A Study on Performance of Fly ash and Recycle Concrete Aggregate in DLC for Rigid Pavement

By

NEEL VINODBHAI MAVANI

(190041011)

Guided by

Mr. Ashraf Mathakiya

Faculty of Engineering and Technology

Atmiya University

A Thesis Submitted to

Atmiya University in Partial Fulfilment of the Requirements for

the Degree of Master of Technology in [Transportation Engineering]

JULY- 2021

Civil Engineering,

Faculty of Engineering & Technology

ATMIYA UNIVERSITY

Yogidham Gurukul, Kalawad Road, Rajkot

CERTIFICATE

It is certified that the work contained in this dissertation thesis entitled '**A Study on Performance of Fly ash and Recycle Concrete Aggregate in DLC for Rigid Pavement'** submitted by **MAVANI NEEL V.**, **190041011** studying at Civil Engineering Department, Faculty of Engineering & Technology, for the award of M.Tech (Civil Engineering) is absolutely based on his own work carried out under my supervision and that this work/thesis has not been submitted elsewhere for any degree/diploma.

Date:

Place: RAJKOT

Signature and Name of internal supervisor **Signature and Name Head of Department**

Signature and Name of external supervisor **Signature and Name of Head of Institute**

Seal of Institute

COMPLIANCE CERTIFICATE

It is certified that the work contained in this dissertation thesis entitled '**A Study on Performance of Fly ash and Recycle Concrete Aggregate in DLC for Rigid Pavement** '' submitted by **MAVANI NEEL V**, **190041011.** studying at Civil Engineering Department, Faculty of Engineering & Technology for partial fulfilment of M.Tech degree to be awarded by ATMIYA University. He/ She has complied the comments of the Dissertation Progress Review-I, Dissertation Part-I as well as Dissertation Progress Review-II with my satisfaction.

Date:

Place: RAJKOT

Mr. Neel V. Mavani
En.No:190041011

Mr. Ashraf M. Mathakiya
Assistant Professor
(Civil Engineering Dept.)
Atmiya University, Rajkot

PAPER PUBLICATION CERTIFICATE

It is certified that the work contained in this dissertation thesis entitled '**A Study on Performance of Fly ash and Recycle Concrete Aggregate in DLC for Rigid Pavement** '' submitted by **MAVANI NEEL V**, **19004100.** studying at Civil Engineering Department, Faculty of Engineering & Technology for partial fulfilment of M.Tech degree to be awarded by ATMIYA University, has published/accepted article entitle **A Study on Performance of Fly ash and Recycle Concrete Aggregate in DLC for Rigid Pavement** ' for publication by the **GRADIYA REVIEW JOURNAL of International Journal**,

Date:

Place: RAJKOT

Mr. Neel V. Mavani
En.No:190041011

Mr. Ashraf M. Mathakiya
Assistant Professor
(Civil Engineering Dept.)
Atmiya University, Rajkot

THESIS APPROVAL CERTIFICATE

It is certified that the work contained in this dissertation thesis entitled '**A Study on Performance of Fly ash and Recycle Concrete Aggregate in DLC for Rigid Pavement** '' submitted by **MAVANI NEEL V**, **190041011.** studying at Civil Engineering Department, Faculty of Engineering& Technology for partial fulfilment of M.Tech degree to be awarded by ATMIYA University

Date:

Place: RAJKOT

External Examiners' Sign and Name:

1) _____

2) _____

Dedicated To,

For Every Success of my life, for being worm and caring, Great Enthusiasm, Inspiration, Support & Love are Heart of My Achievement

Thank you

My Mom, Dad, Brother & My beloved Friends

ACKNOLEDGEMENT

Research brings about dramatic change in the traditional lookout of Science & Technology. It has widened our vision, open newer avenues and lightened the dark abscure facts of mysterious universe. Behind every success there are lot many efforts, but efforts are fruitful due to hands making the passage smoother. I express my deep sense of gratitude for hands, people extended to my during my work.

I would like to thank to my Guide Mr Ashraf Mathakiya, for initial spark, constant unceasing encouragement, critical evaluation, suggestion, constant untiring guidance and affection during the entire span of my post-graduation study.

I am very grateful to express sincere thanks to Prof. H.G.Sonkusare, Head of Civil Engineering Department, Atmiya University for giving me an opportunity to undertake this thesis for study.

I would like to express my special thanks to my classmate who were always stood by me and provided me all the necessary help to complete my work. I am very much thankful to to almighty for giving me chance to have such brilliant and co-operative friends.

At the occasion of this presentation, I would like to thank you from the bottom of my heart my parents, brother and my friends for their endless love, support and encouragement.

NEEL V. MAVANI

CONTENT

CHAPTER - 4 EXPERIMENTAL WORK & RESULTS

LIST OF FIGURE

LIST OF TABLE

“A Study on Performance of Fly ash and Recycle concrete aggregate in DRY LEAN CONCRETE for Rigid Pavement”

Submitted By

MAVANI NEEL V
Enrollment No: 190041011

ABSTRACT

Rigid pavements are constructed of Portland cement concrete slabs resting on a prepared sub base of granular material or directly on a granular sub grade. Load is transmitted through the slabs to the underlying sub grade by flexure of the slabs. There are Sub grade, sub base and base layer for Rigid pavement. Sub base is also known as the DLC layer.

Dry Lean Concrete is a mixture in which the amount of cement is less than the amount of liquid that is present in the layers. It is smooth concrete with a large proportion of aggregate in relation to cement than conventional concrete and is generally used as a base/sub-base for hard paving. Although the actual thickness will be governed by the design considerations, a thickness of minimum 150 mm is recommended for all major projects of State Highways and National Highways. When DLC is adopted as sub base in case of roads other than the above road sits thickness of 100 mm is recommended. Increase the strength of DRY LEAN CONCRETE by using FA & RCA. To Compare to Economic analysis for DLC & DLC added materials of FA and RCA

Study of bearing pressure revealed a good resistance of the granular mixture (recycled concrete aggregate + cement). It has been observed that by curing of blended RCA, it has gained very high strength which shows that with the addition of cement to blend of sand and RCA, it becomes semi- rigid pavement i.e the pavement changes its nature from flexible to semi-rigid pavement.

In present study aims preparing concrete by adding materials of Ordinary Portland Cement (OPC) with fly ash 15% and RCA in various proportion like- 10%, 20%, 30%. By mass of quantity. Maximum compressive strength for DLC + FA (15%) and RCA 20%is 9.48 MPA. The study discloses that high volume of Fly Ash in concrete reduces the water demand and improves. Experiments such as compressive test. Economic analysis compare to DLC and DLC added by Fly ash and RCA.

CHAPTER 1

INTRODUCTION

1.1] GENERAL:

A pavement is one type of hard surface made from durable surface material lay down on an area which is intended to carry vehicular or foot traffic". its main function is to distribute the applied vehicle loads to the sub-grade through different layers.

Types of Pavements:

- Flexible pavement
- Rigid pavement
- Semi Rigid.
- Composite pavement

Rigid pavements are named so because of the high flexural rigidity of the concrete slab and hence the pavement structure deflects very little under loading due to the high modulus of elasticity of their surface course. The most common type of rigid pavement consists of dowel bars and tie bars.

Rigid pavements can be classified into four types:

- Jointed plain concrete pavement (JPCP),
- Jointed reinforced concrete pavement (JRCP),
- Continuous reinforced concrete pavement (CRCP), and.
- Pre-stressed concrete pavement (PCP).

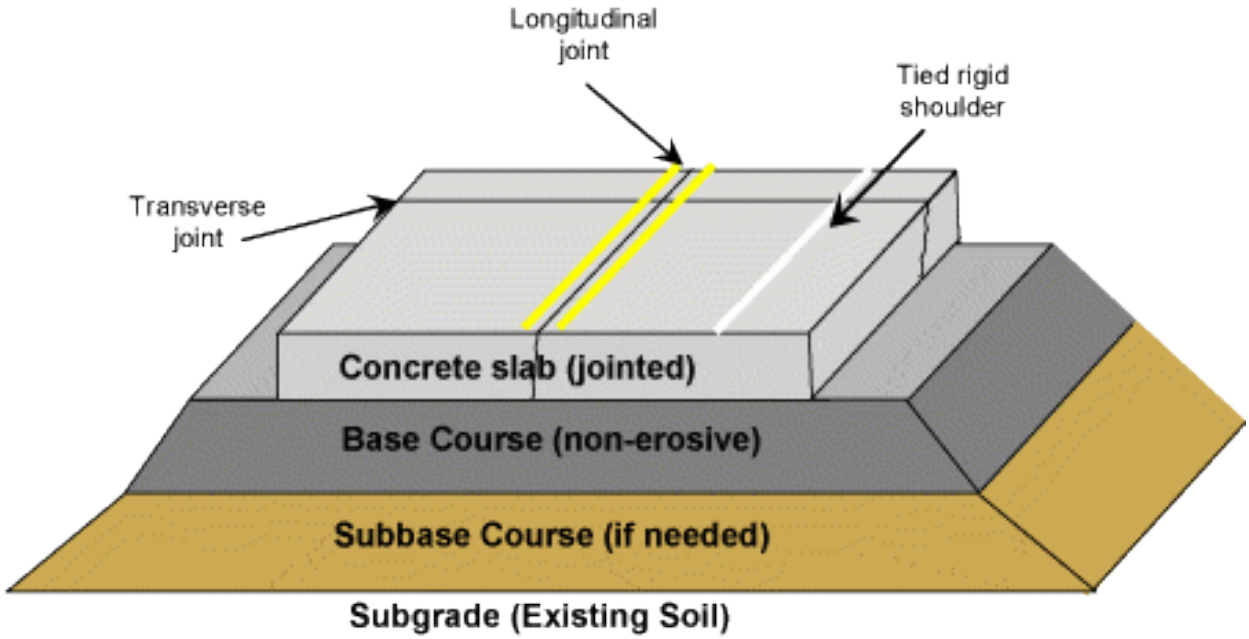


Figure1.1 Rigid pavement

1.2] Dry Lean Concrete:

Rigid pavements (Portland cement concrete roads) are being constructed in many new projects due to added advantages of longer service life, smoother riding surface and little to no maintenance requirement. Government of India is encouraging the construction of cement concrete roads even at village and Municipal levels. The current practices of the construction of cement concrete road for highways in India require a layer of dry lean concrete (DLC) as a base course over which pavement quality concrete slabs rest. The concrete mix shall be proportioned with a maximum aggregate cement ratio of 14:1 where OPC used and 12:1 where PPC or PSC is used. The minimum cementations materials content shall not be less than 140 kg/cum of concrete.

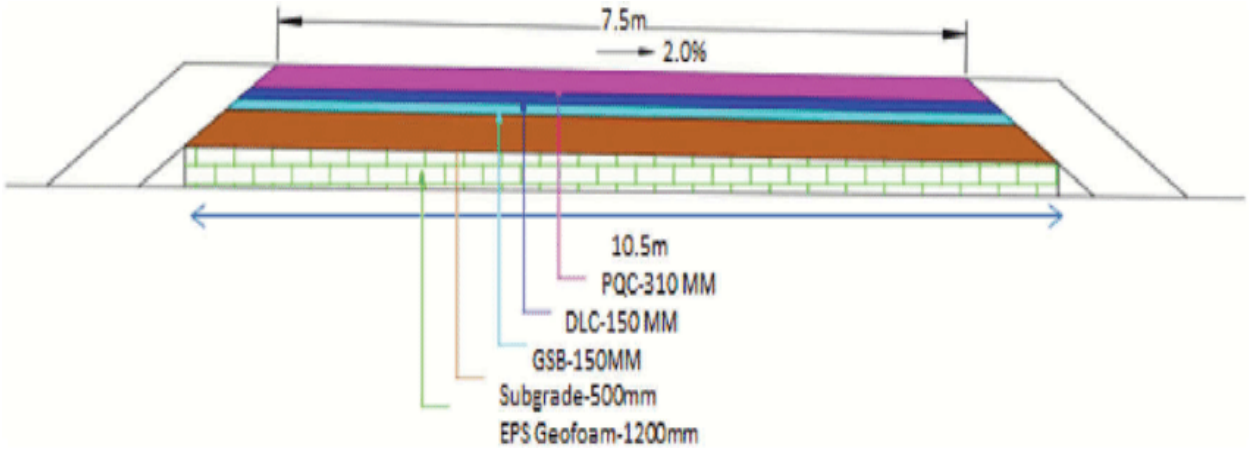


Figure1.2 DLC thickness layer section

DLC is a no slump plain concrete with a large ratio of aggregate to cement. It contains less amount of cement paste as compared to conventional concrete. DLC layer is an important part of modern rigid pavements. The major advantages of using DLC as base layer includes: provision of a uniform and strong support, high resistance to deformation, enhanced load transfer efficiency at joints, proper fixing of form work & proper placement of dowel bar cradles in semi mechanised construction, movement of construction equipments during construction of the roads, all weather construction and finally a reduction in the depth of pavement slab required from the point of view of axle load consideration etc.

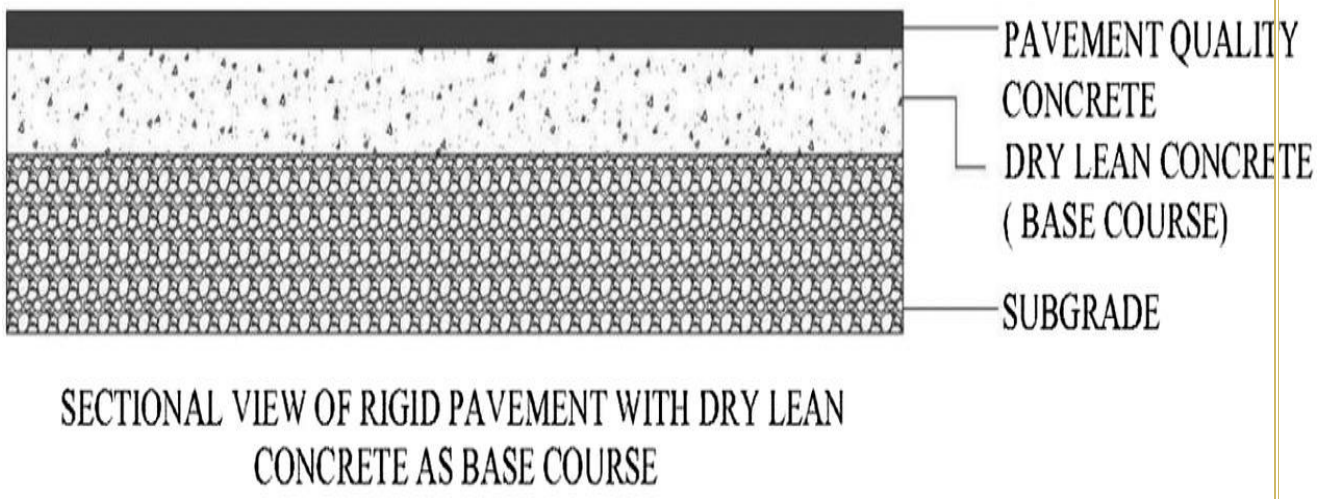


Figure1.3 DLC cross section layer

Advantages of Dry Lean Concrete

- Provides even and stronger support to the hard floor.
- It has a high resistance to deformation.
- It has excellent improved load transfer efficiency at the joints.
- Helps in all weather conditions.
- There is a final reduction in the depth of the slab due to the DLC as a base layer.

1.3] Need for the study:

1] To increase compressive strength of the sub base layer.

2] To increase life span of rigid pavement.

3] To minimize the pavement failure and enhance the sub base layer.

4] To reduce overall cost of rigid pavement construction.

5] To make environment eco friendly

1.4] Objectives of study:

1] To study the check physical properties of cement and aggregate for DLC layer in rigid pavement.

2] To increase the compressive strength of dry lean concrete by using fly ash & recycle concrete aggregate.

3] To determine economic analysis of DLC layer.

1.5] Scopes of study:

Present study considering only on DLC layer of rigid pavement and considering foreign materials FA & RCA are replaced by cement and coarse aggregate respectively. In this study examined the various physical property of DLC, Compressive strength of DLC and determine Economic analysis of DLC layer.

CHAPTER 2

LITERATURE REVIEW

2.1 General

A review of literature plays an important role in any research work. In this aspect, the studies carried out emission rate of the Dry lean concrete layer for rigid pavement. Most of the research has been conducted to understand the rigid pavement.

2.2 Literature Review

A literature view is simply a summary of the research that has already been conducted on particular subject area. An effective review analyzed on published work by doing some study such as summarize and finding evaluate, highlight exemplary study, note gap knowledge, compare and contrast different authors. Summary of published research paper is relevant to the topic under consideration for research familiarity with current thinking and research on particular topic.

2.3 Research Work

Use of Recycled Aggregate and Fly Ash in Concrete Pavement (Vallabuni Vinay Kalyan1, P.Sandeep Chandra2 Mohammed Ibrahim) (2018)

This paper attempts the investigation on the use of fly ash in cement concrete industries. In developedcountries use of mineral admixtures such as fly ash and silica fume and rise husk ash etc. has already adopted in making concrete. This includes commercial application on large scale either for addition or for replacement of cement. In India too much replacement has already been programmed and adopted with the introduction of ready mixed concrete and the process has been accelerated in recent times, in order to effect the economy in construction. An investigation was undertaken to study the effects of fly ash in concrete. In this paper Mechanical properties at different levels of replacements were found. Fly ash from Vijayawada thermal power station, Vijayawada, A. P is proposed for the study. Cement replacement levels by fly ash were 0, 20, 30, 40, 50 and 60 percent are proposed for analysis in this project work. As quality criteria, Compressive strengths of cubes at the ages of 3, 7, and 28, days were determined as per the normal Code practices. The results are

presented in the relevant tables and graphs. The performance of the designed mixes using fly ash content is good enough and the results are presented for kind recommendation to the various cement concrete industries.

Concrete is a composite construction material composed primarily of aggregate, cement and water. There are many formulations that have varied properties. The aggregate is generally coarse gravel or crushed rocks such as limestone, or granite, along with a fine aggregate such as sand. The cement, commonly Portland cement, and other cementitious materials such as fly ash, serve as a binder for the aggregate.

Study and Analysis of Rigid Pavements Using Fly Ash (Mr.Nagesh Tatoba Suryawanshi 1, Mr. Samitinjay S. Bansode2, Dr. Pravin D. Nemade) (2012)

Fly ash is generated in huge quantities every dayin major thermal power stations of Maharashtra. The safedisposal of this fly ash is the major socio-economic problem be fore the authorities and is becoming a costly affair for them. Conventional method of concrete road construction consumes the natural resources like stone metal, sand, murum etc. and hence causes ecological imbalance. The use of fly ash in concrete road construction will save such resources. The cement is also costly ingredient of concrete. A part of cementand sand can be replaced by good quality fly ash to the extent of 10-30 percent and 5-15 percent respectively. This would results in lowering cost of resultant concrete without any loss in strength. The use of fly ash will solve the disposal problem and automatically reduce the construction cost. Hence this paper is aimed to describe the use of fly ash in rigid pavement construction. Because of the use of fly ash, rigid pavement behaves as a semi rigid pavement causing substantial reduction in cost of construction. If the fly ash is utilized on large scale for road construction, the infrastructure development can be completed at lesser cost and will also help for environmental protection of our country. This paper also deals with techno-economic analysis of fly ash reinforced cement concrete over the flexible and rigid pavements.

The beneficial effects of addition of fly ash namely reduced bleeding, lesser segregation and improved cohesiveness are more pronounced in the case of dry lean fly ash concrete (DLFC), permitting its easier placement and finishing. Fly ash addition in DLFC is

through partial replacement of sand with fly ash. Research work at CRRI has shown that 100-175 percent increase in the compressive strength of DLFC can be achieved in mixes with 50 percent replacements of sand with fly ash. DLFC would be particularly useful as base / sub base course in heavy rainfall areas or in black cotton soil areas. Due to its higher strength, DLFC results in reduction of total pavement thickness as compared to pavements constructed using conventional base course of WBM layer. So it is especially suitable for those areas where good quality hard stones for such base courses have to be brought from a long distance.

Use of Eco-Friendly Material like Fly Ash in Rigid PavementConstruction.

(Rakesh Soni) (2015)

Aim of study is to test and analysis compressive strength of fly ash-cement concrete in a normal way as use to determine on construction site, which can utilize in road construction in rural areas. There is a vast area of covered by industrial waste such as fly ash, so using this waste in road construction can dispose this waste and also beneficial in minimize pollution in environment due to this waste. Laboratory experiments were performed on fly ash to determine its properties, which may be used in road construction, earth dam construction, soil stabilization etc. Fly ash was collected from Kalishindh thermal power plant, Jhalawar. In present study aims preparing concrete by replacement of Ordinary Portland Cement (OPC) with fly ash in various proportion like- 10%, 20%, 30%, 40% and 50% Fly Ash by mass. The study discloses that high volume of Fly Ash in concrete reduces the water demand and improves the workability. Study also reveals that the OPCC and HVFAC exhibit similar hardened properties. Experiments such as compressive strength test, slump test for workability, std. consistency test, specific gravity test etc are done in order to determine properties of fly ash, which can take account in the construction field. A comparison is made between fly ash and cement properties which are used as sub-grade, base in Highway construction. It would have been a very good situation if common industrial wastes like fly ash can be considered as an alternative option to mix in concrete materials for highway construction with economical solution.

Fly ash is used by ancient time, initially it is used in less amount, but now a day a major production of fly ash is made so its uses and decomposes is necessary to protect environment from pollution. It is used as follow: -

- The ROMANS used naturally occurring volcanic ash from Mount Vesuvius to cement the paving stones in their roadways. Many miles of this ancient roadway although rough by our standards – still exist as useable highway.

- Fly ash concrete was first used in the U.S. in 1929 for the Hoover Dam, where engineers found that it allowed for less total cement.

-Major breakthrough in using fly ash in concrete was the construction of Hungry Horse Dam in 1948, utilizing 120,000 metric tons of fly ash.

- In January of 1974, The Federal Highway Administration indicated that "the replacement of cement with fly ash of the order of 10% to 25% can be made giving equal or better concrete strength and durability.

- In January 1983, the Environmental Protection Agency published federal procurement guidelines for cement and concrete containing fly ash which encourage the utilization of fly ash and establish compliance deadlines.

Behavior of FLY ASH in Cement-Concrete Pavement. (Magdi M. E. Zumrawi) (2015)

The performance of pavement is very responsive to the characteristics of the soil subgrade. For that reason, weak subgrade is enhanced by adopting the most efficient stabilization technique. Based on the literature review, stabilization with fly ash activated with cement was found to be an effective option for improvement of soil properties. In this regard an experimental program was undertaken to study the effect caused by the combined action of fly ash and cement stabilization on the geotechnical characteristics of expansive subgrade soils. Expansive soil treated with varying percentages of fly ash, 0, 5, 10, 15, and 20 percent combined with 5% cement content were studied. Consistency limits, compaction, California Bearing Ratio, swell potential and swell pressure tests were conducted on treated and untreated soils. The experimental results show that addition of cement-fly ash admixture to the soil has great influence on its properties. It was found that the optimum dosage of fly ash

is 15% mixed with 5% cement revealed in significant improvement in strength and durability and reduction in swelling and plasticity properties of the soil. Based on the results, it is recommended that cement-fly ash admixture be considered a viable option for the stabilization of expansive subgrades.

Subgrade soil provides base for the whole pavement structure. Weak subgrades of expansive soil has great tendency to swell and shrink when in contact with water. This behaviour is believed to have been derived from clay rich of montmorillonite mineral. These expansive soils can be improved through the addition of chemical or cementitious additives. These additives range from waste products to manufactured materials which include fly ash, cement, lime and proprietary chemical stabilizers. Weak subgrade soils are usually improved by cement or lime. In fact, cement stabilization provide an effective solution to the problem of fatigue failures caused by repeated high deflection of asphalt surfaces where a weak subgrade exists in the pavement structure, [1].

Experiences in areas of expansive subgrades, show significant improvement in strength and a marked decrease in deflection when subgrades are stabilized with cement, while treatment with lime or fly ash is a well-known practice adopted to reduce swelling behavior.

Study of Fly Ash Cement Concrete Pavement (Anjali Yadav 1, Nikhil Kumar Yadav 2) (2017)

This experiment study is aimed to investigate the physical, chemical and mechanical properties of fly ash cement concrete for road construction. From research, it has been observed that the use of 30% of fly ash and 70% of cement possess a superior performance. Moreover, in construction, the use of fly ash would result in the reduction of the cost of materials and the reduction of greenhouse gas emission. High strength of concrete can be prepared and the incorporation of admixture or substitute to improve the properties of concrete. Test result of specimens indicates the bonding strength of properties, workability, and different reaction when the water ratio a change its content. Slump test having an appropriate workable mixing the slump of a concrete, gave sufficient compressive strength. Now a day's concrete pavements are achieving popularity for its own good paving properties, as such consumption of cement is increased to a great. As cement demand

increases, production also increases. Every ton of production of cement releases approximately 7% carbon dioxide to environment. In many industries, including power plants, coal is used as fuel. This generates tones of coal ash, which is very difficult to dispose off, which in turn causes pollution. Thus the production of cement and electricity contributes huge amount of carbon dioxide emissions and coal ash causing environmental pollution. Fly ash contains reactive constituents and unreactive crystalline matter. Reactive constituents reacts with lime and offers hydrated minerals to impart strength and un reactive matter gives packing effect to the concrete, filling up of pores and thus increases the strength. Here an attempt is being made to consume this pollution causing material to a utility by using it in concrete.

Electricity is important for development of any country. Coal is a major source of fuel for production of electricity in many countries in of the world. In the electricity generation process, a large quantity of fly ash gets produced and becomes available as a byproduct of coal-based power stations. Fly ash is a fine powder resulting from the combustion of powdered coal which is transported by the flue gases of the boiler and collected in the Electrostatic Precipitators (ESP). Conversion of waste into a resource material is an old practice of human society. In the year 1930, in USA, the fly ash became available in coal based thermal power station.

For its profitable utilization, scientist started research activities and R.E. Davis, in the year 1937, and his associates at university of California published research details on use of fly ash in cement concrete. This research had laid foundation for its specification, testing & usages.

The use of recycled concrete as a sub base layer for highway (Nakul Hans, Er. Dalvir Singh, Dr. Arvind Dewangan) (2019)

In this study, the highest dry densities are for additions of 5% cement in recycled concrete aggregates. The study of bearing pressure revealed a good resistance of the granular mixture (recycled concrete aggregate + cement), which resulted in high values of CBR due to improvement of grain size distribution during the compaction. It has been observed that by curing of blended RCA, it has gained very high strength which shows that with the

addition of cement to blend of sand and RCA, it becomes semi- rigid pavement i.e the pavement changes its nature from flexible to semi-rigid pavement. Then there may be no need of construction of any wearing coarse over the base coarse, only surface coarse will be sufficient. It has been observed

that by curing of blended RCA, it has gained very high strength which shows that with the addition of cement to blend of sand and RCA, it becomes semi- rigid pavement i.e the pavement changes its nature from flexible to semi-rigid pavement. Then there may be no need of construction of any wearing coarse over the base coarse, only surface coarse will be sufficient.

The properties of RCA has been established and demonstrated through several experimental and field projects successfully. It has been concluded that RCA can be readily used in construction of low rise buildings, concrete paving blocks & tiles, flooring, retaining walls, approach lanes, sewerage structures, sub base course of pavement, drainage layer in highways, dry lean concrete(DLC) etc. in Indian scenario. Use of RCA will further ensure the sustainable development of society with savings in natural resources, materials and energy. Concrete aggregate collected from demolition sites is put through a crushing machine, often along with asphalt, bricks, dirt, and rocks. Smaller pieces of concrete are used as gravel for new construction projects. Crushed recycled concrete can also be used

as the dry aggregate for brand new concrete if it is free of contaminants. This reduces the need for other rocks to be dug up, which in turn saves trees and habitats. C&D (construction & demolition) wastes are normally composed of concrete rubble, brick, tile, sand and dust, timber, plastic, cardboard, paper, and metal. Concrete rubbles usually constitute the largest proportion of C&D waste.

A study on compressive strength of recycled aggregates embedded concrete.

(Nagaraja Ba, Vinay K V a, Keerthi Gowda B S a, Karisiddappa b). (2017)

Now a day's demolition of concrete structural elements is quite common work. Lot of debris are generated by this task. Reuse of crushed concrete structural elements is an essential and challenging job. In the present study crushed concrete cube debris (of size 20

mm sieve passed and 10 mm sieve retained) are used as coarse aggregates for the production of cement concrete in economical way. Here compressive strength of conventional concrete is compared with crushed concrete debris embedded plain cement concrete. Percentage of replacement of debris are varied from 10, 20, 25, 30, 35, 40, 50 and 100 to compare the compressive strength results among them. 30 % replacement of debris for conventional coarse aggregate recorded the highest compressive strength of 31.11 MPa. Compressive strength of debris embedded concrete showed higher compressive strength compared to conventional concrete. Also, a plain cement concrete embedded with debris and 10 mm long raw Banana fibers (1% of cementitious material) recorded highest compressive strength compared to other concrete.

Recycling of waste concrete is beneficial and necessary from the viewpoint of environmental preservation and effective utilization of resources. For the effective utilization of demolished concrete, it is necessary to use that concrete as recycled aggregate for new concrete. Various investigations mainly engaged in the processing of demolished concrete, its mix design, physical and mechanical properties. Recycled aggregates generally produced by two stages crushing of demolished concrete, screening and removal of reinforcement, wood and plastic etc. The cement used in the experiment is ordinary Portland cement of a specific gravity of 3.15. M-sand is used for

concrete mix having a fineness modulus of 2.83 and specific gravity of 2.64 was used as fine aggregates.

Normal coarse aggregates of 20 mm maximum size of fineness modulus 6.8, bulk density of 1600 kg/m3 and

specific gravity of 2.54 are used. Water conforming to the requirements for concreting and curing is used throughout. The recycled aggregates are obtained from demolished concrete crushed in the crusher and sieved to obtain a proper size of aggregates. . The recycled aggregates having maximum size 20 mm retaining on 10 mm and having a specific gravity of 2.63 is used. The bulk density of recycled aggregate obtained is 1515 kg/m3.

Blending of recycled concrete aggregates for use in base course construction

(Mr. Alaa Hassoon, Dr. Jalal Al-Obaedi) (2014)

The use of recycled "reclaimed" materials has been increased during the last decades in order to obtain environmental benefits and to reduce the pressure on natural material resources. This paper focuses on using recycled concrete as a subbase material for highways. Concrete cubes produced from concrete tests such as compression strength, have been crushed to produce different particle sizes so as to satisfy the gradations requirements according to the Iraqi specifications for subbase martial. These recycled samples as well as the samples obtained from ordinary subbase have been subjected to maximum dry density, California bearing ratio (CBR) and Atterberg limits tests.

The results obtained from maximum dry density test suggested that the waste materials could be compacted to reach reasonable density. The CBR test's results suggest that the CBR values obtained from recycled concrete is significantly higher than those CBR values obtained from the ordinary subbase. The Atterberg tests showed that the waste concrete material is satisfying Iraqi specifications for roads and bridges (SORB).

In this research work, waste concrete cubes (produces from concrete tests such as compression strength test) have been crushed (see **Figure 1**, which shows the concrete cubes before and after crushing) to produce different particle sizes. This is to satisfy the gradations requirements according to the Iraqi specifications for subbase martial. Three different subbase types have been obtained from the crushing process; these are types B, C and D. Similarly, three types from the ordinary subbase materials have also been prepared for comparison purpose.

CHAPTER - 3

MATERILAS & METHODOLOGY

3.1] METHODOLOGY CHART:

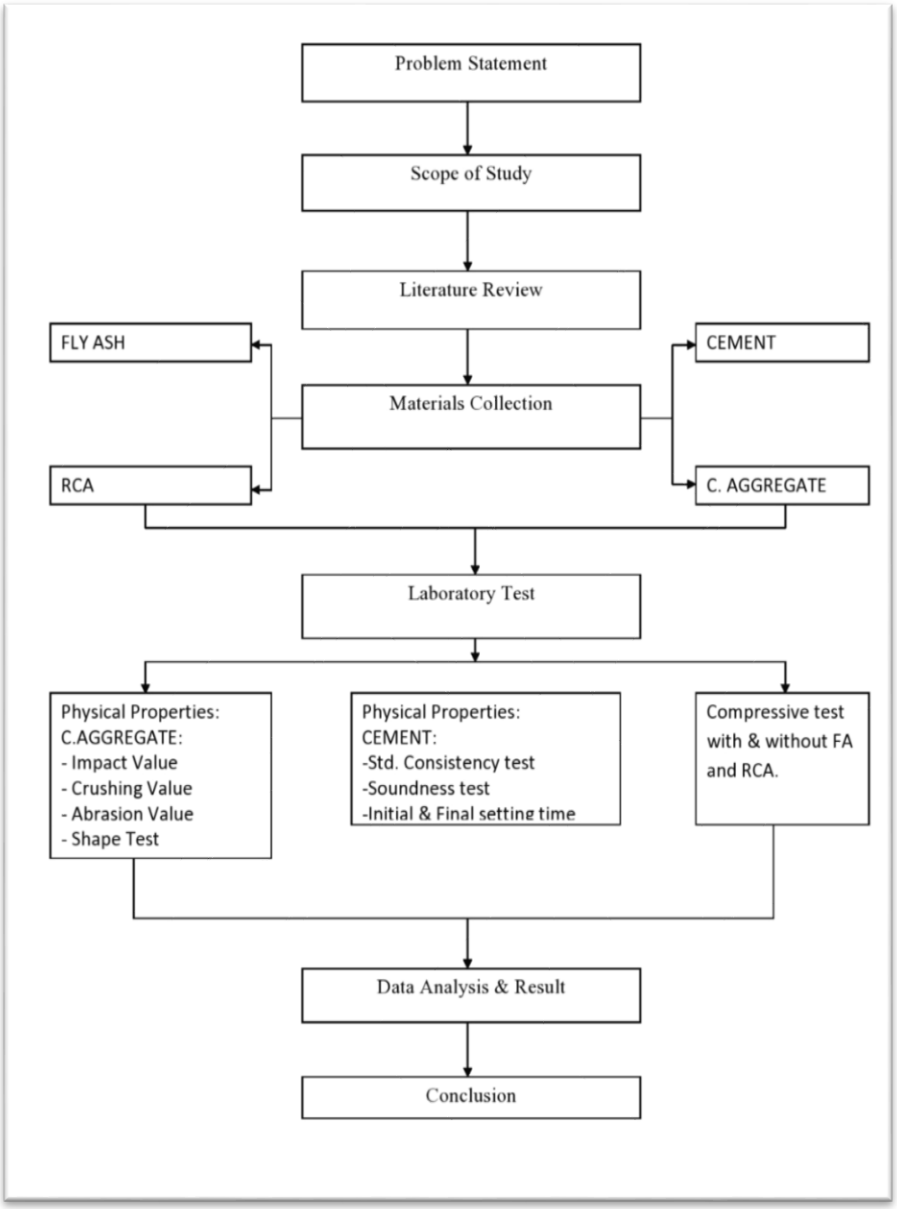


Figure3.1 Methodology chart

3.2] MATERILAS:

3.2.1] CEMENT: (OPC 53 grade)

3.2.2] AGGREGATE: CA (20mm & 10mm)

3.2.3] FLAY ASH:

3.2.4] RECYCLE CONCRETE AGGREGATE:

3.2.1] CEMENT:

- In this study using by OPC (53 grades) – (Ultra Tech Cement). IS CODE- 12269 & IS: 8661 is collected from local shop and cement test is performance of physical and chemical test result around of IS specification.

3.2.2] AGGREGATE:

Aggregates for dry lean concrete shall be natural aggregate complying with IS:383.

-Aggregate collected to PAVAN CONSTRUCTION PVT. LTD having two size of aggregate 20mm, 10mm and Sand.

- Aggregate test performance is IS: 2386 and specification IS: 383.

- In this study using maximum size of aggregate DLC design 26.5mm and minimum size of aggregate is 4.75 retained.

3.2.3] FLY ASH:

- FLY ASH is collected is BHANU RMC PLANT.

- A composite binder made primarily of fly ash, a byproduct of coal-fired power plants, that can replace Portland cement in concrete. ... It also requires only a small fraction of the sodium-based activation chemicals used to harden Portland cement. Fly ash is a fine powder that is a byproduct of burning pulverized coal in electric generation power plants.

3.2.4] RECYCLE CONCRETE AGGREGATE:

- RCA material is collected from road site where removing old RCC road at Ramapir chok, 150 ft ring road Rajkot.

-The use of recycled aggregates from construction and demolition wastes is showing prospective application in construction as alternative to primary (natural) aggregates. It conserves natural resources and reduces the space required for the landfill disposal.

-This paper presents the experimental results of recycled coarse aggregate concrete and results are compared with the natural crushed aggregate concrete. The fine aggregate used in the concrete, i.e. recycled and conventional is 100 percent natural. The recycled aggregate are collected from four sources all demolished structures.

3.3] BASIC TEST ON AGGREGATE:

3.3.1] SHAPE TEST (IS: 2386 - PART 1)

Flakiness Index

Elongation Index

3.3.2] SPECIFIC GRAVITY TEST (IS: 2386 - PART 3)

3.3] IMPACT VALUE TEST (IS: 2386 - PART 4)

3.3.4] CRUSHING VALUE TEST (IS: 2386 - PART 4)

3.3.5] ABRASION VALUE TEST (IS: 2386 - PART 4

1] SHAPE TEST:

OBJECTIVE:

To determine the value of Flakiness and Elongation Index of Coarse aggregates. Combined Index = FI+EI

FLAKINESS INDEX:

The flakiness index of aggregates is the percentage by weight of particles whose least dimension (thickness) is less than three fifths (0.6) of their mean dimension. The test is not applicable to sizes smaller than 6.3 mm.

APPARATUS:

- IS Sieve
- Thickness Gauge
- Balance

PROCEDURE FOR FLAKINESS INDEX:

1] Flakiness index test and therefore the sample is passing 6.3mm Sieve removed.

2] The test sample is 200 pieces of coarse aggregate from each size range is taken weight.

3] Passing sieve is 63mm, 50mm, 40mm, 31.5m, 25mm, 20mm, 16mm, 12.5mm & 10mm. and retained sieve is 50mm, 40mm, 31.5m, 25mm, 20mm, 16mm, 12.5mm, 10mm & 6.3mm.

4] This sample respective slot thickness gauge are given tried to passing specific gauge.

5] The flaky particles passing the appropriate slot of the thickness gauge.

6] Each passing aggregate size range are collected and weighted.

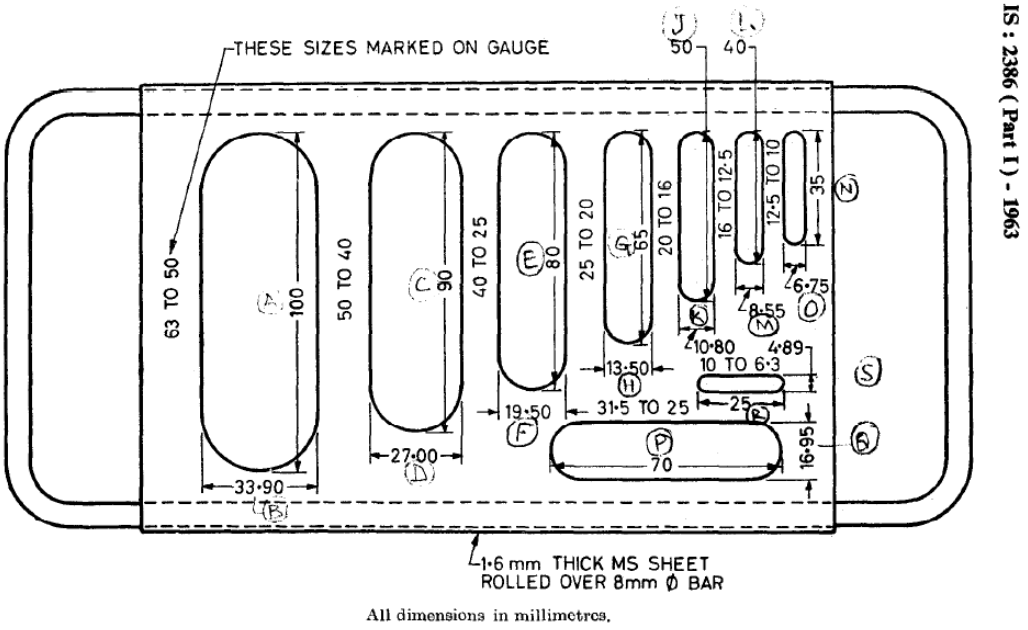


Figure3.2 Thickness gauge

(B) ELONGATION INDEX:

The elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than one and fifth times (1.8 times) their mean dimension. The elongation test is not applicable to sizes smaller than 6.3 mm

APPARATUS:

- IS Sieve
- Thickness Gauge
- Balance

PROCEDURE:

1] The portion of coarse aggregate sample IS 6.3mm sieve removed.

2] The test sample is 200 pieces of coarse aggregate from each size range is taken weight.

3] The sample of coarse aggregate separated in to different size range for length gauge.

4] Passing sieve is 50mm, 40mm, 31.5m, 25mm, 20mm, 16mm, 12.5mm & 10mm and 40mm, 31.5m, 25mm, 20mm, 16mm, 12.5mm, 10mm & 6.3mm.

5] This test using coarse aggregate of passing by thickness gauge.

6] Length gauge retained on the specific slots of the length gauge and weighted.

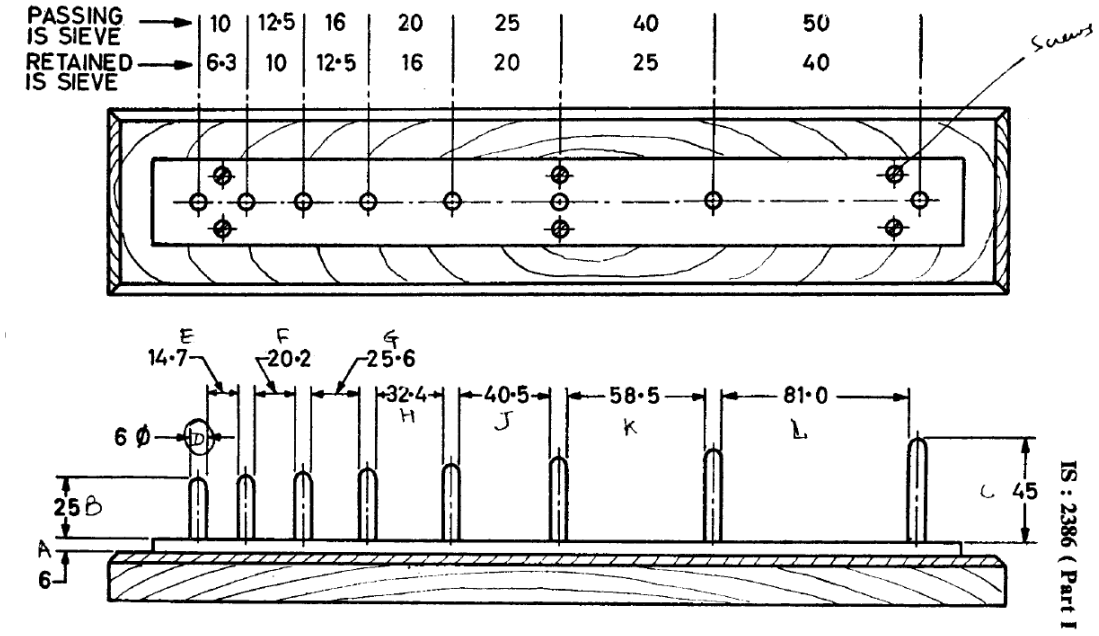


Figure3.3 Length gauge

2] SPECIFIC GRAVITY TEST:

OBJECTIVE:

To determine the specific gravity and water absorption of aggregates by perforated basket.

APPARATUS:

- Specific gravity bottle
- IS Sieve (20mm & 10mm)
- Oven
- Basket

- Weight machine (10 kg capacity)
- Shallow tray

PROCEDURE:

1] This test sample consists about 2kg is coarse aggregate removed fines, drained.

2] This sample is placed wire basket in water temperature between 22 to 32°C and covered of least above to 5 to 10cm of water.

3] This sample is fully saturated of basket.

4] The weight noted of saturated aggregate suspended in water (W1).

5] The empty basket weight is W2.

6] Weight of saturated surface dry aggregate in air is W3.

7] The Weight of oven dry sample is W4.

8] Weight of saturated aggregate in water is Ws.

1] SPECIFIC GRAVITY:

$$\frac{W4}{W3 - WS}$$

2] WATER ABSORPTION:

$$\frac{(W3 - W4)\ 100}{W4}$$

Figure3.4 Specific Gravity apparatus

3] IMPACT VALUE TEST:

OBJECTIVE:

To determine the impact value of given sample using Aggregate Impact Testing Machine.

APPARATUS:

- Cylinder measure
- IS SIEVE (12.5 mm , 10mm & 2.36mm)
- Oven
- Taping rod
- Impact machine
- Weight machine
- Measuring cup

PROCEDURE:

1] This test using sample is oven dry (105°C to 110°C) for 24 ±1 hours.

2] The test consists aggregate passing 12.5mm sieve and retained 10mm sieve.

3] This test sample aroung 1000gm (W1)

4] Sample is filled measuing cylinder 3 layer and each layer 25 blows by taping rod.

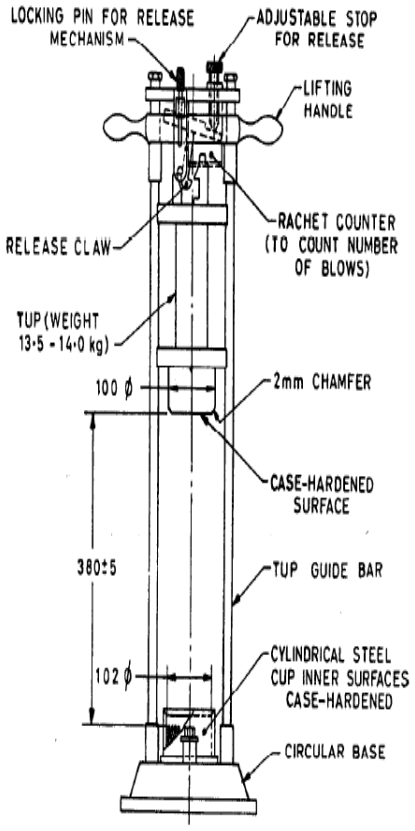
5] After filled 3 layer measuing cylinder surface straight edge.

6] After filled cup and set up impact testing machine.

7] Compaction of machine hammer is 380mm above the 15 blows and each blows being deviled interval not less than one second.

8] Next crushed aggregate passing 2.36mm sieve and weighted of sample (W2)

9] This above procedure 2 times and final value is average for 2 sample.



All dimensions in millimetres.

FIG. 2 AGGREGATE IMPACT TEST MACHINE

Figure3.5 Impact test machine

4.] CRUSHING VALUE TEST:

OBJECTIVE:

To determine the crushing value of the given sample of aggregate with the help of compression testing machine.

APPARATUS:

- IS sieve (20mm, 10mm & 2.36mm)
- Tapping rod
- Weighting machine
- Compressive machine
- Measuring cup
- Oven
- Crushing value test appratues.

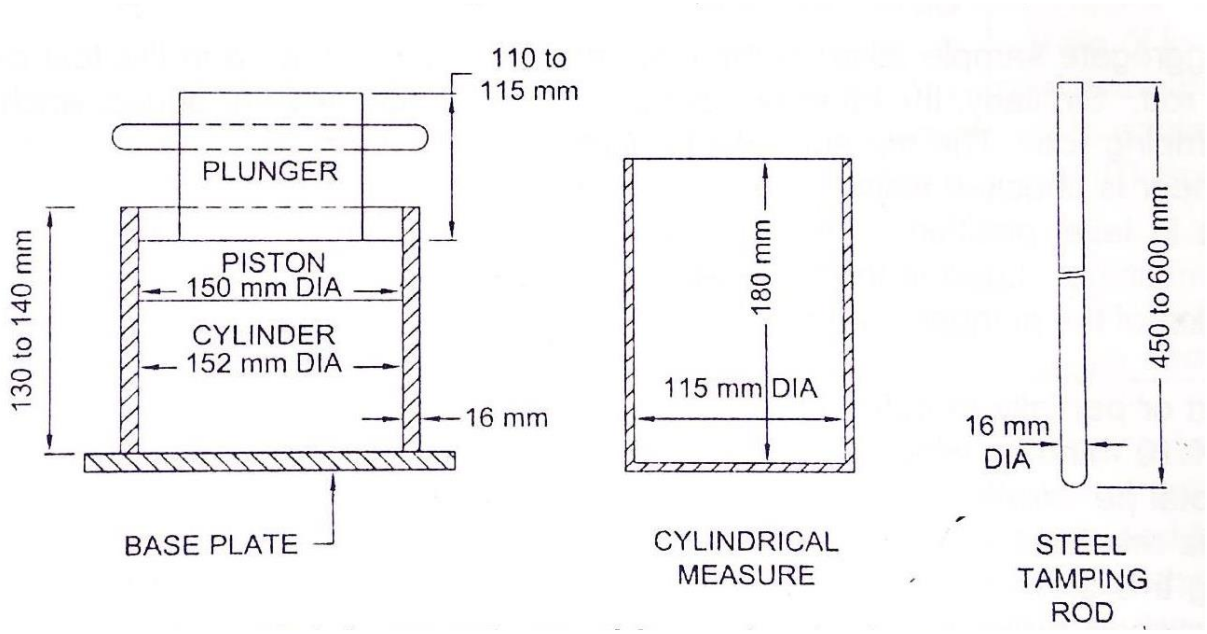


Figure3.6 crushing value test apparatus

PROCEDURE:

1] This test using sample is oven dry (105℃ to 110℃) for 24 ±1 hours.

2] The test consists aggregate passing 12.5mm sieve and retained 10mm sieve.

3] This test sample aroung 1000gm (W1)

4] Next to filled measuring cup 1/3 part and each layer 25 blows by taping rod.

5] Measuring cup surface is straight edge.

6] Set up to Plunger and testing appratus for compressive machine.

7] The measuring cylinder with test sample and plunger at a unifrom load 4 tonne per minutes and total load 40 tonne for 10 minetus.

8] Next crushed sample is passing 2.36mm sieve and weight (W2).

5.] ABRASION VALUE TEST:

OBJECTIVE:

To determine the hardness of the sample aggregate by testing for abrasion value using Los Angles Testing Machine.

APPARATUS:

- Los Angeles Machine
- Spheres
- Oven and accurate balance.
- IS SIEVE
- Weighting machine
- Oven

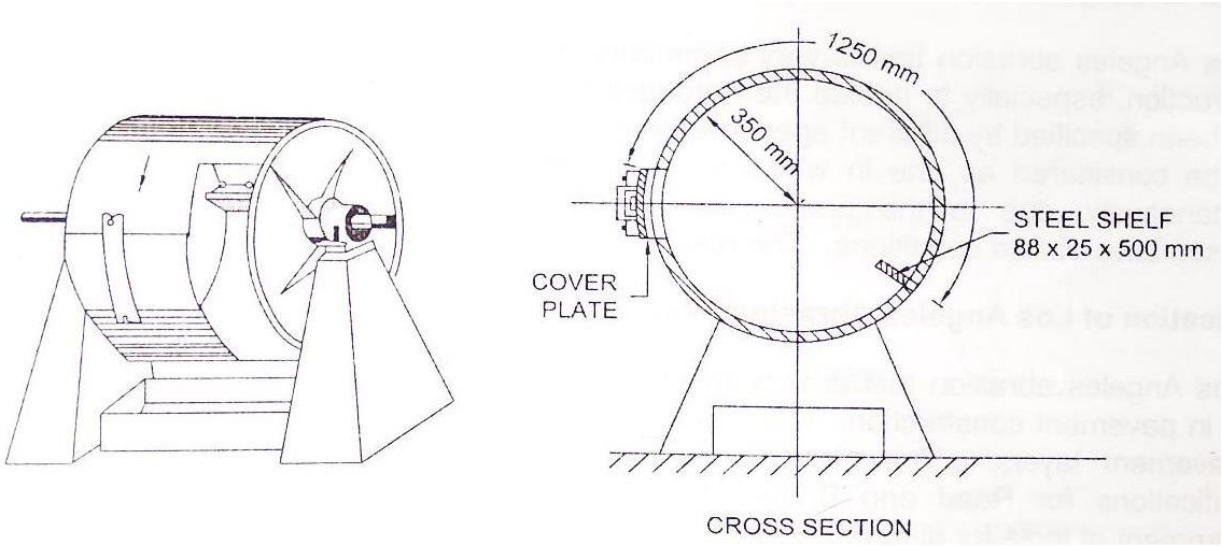


Figure3.7 Abrasion test machine

PROCEDURE:

1] The test sample is oven dry (105°C) 24 ±1 hours of around 1000gm.

2] This sample by conforming any one of a grading A, B, C, D, E, F, G of sieve analysis.

3] Gradation is finding number of spheres for this test.

4] The test sample 5 kg is grading is A, B, C, D & 10 kg is grading is E, F, G,

5] The specified number of revolution of 500 for A, B, C, D & 1000 number of revolution of E, F, G.

6] The machine revolted 30 to 35 minutes/revoluted.

7] In my study is grading is B and number of spheres is 11.

8] In my study abrasive charges is 4584±25 gm.

9] Next crushed aggregate passing is 1.70mm sieve and weight of sample is (W2).

10] Calculation: $\frac{W1 - W2}{W1} * 100$

3.3] BASIC TEST ON CEMENT:

3.3.1] SOUNDENSS TEST (IS 4031 - PART 3)

3.3.2] STANDARD CONSISTENCY TEST (IS 4031 - PART 4)

3.3.3] INITIAL SETTING TIME & FINAL SETTING TIME TEST (IS 4031 - PART 5)

1] SOUNDNESS TEST:

APPARATUS:

- Le-Chateliers Apparatus
- Vernier Calliper
- Water bath
- Balance.
- Glass plate
- Gauging trowel

PROCEDURE:

1] First of testing mould oiling surface because clean mould after test.

2] Mould in base for glass plate and after weight for cement.

3] Water count for standard consistency test water is using this test.

4] Using water for Std. consistency test used water.

5] Water = 0.78*std. consistency * 4 is using for soundness test.

6] Mixed water and cement not touch to hand and filled mould.

7] Filled mould top glass plate and glass palate top to weight.

8] Next sample 24±1 hours normal 27°C in placed for water.

9] After 24 hours mould measured by vernier scale.

10] Next 3 hours for bowling for mould and after measured vernier scale.

11] This measure nearest to 5 mm.

12] There are 3 trials method of this test.

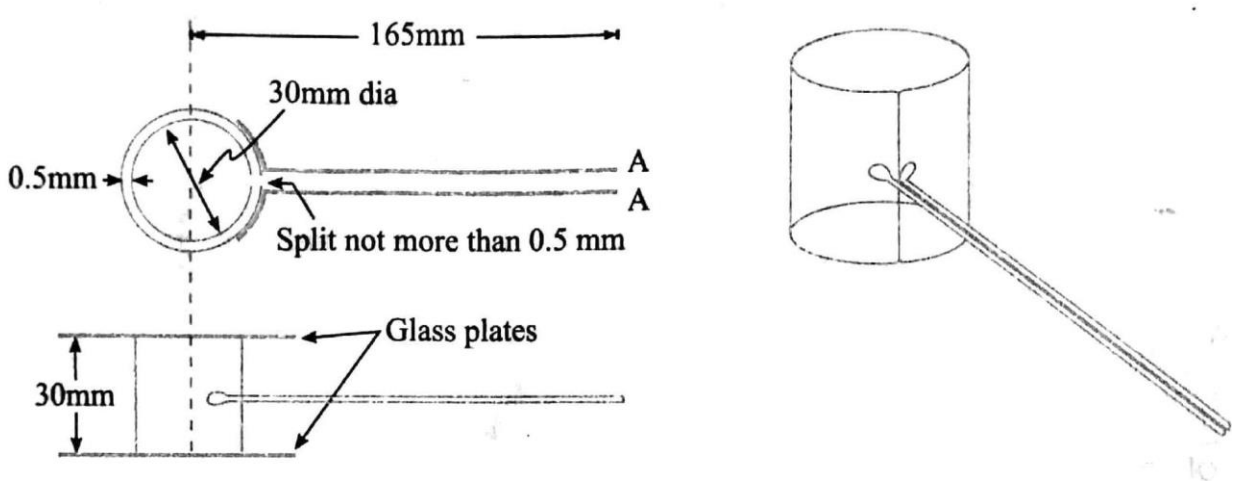


Figure3.8 Soundness test apparatus

2.] STANDARD CONSISTENCY TEST:

APPARATUS:

- Vicat appartus
- Niddles
- Movable rod
- Gradulated scale
- Vicat mould
- Gauging trowel
- Mould (80mm diameter & 40mm height)

PROCEDURE:

1] The temperature is mould of dry materials and water should be maintained 27°C ±2°C.

2] The test sample around 500gm.

3] Next this sample adding 2% water and mixed the cement and water.

4] This ready paste 3 to 5 minetus in filled the measuring cup.

5] Set up the vicat apparatus and fitted the niddle.

6] Plunger touches the paste surface and falling for niddle.

7] Keep adding 2% water till 5 to 7 mm penetration.

8] There is 3 times of trials method and after average reading in this test.

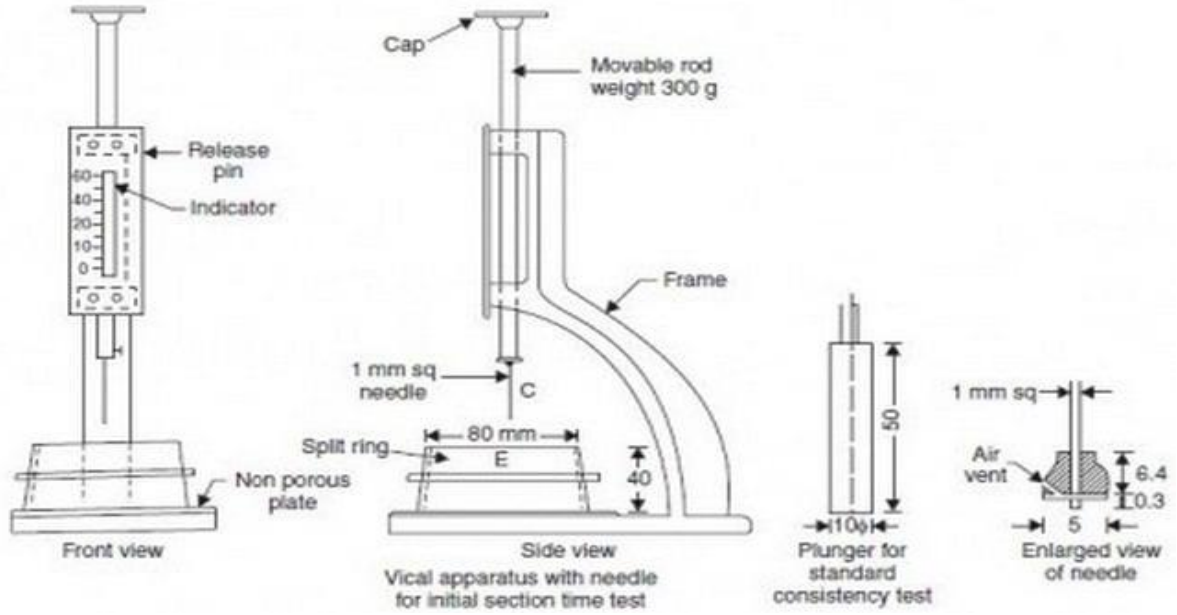


Figure3.9 Vicat apparatus

3] INITIAL SETTING TIME & FINAL SETTING TIME TEST:

OBJECTIVE:

Initial setting time is regarded as the time elapsed between the moments that the water is added to the cement, to the time that the paste starts losing its plasticity.

APPARATUS:

- Vicat apparatus
- Balance
- Stop watch

- Gauring trowel
- Mould

PROCEDURE:

1] Test sample is around 300 gm.

2] Water added by cement and water is value for standard consistency test.

3] Paste is filled is vicat mould and set up the vicat apparatus and niddle is fitted for vicat apparatus.

4] Time noted for niddle is falling for vicat mould.

5] Minimum time is not less than 30min is initial setting time.

6] Final setting time test start is cement added water and paste is filled is vicat mould.

7] Neddle is touched for vicat mould and press to niddle in the mould .

8] niddle is press in mould time noted is final setting time test.

9] Not less than 600 minutes for this test for paste is falling mould.

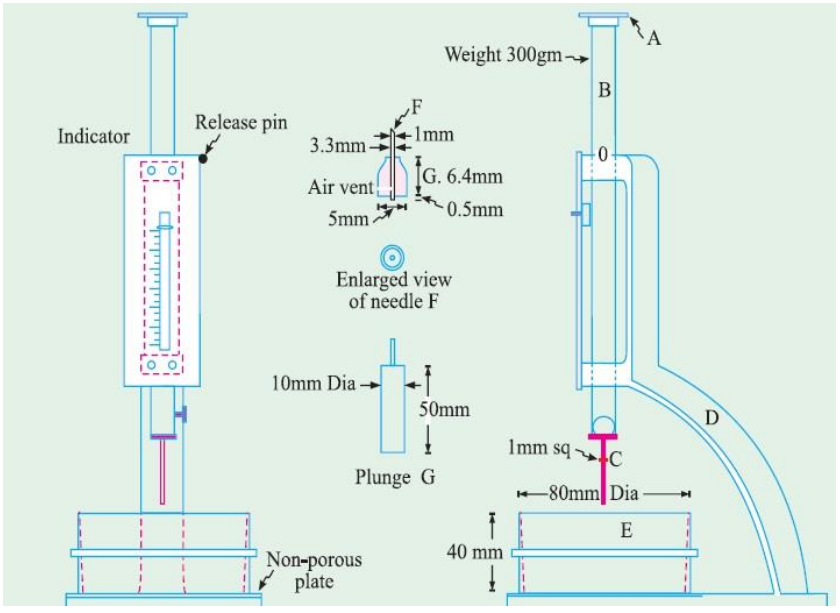


Figure3.10 Vicat apparatus

3.4] COMPRESSIVE STRENGTH TEST:

3.4.1] GENERAL:

The procedure for casting of specimens for compressive strength testis discussed in this section. Cube specimens of dry lean concrete were cast for each percentage of moisture content 6.5% with various combinations of RCA i.e. 10%,20%,30% And FLY ASH 15%. Five number of cube specimens were cast for each combination of RCA with each percentage of moisture content. Six cube specimens of size 150×150×150mm were cast for static compressive test. The quantity of cement, coarse aggregate, fine aggregate, Fly ash, RCA and water for each mix was weighed separately. Cement is mixed into the blend in dry form. The coarse aggregates were mixed to get the same throughout the batch. The compaction of concrete in molds was carried out by using Vibrating needle.

3.4.2] PROCEDURE:

Method of Casting:

Concrete's strength mostly depends on the mix design. But it's affected by several other factors. Such as mixing of concrete, placing of concrete, curing of concrete, as well as quality of concrete ingredients. So we can't be assumed that if we produced that if we produce concrete as per mix design we will get desired strength.

Procedure of making concrete Specimen:

Making Concrete specimen such as cube for compressive strength, cylinder for splitting tensile strength and beam for flexural strength are simple and it's done in three simple steps.

1. Cleaning & Fixing mould.

2. Placing, compacting & Finishing Concrete.

3. Curing.

Cleaning & Fixing Mould:

Clean the mould properly and apply oil on inner surface of mould. But no oil should be visible on surface. Fix the mould with base plate tightly. No gap should be left in joints so that cement slurry doesn't penetrate. Place the mould level surface.

Placing, Compacting & finishing Concrete:

Preparation of concrete analogous to the traditional concrete. Drum Mixture have been accustomed prepare concrete. Mix of all the materials are exhausted the laboratory at temperature machine have been turned 3 to 5 min. Place the concrete into mould in layer. Compact. Left the mould completely undisturbed period, put down identification mark and casting date on the top of concrete specimen.

Curing:

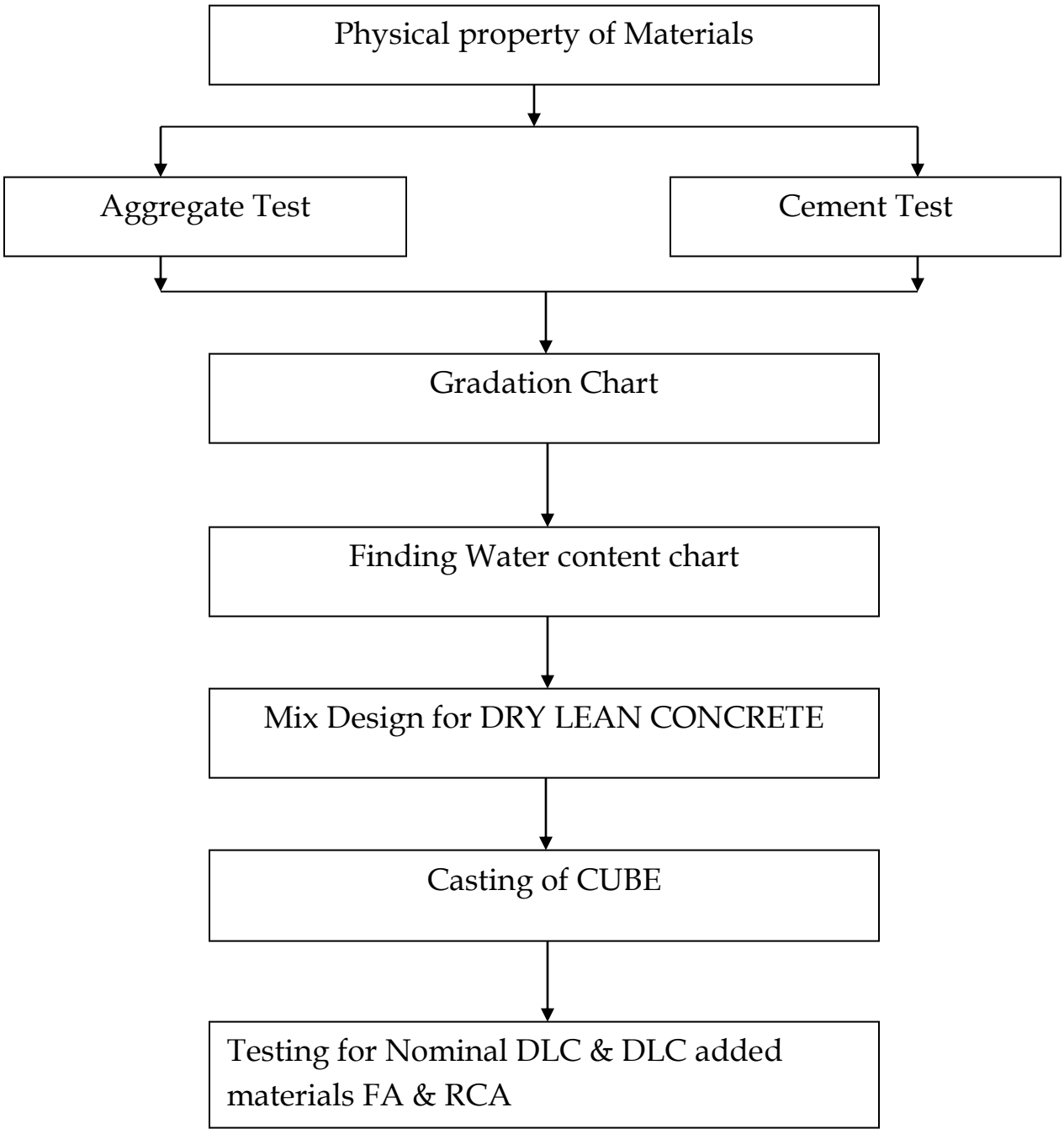
Remove the cube specimen from mould after 24 hours of casting. For removing Specimen from mould, first loosen all nut- bolts and carefully remove specimen because concrete is still lean weak and can be broken. Immediately after removing, put the specimen into a tank of clean water for curing. Make sure specimen is fully submerged in water. After 3, 7 and 28 days of curing take out specimen from water tank and send to laboratory for testing and The arrangement for compressive strength test . At the age oftest, the specimens were taken out of the curing tank and kept outside at room temperature for10 – 15 minutes so it becomes surface dry.

Figure3.11 Compressive machine

CHAPTER 4

EXPERIMANTAL WORK & RESULTS

4.1] EXPERIMANTAL CHART



4.2] RESULT OF CEMENT AND AGGREGATE:

4.2.1] Cement:

Cement is used to work according to IS: 12269 -2013 – Ordinary Portland cement 53 Grade-Specification.

Table 4.1 Physical properties of Cement

SR.NO	Property	Result	Specification
1	Std. Consistency	**26%**	-
2	Soundness	**6 mm**	10mm
3	IST	**78 minutes**	Not less than 30 min
4	FST	**235 minutes**	Not greater than 600 min

4.2.2] Coarse Aggregate

Coarse aggregate is used to work according to I.S. 383- Specifications for coarse aggregate and fine aggregate from natural sources for concrete which fraction is from 20mm to 4.75 mm.

Table4.2 Physical properties of aggregate

SR.NO	Property	Result	Specification
1	Impact value test	**19.63%**	Max 30%
2	Crushing value test	**22.54%**	Max 35%
3	Shape test (combined)	**30.38%**	Max 35%
4	Water absorption	**1.91%**	Max 2%
5	Sp.gravity	**2.63**	

4.3] DETERMINATION OF WATER CONTENT:

CALUCATION FOR DENSITY:

Wet density = Weight of Cube/ Volume of Cube

Dry density = Wet Density/ (1 + w/100)

Table4.3 Water content chart

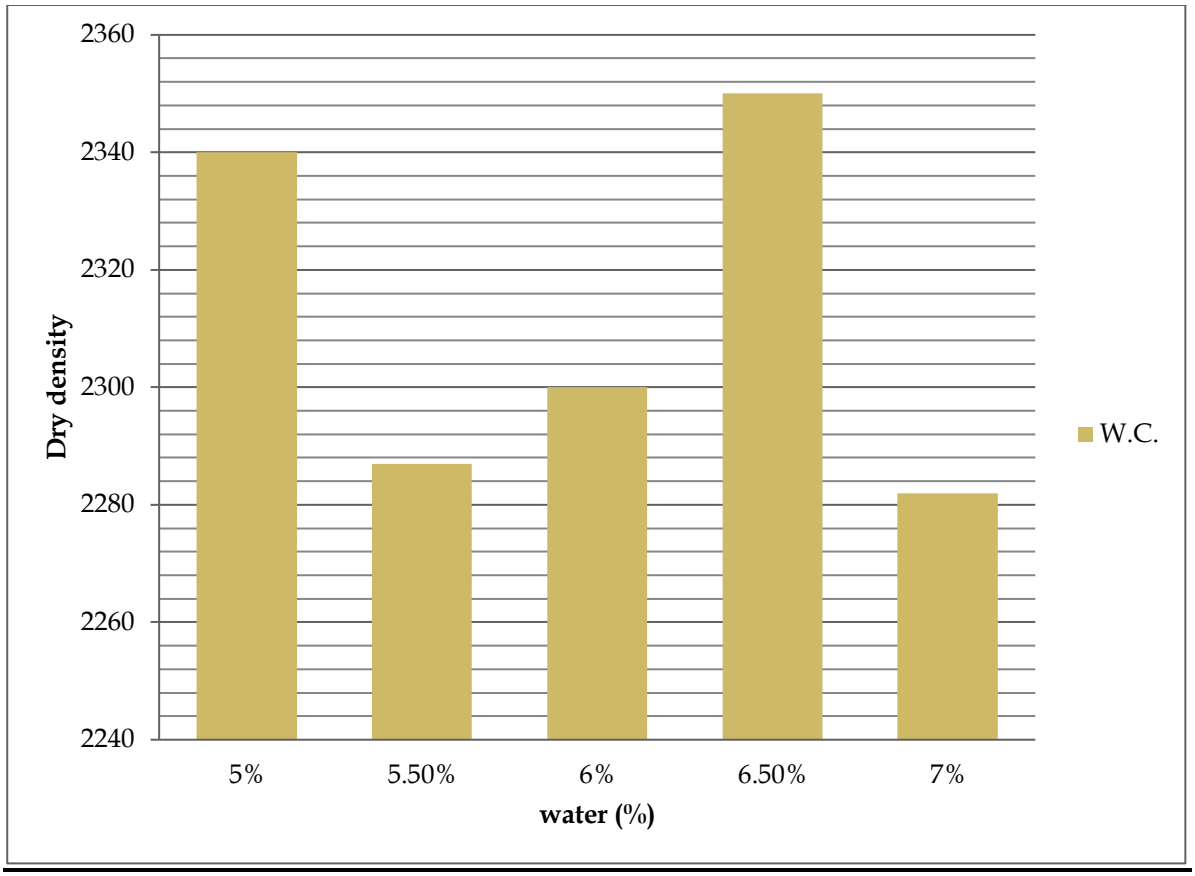
w.c	Cube no	Volume of cube	Wt. Of empty mould	Wt. Of empty mould +concrete	Concrete	Wet density	Dry density
5	5	3375	7.22	12.93	7.3	2464	2340
5.5	5	3375	7.22	12.95	7.17	2420	2287
6	5	3375	7.22	12.97	7.25	2447	2300
6.5	**5**	**3375**	**7.22**	**12.99**	**7.45**	**2514**	**2350**
7	5	3375	7.22	12.94	7.34	2477	2282

MAXIMUM W.C IS 6.5% Calculation:

1] Volume of Cube: $(0.78*d^2*\text{height}) = 3375cm^3$

2] Wet density = weight of cube/ Volume of cube = 12.99/3375 = 2514gm/cc

3] Dry density = Wet density/ ((1+ (w/100)) = 2514/((1+(6.5/100)) = 2350 gm/cc

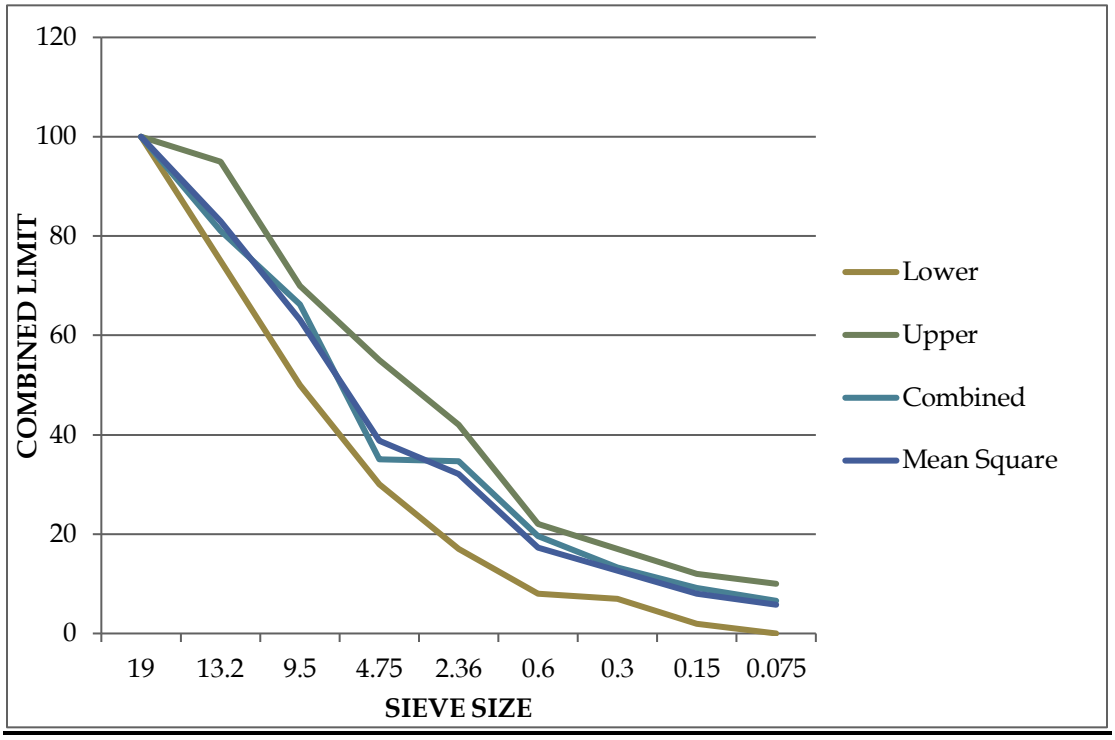


4.4] COMBINED GRADATION:

Is recommended for combined fine and coarse aggregate in case of DLC. This grading is applicable both of natural sand and crushed aggregate.

IS Sieve (mm	Individual gradation			Combined gradation			All in aggregate		Limit (IRC 49)	
	20mm	10mm	Sand	20mm 33%	10mm 33%	Sand 34%	Combined	Ideal	Lower	Upper
19	100	100	100	33	33	34	100	100	100	

13.2	42.5	100	100	14.03	33	34	81.03	85	75	95
9.5	18.63	78.88	100	6.15	26.03	34	66.18	60	50	70
4.75	2.5	0.68	100	0.83	0.22	34	35.05	42.5	30	55
2.36	2.1	0	100	0.69	0.00	34	34.69	29.5	17	42
0.6	0	0	57.65	0.00	0.00	19.60	19.60	15	8	22
0.3	0	0	39.25	0.00	0.00	13.35	13.35	12	7	17
0.15	0	0	26.79	0.00	0.00	9.11	9.11	7	2	12
0.075	0	0	19.35	0.00	0.00	6.58	6.58	5	0	10



4.5] MIX DESIGN OF DRY LEAN CONCRETE (DLC):

4.5.1.] GENERAL MIX DESIGN PARAMETER:

1.] TYPES OF CONCRETE : Dry lean concrete

2.] MINIMUM CEMENT CONTENT : 150kg/cum

3.] MAX.SIZE OF AGGREGATE : 20mm

4.] **A**GGREGATE CEMENT RATIO : 1:12

5.] GRADATION : As per table 600.1 of MoRTH

6.] STRENGTH REQUIRED AT 7 DAYS :7 N/SQMM

4.5.2.] MIX DESIGN OF DLC:

Cement: Aggregate	1:12
Cement , Kg	150
Water, %	6.5
Aggregate, Kg	1800
Sand (34%)	612
Coarse Aggregate	1188
20mm (33%)	594
10mm (33%)	594
Total wt. of Concrete	1950
L	0.15
B	0.15
H	0.15
No.Of Cube	5
Volume of Cube	0.016875
Qun. Of Cube 5	32.9
Cement	2.15
Sand	10.33
20mm	9.018
10mm	9.018
Water	2.14

Table4.5.2 Mix properties of materials

Materials mixed	C.A (20mm)	C.A.(10mm)	F.A
Percentage mixed	**33%**	**33%**	**34%**

4.5.3.] MIX DESIGN OF 15% FLY ASH ADDED IN DLC:

Cement: Aggregate	1:12	
Cement , Kg	150	
Water, %	6.5	
Aggregate, Kg	1800	
Sand (34%)	612	
Coarse Aggregate	1188	
20mm (33%)	594	
10mm (33%)	594	
Total wt. of Concrete	1950	
L	0.15	
B	0.15	
H	0.15	
No.Of Cube	5	
Volume of Cube	0.016875	
Qun. Of Cube 5	32.9	
Cement	2.15	FA = 0.38
Sand	10.33	
20mm	10.02	
10mm	10.02	
Water	2.14	
Dry Density	2350	

Table4.5.3 Mix properties of materials

Materials mixed	C.A (20mm)	C.A.(10mm)	F.A
Percentage mixed	**33%**	**33%**	**34%**

4.5.4.] MIX DESIGN OF 15% FLY ASH & 10% RCA ADDED IN DLC:

Cement: Aggregate	1:12	
Cement , Kg	150	
Water, %	6.5	
Aggregate, Kg	1800	
Sand (34%)	612	
Coarse Aggregate	1188	
20mm (33%)	594	
10mm (33%)	594	
Total wt. of Concrete	1950	
L	0.15	
B	0.15	
H	0.15	
No.Of Cube	5	
Volume of Cube	0.016875	
Qun. Of Cube 5	32.9	
Cement	2.15	FA = 0.38
Sand	10.33	
20mm	9.018	RCA = 2.00
10mm	9.018	
Water	2.14	
Dry Density	2350	

Table4.5.4 Mix properties of materials

Materials mixed	C.A (20mm)	C.A.(10mm)	F.A	RCA
Percentage mixed	**33%**	**33%**	**34%**	**10%**

4.5.5.] MIX DESIGN OF 15% FLY ASH & 20% RCA ADDED IN DLC:

Cement: Aggregate	1:12	
Cement , Kg	150	
Water, %	6.5	
Aggregate, Kg	1800	
Sand (34%)	612	
Coarse Aggregate	1188	
20mm (33%)	594	
10mm (33%)	594	
Total wt. of Concrete	1950	
L	0.15	
B	0.15	
H	0.15	
No.Of Cube	5	
Volume of Cube	0.016875	
Qun. Of Cube 5	32.9	
Cement	2.15	FA = 0.38
Sand	10.33	
20mm	8.016	RCA = 4.00
10mm	8.016	
Water	2.14	
Dry Density	2350	

Table4.5.5 Mix properties of materials

Materials mixed	C.A (20mm)	C.A.(10mm)	F.A	RCA
Percentage mixed	**33%**	**33%**	**34%**	**20%**

4.5.6.] MIX DESIGN OF 15% FLY ASH & 30% RCA ADDED IN DLC:

Cement: Aggregate	1:12	
Cement , Kg	150	
Water, %	6.5	
Aggregate, Kg	1800	
Sand (34%)	612	
Coarse Aggregate	1188	
20mm (33%)	594	
10mm (33%)	594	
Total wt. of Concrete	1950	
L	0.15	
B	0.15	
H	0.15	
No.Of Cube	5	
Volume of Cube	0.016875	
Qun. Of Cube 5	32.9	
Cement	2.15	FA = 0.38
Sand	10.33	
20mm	7.019	RCA = 6.00
10mm	7.019	
Water	2.14	
Dry Density	2350	

Table4.5.6 Mix properties of materials

Materials mixed	C.A (20mm)	C.A.(10mm)	F.A	RCA
Percentage mixed	**33%**	**33%**	**34%**	**30%**

4.6] CASTING SPECIMENS:

The procedure for casting of specimens for compressive Strength testis discussed in this section. Cube specimens of dry lean concrete were cast for each percentage of moisture content 6.5% with various combinations of RCA i.e. 10%,20%,30% And FLY ASH 15%. Five number of cube specimen cast for each combination of RCA with each percentage of moisture content. Six cube specimens of size 150×150×150mm were cast for static compressive test. The quantity of cement, coarse aggregate, fine aggregate, Fly ash, RCA and water for each mix was weighed separately. Cement is mixed into the blend in dry form. The coarse aggregates were mixed to get the same throughout the batch. The compaction of concrete in moulds was carried out by using Vibrating needle. After casting, the specimen kept for 24 hours. Next day the specimen was take out from mould and the specimen are kept in curing tank. For each mix 6 cubes were cast i.e. three cubes for each 3 days, 7days and28dayscompressivestrength test.

Figure4.1 Dry mixing material

Figure4.2 compaction apparatus

Figure4.3 Cube casting with mould

4.7] COMPRESSIVE STRENGTH TEST OF DLC:

4.7.1 DLC CUBE NAME & CONTENTS

Table5.1 DLC CUBE NAME

1	DLC
2	DLC + 15%FA
3	DLC + 15% FA + 10% RCA
4	DLC + 15% FA + 20% RCA
5	DLC + 15% FA + 30% RCA

4.7.2] COMPRESSIVE STRENGTH TESTS OF DLC:

The compressive strength at 3days of DLC Grade of concrete average compressive strength 4.43MPA.

The compressive strength at 7 days of DLC Grade of concrete average compressive strength 7.3MPA.

The compressive strength at 28 days of DLC Grade of concrete average compressive strength 29.2MPA

Table 4.7.2 DLC

CUBE NO	3 DAY	7 DAY	28 DAY
1	4.73	7.34	29.24
2	4.20	7.12	28.48
3	3.69	7.44	29.76

4	4.87	7.38	29.52
5	4.66	7.25	29.00

Fig: 4.7.2 - 3 DAY RESULT

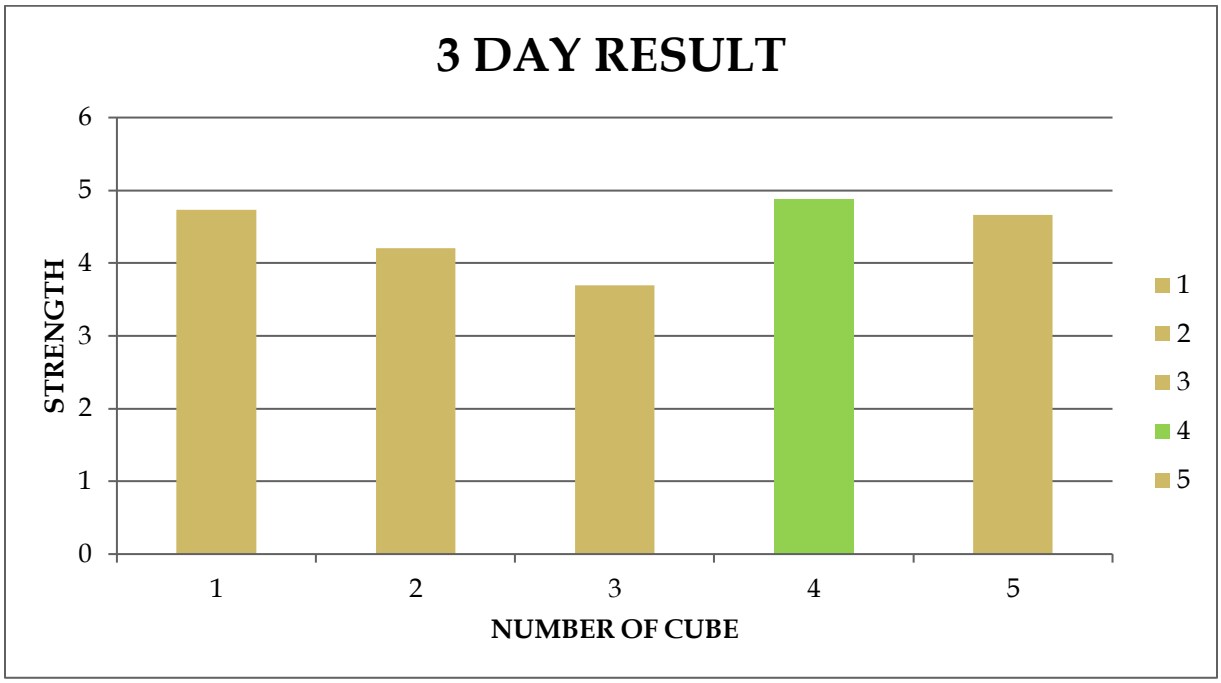


Fig: 4.7.2 - 7 DAY RESULT

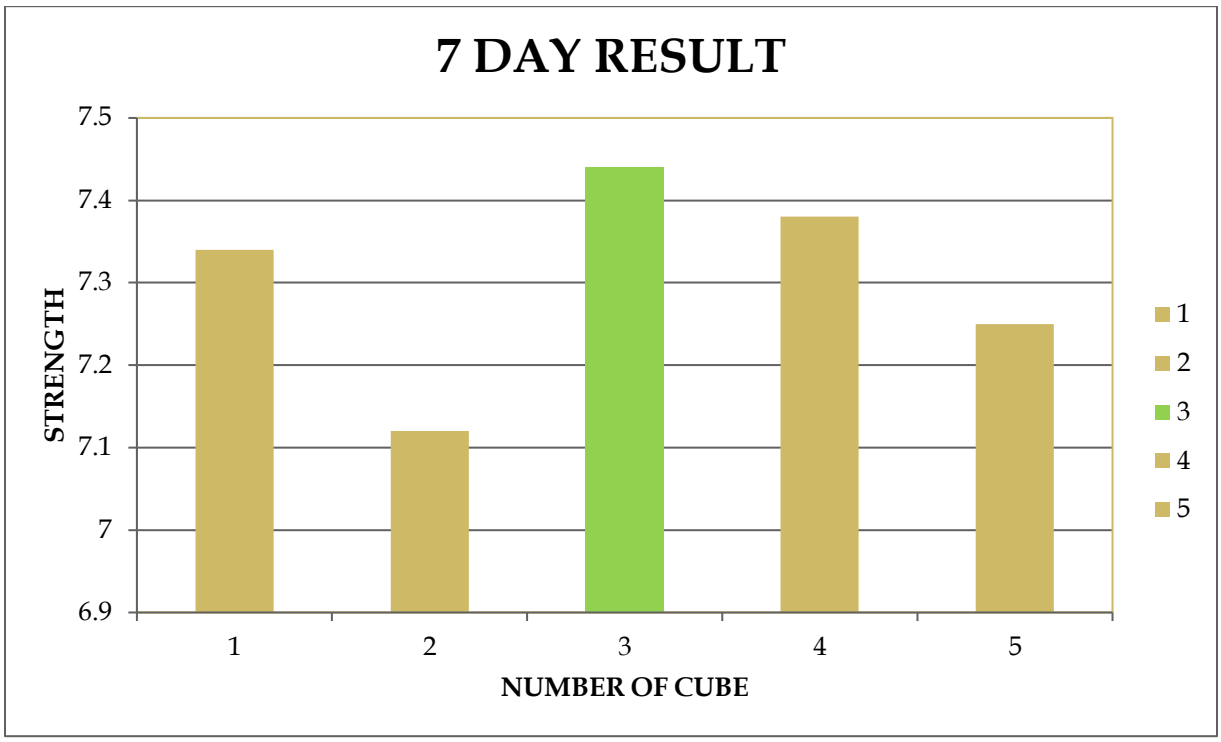
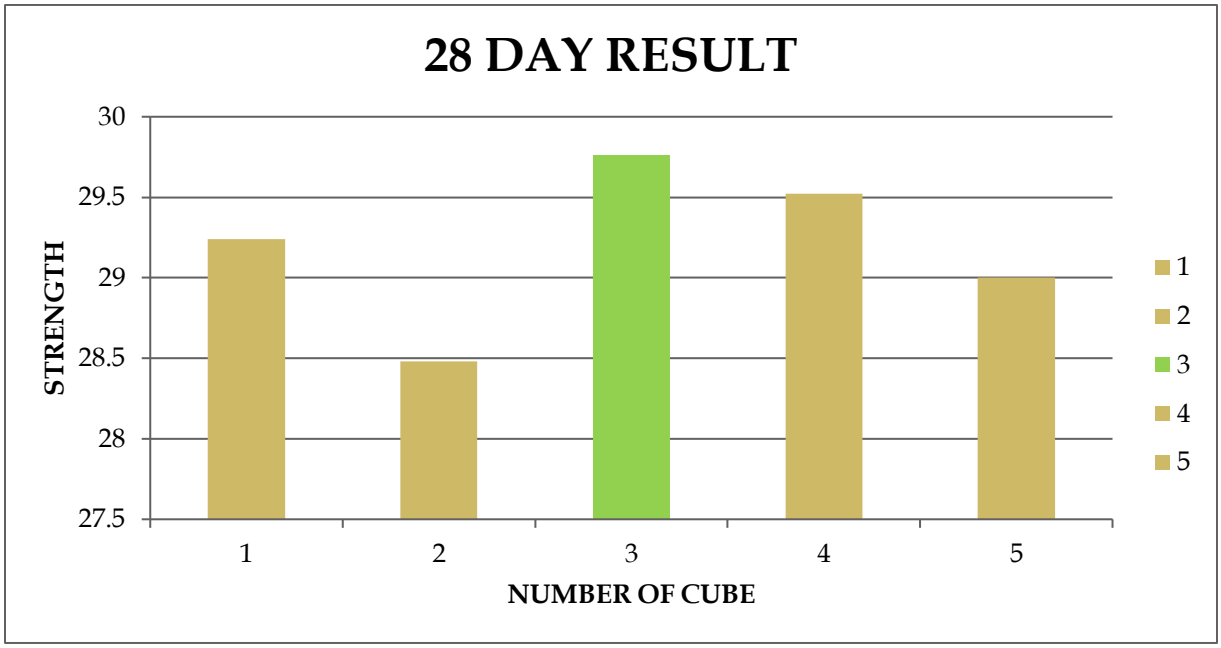


Fig: 4.7.2 – 28 DAY RESULT



4.7.3] COMPRESSIVE STRENGTH TEST OF DLC + 15%FLY ASH:

The compressive strength at 3days of DLC Grade of concrete average compressive strength 4.73MPA.

The compressive strength at 7 days of DLC Grade of concrete average compressive strength 7.34MPA.

The compressive strength at 28 days of DLC Grade of concrete average compressive strength 29.34MPA.

Table 4.7.3 DLC + FA 15%

CUBE NO	3 DAY	7 DAY	28 DAY
1	4.45	7.40	29.60
2	4.66	7.35	29.40
3	5.14	7.14	29.96
4	4.55	7.49	28.56
5	4.87	7.30	29.28

Fig: 4.7.3 - 3 DAY RESULT

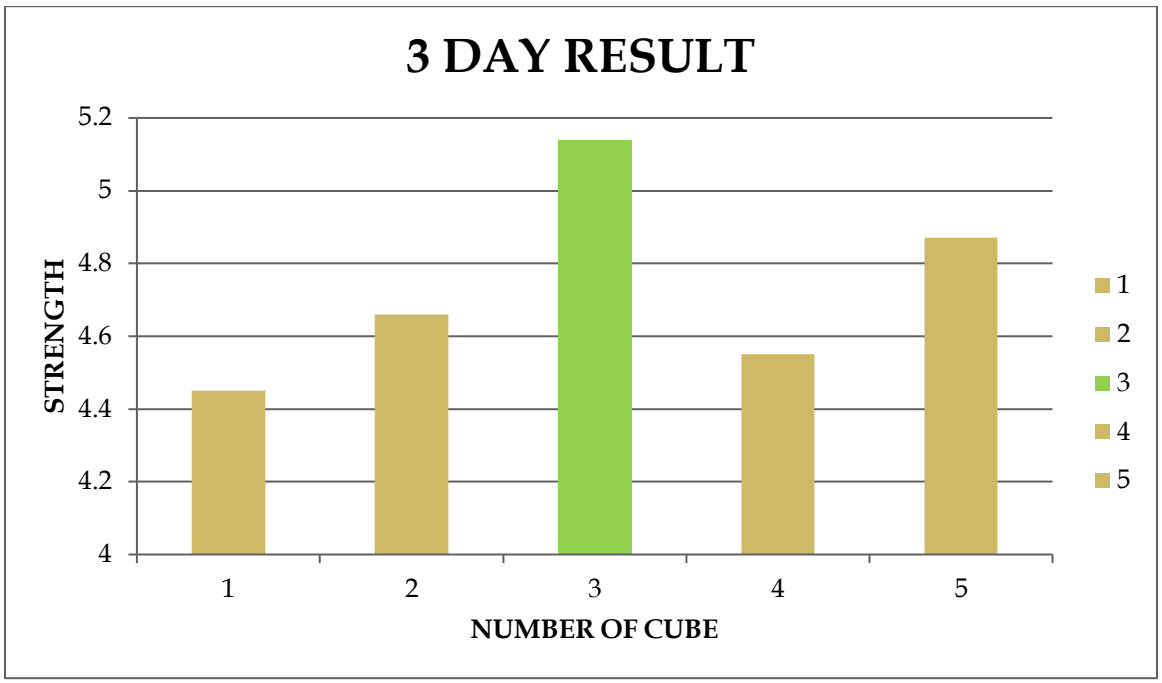


Fig: 4.7.3 - 7 DAY RESULT

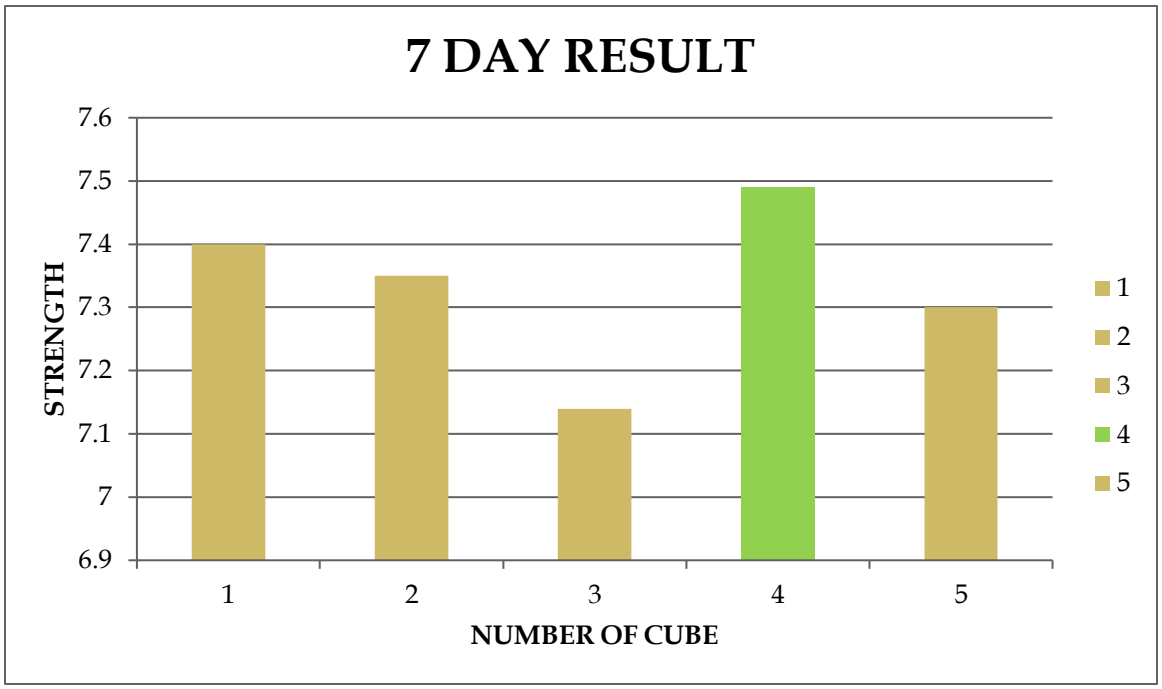
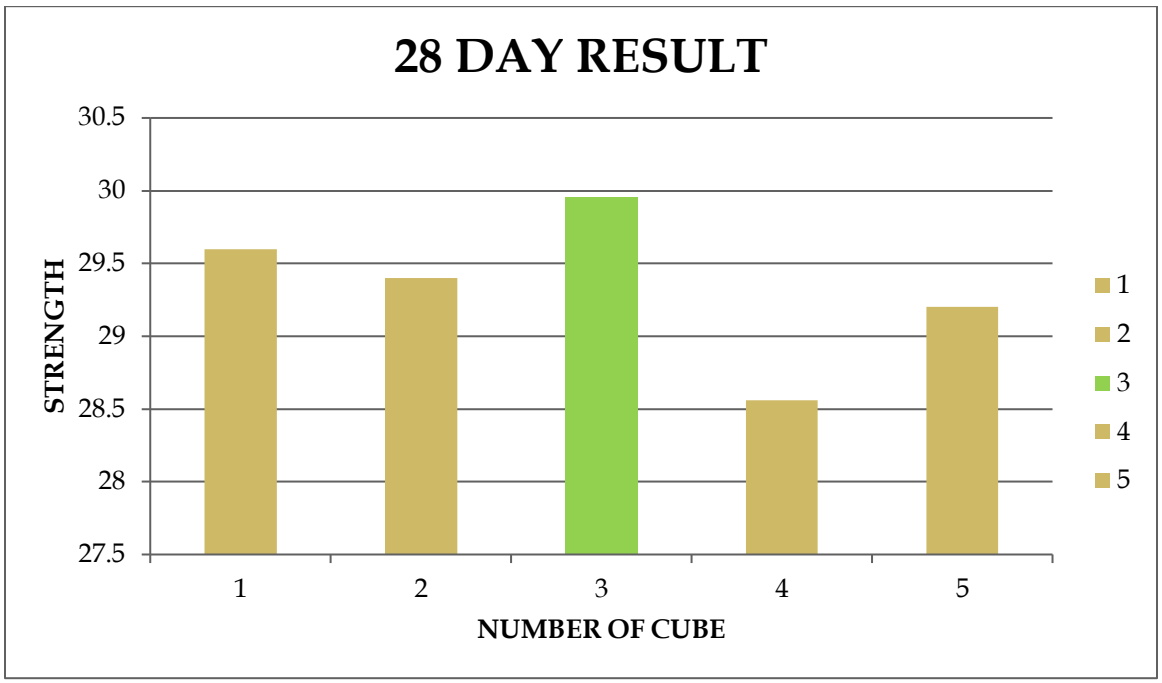


Fig: 4.7.3 – 28 DAY RESULT



4.7.4] COMPRESSIVE STRENGTH TESTS OF DLC + 15% FLY ASH + 10% RCA:

The compressive strength at 3days of DLC Grade of concrete average compressive strength 4.74MPA.

The compressive strength at 7 days of DLC Grade of concrete average compressive strength 8.62MPA.

The compressive strength at 28 days of DLC Grade of concrete average compressive strength 28.1MPA.

Table 4.7.4 DLC + F1 15%+ RCA 10%

CUBE NO	3 DAY	7 DAY	28 DAY
1	4.3	7.30	30.60

2	4.5	7.56	22.80
3	4.9	10.9	32.70
4	5.2	9.00	27.00
5	4.8	8.40	25.2

Fig: 4.7.4 - 3 DAY RESULT

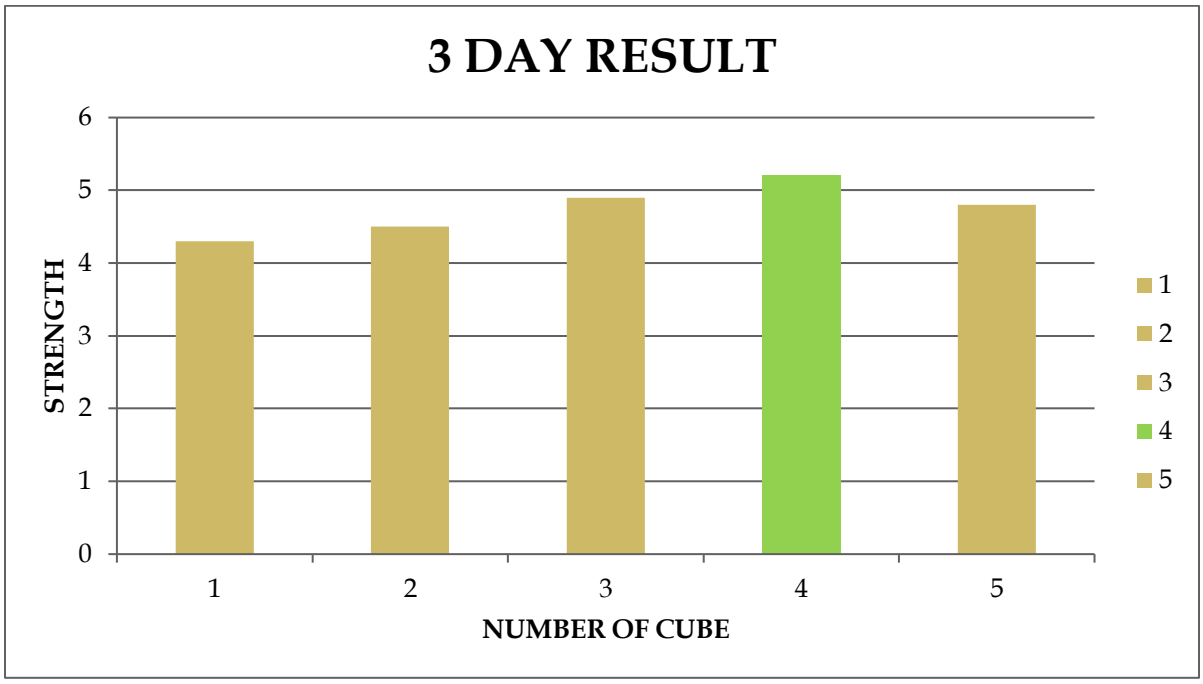


Fig: 4.7.3 – 7 DAY RESULT

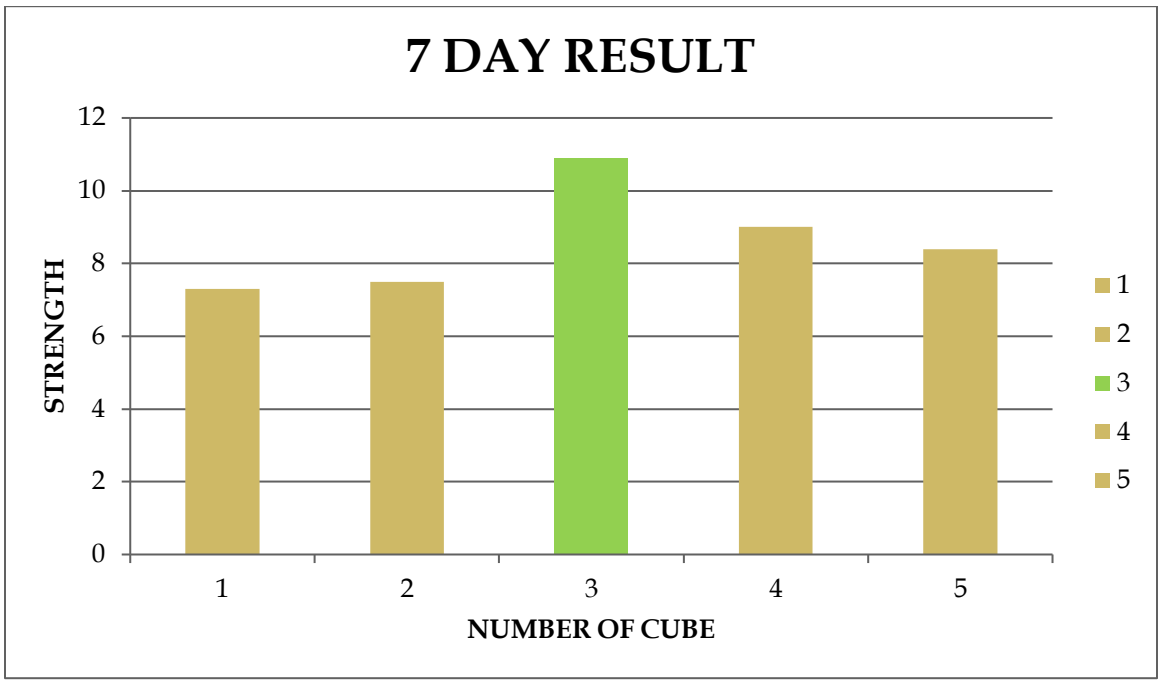
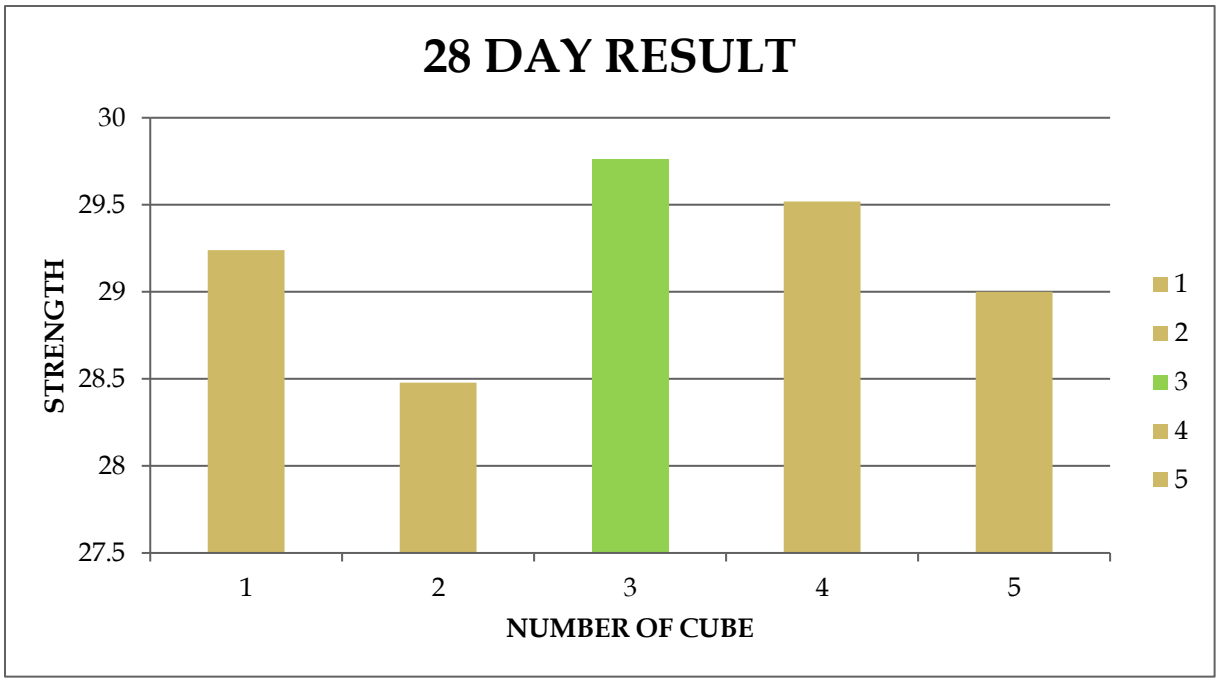


Fig: 4.7.3 - 28 DAY RESULT



4.7.5] COMPRESSIVE STRENGTH TESTS OF DLC + 15% FLY ASH + 20% RCA:

The compressive strength at 3days of DLC Grade of concrete average compressive strength 4.78MPA.

The compressive strength at 7 days of DLC Grade of concrete average compressive strength 9.48MPA.

The compressive strength at 28 days of DLC Grade of concrete average compressive strength 30.6MPA.

Table 4.7.5. DLC + FA 15% + RCA 20%

CUBE NO	3 DAY	7 DAY	28 DAY
1	4.4	9.2	32.9
2	4.7	7.8	22.8
3	5.5	8.5	25.5
4	4.5	10.6	31.5
5	4.8	11.3	40.5

Fig: 4.7.5 - 3 DAY RESULT

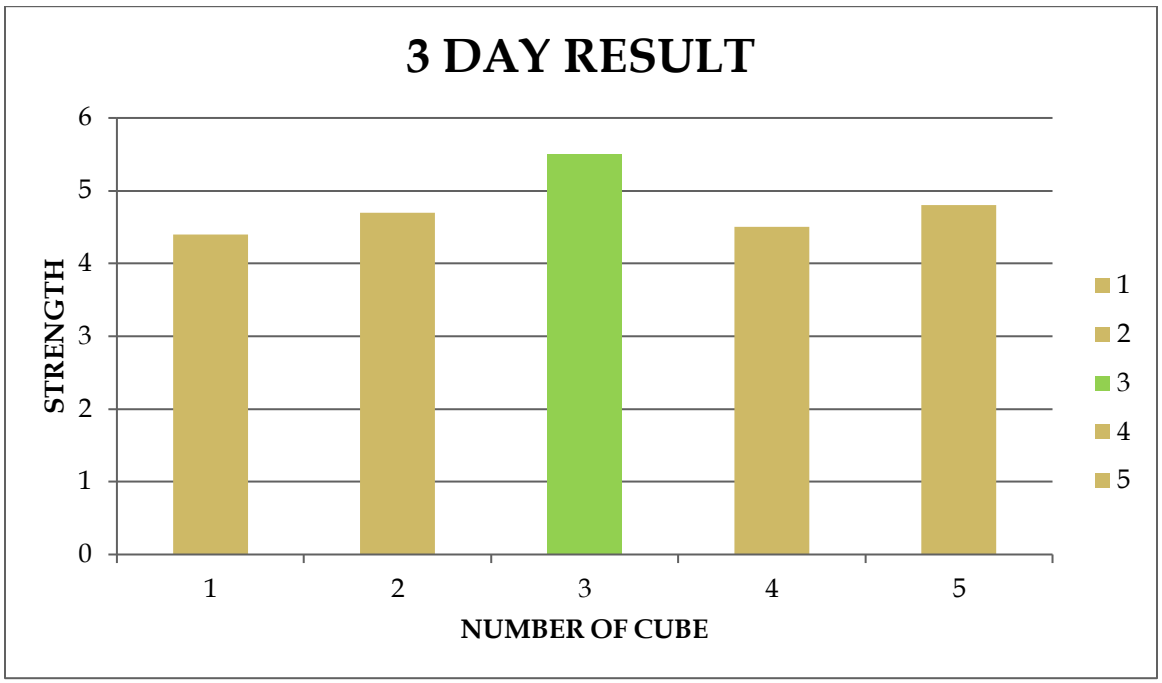


Fig: 4.7.5 – 7 DAY RESULT

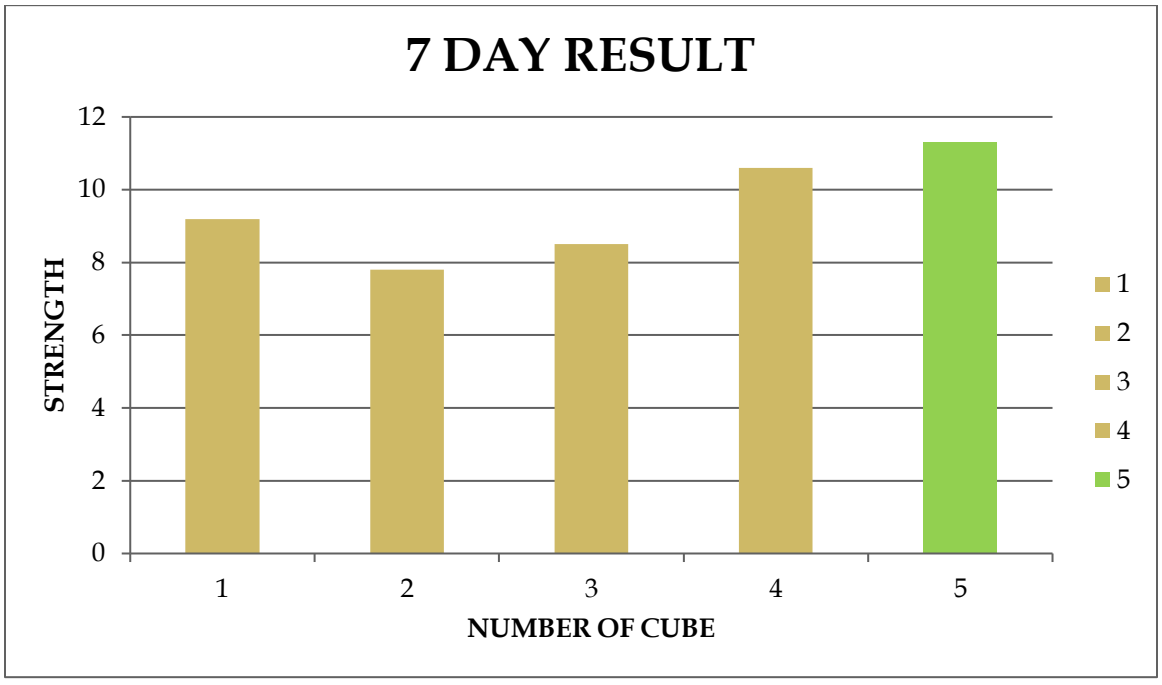
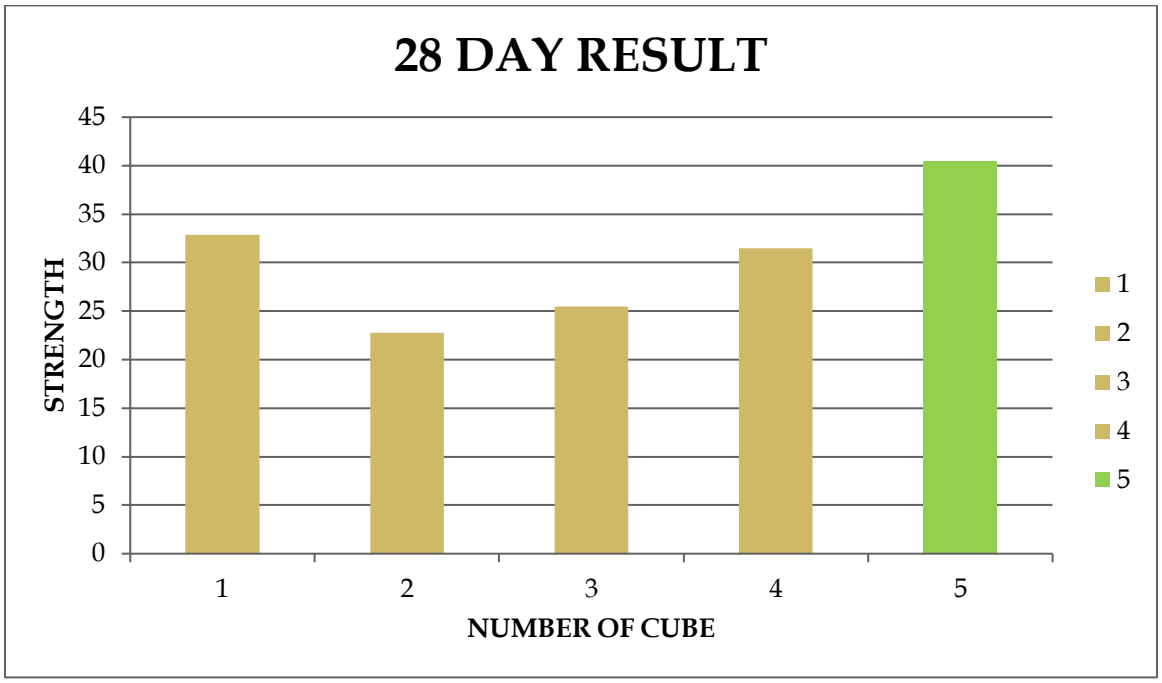


Fig: 4.7.5 – 28 DAY RESULT



4.7.6] COMPRESSIVE STRENGTH TEST OF DLC + 15% FLY ASH + 30% RCA:

The compressive strength at 3days of DLC Grade of concrete average compressive strength 4.66MPA.

The compressive strength at 7 days of DLC Grade of concrete average compressive strength 9.43MPA.

The compressive strength at 28 days of DLC Grade of concrete average compressive strength 28.59MPA.

Table 4.7.6 DLC + FA 15% + RCA 30%

CUBE NO	3 DAY	7 DAY	28 DAY
1	4.5	10.9	30
2	4.9	11	31.44
3	5.2	9.6	27.54
4	4.7	7.4	29.31
5	4.3	8.2	24.66

Fig: 4.7.6 - 3 DAY RESULT

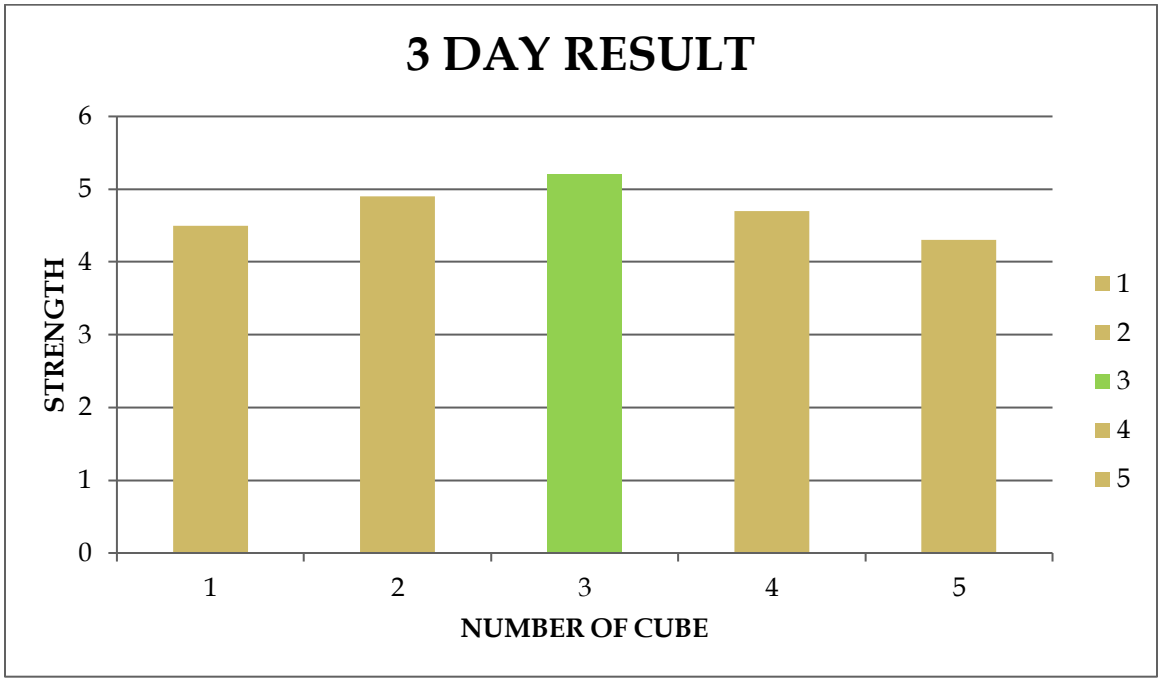


Fig: 4.7.6 – 7 DAY RESULT

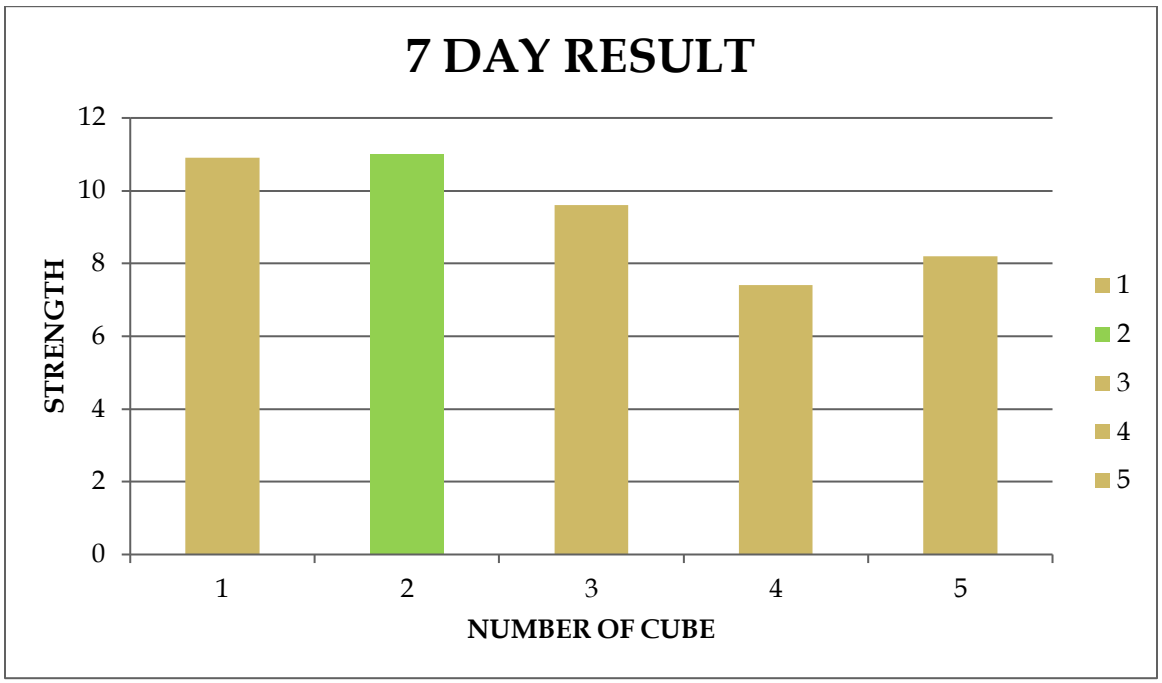
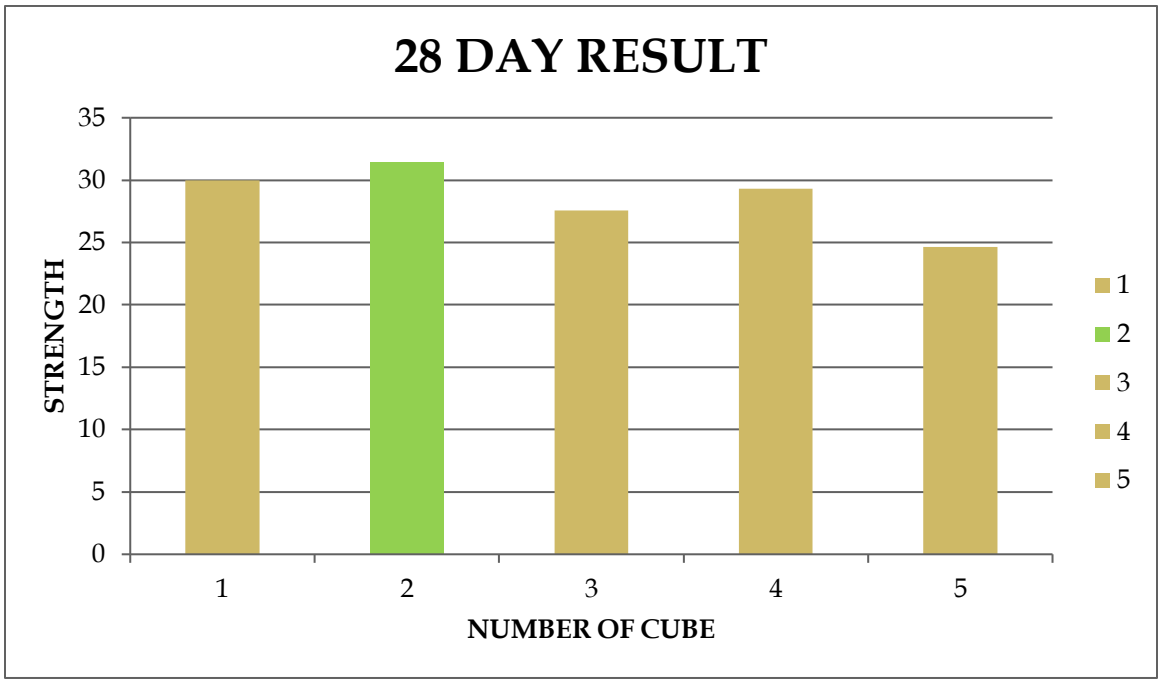


Fig: 4.7.6 - 28 DAY RESULT



4.7.7] SUMMARY OF RESULT 3,7 & 28 DAYS

Table 4.7.7 Results Table

CUBE NAME	CUBE NO	RESULTS (MPA)		
		3 DAY	7 DAY	28 DAY
DLC	01	4.73	7.34	29.24
	02	4.20	7.12	28.48
	03	3.69	7.44	29.77
	04	4.57	7.38	29.52
	05	4.66	7.25	29.00
DLC + FA 15%	01	4.45	7.40	29.60
	02	4.66	7.35	29.40
	03	5.14	10.9	29.96
	04	5.44	9.00	28.56
	05	4.87	8.40	29.28
DLC + FA 15% + RCA 10%	01	4.30	7.30	30.60
	02	4.50	7.56	22.80
	03	4.89	10.9	32.70
	04	5.23	9.99	27.00
	05	4.95	8.40	25.20

DLC + FA 15% + RCA 20%	**01**	**4.40**	**9.29**	**32.90**
	02	**4.77**	**7.80**	**22.80**
	03	**5.50**	**8.55**	**25.50**
	04	**4.55**	**10.69**	**31.50**
	05	**4.89**	**11.33**	**40.50**
DLC + FA 15% + RCA 30%	01	4.49	10.90	30.00
	02	4.90	11.00	31.44
	03	5.10	9.60	27.54
	04	4.57	7.40	29.31
	05	4.33	8.20	24.66

CHAPTER 5

ECONOMIC ANALYSIS

ECONOMIC ANALYSIS FOR DLC & DLC+FA+RC

Table4.8 Economic Analysis

MATERILAS	**QUANTITY**				**PRICE**		**COST**	
	DLC		DLC+FA+RCA				DLC	DLC+FA+ RCA
CEMENT	4.32	BAG	3.70	BAG	400/-	BAG	1728.0	1480.00
SAND	0.612	KG	0.612	KG	850/-	MT	520.0	520.00
C.A (20mm)	0.594	KG	0.238	KG	800	MT	475.20	190.00
C.A (10mm)	0.594	KG	0.238	KG	780/-	MT	463.32	185.64
Fly ash	0.00	KG	0.023	KG	1000/-	MT	0.00	22.50
RCA	0.00	KG	0.0712	KG	0.00/-	MT	0.00	0.00
						COST	**3186.72**	**2398.74**
						DIFFERENT COST:	**787.98/-**	

CHAPTER 6

CONCLUSION

- It is observed from the testing physical properties of Aggregate result is satisfied for IRC guidelines.
- It is observed from the testing physical properties of Cement result is satisfied for IRC guidelines.
- It is observed various percentage of water content for mix design but maximum water content of 6.5 because its maximum dry density 2350 kg/cm^3.
- It is well observed the compressive strength of DLC for 7 day result of 7.30 MPA
- It is well observed the compressive strength increase is noticed in addition of FA 15% & RCA 10%, by weight of respectively cement and coarse aggregate in all the mixes. The result of 7 DAY is 7.34 MPA.
- It is well observed the compressive strength increase is noticed in addition of FA 15% & RCA 10%, by weight of respectively cement and coarse aggregate in all the mixes. The result of 7 DAY is 8.62 MPA.
- It is well observed the compressive strength increase is noticed in addition of FA 15% & RCA 20%, by weight of respectively cement and coarse aggregate in all the mixes. The result of 7 DAY is 9.48MPA.
- It is well observed the compressive strength increase is noticed in addition of FA 15% & RCA 30%, by weight of respectively cement and coarse aggregate in all the mixes. The result of 7 DAY is 9.43 MPA.
- In this observed compare to pure DLC & DLC added mix FA & RCA. That most economical mix design is DLC+FA+RCA.

REFEREANCE

RESEARCH PAPER:

1] DivyaVishnoi, Rajan Choudhary, Mukul Sharma, YogeshKumar Sharma, Vinod Meena. Use of Recycled Aggregate and Fly Ash in Concrete Pavement, IJOF, JUNE-2016

2] Vallabuni Vinay Kalyan , P.Sandeep Chandra, Study and Analysis of Rigid Pavements Using Fly Ash, IJCE, February 2018

3] Mr.Nagesh Tatoba Suryawanshi, Mr. Samitinjay S. Bansode Use of Eco-Friendly Material like Fly Ash in Rigid PavementConstruction, IJOF, December 2012.

4] Rakesh Soni, Behavior of FLY ASH in Cement-Concrete Pavement, GRD, AUGUST 2015

5] Anjali Yadav , Nikhil Kumar Yadav Study of Fly Ash Cement Concrete Pavement, ELSEVIER, FEBRUARY 2017

6] Er. Dalvir Singh, Nakul Hans, BLENDING OF RECYCLED CONCRETE AGGREGATES FOR USE IN BASE COURSE CONSTRUCTION, IJCE, MAY 2019

7] Keerthi Gowda B S, A study on slump and compressive strength of recycled aggregates embedded concrete, IJOF, AUGUST 2018

8] Alaa Hadi Hameed Hassoon, Jalal Taqi Shaker Al-Obaedi , THE USE OF RECYCLED CONCRETE AS A SUBBASE LAYER FOR HIGHWAY, ELSEVIER, January 2014.

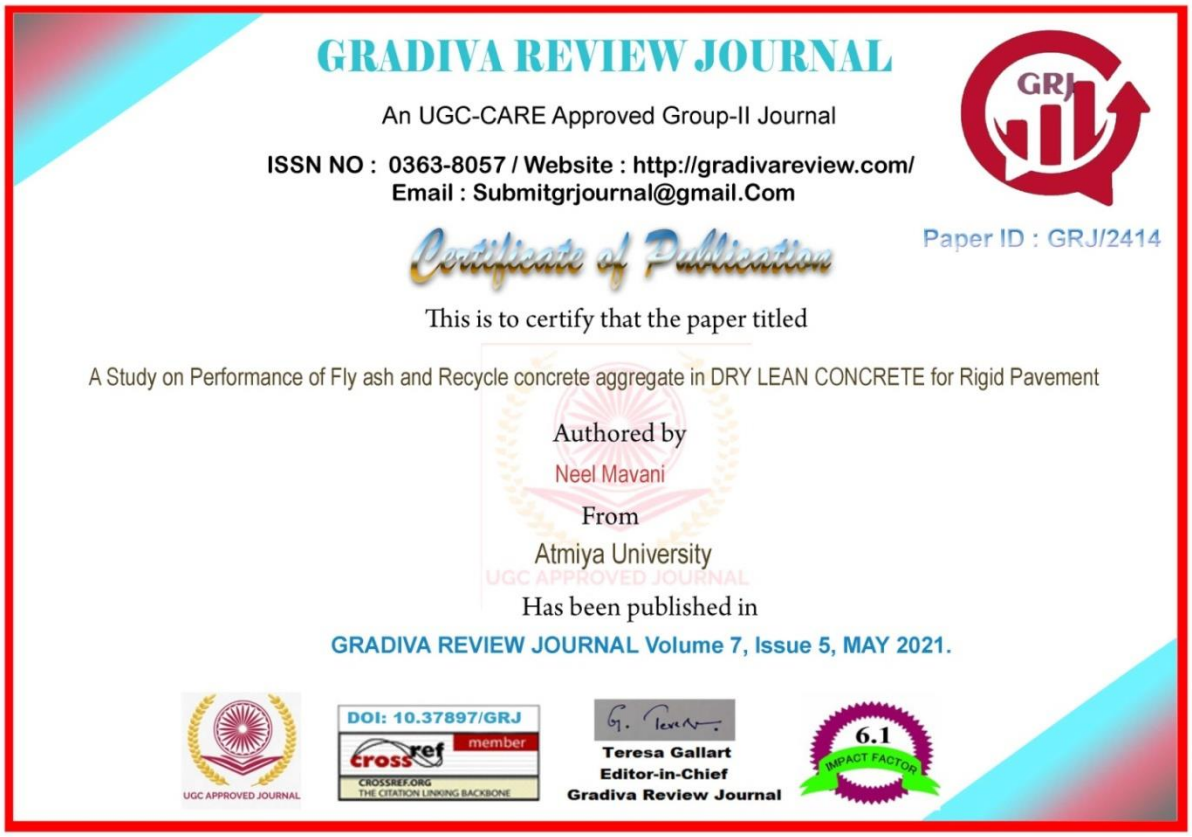
MANUALS:

9] IRC:SP:49-2014 GUIDELINESFORTHE USE OFDRY LEAN CONCRETEAS SUB-BASE FOR RIGID PAVEMENT.

10] MoRTH Specification

ANNEXURE – A

RESEARCH PAPER CERTIFICATE



GRADIVA REVIEW JOURNAL

An UGC-CARE Approved Group-II Journal

ISSN NO : 0363-8057 / Website : http://gradivareview.com/
Email : Submitgrjournal@gmail.Com

Paper ID : GRJ/2414

Certificate of Publication

This is to certify that the paper titled

A Study on Performance of Fly ash and Recycle concrete aggregate in DRY LEAN CONCRETE for Rigid Pavement

Authored by

Neel Mavani

From

Atmiya University

Has been published in

GRADIVA REVIEW JOURNAL Volume 7, Issue 5, MAY 2021.

UGC APPROVED JOURNAL

DOI: 10.37897/GRJ

crossref member

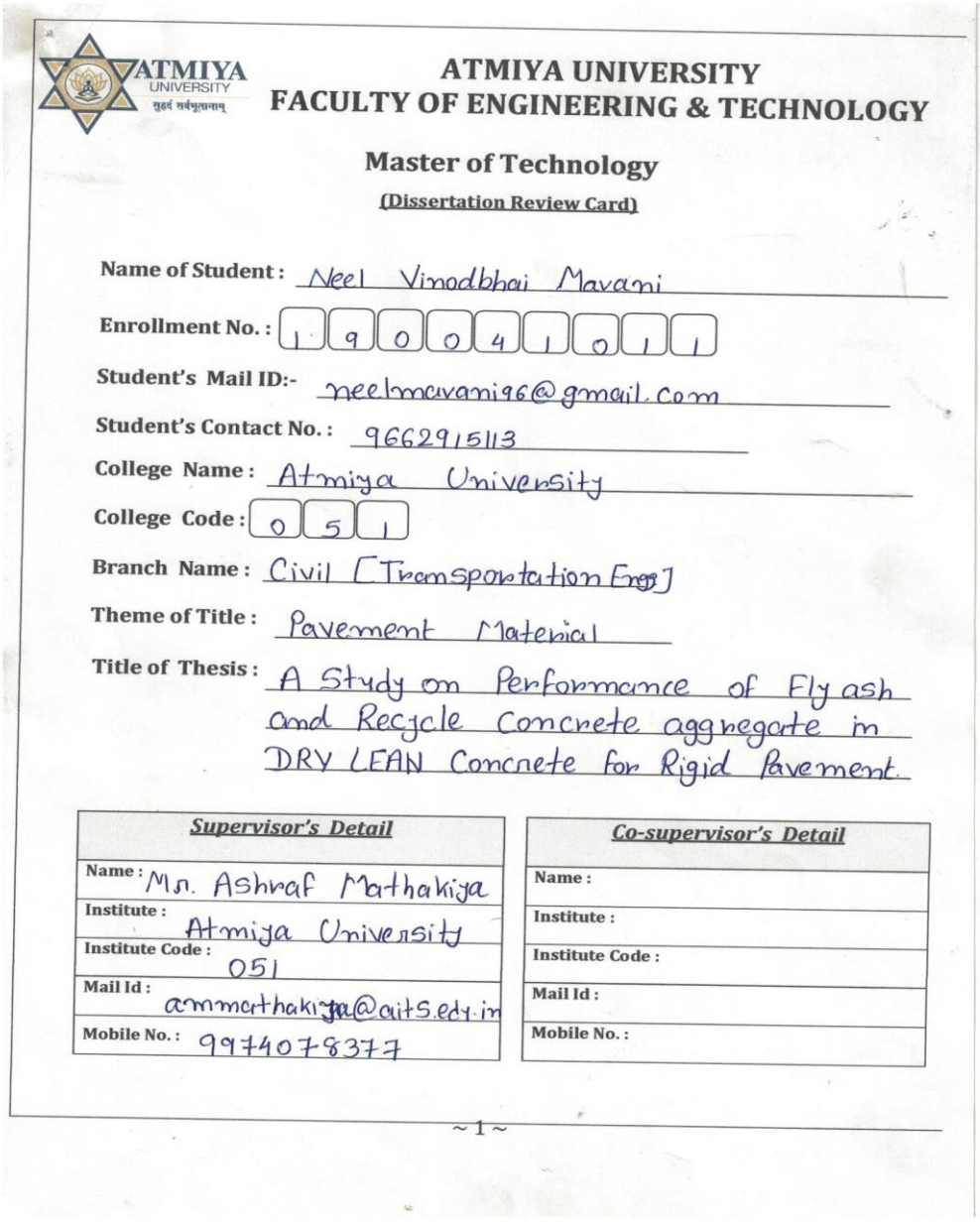
CROSSREF.ORG
THE CITATION LINKING BACKBONE

Teresa Gallart
Editor-in-Chief
Gradiva Review Journal

6.1
IMPACT FACTOR

ANNEXURE – B

REVIEW CARD



ATMIYA UNIVERSITY
सुहृदं सर्वभूतानाम्

ATMIYA UNIVERSITY
FACULTY OF ENGINEERING & TECHNOLOGY

Master of Technology

(Dissertation Review Card)

Name of Student : Neel Vinodbhai Mavani

Enrollment No. : 1 9 0 0 4 1 0 1 1

Student's Mail ID:- neelmavani96@gmail.com

Student's Contact No. : 9662915113

College Name : Atmiya University

College Code : 0 5 1

Branch Name : Civil [Transportation Engg]

Theme of Title : Pavement Material

Title of Thesis : A Study on Performance of Fly ash and Recycle Concrete aggregate in DRY LEAN Concrete for Rigid Pavement.

Supervisor's Detail	
Name :	Mr. Ashraf Mathakiya
Institute :	Atmiya University
Institute Code :	051
Mail Id :	ammathakiya@aits.edu.in
Mobile No. :	9974078377

Co-supervisor's Detail	
Name :	
Institute :	
Institute Code :	
Mail Id :	
Mobile No. :	

~1~

❖ Comments For Internal Review ( ) (Semester 3)

Exam Date : 9/2/21

Sr. No.	Comments given by Internal review panel (Please write specific comments)	Modification done based on Comments
1.	Give Slide number	done
2.	Give proper formating	
3.	Change scope of Study & objectives.	
		(Guide Sign.)

Particulars	Internal Review Panel	
	Expert 1	Expert 2
Name :	Mr. Mayursinh Jadeja	Mr. Ashraf Makhakiya
Institute :	Atmiya University	Atmiya University
Institute Code :	051	051
Mobile No. :	7874800084	9974078377
Sign :		

Particulars	Internal Guide Details	
	Expert 1	Expert 2
Name :	Mr. Ashraf Makhakiya	
Institute :	Atmiya University	
Institute Code :	051	
Mobile No. :	9974078377	
Sign :		

~ 2 ~

Enrollment No. of Student : 1 9 0 0 4 1 0 1 1

❖ Comments of Dissertation Phase-1 ( ) (Semester 3)

Exam Date : 9 / 2 / 2021

Title : A Study on Performance of Fly ash and Recycle concrete aggregate in Dry Lean Concrete for Rigid Pavement.

1. Appropriateness of title with proposal. (Yes/ No) _____

2. Whether the selected theme is appropriate according to the title ? (Yes / No) _____

3. Justify rational of proposed research. (Yes/ No) _____

4. Clarity of objectives. (Yes/ No) _____

~ 3 ~

Enrollment No. of Student : 190041011

Exam Date : 9 / 2 / 21

Sr. No.	Comments given by External Examiners (DP-I) : (Please write specific comments)	Modification done based on Comments
1.)	Need to look out for compacting DLC mould.	done
2.)	Include gradation chart in presentation.	
3.)	Study other physical parameters of DLC. Need to refer latest IRC guidelines.	

(Internal Guide Sign.)

- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

Please tick on any on. If approved/approved with suggession then put marks ≥ 50 %.

➢ ***Details of External Examiners :***

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1				
Expert 2				

~ 4 ~

Enrollment No. of Student : 1 9 0 0 4 1 0 1 1

❖ Comments of Mid Sem Review ( ) (Semester 4)

Exam Date : 18 / 4 / 2021

Sr. No.	Comments given by External Examiners : i) The appropriateness of the major highlights of work done; State here itself if work can be approved with some additional changes. ii) Main reasons for approving the work. iii) Main reasons if work is not approved.	Modification done based on Comments
1.]	Add in Objective regarding the cost optimization if time permits to complete the same.	done
2.]	Mention the conclusions considering the objectives.	
3.]	Complete the pending experimental work & the dissertation write up as per University guide lines.	

Internal Guide Sign.

- *Approved* [✓]
- *Approved with suggested recommended changes* [ ]
- *Not Approved* [ ]

Please tick on any on. If approved/approved with suggession then put marks ≥ 50 %.

➢ ***Details of External Examiners :***

Particulars	*Full Name*	*University / College Name & Code*	*Mobile No.*	*Sign.*
Expert 1				
Expert 2				

ANNEXURE – C

PLAGIARISM REPORT

Curiginal

Document Information

Analyzed document	neel mawani (5).pdf (D110483116)
Submitted	7/15/2021 1:27:00 PM
Submitted by	Dr. Sheetal Tank
Submitter email	librarian@atmiyauni.ac.in
Similarity	3%
Analysis address	librarian.atmiya@analysis.urkund.com

Sources included in the report

W	URL: https://www.slideshare.net/rakeshchoudhary129/rigid-and-flexiable-pavement-of-highway-project-bbjr-report Fetched: 7/4/2020 2:18:12 PM	3
W	URL: https://es.slideshare.net/sushendhukc/partial-replacement-of-fine-aggreggate-by-copper-slag-and-cement-by-fly-ash Fetched: 10/10/2019 7:16:48 PM	2
W	URL: https://vardhaman.org/wp-content/uploads/2019/10/Concrete-Highway-Engineering-lab-1.pdf Fetched: 6/29/2021 7:59:54 AM	1
W	URL: http://www.atri.edu.in/images/pdf/departments/CT%20Lab%20Manual.pdf Fetched: 5/19/2021 4:46:06 PM	1
W	URL: https://jecassam.ac.in/wp-content/uploads/2018/10/Transportation-Engg.-LABORATORY_MANUAL.pdf Fetched: 6/21/2020 1:57:33 PM	1
W	URL: https://businessdocbox.com/Metals/76669724-Rajalakshmi-engineering-college-ce-concrete-highway-engg-lab.html Fetched: 12/3/2020 9:53:22 PM	1
SA	**Atmiya University / Rohit Makwana word file-converted (1).pdf** Document Rohit Makwana word file-converted (1).pdf (D110483117) Submitted by: librarian@atmiyauni.ac.in Receiver: librarian.atmiya@analysis.urkund.com	2
W	URL: https://sjce.ac.in/wp-content/uploads/2018/01/Concrete-Lab-Manual.pdf Fetched: 1/4/2020 8:14:25 AM	1