

Experimental Comparison of Tire Tread Wear Performance on Conventional and Electric Vehicles under Controlled Road Conditions

Melih GELBAL*, Mustafa Umut KARAOĞLAN**

*TOFAS Türk Otomobil Fabrikası, Bursa, Turkey, E-mail: melih.gelbal@tofasc.com.tr

**Dokuz Eylül University, Department of Mechanical Engineering, Izmir, Turkey, E-mail: mustafa.karaoglan@deu.edu.tr

<https://doi.org/10.5755/j02.mech.44614>

1. Introduction

Tire tread wear is a critical performance parameter that directly affects vehicle safety, operating costs, and environmental sustainability [1]. As the automotive industry around the world moves towards electrification, the operating dynamics affecting tire wear are changing rapidly. Electric vehicles (EVs), unlike conventional vehicles, exhibit different characteristics such as immediate torque delivery, increased vehicle weight due to battery packs, and regenerative braking. These evolving conditions significantly influence the mechanical and thermal forces acting on tires, raising new questions about their tread life [2]. In addition to tread wear, other tire-related factors such as rolling resistance, noise emission, and ride comfort have long been studied in conventional vehicle platforms [3].

Tread wear evaluation methods have historically been developed and calibrated using conventional vehicle platforms, where longitudinal load transfer, braking behavior, and torque delivery are relatively predictable. In EVs, however, higher vehicle mass, instant high torque at low speed, altered axle load distribution, and regenerative braking strategies modify tire force histories and slip conditions throughout the duty cycle. These changes can affect contact patch stress distribution, thermal build-up, and transient wear mechanisms, which may reduce the validity of conventional tread wear correlations and benchmark criteria when applied directly to EV platforms. Therefore, existing evaluation and prediction approaches should be re-examined and, where necessary, adapted to reflect EV-specific operating conditions. Established industry standards, such as those published by the European Tyre and Rim Technical Organization (ETRTO), define dimensional, load, and inflation parameters that directly influence tire performance assessments [4]. However, if these standards are not periodically updated and revalidated to reflect EV-specific operating conditions, there is a risk of tire underperformance in EV applications, potentially leading to customer dissatisfaction, increased maintenance costs, and safety-related concerns. In parallel with standards-based considerations, recent literature has investigated tread wear mechanisms, prediction approaches, and wear-related particle emissions under both controlled and real-world conditions.

Recent literature has approached tire tread wear from complementary perspectives, spanning controlled tribology experiments, analytical wear modeling, and real-world fleet measurements. Laboratory and indoor studies have focused on establishing interpretable wear laws and improving the representativeness of test rigs. Controlled abrasion experiments combined with analytical modeling

showed the incorporating local friction states and tread temperature can improve predictive accuracy and explain load/speed dependencies [5]. Similarly, dedicated test rigs have been developed to characterize tread-rubber wear as a function of vertical load, sliding speed, and temperature, providing a basis for local wear-law formulations that connect contact mechanics to wear [6]. On the other hand, new friction–wear simulators have been proposed to better replicate the transient, pulse-like nature of tread-block contact for the long-standing challenge that laboratory tests do not always correlate well with on-road behavior [7]. Beyond tread-depth loss and mileage-oriented wear, multiple studies have highlighted the environmental dimension of tire wear through the characterization and quantification of tire-road wear particles (TRWP). On-road campaigns using instrumented vehicles have linked TRWP morphology and texture to specific wear mechanisms (abrasion, fatigue, tearing) and to driving events such as sudden braking and varying road types [8]. Under controlled chassis-dynamometer conditions, tire wear particle emissions have been shown to depend strongly on the driving cycle phase (notably accelerations at low/medium speeds) and vehicle operating strategy [9]. Real-world fleet data further indicate that wear is sensitive to vehicle type, tire type, axle position, and driving behavior. For instance, braking and acceleration events are repeatedly identified as dominant contributors to wear-rate variability [10]. Although research on tire-road interaction has expanded into adjacent performance domains (e.g., noise and road-conditioning), these efforts reinforce the broader point that electrification shifts the relative importance of tire-related phenomena and motivates more data-driven, route-sensitive evaluation frameworks [11].

However, the literature still provides limited experimental evidence directly comparing the tread-wear performance of conventional and electric vehicles while maintaining consistent tire-related parameters. To address this knowledge gap, the present study evaluates four tire specifications under controlled and repeatable real-world driving conditions. The test matrix includes three summer tire specifications and one all-season tire specification from two manufacturers. Each tire specification was tested on both a conventional vehicle and an electric vehicle using predefined routes representative of their respective powertrain applications. Tread depth and tire mass were measured at predefined intervals using standardized measurement procedures to ensure data reliability and repeatability.

The novelty of this study lies in the direct experimental comparison of tire tread-wear performance between ICE and EV applications under standardized open-road test conditions. Within each ICE–EV comparison, the tire manufacturer, size, specification, inflation pressure, tread-depth

measurement locations, and data-processing method were kept consistent, while the relevant vehicle and route characteristics were measured and documented. In addition, multiple summer and all-season tire specifications were evaluated, and the wear behavior of the front and rear axles was analyzed separately. This paired, multi-specification approach provides experimentally based evidence of the treadwear and estimated tire-life differences associated with conventional and electric vehicle architectures under representative real-world operating conditions.

2. Experimental and Theoretical Approach

A controlled and repeatable open-road treadwear test methodology was used in this study. The method is based on predefined test routes, controlled tire inflation pressure, measured vehicle setup parameters, monitored environmental conditions, fixed tread-depth measurement locations, calibrated measurement devices, repeated measurements during the test cycles, and a common regression-based tread-life estimation procedure. These measures reduce experimental variability, while unavoidable differences between the ICE and EV test configurations, particularly the route characteristics, are quantified and reported. The test matrix includes matched tire sizes and specifications for the two vehicle types, and the same measurement and data-processing procedure is followed across all test runs.

Two tire sizes and four tire specifications were selected for this study: 215/60 R17 and 215/55 R18. Both sizes are intended for passenger-car applications. One of the 215/60 R17 specifications is an all-season tire, while the remaining three specifications are summer tires. Winter tires were not included because the investigated tire specifications were selected from the vehicle manufacturer's original-equipment portfolio. For the vehicle applications considered, winter tires are not fitted at the assembly plant as original equipment. Therefore, only summer and all-season tires were considered to represent actual factory-fitted configurations. Although rolling resistance was not directly measured in this study, it can be evaluated according to the standardized method defined in ISO 28580 [13]. The details of the selected tire specifications are presented in Table 1.

Each tire is mounted on both an EV and an ICE vehicle as shown in Fig. 1. The vehicles are selected to

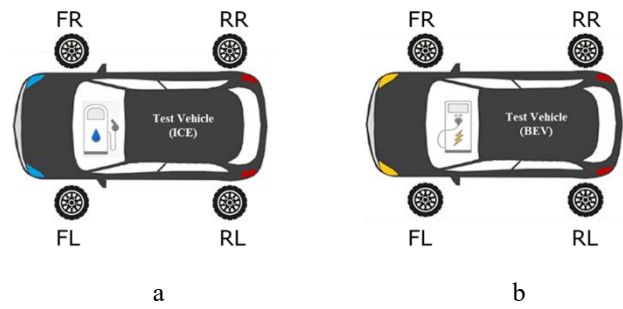


Fig. 1 Test vehicles of a – ICE, b – EV (FR: Front Right, RR: Rear Right, FL: Front Left, RL: Rear Left)

reflect typical usage in passenger car segment. Both vehicle types have been equipped with standard and identical tire pressure monitoring systems. Tire pressure is controlled during tests and adjusted prior to each test cycle.

Before the test, the wheel loads, toe and camber angles, and tire inflation pressures were measured. The tire inflation pressures correspond to the vehicle manufacturer's recommended cold inflation values for each vehicle–tire configuration. The higher pressure specified for the EV reflects its higher vehicle and axle loads and ensures operation under representative real-world conditions. The measured vehicle parameters are presented in Table 2. During the test, the tire pressures were checked daily and adjusted before each test cycle when necessary.

Table 2
Vehicle parameters in each tire for the measurements

Vehicle	Characteristic	FR	RR	FL	RL
ICE	Load, kg	445	267	450	270
EV	Load, kg	472	390	488	397
ICE	Toe, mm	2.1	4.1	2.1	4.1
EV	Toe, mm	1.76	4.1	1.76	4.1
ICE	Camber, °	-0.48	-1.64	-0.48	-1.64
EV	Camber, °	-0.48	-1.60	-0.48	-1.60
ICE	Tire pressure, bar	2.20	2.20	2.20	2.20
EV	Tire pressure, bar	2.50	2.50	2.50	2.50

The selected routes follow a standardized, OEM-oriented on-road validation concept to improve repeatability and to contextualize route severity. Route 1 is characterized by a road distribution of approximately 33% motorway (166 km), 34% national roads (171 km), 24% secondary roads (121 km), and 9% mountain segment (46 km) per dispatch [12]. The operational planning for this route typically targets ~500 km per shift under a two-shift-per-day organization, reaching ~15000–18000 km cumulative mileage. Route 2 is characterized by a higher share of urban and secondary-road operation with a road distribution of approximately 52% urban boulevard/city center (120 km), 12% motorway (28 km), and 36% secondary roads (82 km) per dispatch; vehicles are commonly driven with a high energy-recuperation strategy enabled [12]. The operational planning for this route typically targets ~230 km per shift under a one-shift-per-day organization, reaching ~8,000–10,000 km cumulative mileage.

Table 1
Tire and vehicle types used in this study

Tire Size	Spec	Tire Type	Com-petitor	Ve-hicle Type	Route
215/60 R17	XX111	Summer	A	ICE	1
215/60 R17	XX111	Summer	A	EV	2
215/60 R17	YY222	Summer	B	ICE	1
215/60 R17	YY222	Summer	B	EV	2
215/55 R18	ZZ333	Summer	A	ICE	1
215/55 R18	ZZ333	Summer	A	EV	2
215/60 R17	VV444	All season	A	ICE	1
215/60 R17	VV444	All season	A	EV	2

To further describe route excitation characteristics, the reported acceleration-domain variability indicates $\sigma(Gx) = 0.48$ and $\sigma(Gy) = 0.89$ for Route 1, versus $\sigma(Gx) = 0.75$ and $\sigma(Gy) = 0.94$ for Route 2 [12]. Here, $\sigma(Gx)$ and $\sigma(Gy)$ are used as route descriptors reflecting the dispersion of longitudinal and lateral acceleration demands over the duty cycle; they are not directly wear metrics but provide context on the variability of excitation conditions between routes. These route-level descriptors are used to contextualize the observed tread wear level and wear uniformity differences between conventional and EV platforms.

The ICE test vehicle is evaluated on Route 1, which involves a representative mix of European road types, including motorway, national, secondary and mountainous segments. This mix reflects traditional ICE vehicle operation in European conditions, characterized by longer steady-state drives and limited regenerative effects. On the other hand, the EV test vehicle is evaluated to Route 2, which adapted for the characteristic driving behavior of electric vehicles. This route includes urban driving, secondary road usage and motorway. The route was selected to reflect the influence of regenerative braking, frequent acceleration and deceleration and typical city driving behavior EV usage. Charging stations or points have been defined in advance to ensure the coherence of test.

The geographical layouts of the two open-road validation routes used in this study are shown in Fig. 2. Route 1 corresponds to the ICE validation route, whereas Route 2 corresponds to the EV validation route.



Fig. 2 ICE and EV validation routes

All testing is carried out under controlled environmental conditions with ambient temperature, road surface and humidity monitored. Besides the environmental conditions, tire position on vehicle also under control. Tire position remained constant between beginning of test and end of test. Tires were not rotated during test cycles. Overall, each tire performed sufficient mileage on both vehicle types to reach meaningful tread depth reductions. ICE vehicles approximately run around 20000 km during the test, while EV vehicles, constrained by charge station location and route design, completed around 10000 km. Test can be continued even more than 20000 km for ICE and 10000 km for EV. This mainly depends on tread wear stabilization. Although the absolute mileage varied, the relative wear results offer meaningful comparative insights between ICEs and EVs in real-world conditions.

Measurement of tread depth on tire repeats four times or at each cycle. Measurement frequency is not related

to ICEs and EVs vehicles. Measurement points defined prior to beginning of test for each tire. In this study, 6 points defined along the tire section for the measurements. The measurements are performed at 8 evenly spaced sections around the tire circumference. Position of measurement positions and points are shown below Fig. 3.

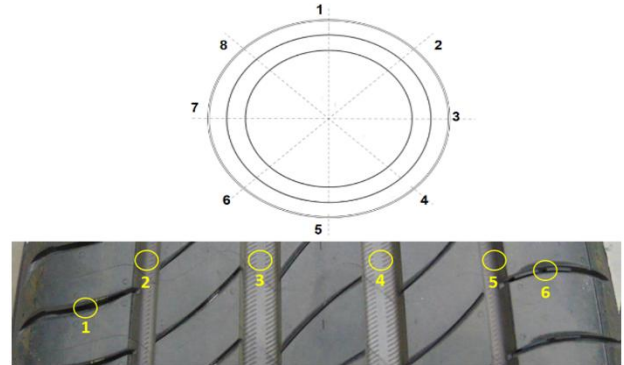


Fig. 3 Measurement positions distribution around the tire circumference and location on tire tread

Each position of measurement, which is shown at Fig. 3, has a specific name and they called as Outer Shoulder depth for Point 1, Groove for point 2-5 and Inner Shoulder depth for 6. The minimum allowable tread depth for these points is determined as 1.6 mm depending on the Tread Wear Indicator (TWI).

Measurements are recorded at the beginning of the test then repeated at every cycle. Following tools are used for measurement:

- Calibrated manual tread depth gauges (Fig. 4)
- High-precision digital laser profilers
- Photographic documentation for visual pattern tracking



Fig. 4 Tread depth measurement

According to the manufacturer's specifications, the digital indicator used for tread-depth measurement has a measuring range of 25.4 mm, a resolution of 0.001/0.01 mm, a maximum permissible error of 0.003 mm, and a repeatability of 0.002 mm.

For each tire position, 8 different points are measured. The average of these measurements is recorded as the tread wear value for that specific position. Tread wear is calculated and used as the primary wear performance indicator. This calculation and measurement process are repeated for each cycle.

After the data stabilized, which is ideally obtained after four cycles, the tire mileage estimation is calculated. This calculation and estimation are performed for each individual measurement point. The point exhibiting the fastest wear (the one with the lowest tread depth) is determined to be the critical factor limiting the tire's lifespan. Consequently, the total tire mileage estimation is based on this fastest-wearing measurement point.

Fig. 5 shows Coefficient of Variation (CV %) for each measurement for ICE and EV. The repeatability of the measurement method was assessed by calculating the Coefficient of Variation (CV %) for each set of 8 measurements. The CV values for all test conditions were consistently below 0.5%, which is well within the acceptable range for high-precision measurements as defined by standards such as ISO 5725-2 [14]. According to widely accepted guidelines in measurement science, a Coefficient of Variation (CV) below 10% is considered excellent. Our calculated CV values of approximately 0.4% demonstrate exceptional repeatability and a high degree of confidence in our measurement results, supporting the reliability of the test equipment and procedure.

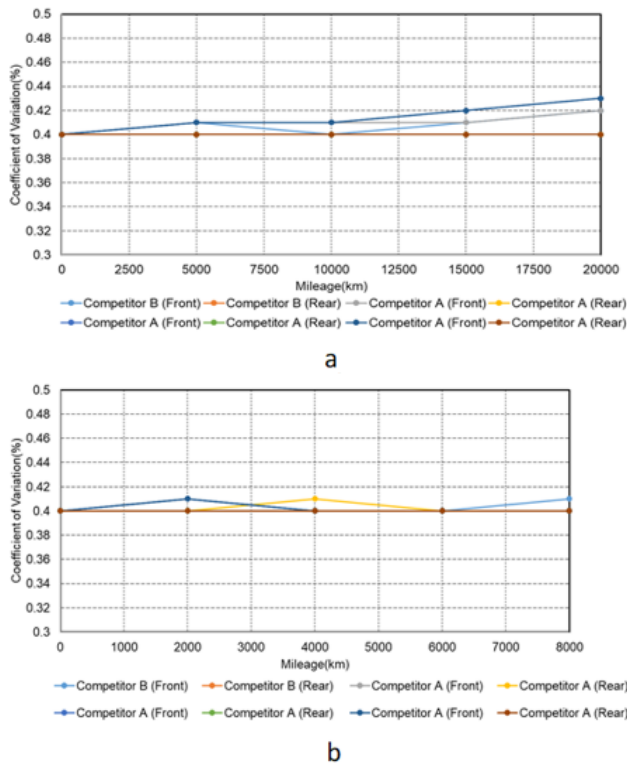


Fig. 5 Coefficient of variation (%) trend for a – ICE, b – EV vehicle

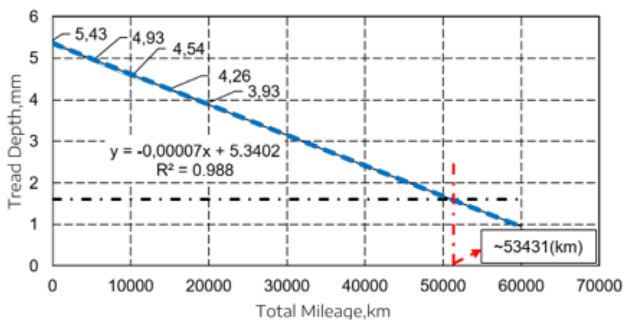


Fig. 6 Tread wear estimation curve

Tread wear estimation curve is shown Fig. 6 depending on the vehicle mileage. Tread wear curve has green line and tread wear limit which is 1.6mm, has orange line. Test has been done 20000km. Since, tread wear has stabilized.

Tread wear at Cycle-3 is 0.28 mm and 0.33 mm for Cycle-4. Results are very close. Also, R^2 value of Tread Wear curve is 0.98. It means that measurement has high correlation between each other. When the plotting curves with results, Eq. (1) has been generated.

$$y = -0.00007x + 5.3402. \quad (1)$$

When the y is equal to 1.6 mm, x will be the value of Tread Wear mileage of tire. By using same approach or method, Tread Wear estimation of all the tires have been calculated for ICE and EV vehicles.

3. Results and discussion

Eight different Tread Wear tests have been performed according to the method explained. There are results for four different tire specifications. One specification belongs to All season tire, others belong to summer tire. Each tire has been measured from points which already defined beginning of test. Aim of this study is to compare tread wear mileage of same tire for different driveline [15]. In this study, drivelines are ICE and EV. All the measurements of tires for ICE and EV are shown at Table 3 and Table 4 below. As defined in the method section, swap between front and rear is not allowed. Therefore, measurement is done separately for front and rear according to fastest wear at right or left tire.

According to measurement results seen that ICE mileage is much more than EV mileage. Also, EV Tread Wear speed is more than ICE. More or less, Tread Depth at 8000km for EV is similar with Tread Depth at 20000 km for ICE. Previous studies have shown that wear and particle emissions from tires vary significantly with driving style, pavement texture, and climate [15]. Vehicle weight, braking

Table 3

Tread depth measurement for ICE

Total Mileage, km	0	5000	10000	15000	20000
215/60 R17(Summer) Competitor B (Front)	5.94	5.53	5.10	4.76	4.40
215/60 R17(Summer) Competitor B (Rear)	5.92	5.68	5.44	5.26	5.01
215/60 R17(Summer) Competitor A (Front)	6.80	6.40	6.05	5.79	5.37
215/60 R17(Summer) Competitor A (Rear)	6.80	6.50	6.35	6.10	5.82
215/60 R17(All season) Competitor A (Front)	7.80	7.36	6.99	6.62	6.29
215/60 R17(All season) Competitor A (Rear)	7.80	7.50	7.20	7.00	6.70
215/55 R18(Summer) Competitor A (Front)	6.80	6.40	6.02	5.70	5.35
215/55 R18(Summer) Competitor A (Rear)	6.80	6.52	6.28	6.05	5.86

Table 4

Tread depth measurement for EV

Total Mileage, km	0	2000	4000	6000	8000
215/60 R17(Summer) Competitor B (Front)	5.94	5.62	5.30	4.98	4.66
215/60 R17(Summer) Competitor B (Rear)	5.92	5.69	5.46	5.23	5.00
215/60 R17(Summer) Competitor A (Front)	6.80	6.40	6.15	5.75	5.32
215/60 R17(Summer) Competitor A (Rear)	6.80	6.62	6.40	6.20	6.07
215/60 R17(All sea- son) Competitor A (Front)	7.80	7.35	6.99	6.60	6.25
215/60 R17(All sea- son) Competitor A (Rear)	7.80	7.56	7.35	7.25	7.00
215/55 R18(Summer) Competitor A (Front)	6.80	6.42	6.12	5.80	5.52
215/55 R18(Summer) Competitor A (Rear)	6.80	6.59	6.42	6.28	6.11

system and more torque could impact and accelerate the tire wearing for EV vehicles. Another output of study is tread wear rate is more at front axle. Non-exhaust PM emissions from tires and brakes can in some cases exceed exhaust emissions, especially in urban driving cycles. Because test vehicles are front wheel drives. Depending on driven axle tires wear is more than another axle. According to each tire, comparison of Tread Wear trend shown in Figs. 7, 8, 9, 10.

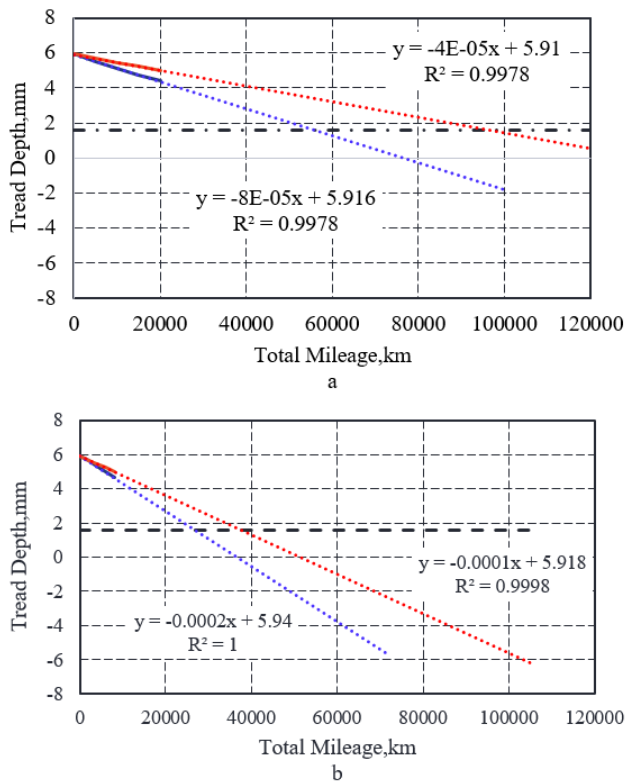


Fig. 7 Tread wear trend comparison for 215/60 R17 (Summer) Competitor B: a – ICE, b – EV

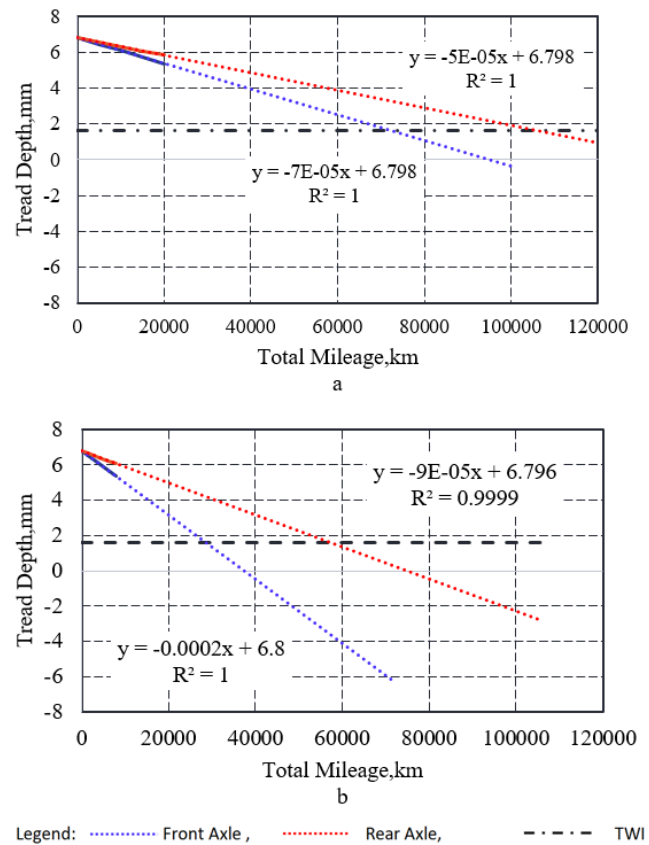


Fig. 8 Tread wear trend comparison for 215/60 R17 (Summer) Competitor A: a – ICE, b – EV

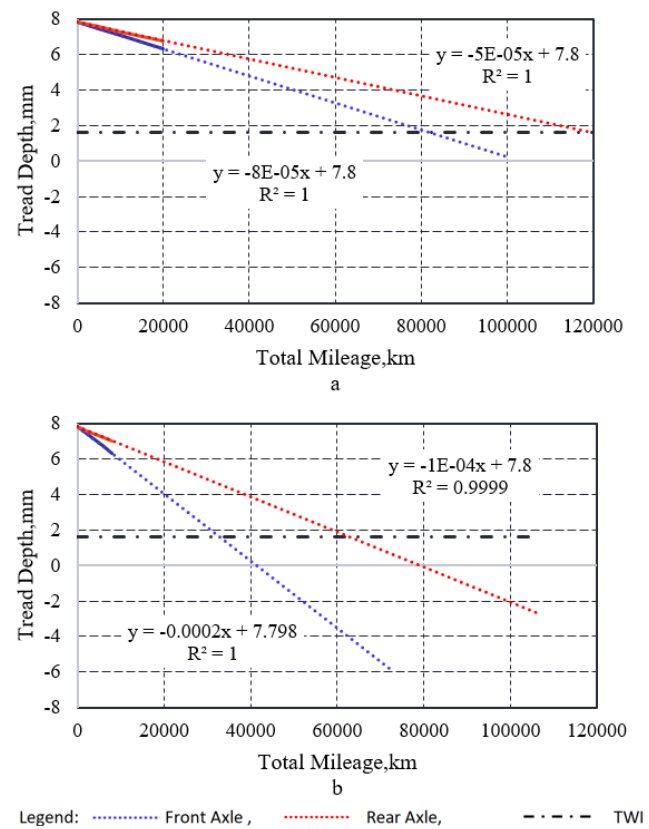


Fig. 9 Tread wear trend comparison for 215/60 R17 (All season) Competitor A: a – ICE, b – EV

Table 5

Tread wear mileage estimation

Total Mileage, km	Front, km	Rear, km
215/60 R17(Summer) Competitor B (ICE)	53988	86258
215/60 R17(Summer) Competitor B (EV)	21688	43225
215/60 R17(Summer) Competitor A (ICE)	73849	103558
215/60 R17(Summer) Competitor A (EV)	26049	57682
215/60 R17(All season) Competitor A (ICE)	77132	123610
215/60 R17(All season) Competitor A (EV)	30835	61743
215/55 R18(Summer) Competitor A (ICE)	74008	103474
215/55 R18(Summer) Competitor A (EV)	25834	64670
215/55 R18(Summer) Competitor A (EV)	25834	64670

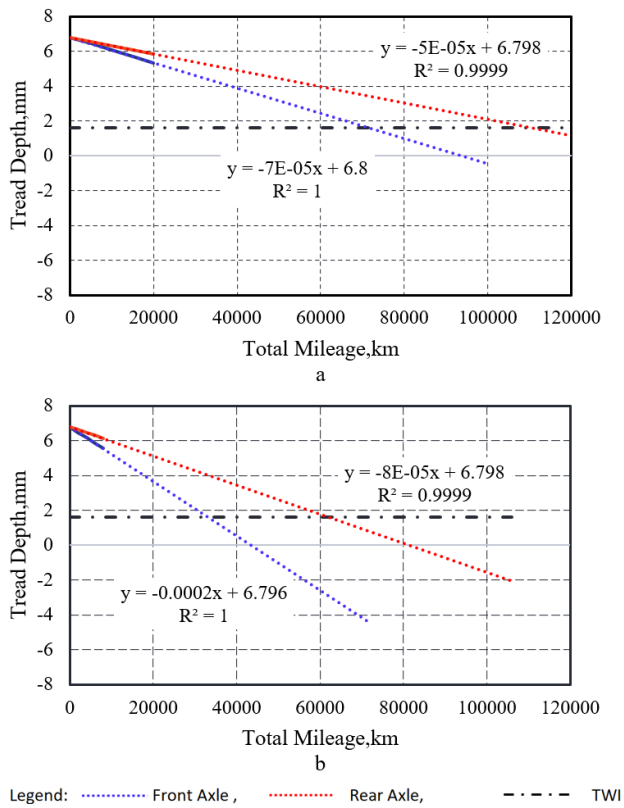


Fig. 10 Tread wear trend comparison for 215/55 R18(Summer) Competitor A: a – ICE, b – EV

Tread depth evolution as a function of total mileage for all tested tire specifications, arranged by vehicle platform (ICE on the left column, EV on the right column). For each specification (rows), the front axle trend is shown by the blue dotted line and the rear axle trend by the red dotted line; linear regression equations and R^2 values are reported within each panel. The horizontal black dashed line denotes the TWI threshold used to extrapolate tread wear-based mileage. Based on these fits, the estimated mileages are: 215/60 R17 Competitor-B Summer front 53,988 km (ICE) vs 21,688 km (EV) and rear 86,258 km (ICE) vs 43,225 km (EV); 215/60 R17 Competitor-A Summer front 73,849 km vs 26,049 km and rear 103,558 km vs 57,682 km; 215/60 R17 Competitor-A All season front 77,132 km vs 30,835 km and rear 123,610 km vs 61,743 km; 215/55 R18 Competitor-A Summer front 74,008 km vs 25,834 km and rear 103,474 km vs 64,670 km (ICE vs EV, respectively). Overall, the figure enables a direct comparison of platform effect (ICE vs EV) and axle effect (front vs rear) on tread wear rate across specifications. It is clearly seen that tire tread wear performance is affected by vehicle driveline which is ICE or EV. According to 8 different tread wear tests (Table 5), tire tread wear mileage at ICE is more than EV.

Tread wear mileage reduction percentage is listed as follows for each test tires:

- 215/60 R17 Summer Competitor B Tread wear ICE to EV: Front: -%40 / Rear: -%50
- 215/60 R17 Summer Competitor A Tread wear ICE to EV: Front: -%35 / Rear: -%56
- 215/60 R17 All season Competitor A Tread wear ICE to EV: Front: -%40 / Rear: -%50
- 215/55 R18 Summer Competitor A Tread wear ICE to EV: Front: -%35 / Rear: -%62

4. Conclusions

This study provides critical insights into how tire tread wear behavior is altered by the fundamental differences between battery electric vehicles (EVs) and internal combustion engine (ICE) vehicles. Across multiple tire types and vehicle platforms, it is evident that EVs introduce a new set of challenges to tire tread wear performance due to their unique dynamic properties. The combination of increased vehicle mass, instantaneous torque delivery, and regenerative braking not only accelerates overall treadwear but also changes the wear distribution, particularly impacting front tires more severely.

The analysis of front vs rear tire wear showed a pronounced degradation on front tires due to torque transfer and the predominance of regenerative braking on the front axle. While ICE vehicles generally maintained more balanced wear across axles, EVs concentrated mechanical stress and energy recovery loads on the front tires. This trend underscores the need for future tire design to adopt axle-specific strategies.

There are also lots of articles which have already been released, for the Tread Wear of tire. These articles are supporting and proving the result of this study. From the article, which source is The Wall Street Journal at March 2024, explains the Tread wear performance together with PM emissions. In conclusion, tire emissions are only one aspect of a vehicle's PM emissions. Even if a EV's increased weight does increase its PM emissions from tires, both analytical and experimental evidence demonstrates that this EV can have lower PM emissions from other sources, such as brakes, tires and the tailpipe, which a EV does not have.

For the tire industry, these findings have significant implications. First, compound innovation must prioritize high-load endurance and temperature resistance. Second, structural design should evolve to include asymmetric reinforcements and zoned wear resistance, especially in ar-

eas exposed to repeated slip and braking forces. Third, testing protocols must evolve to include EV-centric evaluations to reflect realistic usage scenarios that differ from ICE benchmarks. Integrating rolling resistance optimization with wear resistance could provide a balanced approach for future EV-specific tire designs.

Future research should extend the present study by evaluating a broader range of tire categories, including winter, all-terrain, ultra-high-performance, and additional all-season tires, as well as different vehicle architectures such as front-wheel-drive, rear-wheel-drive, all-wheel-drive, and commercial electric vehicles. Repeated tests with larger sample sizes and closely matched or identical ICE and EV routes would help to separate the influence of vehicle architecture from route-related variability. Further studies should also investigate the individual effects of vehicle mass, axle-load distribution, motor torque, regenerative-braking strategy, inflation pressure, ambient temperature, and road-surface characteristics on tread-wear development. In addition, combining tread-depth measurements with tire mass loss and tire-wear particle characterization would provide a more comprehensive assessment of the environmental impact of tire wear.

In conclusion, while EVs represent a technological leap in sustainable mobility, they simultaneously introduce challenges that require the tire industry to rethink treadwear performance and durability. This study serves as a foundation for that shift, emphasizing that next-generation tire design must embrace electric-specific engineering, rigorous testing, and close OEM collaboration to ensure that tire performance evolves alongside the vehicles they support.

References

1. **Giechaskiel, B.; Grigoratos, T.; Dilara, P.; Franco, V.** 2024. Environmental and Health Benefits of Reducing Tyre Wear Emissions in Preparation for the New Euro 7 Standard, *Sustainability* 16(24): 10919. <https://doi.org/10.3390/su162410919>
2. Science Feedback. 2024. Electric vehicles may have higher particulate emissions from tires, but they usually have lower particulate emissions from other sources. Available at: <https://science.feedback.org/review/electric-vehicles-may-have-higher-particulate-emissions-from-tires-but-usually-have-lower-particulate-emissions-from-other-sources/>.
3. **Sandberg, U.; Ejsmont, J. A.** 2002. Tyre/Road Noise Reference Book. Kisa: Informex. 640p.
4. European Tyre and Rim Technical Organization. 2021. Standards Manual 2021. ETRTO.
5. **Zhang, M.; Unrau, H.-J.; Gießler, M.; Gauterin, M.** 2025. Tire tread wear characteristics: Insights from indoor experiments and analytical modeling, *Tribology International* 210: 110752. <https://doi.org/10.1016/j.triboint.2025.110752>.
6. **Liu, C.; Cebon, D.** 2025. Characterizing wear performance of tyre tread rubber, *Wear* 566-567: 205754. <https://doi.org/10.1016/j.wear.2025.205754>.
7. **Plaschka, E.H.; Akutagawa, K.; Di Federico, E.; Busfield, J.J.C.** 2025. Developing a more representative friction and wear simulator for tire tread compounds, *Polymer Testing* 143: 108688. <https://doi.org/10.1016/j.polymertesting.2025.108688>.
8. **Truong, X.T.; Muresan, B.; Lumere, L.; Liu, Y.; Cerezo, V.** 2025. Morphological and textural characteristics of tire-road wear particles linked to different wear mechanisms, *Wear* 571: 205818. <https://doi.org/10.1016/j.wear.2025.205818>.
9. **Costagliola, M. A.; Marchitto, L.; Piras, M.; Mariani, A.; Giuzio, R.** 2026. Measurements of brake and tire wear particulate emissions from light-duty vehicles under WLTC driving conditions, *Science of The Total Environment* 1016: 181462. <https://doi.org/10.1016/j.scitotenv.2026.181462>.
10. **Liu, Y.; Chen, H.; Wu, S.; Gao, J.; Li, Y.; An, Z.; Mao, B.; Tu, R.; Li, T.** 2022. Impact of vehicle type, tyre feature and driving behaviour on tyre wear under real-world driving conditions, *Science of The Total Environment* 842: 156950. <https://doi.org/10.1016/j.scitotenv.2022.156950>.
11. **Demetgul, M.; Lazarova-Molnar, S.** 2026. Data-driven artificial intelligence applications for tyre-road-noise prediction and road condition monitoring: A review and future directions, *Measurement* 264: 120203. <https://doi.org/10.1016/j.measurement.2025.120203>.
12. Automotive OEMs - Partnering along the value chain DEKRA.
13. International Organization for Standardization. 2018. Passenger car, truck and bus tyre rolling resistance measurement method — Single point test and correlation of measurement results (ISO 28580:2018).
14. International Organization for Standardization. 2019. Accuracy (trueness and precision) of measurement methods and results Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method (ISO 5725-2:2019).
15. **Ly, A.; El-Sayegh, Z.** 2023. Tire Wear and Pollutants: An Overview of Research, *Archives of Advanced Engineering Science* 1(1): 2-10. <https://doi.org/10.47852/bonviewAAES32021329>.

M. Gelbal, M. U. Karaoğlu

EXPERIMENTAL COMPARISON OF TIRE TREAD WEAR PERFORMANCE ON CONVENTIONAL AND ELECTRIC VEHICLES UNDER CONTROLLED ROAD CONDITIONS

Summary

The replacement of internal combustion engine (ICE) with electric motor by electric vehicles (EVs) technology is one of the most comprehensive transition in the automotive industry for recent decades. EVs technology causes fundamental changes in vehicle architecture and dynamics including increased overall weight due to battery packs, altered torque delivery, and regenerative braking systems. These changes have significant implications on tires because of the direct interaction of vehicle and road. Therefore, tire performance characteristics are influenced by the type of powertrain. According to the distinctive operating conditions of EVs comparing with the conventional vehicles, determination of the tire tread wear behavior has become a critical challenge for tires. The higher mass and unique driving characteristics of EVs cause fast and unevenly distributed tire wear. This study aims to evaluate the

investigation of passenger car tire tread wears for conventional and electric vehicles under controlled road testing. Four commercially available tires are selected for the tests using conventional vehicles on Route-1 and EV testing on Route-2. Key indicators such as average tread depth reduction, wear uniformity, and wear pattern distribution are measured to assess the impact of vehicle type. The results indicate that EVs consistently impose higher tread wear than conventional vehicles.

For the tested tire specifications, tread-wear-based mileage on electric-vehicle platforms was markedly lower than on conventional platforms, with the strongest reduction observed on the front axle. Depending on tire type, the estimated mileage reduction from ICE to EV ranged from approximately 35% to 62%. The findings indicate that the

combined effect of higher vehicle mass, instantaneous torque delivery and regenerative braking intensifies wear severity and front/rear imbalance, especially under urban and stop-go EV duty cycles. These results support the need for EV-oriented tire compounds, axle-specific design strategies and validation procedures that reflect route severity and real operating conditions.

Keywords: tire tread wear, conventional vehicle, electric vehicle, road testing.

Received March 22, 2026

Accepted August 17, 2026



This article is an Open Access article distributed under the terms and conditions of the Creative Commons Attribution 4.0 (CC BY 4.0) License (<http://creativecommons.org/licenses/by/4.0/>).