Study on Mechanical Behaviour of Ball Point Pen Barrels (Polystrene) And Iron Cement Composite

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Abstract- *Plastic has been widely accept by the global industry is the most common and versatile material for marketing their products. Current level of pen using is well-liked and disposal is one of the massive environmental challenges that we have to give out it. Collecting and recycling ball point pen is one of the most important steps presently used to face this challenge. This paper talk about a bright environmental friendly solution for reducing land pollution by recycling ball point pen barrels (polystyrene). The main aim of our project is to make a ball point pen barrels (Polystyrene) and Iron cement composite and to study the mechanical behaviors like impact strength and Hardness. Making of this composite material give a solution to reuse of waste ball point pen barrels (Polystyrene) and also give a new composite material. In this work, barrels of use and throw ball point pens and iron cement have been utilized as raw materials for the composite, while Araldite resin and hardener are included in 10:8 ratios.*

Keywords- Ballpoint barrels, iron cement, polystyrene, recycling, wastage

I. INTRODUCTION

In India, 80% of total plastic consumption is discarded as waste and official statistics say the country generates 25,940 tonnes of waste daily. At least 40% of this is uncollected.

In the last 70 years, 8.3 billion tonnes of plastic have been produced. There is a bit of plastic everywhere, in our wallets, on our dining tables and kitchens, in our cars and buses and in our phones and offices.

It is nearly impossible to imagine a world without plastics. From its beginning in 1950, global plastic production has increased dramatically from 2 million tonnes to 380million tonnes in 2015. Its sheer convenience, lightweight and durable has made this man-made material ubiquitous in every sphere of human existence. In the last 70 years, 8.3 billion tonnes of plastic have been produced.

We almost always take the suffocation warning on plastic bags and packages seriously, keeping plastic packaging out of reach of babies and children. But we have not been as mindful with the planet. Of the 8.3 billion tonnes of plastic produced 6.3 billion tonnes have been discarded. Every year, nearly 13 million tonnes of plastic waste are added to oceans. Plastic bottles, jars, and containers, also known as rigid packaging, find their way into the reusing and recycling economy through informal chain of rag pickers and scrap dealers. There is a concerted effort to increase recycling of rigid plastic packaging by companies as well. Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly.

Modern composite materials constitute a significant proportion of the engineering materials market from every day products to sophisticated good applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective.

The efforts to produce economically attractive composite components have resulted in several innovation manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough in design, material, process, tooling, quality assurance, manufacturing and even program management for composites to become competitive with metals.

Unlike conventional materials (e.g., steel), the properties of the composite material can be designed considering the structural aspects. The design of a structural component using composites involves both material and structural design.

Plastic usage is banned in many states of India. But, we don’t recycle and reuse of existing plastics and unbanned plastics in large amount. In those ball point pens (Polystyrene) are monster waste which is forget to take into account. Recycling of ball point pens is difficult, but reuse can be

achieved by converting them into useful form without changing their chemical properties.

II. COMPOSITES

DEFINITION OF COMPOSITE

Composites are found by combining material together to form an overall structure that is better than the sum of the individual components. It is (also called a composition material or shortened to a composite) a material made from two or more constituents material with significantly different physical or chemical properties that, when combined produce and material with characteristics different from the individual components.

The individual component remains separate and distinct within the finished structure. The new material may be preferred for many reasons such as stronger, lighter or less expensive when compared to traditional material.

More recently researches have also begun to actively include sensing actuation, computation and communication into composite which are known as robotic material.

CHARACTERISTICS OF THE COMPOSITES

Composites comprise of at least one broken stages inserted in a consistent stage. The intermittent stage is generally harder and more grounded than the constant stage and is known as the "fortification" or "strengthening material", though the persistent stage is named as the 'lattice'.

Properties of composites are unequivocally subject to the properties of their constituent materials, their conveyance and the connection among them. The composite properties might be the volume division entirety of the properties of the constituents or the constituents may associate in a synergistic manner bringing about improved or better properties.

Aside from the idea of the constituent material the geometry of the fortification (shape, size and size conveyance) impacts the properties of the composite all things considered. The fixation dispersion and direction of the support likewise influence the properties.

The state of the broken stage (which may by circular, barrel shaped, or rectangular cross-endorsed crystals or platelets), the size and size circulation (which controls the surface of the materials) and volume portion decide the interfacial region, which assumes a significant job in deciding the degree of the communication between the support and the network.

Fixation typically estimated as volume or weight part, decides the commitment of a solitary constituent to the general properties of the composites. It isn't just the absolute generally significant

TYPES OF COMPOSITE MATERIAL

1 .Particle strengthened

- Large particles
- Dispersion

2. Fiber strengthened.

- Continuous
- Discontinuous

3. Structural Strengthened

- Lamination
- Sandwich boards.

PARTICLE REINFORCED COMPOSITES

These can be additionally ordered undersubgroups: - enormous molecule and scattering reinforce composites. The differentiation between these depends on fortification or fortifying system.

HUGE PARTICLE COMPOSITES:

The term huge show that molecule grid cooperation can't be treated on the nuclear or atomic level. Properties are a blend of those of the segments. The standard of blends predicts that a maximum restriction of the versatile modulus of the composite. Concrete is a recognizable case of huge molecule composite.

SCATTERING STRENGTHENED COMPOSITE*:*

This kind of composite contains little particulates or scatterings, which builds the quality of the composite by hindering the development of separations. The scattering is ordinarily a steady oxide of the first material. Molecule lattice association happens on the nuclear or atomic level and lead to reinforcing. A typical model is sintered aluminum powder (SAP). Particles for scattering fortified composited are regularly a lot littler (width between 0.01 mm and 0.1mm).

FIBER-REINFORCED COMPOSITES

Fortified composites are prevalently being utilized in numerous mechanical applications as a result of their natural high explicit quality and firmness. Because of their magnificent basic exhibition, the composites are increasing potential additionally in trip logical applications. In this sort composite the subsequent stage is as fiber scattered in the grid which could be either plastics or metal.

The volume division (VF) shifts from a couple of rate to as high as 70%. Generally the fiber strengthened is done to get high quality and high modulus. Subsequently it is fundamental for the fiber to gang's higher modulus than the network material, with the goal that the heap is moved to the fiber from the lattice all the more adequately.

MATERIAL SELECTION FOR BALL POINT PEN BARRELS (POLYSTRENE) AND IRON CEMENT COMPOSITE

POLYSTYRENE (PS)

Polystyrene is a manufactured fragrant hydrocarbon polymer produced using the monomer styrene. Polystyrene can be strong or frothed. Universally useful polystyrene is clear, hard and rather weak. Polystyrene is one of the most broadly utilized plastics the size of its creation being a few million tons for every year.

Polystyrene is a flexible plastic used to make a wide assortment of purchaser items. As a hard, strong plastic it is frequently utilized in items that require Clearness, for example, food bundling and research facility. At the point when joined with different colorants, added substances or different plastics, polystyrene is utilized to make machines, gadgets, vehicle parts, toys, planting pots and gear and the sky is the limit from there.

Polystyrene (PS) is a reasonable, nebulous, non polar item thermoplastic that is anything but difficult to process.

Polystyrene is made by stinging together or polymerizing, styrene a structure square substance utilized in the assembling of numerous items..

PS is a generally excellent electrical encasing, has incredible optical clearness because of the absence of crystalline, and has great compound protection from weakened acids and bases. It is additionally simple to create into an enormous number of completed merchandise since it is a thick fluid over its glass progress temperature that can be effectively shaped.

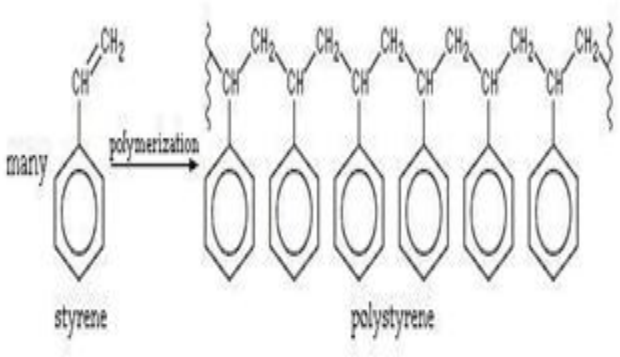

Fig 2.1 STRUCTURE OF POLYSTYRENE

THE THREE MOST IMPORTANT GRADES OF STYRENE ARE:

GPPS: General purpose polystyrene, also known as crystal-clear polystyrene, is a fully transparent, rigid and rather brittle low cost thermoplastic made from styrene monomer. GPPS is a solid product manufactured in the form of 2-5 mm pellets.

HIPS: High impact polystyrene contains usually 5 to 10% rubber (butadiene) and is used for parts which require higher impact resistance. HIPS are a graft copolymer having polystyrene side arms. The grafting occurs when some of the radicals react with the double bonds of the polybutadiene.

EPS: Expandable polystyrene consists of micro-pellets or beads containing a blowing agent (usually pentane). The expanded or foamed polystyrene is thermally insulating, has high impact resistance and good process ability.

Styrene Copolymers and their blends are considered engineering thermoplastics because their properties can be tailored over a wide range for a large number of applications with a broad range of processing methods which permits the manufacture of high quality, very durable plastic products suitable for many demanding applications.

Table 2.1 Physical Properties of Polystyrene

Property	Unit	Value
Specific Gravity	g/cm^3	1.03 to 1.06
Apparent Density	g/cm^3	0.60 to 0.65
Water Absorption	%	0.03 to 0.10

Table2.2 Mechanical Properties of Polystyrene

Property	Unit	Valve
Young's Modulus	MPa	3000-6000
Tensile Strength	MPa	30-60
Tensile Elongation	%	1.0 to 5.0
Shear Modulus	MPa	1400
Flexural Strength	MPa	76
Flexural Modulus	MPa	3200

BALL POINT PEN BARRELS POWDER AND CHIP FORMATION

Polystyrene is used as main element in our composite material. The polystyrene powder made form used ball point pen waste. Ball point were collected from the students and surrounding houses and then the pens which have polystyrene as a barrel were selected and removed all the dirt particles and other materials like cap, refill from the pens. The pens collected would be around 500 pens. This pens barrel only collected for making composite materials. Grain particles were separated and as powder and chips by using sieve

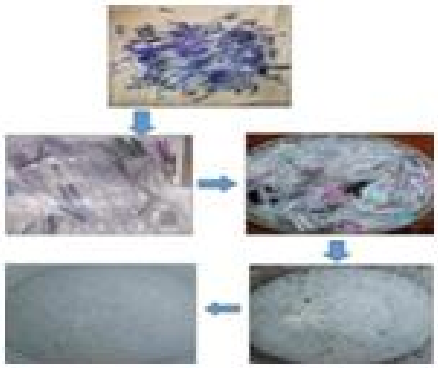

FIG: 2.2 POWDERS AND CHIP FORMATION

IRON CEMENT

IRON CEMENT is an inert material suitable for use as a "cosmetic repair compound" to remove surface defects, such as gas porosity, shrinkage, cracks etc. In ferrous castings and thus improve their overall appearance.

IRON CEMENT is supplied in a dry powder form that can be mixed with water to a paste-like consistency before using. Amount of water required for mixing will depend on the consistency of the paste necessary to suit type and size of the surface defects on castings.

A spatula can be used to apply the prepared Iron Cement paste but, generally, applying with a finger would prove practical and more effective. After polystyrene iron cement is major element in polystyrene and iron cement composite material. Polystyrene and iron cement are mixed in various proportions to make composite material.

The iron cement used as 30 % and 40% for manufacturing the composite specimens. The ratio of polystyrene powder and iron cement is 7:3 and 6:4. For getting good strength in polystyrene and iron cement composite material various ratio are used.

Fig2.3 IRON CEMENT

RESIN

Resin is a liquid synthetic organic polymer used as the basics of plastics, adhesives, varnishes, or other products. It is used to bind the materials. Two types of resin available synthetic and organic.

HARDNER

A hardener is a segment of particular sorts of blend. In certain blends a hardener is utilized essentially to build the strength of the blend, when it sets. In different blends a hardener is utilized as a restoring part. A hardener can be

either a reactant or an impetus in the substance response that happens during the blending procedure.

Araldite is cement utilized for specific purposes. Araldite cement sets by the connection of a pitch with a hardener.

Warmth isn't important albeit warming will lessen the relieving time and improve the quality of the bond.

In the wake of restoring, the joint is professed to be impenetrable to bubbling water and all normal natural solvents.

Different varieties incorporate twofold syringe-type bundles which consequently measure equivalent parts.

FABRICATION OF COMPOSITE

The Fabrication of the polystyrene and iron concrete composite was done at room temperature. The necessary elements of polystyrene powder (from use and through ball point pens), iron concrete pitch and hardener where blended completely in receptacle.

MOULD PREPARATION

Embellishment is the way toward assembling by molding fluid or flexible crude material utilizing an inflexible outline called form or framework.

The form is an emptied out square that loaded up with a fluid or flexible materials, for example, plastics, glass, metal, artistic crude materials. The fluid solidifies or set inside the form and receiving its shape.

In our task shape were set up in paper boxes for required measurements and afterward, the blend is readied with different proportions of polystyrene powder and iron powder with Araldite sap for discovering its mechanical practices.

Two unique kinds of embellishment were readied dependent on our prerequisites utilizing paper box. One is for making example for charpy impact test and other one for Rockwell hardness test.

Fig2.4 MOULD PREPARATION

CURING

curing is a procedure during which a compound response or physical activity, (for example, dissipation) takes places, bringing about a harder and harder or progressively stable linkage, for example, a glue bond.

After the trim procedure the earthenware materials are restoring barometrical temperature. The moldings were permitted to solution for 6 hours in barometrical condition for increment holding. Following 6 hours the paper box form is expelled from the composite example.

Fig 2.5 Curing

TESTING

IMPACT TEST

An impact test is a strategy for deciding the conduct of material exposed to shock loading. This test is intended to decide how a specimen of a realized material will react to an out of nowhere applied pressure. The test determines whether the material is Ductile or brittle. The Impact test is a strategy for assessing the toughness, impact strength and notch sensitivity of engineering material.

IMPACT TEST METHODS

- Charpy Impact Test

- Izod Impact Test

CHARPY IMPACT TEST

The charpy Impact test, otherwise called the charpy V-notch test, is a normalized high strain rate test that decides the measure of vitality consumed by a material during crack. It is broadly applied in ventures, since is anything but difficult to get ready and lead and results can be gotten rapidly and economically.

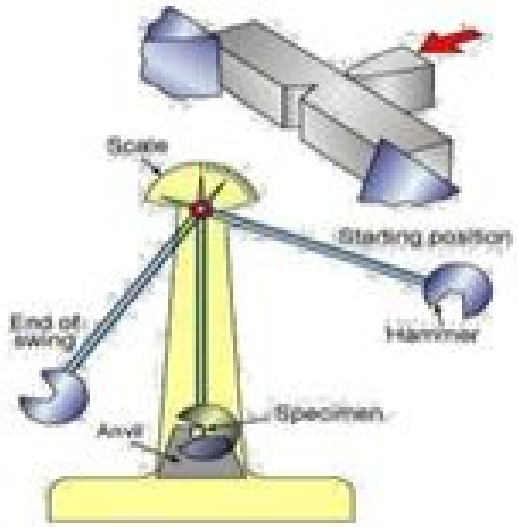

Fig 2.6 Charpy impact testing machine

PREPARATION OF MATERIALS:

- Clean the outside of the example.
- V-notch: 1 mm profound, with 45 angles along the base.
- The each of the four testing examples sharpens according to the measurements.

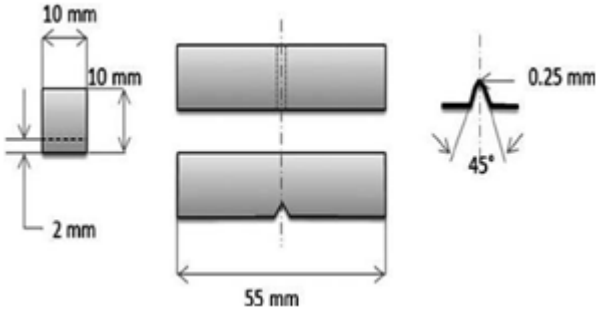

Fig 2.7 Specimen for Charpy Impact test with Standard Dimension

TESTING PROCEDURE

- Check the zero adjustment of the effect analyzer.
- Fix the example in charpy impact testing machine.
- Test the example at room temperature.
- Release the heap and step through the examination results. After the testing is done clean the machine appropriately.

III. IMPACT TEST-POLYSTYRENE POWDER AND IRON CEMENT

COMPOSITES

PROPORTION: 1

- Polystyrene - 70%
- Iron Cement - 30%

CALCULATION:

- Length of the specimen =55mm
- Breath of the specimen =10mm
- Depth below the notch 1 =9mm
- Depth below the notch 2 =9mm
- Area of cross section 1: =Breath*Depth

  =10*9

  $A1 = 90mm^2$
- Area of cross section 2: =10*9 A2

  $=90mm^2$
- Impact strength of specimen 1=J/A1

  =30/90

  $I1 = 0.333J/mm^2$
- Impact strength of specimen 2=J/A2

  =28/90

  $I2 = 0.311J/mm^2$

TABLE3.1 IMPACT TEST FOR COMPOSITION 1

Specimen	Area of cross section (mm)	Energy consumed (J)	Impact strength (J/mm^2)
1	90	30	0.333
2	90	28	0.311
		Mean value	0.322

PROPORTION: 2

- Polystyrene -60%
- Iron cement -40%

CALCULATION:

- Length of specimen =55mm
- Breath of specimen =10mm
- Depth below the notch 1 =9mm
- Depth below the notch 2 =9mm
- Area of cross section 1: =Breath*Depth

=10*9

A1 =90mm^2

- Area of cross section 2: =Breath*Depth

=10*9

A2 =90mm^2

- Impact strength of specimen 1=J/A1

=28/90

I1 =0.31J/mm^2

- Impact strength of specimen 2=J/A2

I2 =0.31J/mm^2

TABLE3.2 IMPACT TEST FOR COMPOSITION 2

Specimen	Area of cross section (mm^2)	Energy consumed (J)	Impact Strength (J/mm^2)
1	90	28	0.31
2	90	26	0.29
		Mean value	0.30

Impact Test–Polystyrene Chips and Iron cement composites

PROPORTION 1:

- Polystyrene - 70%
- Iron Cement - 30%

CALCULATION:

- Length of the specimen =55mm
- Breath of the specimen =10mm
- Depth below the notch 1 =9mm
- Depth below the notch 2 =9mm
- Area of cross section 1: =Breath*Depth

=10*9

A1 = 90mm^2

- Area of cross section 2: =10*9 A2

=90mm^2

- Impact strength of specimen 1=J/A1

=28/90

I1 =0.31J/mm^2

- Impact strength of specimen 2=J/A2

=26/90

I2 =0.29J/mm^2

TABLE3.3 IMPACT TEST FOR COMPOSITION 1

Specimen	Area of cross section (mm^2)	Energy consumed (J)	Impact Strength (J/mm^2)
1	90	28	0.31
2	90	28	0.31
		Mean value	0.31

PROPORTION 2:

- Polystyrene -60%
- Iron cement -40%

CALCULATION:

- Length of specimen =55mm
- Breath of specimen =10mm
- Depth below the notch 1 =9mm
- Depth below the notch 2 =9mm
- Area of cross section 1: =Breath*Depth

=10*9

A1 =90mm^2

- Area of cross section 2: =Breath*Depth

=10*9

A2 =90mm^2

- Impact strength of specimen 1=J/A1

=26/90

I1 =0.29J/mm^2

- Impact strength of specimen 2=J/A2
- =27/90

I2 =0.3J/mm^2

TABLE 3.4 IMPACT TEST FOR COMPOSITION 2

Specimen	Area of cross section (mm^2)	Energy consumed (J)	Impact Strength (J/mm^2)
1	90	26	0.29
2	90	27	0.30
		Mean value	0.29

Fig 3.1 SPECIMENS BEFORE AND AFTER SPECIMEN

IV. HARDNESS TEST

HARDNESS

Hardness is the property of a material that empowers it to oppose plastic miss happening, as a rule by entrance.

In any case, the term hardness may likewise allude to protection from twisting, scratching, scraped spot or cutting.

MEASUREMENT OF HARDNESS

Hardness test is a technique utilized to quantify the hardness of a material. Hardness alludes to a material's protection from changeless space.

There are various methods to gauge hardness and every one of these tests can recognize differing hardness esteems for a single material under testing. Thus, hardness test as a technique can be needy and each test's result should be marked to decide the sort of hardness test utilized.

HARDNESS TEST METHODS

- Rockwell Hardness Test
- Vickers Hardness Test
- Brinell Hardness Test
- Rockwell Superficial Hardness Test

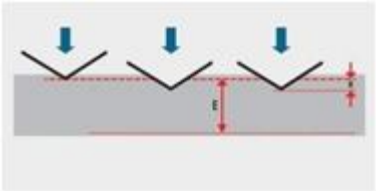

FIG 4.1

ROCKWELL HARDNESS TEST

The Rockwell hardness test technique comprises of indenting the test material with a precious stone cone or solidified steel ball indenter. The indenter is constrained into the test material under a primer minor burden F generally 10 kgf. At the point when harmony has been reached, a demonstrating gadget, which follows the developments of the indenter, thus reacts to the adjustments top to bottom of infiltration of the indenters set to a datum position. While the fundamental minor burden is as yet applied an extra major load is applied with coming about increment in infiltration.

FIG 4.2 ROCKWELL HARDNESS TESTING MACHINE

PREPARATION OF MATERIALS FOR HARDNESS TEST

The outside of the example ought to be cleaned before the testing will be continued. The size of indenter and scale for polystyrene composite was seen from the hardness testing machine.

Size of indenter ='1/4'; Scale = M; Colour =Red

Specimen-1

- Polystyrene powder-70%

Specimen-2

- Polystyrene powder-60%
- Iron cement -40%

Table4.1 ROCKWELL HARDNESS NUMBER

S.NO	Specimen	Load	Indenter Diameter	Rockwell Hardness Number	Mean Value
1.	1	100	"1/4"	99	98
				98	
				97	
2.	2	100	"1/4"	68	66
				66	
				64	

Fig 4.3 SPECIMENS AFTER HARDNESS TESTING

V. RESULT AND DISCUSSION

Table 5.1 IMPACT TESTING RESULT

S.NO	Composite Material ratio	Impact strength J/mm^2
1.	PS70%IC30%P	0.32
2.	PS60%IC40%P	0.31
3.	PS70%IC30%C	0.30
4.	PS60%IC40%C	0.2945

- PS-POLYSTYRENE
- IC-IRON CEMENT
- P –POWDER
- C -CHIPS

Table 5.2 HARDNESS TESTING RESULT

S.NO	Composite material Ratio	HARDNESS Test
1.	P70%IC 30%P	98
2.	P60%IC 40%P	66

VI. CONCULSION & FUTURE WORK

CONCLUSION

Mechanical practices like effect quality and hardness of ball point pen barrel (polystyrene) and iron concrete composite with different extent were dissected and considered. In view of the trial examines the accompanying ends are drawn.

By looking at the after effects of the considerable number of examples, it is seen that composite with 70% Polystyrene powder and 30% iron concrete is having higher effect quality and higher hardness than 60% Polystyrene powder and 40% iron concrete what's more, Polystyrene chips examples.

As the outcome, the scope of hardness increments with expanding of rate of Ball point pens barrel (Polystyrene) powder in examples.

FUTURE WORK

- The same study can be done for other various proportions
- The work extended to study other
- mechanical properties such as compressive, tensile strength, toughness etc.,
- To study their chemical, physical and electrical properties.
- The other materials can be used as a filler material and the same study can be observed.

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