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Design and structural assessment of single clutch plate with variant of materials

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Abstract

A Clutch is a one of necessary machine member which is use to connect the driving shaft to a driven shaft, in order that the driven shaft should also be started or stopped at will, without any change in the driving shaft. A clutch consequently provides an interruptible connection between two rotating shafts. The present used material for friction disc is with different cloth and aluminum alloys. In this thesis evaluation is carried out the usage of composite materials. The composite materials are considered thanks to their excessive energy to weight ratio. In this thesis material E Glass Epoxy and Aluminum Metal Matrix Composite are taken. One plate clutch is supposed and modeled the use of CATIA software. Static evaluation and Dynamic analysis is completed on the clutch to work out stresses and deformations using substances Grey forged iron, Aluminum alloy 7075, Glass Epoxy and Aluminum Metal Matrix Composite. Analysis is accomplished in ANSYS15.

Keywords : clutch plate material, ANSYS15, CATIA

Introduction

A clutch is a flat plate part which provides drive to a different mechanism, typically by connecting the driven mechanism to the driving mechanism. Its opposite component may be a brake, which inhibits motion. Clutches are useful in devices that have two rotating shafts. In these devices, one shaft is usually attached to a motor or other rotating part (the driving member), and therefore the other shaft (the driven member) provides output power for work to be done. In a drill, as an example, one shaft is driven by a motor, and therefore the other drives a drill chuck. The clutch connects the two shafts in order that they will either be locked together and spin at an equivalent speed (engaged), or be decoupled and spin at different speeds (disengaged).A Clutch may be a machine member wont to connect the driving shaft to a driven shaft, so that the driven shaft could also be started or stopped at will, no end the driving shaft. A clutch thus provides an interruptible connection between two rotating shafts. Clutches allow a high inertia load to be stated with a little power.

Method of calculation

Pressure (p)= (P_{max}xri)/ro

Fn=$\int_{ri}^{ro} pdA$[Pmax=0.69 (cast iron)]

= $\int_{ri}^{ro}((Pmax \times ri)/ro$) x 2πrdr

=2πPmaxxri$\int_{ri}^{ro} dr$

Pmax= maximum permissible stress

Ri=inner radius of single plate clutch

Ro=outer radius of single plate clutch

Specifications of friction plate

Power = 52.5KW @ 3600 rpm

Torque = 195 N-m @1400-2200RPM

Material used is pressed asbestos on cast iron or steel

μ = 0.35

Maximum operating temperature 0C = 150 – 250

Maximum pressure N/mm2 = 0.4

r_i and r_o outer and inner radius of friction faces ro =114.5mm and ri =80 mm
R = mean radius of friction surfaces For uniform pressure

$$R = \frac{2}{3} \times \frac{r_o^3 - r_i^3}{r_o^2 - r_i^2} = \frac{2}{3} \times \frac{114^3 - 80^3}{114^2 - 80^2} = 98.26\text{mm}$$

For uniform wear $R = \frac{r_o + r_i}{2} = \frac{114+80}{2} = 97.25mm$

For Considering Uniform Axial Wear

Axial force is required to engage the clutch
W=2πC (r_o-r_i)
C=P × r (C=constant)
The maximum intensity pressure occurs at inner radius (r_i) of friction surface
C = P_{max} × r_i
C = W/ (r_o-r_i) = 2835.04/(.1145-.080) = 13078.58
Pmax = C/r_o = 13078.58/0.08 = 164871 N/m^2 = 0.165 MPa
The minimum intensity pressure occurs at outer radius (r_o) of friction surface
Pmin = C/r_o = 13277.79/0.1145 = 115963N/m^2 =0.115MPa
P_{avg}= (Total force on friction surface) / (Cross -sectional area of friction surface)
P_{avg} = W/π(r_o^2-r_i^2) =136392N/m^2

Considering Uniform Pressure

When the pressure is uniformly distributed over the entire area of the friction face then the intensity of pressure P
P = W/ {π (r_o^2- r_o^2)}
Where W = axial thrust with which the friction surfaces are held together.
In general frictional torque acting on the friction surfaces or on the Clutch is given by-
T = n× μ × W × R
n = no of pairs of friction surfaces for single plate clutch n = 2
R = mean radius of friction surfaces
μ = coefficient of friction
T = 195 = 2 × 0.35 × W × 0.9826
W=2835.04N/m^2

$$P = \frac{w}{\pi(r_o^2 - r_i^2)} = \frac{2835.04}{\pi(114^2 - 80^2)}$$

= 136.392 × 10^3 N/mm^2

Finite element analysis

The finite element analysis is the most widely accepted computational tool in engineering analysis. Through solid modeling, the component is described to the computer and this description affords sufficient geometric data for construction of mesh for finite element modeling. In this project the clutch plate assembly using different lining materials was designed in the previous chapter. In this chapter finite element analysis is going to be done using Ansys software. In the following subchapters structural and thermal analysis is going to be done for each clutch assembly parts and compare different lining to choose the best lining, which were designed in the previous part. 3D modeling was done using Catia V5 for each plate assembly parts and now we are going to import those models to Ansys to do static structural analysis. Material properties of different clutch plate materials are shown bellow in table.

Static Structural Analysis

A static structural analysis determines the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time. A static structural load can be performed using the ANSYS or Samcef solver.

Material	Tensile yield strength [MPa]	Poisson ratio [-]	Modulus of elasticity [GPa]	Density [kg/m3]
Asbestos	800	0.28	165	2800
Sintered metal	140	0.24	115	6400
Cermet	1039	0.23	380	5000
Ceramic	1138	0.22	325	2130
Kevlar	3240	0.36	71	1470
E Poxy glass	1000	0.34	27.6	1900
Cast iron alloy	130	0.28	110	7200

Meshing

After the complete structure is modeled, clutch assembly is meshed. Mesh generation is the practice of generating a polygonal or polyhedral mesh that approximates a geometric domain. The term "grid generation" is often used interchangeably. The process of subdividing the part into small pieces (elements) is called meshing. In general, smaller elements give more accurate results but require more computer resources and time. Ansys suggests a global element size and tolerance for meshing. Bellow figure shows the pictorial value of meshed clutch plate. The size is only an average value, actual element sizes may vary from one location to another depending on geometry. It is recommended to use the default settings of meshing for the initial run. For a more accurate solution, use a smaller element size.

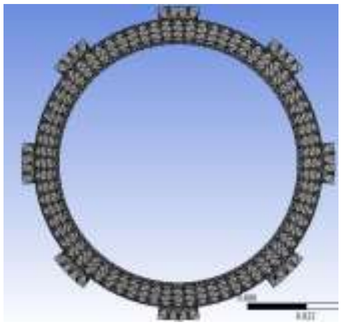


Fig 1 meshed clutch plate

Results

In this chapter the deformation and stress characteristic for the MPCs has been investigated, the structural and model are computed are computed for dimensional radius ratio (R) and also for thickness (t). This analysis is done using ANSYS/ workbench 15. Fig.8 shows the mode shapes for internal and external splines of disc clutch for dimensional radius ratio (R) as 0.875mm.

Contour view of strain, Deformation and stress Aluminum alloy (7075)

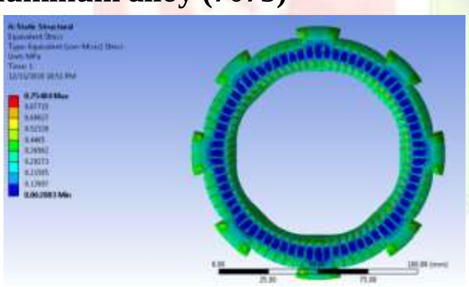


Fig 2 equivalent stress of aluminum alloy

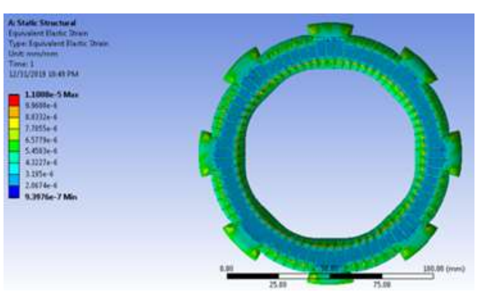


Fig 3 Equivalent strain of aluminum alloy

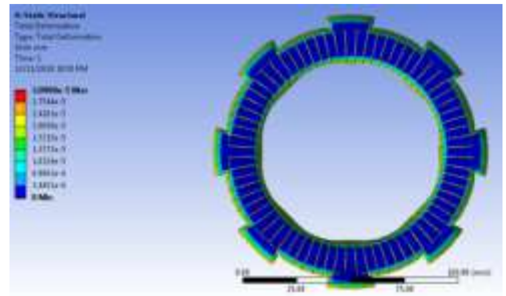


Fig 4 Deformation of aluminum alloy

Contour behavior of asbestos material for clutch plate

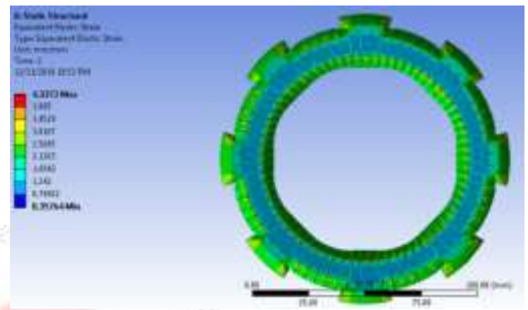


Fig 5 equivalent strain of asbestos

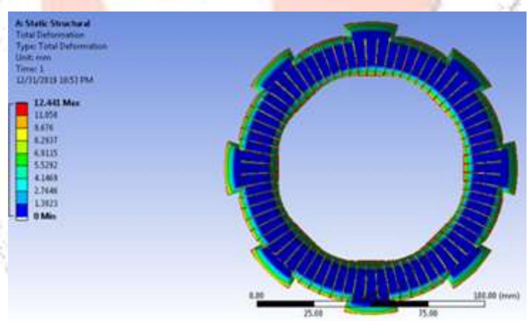


Fig 6 Deformation of asbestos

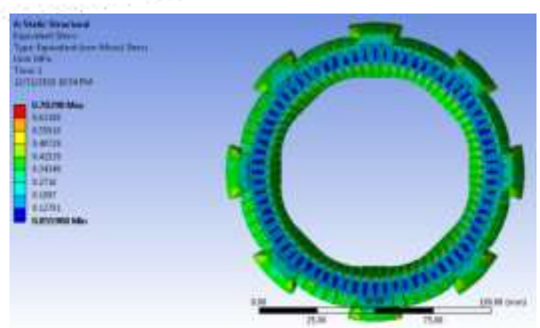


Fig 7 equivalent stress of asbestos

Stress strain and deformation of cast diagram

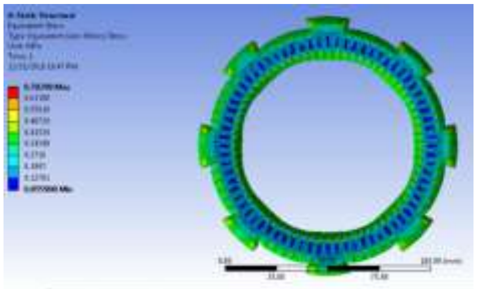


Fig 8 von misses stress distribution CI

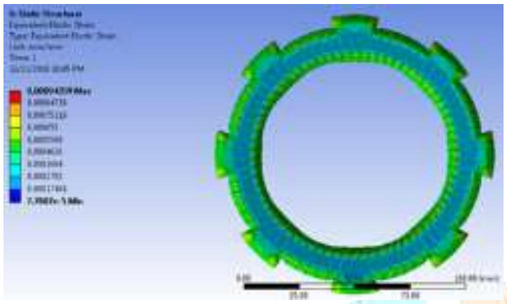


Fig9 strain distribution in cast iron

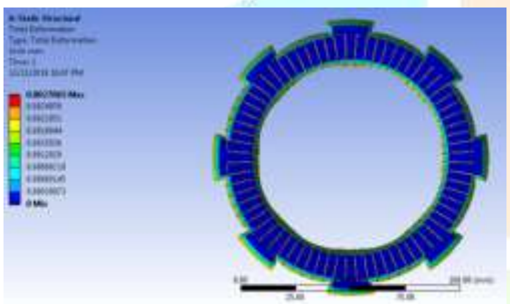


Fig 10 deformation of cast iron

Contour diagram of stress, strain and deformation of ceramic material

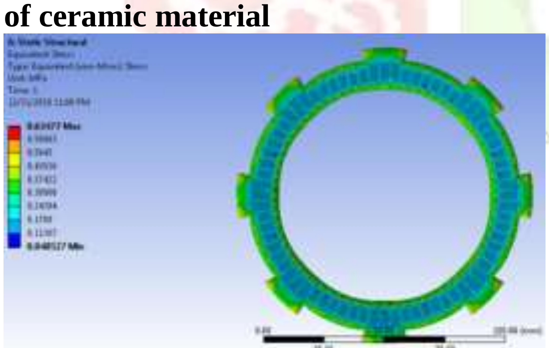
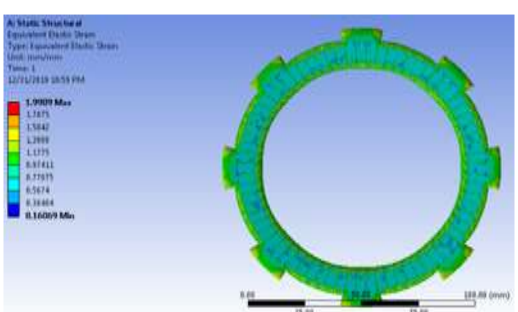


Fig 9 stress distribution of ceramic material Fig



10 strain on ceramic materials

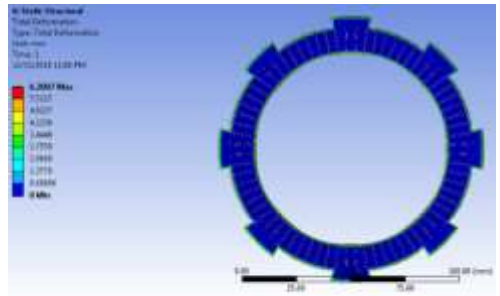


Fig 11 Deformation on ceramic materials

Contour diagram of cermet materials used in clutch plate

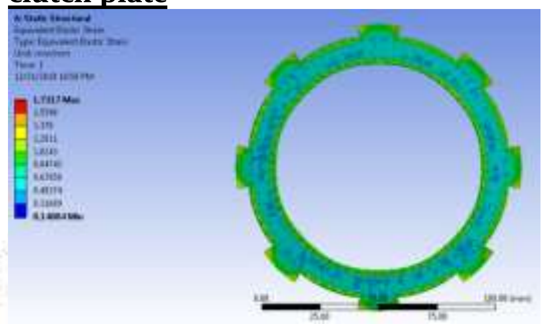


Fig12 strain distribution on cermet clutch plate

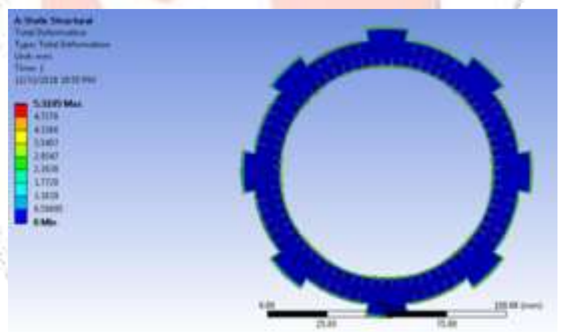


Fig13 Deformation on cermet clutch plate

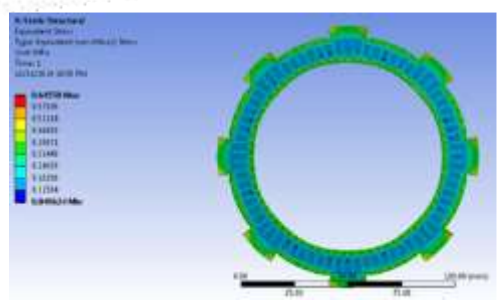


Fig 14 stress distribution on cermet clutch plate

Counter display E poxy material made clutch plate

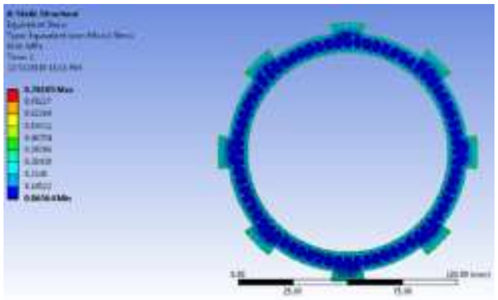


Fig15 stress distribution over clutch plate

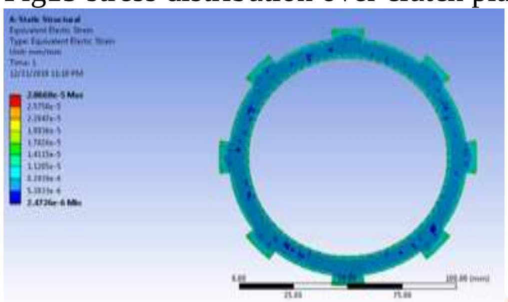


Fig16 strain distribution over clutch plate

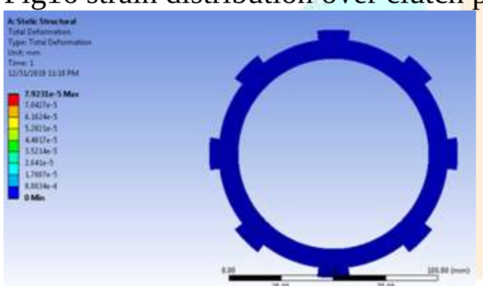


Fig 17 deformation of epoxy made clutch plate

Contour display of Kevlar made clutch plate

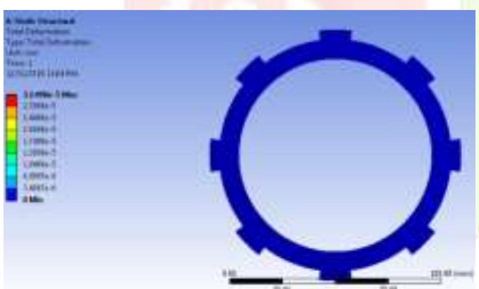


Fig 18 deformation on kavlar made clutch plate

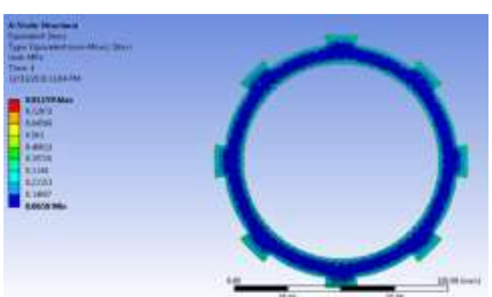


Fig19 Stress distribution on kavlar made clutch plate

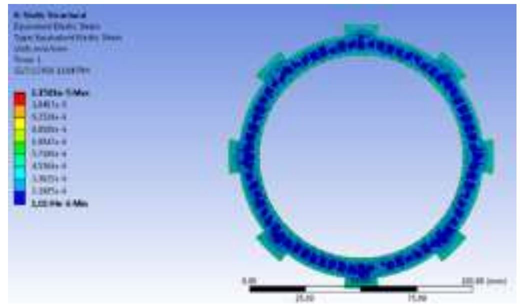


Fig 20 Strain imposed on kavlar made clutch plate

Contour display of sintered material made clutch plate

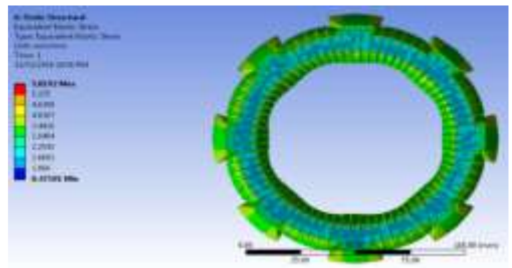


Fig21 strain on sintered made clutch plate

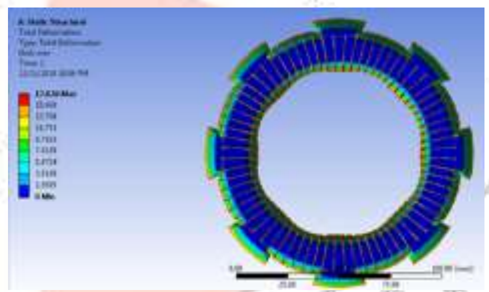


Fig 22 deformation behavior of clutch plate

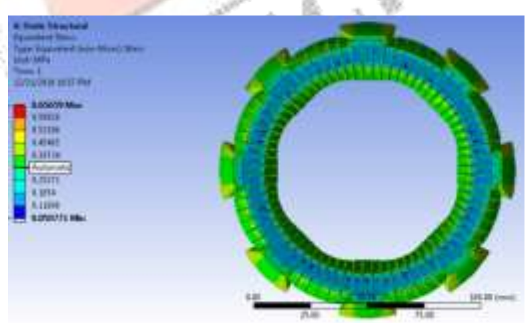


Fig 23 stress distribution on clutch plate

After analysis external single plate clutch results have been tabulated below:

4.2 Discussions

As tabulated results shown in table the Total deformation for Aluminum Alloy external spline single plate clutch is 3.0939e-5mm; that of E-glass Epoxy UD is 7.92e-5mm and that of Gray Cast Iron is 0.00027mm. And from above table, through ANSYS Simulation Workbench 15.

Equivalent Strain for Aluminum alloy is 1.10e-5mm/mm; that of epoxy is 2.86e-5 mm/mm and that of Gray Cast Iron is 0.00094mm/mm through ANSYS Simulation Workbench 15.

Equivalent stress for Epoxy material is .7818MPa which is very similar as compared to Aluminum alloy of .75404MPa; and that of Gray Cast Iron is .70298 MPa through ANSYS Simulation Workbench 15.Also observed that; the total deformation, equivalent strain, equivalent stress for clutch plate with E-Glass Epoxy as a friction material is less than that of Aluminum alloy and Gray Cast Iron. For same input torque stress developed in clutch plate with friction material of E-Glass Epoxy is less compared to Cast Iron and aluminum alloy. Hence it is concluded that the clutch plate with friction material E-Glass Epoxy UD gives better performance than Gray Cast Iron and Aluminum alloy.

In single plate clutch, friction plate plays very important role in torque transmission from engine to transmission system. So the friction material property is very important in clutch design. From the above tables, it is clear that E-glass Epoxy UD material is a better friction material than Gray Cast Iron and aluminum alloy. It is also observed that total deformation, equivalent stress and equivalent strain of E-glass Epoxy UD material are in the permissible range for the ideal friction material compared to the theoretical calculations.

E-glass Epoxy UD has the low total deformation when compared to the existing conventional Gray Cast Iron friction material. Hence, it is concluded that E-glass Epoxy UD serves as a better friction material than Gray Cast Iron, and aluminum alloy and gives better clutch performance.

Another best performance of E-glass Epoxy UD friction material is its lower weight. The objective of this thesis is using materials having lower weight and better in torque transfer. As shown in table of properties of material, the density of E-glass Epoxy UD is lower than that of Aluminum alloy, and Gray Cast Iron. Since the density is the ratio of mass to it volume (ρ= m/v), and increase in mass is proportional to the density. So, Gray Cast Iron has more weight than aluminum alloy, and E-Glass Epoxy with the lowest weight of materials. This shows that E-glass Epoxy UD is the lowest in weight than that of existing commercial clutch materials mostly Gray Cast Iron.

materials	Total deformation (mm)	Equivalent elastic strain (mm/mm)	Equivalent Stress (MPa)
Aluminum	3.09E-5	1.1088E-5	.75404
Asbestos	12.44	4.3372	.70298
Cast iron	0.0027	0.00094	.70298
Ceramic	6.2	1.99	.63477
Cermet	5.31	1.7317	.6455
E Poxy composite	7.92E-5	2.866E-5	.7818
Kevlar	3.14E-5	1.15E-5	.81159
Sintered	17.626	5.819	.6565

REFERENCES

[1]. Design and Analysis of Clutch Using Sintered Iron as a Friction Material by Mamta G. Pawar, Monarch K. Warambhe, Gautam R. Jodh,International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Volume-3, Issue-7, December 2013

[2]. Dynamic Analysis Of Single Plate Friction Clutch by Shrikant V. Bhoyar, Dr. G. D. Mehta, Dr. J. P. Modak, International Journal of EngineeringResearch and Technology, ISSN: 2278-0181

[3].Static Structural Analysis of Multiplate Clutch with Different Friction Materials by Anil Jadhav, GauriSalvi, SantoshUkamnal, Prof. P. Baskar, International Journal of Engineering Research and Technology, ISSN: 2278-0181

[4].Thermo-mechanical Analysis of the Dry Clutches under Different Boundary Conditions by O.I.Abdullaha, Schlattmanna, A.M.Al-Shabibi,Vol.36,No.2(2014)172-180, Tribology in Industry

[5]. Modelling and assembly of single plate friction clutch of an automobile by Prafull. S. Thakare , Vishal J. Deshbhratar AND Abhinav. P. Ninawe,Indian Streams Research Journal, Volume : II, Issue : II, March – 2012

[6]. Dynamic analysis of single plate friction clutch by Shrikant V. Bhoyar, G.D. Mehta, J.P. Modak

[7] May thin gyan, Hla Min Htun, HtayHtay Win, International Journal Of Scientific Engineering And Technology Research Volume.03, Issue No.10, May-2014,Pages: 2238-2241

[8] Ravikiran m. Tate, S. H. Sarje, Design And Analysis Of Clutch Plate For Automotive Single Plate Clutch International Journal Of Scientific Engineering AndTechnology Research Volume.03, Issue No.10, May-2014, Pages: 2238-2241

[9]Ganesh Raut, Anil Manjare, P Bhaskar, Analysis of Multidisc Clutch Using FEA, International Journal of Engineering Trends and Technology (IJETT) – Volume 6 Number 1- Dec 2013, VIT University, TamilNadu-632001, India.

[10]Cooke, D.C, (2014) Automaker Rankings 2014. The Environmental Performance of Car, Companies.Availableat:http://www.ucsusa.org/clean_vehicles/what_you_can_do/automaker-rankings 2014.html#.VThXtSHBzGc.

[11] Mrs.Ch.Vasantha Lakshmi, and SandhyaRani.V, "Design and Structural Analysis of Composite Coated Clutch Plate by using Composite Materials", international journal and Magazine of Engineering, Technology, Management and Research, A peer Reviewed Open Access International Journal. ISSN No: 2348-4845. P1-4.

[12] G.Kannan, K.Krishnamoorthy, K.Loheswaran," Review on Different Materials Utilized in Clutch Plate" South Asian Journal of Engineering and Technology Vol.2, No.23 (2016) 135 – 142