Tribological and Mechanical behaviour of reinforced polymer composite material for clutch facing in automobile application

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Abstract. In the current trend applications the conductive composite polymers are obtained by filling up the polymer matrixes along with different Carbon blacks were also investigated. out of many One of the carbon black is the particulate filler and is the best example which is widely used as reinforce filler in all the polymer industry. The most available carbon blacks in the market are from thermal cracking of natural gas and furnace black which are generated by incomplete combustion of oil filled in different stocks. And hence it is most necessary to implement and develop the alternative best source of the fillers from the renewable resources from the waste from mostly like agriculture units, oil palms, forest bamboo stem and coconut shells. And these are rich in organic materials. Therefore the effective way of utilization of coconut shell which consists of as high as 70.5% Carbon, 0.99% ash, 31.75% lignin and 19.5% cellulose and 70% hemicelluloses. Hence mostly this agricultural waste which is unused can be utilized and upgraded. Hence after lot of experiments we implemented a polymer matrix composite using coconut shell char and investigated their mechanical and tribological properties and behaviour. The brand new item and also the material like hard porous carbon material coconut char has been prepared with the help of carburizing the coconut shell as the main raw material at various temperatures from 650°C till 950°C, and finally the different experiments were been conducted to check the friction wear behaviour of the composite material.

1. Introduction
The best development in the material science gives numerous novel and unrivaled materials. Half breed composite materials which are utilized in different designing and mechanical applications and its hybridization and their maximum utilization methods to get best properties. The various properties of half breed composite materials were purposeful by numerous analysts [1- 5]and further they achieved that mixture gives best protection from water retention, cost sparing, weight decreases. And hence the broad utilization of hybrid composites in ventures is because of their aggregate properties of flexibility, high quality and solidness to weight proportions, creep opposition, consumption obstruction. The use of characteristic fiber as support had expanded a ton of folds in present day time
because of novel ecological principles [4]. They are specifically derived from a vegetables, creature, mineral asset and hence they can get convertible into non-woven textures in the form of felt and also into the form of woven fabric. The expanded interest of normal fiber is because of their ease; restore capacity, biodegradability, and bounty. The finish of this examination [5] assesses that the utilization of common fiber can be expanded by appropriate compound process of strands which produces upgraded mechanical properties than untreated filaments. As indicated by [7] 2, 3-propanediol, 2-dimethy l-1, and 2, 5-furandione is the concoction is called polyester. Unsaturated polyester gums at room temperature fix enables to create amazing, esteem included hybrid composite items. Numerous creators [7–9] expressed various physical polymer properties are hard plastics. And they made reasonable for various applications in marine supports, automobile components and aviation components. In our current research work, hybrid composites were created utilizing distinctive weight rates of unique strands (fortification). These examples were utilized to test their properties as indicated by the strategy according to ASTM models. The impact of flax fiber support for prepared fiber of glass and further the mechanical and wear properties was tested and examined.

1.1. Material
The crossover composite material utilized in this exploration was created utilizing light weight slashed strand tangle of E-glass textures as engineered fortification. Flax filaments were utilized as normal fortification. Flax filaments and the tree from they were extracted are appeared in figure 1. polyester pitches with initiator and quickening agent (cobalt) were utilized as framework materials. Some important polyester properties are given in table I and also in table 2 below.

| Table 1. PROPERTIES OF POLYSTER |
|----------------------------------|
| Properties                      | Polyester         |
| Viscosity at 250µ(cP)            | 240-360           |
| Tensile Strength (Mpa)           | 5                 |
| Flexural strength (MPa)          | 130               |
| Elasticity modulus -Gpa          | 4.5               |
| Density                         | 2                 |
| Heat distortion temperature      | 75 HDT (ºC)       |
| Maximum elongation (%)           | 2.5               |

2. Composite Production model
There are different strategies accessible for assembling of cross breed composites to be specific sap exchange shaping, pressure forming, vacuum forming The hand layup process strategy [11] which is on of the best simple techniques for creation of cross breed composite material. Hence the most preferred standpoint of the hand made layup technique is to decreases the assembling times, basic gear and decently less expensive other than assembling forms [12]. Hence this is basically utilized technique for composite manufacture. Scarcely any critical phases of manufacture of these mixture composite materials are shown in figure 2. The Composite examples which are consists flax fiber and glass fiber fortification was produced with the elements of 250mm x 250mm x 5mm. Three cross breed composites were comprised of nearly 25 percentage fiber and 75 percentage fiber pitch in terms of weight with different blends of flax fiber proportion 10 percentage, 15 percentage and 20 percentage in weight and Glass fiber proportion content at weight percentage of 10/15 and 20 percentage in weight. The different percentages are shown in the table 2.
3. Experimental Procedure for mechanical testing
The different experiments were conducted in B. S Abdur Rahman university and omega labs, Chennai. The cutting operations were also carried out with the procedure of suitable ASTM standards. The different tensile tests for different weight percentages were conducted on the rectangular and plane composite specimens of different in size about 165 mm x 12 mm x 4 mm for 50kN in UTM at the normal room temperature. The different specimens were positioned and they are maintained at the constant speed of around 2mm / min and this is continued until the failure occurs.

3.1. Flexural test
The test flexural which is generally called as 3 point testing and was done with the help of UTM as per the ASTM D790M and the different composite specimen dimensions about 100 x 10 x 4 mm were positioned on the two different supports on either side and were loaded at the centre of the speed of 2mm/min.
3.2. Compression Testing
The compression test also was carried on the same UTM as per the ASTM D3410 standard with the dimensions of 145 x 15 x 5 mm. The tested pieces were positioned in direction of Y-axis and the maximum force of 50kN was applied continuously during the same speed.

![Figure 4. Compression testing Specimen](image)

3.3. ANOVA for Tensile test
The statistical test like analysis of variance (ANOVA) was estimated and shown in the following table 6. The 2 ways classification in the form of between composite material component and also within the composite material component. From the analysis of variance table, the F ratio was calculated and which equals to 9.5

3.4. ANOVA for Flexural strength
The statistical analysis was continuously carried with the help of analysis of variance with one way classification was estimated and the results were obtained and the results were shown in the table 7, which shows the 2 components of flexural strength between the group and within the group. Finally the F-ratio from the last column of ANOVA table which equals to 48 was the ratio between the group to within the group. And the results were tabulated and analyzed.

3.5. ANOVA for Compression strength
The statistical analysis was carried with the help of analysis of variance, 1-way classification was estimated and the results were obtained and are shown in the table 8, which shows the 2 components of compression strength between the group and within the group. Finally the F-ratio from the last column of ANOVA table which equals to 19 was the ratio between the group to within the group. From the test results it was concluded that there was significant difference between the compression strength of the composite material.

3.6. Compressive properties.
The different compressive properties of the different composites materials with various loadings under reinforcement are shown in figure 3. The results also shows that the addition of natural fibers with the combination of glass fibers gives better compressive strength of the composites. And the natural fiber content quantity is bit less than the synthetic fiber content and also the maximum compressive strength was obtained at the 20 percentage of glass and the 10 percentage of flax fiber.

4. Results and discussions

4.1. Tensile properties of prepared specimen
The different tensile properties show that the natural fibers can be added in further by small percentage by 2 percentage with the combination of glass fibers gives better tensile strength of the composites. And the natural fiber content quantity is bit less than the synthetic fiber content and also the maximum tensile strength was obtained at the 20 percentage of glass and the 10 percentage of flax fiber.

Table 2. Flexural strength by weight percentage

| Flax (%) | Glass (%) | Flexural strength (MPa) | Mean flexural strength in MPa |
|----------|-----------|-------------------------|-------------------------------|
| 10       | 20        | 169                     | 8                             |
| 15       | 15        | 276                     | 0                             |
| 20       | 10        | 300                     | 0                             |
| 17       | 23        | 170                     | 2                             |
| 25       | 265       | 25                      | 2                             |
| 29       | 290       | 29                      | 1                             |
| 178      | 247       | 286                     |                               |

Figure 5. Flexural strength graph for various weights

4.2. Flexural properties of prepared specimen

The different flexural properties of the different composites with various loadings gives better flexural strength of the composites. And the natural fiber content quantity is bit less than the synthetic fiber content and also the maximum flexural strength was obtained at the 20 percentage of glass and the 10 percentage of flax fiber.

Table 3. Ultimate strength by weight percentage

| % wt of Flax | % weight of glass | Ultimate tensile strength in MPa |
|--------------|-------------------|---------------------------------|
| 20           | 25                | 85                              |
| 25           | 20                | 85                              |
| 30           | 25                | 70                              |
| 20           | 25                | 66.5                            |
| 25           | 20                | 78                              |
| 30           | 25                | 70                              |
| 20           | 25                | 79                              |
| 25           | 20                | 84                              |
| 30           | 25                | 65                              |
| 20           | 25                | 89                              |
| 25           | 20                | 80                              |
| 30           | 25                | 77                              |
| 20           | 25                | 67                              |
4.3. Compressive properties of prepared specimen
The different compressive properties of natural fibers with the combination of glass fibers gives better compressive strength of the composite materials. And the natural fiber content quantity is bit less than the synthetic fiber content and also the maximum compressive strength was obtained at the 20 percentage of glass and the 10 percentage of flax fiber.

5. Conclusion
Tensile strength with different weight ratio

| Table 4. ANOVA table for tensile strength |
|------------------------------------------|
| DOF  | SS  | MS  | F-Ratio | P-value |
|------|-----|-----|---------|---------|
| 2    | 390 | 195 | 10.02   | 0.005   |
| 9    | 176.9 | 19.5 |         |         |
| 11   | 567 |     |         |         |
| 0.421 | R-Sq = 69% | Square root of (adj) = 62% |

DOF : degrees of freedom/SS : squares of sum , MS : mean sum of squares, p-p value, S-sample mean standard deviation

Figure 6. Ultimate strength graph for various weights

Figure 7. ANOVA results graph for tensile values
Table 5. ANOVA table for Flexural strength

| DF | SS    | MS    | F-Ratio | P-value |
|----|-------|-------|---------|---------|
| 2  | 38,750| 19,340| 47.8    | 0       |
| 12 | 4875  | 410   | 0.13    |         |
| 14 | 43625 |       | R-Sq = 89% |         |
| 0.13 |     |       | R-Sq(adj) = 87% |         |

Figure 8. ANOVA results graph for flexural values

Table 6. ANOVA table for Flexural strength

| DF | SS    | MS    | F-Ratio | P-value |
|----|-------|-------|---------|---------|
| 2  | 38,750| 19,340| 47.8    | 0       |
| 12 | 4875  | 410   | 0.13    |         |
| 14 | 43625 |       | R-Sq = 89% |         |
| 0.13 |     |       | R-Sq(adj) = 87% |         |

Figure 9. ANOVA results graph for Compression strength values

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