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EXPERIMENTAL STUDY ON WHEEL ALIGNMENT SYSTEM AND FUEL PERFORMANCE FOR LIGHT VEHIELE

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Abstract*-The fuel performance of the light vehicle with wheel alignment system was investigated experimentally. The wheel alignment adjustment system and fuel performance was analyzed based on alignment parameters for light vehicle. The proper time examination and adjustment of wheel alignment angles can significantly improve tire life, suspension system components, fuel consumption and driver operating satisfaction. In this paper, a computerized machine vision based wheel alignment measuring system was used and the fuel performance of ECHO PLUS- 2ZZ-GE-02 model light vehicle was investigated before and after wheel alignment. The experimental results show that the fuel performance of vehicle depends on road conditions and wheel alignment. The experimental investigation also observed that the impact on fuel performance, suspension system components and steering turning radius were significantly improved by proper time of wheel alignment.*

Keywords: Wheel alignment, Computerized machine vision, Fuel performance, Road condition, Light vehicle.

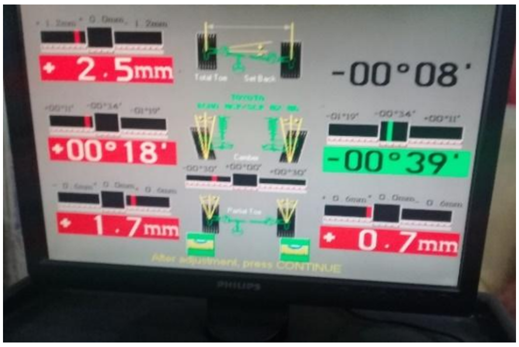
1. INTRODUCTION

Wheel alignment measuring system is the most important factor for vehicle maintenance program. The advancement of automotive technology and travelling speed of an automobile is vastly increased, however, at the same time the automobile stability and travelling safety are also decreased. The alignment system analyzes the wheel functions which is important component of the vehicle stability and safely system. In this process, main target is to reduce tire wear and vehicle of wheel running is straight and right position without any wrong direction [1-2]. The recent researches show the most of the road accident may occurred due to the wheels are not correctly fitting and wheel alignment is not proper setting and steering function is not proper turning position. It also find that the vehicle fuel efficiency is decreasing with increasing the tire wear and road misalignment. Nowadays, modern passenger vehicle has used different wheel alignments technique for safety purpose function such as toe, camber, steering axis inclination (SAI) and caster which are most influencing parameters in vehicle wheel alignment system. Currently many wheel alignment technique has been developed to enhance the tire life and fuel performance and reduction of tire wear of the vehicle. Also it can be ensured the vehicle wheels properly contribute to run straight and right way. Vehicle wheel alignment active safety system functions are caster, camber, toe and steering axis inclination (SAI) alignment which can be easily measured by using IR sensors [1-3]. In this technique, a computerized wheel machine is used to measure proper wheel alignment of heavy and light vehicles [3-6]. The system used simple circuit and it was low cost and high resolution with better working reliability and the process has used to easy data transferring system which is better than the traditional system [2-4]. In recent years, the machine vision process was extensively used for easy and proper way to know the characteristic angles [5]. The wheel alignment process is used computation vision technique for measuring of the vehicle active safety system function and adjusting of wheel characteristic angles and it is also related to fuel efficiency, tire lifespan and driving comfort [7]. In this process the different changes in the geometry features are analyzed such as radius, deflection angle, spiral, road width, length of tangent and obstacles on road surface and will affect the driving speed and fuel performance [8]. However, it should be noted that the tire safety and vehicle stability and also driver and passenger satisfaction are related to the tire quality, tire material and tire proper size [9]. In the present study, a computerized machine vision based wheel alignment measuring system was used and the fuel performance of ECHO PLUS- 2ZZ-GE-02 model light vehicle was investigated before and after alignment of the wheels.

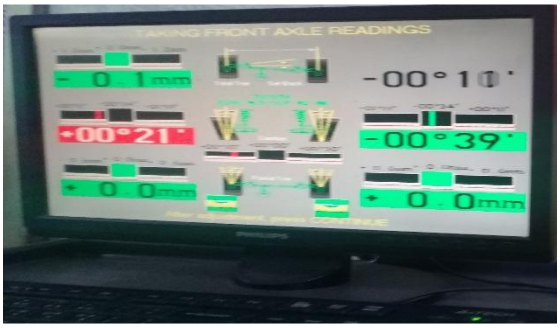
2. EXPERIMENTAL PROCEDURE

Wheel alignment consists of adjusting the angles of the wheels, so that they are perpendicular to the ground and parallel to each other. The steering system is related to the functions such as caster, camber, toe-in and toe-out, kingpin inclination and turning radius check. Experimental analysis includes pre-checking of wheel alignment by manual checking with all wheel alignment related parts. Then the vehicle is aligned by using computerized wheel alignment machine. Figure1 shows the experimental setup for wheel alignment system. Computer vision-based system is used in this experiment and utilized the images captured by video camera and the images are processed algorithm to obtain main wheel angles as shown in Fig. 2. The sensor connecting boards have to be mounted on the wheels before applying the system as the vehicle wheel balances on the platform. The vehicle is lifted park on alignment bay and set on turning table firstly. The four sensors are mounted on four wheels disk on front and rear axle. The vehicle lifted up with the help of air pressure jack.

Fig. 1: Experimental setup for wheel alignment system.



a) Before alignment



b) After alignment.

Fig. 2: Display before alignment and after alignment**.**

The commercial computer software for wheel alignment system is now used to measure the caster angles and this angle was adjusted by open end wrench and memorized with logging steering wheel. Then the camber angles are adjusted by losing and tightened of the tie rod and push rod function with steering system. Similarly, toe-in and toe-out are adjusted. The data were stored in memory drive for each step of measurement. In the present study, a ECHO PLUS-2ZZ-GE-02 vehicle was considered to analysis the wheel alignment system and fuel performance. For analysis, three road conditions such as smooth (road type-1), semi smooth (road type-2), and rough (road type-3) were considered as shown in Fig. 3.

a) Smooth road condition

b) Semi-smooth road condition

c) Rough road condition

Fig. 3: Road condition for vehicle testing.

3. WHEEL ALIGNMENT AND ROAD CONDITION ANALYSIS RESULTS

Table-1 shows the experimental data for wheel alignment of ECHOPLUS-2ZZ-GE-02, 1300cc light vehicle. For three road conditions each time the running distance is considered as 10 km. The light vehicle is tested under two different speed 20km/h and 40km/h and after each test the wheel alignment data and fuel consumption data were recorded as shown in Table 1 & Table 2. The statistical data analysis of Rahimafrooz auto center [10] suggests that the vehicle wheel alignment became misalignment when the running distance range was approximately 4000km to 5000km. The analysis results also observed that the wheel misalignment was increased as the running distance increased.

The fuel consumption rate was deviated for different road conditions presented in Table 2 and graphically shown in Fig. 4. It is found that, before alignment the fuel consumption are 470ml in smooth road, 765ml in semi-smooth road and 1050ml in rough road, respectively when the vehicle running is 10 km and speed 20km/h. However, fuel consumption has significantly improved by wheel alignment adjusting. It is found that after wheel alignment the fuel consumption are 450ml in smooth road, 715ml in semi-smooth road and 950ml in rough road, respectively. Therefore, the light vehicle loses the fuel efficiency by 4.25% (smooth road), 6.53% (semi-smooth road) and 9.70% (rough road), respectively.

Similarly, with the same condition but in vehicle speed 40km/h shows that the fuel consumptions are 415ml in smooth road, 630ml in semi-smooth road and 965ml in rough road before wheel alignment and after alignment the fuel consumptions are 400ml in smooth road, 600ml in semi-smooth road and 900ml in rough road, respectively. In this case, the fuel performance of light vehicle has deteriorated by 3.61% (smooth road), 4.76% (semi-smooth road) and 6.74% (rough road), respectively. The results suggest that the fuel efficiency increased as the vehicle speed increased.

It is also observed that the proper wheel alignment and road conditions can improve the safety of the suspension system components and reduce the tire wear and increases the mileage of the vehicle and driver operating satisfaction.

Therefore, it is recommended that the wheel alignment need to be checked after every an 4000km to 5000km running distance as a part of vehicle preventive maintenance program and also need to be check road condition for better fuel performance of the vehicle.

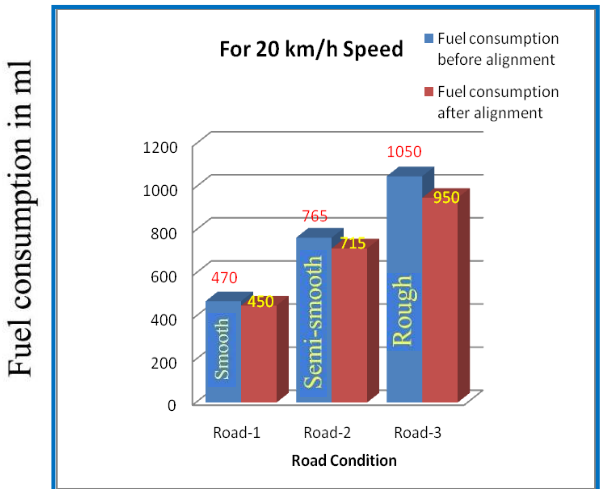
Table 1: Alignment display ECHOPLUS-2ZZ-GE-02, 1300cc light vehicle.

Condition	Position	Toe	Camber
Before alignment	L	+1.7	+00°18 ©
	R	+0.7	+00°39 ©
After alignment	L	+0.0mm	+00°10 ©
	R	+0.0mm	-00°38 ©

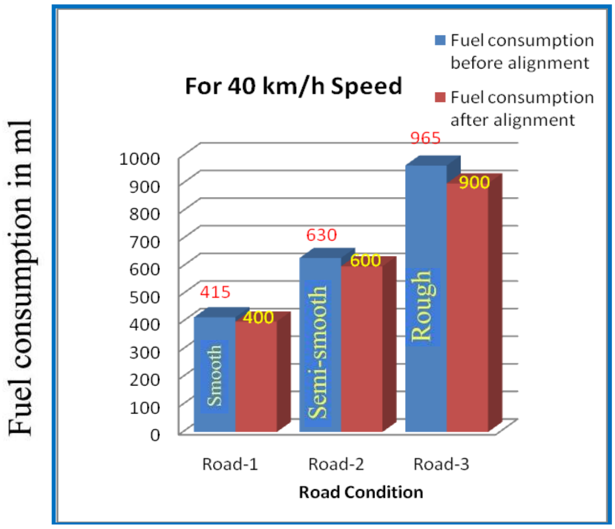
* L = Left; R = Right

Table 2: Test Result for ECHOPLUS-2ZZ-GE-02, 1300cc light vehicle.

Vehicle parameters	Road 1 (Smooth)		Road 2 (semi-smooth)		Road 3 (Rough)	
For distance 10km at speed 20km/h fuel consumption	Before alignment	After alignment	Before alignment	After alignment	Before alignment	After alignment
	470 ml	450 ml	765 ml	715 ml	1050 ml	950 ml
For distance 10km at speed 40km/h fuel consumption	415 ml	400 ml	630 ml	600 ml	965 ml	900 ml



a) Before and after alignment at speed 20 km/h



b) Before and after alignment at speed 40 km/h

Fig. 4: Road condition for fuel consumption.

4. CONCLUSION

In this paper an experimental outcome is presented for wheel alignment and fuel performance of a light vehicle. The results clearly indicate the advantages for applying the wheel alignment adjusting process and road conditions consideration. Based on the observations and experimental results obtained from the wheel alignment system the proper time and road condition consideration can contributed the great influence in tire life and reduction of the tire wear and increases the mileage of the vehicle. The regular maintain routine wise wheel alignment with road condition can significantly increase the fuel performance and also enhance the average life of the vehicle. The proper wheel alignment of the light vehicle can also improve the suspension components and steering turning position in the vehicle. A recommendation is suggested that the wheel alignment need to be checked after an every 4000km to 5000km running distance as a part of the vehicle preventive maintenance program.

5. REFERENCES

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