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# Engine Performance Characteristics

ACHA 4003

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## 1 Introduction

This technical report will investigate the performance characteristics of an engine under varying operating conditions. Data will be gathered using an engine dynamometer, gaining information on the engine load, engine speed and fuel flow rate. Using this data, further calculations will be made to find torque, brake power and specific fuel consumption (SFC). Upon gathering more data on engine performance this report will go on to answer three specific questions: How does SFC vary with engine speed, what is the relationship between torque and engine speed, and lastly, how does brake power change with engine speed.

The findings of the experiment are significant in providing valuable insight into the performance of the engine under different operating conditions. The results obtained can be used to optimise the engine's performance and develop strategies to improve its efficiency.

This report will include the methodology used, the results obtained, and conclusions about the data found. The limitations of the study and further research will also be considered.

## 2 Experiment Methodology

This section will look at the experimental method and equipment used, highlighting key points and their relevance to the experiment.

### 2.1 Equipment

Schenck W230 Dynamometer

- An eddy current dynamometer
- Max load of 230kw
- Maximum RPM 10000
- Measures torque from the engine

(Dadt, 2001)

Honda 1.6 vtec d16 (2001)

- Lower powered import model
- Aftermarket air filter
- No silencer on exhaust
- Sensors for coolant temperature, lambda, flow meter

(Fall, 2023)

Engine Rig with controls

- Throttle actuator, to control throttle input from external computer.

Driveshaft

- Attached to the engine crankshaft to the dynamometer.
- This enables the dynamometer to measure the engines rpm and other parameters.

Fuel System

- Fuel supply board consisting of a fuel flow meter and lift pump, the fuel flow meter assures the engine is fed properly.
- Fed from the main tank with is contained in a fuel safe.
- Ability to efficiently fuel both fuel injected and carburetted engines.

Exhaust Extraction System

- Straight pipe from the engine to a rudimentary extraction unit, situated on the roof of the building.

### 2.2 Types of Dynamometer Testing

An engine dynamometer is a tool used to measure and evaluate the performance of an engine. It is a device which takes the torque of an engine and then goes on to calculate data from the rpm and torque. There are several ways to test engines on a dynamometer, such as test sequencing and p-curve tests, which consist of sweep and step tests. Looking at test sequencing, these are preprogrammed tests designed to simulate driving scenarios and can be performed with different loads and resistances to simulate hills or towing heavy loads (Martyr and Plint, 2012).

Step and sweep tests are two tests which are considered P-Curve tests. Step testing involves running the engine at a fixed speed or RPM and then gradually increasing the load on the engine. Measurements are taken at each of these steps (Fall, 2023).

Sweep testing involves measuring the performance over a range of different speeds while the load or resistance is constant. Sweep tests, notably this approach may not be as precise as a step test which immediately advances to higher speeds; however, the sweep test is deemed advantageous for engine longevity as it mitigates the risk of overheating (Khameneian et al, 2022)

### 2.3 Experimental Method

A sweep test was the chosen method for the experiment. The procedure involves setting the test time to commence at 1250 rpm and ends at 5500 rpm, with logs recorded at 50 rpm increments. The total test duration is 15 seconds then the test concludes with a rest period of 5 seconds at 0% throttle. The speed of the engine is controlled by a dyno, and then 100% throttle is applied via the controller during the test. Data is then gathered, the raw data taken from the dyno run were engine load in Newtons, engine speed in rpm, the fuel flow rate in litres per minute (l/min) and finally, the lambda was taken.

### 3 Calculating Further Data

To gain a deeper insight into the engine's performance, further calculations were made using the equations set out in section 3.2, employing accurate and reliable calculations can also help identify areas for further improvement.

#### 3.1 Symbols and Units

Table 1 - Symbols and Units for Calculations (Summerfield, 2020)

| Symbol  | Name                            | Units                                |
|---------|---------------------------------|--------------------------------------|
| $T$     | Torque                          | Newton Metres (nm)                   |
| $R$     | Radius at Which the Load Acts   | Meters (m)                           |
| $W$     | Engine Load                     | Newtons (n)                          |
| $P$     | Brake Power                     | Kilowatts (kw)                       |
| $N$     | Engine Speed                    | Revolutions Per Minute (RPM)         |
| $n$     | Number of Cylinders             | No units                             |
| $L$     | Length of Stroke                | Metres (m)                           |
| $P_s$   | Corrected Power                 | Kilowatts (kw)                       |
| $P_a$   | Ambient Pressure                | Bar                                  |
| $T_a$   | Ambient Temperature             | Kelvin (K)                           |
| 1.01325 | Standard Pressure               | Bar                                  |
| 293     | Standard Temperature            | Kelvin (K)                           |
| BSFC    | Brake Specific Fuel Consumption | Kilograms Per Kilowatt-Hour (kg/kwh) |
| $M'$    | Mass of Fuel Per Hour           | Kilograms per Second (kg/s)          |
| BMEP    | Brake Mean Effective Pressure   | Pascal (pa)                          |
| C.V     | Calorific Value of Fuel used    | Joules Per Kilogram (j/kg)           |
| $n_t$   | Thermal Efficiency              | %                                    |

#### 3.2 Formulas

##### Torque

$$T = WR \quad (1)$$

##### Brake Power

$$P = \frac{2\pi NT}{60} \quad (2)$$

##### Corrected Brake Power

$$\frac{P_s}{P} = \frac{1.01325}{P_a} \sqrt{\frac{T_a}{293}} \quad (3)$$

rearranged to make  $P_s$  the subject. Therefore,

$$P_s = \frac{1.01325}{P_a} \sqrt{\frac{T_a}{293}} * P \quad (4)$$

**Brake Specific Fuel Consumption**

$$BSFC = \frac{M_f}{BP} \quad (5)$$

**Mean Effective Pressure**

Firstly, the equation for P is considered.

$$P = \frac{(MEP)LANn}{60 * 2} \quad (6)$$

Then rearranged to make MEP the subject. Therefore,

$$MEP = \frac{P * (60 * 2)}{LANn} \quad (7)$$

**Thermal Efficiency**

$$n_t = \frac{BP}{(SFC) * C.V} \quad (8)$$

(Summerfield, 2020)

## 4 Dynamometer Results

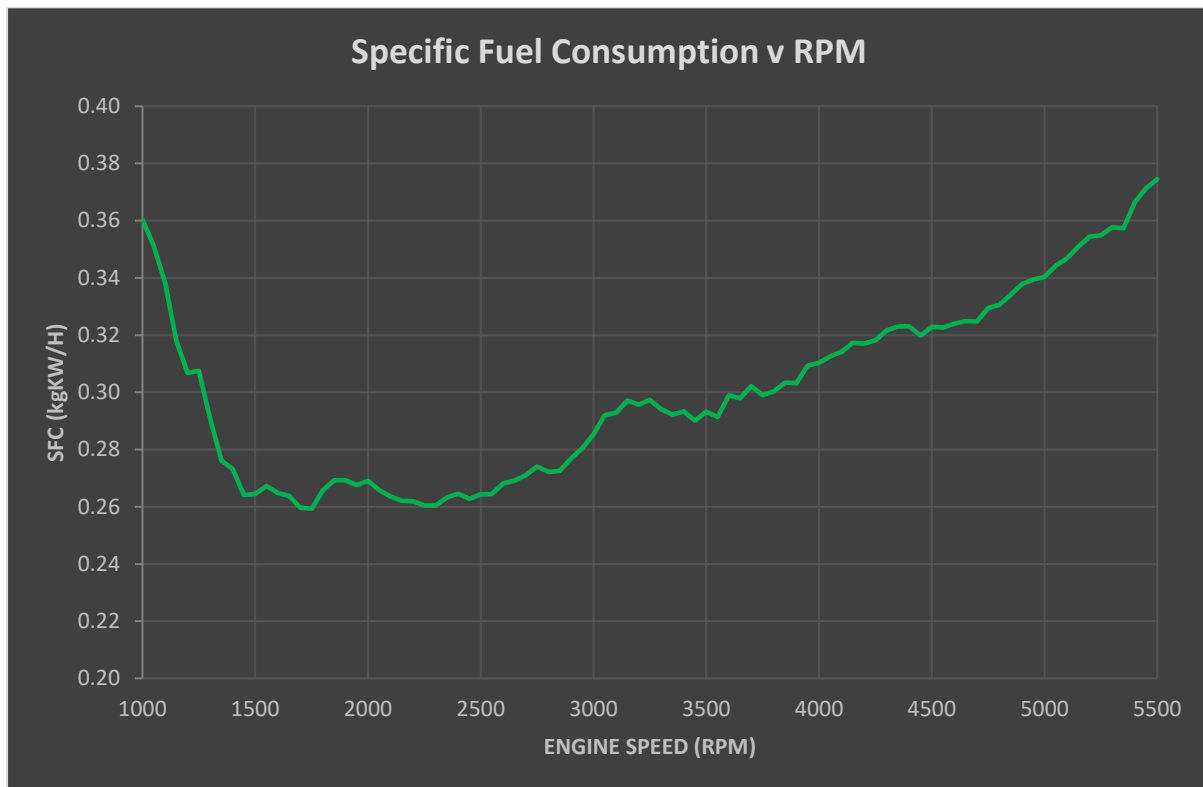


Figure 1 -Table 1 - SFC against Engine Speed (Vine, 2023)

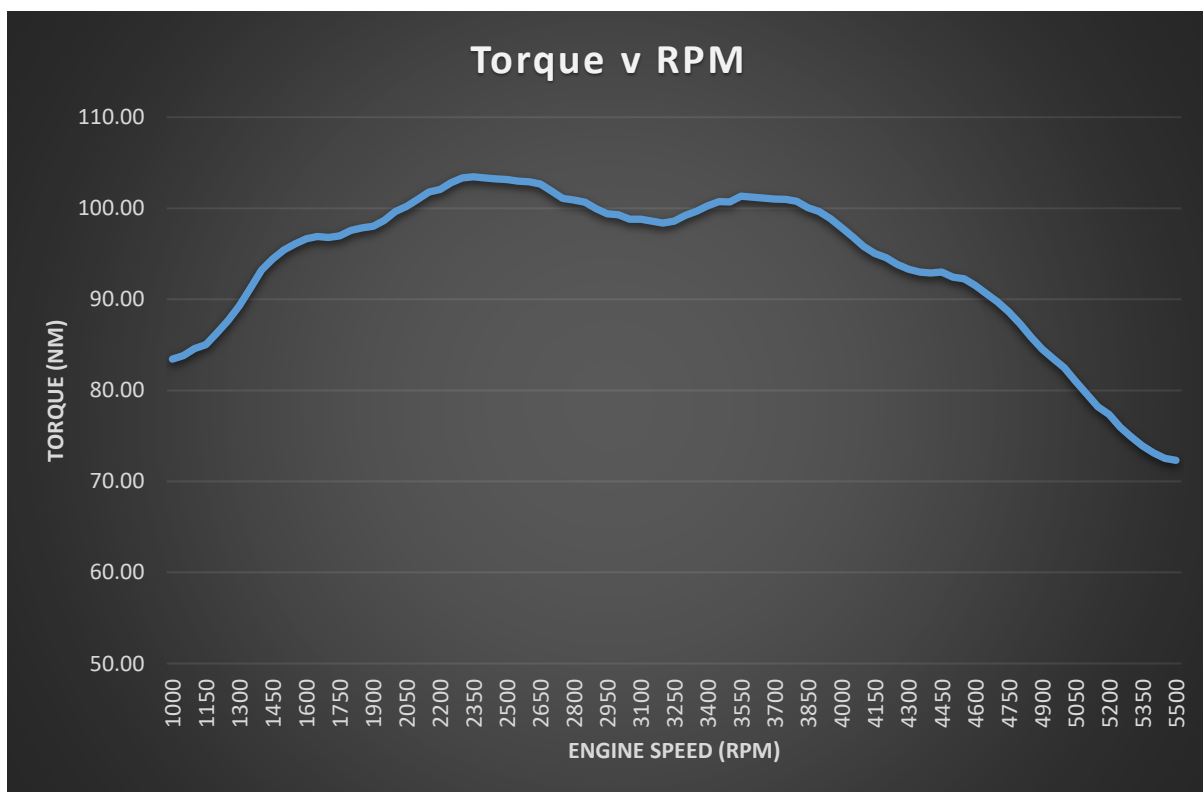


Figure 2 - Torque against Engine Speed (Vine,2023)

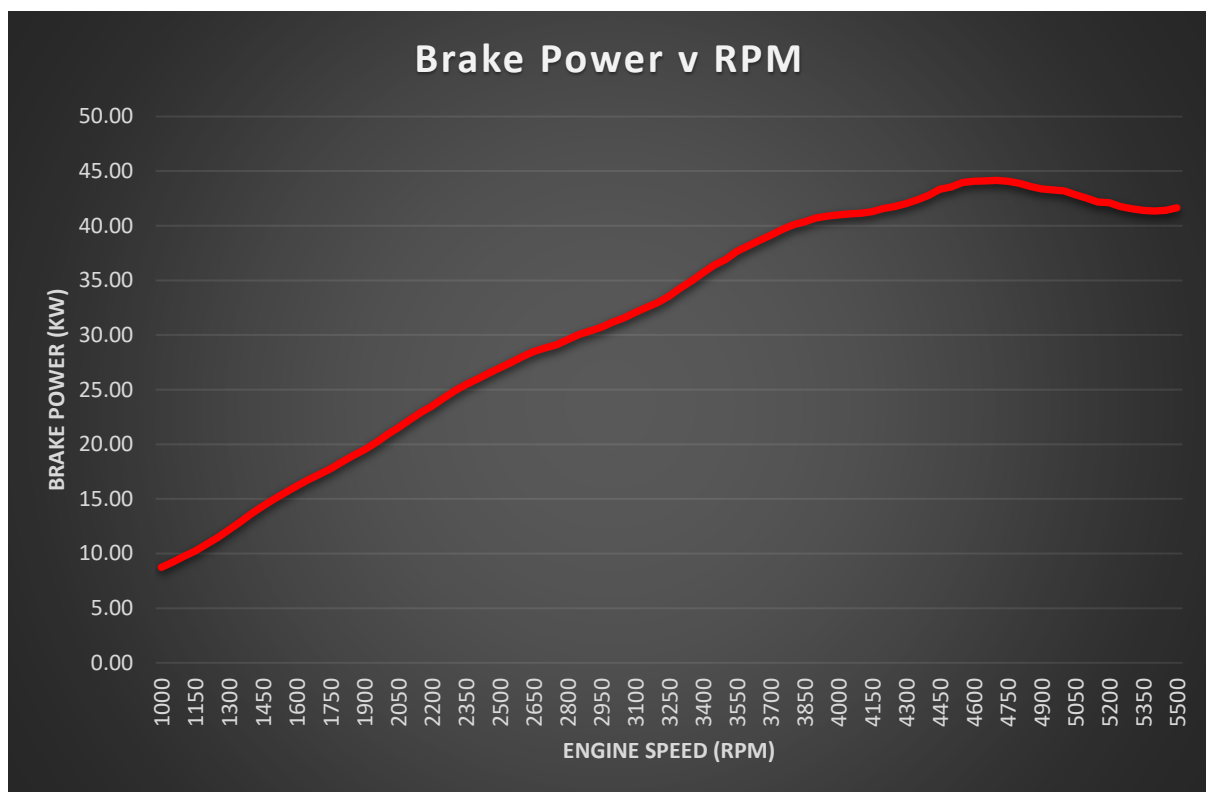


Figure 3 - Brake Power against Engine Speed (Vine, 2023)

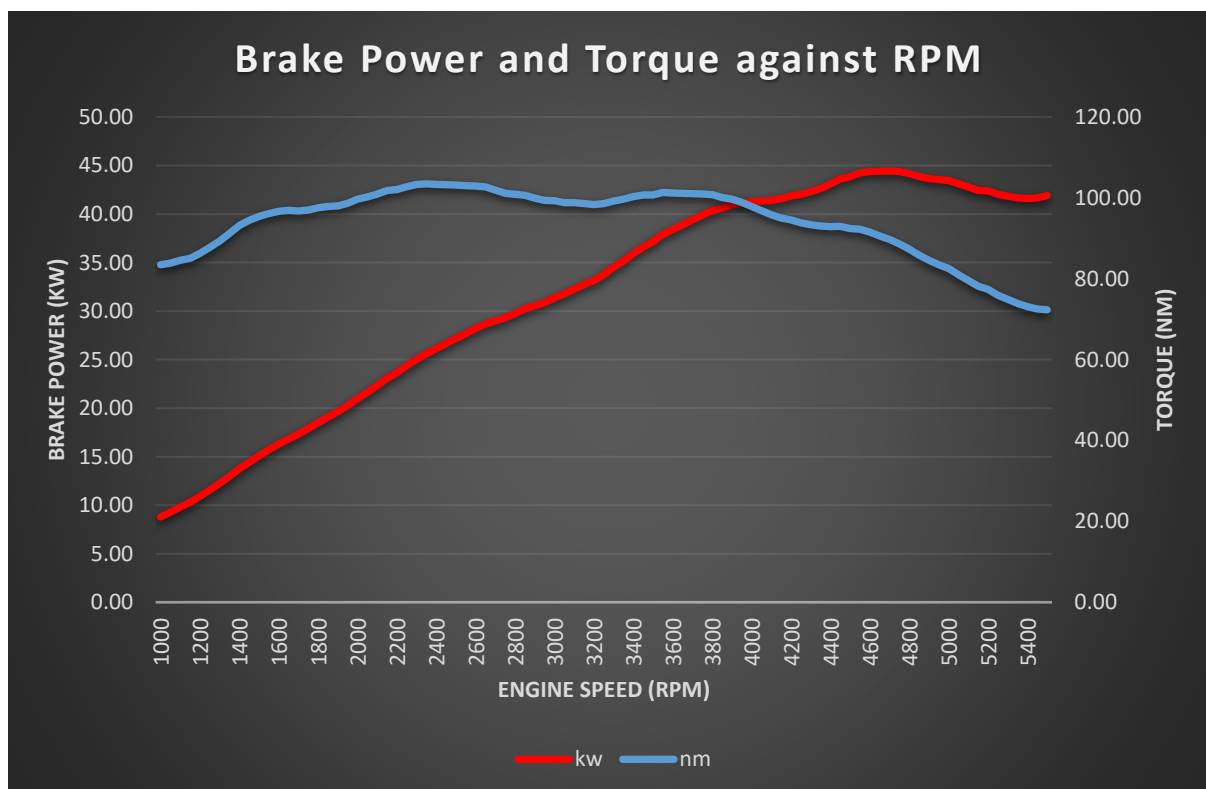


Figure 4 -Brake Power and Torque against Engine Speed (Vine, 2023)

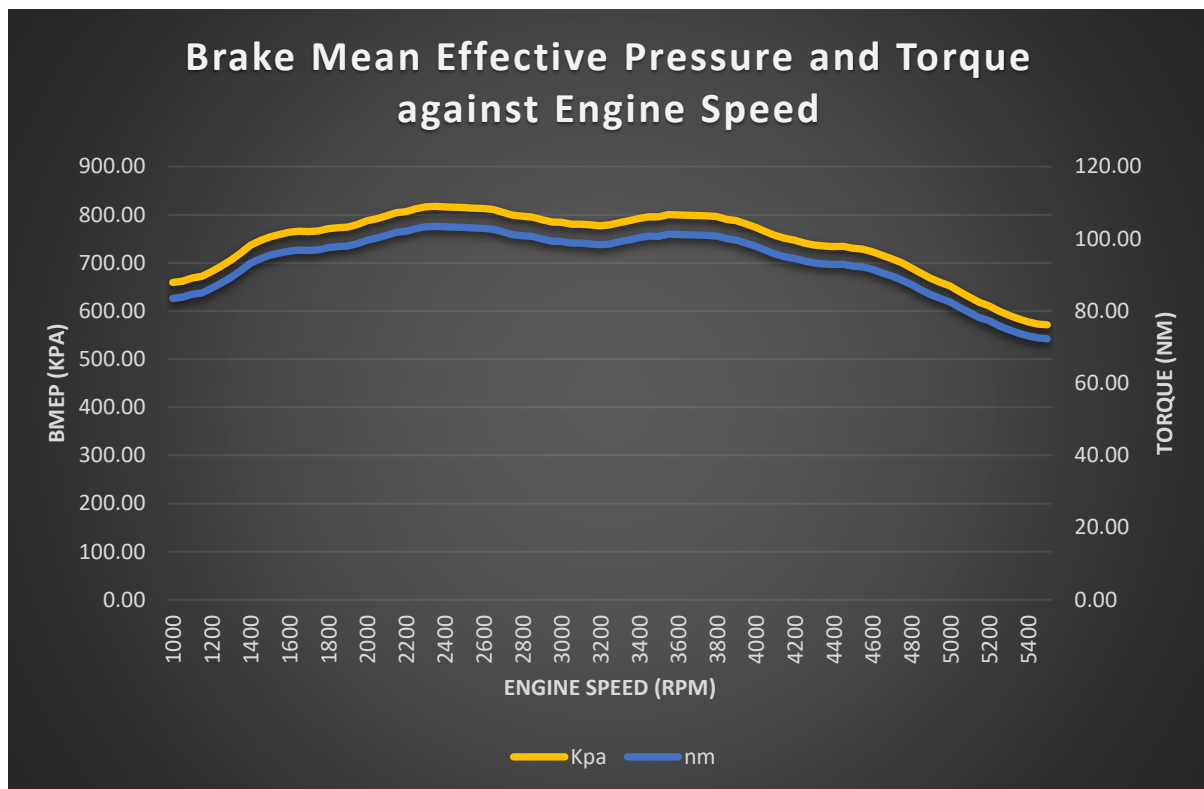


Figure 5 – Brake Mean Effective Pressure and Torque against Engine Speed (Vine, 2023)

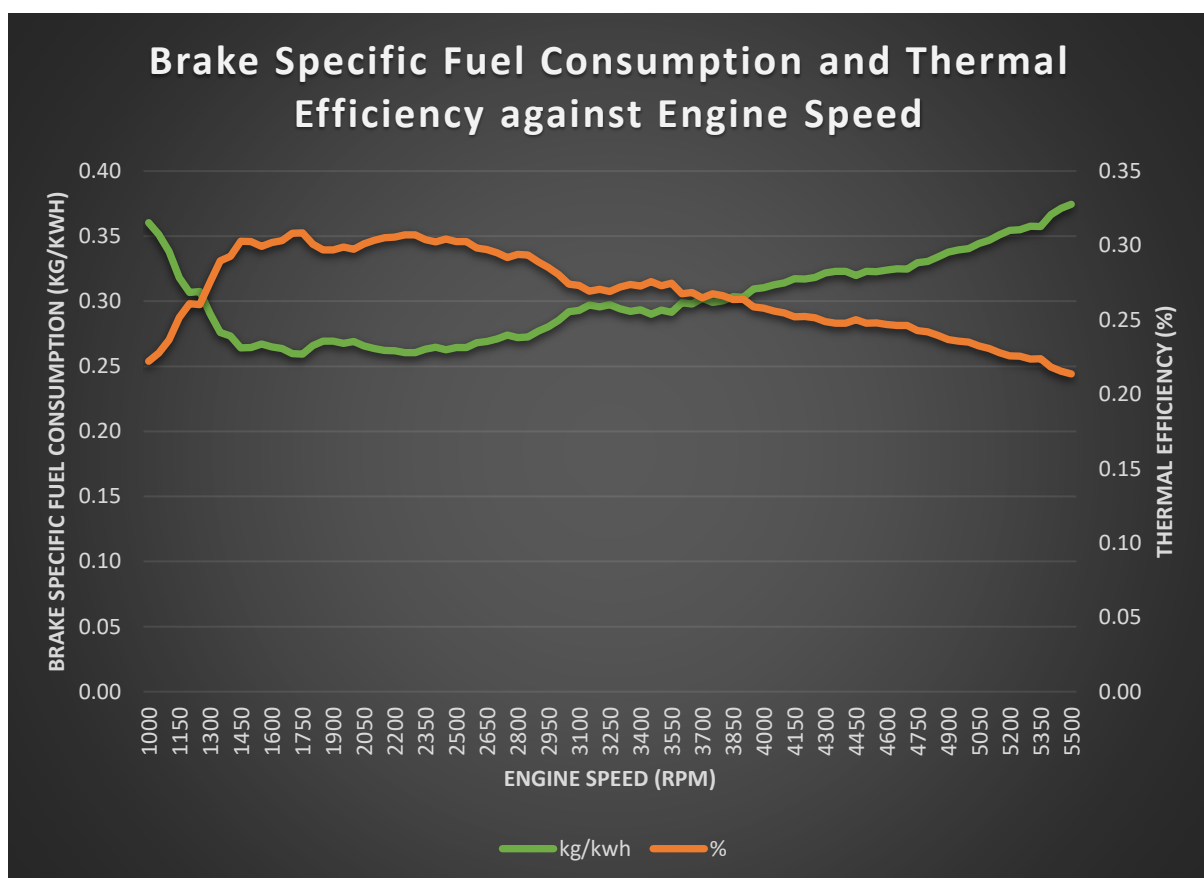


Figure 6 - Brake Specific Fuel Consumption and Thermal efficiency against Engine Speed (Vine, 2023)

## 5 Analysis

This section will look at the resulting graphs from *section 3* and discuss the relationship between the results, looking at Brake Specific Fuel Consumption (BSFC), the Corrected Brake Power (BP) and Torque.

### 5.1 SFC V Engine speed

BSFC is a measurement of fuel economy achieved by the engine, defined as the amount of fuel consumed by the engine per unit of power produced, using the units kg/kwh (Ribbens, 2017). BSFC is commonly used in the automotive industry to evaluate an engine's fuel efficiency, it can be used to compare different fuels and is heavily used concerning emissions and predicting the environmental impact a particular engine may have.

The pattern is attributed to the fact that at lower speeds, the engine may not be operating at its most efficient point, resulting in higher fuel consumption. This can be seen in *figure 1*, possibly due to the sudden increase in throttle as the test begins, at 1000 rpm the fuel consumption spikes before levelling out and slowly improving, reaching a peak efficiency of 0.26kg/kwh. At 3500 rpm the fuel consumption starts to increase as the engine speed increases.

The BSFC does not follow a linear pattern and shows to be temperamental with peaks and dips in the mid-range and could be influenced by many factors, including throttle input, fuel used and thermal efficiency.

### 5.2 The Relationship Between Torque and Engine Speed

Looking at *figure 2*, the torque comes in at 83nm immediately at 1000rpm, rising marginally and then staying relatively consistent throughout the test, matching what would be expected for a car built for city driving. At 5100 rpm, torque decreases to its original value and then continues to decrease for the remainder of the rpm.

At low engine speeds, the engine can draw in more fuel and air per cycle, allowing the engine to produce more torque, as the rpm increases the demand for air and fuel increases but as the engine torque figure starts to drop off, this is when the pushing of the combustion would be optimum as it is close to that of the engines maximum break torque (MBT) After this point, the engine fails to bring in the amount of air and fuel that is necessary per engine cycle (Haywood, 2018) in return, reduces the amount of torque the engine can produce. This can be due to the design of the engine, as it was designed for city driving, the torque curve meets this expectation, aside from two small anomalies, which could be related to the engine not running correctly at the time of testing.

### 5.3 The Relationship Between Brake Power and Engine Speed

The correlation between brake power and engine speed can be witnessed in *figure 3*, the power curve measured in kw can be seen to rise linearly. At low engine speeds the power output is lower than expected. This is because the engine is not operating at maximum efficiency and is running lean, meaning it does not meet the ideal lambda of 1. A lambda of 1 refers to the stoichiometric air-fuel ratio of 14.7:1, considered the ideal mixture for complete combustion. This means for every 14.7 units of air, 1 unit of gasoline is consumed (Al-arkawazi, 2019). The closest the engine gets to this figure is at 5500 rpm, even at this engine speed it still runs lean with a lambda of 1.08 as seen in *table 2*. The linear curve starts to drop as the engine reaches 5050 rpm and then the bp starts to decrease as the engine has now reached its peak power. Beyond peak power, the engine becomes less efficient as it has reached the limitations of its operating characteristics.

Factors which contribute to the decrease in power could be the fuel and air delivery limitations. At higher speeds the engine, possibly due to its aftermarket air filter, cannot take in enough air. The fuel may also not be delivered optimally, a sign of this is a lean mixture, which this engine does show throughout the test. Another factor to consider is heat dissipation. A benefit of a cooler running engine is the ability to enhance its volumetric efficiency, which refers to the amount of air and fuel which can be contained in the cylinder. The cooler the combustion chamber, the more fuel and air can become trapped within the cylinder. A higher volumetric efficiency typically leads to increased power output (Stone, 1992). if the engine is unable to dissipate the heat effectively, it can cause the engine to overheat, thus reducing power output.

Overall, the decrease in power beyond a certain engine speed, as well as the lower-than-expected power output for the duration of the test, can be due to a combination of facts, limiting the engine's ability to operate at its maximum efficiency.

## 6 Conclusion

In conclusion, the tests conducted on the engine dynamometer provide valuable insight into the efficiency and performance of the engine. The BSFC results show that fuel consumption was influenced heavily by engine speed and did not follow a linear pattern. When looking at torque, the results showed some anomalies in the torque curve at mid-range engine speed, but the engine still produced constant figures looking at the average over the 15-second test. The power curve increased linearly until the engine reached its peak power until it was surpassed by the capabilities of the engine. Considering both torque and power curves in *figure 4*. Are consistent with the design of an engine intended for city driving.

Overall, the performance of the engine was affected by a combination of factors, such as air and fuel delivery, thermal efficiency, and heat dissipation. Limiting its ability to operate to its maximum efficiency, nonetheless, these tests provided important data for understanding the engine's performance and options to consider to optimise its efficiency.

## 7 References

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## 8 Appendices

Table 2 - Raw dyno data from dynamometer (Vine, 2023)

| Raw Dyno Data |            |                |                |        |
|---------------|------------|----------------|----------------|--------|
| Load          | Dyno Speed | Fuel Flow Rate | Fuel Flow Rate | Lambda |
| Newtons       | rpm        | l/min          | kg/h           | Lambda |
| 102.28        | 1000.00    | 0.07           | 3.17           | 1.27   |
| 102.76        | 1050.00    | 0.07           | 3.26           | 1.27   |
| 103.69        | 1100.00    | 0.07           | 3.32           | 1.27   |
| 104.21        | 1150.00    | 0.07           | 3.28           | 1.28   |
| 105.81        | 1200.00    | 0.07           | 3.35           | 1.29   |
| 107.51        | 1250.00    | 0.08           | 3.55           | 1.30   |
| 109.49        | 1300.00    | 0.08           | 3.56           | 1.30   |
| 111.80        | 1350.00    | 0.08           | 3.58           | 1.29   |
| 114.27        | 1400.00    | 0.08           | 3.76           | 1.29   |
| 115.78        | 1450.00    | 0.08           | 3.81           | 1.28   |
| 116.99        | 1500.00    | 0.09           | 3.99           | 1.28   |
| 117.79        | 1550.00    | 0.09           | 4.19           | 1.28   |
| 118.47        | 1600.00    | 0.10           | 4.32           | 1.28   |
| 118.77        | 1650.00    | 0.10           | 4.44           | 1.29   |
| 118.66        | 1700.00    | 0.10           | 4.50           | 1.30   |
| 118.86        | 1750.00    | 0.10           | 4.64           | 1.31   |
| 119.58        | 1800.00    | 0.11           | 4.92           | 1.31   |
| 119.93        | 1850.00    | 0.11           | 5.14           | 1.32   |
| 120.18        | 1900.00    | 0.12           | 5.29           | 1.32   |
| 120.95        | 1950.00    | 0.12           | 5.42           | 1.31   |
| 122.16        | 2000.00    | 0.13           | 5.65           | 1.32   |
| 122.85        | 2050.00    | 0.13           | 5.75           | 1.32   |
| 123.80        | 2100.00    | 0.13           | 5.89           | 1.32   |
| 124.79        | 2150.00    | 0.13           | 6.05           | 1.32   |
| 125.14        | 2200.00    | 0.14           | 6.20           | 1.32   |
| 126.03        | 2250.00    | 0.14           | 6.35           | 1.30   |
| 126.66        | 2300.00    | 0.14           | 6.52           | 1.30   |
| 126.82        | 2350.00    | 0.15           | 6.74           | 1.28   |
| 126.69        | 2400.00    | 0.15           | 6.92           | 1.27   |
| 126.55        | 2450.00    | 0.16           | 7.00           | 1.27   |
| 126.44        | 2500.00    | 0.16           | 7.18           | 1.27   |
| 126.24        | 2550.00    | 0.16           | 7.32           | 1.28   |
| 126.16        | 2600.00    | 0.17           | 7.56           | 1.28   |
| 125.85        | 2650.00    | 0.17           | 7.72           | 1.28   |
| 124.91        | 2700.00    | 0.17           | 7.86           | 1.28   |
| 123.93        | 2750.00    | 0.18           | 8.03           | 1.28   |
| 123.69        | 2800.00    | 0.18           | 8.10           | 1.27   |
| 123.39        | 2850.00    | 0.18           | 8.24           | 1.26   |

|        |         |      |       |      |
|--------|---------|------|-------|------|
| 122.52 | 2900.00 | 0.19 | 8.46  | 1.25 |
| 121.84 | 2950.00 | 0.19 | 8.66  | 1.24 |
| 121.71 | 3000.00 | 0.20 | 8.96  | 1.23 |
| 121.12 | 3050.00 | 0.21 | 9.27  | 1.22 |
| 121.12 | 3100.00 | 0.21 | 9.45  | 1.21 |
| 120.85 | 3150.00 | 0.22 | 9.72  | 1.19 |
| 120.60 | 3200.00 | 0.22 | 9.81  | 1.18 |
| 120.84 | 3250.00 | 0.22 | 10.04 | 1.17 |
| 121.63 | 3300.00 | 0.23 | 10.15 | 1.16 |
| 122.18 | 3350.00 | 0.23 | 10.28 | 1.15 |
| 122.93 | 3400.00 | 0.23 | 10.54 | 1.14 |
| 123.48 | 3450.00 | 0.24 | 10.62 | 1.13 |
| 123.43 | 3500.00 | 0.24 | 10.89 | 1.12 |
| 124.21 | 3550.00 | 0.25 | 11.05 | 1.11 |
| 124.07 | 3600.00 | 0.26 | 11.48 | 1.10 |
| 123.97 | 3650.00 | 0.26 | 11.59 | 1.09 |
| 123.82 | 3700.00 | 0.26 | 11.90 | 1.10 |
| 123.77 | 3750.00 | 0.27 | 11.93 | 1.10 |
| 123.51 | 3800.00 | 0.27 | 12.12 | 1.10 |
| 122.67 | 3850.00 | 0.27 | 12.32 | 1.11 |
| 122.16 | 3900.00 | 0.28 | 12.42 | 1.12 |
| 121.18 | 3950.00 | 0.28 | 12.73 | 1.12 |
| 120.00 | 4000.00 | 0.28 | 12.80 | 1.12 |
| 118.73 | 4050.00 | 0.29 | 12.92 | 1.12 |
| 117.44 | 4100.00 | 0.29 | 13.00 | 1.12 |
| 116.50 | 4150.00 | 0.29 | 13.19 | 1.12 |
| 115.93 | 4200.00 | 0.29 | 13.27 | 1.12 |
| 115.03 | 4250.00 | 0.30 | 13.37 | 1.12 |
| 114.39 | 4300.00 | 0.30 | 13.60 | 1.12 |
| 114.02 | 4350.00 | 0.31 | 13.77 | 1.12 |
| 113.87 | 4400.00 | 0.31 | 13.91 | 1.12 |
| 113.99 | 4450.00 | 0.31 | 13.95 | 1.12 |
| 113.31 | 4500.00 | 0.31 | 14.15 | 1.12 |
| 113.07 | 4550.00 | 0.32 | 14.27 | 1.11 |
| 112.20 | 4600.00 | 0.32 | 14.37 | 1.11 |
| 111.06 | 4650.00 | 0.32 | 14.42 | 1.10 |
| 109.97 | 4700.00 | 0.32 | 14.43 | 1.10 |
| 108.65 | 4750.00 | 0.32 | 14.62 | 1.09 |
| 107.08 | 4800.00 | 0.32 | 14.60 | 1.08 |
| 105.24 | 4850.00 | 0.33 | 14.66 | 1.08 |
| 103.63 | 4900.00 | 0.33 | 14.75 | 1.08 |
| 102.34 | 4950.00 | 0.33 | 14.78 | 1.09 |
| 101.11 | 5000.00 | 0.33 | 14.79 | 1.09 |
| 99.31  | 5050.00 | 0.33 | 14.84 | 1.09 |
| 97.58  | 5100.00 | 0.33 | 14.84 | 1.09 |

|       |         |      |       |      |
|-------|---------|------|-------|------|
| 95.85 | 5150.00 | 0.33 | 14.89 | 1.09 |
| 94.80 | 5200.00 | 0.33 | 15.02 | 1.09 |
| 93.10 | 5250.00 | 0.33 | 14.91 | 1.09 |
| 91.79 | 5300.00 | 0.33 | 14.96 | 1.08 |
| 90.59 | 5350.00 | 0.33 | 14.89 | 1.08 |
| 89.64 | 5400.00 | 0.34 | 15.25 | 1.08 |
| 88.93 | 5450.00 | 0.34 | 15.47 | 1.08 |
| 88.65 | 5500.00 | 0.35 | 15.70 | 1.08 |

Table 3 - Calculated data from dynamometer test

| Calculated Dyno Data |           |        |          |       |                 |        |                          |
|----------------------|-----------|--------|----------|-------|-----------------|--------|--------------------------|
| Torque               | bMEP      |        | BP       |       | Corrected Power | Bsfc   | Brake Thermal Efficiency |
|                      |           |        |          |       |                 |        |                          |
| nm                   | pa        | Kpa    | w        | kw    | kw              | kg/kwh | %                        |
| 83.43                | 659226.77 | 659.23 | 8737.12  | 8.74  | 8.79            | 0.36   | 0.22                     |
| 83.83                | 662327.12 | 662.33 | 9217.13  | 9.22  | 9.27            | 0.35   | 0.23                     |
| 84.59                | 668340.89 | 668.34 | 9743.71  | 9.74  | 9.80            | 0.34   | 0.24                     |
| 85.01                | 671692.62 | 671.69 | 10237.69 | 10.24 | 10.30           | 0.32   | 0.25                     |
| 86.32                | 682018.52 | 682.02 | 10847.04 | 10.85 | 10.91           | 0.31   | 0.26                     |
| 87.70                | 692969.64 | 692.97 | 11480.42 | 11.48 | 11.55           | 0.31   | 0.26                     |
| 89.32                | 705719.10 | 705.72 | 12159.31 | 12.16 | 12.24           | 0.29   | 0.28                     |
| 91.20                | 720602.06 | 720.60 | 12893.27 | 12.89 | 12.97           | 0.28   | 0.29                     |
| 93.22                | 736529.21 | 736.53 | 13666.32 | 13.67 | 13.75           | 0.27   | 0.29                     |
| 94.45                | 746294.34 | 746.29 | 14342.07 | 14.34 | 14.43           | 0.26   | 0.30                     |
| 95.43                | 754041.98 | 754.04 | 14990.65 | 14.99 | 15.08           | 0.26   | 0.30                     |
| 96.09                | 759217.82 | 759.22 | 15596.67 | 15.60 | 15.69           | 0.27   | 0.30                     |
| 96.65                | 763620.19 | 763.62 | 16193.14 | 16.19 | 16.29           | 0.26   | 0.30                     |
| 96.89                | 765560.32 | 765.56 | 16741.60 | 16.74 | 16.85           | 0.26   | 0.30                     |
| 96.80                | 764812.63 | 764.81 | 17232.08 | 17.23 | 17.34           | 0.26   | 0.31                     |
| 96.96                | 766133.98 | 766.13 | 17769.55 | 17.77 | 17.88           | 0.26   | 0.31                     |
| 97.55                | 770794.17 | 770.79 | 18388.43 | 18.39 | 18.50           | 0.27   | 0.30                     |
| 97.84                | 773050.14 | 773.05 | 18954.53 | 18.95 | 19.07           | 0.27   | 0.30                     |
| 98.04                | 774609.99 | 774.61 | 19506.10 | 19.51 | 19.63           | 0.27   | 0.30                     |
| 98.67                | 779586.01 | 779.59 | 20148.02 | 20.15 | 20.27           | 0.27   | 0.30                     |
| 99.65                | 787378.78 | 787.38 | 20871.20 | 20.87 | 21.00           | 0.27   | 0.30                     |
| 100.21               | 791813.37 | 791.81 | 21513.46 | 21.51 | 21.65           | 0.27   | 0.30                     |
| 100.99               | 797943.17 | 797.94 | 22208.79 | 22.21 | 22.35           | 0.26   | 0.30                     |
| 101.80               | 804375.90 | 804.38 | 22920.87 | 22.92 | 23.06           | 0.26   | 0.31                     |
| 102.08               | 806586.75 | 806.59 | 23518.38 | 23.52 | 23.67           | 0.26   | 0.31                     |
| 102.81               | 812329.81 | 812.33 | 24224.15 | 24.22 | 24.38           | 0.26   | 0.31                     |
| 103.33               | 816403.45 | 816.40 | 24886.64 | 24.89 | 25.04           | 0.26   | 0.31                     |
| 103.46               | 817447.64 | 817.45 | 25460.18 | 25.46 | 25.62           | 0.26   | 0.30                     |
| 103.35               | 816596.82 | 816.60 | 25974.82 | 25.97 | 26.14           | 0.26   | 0.30                     |
| 103.24               | 815707.32 | 815.71 | 26487.08 | 26.49 | 26.65           | 0.26   | 0.30                     |

|        |           |        |          |       |       |      |      |
|--------|-----------|--------|----------|-------|-------|------|------|
| 103.14 | 814972.52 | 814.97 | 27003.29 | 27.00 | 27.17 | 0.26 | 0.30 |
| 102.98 | 813689.84 | 813.69 | 27500.00 | 27.50 | 27.67 | 0.26 | 0.30 |
| 102.92 | 813187.08 | 813.19 | 28021.89 | 28.02 | 28.20 | 0.27 | 0.30 |
| 102.66 | 811163.15 | 811.16 | 28489.69 | 28.49 | 28.67 | 0.27 | 0.30 |
| 101.90 | 805130.04 | 805.13 | 28811.34 | 28.81 | 28.99 | 0.27 | 0.30 |
| 101.10 | 798787.54 | 798.79 | 29113.72 | 29.11 | 29.30 | 0.27 | 0.29 |
| 100.90 | 797253.48 | 797.25 | 29586.13 | 29.59 | 29.77 | 0.27 | 0.29 |
| 100.66 | 795319.79 | 795.32 | 30041.41 | 30.04 | 30.23 | 0.27 | 0.29 |
| 99.95  | 789712.10 | 789.71 | 30352.92 | 30.35 | 30.54 | 0.28 | 0.29 |
| 99.39  | 785316.18 | 785.32 | 30704.37 | 30.70 | 30.90 | 0.28 | 0.29 |
| 99.29  | 784491.14 | 784.49 | 31191.98 | 31.19 | 31.39 | 0.29 | 0.28 |
| 98.81  | 780714.00 | 780.71 | 31559.16 | 31.56 | 31.76 | 0.29 | 0.27 |
| 98.81  | 780720.44 | 780.72 | 32076.79 | 32.08 | 32.28 | 0.29 | 0.27 |
| 98.59  | 778960.79 | 778.96 | 32520.69 | 32.52 | 32.72 | 0.30 | 0.27 |
| 98.38  | 777317.15 | 777.32 | 32967.19 | 32.97 | 33.17 | 0.30 | 0.27 |
| 98.58  | 778889.88 | 778.89 | 33550.04 | 33.55 | 33.76 | 0.30 | 0.27 |
| 99.23  | 784001.27 | 784.00 | 34289.75 | 34.29 | 34.50 | 0.29 | 0.27 |
| 99.67  | 787533.47 | 787.53 | 34966.12 | 34.97 | 35.19 | 0.29 | 0.27 |
| 100.29 | 792380.59 | 792.38 | 35706.43 | 35.71 | 35.93 | 0.29 | 0.27 |
| 100.73 | 795874.12 | 795.87 | 36391.26 | 36.39 | 36.62 | 0.29 | 0.28 |
| 100.69 | 795571.17 | 795.57 | 36904.62 | 36.90 | 37.14 | 0.29 | 0.27 |
| 101.32 | 800579.43 | 800.58 | 37667.47 | 37.67 | 37.90 | 0.29 | 0.27 |
| 101.21 | 799683.49 | 799.68 | 38155.25 | 38.16 | 38.39 | 0.30 | 0.27 |
| 101.13 | 799045.37 | 799.05 | 38654.31 | 38.65 | 38.90 | 0.30 | 0.27 |
| 101.01 | 798065.63 | 798.07 | 39135.78 | 39.14 | 39.38 | 0.30 | 0.26 |
| 100.97 | 797756.24 | 797.76 | 39649.27 | 39.65 | 39.90 | 0.30 | 0.27 |
| 100.76 | 796093.27 | 796.09 | 40094.17 | 40.09 | 40.35 | 0.30 | 0.27 |
| 100.07 | 790698.28 | 790.70 | 40346.44 | 40.35 | 40.60 | 0.30 | 0.26 |
| 99.65  | 787378.78 | 787.38 | 40698.83 | 40.70 | 40.95 | 0.30 | 0.26 |
| 98.86  | 781107.18 | 781.11 | 40892.29 | 40.89 | 41.15 | 0.31 | 0.26 |
| 97.90  | 773501.34 | 773.50 | 41006.69 | 41.01 | 41.26 | 0.31 | 0.26 |
| 96.86  | 765315.39 | 765.32 | 41079.88 | 41.08 | 41.34 | 0.31 | 0.26 |
| 95.81  | 756987.63 | 756.99 | 41134.51 | 41.13 | 41.39 | 0.31 | 0.25 |
| 95.04  | 750915.85 | 750.92 | 41302.19 | 41.30 | 41.56 | 0.32 | 0.25 |
| 94.57  | 747248.29 | 747.25 | 41595.65 | 41.60 | 41.86 | 0.32 | 0.25 |
| 93.84  | 741466.56 | 741.47 | 41765.16 | 41.77 | 42.03 | 0.32 | 0.25 |
| 93.32  | 737322.02 | 737.32 | 42020.32 | 42.02 | 42.28 | 0.32 | 0.25 |
| 93.01  | 734904.91 | 734.90 | 42369.57 | 42.37 | 42.63 | 0.32 | 0.25 |
| 92.89  | 733970.29 | 733.97 | 42802.07 | 42.80 | 43.07 | 0.32 | 0.25 |
| 92.99  | 734705.09 | 734.71 | 43331.80 | 43.33 | 43.60 | 0.32 | 0.25 |
| 92.43  | 730328.51 | 730.33 | 43557.65 | 43.56 | 43.83 | 0.32 | 0.25 |
| 92.24  | 728833.12 | 728.83 | 43951.45 | 43.95 | 44.23 | 0.32 | 0.25 |
| 91.53  | 723167.42 | 723.17 | 44089.01 | 44.09 | 44.37 | 0.32 | 0.25 |
| 90.60  | 715858.07 | 715.86 | 44117.77 | 44.12 | 44.39 | 0.32 | 0.25 |
| 89.71  | 708845.23 | 708.85 | 44155.31 | 44.16 | 44.43 | 0.32 | 0.25 |

|       |           |        |          |       |       |      |      |
|-------|-----------|--------|----------|-------|-------|------|------|
| 88.64 | 700343.44 | 700.34 | 44089.82 | 44.09 | 44.37 | 0.33 | 0.24 |
| 87.35 | 690172.24 | 690.17 | 43906.86 | 43.91 | 44.18 | 0.33 | 0.24 |
| 85.85 | 678338.06 | 678.34 | 43603.52 | 43.60 | 43.88 | 0.33 | 0.24 |
| 84.54 | 667973.49 | 667.97 | 43379.94 | 43.38 | 43.65 | 0.34 | 0.24 |
| 83.48 | 659613.51 | 659.61 | 43274.14 | 43.27 | 43.55 | 0.34 | 0.24 |
| 82.48 | 651691.83 | 651.69 | 43186.29 | 43.19 | 43.46 | 0.34 | 0.24 |
| 81.02 | 640147.06 | 640.15 | 42845.46 | 42.85 | 43.11 | 0.34 | 0.23 |
| 79.60 | 628974.21 | 628.97 | 42514.46 | 42.51 | 42.78 | 0.35 | 0.23 |
| 78.19 | 617804.58 | 617.80 | 42168.87 | 42.17 | 42.43 | 0.35 | 0.23 |
| 77.34 | 611066.96 | 611.07 | 42113.93 | 42.11 | 42.38 | 0.35 | 0.23 |
| 75.95 | 600072.65 | 600.07 | 41753.88 | 41.75 | 42.02 | 0.35 | 0.23 |
| 74.88 | 591635.32 | 591.64 | 41558.86 | 41.56 | 41.82 | 0.36 | 0.22 |
| 73.90 | 583934.08 | 583.93 | 41404.86 | 41.40 | 41.66 | 0.36 | 0.22 |
| 73.12 | 577769.48 | 577.77 | 41350.62 | 41.35 | 41.61 | 0.37 | 0.22 |
| 72.54 | 573181.48 | 573.18 | 41402.09 | 41.40 | 41.66 | 0.37 | 0.22 |
| 72.32 | 571388.31 | 571.39 | 41651.22 | 41.65 | 41.91 | 0.37 | 0.21 |

# SHOP MANUAL

**HONDA**

**CIVIC**  
COUPE CRX

**CHASSIS MAINTENANCE AND REPAIR 88**



Figure 7 - Honda Civic owners manual

## Design Specifications

|            | ITEMS                                  | METRIC                                                     | ENGLISH         | NOTES                       |
|------------|----------------------------------------|------------------------------------------------------------|-----------------|-----------------------------|
| DIMENSIONS | Overall Length                         | 3,755 mm                                                   | 147.8 in.       |                             |
|            | Overall Width With bumper guard        | 3,795 mm                                                   | 149.4 in.       |                             |
|            | Overall Height                         | 1,675 mm                                                   | 65.9 in.        | KQ, KY                      |
|            | Overall Height                         | 1,670 mm                                                   | 65.7 in.        | Ex. KQ, KY                  |
|            | Wheel Base                             | 1,270 mm                                                   | 50.0 in.        |                             |
|            | Track, Front/Rear                      | 1,280 mm                                                   | 50.4 in.        | KY                          |
|            | Track, Front/Rear                      | 2,300 mm                                                   | 90.6 in.        |                             |
|            | Ground Clearance                       | 1,450/1,455 mm                                             | 57.1/57.3 in.   | Ex. KQ, KY                  |
|            | Ground Clearance                       | 1,445/1,455 mm                                             | 56.9/57.3 in.   | KY                          |
|            | Ground Clearance                       | 1,450/1,455 mm                                             | 57.1/57.3 in.   | KQ                          |
| WEIGHTS    | Overhang, Front/Rear                   | 160 mm                                                     | 6.3 in.         | Without Catalytic Converter |
|            | Overhang, Front/Rear                   | 150 mm                                                     | 5.9 in.         | With Catalytic Converter    |
|            | Overhang, Front/Rear With bumper guard | 765/590 mm                                                 | 30.1/27.2 in.   | } Includes bumper           |
|            | Overhang, Front/Rear With bumper guard | 805/590 mm                                                 | 31.7/27.2 in.   |                             |
|            | Engine Weight (Wet)                    |                                                            |                 |                             |
|            | SOHC                                   | 107 kg                                                     | 236 lb.         |                             |
|            | DOHC                                   | 113 kg                                                     | 249 lb.         |                             |
|            | Curb Weight                            | 925 kg                                                     | 2,040 lb.       | KX                          |
|            | DOHC                                   | 909 kg                                                     | 2,004 lb.       | KY                          |
|            | DOHC                                   | 910 kg                                                     | 2,007 lb.       | KB                          |
| ENGINE     | SOHC                                   | 905 kg                                                     | 1,996 lb.       | KF, KE                      |
|            | SOHC                                   | 900 kg                                                     | 1,985 lb.       | KW                          |
|            | SOHC                                   | 895 kg                                                     | 1,973 lb.       | KS                          |
|            | SOHC                                   | 890 kg                                                     | 1,962 lb.       | KW                          |
|            | SOHC                                   | 900 kg                                                     | 1,985 lb.       | KG                          |
|            | SOHC                                   | 935 kg                                                     | 2,017 lb.       | KQ                          |
|            | Weight Distribution (Front/Rear)       |                                                            |                 |                             |
|            | DOHC                                   | 575/350 kg                                                 | 1,268/772 lb.   | KX                          |
|            | DOHC                                   | 559/350 kg                                                 | 1,232/772 lb.   | KY                          |
|            | DOHC                                   | 560/350 kg                                                 | 1,235/772 lb.   | KB                          |
| ENGINE     | SOHC                                   | 555/350 kg                                                 | 1,224/772 lb.   | KF, KE                      |
|            | SOHC                                   | 550/350 kg                                                 | 1,213/772 lb.   | KW                          |
|            | SOHC                                   | 550/345 kg                                                 | 1,213/761 lb.   | KS                          |
|            | SOHC                                   | 545/345 kg                                                 | 1,202/761 lb.   | KW                          |
|            | SOHC                                   | 550/350 kg                                                 | 1,213/772 lb.   | KG                          |
|            | SOHC                                   | 585/350 kg                                                 | 1,290/772 lb.   | KQ                          |
|            | Max. Permissible Weight (EC)           | 1,290 kg                                                   | 2,844 lb.       | Ex. KS                      |
|            | Maximum Loaded Vehicle Weight          | 1,140 kg                                                   | 2,513 lb.       | KS                          |
|            | Carrying (Loading) Weight Capacity     | 1,370 kg                                                   | 3,020 lb.       | KY                          |
|            | Carrying (Loading) Weight Capacity     | 45 kg                                                      | 100 lb.         |                             |
| ENGINE     | Type                                   | Water cooled 4-cycle S.O.H.C.                              |                 |                             |
|            | Cylinder arrangement                   | Water cooled 4-cycle D.O.H.C.                              |                 |                             |
|            | Bore and Stroke                        | 4-cylinder in-line, transverse                             |                 |                             |
|            | Displacement                           | 75 x 90 mm                                                 | 2.95 x 3.54 in. |                             |
|            | Displacement                           | 1,590 cm <sup>3</sup> (cc)                                 | 97 cu. in.      |                             |
|            | Compression Ratio                      |                                                            |                 |                             |
|            | Without Catalytic Converter            |                                                            | 9.1             |                             |
|            | With Catalytic Converter               |                                                            | 9.5             |                             |
|            | Valve Train                            | 4-valves per cylinder, single or dual overhead camshafts   |                 |                             |
|            | Lubrication System                     | Pressure fed                                               |                 |                             |
| ENGINE     | Fuel Required                          | Unleaded gasoline with 95 research octane number or higher |                 |                             |
|            | DOHC with Catalytic Converter          | Unleaded gasoline with 91 research octane number or higher |                 |                             |
|            | SOHC with Catalytic Converter          | Unleaded gasoline with 91 research octane number or higher |                 |                             |
|            | Without Catalytic Converter            | Leaded gasoline with 97 research octane number or higher   |                 |                             |
|            | Without Catalytic Converter            |                                                            |                 |                             |
|            | Without Catalytic Converter            |                                                            |                 |                             |
|            | Without Catalytic Converter            |                                                            |                 |                             |
|            | Without Catalytic Converter            |                                                            |                 |                             |
|            | Without Catalytic Converter            |                                                            |                 |                             |
|            | Without Catalytic Converter            |                                                            |                 |                             |

Figure 8 - Honda Civic manual engine details p36

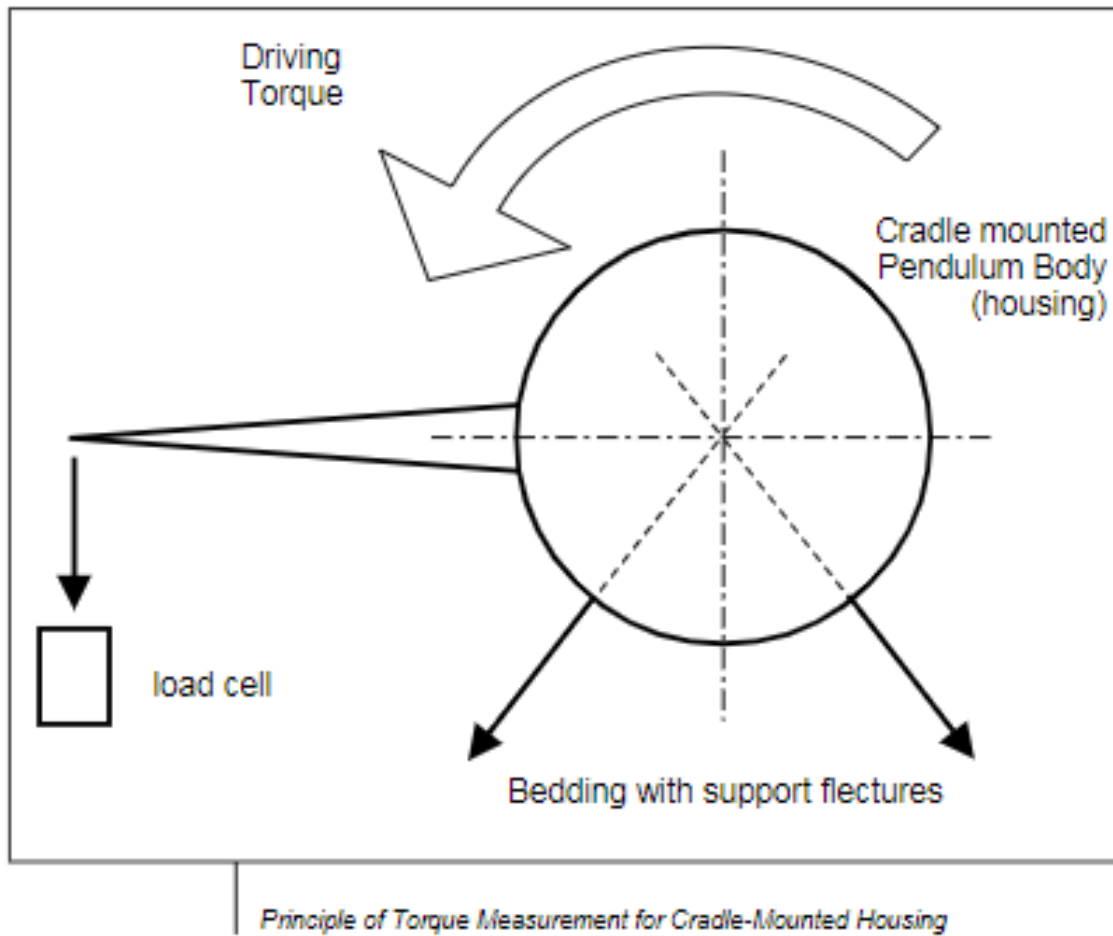


Figure 9 - Example of how torque is measured (Dadt, 2001)