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DESIGN MODIFICATION AND ANALYSIS OF JCB 3DX EXCAVATOR BRAKING SYSTEM

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ABSTRACT

Brake is a device to stopping and reducing speed of the vehicle. It is vital for the automobile. In JCB braking system hydraulic brake are used. For the JCB braking system friction plate and counter plate are vital component. In JCB braking system five friction plates and six counter plates are used for each side of tyre. For circulation of oil the area of circle of friction plate is small so to increase the efficiency and effectiveness of the braking system we will increase the area of circle. Then static and thermal analysis will carried out for the above modification.

INTRODUCTION

Hydraulic brake

Hydraulics is that branch of engineering and applied science which deals with the mechanical properties of fluid. The liquid under pressure is used to transfer force or motion, or to increase an applied force. The pressure that gets applied on a liquid is called HYRAULIC PRESSURE. And the brakes which are operated by means of hydraulic pressure are called HYDRAULIC BRAKES. These brakes are based on the principle of Pascal's law.

Pascal's law

The pressure exerted anywhere in a mass of confined incompressible liquid is transmitted equally in all directions throughout the liquid such that the pressure ratio remains the same. The siphon, Hydraulic jack, Hydraulic press, hydraulic lifts and breaking system for automobiles etc. are some examples of hydraulic applications.

Pascal's law or the principle of transmission of fluid – pressure (also Pascal's Principle) is a principle in fluid mechanics that states, that a pressure change occurring anywhere in a confined

incompressible fluid is transmitted throughout the fluid such that the same change occurs everywhere.

Master Cylinder in Action

In automotive engineering, the master cylinder is a control device that converts non-hydraulic pressure (commonly from a driver's foot) into hydraulic pressure. This device controls slave cylinders located at the other end of the hydraulic system.

Fig., 1 Master cylinder

Working of JCB braking system

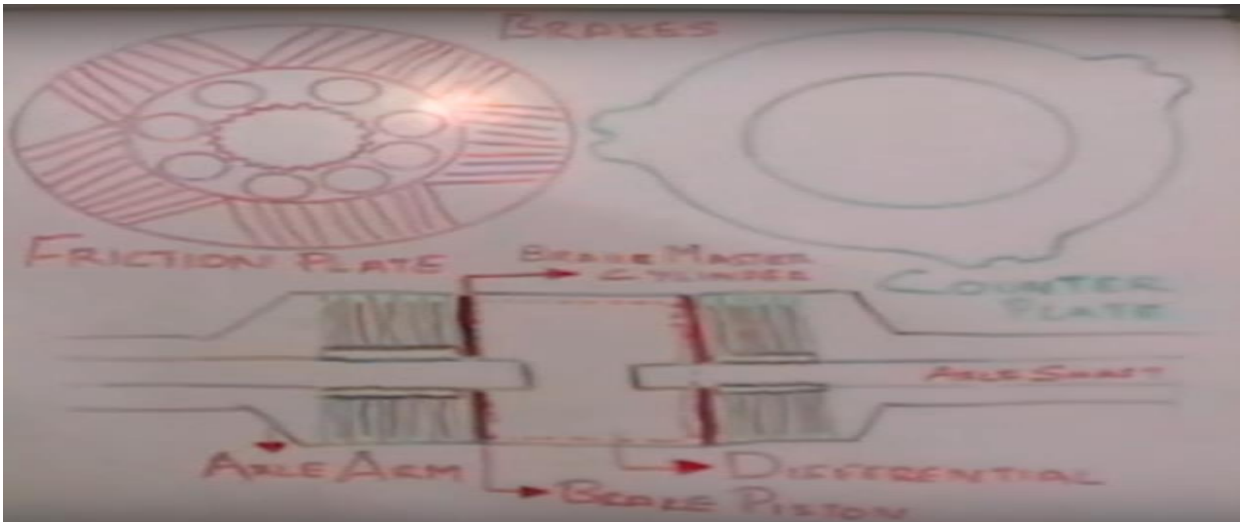

Fig. 2 Friction plate, Counter plate and mechanism

In JCB braking system there are two types of plate are used(1)friction plate(2)counter plate. When the pedal is applied it's also known as non-hydraulic pressure. At that time in master cylinder through pressure is created same time brake piston is move towards the plates (tyre direction) . Due to Chamber fluid pressure the all plate are lock together friction is generated therefore the axle is stop is called JCB hydraulic braking system.

Fig., 3 Friction plate, Counter plate and master cylinder

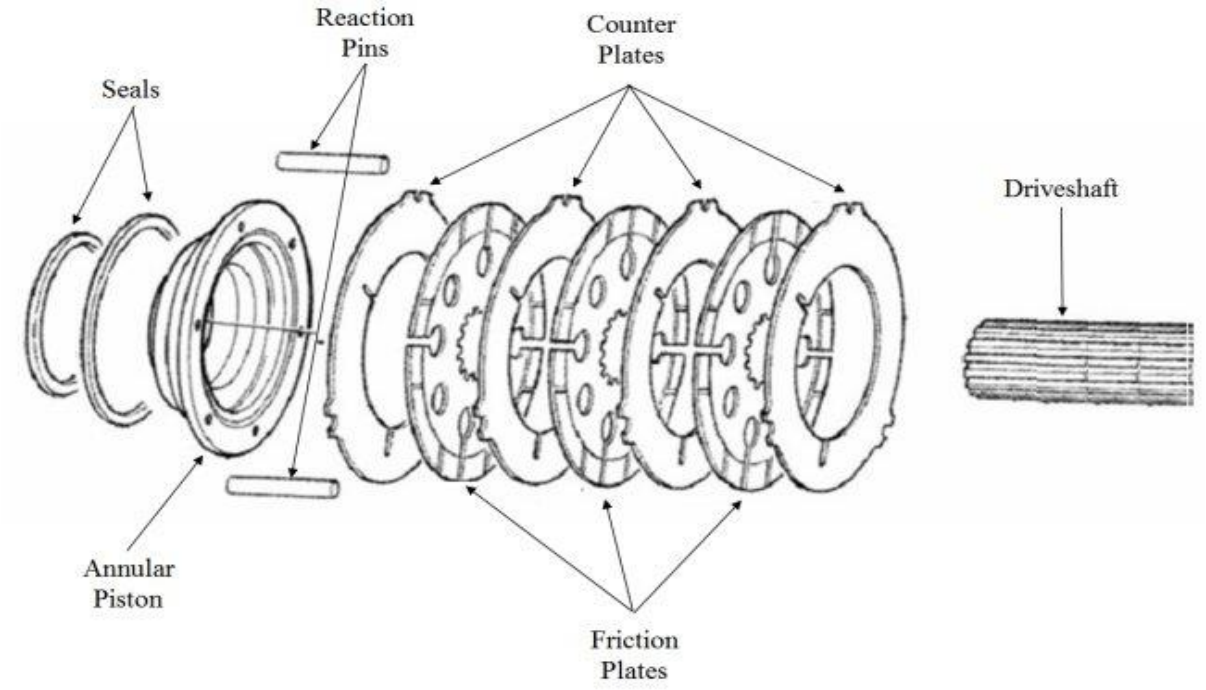

Fig. 4 Assembly of braking system

Fig., 5 practically assembly of JCB braking system

JCB 3DX (Dieselmax engine)

J.C. Bamford Excavators Limited, universally known as JCB, is a British multinational corporation, with headquarters in Rochester, Staffordshire, and manufacturing equipment for construction, demolition and agriculture. It is the world's third-largest construction equipment manufacturer.

What is the meaning of 3DX- JCB DIESELMAX ENGINE?

What is a hydraulic brake?

The hydraulic brake is an arrangement of braking mechanism which uses brake fluid, typically containing ethylene glycol, to transfer pressure from the controlling mechanism to the braking mechanism.

Table 1Difference between 2DX 3DX and 4DX

Specification	2DX	3DX ecoxcellence	3DX extra ecoxcellence	3DX Super ecoxcellence	4DX Super ecoxcellence
Maximum Dig Depth	3.02m	4.77m	5.05m	5.05m	5.36m
Maximum Engine Power	36.4 kW(49.5hp)	56 kW(76hp)	56 kW(76hp)	68.6 kW(92hp)	68.6 kW(92hp)
Maximum Loader Capacity	800 kg	1800 kg	1800 kg	1800 kg	1800 kg
Shovel Capacity	0.6 cum	1.1 cum	1.1 cum	1.1 cum	1.2 cum

LITERATURE REVIEW

May Thin Gyanet all, "Design and Structural Analysis of Single Plate Clutch" (2014). [1]

In this article **t**he comparison result is done for using three materials to define the best material for friction plate. The stress of clutch disc is analyzed to observe the stress, displacement and strain during applying pressure on clutch disc face by using Solid Works software. The result of this paper, using cast iron as friction material is advantageous than using alloy steel and copper as friction material. The cast iron using as friction material is the best for single plate clutch.

SagarOlekaret all, "Structural analysis of multiplate clutch" (2013).[2]

In this paper, the multi plate clutch is designed by using uniform wear theory. The 3D model of multi plate clutch has been prepared using modelling software Pro/E. The structural analysis is carried out for friction plate by using analysis software Ansys Workbench 14.0. The results for stress, strain, total deformation and for strain energy are obtained. These results are compared for two different friction materials viz. cork and SF001, Hence it is concluded that the clutch plate with friction material SF001 gives better performance than cork.

Mr. Vishal J et all, "Design and Structural Analysis of Single Plate Friction Clutch" (2013). [3]

In this article After completion of the analysis in CAE software i.e. ANSYS 9.0 based on the values of Equivalent Stresses for material loading conditions it is clearly seen that these are less than the allowable stresses for that particular material under applied conditions the part not going to yield and hence the design is Safe.

QuQingwenet all, "The Research for Methods of Mixing Processes Affect the Performance of Friction Plate" (2010).[4]

In this research paper that have obtained the best process method of and parameters, based on conducting a large number of experiments, and provides the data to support for the industrialization. In this paper, based on a large number of experimental studies, a new pre-treatment methods of friction plate material was discovered, the new low-temperature cementing material, energy saving environmental protection, pollution-free, that was moulding at low temperatures is an ideal replacement of friction plate material. Some main parameters of friction characteristics of have been

presented in the key material handling process of the moulding process, and provide the reference for the production.

Ganesh Rautet all, "Analysis of Multidisc Clutch Using FEA" (2013). [5]

In this research paper multi plate clutch is most widely used in racing cars and heavy duty vehicle where high torque transmission required and limited space is available. In this paper we designed a multi plate clutch by using empirical formulae. A model of multi plate clutch has been generated in CATIA V5 and then imported in ANSYS workbench for Automobile Applications. We have conducted structural analysis by varying the friction surfaces material and keeping base material aluminium same. By seeing the results, Comparison is done for both materials to validate better lining material for multi plate clutch by doing analysis on clutch with help of ANSYS Workbench software for find out which material is best for the lining of friction surfaces. By observing the analysis results, the maximum shear stress, Von-Mises stress and total deformation values for hybrid SF-BU are less than LO31 respective values. So we expected that for multi plate clutches using as hybrid SF-BU friction material is advantageous than using LO31 as friction material

Rahul A. Raikwar et all, "Study the Design Aspects and Function of Wet Type Multi-Plate Clutch" (2015).[6]

In this article this gives better understanding about working principle of clutch, material used for making the clutch plates. Effect of design consideration can be further studied during its application in various conditions. In the CAD model actual clutch has also been explained. The design approach is in the way of improving the efficiency of transmission system. Lastly there is the solution given to the analyzed error. Advantages, disadvantages and various practical applications are also discussed. From the various obtained result the study work can be concluded that the mechanical properties vary depending upon the various heat absorbing process. Hence depending upon properties and application required we should go for suitable fluid or oil for gear box. We have measure the hardness of the material in the Rockwell hardness testing machine with help of Rockwell hardness test with the help of intender.

K.S.Aravindh1et all, "Fem Analysis Of Wet Multi Plate Clutch By Varying Friction Surface Material"(2015).[7]

The friction materials which are used here represent the most important part of each friction combination, which effectively consist of the counter frictional surface and in the case of wet-running. Structural and Thermal analysis is done on the wet friction plates to verify the strength.

Design of wet multiple plate clutch is carried out by using CATIA design software and Finite Element Analysis is carried out by using ANSYS v11 software. Friction materials used are Cork and Copper Powder Metal. Material used for inner disc is steel and outer disc is bronze. Hence we conclude that for multi plate clutches using Copper powder metal as friction material Strength is Improved, Deformation is reduced and Material Life of the Clutch is improved. To improve Performance of clutch Lubricant Oil is maintained and servicing of Automobile is done in Perfect Time

Andrea Bassiet all, "Dynamic Analysis of the Lubrication in a Wet Clutch of a Hydro mechanical Variable Transmission"(2016).[8]

In this article the paper investigates the oil flow through a multi plate clutch for a hydro-mechanical variable transmission under actual operating conditions. The analysis focuses on the numerical approach for the accurate prediction of the transient behaviour of the lubrication in the gear region: the trade-off between prediction capabilities of the numerical model and computational effort is addressed. The numerical simulation includes the full 3D geometry of the clutch and the VOF multi-phase approach is used to calculate the oil distribution in the clutch region under different relative rotating velocities. Furthermore, the lubrication of the friction disks is calculated for different clutch actuation conditions, i.e. not-engaged and engaged positions. The influence of different geometrical features of the clutch lubricating circuit on the oil distribution is also determined. The results show the areas where poor lubrication occurs and extend the experiments where measurements are difficult to carry out. The simulation highlights the regions where high thermal stresses are observed during tests. Finally, two sets of rotations and the disengaged and engaged configurations were simulated and compared. By observing the oil distribution in the gear chamber when fully stabilized flow regime is reached, the slower set of velocities was characterized by a larger film thickness in the inner wall of the gear with respect to the fastest set of rotations. This behaviour was also confirmed by a more uniform distribution of the oil through the different plates in case of the slower set of rotations. When comparing the disengaged and engaged configurations by modifying the gap between the plates and thus the relative position of the GHs, the conductance of each plate changed and a different oil distribution was found. Nevertheless, for both geometries, the farthest plates from the inlet duct resulted more lubricated compared to the ones close to the oil supply duct. This behavior can suggest a critical issue in the operation of the real clutch, since the plates close to the inlet demonstrated experimentally to be the most thermally stressed.

W. Ost et all, "The tribological behavior of paper friction plates for wet clutch application investigated on SAE#II and pin-on-disk test rigs" (2001).[9]

In this paper, both SAE#II and pin-on-disk tests are used to investigate the wear and friction characteristics of the friction material. They can be used for a qualitative analysis of the influence of material parameters and operating conditions on both friction coefficients and wear rate. used in earthmoving off-road vehicles, This paper mainly focuses on wear of the friction material, as this will affect the lifetime of the clutch, and the consequent friction changes of the clutches The clutch essentially consists of nine friction plates and eight separators, 'Paper' is a modern friction material, sometimes called 'organic' material, Dynamic friction coefficient increases as the apparent contact pressure decreases. Independent of the applied contact pressure, the dynamic friction coefficient decreases with increasing sliding speed. Hardness of the separator plates does not influence the dynamic friction coefficient. It can be concluded that the wear rate of the friction material increases with increasing hardness of the separator plate.

W. Ostet all,"The Tribological Behavior of Paper Friction Plates for Wet ClutchApplications Investigated on *SAE* I1 and Pin-on-Disc Test Rigs" (2003). [10]

In this research, both SAE 11 and pin-on-disc tests have been used to investigate the wear and friction characteristics of paper friction material mainly due to the great difference in surface temperature between the two tests and to the sensitivity of the wear rate to temperature. However, the pin-on-disc tests indicate that it could be possible to increase the contact pressure used in the, clutches (2 MPa) with very little effect on wear rate of the friction material, if care is taken to control the surface temperatures of the plates.

Vaibhav A. Ajmire et all, "Structure Optimization of Disc Brake" (2015). [11]

In this article the action force, friction force and brake torque on rotor disc are studied by the basic formulae of disc brake. The aim is to compare between the rotor disc of a standard motorcycle "Bajaj Pulsar" and a non-standard rotor disc to find out the relationship value between brake torque, rotor disc dimension etc. Weight of the selected disc is less as compared to original disc, this saves the material. Heat generated in selected disc is less as compared to original disc but it is not showing significant effect on variation in temperature distribution.

Leiming Shi et all, "TheOptimization Design and Research of CX20 Clutch Friction Plate" (2014). [12]

In this article with the observation and performance study of the microstructure of friction-wear materials, the results showed that film and air cushion film would lead to thermal recession, transfer film has positive effect on the coefficient of friction, the thermal wear, abrasive wear, accompanied by adhesive wear was mainly in the high temperature condition.

Xuezeng Zhao et all, "Analysis on the Influence of the Strength and Stiffnessunder the Contact Conditions for Friction Plate"(2013).[13]

In this article through modal analysis of force and its distribution in different layers of friction plate assembly friction plate, a friction plate component analysis layers, friction plate by the effect of preload on the friction plate assembly strength, and in this state analysis of the friction plate stiffness. The same condition considering the friction between the blade assembly sheets after the contact, with the increase of layers, each layer of multilayer friction plate assembly friction plate and the maximum stress is obviously reduced. With the number increasing, the friction stress maximum drops down. The friction plate components of each layer of friction stress distribution tendency basic consistent, the maximum stress were concentrated in the vicinity of bolt hole, the minimum stress concentration in the adjacent connecting bolt hole in the middle. With the increase of pre tightening force, friction plate assembly in the layer friction appears stress was increased in varying degrees. With the preload force increases to a certain extent, between the two layers of the friction plate has reached close contact, friction stress will make it possible to maintain a stable numerical range. Stiffness cannot be friction plate only through the monolithic lining stiffness of the linear superposition .With the increase of axial displacement, nonlinear characteristics of axial stiffness gradually became obvious.

CONCLUSION

- Due to the change of the material of disk it will be moulding at low temperature, energy saving, environmental protection, pollution free.
- Total deformation, strain energy, shears elastic strain SF001 is best then Cork. Hence Friction material SF001 is better compare to the cork.
- By observing the analysis results, the maximum shear stress, Von-Misses stress and total deformation values for hybrid SF-BU are less thanLO31 respective values. So we expected that for multi plate clutches using as hybrid SF-BU friction material is advantageous than using LO31 as friction material.

- Design which improves the overall brake performance of disc brake system. It is found that the results given by the selected disc are desirable, Weight of the selected disc is less as compared to original disc, this saves the material and Heat generated in selected disc is less as compared to original disc but it is not showing significant effect on variation in temperature distribution.

- The same condition considering the friction between the blade assembly sheet after the Contact, with the increase of layers, each layer of multilayer friction plate assembly friction plate and the maximum stress is obviously reduced.

- With the number increasing, the friction stress maximum drops down.

- With the increase of pre tightening force, friction plate assembly in the layer friction appears stress was increased in varying degrees.

- With the preload force increases to a certain extent, between the two layers of the friction plate has reached close contact, friction stress will make it possible to maintain a stable numerical range.

- Stiffness cannot be friction plate only through the monolithic lining stiffness of the linear super position.

- Dynamic friction coefficient increase as the apparent contact pressure decrease

- Independent of the applied contact pressure, the dynamic friction coefficient decreases with increasing sliding speed.

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