

A PARTIAL REPLACEMENT OF COARSE AGGREGATE BY USING RUBBER CHIPS IN CONCRETE MIX DESIGN

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in
Civil Engineering

By

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade “A++” by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Vishnu Datha .B (Register No: 40200015), Kandula Manoj (Register No: 40200704), Bharath.R (Register No: 40200710) who carried out the project entitled "Experimental investigation of areca fibre reinforced concrete for enhancement of concrete properties "under our supervision from June 2023 to October 2023.

Internal Guide

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Submitted for Viva voice Examination held on 05/04/24

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DECLARATION

We Vishnu Datha.B (Register No: 40200015), Kandula Manoj (Register No:40200704), Bharath.R (Register No:40200710) here by declare that the Project Report entitled "Experimental investigation of areca fibre reinforced concrete for enhancement of concrete properties" done by us under the guidance of Dr. P. ESHANTHINI is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

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DATE: 05/04/24

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ABSTRACT

This experimental study is conducted to analyse the behaviour characteristics of rubberized concrete where tire rubber is partially replaced with coarse aggregate. It is estimated that more than 270 million scrap-tires are arising each year. In India the disposal of waste tire in landfills is a major issue handled by local municipalities and government sectors. This waste being non-biodegradable possess severe fire, environmental and health risks. A side from tire derived fuel, the most promising use of tires in engineering applications as artificial reefs, erosion control and aggregates for asphalt and concrete. The use of recycled tire rubber as partial aggregate in concrete has great potential to positively affect the properties of concrete in a wide spectrum. Concrete is one of the most popular construction materials. Due to this fact, the construction industry is always trying to increase its uses and applications and improving its properties, while reducing cost. M30 grade concrete has been chosen as the reference concrete specimen. Scrap tire rubber chips has been used as coarse aggregate with the replacement of conventional coarse aggregate.

LIST OF SYMBOLS AND ABBREVIATIONS

ACRONYMS

EXPANSIONS

g	SPECIFIC GRAVITY
R.C.C	REINFORCED CEMENT CONCRETE
I.S METHOD	INDIAN STANDARD METHOD
%	PERCENTAGE
R.C	RUBBER CHIP

CHAPTER -1

INTRODUCTION

1.1 GENERALS

Infrastructure development across the world created demands for construction material. Concrete is the premier civil engineering material. Concrete manufacturing involves consumption of ingredients like cement, aggregates, water & admixtures. Among all the ingredients, aggregates form the major parts. Two billion of aggregate are produced each year in the United States. Production is expected to increase to more than billion tons per year by the year similarly; the consumption of the primary aggregate was 110 million tons in the UK in year 1960 and reached nearly 275 million tons by 2006. Use of natural aggregates in such a rate leads to a question about the preservation of natural aggregates sources. In addition, operation associated with aggregates extraction and processing is the principal cause's environmental concern. In light of this in the contemporary civil engineering construction, using alternative materials in place of natural aggregate in concrete production makes concrete as sustainable and environmentally friendly construction material. Rubber chips being a hard and not easily degrade material if crushed to size of sand can be a potential material to substitute sand. At present, Rubber chips has also been burnt to produce charcoal and activated carbon for food and carbonated drink and filtering mineral water use. However, the Rubber chips is still underutilized in some places. The chemical composition of the Rubber chips is. It contains styrene butadiene, isoprene(C_5H_8), neoprene, styrene(C_8H_8).

Concrete is an artificial material similar in appearance and properties to some natural lime stone rock. It is a manmade composite, the major constituent being natural aggregate such as gravel, or crushed rock, sand and fine particles of cement powder all mixed with water. The concrete as time goes on through a process of hydration of the cement paste, producing a required strength to withstand the load. The use of Rubber chips as coarse aggregate in concrete has never been a usual practice among the average citizens, particularly in areas where light weight concrete

is required for non-load bearing walls, non-structural floors, and strip footings. Although coarse aggregate usually takes about 50% of the overall self-weight of concrete.

Towards exploring new ingredients are required for producing sustainable and environment friendly construction materials. The recycling of solid wastes in civil engineering applications has undergone considerable development over a very long time. The utilization of fly ash, blast furnace slag, recycled aggregates, red mud, Kraft pulp production residue, waste tea, etc., in construction materials shows some examples of the success of research in this area. Similarly, the recycling of hazardous wastes for use in construction materials and the environmental impact of such practices have been studied for many years. This is considerable one of the main environmental challenges the world is facing because waste rubber is not easily biodegradable even after a long period of land fill healing. One of the solutions suggested was the use of tyre rubber as partial substitution of coarse aggregate in cement-based materials. Rubber chips represents more than 60% of the domestic waste volume. Rubber chips, which presents serious disposal problems for local environment, is an abundantly available agricultural waste from local Rubber industries. In developing countries where abundant agricultural and industrial wastes are discharged, these wastes can be used as potential material or replacement material in the construction industry. This will have the double advantage of reduction in the cost of construction material and also as a means of disposal of wastes.

RUBBER CHIPS AS COARSE AGGREGAT

The concrete obtained using Rubber chips aggregates satisfies the minimum requirements of concrete. Concrete using Rubber chips aggregates resulted in acceptable strength required for structural concrete. Rubber chips may offer itself as a coarse aggregate as well as a potential construction material in the field of construction industries and this would solve the environmental problem of reducing the generation of solid wastes simultaneously. The Rubber chips-cement composite is compatible and no pre-treatment is required

The Rubber chips are obtained from a local Rubber field. They are sun dried for 1 month before being crushed manually. The crushed materials are later

transported to the laboratory where they were washed and allowed to dry under ambient temperature for another 1 month. Rubbers show a wide diversity in size, weight, shape and colour, depending on genetic variety and maturity of the nut at harvest. The particle sizes of the Rubber chips range from 5 to 20 mm.

1.2 BACK GROUND

The development of construction industry now-a-days is increasing rapidly because of that it will reduce the number of natural resources in our country and many of the natural resources will be sacrificed to obtain a source of materials for construction. To save the environment from this loss because of the developmental activities, we need to think of suitable materials that can be used to replace these materials for pavement construction. Environment must be sustained and protected by us for next generate. Now- a- days, there are so many researches that has been done to improve and upgrade the materials for concrete properties to be enhanced. The utilization of various natural and waste materials as a replacement for producing the concrete can give a lot of benefits to the humans and environment. Rubber chips is some of the alternative that can be used to replace with coarse aggregates in the preparation of concrete. As major natural resource Rubber chips can be obtained abundantly at free of cost.

In research conducted by Olanipekun on the comparative cost analysis and strength characteristics of concrete by using crushed granular Rubber and palm kernel as substitute for conventional coarse aggregate in the following ratios: 0%, 25%, 50%, 75% and 100% with mix ratios (1:1:2 and 1:2:4). The total 320 cubes of size 100x100x100mm were casted, tested and their physical and mechanical properties were determined.

The RC were scarped and substituted for conventional coarse aggregates in gradations of 0%, 25%, 50%, 75% and 100%. Two mix ratios (1:1:2) and (1:2:4) were used respectively. The compressive strength of the concrete decreased as the percentage of the shells increased in the two mix ratios.

1.3 PROBLEM STATEMENT

Now a days the use of Rubber chips for concrete production has increased rapidly due to increase in number of construction industries. The increase in rate of production of concrete leads to increase in demand for raw materials which in turn leads to price hike of raw materials. Also, this demand may be due to scarcity in availability of raw materials mostly the Rubber chips. So, by using the Rubber chips which is abundantly available for the low volume road construction, much of the economy of construction could be saved.

So, by using Rubber chips as a coarse aggregate replacement in preparation of concrete would save our earth for a sustainable environment. It also helps to save money and utilization of waste material like Rubber chips from being deployed for construction.

1.4 SIGNIFICANCE OF STUDY

From the study, it is crucial to know whether Rubber chips can be used for concrete production. There are many materials in the world that can be categorized as excessive materials including Rubber chips. This should be a crucial step in the development of construction industry to be more realistic and flexible. Beneficial uses of industrial by products, in general promote sustainable development, green building and environmental responsibility by reducing the quality of materials such as natural aggregates that must be mined. Natural aggregates are becoming increasingly scarce and their production is environment.

1.5 APPLICATIONS OF RUBBER CHIPS AS COARSE AGGREGATE IN CONCRETE

Concrete: Far more concrete is produced than any other man-made material. Annual production represents one ton for every person on the planet. It is incredibly versatile, and is used in almost all major construction projects. Aggregates are used in concrete for very specific purposes. Aggregates typically make up about 60 % to 75 % of the volume of a concrete mixture, and as they are the least expensive of the materials used in concrete, the economic impact is significant. 80 % of buildings CO₂ emissions are generated not by the production of the materials used in its construction, but in the electric utilities of the building over its life-cycle. Compared to other comparable building materials, concrete is less costly to produce and remains extremely affordable.

Use of waste in concrete: A research effort has been done to match society's need for safe and economic disposal of waste materials. The use of waste materials saves natural resources and dumping spaces, and helps to maintain a clean environment. The current concrete construction practice is thought unsustainable because, not only it is consuming enormous quantities of stone, sand and drinking water, but also two billion tons a year of Portland cement, which releases green-house gases leading to global warming.

The three basic needs of man are food, clothing and shelter. Civil Engineer has relevance with all basic needs of man directly or indirectly. Man has progressed a lot in developing the method of constructing shelter. Initially man used to stay in huts and time passed it developed into house that is load bearing. In this constructed environment, the rising cost of building construction materials is the factor of great concern. Moisture retaining and water absorbing capacity of Rubber chips are more compared to conventional aggregate. Using alternative material in place of natural aggregate in concrete production makes concrete as sustainable and environment friendly Construction material.

CHAPTER -2

2.LITERATURE SURVEY

2.1 GENERAL

The following major research project has been taken from international journals as reference to analyse the concepts for the project.

2.2 REVIEW OF THE LITERATURES

Dewanshu Ahlawat et al. (2014) were investigated the Rubber chips as partial replacement of coarse aggregate in concrete. The aim of this research is to spread awareness of using Rubber chips partial replacement of coarse aggregate in concrete and determining its compressive strength and density. The conclusions for the research are the compressive strength of the concrete decreased as the percentage shell substitution increased. Also increased in percentage replacement by Rubber chips increase workability of concrete. Rubber chips can be used as partial replacement of coarse aggregate in R.C.C. concrete.

B. Damodhara Reddy ET al. (2014) were investigated the use of Rubber chips as coarse aggregate. In this study, Rubber chips is used as light weight aggregate in concrete. The project paper aims at analysing flexural and compressive strength characteristics of with partial replacement using M30 grade concrete. The project also aims to show that Rubber chips aggregate is a potential construction material and simultaneously reduces the environment problem of solid. The conclusions for the result are, RC where 25% of the coarse aggregate is replaced, shows properties similar to the nominal mix and 50% replaced RC shows properties similar to light weight concrete which can be used as filler materials in framed structures, flooring tiles, thermal insulating concrete etc.

AmarnathYerramala_et al. (2012) from structures and materials laboratory of Civil Engineering, Intel Engineering College, Anantapur, India were Properties of concrete with Rubber chips (RC) as aggregate replacement were studied. Control concrete with normal aggregate and RC concrete with 10-20% coarse aggregate replacement with RC were made. Two mixes with RC and fly ash were also made to investigate fly ash effect on RC replaced concrete. Constant water to cementitious ratio of 0.6 was maintained for all the concrete.

In this research properties like compressive strength, split tensile strength, water absorption and moisture migration were investigated in the laboratory. The aim of this work is to provide more data on the strengths of Rubber chips concrete at different Rubber chips replacement and study the transport properties of concrete with RC as coarse aggregate replacement. The result showed that, addition of RC decreases workability and addition of fly ash either as cement replacement or aggregate replacement increases workability of RC concrete and also compressive strength and split tensile tensile strength also decreased with increase in RC replacement. Furthermore, for 28 days of curing addition of fly ash as cement replacement reduced overall split tensile strength of RC concrete and fly ash addition as aggregate replacement showed no major difference with corresponding RC replaced concrete.

Prof. M. R. Wakchaura and Mr. Prashant. A. Charan. In this study they did partial replacement of fine aggregate as crumb rubber as 0.5%, 1%, 1.5% and 2% in M25 grade of concrete and its effects on concrete properties like compressive strength, flexural strength were investigated. Results indicate that replacement of waste tyre crumb rubber particle to the fine aggregate in concrete at ratio 0.5% and 1% there is no effect on the concrete properties would occur, but there was a considerable change for 1.5% and 2% replacement ratio. Addition to this combination of glass fibre at ratio 0.4% and 0.5% addition to the weight of cement are used to regain the reduced strength due to waste tyre crumb rubber particle.

Tushar R More, Pradip D Jadhao and SM Dumme, in their study the aim was to study of waste tyre as partial replacement of fine aggregate to produce rubberized concrete in M25 grade of mix. Different partial replacement of crumb rubber i.e., 0%, 3%, 6%, 9% and 12% by volume of fine aggregate are casted and tested for flexural strength and split tensile strength. The result shows that there is a reduction in all type of strength for crumb rubber mixture, but crumb rubber content concrete become leaner due to increase in partial replacement of crumb rubber as fine aggregate i.e., 3%, 6%, 9% and 12%. Flexural strength of concrete decreases with 3% replacement of sand and further decrease in strength with the increase in percentage of crumb rubber. For split tensile strength decreases with 3% replacement of sand and further decrease in strength with the increase in percentage of crumb rubber. This is mainly due to lower bond strength between cement paste and rubber tyre aggregate.

Dr. B. Krishna Rao in this investigation he did casting and testing of cubes, cylinders, and prisms for M20 grade of concrete and added 5% and 10% of rubber fibre by volume of concrete. There the specimens are tested for compression, split tensile and flexural strength. The test results were done and noted that due to addition of rubber fibre, strength of concrete decreases, but as observing ductility is improving. Hence it is used for medium grade of concrete. The various rubberised concrete mixes were designed in accordance with standard mix design procedure for normal concrete with grade of M20. As expected, the target strength was not achieved for the mixes incorporating rubber fibre.

Sulagno Banerjee, Aritra Mandal, Dr. Jessy Robby the aim of their investigation was studies on mechanical properties of tyre rubber concrete. In their study they made a concrete of M25 grade by replacing 5%, 10%, 15%, 20% and 25% of tyre concrete with coarse aggregate and compared with regular M25 grade concrete. The properties of fresh concrete and flexural strength of hardened concrete were identified. So, they concluded that flexural strength decreases in concrete. In 7 days', flexure strength, there is not much variation seen between conventional and rubberized concrete. So, there was not much difference in strength of rubberized and conventional concrete

Nithiya P and Portchejian_G In this research paper the mix design was done as per IS:10262-2009 to achieve the target strength. The concrete mixes were made by replacing fine aggregate with 5%, 10%, 15% and 20% for M20 grade concrete. So, they found that compressive strength decreases with the replacement of crumb rubber increased and 5% replacement of crumb rubber proves exceptionally well in compressive strength and tensile strength. It also gives more strength at 28th days for 5% replacement for M20 grade of cement and split tensile strength decreases at the maximum at the maximum of 25% when crumb rubber is replaced up to 10% of fine aggregate. Thus, by replacing fine aggregate by crumb rubber safeguard the environment.

Ammar A.H. Beiram The main aim of this paper is to investigate the properties of various concrete mixtures obtained by partially substituting coarse aggregate with different volume percentages of waste tyre rubber particles (10%, 20%, and 30%). Workability, density, compression strength, splitting strength, strength of rupture, elastic modulus, impact resistance, and conductivity. The rubberized concrete mixtures have a lower density and workability than normal concrete. The compressive strength values and other characteristic strength indicated a greater drop in mechanical characteristics of rubberized concrete. the impact resistance and thermal conductivity of rubberized concrete increased by 356% and 20.6%, respectively, indicating better energy absorption, ductility indicators, and insulating properties in the values found for rubberized concrete.

Nileshwar Taak, Lovneesh Sharma In this research work, a new kind of testing method is taken into consideration for the production of precast members. Compression casting is mainly considered for the production of compressed concrete precast members. Chipped rubber is used as an option over natural coarse aggregate. The freshly prepared concrete is condensed in a specially designed mould and after that compression, casting technique is applied over it. Samples of both compressed chipped rubber as well as uncompressed chipped rubber are prepared and then tested further for compressive strength test, modulus of elasticity test, water absorption test.

K. HimaBindu, L. Narendra Naidu, S. Sri Hari, N. Ashok in this modern era, many new technologies came into existence in generation of modern construction materials. More Over Growing population, urbanization and industrialization increased the requirement cement and natural aggregates. The availability of materials of good quality are rare and also economically the price was very high. So, we need a material which was less expensive as well as eco-friendly like cow dung ash and refused rubber tube shreds. Furthermore, these aggregates have been customarily treated as inert filler in concrete but in fact, aggregates not truly inert but its physical, thermal, and chemical properties influence the concrete. □ the best management strategy preferred is recycling of rubber dregs and cowpat soot that leads to effectual utilization that minimizes environmental impact and maximize the conservation of natural resources. These materials are partially replaced by coarse aggregate and cement in manufacturing of concrete.

AvishreshthSingh, Krishna Prapoorna although multiple studies have reviewed the mechanical, durability, and acoustic characteristics of rubberized concrete (RC) mixtures, very limited studies have focused on a comprehensive collation of literature pertaining to their environmental, economic, and field implementation aspects. The various rubber treatment methodologies to enhance rubber-cement interaction were underscored and the impact of rubber aggregates on mix properties was discussed. Importantly, this state-of-the-art review identified the scope for future advancements at environmental, economic, and technical levels, which is envisioned to advance the widespread implementation of RC and pave the way for creation of an eco-efficient built environment.

2.3 INFERENCE FROM THE LITERATURE

1) It can be concluded that despite the observed lower values of the mechanical properties of concrete there is a potential large market for concrete products in which inclusion of rubber aggregate would be feasible.

- 2) If the rubber tyre aggregate was used at relatively low percentages in concrete, the amount of waste tyre rubber could be greatly reduced due to the very large market for concrete products worldwide.
- 3) Rubberized concrete is more fire resistant than regular concrete.
- 4) Rubberized concrete's compressive strength decreases as the rubber component increases.
- 5) Tyre rubber is a non-degradable substance that has a negative impact on the environment and generates several disposal concerns.
- 6) The findings demonstrate show that adding recycled crumb rubber aggregates to a standard concrete mix reduces the workability of the various mix samples.
- 7) The compressive strength of concrete containing tyre chips as a partial replacement of coarse aggregate also decreases with the percentage of tyre chips is added into concrete mixture increases.
- 8) The concrete becomes crack resistance.
- 9) It helps to produce an eco-friendly material which is not harmful for nature.
- 10) The decrease in strength is often followed by a decrease in concrete density. Compared with the regular concrete, the rubberized concrete has a light.

2.4 OBJECTIVE OF THE STUDY

The objectives of this study are:

- To determine the performance of concrete made with Rubber chips.
- To determine the feasibility of using Rubber chips as a coarse aggregate in concrete.
- To investigate the basic properties such as Flexural Strength, Compressive strength of Coarse aggregate replaced concrete by Rubber Chips in comparison with normal concrete.

- To determine the workability of freshly prepared concrete by Slump test and Compaction factor test.
- To determine the compressive strength of cubes at 7, 14, 28 days.

2.5 AIM OF THE STUDY

A Partial Replacement of Coarse aggregate using Rubber Chips in the Concrete mix design.

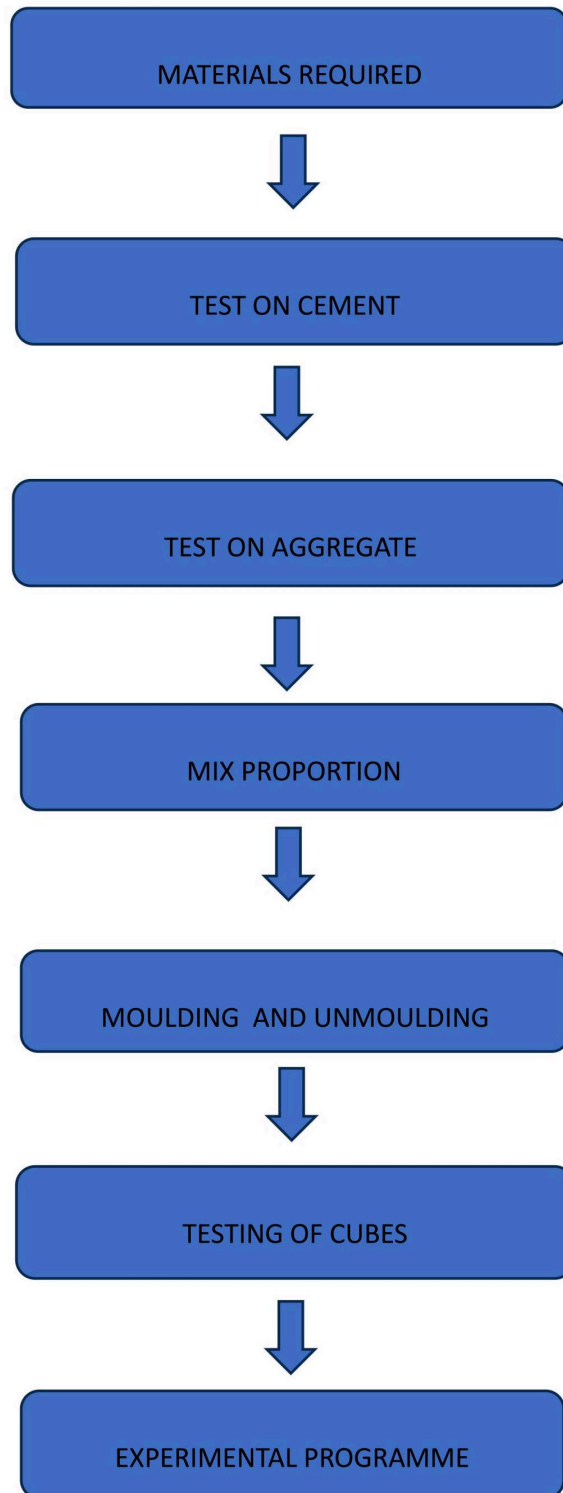
2.6 SCOPE OF THE PROJECT

The scope of the study will be focused on the performance of concrete with 20mm nominal maximum aggregate size. All laboratory works were performed at SISTK.

CHAPTER – 3

3.1 METHOD OF INVESTIGATION

The methodology of the experimental study is shown in the below figure



3.1.2 MATERIALS COLLECTED

The raw materials used in this experimentation were locally available and these included Ordinary Portland Cement as binding agent, river sand as fine aggregate and coarse aggregate and Rubber chips as a coarse aggregate. Potable tap water was used for mixing and curing throughout the entire investigation.

3.1.3 TEST ON CEMENT

Checking of materials is an essential part of civil engineering as the life of structure is dependent on the quality of material used. Following are the tests to be conducted to judge the quality of cement.

- Fineness
- Consistency
- Initial And Final Setting Time
- Soundness
- Specific gravity
- Compressive strength

3.1.4. Fineness of Cement by Dry-Sieving Method :(As Per IS-4031 part 1)

Fineness of cement is a measure of size of particle of cement. It is expressed as specific surface of cement (in sq. cm /gm.). The fineness of cement is an important factor in determining the rate of gain of strength and uniformity of quality. It is measured in terms of specific surface of the cement and can be calculated from the particle size distributions are determined by one of the air permeability. We have used IS sieve No.9 (90 microns), as per Indian standards (IS :269- 1975), the percentage of residue left after sieving a good Portland cement through IS sieve number 9, should not exceed 10%.

3.1.5. Standard Consistency of Cement

Normal or standard consistency of any given cement sample is that water content which will produce a cement paste of standard consistency. Consistency is determined by the Vicat apparatus, which measures the depth of penetration in paste of a 10 mm diameter plunger under its own weight. Normal or standard consistency is expressed as that percentage of water, by mass of dry cement, corresponding to which a specified depth of penetration in paste is achieved. For Portland cements, the normal consistency varies from 26 to 33%.

Normal consistency of cement is determined for the purpose of determining the water to cement ratios for preparing the specimens to be used for other quality tests such as times of set, compressive and tensile strengths, and soundness tests, on the same cement. For finding out initial setting time, final setting time and soundness of cement and strength a parameter known as standard consistency has to be used. The object of conducting this test is to find out the amount of water to be added to the cement to get a paste of normal consistency i.e., the paste of a certain standard solidity, which is used to fix the quantity of water to be mixed in cement before performing tests for setting time, soundness and Flexural Strength. The test is required to be conducted in a constant temperature ($27^{\circ}\text{C} \pm 2^{\circ}\text{C}$) and constant humidity (90%).

3.1.6. Initial Setting and Final Setting

In order that the concrete may be placed in position conveniently, it is necessary that the initial setting time is not too quick and after it has been laid, hardening should be rapid so that the structure can be made use of as early as possible. The initial set is a stage in the process of hardening after which any crack that may appear will not re-unite. The concrete is said to be finally set when it has obtained sufficient strength and hardness. For Portland cement, the initial setting time should not be less than 30 minutes and final setting time should not be more than 600 minutes. The setting time is influenced by temperature, humidity and quantity of gypsum in the cement.

3.1.4. Soundness of Cement (By Le-Chatelier Method)

This test indicates the liability of cement to expand sometimes after setting and causes severe cracking of failure of concrete. The chief test for soundness is the “LeChatelier” test.

Scope

To decide the suitability of given cement sample. The cement is said to be sound when the percentage of free lime and magnesia is within specified limits. These materials expand in the structure and thus the concrete or mortar also expands, causing unequal expansion of paste. Disintegration of cement compound is determined by Le- Chatelier apparatus.

3.1.5. Specific gravity of Cement

Specific gravity is normally defined as the ratio between the mass of a given volume of material and mass of an equal volume of water. One of the methods to determining the specific gravity of cement is by the use of a liquid such as water-free kerosene which does not react with cement. A specific gravity bottle may be employed or a standard Le-Chatelier flask may be used.

Scope

Specific Gravity is the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water. Water, at a temperature of 73.4°F (23°C). Specific Gravity is important for several reasons. Some deleterious particles are lighter than the “good” aggregates. Tracking specific gravity can sometimes indicate a change of material or possible contamination. Differences in specific gravity may be used to separate the deleterious particles from the good using heavy media liquid. Specific gravity is critical information for the Hot Mix Asphalt Design Engineer. Knowing the specific gravity of aggregates is also critical to the construction of water

filtration systems, slope Stabilization projects, railway bedding and many other applications.

3.1.6. Compressive Strength of Cement

Strength tests generally carried out in tension on samples of heat cement are of doubtful value as an indication of ability of cement to make concrete strong in compression. Therefore, these are largely being superseded by the mortars cube crushing tests and concrete compression tests these are conducted on standardized aggregate under carefully controlled conditions and therefore give good indications on strength qualities of cement.

Theory and Scope

The Flexural Strength of cement mortar is determined in ordered to verify whether the cement conforms to IS specifications (IS: 269-1976) and whether it will be able to develop the required Flexural Strength of concrete.

3.2. TESTS ON AGGREGATE

There are many tests which are conducted to check the quality of aggregates. Aggregates are very important components of concrete, so the quality really matters when it comes to aggregates. Various tests which are done on aggregates are listed below.

- Sieve analysis for fine aggregate
- Sieve analysis for Coarse Aggregate
- Specific gravity and water absorption of Aggregate

3.2.1. Grain Size Distribution of Fine Aggregate

To study the particle size distribution of given fine aggregate by doing sieve analysis, we need to draw the grading curve and determine the fineness modulus of the given fine aggregate sample. We have used a set of sieves consist the sizes of 4.75 mm, 2.36 mm, 1.18 mm, 600, 300 μ , 150 μ and pan. Sample should be

taken for which the sample is thoroughly mixed and spread over a clean surface. If any further reduction of quantity is required the process may be repeated. Weight retained on each sieve shall not exceed the limits specifies IS code.

3.2.2. Grain Size Distribution of Coarse Aggregate

To study the particle size distribution of given coarse aggregate by doing sieve analysis, we need to determine the fineness modulus of the given coarse aggregate sample. We have used a set of sieves consist the sizes of 40 mm, 20 mm, 12.5 mm, 4.75 mm, 2.36 mm and pan. Sample should be taken for which the sample is thoroughly mixed and spread over a clean surface. If any further reduction of quantity is required the process may be repeated. Weight retained on each sieve shall not exceed the limits specifies IS code.

Scope

This method of test covers a field procedure for the determination of particle size distribution of fine and coarse aggregates, using sieves with square openings.

Significance and Use

The gradation of fine and coarse aggregate samples must be tested to determine compliance with the specifications for these materials.

3.2.3. Aggregate Abrasion value

Abrasion testing of aggregate is of more direct application to the testing of stone aggregate for wearing. It has been found that the aggregate which shows a low loss in this test will general be hard, tough, resistant to abrasion and strong which are the desirable and necessary qualities for durability of concrete. The abrasion test on aggregate is found as per IS-2386 Part IV. The sieving operation should be conducted by mass of a lateral and vertical motion of the sieve, accompanied by the jarring action so as to keep the sample moving continuously over the surface of the

sieve. In no case shall the fragments of the sample be turned or manipulated through the sieve by hand. Use a coarse sieve first in order to minimize wear of 1.7 mm IS sieve.

3.2.5. Aggregate crushing value

This is one of the major Mechanical properties required in a concrete and road stone. This test helps to determine the aggregate crushing value of coarse aggregates as per IS: 2386 (Part IV) – 1963. The apparatus used is cylindrical measure and plunger, Compression testing machine, IS Sieves of sizes – 12.5mm, 10mm and 2.36mm. It gives a relative measure of the resistance of an aggregate sample to crushing under gradually applied compressive load.

Generally, this test is made on single sized aggregate passing 12.5 mm and retained on 10 mm IS sieve. The aggregate is placed in a cylindrical mould and a load of 40 ton is applied through a plunger. The material crushed to finer than 2.36 mm is separated and expressed as a percentage of the original weight taken in the mould. This percentage is referred as aggregate crushing value. The crushing value of aggregate is restricted to 30 percent for concrete used for roads and pavements and 45 percent may be permitted to other structures. With the aggregate crushing value 30 % or higher, the result may be anomalous and in such cases the ten percent fines value test should be determined instead.

3.2.6. Specific gravity and water absorption of fine aggregate

The specific gravity of an aggregate is defined as the ratio of mass of a given volume of sample to the mass of an equal volume of water at the same temperature. The specific gravity of fine aggregate is generally required for calculations in connection with concrete mix design, for determination of moisture content and for the calculations of volume yield of concrete. The specific gravity also gives information on the quality and properties of aggregate. Departure of specific gravity from its standard value indicted change in shape and grading. It influences the behaviour of aggregate in concrete in several important aspects. The air trapped in the aggregate should be brought to surface by rolling the flask in inclined position. All weighing should not be allowed to stick to the sides of the jar or flask. The results of

different repetitions should not differ more than 0.02 for specific gravity and 0.005 percent for absorption.

3.3 MIX PROPORTION

3.3.1 Mix Design

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible.

3.3.2 Concept of mix design

It will be worthwhile to recall at this stage the relationships between aggregate and paste, which are the two essential ingredients of concrete. Workability of the mass is provided by the lubricating effect of paste and influenced by the amount of dilution of paste. The strength of concrete is limited by the strength of paste, since mineral aggregate with rare exception, are stronger than the paste compound. Essentially the permeability of concrete is governed by the quality and continuity of the paste, since little water flows through aggregate either under pressure or by capillarity. Further, predominate contribution to drying shrinkage of concrete is that of paste. Since the properties of concrete are governed to a considerable extent by the paste, it is helpful to consider more closely the structure of the paste. The fresh paste is a suspension, not a solution of cement in water.

3.3.3 VARIABLES IN PROPORTIONING

With the given materials, the four variable factors to be considered in connection with specifying a concrete mix are:

- Water –cement ratio
- Cement content or cement – aggregate ratio
- Gradation of the aggregates
- Consistency

3.3.4 Requirements of Concrete Mix Design

The requirements which form the basis of selection and proportioning of mix ingredients are:

- The minimum Flexural Strength required from structural consideration. The adequate workability necessary for full compaction with the compacting equipment available.
- Maximum water-cement ratio and/or maximum cement content to give adequate durability for the particular site conditions
- Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

3.3.5 TYPES OF MIXES

(1) Nominal Mixes:

In the past the specifications for concrete prescribed the proportions of cement, fine and coarse aggregates. These mixes of fixed cement-aggregate ratio which ensures adequate strength are termed nominal mixes. These offer simplicity and under normal circumstances, have a margin of strength above that specified. However, due to the variability of mix ingredients the nominal concrete for a given workability varies widely in strength.

(2) Standard Mixes:

The nominal mixes of fixed cement-aggregate ratio (by volume) vary widely in strength and may result in under- or over-rich mixes. For this reason, the minimum Flexural Strength has been included in many specifications. These mixes are termed standard mixes. IS 456-2000 has designated the concrete mixes into a number of grades as M10, M15, M20, M25, M30, M35 and M40. In this designation the letter M refers to the mix and the number to the specified 28-day cube

strength of mix in N/mm². The mixes of grades M10, M15, M20 and M25 correspond approximately to the mix proportions (1:3:6), (1:2:4), (1:1.5:3) and (1:1:2) respectively.

3.4 EXPERIMENTAL PROGRAMME FOLLOWED

3.4.1 Test Methods conducted in the study

1. Compressive Strength
2. Split tensile strength

3.4.2 Type of curing method used

Traditional curing Type of Materials used for replacement in the concrete mix:
Different percentages of Rubber chips replaced with coarse aggregate:

- Rubber chips of 0% added in concrete mix.
- Rubber chips of 10% added in concrete mix.
- Rubber chips of 20% added in concrete mix.
- Rubber chips of 30% added in concrete mix.

3.4.3 Tests to be conducted on site as well as lab for quality control are

- ❖ Slump Test
- ❖ Compaction Factor test

3.4.3.1 Slump test

The slump test is the most well-known and widely used test method to characterize the workability of fresh concrete. The inexpensive test, which measures consistency, is used on job sites to determine rapidly whether a concrete batch should be accepted or rejected. The test method is widely standardized throughout the world. The apparatus consists of a mold in the shape of a frustum of a cone with a base diameter of 8 inches, a top diameter of 4 inches, and a height of 12 inches. The mold

is filled with concrete in three layers of equal volume. Each layer is compacted with 25 strokes of a tamping rod. The slump cone mould is lifted vertically upward and the change in height of the concrete is measured. Four types of slumps are commonly encountered, as shown in Figure. The only type of slump permissible under ASTM C143 is frequently referred to as the “true” slump, where the concrete remains intact and retains a symmetric shape. A zero slump and a collapsed slump are both outside the range of workability that can be measured with the slump test.

The slump test is not considered applicable for concretes with a maximum coarse aggregate size greater than 1.5 inches. For concrete with aggregate greater than 1.5 inches in size, such larger particles can be removed by wet sieving. Additional qualitative information on the mobility of fresh concrete can be obtained after reading the slump measurement. Concretes with the same slump can exhibit different behaviour when tapped with a tamping rod. A harsh concrete with few fines will tend to fall apart when tapped and be appropriate only for applications such as pavements or mass concrete. Alternatively, the concrete may be very cohesive when tapped, and thus be suitable for difficult placement conditions. This is a site test to determine the workability of the ready mixed concrete just before it's placing to final position inside the formwork, and is always conducted by the supervisor on site. However, in mid of concreting process, should the site supervisor visually find that the green concrete becomes dry or the placement of concrete has been interrupted, a re-test on the remaining concrete should be conducted in particular of the pour for congested reinforcement area.

The procedure of test in brief is as follows: -

Ensure the standard Slump Cone and associated equipment's are clean before test and free from hardened concrete. Wet the Slump Cone and drain away the superfluous water. Request the mixer or concrete truck to well mix the concrete for additional 5 minutes. Place the Slump Cone on one side (i.e., not in middle) of the base plate on levelled ground and stand with feet on the foot-pieces of cone. Using a scoop and fill the cone with sampled concrete in 3 equal layers, each of about 100mm thick. Compact each layer of concrete in turn exactly 25 times with a Slump Rod, allowing the rod just passes into the underlying layer. While tamping the top layer, top up the cone with a slight surcharge of concrete after the tamping operation. Level the top by

a “sawing and rolling” motion of the Slump Rod across the cone. With feet are still firmly on the foot-pieces, wipe the cone and base plate clean and remove any leaked concrete from bottom edge of the Slump Cone. Leave the foot-pieces and lift the cone carefully in a vertical up motion in a few seconds’ time. Invert the cone on other side and next to the mound of concrete. Lay the Slump Rod across the inverted cone such that it passes above the slumped concrete at its highest point. Measure the distance between the underside of rod and the highest point of concrete to the nearest 5mm. This reading is the amount that the sampled concrete has slumped. If the concrete does not show an acceptable slump, repeat the test with another sample. If the repeated test still does not show an acceptable slump, record this fact in the report, or reject that load of concrete.

3.4.3.2 Compaction factor test

The compaction factor test measures the degree of compaction resulting from the application of a standard amount of work. Compaction factor test is adopted to determine the workability of concrete, where nominal size of aggregate does not exceed 20 mm. It is based upon the definition, that workability is that property of the concrete which determines the amount of work required to produce full compaction.

The test consists essentially of applying a standard amount of work to standard quantity of concrete and measuring the resulting compaction. To find the workability of freshly prepared concrete, the test is carried out as per specifications of IS: 1199-1959. Workability gives an idea of the capacity of being worked, i.e., idea to control the quantity of water in cement concrete mix to get uniform strength. The test should be carried out on a level ground. The top hopper must be filled gently and to the same extent on each occasion and the time between the end of mixing and release of concrete from top hopper must be content, two minutes will be convenient. The outside of mould must be wiped clean before weighing and mass should be recorded to the nearest 10 gm.

The mix should not be pressed or compacted in the upper hopper. The apparatus, which is commercially available, consist of a rigid frame that supports

two conical hoppers vertically aligned above each other and mounted above a cylinder. The top hopper is slightly larger than the bottom hopper, while the cylinder is smaller in volume than both hoppers. To perform the test, the top hopper is filled with concrete but not compacted. The door on the bottom of the top hopper is opened and the concrete is allowed to drop into the lower hopper.

Once all of the concrete has fallen from the top hopper, the door on the lower hopper is opened to allow the concrete to fall to the bottom cylinder. A tamping rod can be used to force especially cohesive concretes through the hoppers. The excess concrete is carefully struck off the top of the cylinder and the mass of the concrete in the cylinder is recorded. This mass is compared to the mass of fully compacted concrete in the same cylinder achieved with hand tampering or vibration. The compaction factor is defined as the ratio of the mass of the concrete compacted in the compaction factor apparatus to the mass of the fully compacted concrete. The standard test apparatus, described above, is appropriate for maximum aggregate sizes of up to 20 mm. A larger apparatus is available for concretes with maximum aggregate sizes of up to 40 mm.

The test has typically been used in precast operations and at large construction sites. Compared to the slump test, the apparatus is bulky and a balance is required to perform measurements. In addition to these practical drawbacks, the test has several flaws that reduce the accuracy of the results. Some of the work imparted into the concrete is lost in friction between the hoppers and the concrete. The magnitude of this friction varies between different concrete mixtures and may not reflect field conditions. Further, the compaction factor test does not utilize vibration, the main compaction method used in the field.

3.4.4 PREPARATION OF TEST SPECIMENS

The preparation of test specimen including sampling of materials, preparation of materials, proportioning, weighing, mixing, testing for workability, choice of the size of test specimens, compacting, and capping of specimen shall be in accordance with IS: 516- 1959*, if tests are intended to draw correlation curve between the results from Flexural Strength tests on specimens cured by normal curing method and accelerated curing method. If the tests are intended for control

purposes, sampling shall be done in Accordance with IS: 1199-1959t and choice of the size of test specimens, compacting, and capping of specimen shall be in accordance with IS: 516-1959*. Immediately after moulding, each specimen shall be covered with a steel plate thinly coated with mould oil to prevent adhesion of concrete. Threat and extent of hydration of cement under a particular curing regime depend mainly upon the chemical composition of cement, water cement ratio and mix proportions, which are considered to be important parameters in the correlation of results from Flexural Strength tests on specimens cured by normal curing method.

3.4.5 CURING METHOD FOLLOWED

Traditional curing

All specimens will be moist cured for one day and after moist curing the specimens will be water cured for required days. Testing will be done after required days. In the Traditional curing the cubes moulded with the cement concrete is subjected to curing in the water Tank and then check the strengths achieved by the cubes and beams for every 3days, 7 days and 28 days from this we can get the Flexural Strength from cubes and Flexural strength from Beams, split tensile strength for cylinders.

3.4.6 TESTS ON HARDENED CONCRETE

For testing concrete in hardened state, it is required to cast the various moulds like cubes and beams. It is cured for the required period after 24 hrs of casting.

3.4.7 Test for Compressive Strength of Concrete

This deals with the procedure for determining the Compressive Strength of concrete specimens. Tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days. Ages of 13 weeks and one year are recommended if tests at greater ages are required. Where it may be necessary to obtain the early strengths, tests may be made at the ages of 24 hours $\pm$ ½ hour and 72 hours $\pm$ 2 hours. The ages shall be calculated from the time of the addition of water to the dry ingredients. Specimens stored in water shall be tested immediately on removal from the water and while they are still in the wet condition. Surface water and

grit shall be wiped off the specimens and any projecting fins removed. Specimens when received dry shall be kept in water for 24 hours before they are taken for testing. The dimensions of the specimens to the nearest 0.2 mm and their weight shall be noted before testing.

Placing the Specimen in the Testing Machine the bearing surfaces of the testing machine shall be wiped clean and any loose sand or other material removed from the surfaces of the specimen which are to be in contact with the compression platens. In the case of cubes, the specimen shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cubes as cast, that is, not to the top and bottom.

As the spherically seated block is brought to bear on the specimen, the movable portion shall be rotated gently by hand so that uniform seating may be obtained. The load shall be applied without shock and increased continuously at a rate of approximately 140 kg/sq. cm/min until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained.

The maximum load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted. It is determined from the expression given as follows Compressive Strength = P/A , in Mpa

Where,

P = Maximum applied load in KN

A = Area of mould.

3.4.8 Test for Tensile Strength of Concrete

Tensile strength is an important property of concrete because concrete structures are highly vulnerable to tensile cracking due to various kinds of effects and applied loading itself. However, tensile strength of concrete is very low in compared to its compressive strength.

The standard size of cylinders is 150mm (Dia),300mm(height). The Tensile strength is calculated as follows

$$f_t = 2P / (3.14 \times D \times L)$$

Where,

D = Diameter of cylinder

L= length of the cylinder

P= Load at failure

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