IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

STUDY OF EN-24 GRADE MATERIAL IN AUTOMOBILE BRAKE DISCS

Vikash V, Pradeepan s, Sukesh R
STUDENT
KUMARAGURU COLLEGE OF TECHNOLOGY

ABSTRACT:

Automobile brake discs are manufactured with grey cast iron, which exposes large thermal and wear stresses during braking during downhill and long-range rides. The brake discs tend to break or fail due to this action. This analysis aims to replace the EN-24 grade material with more thermal strength and high tensile strength combined with good ductility and resistance to shock. This is to be verified by the specimen undergoing experimental analysis like tensile, hardness, wear and tear, and creep tests.

KEY WORDS: Brake disc, EN-24 iron, Wear and tear test.

INTRODUCTION:

Brake plates are flat metal discs that are part of brake systems in vehicles. They typically sit on the inside of the brake callipers and are used to hold the brake pad in place as well as provide a surface for the pad to press against when the brakes are applied. Brake plates may be made from a variety of materials, including cast iron, steel, or aluminium, and are designed to withstand high temperatures and frictional forces. They may be coated with a protective layer, such as zinc or ceramic, to prevent corrosion and improve durability. In addition to their critical role in braking performance, brake plates may also have a significant impact on the noise, vibration, and harshness (NVH) characteristics of a vehicle. Properly designed and manufactured brake plates can help reduce brake noise and improve driver comfort. Materials used in the disc should be stable, reliable to friction and wear resistance properties. These properties should withstand varying conditions like load, velocity, temperature and high durability. They can withstand 315 degrees Celsius when they reach a certain temperature break failure may happen. When high performance breaking the plates, temperature is increased, while sudden impact they tend to break. Cast iron has many grades, some are white cast iron, Malleable iron, Ductile iron, graphite iron. But major used cast iron is Grey cast iron. To overcome these issues, we may replace the materials from cast iron alloys to EN-24 grade material. The EN-24 has similar material composition compared to gray cast iron.

LITERATURE REVIEW:

The range of friction coefficients for brake material pairs is 0.07 to 0.7, but practically, most vehicles operate within a narrower range. Typical values range from about 0.3 to 0.6 in friction coefficient. In accordance with their functional potential, Anderson specifies six kinds of friction materials. The higher the class number, the more severe the operating conditions. Materials must be designed to withstand the demands of energy dissipation during use. Classes III and IV used in trucks, for example, must withstand 3–4 MPa of pressure and speeds of 35–50 m/s, respectively. The temperatures reach up to 600–800 °C. This least temperature range is set to 15 degree Celsius and above temperature is noted for aluminium metal matrix composites.[1]

The physicochemical and mechanical properties of the intermetallic Ni3Al alloys have been analysed and compared to traditional metallic materials. The majority of the time, Ni3Al alloys outperform commercial alloys, particularly when it

comes to high-temperature characteristics in an oxidising and carburizing environment. The structural qualities of the Ni3Al intermetallic are what give it its most desirable properties. The most attractive properties of the Ni3Al intermetallic include structural characteristics responsible for the physical and mechanical properties of the intermetallic, namely a relatively high melting point and a high strength.[2]

Overlay Coatings in this category incorporates a very wide variety of coating processes where in a material different from the bulk is deposited on the substrate. The coating is distinct from the substrate in the as-coated condition and there exists a clear boundary at the substrate/coating interface. The adhesion of the coating to the substrate is a major issue.[3]

Nickel aluminides can be fabricated by powder metallurgy, near-net-shape processes, and conventional processing. Among the three methods, near-net shaping is the most advanced, the most useful, and the most economical. The near-net- shaping methods include precision casting, sand casting, direct sheet and bar casting, and centrifugal casting. Additional work is required in processing large ingots by conventional technical.[4]

The purpose of this work is to design a process for material selection and choose the best material for use in brake disc systems, with a focus on replacing cast iron with any other lightweight material. Then the various materials are selected, and their properties are compared. Then the performance index is valuated, and the result is formed.[5]

Disc brakes are exposed to large thermal stresses during routine braking and extraordinary thermal stresses during hard braking. In these 3 materials are selected, they are Stainless Steel and Cast-iron carbon carbon composite. Modelling is done using NX/UG. Then finite element analysis and the yield stress is found. Then the design is said to be safe.[6]

To reduce weight and improve fuel efficiency automobile industry use aluminium matrix composites mmc because they are lighter than grey cast iron. Now need to select the material according to indices chart.as an alternative approach digital logic method is used in material selection. Then the stages of material selection are processed according to the flow chart. Then the existing material are compared to the selected, material like cast iron, titanium alloys and aluminium-metal matrix composites (AMC) are studied. Then digital logic method is used for optimal selection of materials and factors are considered such as comprehensive strength, friction coefficient, wear resistance and thermal capacity. By using the above details optimum material selection is done under the performance index and cost of the material. then material is selected, and design is developed.[7]

We know that Volvo car corporation is the strongest automobile brand. they have been focusing on traffic safety engineering and has a long reputation, liability and safety. They have implemented forced hydraulic breaking with help of booster which uses the vacuum produced in main intake manifold of petrol engine and for diesel engine, a separate vacuum pump is installed. In this review the heat produced, strength, structures in the disc plate are analysed by using the FEA and the conclusion is made as the considered design is safe.[8]

High chromium white irons can withstand various forms of abrasive wear. They can be also improved by heat treatment that increases the hardness, abrasion resistance and facture toughness. The reports indicate the rare earth elements REEs improve the properties of non-alloyed and low alloyed white iron. The chemical composition of white cast iron is melted in induction furnace and cast into modules of bentonite sand mixture of rods of [50(dia) * 200 mm test rods]. Then these are analysed and observed in the microscope, Energy dispersive X-ray [EDX] and the microstructure is captured. in the conclusion high chromium iron will change its properties and microstructure according to their compositions of alloyed mixed.

We know that brake is quite complicated part which have affected by various constraints and environment conditions. The analysing the brake it can be divided into 2 major stages. The 1st phase is braking decision of driver and 2nd phase is applying brake and its effect. The working analysis of brake discs is performed. Then brake disc performance analysis is made in cast iron, grey cast iron. The grey cast iron have variety of distribution shapes according to its graphite composition. There are six types of A, B, C, D, E, and F. A-type (straight flake) is an uniformly distributed structure, B-type (rose-like) graphite often appears in CI with high eutectic property, C-type (coarse slab) graphite is typical graphite of hypereutectic gray iron, D-type (dendritic point) graphite mostly appears in CI with low eutectic property, E-type(dendritic) graphite is also an undercooled graphite. F-type(star) graphite is the product of hypereutectic cast iron under extreme subcooling. These materials are tested and analysed to thermal, wear resistance, noise testes. Then comes to an conclusion that considering the performance tested taken its is better than steel fibre disc.

MATERIAL SELECTION AND METHODS:

Composite of EN-24 grade material are the matrix of six elements.

GRADE	CARBON	SILICON	MAGANESE	COPPER	NIKEL	MOLYBDENUM
EN-24	0.35<0.45	0.1<0.3	0.45<0.7	0.9<1.40	1.30<1.8	0.2<0.4

This matrix is in powder form and the material is taken to sustain wanted volume, heated in the furnace, and poured in the cased in wanted shape(rod) and it is thermally treated.

EXPERIMENTAL ANALYSIS:

Initially, the specimen undergoes the following tests:

Tensile strength, yield strength, % elongation, and % reduction area are measured in the UTS machine. It is tested by the ASTM A370:21 test methodology. And undergoes a hardness test. It is tested in the A370:21 test methodology.

. **TENSILE TEST:**

PARAMETERS	OBSEVED VALUES
TENSILE STRENGTH IN MPA	642.72
YIELD STRENGTH IN MPA	617.27
% OF ELONGATION	23.32
% OF REDUCTION OF AREA	68.96

IMAGES:

FIG 1

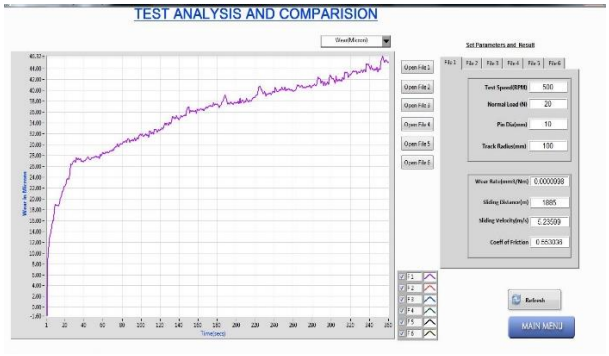
FIG 2

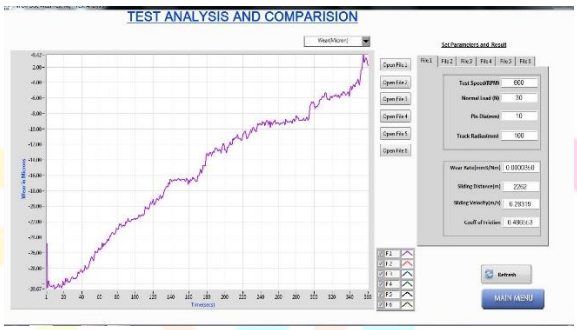
FIG 3

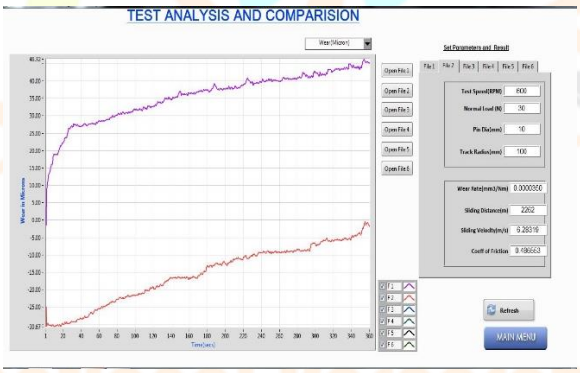
- **HARDNESS**:

PARAMETERS	OBSEVED VALUES in HRA
	ROCKWELL HARDNESS
SAMPLE 1	62
SAMPLE 2	62.5
SAMPLE 3	62.5
AVERAGE	62.3

- **WEAR AND TEAR:**







CREEP:

TIME IN MIN	DEFORMATION IN MM	LOAD IN KGS
10	2.2486	20
20	4.2591	20
30	5.1301	20
40	5.9751	20
50	6.5088	20
60	6.3587	20

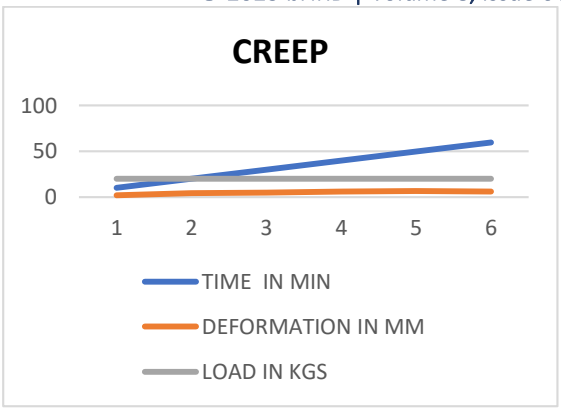


IMAGE OF WEAR AND TEAR TESTING MACHINE:

FIG 4

IMAGE OF CREEP TESTING MACHINE:

FIG 5

CONCLUSION:

In this study the brake plate material has undergoes various test and analyses, to compare the existing material gray cast iron and EN-24 grade material. The test conducted are to find the Tensile strength, hardness, wear and creep of the selected material whuch are experienced by the brake plate during the braking.

The cost estimation of this material (EN-24) is lower to the existing material [i.e., grey cast iron] they have similar material composition And the tensile strength is 200% higher than existing material. The production process of the new material for disc plate remains the same as the existing material.

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