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Utilization of Citrus-Enzyme in concrete as an admixture

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Abstract : The rising standard of living for the masses has resulted in rapid boost in the construction and infrastructure sector. As a result, the consumption of concrete has been increasing. To meet the various requirements of the structure, admixtures and plasticizers are added to concrete to enhance its conventional properties. But the production of admixtures involves various chemicals which in return deteriorate the environment. At the same time, the increasing population has resulted in higher demand of edible food items which primarily include fruits and vegetables. The higher the consumption, higher is the waste generated. The waste, being organic in nature, leads to soil and water pollution and also produce greenhouse gases. Also, it becomes difficult to transport and handle the waste. Thus, to produce an environment friendly alternative to the admixtures and to utilize the organic waste – fruits, can be used to produce biological enzymes. This project deals with the production and application of biological enzymes as an admixture in concrete. Further, the optimum dosage required in order to achieve quality workable concrete is also found out by testing different dosages of bio - enzyme admixture with concrete., Slump Test of concrete. By adding different dosages of Bio-enzyme to samples, we get compressive strength of every sample. By plotting a graph of Dosage of Bio- enzyme v/s Compressive strength, we can determine the maximum compressive strength of concrete having optimum dosage of Bio-enzyme. The results would clear whether the use of bio- enzyme increases the compressive strength of concrete or not. An increase in compressive strength of concrete has been found with the use optimum dosage of bio-enzyme.

Material **– Cement, Sand, Aggregate, Water, Admixture**

1.INTRODUCTION

The quality of the concrete is determined by the materials of concrete preparation. In order to make concrete with high compression strength and has a certain concrete specification cannot be obtained simply by mixing Portland cement or other types of coarse aggregate, fine aggregate, and water. But it is necessary to also control the quality of the concrete mix. Improving the quality of the concrete mix will increase the compression strength is generated. Mixed concrete technology is currently also developing rapidly, many other added material application technologies to produce concrete with the desired characteristics. One way to improve the quality of the concrete mix is to use the added material, either a chemical such as entraining admixture, reducing water in the form of synthetic or organic. On this paper, we would like to introduce our research on improving concrete quality with green technology using bio enzyme, which is not covered yet in current classification A to F of concrete chemical admixtures used.

Biomedical waste management defines waste management as the practices & procedures or the administration of activities that provide for the collection, source separation, storage, transportation, transfer, processing, treatment & disposal of waste . Biomedical waste management is a routine procedure of hospital administration as prescribed by law .Hospital waste , hospital acquired infection , transfusion transmitted diseases, rising incidence of hepatitis B, HIV & Other diseases, create potential threat of infection, contamination & serious health hazards to doctors, nurses, ward boys, support staff, sanitation workers, rag pickers & other health care workers. Who are regularly exposed to biomedical waste as an occupation hazards as well as general public in the surrounding area .

1.1NEED OF THE STUDY.

1) By the help of bio enzyme in concrete as an admixture which is made up of organic waste, it is directly reduces the cost as compare other chemical admixture.
2) To study the behavior of bio enzyme in concrete as an admixture.
3) Addition of bio enzyme in concrete mixture that will be compared with normal concrete in order to know the optimum level of dosage of bio enzyme concrete to increase the strength.
4) By the simple usage of bio – extracts, a major chunk of national waste can be reduce thus bringing about a paradigm shift in the way demolition waste is treated, ultimately leading to sustainable development.
5) To study the effect on environment by using an bio - enzyme as an admixture.

1.2 Objective of Study

1) To study and compare the setting time, consistency & slump, etc.
2) To reduce the overall cost of the project by reducing the use of bio - enzyme which would result in more revenue generation.
3) Achieving better results in terms of quality, strength and performance than the concrete which uses conventional methods of production.
4) To assess the strength of concrete with respect to the standard chemical added admixture concrete.
5) To observe the durability of concrete.
6) To study the behaviour of bio-enzyme added in concrete instead of chemical admixture.

2 LITERATURE REVIEW

A literature review is a comprehensive summary of previous research on a topic. The literature review surveys scholarly articles, books, and other sources relevant to a particular area of research. The review should enumerate, describe, summarize, objectively evaluate and clarify this previous research.

2.1 Citrus Enzyme Literature Review

The chemical admixture used during the make not only increases the cost of concrete but also promotes the use of chemicals. Thus, making bio-enzyme out of waste citrus fruits, and adding them in concrete as admixture instead of chemical admixtures results in better solid waste management and reduces the cost of concrete. The bio enzyme admixture, is a bio-technology product made of organic/natural materials, denatured proteins, biopolymer surfactant and organic minerals which fermented by beneficial microbes. The quality of the concrete is determined by the materials of concrete preparation. To make concrete with high compression strength and has a certain concrete specification cannot be obtained simply by mixing cement Portland cement or other types of coarse aggregate, fine aggregate, and water. But it is necessary to also control the quality of the concrete mix. Improving the quality of the concrete mix will increase the compression strength is generated

2.3 Literature Survey

1. Kandhal Tony Hartono Baggio, Makino Basuki, Justyna Testimonio, & Sofyan Ali Pradana (2017) in Optimum concrete compression strength using bio-enzyme studied Onaddition of Bio- Enzyme as an admixture, the concrete shows changes in its compressive strength. Different doses added to the concretemakes it either stronger or weaker accordingly .Optimum dose of a specific designed was found out by conducting suitable experiments.

2. Ichabod G. Amadi & Kemijoki I. Amadi – Operalia (2018) in Effect of Admixtures on Strength and Permeability of Concrete studied Admixtures such as accelerators, superplasticizers combined with a reduction in w/c gave a higher compressive strength, lower surface absorption and lower permeability than conventional reference concrete which was tested.

3. I.B. Muhit (2013) in Dosage Limit Determination of Super plasticizing Admixture and Effect Evaluation on Properties of Concrete studied Various effects of superplasticizer on properties of concrete (workability & compressive strength) with characteristic strength of 35 N/mm2 was studied. By using the proper chemical admixtures slump loss can be reduced to a great extent. In superplasticizer concrete effect is too high.

4. Drowse I. Khalil (2009) in Using Citric Acid as An Admixture and Its Influence on Some Properties of Concrete studied the effect of citric acid on concrete with respect to optimum doses added was concluded. Citric acid acts as an effective retarder. The optimum dosage of citric acid causes a delay in initial and final setting time. Over dosages of citric acid retards the initial and final setting time for very long time.

3. RESEARCH METHODOLOGY

The proposed methodology makes use of both qualitative and quantitative perspectives, and includes a broad array of approaches such as literature reviews, expert opinions, focus groups, and content validation. It also involves sophisticated assessment of construct validity including substantive and structural aspects.

Consideration of materials for the preparation of concrete as per the standard as per the standard norms

- Citrus enzyme : Fermented Orange
- Cement: (OPC 53 grade)
- Fine aggregate : Sand
- Coarse aggregate : Khadi (local aggregate)

3.1 Classification of material on the basis of following material properties:

Citrus enzyme : Around 3.8 million tons of orange peel waste get generated in a year. So there is high availability of material . And It is organic and doesn't pollute much toxic waste during the recycling process. Instead of having an adverse effect it have a positive behaviour towards concrete. I t not only increases the binding property but also increases the compressive strength of concrete.

Cement (OPC 53 grade): It is having a good stiffness property which enhances the strength as well as increases the compressive strength around 53 N/mm2. Also cement is one of the best binding material used in modern construction.

Fine Aggregate and Coarse Aggregate : Which is locally available in market.

4.1 Preparation of Concrete as per the Indian standard

Different Is code used are as follows -:

- IS 383 for aggregate
- IS 456 for water cement ratio
- IS 12269 for 53 grade of cement
- IS code 10262 for Design mix
- IS code 1199 for Analysis of concrete

Equipment utilize in the testing of concrete

- Weighing machine
- Sand Sieve (for aggregate testing)
- Oven (for drying)
- Water Flask
- Slump Cone apparatus
- Small water pool (For continuous curing)
- Compression Testing Machine (for testing of concrete)

4.2 Preparation of Citrus Enzyme

Cut orange peels (you can use pineapple peels also) into medium sized pieces.Grate jaggery or you can use powdered jaggery or brown sugar. (do not use white sugar).Take a plastic bottle with a tight lid. (do not use glass bottles as gas build-up from the fermentation process might cause explosion).Natural multipurpose cleaner recipe Add jaggery and 1 liter of water.Toxic free citrus cleaner. Add the citrus peels and yeast. Make sure there is a little space on the top. Fill the container only up to 80%. Close it tightly and shake it well. Label the container indicating the date on which it was kept for fermenting. Leave it to ferment for 3 months. If you add yeast, it will take only 2 months for the fruit enzymes to be ready. You have to open the lid everyday for the first week to prevent gas build up and close it again,otherwise the gas will build up to explode in the container. From the 2nd week, you can open it on alternate days and close it back tightly. After second week, open the lid once in a week to let the gas out. Store it away from sunlight in a warm dry place. It will take 2 months (if yeast is added or otherwise 3 months). After 3 month it is ready to use.

4.2.1 Preparation of Control Mix

a) Cement Used : OPC 53 Grade Confirming to IS 12269
(b) Specific Gravity of Cement : 3.15
(c) Chemical admixture : Super plasticizer confirming to IS 9103
(d) Specific gravity
Specific gravity of Fine Aggregate (sand) : 2.65
Specific gravity of Coarse Aggregate : 2.74
(e) Water Absorption
Coarse Aggregate : 0.4%
Fine Aggregate : 1.0%
(f) Free (surface) moisture
Coarse Aggregate : Nil
Fine Aggregate : Nil
Aggregate are assumed to be in saturated surface dry condition usually while preparing design mix.
(e) Type of exposure the structure will be subjected to (as defined in IS: 456) — Moderate
(h) Method of concrete placing: pump able concrete

4.2.2 Procedure for Concrete Mix design of M30 Grade Concrete

Step-1 : Determining the Target Strength for Mix Proportioning
F'ck = fck + 1.65 x S
Where, F'ck = Target average compressive strength at 28 days
Fck = Characteristic compressive strength at 28 days
S = Assumed standard deviation in N/mm2 = 5 (as per table -1 of IS 10262- 2009)
= 30 + 1.65 x 5.0 = 38.25 N/mm2

Note: Under control conditions if Target average compressive strength is achieved then at field the probability of getting compressive strength of 30 MPa is very high

4.2.3 Selection of Water Cement ratio

From Table 5 of IS 456, Maximum water-cement ratio = 0.50
Taking water cement ratio as 0.45 by ISCODE 456 For OPC 53 grade of cement.
We are targeting a slump of 100mm, we need to increase water content by 3% for every 25mm above 50 mm i.e. increase 6% for 100mm slump.
i.e. Estimated water content for 100 Slump = 186+(6/100) X 186 = 197 litre
Water content = 197 liters.

4.2.4 Calculation of Cement Content

Water-Cement Ratio = 0.45
Water content from Step – 3 i.e. 197 liters
Cement Content = Water content / "w-c ratio" = (197/0.45) = 438.183 kgs
From Table 5 of IS 456,

Minimum cement Content for moderate exposure condition = 300 kg/m3
488.183 kg/m3 > 300 kg/m3, hence, OK.

4.2.5 Proportion of Volume of Coarse Aggregate and Fine aggregate Content
From Table 3 of IS 10262 Volume of coarse aggregate corresponding to 20 mm size =0.63 and fine aggregate (Zone 2) =0.37

4.2.6 Estimation of Concrete Mix calculations
The mix calculations per unit volume of concrete shall be as follows:
Volume of concrete = 1m3.
Volume of cement = (Mass of cement / Specific gravity of cement) x (1/100) = (438.133/3.15) x (1/1000) =0.1309 m3
Volume of water = (Mass of water / Specific gravity of water) x (1/1000) = (197/1) x (1/1000) = 0.197m3
Total Volume of Aggregates = 1- (b+c) =1- (0.1309+0.197) = 0.6587 m3
Mass of coarse aggregates = d x Volume of Coarse Aggregate x Specific Gravity of Coarse Aggregate x 1000 = 0.6587 x 0.63 x 2.740 x 1000 = 1128.50kgs/m3
Mass of fine aggregates = d x Volume of Fine Aggregate x Specific Gravity of Coarse Aggregate 1000 = 0.6587 x 0.37 x 2.65 x 1000 = 641.001 kgs/m3

4.2.7 Concrete Mix Proportions for Trial Mix
Mix Proportions for trial Mix-1:
Cement = 438.133 kg/m3
Water = 197 kg/m3
Fine aggregates = 641.001 kg/m3
Coarse aggregate = 1128.50 kg/m3
Water-cement ratio = 0.45

Note: Aggregates should be used in saturated surface dry condition. If otherwise, when computing the requirement of water, allowance shall be made for the free (surface) moisture contributed by coarse aggregate and fine aggregate. On the other hand, if the aggregates are already dry, the amount of water mixed should be increased by an amount equal to the moisture likely to be absorbed by the aggregates. Necessary adjustments are also required to be made in the mass of the aggregates. The surface water and percentage water abosorption shall be determined according to IS 2386.

Correction in water content due to absorption or moist aggregates
The slump shall be measured and the water content and shall be adjusted for achieving the required slump based on trial, if required.

For 0.25 % dosage of enzyme in concrete.
- Cement = 438.133 kg/m3
- Water = 196 kg/m3
- Fine aggregates = 641.001 kg/m3
- Coarse aggregate = 1128.50 kg/m3
- Water-cement ratio = 0.45
- Admixture = 1.09kg

For 0.50 % dosage of enzyme in concrete
- Cement = 438.183 kg/m3
- Water = 194.97 kg/m3
- Fine aggregates = 641.001 kg/m3
- Coarse aggregate = 1128.50 kg/m3
- Water-cement ratio = 0.45
- Admixture = 2.19 kg

For 1% dosage of enzyme in concrete
- Cement = 438.133 kg/m3
- Water = 192.77 kg/m3
- Fine aggregates = 641.001 kg/m3

5.1 Testing and Analysis of Concrete as per the Indian standard

Slump cone Test:

SR. NO	SAMPLE M30 GRADE	SLUMP (MM)
1	CONTROL MIX	128
2	0.25 % DOSAGE	176
3	0.5 % DOSAGE	87
4	1 % DOSAGE	45

1. Control Mix:
The handling and mixing of concrete was easy as the desired slump was obtained in the mix. Bleeding was observed. Pumping of concrete was possible.

2. 0.25% dosage of enzyme in concrete:
A significant increase in the slump value was observed. The slump increased by around 50mm.The mix became more easier to deal with. The handling and placing of concrete was easy. The concrete obtained was highly pumpable. A increase in the bleeding was observed.

3. 0.5% dosage of enzyme in concrete:
The result outcome was opposite than the expected one. A drastic change in the slump value of concrete was seen. The value of-slump fall by around 90 mm with the further increase of 0.25% dosage. The concrete was difficult to handle. The mixing of concrete was not easier as it seemed that the water amount was not sufficient. The concrete was no more pumpable. Very loss or no bleeding was observed. The concrete set earlier than the expected timings.

4. 1% dosage of enzyme in concrete:
With increase of further 0.5% dosage of enzyme , the slump value further declined by 50% as compared to the previous one. In this dosage the dealing with concrete became more difficult. The mixing of concrete was difficult. The mix appeared to be dry (seemed to be not having appropriate amount of water in it). The initial setting time of concrete was also seen to be affected as the concrete set at the faster rate. Segregation of ingredients of concrete was also observed during placing in last moulds. No bleeding was seen.

Compressive strength of concrete:
The compressive strength of concrete was done at 7 and 28 days in order to check what amount of strength the concrete has acquired at the respective dates. The compressive strength of the concrete was done in the CTM (Concrete Testing Machine) which was there in our college. The loading pace was 2.5kN/sec. A standard Mould of 150mm*150mm*150mm with area of 225.00mm^2 was used.

Compressive strength result at 7TH day:

SR. NO	SAMPLE M30 GRADE	STRENGTH (MPA)
1	CONTROL MIX	24.35
2	0.25 % DOSAGE	30.65
3	0.5 % DOSAGE	26.7
4	1 % DOSAGE	33.5

The strength written is in MPA or simply in KN/mm^2.The strength of obtained is the average of 2 concrete samples.The control mix showed appropriate strength at the 7th day but when we added theenzyme by 0.25% of weight of cement, we observed that the concrete is showing higher strength.The result for the 0.5% dosage was opposite than the expected one the strength falls below the strength of 0.25% enzyme dosage but still it was greater than the strength of the control mix.At 1% enzyme dosage the results were surprisingly the strength increased with a large margin it showed the strength greater than all the other 3 samples. The enzyme can be used if the structure is demanding a higher strength at the initial days with 0.25% dosage or 1% dosage however, the recommendation is to use the 0.25% dosage as it gives you a higher workability characteristic.

Compressive strength result at 28TH day:

SR. NO	SAMPLE M30 GRADE	STRENGTH (MPA)
1	CONTROL MIX	37.5
2	0.25 % DOSAGE	39.7
3	0.5 % DOSAGE	32.3
4	1 % DOSAGE	40.96

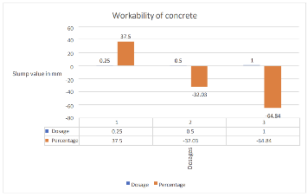
The strength written is in MPA or simply in KN/mm^2. The strength of obtained is the average of 3 concrete samples.The control mix showed good strength at the 28th day but when we added the enzyme by 0.25% of weight of cement, we observed that the concrete is showing higher strength.The result for the 0.5% dosage was opposite than the expected one, the strength falls below the strength of 0.25% enzyme dosage and also below the strength of control mix. At 1% enzyme dosage the results were surprisingly the strength increased with a considerable margin it showed the strength greater than all the other 3 samples. However,the strength was nearly equal to the strength of 0.25% dosage. The enzyme can be used if the structure is demanding a higher strength at the initial days. i.e. on 7th day with 0.25% dosage or 1% dosage however, the recommendation is to use the 0.25% dosage as it gives you a higher workability characteristic. The 0.25% dosage of enzyme in concrete also increases the strength at 28th day with a greater number.

The concrete obtained with 0.25% enzyme dosage has advantages over the concrete obtained with control mix or 0% dosage of enzyme as it gives us

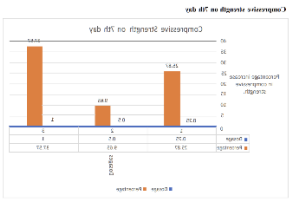
- Higher strength.
- High slump value.
- The concrete is highly pumpable.
- The concrete becomes workable.

The 1% dosage can be used if there is no requirement of higher slump and the we want are concrete to set at faster rate, at this dosage the concrete is not pumpable. The 1% dosage showed the maximum strength but it was nearly equal to the 0.25%
Dosage The 0.25% dosage is seen to be the optimum dosage for this citrus enzyme. The 0.5% dosage showed opposite results to the expected ones so before commenting more on that we need to take a number of trails.

6. RESULTS AND DISCUSSION



The addition of enzyme showed increased in the workability for only 0.25% of dosage and there was sharp fall in the workability for the rest of two dosages. No Segregation was seen at 0.25% dosage & the bonding characteristics of concrete was also not affected at this point of dosages.



Thus, from the above testing we can concluded that the addition of bio-enzyme has a signification change/improvement in the strength of concrete. The compressive strength of concrete increased by 25.87% for 0.25% dosage . The compressive strength took downward hit with 0.5% enzyme dosage,however the compressive strength was still greater than 9.65% as compared to the control mix. When 1% of enzyme dosages was added , the compressive strength was increased by 37.57% as compared with control mix & it was the greatest strength achieved when comparing with other two dosages.

On addition of 0.25% of enzyme dosages increase in the strength of concrete was observed.The increase was by 5.87% with respect to the control mix. The compressive strength took a downward hit with 0.5% of enzyme dosage.The compressive strength obtained at this particular dosages was less than 16.09% when compared to control mix.The compressive strength increased notably for 1% dosage. The increase was by 9.26%.

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