CHAPTER 1
Partial Replacement of Fine Aggregate in Concrete by Using Bakelite Waste

Prof. M. Vadivel
Nehru Institute of Technology, India

Dr. M. Sivaraja
Nehru Institute of Technology, India

Prof. P. Madhan
Nehru Institute of Technology, India

Prof. P. Siddharthan
Nehru Institute of Technology, India

ABSTRACT

The automobile marketing is one of the major problems in creating environmental problems in the earth. One of the most automobile waste is Bakelite i.e., E-plastic waste, which is the phenol formaldehyde resin (thermosetting plastic). It is one of the most toxic materials. The Bakelite waste is filled on the land or incinerated, both causes hazards to the environment and creates health problems to the living organisms. Bakelite waste is prohibited from disposing of direct land filling and open burning, which becomes a waste management problem. The purpose of this research is the use of waste Bakelite aggregate as fine aggregate to replace natural sand material partially. The Waste Bakelite Fine Aggregate (WBFA) was mixed in concrete mixture with various proportion. The sample was tested for compressive strength, split tensile strength and flexural strength shear strength and modulus of elasticity. The objective of this study is a transformation of a waste Bakelite from industrial manufacturing by size reduction with the milling machine. The smaller size of waste Bakelite will be classified into coarse aggregate and fine aggregate by sieve. There are some studies and conclusions by researchers for the properties of plastic waste mixed in the concrete. The compressive strength of premixed concrete blended with recycling plastic (PCBWRP) decreased when a percentage of recycling plastic in the concrete was increased. The tensile strength of plastic mixed concrete lower than traditional mortar and adversely correlated to the rate of recycling plastic mix in the concrete and tensile strength. In the paper, the studying will focus on the transformation of waste of Bakelite and utilization of waste Bakelite fine aggregate (WBFA) as natural fine aggregate (NFA) replacement in a cement mortar. The milling capacity, the gradation of waste Bakelite fine aggregate grain size was analyzed, and illustrated by particle size distribution curve. The utilization study of waste Bakelite concrete (WBC) proceeded by the inspection of the compressive strength of mortar specimens, Furthermore, find the correlation between waste Bakelite fine aggregate (WBFA) content and compressive strength of the mortar. By preparing and testing mortar samples with 0% 20% sand replacement percentage at curing age 28 days, the samples test follows ASTM 109 and the test results compared with the industrial standard allowable compressive strength of plastic cement concrete.

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The conversion process of waste Bakelite compose of waste Bakelite size reduction, waste Bakelite aggregates classification by the sieve , waste Bakelite fine aggregate utilization in cement mortar and sample test.

Keywords: *E-plastic waste, Bakelite size reduction, distribution curve etc*

INTRODUCTION

Concrete is the most widely used material in construction industry. It is understood that concrete is the second most used material after water. Considering the usage and importance, several newer techniques have evolved over time. The complexity and deficiencies associated with it is not fully resolved.

Bakelite, is an early plastic. It is thermosetting phenol formaldehyde resin, formed from condensation reaction of phenol with formaldehyde. Bakelite material has been used to produce the various components for cars and consumer goods industry. The growth of Bakelite consumption increases Bakelite waste. Bakelite waste is prohibited from disposing of direct land filling and open burning, which becomes a waste management problem. The purpose of this research is the use of waste Bakelite aggregate as fine aggregate to replace natural sand material partially. The Waste Bakelite Fine Aggregate (WBFA) was mixed in concrete mixture with various proportion. The sample was tested for compressive strength, split tensile strength and flexural strength shear strength and modulus of elasticity.

To achieve rapid urbanisation every year smaller structures are demolished and newer and bigger ones are constructed. These demolished materials are often dumped on land and is not reused for any purpose. This practice effects the fertility of land. With the wave of sustainability also impacting the construction industry, scientist and engineers throughout the world are looking for sustainable and reusable construction materials. One such material is recycled aggregate concrete.

During the part few decades kongkaratet stated that the global demand for plastics had grown significantly over , with the world wide consumption approaching ~ 100 million tons per year crespyetal ;dharanidharanetal with explained that Bakelite in 1993 , it was designated a national historic chemical landmark by the American chemical society in recognition of its significance as the world's fist synthetic plastic .It is a thermoset phenol formaldehyde resin commonly used for parts of automobiles, electric insulators, telephone casings and heat resistant properties in kitchenware that is formed from an elimination reaction of phenol with formaldehyde. These products are suitable for the high durability application. Calcium carbonate ($CaCO_3$) is found in the polymer as a filler material, and limited published research exists on the recycling of thermosets. It cannot be remelted from a new product, and are landfilled or incinerated, both of which lead to environmental problems.

Toxic effects of Bakelite are caused by the presence of phenol as well as methyl and athyl alcohols. The influence of Bakelite on water quality can be observed in an increasing of the oxidisability and the appearance of phenol in the water. Hence, disposal of Bakelite should be avoided to prevent water pollution.

Cross-linked polymers are formed when long chains are linked in one significant as the 3-dimentional structure with excellent rigidity. Addition and condensation polymers can exist with a cross-linked network depending 30on the monomers used in the synthesis. Familiar examples of cross-linked polymers are Bakelite, rubber, and casting (boat)resin. The process can be represented as follows.

Highly functional plastic products centering on phenol resin products are used in various automobiles-related products due to the outstanding properties achieved by its strong network bridge structure. Such as high heat resistance and excellent chemical resistance. In particular, Glass fiber-reinforced moulding materials excel in strength, rigidity , dimensional stability , and reliability and are used in various elements of mechanisms such as a pulley , disk brake pistons, and water pumps.

The objective of this study is a transformation of a waste Bakelite from industrial manufacturing by size reduction with the milling machine. The smaller size of waste Bakelite will be classified into coarse aggregate and fine aggregate by sieve.

There are some studies and conclusions by researchers for the properties of plastic waste mixed in the concrete. Usahanunth et al.Concluded that the compressive strength of premixed concrete blended with recycling plastic (PCBWRP) decreased when a percentage of recycling plastic in the concrete was increased. The tensile strength of plastic mixed concrete lower than traditional mortar and adversely correlated to the rate of recycling plastic mix in the concrete and tensile strength. Rahman et al.utilized PET-Fiber mixed in the cement concrete as fine aggregate partially replacement and found that the compressive strength of PET-concrete lower than conventional concrete but water absorption and porosity were higher than conventional .

In the paper, the studying will focus on the transformation of waste of Bakelite and utilization of waste Bakelite fine aggregate(WBFA) as natural fine aggregate (NFA) replacement in a cement mortar .The milling capacity, the gradation of waste Bakelite fine aggregate grain size was analysed, and illustrated by particle size distribution curve.

The utilization study of waste Bakelite concrete (WBC) proceeded by the inspection of the compressive strength of mortar specimens, Furthermore, find the correlation between waste Bakelite fine aggregate (WBFA) content and compressive strength of the mortar. By preparing and testing mortar samples with 0% 20% sand replacement percentage at curing age 28 days, the samples test follow ASTM 109 and the test results compared with the industrial standard allowable compressive strength of plastic cement concrete. The regression equations can represent the correlation between waste Bakelite fine aggregate replacement percentage and the compressive strength of waste Bakelite mortar. This formulation can determine the optimized replacement fraction to meet TIS 1776 -2542 minimum compressive strength.

The conversion process of waste Bakelite compose of waste Bakelite Bakelite size reduction , waste Bakelite aggregates classification by the sieve , waste Bakelite fine aggregate utilization in cement mortar and sample test.

LITERATURE REVIEW

Iglesias et al (2007) studied the tribological behaviour of Bakelite resin–matrix composites reinforced with nanocrystalline Al 6061 T6 particles produced by machining (grain size 70–500 nm). The combination validated a wear reduction of 60% with respect to the conventional microstructure reinforcement.

ku et al (2008) prepared Bakelite composites with ceramic based fillers envirospheres to increase strength and fracture toughness.

Yang et al. (2008), prepared phenolic silica hybrid using glycidyl alkene trialkoxy silane with improve strength and toughness. Gao (2008), prepared organic– inorganic hybrid boron-containing phenol–formaldehyde (BPFR) resin/SiO2 nanocomposites in-situ from boric acid, phenol, and tetramethoxysilane. TGA results revealed that the modified composites with 3 wt. % SiO2 exhibited higher heat resistance. The temperature of weight loss of 5% weight was 12.4°C higher than common BPFR. The residual ratio of 3 wt. % SiO2/BPFR was 11.2% higher at 900oC than common BPFR.

Jigang Wang et al (2009), studied the bonding assets of Bakelite resin with elemental silicon or boron carbide as modification additives. It was found that high temperature adhesive show drastic volume shrinkage and the decrease of mechanical strength at high temperature. Thus, the key to use HTA is to have good selection of additive and keeping resin matrix at optimized ratio.

Kawamoto et al (2010), prepared phenolic resin with inclusion of fillers, such as SiC and B4C, which results in better thermo-oxidative stability and mechanical strength. But it has poor homogeneity, adhesion and processing difficulties during moulding.

Shasha et al (2011), prepared novolac resin modified with γ- aminopropyltriethoxysilane-treated boron nitride (BN) particles. The effect of varying the BN concentration, particle size, and hybrid BN Fillers with the binary particle size distribution on the thermal conductivity of the composites was studied. It was observed that thermal stability was dependent on concentration and size of fillers.

Azeem and Zain-ul-Abdein (2012), prepared bakelite–graphite composite material by compression moulding technique. Gradual increase in thermal conductivity has been observed, with increase in conductive filler percentage in composite sample.

Zain-ul-Abdein et al (2012), studied computational development of graphite effect in different volume fractions on thermal conductivity of composite. It was found that optimum particle size and packing density are major factors to make it thermally stable as per industry requirements.

Chen et al (2013), introduced ZrB2 particles in Carbon–phenolic (C–Ph) composites to prepare thermal protection system. The ZrBO2 and B2O3formed help in improving ablation resistance and insulation performance of C–Ph composites.

Yuan et al (2013), used Zinc Oxide whiskers and Boron Nitride flakes as dispersion medium in Bakelite matrix to prepare effective thermal conductance network with maintained electric insulation. The elongation of break and strength also improved due to bridging of T-ZnO whiskers between BN flakes.

Lin et al (2013), prepared Novolac-type bisphenol-F based molybdenum– phenolic resins/silane-modified aluminium nitride composites. The molybdate form additional linkage with Bisphenol imparting a strong physical bonding between the two phases and silane modified aluminium nitride were well dispersed in the matrix with no gaps. Thus, the composites formed had several improved attributes such as high glass transition temperature, thermal resistance, flexural strength, and hardness.

METHODOLOGY

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. Typically, it encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques.

In this chapter we are going to discuss about the works carried out in this project i.e., from selection of topic to result analysis. Methodology helps us to know about the following details:

1. Literature survey
2. Data collection
3. Preparing specimen

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4. Casting the specimen

5. Testing of specimen

6. Analysis, results and conclusion

METHODOLOGY

Fig.3.1 METHODOLOGY.

COLLECTION OF MATERIALS

Cement-Ordinary Portland cement 53grade which is available in the market is used.

Coarse Aggregate-Locally available crushed stone, sieved with a 20 mm sieve, was used as coarse aggregate.

Fine Aggregate- Natural fine aggregate (NFA) . The natural saved used to fine aggregate complied to ASTM 136 which dry bulk specific gravity is 1602 kg/m as shown in the particular size distribution of natural fine aggregate. M Sand and natural sand which is locally available was used as fine aggregate.

Bakelite- (WBFA) shown in Bakelite fine aggregate (WBFA). The waste Bakelite fine aggregate was used to replace fine aggregate conformed to ASTM . The dry bulk specific gravity is 1304 kg/m as shown in(a) . The particular gradeation curve of natural fine aggregative (NFA) provided in. Waste Bakelite fine aggregate has specific surface area 0.828 m2/g, volume weighted mean 149.217µm. Analysis by mastersizer 2000 (Malvern instrument) as shown in.

MATERIAL PROPERTIES

CEMENT

Cement is a fine, grey powder. It is blended with water and materials, for example, sand, rock and squashed stone to make concrete. The bond and water frame glue that ties alternate materials together as the cement solidifies. The standard concrete contains two fundamental fixings in particular argillaceous and calcareous. In argillaceous materials mud prevails and in calcareous materials calcium carbonate.

AGGREGATES

Aggregate constitute the bulk of a concrete mixture and give dimensional stability to concrete. The most important function of the fine aggregate is to assist in producing workability and uniformity in mixture. The aggregates provide about 75% of the body of the concrete and hence its influence is extremely important. Based on the size of the aggregate they are divided into Fine and Coarse aggregates. Aggregates provide dimensional stability and wear resistance for concrete. Aggregate act as a filler material and lower the cost of concrete. Aggregates shall be hard, strong, dense, durable, clear and free from veins. As far as possible, flaky and elongated pieces should be avoided. Aggregates shall not contain any harmful material such as pyrites, coal, lignite, mica and inorganic quantity as to affect the strength or durability of the

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concrete. Aggregates which are chemically reactive with alkalis of cement are harmful as cracking of concrete takes place. The size and grading of aggregates are important parameters in the mix design.

Polyoxy benzyl methylen glycolan hydride was thermosetting phenol formaldehyde resin made from the condensation reaction of phenol with formaldehyde. Waste bakelite is obtained from machine parts of electrical systems, automobile parts, telecommunication workshop, etc.,

FINE AGGREGATE

In this project, manufactured sand (M sand) was used as fine aggregate. It is an alternative for river sand, due to fast growing construction industry the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the world. Due to the depletion of good quality river sand for the use of construction, the use of M sand has been increased. Another reason for the use of M sand is its availability and transportation cost. The M sand has required gradation of fines, physical properties such as shape, smooth surface, texture and consistency which make it the best sand suitable for construction. It provides greater strength to the concrete by reducing segregation, bleeding, honey combing, voids and capillary.

COARSE AGGREGATE

Locally available coarse aggregate retaining on 4.75 mm Sieve conforming to the recommendation of IS 383-1970 is used. Locally available coarse aggregate having the maximum size of 20mm is usually used. The aggregate must be clean and free from impurities. The coarse aggregate used in this project is of the size 20 mm.

MIX DESIGN

Mix design is a process of selecting suitable ingredients and determining their relative proportions with the objective of producing concrete of having minimum workability, strength and durability as economically as possible. M20, M25&M30 grade was used in this study.

CASTING

Materials are collected, weighed and mixed together with water added at regular intervals. After proper mixing, the mixture is poured into a well cleaned mould. It should be kept in a warm place and remain undisturbed for 24 hours. It should be removed after 24 hours.

TESTING

Various tests are performed in the laboratory for fresh and hardened concrete to compare the compressive strength, tensile strength and flexural strength of the control concrete with concrete made of different fibres.

There are 2 types of tests done in this project. They are:

- Tests on Fresh concrete.
- Tests on Hardened concrete

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Test on Fresh Concrete

Various test are performed on fresh concrete, they are:

- Slump cone test
- Flow test
- Vee bee consistency test
- Compacting factor test

Test on Hardened Concrete

- Compressive strength test
- Tensile test
- Flexural strength

MIX DESIGN

Mix design is a process of selecting suitable ingredients and determining their relative proportions with the objective of producing concrete of having minimum workability, strength and durability as economically as possible.

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. Mix design is mainly done to achieve the aimed test strength. If the water- cement ratio is below 0.5 then the workability is less. So, to increase the workability super plasticizer is added.

CONCRETE

Concrete is a composite material composed of coarse aggregate bonded together with fluid cement that hardens over time. Most concretes used are lime-based concrete such as Portland cement concrete or concretes made with other hydraulic cements.

NORMAL CONCRETE

The concrete in which common ingredients i.e. aggregate, water, cement is used is known as normal concrete. It is also known as normal weight concrete or normal strength concrete. It has a setting time of 30-90 minutes depending upon moisture in atmosphere, fineness of cement etc. The development of strength starts after 7days the common strength value is 10MPa to 40MPa.

Properties of Normal Concrete:

- Its slump varies from 1-4 inches.
- Density ranges from 140 kg/m3 to 175 kg/m3.

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- It is strong in compression and weak in tension.
- Air content 1-2 %.
- It is not durable against severe conditions like freezing and thawing.

REQUIREMENTS OF CONCRETE MIX DESIGN:

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

- 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.

TYPES OF MIX

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 the specified. However, due to the variability of mix ingredients the nominal concrete for a given workability varies widely in strength.

STANDARD MIXES

In the nominal mixes of fixed cement-aggregate ratio (by volumes) vary widely in strength and may result in under or over-rich mixes. For this reason, the minimum compressive 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 M20, M25, M30. In this designation the letter 'M' refers to the mix and the number specifies 28 days cube strength of mix in N/mm2.

DESIGNED MIXES

A single batch of ordinary Portland cement (OPC), M25 grade was used in this study. Polypropylene fibre and coconut fibre was bought from the store in Coimbatore.

The sand used in concrete was M sand and the coarse aggregate. This study is for creating high performance on concrete compressive strength.

AGGREGATE CONTENT

From Table 3 of (IS 10262:2009) Volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone II) for water-cement ratio of 0.50 =0.62 .

In the present case water-cement ratio is 0.44. Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water-cement ratio is lower by 0.06. The proportion

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of volume of coarse aggregate is increased by 0.02 (at the rate of -/+ 0.01 for every ± 0.05 change in water-cement ratio). Therefore, corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.47 = 0.63

NOTE: In case the coarse aggregate is not angular one, then also volume of coarse aggregate may be required to be increased suitably based on experience & Site conditions.

For pumpable concrete these values should be reduced up to 10%. Therefore, volume of coarse aggregate =0.63 x 0.9 =0.57.

Volume of fine aggregate content = 1 – 0.57= 0.43.

A-8 MIX CALCULATIONS

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = 1 m

b) Volume of cement = [Mass of cement] / {[Specific Gravity of Cement] x1000}

= 336/ {3.15 x 1000}

= 0.106 m

c) Volume of water = [Mass of water] / {[Specific Gravity of water] x 1000}

= 158/ {1 x 1000}

= 0.158m

d) Volume of chemical admixture = 1.75 litres/ m (By Trial and Error Method used 0.4% by the weight cement)

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

= [1-(0.106+0.158+0.004)]

= 0.732 m

f) Mass of coarse aggregate= e x Volume of Coarse Aggregate x Specific Gravity of Fine Aggregate x 1000

= 0.732x 0.57 x 2.67 x 1000

= 1114 kg/m

g) Mass of fine aggregate= e x Volume of Fine Aggregate x Specific Gravity of Fine Aggregate x 1000

= 0.732 x 0.43 x 2.65 x 1000

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= 834 kg/m.

A-9 MIX PROPORTIONS

Cement = 269kg/m

GGBS = 67 kg/m (20% By Total weight of Cement) Water = 158 l/m

Fine aggregate = 834 kg/m

Coarse aggregate 20mm = 891 kg/m

12mm = 223 kg/m (20% By Total weight of Coarse Aggregate)

Chemical admixture = 1.34 kg/m (0.4% by the weight of cement) Density of concrete = 2443 kg/m

Water-cement ratio = 0.47

Mix Proportion By weight = 1: 2.48: 3.31

TESTS CONDUCTED ON MATERIALS

TESTS ON AGGREGATES

In order to determine the properties of the aggregate number of tests have been carried out on the aggregate, they include porosity, void ratio and specific gravity.

SIEVE ANALYSIS

- Clean the sieves of sieve shaker using cleaning brush if any particles are struck in the openings.
- Record the weight of each sieve and receiving pan.
- Dry the specimen in oven for 3-4 minutes to get the dried specimen (ignore, if the specimen is already dried).
- Weigh the specimen and record its weight.
- Arrange the sieves in order as the smaller openings sieve to the last and larger openings sieve to the top. (Simply, arrange them to the ascending order of sieve numbers – No.4 sieve on top and no.200 sieve at bottom).
- Keep the weight recorded specimen on the top sieve and then keep the complete sieve stack on the sieve shaker.
- Allow the shaker to work 10-5 minutes – use the clock here..!
- Remove the sieve stack from the shaker and record the weight of each sieve and receiving pan separately.

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Sieve analysis helps to determine the particle size distribution of the coarse and fine aggregates. This is done by sieving the aggregates as per IS; 2386(Part I)-1963. In this we use different sieves as standardized by IS code and then pass aggregates through them and thus collect different sized particles left over different sieves.

A set of IS sieves of sizes- 4.75mm , 2.36mm, 1.18mm, 600µm, 300 µm, 150µ m, 75µ m, sieve and pan are used for this process. Weight of sand particle in each sieve is noted by weighing each sieve and then tabulates the value in the tabular column.

Fineness modulus of aggregate = (cumulative % retained)/100

TESTS ON CEMENT

- Field testing
- Standard consistency test
- Fineness test
- Strength test

FIELD TESTING

- Open the bag and take a good look at the cement, then it should not contain any visible lumps.
- Colour of cement should be greenish grey.
- Should get cool feeling when thrusted.
- When we touch the cement, it should give a smooth &not a gritty feeling.
- When we throw the cement on a bucket full of water before it sinks the particles should flow.

- When we make a stiff paste of cement & cut it with sharp edges & kept on a glass plate under water there won't be any disturbance to the shape& should get strength after 24hours.

STANDARD CONSISTENCY TEST

- Carefully weigh 400 gm of cement and place it on a non-porous surface
- Form a curator in the centre, in which add about 100 to 120 cc. of water
- Thoroughly mix the cement with water and fill, the Vicat's mould with the paste
- The interval from the moment of adding water to the dry cement to the moment of commencing to fill the mould is known as the time of gauging Aurora's Technological & Research Institute Concrete and Highway Engineering Lab Department of Civil Engineering 4 and shall not be less than 3 minutes and more than 5 minutes. Lower the plunger gently and test the penetration

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- If the penetration is between 5 to 7 mm from the bottom of the mould the quantity of water added is the required consistency. 6. Otherwise repeat the test with different percentages of water until the required penetration is obtained. Express the amount of water as a percentage by weight of the dry cement

Result: Standard consistency test on cement = 7mm.

FINENESS TEST

- Stir the sample of cement to be tested by shaking for 2 minutes in a stopper jar to disperse lumps. Stir the resulting powder gently using a clean dry rod in order to distribute the fines throughout the cement.
- Attach a pan under the sieve to collect the cement passing the sieve.
- Weigh approximately 10 g of cement to the nearest 0.01 g and place it on the sieve. Fit the lid over the sieve.
- Shake the sieve by swirling, planetary and linear movement until no more fine material passes through it.
- Remove and weigh the residue. Express its mass as a percentage (R1) of the quantity first placed in the sieve.
- Repeat the steps 3 to 5 with a fresh sample to obtain R2.
- If the results differ by more than 1 percent absolute, carry out a third sieving and calculate the mean of the three values.

Result: Percentage of fineness test on cement = 75.67%.

Strength Test

- This test shall be conducted at a temperature 270 + 20C.
- Weigh the material required for each cube separately.
- The quantity of cement, standard sand and water required for each cube are as follows
- Cement = 200gms
- 2mm to 1mm – 200gms
- Standard Sand = 600gms 1mm to 500mic – 200gms
- Conforming to IS: 650 –1991. 500mic to 90mic – 200gms
- Water =(P/ 4+ 3) Percentage of combined mass of cement and sand.
- P is the consistency of cement as per IS: 4031 (Part 4) 1988.
- Place on a nonporous plate, a mixture cement and standard sand.
- Mix it dry with a trowel for one minute and then with water until the mixture is of uniform colour.

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- The time of mixing shall in any event be not less than 3 minutes and should be the time taken to obtain uniform colour exceeds 4 minutes.

- In assembling the moulds ready for use, cover the joints between the halves of the mould with a thin film of petroleum jelly and apply a similar coating of petroleum jelly between the contact surface of the bottom of the mould and base plate in order to ensure that no water escapes during vibration.

- Place the assembled mould on the table of the vibration machine and hold it firmly in position by means of suitable clamp, attach a hopper of suitable size and shape securely at the top of the mould to facilitate filling and hopper shall not be removed until the completion of vibration period.

- Immediately after fixing the mould in the vibrating machine, place the mortar in the cube mould and prod with the rod.

- Prod the mortar 20 times in about 8 seconds to ensure elimination of entrapped air and honey combing.

- Place the remaining mortar in the cube mould and prod again as specified for the first layer and then compact the mortar by vibration.

- The period of vibration shall be two minutes at the specified speed of 12000 + 400

- Vibrations per minute.

- Remove the mould from the vibrating machine and cut of the excess mortar with a Straight edge.

- Store the test specimens in a place free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27 + 20C for 24 + 1/2 hours from the addition of water to the dry ingredients.

- After this period, mark the specimens and remove from the moulds and unless required for test within 24 hours.

- Immediately submerge the cubes in a clean, fresh water or saturated lime solution and keep there until taken out just prior to test.

- Renew the water or solution in which the specimens are submerged for every seven days, and the temperature of water is maintained with the specified limits.

- Conduct testing at recognized ages of the specimens, the most usual being 7 and 28 days.

- When it may be necessary to obtain the early strength, tests may be conducted at the age of 72 + 2 hours. Calculate the ages from the addition of water to the dry ingredients. Test at least three specimens preferably from different batches at each selected age.

CASTING OF CONCRETE

The major impact of introduction of partial replacement of Bakelite reinforced concrete (BRC). The choice and handling of constituents are modified as well as mix design, batching, mixing and transporting. The casting of specimen which is used for testing of the strength parameters of concrete will be discussed in this chapter.

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EQUIPMENT’S NEEDED FOR CASTING SHOVELS

Shovels help distribute concrete around the job site to fill in gaps left during the pouring process or for smaller applications. Square-ended shovels generally work better for concrete; rounded ones spread concrete unevenly.

Moulds

For hard concrete tests such as Compression test and Split tensile test, we need specimen in the form of cubes, cylinders and beams.

CASTING PROCEDURE FOR NORMAL CONCRETE;

- Materials required for the mix is collected and weighed.
- Mix the materials by hand mixing.
- When mix is done, first coarse aggregate should be added followed by fine aggregates and at last cement with water added at regular intervals.
- The moulds should be cleaned properly and tightened using nuts and bolts. Oil or grease should be applied inside the base and walls of the moulds for easy removal of hardened concrete.
- After 10-15 minutes of mixing, concrete will be in fluid state. Concrete should be poured in the mixing sheet or taken in pans and laid inside the moulds.
- The moulds should be kept in a warm place and remain undisturbed for 24 hours. After 24 hours the mould should be removed.

TEST ON HARD CONCRETE

After casting and curing of concrete, the hardened concrete is tested at an interval of 7, 14 and 28 days in order to know the properties of hardened concrete and its strength parameters. Hard concrete tests are as follows

- Compression test
- Split tensile test
- Flexure test

COMPRESSION TEST

Out of many tests applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not.

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Compressive strength of concrete depends on many factors such as water- cement ratio, cement strength, quality of concrete material, and quality control during production of concrete etc. Test for compressive strength is carried out either on cube or cylinder. Various standard codes recommend concrete cylinder or concrete cube as the standard specimen for the test.

Procedure as per IS 516-1959for testing of concrete:

- Keep the specimen to be tested centrally on the clean lower plate so that small clearance is left between the upper platen and the top the specimen under test.
- Close the pressure release valve.
- Make the digital display to read "Zero" by adjusting the knob.
- Put the display unit on "Peak Hold"' mode to hold the maximum reading.
- Start applying the load at the specified pace rate, which could be maintained by adjusting the slow fast knob.
- If the pace rate is on higher side the indicator displays red colour and the pace rate is on lower side the indicator will display yellow colour.
- If the pace rate is exactly equal to set rate then the indicator will display green colour.
- As soon as sample fails, release the pressure slowly by opening valve.
- The digital display will be holding the maximum load reading at which sample has failed. Note down the pattern of failure and calculate the compressive strength in N/mm2 or Kg/cm2.
- Before starting another test, clean the lower platen and bring the digital display to “Zero” position by depressing the "Reset" switch.

SPLIT TENSILE TEST

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete.

The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

Procedure of Split Tensile Test:

- Take the wet specimen from water after curing.
- Wipe out water from the surface of specimen.
- Draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place.

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- Note the weight and dimension of the specimen.
- Set the compression testing machine for the required range.
- Keep are metal plate on the lower plate and place the specimen.
- Place the other metal plate above the specimen.
- Bring down the upper plate to touch the metal plate.
- Note down the breaking load (P)

FLEXURE TEST

Flexure tests are generally used to determine the flexure modulus or flexural strength of a material. Unlike a compression test or tensile test, it does not measure fundamental material properties. When a specimen is placed under flexure loading all three fundamental stresses are present: tensile, compressive and shear and so the flexure properties of a specimen are the result of the combined effect of all three stresses as well as the geometry of the specimen and the rate the load is applied.

Flexure strength is defined as the maximum stress at the outermost fibre on either the compression or tension side of the specimen. Flexure modulus is calculated from slope of the stress versus strain deflection curve. These two values will give bending forces.

Prepare the test specimen by filling the concrete into the mould in 3 layers of approximately equal thickness. Tamp each layer 35 times using the tamping bar as specified above. Tamping should be distributed uniformly over the entire cross-section of the beam mould.

The span length shall be 450 mm, which shall be ensured to the nearest mm, using a ruler. The test specimen must be turned on a side perpendicular to the position as cast, before placing it on the supports. The specimen shall be placed in the testing machine, correctly centered and with the longitudinal axis of the specimen at right angles to the longitudinal axes of the rollers. Tests during which the crack starts outside the middle third shall be rejected.

Calculation:

1. All load and deflection data required for further calculations shall be obtained from the digital data stored from the test

2. The first peak load (Pmax) is obtained as the load at the point where the slope of the load deflection curve is first zero.

3. The flexural strength (or modulus of rupture) is obtained for the first obtained for the first peak load, P'max, as:

Fct = (Pmax x L) / bd2

Where,

Fct = the flexural strength of an individual specimen, MPa Pmax = peak load, N

L = the span, mm

b = the average width of the specimen, as oriented for testing, mm d = the average depth of the specimen, as oriented for testing, mm

It should be noted that the value obtained may be significantly different from that obtained in a conventional test carried out under load control, where the specimen fails at the peak load.

RESULTS

This chapter deals with the presentation of results obtained from various tests conducted on concrete specimens cast with partial replacement of Bakelite. The main objective of the experimental program was to understand the strength and durability aspects of concrete obtained using Partial replacement of Bakelite. In order to achieve the objectives of present study, an experimental program was planned to investigate the effect of concrete on compressive strength and split tensile strength. The experimental program included the following:

- Testing the properties of materials used for making concrete. Design Mix M20& M25.
- Casting and curing of specimens.
- Tests to determine the compressive strength and split tensile strength of concrete.

CONCLUSION

The use of Bakelite as partial replacement for natural sand are economical for increasing their certain properties; for example, tensile strength, shear strength, toughness and combinations of these. Bakelite reduce the water permeability, plastic, shrinkage and settlement and carbonation depth. Workability of concrete decreases with increase in Bakelite concrete. The addition of Bakelite significantly improved many of the engineering properties of the concrete, notably compression, and tensile strength. Despite its excellent properties, Bakelite as an enhancement of concrete is unlikely to replace steel for the vast majority of structures.

The findings of experimental investigations on the strength characteristics of concrete enhanced with polypropylene fibre and coconut fibres are reported.

- The Bakelite concrete (2% to 4%) gives compressive strength which is more to the conventional concrete. So it is applicable for construction field.

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