CHAPTER 1

INTRODUCTION

1.1 GENERAL

One billion end-of-life tires (Rubber tires) are generated globally each year, 355 million of Rubber tires out of this production are related to the EU. The majority of Rubber tires are land filled and only about 5% is used for civil engineering applications. However, considering the massive requirement for construction (approximately 32 billion tons each year), the application of crumb rubber (CR) as a recycled organic component in Portland cement concrete can effectively resolve the environmental pressures and has the potential to abate the consumption of virgin materials while simultaneously reducing landfill dumping . The use of Rubber tires as CR aggregates (coarse and fine granulates) in the construction industry has been intensively studied in several countries Several researchers referred to the decrease of the mechanical properties of rubberized concrete, some researchers reported the enhancing of the properties of the CR particles by means of pre-treatment of CR surface to be compatible with cement matrix, but less information was provided regarding CR hazardous impact to the environment and how to mitigate it. The outcome of experimental programs showed that there are certain gaps that prevent to obtain a coherent overview of both mechanical behaviour and environmental impact of crumb rubber concrete (CRC) to object the stereotypes which prevent to use CR in concrete in the construction industry.

The current definition of the gaps in research and market indicates certain barriers or stereotypes which limit the application of CR in the construction industry. Those could be listed as follows:

- The current construction materials market is rather conservative and there is a need to foresee the alternative solutions since natural aggregates resources are depleting ;
- Constant flow of available materials and their storage, efficient time frame for the delivery of the materials within the country/countries (for example, secondary streams are very important). Meanwhile, the cost for natural aggregate keeps increasing due to the limited source and long transport distance ;
- CRC cost analysis and comparison to the traditional concrete vary from country to country due to the limited industrial-scale production of CR. The price of CR ranges from 40 to 320 EUR per ton based on its origin and fineness;
- The end-of-waste (EoW) management is crucial, and recycling is mandatory; however, the profit of recycling is limited by the manufacturing costs; also, it depends on the recycling developments within the countries (which may differ quite a lot from country to country);
- Society reaction to waste usage in construction materials due to lack of sufficient technical information and comprehension may develop certain barriers in application of different recycled materials;
- The recycled rubber products have poor mechanical performances-interfacial bond strength as the main factor which limits the application of CR in construction elements;
- Insufficient investigation of leaching behavior and ecotoxicological impact to the environment;
- Insufficient information on the recyclability of concrete containing CR;
- For the moment, there are no restrictions defined regarding CR application in concrete nor rubberized concrete aggregates.

In 2016, yearly global production of natural and synthetic rubber reached 27.3 million tons (54% synthetic), with ~70% used in the manufacture of vehicle tires. It has been recorded that around 1 billion tires are discarded every year and this number may increase up to 1.2 billion by the end of 2030 . Tire manufacturing is a global business: there are over 160 tire manufacturers located in more than 45 countries worldwide. Tires are made to international standards and are freely traded across the world. Not each country might have natural resources for construction, but it has tires disposal. Stockpiling of used tires is very common in several countries that leads, in general, to a serious ecological threat contributing to the reduction of biodiversity since the tires also contain toxic and soluble components .

Tire materials are complex mixtures; as various chemicals are used during the production of tires. Tires contain a total of approximately 1.5% by weight of potentially hazardous waste compounds: copper (Cu) (0.02%), zinc (Zn) (1%, but can be up to 2%), cadmium (Cd) (max 0.001%), lead (Pb) and Pb compounds (max 0.005%), acidic solutions (0.3%). Despite consistent usage of the general ingredients, the composition of a specific tire depends on its application. For example, a common-sized all-season passenger commercial tire contains approximately 30 types of synthetic and 8 natural rubbers, 8 kinds of carbon black, steel cord for belts, polyester and nylon fiber, steel bead wire and 40 different chemicals, waxes, oils, pigments, silica and clays . One of the suggested compositions can be taken as a reference: rubber/elastomers (48%), carbon black (22%), metal (15%), additives (8%), textile (5%), zinc oxide (1%-passenger tires or 2% truck and off-road tires), sulphur (1%).

The ELTs are generally disposed of in different ways such as burning, landfilling and use as fuel. The burning of tires causes serious fire hazards, emission of potentially harmful compounds, landfilling by ELTs results in depletion of the available useful sites. The use of ELTs as fuel is economical but not attractive when compared to other products used for the same purpose.

In the last years, the suitability and efficiency of using different by-products (mainly steel fibers-used as a partial or total replacement of industrial steel fibers to produce Fiber Reinforced Concrete (FRC) and rubber particles-used as a partial replacement of natural aggregates for producing rubberized concrete) obtained from the recycling of waste tires for improving some concrete properties have been investigated, however, the related research is limited and leaves a wide space for further investigations. With regards to the terminology, the most common frequently used terms for this type of concrete are rubberized concrete and crumb rubber concrete (CRC).

1.2 CRUMB RUBBER

Crumb rubber is recycled rubber produced from automotive and truck scrap tires. During the recycling process, steel and tire cord (fluff) are removed, leaving tire rubber with a granular consistency. Continued processing with a granulator or cracker mill, possibly with the aid of or by mechanical means, reduces the size of the particles further. The particles are sized and classified based on various criteria including color (black only or black and white). The granulate is sized by passing through a screen, the size based on a dimension (1/4 inch) or mesh (holes per inch : 10, 20, etc.). Crumb rubber is often used in artificial turf as cushioning.

The following are common classifications of crumb rubber:

Retreaters tire buffing's shall consist of clean, fresh, dry buffings from tire retread preparation operations.

No.1 - Tire Granule shall consist of granulated tire crumb, Black Only Guaranteed MetalFree, sized. Magnetically separated materials are not acceptable. Fluff from tire cord removed.

No.2 - Tire Granule shall consist of granulated tire crumb, Black & White Guaranteed MetalFree, sized to minus 40 Mesh. Magnetically separated materials are not acceptable. Fluff from tire cord removed.

No.3 - Tire Granule shall consist of granulated tire crumb, Black Only Magnetically Separated, sized. Fluff from tire cord removed.

No.4 - Tire Granule shall consist of granulated tire crumb, Black & White Magnetically Separated, sized. Fluff from tire cord removed.

No.5 - Tire Granule shall consist of unclassified granulated tire crumb, Sized, Unseparated, not magnetically separated, fluff from tire cord not removed.

1.3 PVC PIPE

Plastic pipe is a tubular section, or hollow cylinder, made of plastic. It is usually, but not necessarily, of circular cross-section, used mainly to convey substances which can flow—liquids and gases (fluids), slurries, powders and masses of small solids. It can also be used for structural applications; hollow pipes are far stiffer per unit weight than solid members.

Plastic pipework is used for the conveyance of drinking water, waste water, chemicals, heating fluid and cooling fluids, foodstuffs, ultra-pure liquids, slurries, gases, compressed air, irrigation, plastic pressure pipe systems, and vacuum system applications.

uPVC or PVC-U, is a thermoplastic material derived from common salt and fossil fuels. The pipe material has the longest track record of all plastic materials. The first uPVC pipes were made in the 1930s. Beginning in the 1950s, uPVC pipes were used to replace corroded metal pipes and thus bring fresh drinking water to a growing rural and later urban population. uPVC pipes are certified safe for drinking water per NSF Standard 61 and used extensively for water distribution and transmission pipelines throughout North America and around the world. uPVC is allowed for waste lines in homes and is the most often used pipe for sanitary sewers.

Further pressure and non-pressure applications in the field of sewers, soil and waste, gas (low pressure) and cable protection soon followed. The material's contribution to public health, hygiene and well-being has therefore been significant.

Polyvinyl chloride or uPVC (unplasticized polyvinyl chloride) pipes are not well suited for hot water lines and have been restricted from inside water supply line use in the USA for homes since 2006. Code IRC P2904.5 PVC Not listed.

PVC has high chemical resistance across its operating temperature range, with a broad band of operating pressures. Max operating temperature is reported at 140 °F (60 °C), and max working pressure: 450 psi (3,100 kPa). Due to its long-term strength characteristics, high stiffness and cost effectiveness, PVC systems account for a large proportion of plastic piping installations.

1.4 AIM

- To investigate the flexural behaviour of the beam, which has Rubber crumbs compacted PVC pipe.
- Comparing flexural strength of the conventional beam to the proposed beam.

1.5 OBJECTIVES

- Performance evaluation of beam with PVC filled with rubber crumbs.
- To minimize the overall environmental effects by incorporate waste chipped rubber to the concrete.
- To study the flexural strength development of concrete with and without PVC pipe filled with rubber crumbs.

CHAPTER – 2

LITERATURE SURVEY

Hao Zhou, Bin Jia et al (2020), Experimental Study on Basic Mechanical Properties of Basalt Fiber Reinforced Concrete, materials**.** Blending a certain proportion of basalt fiber into concrete improves the toughness of concrete, which prevents cracking and avoids the brittle behaviors. In this paper, the compressive, tensile, and flexural tests of concrete with different basalt fiber contents were carried out. Then the test phenomena, failure modes, and mechanical properties were compared and analyzed to derive the relationship between the basalt fiber contents and mechanical properties. The toughness and crack resistance performance of basalt fiber reinforced concrete were evaluated by the fracture energy, advanced toughness parameters, and characteristic length proposed by Hillerborg. The correlation coe_cient of basalt fiber was introduced to establish the calculation formula for mechanical properties of basalt fiber reinforced concrete. The results indicated that basalt fiber significantly improved the toughness and crack resistance performance of concrete. The enhancing e_ect of the basalt fiber on the compressive strength of concrete is lower than that of tensile strength and flexural strength. Moreover, the improvement e_ect was the highest with the basalt fiber content was 0.3% and 0.4%.

Sujaatha a et al (2019), Flexural behaviour of basalt fibre reinforced concrete filled steel tube beams, International Journal of Research and Analytical Reviews, Volume 6, Issue 3. The incorporation of fibre has become the main approach for improving the mechanical properties of concrete. At present, fibres are mainly used in concrete including basalt fibre. The study is aimed at the effect of basalt fibre on the flexural behaviour of Concrete Filled Mild Steel Tube Beams. Basalt fibre of 12mm length and 13μm diameter is used for the study. The fibre is mixed with M30 grade concrete. Conventional concrete is tested for its compressive strength using 9 cubes at the age of 3, 14 and 28 days. Basalt Fibre Reinforced Concrete (0.5% by weight of cement & 0.75% by weight of cement) is also tested for the above properties. Three steel tubes of size 100 x 50 mm and length 900mm with depth to thickness ratio (d/t) of 28.5 are filled with different types of concrete (normal and basalt fibre reinforced concrete).Basalt Fibre Reinforced Concrete in – filled rectangular mild steel tube beams with and without fibre reinforced are tested for the flexural behaviour under four – point load test and the comparative values are recorded and analysed.

Ahmed SagbanSaadoon et al (2019), A survey of studies on plastic tubes confined plain concrete as compression members, ARPN journal of engineering and applied sciences, vol. 14, no. 13. There are few studies concerning with plain concrete filled plastic tubes. In this review, available published studies, on this type of composite columns, are reviewed and summarized to view the type of the studied columns and the main studied variables that affecting the behavior of these composite columns. More than (145) specimens are collected and showed in this review.

Nur HajarulFalahi Abdul Halim et al (2017), Durability of Fibre Reinforced Polymer under Aggressive Environment and Severe Loading,International Journal of Applied Engineering Research Volume 12, Number 22. The durability and high resistance of FRP under aggressive environmental condition make it superior compared to conventional reinforcement bars especially when structures are exposed to higher risk of corrosion. Its high strength-to-weight ratios give advantages to the application of FRP for seismic retrofit since an increase in weight will lead to increase in seismic force. Although in general FRP has high resistant to chemical, corrosion, and extreme weather as well as having high strength, their performance is very much affected by the mechanical properties, fabrication methods, types of materials used, etc. Understanding this behavior provides a good insight into the superiority and benefits of FRP compared to other construction materials as well as their limitations. This paper reviews the durability of FRP under aggressive environment and severe loading. Provisions in design codes are also included to provide guidelines for the application of FRP under these conditions. It covers different types of FRP in laminates and bar form. A lot of research has been conducted to better understand the behavior and performance of FRP, however, studies on some aspects are still limited. This includes the performance of FRP under impact loading.

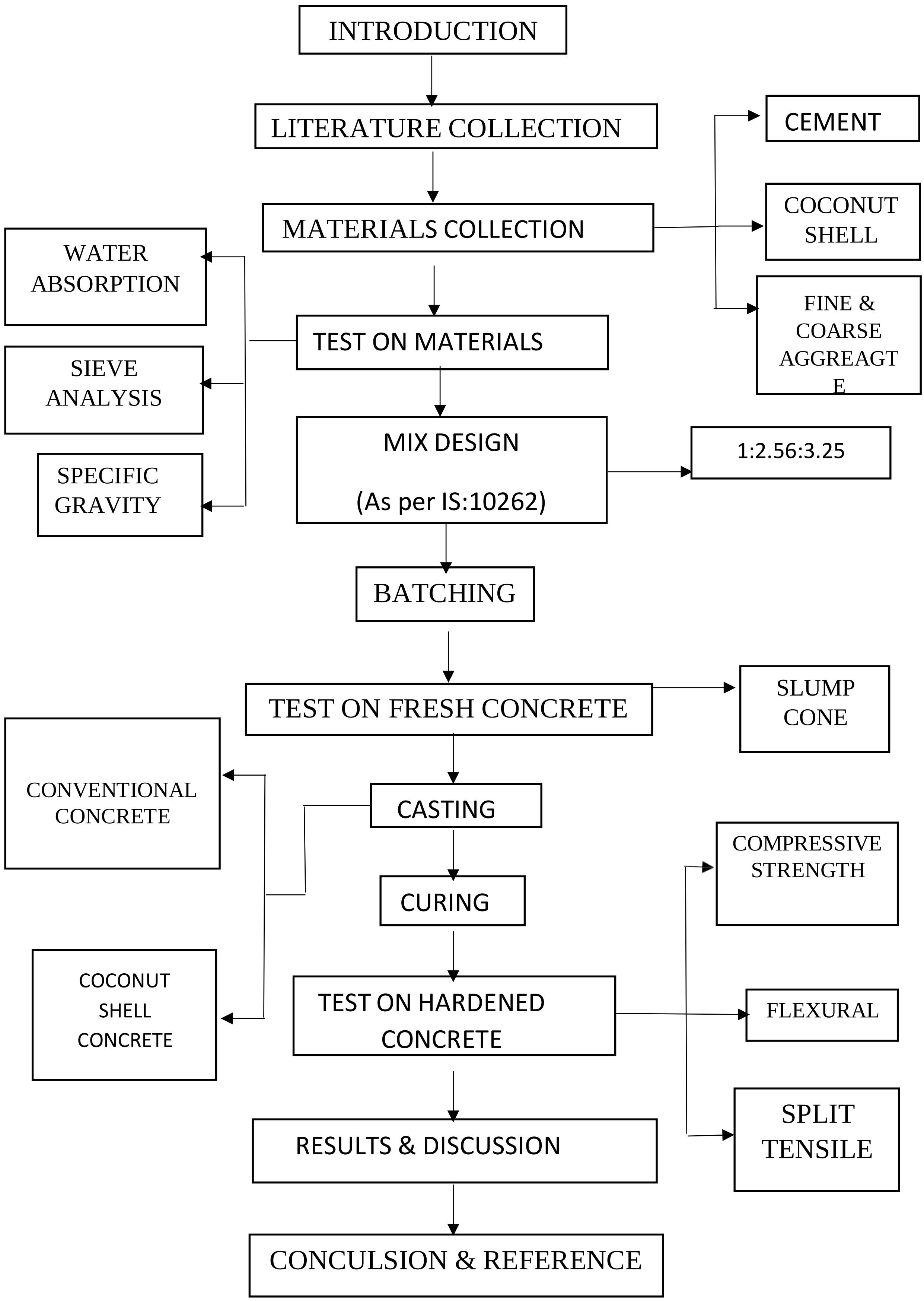
PoornimaPradeep (2019),Flexural Behaviour of Basalt Fiber Reinforced Concrete Beam Enhanced with Wire Mesh Epoxy Composite, International Journal of Applied Engineering Research, Volume 14, Number 12. The recent developments in the application of the advanced composites in the construction industry for concrete rehabilitation and strengthening are increasing on the basis of specific requirements, national needs and industry participation. The speciality of concrete is that it is very strong against compression and for tension it is weak. The use of reinforcement and to some extent the inclusion of certain fibers in concrete increases the tensile strength of concrete. In this project, the tensile strength of reinforced concrete beam is increased by adding basalt fibre into the concrete by weight of concrete and is again strengthened with the help of wire mesh epoxy composite. The wire mesh is placed on the specimen in different alignments and is covered with epoxy resin. Five specimen including thecontrol beam is casted. The flexural behavior of basalt fibre reinforced beam enhanced with wire mesh epoxy composite is then compared with the control beam. Based on this study, the beam specimen with the addition of basalt fiber enhanced with welded wire mesh U – wrapped completely attained higher strength than control beam and is 42.6% more stronger.

Satya M Saad et al (2015), Study of Ductility properties by effective replacement of Steel with Basalt Fibre Reinforced Polymer, International Journal of Engineering Research and General Science Volume 3, Issue 3. There are widely researched range and types of FRP namely: Aramid FRP (AFRP), Carbon FRP (CFRP) and Glass FRP(GFRP). FRP shows various advantages out of which few are: high tensile strength, high strength-weight ratio, no corrosion and also light in weight. These many of such benefits suggest the structural designers to research & implement on a large scale the replacement of steel with different FRPs as a choice of reinforcing material for concrete. One of the choice that we have made is Basalt Fibres Reinforced Polymer (BFRP) which is rather a new material to structural design, although it has been known for several decades. They are made from basalt rock, are very light and have tensile strength, over twice as high as steel. Tensile strength of BFRP tendon is about twice the tensile strength of steel reinforcement and elongation of BFRP tendons is much more than of steel In this paper beam specimen (900mm x 230mm x 230mm) with four varying reinforcement of steel rebar, steel rebar + Basalt fibre (2% replacement by weight of cement), BFRP rebar and Composite reinforcement (BFRP rebar + Steel rebar, 65% + 35% respectively) have been tested for deflection. From the experimental results, it is observed that the beam with composite reinforcement where 65% of steel is replaced with BFRP rebar, it is the effective replacement and makes the beam most ductile against other specimens tested.

Ranjitsinh k. Patil et al (2014), comparative study of effect of basalt, glass and steel fiber on compressive and flexural strength of concrete,international journal of research in engineering and technology, volume: 03 issue: 06. The comparative study of effect basalt, glass and steel fiber on compressive and flexural strength of M40 grade concrete. For flexural and compressive strengthening of reinforced concrete, total thirty-nine cubes and thirty-nine beams were cast and beams were tested over an effective span of 900 mm up to failure of the beam under two-point loading. The beams were designed as balance-section. The fibers were placed in concrete randomly by (0.25%, 0.5%, 0.75%, 1%) of its total volume of concrete. For each percentage of fiber total three cubes and three beams were casted to take average results. Finally comparative results are shown for each percentage and for these three fibres.

C. Sudha and Mohan GS.(2019), BEHAVIOUR OF FIBRE REINFORCED CONCRETE USING BASALT FIBRE IN BEAM COLUMN JOINT UNDER CYCLIC LOADING, ARPN Journal of Engineering and Applied Sciences. The effect of fibre reinforced concrete in exterior beam column joint with and without basalt fibre under cyclic loading. And the fibre used in this study is basalt fibre, which is more efficient than other fibres. Mechanical properties like compression, split tension flexural and impact load test were carried out. Cumulative energy dissipation of all mixes was taken. High performance concrete of M60 grade used. Fibres are used in different percentage (0.75%, 1% and 1.25%) with the volume of concrete. Mechanical properties of the concrete were discussed and the behavior of beam column joint was studied under cyclic loading. To increase the energy absorption and load bearing capacity of the beam column joint ductile detailing is provided. With the load vs deflection, beam column joint curvature is made to find the load bearing capacity. Use fibre to the concrete will reduce the size of crack pattern during failure. The result shows that behavior of beam column joint shows better performance. The studied properties are discussed and the fibre used shows the increase in strength with addition of different percentage of fibre respectively by cyclic loading.

METHODOLOGY:



CHAPTER – 3

MATERIALS USED

3.1 CEMENT:

Cement is obtained by grinding various raw materials after calcination. The degree to which cement is ground to smaller and smaller particles is called fineness of cement. The fineness of cement has an important role on the rate of hydration and hence on the rate of gain of strength and also on the rate of evolution of heat. Finer cement offers a greater surface area for hydration and hence the faster development of strength although the ultimate strength his not affected

Fineness of cement is tested either by sieving or by determination of specific surface using air-permeability apparatus. The specific surface is defined as the total surface area of all the particles in cm^2 per one gram of cement. Although determination of specific surface is more accurate to judge fineness of cement, it is rarely used except for specific purpose. In contrast sieving is most commonly used method to determine fineness of cement and is quite good for field works.

3.1.1 Determination of Fineness of Cement by Dry Sieving.

Reference: IS4031(Part-1):1988.

Apparatus : IS-90 micron sieve con forming to IS:460(Part1-3)-1985; Weighing balance; Gauging trowel; Brush.

Material : Ordinary Portland Cement

Procedure:

- Weigh accurately 250g of cement to the nearest 0.01g and place it on a standard 90 micron IS sieve.
- Break down any air-set lumps in the cement sample with fingers.
- Agitate the sieve by givings wirling, planetary and linear movements for

a period of 10 minutes or until no more fine material passes through it.

- Collect there sidue left on the sieve , using brush if necessary, and weigh there sidue.
- Express there sidue as a percentage of the quantity first placed on the sieve to the nearest 0.1 percent.
- Repeat the whole procedures two more times each using fresh 250g sample.

Table 3.1 Determination of Fineness of Cement

TRIAL	WEIGHT OF SAMPLE TAKEN(W)	WEIGHT OF RESIDUE (R)	%AGE OF RESIDUE
1.	250	9.3	3.27
2.	250	11.56	4.63
3.	250	5.48	2.19

% OF RESIDUE = W/R×1OO%

Average percentage of residue = 3.36

Conclusions:

The given sample of cement contains less than / morethan10% by weight of material coarser than 90 micronsieve. Therefore it satisfies/not satisfies the criterion as specified by IS code.

3.1.2 Consistency Teston Cement

This test is conducted to calculate the amount of water to be added to the cement to get a paste of standard consistency which is defined as that consistency which will permit the Vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the Vicat mould.

Table 3.2 DeterminationofConsistencyof Cement

TRIAL	Quantity of cement taken in g	Quantity of water added in ml	Penetration in mm	Nominal Consistency in %
1.	250	62.5	3	25
2.	250	75	4.5	30
3.	250	87.5	6	35
Average				**30%**

Standard Consistency of Cement = (Quantity of water for 5-7 mm penetration/Weight of cement) × 100

4.1.3 Determination of Setting Times of Cement

Cement when mixed with water forms slurry which gradually becomes lesser and lesser plastic, and finally forms a hard mass. In this process a stage is obtained when the cement paste is sufficiently rigid to with stand a definite amount of pressure. The time to reach this stage is called setting time. The setting time is divided into two parts: the initial setting time and the final setting time.

Initial set is a stage where the cement paste stiffens to such an extent that the Vicat needle is not permitted to move down through the paste within 5±0.5mm measured from the bottom of the mould. In other words, the cement paste starts losing its plasticity. The time elapsed between the moments that the water is added to the cement to the initial set is regarded as initial setting time. Any crack that may appear after initial set may not re-unite. Final setting time is the time when the paste becomes so hard that the annular attachment to the needle under standard weight only makes an impression on the hardened cement paste.

In order that the concrete may be mixed, transported and placed in position conveniently, it is necessary that the initial set of cement is not too quick. But after, it has been laid; the hardening should be rapid so that the structure can be made use of as early as possible. For an ordinary portland cement, the initial setting time should not be less than 30 minutes while the final setting time should not be more than 600 minutes.

The setting time of the cement is influenced by factors such as: percentage of water, amount of kneading the paste, temperature and humidity of the environment. As per codal provisions; this test should be conducted at temperature of $27^{oo} \pm 2^{oo}CC$ and 90% humidity.

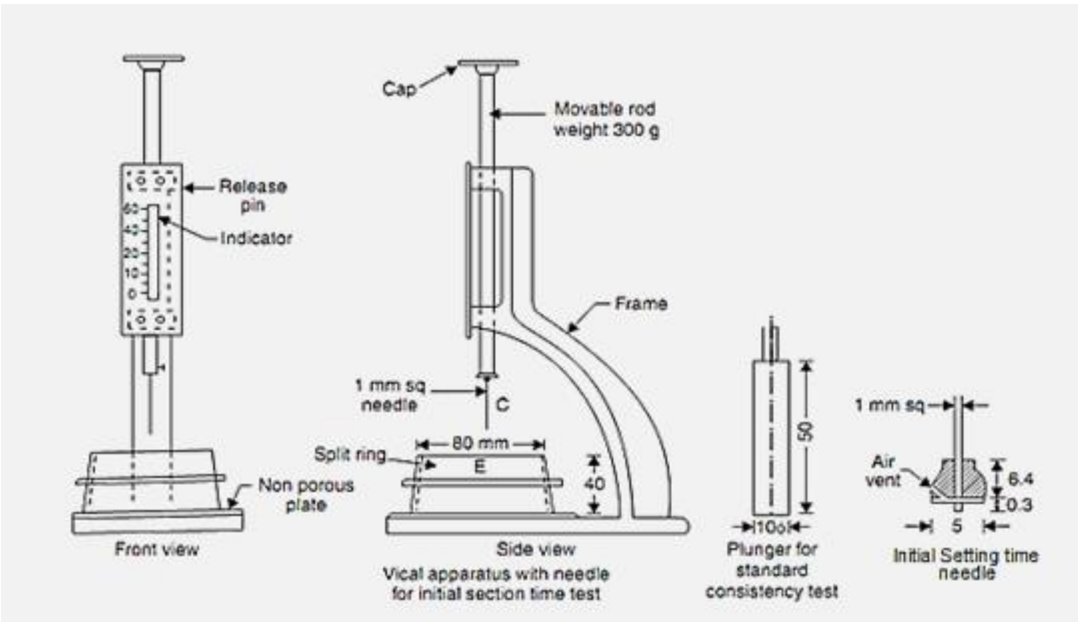


Fig 3.1 Vicat's Apparatus

Reference : IS 4031(Part-5):1988

Apparatus : Vicat apparatus conforming to IS:5513-1998; Weighing balance; Gauging trowel; measuring cylinder; stop watch.

Material : Ordinary Portland cement; Water

Procedure:

- Prepare a uniform cement paste by gauging 400 g of cement with 0.85 times the water required to give a paste of standard consistency. The procedure of mixing and filling the mould is same as standard consistency.
- Start the stop watch or note down the time when water is added to the cement.

3.1.3.a Determination of initial setting time:

- Place the test block confined in the mould and resting on the non-porous plate, under the rod bearing the initial setting needle (with cross section 1 mm^2);lower the needle gently until it comes in contact with the surface of the test block and quickly release, allowing it to penetrate into the test block
- Repeat this procedure until the needle, when brought in contact with the test block and released as described above, fail stopierce the block beyond5.0± 0.5mm measured from the bottom of the mould. Note the time.
- The difference of time between operations (2) and (4) provides the initial setting time of cement.

3.1.3.b Determination of final setting time:

- Replace the initial setting needle of the Vicat apparatus by the needle with an annular attachment.
- The cement shall be considered as finally set when, upon applying the needle gently to the surface of the test block, the needle makes an impression there on, while the attachment fails to do so.
- The interval of time between operation (2) and (7) provides the final setting time of cement.

Table 3.3 Determination of initial setting time

Time at which water is added to cement (min)	Time at which the needle fails to pierce the test block by 5.0±0.5mm (min)	Initial setting time (min)
0	45	45

Table 4.4 Determination of final setting time

Time at which water is added to cement (min)	Time at which the needle fails to pierce the test block by 5.0±0.5mm (min)	Final setting time (min)
45	**310**	**310**

3.1.4 Determination of Specific Gravity of Cement

Specific gravity is defined as the ratio between weight of a given volume of material and weight of an equal volume of water. In case of cement, specific gravity is determined by use of a Le Chatelier’s flask. To determine the specific gravity of cement, kerosene is used which does not react with cement. The specific gravity of OPC is generally around 3.15.

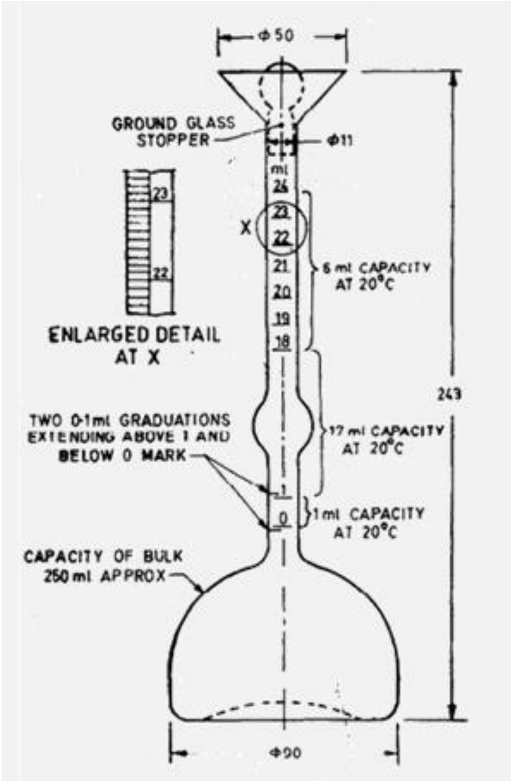


Fig.4.2 Le Chaterliers flask

Reference : IS4031(Part-11):1988.

Apparatus : Le Chaterliers flask, weighing balance, kerosene (free from water).

Material : Ordinary Portland cement; Water; Grease

Procedure:

- Dry the flask carefully and fill with kerosene or naphtha to a point on the stem between zero and 1 ml.
- Record the level of the liquid in the flask as initial reading.
- Put a weighted quantity of cement (about 60 g) into the flask so that level of kerosene rise to about 22 ml mark, care being taken to avoid splashing and to see that cement does not adhere to the sides of the above the liquid.
- After putting all the cement to the flask, roll the flask gently in an

inclined position to expel air until no further air bubble rise3s to the surface of the liquid.

- Note down the new liquid level as final reading.

OBSERVATION:

1. Initial reading of flask in ml (V_1) : 0.5ml
2. Final reading of flask in ml (V_2) : 19.5ml
3. Volume of cement particle (V_2 - V_1) : 19ml
4. Weight of equal volume of water in g (W_2) : 19ml
5. Specific gravity of cement (W_1/ W_2) : 3.15

3.2 TESTS ON FINE AGGREGATE

Aggregate is the inert, inexpensive materials dispersed throughout the cement paste so as the produce a large volume of concrete. They constitute more than three quarters of volume of concrete. They provide body to the concrete, reduce shrinkage and make it durable. The aggregates are classified in two categories; fine aggregate and coarse aggregate. The size of fine aggregates is limited to a maximum of 4.75 mm, beyond which it is known as coarse aggregates.

3.2.1 Sieve Analysis of Fine Aggregate

Fineness modulus for a given aggregate is obtained by sieving known weight of it in a set of standard sieves and by adding the percent weight of material retained on all the sieves and dividing the total percentage by 100. It serves the purpose of comparing one aggregate with another in respect of fineness or coarseness. For classification of fine aggregates, the following limits may be taken as guidance:

Fine sand : Fineness modulus should lie in between 2.2 to 2.6

Medium sand : Fineness modulus should lie in between 2.6 to 2.9

Coarse sand : Finenessmodulusshouldlieinbetween2.9to3.2

Table 3.5 Sieve Analysis of fine aggregate

Weight of fine aggregate taken (W_f): 500g					
Sl. No.	**Sieve size**	**Weight retained (in g)**	**%age retained $\frac{C3}{W_f}$ x100**	**Cumulative % age retained**	**Percentage passed (100 – C_5)**
C_1	C_2	C_3	C4	C_5	C_6
1	4.75 mm	9.4	1.88	1.88	98.12
2	2.36 mm	10.32	2.06	3.94	96.06
3	1.18 mm	30.78	6.16	10.1	89.9
4	600 micron	120.94	24.19	34.29	65.71
5	300 micron	134.12	26.82	61.11	38.89
6	150 micron	106.53	21.31	82.42	17.58
7	Pan	82.01	16.40	98.82	1.18
Fineness Modulus $\frac{\Sigma C5}{100}$ =				**2.93**	**-**
Zone to which the fine aggregate belongs:				**ZONE - II**	

Fig 3.3 Sieve Analysis of Fine Aggregate

3.2.2 Specific Gravity of Fine Aggregate

Specific gravity of an aggregate is defined as the ratio of the mass of solid in a given volume of sample to the mass of equal volume of water at $4^{oo}CC$. However, all rocks contain some small amount of void and the apparent specific gravity includes this voids. The specific gravity of aggregates is an indirect measure of material’s density and its quality. A low specific gravity may indicate high porosity and therefore poor durability and low strength

Fig3.4 Specific Gravity of Fine Aggregate

Sl.no	Description(gm)	Trial1	Trial2	Trial3	Mean
1	Weight of empty bottle (M_1)	612	612	612	2.75
2	Weight of bottle + Fine Aggregate(M_2)	860	862	849	
3	Weight of bottle + Fine Aggregate + water (M_3)	1608	1611	1611	
4	Weight of bottle + water (M_4)	1450	1450	1450	
5	Specific gravity of Fine Aggregate	2.75	2.81	2.68	

Table3.6 Determination of Specific Gravity of fine aggregate

3.2.3 Determination of Water Content by Pycnometer

$$w = \left\{ \left[\frac{(W_2 - W_1)}{(W_3 - W_4)} \frac{(G-1)}{G} \right] - 1 \right\}$$

For Trial 1 of specific gravity, water content can be determined by:

1. Weight of empty bottle (W_1) = 612g
2. Weight of bottle + Fine Aggregate (W_2) = 860g
3. Weight of bottle + Fine Aggregate + water (W_3) = 1608g
4. Weight of bottle + water (W_4) = 1405g
5. Specific gravity (G) = 2.75
6. Water Content = 99.88%

3.3 TEST ON COARSE AGGREGATE

3.3.1 Sieve Analysis of Coarse Aggregate

The coarse aggregates have fineness modulus usually more than 5.A heap of aggregate is classified as a single sized aggregate when the bulk of aggregate passes one sieve in normal concrete series and retained on next smaller size. Such aggregates are normally expressed by the maximum size of the aggregates present in considerable amount in it. For example, a heap of 20 mm size aggregate means that the heap containsmaximum20mm size aggregate in a substantial amount.

A graded aggregate comprises of a proportion of all sizes in a normal concrete series. When these sizes are so proportionated to provide a definite grading, it is known as well graded aggregate. Well graded aggregates are desirable for making concrete, as the space between larger particles is effectively filled by smaller particles to produce a well-packed structure. This minimizes the cement requirement.

All-in aggregates comprise a mixture of coarse aggregate and fine aggregates. Such aggregates may directly be used for low quality concreting. But in case of good quality concreting work; necessary adjustments may be made in the grading by the addition of single-sized aggregates.

Fig 3.5 Sieve Analysis of coarse aggregate

Table 3.7 Sieve Analysis of Coarse Aggregate

Weight of coarse aggregate taken (W_c): 5Kg					
Sl. No.	**Sieve size**	**Weight retained (in kg)**	**%age retained $\frac{C_3}{W_c} \times 100$**	**Cumulative %age retained**	**Percentage passed (100 – C_5)**
C_1	**C_2**	**C_3**	**C_4**	**C_5**	**C_6**
1	**80 mm**	**0**	**0**	**0**	**100**
2	**40 mm**	**0**	**0**	**0**	**100**
3	**20 mm**	**2.685**	**53.7**	**53.7**	**46.3**
4	**10 mm**	**2.234**	**44.68**	**98.88**	**1.62**
5	**4.75 mm**	**0.081**	**1.62**	**100**	**0**
6	**Pan**	**0**	**0**	**100**	**0**
Sum of cumulative percentage retained (excluding pan) $\sum C_5$=				**252.08**	**-**
Fineness Modulus $\frac{\sum C_5}{100}$ +				**2.52**	**-**
Grade to which the coarse aggregate belongs:				**Well Graded**	

3.3.2 Water Absorption Test:

This test helps to determine the water absorption of coarse aggregates as per IS: 2386 (Part III) – 1963. For this test a sample not less than 2000g should be used.

Apparatus used:

Wire basket – perforated, electroplated or plastic coated with wire hangers for suspending it from the balance, Water-tight container for suspending the basket, Dry soft absorbent cloth – 75cm x 45cm (2 nos.), Shallow tray of minimum 650 sq.cm area, Air-tight container of a capacity similar to the basket and Oven.

Procedure:

- The sample should be thoroughly washed to remove finer particles and dust, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22 and 32^{o}C.
- After immersion, the entrapped air should be removed by lifting the basket and allowing it to drop 25 times in 25 seconds. The basket and sample should remain immersed for a period of 24 + ½ hours afterwards.
- The basket and aggregates should then be removed from the water, allowed to drain for a few minutes, after which the aggregates should be gently emptied from the basket on to one of the dry clothes and gently surface-dried with the cloth, transferring it to a second dry cloth when the first would remove no further moisture. The aggregates should be spread on the second cloth and exposed to the atmosphere away from direct sunlight till it appears to be completely surface-dry. The aggregates should be weighed (Weight 'A').
- The aggregates should then be placed in an oven at a temperature of 100 to 110^{o}C for 24hrs. It should then be removed from the oven, cooled and weighed (Weight 'B').

Formula used is Water absorption = [(A – B)/B] x 100%.

Table 3.8 Water Absorption Test

TRIAL	Wt. of Saturated Sample in grams A	Wt. of Oven Dried Sample in grams B	%age of water absorption	Average
1.	1080	1010.2	6.91	4.04
2.	1072.9	1054.6	1.73	
3.	1036.4	1001.5	3.48	

3.3.3 Impact Test on Coarse Aggregate

The test sample consists of aggregates sized 10.0 mm 12.5 mm. Aggregates may be dried by heating at 100-110° C for a period of 4 hours and cooled.

- Sieve the material through 12.5 mm and 10.0mm IS sieves. The aggregates passing through 12.5mm sieve and retained on 10.0mm sieve comprises the test material.
- Pour the aggregates to fill about just 1/3 rd depth of measuring cylinder.
- Compact the material by giving 25 gentle blows with the rounded end of the tamping rod.
- Add two more layers in similar manner, so that cylinder is full.
- Strike off the surplus aggregates.
- Determine the net weight of the aggregates to the nearest gram(W).
- Bring the impact machine to rest without wedging or packing up on the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical.

- Fix the cup firmly in position on the base of machine and place whole of the test sample in it and compact by giving 25 gentle strokes with tamping rod.
- Raise the hammer until its lower face is 380 mm above the surface of aggregate sample in the cup and allow it to fall freely on the aggregate sample. Give 15 such blows at an interval of not less than one second between successive falls.
- Remove the crushed aggregate from the cup and sieve it through 2.36 mm IS sieves until no further significant amount passes in one minute. Weigh the fraction passing the sieve to an accuracy of 1 gm. Also, weigh the fraction retained in the sieve. Compute the aggregate impact value. The mean of two observations, rounded to nearest whole number is reported as the Aggregate Impact Value.

Table 3.9 Impact test of coarse aggregate

S. NO	DESCRIPTION	TRIAL 1	TRIAL 2	TRIAL 3
1.	Total weight of aggregate sample filling the cylinder (W_1 g)	382	385	381
2.	Weight of aggregate passing 2.36mm sieve after the test (W_2 g)	79.6	74.3	82.7
3.	Aggregate Impact Value (w_2/w_1) x 100%	20.83	19.30	21.7
4.	Average Impact Value%	20.61		

3.4 WATER QUALITY STANDARDS:

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. A popular yard-stick to the suitability of water for mixing concrete is that, if water is fit for drinking it is fit for making concrete.

Table No 3.10 Determination of Water Quality

S. NO	TESTS TO BE CONDUCTED	OBTAINED LIMITS	PERMISSIBLE LIMITS	REFERRED CODE BOOKS
1.	Determination of Calcium in the given water sample	72.156 mg/l	75mg/l	IS3025 (PART 23)
2.	Determination of Ammonia Nitrogen in the given water sample	11.3 mg/l	12mg/l	IS10500
3.	Determination of Chloride in the given water sample	200mg/l	250mg/l	IS3025 (PART 32)
4.	Determination of pH in the given water sample	7	6.5 – 8.5	IS3025 (PART 11)

CHAPTER - 4
MIX DESIGN

DESIGN STIPULATION:

Grade Designation	M30
Type of cement	OPC 53grade
Fine Aggregate	Zone-II
Sp. Gravity Cement	3.15
Sp. Gravity Fine Aggregate	2.65
Sp. Gravity Coarse Aggregate	2.67
Sp. Gravity GGBS	2.84
Slump	100 mm

1. TARGET MEAN STRENGTH:

$f_{ck} = f_{ck} + 1.65s$

$= 30 + (1.65 \times 5)$

$= 38.25\ N/mm^2$

2. SELECTION OF WATER CEMENT RATIO:

W/c = 0.45 (From Table 5 of IS 456 – 2000)

Water cement ratio = 0.40 (Based on experience)

Adopt lower value w/c = 0.40

3. CALCULATE OF WATER CONTENT & SAND CONTENT:

Water content = 186 kg (As per Table No. 2, IS: 10262:1982)

Required water content $= 186+[\frac{6}{100} X\ 186]$

$= 197.16\ lit/\ m^3 \sim 197\ lit/\ m^3$

Use of super plasticiser water content can reduced to 20%

$= 197 \times 0.8 \sim 158 lit/\ m^3$

4. CALCULATE THE CEMENT CONTENT:

Cement content = water content / w/c ratio

= 158/0.40

= 395 kg/m^3

5. CALCULATE VOLUME OF CA &FA:

From Table 3 of is 10262 : 2009,

At rate of ±0.01 for every ±0.05 change in water-cement ratio

Therefore, Volume of coarse aggregate = 0.64

Volume of fine aggregate = 1 – 0.64 = 0.36

6. MIX CALCUALATION:

a. Volume of concrete = 1m^3

b. Volume of cement $= \frac{\text{Mass of cement}}{\text{Specific Gravity of cement}} \times \frac{\mathbf{1}}{\mathbf{1000}}$

$= \frac{395}{3.15} \times \frac{1}{1000}$

= 0.125m^3

c. Volume of water $= \frac{\text{Mass of water}}{\text{Specific Gravity of water}} \times \frac{\mathbf{1}}{\mathbf{1000}}$

$= \frac{158}{1} \times \frac{1}{1000}$ = 0.158 m^3

d. Volume of chemical admixture $= \frac{\text{Mass of water}}{\text{Specific Gravity of water}} \times \frac{\mathbf{1}}{\mathbf{1000}}$

(2% of cement) $= \frac{8}{2.84} \times \frac{1}{1000}$ = 0.002 m^3

e.Volume of all in aggregate = [a - (b+c+d)]

= [1 – (0.125+0.158+0.002)]

= 0.697m^3

e. Mass of coarse aggregate= d × volume of C.A × specific gravity of C.A × 1000

= 0.697 × 0.64 × 2.67 × 1000

~1191 kg

f. Mass of fine aggregate = d × volume of C.A × specific gravity of F.A × 1000

= 0.697 × 0.36 × 2.65 × 1000

= 664.8~ 665 kg

7. RESULT:

a.	Cement	= 395 kg/m^3
b.	Water	= 158 litres
c.	F.A	= 665 kg
d.	C.A	= 1191kg
e.	w/c ratio	= 0.40
f.	Chemical Admixture	= 8kg
g.	Mix Proportion	=395: 665 : 1191
		= 1: 1.68: 3.01
		˜ 1: 1.5: 3

RESULTS & DECLARATION

4.1 RUBBER POWER: AN OVERVIEW

In recent decades, the worldwide growth of the automobile industry and the increasing use of cars as the main means of transport have tremendously boosted tire production. This has generated massive stockpiles of used tires. Extensive research projects were carried out on how to use used tires in different applications. The scrap tires in Algeria are estimated at approximately 25,918 tones/year.Waste tires need a larger storage space than other waste due to their large volume and fixed shape. They are unlikely to be decomposed, as burying the waste tires would shorten the service life of the burial ground and have low economic benefit; In addition, buried waste tires often emerge from the burial ground surface or destroy the anti-leakage cover of the burial ground and the exposed waste tires accumulate water that may breed bacteria, molds, insects or mice. In case of fire, waste tires generate toxic gases, such as dioxin, that could result in severe pollution problem.

In order to properly dispose these millions of tires, the use of innovative techniques to recycle them is important. The use of scrap tires including tire chips or tire shreds comprised of pieces of scrap tires, tire chip/soil mixtures, tire sidewalls, and whole scrap tires in civil engineering applications is the object of the standard ASTM D 6270. These materials can be used in lightweight embankment fill, lightweight retaining wall backfill, drainage layers, thermal insulation to limit frost penetration beneath roads, insulating backfill to limit heat loss from buildings, and replacement for soil or rock in other fill applications.

Rubber tires can also be used in civil and non-civil engineering applications such as in road construction, in geotechnical works, as a fuel in cement kilns and incineration for production of electricity or as an aggregate in cement-based products or in geotechnical field.

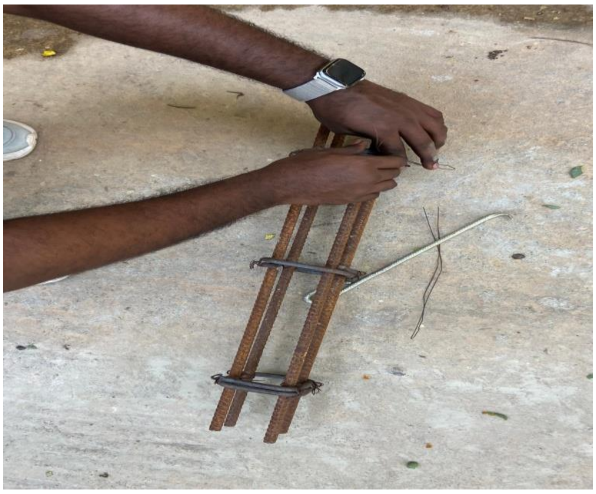
4.2 CASTING OF CONCRETE

Concrete is a composite material composed of fine and coarse aggregate bonded together with a cement that hardens over time. Composed of sand, gravel and cement, concrete is usually lime-based. Water is the catalyst which causes the lime to react. Casting concrete is considerably crucial task in building construction and requires great planning and accuracy, in addition to proper execution sequence. Concrete of mixing is a process of mixing the ingredient of concrete such as cement, sand, aggregate, water, and admixture together to make concrete of suitable grade. To make the different grades of concrete, mixing of concrete materials should be done properly as per the mix design of concrete to achieve the design strength of concrete.

Mixing of Concrete is a very complex process. For making good quality concrete, we just have to follow some standard process of mixing its ingredients. It just does not up to making concrete, but making good quality concrete is important.

Production of good quality and bad quality of concrete includes the same material, but the proportion and mixing method can be a differentiating factor. It requires proper care and knowledge for making good quality concrete.

CASTING PHOTOS:



4.3 CURING OF CONCRETE:

Curing of Concrete is a method by which the concrete is protected against loss of moisture required for hydration. Curing practice involves keeping the concrete damp or moist until the hydration of concrete is complete and strength is attained. Curing of concrete should begin soon after initial setting time of concrete or formwork/shuttering is removed and must continue for a reasonable period of time as per the specified standards, for the concrete to achieve its desired strength and durability. A curing practice involves keeping the concrete damp or moist until the hydration of concrete is complete and strength is attained. Curing of concrete should begin soon after initial setting time of concrete or formwork/shuttering is removed and must continue for a reasonable period of time as per the specified standards, for the concrete to achieve its desired strength and durability.It is important to make sure an uninterrupted hydration of PCC & RC after concrete is placed and finished in its position. Uniform temperature ought to be maintained throughout the concrete-section depth to avoid thermal shrinkage cracks.

4.4 FLEXURAL STRENGTH

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam to resist failure in bending. It is measured by loading 150 x 150mm concrete beams with a span length of 700 mm. This test is performed by three point loading experiment. The Third point loading test applies the forces at the 1/3 and 2/3 points equally from the top side by distributing a single centred force through a steel beam to two points rather than one. The beam is supported at two points from below near the ends. The bending moment is lower in a third point test than in a centre point test. Highway designer use a theory based on flexural strength for design of pavements. However, there is very limited use of flexural testing for structural concrete.

Flexural strength tests are extremely sensitive to specimen preparation, handling, and curing procedure. Beams are very heavy and can be damaged when handled and transported from the jobsite to the lab. Allowing a beam to dry willyield lower strengths. The beams must be cured in a standard manner, and should be tested while wet. Meeting all these requirements on a job site is extremely difficult and hence often results in unreliable and generally low MR values. A short period of drying can produce a sharp drop in flexural strength.

Objective : To determine flexural strength of cubic concrete specimens.

Reference : IS:516-1959,IS:1199-1959,SP:23-1982,IS:10086-1982.

Apparatus : Flexural testing beam moulds, tamping rod, metallic sheet, Universal testing machine.

Material : Cement, sand, aggregate and water, grease

Procedure:

- Sampling of Materials: Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition. The cement samples, on arrival at the laboratory, shall be thoroughly mixed dry either byhand or in a suitable mixer in such a manner as to ensure the greatest possible blending and uniformity in the material.
- Proportioning: The proportions of the materials, including water, in concrete mixes used for determining the suitability of the materials available, shall besimilarin all respects to those to beem ployed in the work.
- Weighing: The quantities of cement, each size of aggregate, and water for each batch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch.
- Mixing of Concrete: The concrete shall be mixed by hand, or preferably, in a laboratory batch mixer, in such a manner as to avoid loss of water or other materials. Each batch of concrete shall be of such a size as to leave about 10

percent excess after moulding the desired number of test specimens.

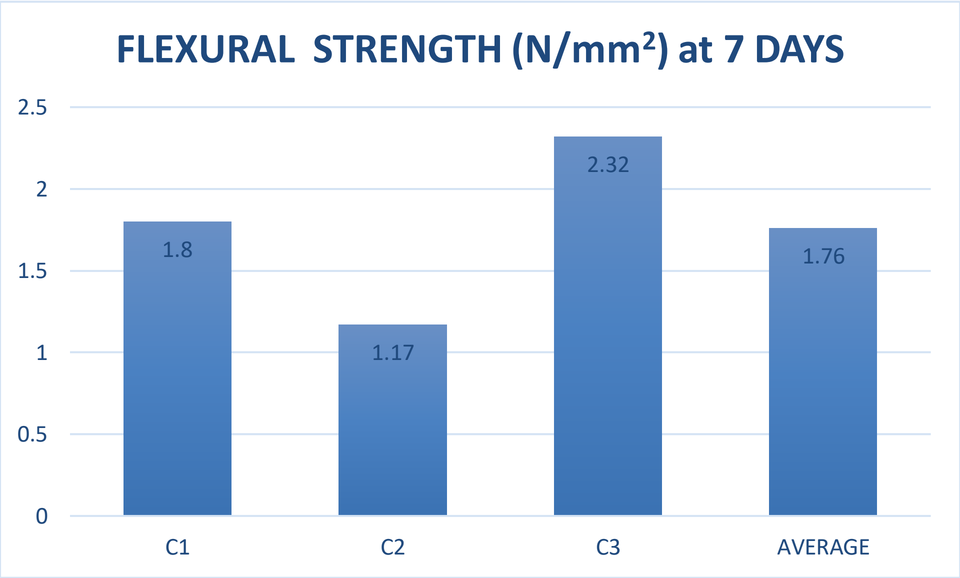
- Mould: The standard size shall be 15 × 15 × 70 cm. Alternatively, if the largest nominal size of the aggregate does not exceed 19 mm, specimens 10 × 10 × 50cm may be used.
- Compacting: The test specimens shall be made as soon as practicable after mixing, and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance.
- Curing: The test specimens shall be stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27° ±2°C for 24 hours ± ½ hour from the time of addition of water to the drying redients.
- Placing the Specimen in the Testing Machine: The bearing surfaces of thesupportingandloadingrollersshallbewipedclean,andanyloosesandorother material removed from the surfaces of the specimen where they are to make contact with the rollers
- The specimen shall then be placed in the machine in such a manner that the load shall be applied to the uppermost surface as cast in the mould, along two line spaced 20.0 or13.3cm apart.
- The axis of the specimen shall be carefully aligned with the axis of the loading device. No packing shall be used between the bearing surfaces of the specimen and the rollers.
- The load shall be applied without shock and increasing continuously at a rate such that the extreme fibre stress increases at approximately 7 kg/sq cm/min, that is, at a rate of loading of 400 kg/min for the 15.0 cm specimens and at arateof180 kg/min forthe10.0 cm specimens.
- The load shall be increased until the specimen fails, and the maximum load applied to the specimen during the test shall be recorded. The appearance of the fractured faces of concrete and any unusual features in the type of failure shall be noted.

TESTING PHOTOS

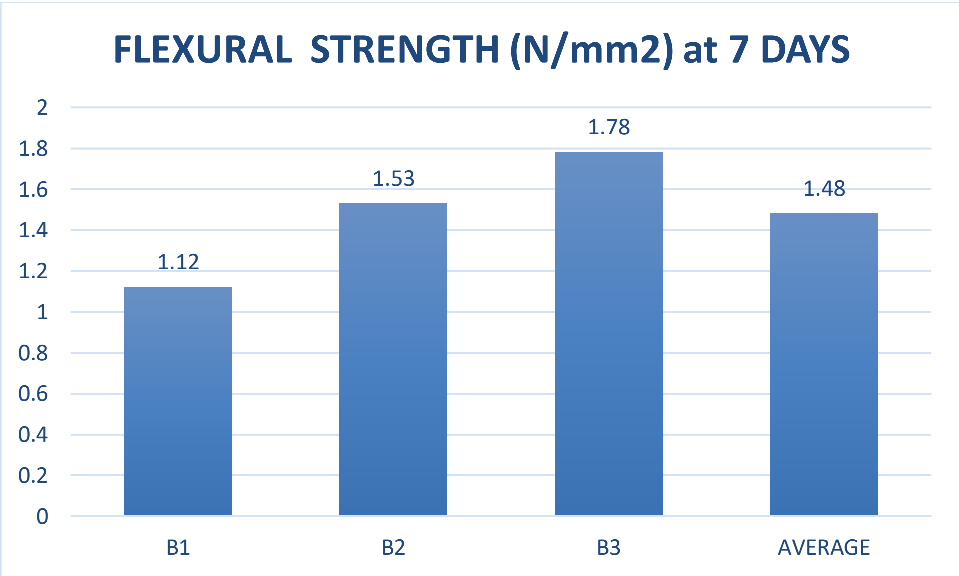
4.5RESULT :

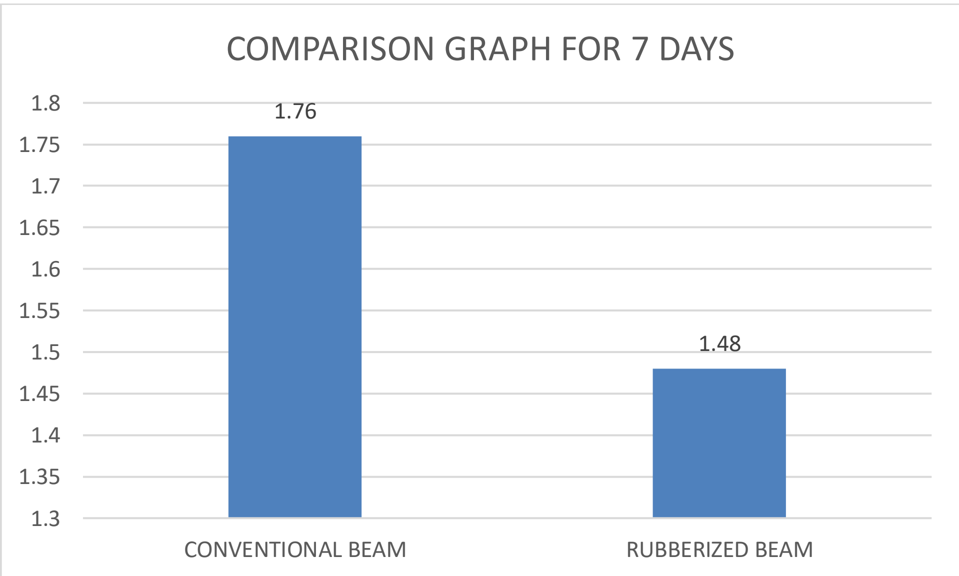
4.5.1FLEXURAL STRENGTH (N/mm^2) at 7 DAYS

SPECIMEN DETAILS	FLEXURAL STRENGTH (N/mm^2) at 7 DAYS
C1	1.8
C2	1.17
C3	2.32
AVERAGE	1.76



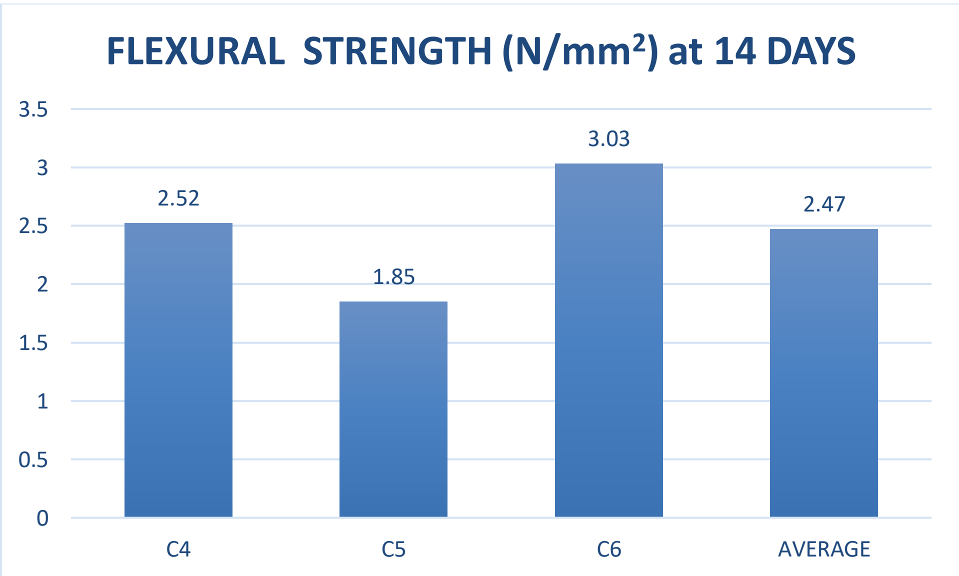
SPECIMEN DETAILS	FLEXURAL STRENGTH (N/mm^2) at 7 DAYS
B1	1.12
B2	1.53
B3	1.78
AVERAGE	1.48



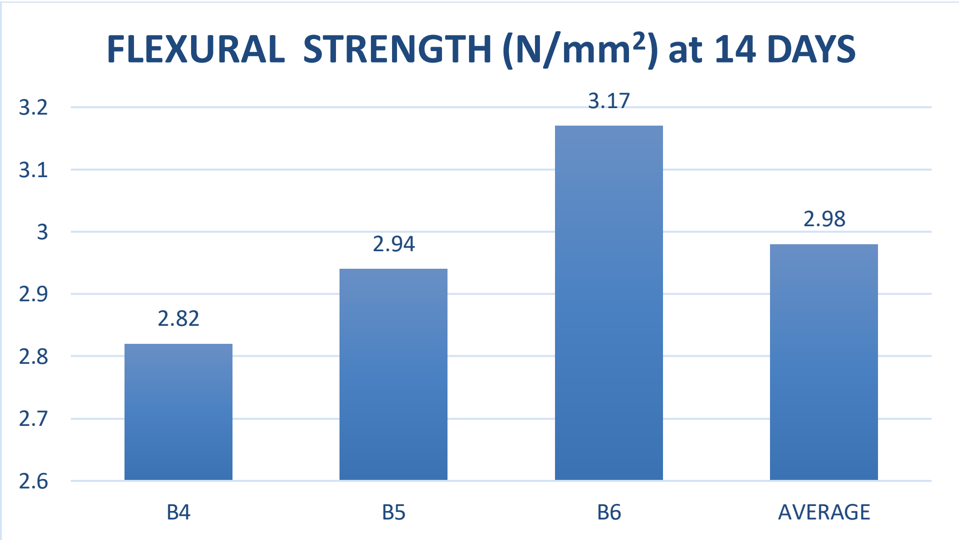


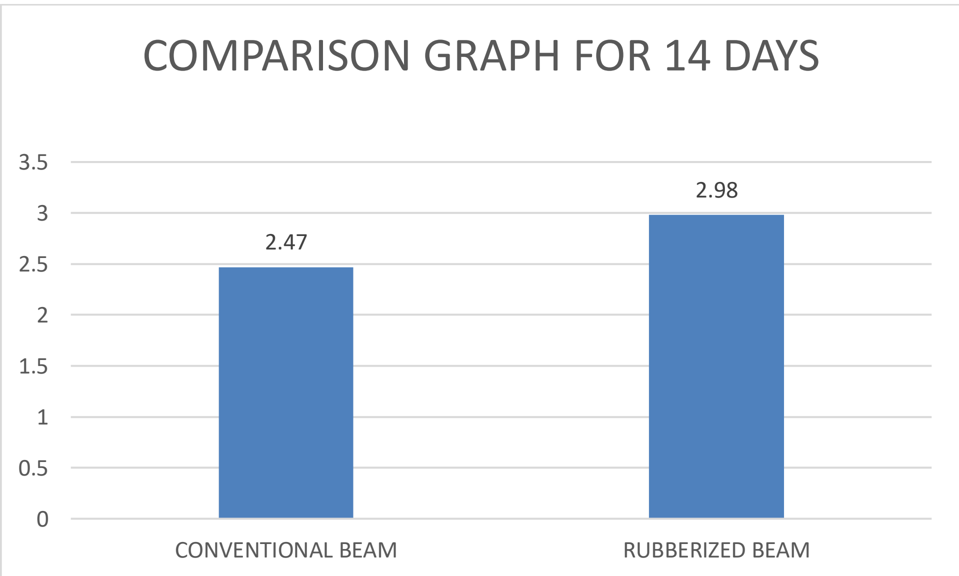
4.5.2 FLEXURAL STRENGTH (N/mm^2) at 14 DAYS

SPECIMEN DETAILS	FLEXURAL STRENGTH (N/mm^2) at 14 DAYS
C4	2.52
C5	1.85
C6	3.03
AVERAGE	2.47



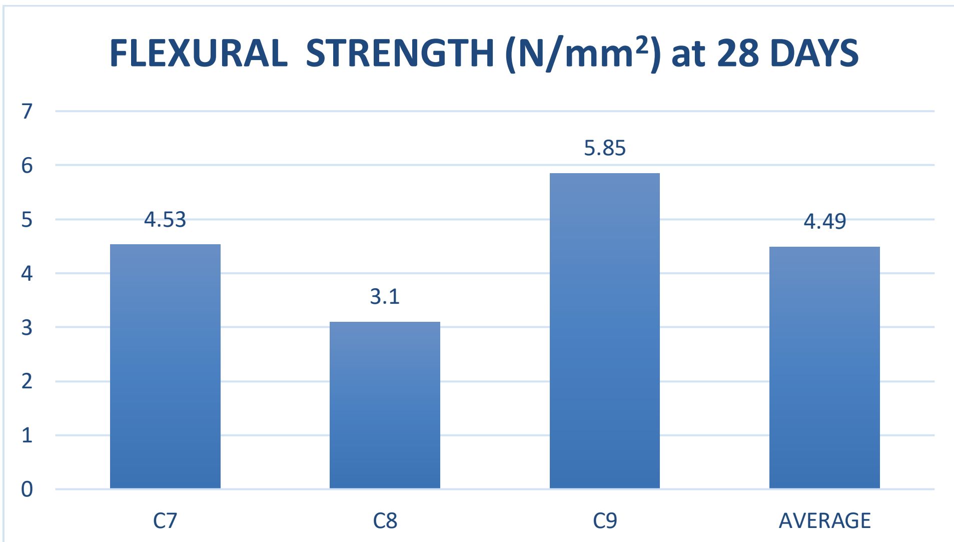
SPECIMEN DETAILS	FLEXURAL STRENGTH (N/mm^2) at 14 DAYS
B4	2.82
B5	2.94
B6	3.17
AVERAGE	2.98



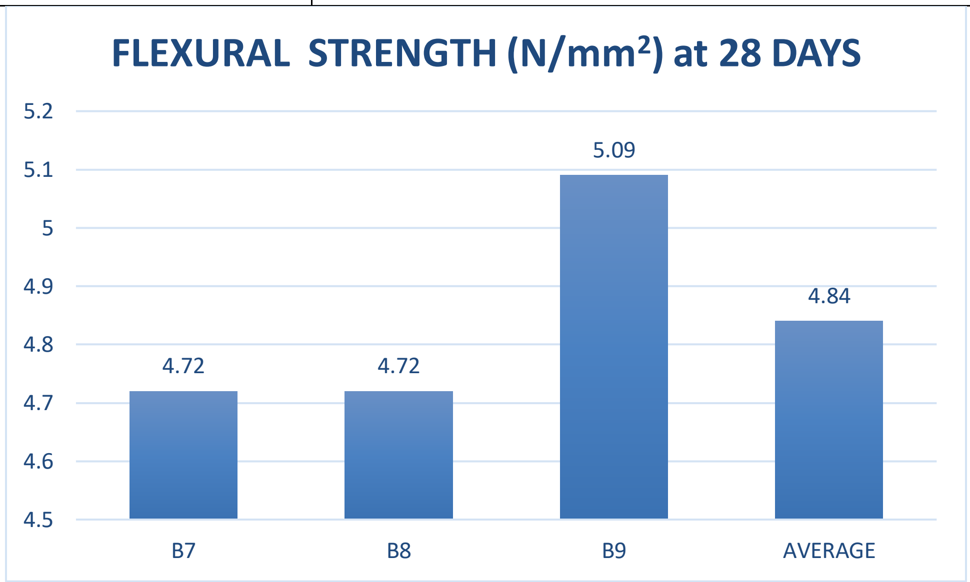


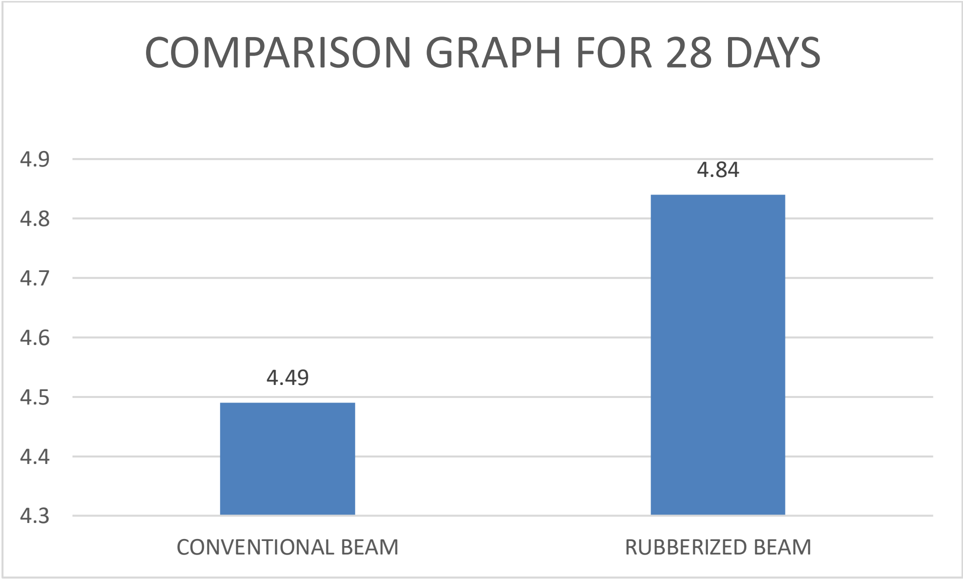
4.5.3FLEXURAL STRENGTH (N/mm^2) at 28 DAYS

SPECIMEN DETAILS	FLEXURAL STRENGTH (N/mm^2) at 28 DAYS
C7	4.53
C8	3.1
C9	5.85
AVERAGE	4.49



SPECIMEN DETAILS	FLEXURAL STRENGTH (N/mm^2) at 28 DAYS
B7	4.72
B8	4.72
B9	5.09
AVERAGE	4.84





CHAPTER – 5

CONCLUSION

Based on the presented experimental program, the following conclusions can be offered.

- The installation of PVC pipes in reinforced concrete beams increases the strength and rigidity of the beams depending on sizes and locations of these pipes.
- There is no need to take any precautions regarding the beam with central pipe if the diameter of the pipe is about or less than one third of the beams width. The most preferable location to install pipe in reinforced concrete moderate deep beams is at the center of the beams away from the tension reinforcement in order to avoid bond failure.
- Experimental investigation revealed that rubberized beam can withstand approximately the same stress as that of conventional beam and their strength increased gradually with the curing period.
- Therefore, beams embedded with PVC pipe filled with crumbled rubber powder can replace conventional beam due to its economy, strength and the PVC pipe can serve the purpose of conduit pipes for electrical wire installation.

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