IJBPAS, November, Special Issue, 2021, 10(11): 1381-1392

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

DESIGN, ANALYSIS, AND BIO MANUFACTURING OF DISC BRAKES WITH CNC FOR REACTOR SAFETY

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Received 26th July 2021; Revised 27th Aug. 2021; Accepted 1st Oct. 2021; Available online 1st Nov. 2021

https://doi.org/10.31032/IJBPAS/2021/10.11.1120

ABSTRACT

In today's fast-paced economy, the car is the primary means of transportation, and its actions have consequences. As a result, we chosen to conduct a formulation design and analysis of the Brake Rotor to improve the disc brake functionality. Cast iron, aluminum, Stainless steel, composite ceramics, and silicon carbide are often used in the production of disc brake rotors. The idea is to produce a greater disc brake rotor by studying and producing this bio manufacturing using various materials. In design software programs, a replica of a disc brake rotor is created and evaluated i.e. Pro-e and Ansys 14.5. The primary component of an automobile's brakes has been the disc brake rotor, which is pressed against the brake rotor to

generate contact and therefore avoid collision. So, the motivation of this paper is to develop reactor safety Disc Brake Rotors that perform superior to the current disc brake.

Keywords: Design and optimization, Disc brake rotor, Grey Cast Iron (GCI), Ductile Cast Iron (DCI), Reactor safety; Bio Manufacturing

INTRODUCTION

Braking is a piece of technology that uses artificial stress concentration to halt the movement of a moving component **[1, 2]**. The braking absorbs latent heat (Potential Energy) or thermal energy (Kinetic Energy) from the mechanical system while accomplishing this job. The brake pads collect force, which would then be released in the presence of energy. The heat that has been dissipated is then discharged into the atmosphere **[3-5]**.

A brake is a component that aids in slowing down or halting the movement of a vehicle or equipment or a mechanism that prevents something from speeding up and moving again. Nearly motorized vehicles, especially cars of all types, Lorries, railways, motorbikes, and bicycles, are equipped with brakes of some kind. For usage with a rolling ramp, luggage carts and shopping bags may also have them **[6, 7]**. The underbelly of some of the aircraft is equipped with main bearings. Some planes are also equipped with air brakes, which can be used to keep them at bay while in flight. Automotive frictional brakes store heat in the spinning component (disc brake/drum brake) while braking and progressively dissipates it into the air. Contact between these two components typically involves the conversion lost by the moving component into heat. The mechanism for the braking is on the other hand, recovers a large amount of energy and stores it in a flywheel or capacitors, or converts it to alternating current (AC) by an alternator, which is then converted and connected to the power for subsequent use **[8-10]**.

Literature Survey

The square of the velocity ($E = (mv^2)/2$) increases kinetic energy (K.E). This implies that if a vehicle's speed doubles, it possesses four times the energy. To stop the car, four times the energy must be dissipated from the brake, and four times the braking distance must also be supplied, according to the equation **[11, 12]**. When you press the brake pedal, the vehicle's braking system uses fluid to transfer the force from your foot to the brakes. Because the real brakes need more force than the leg can provide, the car must double the foot force. Mechanical advantage (leverage) and hydraulic force multiplication are two methods for doing this. Friction is used by the brakes to transfer force to the tyres, and friction is also used by the tyres to transmit force to the road **[13-16]**.

For the last 100 years, researchers have been working on a system that is breaking down. In most cases, the braking system comprises of disc or disc brakes in the back wheels and a disc brake in the front axle that is linked to the hydraulic system. Garage brakes, a power brake booster, and a generally pro braking system are all included in these brakes **[17]**. Whenever you press the foot brake, it pushes against all the actuators in the proportioning valve, forcing hydraulic system such as fluid source and the piston arrangements through such a system of tubes and hoses to each wheel's braking unit. Substances are known to be incompressible, whereas when we push them, they behave like a metal plate forcing through with a pipe. Fluid, but unlike metal plates, may be guided through numerous bends and curves on its route to its destinations while maintaining the same velocity and pressure it began with. The fluid must be pure liquid and free of gas bubbles **[18-20]**. Air may compress, resulting in pedal rotational inertia and a significant reduction in stopping effectiveness. If the presence of air is detected, the machine must be bled to eliminate the air. For this reason, "solenoid valve screws" are placed at every cylinder head and caliper.

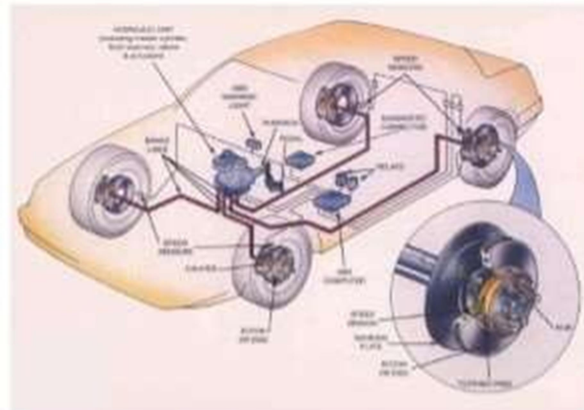

Figure 1: Car braking system

The primary purpose of the wheel rim is to transfer compressive energy and disperse energy consumed, which necessitates its use at both low and high concentrations of temperature and pressure. Because when the brake pedal is pressed, the brake system rotor offers a braking interface or contact surface for the disc brakes to press against. In comparison to alternative brake systems rotor materials such as metals composite, Aluminum -Metal Matrix Composites, and ceramic parts and elements, a rotor is often constructed of grey cast iron (GCI), which offers excellent wear resistance with high-temperature permeability and has a cheap manufacturing cost. Solid disc and vented new wheel rotors are the two kinds of brake discs rotors now utilized in passenger cars.

A solid disk is just a solid piece of metal having frictional surfaces on both sides, but it is light, simple, straightforward, and inexpensive to produce. Meanwhile, a vented disc is a braking disc or rotors with different opening configurations such as grooves, holes that offer improved cooling (different thermal expansion functions), lightweight, and aesthetically pleasing. As a result, it is more frequently utilized than solid disc.

While developing any disc, the thermal conductivity of the disc form is a critical consideration. The design philosophy for the brake disc, thermal decomposition before manufacturing, and the amount of the substance used for it are all variables that influence the disc's form. The following are the thermal characteristics that influence the antilock braking rotor:

(1) Thermodynamic expansions coefficient: This characteristic may cause hot spots and disc thinning fluctuation. The disc brake's heat generation may induce uneven temperature rise of the substance.

(2) Thermal conductivity: When pressing the stopper, heat is produced caused by friction, and the severity of this heat is dependent on the length of time the brake is engaged. And the heat produced is related to the substance's heat capacity. The peak temperature under lengthy and minimal braking is mainly determined by the disc substance conductance.

(3) Heat dissipation: A little quantity of heat is produced during brief braking, but it does not affect the braking. However, with lengthy braking, more power is released, which must be dispersed in a short period. Otherwise, the disc material will indeed be harmed.

(4) Thermal impedance is an ability of a substance that allows it to store heat. A tiny quantity of heat energy is stored throughout the stopping process, and this thermal capacitor predominates during brief stopping.

Analysis and Modeling

A rotor for a disc brake is modeled as follows:

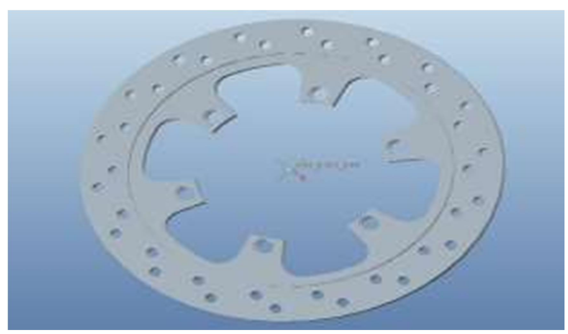

Figure 2: Modeling for reactor safety disc brake rotor

Table 1: Design specifications of the Disc Brake Rotor assembly

Diameter of disc	240 millimeter
Thickness of disc	5 millimeter
Diameter of bolts	12 millimeter
Number. Of bolt circles	6
Diameter of holes	7 millimeter
Number of holes	18
Angle between the holes	20
Diameter of centre pocket	170 millimeter

The hypothesis that the disc should be analyzed

— Two and four wheels apply the brakes.

— The 5 mm thickness for all versions is regarded.

− The lifespan of the brake disc was never determined by this study—There is a strong position brake pad mechanism used.

—All substance's heat capacity is consistent.

— T heat is consistent all across the substance's thermal conductivity and is not changing with temperatures.

—This means there is no transfer of water between a tyre and the road. · The energy released by vehicles is lost by drum brakes.

Table 2: Material Properties of the Disc brake Components

Property	GCI	DCI
Young's Modulus	102 GPa	172 GPa
Density	7.06*10^3 Kg/m³	7.2*10^3 Kg/m³
Poisson Ratio	0.28	0.3
Elongaition	1%	3%
Specific Heat	450 J/Kg-k	460 J/Kg-k
Tensile strength	180 MPa	830 MPa
Yield strength	110 MPa	620 MPa
Shear strength	220 MPa	800 MPa
Thermal conductivity	46 W/m-K	31 W/m-K
Thermal Expansion	10.5µm/m-K	11µm/m-K

RESULTS

By viewing the process parameters, we can determine which consequences will be excellent, but perhaps the wall thickness and deformity in a specific component are hard to comprehend further analysis. In the next photos, a chart of GCI and DCI is shown.

Grey Cast Iron

The distortion of the disc wheel is shown in **Figure 3** to be 0.624E-04 mm at the perimeter. The homogeneous distribution of stresses around the perimeter of the wheel is seen in **Figure 4**. The tension on the outskirts of the discs is 22.84 MPa. The association between perceived and distortion is shown in **Figure 5**. The highest stress achieved is 91 MPa and dislocation is 9 mm, which results in rapid modification of the load with such an expanding displacement. The link between both strain and distortion is shown in **Figure 7**.

Ductile cast iron

The perimeter of the disc wheels is 0.31 E-04 mm, shown in **Figure 8**. Overall distortion is greater. The homogeneous concentration of tension around the wheel perimeter is seen in **Figure 9**. On the perimeter of the disc breaking, 22.62 MPa are stressed. The connection from stress to displacement is shown in **Figure 10**. However, at the stage the highest stress reached is 91MPa, and distortion is 6mm, up to 11mm, after which the load changes suddenly, with deformations rising. The relationship of strain to distortion is seen in **Figure 12**.

When the Gray And Ductile CI analysis is carried out, the maximum stress is decreased to DCI. Therefore the DCI for the disc brake may be preferable.

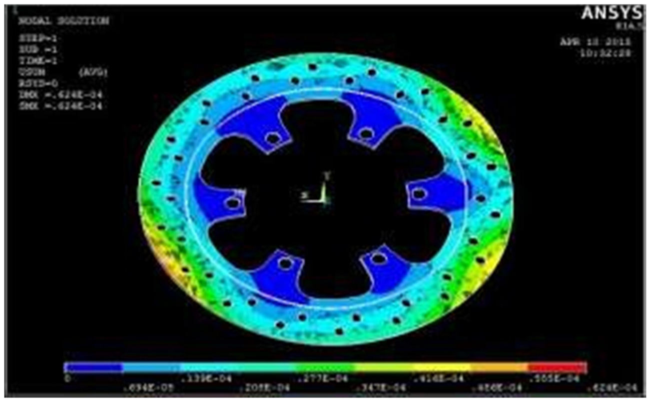

Figure 3: Buckling of GCI

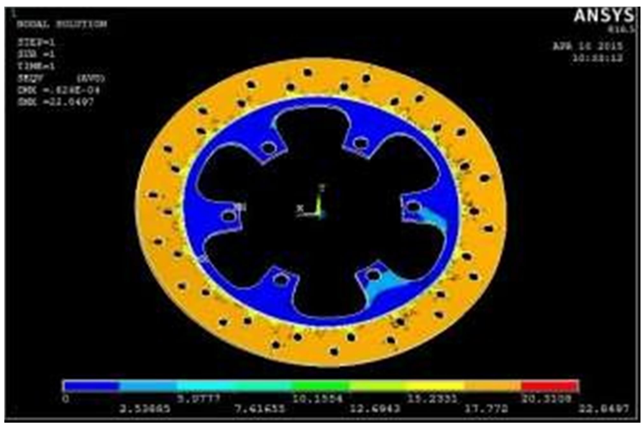

Figure 4: Stress developed in GCI

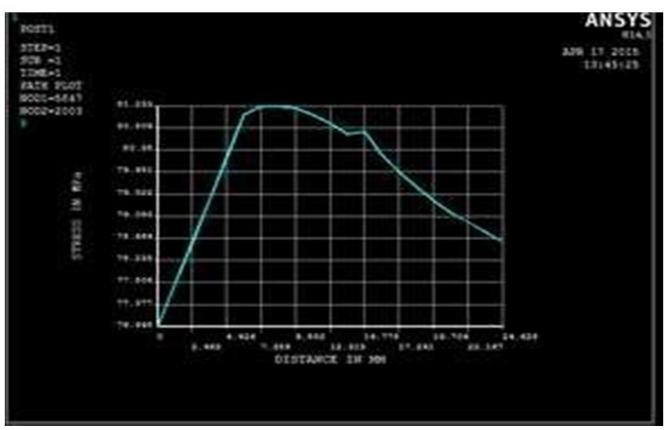

Figure 5: Stress distribution

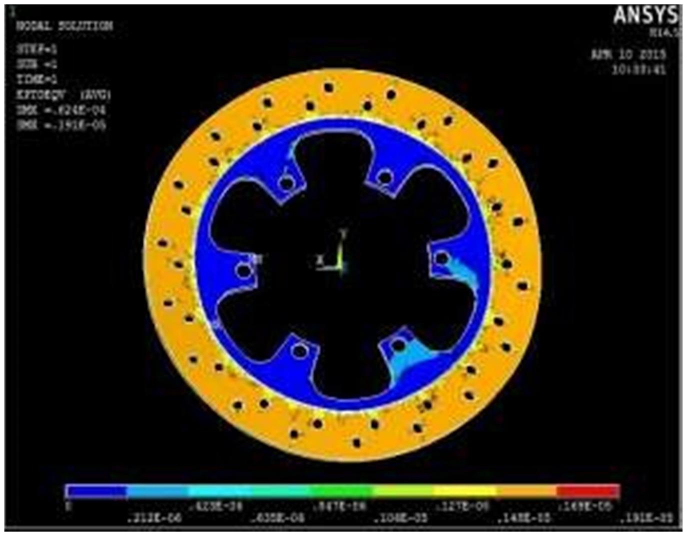

Figure 6: Strain of GCI

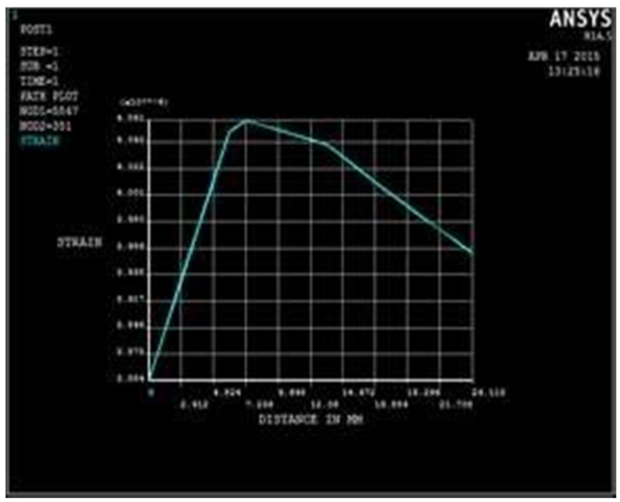

Figure 7: Strain distribution in GCI

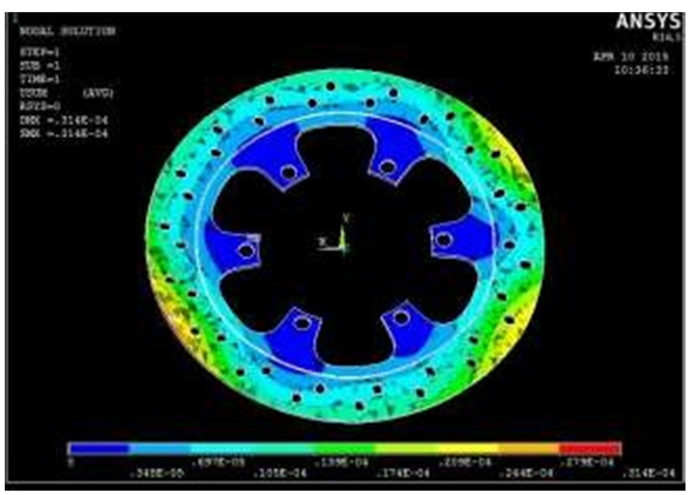

Figure 8: Deformation of Ductile CI

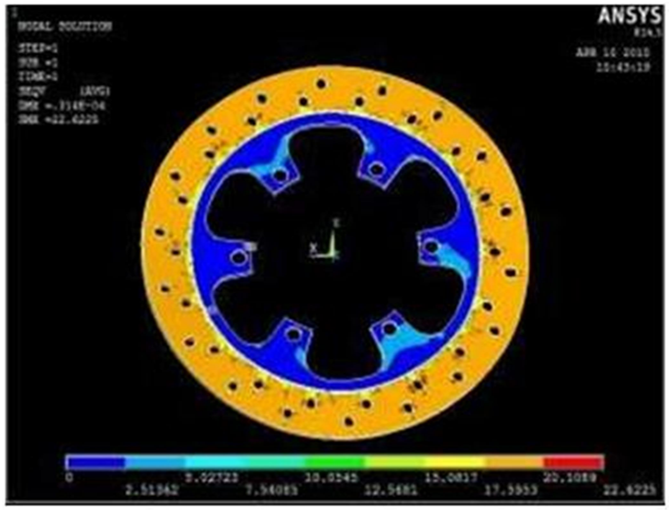

Figure 9: Stress of Ductile CI

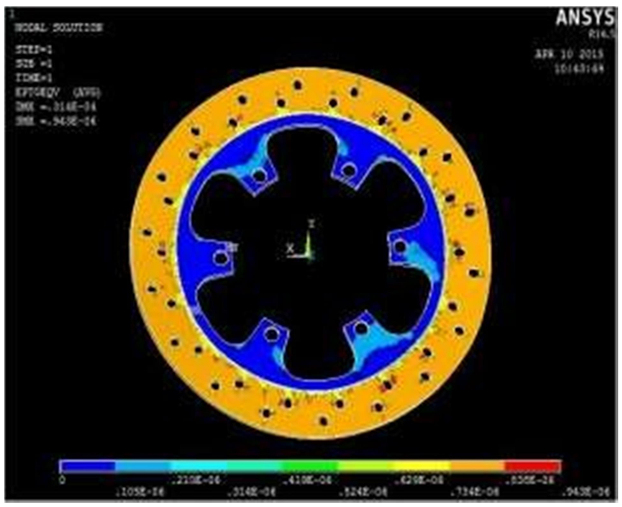

Figure 10: Stress graph of Ductile CI

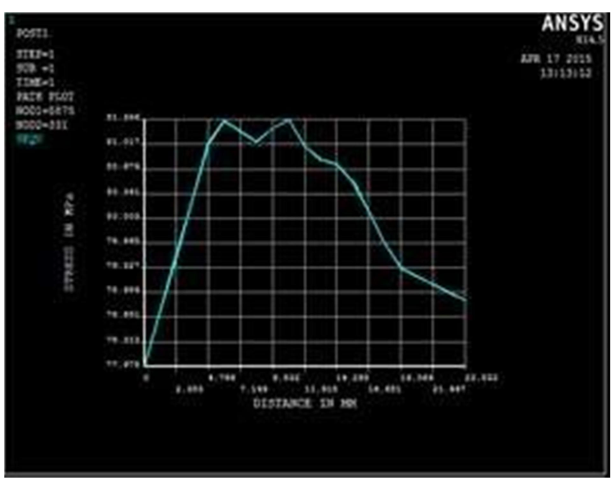

Figure 11: Strain of Ductile CI

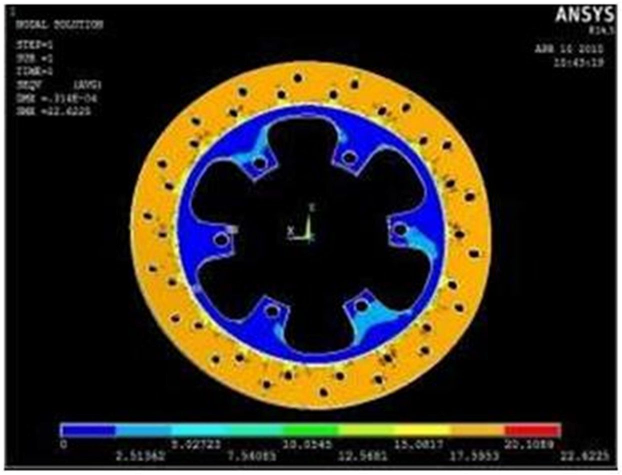

Figure 12: Strain chart of DCI

Table 3: Stress-Strain comparison for GCI and DCI

Material	*Deformation*	*Stress*	*Strain*
GREY CAST IRON	0.624E-04	22.84	0.19E-05
DUCTILE CAST IRON	0.31E-04	22.62	0.094E-05

CONCLUSION

Disc Brake Rotor Assessment and Optimization is a very difficult procedure including significant procedures some of which are created, evaluated, and produced. The right material, the right sizes, and even the right form of all the numerous pieces take some time to consider. No less difficult than just about every other aspect is the development of the disc brake. Nevertheless, it is the major part employed when another brake has been used to stop the car. Its weighing and size were extremely beneficial and used significantly. There have been various phases did regarding the part of the contract prototype. In the end, the very first phase concerns the alignment and performance of the Brake Rotor. It was largely utilized for braking and is a very important component of a vehicle effective ones.

Phase two dealt with PRO-E modeling and started with sketches. It was novel to me in the beginning but there were many things comparable to the other CAD/CAM applications. It became simpler for me for a week and then to start with the primary project topic. First and then the measurements of the part, so that every part would be able to fit exactly on the place.

Phase three met with ANSYS assessments. Initially, it was a new thing for me, identical to PRO-E, and had many difficulties in comprehending the activities. In the next section, the sort of assessment to be carried out on to the model was considered. A lot of issues since the mesh and stresses operating on it are tough to accomplish. Lastly, it is very vital for me that performing changes are made based upon needed analysis. The very last level had been with CNC Vertical Machining Center production. At the start, believed it was a very complex work to comprehend the procedures and the scripts to be executed. As the days go on it appears like a simpler piece of work for me. The program of the work is the most essential item. Thinking more about the concept and for all comprehension. Reactor Safety DISC Braking system ROTOR program and it's made in the CNC. Finally made the Brake System with ROTOR and the type utilized for the market sounds incredibly comparable.

REFERENCES

[1] Andrew, I. & Beaumont, R. (2007, Oct. 2). Retrieved Sept. 23, 2008, from http://www.cdxetextbook.com/index.html

[2] ANSYS User Manual-Chandrupatla, T. R. & Belegundu, A. D. (2008). Introduction to Finite Elements in Engineering. (Vol. 3, A. K. Ghosh, Ed.). Connaught Circus, ND: Prentice-Hall of India Private Limited.

[3] Lawrence, K. L. (2006). ANSYS Tutorial. (Vol. Release 10,). Mission, KS: SDC

[4] Metcalfe, L. (n.d.). In Nation Master. (chap. List of Materials Properties). Retrieved Oct. 25, 2008, from http://www.nationmaster.com/encyclopedia/List-of-materials-properties

[5] H. S. Haripal Singh, "Thermal Analysis of Disc Brake Using Comsol," International Journal on Emerging Technologies, vol. 3, no. 1, pp. 84-88, 2012.

[6] Thermal Analysis of Rotor-Disc of Disc Brake," International Journal of Innovative Research in Science, Engineering and Technology, vol. , no. 12, pp. 7741-7749, 2013.

[7] P. P. C. D. S. B. Jaju, "A Review On Thermal And Contact Stress Analysis Of Disc Braking System," International Journal of Engineering Research and General Science, vol. 2, no. 1, pp. . 78-84, 2014

[8] Sneha P, Balamurugan K, Kalusuraman G. Effects of Fused Deposition Model parameters on PLA-Bz composite filament. InIOP Conference Series:

Materials Science and Engineering 2020 Dec 1 (Vol. 988, No. 1, p. 012028). IOP Publishing.

[9] Devaraj S, Malkapuram R, Singaravel B. Performance analysis of micro textured cutting insert design parameters on machining of Al-MMC in turning process. International Journal of Lightweight Materials and Manufacture. 2021 Jun 1;4(2):210-7

[10] Garigipati RK, Malkapuram R. Characterization of novel composites from polybenzoxazine and granite powder. SN Applied Sciences. 2020 Sep;2(9):1-9.

[11] Yarlagaddaa J, Malkapuram R. Influence of carbon nanotubes/graphene nanoparticles on the mechanical and morphological properties of glass woven fabric epoxy composites. INCAS Bulletin. 2020 Oct 1;12(4):209-18.

[12] Rama Krishna M, Tej Kumar KR, DurgaSukumar G. Antireflection nanocomposite coating on PV panel to improve power at maximum power point. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects. 2018 Oct 18;40(20):2407-14.

[13] Yarlagaddaa J, Malkapuram R, Balamurugan K. Machining Studies on Various Ply Orientations of Glass Fiber Composite. InAdvances in Industrial Automation and Smart Manufacturing 2021 (pp. 753-769). Springer, Singapore.

[14] Sekaran, K., Rajakumar, R., Dinesh, K., Rajkumar, Y., Latchoumi, T. P., Kadry, S., & Lim, S. (2020). An energy-efficient cluster head selection in wireless sensor network using grey wolf optimization algorithm. TELKOMNIKA, 18(6), 2822-2833.

[15] Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

[16] Sridharan, K., & Sivakumar, P. (2018). A systematic review on techniques of feature selection and classification for text mining. International Journal of Business Information Systems, 28(4), 504-518.

[17] Vemuri, R. K., Reddy, P. C. S., Kumar, B. P., Ravi, J., Sharma, S., & Ponnusamy, S. (2021). Deep learning based remote sensing technique for environmental parameter retrieval and data fusion from physical models. Arabian Journal of Geosciences, 14(13), 1-10.

[18] Nice, K. (n.d.). How Disc Brake Works. (sect. Disc Brake Basic). Retrieved Sept. 22, 2008, from http://auto.howstuffworks.com/disc-brake1.htm

[19] S. S.Rao, (2005). The Finite Element Method in Engineering. In Overview of Finite Element Method (ed. 4, p. 3-43). Sriniwaspuri, ND: Elsevier

[20] White, M.A.(1999). Properties Of Materials, Thermal Properties Of Materials (p.91-155).New York, NY: Oxford University, Press, Inc