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DOI: https://doi.org/10.64388/IREV9I7-1713306

Evaluation of Mechanical Properties of Aramid, Boron and Carbon Fiber with Iron Ore Powder Using Hand Layup Technique

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Abstract-* Generally composite materials are made up of the two or more constituent materials. Now a day's used various applications in society. Synthetic fibers have best properties compared to the materials. Composites materials are very stronger, lighter and less expensive compared to the traditional materials. Mostly synthetic fibers have good elasticity properties and present days FRP composites are used in almost all type of advanced engineering Applications structure like aircraft, boats, missile etc.., better mechanical properties like tensile strength, flexural strength, hardness and impact strength. The aim of the project is fabrication and testing of Aramid, Boron, Carbon fiber Reinforcement of iron ore powder combination of Aramid, Boron, Carbon fiber, Aramid + Boron, Boron + Carbon fiber, Aramid +Carbon fiber and Aramid +Boron+ Carbon fiber commonly used every composition iron ore powder using hand layup technique finally find out the tensile strength, flexural strength, impact strength and hardness compared to the 7 combinations finally find out the best composition of material among all compositions for real world applications. After all the tests has performed on the specimens the Boron+Carbon+Aramid+ iron ore powder shows a best result in the tensile strength (0.36 N/mm2), impact strength (78.5 J), hardness test (40) and as well as flexural strength (84.94 N/mm2). For the above investigations we are proposed the Boron+Carbon+Aramid+iron ore powder having good mechanical properties when comparing with other results

***Key Words: -* Aramid, Carbon, Iron ore, Mechanical properties, Flexural Strength.**

I. INTRODUCTION

Natural fibers, which occur in the vegetable or animal kingdom, exhibit a polymeric nature in terms of their chemical composition. In contrast, natural fibers found in minerals resemble crystalline ceramics. A distinguishing characteristic of natural fibers is their typically heterogeneous composition, consisting of various compounds, whether chemical or physical in nature. Synthetic fibers can be further classified into polymers, metals, ceramics, or glass, with a unique subclass known as whiskers. Whiskers, being monocrystalline and short, boast exceptional strength, approaching theoretical limits due to the absence of crystalline imperfections like dislocations and grain boundaries. These whiskers usually obtained through vapor phase growth, exhibit diameters of a few micrometers and lengths ranging from a few millimeters, resulting in aspect ratios (length/diameter) that can vary from 50 to 10,000. However, a drawback of whiskers lies in their non-uniform dimensions and properties. Natural fibers offer notable advantages, including low density, suitable stiffness, mechanical properties, and high disposability and renewability. They are recyclable and biodegradable, contributing to environmental sustainability. Over the past decade, there has been increased interest in composites of polymers reinforced by natural fibers, such as Jute, Coir, and Hay fibers, which exhibit excellent reinforcing capabilities when compounded with polymers. The unique aspect of designing parts with fiber-reinforced composite materials lies in the ability to tailor mechanical properties to suit specific applications, aiming for an optimal weight-to-strength ratio.

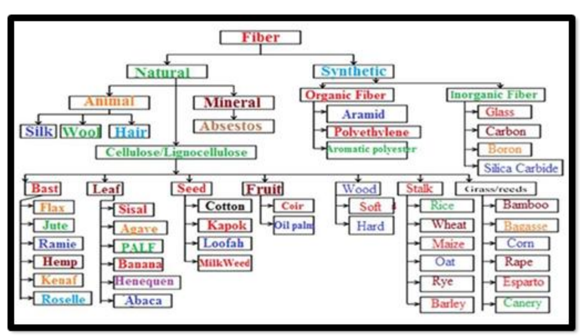

Figure 1: Classification Of Natural Fibers According to Origin with Examples

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II. MATERIALS USED

2.1. ARAMID FIBER:

Aramid fiber, also known as aromatic polyamide fiber, is a class of strong, synthetic fibers that are heat-resistant and have excellent chemical resistance. Aramid fibers are made from long chains of polyamide molecules that contain aromatic rings in their structure. These aromatic rings give Aramid fibers their high strength and heat resistance.

Figure 2.1: Aramid Fiber

2.2. CARBON FIBER:

Carbon fiber is a strong, lightweight material known for its high stiffness, tensile strength, and chemical resistance. It is composed of Carbon atoms bonded together to form a long chain structure, typically woven into a fabric or layered into sheets. Carbon fiber is commonly used in various industries such as aerospace, automotive, marine, and sports equipment manufacturing due to its exceptional mechanical properties

Figure 2.2: Carbon Fiber

2.3. BORON FIBER:

Boron fibers are typically produced through a chemical vapor deposition (CVD) process, where Boron is deposited onto a substrate in a controlled environment. This process results in high- purity Boron filaments with excellent mechanical properties. Despite its exceptional properties, Boron fiber is expensive to produce and process, which limits its widespread use in commercial applications compared to other composite materials like Carbon fiber. However, in specialized industries where performance is paramount, Boron fiber remains a valuable and sought-after material. Despite its exceptional properties, Boron fiber is expensive to produce and process, which limits its widespread use in commercial applications compared to other composite materials like Carbon fiber. However, in specialized industries where performance is paramount, Boron fiber remains a valuable and sought-after material.

Figure 2.3: Boran Fiber

2.4. IRON ORE POWDER:

Iron ore powder, also known as iron ore fines, is a finely crushed form of iron ore. It is typically obtained during the mining and processing of iron ore and is used as a raw material in various industries.

Figure 3.4: Iron Ore Powder

2.5. EPOXY RESIN:

Epoxy resin is a thermosetting polymer that is commonly used as a matrix material in composite materials. It is known for its excellent strength, adhesion, and chemical resistance properties.

Figure 2.5: Epoxy Resin

2.6. Hardener:

Aradur HY951 is a cycloaliphatic amine hardener used in conjunction with epoxy resins to cure and form a strong, solid material. It is a clear, low-viscosity liquid with a flash point of 110 degrees Celsius and a specific gravity of 0.98 grams per cubic centimeter at 25 degrees Celsius. Aradur HY951 is a versatile hardener that can be used with a variety of epoxy resins, including bisphenol-A diglycidyl ether (BADGE) and bisphenol-F diglycidyl ether (BFGE). It is a room-temperature curing hardener, which means that it does not require heat to cure.

Figure 2.6: Hardner HY951

III. METHODOLOGY

3.1.Hand Lay Up Process:

Hand lay-up technique is the simple and cheapest method of composite processing. The infrastructural need for this technique is also minimal. The standard test procedure for Mechanical properties of fiber-resin composites; ASTM-D790M-86 is utilized to according to the measurements. The mold is prepared on smooth clear film with 2 way tape to the required measurement. At that surface mold is prepared keeping the 2 way tape on the clear film.

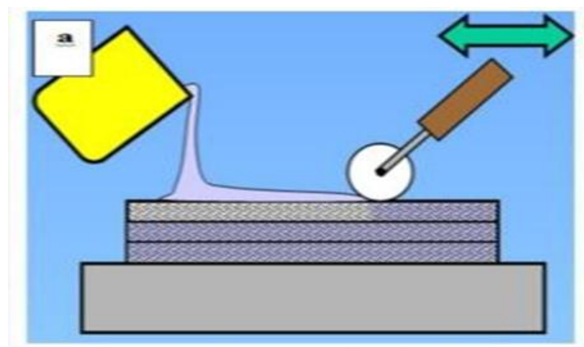

Figure 3.1: Hand Layup Process

3.2. Compositions Used:

BORON FIBER+ IRON ORE POWDER
CARBON FIBER+IRON ORE POWDER
ARAMID FIBER+ IRON ORE POWDER
BORON FIBER+ CARBON FIBER + IRON ORE POWDER
CARBON FIBER+ ARAMID FIBER + IRON ORE POWDER
ARAMID FIBER+BORON FIBER+ IRON ORE POWDER
BORON+CARBON+ARAMID+ IRON ORE POWDER

3.3.Pure Fibers:

Type	Fiber (%)	Epoxy (%)	Hardner (%)	Iron ore (%)
Aramid	38	55	5.6	1.4
Boron	38	55	5.6	1.4

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Carbon	38	55	5.6	1.4

3.4.Combination of Fibers:

Type	Fiber (%)	Epoxy (%)	Hardner (%)	Iron ore (%)
Boron + Carbon	38	55	5.6	1.4
Boron + Aramid	38	55	5.6	1.4
Aramid + Carbon	38	55	5.6	1.4
Aramid +Boron + Carbon	38	55	5.6	1.4

3.5. Steps Involved in the Fabrication of Specimen:


Dry Fiber Sheets


Applying Resin


Rolling The Mould


Laminating


Curing Of Fiber

Figure:3.5. Process of Fabrication

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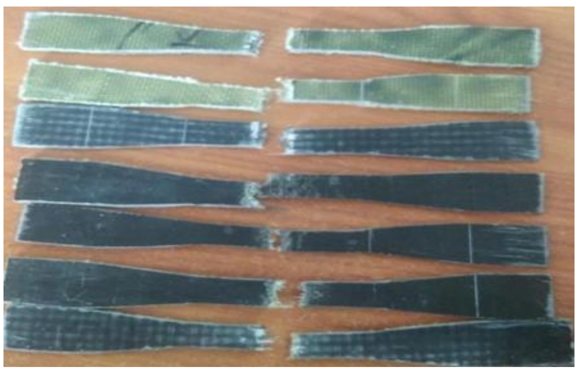
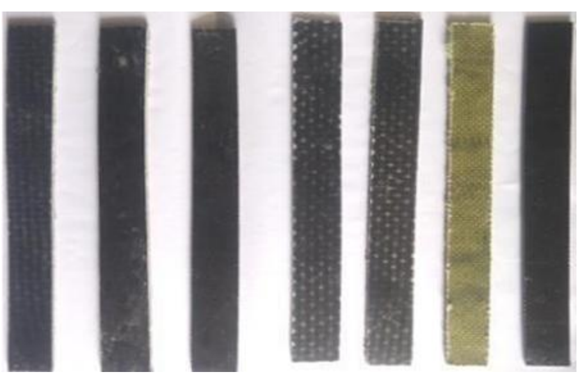
IV. MECHANICAL TESTINGS OF SPECIMENS

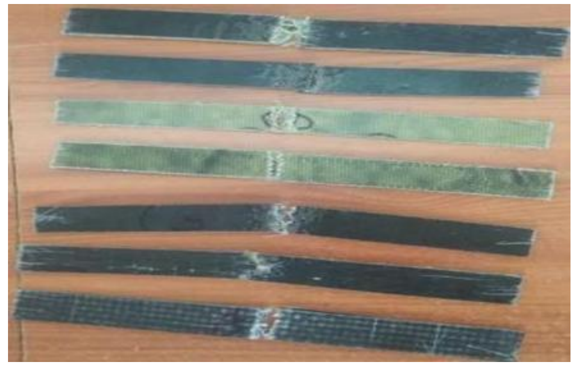
4.1. Specimens Before and After Tensile Testing:


Before Testing

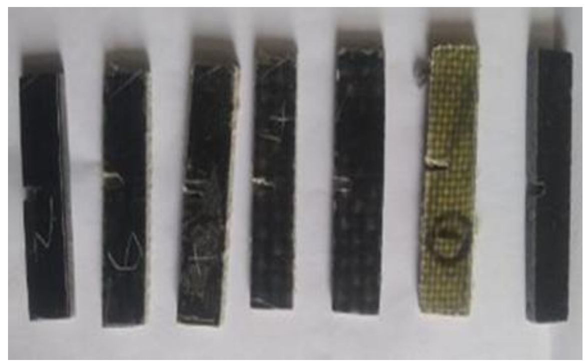

Ater Testing

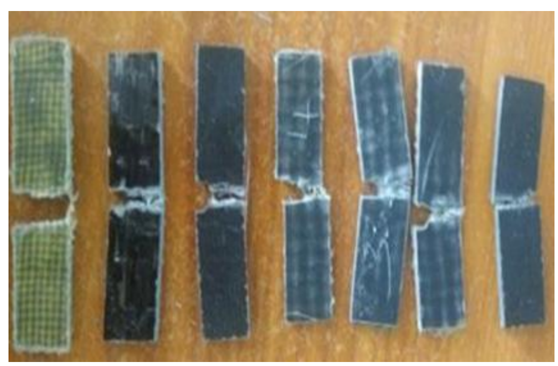
4.2. Specimens Before and After Flexural Strength Testing:


Before Testing


After Testing

4.3. Specimens Before and After Hardness & Impact Testing:


Before Testing


After Testing

4.4. Specimens Before and After Hardness Testing:

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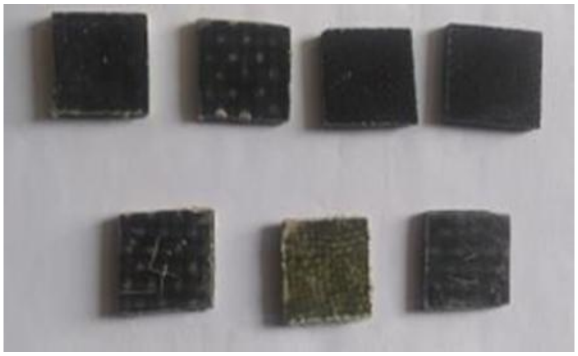


Before Testing

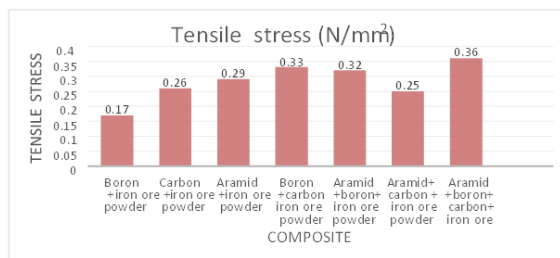
After Testing

V. RESULTS AND DISCUSSIONS

5.1Mechanical Characteristics of Composites Tensile Strength Results:

s.no	Composite	Tensile strength			
		Load(N)	Elongation (mm)	Tensile stress (n/mm2)	% elongation
1	Boron +iron ore powder	1294.5	4.12	0.17	2.51
2	Carbon +iron ore powder	1912.4	3.4	0.26	2.07
3	Aramid +iron ore powder	2157.5	7.13	0.29	2.54
4	Boron +Carbon iron ore powder	2461.6	4.18	0.33	3.45
5	Aramid +Boron+ iron ore powder	2373.3	5.66	0.32	4.34
6	Aramid+ Carbon + iron ore powder	1882.9	3.47	0.25	2.11
7	Aramid +Boron+ Carbon+ iron ore	2666.7	3.21	0.36	1.95

Testing results



Composite vs Tensile stress graph

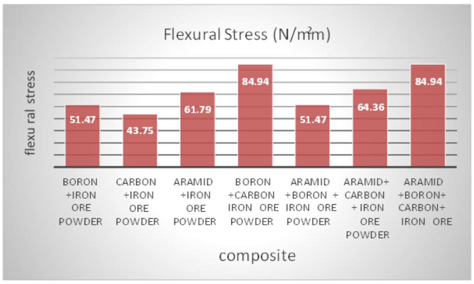
Boron+ Carbon + Aramid has the high tensile strength among all the compositions i.e 0.36N/mm^2

5.2. FLEXURAL STRENGTH:

S.no	Composite	Flexural Test			
		Load(N)	Elongation (mm)	Flexural stress(N/mm^2)	% elongation
1	Boron +iron ore powder	196.1	7.1	51.47	4.32
2	Carbon +iron ore powder	166.7	4.06	43.75	6.41
3	Aramid +iron ore powder	235.4	5.69	61.79	3.46

4	Boron +Carbon iron ore powder	323.6	9.34	84.94	5.69
5	Aramid +Boron+ iron ore powder	323.6	4.51	51.47	2.47
6	Aramid+ Carbon + iron ore powder	245.2	6.82	64.36	2.75
7	Aramid +Boron+ Carbon+ iron ore powder	196.1	4.06	84.94	4.15

Flexural Testing Results

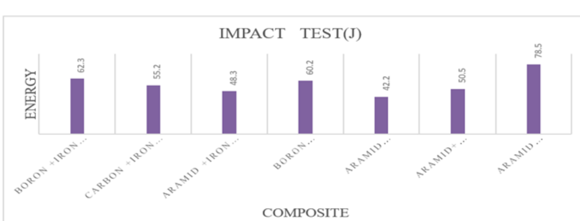


Based on the flexural strength finally concluded that Aramid+ Carbon+ Boron epoxy composite possess high flexural strength compared to remaining composite i.e.84.94N/mm2.

5.3 IMPACT STRENGTH:

S.no	Composite	Impact(J)
1	Boron +iron ore powder	62.3
2	Carbon +iron ore powder	55.2
3	Aramid +iron ore powder	48.3
4	Boron +Carbon iron ore powder	60.2
5	Aramid +Boron+ iron ore powder	42.2
6	Aramid+ Carbon + iron ore powder	50.5
7	Aramid +Boron+ Carbon+iron ore powder	78.5

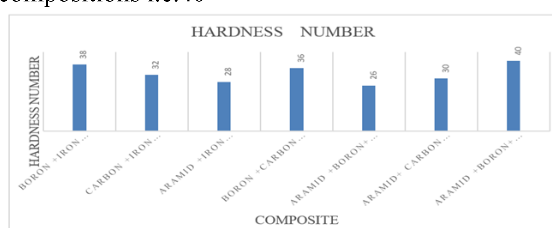
The composition Aramid+Boron+Carbon is having the highest energy absorbing capacity, Impact strength among the all compositions i.e.78.5J



5.4.HARDNESS NUMBER:

s.no	Composite	Hardness number
1	Boron +iron ore powder	38
2	Carbon +iron ore powder	32
3	Aramid +iron ore powder	28
4	Boron +Carbon iron ore powder	36
5	Aramid +Boron+ iron ore powder	26
6	Aramid+ Carbon + iron ore powder	30
7	Aramid +Boron+ Carbon+iron ore powder	40

The composition of Boron+Carbon+Aramid+ has the highest hardness number among the seven compositions i.e.40



CONCLUSION

6.1 CONCLUSION

- The present work has been done with an objective to explore the use of Boron fiber+ iron ore powder, Carbon fiber+iron ore powder, Aramid fiber+iron ore powder, Boron fibre+ Carbon fibre +iron ore powder, Carbon fibre+ Aramid fiber +iron ore powder, Aramid fiber+Boron fiber+ iron orepowder, Boron+Carbon+Aramid+iron ore powder are manufactured using hand lay-up method. Epoxy is used as matrix in the reinforced composite and investigated the mechanical properties like tensile, flexural, impact and

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DOI: https://doi.org/10.64388/IREV9I7-1713306

hardness number of composites.

- This work is focused to find the best composite among the seven combinations. After all the tests has performed on the specimens the Boron+Carbon+Aramid+ iron ore powder shows a best result in the tensile strength impact strength, hardness test and as well as flexural strength.
- For the above investigations we are proposed the Boron+Carbon+Aramid+iron ore powder having good mechanical properties when comparing with other results.
- Tensile stress is 0.36N/mm2
- Flexural stress is 84.94N/mm2
- Impact energy is 78.5J
- Hardness number is 40
- These are the results for proposed composite.

6.2 FUTURE SCOPE

- The extension of this thesis work can be done by considering the following points:
- The fiber can also take in the form of powder to fabricate the specimen which may increases the strength.
- Different type resins can be used to find the mechanical properties like strength, wear resistance
- By considering different process parameter and different composites which improves the properties of composites.

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