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EXPERIMENTAL INVESTIGATION ON MECHANICAL CHARACTERISTICS AND FABRICATION OF RECYCLED PET PLASTICS FOR IRRIGATION

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ABSTRACT

The destruction of a considerable amount of plastic cover can sometimes pollute the land, water bodies, and air. India's industrial development generates substantial non-biodegradable solid waste and plastic waste. Plastic waste is prevalent and hardly ever recycled, with up to 40% landfill. Plastic waste is non-biodegradable and can persist in the environment for decades. It can age because of physical, biological, and natural actions, harming natural habitat and undermining the existing environment. The enormous environmental problem caused by the disposal sites of plastic waste containers has prompted an extensive research effort to find a viable alternative to managing, processing, and disposing of used plastic containers. As a result, researchers have discovered alternative uses for its recovery. The materials can be recycled, reused, or reproduced as irrigation and application alternatives. Plastic consumption has more than increased within the last five decades. Plastics would be most used for packaging food, beverage storage, drug companies, cosmetic industries, usable durables and FMCG, irrigation purposes, etc. Because of the abundance of plastic in nature, there is urgent to address this issue. During the investigation, pipes can carry water for agricultural and sewage purposes, which is one of the alternative approaches used to address the issue. Around the world, the most commonly available plastic is 70% PET. To improve the mechanical properties of recycled PET (polyethene terephthalate) plastic, a suitable nano powder of Polycarbonate is added. The results obtained shall be used to substitute existing PVC (polyvinyl chloride) pipes. Recycling PET plastic as a raw material for pipe manufacture reduces plastic waste and minimizes energy consumption for plastic production using conventional methods. The experimental investigation used PVC plastic and virgin PET plastic, P.C. (Polycarbonate) in varying ratios to improve mechanical properties. The manufactured recycled pipes will be tested for mechanical properties such as tensile strength and compression strength with percentages ranging from 90% PET to 10% P.C. to 50% PET to 50% P.C. The results will be compared to conventional PVC pipes—the use of PET pipes that can carry water for both agriculture and sewage purpose.

Keywords: Plastic Pipe, Pollute, Recycling, Energy Consumption, Properties.

1. INTRODUCTION

Plastic waste needs more attention due to its non-biodegradable nature, causing a slew of current environmental problems. Every year, 40 million tons of trash are generated in India. This is increasing at a 1.5 to 2 per cent annual rate. Plastic outfit consider for12.3 per cent of complete extravagances generated, which comes from chucking away water bottles. PET bottles cannot be discarded by jilting or combusting because they beget uncontrolled fires and pollute the soil and champaigns. Considerable examinations on this content enjoy been administered in nations like the United States and the United Kingdom. However, there have been few studies on plastics in irrigation and agriculture in India. As a result, an effort is made to use waste Poly-ethylene Terephthalate (PET) bottle granules as aggregate, and its mechanical property is explored. Alter ink et al. [1] investigated the mechanical behavior of PVC pipes (polyvinyl chloride) with recycled PET. Recycled terephthalate mixed with Polycarbonate at different concentration ranging from 20% to 50%. Polycarbonate has a high strength and stiffness, which enhances the properties of recovery and recycling High - density polyethylene. PET material (10% and 20% by volume) and particle density, as well as the effect of thermal decomposition of PET in water bottles whenever the blends were exposed to new temperatures, were investigated (200, 400, 600C). Lower strength properties were observed for both w/c ratios. The flexural strength of concrete-PET when subjected to a heat source, on the other hand, was powerfully sensitive to temperature, water/cement ratio, and PET content and particle density. PET waste bottles, both fiber and plastic, were used in the blending of poly chloride from pet pipes. It is stated that regardless of the size and category of aggregate used in the mortar shells, the strength decreases as the accumulated content increases. As a result, in the case of some polymers such as HDPE, PET, and PVC, recycling is a viable option for recovering some of this energy. Moreover, the cost of used plastics was roughly half those of raw material. Rather than producing them from raw materials, they provide them at a lower cost by reusing PET. As an issue, the arm demanded for recovering plastic is lower than the energy demanded for making the equal resin from uncooked substance. As a result, the primary ideal of this exploration is to compare the starch recapture of uncooked polyethylene terephthalate (PET) plastic and applied PET plastic bottles at colorful stresses and temperatures. The goal is to assess the energy generated by raw and used PET as during recycling process. The purpose of this research is to assess the ability of energy recovery, that can lead to the conserving and the institution of a good waste management practices.

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2. LITERATURE SURVEY

It was revealed that the percentage of lead (Pb), the heat stabilizer for reusing PVC, tends to increase as the subject of reprocessed PVC increases, and that the concentration level of recovery and recycling PVC impacts the blend's toughness. Macroscopic byproducts were found at the crack growth site once recycled PVC was added, possibly reducing fatigue life. The deterioration features were investigated using a variety of deemed important. Furthermore, the fracture toughness of specimens was meticulously examined in order to comprehend the differences in fracture mechanisms among the samples. The fracture surface becomes brittle as the reprocessed PVC contented growth progresses, making it more difficult seeing any well-developed febrile deformations of the matrix materials. -M. Lee1, J-S. Moon2, H. Lee1, and B-H. Choi3 participated in the research. Experiment with the addition of pre-consumer PVC pipe scraps to see how static mechanical properties change and start investigating using deterioration analyses of reprocessed PVC scraps. In order to make the properties better, Recycled terephthalate is blended with Polycarbonate in various proportions ranging from 20% to 50%. Polycarbonate has a high impact strength, which helps to improve the properties of recovery and recycling high-density polyethylene. The properties of the polyethylene terephthalate matrix were improved by copper alloys recycled terephthalate with Polycarbonate, which increased the usability of recycled polyethylene terephthalate for a variety of applications. PET has a wide range of applications, but it is not biodegradable. The most efficient way to reduce PET solid waste is to recycle it. During the recycle, a variety of recycled PET's mechanical properties started to deteriorate. The combination of recycled PET and polyvinyl chloride improved the properties that deteriorated during the recycling process. Shahrzad Khoramnejadian conducted Experiment on recycled Polyethylene terephthalate prepared from the coke bottle. [2-3]

Plastic bottles that have been broken down into granules or small (PET) particles and used as dust aggregate particles in concrete mixture concrete complexes appear to provide a low-cost, coherent material. Controlled on schoolwork the goods of waste PET plastics, processing methods, and them reclaim as laminated composites as a substitute for firewood. The integrated waste management approach, which includes participation from business, government, and the public, can solve the waste disposal problem without causing harm to the environment or industry. To break this problem, the country's socioeconomic angle should breathe advocated by applicable technology, legislation, and extravagance discarding courses. PET is light in weight, so its feedstock is first attainable and affordable. As a result, the drive needed for PET processing and fabrication for consumer goods is the smallest of all the different accoutrements. Domestic affairs for mass feedings are accessible indeed to the poorest of the poor. Therefore, PET come a red herring to the environmentalists, and by their strain, administrations are constrained to legislate laws, which are not conducive to the addition and growth of polymer industry.[4]

3. OBJECTIVE OF PROJECT

The main objective of this research paper is to evaluate the possibility of using granulated plastic waste materials is used for transport of water for agriculture purposes and various Engineering applications:

1. As partial substitute for the five aggregates in Pet plastic pure ,90% Pet +10% poly carbonate,80%Pet+20% Pvc,70% Pet+30%Pvc ,60% Pet+40%Pvc of composites.
2. To investigate the mechanical properties of compressive strength and tensile strength
3. To determine the percentage of Pet and adding of PVC which gives more strength compared to PVC pipes.

4. IMPORTANCE OF THESE PROJECT

The issue of getting rid and trying to manage solid waste materials became one of the most serious environmental, economic, and social problems in all nations. To regulate the growing disposal problems, a comprehensive waste management scheme that includes waste minimization, reuse, recycling, landfilling, and combustion must be put in place.

- Generally, a plastic is not reprocessed into same plastic material; therefore, reprocessed plastic items are not always recyclable. Biodegradable polymers are becoming more popular. Because the differences in characteristics and melt temperatures, if these are blended in with other plastic products for reprocessing, the reclaimed plastic is not able to be recycled.
- The aim of the design is to charge the feasibility of applying granulated malleable extravagance products as a biased cover for total (beach) in concrete mixes. The polyethylene (PET) bottle, that can be fluently attained from the surroundings at a low cost, is ripped up and mixed with conventional concrete to test the strength gets of colorful samples.
- Thermal insulation augmentation in pipelines can be investigated by trying to add waste PET and rubber pieces. Furthermore, review of the literature, the waste plastic has been found to have had no absorption of water, allowing for corrosion prevention analysis.

  The industry creates in this venture have true commercial value because there is a need for alternatives for transport of water to agriculture and numerous engineering software. PET pipes that can be used in wall construction will have a higher commercial value than hollow blocks and fly ash blocks. Furthermore, lightweight paneling and balustrades will pique the interest of the construction industry, as will the transfer of municipal water to rural areas. Pipe fabrication is the production of straight

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durations of metallic pipe as well as piping elements, such as wrought or fashioned elbows, tee and reducer fittings, forged flanges, and the pipe itself, to create simplified pipework to transport or process liquids, gases, and solids.

5. METHODOLOGY

1. Gathering the PET bottles required for research
2. Obtaining the necessary equipment
2. Shred the waste bottles and insert them into the pipes
3. Granulating the pipes to the same size as sand
4. Casting and trying to cure of basic test samples (9cubes, cylinders, prisms) for strength determination
5. Structural component casting and curing
6. To put pet's modelling techniques and concentration levels to the test.

5.1 FLOW CHART PROCESS OF EXPERIMENTATION

1.Collection of plastic: The first step in the plastic recycling process is always to gather the plastic material to be recycled. Eighty percent of the supply of pet bottle waste for recyclers came from garbage collection, while a few companies hired rag pickers to collect pet bottle excess. The large percentage of hoteliers discarded of pet carafes by selling them to a compost collector.

Fig :1 Collection of plastic waste

2.Sorting of plastics: Many different types of plastic can be found in the obtained surplus. Only PET plastic that is to be recycled should be located and sorted among them. First and foremost, the condition of the plastic is prioritized. The plastic that can be divided into subdivisions is chosen. This is done because only a few product lines are capable of recycling**.**

3.Washing/cleaning: Labels, adhesive, or even food deposits on document vessels and packages must be ignored. This non-plastic waste cannot be recycled and may cause the final product to be ineffective. The main goal of this step is to remove any impurities as well as any hidden plastic.

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4.Resizing: Resizing entails shredding or refining the residual Polycarbonate into insignificant particles. This provides a large surface area of the plastic, making it easier to process and reshape. It also helps give recycled paper organizations one last chance to confiscate any non-plastic pollutants that has survived the first 3 phases.

5.Preparation of die: Minor steel is used to finish the die in designed to endure the melting temperature of plastic (around 250°C). The drop dead is finished in such a way that it can be processed via injection molding. The die is precisely prepared to 3.2mm thickness, so that the sample could be cut in accordance with ASTM standards.

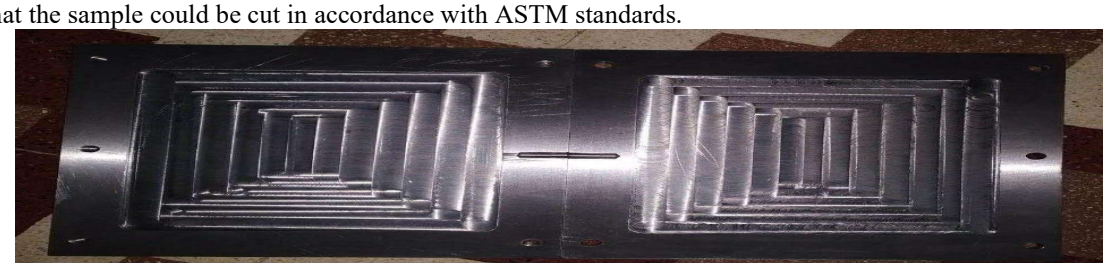

Fig :2. Prepared die

6.Mixing of plastic with additive: The process is carried out with five various proportions of base material i.e., PET plastic. The five proportions of mixtures are given below:

- 100% PET (virgin PET plastic)
- 90% PET + 10% POLYCARBONATE
- 80% PET + 20% POLYCARBONATE
- 70% PET + 30% POLYCARBONATE
- 60% PET + 40% POLYCARBONATE

The additive is added to plastic in ratios mention above in weight proportions. By using Digital weighing machine, the materials are added very accurately.

Fig :3. Mixing of PET plastic and Polycarbonate

7.Processing: Following the mixing of the additive with the plastic, the plastic is processed using any of the machines listed in Chapter 1. Based on the availability of the process, we used an injection molding machine. The die is configured in such a way that the molten rock enters through the die's gate hole. After the material has been melted, the molten plastic is pressed into the die by applying constant pressure to the vehicle's handle. The die is then deleted and allow it to cool for a period.

Fig :4. Injection molding setup

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8.Preparation of Specimen: The specimen's outcome is triangular, which is not the required specimen for testing. As a result, the element is manufactured to the dimensions specified by ASTM standards.

Tensile specimen: - ASTM D638

- Compression specimen: - ASTM D695

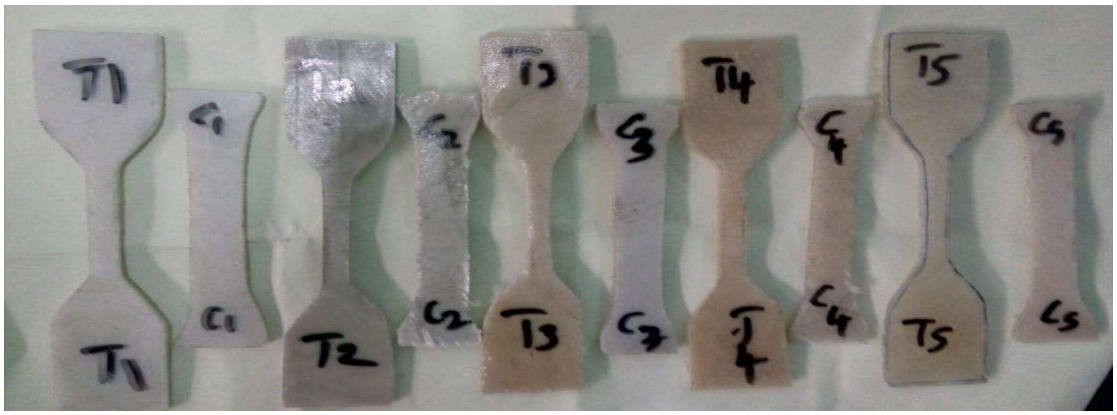

Fig :5. prepared specimens

9.Testing: "Tensile testing was carried out using a Worldwide testing machine. The testing should be done at different strain rates. The stress-strain graphs for all tests show that the curves overlap each other roughly in the initial elastic county and that the yield point shifts with progressive change in strain rate of testing."

Fig 6. Tensile Testing

10.Compression testing: At appropriate intervals, test the load and record the corresponding rinsing. The compressive métier is recorded at specimen breakage. The corresponding stress strain curve is created. Place thin samples in the jig, flat with the base and centered. Adjust the testing device so that it just touches the top of the compression tool plunger.

Fig :7. Compressive Testing

11.Fabrication of pipe: By collecting plastics, sorting plastics, washing, resizing die preparation, taking ratios, taking ratios as per specimens, and testing, we discovered that pvc pipes can be replaced by PET pipes.

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12.Pipe die preparation: To withstand the melting temperature of plastic (around 250°C), the die is made of mild steel. The die is precisely prepared to allow for thickness differences of 5mm, so that the specimen can be a standard one. The die is designed in such a way that it can be processed using injection molding.

Fig :8. Prepared pipe die

13.Mixing ratio and process: The additive is got to add to the plastic in a ratio that provides high strength with weight proportions, and the substance is decided to add very precisely using a digital weighing machine. The plastic is then processed using any of the machines mentioned. Based on availability of the process, we used an injection molding machine. After turning on an injection molding setup and allowing it to heat up with a heater, mixed material is poured into the hopper. The die is configured in such a way that the molten material enters through the die's gate hole. After the material has been melted, the molten material is pressurized into the die by applying constant pressure to the machine's handle. The die is then removed and cooled for a short period of time, allowing the final output of processing to be removed from the die after cooling**.**

Final fabricated product: The fabricated pipe has a circular hollow shaped form that meets the standard form and dimensions. The finished pipe has a length of 65 mm, an inner radius of 50 mm, and an outer radius of about 55 mm.

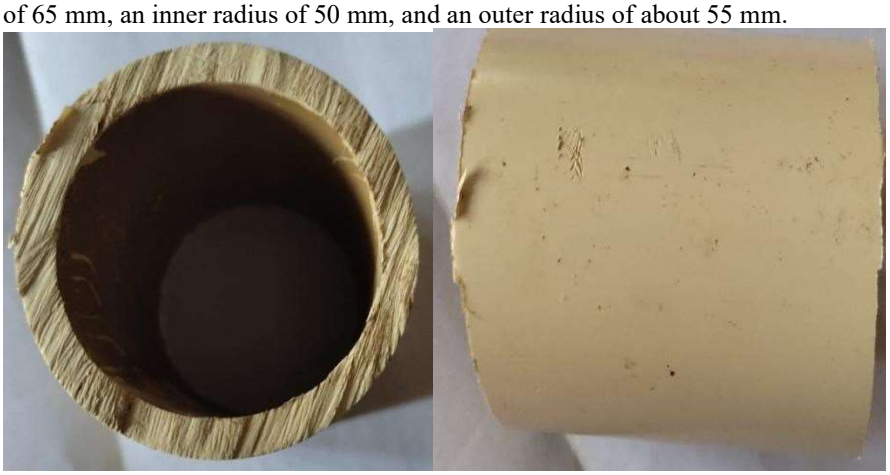

Fig :9. Fabricated pipe

6.Results and discussion

6.1. Tensile testing

Polycarbonate was used as reinforcement in various weight ratios such as 10%, 20%, 30%, and 40%. Polycarbonate properties demonstrate its effect on increasing its characteristics such as impact strength, etc. When compared to other mixtures, virgin PET plastic demonstrated the greatest strength. The tensile strengths of virgin PET plastic, 90 percent PET with 10% PC, 80 percent PET with 20% PC, 70 percent PET with 30% PC, 60 percent PET with 40% PC, and 50 percent with 50% PC are 17.25MPa, 13.13MPa, 11.65MPa, 10.01MPa, and 8.8 1MPa, respectively.

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TEST NO	PVC	VIRGIN PET	90% PET + 10% PC	80% PET + 20% PC	70% PET + 30% PC	60% PET + 40% PC	50% PET + 50% PC
Test 1	10.8	6	17.25	13.13	11.65	10.01	8.81
Test 2	10.5	6	17.25	13.13	11.65	10.01	8.81
AVG	10.65	6	17.25	13.13	11.65	10.01	8.81

Table :1Tensile strength values

The above furnished values of tensile strength are the average values of tensile strength by conducting three tests.

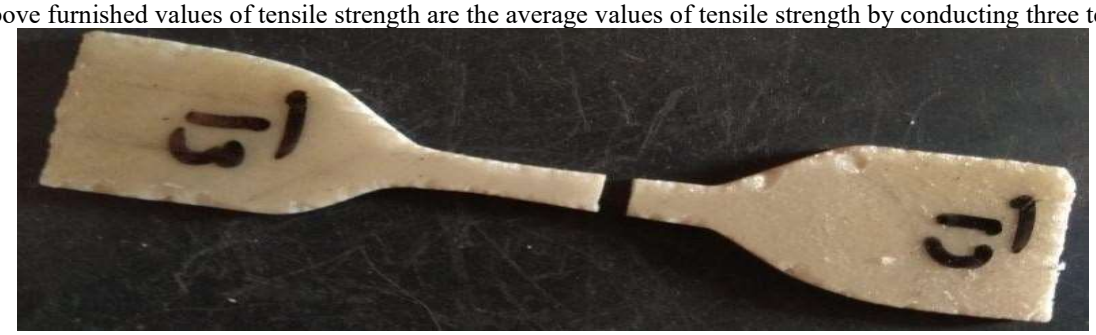

Fig :10. Failure of tensile testing specimen

The figure above depicts the failure of a specimen at maximum tensile stress as the load is increased. Each component, which is made up of different ratios of PET and P.C., has its own maximum tensile strength, also known as the break point. Three such tests are performed for each variant of proportions, and the average value of tensile strength is used to determine the component's maximum tensile strength.

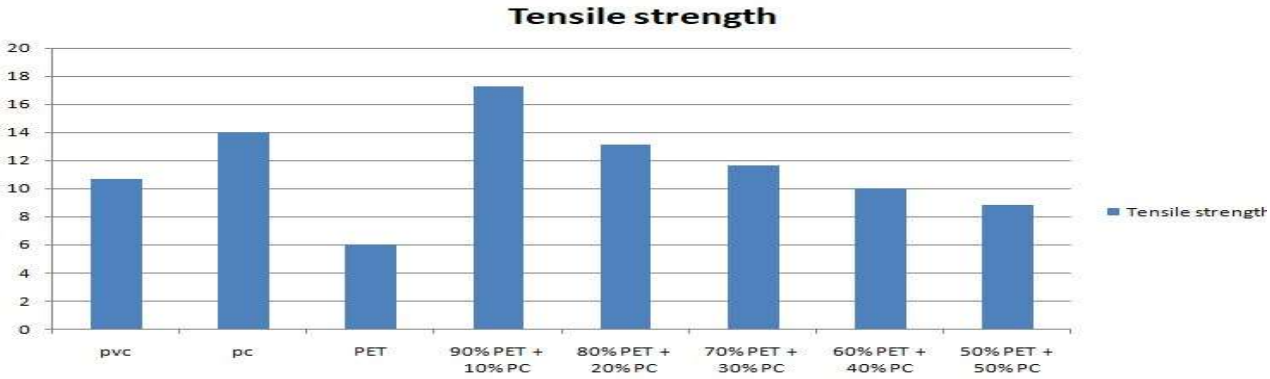

Fig: 2... Tensile strength values of PET plastic blends, PVC, P.C.

The graph above shows that the tensile strength of specimens made of various plastic and reinforcement ratios is decreasing. This is due to the addition of reinforcement, such as Polycarbonate, which acts as concrete to the plastic material. PET plastic's properties improve as its polycarbonate content rises.

6.2. COMPRESSIVE STRENGTH: PVC outperforms PET plastic in compressive strength. All specimens were subjected to compressive testing using a compressive testing machine. It was discovered that virgin plastic has the highest strength when compared to other mixtures and is less than PVC. Table 6.2 shows the compressive properties of PET plastic after varying the proportions of Polycarbonate added. Polycarbonate was used as reinforcement in various weight ratios such as 10%, 20%, 30%, and 40%. The compressive strength values of virgin PET plastic, 90 percent PET with 10% PC, 80 percent PET with 20% PC, 70 percent PET with 30% PC, and 60 percent PET with 40% PC are 10.4MPa, 13.75MPa, 11.9MPa, 11.1MPa, 10.5MPa, and7.22MPa, respectively.

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TEST NO	PVC	VIRGIN PET	90% PET + 10% PC	80% PET +20% PC	70% PET + 30% PC	60% PET + 40% PC	50% PET + 50% PC
Test 1	11	10.4	13.75	11.9	11.1	10.5	7.22
Test 2	11	10.4	13.75	11.9	11.1	10.5	7.22
AVG	11	10.4	13.75	11.5	11.1	10.5	7.22

Table 3. compressive strength values the above furnished values of compressive strength are the average values of compressive strength by conducting three tests.

Fig 11. Failure of compressive testing specimen

The figure above depicts the failure of a specimen at maximum compressive stress as the load is increased. Each component, which is made up of different ratios of PET and P.C., has its own maximum compressive strength, also known as the break point. Three such tests are performed for each variant of proportions, and the average value of compressive strength is taken as the component's maximum compressive strength.

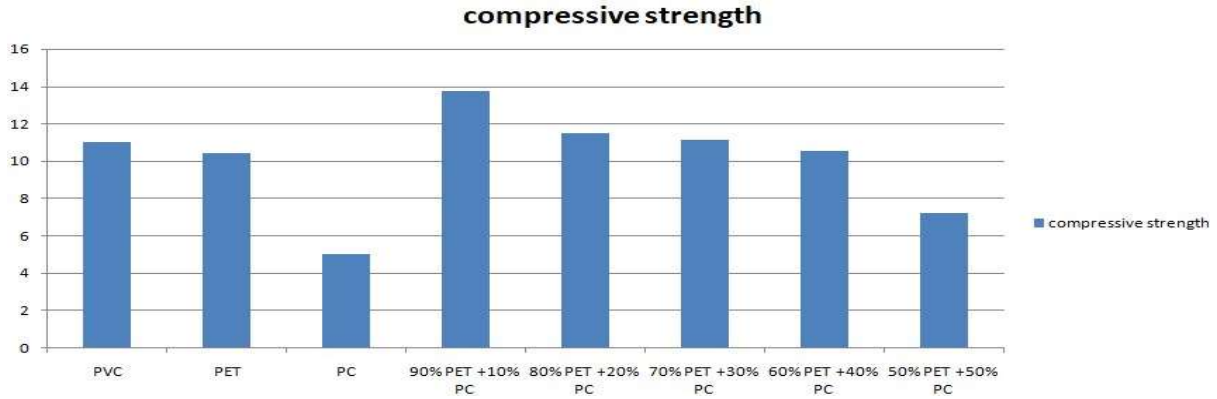

Fig:12. compressive strength values of PET plastic blends, PVC, P.C.

The graph above compares the compressive strength of components made of various plastic and reinforcement ratios. The graph shows that the compressive capacity of the specimens is slightly decreasing. This is due to the addition of reinforcement, such as Polycarbonate, which acts as concrete to the plastic material. The property of Polycarbonate continues to dominate the property of PET plastic as the polycarbonate content was increased. As a result, increasing the polycarbonate content reduces the compressive strength of the plastic.

7.CONCLUSION: From the mechanical properties of PET plastic when compounded with Polycarbonate are observed in the experimental study.

The use of plastic waste for construction purposes in the engineering industry has a high potential for reducing global ecological pollutants and pollution. Researchers are generally interested in knowing components that can reduce construction costs while increasing the strength of engineering infrastructure. Plastic waste was used to create aggregates, cementitious materials, soil

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stabilization additives, and other construction resources. The investigation revealed that engineering preparation of plastic waste products. The compressive strength of PVC plastic is greater than PET plastic when added with Polycarbonate. The tensile strength of virgin PET plastic is comparatively more than PVC plastic used for irrigation purpose.

- Even though the mechanical properties are not as expected, the effective properties of Polycarbonate, such as impact strength, toughness, and so on, compensate for the disadvantage of having lower strength than PVC plastic.
- PVC plastic has tensile and compressive strengths of 50Mpa and 145Mpa, respectively. The tensile and compressive strengths of virgin PET plastic are 84.95Mpa and 106.4Mpa, respectively, whereas Polycarbonate has values of 65Mpa and 82.7Mpa. As a result, as the strength of P.C. is less than that of PET, as the polycarbonate content increases, the overall compressive and tensile strength decreases.
- When compared to PVC specimens, the specimen made of 90% PET and 10% Polycarbonate yields the best results when all factors are considered. This proportion of the mixture can be used to make irrigation pipes, and PVC can be replaced.

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