EXCITING WORLD OF

AUTOMOBILES

STUDENT WORKBOOK

Curriculum :AUTO-SRV *L4-NQ*^{2013}

Unit :AUTO-SRV *L4U4*

Suspension system

Vocational Learning Material for Schools

PSS Central Institute of Vocational Education

Bhopal

PREFACE

Improving the parity of esteem between the general academic education and vocational education, is the policy priority of the Government of India. The National Vocational Education Qualification Framework (NVEQF) developed by the Ministry of Human Resource Development (MHRD), Government of India, is a descriptive framework that provides a common reference for linking various qualifications. It will be used for setting common principles and guidelines for a nationally recognized qualification system covering Schools, Vocational Education and Training Institutions, Technical Education Institutions, Colleges and Universities. The NVEQF will act as a translation device to make qualifications more understandable to employers, students and institutions. It will promote transparency of qualifications and facilitate learnerôs mobility between different qualifications, thus encouraging lifelong learning. PSSCIVE has taken lead in development of learning material for the Automobile Sector for all level in collaboration with the Automobile Skill Development Corporation (ASDC).

The present material contains activity related to Level L-4 for the Automobile service sector. This will fulfill the needs of the students willing to learn activities relating to the Automobile Service Sector. Any student/ entrepreneur willing to start an Automobile Service Sector can acquire the desired competencies with the help of this book.

The book has been written by experts but reviewed by all the members of the group. I am grateful to the authors for the development of this book and to the members of the Working Group for their candid suggestions, during the development and review. Their names are given elsewhere.

I appreciate efforts put in the by Dr. Saurabh Prakash, as the Project Coordinator of the Working Group in planning and organizing Meetings which led to the final form of this title.

I shall be grateful to receive suggestions and observations from readers, which would help in bringing out a revised and improved version of this book.

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June, 2013

This student workbook was developed, with active involvement of the Automobile Skill Development Council (ASDC) keeping in view the National Occupation Standard (NOS) for Service Technician L4 developed by ASDC.

This project for development of the student workbook was coordinated by the PSS Central Institute of Vocational Education, a constituent unit of National Council of Educational Research and Training, which is under Ministry of Human Resource Development, Government of India.

Student Details

Student Name: _____

Student Roll Number:_____

Batch Start Date: _____

Contents

About this Workbook

This workbook is to assist students with completing the Auto Sector **L4U4-NQ2013** unit of competency: **Suspension System.** Students should peruse the workbook in class or in their own time.

This workbook contains sessions for imparting knowledge & skills on various basic aspects of the unit of competency. The workbook also includes information, exercises, and assessment activities to complete. The assessment plan has been included in the workbook to assist you in scheduling your time for completing the assignments. Each assessment activity is followed by a checklist for meeting the assessment criteria. The criteria will help you to ensure that you have fulfilled all of the assessment requirements to receive a ôcompetencyôgrading/Certification by ASDC.

Unit Information

Unit name: Suspension System
Unit code: Auto L4U4-NQ2013
Unit descriptor:

This unit provides introductory knowledge and skills covering periodic maintenance of suspension system, servicing or overhauling while the general servicing of the vehicle. Students will be given a broad view of these important issues.

Resource Required:

- Notebooks, Pen, Pencil, Eraser,
- Computer, Open Source Software for making digital presentation, LCD projector.
- Sketches, pictures, animation and videos of wheels stud and its components.
- Posters for building awareness about these topics.

Nominal hours: 40 periods

Elements and Performance Criteria

- Elements define the critical learning outcomes of a unit of competency.
- Performance criteria specify the level of performance required to demonstrate the achievement of the competency element.

Element of knowledge	Performance Criteria
Importance of maintenance of suspension system	Maintenance tips of suspension system
Importance of servicing and repair of leaf spring set etc	Service and repair of leaf spring set etc
Procedure of replacement of strut/shock absorber	Replacement of strut/shock absorber
Manual and power steering system	Adjustment of manual and power steering system
Steering system adjustment	Adjustment Steering system

Relevant Knowledge and Skills

1. Relevant Knowledge

- Maintenance of suspension system
- Service and repair of leaf spring set etc
- Replacement of strut/shock absorber
- Manual and power steering system
- Steering system adjustment

2. Skills

- Able to do maintenance of suspension system
- Able to do service and repair of leaf spring set etc
- Able to do replacement of strut/shock absorber
- Able to do adjustment of manual and power steering system
- Able to do adjustment of steering system

- **Assessment Plan**

Session No.	Assessment method	Due Date	Completion Date
1.	Fill in the Blanks		
2.	Fill in the Blanks		
3.	Fill in the Blanks		

Introduction

When you walk on smooth road, you don't feel any jurk or jurking movement due to body structure. In case of rough road, we feel more jerk and strain on our body movement. Similarly whenever a vehicle moves on smooth or rough roads, more jerk takes place. To reduce the jerk in a vehicle, a suspension system is provided.

This suspension system safeguards vehicle chassis and carriage carried by the vehicle. It also helps smooth rolling of wheels. This maintains stability in control of vehicle. Suspension system consists of leaf spring set, damper, shock absorber, strut, inflated tyre.

In this Unit, you will develop an understanding of the suspension system used in a vehicle, Maintenance of suspension system, Service and repair of leaf spring set etc., Manual and power steering system, Steering system adjustment adjustments of a vehicle so that vehicle's efficiency increases.

Session 1: Maintenance of suspension system

Relevant Knowledge

Why vehicles's suspension?

Vehicleûs suspension system is made up of four basic components namely the struts, shock absorbers, springs and tyres. Shock absorbers and struts are vital for on road safety performing the function of keeping the tyres evenly connected with the road and maintaining a vertical load on the tyres.

The shock absorbers on a vehicle go through as many as one thousand movements per kilometre so it is not surprising that they wear out quite quickly and should be checked every 20,000 kilometres during major servicing. The springs support the weight of vehicle act as a flexible link that allows the body and frame to ride with minimal disturbance, while the tyres and suspension follow the road.

The suspension of the vehicle has a number of functions vital to safety and optimum performance. They include:

- Maintaining the correct vehicle ride height
- Reducing the effect of shock forces to the vehicle
- Maintaining the correct wheel alignment
- Supporting the vehicles driving stability
- Keeping the vehicles tyres in contact with the road
- Control of vehicleûs direction of travel

Clearly the maintenance of vehicle suspension system will be of vital important. One must observe that how vehicle behaves on the road. Making sure it is working properly and will not only make your vehicle safer but will also help to reduce unnecessary wear and tear.

Why get regular suspension checkups?

The simple answer is that suspension is vital to the safety and performance of vehicle. As the part of vehicle that puts tyres in contact with the road, the suspension plays a critical role in how your car handles. Badly maintained

suspension results in faster and more uneven tyre wear, which further compromises safety. If you don't have a well maintained suspension system you are not as safe as you should be and are putting yourself and others at risk. Most of the suspension parts are made of rubber material to minimize shocks, therefore it is necessary that rubber parts should be regularly checked for wear, tear and torn.

We should always maintain suspension system and regular checkup should be conducted.

Maintenance Tips for Suspension system

- Thoroughly clean the leaf spring set and its fittings,
- With the help of grease or pneumatic grease gun, lubricate all shackle pins, swing arm of the leaf spring set,
- Lubricate each leaf with graphite grease,
- Tighten the u clamp bolts /nuts with specified torque,
- Check the centre bolt,
- Tighten the clamp nut bolt with specified torque,
- Check the slackness of shackle and tighten the set if needed
- In case of shock absorber/stud, tighten the holding nuts and bolts at both ends
- In case of two wheeler, tighten the swinging of nuts/bolts of front and rear wheels,
- Avoid overloading vehicle,
- Avoid sudden acceleration and breaking.

Session 2: Service and replacement of leafs, cambering of leaf springs, shackle, shackle pin and centre bolt

Relevant Knowledge

Leafs spring: A leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicles, sometimes referred to as a semi-elliptical spring or cart spring, it is one of the oldest forms of springing, dating back to medieval times.

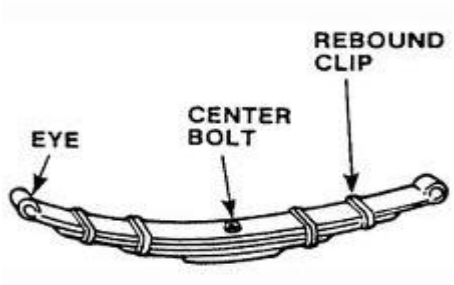

Fig1: Leaf spring

A leaf spring takes the form of a slender arc-shaped length of spring steel of rectangular cross-section. The centre of the arc provides location for the axle, while tie holes are provided at either end for attaching to the vehicle body.

For very heavy vehicles, a leaf spring can be made from several leaves stacked on top of each other in several layers, often with progressively shorter leaves. Leaf springs can serve locating and to some extent damping as well as springing functions. While the interleaf friction provides a damping action, it is not well controlled and results in stiction (static friction) in the motion of the suspension.

Fig 2: Leaf spring fitted in a vehicle

A leaf spring can either be attached directly to the frame at both ends or attached directly at one end, usually the front, with the other end attached through a shackle, a short swinging arm. The shackle takes up the tendency of the leaf spring to elongate when compressed and thus makes for softer springiness.

Fig 3:Shackle

Role of leaf spring

- The leaf spring acts as a linkage for holding the axle in position and thus separate linkage are not necessary. It makes the construction of the suspension simple and strong.
- As the positioning of the axle is carried out by the leaf springs so it makes it disadvantageous to use soft springs i.e. a spring with low spring constant.
- The inter-leaf friction between the leaf springs affects the riding comfort.

Cambering of leaf springs

Process of hammering leaf throughout the length so that it will achieve desired angle to maintain the height from the center to eye holes at both end. This process is called Cambering process. It helps to reduce the flexibility of spring. It helps to overcome the problem of lowering of fender.

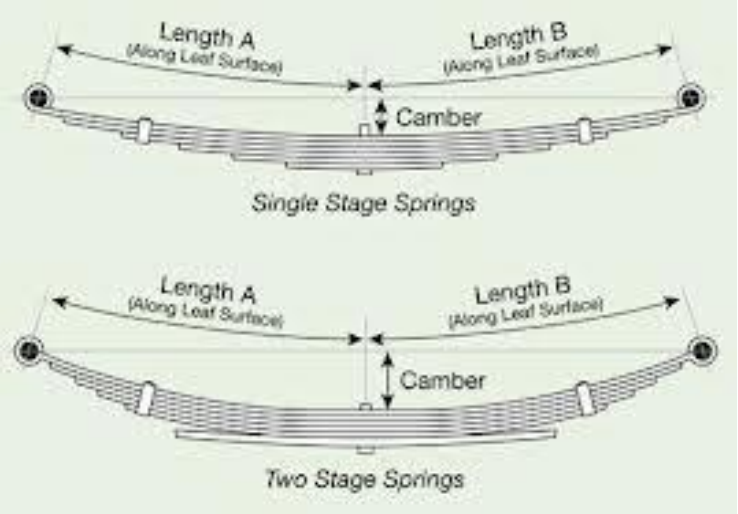

Fig 4: Cambering of leaf spring

Fig 5: Shackle Pin

Shackle: A spring shackle is a device found on leaf-spring equipped vehicles. The spring shackle mounts to one end of the leaf spring and allows it to flex and move while keeping the tire on the road. Without a shackle, the spring would not be able to move and the tire would be pulled off of the road's surface when a bump or obstacle was encountered. The spring shackle can also be lengthened and give lift or a greater amount of ground clearance to the vehicle.

The leaf spring is attached at the front and rear by a long bolt passing through the spring's eyelet as well as a mounting bracket. One end of the

spring is held closely to the vehicle's chassis and cannot move, the other end of the spring has a spring shackle mounted between the chassis mount and the spring's eye. This spring shackle is nothing more than two flat pieces of steel with several holes drilled through to allow different mounting heights. The shackles allow for movement of the suspension by pulling in or pushing out as the suspension travels through its up and down cycle.

Centre Bolt : It holds the bunch of leaf together to bear the shocks. If it is broken, it will leads to vehicle pull to one side, It is necessary to replace immediately.

Service Procedure

Tools Required: Chassis jack/hydraulic jack, screw jack, supporting stands, Socket spanner set, Open end spanner, DE ring spanner, spring clamp, anvil, hammer.

Activity : To carry out the servicing, maintenance and repair of leaf spring.

Procedure

1) Keep the vehicle on plane hard surface.
2) Disconnect the negative terminal from the battery.
3) Then take the stand and support the chassis at appropriate height.
4) Then take the stand and support the axle/axle beam.
5) Now by using appropriate spanner loosen the nuts and remove the U clamp bolts.
6) Then remove the shackle pin from the chassis fixed end.
7) Now slowly dismount the spring assembly set from the chassis.
8) Then take the leaf spring set and place it on the workbench.
9) With proper precaution, place the leaf spring in the spring vice and remove the centre bolt.
10) Separate the spring leaves and place it in proper order.
11) Now clean the leaves thoroughly.
12) Then inspect the angle of each leaf and check if necessary to replace any broken leaf.

13) If the spring is too flexible, or angle is improper, we have to carry out the cambering process.
14) Then first take the master leaf and place it on the anvil and hammer it throughout the length as the leaf spring gets desired angle.
15) Now arrange the leaves in proper order apply graphite grease to each leaves, place the set on spring vice.
16) Place the centre bolt and tighten the same to the specified torque.
17) Repeat the same to all leaves as per their size.
18) If the leaf is broken we have to do the same process with the new spring leaf.
19) Now apply the graphite grease between each leaf.
20) Check the opening of the eyehole of the master leaf, if it is widened it will make the chattering noise, hold the same end on the perk of the anvil and repair the eyehole.
21) Now replace the eye bush of the shackle.
22) Inspect the shackle pin for the wear and replace the same, if necessary.
23) Now mount the leaf spring set on the axle and fix the shackle pin to the chassis.
24) Check the shackle pin. If worn out replace it.
25) Fix the U clamp bolt to the spring set and tighten the same to the specified torque.
26) Fix and tighten the clamp nuts at specified torque only.

Precaution

1) Fix the spanners properly.
2) Use special jack and the stand to support the spring.
3) While disassembling the leaf spring, fix it on the vice and disassemble it.
4) Place the every nut/bolts properly in the tray.
5) Support the chassis and axle with stand before removing it from the chassis.
6) Tighten the nut/bolts to the specified torque.

Session 3: Replacement of strut/shock absorbers, inspection of steering linkages

Relevant Knowledge

Replacement of strut/shock absorbers:

Why we do it?

A shock absorber is a mechanical device designed to smooth out or damp shock and dissipate energy. In a vehicle, shock absorbers reduce the effect of traveling over rough ground, leading to improved ride quality and vehicle handling. Every shock up/suspension has its own life. Suspension system has damper with spring. This works as shock absorber/strut.

Fig 6: Shock absorber

Life of shock absorber is affected due to following reasons:

- Overloading
- Road conditions
- Worn-out Linkage/bushes
- Leakage of fluid/gas
- Broken casing
- Deterioration of Bump stopper
- Rubber bellows
- Improper handling in service

Testing of shock absorber on the vehicle

Following procedure should be adopted. (For example)

- Keep the vehicle on the level ground,
- Press the front portion of the car with gentle pressure,
- Now feel resistance in the up and down movement of front portion,
- If notice any jerking movement, indicates defect in shock absorber,
- Release the pressure and experience, upward movement with same resistance,
- If it feels hard, noisy and stucked/binding at any movement indicate faulty shock up.
- Visually inspect the shockup for fluid leakage if found, replace it

Testing of shock absorber off the vehicle

Activity: To overhaul suspension system used in the car

Tools and Equipment

Opened end spanners, ring spanner, tube spanner, locking clumps, screw drivers etc.

Material required

Oil, grease, metal tray, bolts waste, equivalent parts etc

Sequence of operation

1. Keep the vehicle on level ground
2. Jack up the vehicle at the certain height to make the wheel free to rotate
3. Loosen the wheel nut and remove out the front wheel
4. Extract brake drum with bearing from stub axle by using puller
5. Remove the brakes pins/ bolts from strut bracket
6. Remove the strut bracket bolts
7. Remove support nuts by supporting the strut properly
8. Dismount the strut assembly from the vehicle

9. Use a spring compressor to remove the strut spring
10. Fix the spring compressor on the strut and compress the spring
11. To remove the spring support unit, loosen the nut slowly and release the spring compressor.
12. Remove the spring from the strut

Testing of shock absorber/struts of the vehicle

- Visually inspect strut for fluid leakage
- Inspect the piston rods/strut rod for bend, scratches etc.
- Press the rod inside with pressure and release the same, it should move in and out with resistance
- If it does not work, replace the strut/shock absorber as it is not repairable.

Session 4: Inspection of steering linkage

Relevant Information

Inspection of steering Linkage

A steering linkage is the part of an automotive steering system that connects to the front wheels.Steering linkages consist of drag link (pitman arm), tie rod, ball joint, end joint, arm assembly, torsion bar, steering shock absorber, bushes of steering axis, steering arm and stub axle.

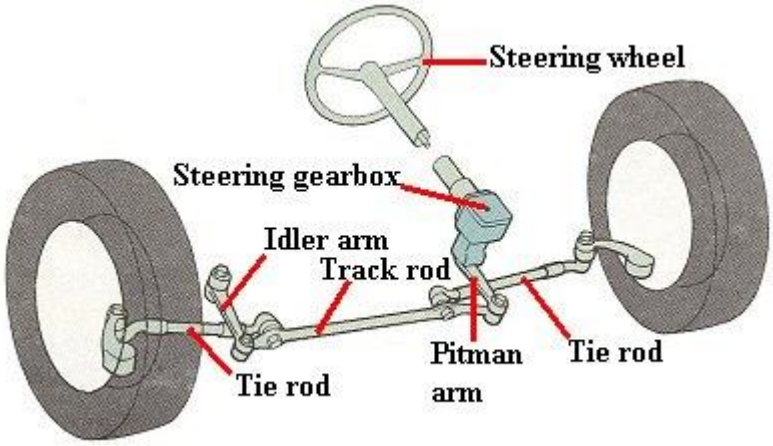

Fig 7: Steering Linkage

Regular Inspection of steering linkage is necessity to maintain safety and control of the vehicle. If it is ignored, it may cause fatal accident.

Inspection of steering linkages

Following procedure should be adopted for inspection of steering linkages

- Lift the front portion of the car/vehicle,
- Turn the steering from one end to another end,

- Check for noise and binding in-steer,
- If the binding is traced,
- Remove the drag link connection from steering gearbox,
- Now rotate the steering gear box in both the direction and trace for the binding. If the binding is noticed then it probably lies in the steering gear box
- If the binding is not traced in steering gear box then problem is in steering linkage,
- Check the ball joint/bushes for free movement with thumb pressure and replace the same if necessary,
- Inspect the ball joint if it is worn out or bellow torned then replace it,
- Inspect the bushes of the torsion bar and replace it,
- Inspect the draglink, tie rod for its straightens,
- Remove the bushing by using special tools and replace the same.
- Inspect damper/strut for any crack, rust and also check its length if it is not with a specified value then replace it.
- Check the bushes for wear.
- Check the coil spring for its length, height and tension.

Precaution

1. Fix the spanner properly.
2. Keep the removed nut bolts properly.
3. Handle the pots carefully.
4. Support the chassis properly with stand.

Session 5: Manual and Power steering System

Relevant Knowledge

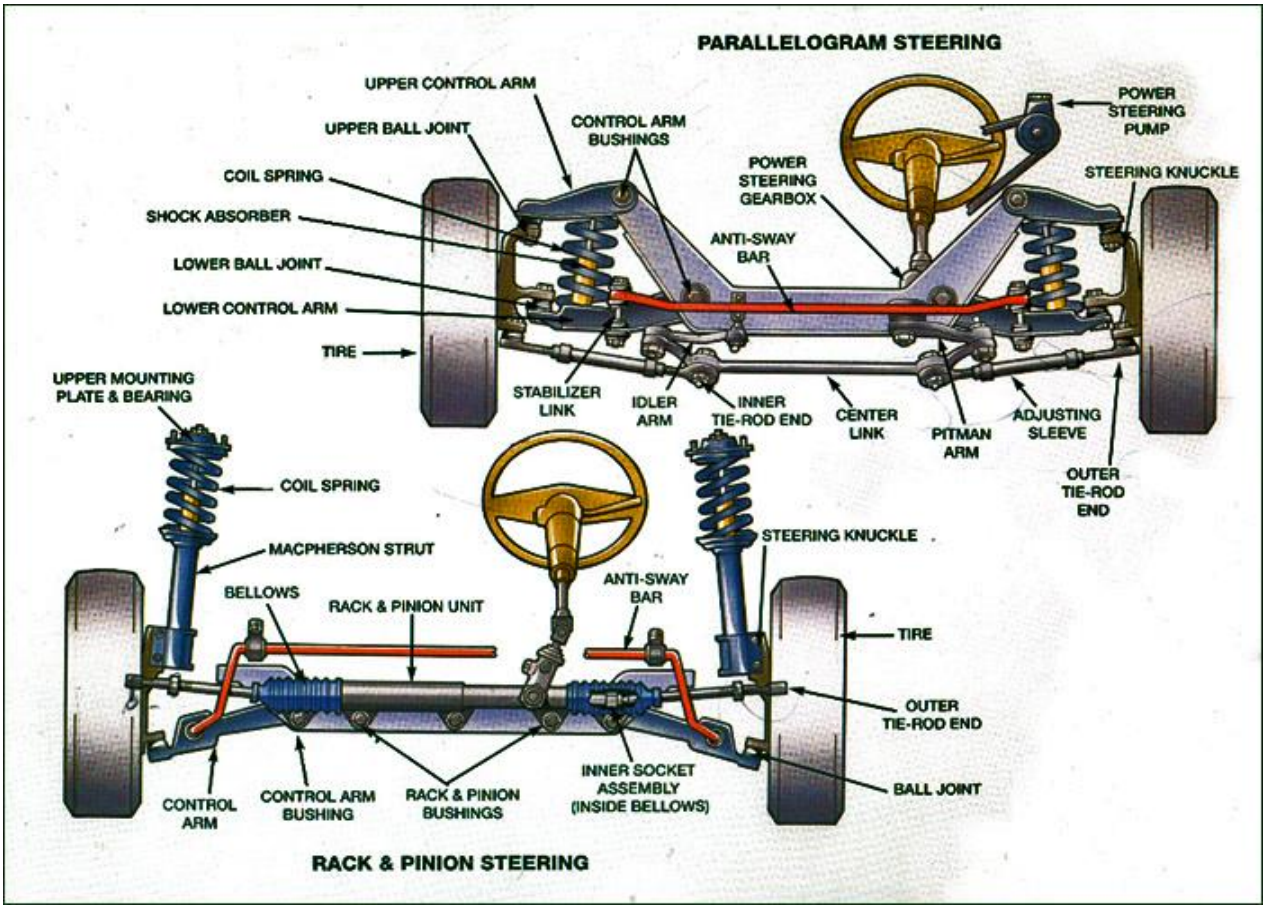

Fig 8: Steering System

Manual Steering

Vehicle is steered with mechanical efforts and maintains and control road stability. Different types of steering box are used in automobile vehicle.

- Worm and roller shaft
- Worm and nuts
- Rack and pinion
- Worm and sector

  These all gearboxes are supported with power steering, which helps the driver to increase his efforts in steering of vehicle.

Manual Steering: Mechanically/Manual operated steering

- **Procedure for servicing of the manual steering system (**Worm and roller shaft**)**

  To check the working of mechanically/manually operated steering system, following steps are followed.

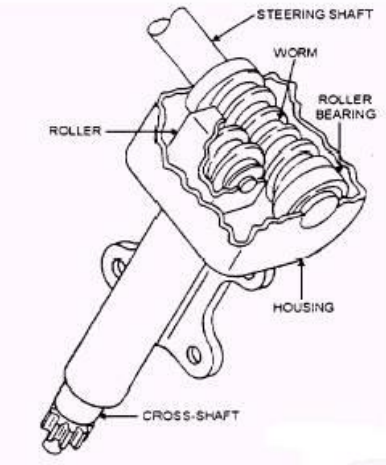

Fig 9: Worm and roller steering gear

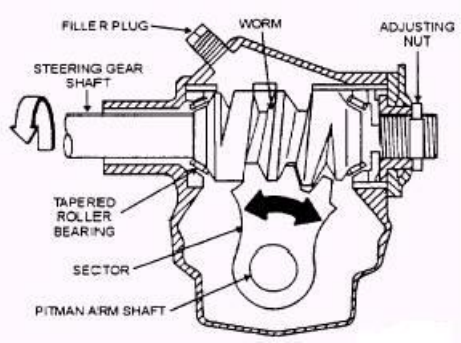

Fig 10: Worm and sector steering gear

1. Conduct the road test and mark the central or the mid position of the road wheels and the steering gear box,
2. Now raise the front portion of a car and turn the steering wheel,
3. To check for the binding in the steering,
4. If binding is traced then disconnect the drop arm from the cross shaft of the steering gear box,
5. Now again turn the steering and inspect for the binding,
6. If the binding is traced then the fault is in the steering gear box, and need to service the steering gear box,
7. Disconnect the electric connections from the steering wheel,
8. Now using specified spanner remove the steering wheel nut from the steering shaft,
9. Use special tool to remove the steering wheel,
10. Remove the steering gear mounting bolts and dismount the steering gear box from the chassis,
11. Clean the external portion of the steering box,

12. Remove the side cover from the steering gear box,
13. Now remove the cross shaft from the steering gear box casing,
14. Loosen the steering column bolts and remove it out,
15. Slowly remove the steering shaft from the casing,
16. Wash the components check their wear also check their alignment
17. Replace the worn out components,
18. Assemble the worm shaft and then the cross shaft with their bearing(s).
19. Conduct the road test and assure proper steering alignment

Rack and pinion type steering gear box:

This type of steering gear is used for light vehicles and in power steering. It occupies very small space and uses lesser number of linkage components as compare to worm and wheel type of steering gear.

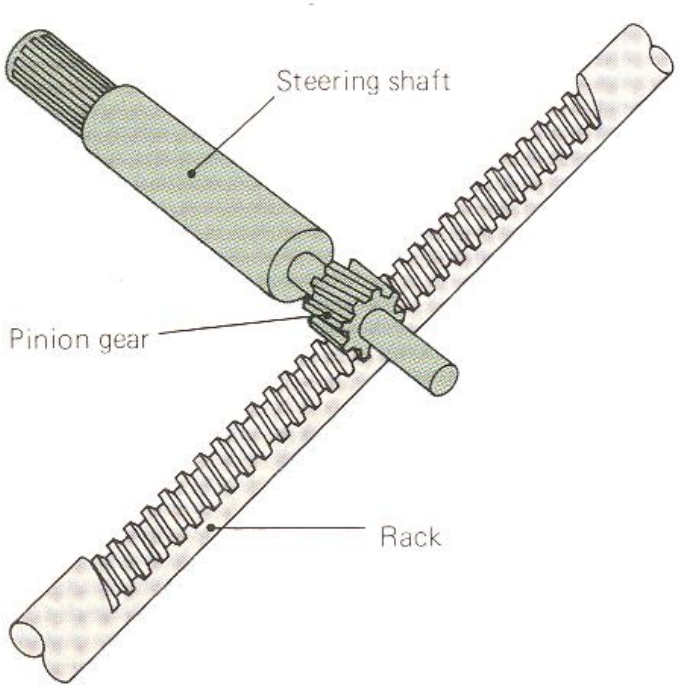

Fig 11: Rack and pinion steering system

Procedure for servicing of the rack and pinion type steering gear box

Procedure:

1. Unthreaded the steering wheel nut using socket, ratchet. Separate the wheel from steering shaft.
2. Unthreaded the steering rodôs guide nut.
3. Using screwdriver, the screw of gear lever bracket was unscrewed and separates the gear lever bracket.
4. Separate the guide nut support plate and gear lever bracket.
5. To separate the steering shaft and gear shaft from steering column both nuts of bracket were loosened.
6. Steering shaftôs lock nut and both was opened with the help of ring spanner and double ended spanner. Separate pinion from steering shaft.
7. By removing the lock nut of gear rod from support plate, the rod was taken out.
8. Support plate was separated from gear box housing and end plate, using ring spanner (9/16ò)
9. End plate was taken out from steering gear box housing.
10. Loosened the wheel nuts and jacking up the vehicles. Take the front wheels out.
11. Unthreaded the tie rod end nut from both the sides and take out the rubber boots from steering gear box housing.
12. Using pipe wrench, both the ball joints were taken out from steering rack.
13. Remove the U clamp bolt form the steering column by using socket spanner and take out the steering assembly.
14. Using socket plier to remove the pinion assembly from the housing.
15. Now slowly push out the rack from the column.
16. Inspect the rack for bend and teethôs for the wear; also inspect the pinion assembly for wear.
17. Also check the pinion bearings, splines for the wear.
18. Thoroughly clean the components of steering.
19. Place the rack in the column and place the pinion in housing.

20. Lubricate rack and pinion with silicon grease.
21. Now assemble the rack and pinion assembly on the vehicle with help of supporting bolts, tighten the same to specified torque.
22. Check the rack play adjustment and adjust the rack with the help of shims/nut.
23. Check the pinion play adjustment if noticed more/less adjust the spacer with more/less length.
24. Place the
25. Now slowly turn the pinion and check it for the free movement.
26. Fix the steering wheel as per the aligning mark and tight the nut.
27. Connect the lower and upper steering shaft and fasten it with the pinion coupling.
28. Carry out central or mid position adjustment and connect the ball joint with steering shaft.
29. Fix both dust boots over the ball joints and lock it.
30. Tighten the ball joint with specified torque with steering shaft.
31. Conduct the road test and adjust the steering accordingly.

Power Steering

To reduce the steering effort at steering wheel turning, two types of power is applied mainly hydraulic and electronically operated motor.

Hydraulic operated power steering: In this type of power steering, fluid is pressurized through a centrifugal pump. This centrifugal pump is driven by the engine crankshaft through v belt. Hydraulic system consist of pump, fluid container, hoses and steering mechanism having in and out valve connected through pipes and hoses. When the vehicle is moving in straight ahead direction, pump rotates and does not actuate the steering effort, when vehicle takes turn at low speed or in standing condition or parking condition. Pressurized Fluid is forced through the steering worm and rack piston through inlet valve. It helps to steer vehicle easily by reducing steering efforts.

Inspect the power steering

Following step are to be taken

- Park the vehicle on the level ground
- Switch off the engine and check the oil level in power steering container
- It should be between minimum and maximum level
- Type of fluid is known as power steering fluid
- Check power steering hose connections for leakage/damages/cracks
- Check and replace fluid filter at regular interval as per service manual.
- Inspect the functioning of centrifugal pump in turning of vehicle, if faulty replace the pump
- Carry out bleeding operation after each service

2nd type of Electronic power assisted steering system EPS

EPS uses as electric motor to assist the driver of the vehicle. Steering sensors detect the position and torque of the steering column and ECU applies assistive torque via the motor which connect to either steering gear or steering column. This mechanism is fitted at steering shaft/ worn shaft. It helps in assisting in steering of vehicle. In this system electrical motor operated

Advantage of this system is in fuel efficiency because there is no belt driven hydraulic pump constantly running by the engine.

Air Suspension System

Air suspension is a type of vehicle suspension powered by an electric or engine driven air pump or compressor. This pump pressurizes the air, using compressed air as a spring. Air suspension is used in place of conventional steel springs and in heavy vehicle applications such as buses and trucks. If the engine is left off for an extended period, the vehicle will gradually settle to the ground. The purpose of air suspension is to provide a smooth, constant ride quality and in some cases it is self-leveling. Now days gas filled shock absorber are being used for more comfort.

Fig12: Air Suspension System

Over the last decade air suspension has become extremely popular in the automobile.

Session 6: Steering System Adjustments

Relevant Knowledge

Steering system adjustments consist of wheel balancing, wheel alignment and checking of steering adjustment. We will concentrate on these topics.

Wheel balancing

Wheels that are not balanced or are out of balance generally produce a vibration that is uncomfortable to drive in and results in premature wearing of suspension and steering components, rotating parts and tyres.

Correctly balanced wheels help to eliminate vibration and avoid premature wear caused by an imbalance in the rotating wheel and tyre assembly.

The first sign that wheels may be out of balance is when steering wheel starts to wobble above a certain speed. The light weight of modern cars means that they don't dampen down the vibrations caused by spinning wheels in the way that older, heavier vehicles could.

A driver may not always sense an imbalance at the steering wheel. It could be present with but dampened by the vehicle weight. This is why balancing is equally important for both front and rear wheels.

Wheels are balanced on a wheel balancing machine. The machine rotates the tyre and wheel assembly and automatically calculates the weight and location of the balance counter, As a result of wheel balancing, one will feel a smoother ride and low wear from tyres.

Fig 13: Wheeel Balancing Machine

Wheel Alignment: It consists of adjusting the angles of the wheels so that they are set to the manufacturer's specification. The purpose of these adjustments is to reduce tire wear, and to ensure that vehicle travel is straight and true (without "pulling" to one side). Angles of wheels are of two types, Primary and Secondary type.

The primary angles are the basic angle alignment of the wheels relative to each other and to the car body. These adjustments are the camber, caster and toe.

- Front: Caster (left & right)
- Front: Camber (left & right)
- Front: Toe (left, right & total)
- Rear: Camber (left & right)
- Rear: Toe (left, right & total)

Secondary Angles:

The secondary angles include numerous other adjustments, such as:

- SAI (Steering Axis Inclination) (left & right)
- Included angle (left & right)
- Toe out on turns (left & right)
- Maximum Turns (left & right)
- Toe curve change (left & right)
- Track width difference
- Wheelbase difference
- Front ride height (left & right)
- Rear ride height (left & right)
- Frame angle
- Setback (front & rear)

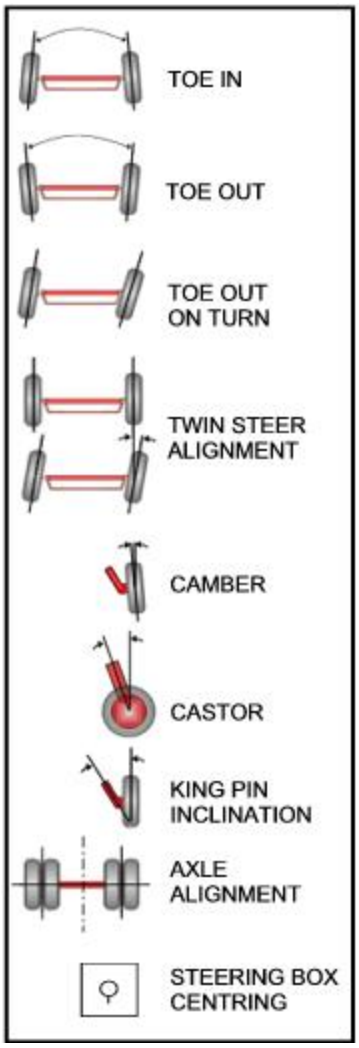

Fig14: Steering Angles

Procedure for checking and adjustment of wheel alignment

1. We were given car to do its wheel alignment
2. Made ON the red color switch on the back side of machine.
3. Parked the vehicle with its front wheels on turntables.
4. Fitted both heads (of machines) to both rims.
5. Tied the vehicle with string, from one front wheel to other through both rear wheels.
6. Switched ñONò the monitor. It showed ñMENUò on the screen.
7. There were five details in the menu.
    - Measurement

- Front self calibration.
- Rear self calibration.
- Records of new models.
- Service.

8. There were some figures and numbers on the keys of keyboard .Pressed number (1) and then (Enter).We got the next step. There was (selection 1 to 5)below menu. Pressed the desired job(select 1 to 5). Press ñEnterò after it.

9. Fed the vehicle details/code using key board. After entering the data pressed ñEnterò

10. We got the ñDate and specification chartò on screen. Fed the vehicle details to the blank space in this chart. Pressed ñEnterò

11. We got ñselection (1 to 4)ò Details of operation 1 to 4 were given below the selection.

12. We were to do alignment of front wheels so we pressed ñ2ò and then ñEnterò As soon as we pressed the ñenterò, we got the Toe-in, Camber Angle, Caster Angle, King Pin Set Back Max and Steering Angle,on screen.

Wheel Steering Adjustment

Steering Adjustments

Adjustments in steering gear

a. Worm shaft and play adjustments

- Hold the steering wheel by the right hand and with a left hand hold the steering column
- Now pull and push the steering shaft /worm shaft in and out
- If excessive play is noticed check the condition of the worm shaft bearings or add the shims again check the end play.

b. Cross shaft end play adjustments

- Loosen the adjusting nut of the cross shaft
- Now pull and push the cross shaft in and out
- If excessive play is noticed then tighten the stud and reduce the play
- After setting the play tighten the nut

c. Central or mid-position adjustment

- Turn the steering wheel from one lock position to other lock position
- Mark the position and count the number of turns of the steering wheel from lock to lock position
- Divide the number of turns by 2 and set the center position of the steering gear box
- Now assemble steering gear box on the marked position and fix the drop arm without shifting the position of the draglink and center position of the road wheels

d. Wheel lash adjustments

- Now turn the steering wheel without movement of the road wheels is called wheel lash ,it should not exceed the value 10-12mm
- If it is excessive inspect the steering linkage for wear and replace the worn out components

Assessment

Answer the following?

- What is the need of suspension system in vehicle?
- Write the name of main components of suspension system?
- What is the use of shock absorber?
- Why leaf springs are used in the vehicle & its function?
- What is the use of castor plate?
- What is the use of steering in the vehicle?
- Write the components of steering system?
- Write the types of steering used in modern vehicle?
- What are the limitations of manual steering?
- What is advantage of power steering over manual steering?
- Write the turning radius of two small cars?
- Wheel Balancing/Wheel alignments
- Why wheel balancing is required in a vehicle?
- How dynamic balancing of wheel is carried out with the help of balancing machine?
- Write the symptoms of imbalanced wheel in the vehicle?
- What are the ill-effects, if wheels are not properly balanced in a car?

Suggested Reading

Books

Title	Author	Publisher
Automobile Engineering Vol I	Kirpal Singh	Standard Publishers
Automobile Engineering,Vol II	Kirpal Singh	Standard Publishers
Text Book of Automobile Engineering	Rajput R K,	Laxmi Publications
Automobile Engineering	R. K. Singal	S. K. Kataria and Sons
Automobile Engineering Theory	Kapil Dev	Computech Publications
Automobile Engineering,	K. M. Moeed	S. K. Kataria and Sons

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