DESIGN AND FABRICATE TEST RIG STRUCTURE FOR AN AUTOMOTIVE TURBOCHARGER TESTING APPARATUS

DAELAMI BIN AMINUDDIN

Report submitted in partial fulfillment of the requirements
for the award of Diploma in Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

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SUPERVISOR DECLARATION

I hereby declare that I have read this project report and in my
Opinion this project report is sufficient in terms of scope and
Quality for the award of the Diploma in Mechanical Engineering

Signature : …………………………………………….
Supervisor name : EN. ISMAIL BIN ALI
Date : …………………………………………….

FAKULTI KEJURUTERAAN MEKANIKAL
UNIVERSITI MALAYSIA PAHANG
LEBUHRAYA TUN RAZAK, 25000, GAMBANG
KUANTAN PAHANG DARUL MAKMUR.

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DECLARATION

I declare that this thesis entitled “Design and Fabricate Test Rig Structure for an Automotive Turbocharger Testing Apparatus” is the result of my own study except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree

Signature : …………………………………

Name : DAELAMI BIN AMINUDDIN

Date : ………………………………...

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ABSTRACT

This project focuses in design and fabricates the main structure for turbocharger testing apparatus. To achieve the project objective, the test rig structure must be design and suitable for place the turbocharger testing apparatus. The test rig structure should be fabricated using welding process and some laboratory skills. This project flow must start from study, design, and lastly fabrication process. Before fabricate the test rig structure, a study has been made for the design by searching information from the internets, reference books and journal magazines. It is important to study about the test rig structure because, to get the basic information about the test rig structure design. The fabrication process for this project must through a lot of process that must be followed step by step. This is to ensure that the design that has been fabricated followed the design specification. These test rig structure will combine with the turbocharger testing apparatus that has been fabricate by other final year student. The turbocharger testing apparatus consists of turbocharger itself, variable speed pump and piping system. The variable speed pump is the power source to working the turbocharger testing apparatus. The test rig structure is available for any addition in the future. The structure was design to have the extra space for any application addition such as computer that can analysis and produce data for the air flow in the turbocharger testing apparatus.

ABSTRAK

Mereka bentuk dan mencipta struktur badan untuk sistem ujian pengecas turbo merupakan tajuk yang telah dicadangkn oleh pensyarah FKM iaitu En. Ismail B. Ali. Projek ini hanya memfokuskan terhadap mereka bentuk dan menghasilkan struktur badan utama untuk meletakkan sistem pengecas turbo. Bagi mencapai objektif projek ini, struktur badan hendaklah direka dan sesuai untuk menempatkan sistem ujian pengecas turbo. Struktur badan ini boleh dihasilkn dengan meggunakan proses menimpal dan beberapa kemahiran makmal. Projek ini perlu dijalankan bermula dari proses analisis bentuk, mereka bentuk dan mencipta. Sebelum memulakan proses membentuk, satu proses mencari maklumat telah dijalankan melalui internet, buku rujukan dan majalah jurnal, ini adalah untuk mendapatkan maklumat asas untuk struktur badan yang akan dicipta. Proses mencipta melalui beberapa langkah yang perlu dituruti secara tersusun, ini adalah untuk memastikan hasil pembuatan akan mengikut spesifikasi rekacipta. Struktur badan ini akan dicantumkan dengn sistem ujian pengecas turbo yang telah dihasilkan oleh pelajar tahun akhir yang lain. Sistem ujian pengecas turbo terdiri daripada pengecas turbo itu sendiri, pam pelbagai laju dan sistem paip. Pam pelbagai laju merupakan punca kuasa yang menghidupkan dan menjalankan sistem pengecas turbo. Struktur badan ini juga boleh ditambah penggunaan pada masa akan datang. Struktur badan ini telah direka untuk mempunyai tempat yang lebih untuk penambahan aplikasi seperti computer yang boleh menganalisis dan menghasilkan data tentang pergerakan angina di dalam sistem pengecas turbo.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

The purpose of the project is to design and fabricate test rig structure for an automotive turbocharger testing apparatus. This test rig structure should be able to stand the turbocharger air flow piping that will contain four important parts which are turbocharger, pump, intercooler and pipe. In this project, the test rig structure has been design and fabricate to a simple and easy-move body. As the Diploma Final Year project allocates the duration of one semester, this project need combination of knowledge and skills to handle several machine such as bending machine, drill machine, welding machine, grinding machine and others.

This project involves the fabrication of test rig structure with specification regarding the strength, material and cost. Tests are required on the new design and fabrication to get a perfect result.

In University Malaysia Pahang (UMP) doesn’t have the test rig structure for an automotive turbocharger testing apparatus. From this problem, came out an idea to design and fabricate a new test rig structure.

1.2 Project Scopes

a) To design a simple and compact test rig structure that can be use by other students and lecturer.

b) The test rig structure consists of turbocharger mechanism that contains the turbocharger itself, variable speed pump, intercooler and pipe. So, can do an experiment to study the pressure from the air flow and how the whole component working.

1.3 Project Objective

Objectives that are needed to achieve are:

a) Design and fabricate test rig structure for an automotive turbocharger testing apparatus.

b) Design a multifunction test rig structure, means that, there are other components can be added in the future because of the extra spaces.

1.4 Gantt Chart

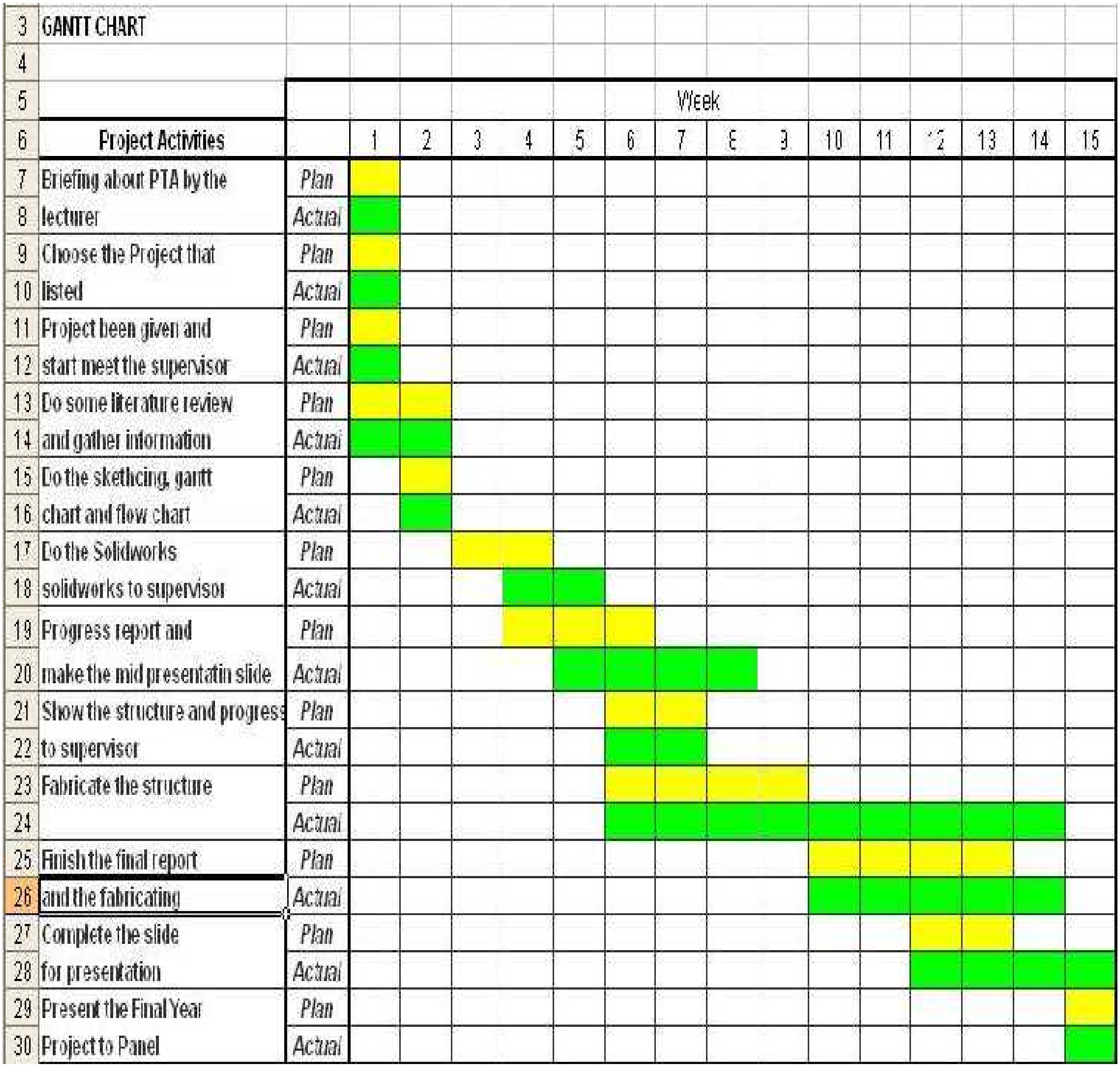


Figure 1.1: Gantt chart

1.5 Flow Chart

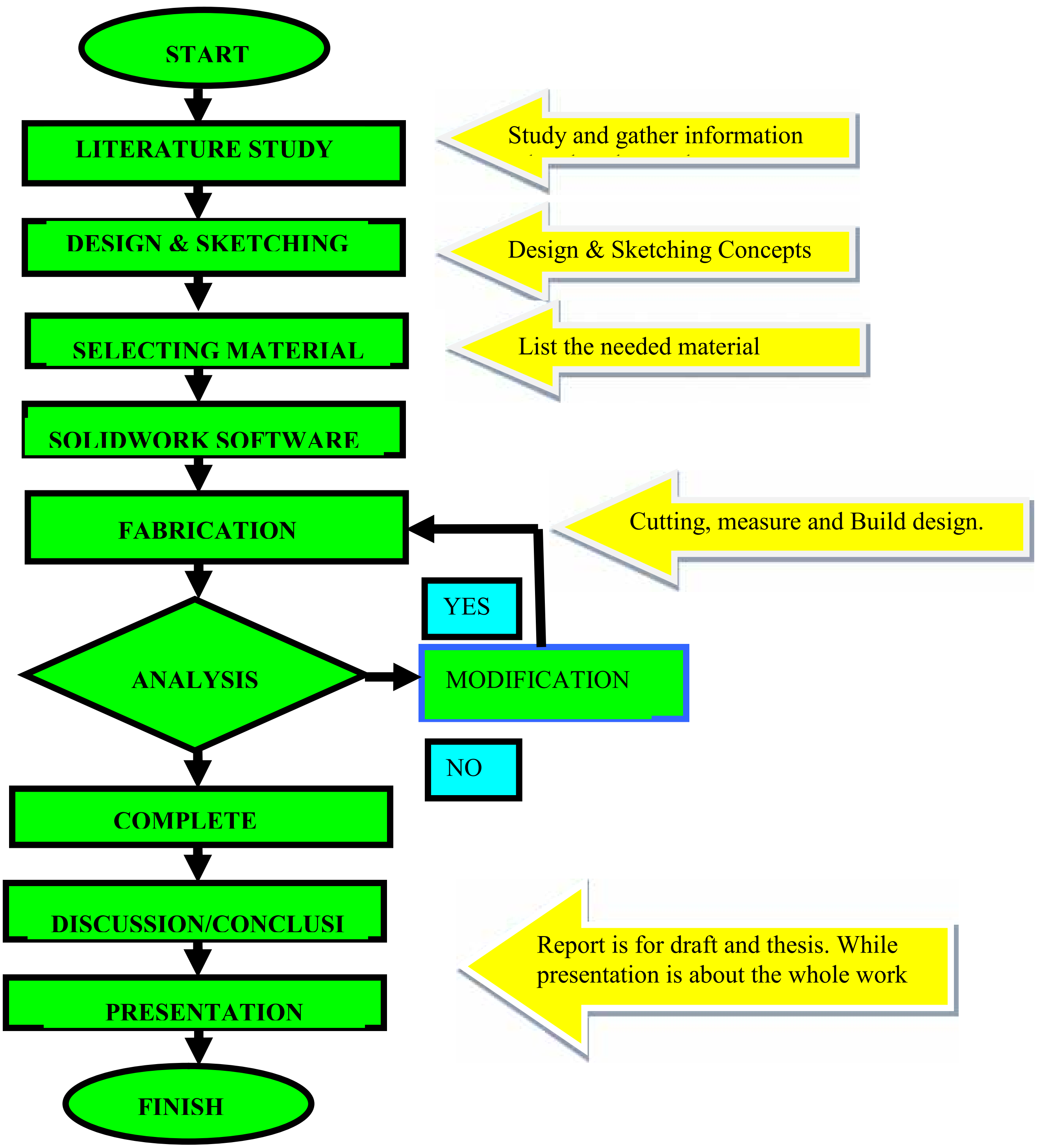


Figure 1.2: Flow Chart

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Turbocharger Test Rig Structure

The test rig structure is the main structure for the turbocharger testing apparatus. The turbocharger testing apparatus contains of three main parts that is a turbocharger, intercooler and variable speed pump. The turbocharger test rig include of piping that connect the turbocharger, intercooler and pump with each other. The air that produce by the pump will flow through this pipe and the whole component will work. The pump have a variable speed, so to make an experiment about the pressure and air flow, we just change the speed that needed.

The test rig turbocharger functions are to study and experiment how the turbocharger and other components working together. This test rig turbocharger is the simple and easiest way to study about the real turbocharger that working in the vehicle, and encourage the students about the turbocharger testing apparatus. (Refer figure 2.1).

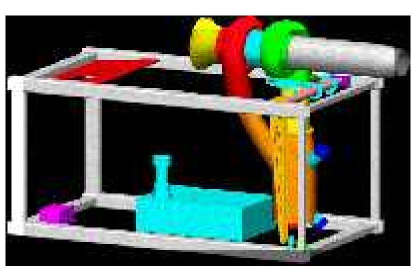


Figure 2.1: Example of turbocharger test rig

Turbocharger

A turbocharger is a device that makes power by forcing air into the engine. By compressing air, the turbocharger squeezes air into the engine, which also brings in more fuel. More fuel and more air mean bigger explosions in each cylinder. And more explosions mean more power to the engine.

A turbocharger consists of a turbine and a compressor linked by a shared axle. The turbine inlet receives exhaust gases from the engine causing the turbine wheel to rotate. This rotation drives the compressor, compressing ambient air and delivering it to the air intake manifold of the engine at higher pressure, resulting in a greater amount of the air entering the cylinder. In some instances, compressed air is routed through an intercooler before introduction to the intake manifold.

The objective of a turbocharger is the same as a supercharger; to improve upon the size-to-output efficiency of an engine by solving one of its cardinal limitations. A naturally aspirated automobile engine uses only the downward stroke of a piston to create an area of low pressure in order to draw air into the cylinder through the intake valves. Because the pressure in the atmosphere is no more than approximately 14.7 PSI, there ultimately will be a limit to the pressure difference across the intake valves and thus the amount of airflow entering the combustion chamber. This ability to fill the cylinder with air is its volumetric efficiency. Because the turbocharger increases the pressure at the point where air is entering the cylinder, a greater mass of air will be forced in as the inlet manifold pressure increases. The additional air makes it possible to add more fuel, increasing the power and torque output of the engine.

2.1.2 How Do Turbocharger Work

A turbocharger is an exhaust-driven air compressor. It becomes an air compressor by utilizing expanded exhaust gases from the engine. The exhaust gas pressure and the heat energy extracted from the gas causes the turbine wheel to rotate, thus driving the compressor wheel through a common shaft. Exhaust temperature and pressure drop as they pass through the turbine housing and into the atmosphere. The rotating compressor wheel draws air in and the blades accelerate and expel the air into the compressor housing. Once into the compressor housing, the air is compressed and flows toward the intake manifold, pressurizing the intake in a measurable form we call boost pressure. (Refer Figure 2.2)

1. Turbine Section: the spinning wheel and blades that are attached to a compressor.
2. Compressor Section: a fitted wheel in an enclosed housing that spins rapidly, raising the air pressure.
3. By raising the air pressure, more air can be forced into the engine's fuel intake system.
4. Wheel shaft: the shaft that rotates between the turbine and the compressor.
5. Bearing system: the system that lubricates and cools the wheel and shaft.

Figure 2.2: Example of turbocharger

Intercooler

Intercooler system ensures much lower engine operating temperatures. The turbo charger function is to compress and force a greater volume of air into the engine, producing more power. It is a basic law of physics, the temperature will increase when the air compress.

Passing a compressed and heated intake charge through an intercooler reduces its temperature (due to heat rejection) and pressure (due to flow restriction of fins). If properly engineered, the net result is an increase in density. This increases system performance by recovering some losses of the inefficient compression process by rejecting heat to the atmosphere.

An intercooler cools the air sufficiently in order to improve engine performance as well as prolong the working life of the engine.

The engine is in effect a type of air pump. It is a constant volume pump; this means that for any constant speed, a specific volume rate of air passes through the engine. The rate of air flowing through the engine is only dependent on engine speed. As a result the mass flow rate of air flowing through the engine is mainly dependent on the temperature of the air. At higher temperatures, the air is less dense and for the same volume, there is a smaller mass of air. The reverse is true for cold air.

By cooling the air that flows into the engine, increases the mass of air flowing into the engine. A higher mass of air means more fuel can be burnt in a single combustion stroke and more power is produced per stroke. Obviously, the downside to this is that any object placed in the stream disturbs the airflow pattern and hence reduces the amount of air that can be passed. Although this is true for older intercooler designs, the newer intercoolers have been designed with flow efficiency in mind, and as such flow restrictions are minimized. Hence, in modern day terms, the gains to be had using an intercooler far outstrips any disadvantages.

Intercoolers are usually placed between the turbo and the engine air inlet. Compressing the air adds a lot of energy to it which makes it fairly hot, by cooling it this increases the density of the air cramming more air per volume. This increases the performance and efficiency of the engine. (Refer Figure 2.3).

Figure 2.3: Example of intercooler

2.2 Welding

2.2.1 Introduction

Welding is a fabrication process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the weld puddle) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the work pieces to form a bond between them, without melting the work pieces.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding can be done in many different environments, including open air, underwater and in outer space. Regardless of location, however, welding remains dangerous, and precautions must be taken to avoid burns, electric shock, eye damage, poisonous fumes, and overexposure to ultraviolet light.

2.2.2 Arc Welding

These processes use a welding power supply to create and maintain an electric arc between an electrode and the base material to melt metals at the welding point. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes. The welding region is sometimes protected by some type of inert or semi-inert gas, known as a shielding gas, and filler material is sometimes used as well. (Refer figure 2.4).

Figure 2.4: Example of arc welding

2.2.3 Metal Inert Gas

Gas metal arc welding (GMAW), sometimes referred to by its subtypes metal inert gas (MIG) welding or metal active gas (MAG) welding, is a semi-automatic or automatic arc welding process in which a continuous and consumable wire electrode and a shielding gas are fed through a welding gun. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used. There are four primary methods of metal transfer in GMAW, called globular, short-circuiting, spray, and pulsed-spray, each of which has distinct properties and corresponding advantages and limitations. (Refer Figure 2.5 and Figure 2.6).

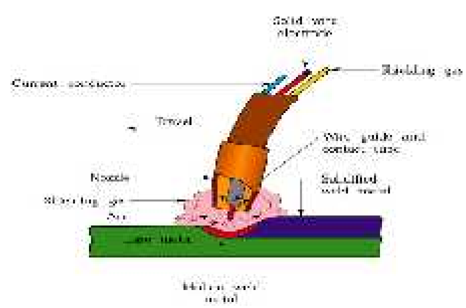


Figure 2.5: Example structure of metal inert gas welding

Figure 2.6: Example of metal inert gas welding

2.3 Drilling

2.3.1 Introduction

A drill is a tool with a rotating drill bit used for drilling holes in various materials. Drills are commonly used in woodworking and metalworking. The drill bit is gripped by a chuck at one end of the drill, and it pressed against the target material and rotated. The tip of the drill bit does the work of cutting into the target material, slicing off thin shavings (twist drills or auger bits) or grinding off small particles (oil drilling).

2.3.2 Drill Press

A drill press (also known as pedestal drill, pillar drill, or bench drill) is a fixed style of drill that may be mounted on a stand or bolted to the floor or workbench. A drill press consists of a base, column (or pillar), table, spindle, and drill head, usually driven by an inductor motor. The head has a set of handles (usually 3) radiating from a central hub that, when turned, move the spindle and vertically, parallel to the axis of the column. The table can be adjusted vertically and is generally moved by a rack and pinion; however, some older models rely on the operator to lift and re-clamp the table in position.

The table may also be offset from the spindle's axis and in some cases rotated to a position perpendicular to the column. The size of a drill press is typically measured in terms of *swing*. Swing is defined as twice the *throat distance,* which is the distance from the center of the spindle to the closest edge of the pillar. For example, a 16-inch drill press will have an 8-inch throat distance.

A drill press has a number of advantages over a hand-held drill:

- Less effort is required to apply the drill to the work piece. The movement of the chuck and spindle is by a lever working on a rack and pinion, which gives the operator considerable mechanical advantage.

- The table allows a vice or clamp to position and lock the work in place making the operation secure.
- The angle of the spindle is fixed in relation to the table, allowing holes to be drilled accurately and repetitively.

Speed range is achieved by manually moving a belt across a stepped pulley arrangement. Some drill presses add a third stepped pulley to increase the speed range. Modern drill presses can, however, use a variable-speed motor in conjunction with the stepped-pulley system; a few older drill presses, on the other hand, have a sort of traction-based continuously variable transmission. (Refer Figure 2.7).

Figure 2.7: Drilling machine

CHAPTER 3

METHODOLOGY

3.1 Design

3.1.2 Introduction

The design of the turbocharger test rig must fulfill all the criteria needed before being produced or fabricate. It is important to produce a product that is multifunction and compact. The best design has been choosing among the other designs that have a different concept from each other. The aspect must be considered in designing the test rig structure are:

- Durability : The test rig structure must be durable when fill with the turbocharger testing apparatus.
- Material : The materials that will be used must be suitable to fabricate the test rig structure.
- Cost : It depends on material and manufacturing process should reduce the cost to the minimum.

3.2 Design Specification

Turbocharger test rig structure (main body)

No.	Materials	Length (mm)	Unit
1	1 ½ x 1 ½ inches hollow steel bar	900	12
2	1 x 1 inches hollow steel bar	900	2
3	3 inches wheel	-	4

Table 3.1: Design specification for test rig structure

Turbocharger stand

No.	Materials	Length (mm)	Unit
1	1 ½ x 1 ½ inches hollow steel bar	900	1
2	1 x 1 inches hollow steel bar	65	1
3	Steel plat, 5mm thick	150 x 75	1
4	Steel plat, 5mm thick	125 x 30	1
5	Galvanize iron, 2mm thick	500 x 400	1
6	Bolt and nut	-	4

Table 3.2: Design specification for turbocharger stand

3.3 Fabrication Process

Next, after finish designing the turbocharger test rig structure and choose the best design concept, the fabrication process may be start by using the suitable raw material according to the product dimension. There are lot of method can be used to fabricate this project. Manufacturing Process is a collection of technology and methods used in the manufacturing defines when and how it is to be made. Fabrication process is a process to make only one product rather than manufacturing process that focus on the large scale production .The manufacturing and fabricating process differentially by quantity of product producing. In this project, the design is to make a real apparatus and can be used fully at the end.

3.4 Fabricate Process

No.	Process	Explanation
1	Measuring	Measure the part / material based on the specification design.
2	Marking	Mark the material after measuring.
3	Cutting	Cut the raw material followed the dimension.
4	Filling	Remove the sharp edge at the component.
5	Assembly	Assemble all the part/component.

Table 3.3: Fabricate process

3.5 Fabrication Method

Hollow steel bar is the main material that use for this project, which is for structure or main body for turbocharger test rig. The fabrication processes start with measuring the material needed according to the design dimension by using tape scale. After mark the materials with L square and marker pen, need to ensure that the measuring is followed the design dimension.

The next step is to cut the material with disc cutter and cut it according to the design needed. After the cutting process is completed, the sharp edge at the end of the material must be filled by using hand grinder or angle grinder. (Refer Figure 3.1).

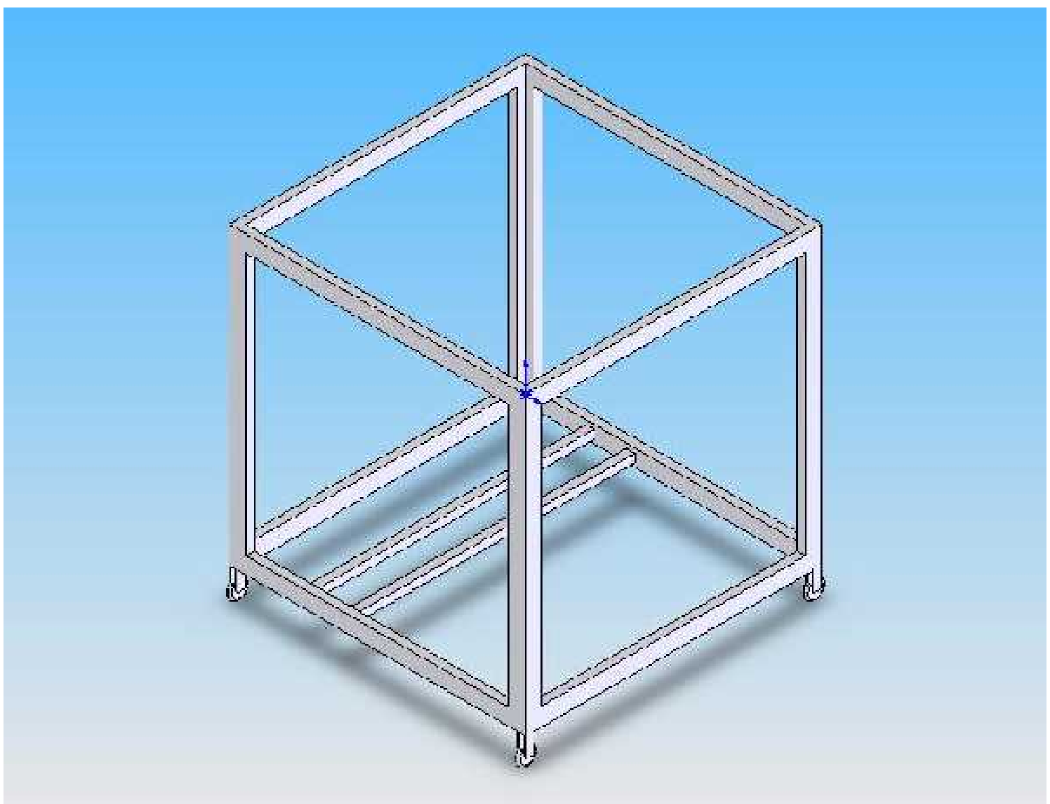


Figure 3.1: Design of main body

Figure 3.2: Cutting material using disc cutter

i. Cut the 1 ½ x 1 ½ inches hollow steel bar by using disc cutter and cut it to 12 pieces.
ii. Cut the 1 x 1 inches hollow steel bar and cut it to 2 pieces.
iii. The length for each pieces are 900mm. (Refer to Figure 3.2).

Figure 3.3: Grinding process

i. Filled the sharp edge by using hand grinder or angle grinder.
ii. This step is to clean up the material from burr and rust.
iii. To get a great and precise measurement of work piece according to design specification. (Refer to Figure 3.3).

After all the materials have been cut, the assembly process can be started. In this assembly processes, it is important to make sure the best step to assemble work pieces. The best way to assemble the work pieces is start assemble from the base or the foundation of the structure. To assemble all the work pieces, it is prefer to use arc welding and metal inert gas (MIG) welding. These two kinds of welding are the best ways to connect all the work pieces and stand the force that action on the body or structure after assemble.

3.5.1 The Steps for Test Rig Structure

Figure 3.4: Set the frequency power of arc welding machine

i. Turn on the main power of the arc welding machine.
ii. It's important to set the right frequency and suitable for the material that is going to weld.
iii. Put the rod on the top of welding head and start welding. (Refer to Figure 3.4).

Figure 3.5: Assemble the work pieces

i. Assemble four pieces of hollow steel bar to produce a square.
ii. This square will be the foundation or base.
iii. Produce this square for two parts. (Refer to Figure 3.5).

Figure 3.6: Welding the hollow steel bar on the base/foundation

i. Welding a hollow steel bar on the top and the end of the base/foundation.
ii. Do these step four times to produce a square with four hollow steel bars on the base. (Refer to Figure 3.6).

Figure 3.7: Combine all parts

i. Put the another square that has been assemble before on the top of the hollow steel bars and assemble those part using arc welding.
ii. Attached two hollow steel bar (1 x 1 inches) on the below surface and middle of the body. As the turbocharger stand foundation. (Refer to Figure 3.7).

Figure 3.8: Attached wheels to the body

i. Welding four wheels to the body.
ii. Two flexible wheel as the front wheel and two fix wheel as the rear wheel.
iii. Easy to move anywhere.
iv. Finally a complete structure or body part has been produced. (Refer to Figure 3.8).

The next step is to produce a turbocharger stand. This turbocharger stand is not attached together with the main body because it can be place anywhere in the test rig body and it also flexible. The turbocharger need to stand at the middle of the test rig, that's the main point why the turbocharger stand is produced. (Refer to Figure 3.9).

There are several steps to produce the turbocharger stand. As usual, measure the material and marking using L square and marker pen. Need to ensure that the measuring is following the design dimension before start the cutting process. Cut the material with disc cutter and cut it according to the design needed. After the cutting process is completed, the sharp edge at the end of the material must be filled by using hand grinder or angle grinder.

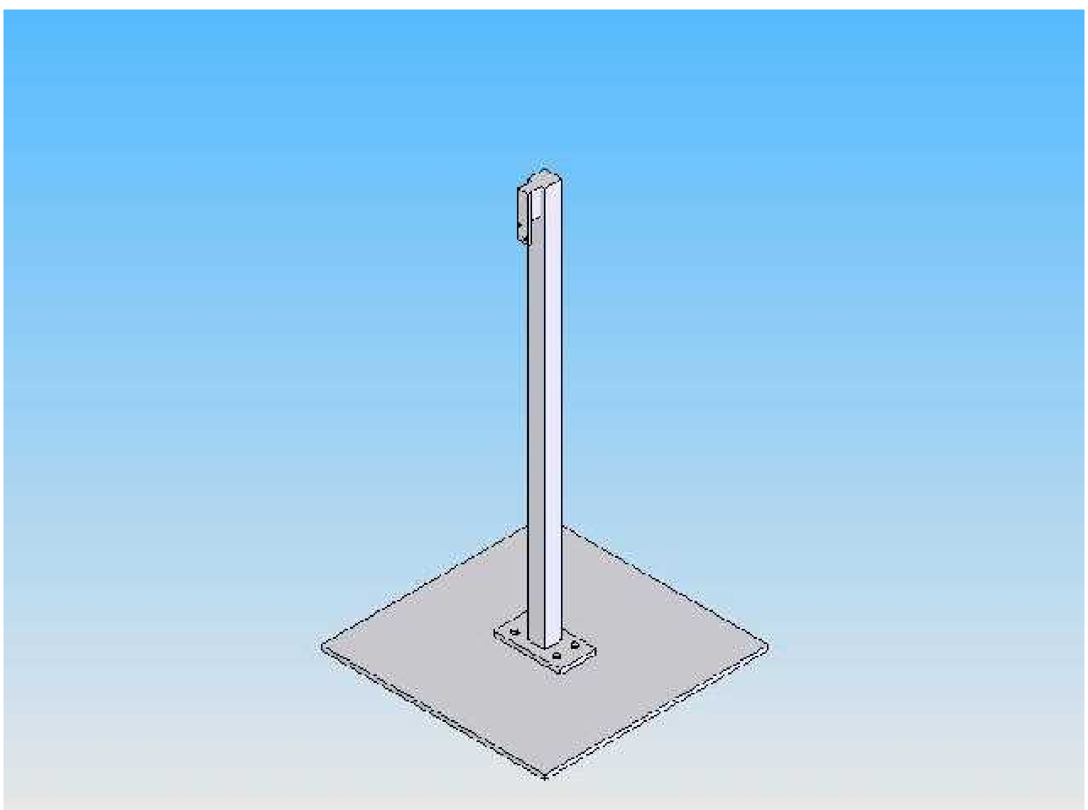


Figure 3.9: Design of turbocharger stand

3.5.2 The Steps for Turbocharger Stand

Figure 3.10: Cut the materials follow design specification

i. Cut the 1 ½ x 1 ½ inches hollow steel bar by using disc cutter.
ii. Cut the 1 x 1 inches hollow steel bar by using disc cutter. (Refer to Figure 3.10).

Figure 3.11: Hand grinder

i. Cut both two steel plates according to design specification by using hand grinder. (Refer to Figure 3.11).

Figure 3.12: Sheering machine

i. Cut the galvanize iron by using sheering machine.
ii. Press the button using foot to cut the galvanize iron plate. (Refer to Figure 3.12).

After that, two plates and galvanize iron that have been cut follow the design specification need to drill to make the holes. Drilling machine is use to make this holes, but before do the drilling process, it’s important to calculate the RPM needed. The RPM are different for different diameter of tools that are going to use.

Figure 3.13: Set the rpm at the drilling machine

i. Calculate the RPM needed according to the diameter of tool that is going to use.
ii. Key in the RPM using the round button. (Refer to Figure 3.13).

Figure 3.14: Drilling process

i. Drilling process (Steel plate, 5mm thick, 150 x 75).
ii. Find the suitable point to make the holes.
iii. Mark four points on the steel plate using marker pen.
iv. Use a hammer and scriber to thick the point.
v. Use a 10mm diameter drill.
vi. The plate is ready for drilling. (Refer to Figure 3.14).

Figure 3.15: After drilling process

i. This is last result after the drilling process.
ii. Make sure that the position of the holes follows the design specification. (Refer to Figure 3.15).
iii.

Figure 3.16: Drilling process

i. Mark two points follow to the turbocharger holes condition.
ii. Use a hammer and scriber to thick the point.
iii. Use an 8mm diameter drill.
iv. Key in the RPM needed
v. The plate is ready for drilling. (Refer to Figure 3.16).

Figure 3.17: After drilling process

i. This is last result after the drilling process
ii. Make sure that the position of the holes follows the turbocharger holes. (Refer to Figure 3.17).

Figure 3.18: Mark the point

i. Put the 150mm x 75mm steel plate on the center point of the galvanize iron.
ii. Mark the point through the holes from the steel plate using marker pen.
iii. Use a hammer and scriber to thick the point.
iv. Use a 10mm diameter drill.
v. The material is ready for drilling. (Refer to Figure 3.18).

After the cutting process for the materials are done, the next step is assemble those parts using inert gas welding machine. The setting of inert gas welding machine is different than the arc welding machine.

Figure 3.19: Setting the frequency

i. Turn on the main power of the metal inert gas welding machine.
ii. Set the right frequency and suitable for the material that is going to weld. (Refer to Figure 3.19).

Figure 3.20: Part 1

i. Part 1 - weld the 1 x 1 inches hollow steel bar to the 125mm x 30mm steel plate. (Refer to Figure 3.20).

Figure 3.21: Part 2

i. Part 2 - weld part 1 to the 1 ½ x 1 ½ inches hollow steel bar. (Refer to Figure 3.21).

Figure 3.22: Part 3

i. Part 3 - weld part 2 on the surface of 150mm x 75 mm steel plate. (Refer to Figure 3.22)

Figure 3.23: Bolt and nut

i. Put part 3 on the galvanize iron surface.
ii. Assemble using bolt and nut.
iii. Use a 12mm diameter bolt and nut. (Refer to Figure 3.23).

Figure 3.24: The turbocharger stand

i. The turbocharger stand is ready to use.
ii. The turbocharger is able to attach to the stand. (Refer to Figure 3.24).

Finally the both test rig structure and turbocharger stand are completely produced and ready for usage.

3.6 Analysis

Before start the fabrication, it is important to make some analysis for the turbocharger test rig and turbocharger stand. It is because, to avoid problem occur while producing the product. To do the analysis, it needs the solid work software to study the analysis. This solid work will help to analysis about the stress and displacement on the products.

After the analysis study have done, it is safe to start the fabrication process. The analysis data that produced by the solid work software will reveal weather the raw materials that are going to use are suitable or not. The data that gain from the analysis will be use as the reference to start the fabrication process.

3.6.1 Analysis Result

Turbocharger stand

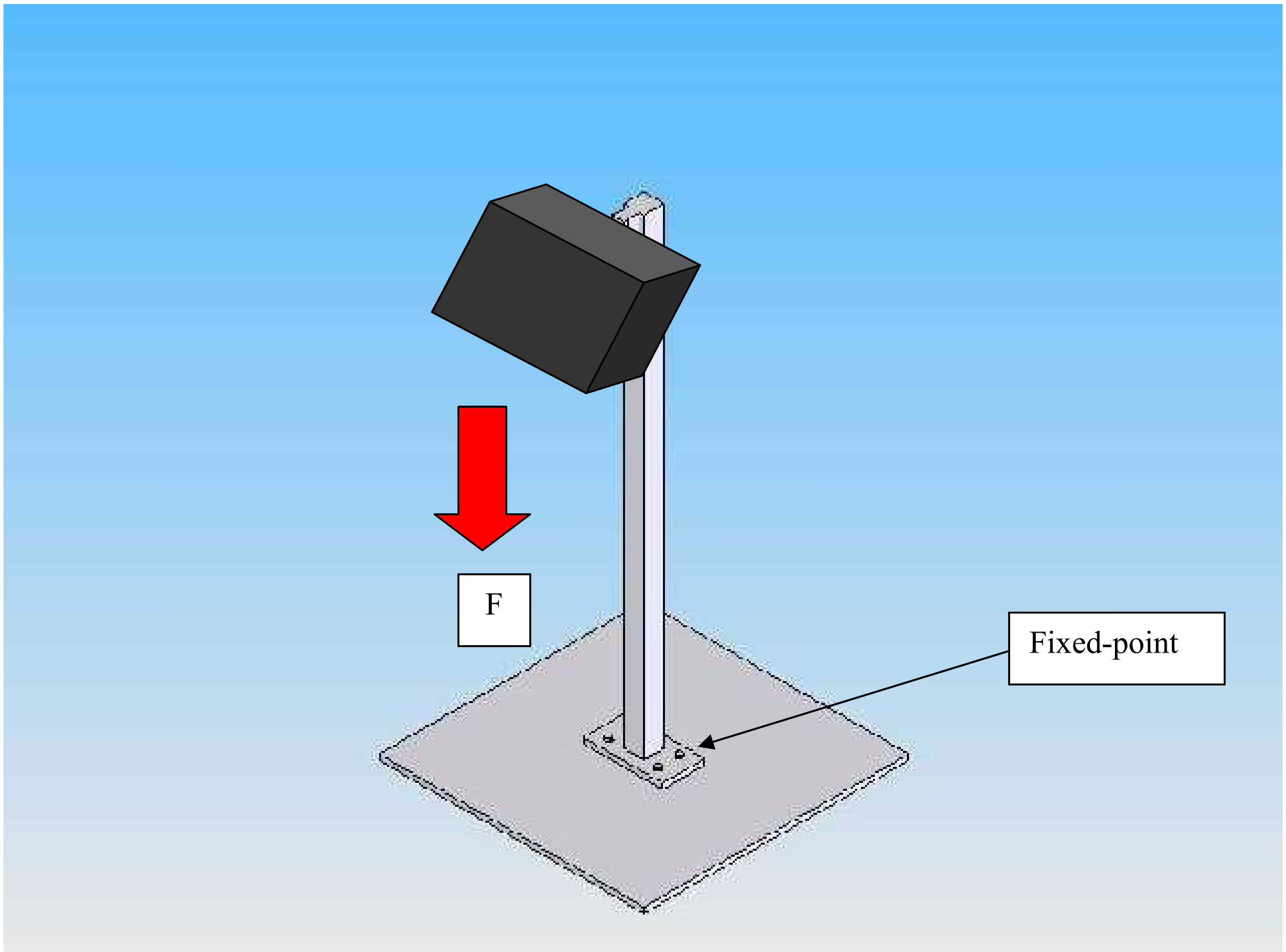


Figure 3.25: Turbocharger stand analysis

According to figure 3.27, it shows a 100N load has been acted on the turbocharger stand. This force is exerted vertically, which mean the turbocharger stand will stand a load that acting downward. The theory of gravity also related with this analysis. The weight of turbocharger has the force that acted downward, so the analysis needs some formulas to use that are:

1. W = mg

2. M = 0

W: weight, m: mass, g: gravity.
M: moment.

3.62 Free Body Diagram

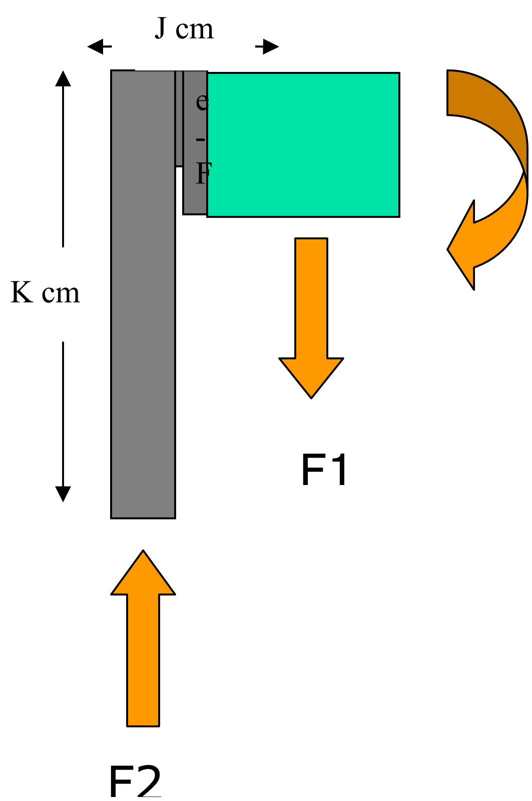
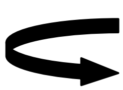


Figure 3.26: Free body diagram analysis

Referring to figure 3.26, the formulas that need to use are:



$+ M_A = 0$

$-F1 \times J \text{ cm} = 0$

$F1 = F2$

So the forces, F2 that need to cover the force made by the turbocharger, F1 both have the same amount of force. Use the W = mg formula to calculate the F1.

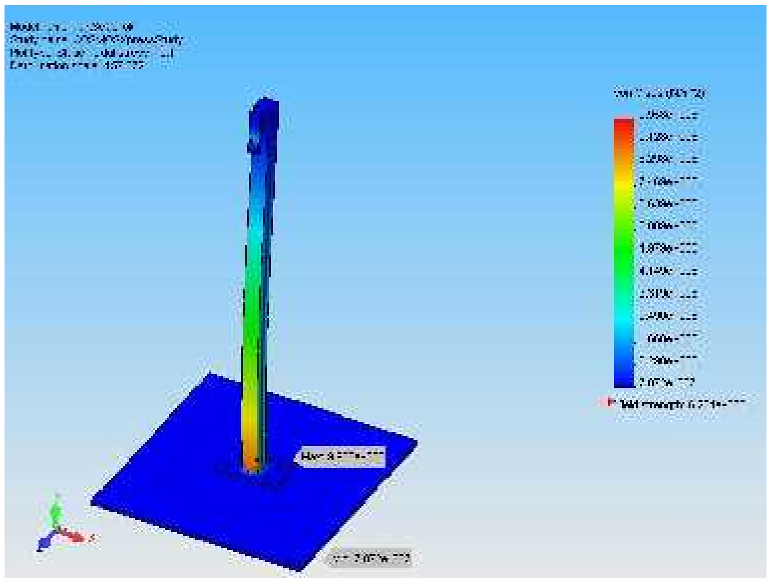


Figure 3.27: Stress analysis on turbocharger stand

From the stress analysis on the turbocharger stand using the same materials and dimension as in produce the turbocharger stand, using 100 N force as the limit force that the materials could stand, it shows that the factor of safety is below 1, which mean the turbocharger stand is safe to produce using the raw material according to the design specification. To produce this result need to use the solid work software. (Refer Figure 3.27).

Test Rig Structure

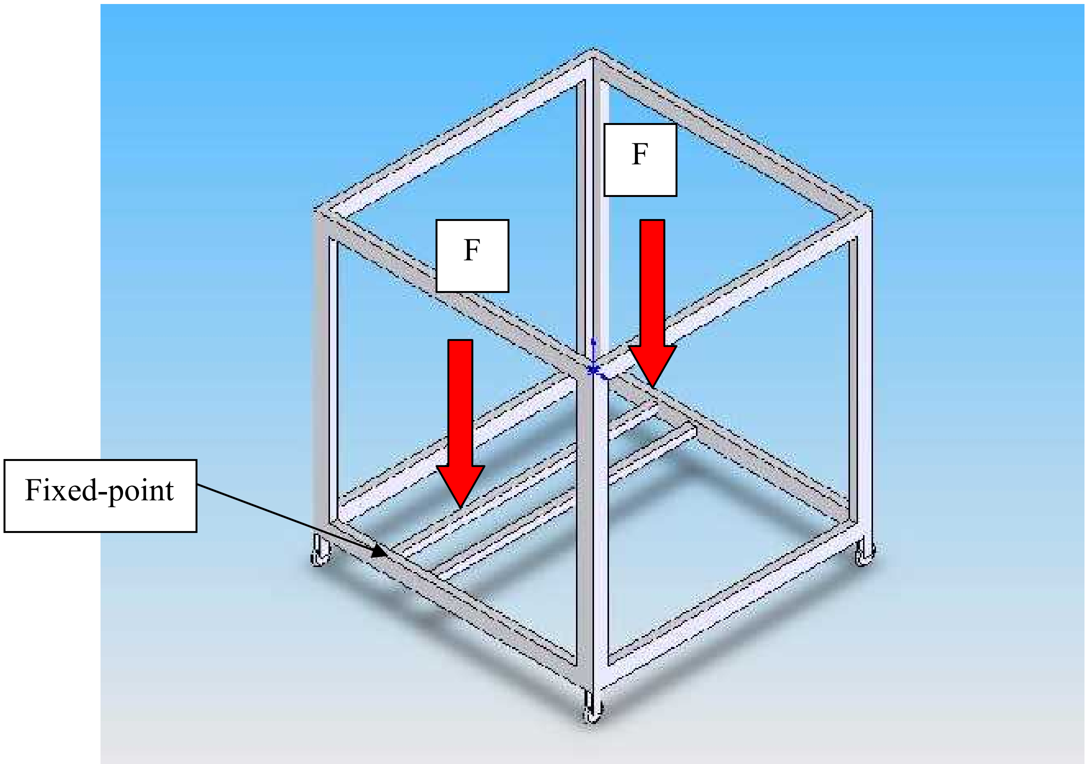


Figure 3.28: Analysis on test rig structure

Referring to figure 3.28, the test rig structure has been acted by forces. The two hollow bars that attach in the middle of the test rig structure is the place where the forces act. This foundation will stand the turbocharger stand that has a load of 20 kilogram. The amount forces that use to study the analysis is 300N. To study the analysis, the solid work software can be use.

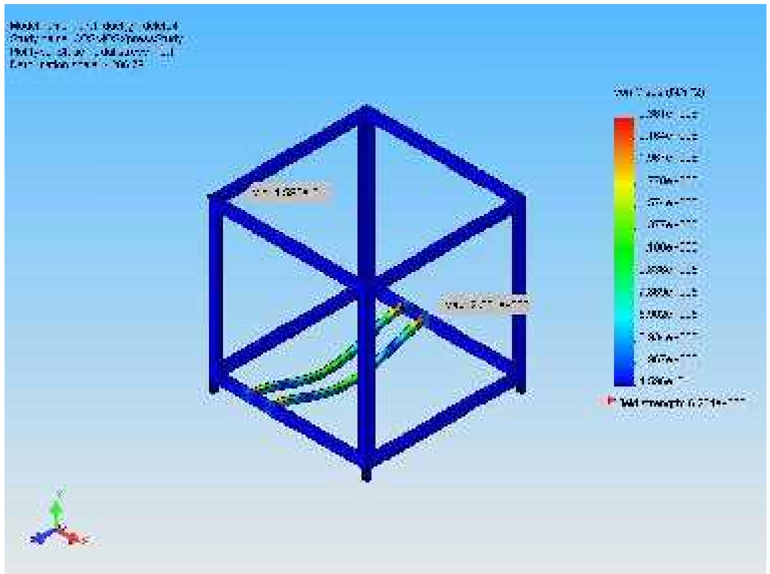


Figure 3.29: Stress result for test rig structure

From the stress analysis on the test rig structure using the same materials and dimension as in produce the turbocharger test rig, using 300N force as the limit force that the materials could stand, it shows that the factor of safety is below 1, which the turbocharger test rig is safe to produce using the raw material according to the design specification. (Refer Figure 3.29).

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Introduction

This chapter will mention all data about after finish the fabrication process and analysis data for the turbocharger test rig structure and turbocharger stand. The analysis data will show how much load can be standing by the test rig and the turbocharger stand includes the stress and displacement on the turbocharger stand after the turbocharger attach on it. These data will show either the turbocharger stand is strong enough to stand the force that action on it.

4.2 Results

The final result finally achieved according to the design specification and work perfectly, its also successfully achieve the main objective of this project that are, design and fabricate the overall test rig structure for turbocharger system and complete airflow piping.

The air flow piping or turbocharger mechanism system has been done successfully by other final year project student. The turbocharger mechanism contain of turbocharger itself, variable speed pump and piping system. This mechanism will attach to the turbocharger test rig and finally produced a functional test rig structure.

Figure 4.1: Turbocharger test rig

According to figure 4.1 shows the final results after through the fabrication process. The fabrication process took eight weeks from week six to week fourteen. Finish the test rig structure with some touch up by spray the whole body and the turbocharger stand. The turbocharger testing apparatus is attached to the test rig structure.

4.3 Drawing and Dimensions

4.3.1 Test Rig Structure

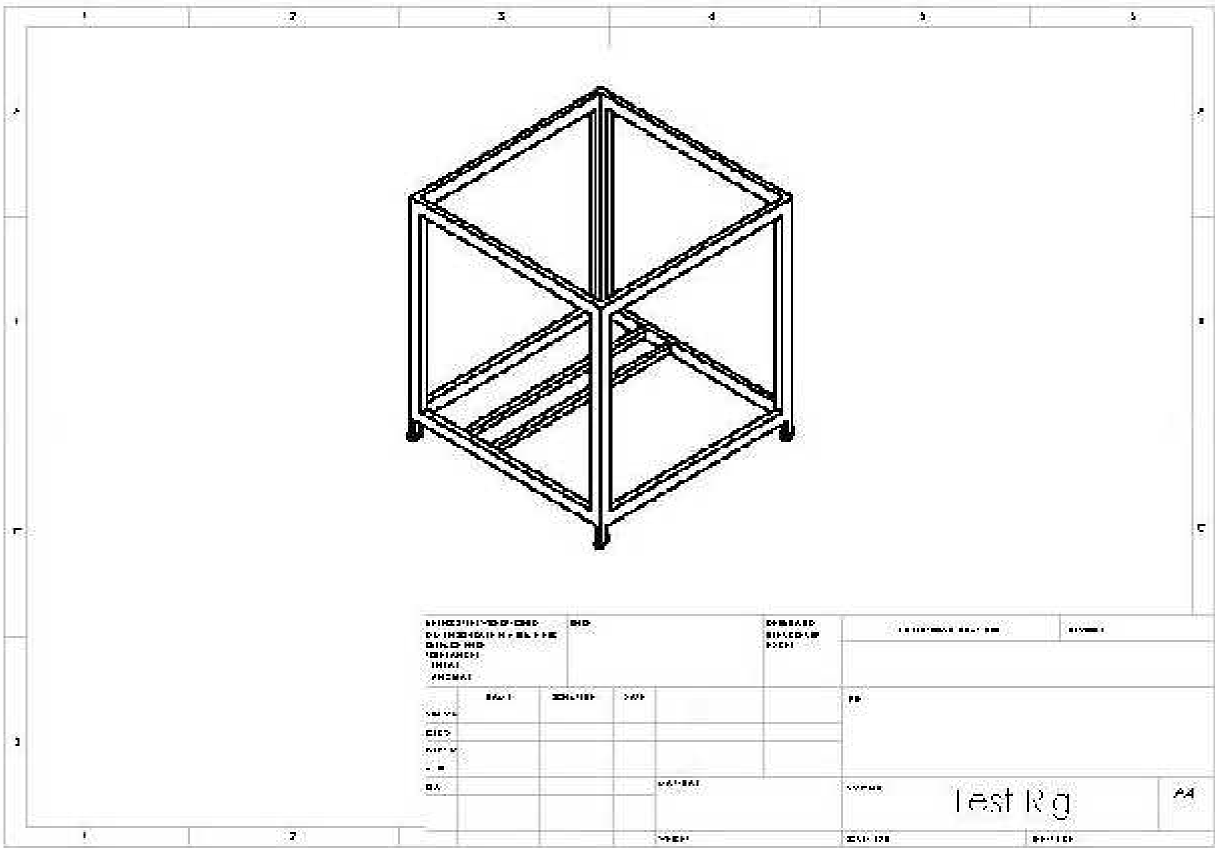


Figure 4.2: Test rig structure isometric view

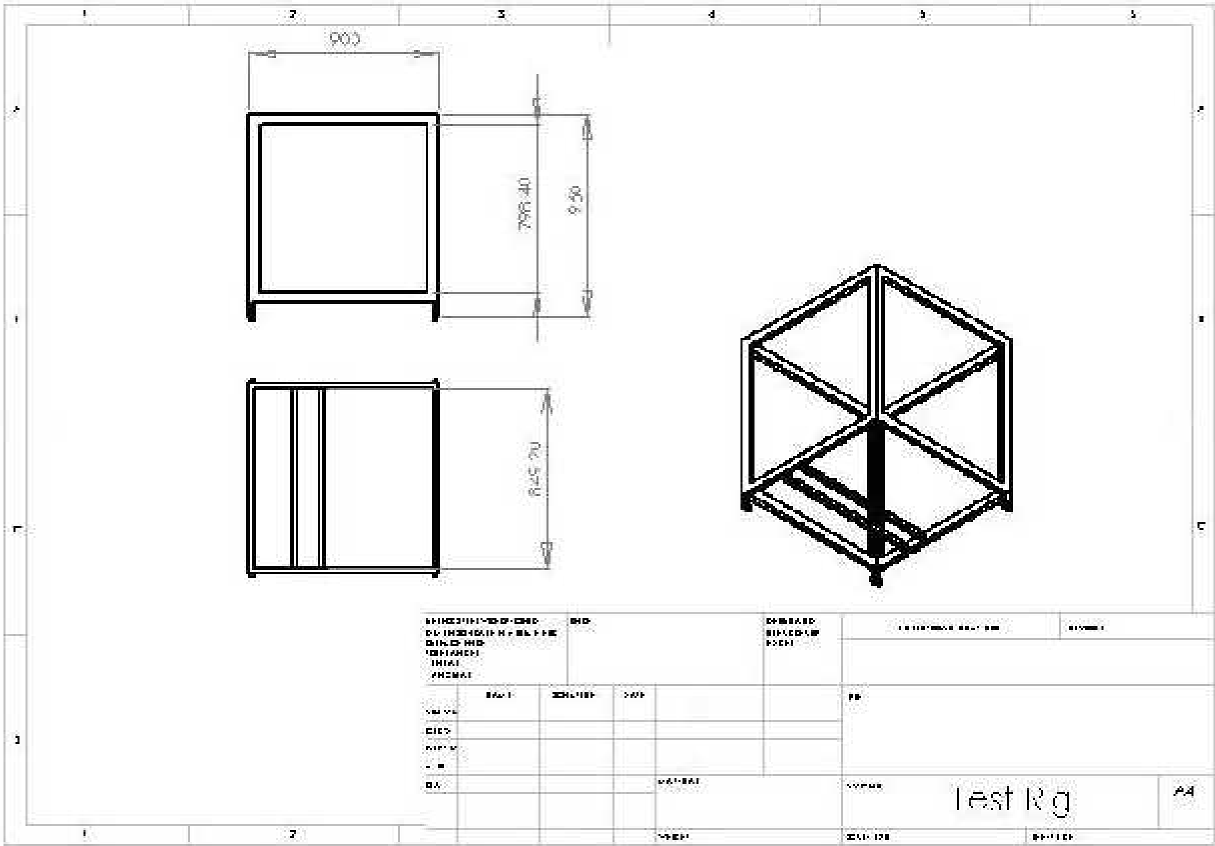


Figure 4.3: Test rig structure dimensions

4.3.2 Turbocharger Stand

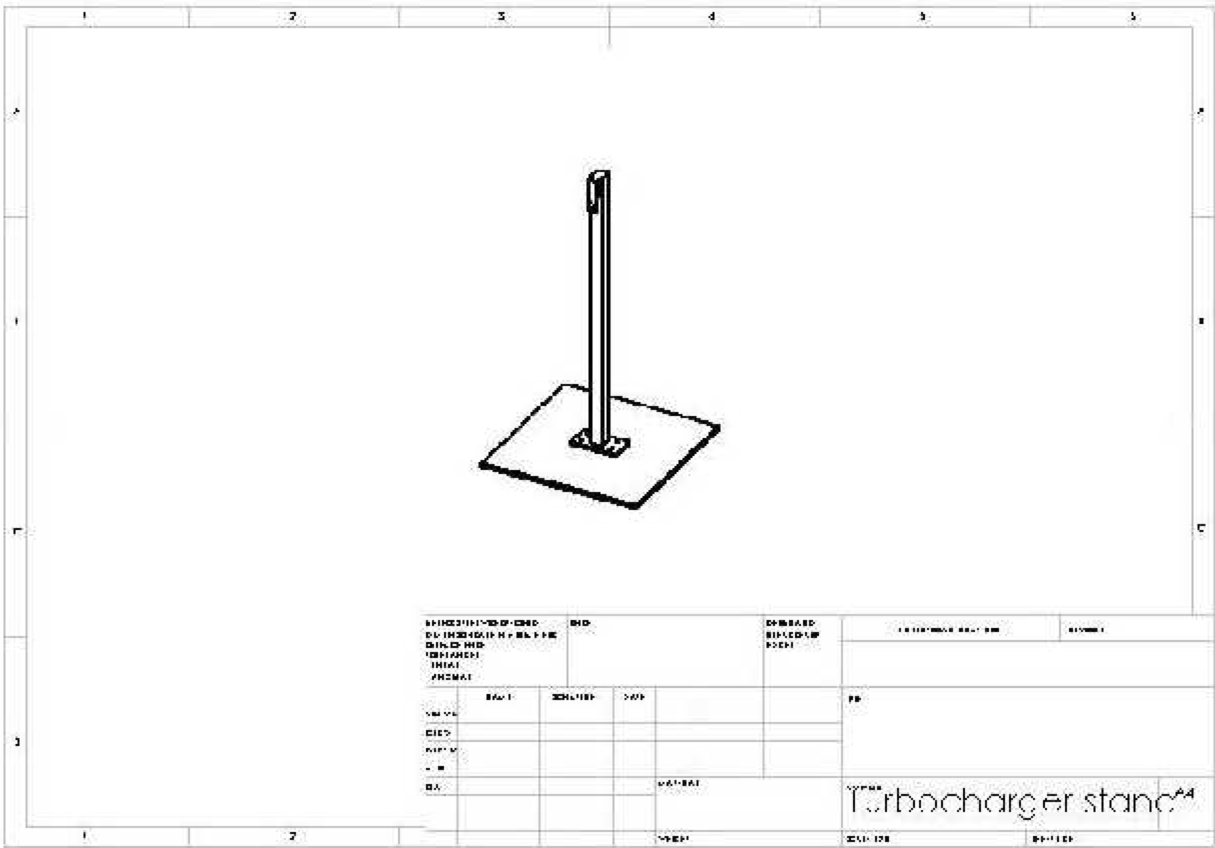


Figure 4.4: Turbocharger stand isometric view

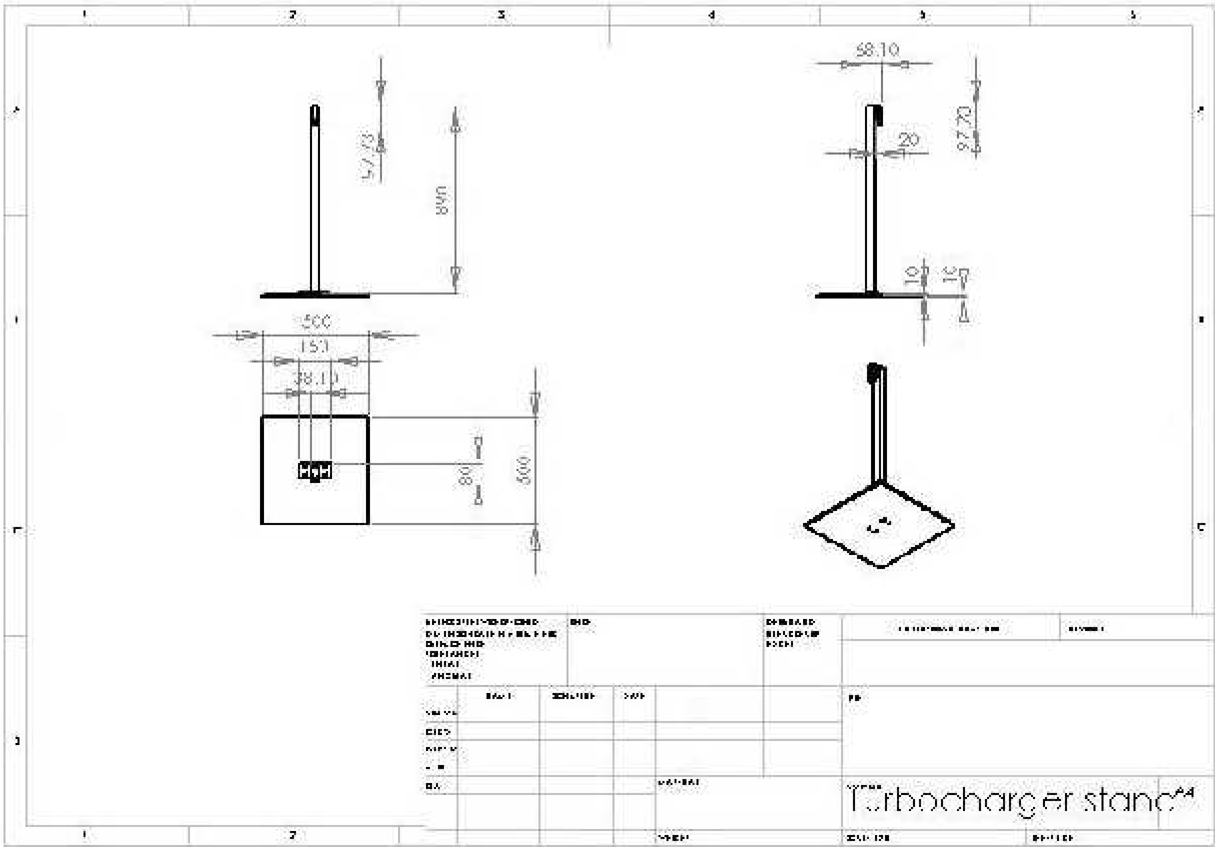


Figure 4.5: Turbocharger stand dimensions

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.0 Introduction

In this final chapter is to conclude and recommendation about the project that is producing the turbocharger test rig. There are a lot of processes need to get through before achieve to produce this product. In this process, student have apply all the lab skill and knowledge such as using computer software like solid work and auto CAD, using the lab machine such as drilling machine, disc cutter machine, sheering machine, welding machine and others. This shows that, this project help student in improving themselves in apply their skill and knowledge.

5.1 Conclusion

The conclusion is, the objective, to design and fabricate test rig structure for an automotive turbocharger testing apparatus finally achieve. The test rig structure is successfully produced according to the dimension as well as the design specification needed.

5.2 Recommendation

After finish produce the test rig structure, this product is ready for use as study by other students. This structure will provide study about the air flow in the turbocharger system and how the turbocharger working. In the future, this structure can be filling for more components, prefer to more component that can continue the turbocharger system study such as:

- The intercooler to complete the turbocharger system.
- Computer that can generate data about the air flow in the piping system.
- A device that can measure the heat or temperature that produces by the turbocharger.

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iv. http://en.wikipedia.org/wiki/Welding

v. http://en.wikipedia.org/wiki/grinder

vi. http://en.wikipedia.org/wiki/punch_press

vii. http://en.wikipedia.org/wiki/turbocharger

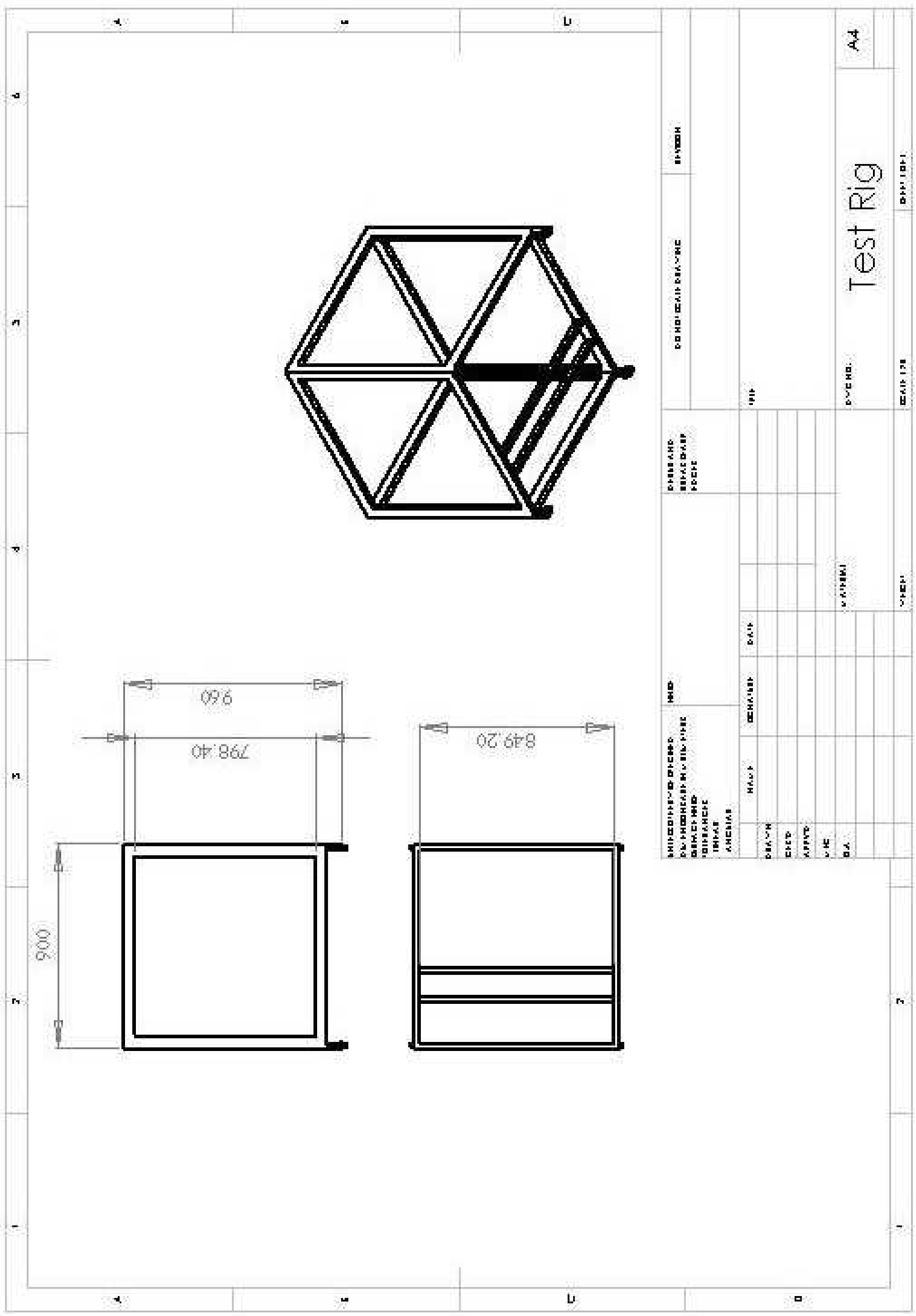
viii. http://en.wikipedia.org/wiki/intercooler

APPENDIX

DETAIL DRAWING OF THE PART

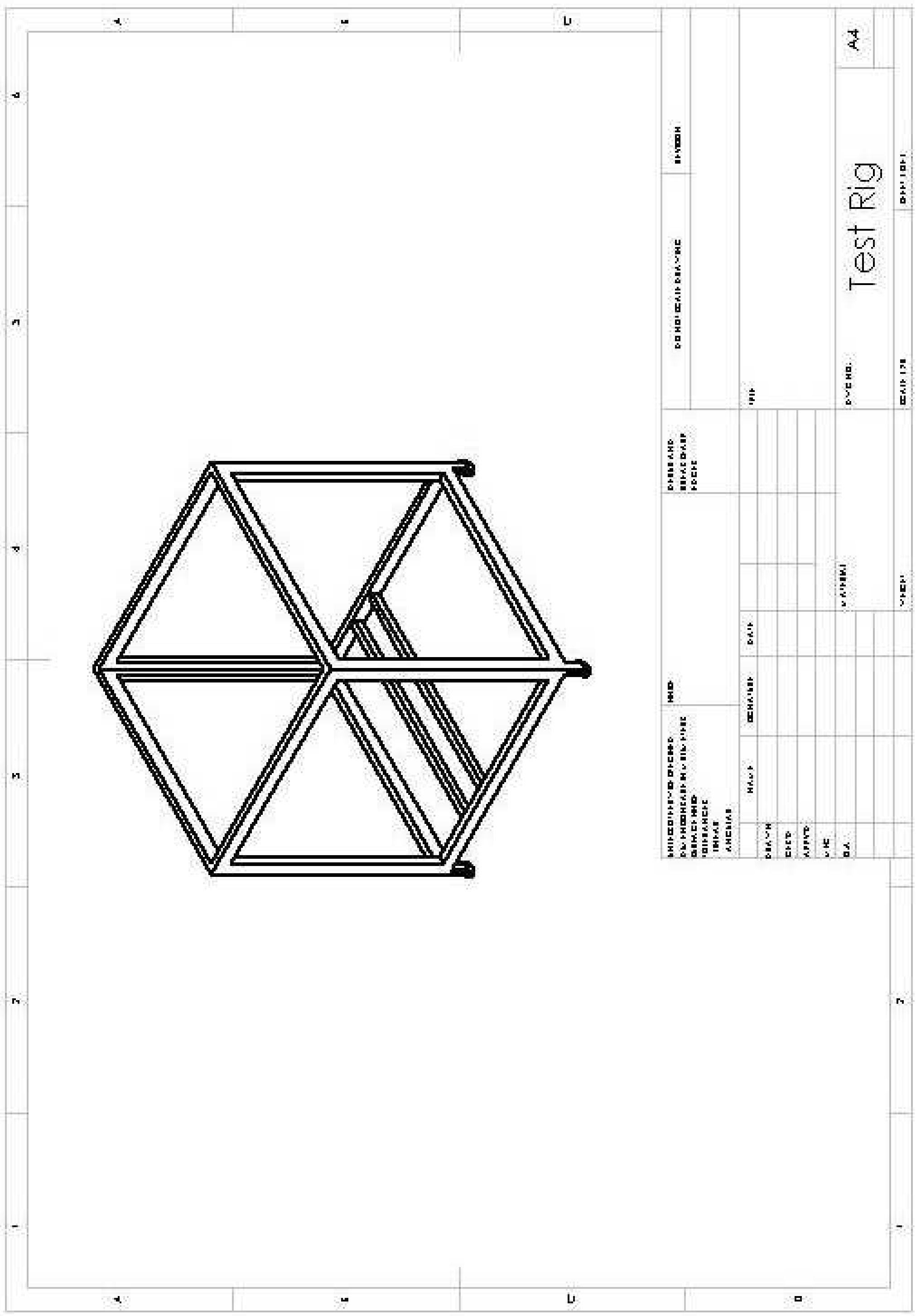
APPENDIX A

Test rig structure dimension



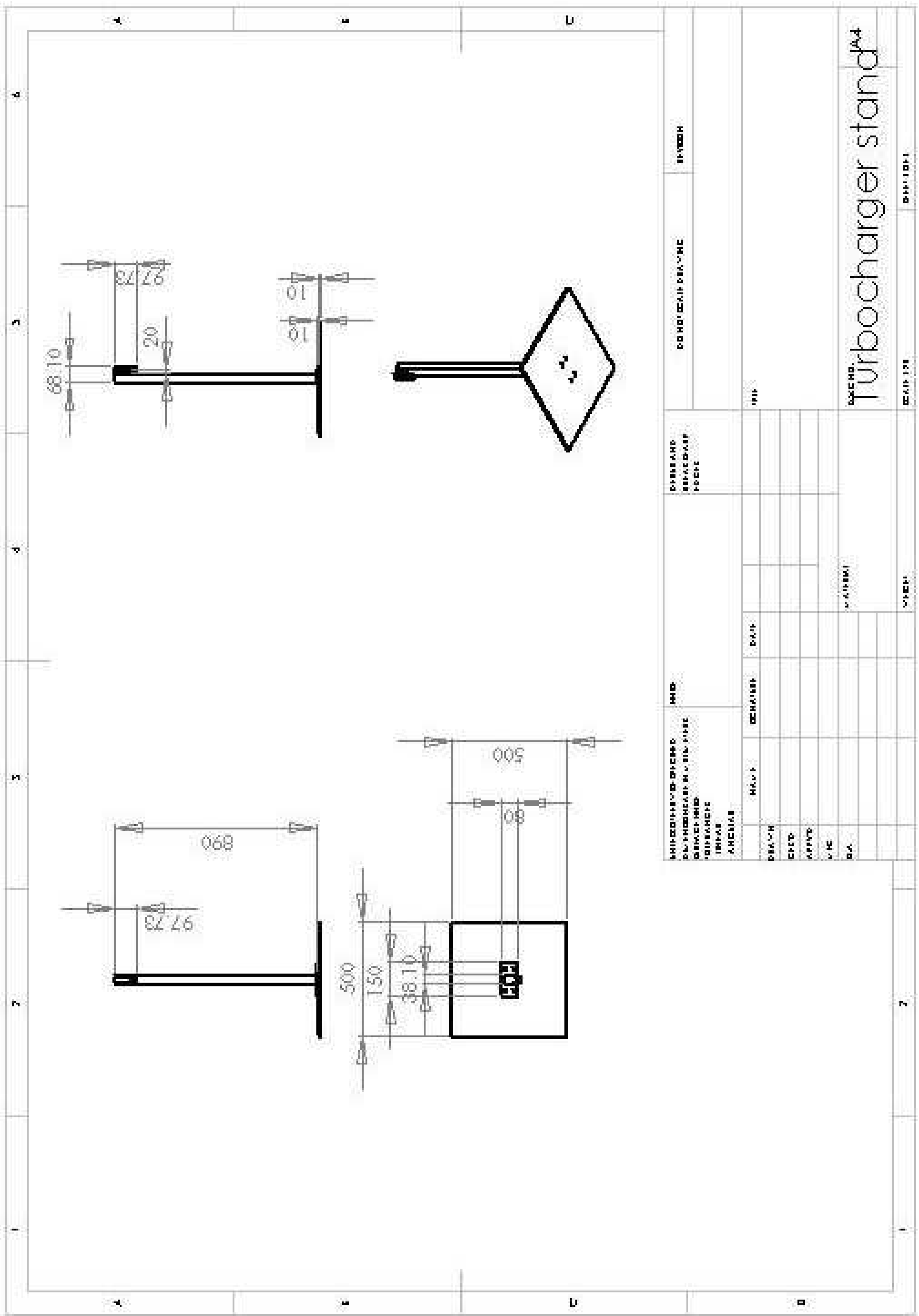
APPENDIX B

Test rig structure isometric view



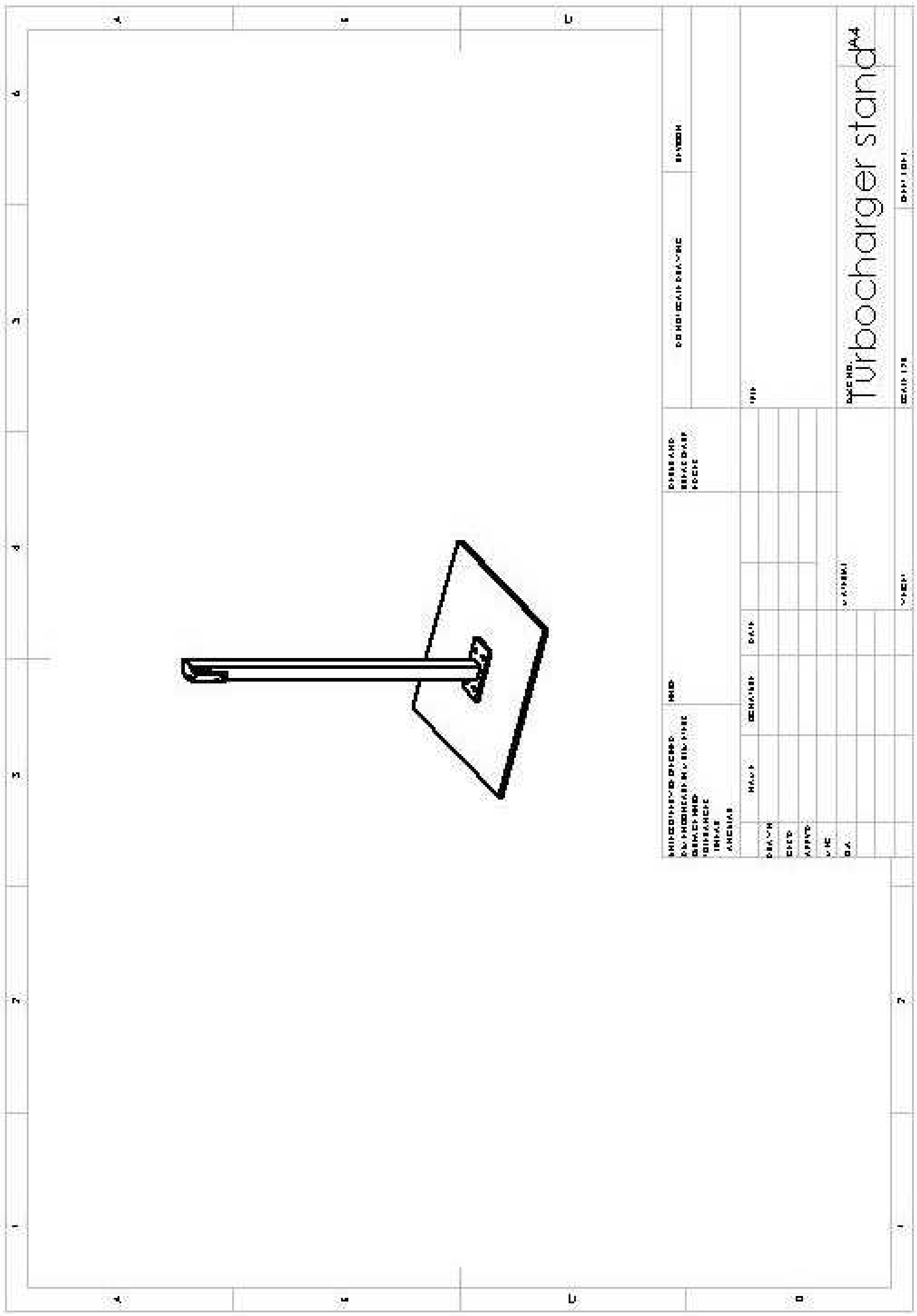
APPENDIX C

Turbocharger stand dimension



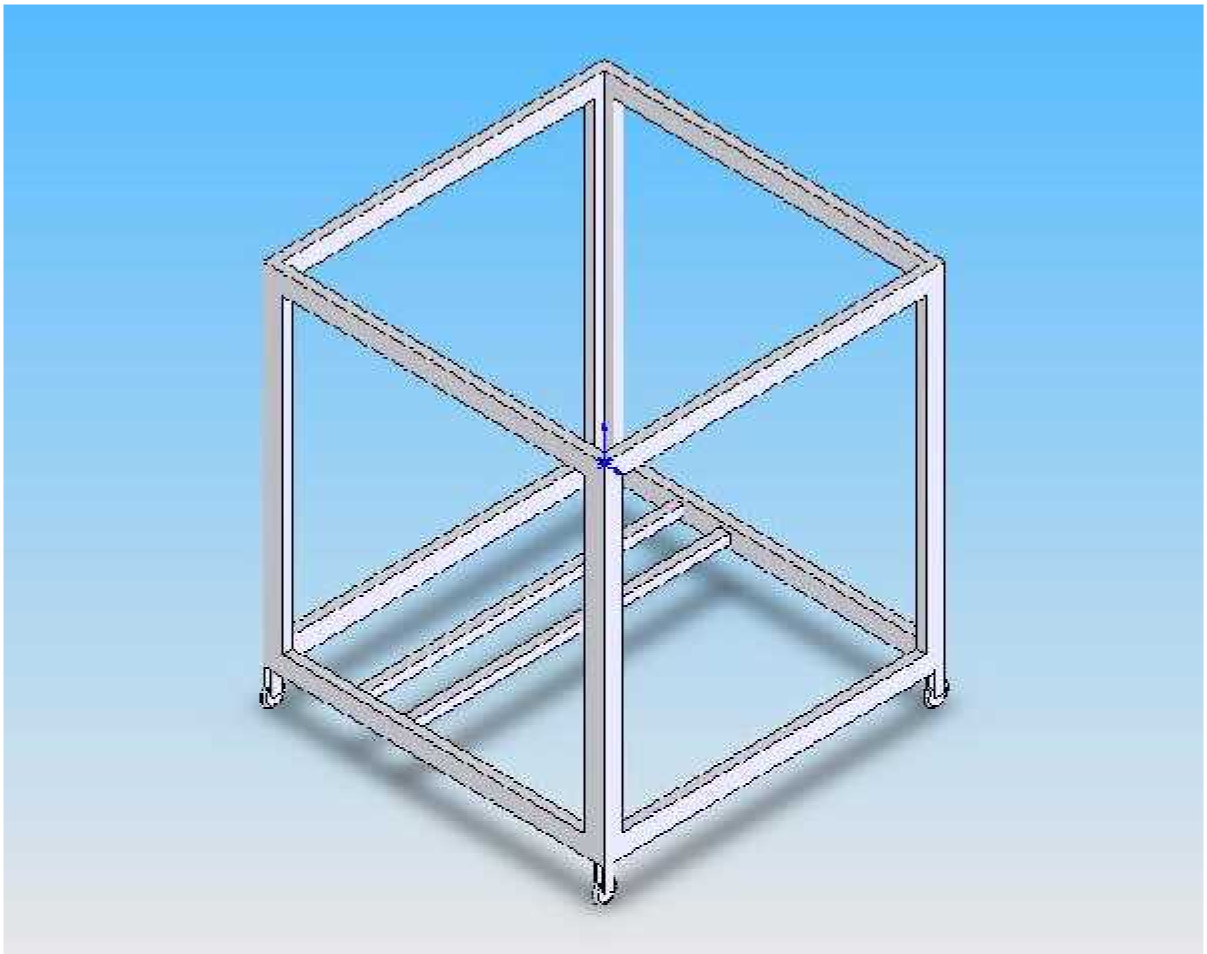
APPENDIX D

Turbocharger stand isometric view



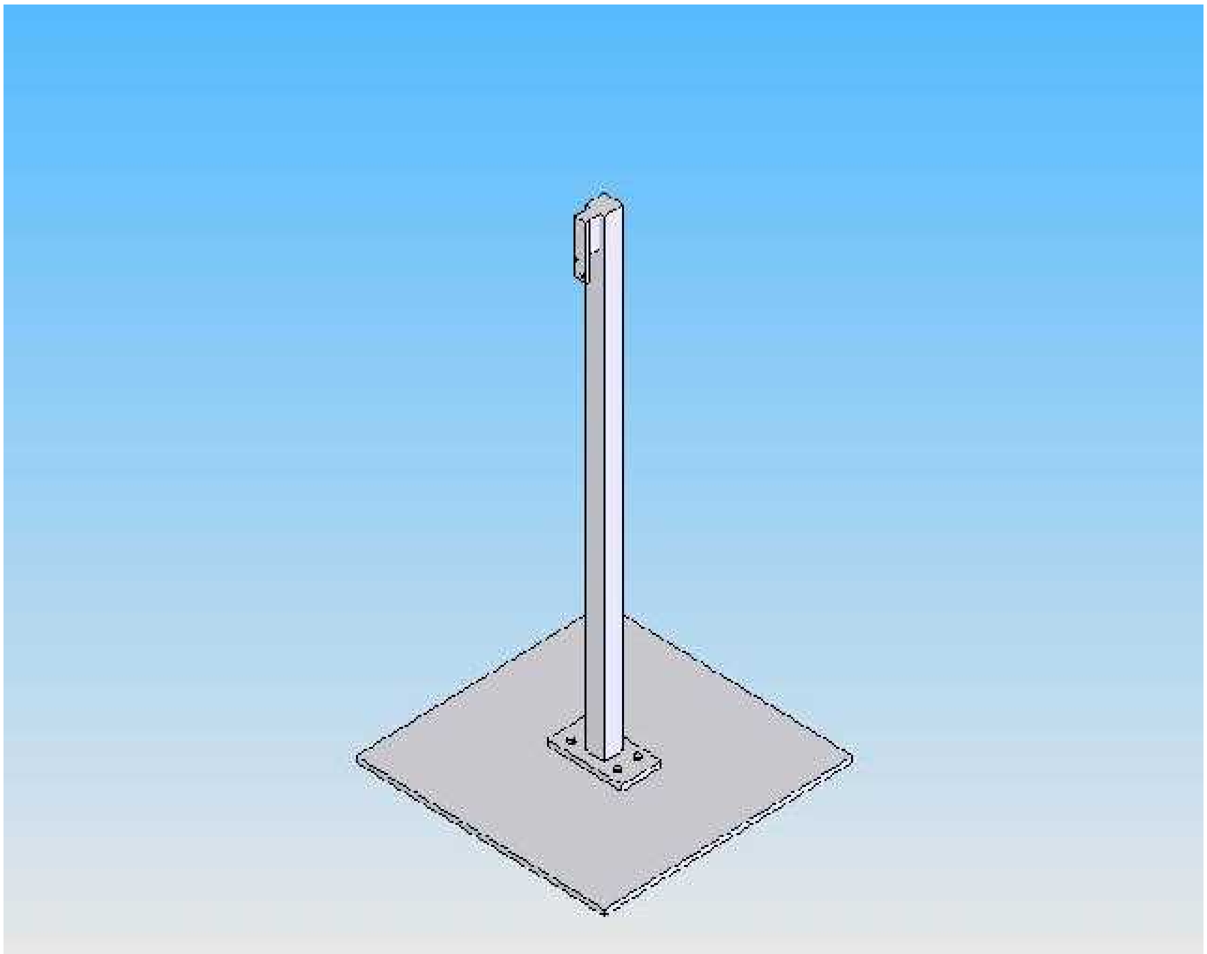
APPENDIX E

Test rig structure



APPENDIX F

Turbocharger stand



APPENDIX G

Product features