ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 10, October 2023

Investigation on Applicability of Silica Sand Contented Waste Glass and Waste Thermoplastics Composite

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Abstract*— In most cities of the country Ethiopia, wasted plastics and glasses are seen being dumped in the road side and other public places. These wasted plastics and glasses require proper recycling and reusing to be applied on different applications. The existing waste plastic and glass recycling process is practiced only for few applications. Most of them are applied in construction works, pyrolysis of fuel oil and manufacturing of various clothing products. But, recycling of a wasted thermoplastics by reinforcing them with a silica sand contented wasted glasses to make a commonly used brittle products (such as plastic pipes, water bottles, detergent bottles and feeding plates is not practiced yet. Therefore, this research project is aimed to apply the concept of mechanical composite materials for these wasted thermoplastic/flint glass recycling processes. The main purpose of this new attempt is to recycle a wasted thermoplastic matrix by reinforcing it with a wasted flint glass powder including optimum additives to make commonly used brittle products. i.e, products that were previously made from HDPE (High Density Poly Ethylene) and from PVC (Polyvinyl Chloride) plastics. Based on the sampling and particle size preparation standard of composite materials, samples of each wasted raw material are prepared. Also, the required mechanical properties such as; hardness, tensile strength, tear strength and physical properties such as; water absorption test, density, and heat resistance capability are measured. Finally, the sample material within optimum properties such as an average tensile strength of 22. 345 MPa, average tear strength of 18.424 MPa, average density of 1.182 g/cm^3 and average specific gravity1.3815 g/cm^3, maximum heat resisting capability of 195^{o}C, increasing in hardness value and better surface abrasion resistance capability are selected to be converted in to the supposed polymer composite products.

Keywords: Wasted thermoplastics, silica sand contented waste glass, mechanical property testing, and physical property testing.

I. INTRODUCTION

Nowadays, due to the enormous increasing the demand of polymeric and glass products, the manufacturing of thermoplastic polymers and flint glasses is increasing worldwide. In similar manner, consumption of virgin thermoplastic polymers and virgin silica sand is increasing at an alarming rate for making various polymer and glass products. Plastic and glass processing industries are the biggest consumers of such virgin raw materials. Therefore, increasing the consumption of thermoplastics and silica sand increases the amount of wasted plastics and glasses.

Thermoplastic waste is usually generated by disposal of post-consumer products, mainly including waste polymers. In addition to this, the quantities of waste thermoplastics which are wasted at the end of life increases every year, similar to flint glasses. So, if it is not properly disposed or recycled, it leads to the environmental pollution and some other related problems on the community. In recent years, there has been widespread interest in the recycling and manufacturing of products from recycled materials. For example, waste plastics, especially waste HDPE and PVC has been recycled to serve a new economic purpose such as in making asphalt, simple pipes, shoe soles, fuel alternatives, etc. The advantages of doing this is the fact that material recycling makes the technology more economically and environmentally attractive.Based on the importance of different wastes, many different studies were conducted in most developed countries in order to recycle and then reuse of such wastes in other forms to be applicable for various applications.

Also, in Ethiopia, similar studies were conducted in various waste recycling technologies. But still now, using waste thermoplastic (matrix) and waste flint glass (reinforcement) raw materials for producing various polymer composite products is not properly initiated and practiced.

Therefore, this investigation is mainly focused on exploring the possibility of recycling and then reusing a waste thermoplastics and waste flint glass particles for the purpose of producing different polymer composite products and to replace virgin polymers (HDPE or PVC polymers) and virgin silica reinforcement. In this case, the wasted thermoplastic is then used as a matrix and the wasted flint glass is used as a reinforcement material. And then, by properly applying the scientific concept of composite materials and mechanisms, the selected matrix material and reinforcement material are required suitably for adapting various applications.

In this research project the experimental investigation is proposed to perform by fabricating the wasted thermoplastic/flint glass composite. The composite samples

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

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are fabricated by varying the amount of flint glass (wasted) and silica powder (virgin) and similar percentage of thermoplastics including the necessary additives. The experimental setup for fabricating and testing the samples is made various workshops. Totally, six (6) samples are produced by varying the amount of silica sand contented wasted flint glass powder and virgin silica powder based on the polymer composite standards used by the cited industries and other related ASTM standards. And as per such standards (rules), the required mechanical and physical property testing such as tensile strength testing, tear strength testing, hardness testing,density and specific gravity/relative density testing, surface abrasion resistance testing, heat resistance testing and water absorption testing of each sample are conducted. The results gained from each test are recorded differently for each sample after accomplishing each test.

Finally, the sample material which satisfied the required criteria of common polymer matrix composite materials and related standards is selected within an optimum amount of each property and within a properly achieved polymer composite saturation point/line rule.

II. EXPERIMENTAL METHODS AND LABORATORY TESTS:

2.1. Wasted thermoplastic raw materials preparation methods:

In this part, some steps have been followed to prepare the wasted thermoplastic raw material:

Step-1: Observing and searching thermoplastic wastes, investigating waste types which are commonly dumped and dumping areas: The wasted thermoplastics were obtained from the dumping areas which the people regularly or irregularly dump them. In every research area, the wastes were observed around road sides, around different coffee houses, around different shops, supermarkets, hotels etc. And the most commonly dumped thermoplastic materials are plastic bottles. The waste thermoplastics which were commonly dumped around road sides are as shown in figure1 below.

Figure 1: Dumped plastic bottle thermoplastics

Step-2: Collecting different wasted thermoplastics: Different wasted thermoplastics were collected from the sampled cities which were from the disposal areas of every dumped wasted thermoplastic.

Step 3: Thermoplastic type selection: Based on the difference in property, based on the required properties of the product which is supposed to be produced, processing methods, percentage of dumping, additive raw materials selection, reinforcement materials selection, mixing methods, temperature effect, pressure effect, time effect, etc. of the polymer materials, primarily thermoplastic bottle polymer is selected in this study.

Step-4: Preparation of waste thermoplastic raw material for the simplicity of heating/melting and mixing process [pre thermoplastic sample preparation]: Based on the size (space) of the rollers found on the selected mixing machine and based on simplicity of mixing and melting process, the waste thermoplastic raw materialwas converted in to a similar shape form with the help of manual cutting process. The maximum space/gap between the two mixing rollers was maintained as four mm. The difference in particle size of the thermoplastic particle does not have any effect on the required property of the sample material. Therefore, as per the sharpness of the cutter, 3.5 mm averaged sample size of the thermoplastic particle was prepared.

Step-5: Cleaning, washing and drying the thermoplastic particles: The wasted thermoplastic particles were washed, cleaned and washed through wire brush (cleaning process) and pure water (washing process) until the particles are free from any dust and were put on a place which was exposed to sun light until the particle becomes free from any moisture.

2.2. Silica sand contented wasted glass powder preparation methods:

In the preparation of powder/particle of the wasted flint bottle glass, the following steps were followed.

Step-1: Collecting the selected flint glasses: As shown in Figure2, wasted flint bottle glasses of different beverage (beer) bottles were collected from the different disposal areas of the sampled cities.

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Figure 2. Wasted bottle glasses

Step-2: Cleaning the bottles**:** Almost all the bottles were stacked with a paper brand stamped on their body surface. The next step was done to separate (clean) of thus stamped papers from the flint glass materials manually.

Step-3: Reducing the glasses, washing the broken glasses, drying the washed glasses, grinding the glass, sieving/powder preparation: Then finally the powder and particle mixture was separated by using different sized sieving setups. Then, the powder with a minimum particle size (0.1 mm sized glass powder) was selected as reinforcement. The ground flint glass powder with various particle sizes 2, 1.7, 1, 0.4 and 0.1 mm was found and the powder within the minimum particle size (0.1 mm) was selected for study.

2.3. Machines and equipment used during sample preparation

2.3.1. Raw material preparation

The main materials which are used on this investigation are wasted thermoplastic bottles, silica sand contented wasted flint glass, and some other necessary additives such as dutrex oil, normal sulfur, zinc oxide.

2.3.2. Types of machines and equipment used for study

The main machines/equipment which was used to perform the proposed activities for preparing the samples are manual sharp knife and simple scissor, manual grinding set up for grinding the flint glass, different sized sieve used to sieve/separate the powder glass from the particle, wo role colander machines used for primary heating and mixing the thermoplastic particles with the flint glass powder and with other selected additives, curing press machine which was mainly used to apply heat and pressure on the samples for getting the correct structure with good bonding between the particles to hold enough in its position, distilled water, hot water, soap, soapsuds, powder soup, washing brush and washing tank was used for washing the thermoplastics and the glass to remove the dust, oil and unnecessary dirt from the prepared thermoplastic particles and the wasted flint glass bottles, thickness measuring set up, weight measuring set up, hardness tester (shore hardness), universal tensile strength and tear strength testing machine, mold, surface abrasion testing set up, Press cutter and bra-bender.

2.4. Sample preparation and testing

2.4.1. Sample preparation

Based on the capability of achieving polymer composite rules, based on the weight and effect of silica sand contented flint glass powder on the masticating property of the sample, based on the masticating capability of the prepared sample and based on the capability of achieving thermoplastic composite products specification of the sample totally six samples were prepared with the following composition.

1. 90% of virgin thermoplastic matrix, 6.53% of Virgin Silica sand reinforcement and 3.47% of Additives. And this is the standard amount of polymer material processing and it is represented by “OSM (Original Sample Material)”.
2. 90% of wasted thermoplastic matrix, 2.5% of wasted flint glass powder reinforcementand 7.5% of Additives. And it is represented by “S1”.
3. 90% of wasted thermoplastic matrix, 5% of wasted flint glass powder reinforcement and 5% of Additives. And it is represented by “S2”.
4. 90% of wasted thermoplastic matrix, 6.53% of wasted flint glass powder reinforcement, and 3.47% of Additives. And it is represented by “S3”.
5. 90% of wasted thermoplastic matrix, 7.5% of wasted flint glass powder reinforcement, and 2.5% of Additives. And it is represented by “S4”.
6. 90% of wasted thermoplastic matrix, 10% of wasted flint glass powder reinforcement, and 0% of Additives. And it is represented by “S5”.

- The weight percent of the new raw materials was given by considering weight percent of the existing raw materials used by the cited companies and other related polymer composite standards. This means that, the maximum standard amount of virgin silica reinforcement used during the preparation of one batch of polymer composite sample is 6.53% or 32.64 gram of one batch (500 gram). In this study it was aimed to use three (3) different weight percent of the new raw materials and to consider the effect when using different weight percent. These are weight percent above the standard amount (›6.53%), below the standard amount (‹6.53%) and equal to the standard amount (=6.53%). Totally two (2) samples were prepared by having weight percent below 6.53% (S1=2.5% and S2=5%), two (2) samples were prepared by having weight percent above 6.53% (S4=7.5% and S5=10%) and two (2) samples were prepared by having the same weight percent but different material type. But, for the matrix material the maximum amount (90%) was used. As discussed above, the difference in weight percent was sampled based on satisfying the polymer composite masticating property of each sample. Therefore, the weight percent of samples which satisfy the required

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polymer composite property were selected on the study.

Therefore, the 6(six) different samples were sub divided in to 5 specimens required for conducting the experiments. Generally, the main steps and procedures followed on this study which was used to prepare the final sample materials are discussed and analyzed briefly as follows. The sample preparation consists of the following steps and considerations:

Step-1: Thermoplastic & flint glass polymer compositeraw material preparation

The necessary raw materials used to produce the proposed polymer composite were primarily prepared. The percentage values given for a flint glass powder were based on the batch value (percentage). This means that 500 grams = 100% of one (1) batch, then based on this total value each of the samples were converted in to a percentage.

According to batch rules of polymer composite product processing, one batch means 500 grams of total raw materials weight (0 to 10% of reinforcement, 85 to 90% of matrix, and 0 to 10% of additives). Also, the weight of raw materials that the two-roll colander machine can carry about is 500 grams. Therefore, the weight of each of the raw materials were measured based on this rule. Therefore, the percentage value given for the flint glass powder reinforcement was based on the amount of the existing silica reinforcement standard. This means that, 32.64 gram of silica was the average amount of silica that can be added during the polymer composite material processing.

And therefore, this value was taken as 6.53 % of silica reinforcement material and the rest percentage and gram values given above were calculated based on this 6.53% standard percentage value. According to polymer composite product processing rule, the minimum and maximum amount of reinforcement materials were selected based on the polymer composite saturation point/line resulted from many trials and errors of each sample test.

- The purpose or experimental applications of raw materials used on the preparation of the polymer composite product are listed on Table 1.

Table 1. Purpose of each raw additives

RawAdditives	Purpose
ZnO	Activates the chemical reaction and mixing process of each content of the sample material.
Dutrex oil	To facilitate the masticating process and to increase masticating property of the sample. It also used as a bonding agent.
Sulfur	To increase the hardness of the sample and it is used as a vulcanizing agent.

Step-2: Determining the temperature and time values for mixing: Based on the property of the polymer composite product processing, the temperature and time values were determined separately for each sample of compositions with the help of rheo-line machine. Therefore, the mixing process was done at 80^{o}C of heating temperature and 130 minute of curing time.

Step-3: Mixing process:At this step, two different mixing process of the main raw material with the additives was performed. These two mixing processes are termed as primary mixing and secondary mixing processes. In the primary mixing process, the matrix material (wasted thermoplastic) was mixed with the additives and in the secondary mixing process the reinforcement materials (silica and the glass powder) were mixed separately with the ingot which processed with the primary mixing process.

Generally, the curing temperature and time values used on the mixing process to prepare each sample are listed and described as in Table 2.

Table 2. Curing temperature and curing time used for mixing the raw materials

Mixing process	Temperature (^{o}C)	Curing Time (minute)	Activity
Primary mixing	80	30	Heating the thermoplastic polymer matrix.
		70	Adding and mixing the necessary additives
Secondary mixing	80	(5 per one sample) = 30	Adding Silica/Glass powder and mixing separately for each sample step by step.
Total time(summation)		130 min	

From this table, the secondary mixing process describes only for one sample. Totally 6 different samples were prepared on this study and then adding and mixing time was multiplied by 6. This means that 30 min time was required to accomplish secondary mixing process. But primary mixing process describes for all samples. The main sub-steps used to accomplish both the primary and secondary mixing processes are:

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Sub-step-1: Raw material preparation:

Sub-step-2: Weight measurement of each raw material: The weight of each raw material was measured based on the batch size.

Sub-step-3: Properly cleaning the mixing machine:It was better to clean the mixing set up to protect the sample material from unnecessary dusts, moistures, chemicals and other wasted materials.

Sub-step-4: Primary Mixing: Before adding the reinforcement materials, the thermoplastic polymer was primarily heated and mixed with the other selected additives.

Sub-step-5: Secondary mixing: After properly applying the primary mixing process, then the addition and mixing process of the selected reinforcements was accomplished.

Sub-step-6: Raw sample preparation:By applying such mixing processes, the resulting 6(six) samples were finally produced.

Step-5: Heating process

Step-6: Pressing the samples: Based on polymer composite standard, the curing temperature, pressure and time values used to prepare the samples are listed in table 3.

Table 3. Curing temperature, pressure and time values used to prepare the samples

Sample Number	Temperature(^{o}C)	Pressure(KPa)	Curing time(minutes)
OSM	150	1034.25	30
S-1	150	1034.25	30
S-2	150	1034.25	30
S-3	150	1034.25	30
S-4	150	1034.25	30
S-5	150	1034.25	30

Step-7: Preparation of specimens for testing:At this experimental stage, 5(five) specimens were used/preparedfor each testing based on the testing machine's thickness and size requirement.

2.4.2. Sample Testing

2.4.2.1. Mechanical property testing

1. **Hardness testing:**Thehardness of each specimen was tested by using the following steps.

Step-1: Checking the dimensional specifications of each sample by measuring the thickness, width and length of the specimens with the help of thickness measuring set-up recorded the dimensions. The thickness of each specimen was measured at 3(three) different places of each specimen (top, middle and bottom) and finally average values were considered for further calculations.

Step-2: The hardness of each specimen was measured with the help of shore machine. The hardness measurement was done at the 3 different places (at the top, middle, and bottom) and the average value was then finally considered to display the results.

2. **Tensile strength, breaking load and elongation testing:** For measuring the tensile strength, percentage of elongation and breaking load of the specimens the following steps and procedures were followed.

Step-1: Dimensions of the specimens were checked against to the standard dimensions of tensile testing of polymer composites.

Step-2: Placing the specimen rigidly between the upper and lower indenters of the universal testing machine and ensure wither it is properly held in its position.

Step-3: Applying the required load to specimen through the machine for stretching the specimen and the load was continued till the samples get fracture.

Step-4: The test parameters were measured and recorded by using the computer interfacing device which connected with the machine.

3. **Tear strength testing:**The tear strength property was measured by using tensile testing machine. For measuring the tear strength, the following steps are followed.

Step-1: Dimensions of the specimens were checked against to the standard dimensions of tear strength testing of polymer composites.

Step-2: Placing the specimen rigidly between the upper and lower indenters of the universal testing machine and ensure it properly held in its position.

Step-3: Applying the required load to specimen through the machine for stretching the specimen and the load was continued till the samples get fracture.

Step-4: The test parameters were measured and recorded by using the computer interfacing device which connected with the machine.

4. **Surface abrasion resistance testing:** surface abrasion resistance capacity of the samples was tested.

2.4.2.2. Physical property testing

1. **Density and specific gravity testing:**

In order to know the specific gravity of each specimen, primarily the density of the samples was measured by using their weight with respect to their volume with the help of specific gravity testing set up. And then, the final result of the

ISSN (Online) 2456-1290

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density of each sample was divided by density of the water content of the samples, and finally the specific gravity of all the samples was therefore measured by the help of Bra-bender and the results are recorded step by step.

2. Testing the heat resisting capacity of each sample:

By the help of Mooney line viscometer, the maximum heat resisting capacity of each sample material is properly tested

3. Testing the water absorption behavior

Water absorption test of each sample was measured according to the procedures and testing regulations/standard and according to the standard used by the cited polymer composites producing industries and other related standards. Therefore, the steps and methods used on this study are:

Step-1: Measuring the weight of each dry sample material before immersing in the water.

Step-2: Immersing the sample into water which was in a container and allowed the samples in the same condition for period of 24 hours.

Step-3: After 24 hours immersing standard time, the immersed samples were taken out and immediately weight was measured. And then, from the difference in weight and the effect of water on polymer composite sample the capability of absorbing water of each sample was observed.

Step-4: The percentage of water absorption was determined by using the formula given below:

Percentage of water absorption = [(wet weight – dry weight)/dry weight] x 100

2.5. . Results gained from each property testing

2.5.1. Results gained from mechanical property testing

I. Results of thickness measurement: According to specimen preparation standard, each specimen was prepared within an average 2.2 mm thickness

II. Results gained fromhardness measurement: Hardness of each sample was measured by varying the weight percent of each raw material. The effect of weight difference of flint glass powder on the hardness of each sample is shown in figure 3. As observed from this figure, the hardness value of each sample is increased with increasing the weight percent of flint glass powder.

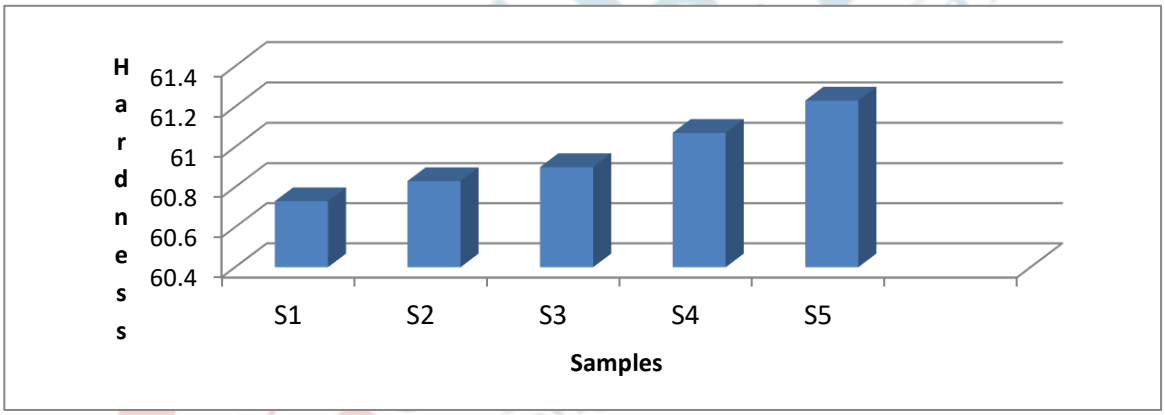

Figure 3. Effect of weight difference in hardness

III. Results gained from tensile strengthtesting: As observed from figure 4, sample number4 (S4) has reached the average polymer composite sample standard. In sample S5, the tensile strength starts to decrease. This shows that, adding above 37.5 gram of a glass powder in to the sample affects the tensile strength result.

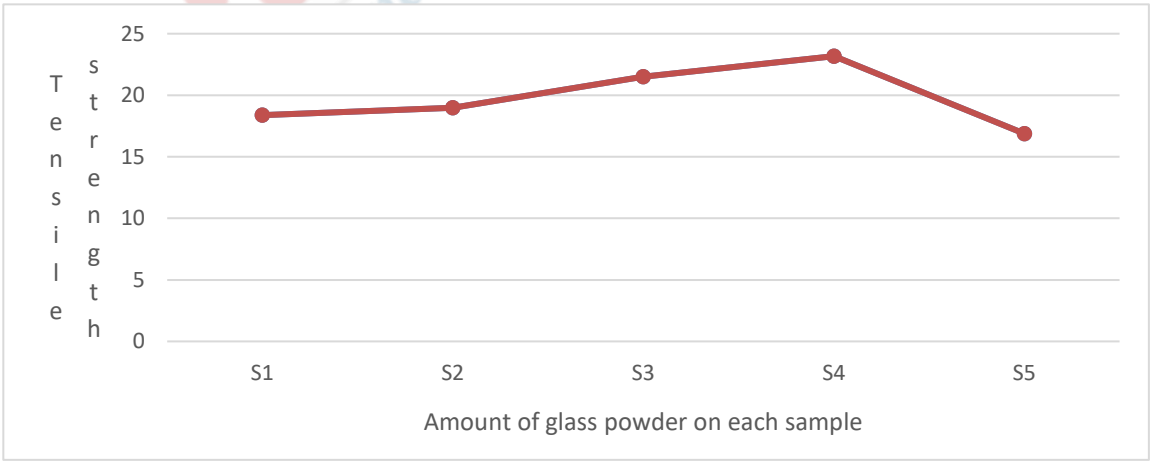

Figure 4. Tensile strength testing result

ISSN (Online) 2456-1290

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IV. Results gained from tear strength testing: In this part also, sample number 4 has reached the maximum amount of tear strength as shown in figure 5 below.In sample S5, the tensile strength starts to decrease. This shows that, adding above 37.5 gram of a glass powder in to the sample affects the tensile strength result.

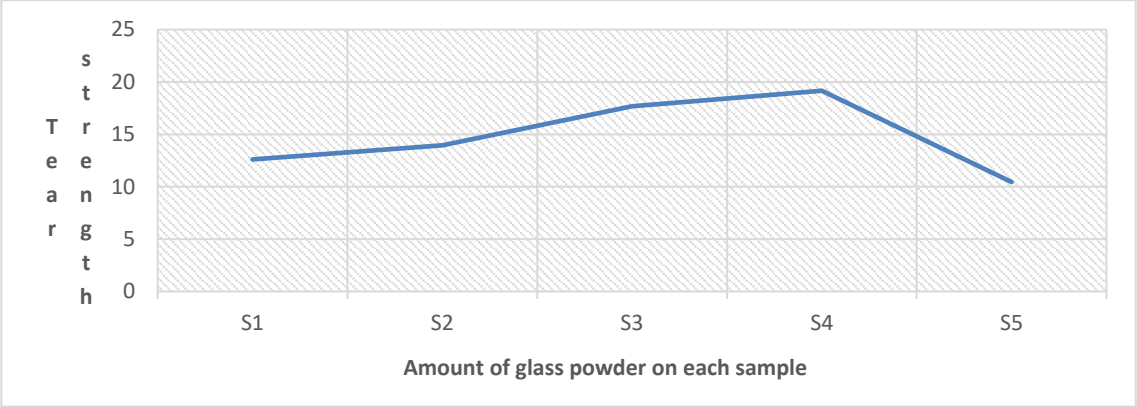

Figure 5. Tearstrength testing result

V. Results gained from surface abrasion resistance: The primary weight measured before abrasion and secondary weights measured after abrasion of each sample are listed in the table 4 and it shows that a few differences in abrasion resistance is occurred on samples S1 to S4 as compared with sample OSM. In sample S4 approximately similar result is obtained. But in sample number S5, a little reduction in weight is occurred as comparing it with the other samples. Therefore, percentage of the raw materials used in sample S4 is better than as in the other samples.

Table 4. Abrasion resistance results of each sample material

Sample material	Weight (grams)	
	Before eroding	After eroding
OSM	30	30.65
S1	30	30.56
S2	30	30.59
S3	30	30.61
S4	30	30.64
S5	30	30.05

2.5.2. Results gained from physical property testing

The main physical property testes and the results gained from each test are listed and discussed briefly as follows.

I. Results gained from density and specific gravity testing

As observed from table 5, the average specific gravity value of OSM is 1.425 g/cm^3, and this result is also measured on sample S4. And, on samples S1 to S4 as the amount of flint glass powder is increased the specific gravity is also increased. But on sample number S5, the specific gravity value is reduced in to 1.372 g/cm^3.The results obtained from specific gravity testing are shown in figure 6 below.

Table 5. Density and relative density (specific gravity) value of each sample:

Sample	OSM	S1	S2	S3	S4	S5
S.G/R.D (g/cm^3)	1.425	1.332	1.337	1.398	1.425	1.372
Density (g/cm^3	1.245	1.230	1.148	1.152	1.156	1.187

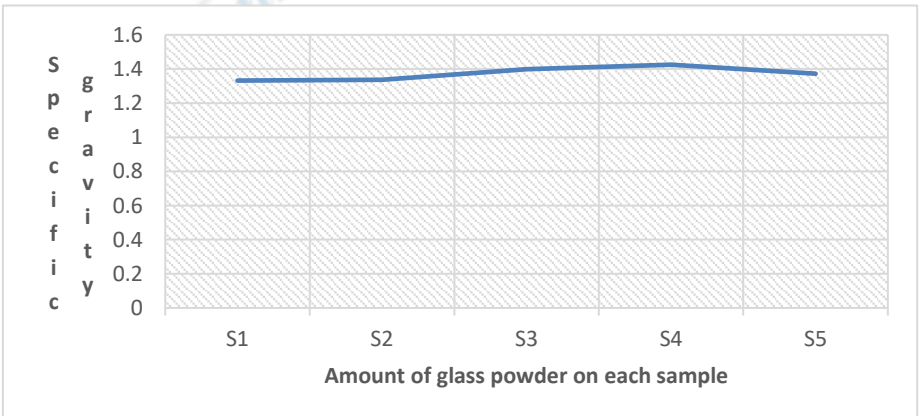

Figure 6. Results obtained from specific gravity testing

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This graph shows that, the specific gravity values of each sample material have achieved the rule of polymer composite saturation point. This point is found on sample K4. This shows that the maximum weight of flint glass should not be exceeded from 37.5 gram.

- **Calculating the theoretical density of each sample:** According to ASTM standard C128 and based on the composite mixture rule formula of equation, the theoretical density of the samples is calculated as:
  - ✓ Theoretical density of the composite (TDC) = [(density of the matrix (DM))*(volume of the matrix (VM)) + (density of the reinforcement material (DR))*(volume of the reinforcement (VR)) + (density of the additives(DA)) * (Volume of the additives(VA))]
  - ✓ TDC = (DM)(VM) + (DR)(VR)

For sample OSM, TDC_{OSM} = [(DM) (VM) + (DR)(VR) + (DA)(VA)]

[(93.47/100) (1.1) + (6.53/100) (2.1) = 1.165 g/cm^3

- ➢ For sample S1, TDC_{S1} = [(DM)(VM) + (DR)(VR) + (DA)(VA)]

[(97.5/100) (1.1) + (2.5/100) (2.1)] = 1.125 g/cm^3

- ➢ For sample S2, TDC_{S2} = [(DM)(VM) + (DR)(VR) + (DA)(VA)]

[(95/100(1.1) + (5/100) (2.1) = 1.15 g/cm^3

- ➢ For sample S3, TDC_{S3} = [(DM)(VM)+ (DR)(VR) + (DA)(VA)]

[(93.47/100(1.1) + 6.53/100(2.1) = 1.165 g/cm^3

- ➢ For sample S4, TDC_{S4} = [(DM)(VM)+ (DR)(VR)+ (DA)(VA)]

[(92.5/100(1.1) + 7.5/100(2.1)] = 1.175 g/cm^3

- ➢ For sample S5, TDC_{S5} = [(DM)(VM) + (DR)(VR) + (DA)(VA)]

[(90/100(1.1) + (10/100) (2.1)] =1.2 g/cm^3

Table 6. Comparison of measured (actual) density and calculated (theoretical) density.

Sample	OSM	K1	K2	K3	K4	K5
Actual density (g/cm^3)	1.155	1.139	1.148	1.152	1.154	1.187
Theoretical density (g/cm^3)	1.165	1.125	1.150	1.165	1.175	1.2

- ➢ The density comparison of each sample can be expresses as follows in figure 7.

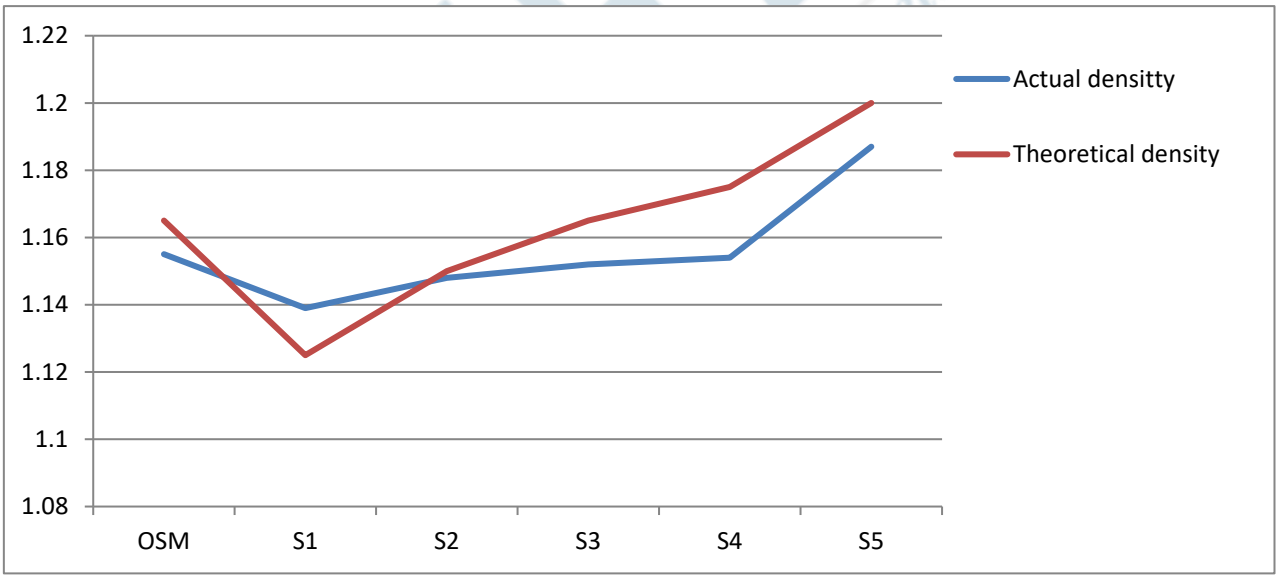

Figure 7. Comparison between Actual and theoretical densities of each sample

II. Results gained from heat resistance capacity testing

The maximum heatresisting capability of all the samples obtained from Rheometer and Viscometer tests is averagely 195ºC which is approximately similar amount with the amount of the original sample materialresulted about 198ºC.

III. Results gained from water absorption testing

Dry and wet weights and weight difference of each sample are listed in Table 7. As observed from the results gained from the water absorption test of each sample, there is no any weight difference happened. Dry weight and Wet weight of each sample is completely the same. Also, the percentage of water absorption of each sample is 0% and it was calculated by subtracting the wet weight from the dry weight of the samples

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Table 7. Dry & Wet weight and weight difference of each sample

Sample material	Dry weight (in grams)	Wet weight (in grams)	Weight difference (gram) (Dry weight - Wet weight)
HAT	30	30	30 – 30 = 0
S1	30	30	30 – 30 = 0
S2	30	30	30 – 30 = 0
S3	30	30	30 – 30 = 0
S4	30	30	30 – 30 = 0
S5	30	30	30 – 30 = 0

III. CONCLUSIONS

In this study a new way of applying silica sand contented glass powder reinforcement and waste thermoplastic polymer matrix was used to prepare the new composite. And after the experimental investigation and property testing is properly conducted, thesample material within optimum properties such as an average tensile strength of 22. 345 MPa, average tear strength of 18.424 MPa, average density of 1.182 g/cm^3 and average specific gravity1.3815 g/cm^3, maximum heat resisting capability of 195^{o}C, increasing in hardness value and better surface abrasion resistance capability are selected to be converted in to the supposed polymer composite products. And the average amount of silica sand contented waste glass powder reinforcement that results such an optimum polymer composite results is 32.64 gram.

IV. ACKNOWLEDGMENT

As per the accomplishment of this research project, it is better to raise great respect and thanking for Adigrat university research and community service, BruhTesfa HDPE IndustryAdigrat Ethiopia, Horizon Addis Tire IndustryAdigrat Ethiopia, Asko flint glass industryAdis Ababa Ethiopia, Mekelle and Adigrat University Mechanical & Industrial Workshop assistants and Laboratory assistants for their generous help during sample preparation and testing. I would like to thank for the community of sampled research areas of Tigray for everything helped me during getting enough information about the data related to my investigation.

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