Review on Performance of Dual Mass Flywheel over Conventional Flywheel

Kashinath H. Munde[1], Vikas K. Mehtre[1], Dhanashree S. Ware[1], Dattatray P. Kamble[1]

[1]Mechanical Engineering Department, Anantrao Pawar College of Engineering & Research, Parvati, Pune.

Article Info
Page Number:496-505
Publication Issue:
Vol 71 No. 1 (2022)

Article History
***Article Received**: 02 February 2022*
***Revised**: 10 March 2022*
***Accepted**: 25 March 2022*
***Publication**: 15 April 2022*

Abstract

The Dual Mass Flywheel is used for dampening the oscillations created at the time of working in automotive power transmission system.Dual mass flywheel is a multi-clutch device. The torsional frequency is defined as the rate at which the torsional vibration produced. When the torsional frequency of the crankshaft is equal to the transaxles torsional frequency an effect known as the torsional resonance occurs. When the operating speed of the engine is minimum, vibration occurs due to the torsional resonance and this can be avoided using dual mass flywheel.We explained detailed initial model in the paper. In this mainly having the two arc springs and two masses in the DMF and their nature. By experiment the Dual Mass Flywheel model is compared to convention flywheel. Finally the observation of the engine torque using the DMF is taken. The DMF is manufactured and done experiment or testing to see the results. And then results which came are compare with the conventional flywheel.

Keywords— Dual & conventional mass flywheel, concept,study.

I. INTRODUCATION

Use of vehicle is increases in now days and the field development is growing rapidly so higher-performance engines paralleled by an increased demand for driver comfort. In addition, lean concepts, extremely low-speed engines and new generation gear-boxes using light oils contribute to this. Since the year 1980s, this advancement has pushed the classic torsion damper as an midway integral part of the clutch driven plate to its limits. With the same or even less installation space available, the classic torsion damper has proved constantly increasing engine torques. Extensive development in this field resulted in a simple, but very effective solution –DMF a new torsion damper concept for the drive train. All the referred papers refer to various regeneration methods of flywheel by which we can produce power and store in battery for further use, or method and implements to reduce weight of the flywheel using different composite materials. In our case using the two spring two mass system to produce useful vibrations which will be employed to increase the inertia of the system and thereby enable us to either reduce the weight of existing flywheel or increase power output using existing weight of flywheel also we will be able to improve acceleration characteristic of given system.In today's world power train control systems need accurate torque information to perform various tasks. These tasks include for example the clutch actuation in automated manual transmissions (AMTs) and dual-clutch transmissions (DCTs) as well as the control of electric motors in hybrid power trains. Indirect torque estimation is needed because the direct measurement of the transmitted torque using strain gages cannot be done in volume production cars for economic reasons. One source for power train torque estimation is the engine itself. However, the torque estimation provided by the internal combustion engine is based on complex thermodynamic models. The repeated period combustion cycles of a 4-stroke engine produce torque fluctuations which excite torsional vibration to be passed down the drive train. The resulting noise and vibration, such as gear rattle, body boom and load change vibration, result in poor noise behavior and driving comfort. Thus engine models tend not to be reliable in all situations. Because of rotational vibrations created due to variation in torque this variation results from the discrete piston combustion cycle of the engine as a function of the ignition frequency. Here the possibility of torque estimation using the Dual Mass Flywheel is analyzed. Such that DMF is used to detect engine misfire which is similar to power train torque observation. The objective when developing the Dual Mass Flywheel was therefore to isolate torsional vibration from the drive train as much as possible caused by the engine‟s rotating mass. The Dual Mass Flywheel almost absorbs this torsional vibration. The result is very good vibration damping.

II. LITERATURE REVIEW

1.Jordan Firth, Jonathan Black

This paper explains the vibration interaction in a multiple flywheel system. Flywheels can be used for kinetic energy storage. In this paper one unstudied problem with vibration interaction between multiple unbalanced wheel. This paper uses a linear state space dynamics model to study the impact of vibration interaction. Specifically, imbalanced induced vibration inputs in one flywheel rotor are used to cause a resonant whirling vibration in another rotor. Vibration is most severe when both rotors are spinning in the same direction.[4]

2. Bjorn Bolund, Hans Bernhoff, Mats Leijon

This paper explains the use of flywheel. Nowadays flywheels are complex construction where energy is stored mechanically and transferred to and from the flywheel by an integrated motor or generator. The wheel has been replaced by a steel or composite rotor and magnetic bearings have been introduced. By increasing the voltage, current losses are decreased and otherwise necessary transformer steps become redundant.[5]

3.Ulf Schaper, Oliver Sawodny, Tobias Mahl and Uti Blessing

They explains the DMF along with its application and components. Afterwards a detailed model of the DMF dynamics is presented. This mainly includes a model for the two arc springs in the DMF and their friction behaviour. Both centrifugal effects and redirection forces act radially on the arc spring which induces friction. The numerical method is used to measure model validation.[6]

III. PROBLEM STATEMENT

To inspect the performance characteristics of Dual mass flywheel over conventional flywheel. And compare which one having good efficiency for use. Optimize the Dual mass flywheel performance results than that of conventional flywheel.

IV. DESIGN OF CONVENTIONAL FLYWHEEL

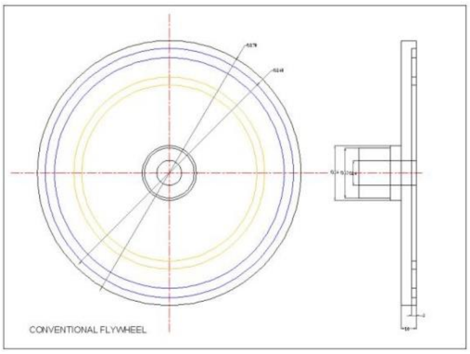


Figure no.1 Conventional Flywheel

V. DESIGN OF DUAL MASS FLYWHEEL SYSTEM

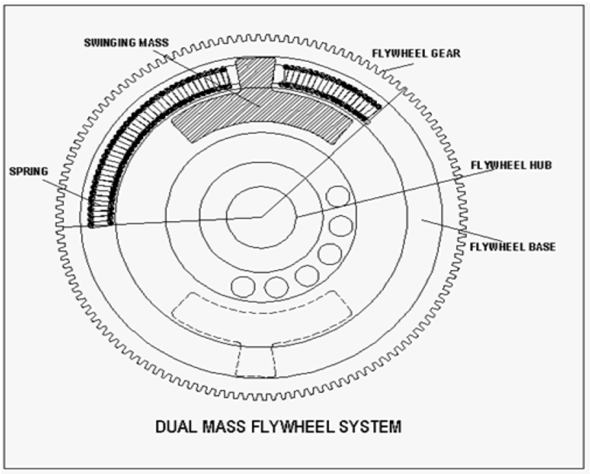


Fig.5.Dual Mass Flywheel System

Figure no.2 Dual Mass Flywheel

VI. EXPERIMENTAL SETUP[ref.1]

Figure no.3 Experimental Setup

VII. EXPERIMENTAL RESULT

The effect of inertia can be seen by the difference in the fluctuation of energy in the DMF and the Conventional flywheel.[1]

Let, Maximum fluctuation of energy of Dual mass flywheel $= \nabla E_{dmf} = mR^2 \omega_{dmf}{}^2 Cs$

Where,

R= Mean Radius of rim = 68 mm = 0.068

ω_{dmf} = mean angular speed of dual mass flywheel

$$= \frac{2\pi(N_1 + N_2)}{2} = \frac{2\pi(1430 + 930)}{2}$$

ω_{dmf} =7414 rad/sec

Cs= Coefficient of fluctuation of speed= $N_1 - N_2/N$

Where N= $\frac{(N_1+N_2)}{2}$ = 1180

Cs= 1430-930 /1180 =0.423

$\nabla E_{dmf} = mR^2 \omega_{dmf}{}^2 Cs$ = 1.9 x 0.068^2 x 7414^2 x 0.423 = 204.27 KJ

Maximum fluctuation of energy of Conventional flywheel

Where, $m = mass\ of\ flywheel = 1.9Kg$

R= Mean Radius of rim = 68 mm =0.068

ω_{cnv} = mean angular speed of dual mass flywheel

$$= \frac{2\pi(N_1 + N_2)}{2} = \frac{2\pi(1315 + 910)}{2}$$

ω_{cnv} =6990 rad/sec

Cs = Coefficient of fluctuation of speed =$N_1 - N_2/N$

Where N= $\frac{(N_1+N_2)}{2}$ =1112

Cs = 1315-910 /1112 = 0.364

$\nabla E_{cnv} = mR^2 \omega_{cnv}{}^2 Cs$ = 1.9 x 0.068^2 x 6990^2 x 0.364 =156.25 KJ

Effectiveness (ɛ) = $\nabla E_{dmf} / \nabla E_{cnv}$ = 204.27 /156.25

=1.30

Thus the Dual mass flywheel is 1.3 times effective than the Conventional flywheel.

VIII. OBSERVATIONS

Sample calculations:

a)

$output\ torque =$
$W \times 9.81\ radius\ of\ dyno\ brake\ pulley$
$Top = 4 \times 9.81 \times 0.032 = 1.26\ Nm$

b)

$Efficiency =$
$(Output\ power / input\ power) \times 100 =$
$152.39/205 = 74.33$

RESULT TABLE

Table no. 1 Result Table of Conventional Flywheel[ref.1]

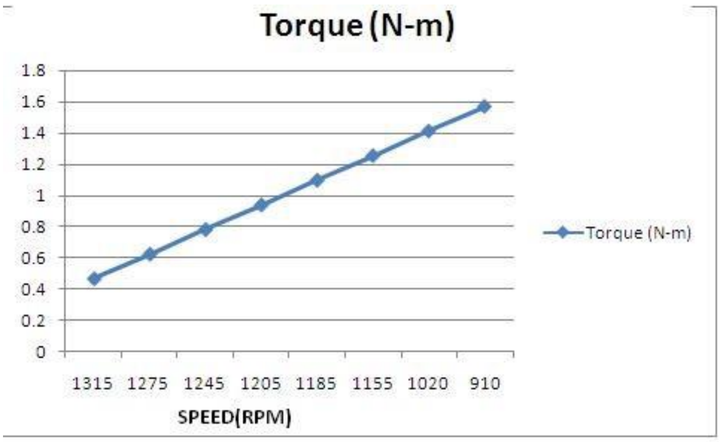
Sr. No	Load(gm)	Speed(rpm)	Torque(Nm)	Efficiency
1	1500	1315	0.47088	31.6349
2	2000	1275	0.62784	40.8969
3	2500	1245	0.7848	49.9183
4	3000	1205	0.94176	57.9773
5	3500	1185	1.09872	66.5176
6	4000	1155	1.25568	74.0955
7	4500	1020	1.41264	73.6144

Table No.2 Result Table of Dual Mass Flywheel[ref.1]

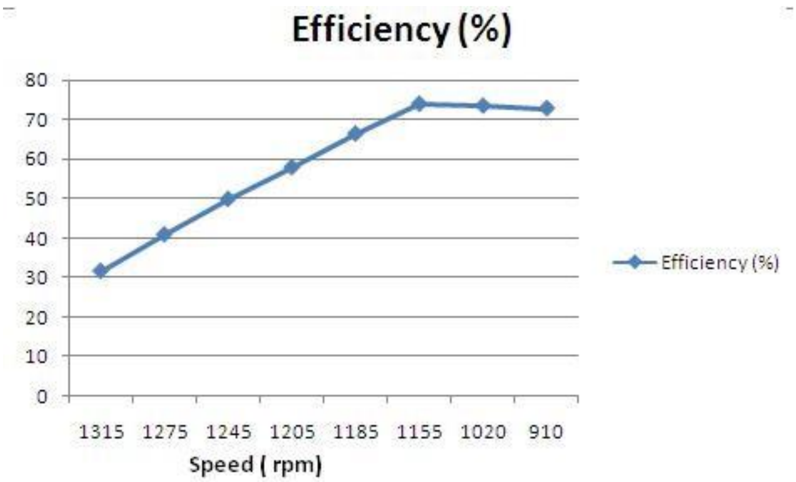
Sr. No	Load(gm)	Speed(rpm)	Torque(Nm)	Efficiency
1	1500	1425	0.47088	34.2594
2	2000	1345	0.62784	43.1147
3	2500	1365	0.7848	54.6948
4	3000	1315	0.9417	63.2256
5	3500	1285	1.09872	72.085
6	4000	1245	1.25568	79.8184

7	4500	1080	1.41264	77.895
8	5000	930	1.5696	74.5292

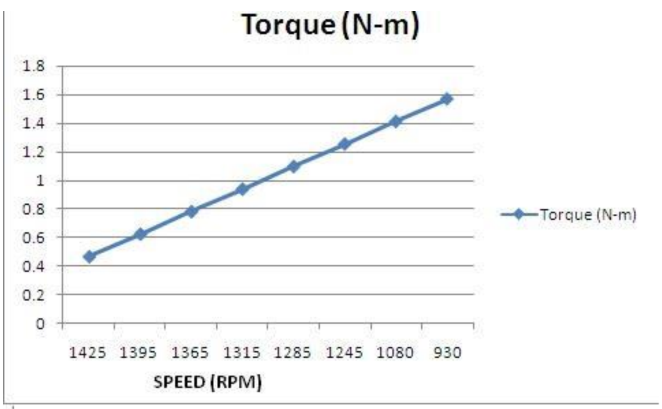
Graph of Torque Vs Speed for Dual Mass Flywheel



Graph of Efficiency Vs Speed for Dual Mass Flywheel



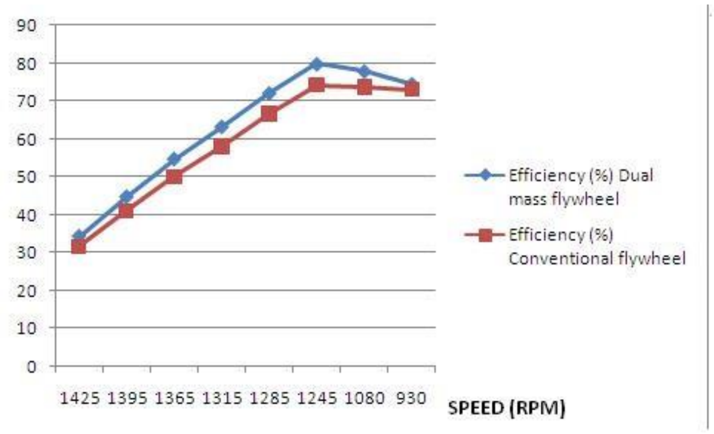
Graph of Torque Vs Speed for Conventional Flywheel



Graph of Efficiency Vs Speed for Convention Flywheel

IX. CONCLUSION

Comparison- Efficiencyof Conventional and Dual mass flywheel:



The DMF having good efficiency than that of Conventional flywheel, it is near to 5 to 6% efficient. Due to this increases fuel economy of engine.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to Dr. Pradeep J. Awasare (Adjunct Professor), Er. Sudarshan Natu (Innovation Club Member) for their invaluable guidance and support throughout the research process. We also wish to thank Dr. Sunil B. Thakare (Principal, APCOER, Pune) for their support. Finally, we are grateful to all of the research participants who generously gave their time and effort to this project.

REFERENCES

1. N.N.Suryawanshi,Prof.D.P.Bhaskar,"Design,Development of Dual Mass Flywheel and Comparative Testing with conventional Flywheel"International Engineering Research Journal (IERJ) Special Issue 2 Page 5024-5028, 2015, ISSN 2395-1621

2. Manuel Olivaresa, Pedro Albertosb "Linear Control Of The flywheel Inverted Pendulum", ISA Transactions 53(2014) 1396-1403.
3. Paul D. Walker*, Nong Zhang, "Modelling Of Dual Clutch Transmission Equipped Powertrains For Shift Transient Simulations", Mechanism And Machine Theory,60(2013) 47-59.
4. Dhabliya, D. (2021d). Examine Several Time Stamping Systems and Analyse their Advantages and Disadvantages. International Journal of Engineering Research, 1(2), 01–05.
5. Dhabliya, D., & Others. (2021). An Integrated Optimization Model for Plant Diseases Prediction with Machine Learning Model. Machine Learning Applications in Engineering Education and Management, 1(2), 21–26.
6. Rabanal, N., & Dhabliya, D. (2022). Designing Architecture of Embedded System Design using HDL Method. Acta Energetica, (02), 52–58.
7. Jordan Firth, Jonathan Black, "Vibration Interaction In A Multiple Flywheel System", Journal Of Sound And Vibration, 331(2012) 1701-1714.
8. Bjorn Bolund, Hans Bernhoff, Mats Leijon, "Flywheel Energy And Power Storage Systems", Renewable And Sustainable Energy Reviews, 11(2007) 235-258.
9. Ulf Schaper, Oliver Sawodny, Tobias Mahl And Uti Blessing, "Modeling And Torque Estimation Of An Automotive Dual Mass Flywheel", American Control Conference, 2009.
10. Ashish R. Pawar, "Roof Crash Simulation of Passenger Car for Improving Occupant Safety in Cabin" in Elsevier Journal
11. Ashish R. Pawar, "Design and Development: A Simulation Approach of Multi-Link Front Suspension for an All-Terrain Vehicle", SAE Technical Paper, SIAT 2021
12. Aditya Pawar, Aniket Wanjale, Harshal Wanjale, Yash Sathe, Ashish R. Pawar, "Static Structural Analysis & Optimization Of Driver Cabin Mounting Bracket Of Heavy Commercial Vehicle", Journal of Analysis & Computation (IJAC, UGC), Volume XV Issue VI, June 2021 ISSN: 0973-2861, pp. 111-124
13. Siddharth P. Patil, Saurabh R. Birwatkar, Pranil D. Phadke, Karan R. Pawar, Ashish R. Pawar, "Static Structural Analysis & Topology Optimization Of Automotive Track Control Arm For Light Passenger Vehicle", Journal of Analysis & Computation (IJAC, UGC), Volume XV Issue VI, June 2021 ISSN: 0973-2861, pp. 91-100
14. Sandhya R. More, Ganesh E. Kondalkar, Ashish R. Pawar, "Crash Analysis Of A Conformable CNG Tank Using FEA Tool", Journal of Analysis & Computation (IJAC, UGC), Volume XV Issue VI, June 2021 ISSN: 0973-2861, pp. 71-78
15. Sumit Ekbote, Sidhhesh Gade, Sanket Mhetre, Raj Dhawade, Ashish R. Pawar, "Experimental Analysis Of Automatically Manufactured Chain Link Fencing Wire", Journal of Analysis & Computation (IJAC, UGC), Volume XV Issue VI, June 2021 ISSN: 0973-2861, pp. 57-67
16. Tushar S. Kalaskar, Kashinath H. Munde, Ashish R. Pawar, "Design And Analysis Of Hybrid Aluminium-Composite Driveshaft With Crack Using Experimental Modal Analysis And FEA", Journal of Analysis & Computation (IJAC, UGC), Volume XV Issue VI, June 2021 ISSN: 0973-2861, pp. 27-40

17. Sandhya R. More, Ganesh E. Kondalkar, Ashish R. Pawar, “Review Of Conformable Cng Tank Storage In Light Goods Vehicle”, Journal of Analysis & Computation (IJAC, UGC), Volume XV Issue VI, June 2021 ISSN: 0973-2861, pp. 21-26
18. Deepak N. Patil, Ganesh E. Kondhalkar, Ashish R. Pawar, “Improvement In Productivity And Quality Of Bumper Punching Machine”, Journal of Analysis & Computation (IJAC, UGC), Volume XV Issue V, May 2021 ISSN: 0973-2861, pp. 1-6
19. Shubham A. Andore, Ashish R. Pawar, P. N. Abhyankar, “Study Of Effects Of Different Profiles Of Dental Implant Using FEA”, Journal of Analysis & Computation (IJAC, UGC), Volume XV Issue V, May 2021 ISSN: 0973-2861, pp. 1-13
20. Abhilash D. Bhosale, Ashish R. Pawar, “Experimental & Numerical Investigation Of Pretention Effect On Fatigue Life Of Double Lap Bolted Joint Under Dynamic Shear Loading”, Journal of Analysis & Computation (IJAC, UGC), Volume XV Issue V, May 2021 ISSN: 0973-2861, pp. 1-19
21. Deepak N. Patil, Ganesh E. Kondhalkar, Ashish R. Pawar, “Structural Optimization Of Bumperfog Lamp Punching Machine”, Journal of Analysis & Computation (IJAC, UGC), Volume XV Issue V, May 2021 ISSN: 0973-2861, pp. 71-84
22. Ashish Pawar, Suraj Jadhav, “Investigate Optimum Shape of Crash Box Analysis Experimentally & Numerically on Geometry Aspect” in Journal of Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861
23. Ashish Pawar, Yogesh Vyavahare, Ganesh Kondhalkar, “Roof Crash Simulation of Passenger Car for Improving Occupant Safety in Cabin” in IUP Journal of Mechanical Engineering, Volume 13 Issue 2/3.
24. Ashish Pawar, Suraj Jadhav, “Experimental & Non-Linear Analysis to Investigate Optimum Shape Crash Box” in Journal of Interdisciplinary Cycle Research (JICR, UGC), Volume XII Issue VII, July 2020 ISSN: 0022-1945, pp. 966-973
25. Ashish Pawar, Swastik Kumar Pati, Ganesh Kondhalkar, “Comparative Analysis of Kenaf & Jute E Glass Epoxy Specimen Along with B Pillar Natural & Synthetic Combination Replica Test Under UTM” in Journal of Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861
26. Ashish Pawar, Harshal Dharmale, Ganesh Kondhalkar, “Experimental FEA Investigation of Bolt Loosening in a Bolted Joint Structure ” in Journal of Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861, pp. 1-12
27. Ashish Pawar, Harshal Dharmale, Ganesh Kondhalkar, “Numerical Investigation Of Bolt Loosening In A Bolted Joint Structure” in Journal of Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861, pp. 1-12
28. Ashish Pawar, Abhijeet Salunkhe, Kashinath Munde, “Optimization of Power Lift Gate Spindle & Socket Assembly” in Journal of Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861
29. Ashish Pawar, Abhijeet Salunkhe, Kashinath Munde, “Investigate Numerical Analysis of Power Lift Gate Spindle & Socket Assembly with Modifications” in Journal of Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861
30. Ashish Pawar, Balasaheb Takale, “ ” in Journal of Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861

31. Ashish Pawar, Sampada Ahirrao, Ganesh Kondhalkar, “Fatigue Analysis of Leaf Spring Bracket for Light Duty Vehicles on Topology Optimization Approach” in Journalof Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861, pp. 1-11
32. Ashish Pawar, Rahul Nimbalkar, “Investigation of Carbon Fiber & E Glass Epoxy Composite with Multi-Bolt Joints using Tensile Loading ” in Journal of Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861
33. Ashish Pawar, Rahul Nimbalkar, “Numerical Analysis of Carbon Fiber & E Glass Epoxy Composite Plates in Tensile Loading with Multi-Bolt Joints” in Journal of Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861
34. Ashish Pawar, Makarand Patil, Ganesh Kondhalkar, “Predication of Effect of Welding Process Parameter of MIG Process on Weld Bead Geometry” in Journal of Analysis & Computation (IJAC, UGC), Volume XIV Issue VII, July 2020 ISSN: 0973-2861
35. Ashish Pawar, “Topology Optimization Of Leaf Spring Bracket For Light Duty Vehicle” in Journal of Emerging Technologies and Innovative Research (JETIR, UGC), Volume 6 Issue 5, May 2019 ISSN: 2349-5162
36. Ashish R. Pawar, Dr. K. H. Munde, Vidya Wagh, “Stress Analysis of Crane Hook with Different Cross Section Using Finite Element Method” in Journal of Emerging Technologies and Innovative Research (JETIR, UGC), Volume 6 Issue 1, Jan 2019 ISSN: 2349-5162, pp. 79-83
37. Ashish R. Pawar, Dr. K. H. Munde, Mahesh Mestry, “Pre-Stressed Modal Analysis of Composite Bolted Structure” in Journal of Emerging Technologies and Innovative Research (JETIR, UGC), Volume 5 Issue 7, July 2018 ISSN: 2349-5162
38. Ashish R. Pawar, Kashinath Munde, Vijay Kalantre, “Topology Optimization of Driver Cabin Mounting Bracket of Heavy Commercial Vehicle” in International Journal of Science & Engineering Development Research (IJSDR), Volume 3, Issue 7, July 2018 ISSN: 2455-2631
39. Ashish R. Pawar, Kashinath Munde, Vijay Kalantre, “Topology Optimization of Front Leaf Spring Mounting Bracket” in International Journal of Science & Engineering Development Research (IJSDR), Volume 3, Issue 7, July 2018 ISSN: 2455-2631