INVESTIGATIONS ON REUSE POSSIBILITY OF ALUMINIUM DROSS IN COMPOSITE PLATE MANUFACTURING

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ABSTRACT

Aluminium is a common raw material used in the manufacturing of various automotive products. The production of automotive products using raw material aluminium generate solid wastes such as slag, scrap, dross etc., The dross are the wastes which are formed in the furnace during the aluminium melting process. The dross waste which are usually dumped as waste can be utilized to manufacture various products. This work is an attempt to explore the ways to utilize the aluminium dross to make a composite material product. Products made of composite material using Glass fiber Reinforced Polymer materials and epoxy resin were tried in this research. Three types of composite plates are prepared and tests were carried out to find the tensile, compressive and impact strengths. The testing's were performed as per the internationally recognized standards. The plates are made out of aluminium powder coating, dross powder coating and with the combination of both aluminium and dross powder. The plate with dross powder coating provides lower strengths when compared to others. But the plate made using combination of dross with aluminium powder showed improved strengths on comparision.

Index Terms:, Aluminium dross, composite material, reuse

1. INTRODUCTION

Aluminium is a recyclable metal which was available in the earth. The extraction of aluminium involves consumption of high energy. The extraction process begins with the bauxite mining and an electrolyte process known as Hall-Heroult process which reduces the alumina into aluminium[1]. The processed aluminium are used in automobile industries for a valuable product manufacturing. The primary or virgin aluminium has higher purity of about 99.99% [2]. Automobile industry generates waste in the form of scraps, dross, oils, waste waters etc., The scraps can be reused as a secondary aluminium by melting them. The dross is a waste generated during the aluminium melting process and settled at the bottom of a furnace. The dross wastes are disposed as a landfill in various industries [3]. A typical industry generates dross waste of about 35 kg per day during the melting of around 3 tons of aluminium. The dross can be utilized in various fields such as construction, composite material manufacturing, effluent water treatments etc.,[4]. The dross provides a nominal strength when combined with aluminium powder. Composite plates were made using dross waste , Glass Fiber Reinforced fabrics, epoxy and resin. Three types of sample plates are prepared namely aluminium powder coated plate, dross powder coated plate and combination of dross & aluminum powder coated plate. It was found that dross with aluminum powder provides higher tensile, compressive and impact strengths than the ordinary dross coated plate. Thus the dross can be used as a material for manufacturing various products such as pipes, tables, plates, paper, etc.

2. PLATE MAKING PROCEDURE

- The glass fiber fabric was cut into square shape of 300mm x 300mm.
- The resin was taken in the ratio of 3:2. to the weight of the fabric.
- The epoxy of Resin: LY556 and Hardener: HY951 were mixed in the proportion of 10:1.
- To the epoxy aluminium powder, aluminium dross powder and combination of aluminium powder and dross were added separately in the ratio of 10:1 ratio for making three sample plates .
- The epoxy mixture was applied uniformly using manual laying method.
- The above process was repeated for 7 layers of Glass fibre fabric and epoxy resin coating.

- After the above processes the lamination sheet is placed and applied with wax at the end.
- Again the epoxy was applied on the layer of fabric and another fabric was placed on it.
- Finally the samples are allowed to undergone curing which takes around 48 hours.
- The above method was done for the 3 types of composite plates
- The plates after curing was subjected to tensile, compressive and impact testing. The plates were cut into the required dimensions and testing's were carried out as per guidelines of international standard ASTM D3039 and ISO 180.

3.Materials and Methods:

The Table 3.1 provides the details of the material used to prepare composite plates.

Table-3.1.Materials used in composite plate preparation

S.No	Composite Plate	Weight Of Glass Fiber Fabric (g)	Coated Material	Weight Of Coated Material (g)	Resin (ml)	Hardener (ml)
1	GFRP with Aluminium Powder	464.5	Aluminium Powder	46.5	333	33
2	GFRP with Dross Powder	518	Dross Powder	50.5	379	38
3	GFRP with Aluminium Powder & Dross Powder	482	Aluminium Powder + Dross Powder	25+24.5	354	35

The figure-3.1 shows the composite plate preparing stages for making aluminum dross with GFRP fabrics as per the the procedure mentioned above. The figure 3.2 shows the composite plates with the markings for preparing of sample plates. The samples were tested for tensile, compressive and impact testing according to the standards. The figures 3.1 (a), (b) and (c) represent production steps for manufacturing aluminium powder composite plates, aluminium dross composite plates and composite plates made by combining aluminium powder & aluminium dross respectively.

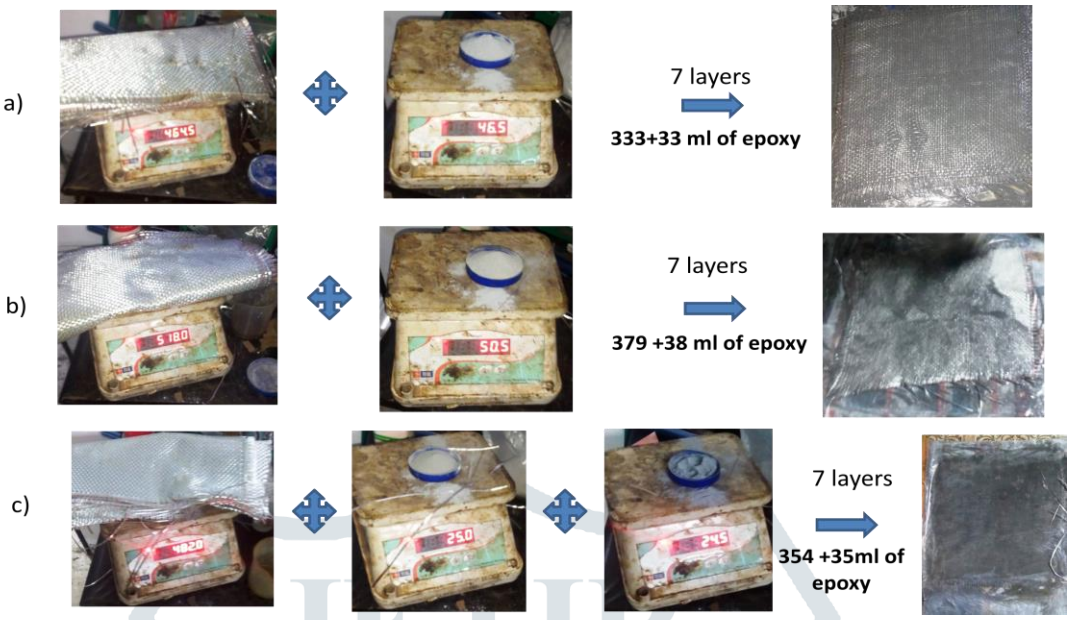

Figure-3.1.composite plate preparation stages

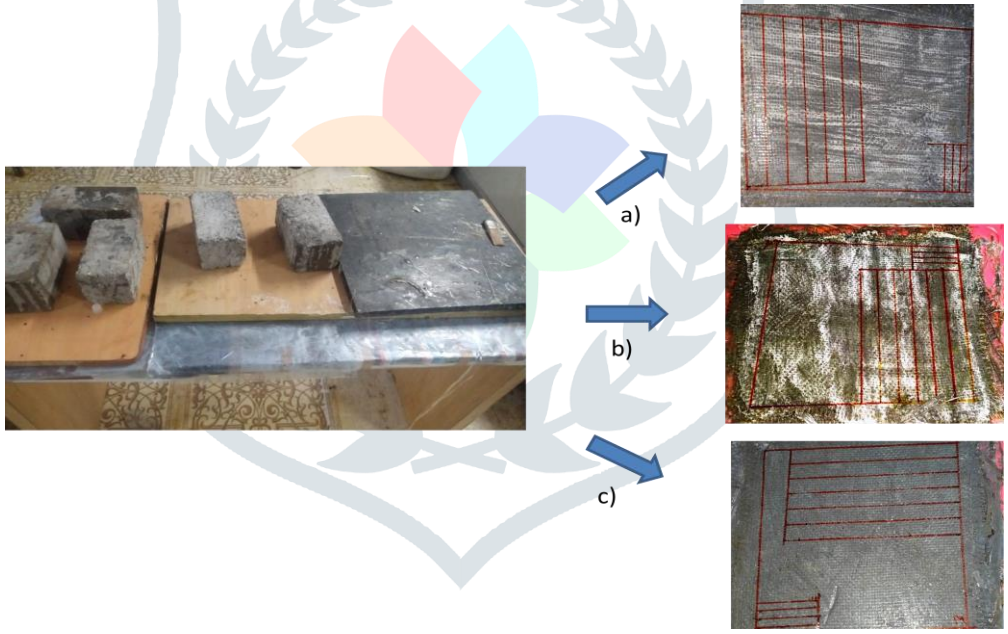

Figure-3.2. composite plates

4.PLATE TEST RESULTS

The Tensile, Compressive and Impact results carried out for various composite plates are furnished in the table 4.1 , table 4.2 and table 4.3 respectively.

Table-4.1.Tensile Test Results

Test Parameters		**Observed Values**					
S.No	Sample id	GFRP with Aluminium Powder		GFRP with Dross Powder		GFRP with Aluminium Powder & Dross Powder	
		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
1	Width of plate (mm)	24.38	24.38	25.20	25.36	25.60	24.84
2	Thickness of plate (mm)	4.01	4.07	4.47	4.55	4.76	4.63
3	Original cross sectional area (mm^2)	97.76	99.23	112.64	115.39	121.86	115.01
4	Ultimate Tensile Load (kN)	27.94	30.11	24.90	22.83	29.67	26.16
5	Ultimate tensile strength (MPa)	286	303	221	198	243	228

Table-4.2.Compressive Test Result

Test Parameters		Observed Values					
S.No	Sample id	GFRP- with Aluminium Powder		GFRP- with Dross Powder		GFRP- with Aluminium Powder & Dross Powder	
		Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
1	Width of plate (mm)	24.94	25.43	25.30	26.09	25.53	27.55
2	Thickness of plate (mm)	4.14	3.99	4.80	4.07	4.90	4.43
3	Original cross sectional area (mm^2)	103.25	101.47	121.44	106.19	125.10	122.05
4	Ultimate Tensile Load (kN)	1.35	1.34	1.48	0.83	1.80	1.57
5	Ultimate tensile strength (Mpa)	13	13	12	8	14	13

Table-4.3.Charpy Impact Test Result

S.No	Sample id	Specimen Size Dimension in mm	Notch type	Absorbed Energy-Joules			Average Joules
				S-13	S-14	S-15	
1	GFRP with Aluminium Powder	4 x 10 x 80	Un notched	10	10	12	10.67
2	GFRP with Dross Powder	4 x 10 x 80	Un notched	04	04	10	6.00
3	GFRP with Aluminium Powder & Dross Powder	4 x 10 x 80	Un notched	06	08	06	6.67

5. RESULTS AND DISCUSSIONS

The figure-5.1 shows the tensile test results made of the various plates. It is seen that the tensile strength is higher in aluminium plates whereas lesser in dross plates. The combination of dross and aluminium powder plates provides the higher strength than the dross plates. This proves that the dross can provide additional strength when it is added with the aluminium powder.

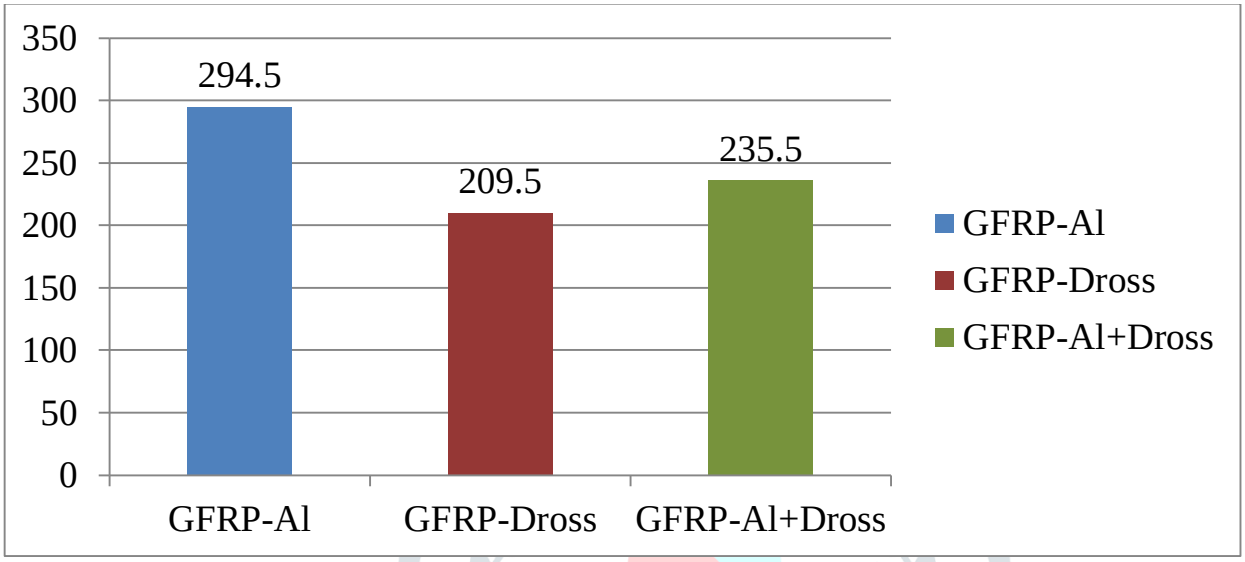

Figure-5.1. Tensile test of plate results in MPa

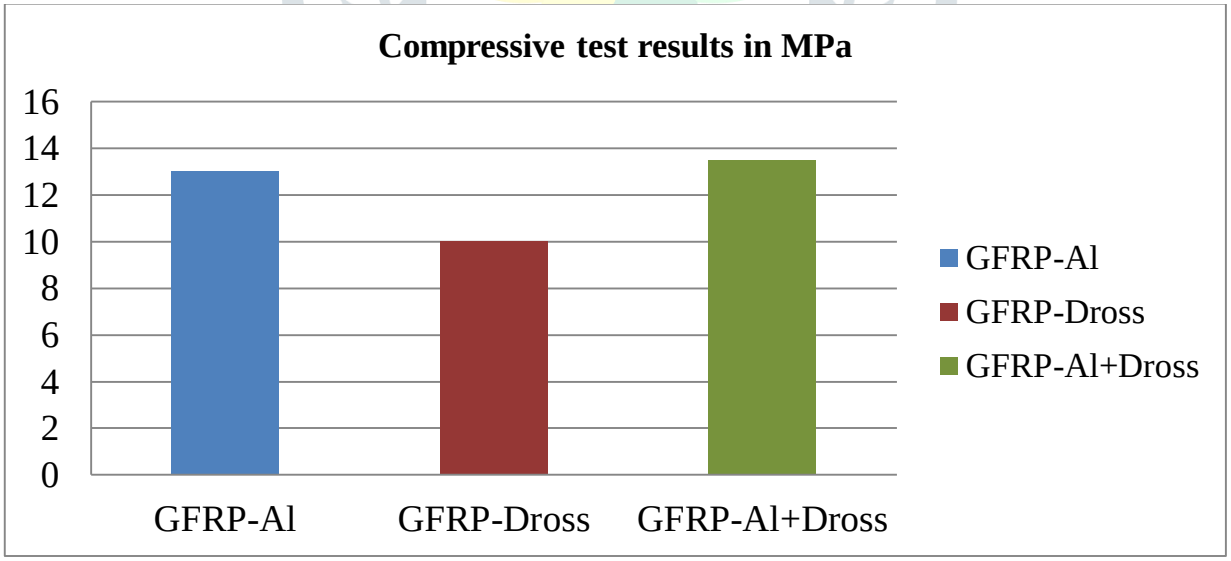

Figure-5.2.Compressive test of plates

The figure-5.2 shows the compressive test results made for the various plates. It is seen that the compressive strength is higher in aluminium and dross powder combination plates whereas lesser in dross plates. The combination of dross and aluminium powder provides higher compression strength

than the others. Thus dross powder when added with aluminium powder can give more compressive strength than tensile strength.

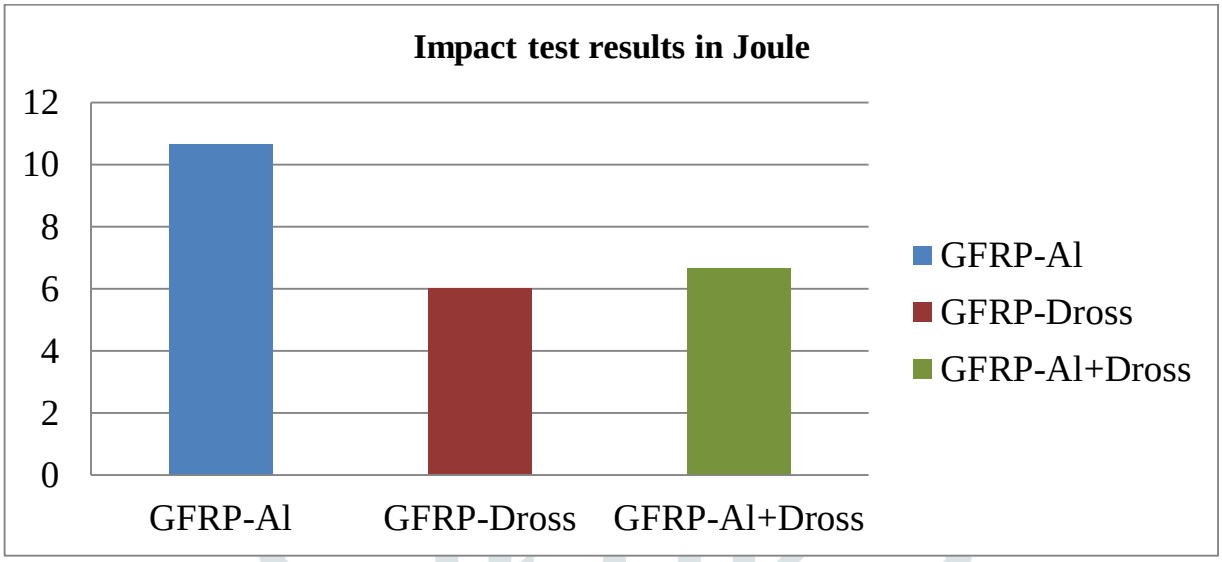

Figure-5.3.Impact test of plates

The figure-5.3 shows the impact test results carried out on various plates. It is seen that the impact strength slightly increased when the dross was added with aluminium powder. But the ordinary dross sustains only lesser impact than the others. The aluminium powder plate sustains higher impact than others.

3. Conclusion

The recycling of aluminium dross waste will reduce the environmental aspects by reducing the need to extract aluminium from its ores by bauxite mining. The consumption of energy and fuels will also reduced by these methods. The dross which contains the aluminium metals can have a good binder characteristic in the concrete mixing, dyes and paints. This dross can be mixed with sand and cement in the concrete block manufacturing and can provide high strength and long life for buildings. The plates made of fine dross and aluminium powder at 50:50 ratios gives higher strength than the plates made of ordinary dross. The plate of AL-powder and Dross powder sustains higher compressive loads than the other plates. Finer dross can provide higher strengths when a composite was made with aluminium powder. The applications such as doors, frames, water tubs, pipes etc., can be made from the plates made of aluminium dross.

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