ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Two-Wheeler Transmission System Health Monitoring: A Case Study

Manpreet Singh*, Chilakala Mahendra*, Mangalapuri Rajesh*, Gollapalli Sai Sri Ram*, Rajeev Kumar*, Piyush Gulati*, Jaiinder preet Singh*, Sumit Shoor*, Harpreet Singh**

*School of Mechanical Engineering, Lovely Professional University, Phagwara, Punjab-144411

**Department of Planning and Quality, Nettbuss AS, Oslo, Norway

Abstract

Sound levels are very crucial for an automobile because of strict norms framed by the government. After vehicle is sold out to the customer then it's customers duty to maintain its health otherwise the sound level of the automobile will grow up. The higher sound level arises due to improper maintenance will not only dangerous to the humans but also a sign of fault arises in the main component of automobile. In this case study structure born sound of transmission system for four different variantsof Bajaj pulsar bikesbased on odometer reading were studied. Mainly, bikes were made to run in all the four gear ratios at 2000 rpm and sound levels at idle condition, moving and pass-by noise were recorded. The recorded sound levels were studied on the basis of excessive sound if any along with the feedback from the owners. It has been observed that the improper servicing of the bikes and tire condition plays very significant role in enhancing the sound levels of the vehicle.

Introduction:

Sound pollution is term we often come across which is the propagation of disruptive noise in the environment causing a serious impact to the human. The main sources of this disruptive noise close to the human life can be estimated as the traffic noise or the vehicle noise [12]. Unfortunately, with less focus on that day by day conditions are becoming worst. This concern is not only lying with the manufacturer to manufacture a vehicle generating less noise but also to the consumers that how they are maintaining it. This is not only avoiding the detrimental effect on the humans but also it will enhance the life of the vehicle [1]. The five main sources of sound in an automobile are engine, transmission system, cooling system, exhaust system and tires [1,4]. When engine is turned on and in idle condition then engine sound, partial exhaust sound and

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

partial transmission sound are the mainly contributes to the total sound [2-3]. Tires, transmission system and exhaust system are contributing more sound when automobile is in running condition especially in the case of bikes.Each part is having its own significance and reasons for generating sound [5-9]. The sound level of each part stays within the limit as long as it's in a proper working condition but when it starts deteriorating or some fault initiates then the sound level increases due to harshness [10-14]. Even if the sound level of one-part increases then it affects the overall sound level of the automobile.

This study aims to estimate the health condition of four same two wheelers Bajaj pulsar with different odometer readings. The sound levels of vehicles were recorded by using sound level meter for the idle and running conditions. All the recorded sound levels were compared for various conditions such as running it while putting it on stands, actual running condition and pass-by noise. On the basis of compared sound levels the estimations made were confirmed through visual inspection or feedback from the owner.

Description of selected vehicles:

The four selected bikes of Bajaj pulsar were categorized on the basis of their odometer readings.The Bike 1 manufactured in year 2017 and driven for 22341 kms and lastserviced at 20000 kms (estimation from the owner). The service gap describes the how many kms the vehicle was driven after its service. Similarly, other bikes with the same data are presented in the Table1 and been designated as Bike 2, Bike 3 and Bike 4 on the basis of odometer reading.

Table1. Description of the cars tested

Bajaj pulsar	*Odometer reading*	*Last service*	*Service gap*	*Manufacturing year*
Bike 1	22341	20000	2341	2017
Bike 2	41536	40000	1536	2015
Bike 3	64298	59000	5298	2014
Bike 4	78052	67000	11052	2014

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Test results with discussion:

In the first set of experiment the bike was putted on to the stand for recording the sound levels without and with engaging the four gears. This generally gives the combined sound of engine, transmission system and exhaust system. This test is specifically estimating the condition of transmission system when running without loading condition.The recorded values of sound for all the cases are shown in Table 2. It can be observed that in all the cases Bike 1 is generating minimum sound levels. The main reason for generating minimum sound level estimated to be the Bike 1 is least driven and its parts are in good shape. But the full throttle on signifies no engagement of the transmission system and the less sound level can be said because of its engine and exhaust systems are in good condition. The Bike 2 despite of having least service gap is generating the maximum level of sound in all the cases. The higher level of sound in the case of full throttle justifies the problem in either engine or exhaust system in comparison to the other cases.Table 3 represents the percentage of more sound level generated by other bikes at the same condition in comparison to the minimum level for the idle conditions.Apart from detrimental condition of Bike 2 the results also show that in gear 1 Bike 3 has also produced almost double sound than that of the minimum sound level.

Table2: Recorded sound levels for the idle conditions without loading

Sound level without loading @ 2000 rpm	**Bike-1**	**Bike 2**	**Bike-3**	**Bike-4**
Ideal full throttle	**100.5**	105.6	102.2	103.5
Ideal 1st gear (2000rpm)	**68.9**	74.9	73.9	72.7
Ideal 2nd gear (2000rpm)	**70.5**	75.4	73.1	72.4
Ideal 3rd gear (2000rpm)	**71.8**	75.4	73.4	73.2
Ideal 4th gear (2000rpm)	**73.6**	75.1	74.7	75.1

Table 3: Percentage of more sound level generate by other bikes in comparison to the minimum level for the idle conditions

Sound level without loading @ 2000 rpm	**Bike-1**	**Bike 2**	**Bike-3**	**Bike-4**
Ideal full throttle	**0**	223.59 %	47.91 %	99.52 %

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Ideal 1st gear (2000rpm)	**0**	289.10 %	216.22 %	139.88 %
Ideal 2nd gear (2000rpm)	**0**	209.02 %	81.97 %	54.88 %
Ideal 3rd gear (2000rpm)	**0**	129.08 %	44.54 %	38.03 %
Ideal 4th gear (2000rpm)	**0**	41.25 %	28.82 %	41.25 %

In the second set of experiments the bikes were made to run in all the gears at 2000 rpm and the sound levels were recorded from one meter of distance. The person sitting behind the rider has recorded the sound levels from the same position.The recorded sound levels for the bike in actual running condition are shown in Table 4. The recorded sound level shows that Bike 1 is continuously performing well as it has the minimum level of sound in all the cases compared to all other bikes. Table 5 represents the percentage of more sound level generated by other bikes at the same condition in comparison to the minimum level for the actual moving conditions. It can be observed that the Bike 3 in 1st and 4th gear and Bike 4 in all gears were making significantly excessive noise in comparison to the minimum levels. The feedback was taken from the owners of Bike 3 and Bike 4 regarding transmission system maintenance. The Bike 3 owner has done all the services of the bike including gear system with in the acceptable time interval. The deterioration of his transmission system was estimated because of the ageing of may be any unforeseen reason. The Bike 4 owner admitted that he has not serviced his vehicle with in the time frames and once he forgets to change the transmission system oil in time. The transmission system with the absence of healthy transmission oil might get wear up and that can be the main cause of high sound levels.

Table4: Recorded sound levels for the actual moving conditions with loading

Sound level in actual running @ 2000 rpm	**Bike-1**	**Bike 2**	**Bike-3**	**Bike-4**
Moving 1st gear (2000rpm)	**65.2**	65.4	71.4	70.2
Moving 2nd gear (2000rpm)	**67.8**	70.1	70.5	75.1
Moving 3rd gear (2000rpm)	**68.5**	70.4	72.7	75.6
Moving 4th gear (2000rpm)	**70.1**	72.6	76.3	73.9

Table 5: Percentage of more sound level generate by other bikes in comparison to the minimum level for the actual moving conditions

Sound level in actual running @ 2000 rpm	**Bike-1**	**Bike 2**	**Bike-3**	**Bike-4**

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Moving 1st gear (2000rpm)	**0**	04.71 %	316.86 %	216.22 %
Moving 2nd gear (2000rpm)	**0**	69.82 %	86.20 %	437.03 %
Moving 3rd gear (2000rpm)	**0**	54.88 %	163.02 %	412.03 %
Moving 4th gear (2000rpm)	**0**	77.82 %	316.86 %	139.88 %

In the last set of experiments the pass-by noise was recorded for all the bikes by keeping the sound level meter at a distance of 5 meters. Due to the restricted road length the speeds of the bikes were not been able to attained in the fourth gear at 2000 rpm so, the readingswere not recorded for fourth gear at 2000 rpm.Again, in this set of readings Bike 1 outperforms other bikes as the recorded sound levels were significantly low for Bike 1 as compared to other bikes. The Bike 3 also have low level of sound level in this set of experiment and this can be because of good tire condition. The tires of Bike 2 were worn out and need to be replaced therefore the pass-by sound level for this bike was significantly high.The Bike 4 is showing clear signs of bad form of transmission system as its tires are not in bad shape compared to Bike 2.

Table 6: Recorded pass-by sound levels for the actual moving conditions

Pass-by Sound level in actual running @ 2000 rpm	**Bike-1**	**Bike 2**	**Bike-3**	**Bike-4**
Pass by 1st gear(2000rpm)	**61.3**	66.91	61.9	69.4
Pass by 2nd gear(2000rpm)	**63.7**	74.2	65.6	75.8
Pass by 3rd gear(2000rpm)	**68.6**	74.7	71	72.3

Table 5: Percentage of more sound level generate by other bikes in comparison to the minimum level for the actual moving conditions

Pass-by Sound level in actual running @ 2000 rpm	**Bike-1**	**Bike 2**	**Bike-3**	**Bike-4**
Pass by 1st gear(2000rpm)	**0**	263.91 %	14.81 %	545.65 %
Pass by 2nd gear(2000rpm)	**0**	1022.01 %	54.88 %	1521.81 %
Pass by 3rd gear(2000rpm)	**0**	307.38 %	73.78 %	134.44 %

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Conclusion:

The case study done on the Bajaj pulsar bikes has helped in drawing the following conclusion

1. The first set of experiment where bikes were made to run without loading conditions reveals no information of the transmission system faults. But it can be used for determining the health of engine and exhaust system.
2. The sound level analysis is helpful in identifying the transmission system problem. As in Bike 4 the problem of transmission system was identified through sound level and later on in the feedback analysis casual approach of the owner in maintaining the transmission system was identified.
3. The worn-out tires produce more sound compared to the normal tires and it can be identified from the recorded pass-by noise level. The Bike 2 high level of pass-by noise was justified because of its worn-out tires as this bike shows good agreement in other tests.

References:

1. S. Raju., “ARAI Pune, Workshop on Noise, vibration and harshness for automotive engineering”,pp:123- 139, 2004.
2. N.V. Karanath and S. Raju,“Investigation of relation between stationary and pass by noise for new in use vehicle”, SAE paper No. 2005-26-051. ARAI Pune, 623-629, 2005.
3. N.Nayak, P.V. Reddy, Y. Aghav, N. S. Sohi andA.D. Dani “A.D.,Study of Engine vibration due to piston slop on single cylinder High powered Engine,Kirloskar Oil Engines Ltd. Pune”, India, SAE paper 2005-26-046, pp. 581- 588, 2005.
4. P.S. Mahale, D.J.,Kalsule, A. Muthukumar and S. Raju, “Vehicle interior noise source identification and analysis for benchmarking,ARAI Pune”. SAE paper 2005-26-048,592- 603, 2005.
5. S.S. Gosavi, “Automotive Buzz, Squeak and Rattle (BSR) detection and prevention,TATA technologies Ltd”, ARAI Pune, 661-667, 2005.
6. M.D. Rao, “Recent applications of viscoelastic damping for noise control in automobiles and commercial airplanes” Keynote speech, Michigan Technological University, Houghton, Michigan & 9931 USA 2001.
7. J. Gabiniemic, J. Gatt, G. Cerrato, Jay (Tecumesh products research laboratory) Automatic detection of BSR events. (Magna Automotive Testing).
8. A.D. Nashif, D.I.G. Jones and J.P. Henderson,“Vibration Damping”, New York: 1985 John Wiley and Sons.
9. J. Soovere,M.L. Drake, and V.R. Miller,“Vibration Damping workshop Proceedings” 1984,AFWAL-TR-84- 3064 publications by Air force Wright aeronautical Laboratories, Wright-Patterson Air Force Base, Ohio, VV-1-VV-10, a design guide for damping of

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

aerospace structures.

10. S.W. Kung, and R. Singh,“Development of approximate methods for analysis of patch damping and design concepts”, Journal of Sound and vibration 219, pp. 785-812, 1999.
11. E.J. Vydra and J.P. Shorgen,“Noise and noise reducing materials”, Society of Automotive Engineers, Paper No 931267,1993.
12. E.M. Kerwin,.”Damping of flexural waves by a constrained viscoelastic laye”r. Journal of the Acoustical Society of America 31, 952-962,1959.
13. K.M. Lilley,M.J. Fasse and P.E. Weber, “A comparison of NVH treatments for vehicle floorplan applications”. SAE paper No.2001-01-1464, 2001.

A. Hussaini,“Designing an interior waterborne coating for use in automotive paint shops to replace sound deadening pads”, SAE paper no. 2001-01-1391, 2001.