ISSN (Online) : 2455 - 3662
SJIF Impact Factor :5.148

EPRA International Journal of

Multidisciplinary Research

Monthly Peer Reviewed & Indexed
International Online Journal

Volume: 4 Issue:12 December 2018

Published By :
EPRA Journals

Volume: 4 | Issue: 12 | December 2018 SJIF Impact Factor: 5.148 ISSN (Online): 2455-3662

EPRA International Journal of
Multidisciplinary Research (IJMR)

DELONIX REGIA AND WASTE GLASS-POLYURETHANE COMPOSITE MATERIAL

Kumar Sonu
Assistant Professor,
Department of Mechanical Engineering,
Aryabhatta College Of Engineering &
Research Center,
Ajmer- 305001,
Rajasthan,
India

ABSTRACT

The aim of this paperwork is to produce cheaper and environmentally friendly composite material by mixing Delonix regia pod powder (DRF) and polyurethane. The waste glass powder was used as a filler material in a ratio of 1:1 with Delonix regia fruit powder to evaluate its effect on the mechanical properties. The density, percentage water absorption, hardness, tensile strength, flexural strength and impact strength of both Delonix regia pods, powdered particles (DRF) and Delonix regia pod powdered particles and glass powdered particles (DRFG) composite were determined. The result showed that the use of glass powder as a filler material has improved these properties. The physical properties such as density, moisture absorption and hardness of DRF and DRFG composite are compared with the reported natural wood.

KEYWORDS: *Delonix regia, Waste glass powder, polyurethane, density*

INTRODUCTION

There is a constant search of low cost, and eco-friendly composite material at improved desired properties from industrial and agro byproduct. This would reduce the burden on the conventional materials. Composite material, today had found its application in almost all fields of science. Glass fiber and carbon fiber reinforced composite constitutes about 90% of the global market, respectively[2]. The high manufacturing cost at higher environmental impact by, these synthetic fiber composites have forced the researchers to shift towards natural, eco-friendly, cheaper, lightweight composite materials for lower technology application. The availability of *Delonix regia* tree in abundance and producing a huge amount of bio-waste in terms of its hard pod in dry seasons has become the reason for its research in the field of composite material. *Delonix regia* (Gulmohar) is one of the traditional medicinal tree of Plantae kingdom, Fables order and Fabaceae family, whose leaves, seeds and barks are used for treatment of diseases such as pneumonia, stomach disorder, bronchitis and rheumatism. The fruit (pod) of *Delonix regia* is flaccid and green when young but turns into dark brown hard woody pod, which is a bio waste.[3] Obam[4] used saw dust, waste paper and starch for manufacturing of composite for ceiling board. Non -biodegradable, the limited lifetime; glass is the major solid waste constituting a problem of its disposal in various municipalities. There are several existing methods to recycle these waste glass, the researchers are also trying to use these waste in various construction material. Ahmad[6] investigated the performance of glass powder in concrete with satisfactory result. The paper work is aimed to produce environmental friendly, *Delonix regia* fruit powder- polyurethane composite material and at the same time to evaluate the effect of waste glass powder on its mechanical properties.

2. EXPERIMENTAL

2.1 Materials

The *Delonix regia* fruit pod which is a hard woody pod upon drying was used as a matrix in this composite was collected from the *Delonix regia* trees at VIT, Vellore, arena. The *Delonix regia* fruit pod was crushed to small pieces, dried in sunlight and ground to mesh size of 80 and 100. The powdered pod of *Delonix regia* fruit was dried at 105°C for about 24 hours in hot air oven until constant weight was reached to insure the complete removable of moisture, and then stored in the polyethylene bag to be used conveniently [8]

The waste glass used as a filler material for improving the mechanical properties of the developed composite was collected from dumping site at Ranipet, Vellore District. These collected glasses were cleaned with disinfectant, 1 N NaOH solution, dried in the sunlight and ground to mesh size of 80 and 100. Polyurethane with the density of 1.07 g/m^3 and viscosity of 75 mPas was used as a polymer matrix.

2.2Manufacturing The traditional hand lapping process at ambient temperature ranging from 30°C to 35°C was used to develop the composite. The two combination of composite reinforcement was used; one with *Delonix regia* fruit pod powdered particles (DRF) and another with *Delonix regia* fruit pod powdered particles and glass powdered particles (DRFG) in a ratio of 1:1 by weight. The reinforcement and the matrix (Polyurethane) were mixed in a ratio of 1:1 by weight and stirred uniformly for insuring proper mixing. The mixtures were then placed in a wooden mold with releasing paper and allowed to cure for 24 hours. The specimens for testing the different mechanical properties were cut from the molded composite according to ASTM standard.

Fig 1 Photographic view of DRFG composite

2.3 Testing of Samples

The tensile, flexural and impact test was carried at Microlab Metallurgical Test House, Ambattur Industrial Estate, Chennai-600058. The moisture absorption and the hardness test were carried out at the Department of Mechanical Engineering, Strength Of Material Lab, Vellore Institute of Technology, Vellore. Mass and the volume of the developed composite were used to calculate the density of the composite. [8]

2.3.1 Water Absorption

Four replicates samples for both DRF and DRFG composites of dimension 40 mm×10 mm×4. 1 mm was manufactured for percentage water absorption test. The samples were dried in hot air oven at 60^{0}C till the constant weight was reached. The digital weighing machine of precision of 0.000 g was used for weighing the sample. These samples were then placed in deionized water at ambient temperature. The samples were taken out periodically from the water, wiped to remove surface water, the weight and immediately kept in the water. The following formula was used to calculate the percentage water absorption of the composite,

Water absorption (%) $= [(W2 - W1)/W1] * 100$

Here W2 is the sample weight after keeping in water and W1 is the initial weight of the sample.

2.3.2 Hardness Test

The hardness test of DRF and DRFG composites were performed according to ASTM D785-98 on the Rockwell Hardness Testing Machine. The specimen thickness of 6.4mm was maintained. Four replicates samples for each test were tested and the average values were reported.

2.3.3 Tensile Test

The tensile test of DRF and DRFG composites were performed according to ASTM D638-01 on Universal Testing Machine. ASTM D638 specimen dimension is (165,19,7) mm. Four replicates samples for each test were tested and the average values were reported.

2.3.4 Flexural Test

The flexural test of DRF and DRFG composites were performed according to ASTM D790-00. ASTM D790-00 specimen dimension is (125,12.7,3.2) mm. Four replicates samples for each test were tested and the average values were reported.

2.3.5 Impact Test

The Charpy impact test of DRF and DRFG composites were performed according to ASTM D6110 . ASTM D6110 specimen dimension is (132,45,105) mm Four replicates samples for each test were tested and the average values were reported.

3. RESULT AND DISCUSSION

3.3.1 Water absorption & Density

The maximum percentage water absorption for DRF and DRFG composites were observed as 14.45% and 11.2% after 16 and 20 days respectively. The water absorption primarily depends upon the nature of the individual input ingredient (*Delonix regia* fruit, powdered, glass powdered and polyurethane). The decrease in the component of the cellulose and hemicellulose which are hydrophilic, the percentage of water absorption is reduced by 3.25 with the glass powder incorporation.

The density of any composite depends upon the specific gravity, the interaction and the proportionate formulation of its individual components. The density of DRF and DRFG composites measured to be 1414kg/m^3 and 3179.2 kg/m^3 respectively. The presence of voids could be also the possible reason for higher densities of these developed composites.

3.3.5 Hardness

The measured hardness of the DRF and DRFG composites were 45 and 68 on the Rockwell scale respectively. The better dispersion between the glass (filler) and the polyurethane (matrix) thereby reduction in void could be the possible reasons for the improvement of DRFG composites. Rahman[7] reported that hardness properties could be enhanced by increasing stiffness and decreasing flexibility. As per Mohammed [8], the well-polished surface has better hardness. DRFG composites had a better surface finished, showed better hardness.

Table 1 Characteristic of DRF and DRFG composites

Sample	Density (kg/m3)	Water absorption (%)	Hardness (Rockwell Scale)	Tensile strength (Mpa)	Flexural strength (Mpa)	Impact strength (kJ/m2)
DRF-Polyurethane	1414	14.45	45	4.5	15.25	10.61
DRFG-Polyurethane	3179.2	11.2	68	9	22.07	10.61

3.3.5 Tensile strength

The presence of glass powder has improved the interfacial strength between the glass powder and the matrix (polyurethane) leading to an improvement in the tensile strength of the DRFG composites by 3.5 Mpa. The calculated tensile strength of the DRF and DRFG composites were 4.5 and 9 Mpa, respectively.

Fig 2 Cracked DRF composite specimen under Tensile strength test

3.3.5 Flexural strength

The result obtained from the flexural test showed that the flexural strength increased by adding the glass powder (filler). Flexural strength of the DRF and DRFG composites were 15.25 and 22.07 Mpa, respectively. The addition of glass (filler) had increased the stress transfer between the filler and matrix.

Fig 3 Cracked DRFG composite specimen under Flexural strength test

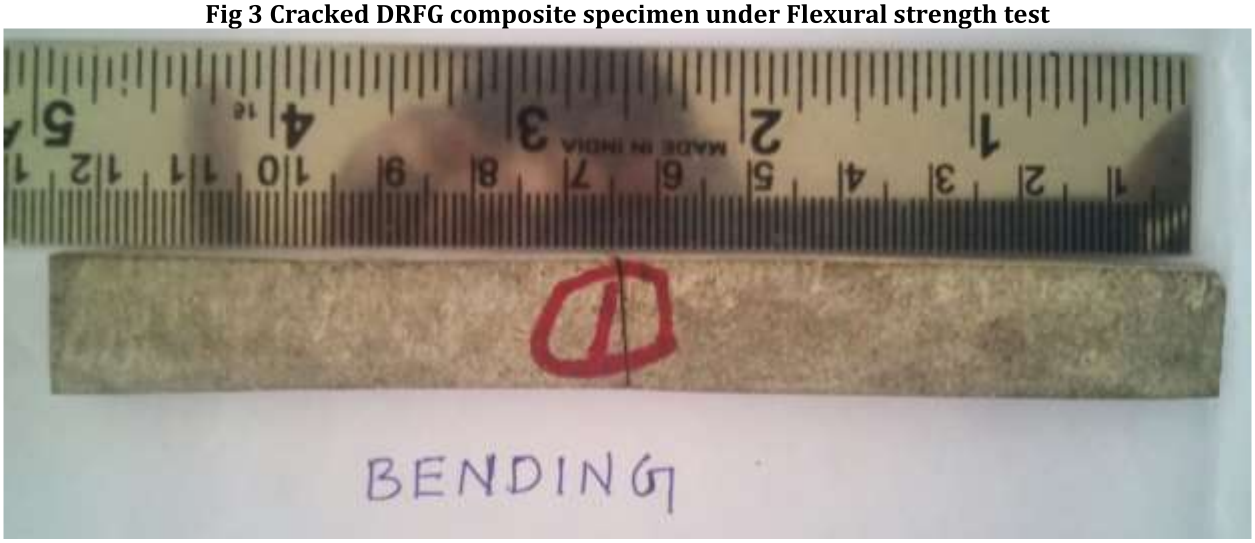

Fig 4 Cracked DRF composite specimen under Flexural strength test

3.3.5 Impact strength

The impact strength of both DRF and DRFG composites were 10.61kJ/m^2. There is no improvement in impact strength by addition of glass powder as filler. The higher impact resistances are demanded by the composite that are subjected to impact stresses and recurrent vibrations.

CONCLUSION

Delonix regia fruit (bio-waste) powdered and glass powdered (municipal solid waste) were recycled and composite material was developed which is eco-friendly, innovative, effective and cheaper. Comparing the physical properties with the natural soft wood and natural hard as evaluated by Mohammed [8], the present developed DRF and DRFG composites have similar properties. The density of the present developed composites is higher than natural wood which resist their applications, but the other physical and mechanical properties could be used for specific applications such as flooring and doors. The table 2 shows the comparison of physical properties of natural wood evaluated by Mohammed [8] with the present developed composites.

Table 2 Comparison of physical properties of natural wood evaluated by Mohammed [8] with the present developed composites

Sample	Density (kg/m3)	Water absorption (%)	Hardness(Rockwell Scale)	Refs.
Natural hard wood	660	29.2	85.46	15
Natural soft wood	470	42.4	56.1	
DRF- Polyurethane	1414	14.45	45	Present work
DRFG-Polyurethane	3179.2	11.2	68	

The addition of glass powder as a filler material has made the composite dense. The water absorption is inversely proportional to the density of the composite. The hardness of DRF composite is less than DRFG. The glass powder has improved the tensile strength of the composite as well as its flexural strength. The impact strength of the composite is same for both DRF and DRFG composites.

Considering the environment, the recycling of glass would save much pollution and power at the same time using *Delonix regia* fruit would save forest resources and tree thereby promoting green environment. Considering economics, these are the cheapest waste that could be a valuable asset to the construction industry. The use of other both biodegradable and non-biodegradable polymer is suggested as future work

Acknowledgement

I am very grateful to the Vellore Insitute of Technology and Microlab- Metallurgical Test House, Ambattur Industrial Estate, Chennai-600058 for their support to carry out the above project work.

REFERENCES

1. *Morales MJ, Rodríguez LC &Pedrerio MA, Constr& Build Mater, 114 (2016) 6–14.*
2. *Norshah A S & Paul T M, J of Clean Prod,120(2016)198-206.*
3. *Sumitra S & Sonia N K, W J of Pharm & pharmaceutical Scie, 3(2014)2042-2055*
4. *Obam& Sylvester O, A J Sci&Ind Res, 3(2012) 300-304.*
5. *Ravindra R , Irshad M, Renu D, Rita K &Veena S,Fuel, 134 (2014) 17–25*
6. *Ahmad S &Aimin X, Cem& Con Res, 36(2006) 457–468*
7. *Rahman R, Muhammad A, Sinin H & Muhammad S I, J of Biomat and Nanobio,2(2011) 435-444.*
8. *Mohammed A B & Maher ME,Constr& Build Mater, 47(2013)1431–1435.*