IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684 Volume 5, Issue 6 (Mar. - Apr. 2013), PP 29-32
www.iosrjournals.org

Breaking Load Analysis of Wood Plastic Composite Materials with Surface Roughness Variation

Chandra Prakash Giri [1], Abhishek Jha [2], Omesh Chandrakar [3]
[1]*(Department of Mechanical Engineering,CCEM,Raipur/ CSVTU,India)*
[2]*(Department of Mechanical Engineering,CSIT Durg/ CSVTU,India)*
[3] *(Department of Mechanical Engineering,CCEM,RCET,Bhilai/ CSVTU,India)*

Abstract :*Wood based composite materials are becoming very popular among manufacturers due to its unique qualities like better surface appearance, high durability and lesser corrosion and erosion. But during very fast development of technology it becomes imperative to control the cost parameter. This work is an attempt to give a solution to achieve a higher order of strength without affecting the budget significantly. By increasing surface roughness of WPC (wood plastic composite) it is tried to produce a stronger structure of same dimensions .Pattern of variation in breaking load with surface roughness is analyzed and found the zone of the highest strength.*
Keywords - *WPC, Surface Roughness, Breaking Load, Adhesive, Bonding*

I. INTRODUCTION

Wood –plastic composites are one of the emerging low cost advance materials using in applications including guard rails, sound barriers, traffic cones, mileage and sign posts, road lane markers, snow fences and crash barriers etc, which is also termed as road furniture. It is one of the fastest growing composite materials. It is recommended that the relatively low-tech products related to highway infrastructure could provide better opportunities for utilization of significant volumes of biomass, especially since it can be locally harvested and potentially locally processed and locally used. Automobile industries are also using WPC materials to achieve lesser weight, better surface finishing and lesser cost. As a rule-of-thumb is that 5% less weight means average fuel savings of 3%, according to industry association Plastics Europe.Wood is one of many biofibres currently being considered for the replacement of mineral fillers and glass fibers in thermoplastic resins. The Michigan, US, company RheoTech has recently introduced two other fibers, agave and coconut, into its wide range of products. Rheotech describes its core business as grinding, blending, and brokering scrap parts from local plastic moulders. It offers among other grades many varieties of polypropylene and polyethylene. Though areas of application of WPC are very wide but the constraint low adhesive force between wood fibers and plastic makes it inadequate for very high load application.

II. PROBLEM IDENTIFICATION

As it is clear from the above description that applying adhesive provides a composite of higher strength .But we can not apply it in excess due to its high cost and more over it leads to reduce the load and weight ratio. Simply applying more adhesive material can't help, so keeping this problem in view it becomes necessary to find alternative to produce same strength without significant increase in weight.

III. CONCEPT OF SOLUTION

As it can be easily understood from the figure that these all bond developing are at the surface level it means as much as grip molecules of adhesive and wood fiber will get on each other will create stronger bond. If we try to understand fundamentally one fact is the most imperative that area of contact of molecules of wood fiber and adhesive. Ultimately we need to increase the area of contact in a fixed given space.

Smooth and charming appearance is one the most important quality of WPC materials, as the nice appearance is required to maintain over the upper surface but somehow it we make the internal surface of wood plastic composite more rough it helps to increase the overall contact area of adhesive and wood fibers. However merely applying this principle theoretically is not enough, so we need to analyze the effect of surface roughness on adhesive bond strength.

IV. MECHANISM OF BONDING

Basically Wood is hydrophilic – it absorbs water – and plastic is hydrophobic, repelling it. A "compatibilizer," typically a polymer that bridges the interface between the wood and plastic in these products, enhances uniform load transfer and increases their strength and stiffness. We can understand it better like an example of the blended solution of oil and water though they completely come in the contact to each other but due to their own electronic configuration and internal bonding structure they can not mix properly i.e. they don't form new bond while mixes to each other.

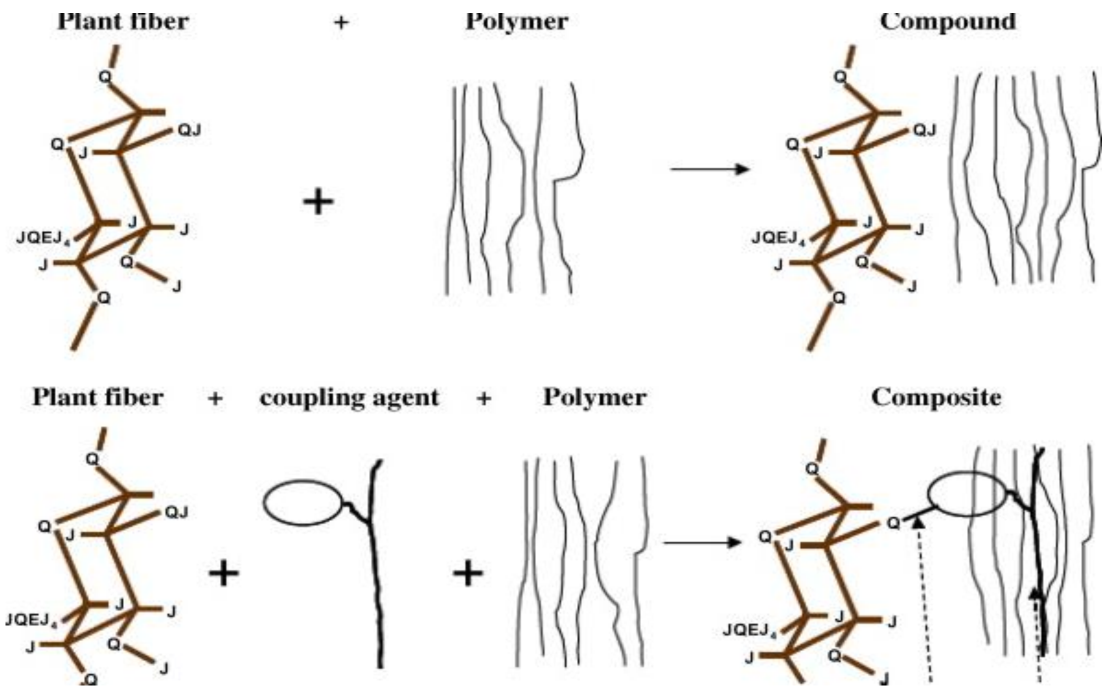


Fig. 1 wood plastic composite bonding mechanism

V. QUANTITATIVE APPROACH TO THE SOLUTION

Measurement of the roughness is on the basis of two things first one is the arithmetic average of the absolute values of the roughness profile in ordinates. It is a most commonly used parameter to monitor a production process.
Statistically it is very stable, repeatable parameter.

$$R_a = \frac{1}{n}\sum_{i=1}^{n}[y_i] \qquad (1)$$

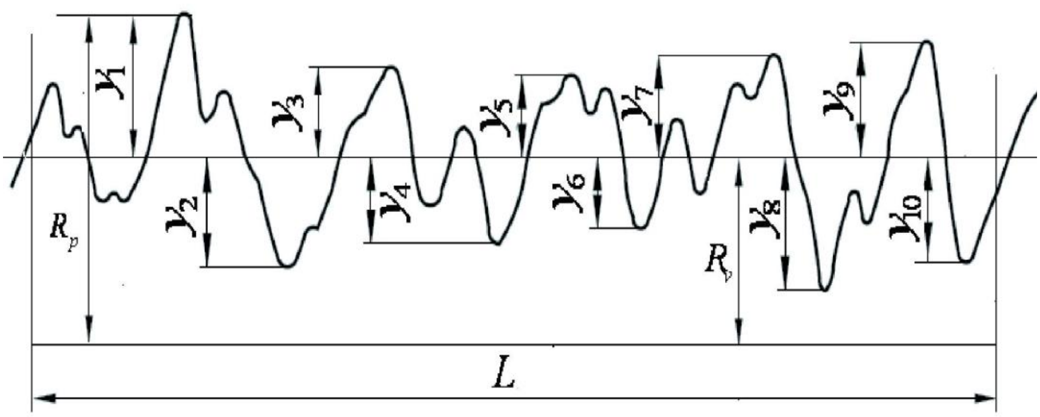


Fig. 2 surface roughness profile

The second thing is root mean square average R_{rms} It is more sensitive to peaks and valley than Ra. It used to control very fine surface in scientific measurement and statistical evaluation.

$$R_{rms} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} y_i^2} \qquad (2)$$

VI. ROUGHNESS MEASUREMENT

Three wood piece samples have taken separately and surface roughness of each is increased by means of rubbing different grade of emery papers on the surface of these wood samples. Initially P-12,P-24 and P-36 grade of emery papers are used .In all three cases the rubbing action took place for 4 minutes. Roughness measurement is taken by 7100 white light interferometer manufactured by Zygo Corporation. Roughness measurement results are as below.

TABLE 1 VALUE OF SURFACE ROUGHNESS

Surface Treatment	**R_a value (µm)**	**R_z value (µm)**
No treatment	0.9417 ± 0.15	8.75 ± 1.25
Grinding P-12	2.680 ± 0.14	14.27 ± 2.5
Grinding P-24	4.697 ± 0.17	24 ± 1.68
Grinding P-36	5.660 ± 0.13	33.5 ± 2.0

VII. EXPERIMENTAL STATICS

One side of the composite sample is prepared by purchased commercial wood .Falcofix adhesive manufactured by Suparshva Adhesives Ltd., Pune is used as a bonding medium other side of composite is made by high gloss PVC sheet Hebei Zhengyang Building Materials Co., Ltd. The dimensions of both wood and high gloss PVC are kept 15 ×10×1.5 cm and thickness of the adhesive is kept 4 mm. Further a high load of 500 N is applied for 10 hours to produce a uniform and stable composite.

VIII. TESTING AND RESULTS

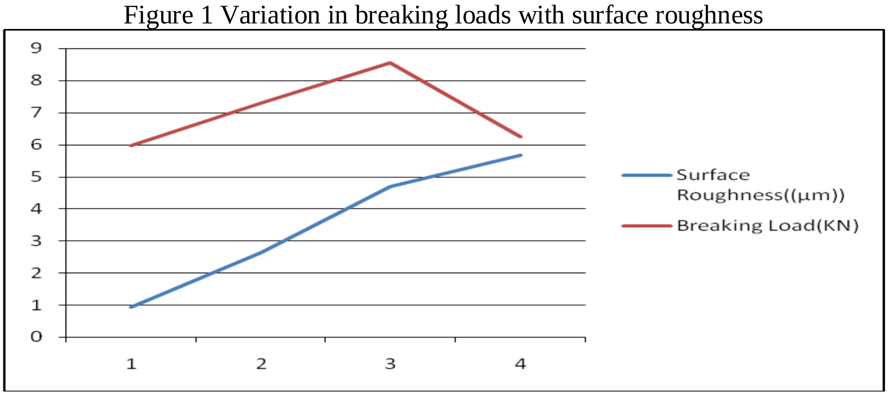
All three specimen are tested on UTM facilitated with data acquisition and storage system and pure tensile load of 10 KN is applied and value of breaking load are determined. The results are listed below.

TABLE 2 BREAKING LOAD WITH RESPECT TO ROUGHNESS FOR WPC COMPOSITES

Sr. No.	**Roughness (µm)**	**Breaking load (kN)**	**Percentage increase in load (%)**
1	0.9417 ± 0.15	5.98	
2	2.680 ± 0.14	7.31	22.24
3	4.697 ± 0.17	8.56	17.09
4	5.660 ± 0.13	6.25	-26.98

Variation in breaking loads with surface roughness is mentioned in the graph below.

Figure 1 Variation in breaking loads with surface roughness



IX. CONCLUSION

The whole study describes the pattern of variation in strength of composite materials with variation in surface roughness. During testing this fact comes out that initially increasing surface roughness helps to improve strength of the composite due to increment in contact surface area which helps to produce more bonds in the same fixed area .However beyond a certain level increment in surface roughness leads to reduce breaking load i.e. lower strength. This concept can achieve more durability without any significant extra cost as low cost of emery paper.

REFERENCES

[1] M Ozaki, Y. Adachi, Y. Iwahori, and N. Ishii, Application of fuzzy theory to writer recognition of Chinese characters, *International Journal of Modelling and Simulation, 18(2),* 1998, 112-116.

[2] Sekercioglu T, Rende H, Gulsoz A, Meran C (2003) "The effect of surface roughness on strength of adhesively bonded cylindrical components*".Journal of Material Processing Technology Vol-143:82-86*

[3] Nergiz I, schmage P,ozcan M, herrmann W (2003) "Effect of alloy type and surface conditioning on roughness and bond strength of metal brackets" *American journal of orthodontist and dentofacial orthopedics Vol-125*

[4] Benard Q,Fois M,Grisel M (2005) "Peel ply surface treatment for composite assemblies:Chemistry and morphology effects" *Journal of Applied Science and Manufacturing Vol-36:1562-1568*

[5] Baburag EG, Stankar D, Evans J (2006) "Enhancement of adhesive joint strength by laser surface modification"

[6] Zhang J, Zhao X, Zuo Y, Xiong J (2007) "Effect of surface pretreatment on adhesive properties of aluminium alloys. *Journal of material sciences.*

[7] Borsellino C, Bella GD, Ruisi VF (2008) "Adhesive joining of aluminium AA6082:The effects of resin and surface treatment" *International journal of adhesion and adhesive Vol-29:36-44*