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Exhaust Prototype Design of L12B Engine

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ABSTRACT
The CFD simulation test carried out on the prototype exhaust, produce an average fluid flow velocity value of 8.36 m/s, and the experimental test results using a flow bench engine on the prototype exhaust, produce an average fluid flow velocity value of 8.49 m/s, so the error comparison from the measurement results on the prototype exhaust between the CFD simulation and experimental results is 1.53%. Fluid flow velocity is a measurement reference in this study because it directly affects the scavenging effect on the internal combustion engine, which of course will directly affect the level of power generated by the engine.

Key words: Exhaust, Prototype, Design, Engine, L12B

1. INTRODUCTION

The world of racing/motorsports is a sport that combines the power of humans and machines to compete with each other on a racing track or circuit. The world of racing includes both car racing and motorbike racing, both of which require the physical fitness of a human being and the prime condition of the racing vehicle used, discussing the prime condition of a racing vehicle, then what is meant is how high the performance and reliability of each component installed on these vehicles [1-5].

These components include engine parts such as pistons, crankshafts, camshafts, connecting rods to the engine cooling components of the intercooler, components that are useful for control, such as suspension components which are divided into tie rods, suspension arms, steering racks, and even coil-over and its condition because it will affect the overall performance of the vehicle, the components that are useful for the exhaust process are also considered for their performance and physical condition, one of the components that is part of the exhaust component is the exhaust system or exhaust [6-7].

However, the advancement of computational technology has been significantly developed, almost all engineering cases can be solved using computer simulation analysis. Therefore the use of computational technology is used in this research. The use of computational technology in this research is the use of computational fluid dynamics software or abbreviated as CFD [8-12].

The use of CFD cannot be done without the knowledge of the basics of simulation using CFD, there are several parameters that must be met so that the CFD simulation results can produce research results that have high accuracy (around 95%). The determining factor is the quality of the mesh, the quality of the mesh really determines the merits of the simulation results using CFD, and there are 4 main parameters that need to be met to produce an acceptable mesh quality.

In this research, the L12B engine was chosen to be the reference sample in this racing exhaust design research because the car that uses the L12B coded engine is participating in the one-make race event at ISSOM-HBSC 2020 (Indonesia Sentul Series Of Motorsport - Honda Brio Speed Challenge). The strict regulations in the ISSOM-HBSC racing event prohibit tuners from upgrading the engine and the legs (suspension), but upgrading the exhaust is not prohibited by regulations, this loophole in regulations is used to carry out this final project research as well as improve the overall performance of the car [13-18].

By optimizing the exhaust design that is suitable for racing needs and in accordance with the characteristics of the L12B engine, it is hoped that the final results of this study can increase engine power which will lead to greater opportunities for drivers to reach the podium in the ISSOM-HBSC 2020 event. In brief, literature carried out, in a number of automotive engineering books and automotive scientific journals it was found that the difference in the diameter and length of an automotive component that functions to flow fluids, both gaseous and liquid, will affect the characteristics of the fluid flowing in these components. Differences in fluid characteristics will result in differences in performance. [12, 14]

So that it can lead to the initial hypothesis, if the difference in the diameter and length of an automotive component that flows the fluid will result in a difference in performance, then if it is implemented to the exhaust system or exhaust components, it is likely that it can affect the characteristics of the combustion fluid that is disposed of by the exhaust and of course it will affect the overall engine performance.

Something that affects engine performance can have two possibilities, namely an increase in engine performance or a decrease in engine performance due to its influence on fluid characteristics.

In an internal combustion engine type car engine, the impact of the flowing exhaust fluid will affect the scavenging effect cycle that occurs in the combustion chamber when the engine is in working mode. This is based on the basic work of the internal combustion engine, which requires three main elements, namely gasoline, air and fire in order to do work.

2. MATERIALS AND METHODS

In this research, the initial hypothesis has been established, the research steps for racing exhaust design begin with measuring the width of the exhaust head port dimensions on the L12B engine block, this is done so that the dimensions of the exhaust head port can be used as a reference in the 3D process of modelling the exhaust downpipe or exhaust downpipe using CAD software, this is done so that the downpipe is made to match the exhaust size head port on the L12B engine so that the downpipe can be attached to the exhaust head port of the L12B engine.

a

b

c

Figure 1: (a) Exhaust head port for L12B engine on the engine block, (b) measure exhaust head port diameter with callipers, (c) photo of the L12B engine block as a whole.

Based on Figure 1, the measurement results using callipers show that the diameter of the exhaust head port on the L12B engine block has a size of 85.7mm. The measurement process on the L12B engine block can only be carried out after the car has undergone a thorough condition inspection and the car engine is lowered for maintenance needs.

3. RESULTS AND DISCUSSION

After the sample version racing exhaust design process is complete, then the prototype racing exhaust design is carried out which has a contour and exhaust shape that resembles the factory default exhaust on an L12B-engined car. However, the prototype exhaust does not use components such as a catalytic converter, resonator and muffler as in a standard exhaust, then the exhaust pipe diameter on the prototype exhaust is made 1.5 inches from start to finish.

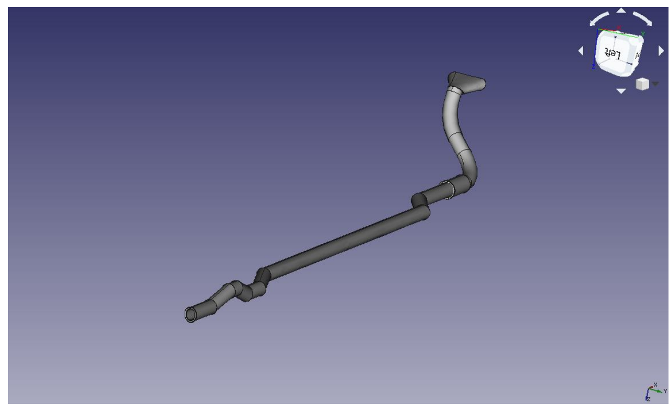

Figure 2: Prototype Exhaust

The prototype exhaust in Figure 2 is made in such a way with additional modifications to the width of the exhaust pipe diameter which is reduced to 1.5 inches from the standard factory default exhaust pipe size which is close to 1.75 inches, as well as being designed with exhaust contours that are adjusted to the bottom of the Honda Brio car chassis so that in other words, the prototype exhaust made in this study is only suitable for use on the Honda Brio and will not be suitable when paired with other cars. The prototype exhaust made has an overall length of 2795.28mm or 2.8 meters, as shown in Figure 3.

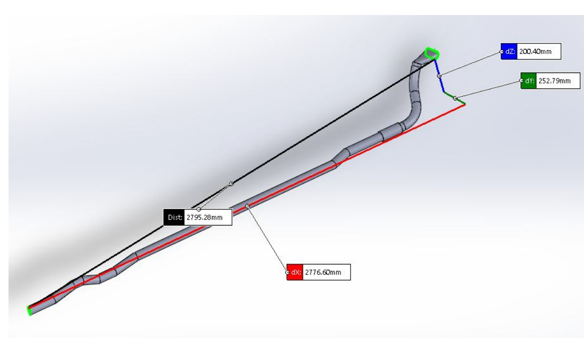

Figure 3: Length of prototype exhaust

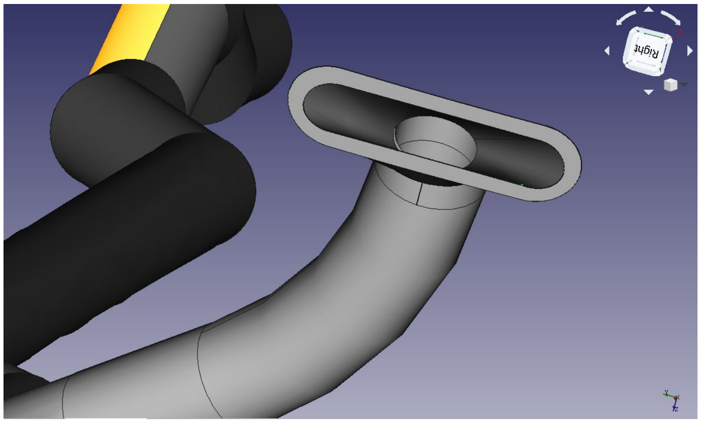

Figure 4: Head exhaust on prototype exhaust

Based on Figure 4, the exhaust head is made to more or less resemble the head exhaust port on the L12B engine, with a size of 85.7 mm.

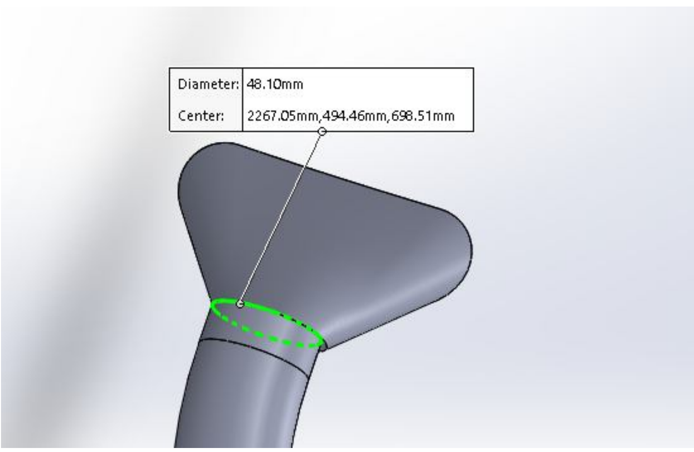

Figure 5: Downpipe after the head exhaust

Figure 5 showed that the outer diameter on the downpipe has an outer diameter of 48.1 mm, with an inner diameter of 38.1 mm or equal to 1.5 inches. In other words, the prototype exhaust has a wall thickness of 10 mm.

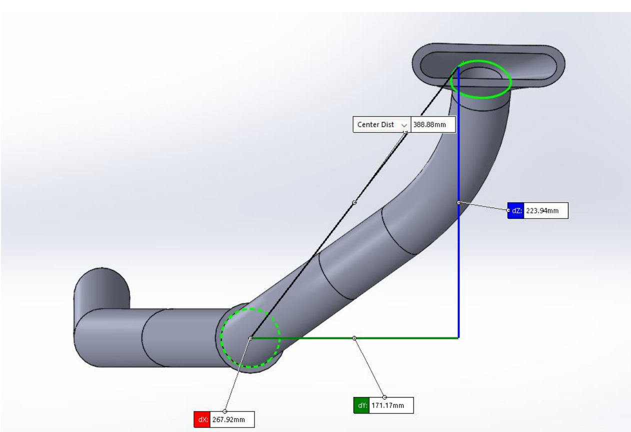

Figure 6: Length of the head exhaust to the flexible

Figure 6 showed that the length of the head exhaust towards the flexible exhaust is 388.88 mm.

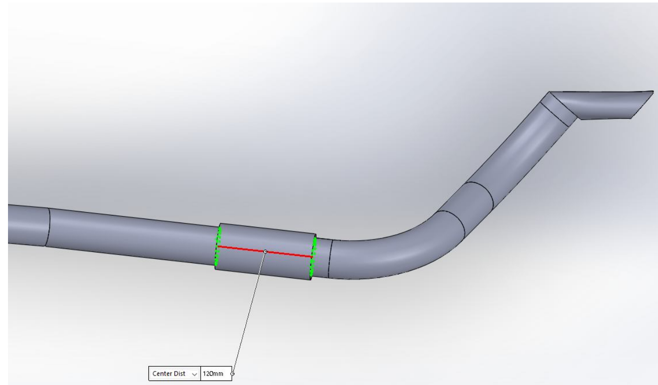

Figure 7: Flexible component

Flexible components are useful for dampening vibrations that are too high when the exhaust flow passes through the downpipe so as not to cause cracks in the exhaust structure, according to Figure 7 the flexible size of the prototype exhaust is 120 mm.

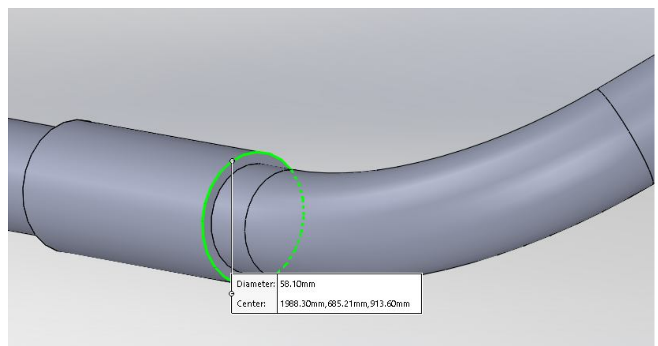

Figure 8: Flexible component thickness on prototype exhaust

The flexible component has an outer diameter of 58.1 mm, according to figure 18, while the flexible inner diameter has a diameter of 48.1 mm as in Figure 8 and Figure 9.

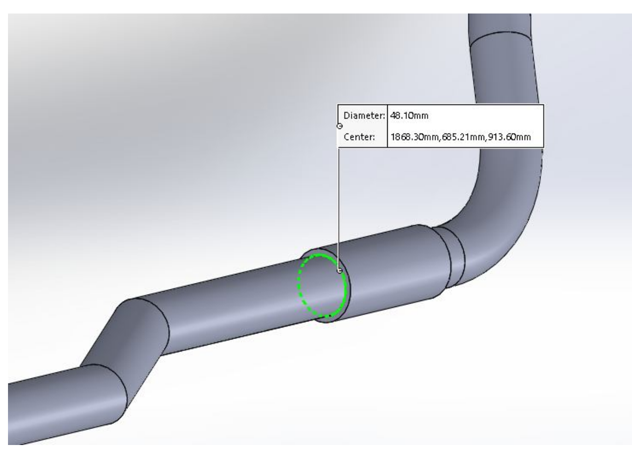

Figure 9: Diameter flexible components

Another component that will be discussed in detail about its size is the exhaust pipe after being flexible. The pipe has a slight turn before entering the center of the exhaust pipe, with an overall length of 343.66 mm, according to Figure 10.

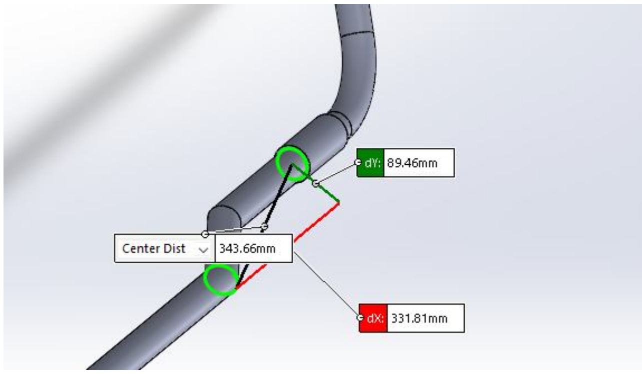

Figure 10: Exhaust pipe after flexible

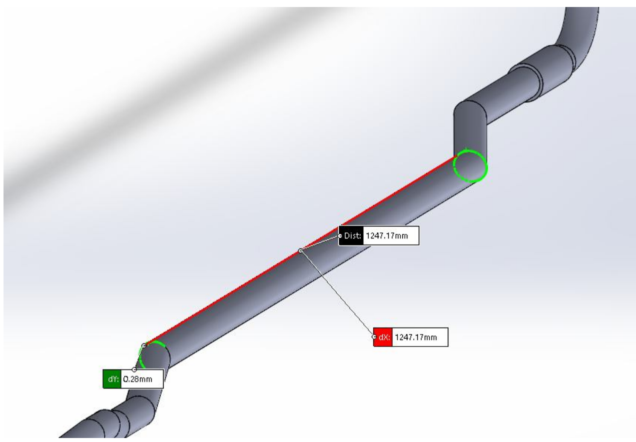

Figure 11: The center of the exhaust

Based on Figure 11, the center of the exhaust has a pipe length of 1247.17 mm. This long and straight part is thought to be prone to backpressure.

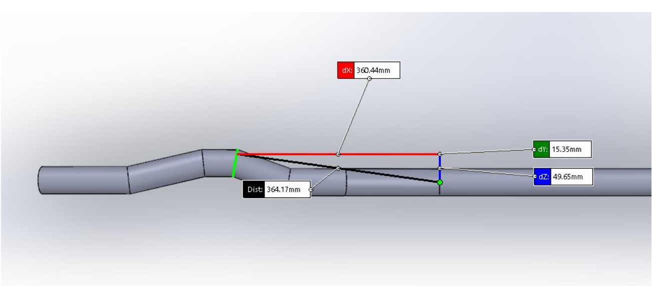

Figure 12: Exhaust pipe after the center

Then after the center of the exhaust, there is a pipe section that has a length of 364.17 mm according to Figure 12.

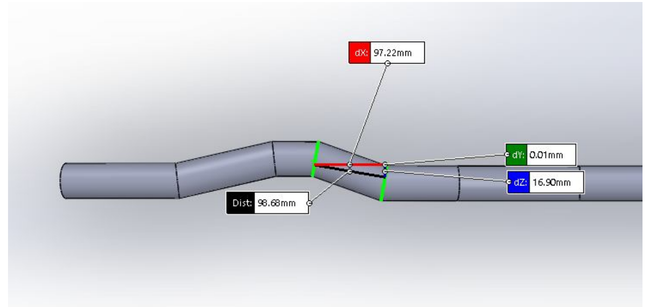

Figure 13: The exhaust pipe slightly increases or elevations

One unique part of the prototype exhaust is the slight increase or elevation of 98.68 mm, the reason for this is because of the need for space for the axle of the car, so in other words, the exhaust will be in a position above the axle of the car (Figure 13). Given space on the car's axle, a pipe length of 49.89 mm is required according to Figure 14 to provide enough space for the car's axle so that there will be no contact between the car's axle and exhaust.

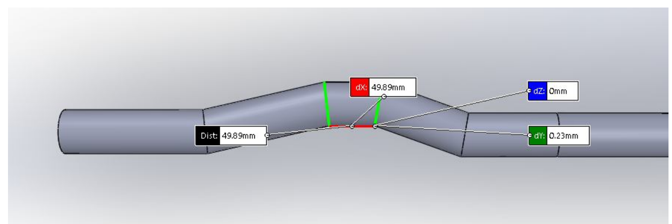

Figure 14: 49.89 mm pipe that is on the axle of a car

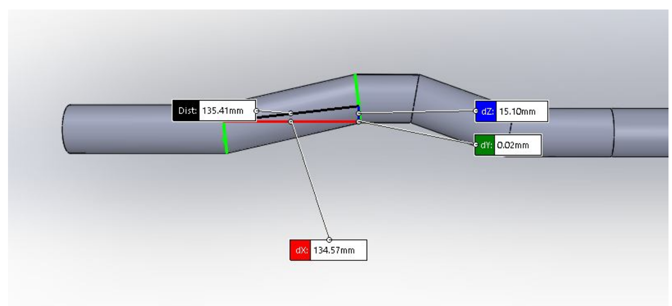

Figure 15: 135.41 mm pipe that is on the axle of a car

To adjust the exhaust to return to its center after being forced to make room on the axle, a 135.41 mm downhill pipe was created. Then the final part or exhaust tip on the prototype exhaust has a length of 144.51 mm (Figure 15 and Figure 16).

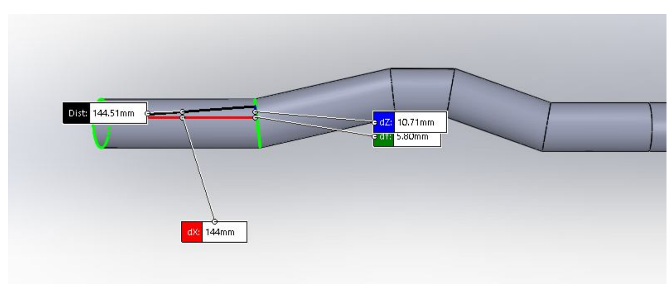

Figure 16: An exhaust tip

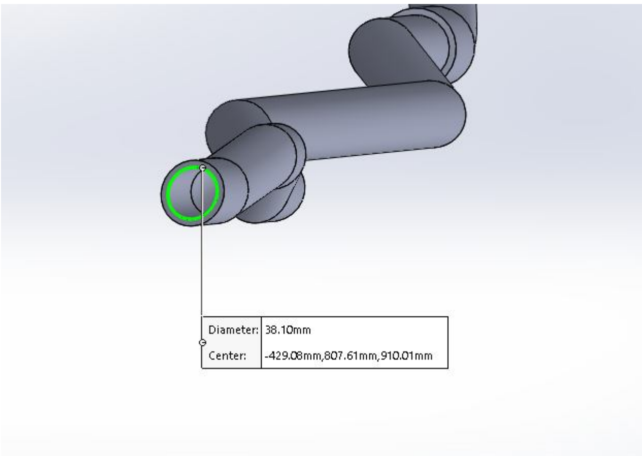

Figure 17: The width of the diameter on the exhaust pipe

On the exhaust tip or the end of the exhaust, it is proven that the inner diameter size of the prototype exhaust is 38.1 mm. This prototype exhaust is a representation of the prototype exhaust made in this study (Figure 17).

4. CONCLUSION

Utilization of CAD software in the design of l12B engine-specific racing exhaust proved effective and appropriate in meeting the research timeline. In the 3D design process, the exhaust model using CAD software proved that the difference in exhaust pipe diameter between 1.5 inches (Sample Exhaust A) was able to produce an average fluid flow speed of 15.43 m/s, while for 1.75 inches, it was only able to produce an average fluid flow speed of 12.79 m/s as measured by CFD simulation software.

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