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Mechanical Properties of Tensile, Flexural, Impact, Hardness and Water Absorption Tests on Epoxy Composite with Glass Fibre, Black Granite Powder, White Granite Powder and Stone Powder

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***Abstract*: Improving the Mechanical properties of Composite consisting Epoxy Resin and glass fibre with additives of 5, 10 and 15 by weight percentage of nano particles of White Granite powder, Black Granite powder and Stone powder by considering three test samples. Samples were prepared based on ASTM standards and then finding the Tensile, Flexural, Impact, Hardness and Water Absorption test results. It was observed Tensile, Flexural and Impact, hardness was improved and water absorption capability reduced as compare with the test results of glass Epoxy samples.**

Key words: Epoxy, Glass Fibre, Black Granite powder (BGP), White Granite powder (WGP), Stone powder (SP).

1. INTRODUCTION:

Composite is a material formed by the combination of two or more materials with distinct chemical properties and obtained material also having distinct chemical properties from its parent material. Epoxy is a versatile polymer consisting one oxygen atom bonded with two carbon atoms and these carbon atom already bonded by some other means. Glass fibre consisting of extremely fine layer of glass. Granite powder and stone powder are the granite polishing industrial wastage.

Tensile, Flexural, Impact, Hardness and Water absorption tests carried on work samples prepared by varying percentage of granite and stone powder fillers based on ASTM standards to improve the mechanical properties.

2. METHODOLOGY:

2.1. Work Sample Preparation:

Based on the dimensions of the Teflon mould cavity 26×13×0.3 cm^3, cut the glass fibre and prepare the Glass Epoxy composites with and without fillers of granite and stone powder by adding 5, 10, 15 weight percentage of fillers and apply first layer of Epoxy in the cavity of Teflon mould.

Place the first layer of glass fibre on the applied Epoxy and then stick it firmly with Epoxy layer, apply the second layer of Epoxy, Place the second layer of glass fibre on the applied and then stick it firmly on applied Epoxy layer, apply the third layer of Epoxy and Cure the prepared Epoxy sample at room temperature up to the 48 hours.

2.2 Tensile Test:

Prepare the Tensile test sample based on ASTM standards D3039/D3039M. Universal Testing Machine is used for tensile test. Locate the sample in between the jaws one is the fixed jaw and other is movable jaw and then firmly fix sample. Start the machine that applies the pulling load on work sample, observe load is gradually increasing at required load the work sample get broken. Process is continued with all work samples and machine gives the tensile strength results of all samples.

2.3 Flexural Test:

Prepare the Flexural test sample based on ASTM standards D7264. Again using the same Universal Testing Machine, place the sample in a fixer of the table and a flexural tool fixed with in the movable ram and this ram applies the load on the sample, obseve the load is gradually iuncreasing at one extent the work sample get broken. Repeat this procedure with all samples and machine generates the flexural strength results.

2.4. Impact Test:

Prepare the Impact test sample based on ASTM standards D6110-08, Charpy Impact testing machine used to determined the toughness of the sample, it consists of a pendulum hammer, head dial and fixer. First firmly fix the work sample in a fixer, set the dial reading to its staring position and apply the load by releasing pendulum hammer that cuts the sample and reading shows the toughness of the work sample.

2.5. Rockwell Hardness Test:

Prepare the hardness test sample based on ASTM standards D785**,** Rockwell hardness testing machine is used to find out the hardness of the sample work piece, the main parts of machine are head dial, flat plate, indenter, load lever and hand wheel. Head dial having three scales HRA, HRB and HRC and a small dial that indicates the primary load should be less than 10kgf. Lower support holds the flat plate and operated by hand wheel to move up and down and locate the work piece in between the indenter and the flat plate and

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then apply the primary load. Then apply the secondary load by using load lever after 30 seconds unload the load by using load lever, reading on main dial scale shows the hardness of the sample work piece.

2.6. Water Absorption Test:

Prepare the water absorption test sample based on ASTM standards G99. Water absorption test is used to know the amount of water absorbed by the sample work piece. To do this experiment measure the weight of the work piece and then immersed it into distilled water in a beaker. After 48 hours take out the sample work piece from the water beaker and then measure its weight. The difference in weight shows the amount of water absorbed by the work sample.

3. RESULTS AND DISCUSSION:

3.1 Notations:

Notations of Experiment Results are shown in the Table.1.

Table 1. Notations of the prepared samples

WF	Without Filler
BG	Black Granite
WG	White Granite
SP	Stone Powder
WF	100% of Glass Epoxy
5BG	5% of Black Granite Filler and 95% of Glass Epoxy
5WG	5% of White Granite Filler and 95% of Glass Epoxy
5SP	5% of Stone Powder and 95% of Glass Epoxy

3.1. Tensile Test Results:

The Ultimate Tensile Strengths of black granite powder, white granite and stone powder of work samples are shown in Table.2 and Fig.1.

The ultimate tensile strength of glass epoxy is 924MPa and with additive shows comparatively good results at 10% filler materials of black granite powder will improve the strengths 3167MPa, at 5% filler material of white stone granite powder strength improves to 3288MPa as well as at 10% filler material of stone powder the strength improves to 2055MPa.

Table 2. Standard Ultimate Tesile strengths

Filler (%)	Avg. Load (N)	Avg. Tensile Stress (MPa)	Avg. Strain (mm/mm)	Tensile Modulus (MPa)
0WF	8459.18	112.79	0.122	924
5BG	6495.28	161.97	0.0662	2446
10BG	8502.17	174.55	0.0551	3167
15BG	7950.31	106.00	0.0683	1552
5WG	7386.83	198.34	0.0603	3288
10WG	7172.71	108.93	0.0568	1917
15WG	7178.67	139.68	0.0507	2754
5SP	7956.40	106.08	0.0688	1541
10SP	9220.07	122.93	0.0598	2055
15SP	6278.54	83.71	0.0482	1738

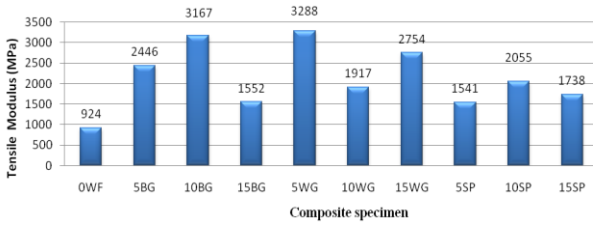

Fig.1. Ultimate Tesile Stengths

Maximum Tensile strength value increases up to addition of 10% filler material of Black Granite and Stone Powder, further addition of filler decreases their strength whereas as in White Granite composite, maximum strength is observed at 5% of filler and further addition of filler material decreases.

3.2. Flexural Test Results:

The Ultimate Flexural Strengths of black granite powder, white granite and stone powder reinforced epoxy composites are shown in Table.3 and Fig.2.

Table 3. Standard Ultimate Flexural strengths

Filler %	Avg. Load (KN)	Avg. Stress (MPa)	Flex Modulus (MPa)
0WF	0.056	14.065	1185
05BG	0.076	17.21	1741
10BG	0.113	27.34	2157
15BG	0.120	28.91	2728
05WG	0.100	24.058	2038
10WG	0.110	26.31	2111
15WG	0.113	26.633	2261
05SP	0.146	34.55	3088
10SP	0.100	23.79	2937
15SP	0.1300	31.08	3066

The ultimate Flexural strength of glass epoxy with additive shows comparatively good results at 15% by the weights of filler material black granite powder and white granite powder and also 5% by the weights of stone powder.

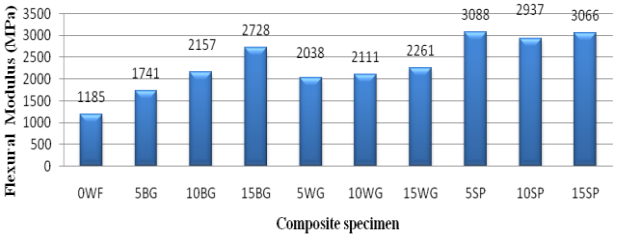

Fig.2. Ultimate Flexural strengths

The ultimate flexural strength of glass epoxy is 1185MPa, the improvements of strength level of the glass fibre Epoxy composite by the additive of Black Granite powder is 27280MPa, white Granite powder is 2261MPa and with stone powder the flexural strength improved to 3088MPa.

3.3. Impact Test Results:

The Ultimate Tensile Strengths of black granite powder, white granite and stone powder work samples are shown in Table.4 and Fig.3.

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Table 4. Ultimate Impact strengths of three test samples

Filler (%)	Sample 1	Sample 2	Sample 3	Average Impact Test
0WF	1.8	1.8	3	2.2
5BG	3.6	3.1	3	3.2
10BG	2.3	2.4	1.8	2.2
15BG	2.8	3.8	1.8	2.8
5WG	2.2	2.8	2.1	2.4
10WG	2.6	2	3.2	2.6
15WG	2	2.4	2.4	2.3
5SP	3.6	3.4	3.2	3.4
10SP	4	4.8	3	3.9
15SP	4.2	2.6	3.4	3.4

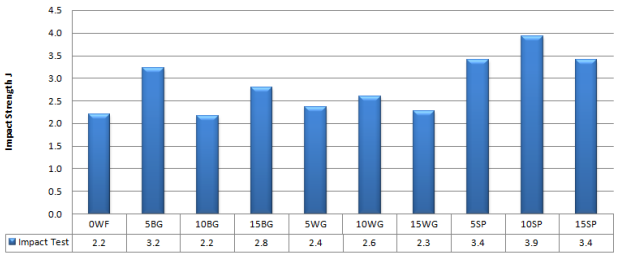

Fig.3. Ultimate Impact strenths

The impact strength is good at 10% of filler material White Granite and Stone Powder and at 5% of Black Granite. The maximum impact strength is observed at 10% of filler composition of stone powder.

The ultimate impact strength of glass epoxy is 2.2J/cm^2, the improvements of strength level of the glass fibre Epoxy composite by the additive of Black Granite powder is 3.2J/cm^2, white Granite powder is 2.6J/cm^2 and with stone powder the flexural strength improved to 3.9J/cm^2.

3.4. Rockwell Hardness Test Results:

The Rockwell hardness of three test samples of black granite powder, white granite and stone powder reinforced epoxy composites are shown in Table.5 and Fig.4.

Table 5. Rockwell hardness of three test samples

Filler%	Sample 1	Sample 2	Sample 3	Average Rockwell Hardness number
0WF	37	23	32	31
5BG	25	48	35	36
10BG	45	37	40	41
15BG	40	32	34	35
5WG	33	36	34	34
10WG	34	52	40	42
15WG	41	35	33	36
5SP	38	44	40	41
10SP	32	53	40	42
15SP	42	32	37	37

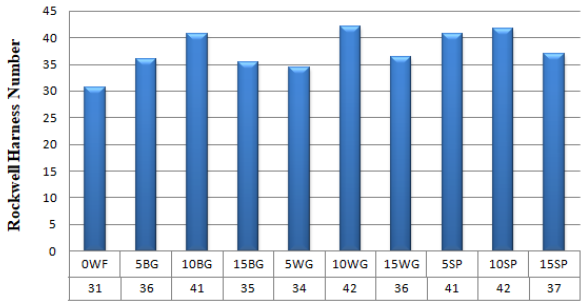

Fig.4. Rockwell hardness test results

The Rockwell Hardness Number increases gradually from 5% to 10% filler composition in Black Granite, White Granite and Stone Powder whereas it decreases by addition of filler composition to 15%.

The improvement of Rockwell Hardness Number with the additive of Black Granite is 41, White Granite powder and stone powder is 42.

3.5. Water Absorption Test:

The Water absorption test samples of black granite powder, white granite and stone powder work samples are shown in Fig.5 and Table.6.

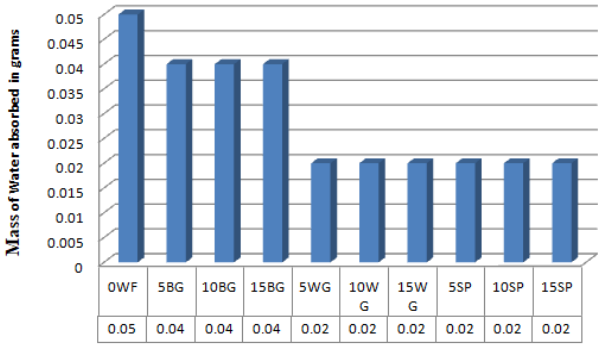

Fig.5. Water absorption test amples result

Table 6. Water absorption test samples result

Filler (%)	Before immersed in water Specimen weight (gm)	After immersed in water Specimen Weight (gm)	Mass of water absorbed in grams
0WF	6.12	6.17	0.05
5BG	5.82	5.86	0.04
10BG	5.15	5.19	0.04
15BG	5.58	5.62	0.04
5WG	5.51	5.53	0.02
10WG	5.67	5.69	0.02
15WG	5.54	5.56	0.02
5SP	6.39	6.41	0.02
10SP	6.89	6.91	0.02
15SP	7.11	7.13	0.02

It was observed White Granite and Stone Powder filler compositions absorbed less water than compared with Black Granite filler compositions.

The Water absorption is constant for all the filler composition of Black Granite, White Granite and Stone Powder.

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The Water absorption is 0.04gms with the additive of Black Granite, 0.02gms with the additives of White Granite powder and stone powder.

CONCLUSION:

Tensile strength improved to 3167MPa with Black Granite powder by the weight percentage additive is 10%, 3288MPa of strength improved with the 5% of white Granite and 2055MPa strength improved with the 10% of Stone powder.

Flexural strength improved to 2728MPa with Black Granite powder by the weight percentage additive is 15%, 2261MPa of strength improved with the 15% of white Granite and 3088MPa strength improved with the 5% of Stone powder.

The ultimate impact strength of glass epoxy is 2.2J/cm^2, the improvements of strength level of the glass fibre Epoxy composite by the additive of Black Granite powder is 3.2J/cm^2, white Granite powder is 2.6 J/cm^2 and with stone powder the flexural strength improved to 3.9 J/cm^2.

Rockwell Hardness Number improved to 41 with Black Granite powder by the weight percentage additive is 10%, 42 of improved with the 10% of white Granite and Stone powder.

Water absorption is constant to 0.04gms with Black Granite powder. 0.02gms white Granite and Stone powder.

The Maximum tensile strength is obtained at filler composition of 5% of WG i.e. 3288MPa. The Maximum flexural strength is obtained at filler composition of 5% of SP i.e. 3088MPa. The Maximum Impact strength is obtained at filler composition of 10% of SP i.e. 3.9J/cm^2. The Maximum Rockwell Hardness Number is 42 for the filler composition of 10% of WG and SP and the less Water absorption is 0.02gms for the filler composition of WG and SP.

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