Investigation on the Physical/Mechanical Properties of NAO brake friction Composites by using Kenaf fiber

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Abstract.

Natural fibers utilization for various applications is in increasing trend owing to its eco friendliness and ease availability. In this work the effect of kenaf fibers as key ingredient is studied for brake pad applications. The Consequences of kenaf fiber as reinforcement is studied for physical and mechanical properties. Kenaf fibers have been added in 3 different weight percentages from 0 wt% to 15 wt%. The developed composites were evaluated as per industrial standards. Properties such as density, ash content, hardness, water absorption and compressibility have been studied in this work. The brake pad samples were prepared and subjected for testing for various physical and mechanical properties. All the tests have been carried out by standard industrial procedure. Based on the results it can be clinched that the properties of hardness, density and content of ash density, decreased to certain extent and other properties such as compressibility, porosity and water absorption capacity increased with fiber loading of kenaf fiber. It can be concluded that the fiber loading has impact on the performance of fibers.

Keywords: Natural Fibers, Kenaf Fibers, Mechanical properties, Fiber Loading, Brake Pad

1. Introduction

In Recent years, attention towards natural fibers increased drastically. The natural fibers have been utilised in various industries for its versatile applications and its cost effectiveness[1-5].Polymeric materials are used as an key friction ingredient material in various automotive applications. For a friction material there are some desired quality to possess such as stable coefficient of friction, resistance to abrasion and wear, high recovery and least fade value. Fricitonal materials should also have less noise and it should not vibrate in an extensive environment. In order achieve all these qualities in friction material applications around 10-12 ingredients are added[6-7]. It constitutes of binder/filler/frictional modifier and reinforcement fibers. Out of all of these ingredients the roles played by fibers are important. The fibers with the desired combinations is vital is examining the performance of brake pad composites.
Numerous works have been carried out by using various different fibers such as palmkernel, areca, ramie, banana, glass, carbon, basalt etc. These fibrous materials have been used as an reinforcement to maintain stable friction. Out of all these fibers some fibers had some fibers are expensive and repeatability was seemed to be difficult, and the other fibers such as copper and asbestos may cause serious health issues and may spoil aquatic life badly. so ban of copper by 2021 is already in real world scenario. The various types of fibers were used by various researchers with some modifications and without modifications [8-10]. MaY et al analysed the performance by using two different fibers in his two different research works. He analysed the performance by various fiber loading weight percentages. He varied the weight percentages of the fibers. Initially he carried put his work by using rattan as a reinforcement materials at different loading conditions. He carried out in 4 different loading conditions such as 2.5, 5, 7.5 and 10 percentages. He concluded that the 5 weight percentages of rattan fibers possessed good frictional values [11].

Likewise, Sai Krishnan et al analysed the performance of areca fibers as a key varying material and he concluded areca sheath fibers at 5 weight percentages had good fade and recovery. He also tried frictional performances with palm kernel fibers and concluded palm fibers with additives enhanced the frictional coefficient and wear resistance [12-13]. Tej Singh et al examined the tribological performance by using ramie fibers and concluded that the maximum frictional coefficient was achieved at 5 weight percentage loading and had excellent tribological properties [14]. Similarly various fibrous reinforcement materials have been tried and excellent out come was revealed by using this materials [15-17]. Based on the various literatures done it was evident that the fibrous materials had greater impact on frictional performances. so it can be used as an potential replacement. In this research work, kenaf fibers were identified owing to its excellent mechanical properties and eco friendliness. It was selected and used as an reinforcement material in polymeric applications [18-20]. Though it had various advantages its potential utilization in frictional materials applications have not been explored so far. Owing to this it was used as an reinforcements and added as a key ingredient in developing the brake pad. The composites brake pad were developed by varying in four different weight percentages from 0 to 15 weight percentages. The basic properties were evaluated in this work for potential utilisation.

2. Materials and Methods (Preparation of Composites) and characterisation of basic properties

The materials used in this works are given in detail in table 1. The Various friction composite materials with varying ingredient is presented. Kenaf fibers were collected from Jeeva natural fibers, Chennai. The Composition of kenaf fiber contains 68.9% cellulose, 0.3% lignin and 11.87% hemicellulose. Initially after collecting the ramie fibers it was chemically treated with NaOH solution having 3 weight percentages for a period of 24 hours. The Kenaf fibers were washed thoroughly with distilled water and dried for 6 hours at room temperature. And after that the kenaf fibers were cut down into length of 2-6mm length and used in frictional material composite as brake pad with varying percentages from 0 weight percentages to 15 weight percentages and designated as KFB1, KFB2, KFB3 and KFB4 and presented in table 1. With this the brake pads were fabricated as a frictional composites by following standardised procedure such as sequential mixing and followed by post curing. The specimen were cut into standard sized specimens of 25x25x6 millimeter cube. It is subjected to basic physical and mechanical test and friction test were carried out. The physio-Mechanical and chemical properties were analysed and average values were taken for 5 times and reported. Wensar density measuring kit was utilised to measure the density of the specimen. JISD4417 standard procedure were used to measure the porosity. Soxhlet extraction kit was used in measuring the acetone extraction for uncured resin. ASTMD570-98 was carried out in examining the ash content present in the composites-Scale intender was measured by using rockwell hardness tester kit by following the standards of D785.
Table 1: Brake pad Composite Varying Ingredients (Materials Used)

| Sl.no | Ingredients                  | KFB1 | KFB2 | KFB3 | KFB4 |
|-------|------------------------------|------|------|------|------|
| 1     | PF(Phenol Formaldehyde Resin) | 15   | 15   | 15   | 15   |
| 2     | Aramid Fiber                 | 20   | 20   | 20   | 20   |
| 3     | Natural Graphite             | 10   | 10   | 10   | 10   |
| 4     | Vermiculates                 | 10   | 10   | 10   | 10   |
| 5     | Alumina                      | 5    | 5    | 5    | 5    |
| 6     | Barytes                      | 40   | 35   | 30   | 25   |
| 7     | Kenaf fibers                 | 0    | 5    | 10   | 15   |

3. Results and Discussion

In this the results of brake pad composites is analysed for various characteristics. Various Physical, Chemical and Mechanical tests were done and it is presented in table 2. The Wensar density measuring kit was utilised to measure the density of the specimen. The specimen testing were carried out as per industrial standards.

Table 2: Friciton Composite Physical, Chemical and Mechanical Results.

| Sl.no | Examined Results                          | KFB1 | KFB2 | KFB3 | KFB4 |
|-------|------------------------------------------|------|------|------|------|
| 1     | Density of the developed Specimen        | 2.52 | 2.46 | 2.34 | 2.24 |
| 2     | Porosity                                 | 7.08 | 7.68 | 8.39 | 9.28 |
| 3     | Water Absorption Capacity                 | 1.38 | 1.59 | 2.10 | 2.68 |
| 4     | Ash Content in percentages                | 78.24| 77.25| 76.23| 73.25|
| 5     | Acetone Extraction in Percentages         | 0.63 | 0.56 | 0.54 | 0.60 |
3.1 Density of the developed composites:

Each composites were cut into standard specimen size and the density of the composites were measured. The density of composite KFB1 was 2.52, KFB2-2.46, KFB3-2.34 and KFB4-2.24. Density values got decreased by adding the kenaf fiber content. Declining trend was observed for the brake pad composites while calculating the density. It is mainly due to the properties of the fiber and the present of high density barytes. Due to the low weight percentage of kenaf and higher density of barytes the density values decreased. This is in tandem with the literature works done before[21].

![Figure 2: Density of developed Brake Pad Composites](image)

3.2 Porosity and water absorption capacity of the developed composites

The void content(i.e porosity) shows an increasing trend values. Addition of fibers increased the percentages of void in the developed brake pad composites. In the present work also same trend was observed. Increase in the weight percentages of kenaf fiber content in the brake pad composites increased the porosity. The porosity of the developed composites KFB1-7.08, KFB2-7.68, KFB3-8.39 and for KFB4-9.28. In this also increase in the weight percentages of fibers increased the values of porosity. The main reason for this is because of structural integrity present in the fiber. Structural In-homogeneity present in the composites increased the void contents. The similar observations was seen in various work done before. Water absorption for all the brake pad composites were analysed and it was identified that the composites with KFB-1 possessed low water absorption capacity of 1.38 when compared to other. The decrease in the values of porosity also elucidated that the water absorption capacity and compressibility increase with the increase in the fiber weight percentages[22-24].
Figure 3: Porosity of developed Brake Pad Composites

Figure 4: Water Absorption Capacity of the developed Brake Pad Composites
3.3 Hardness and Acetone Extraction of the developed Composites

The hardness of the developed brake pad composites is calculated by using hardness test rig with the Rockwell intender. The hardness of the developed composites in addition with the kenaf fibers possessed decreasing trend with the fiber loading at various percentages. The decrease in the hardness value is attributed owing to its inclination in the porosity of the brake pad composites. The Composites with 15 weight percentages had the lowest values of 105.23. Lower the porosity higher the hardness values were observed for the developed composites. The same trend were observed in various literatures done before[25].

![Figure 5:Hardness Value the developed Brake Pad Composites](image1)

![Figure 6:Acetone Extraction of the developed Brake Pad Composites](image2)
4. Conclusion

In present research, The brake pad friction material composites were developed by varying from 0 weight percentages to 15 weight percentages. The composites were fabricated by conventional technique and evaluated for various physio/chemical/mechanical properties. Based on the results it can be concluded that the kenaf fibers can be effectively used as an reinforcement material in frictional material applications. Density values got decreased by adding the kenaf fiber content. Declining trend was observed for the brake pad composites while calculating the density. hardness of the developed composites in addition with the kenaf fibers possessed decreasing trend with the fiber loading at various percentages. The decrease in the hardness value is attributed owing to its inclination in the porosity of the brake pad composites. . The porosity of the developed composites KFB1-7.08,KFB2-7.68,KFB3-8.39 and for KFB4-9.28.In this also increase in the weight percentages of fibers increased the values of porosity. The main reason for this is because of structural integrity present in the fiber.

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