HAWASSA UNIVERSITY

INSTITUTE OF TECHNOLOGY

Department of Electromechanical engineering

Practical industrial training Report in

South Roads authority

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Declaration

I hereby, declare this final internship report is the results of my work except as cited in the reference; and compiled according to the internship report guideline given.

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This final internship report has been submitted for examination with my approval as University advisor.

Advisor Name Signature Date

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Acknowledgement

Above all, i would like to thank the almighty God with his mother St. Marry who have been with me throughout my work. Then I would like to thank the officer of the maintenance section of south road authority for the acceptance our request to join the organization for internship program. All member of the company which I got in maintenance section had a good relation with us and they us in different ways. In mechanical shop I want to thank Mr. Simion who is a mechanic, he tells us everything we asked in theory and also show us in practical. Mr. Biniyam, also mechanics who were helping us in different ways. In manufacturing shop Mr. fente tarekegn who is the head of machine shop and show us different manufacturing process, machineries and tools. we would like to thank a Mrs. Webit who are the machinists for guiding on some operation on lathe machine and for giving and explaining different shop manuals. I would like to thank Mr. Sintayehu who is our engine shop assistant and I want to thank Mr. Getachew who shows us the man part in electrical workshop, finally we would like to thank our company advisor Mr. Tagaye which really helped us in the overall internship time.

Mr. Fantaye Machine Shop Mr. Simion Garage mechanic

Mr. Getachew Electrical workshop Mr. Tagaye Company advisor

EXCUTIVE SUMMERY

This industrial internship report includes the detail information about south road authority. The product and customer of the south road authority are described. The individual office with the workflow is described and the detail explanation of each shop are arranged according to the work task, specification, size etc. this report also discuss about the overall benefits we gain from industrial internship program. The problem in the company has been specified and their solutions are also proposed. This paper also describes briefly about scissor lift.

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CHAPTER ONE

1. GENERAL BACKGROUND OF SOUTH ROADS AUTHORITY (SRA)

1.1 Brief history

The south Roads Authority (SRA), since it was established in 1989 E.C by declaration has been working on design study, Road construction and Maintenance with a great deal of sectorial responsibility in the region's different zones, special woredas and woredas. In the activity of roads maintenance, for the last 13 years, more than 9500kms have been made get routine and periodic maintenance. They all are made comfortable for traffic and well secured. In the activity of Road design study until now, more than 2000kms Roads have been studied and designed for standard road construction. Road network study that shows the status of the region's road network has been studied and implement. To implement the road's development policy, the regional government is increasing the amount of the yearly budget, is strengthening the works of construction and maintenance of roads and bridges including design study in order to fulfil the road of the region's people. In relation with this, the regional government is purchasing different road construction and maintenance machineries to develop the authority’s capacity. On the other hand, authority to tackle different problems and to satisfy the need of customer, has implemented BPR study.

Fig 1.1 Head office of south roads authority

1.2 South Roads Authority (SRA) Vision, Mission, Goals and Values.

Vision of SRA

To see the regional society with adequate, comfortable and safe road network that enable it to economic, social administrative centers and civil service institutions.

Mission of SRA

In collaboration with people, investors and aid organization to study roads at different status and then construct, maintain and secure them with corresponding technology and reasonable expense in order to bring well organized development for the regional society.

Goal of SRA

To identify roads that are useful for the region's economic and social development in order to construct, upgrade and reconstruct Roads to increase the coverage of quality Roads in the region.

Values of SRA

To make quality, transparency, accountability, fairness and loyalty and part of our resources. Development with the active participation of the society. To use resource economically and wisely, human resource is our biggest resource also professional ethics and surveying people.

1.3 Main product or service of SRA

✓Roads construction and design study.

- ➢1160km road study and design works.
- ➢1580km Design standard 6(DS6) level roads construction.
- ➢400km DS8 resettlement roads construction.
- ➢1000km DS8 roads construction in different zones.
- ➢2000km DS8 roads construction at woreda level.
- ➢12700km road maintenance and 18000km road construction by community participation.
- ➢16768km road construction by Universal Rural Roads Access Program (URRAP).

✓Road maintenance

- ➢To increase the coverage of roads to be maintained from an average of 35.5% to 71%.

This means:-

1200km periodic road maintenance.

9800km routine roads maintenance.

✓Upgrade and reconstruct roads

✓Construction and maintenance of bridges including design study

✓Maintain machines used for road maintenance

Generally the main product or service of SRA are Roads construction and design study, Road maintenance, Upgrade and reconstruct roads and Construction and maintenance of bridges including design study for the regions people.

1.4 Main customers of its product

Generally, the main customers of its product are the regions people or society that are found in different zones, special woredas and woredas.

1.5 Types of maintenance activities performed in SRA.

The maintenance program done in SRA is almost mixed type of maintenance program depending on the type and life of the vehicles. For latest vehicles reliability-based maintenance is performed it more expensive with respect to cost and availability. For old vehicles most of the time preventive maintenance is taken to have longer life of functioning with the vehicle. If the vehicle is failed many times and maintenance activity is done each time for the vehicle; the cost of maintenance would be higher than the usage of the vehicle. In this type of condition reactive maintenance, the appropriate type of maintenance program.

1.5.1. Preventive Maintenance (PM)

All actions carried out on a planned, periodic, and specific schedule to keep an item/equipment in stated working condition through the process of checking and reconditioning. These actions are precautionary steps undertaken to forestall or lower the probability of failures or an unacceptable level of degradation in later service, rather than correcting them after they occur. Regular maintenance is performed at pre-scheduled cycles to ensure optimal performance, efficiency, safety and reliability of assigned equipment. Preventive maintenance is based on the manufacturer's suggested recommendations.

During the PM scheduled service, the mechanic will document all defects found and will have all defects listed on the repair order and corrected prior to returning the transit vehicle to service.

1.5.2. Reactive Maintenance (Break down or run to failure maintenance)

Before five years the maintenance program of the SRA is almost reactive maintenance type. Reactive maintenance is basically the "run it till it breaks" maintenance mode. No actions or efforts are taken to maintain the equipment as the designer originally intended to ensure

design life is reached.

1.5.3. Reliability Centered Maintenance (Proactive or Prevention maintenance)

Reliability centered maintenance (RCM) is a process used to determine the maintenance requirements of any physical asset in its operating context

Table 1. Details of planned preventive maintenance jobs executing in the company for light duty vehicles.

After every 10 service hrs. daily	After every 50 service hrs./weakly	After every 5000km	After every 10000km
Check engine oil level	Wash & clean vehicle	Change engine oil	Adjust valve clearance
Check coolant level	Lubricate all greasing points	Change engine oil filter	Inspect air clearance element
Test brake system	Wash & clean the vehicle	Inspect glow plugs & change if necessary	
Test clutch system	Conduct drive test & check all systems, components, accessories, indicators & control gauges	Inspect brake pads & change if necessary	
Test oil indicators	Inspect radiator hoses		

1.6 Machinery capacity building

Road construction and maintenance machineries.

- Earth Moving Equipment (EME) and
- High Duty Vehicle (HDV).

Table 2. Road construction and maintenance machineries

No	**Types of machines**	**Quantity**	**Currently in use**
1	Dozer	30	7
2	Grader	20	10
3	Loader	15	10
4	Roller	17	8
5	Bacon loader	3	3

6	Tractor	10	5
7	Excavator	1	1
8	Low bed	3	2
9	Fuel holder	4	4
10	Water holder	8	7
11	Garage crane	4	2
12	Dam tracks	80	2
13	Solid load tracks	2	1
14	Forklifts	1	1
Total	198	63	

1.7 Man power / human resources

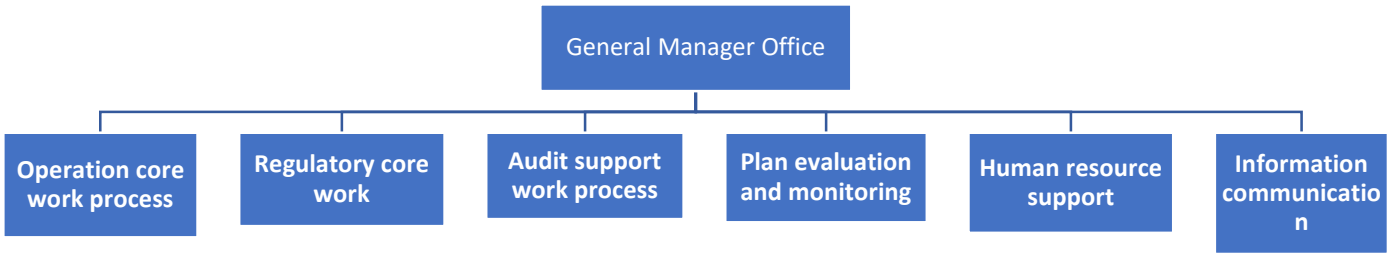
Totally in the organization 230 workers are available from those 46 are women, but I want to focuses on human resources available under maintenance wing section in each workshop with different disciplines as shown below.

Table 3. Permanent human resource available in the workshop

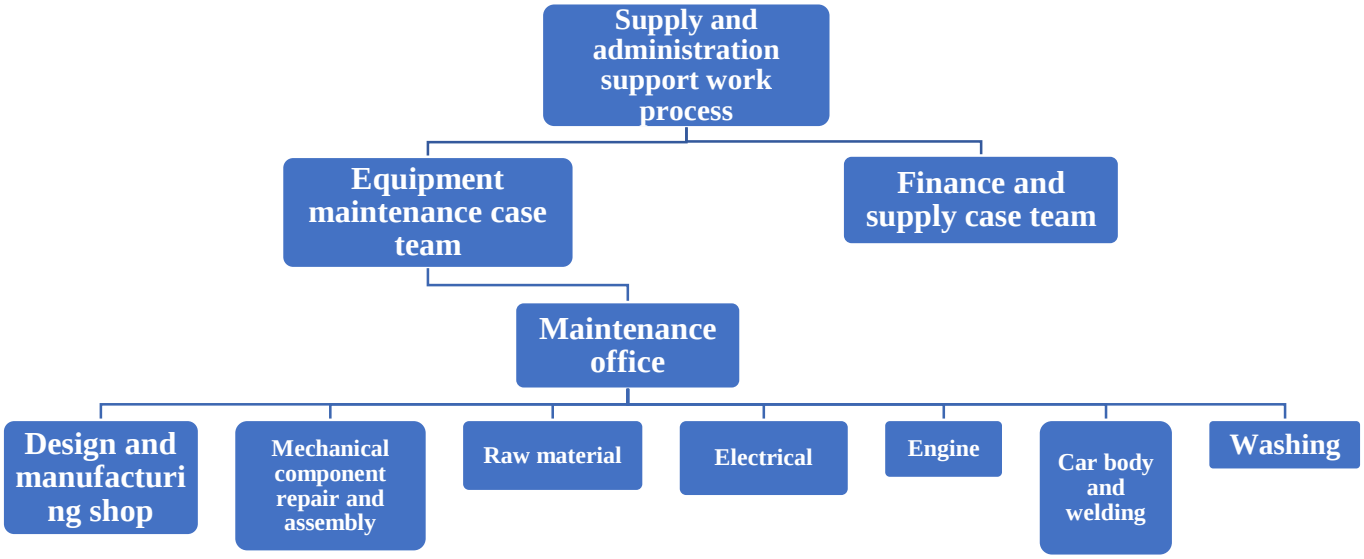
Work placement/position	**Quantity**	**Educational level**
1. Supervisors/ officers/	4	Technical/diploma
2. Mechanic	4	Technical/diploma
3. Senior mechanic	7	Level 2&3
4. Junior mechanic	3	Level 2
5.Electric shop	4	Technical/diploma level 2&3
6.Machinist/machine shop/	3	Technical/diploma & level 1&2
7. Senior welder	3	Level2&3
8. Store man	4	Technical/diploma
9. Tool man	2	Certificate
10. Security guard	4	Seven& eight
11. Cleaner/garage/	2	Six& five

12. Fuel, grease and oil keeper	2	Degree
13.Car washer	2	Ten
14.Tire repair	2	Eight
Total	44	

Work flow structure of south road authority



Work flow and shops of maintenance section



Chapter Two

2. Overall internship experience

2.1. How I get into SRA

One of the main and basic objectives of the internship program for engineering student is to have practical knowledge about what they learn and how really look like the environment of industries. According to this program, the University put a qualification to students (i.e. holistic exam) before sending to different governmental and non-governmental companies or organization. We have already passed the exam and being qualified.

The university industrial leakage, gives two chances for the students to found the hosting company. The first is to find hosting company by ourselves and the second is to place by the department. Personally we try the first choices, this gives a chance to select and apply our paper for the company, which is best for us in terms of knowledge, skill, and technology transfer so I apply to south road authority.

2.2 Section of the organization I have been working in

The organization has many sections which can be divided into three main sections:

- Ware house section
- Maintenance wing section
- Logistic section

Under maintenance wing section there is maintenance office, also under maintenance office there are many shops. These are

- Electrical shop
- Machine shop
- Garage (mechanical) shop
- Engine shop

2.3 Function of each shop

Raw Materials Room: - This is room where raw material for each section are stored and it contains so many components or parts of machine that are used during the maintenance of machine or vehicle and materials for production purpose.

Design and Manufacturing shop: -In this shop there is a design process and manufacturing process are taking place. For example, the damaged material is not available in the market by using the raw material from the raw material room and by observing the previous model or the existing one we can design as it is or by adding some modification, we can simply manufacture it in this shop. Machines available in these shops are lathe machine, drilling machine, hydraulic press machine, welding machine and grinder machine.

Engine overhauling shop: -Different types of engine overall maintenance and repairing are performed under this shop.

For example: - NISSAN DIESEL engine.

TOYOTA 1PZ, 1HZ, 1HD-T engine.

SINOTRUK WD615 series diesel engine.

MAHINDRA Pickup.

Electrical shop: -Electrical shop is a shop that is used to conduct some electrical related maintenance. In this shop there are emergency lamps and switches. Emergency lamps blew to tell the place where the damage is occurred in whole department.

Car body and welding shop: -In this shop welding of machine parts or damaged car body due to the accident is performed which is necessary for the purpose of maintenance. Equipment available in this shop are welding machines, grinders, metal plates, and other elements used for the purpose of welding. Grinders are used to remove unwanted part of the welded metal.

Mechanical component repair and assembly shop: -Another name for this shop is mechanical shop and under this shop different kinds of machine are maintained day to day with skilled man power. They perform major and minor vehicle maintenance under mechanical shop. Under mechanical shop the following maintenance has be done.

- **Power train:** it including clutch, gearbox, propeller shaft, differential and other parts of the power train maintenance or service.
- **Steering system:** it including steering wheel, steering gear box, steering shaft and idler.
- **Suspension system:** it including spring, shock absorber and axle.
- **Braking system:** it including braking pad, braking drum, braking caliper, changing braking fluid and service parking braking and brake shoe.

Tire repair shop: - In this shop there is replacement of damaged or out of serviced different types of car tire (i.e., TOYOTA, HYUNDIA, NISSAN DIESEL AND SINOTRUK) and if there is a problem on brake system simultaneously replacement of brake shoe has been performed.

Washing area: in this shop washing of internal and external parts of the vehicle takes place. The organization is used for washing of vehicle some row materials which are used to clean the car such as tap water, powder sops, and its own washing materials (stracho).

Generally, I have been working in maintenance wing section of the organization. Under this section there are many shops which are listed above and I have been working through all of the above shop turn by turn with other fellow student practicing there, so that could grasp multi-dimensional (wide and deep) knowledge regarding my study field. But among these eight shops especially I have been working in Engine overhauling shop, Design and manufacturing shop and mechanical component repair and assembly shop because the duration is only two months.

2.4 The Work Flow in the Working Section

From this the work flow looks like the following; first the customers that have South Road Company vehicles to be maintained or serviced ask the Guard to give a permission to enter the company with their vehicles. When they get permission to enter the company, they have been gone to the parking and ask the formal to see their vehicles servicing or maintaining part. The formal registered the vehicles in order of their time entrance. Then he assigns the workers (mechanics, electricians, body men etc.) based on the need of customers. After the workers are assigned at any vehicle in their specific ability of maintenance and service. The workers ask genuine parts from shop workers to change the old and damaged parts.

Waste oil has a container in the company at which it is stored and gives income to the company by selling to customers which need it for painting wood and other materials to prevent from insects which bore wood.

The old (changed) parts of the vehicle are packed with the package of genuine parts and returned with maintained and serviced to the customers. When each worker finishes his/her assigned work, he/she reports to the formal and then the formal tells the customers, finally the customers come and pay the repairing cost to the finance case team and take their vehicles out of the company. The work flow can be shown below.

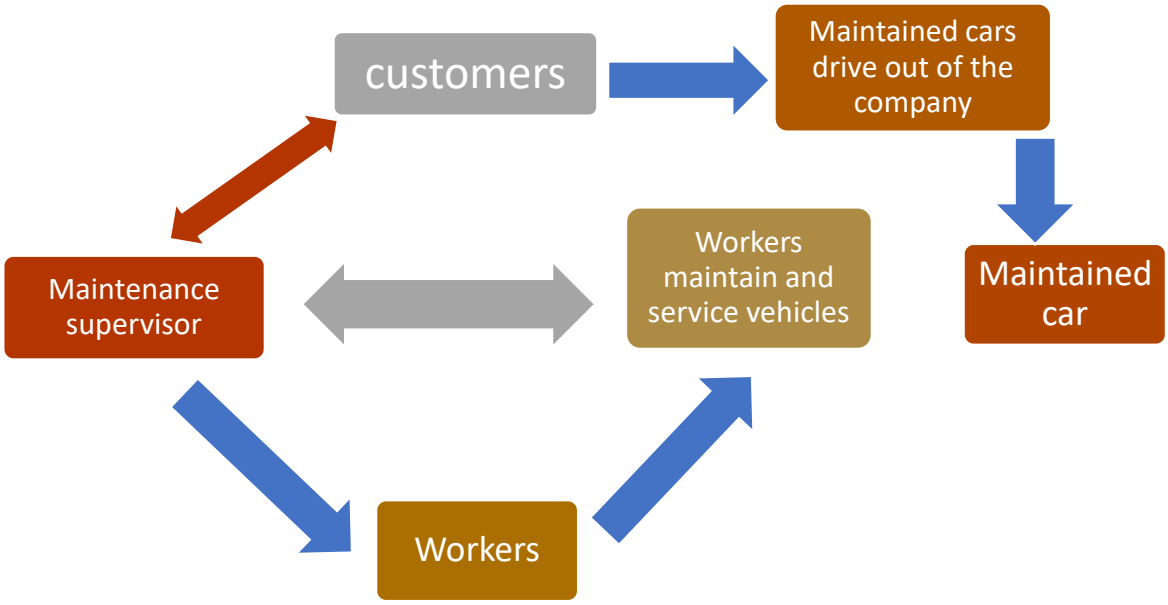


FIG 2.1 WORK FLOW OF THE COMPANY

2.4.1. Electrical system work shop

In this shop all the electrical systems of an automobile part are maintained and changed according to their service time kilometer per hour. From those electrical parts of an automobile including; it is generally classified in to five major parts.

1). Ignition system
2). Starting system
3). Charging system
4). Lightning system
5). Accessory system

1. Ignition system: its main function is to create the electrical spark in the engine combustion chamber at exactly the right time in order to ignite the mixture. It is found only in gasoline engine.

2. Starting system: it consists of battery, ignition key, and starter motor.

⇒ **Battery**; is where the electric power begins to generate. It changes chemical energy to Electrical energy. It consists of 35 percent of acid and 65 percent of distilled water.

⇒ **Ignition key**; is a switch helps to transfer electrical current from battery to starter motor and other components.

⇒ **Stator motor**; used to start up the motor by charging electrical energy from battery to mechanical energy.

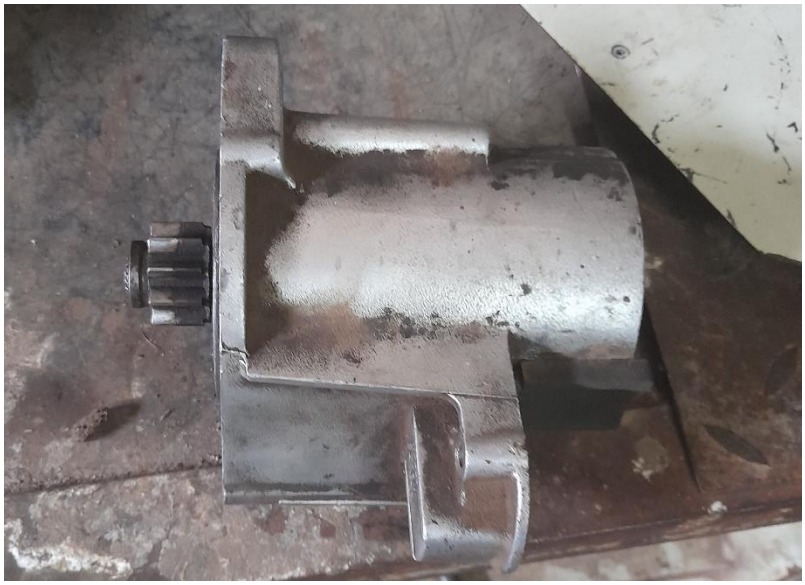


Fig 2.2 Starter Motor

3. Charging system

Generator/Alternator; a system of charging battery is driven by the engine crank shaft by belt and changes mechanical energy to electrical energy and charges the battery and supplies to other parts.

Electric regulator; it limits the electrical force not to create damages. It regulates the electrical flow from generator to battery, prevent over charging of battery.

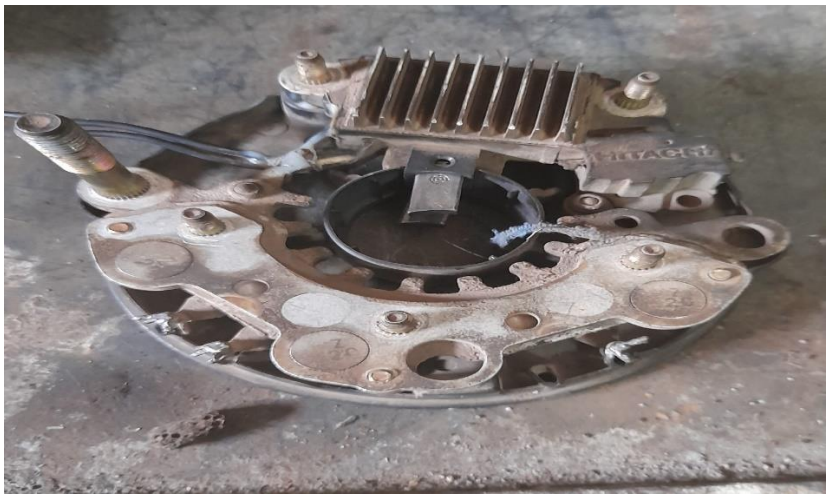


Fig 2.3 IC regulator

4. Lighting system; consists of head and back lights, turn signal lights e t c.

Fig 2.4 Car Front Lamp

4. Wiper motor; operates by changing the electrical energy to mechanical energy for washing the front glass.

5. **Accessories of the car**: are equipment in the car that used in motor, dash board and different parts of the car that used to maximize the car performance like sensors, dash board, display radio, camera etc.

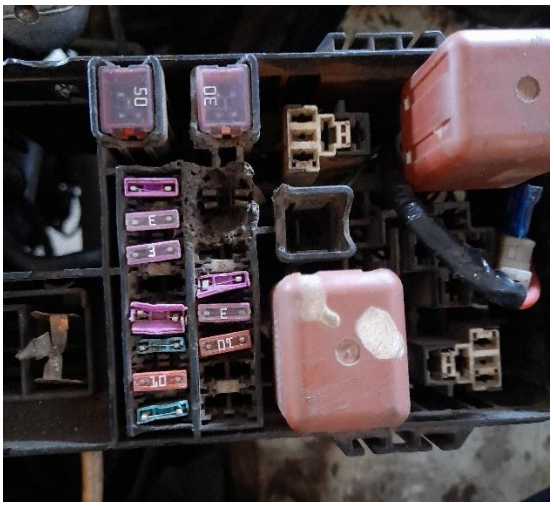


Fig 2.5 Fuse Box

Fig 2.6 EC Board of Toyota

How good I have been in performing my work task

Through my time at this garage, I can say that I have been doing good in performing some of the work tasks that was done. In the first few weeks it was very challenging to keep up with the work. This is due to my luck of experience in practical work place. To perform my work with good performance I tried to take the tasks step by step because by doing that I can manage the knowledge

that I have gained in campus with the field work properly. So, once I get the hint of the performances done. I tried to keep up with the hard work.

Challenge I have faced in my internship

In my time at this garage, I have faced some problems

- In the first two weeks it's difficult for me because I am new with practical work. And the other difficult thing is I have poor communication skill and I am new for the company.
- So Many times, I have been hurt my hand because of the luck of safety and the luck of experience. And the company has no first aid service.

2.4.2. Garage work shop

COOLING SYSTEM

Based on cooling system engines are classified as water cooled and air cooled.

i) **Water cooled engine**: the cooling parts of water-cooled engine are the following.

1. Radiator: it acts as a heat exchanger. It is design to transfer heat from the hot coolant that flows in it to the air blown though it by the fun. the water enters to cap of radiator and the fun keyed to the water pump shaft is used to cool the water and this cooled water go to the lower hose (inlet) plastic pipe and enter to the engine through the thermostat and it will stay in the engine until 74 ℃.Above this temperature the radiator will be opened and the hot water comes back to radiator.

This type of cooling system is indirect cooling. Because first the fun cools the hot water in the radiator and then the cooled water used to cool engine.

Radiator cap: radiator has two valves. These are;

A). Pressure valve: when the water in the cooling system heats up it expands causing the pressure to build up. When the pressure reaches maximum point, the pressure pushes the valve open allowing the coolant to escape from the cooling system. This coolant flows through the over flow tube in to the bottom of over flow tank.

B). Suction valve: when the radiator cools back down a vacuum is created in the cooling system that pulls the over flowed water to radiator.

2. Thermostat: its main job is to allow the engine to heat up quickly and to keep the engine at constant temperature, it does this by regulating the amount of water that goes through the radiator .at low temperature the out let of radiator is completely blocked and the coolant circulate in the engine.

3. Fan: used to maintain temperature of the engine by forced convection.

Fig 2.7 Fan

4. Water pump: used to circulate the coolant that the engine is running. the fluid leaving the pump enter to the engine block and cylinder head then to the radiator finally back to the pump.

5. Water jacket: hollows in the engine block which allows coolant circulation to prevent engine overheating.

ii) **Air cooled engine:**

the engine block is covered with aluminum fins that conduct heat Away from the engine. A powerful fan forces air over these fins which cool the engine by transferring the heat to air.

Safety measures for cooling system

- The cooling parts must be clean.
- Damaged parts must be replaced by new parts.
- Leaking parts must be checked and replaced.

Stroke type: based on the type of stroke engines can be two stroke or four stroke engines.

a) **Two stroke model**; it has no moving valves and the spark plug fires each time. the piston hits the top of its cycle a hole in the lower part of cylinder wall lets in fuel and air.

As the piston moves up it is compressed the spark plug ignites, combustion and exhaust exit through another hole in the cylinder.

b) **Four stroke model**: with both valves closed the combination of the cylinders and the combustion chamber form a completely closed vessel containing air fuel mixture.

Pairing and adjustment of valves in four stroke model:

Pairing of valves means the pair of pistons which will do the same function at the same time i.e., piston which compresses at the same time, suck air the same time etc. to know the pairing of cylinders we give number for each cylinder starting from the front as first, second and third etc. thus the way of deciding the pair is adding the numbers given for cylinders to give a summation value of one greater

than the number of cylinders. For example, for an engine having six cylinders the pairs are; 1&6, 2&5, 3&4 and for engine having four cylinders the pairs are;
1 & 4, 2&3 and their firing orders are 1&5, 3&6, 2&4 and 1&3, 4&2 respectively.

FUEL SYSTEM

Based on the fuel they used engines can be diesel engine and gasoline (benzene)

A) DIESEL FUEL ENGINE

it works as follows. First air enters through the air sucker and then passes to the air cleaner and then pass to the intake manifold then to the valves and it is sucked by the piston of the engine and then compressed at this compression fuel is injected by injector nozzles. air heats up when it is compressed, so that the fuel ignites and power developed and the exhaust gas pass through exhaust manifold to the surrounding. As a result, the crank shaft rotates and torque transmitted through flywheel and clutch to the gear box and differential to wheels and then the vehicle can move.

The fuel transmission units in diesel engine

A). Fuel tank: is the storage unit of fuel.

B). Feed pump: used to suck the fuel from the tank and pass to the fuel filter.

C). Fuel filter: there are two types of fuel filter this are primary and secondary filters. They are used to clean the fuel.

D). Injection pump: it pumps fuel into the cylinders of the diesel engine and to rise the fuel pressure, fuel delivery in each cylinder in firing order of sequence.

E). Injector nozzle: it produces forceful energy by taking the fuel from the injection pump to the cylinder.

F). Return line: each injector nozzle has its own alignment which collects the left over fuel from the injector nozzle and passes it to the tank.

G). Glow plug: heating device used to aid starting diesel engine.

Generally, the fuel flow in diesel engines looks the following.

B) GASOLINE FUEL ENGINE

The fuel transmission units of gasoline engine are same to diesel engine, except the following which are found only in gasoline engine. These are;

a). Carburetor: it mixes the fuel with air as the air flows into the engine. Air and fuel are mixed before entering the engine by the carburetor.

b). Throttle valves: these are rotating valves which control the flow of air fuel mixture from carburetor to cylinder and thus the quantity of air fuel mixture that the system will deliver is by regulating engine power and speed.

c). Choke: it is used to provide extra fuel to the carburetor.

BRAKE SYSTEM MAINTENANCE

Brakes Produces friction to slow or stop the vehicle When the driver presses the brake pedal, fluid pressure actuates a brake mechanism at each wheel.

There are three types of brakes

Fig 2.8 Drum type Brake

Fig 2.9 Disk type Brake

MECHANICAL BRAKES

drum brakes

disk brakes

HYDRAULIC BRAKES

POWER BRAKES

AIR BRAKES

- air hydraulic brakes
- vacuum brakes

- electric brakes

This system mainly composed of the following system

- **Master cylinder**: - mostly found on the engine side of the body connected to the push-rod to the pedal.
- **Wheel cylinder**: - serve either to expand a pair of friction-lined shoes against their brake drum or to clamp a pair of friction-lined pads vice-like against their brake disc.
- **Connecting pipes and hoses**: - connect the wheel cylinders to the master cylinder.
- **Brake fluid**: - contained in a reservoir connected to the master cylinder.

Drum type hydraulic brake system

There are various brake shoes arrangements but **Leading and trailing shoe brakes** is the mostly used. The drum brake has a metal brake drum that encloses the brake assembly at each wheel. Two curved brakes shoes expand outward to slow or stop the drum which rotates with wheel. Drum brakes works us when shoes press against a rotating surface which is known as drum. It also has an adjuster mechanism, an emergency brake mechanism and lots of springs. The shoes are pulled away from the drum by the spring when the brakes are released.

Mainly consist of

i. Piston
ii. Return spring
iii. Expander and expander housing
iv. Friction material (made from **asbestos)**
v. Leading shoe and trailing shoe (made from **cast iron)**
vi. Bleed screw
vii. Pipe

Table 4: Troubleshooting chart for disc brakes

Compliant	Possible cause	Check or correction
Depressing brake pedal produces no braking effect	- Reservoir fluid level low - bleeder screw open - improperly positioned pad - Leak in brake cylinder	- Check for cause of fluid leak; repair as required, refill the reservoir. - bleed the system

	- piston seal damaged in one or more of cylinder	-reposition pads (depress the pedal a second time)
Noise Groan Rattle Scraping	-brake noise when slowly releasing brakes (creep-groan). Not detrimental to function of disc brakes-corrective action required. -This noise may be eliminated by slightly increasing or decreasing brake pedal force. -brake noise at low speeds on rough roads may be due to excessive clearance between the pad and the caliper -disc rubbing housing -Loose wheel bearings -linings worn, allowing wear indicator to scrap on disc.	-install new pad and lining assemblies to correct -check for rust or mud build up on caliper housing; check caliper mounting and bridge bolt tightness. -replace pads

Table 5: Troubleshooting chart for drum brakes

Complaint	Possible cause	Check or correction
- Low pedal	- low fluid level permits air to enter the system -leak in the hydraulic system -improperly adjusted master cylinder push road -excessive clearance between drums and linings -automatic adjusters not working -manual adjuster don't work	-refill and bleed the master cylinder -check the master cylinder, wheel cylinder, tube and hoses for leakage. Repair or replace faulty parts -adjust the brakes -make several forward and reverse stops; if pedal doesn't

		come up, repair the automatic adjuster -replace or repair manual adjusters.
Noisy brakes	-linings worn -shoe warped -shoe rivets loose -drums worn or rough -loose parts -loose wheel bearings	-replace -replace -replace shoe or lining -turn or grind drums -tighten -readjust
-Excessive stopping distance and/or pedal effort	-after extended use, linings worn out or, poor quality brake linings -excessive lining clearance -faulty power brake booster -loose or leaking vacuum hose to power brake -wheel cylinder or master cylinder piston stuck	-replace with approved shoes and linings in axle sets -check and correct pawl advancement on the automatic adjuster-star-wheel type -replace power booster -tighten clamps, or replace hose, as required -rebuild or replace appropriate cylinder.
Car pulls to one side	-faulty suspension parts -incorrect linings and shoes -weak shoe return springs hold-downs	-repair suspension system -replace with correct shoes and linings -replace with new parts
Braking off-track	-Brake clearance not properly adjusted . Un uniform wearing of brake shoes	- Readjust the clearance. -Replace the shoes make laser cutting if necessary. -Clean the shoes with gasoline, replace if necessary

	-Oil and dirt on one side of brake shoes -Different materials and models of brake shoes -Abnormal working on one side of brake chamber -brake drum poor roundness	-Replace with the same material and same model. -Repair or replace braking chamber Boring the drum.

SUSPENSION SYSTEM

Suspension system is located between the wheel axles and the vehicle body or frame and it has the following uses

- It allows the vehicle to travel over rough surfaces with a minimum of up and down body movement
- It provides a cushioning action so road shocks have minimum effect on the occupants and load in the vehicle
- It holds the wheels in alignment

APPLICATION OF SUSPENSION SYSTEM

- **Front Suspension System** Support the front weight of the vehicle and design to free the wheels to move up and down and free the wheels to swing left to right for steering.
- **Rear Suspension System**

It provides limited rear-wheel steering

COMPONENT PARTS OF THE SUSPENSION

Springs and shock absorber are the two main parts of the suspension system.

Springs - support the weight of the vehicle and its load, and absorbs shocks.

TYPES OF SPRINGS

Coil spring- is made of length of round spring steel rod wound into a coil. As the spring compressed, its resistance to further compression increases.

Leaf Spring - it has several flexible steel plates of graduated length, stacked and held together by clips. the plates bend and slide on each other to permit its action.

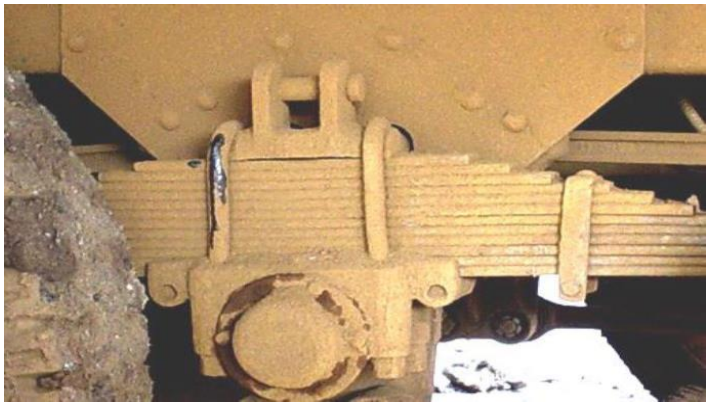


Fig 2.10 leaf spring suspension on CAT grader(Balestera)

Torsion Bar (Torque Bar) - it is a straight rod of spring steel, rigidly fastened at one body. The other end attaches to an upper or lower control arm. as the control arm swings up and down in response to wheel movement, the torsion bar twists to provide spring action.

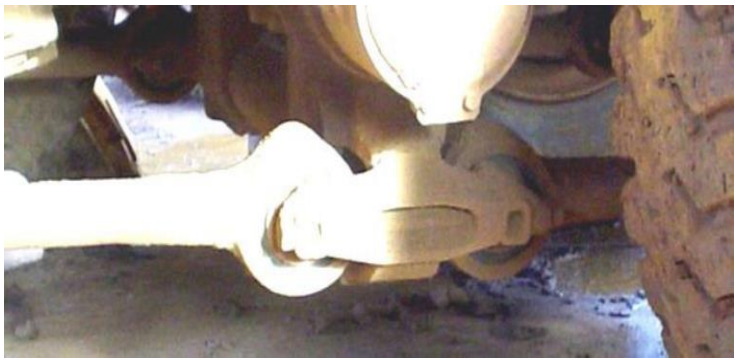


Fig 2.11 Torque Bar

Air Spring - is rubber cylinder or air bag filled with compressed air. a plastic piston on the lower control arm moves up and down with the lower control. this causes the compressed air to provide spring action.

Fig 2.12 Air Spring

Shock Absorber - is a tabular hydraulic device placed near each wheel to control or dampen spring oscillation.

Fig 2.13 Shock Absorber (Amorzater)

TYPES OF SHOCK ABSORBER

- Hydraulic Type
- Gas Type

Stabilizer Bar- it helps control body swaying when cornering or driving on rough or uneven surfaces.

Ball Joints - is a flexible ball-and-socket that mounts in the outer ends of the front- suspension control arm. It provides a pivoting joint that attaches the steering knuckle to control arms. This allows the steering knuckle and wheel to turn in and out for steering.

HOW TO CHANGE SHOCK ABSORBER STEP BY STEP

Step 1: - Jack up the front end of the car

Step 2: - place a jack stand under the suspension parts beneath each shock

Step 3: - Lower the jack on to the jack stands so that the shocks will not be fully extended

Step 4: - Remove the attachment bolts

Step 5: - Remove the shocks

Step 6: - Compare the new shocks with the new ones to be sure. we have the correct replacements

Step 7: - you must purge the new shocks to remove any air that might be trapped in the hydraulic fluid. To do this, fully extend the shock while holding it right-side-up. Then turn it upside down and push it together. Run through this step four or five times.

Step 8: - put the new shocks in place

Step 9: - attach the mounting bolts, but do not tighten them completely

Step 10: - Jack the car up and remove the jack stands

Step 11: - Lower the car to the ground or floor, (This step permits the shocks to center themselves)

Step 12: - Tighten the attachment bolts to the manufacturer's specifications

COMMON SUSPENSION PROBLEM

Suspensions are damaged by so many reasons such as excessive vehicle bounce after heating a bump. This is usually caused by worn shock absorbers. However, a broken shock absorber bracket may also cause vehicle bounce. A broken bracket is usually accompanied by a thumping noise as the free end of the shock absorber hits other parts.

A car that is heavily loaded for a long period of time or one that has been frequently driven over poor roads may have broken or sagging springs. A vehicle that has been in an accident could also have damaged springs. Some of the symptoms of spring problems are faculty headlight aim, rapid tire wear, erratic handling, and suspension noise.

Poor handling can also be caused by worn ball joints or incorrectly adjusted wheel bearings. Worn ball joints cause excessive tire wear. In serious cases, they can cause total loss of control. Mal adjusted or worn wheel bearings can cause the front wheels to wobble.

STEERING SYSTEM

It is used to enable the driver to control the position of the front wheels. The basic parts of steering system are;

1. STEERING WHEEL

A hand wheel that is used for steering .it is the part of steering system that is manipulated by the driver.

2. STEERING SHAFT

Transfer steering motion from the steering wheel to the steering gear box.

3.STEERING GEAR BOX

Serves two basic functions.

It produces a large portion of the mechanical advantage required to provide easy and safe steering.

It provides convenient means of converting the turning motion of the steering wheel in to back and forward motion required to operate the steering.

4. SECTOR SHAFT

Receives energy from the steering gearbox and pass it to the tires though the tie rod and control arms by makes the tires to turn left and right to the steering wheel direction.

5. BOLL JOINT

A flexible coupling of a vehicles suspension that connects the control arm to the steering knuckle. A boll joint is so named because of its boll and socket constrain.

6. TIE ROD

It is used to connect the steering arms to the center link. Boll joint at each end provide the necessary flexibility. The boll joints are threaded in to each end of the

POWER TRAIN

Power train essentially the driveline and engine together, but may be train to include other related parts of the vehicle such as the exhaust or fuel system. power transmission has to take place between engine and driven wheels.

- The power of the engine is transmitted via
  - Clutch,
  - Transmission,
  - Drive shaft and
  - Differential to the wheels
- Drive Train (Drive line)
  - power transmitting parts of a car between the flywheel and the wheels.

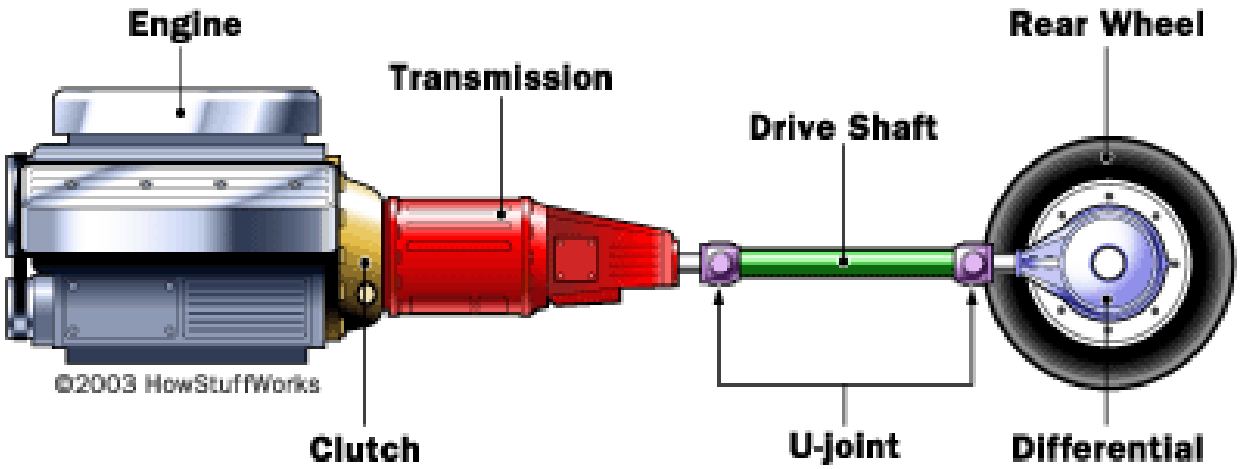


Fig 2.14 image showing power transmission from an engine to tires

- Clutch
  - is a device that connects and disconnects two collinear shafts.
  - Similar to couplings
  - Operating by Friction principle and hence heat dissipation
  - Clutch is a device to connect driving and driven shafts of a machine, where the driven shaft can be disconnected almost instantaneously from the driving shaft as desired by the operator or driver.
- An engine clutch consists primarily of four parts:
  - Inside the clutch Housing
    - Fly wheel
    - Friction/clutch disc
    - Pressure plate assembly
  - Outside the clutch Housing
    - Release/control mechanism

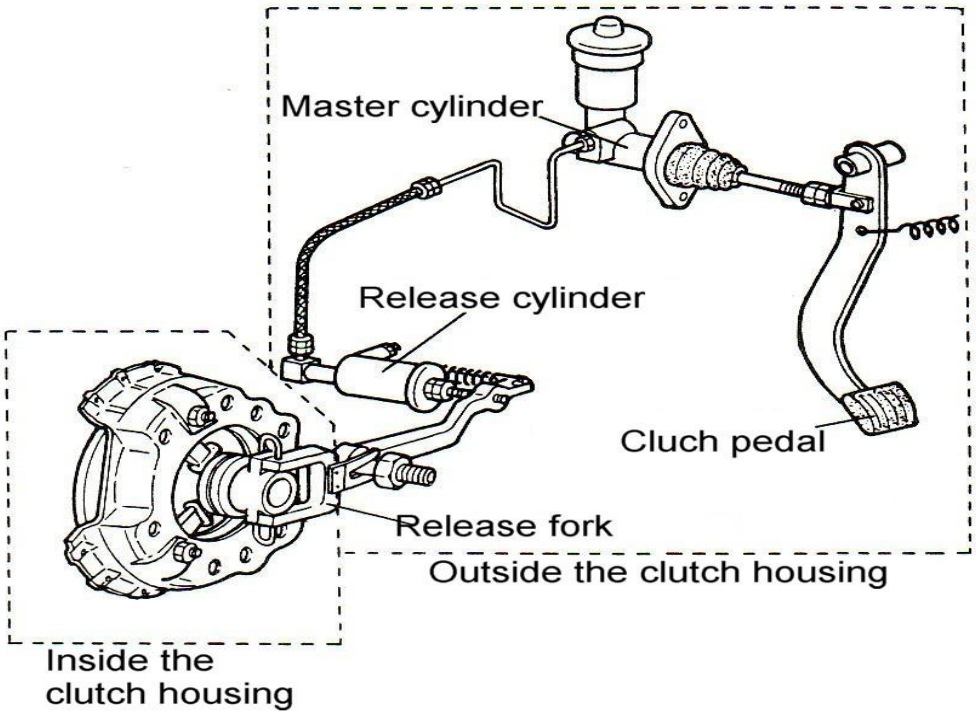


Fig 2.15 Image showing the operation of Clutch

- The Flywheel
  - The flywheel is a fairly large wheel that is connected to the crankshaft. (Stores K.E during engine power stroke and release during idle strokes)
  - The clutch assembly is mounted to the flywheel, sandwiching the clutch disk in between
  - provides a friction surface to the clutch

Fig 2.16 Clutch disc

- Friction/Clutch disc Consists of

- a splined hub and
- A round metal plate covered with friction material or disc lining or facing
  - is made of heat-resistant asbestos, cotton fibers, and copper wires woven or molded together.
  - Grooves are cut into the friction material to aid cooling and release of the clutch disc.
  - Rivets are used to bond the friction material to both sides of the metal body of the disc.

❖ Pressure Plate assembly
- ➢ There are two types
  - Pressure plate assembly with coil spring
  - Pressure plate assembly with Diaphragm type spring
- ➢ Pressure plate assembly with coil spring
  - The main parts of a pressure plate assembly are:
    - Pressure plate cover
    - Pressure springs (coil springs)
    - Pressure plate
    - Release levers
    - Eye bolt assembly

❖ Clutch Fork is also called a clutch arm or release arm transfers motion from the release mechanism to the release bearing and pressure plate

❖ Clutch Release Mechanism

❖ There are two types of clutches, distinguished by the way they are operated:
- ➢ the hydraulically operated clutch and
- ➢ the mechanically operated clutch using a cable linkage

MANUAL POWER TRANSMISSION

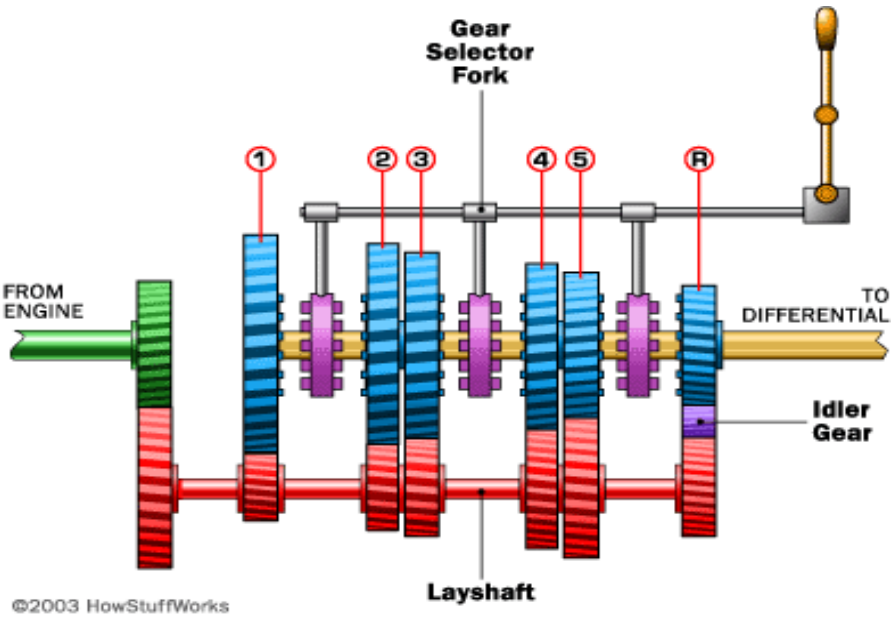


Fig 2.17 Image showing manual power transmission in a car

Transmission or Gearbox or Transaxle is an assembly of gears and shafts to transmit the rotation and torque of the engine to the driveline or final drive

FUNCTIONS OF TRANSMISSION

- To provide a means to vary the torque ratio between the engine and the road
- wheels as required

MAJOR COMPONENTS OF A MANUAL TRANSMISSION

- Transmission Case
- Extension Housing
- Transmission Shafts
  - the input shaft or clutch shaft
  - the countershaft, or cluster gear shaft
  - the reverse idler shafts
  - the main shaft or the output shaft
- Transmission Gears
  - input gear, countershaft gear, main shaft gears, and the reverse idler gear
- Shift Linkage and Levers
- TRANSMISSION OIL

DRIVE SHAFT

To Transfers power (and torque) from output of gear box to (usually unsprung) rear drive axle

Fig 2.18 Drive shaft

- It drives shaft line assembly must perform the following:
  - Send turning power from the transmission to the rear axle assembly.
  - Flex and allow up-and-down movement of the rear axle assembly.
  - Provide a sliding action to adjust for changes in drive line length.
  - Provide a smooth power transfer.
  - Light weight and strong enough.

Components of drive line assembly

- SLIP YOKE
  - connects the transmission output shaft to the front universal joint
- FRONT UNIVERSAL JOINT

- the swivel connection that fastens the slip yoke to the drive shaft.
- DRIVE SHAFT
  - a hollow metal tube that transfers turning power from the front universal joint to the rear universal joint.
- REAR UNIVERSAL JOINT
  - a flex joint that connects the drive shaft to the differential yoke.
- REAR YOKE
  - holds the rear universal joint and transfers torque to the gears in the rear axle assembly.

DIFFERENTIAL

- Transmit torque from drive shaft to drive axles and rear wheels
- Transmit torque at a 90-degree angle
- Provides a gear reduction between the drive pinion and drive axles.
- Split driving torque between the two wheels
- Allows drive wheels to turn at different speeds when turning corners.
- Supports the Chassis, drive axles, and differentials

Provides the means to attach the suspension system brake assemblies, and drive

Components of differential

- *Differential drive pinion yoke (flange)*
  - *connects drive shaft to differential ring gear.*
- *Drive pinion:*
  - *transmits torque from drive shaft to differential ring gear*
- *Ring gear*
  - *transmit torque from drive pinion to differential case*
- *Differential case*
  - *transmits torque from ring gear to differential pinion shaft contains differential pinion shaft; differential pinion gears, and axle side gears.*

Fig 2.19 Differential Gear Unit

Basic Construction of the Differential Gear Unit

- Power Flow
    - Crankshaft rotation
    - propeller shaft
    - drive pinion
    - ring gear
    - differential case
    - differential pinion
    - Side (Sun) gears
    - axle shaft
    - wheel

AXLE SHAFT

- The axle shaft transmits the drive from the differential side gears to the rear hub
- The shaft is subjected to:
    - Torsional stress due to driving and braking torque
    - Shear stress due to the weight of the vehicle
    - Bending stress due to the weight of the vehicle
    - Tensile and compressive stress due to cornering forces
- Types of Axle Shaft
    - Semi-floating
    - three-quarter floating
    - Fully floating

Fig 2.20 Axle shaft

2.4.3. Engine Shop

The internal combustion engine (IC-Engine) is a heat engine that converts chemical energy in a fuel into mechanical energy, usually made available on a rotating output shaft. Chemical energy of the fuel is first converted to thermal energy by means of combustion or oxidation with air inside the engine. This thermal energy raises the temperature and pressure of the gases within the engine and the high-pressure gas then expands against the mechanical mechanisms of the engine. This expansion is converted by the mechanical linkages of the engine to a rotating crankshaft, which is the output of the engine. The crankshaft, in turn, is connected to a transmission and/or power train to transmit the rotating mechanical energy to the desired final use. For engines this will often be the propulsion of a vehicle (i.e., automobile, truck, locomotive, marine vessel, or airplane). Other applications include stationary engines to drive generators or pumps, and portable engines for things like chain saws and lawn mowers.

TERMINOLOGY AND ABBREVIATION

The following terms and abbreviations are commonly used in engine technology

Internal Combustion (I.C) generation of heat in side of the engine when flammable substance is burned internally.

Spark Ignition (S.I) an engine in which the combustion process in each cycle is started by use of a spark plug.

Compression Ignition (CI)

An engine in which the combustion process starts when the air-fuel mixture self-ignites due to high temperature in the combustion chamber caused by high compression. CI engines are often called Diesel engines, especially in the non-technical community.

Top-Dead-Center (TDC)

Position of the piston when it stops at the furthest point away from the crankshaft. Top because this position is at the top of most engines (not always) and dead because the piston stops at this point. Because in some engines top-dead-center is not at the top of the engine (e.g., horizontally opposed engines, radial engines, etc.), some Sources call this position Head-End-Dead-Center (HEDC). Some sources call this position Top-Center (TC). When an occurrence in a cycle happens before TDC, it is often abbreviated bTDC or bTC. When the occurrence happens after TDC, it will be abbreviated aTDC or aTC. When the piston is at TDC, the volume in the cylinder is a minimum called the *clearance volume.*

Bottom-Dead-Center (BDC)

position of the piston when it stops at the point closest to the crankshaft. Some sources call this Crank-End-Dead-Center (CEDC) because it is not always at the bottom of the engine. Some sources call this point Bottom-Center (BC). During an engine cycle thing can happen before bottom-dead-center, bBDC or bBC, and after bottom-dead-center, a BDC or a BC.

Direct Injection (DI).

fuel injection into the main combustion chamber of an engine. Engines have either one main combustion chamber (open chamber) or a divided combustion chamber made up of a main chamber and a smaller connected secondary chamber.

Indirect Injection (IDI)

fuel injection into the secondary chamber of an engine with a divided combustion chamber.

Bore Diameter of the cylinder

It is also called diameter of the piston face, which is the same minus a very small clearance.

Stroke Movement

Distance of the piston from one extreme position to the other. DC to BDC or BDC to TDC.

Clearance Volume Minimum volume in the combustion chamber with piston at TDC.

Displacement Volume.

Volume displaced by the piston as it travels through one stroke. Displacement can be given for one cylinder or for the entire engine (one-cylinder time's number of cylinders). Some literature calls this *swept volume.*

Ignition delay (I.D). Time interval between ignition initiation and the actual start

Break Maximum Torque (BMT) Speed at which maximum torque occurs.

Overhead Valve (ORV) Valves mounted in engine head.

Overhead Cam (ORC) Camshaft mounted in engine head, giving more direct control of valves which are also mounted in engine head.

DIESEL ENGINE

Theoretically, the diesel cycle differs from the Otto cycle in that combustion takes place at constant volume rather than at constant pressure. Most diesels are also four stroke engines but they operate differently than the four-stroke Otto-cycle engines. The first, or suction, stroke draws air, but no fuel, into the combustion chamber through an intake valve. On the second, or compression, stroke the air is compressed to a small fraction of its former volume and is heated to approximately 440°C (approximately 820°F) by this compression. At the end of the compression stroke, vaporized fuel is injected into the combustion chamber and burns instantly because of the high temperature of the air in the chamber. Some diesels have auxiliary electrical ignition systems to ignite the fuel when the engine starts and until it warms up. This combustion drives the piston back on the third, or power, stroke of the cycle. The fourth stroke, as in the Otto-cycle engine, is an exhaust stroke.

ADVANTAGES IN USING DIESEL ENGINE

- More efficient and less expensive to operate than gasoline-powered engines, partly because diesel fuel costs less;
- Consume less fuel and emit fewer waste products;
- Big and heavy suitable for shipping and railroad industries; and
- Still the engine choice for heavy transportation and industry.

DISADVANTAGE IN USING DIESEL ENGINE

- Production of sooty and smelly smoke

Operation of the Four Stroke Cycle

ENGINE COMPONENTS

The following is a list of major components found in most reciprocating internal combustion engines

CYLINDER BLOCK.

Body of engine containing the cylinders, made of cast iron or aluminum. In many older engines, the valves and valve ports were contained in the cylinder block. The block of water-cooled engines includes a water jacket cast around the cylinders. On air-cooled engines, the exterior surface of the block has cooling fins.

Fig 2.21 Cylinder block

CYLINDER HEAD.

It is the top most part of the engine, which covers the cylinder block. This will also carry the valves, rocker arms and springs for the opening and closing of the valves. It has also inlet and exhaust ports, combustion chamber and camshaft in some engine, likewise nozzle if diesel engine. The piece which closes the end of the cylinders, usually containing part of the clearance volume of the combustion chamber. The head is usually cast iron or aluminum, and bolts to the engine block. In some less common engines, the. Head is one piece with the block. The head contains the spark plugs in SI engines and the fuel injectors in CI engines and some SI engines. Most modern engines have the valves in the head, and many have the camshaft(s) positioned there also (overhead valves and overhead cam).

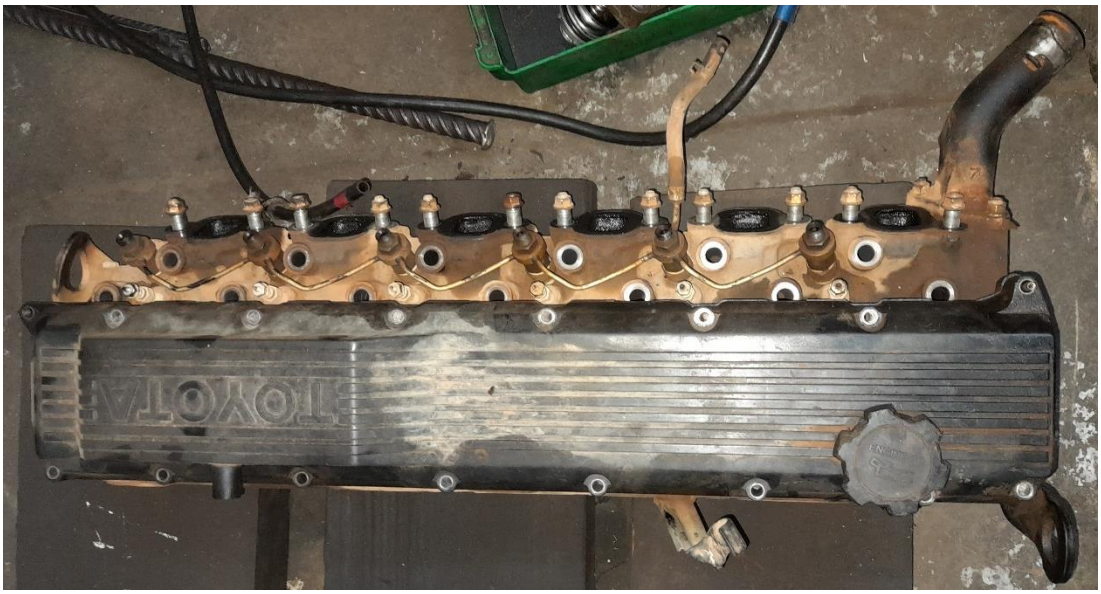


Fig 2.22 Cylinder Head

HEAD GASKET

Gasket which serves as a sealant between the engine block and head where they bolt together. They are usually made in sandwich construction of metal and composite materials. Some engines use liquid head gaskets.

VALVES

Valve is Used to allow flow into and out of the cylinder at the proper time in the cycle. Most engines use *poppet valves*, which are spring loaded closed and pushed open by camshaft action. Valves are mostly made of forged steel. Surfaces against which valves close are called valve seats and are

made of hardened steel or ceramic. *Rotary valves* and *sleeve valves* are sometimes used, but are much less common. Many two-stroke cycle engines have *ports* (slots) in the side of the cylinder walls instead of mechanical valves.

Fig 2.23 Exhaust Valve

WATER JACKET

System of liquid flow passages surrounding the cylinders, usually constructed as part of the engine block and head. Engine coolant flows through the water jacket and keeps the cylinder walls from overheating. The coolant is usually a water-ethylene glycol mixture.

CAMSHAFT

Rotating shaft used to push open valves at the proper time in the engine cycle, either directly or through mechanical or hydraulic linkage (push rods, rocker arms, tappets). Most modern automobile engines have one or more camshafts mounted in the engine head (overhead cam). Older engines had camshafts in the crankcase. Camshafts are generally made of forged steel or cast iron and are driven off the crankshaft by means of a belt or chain (timing chain). To reduce weight, some cams are made from a hollow shaft with the cam lobes press-fit on. In four-stroke cycle engines, the camshaft rotates at half engine speed.

PUSH RODS

Mechanical linkage between the camshaft and valves on overhead valve engines with the camshaft in the crankcase. Many push rods have oil passages through their length as part of a pressurized lubrication system.

COMBUSTION CHAMBER

The end of the cylinder between the head and the piston face where combustion occurs. The size of the combustion chamber continuously changes from a minimum volume when the piston is at TDC to a maximum when the piston is at BDC. The term "cylinder" is sometimes synonymous with

"combustion chamber" (e.g., "the engine was firing on all cylinders"). Some engines have *open* combustion chambers which consist of one chamber for each cylinder. Other engines have *divided* chambers which consist of dual chambers on each cylinder connected by an orifice passage.

GLOW PLUG

Small electrical resistance heater mounted inside the combustion chamber of many CI engines, used to preheat the chamber enough so that combustion will occur when first starting a cold engine. The glow plug is turned off after the engine is started.

CYLINDERS

The circular cylinders in the engine block in which the pistons reciprocate back and forth. The walls of the cylinder have highly polished hard surfaces. Cylinders may be machined directly in the engine block, or a hard metal (drawn steel) sleeve may be pressed into the softer metal block. Sleeves may be dry sleeves, which do not contact the liquid in the water jacket, or wet sleeves, which form part of the water jacket. In a few engines, the cylinder walls are given a knurled surface to help hold a lubricant film on the walls. In some very rare cases, the cross section of the cylinder is not round.

PISTON

The cylindrical-shaped mass that reciprocates back and forth in the cylinder, transmitting the pressure forces in the combustion chamber to the rotating crankshaft. The top of the piston is called the *crown* and the sides are called the *skirt*. The face on the crown makes up one wall of the combustion chamber and may be a flat or highly contoured surface. Some pistons contain an indented bowl in the crown, which makes up a large percent of the clearance volume. Pistons are made of cast iron, steel, or aluminum. Iron and steel pistons can have sharper corners because of their higher strength. They also have lower thermal expansion, which allows for tighter tolerances and less crevice volume. Aluminum pistons are lighter and have less mass inertia. Sometimes synthetic or composite materials are used for the body of the piston, with only the crown made of metal. Some pistons have a ceramic coating on the face.

Fig 2.24 Dismantled Piston

PISTON RINGS

Metal rings that fit into circumferential grooves around the piston and form a sliding surface against the cylinder walls. Near the top of the piston are usually two or more compression rings made of highly polished hard chrome steel. The purpose of these is to form a seal between the piston and cylinder walls and to restrict the high-pressure gases in the combustion chamber from leaking past the piston into the crankcase. Below the compression rings on the piston is at least one oil ring, which assists in lubricating the cylinder walls and scrapes away excess oil to reduce oil consumption.

WRIST PIN

Pin fastening the connecting rod to the piston (also called the *piston pin).*

CONNECTING ROD.

Rod connects the piston with the rotating crankshaft, usually made of steel or alloy forging in most engines but may be aluminum in some small engines.

CONNECTING ROD BEARING

Bearing where connecting rod fastens to crankshaft.

CRANKCASE.

Part of the engine block surrounding the rotating crankshaft. In many engines, the oil pan makes up part of the crankcase housing.

CRANKSHAFT

Rotating shaft through which engine work output is supplied to external systems. The crankshaft is connected to the engine block with the *main bearings.* It is rotated by the reciprocating pistons

through connecting rods connected to the crankshaft, offset from the axis of rotation. This offset is sometimes called *crank throw* or *crank radius.* Most crankshafts are made of forged steel, while some are made of cast iron.

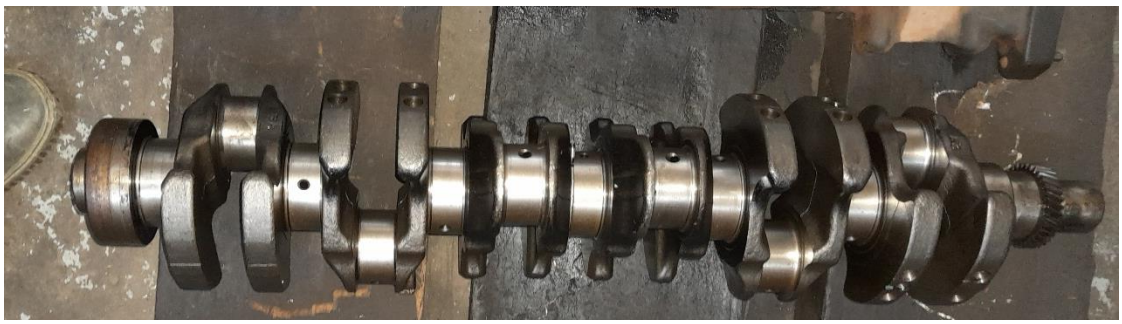


Fig 2.15 Crank Shaft

MAIN BEARING

The bearings connected to the engine block in which the crankshaft rotates. The maximum number of main bearings would be equal to the number of pistons plus one, or one between each set of pistons plus the two ends. On some less powerful engines, the number of main bearings is less than this maximum.

OIL PAN (OIL SUMP)

Oil reservoir usually bolted to the bottom of the engine block, making up part of the crankcase. Acts as the oil sump for most engines. Some engines (aircraft) have a separate closed reservoir called a *dry sump.*

FLYWHEEL

Rotating mass with a large moment of inertia connected to the crankshaft of the engine. The purpose of the flywheel is to store energy and furnish a large angular momentum that keeps the engine rotating between power strokes and smooths out engine operation. On some aircraft engines the propeller serves as the flywheel, as does the rotating blade on many lawn mowers.

INTAKE MANIFOLD

Piping system which delivers incoming air to the cylinders usually made of cast metal, plastic, or composite material. In most SI engines, fuel is added to the air in the intake manifold system either by fuel injectors or with a carburetor. Some intake manifolds are heated to enhance fuel evaporation. The individual pipe to a single cylinder is called a *runner.*

EXHAUST MANIFOLD

Piping system which carries exhaust gases away from the engine cylinders, usually made of cast iron. Exhaust system Flow system for removing exhaust gases from the cylinders, treating them, and exhausting them to the surroundings. It consists of an exhaust manifold which carries the exhaust gases away from the engine, a thermal or catalytic converter to reduce emissions, a muffler to reduce engine noise, and a tailpipe to carry the exhaust gases away from the passenger compartment.

TURBOCHARGER

Turbine-compressor used to compress incoming air into the engine. The turbine is powered by the exhaust flow of the engine and thus takes very little useful work from the engine.

RADIATOR

Liquid-to-air heat exchanger of honeycomb construction used to remove heat from the engine coolant after the engine has been cooled. The radiator is usually mounted in front of the engine in the flow of air as the automobile moves forward. An engine-driven fan is often used to increase air flow through the radiator.

WATER PUMP

Pump used to circulate engine coolant through the engine and radiator. It is usually mechanically run off of the engine.

FAN

Most engines have an engine-driven fan to increase air flow through the radiator and through the engine compartment, which increases waste heat removal from the engine. Fans can be driven mechanically or electrically, and can run continuously or be used only when needed.

COOLING FINS

Metal fins on the outside surfaces of cylinders and head of an air-cooled engine. These extended surfaces cool the cylinders by conduction and convection.

FUEL INJECTOR

A pressurized nozzle that sprays fuel into the incoming air on SI engines or into the cylinder on CI engines. On SI engines, fuel injectors are located at the intake valve ports on multipoint port injector systems and upstream at the intake manifold inlet on throttle body injector systems. In a few SI engines, injectors spray directly into the combustion chamber.

FUEL PUMP

Electrically or mechanically driven pump to supply fuel from the fuel tank (reservoir) to the engine. Many modern automobiles have an electric fuel pump mounted submerged in the fuel tank. Some small engines and early automobiles had no fuel pump, relying on gravity feed.

OIL PUMP

Pump used to distribute oil from the oil sump to required lubrication points. The oil pump can be electrically driven, but is most commonly mechanically driven by the engine. Some small engines do not have an oil pump and are lubricated by splash distribution.

Fig 2.16 Oil Pump

DETAIL ASSEMBLY OF THE ENGINE

DISASSEMBLING AND ASSEMBLING

Disassembly steps

1. Starter motor assembly
2. Cooling fan
3. Fan belt
4. Fan pulley
5. Damper pulley
6. Engine hunger
7. Water by-pass hose
8. Generator assembly and engine foot
9. Thermostat housing
10. head cover with positive crankcase ventilation
11. injection pipe and clip
12. Nozzle holder assembly
13. Glow plug and connector
14. oil pressure switch, unit and oil pipe
15. Oil filter and oil cooler
16. Oil pan
17. Tension spring
18. Dust cover

TROUBLESHOOTING OF AN ENGINE

Table 6: Troubleshooting chart for engine

Complaint	Possible cause	Check or correction
Fuel supply system failure:	- There is air in the fuel supply system - Fuel pipeline blocked - Fuel filter clogged - Fuel supply pump does not supply fuel or supplies fuel intermittently - The injector injects very little fuel or does not inject fuel, or injection pressure is too low - Injection pump failed - Improper valve timing or angle of fuel supply commencement	- Check if the fuel pipe joint is loose and if the pipe is damaged. Loosen air bleed plugs on the fuel injection pump and the fuel filter, use a hand pump to suck fuel or pressurize the fuel tank to bleed the air in the fuel supply system. - Check if the pipeline is clear. - Wash fuel filter. - Check if there is air in the fuel inlet pipe. Otherwise, check and repair fuel supply pump. - Remove the fuel injector but with it still connected to the high-pressure fuel pipe, use the starter to rotate the crankshaft and drive the injection pump plunger. Observe the condition of fuel injection and atomization; remove it for check and Check
Starting system failure:	- Starting system is incorrectly wired or in poor contact - Battery capacity is insufficient	- Check the wiring condition and connect it properly. - Check battery capacity and recharge the battery.

	- Starter brushes and the commutator are in poor contact - Starter runs idle. The engine cannot be started with clutch pedal released, but can be started with clutch pedal stepped.	- Use fine sand paper to lap the commutator surface, blow off dust and replace brushes. - Check if the starter mounting and the friction clutch are normal.
The compression pressure of the cylinder is insufficient:	- Piston ring is worn excessively - Valve leaks	- Replace piston ring. - Check valve clearance, valve spring, and the tightness between the valve and the valve seat, lap the valve if the annular contacting zone is in continuous.
Air intake is difficult:	- Air inlet blocked - Fuel filter clogged - Ambient temperature and engine temperature too low	- Clean the clog. - Wash air filter. - Correctly use cold starting system.
Engine Power Insufficient	-Injection pump failed -Injection pump is clogged or in poor atomization -Cylinder head fuel injector seat hole leaks air	-Check and adjust the injection pump, and replace the needle valve matching parts -Tighten injection pump needle valve fixing sleeve or lap the mating and pressure-bearing surface - Clean copper shim seat hole surface
Engine generates abnormal noise	-Fuel supply is too early. - Fuel supply is too late.	- Readjust the fuel supply timing.

	- The mating between the piston pin and the connecting rod small end pin hole is too loose. - The clearance between the piston and the cylinder is too big. - The connecting rod bearing shell is too loose or clearance is too big.	- Readjust the fuel supply timing. - Replace the connecting rod small end bushing, so as to set the clearance within its specified range. - Replace the piston or replace the piston and the cylinder liner according to the state of the wear.

2.4.4. Manufacturing Shop

I have spent much time than my friends So in this shop their design, fabrication and repair different items with the help of different types of useful machineries for maintenance and fabrication such as

LATHE MACHINES

In this shop there are two lathe machines**.** They are used to different applications like fabrication of shaft with different features**,** bolts and nuts and some components of vehicles which are not available on the market.

HYDRAULIC PRESS

Machine they use the machine for press and disassemble different cylindrical attached parts like piston line.

DRILLING MACHINE

To drill out different parts which are fabricate in the shop.

BURNER

It’s a simple device which generate an air with a motor to burn the inserted fuel (charcoal) in the burner house. They use this device for heat treatment application after they fabricate some components like bolts and nuts.

SURFACE GRINDER MACHINES

There are two grinders to work surface finishes of fabricated components and sometimes to reduce the size of some components.

BENCH VISE

Its well-known device which used to hold the work piece and apply some mechanical works like hammering, bending and so on.

Fig 2.17 Lathe Machine

Fig 2.18 Pressing Machine

Fig 2.19 Drilling Machine

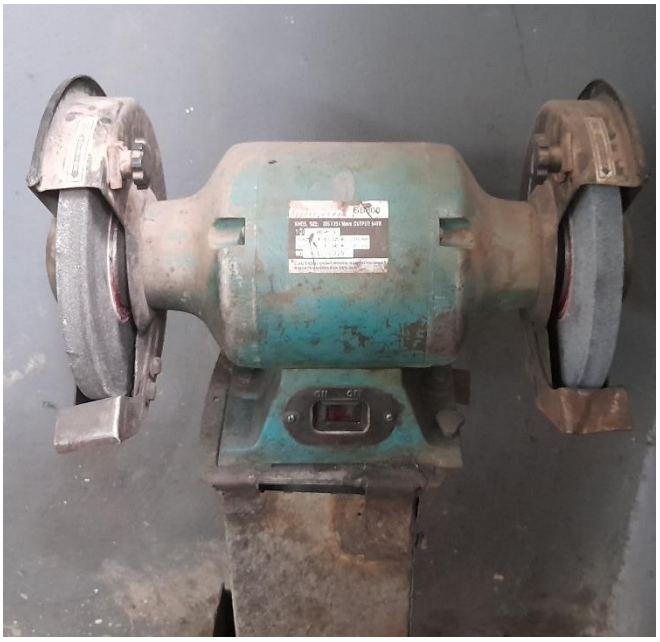


Fig 2.20 Surface Grinding Machine

Fig 2.21 Cutting Grinder

Fig 2.22 Bench Vise

THINGS I HAVE DONE IN MACHINE SHOP:-I have taken some tasks in this shop such as

1. Fabricate a hexagonal bolt on lathe machine

In this task I have got the specifications and to get the real dimensions by measuring the failed components and use some standard calculations by referring their workshop manuals. I have used Varner caliper and pitch gages to measure the pitch of the threads. After getting the dimensions, layout the drawing then I have got the work piece which was hexagonal shaped mild steel shaft. Then I have made the it on lathe machine.

Fabricating hexagonal bolt with a pitch diameter of 20mm, 54mm length and 1.25 thread depth. I have done this bolt with the help of the machinist who work in that shop.

Grind fabricated bolts with dies which have internal threads to fine the tread of the bolt.

Burn (heat treatment) fabricated bolt in burner and quench it in oil. The final product is shown below.

In this shop I have seen so many problems and I try to solve some of them. They use traditional working system that mean they receive specification in partial or they receive the failed components and oral instruction rather than the drawings then they try to layout the drawing. I have suggested them to use computers to work the drawings on AutoCAD and other software and I have given those materials. And also, have taken the task to design a circle drive grader shaft of grader.

2. Design a circle drive shaft of grader

This circle drive shaft is a part of grader which used to move hook in different direction. By the failure of this component the grader stop and the construction works are also wait the grader. This component has a price of 72,000br in the market to buy and assemble. In order to save this high buying cost the one and best choice is manufacture it in the machine shop and the cost will be minimized into 15000-20000br including the machine cost, initial cost and the operator payment…. the time duration to manufacture is 4hrs. so manufacturing the component is advisable rather than buy it because they get the work pieces from the other failed components in the shop.

2.4.5. Tire maintenance shop

In This shop different tire problems will be solved. There are two machines. Both of them are operated electrically. Those are including: -

1. Wheel balance machine
2. Tire fitting machine
3. Compressor

Even though the wheel balance machine is present in this shop it doesn't give a successful function within the required time and place due to unavailability of the electric in all place.

Fig 2.23 Wheel Alignment machine

Fig 2.24 Tire Fitting Machine

Fig 2.25 Air Compressor

CHAPTER THREE

3. OVERALL BENEFITS GAINED FROM INTERNSHIP

Intern ship is a practical application on which what students know about their field in theoretical class. This helps the student to have better knowledge about their field of studies in which what they are going to work. Because Engineering is a practical field of study, and it's difficult to understand easily without practical classes. It is important because the practical session in higher educational institutes is held under limited condition. During the internship however, students are exposed to the real application area of their concern there by developing their practical skills. And also, it gives a better opportunity to understand working with peoples, work responsibilities and disciplines. So, I will encourage this program even more.

3.1 Improving practical skill

Doing practical activates Improve practical skill in different aspects. Day to day activates in South Roads Authority (SRA) is supported by different machineries this helps to improve practical skill.

Assembling involves connecting one part to the other so that power and hence motion is transmitted from part to part. During this task interns practically observe how power and motion is transmitted and the elements that are involved in power transmission. So I understand the real case by which the reciprocation of piston due to gas pressure is changed to rotation of crankshaft from which this rotational motion is transmitted to gearbox through clutches. In gearbox, the speed of rotation of the system (rpm) is reduced by gears of different sizes. The reduced motion is transmitted to the final drive through differential after its direction of motion is changed by 90o at this differential. So these operating systems are connected to produce an operating power transmission system. Interns up on taking part on this assembling hence improve their skill on this perspective. Also I got full experience on assembling of WD615 SINOTRUK engine.

3.2 Upgrading Theoretical Knowledge

Theoretical knowledge is prerequisite for practical operation and provision of recommendations for maintenance activities. For example, if a vehicle is found to release black exhaust gas continuously, they implication behind this is that the engine injection pump failed to supply very pressurized fuel. In diesel engine, the air is compressed to very high pressure in combustion chamber so that its temperature rises dramatically. Then fuel is injected in spray form by the injection pump. Here the fuel itself starts (causes) combustion by igniting due to the high temperature of the

compressed air. However, if the fuel is not vaporized and sprayed or if the fuel is supplied in to the cylinder in droplet from, the thermal efficiency of the engine decreases. This is observed when the engine releases black exhaust continuously. There are different kinds of lubricating oils differing by their viscosity. These oils are used for different systems for lubrication. Two types of oils are used for lubrication purpose in vehicles or cars. These are oil having viscosity number of 40 and that of 140. Viscosity number is high for highly viscous oils. In general, for heavy duty vehicle the 140 oil is used for lubrication of gears in gear box and final drive.

3.3 Improving Interpersonal Communication Skills

Interpersonal communication helps peoples working together to consolidate and promote friendship peace and stability. Interpersonal communication also helps peoples for mutual benefits. This internship program gives a chance of working with many professions those have different communication skill. On this internship program I would improve interpersonal communication skills on: -

- How to communicate and with whom to communicate
- How more to be communicate
- Listing more than speaking is good
- Selection of words the basic for communication
- Identifying of words using for communication way be considering to whom to be speaking.

Engine assembly is done in group. In this group even if each student has his own task to do and there are common tasks to be performed cooperatively. In this situation interns develop team work skill. Team work also involves communication with each other in solving some problems. What is needed here is contribution of supportive idea that can solve the problem. The group members should accept the idea of one another. This enables develop interpersonal communication skill. Finally, from this program I would improve interpersonal communication skills from different professional person who have work experience in different job sectors and from my friends.

3.4 Improving Team Playing Skills

The benefits of team playing association are to find solution to their difficulties and to bring about change as group. Through face-to-face meeting people learn more about each other's viewpoint and discover they have thing in common.

Team playing is particular form of reasoning and talk together in which we have careful the cost and consequence of our various option for action in the context of the views of others. Peoples cannot act together either to set dissection or building relations as citizen without

making choose or decision. Team playing helps as to find connections among our varied purposes and share sense of dissections. In internship program, I would improve team playing skills in different way on:-

- Share ideas
- Explore different in ideas
- Negotiate, extend and modify ideas
- Test and substantiate ideas
- Finalize and act on group consensus

Team playing is also creating basis for me on action that are mutual reinforcing or complementary, because they serve compatible purpose.

Generally on this internship program I would improve team-playing skills in different ways what I mentioned in the above.

3.5 Improving Leadership Skills

Performing one's task without leadership is like trying to drive car downhill without a brake or steering wheel. I was believing that, for Success work good leadership skill has a great role. I was carried out some responsibilities in the project. So, to accomplish the tasks I was paying sacrifices especially, guiding labors when I was doing with them to do accordingly what I work ,to checking quality and availability of construction materials, in guiding machine operators when they operating, and soon. I have understood the meaning of leadership practically. "Leadership is not a matter of position but it is a matter of responsibility". Even if I was facing challenges, I was trying my best to get the solution for the problems. This leads to be effective in leadership and in improving qualities of leadership.

I have improved leadership skill in this intern period through:

- Guiding, controlling and monitoring the work as it's possible.
- Developing confidence to manage and organize construction works.
- Taking necessary measures in any case challenges.
- Resolution of conflict and make a conciliation of disagreement among people.
- Good correlation with others.
- Respecting the staff members.
- Prohibit the destruction of government fixed asset.
- Conducting labors and guiding machine operators, drivers of truckers.

3.6 Understanding work ethics & related issues

Ethics is a brunch of philosophy that deals with moral principles. Work ethics is amoral

principle that controls the person's behavior in work area. This internship enabled to improve moral principles in any work pieces. Every day I was reflecting good behavior in work area. It is mostly expected from professionals who are engaged in different professional works at each level. It is also referred to as the generally accepted guideline for right or wrong behavior in work space. Actually, I have understood different types of work ethics in internship period.

- Loyalty/allegiance: to perform tasks loyally
- Integrity : to analyze and interpret the data collected carefully
- Punctual: to work task on arranged time and coming on time
- Transparency : to tell the truth
- Commitment: giving promise to do or not to do something
- Honesty: keeping secreted documents in the office
- Responsibility : take care of tasks
- Accountability: to responsible for tasks

Work ethics has to do with the moral principle or behavior of a person or a group. It is refers to the generally accepted guideline for right or wrong behavior in work space. It involves several principles to effective work habits and personnel qualities.

A good work ethics is an aspect of being a responsible citizen and includes punctuality. Keeping promises and giving thanks to take good ideas.

Characteristics of ethics: -

- interpersonal skill
- initiative
- dependence

From these what I mention above I would observe from organization workers, so I would improve this characteristic from them and reflect this characteristic through my life time in job sectors. General from internship program I would improve work ethics in different situations.

3.7 Improving entrepreneurships skills

In order to effectively execute of practical knowledge, this internship program enabled to be creative, reasonable, hard worker and motivated to perform related works with field of study. Entrepreneurship is the mechanisms of process of creating new idea, system, technology and new business. This idea is a concept of innovation on work to increase result of work to get high benefits from products. From the program, I able to understand those qualities listed above are important for me.

Direction to successfully entrepreneurship included: -

- Independent thinker although one should pay attention to the view of others.
- Logical thinking and planning
- Risk think and change
- Relaxing
- Acting itself interest

Finally under this internship program I would improve that the skills of creating new idea to encourage for entrepreneurship it helps to develop business concept.

CHAPTER FOUR

4. CONCLUSION AND RECOMMENDATION

4.1 Conclusion

To sum up, I have tried to achieve and accomplish the internship program well by practicing how to design, construct and maintain small and medium parts of vehicle. Besides to improving practical knowledge, I have been able to upgrade theoretical knowledge what I have learnt in class. This internship program had given a great opportunity to be familiar with people of great experience in different study of fields and with diversified scopes. It was good condition to relate the things what I have learnt in class practically on the field. This enabled to gain practical skill with up graded theoretical knowledge.

I have been working and trying to understand well the work most on the shop by following the relevant procedures which I had developed before and during internship period.

I had spent good time in the past three-month internship program. My hosting organization is South Roads Authority (SRA) provided better access to grow in my career, theoretical knowledge and practical skill. I had been worked hard from the beginning to the end of the internship period. I never forget this time and I am lucky to be this program study

Generally, the internship program is a very necessary thing especially for engineering students.so the school and organizations should take care of it and prepare things which are needed for the program in south road authority there is a big maintenance section that have different shops so Hawassa university should work with the company for mutual benefit one the students in the university will get a vast practical world knowledge and also will develop it self by working with universal organization like our university

4.2 Recommendation

As there are some limitations in the maintenance department of the organization; as student of mechanical engineering, I recommend on the following points.

- The Organization should have educated man power to do full maintenance for the vehicle; such as Electro Mechanical Engineers who can control Electrical, mechanical and Electro mechanical aspects problems.
- They should give enough training for drivers, mechanics and other workers in order to keep the vehicle in healthy condition.
- There should be pre prepared schedule for each vehicle in maintenance program, in order to have a reliable and long-life vehicle.
- The mostly required parts must be bought when there is a chance of getting the parts even if the parts are not required at the time.
- Electrical shop of this organization must have a proper arrangement to give its service appropriately specially in the time of emergency.
- The organization must use Predictive Maintenance (Condition Based Maintenance) in addition to three maintenance type because predictive maintenance is the use of modern measurement and signal processing methods to accurately diagnose item/equipment condition during operation.
- They should be use car lifter machine for different types of maintenance activity.
- The organization is must adopting the kaizen theory in order to manage spare parts and other equipment. The spirit of kaizen is all about achieving improvement by taking small steps in steady of drastic, rigorous changes. It involves setting and continuously improving standards without large capital investment.

The objective of kaizen is eliminating waste or an activity that adds cost but not value just in time delivery production load.

The kaizen theory have 5s basic word to manage equipment. The method of managing equipment in proper way is defined on kaizen board. Kaizen Board contain 5s

- Sort: take out unnecessary items and dispose
- Systematize: arrange necessary items in good order
- Sweep: cleaning work place
- Sanitize: maintaining high standard
- Self-Discipline: do things continuously without being told ordered

- Finally, the organization must be doing with the University students in order to teach students and get the scientific fact from the students and other university staffs.

5. References

- Organization profile
- Organization library
- Automotive Engineering Powertrain, Chassis System and Vehicle Body book
- Theories and principles of engine operation
- Force transmission from wheel to road book.
- WD615 SINOTRUK diesel engine manual
- Motor vehicle lecture note
- Principles of Automotive Vehicles book
- Different websites like –Wikipedia, Google, Top Tech boys, Branity

Appendices

SRA…….... South Roads Authority

MOENCO……The Motor and Engineering Cooperation of Ethiopia

SWWCE……...South Water Work Construction Enterprise

URRAP……. Universal Rural Roads Access Program

EMS……. Engine Management system

EME……Earth Moving Equipment

HDV…… …. High Duty Vehicle

WD615…… SINOTRUK car engine model

1PZ, 1HZ, 1HD-T engine……model of Toyota vehicle it used at the time of spare part.

TDC & BDC……. Top Dead Center & Bottom Dead Center