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A Descriptive Comparison of Standard, Brand A Racing, And Brand B Racing Exhaust Performance on A Two-Stroke Kawasaki Ninja Rr

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Abstract. This study descriptively compares maximum power, maximum torque, and the engine speeds at which these peaks occur on a two-stroke Kawasaki Ninja RR equipped with a standard exhaust, Brand A racing exhaust, and Brand B racing exhaust. The data comprise one dynamometer result sheet for each configuration. The standard exhaust recorded 39.30 HP at 10,305 rpm and 28.77 Nm at 9,071 rpm; Brand A recorded 46.80 HP at 11,409 rpm and 29.54 Nm at 11,080 rpm; and Brand B recorded 47.80 HP at 11,459 rpm and 30.79 Nm at 9,454 rpm. Relative to the standard exhaust peak values, the differences in peak power for Brands A and B were +19.08% and +21.63%, respectively, while the differences in peak torque were +2.68% and +7.02%. These comparisons involve peaks reached at different engine speeds rather than measurements at identical rpm. Because repeated tests, raw data, correction-standard information, and complete documentation of testing conditions are unavailable, the results cannot establish statistical significance or overall performance superiority. The graphs presented are illustrative reconstructions, not raw instrument data.

Keywords: Two-Stroke Engine, Standard Exhaust, Brand A Racing Exhaust; Brand B Racing Exhaust, Dynamometer.

1 Introduction

Motorcycle engine performance is commonly described using two principal parameters: torque and power. Torque represents the turning moment generated by the engine shaft, whereas power describes the rate at which work is performed. Torque is associated with the engine's ability to produce rotational force to propel the vehicle, while power represents its ability to perform work at a given engine speed. The two parameters are mathematically related through torque and rotational speed. Nevertheless, maximum torque and maximum power do not necessarily occur at the same engine speed. Peak torque indicates the operating point at which the engine produces its greatest turning moment, whereas peak power represents the point at which the combination of torque and rotational speed yields the greatest power output. Accordingly, engine

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performance should be assessed in terms of both output magnitude and the engine-speed range at which that output occurs [1]–[4].

In addition to combustion characteristics and engine construction, the exhaust system is a component that can influence engine performance. Beyond discharging combustion gases into the environment, it interacts with the gas-exchange process inside the cylinder. Passage geometry, pipe length, expansion-chamber volume, and silencer characteristics can affect gas flow and pressure waves in the exhaust passage. Changes in these characteristics may influence the discharge of residual combustion gases and the charging of the cylinder with fresh mixture. Thus, exhaust-system design should be matched to engine construction and operating characteristics to support efficient combustion [2], [5]–[8].

The exhaust system plays a particularly important role in two-stroke engines. Unlike four-stroke engines, which complete one operating cycle in two crankshaft revolutions, two-stroke engines complete a cycle in one revolution. Exhaust discharge and fresh-charge admission therefore take place over relatively short intervals. As the piston approaches bottom dead center, the exhaust port opens, allowing high-pressure combustion gases to leave the cylinder. Fresh mixture subsequently enters through the transfer ports and helps displace the remaining combustion gases. This process is known as scavenging [2], [6], [7].

During scavenging, some of the fresh mixture may escape through the exhaust port before the piston closes it. This can reduce the amount of fresh charge retained in the cylinder for the next combustion event. Consequently, flow behavior and pressure waves in the exhaust passage play an important role in gas-exchange efficiency. Expansion-chamber exhaust systems are designed to exploit pressure waves generated during exhaust discharge. These waves can help regulate gas flow and return some of the fresh mixture to the cylinder before the exhaust port closes. The effectiveness of this mechanism depends on the dimensions and shape of the expansion chamber and their compatibility with the engine operating speed [2], [6], [7], [11], [12].

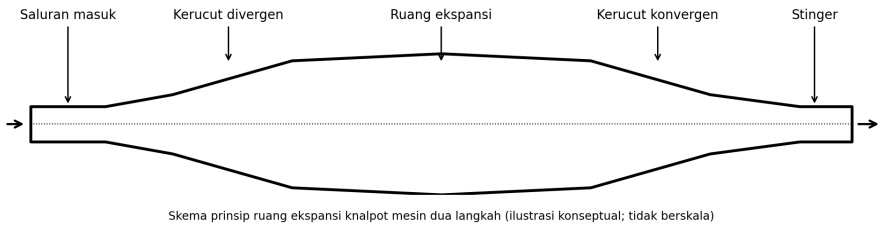


Fig. 1. Conceptual diagram of a two-stroke engine exhaust expansion chamber

Note: This diagram conceptually illustrates the principal components of an expansion chamber. The product specifications reported in the Methods section have not been verified through measurements of the actual exhaust geometry.

A standard exhaust is generally developed as part of the vehicle's overall design. Its development considers normal-use requirements such as engine performance, noise, component durability, fuel consumption, and riding comfort. Because it is designed to meet a broad range of needs, a standard exhaust is not necessarily optimized for

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maximum power within a narrow engine-speed range. Racing exhausts, by contrast, are generally designed to shape exhaust-gas flow and pressure-wave behavior within particular operating ranges. These design differences may produce different power and torque characteristics when installed on the same engine. However, installing a racing exhaust does not automatically improve every aspect of performance. The outcome depends on the compatibility of exhaust geometry with engine characteristics, combustion processes, and testing conditions [5], [9], [10], [15]–[19].

Previous studies have shown that modifications to intake and exhaust components can affect the power and torque characteristics of two-stroke engines. Al-Rasyid et al. [13], for example, reported changes in power and torque after modifying the exhaust-port height of a two-stroke Yamaha F1ZR. Their findings indicate that exhaust-port geometry can influence gas exchange and engine output. Prastyo et al. [14] likewise observed changes in power and torque after modifying the intake and exhaust ports of a 150 cc two-stroke Kawasaki Ninja. Research comparing standard and modified exhausts on a 150 cc Ninja SS also identified differences in performance characteristics across exhaust configurations [15]. These studies suggest that exhaust performance should be evaluated using test data rather than solely on product categories or commercial terminology.

Studies involving other engine configurations provide additional context for the relationship between exhaust systems and vehicle performance. Saputra et al. [16] compared standard and racing exhausts on a four-stroke motorcycle and reported differences in power and torque. Nasir et al. [17] investigated the effects of exhaust type on back pressure, temperature, and noise in a four-stroke motorcycle. Studies of torque expansion chambers have also shown that inlet and outlet positions and auxiliary-chamber configurations can influence power, torque, and specific fuel consumption [18], [19], [23]. More recent research has examined exhaust-structure optimization to control flow characteristics and noise in two-stroke engines [25]. Nevertheless, findings from four-stroke engines and other applications should be regarded as supporting context rather than direct evidence of the behavior of the two-stroke Kawasaki Ninja RR.

Previous research has examined exhaust systems through various approaches, including exhaust-port geometry modifications, changes to intake and exhaust passages, and the use of additional expansion chambers. A direct comparison between standard and racing exhausts on the two-stroke Kawasaki Ninja RR remains relevant for providing empirical descriptions of differences in power and torque output. Such comparisons should consider not only maximum values but also the engine speeds at which they occur, because the three exhaust configurations may produce different peaks and operating-speed characteristics.

This study aims to describe and compare peak power, peak torque, and their corresponding engine speeds using three dynamometer result sheets for a two-stroke Kawasaki Ninja RR fitted with a standard exhaust, Brand A racing exhaust, and Brand B racing exhaust. The identification of the third test sheet as Brand B was confirmed by the researcher. The comparison is limited to the available test records and does not constitute a controlled experiment establishing the causal effect of replacing the exhaust. Additional documentation is required to establish equivalence of testing conditions.

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2 Research Methods

This study adopts a descriptive-comparative quantitative approach based on three dynamometer result sheets representing the standard exhaust, Brand A racing exhaust, and Brand B racing exhaust. The analyzed parameters are maximum power, maximum torque, and the engine speeds corresponding to each peak. One result sheet is available for each configuration; repeated measurements and raw measurements at identical rpm are unavailable.

The designation of the third test sheet as Brand B follows confirmation by the researcher who provided the data. This confirmation supports identification of the configuration in the manuscript but does not replace the need for physical exhaust documentation and testing-condition records for independent verification. The numerical analysis is descriptive and is not intended to demonstrate causality.

2.1 Research Object and Equipment

The research object was a two-stroke Kawasaki Ninja RR motorcycle. The research proposal identified a dynamometer, tachometer, and digital thermometer as test equipment. The available test sheets report maximum power, maximum torque, and their corresponding engine speeds. However, verified engine-displacement details, dynamometer specifications, calibration status, fuel type, engine modifications, and environmental conditions have not all been documented. These details should be completed from laboratory records before manuscript submission.

The Brand A racing exhaust was reported to use a galvanized-steel expansion chamber with a stated dimension of 40.5 mm and a 28 mm diameter stinger. Its silencer is made of aluminum, measures 30 cm in length, and has a 28 mm diameter perforated core. The exhaust header has a C-shaped configuration, and the expansion chamber follows the Supercobra design.

The Brand B racing exhaust was reported to use a stainless-steel expansion chamber with a stated dimension of 41–42 mm and a 28 mm diameter stinger. Its aluminum silencer has a carbon-finish exterior, measures 30 cm in length, and has a 30 mm diameter perforated core. This exhaust also features a C-shaped header and a Supercobra expansion-chamber design. All specifications were supplied by the researcher; the measurement locations and methods for the reported chamber dimensions, as well as independent verification of physical dimensions, have not been separately documented.

2.2 Testing Procedure and Data Extraction

Data were extracted from three dynamometer result sheets: standard exhaust (39.30 HP at 10,305 rpm; 28.77 Nm at 9,071 rpm), Brand A racing exhaust (46.80 HP at 11,409 rpm; 29.54 Nm at 11,080 rpm), and Brand B racing exhaust (47.80 HP at 11,459 rpm; 30.79 Nm at 9,454 rpm). The identification of the Brand B test sheet was based on researcher confirmation. The dynamometer model and calibration, fuel type, engine settings, engine temperature, tire pressure, environmental conditions, correction standard, and consistency of testing procedures have not been fully documented. Therefore,

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equivalent testing conditions are not assumed, and the results are compared descriptively only.

Peak values were obtained from the annotations on the printed result sheets rather than re-reading the curves. Figures 2–4 are visual reconstructions intended to help readers locate the peaks; the lines between points do not represent measured raw data or validated performance profiles. Because paired measurements at identical engine speeds are unavailable, curve comparisons at specific rpm values were not performed. The reconstructions may contain inaccuracies in curve shape and interpolation.

2.3 Data Analysis

The analysis compares peak values across result sheets, using the standard exhaust as the reference. Percentage differences were calculated as (comparison-sheet peak value − standard-sheet peak value) / standard-sheet peak value × 100%. Power and torque peaks occurring at different engine speeds were not treated as comparisons at identical rpm. In the absence of repeated measurements, standard deviations, and instrument uncertainty estimates, no statistical significance tests were performed. ISO 4106:2026 and SAE J1349 are cited only as methodological references; the application of their procedures or correction factors to these data has not been verified. Consequently, the reported percentages represent differences between recorded values rather than generalizable estimates of corrected performance gains.

3 Results

The standard exhaust recorded a maximum power of 39.30 HP at 10,305 rpm and maximum torque of 28.77 Nm at 9,071 rpm. Brand A recorded 46.80 HP at 11,409 rpm and 29.54 Nm at 11,080 rpm. Brand B recorded 47.80 HP at 11,459 rpm and 30.79 Nm at 9,454 rpm. Brand B exhibited the highest peak values among the three result sheets, but superiority at identical rpm or under all operating conditions cannot be established.

Relative to the standard-exhaust sheet, Brand A differed in peak power by +7.50 HP (+19.08%) and in peak torque by +0.77 Nm (+2.68%). For Brand B, the recorded differences were +8.50 HP (+21.63%) in power and +2.02 Nm (+7.02%) in torque. Compared with Brand A, Brand B showed peak values higher by 1.00 HP (2.14%) and 1.25 Nm (4.23%). Relative to the standard exhaust, peak-power engine speed differed by +1,104 rpm for Brand A and +1,154 rpm for Brand B; the corresponding peak-torque engine-speed differences were +2,009 and +383 rpm. These differences involve peaks that do not necessarily occur at the same rpm and cannot establish superiority across the entire engine-speed range.

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Table 1. Comparison of three exhaust configurations based on dynamometer results.

Parameter	Standard	Racing Brand A	Racing Brand B
Maximum power	39.30 HP (10,305 rpm)	46.80 HP (11,409 rpm)	47.80 HP (11,459 rpm)
Maximum torque	28.77 Nm (9,071 rpm)	29.54 Nm (11,080 rpm)	30.79 Nm (9,454 rpm)
Δ power vs. standard	Reference	+7.50 HP (+19.08%)	+8.50 HP (+21.63%)
Δ torque vs. standard	Reference	+0.77 Nm (+2.68%)	+2.02 Nm (+7.02%)

Figure 2 shows the dynamometer test curve for the standard-exhaust configuration. The report records a maximum power of 39.30 HP at 10,305 rpm and maximum torque of 28.77 Nm at 9,071 rpm. Peak torque occurred at a lower engine speed than peak power, indicating that the two maximum values were not reached at the same engine speed.

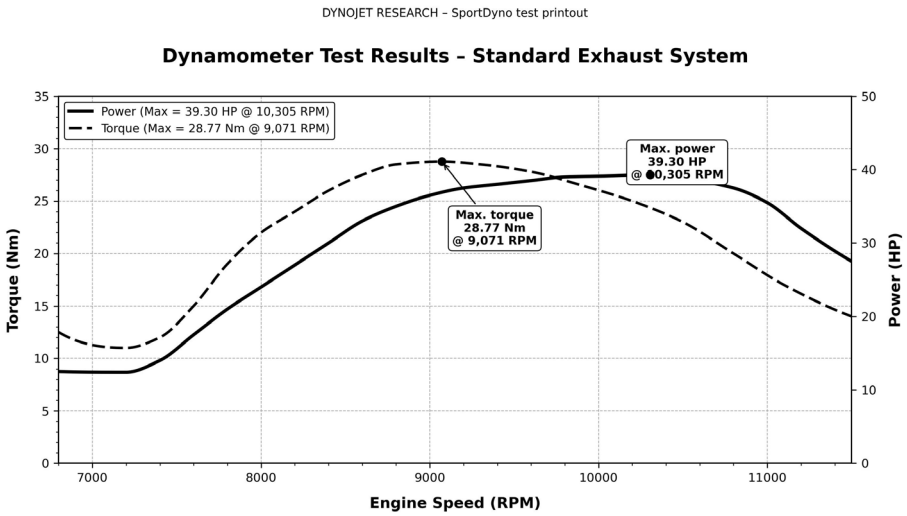


Fig. 2. Dynamometer test results for the Kawasaki Ninja RR with the standard exhaust.

Figure 3 shows the curve for Brand A racing exhaust. Peak power was recorded as 46.80 HP at 11,409 rpm, and peak torque as 29.54 Nm at 11,080 rpm. Both peaks occurred at higher engine speeds than those recorded for the standard exhaust.

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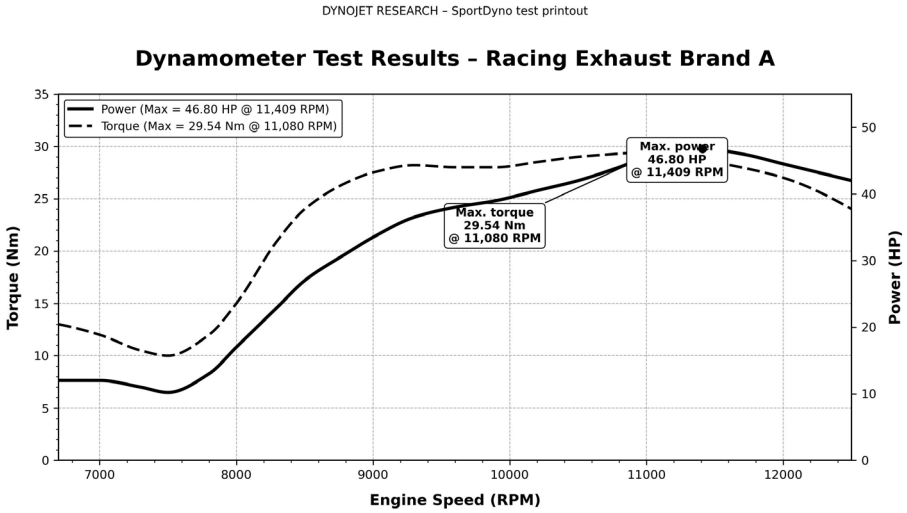


Fig. 3. Dynamometer test results for the Kawasaki Ninja RR with Brand A racing exhaust.

Note: Figures 2 and 3 are illustrative reconstructions of printed dynamometer results, not raw data or instrument exports. Peak values and engine speeds were taken from the printed annotations; curve shapes and intermediate points should not be interpreted as precise measurements.

Table 2. Differences in peak values relative to the standard exhaust.

Parameter	Brand A vs. standard	Brand B vs. standard
Maximum power	+7.50 HP (+19.08%)	+8.50 HP (+21.63%)
Maximum torque	+0.77 Nm (+2.68%)	+2.02 Nm (+7.02%)
Shift in peak-power rpm	+1,104 rpm	+1,154 rpm
Shift in peak-torque rpm	+2,009 rpm	+383 rpm

Table 3. Test parameters and information availability for the three configurations.

Parameter	Information availability
Test type	Dynamometer; three result sheets
Research object	Two-stroke Kawasaki Ninja RR; use of the same test vehicle requires confirmation
Configurations	Standard; Brand A racing exhaust; Brand B racing exhaust
Peak values and rpm	Available for all three sheets
Brand B exhaust identity	Confirmed by researcher; supporting physical documentation not attached
Repeated runs and raw data	Unavailable
Calibration, environment, and fuel	Not fully documented

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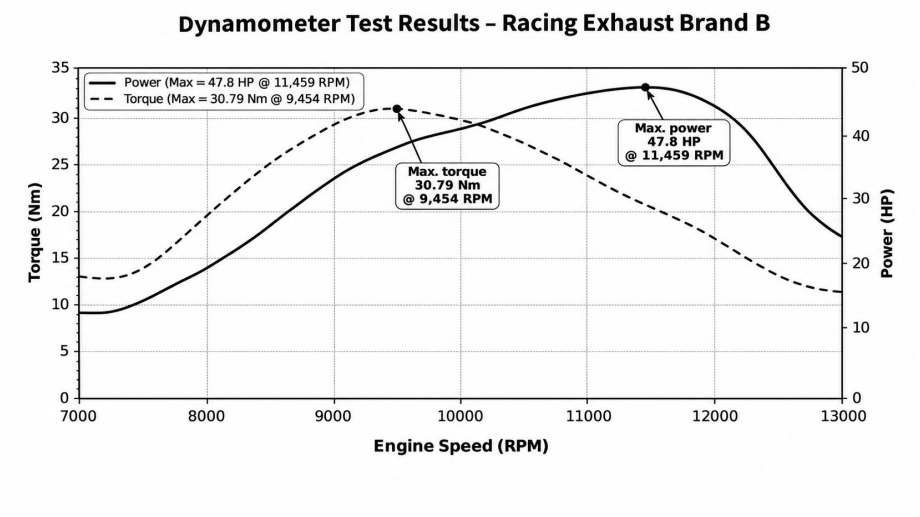


Fig. 4. Illustrative reconstruction of Brand B racing exhaust dynamometer results (not raw instrument data). Peak values follow the test sheet: 47.80 HP at 11,459 rpm and 30.79 Nm at 9,454 rpm.

4 Discussion

The three dynamometer result sheets recorded different peak values: 39.30 HP and 28.77 Nm for the standard exhaust, 46.80 HP and 29.54 Nm for Brand A, and 47.80 HP and 30.79 Nm for Brand B. Relative to the standard exhaust, peak-power differences for Brands A and B were +19.08% and +21.63%, respectively, while peak-torque differences were +2.68% and +7.02%. These percentages compare maxima reached at different engine speeds and do not account for measurement uncertainty or the correction standard used. Accordingly, they do not establish superiority throughout the operating range or statistically significant differences.

These differences are consistent with research indicating that exhaust-passage characteristics and gas exchange can influence two-stroke engine performance. Al-Rasyid et al. [13] identified differences in power and torque after changing the exhaust-port height on a two-stroke Yamaha F1ZR. Prastyo et al. [14] likewise reported changes in power and torque following porting modifications on a two-stroke Kawasaki Ninja. Although these interventions differ from replacing an entire exhaust system, both studies support the importance of exhaust-side configuration for engine output.

Research on expansion chambers provides additional explanations for the relationship between exhaust geometry and engine speed. Subroto et al. [18], [19] showed that variations in the position and configuration of torque expansion chambers produced differences in power, torque, and specific fuel consumption. Two-stroke engine literature explains that pressure waves in exhaust passages can influence cylinder emptying and charging, making it necessary to match expansion-chamber length and shape to the operating-speed range [2], [5]–[8], [11], [12], [22], [25]. Thus, the shifts in peak-power

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and peak-torque engine speeds observed here can be discussed as changes in output characteristics, but their specific mechanisms cannot be established without pressure measurements and complete exhaust-geometry data.

In terms of the reported specifications, both racing exhausts use a Supercobra expansion-chamber design, a C-shaped header, a 28 mm diameter stinger, and a 30 cm long silencer. The reported differences concern chamber material (galvanized steel for Brand A versus stainless steel for Brand B), chamber dimension (40.5 mm versus 41–42 mm), silencer-core diameter (28 mm versus 30 mm), and silencer finish. These differences provide descriptive context for interpreting the test results, but they cannot be identified as causes of the power and torque differences because complete geometric measurements and controlled tests are unavailable.

The larger percentage difference in power than in torque should also be understood through the relationship among power, torque, and angular velocity. Power is the product of torque and angular velocity; therefore, peak power may increase at a higher engine speed even when the increase in peak torque is relatively small [1], [3], [4]. In the present data, the engine speed at peak power for Brand A was 1,104 rpm higher than the standard value, while the engine speed at peak torque was 2,009 rpm higher. These shifts show that the racing exhaust configuration reached its peak outputs at higher engine speeds, but they are insufficient to establish changes in the entire torque curve or vehicle acceleration.

Brand B reached maximum torque at 9,454 rpm, compared with 11,080 rpm for Brand A. Although Brand B had a higher peak torque value, the two values were not measured at the same rpm. Without raw data at consistent engine-speed intervals, it is not possible to determine which configuration produced greater torque or power at any particular speed. The identification of Brand B follows researcher confirmation; documentation of vehicle conditions and testing procedures remains necessary to strengthen the comparison.

Research on exhausts for four-stroke motorcycles has also reported that changes in exhaust systems can influence power, torque, back pressure, temperature, noise, and emissions [16], [17], [23], [24], [25]. These findings emphasize that power output is not the only criterion for exhaust evaluation. However, because this study did not measure fuel consumption, emissions, temperature, back pressure, or noise, it cannot establish that racing configurations are superior overall. Future evaluations should include these parameters to provide a more comprehensive assessment of performance and vehicle use.

The principal limitation of this study is the availability of only one clearly identified dynamometer result sheet for each exhaust configuration. The number of repeated tests, raw measurements at individual engine speeds, standard deviations, and measurement uncertainties are unknown. The result sheets also do not fully document the dynamometer model and calibration, correction factors, environmental conditions, fuel specifications, tire pressure, engine temperature, or other vehicle modifications. Therefore, the reported differences are descriptive differences between recorded results, not evidence of statistically significant effects.

Future testing should include at least three repeated runs for each configuration under consistent warm-up procedures and test conditions. Instrument identity, calibration

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status, correction standard, fuel type, tire pressure, engine temperature, environmental conditions, and exhaust dimensions should be recorded. Power and torque data should be exported at identical engine-speed intervals to permit quantitative curve comparisons. If repeated measurements become available, inferential analysis and reporting of variability may be considered as appropriate to the study design [20], [21].

The practical implications of this study are limited to documenting peak power, peak torque, and their associated engine speeds. The data are insufficient to recommend any configuration as the best for everyday use or to establish overall superiority. Noise, fuel consumption, emissions, durability, response at identical rpm, and safety factors were not measured. Further work requires physical identification of each exhaust, documentation of test conditions, repeated measurements, and raw data at consistent rpm intervals.

5 Conclusion

Based on one dynamometer result sheet per configuration, the standard exhaust recorded a maximum power of 39.30 HP at 10,305 rpm and maximum torque of 28.77 Nm at 9,071 rpm; Brand A recorded 46.80 HP at 11,409 rpm and 29.54 Nm at 11,080 rpm; and Brand B recorded 47.80 HP at 11,459 rpm and 30.79 Nm at 9,454 rpm. Relative to the standard exhaust peaks, power differences for Brands A and B were +19.08% and +21.63%, respectively, and torque differences were +2.68% and +7.02%. Brand B had the highest peak values in the available data. However, these peaks occurred at different engine speeds and do not establish superiority at identical rpm. The absence of repeated tests, raw data, a verified correction standard, and complete testing-condition documentation limits the conclusions to descriptive comparisons of peak values rather than statistical significance or overall performance.

6 Acknowledgements

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