of cement | 8% |
| 3 | a)Initial setting time<br><br>b)Final setting time | 35min.<br><br>450min. |
| 4 | Specific gravity | 3.12 |

### 2.2 Flax seeds

The flax seeds are the natural form of fiber, 147,000 metric tons of flax seeds were produced in India and it is abandoned over here. Hemp and kenaf are also natural form of fibers but they are restricted as they create a harmful impact towards the environment and as well as at the process of cultivation due to pest used and other factors harm the environment. So, we are using flax seeds as the partial replacement on cement.
The flax seeds are lustrous, soft and flexible in nature, which possess condescending young's modulus and tensile capacity. The flax seeds are organic in nature and it is environmental friendly. It is produced abundantly in India, are obtained in dry form then they are powdered in a fine manner, which is shown in figure and it is used as the

partial replacement of cement. Specific Gravity of Flax seeds powder is 1.75 .

**Fig-1:** Flax seeds powder

### 2.3 Fine Aggregate

The size of the fine aggregate is below 4.75mm, natural sand used as the fine aggregate in concrete mix. Sand may be obtained from rivers, lakes but when used in concrete mix, it should be properly washed and tested to ascertain that total percentage of clay silt, silt and other organic matters does not exceed the specified limit. For the experimental investigation locally available river sand which is free from organic impurities is used.

**Table-2:** Physical properties of Fine Aggregate

| S.No | Property | Value obtained |
|---|---|---|
| 1 | Specific gravity | **2.58** |
| 2 | Fineness Modulus of fine aggregate | **2.83** |
| 3 | Bulk Density(kg/m$^3$) | **1750** |
| 4 | Grading Zone | **III** |

### 2.5 Coarse Aggregate

The coarse aggregates are granular materials obtained from rocks and crushed stones. They may be also obtained from synthetic material like slag, shale, fly ash and clay for use in light-weight concrete. In this project coarse aggregate of sizes 20mm(70%) and 12.5mm(30%) are used.

**Table-3:** Physical properties of coarse aggregate

| S.No | Property | Value obtained for 12.5mm | Value obtained for 20mm |
|---|---|---|---|
| 1 | Type | **Crushed** | **Crushed** |
| 2 | Specific gravity | **2.85** | **2.72** |
| 3 | Water absorption | **0.29%** | **0.39%** |

### 2.4 Jaggery

In the ancient times they had utilized the materials like egg, blood, animal fat, cactus extract in the concrete as admixtures. Generally, the admixtures have specific characteristics such as accelerating, retarding, air entraining and water reducing abilities.

In this study we utilized the ancient admixture viz., jaggery powder. Concrete with natural admixtures provides greater qualities such as stickiness, ease of applications, breathability, moisture resistance, natural antiseptic, self- healing, durability, low thermal conductivity, incombustible, solar production, harmonious balance.

**Fig-2:** Jaggery

## 3. EXPERIMENTAL INVESTIGATION

This work is aimed to determine and compare the flexural behavior of reinforced concrete beams casted using Flax seeds as partial replacement of cement and Jaggery as admixture with conventional reinforced concrete beams of same grade. The total work is carried out in two phases.

This experimental study consists of two parts. Firstly, the flax seeds powder is partially replaced with cement at different proportions i.e., 0.5%, 1%, 1.5%, 2% and are tested for compressive strength. The optimum percentage replacement of flax seeds is found out. Now, by using the optimum percentage of flax seeds powder, Jaggery is used as admixture by replacing it with cementitious material at various proportions i.e., 0.05%,0.1%,0.15%,0.2% and the setting time, workability, compressive strength are calculated. And optimum percentage of jaggery as admixture is found out. In the second phase of work, beam elements were casted and tested by the optimum percentages of flax seeds powder and jaggery, which are obtained in the first phase of work, so as to determine the flexural behavior of RCC beam casted with flax seeds and jaggery. And finally comparing the results with conventional RCC beam.

## 4. STRENGTH PARAMETERS

### 4.1 Optimum percentage of Flax seeds powder

Flax seeds powder is replaced in the proportion of 0,0.5,1,1.5,2 percentages by weight of cement and find out the compressive strength at 7, 14, 28 days respectively and tabulate the results.

**Table-4:** Compressive Strength with Flax seeds powder as replacement of cement

| Percenatge of Flax seeds powder | 7 Days (N/mm$^2$) | 14 Days (N/mm$^2$) | 28 Days (N/mm$^2$) |
|---|---|---|---|
| 0% | 25.08 | 34.73 | 38.21 |
| **0.5%** | **25.17** | **34.85** | **38.34** |
| 1% | 25.11 | 34.81 | 38.28 |

| | | | |
|---|---|---|---|
| 1.5% | 24.07 | 34.64 | 38.05 |
| 2% | 23.86 | 34.58 | 37.87 |

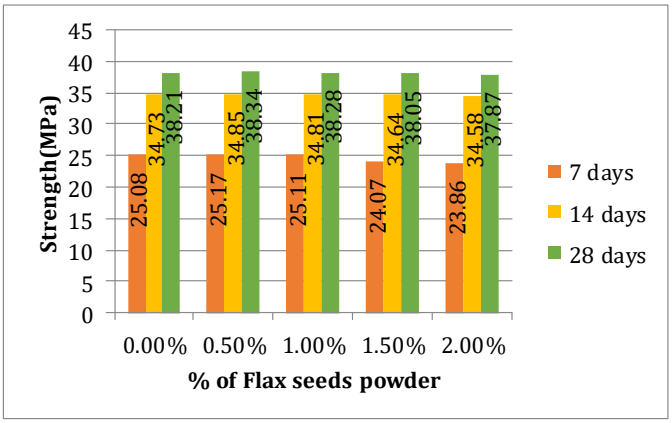


**Chart-1:** Compressive strength of concrete with partial replacement of cement by Flax seeds powder

From the test results, the optimum value of flax seeds powder can be considered as **0.50%** by weight of cement.

### 4.2 Optimum percentage of Jaggery (with 0.5% of flax seeds powder)

Jaggery is replaced in the proportion of 0,0.05,0.1,0.15,0.2 percentages by weight of cement with 0.5% of Flax seeds powder then the fresh properties and strength properties are observed and tabulated below:

**Table-5:** Initial and Final setting time of cement containing jaggery

| S.No | Percentage of Jaggery | Initial Setting time (min) | Final setting time (min.) |
|---|---|---|---|
| 1. | 0 | 35 | 450 |
| 2. | 0.05 | 40 | 480 |
| 3. | 0.1 | 45 | 530 |
| 4. | 0.15 | 55 | 580 |
| 5. | 0.2 | 65 | 630 |

**Table-6:** Workability of concrete containing jaggery

| S.No | Percentage of Jaggery | Slump (mm) |
|---|---|---|
| 1. | 0 | 75 |
| 2. | 0.05 | 86 |
| 3. | 0.1 | 98 |
| 4. | 0.15 | 109 |
| 5. | 0.2 | 112 |

**Table-7:** Compressive strength with Jaggery as admixture

| Percenatge of Jaggery | 7 Days (N/mm²) | 14 Days (N/mm²) | 28 Days (N/mm²) |
|---|---|---|---|
| 0% | 25.08 | 34.73 | 38.21 |
| 0.05% | 25.54 | 35.48 | 39.14 |
| **0.1%** | **25.98** | **35.98** | **39.58** |
| 0.15% | 25.13 | 35.14 | 39.58 |
| 0.2% | 24.76 | 34.46 | 37.43 |

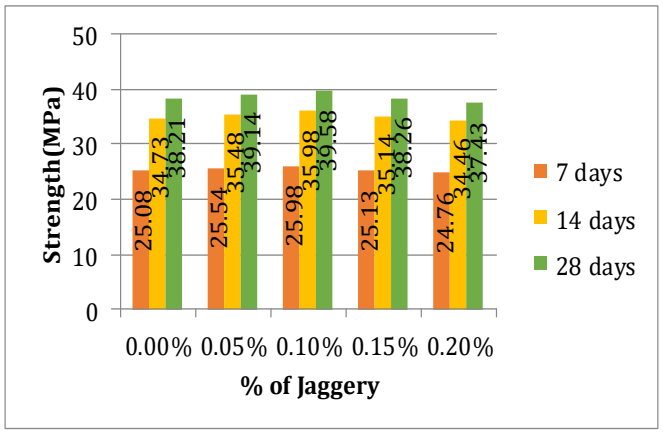


**Chart-2:** Compressive strength of concrete with 0.5% of Flax seeds powder and Jaggery as admixture

So, the above results shows that **the optimum percentage of jaggery is 0.1%** by weight of cementitious material with 0.5% of flax seeds powder.

## 5. FLEXURAL STRENGTH OF RCC BEAMS

The test setup for single point loading was shown in figure, lettering and marking of gauge lengths are shown in figure . The beams were simply supported at their ends. And the supports of the beams are rested on stiffened steel girder of length 1000mm. The effective span of the beam was 700mm.

For single point static loading, the load was applied at the center of beam i.e., 350mm from the support towards the center of the beam.

Dial gauges of 0.01mm least count were used for measuring deflections under the load points and at mid span for measuring deflection. The dial gauge readings were recorded at different loads. The behavior of the beams was observed carefully and the first crack load and ultimate loads are obtained by visual examination. The crack patterns and failure mode of beams are also recorded.

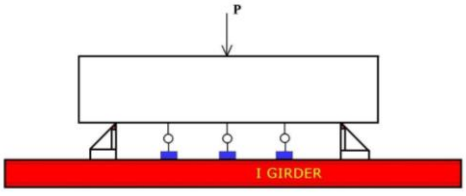


**Fig-3:** Experimental Plan of RCC Beam arrangement on UTM

### 5.1 Load vs Deflection of Conventional RCC Beam

The graph has been plotted between the applied load and corresponding deflection occurred in the specimen. In the graph the deflection lies in the X-axis and the applied load is in Y-axis.

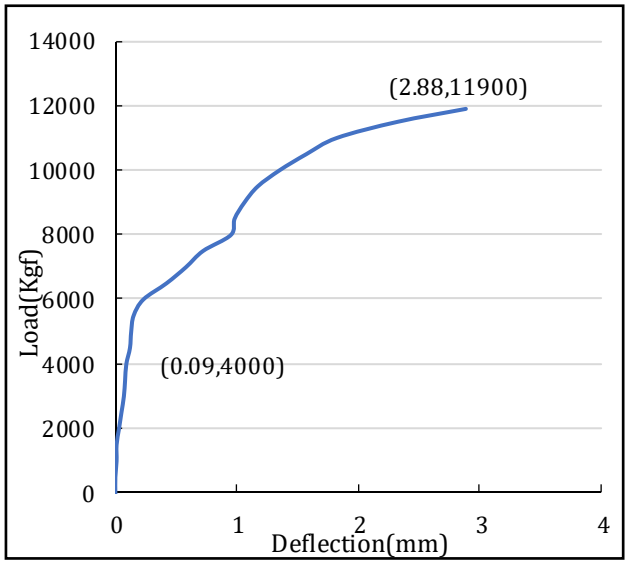


**Chart-3:** Load vs. Deflection curve of Conventional RCC Beam

### 5.2 Load vs. Deflection of RCC beam casted with 0.5% of Flax seeds powder and 0.1% of jaggery as replacement of cement

The graph has been plotted between the applied load and corresponding deflection occurred in the specimen. In the graph the deflection lies in the X-axis and the applied load is in Y-axis.

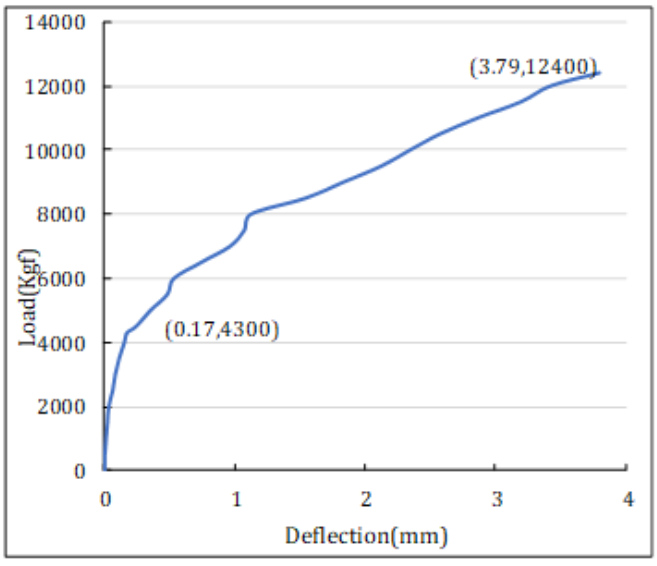


**Chart-4:** Load vs. Deflection curve of RCC beam with 0.5% of Flax seeds powder and 0.1% of Jaggery as partial replacement of cement

## 6. CONCLUSIONS

- Concrete with 0.5% of Flax seeds powder as replacement of cement shows increase in mechanical properties and decreases from 1%, 1.5%, 2%.
- The optimum percentage of Flax seeds for partial replacement of cement is 0.5%.
- The compressive strength attained by concrete with 0.5% of Flax seeds powder as replacement of cement is 0.34% more than that of conventional concrete.
- The slump value of concrete mix with jaggery as admixture increases with increase in percentage of jaggery(0.05%, 0.1%, 0.15%, 0.2%). Hence, the workability is increased with the percentage increase in jaggery compared to the nominal concrete.
- The addition of more jaggery(admixture) i.e., at 0.15%,0.2% shows collapse of slump, which is not recommended.
- The setting time of concrete with jaggery as admixture increases with increasing in percentage of jaggery and the values are within the limits as per IS:456.
- Time taking for demoulding of specimens has been increased compared to nominal concrete i.e., 48hrs for 0.05%, 72hrs for 0.1%, 96hrs for 0.15%, 120hrs for 0.2% of jaggery due to increase in setting time.
- The optimum percentage of jaggery as admixture with 0.5% of Flax seeds powder is 0.1% of cementitious material as it shows good strength compared to nominal concrete.
- The concrete with 0.1% of jaggery, at 0.5% of Flax seeds powder, as replacement of cementitious material shows 3.58% more compressive strength compared to nominal concrete.
- In flexural strength test, the deflection at yielding point for RCC beam casted with conventional concrete is 0.09mm.
- In flexural strength test, the maximum deflection for RCC beam with 0.5% of flax seeds powder and 0.1% of jaggery as replacement of cement is 0.17mm
- In flexural strength test, the RCC beam with 0.5% Flax seeds and 0.1% Jaggery can sustain more loading and shows better resistance against cracking than the conventional RCC beam.
- The first cracking load or yielding load of RCC beam with 0.5% Flax seeds and 0.1% Jaggery (4000 Kgf) is 7.5% more than the first cracking load of conventional RCC beam (4300Kgf).

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