

Study on the Front Axle and Rear Axle Attached to Differential System

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Abstract

Axle is the important part of the differential. The axle is a straight shaft that is fixed in location, it is combined with bearing or brushing use to mount rotating wheel or gears. The wheel or gear can be attached to it with a built in gearing or bushing. A bearing or brushing fits inside the center of the wheel and allow it to rotate without affecting the axle itself. The purpose of axle is to secure the wheels or gears to specific locations relative to other wheels or gear. The wheels would not remain fixed in position and the force and vehicle would make the wheel bend flat. In automobile two types of differential are used. Which are front axle and rear axle. The power developed by the engine is transferred to the wheels through clutch, gear box, universal joints, propeller shaft, final drive, differential and rear axles.

Keywords: Front axle, Rear axle, Differential system, Steering system.

I. INTRODUCTION

Rear axle transmits power from differential to the wheels so that vehicle may turn. Rear axle isn't a single part but it consist two parts which are connected to the differential. These are shown in Fig. 1. all parts of rear axle is called half shaft. Outer end of the rear axle carries the wheel while inner end is connected by sun gear of the differential. In vehicles which employ rear wheel drive, which are driving wheels. However, In front wheel drive vehicles, front wheels are driving wheels. Rear axles and differential are completely enclosed in a housing to protected from dirt, dust, water and any accidently damage.[1].Differential section outlines the minor design, installation and performance requirement for the replacement of front axle assemblies, one by one to the steering system and the fitting of non-standard replacement wheels rims and tyre to front axle of commercial vehicles in excess 4.5 tonnes mass of Gross Vehicle. It's cover for modifications required specially to change the power steering are original fitted, and also the actions required when modifications to other area affect the steering systems. In any car or four and six wheeler vehicles, steering is main part. Properly steering works are good and guides the vehicle to move in actual direction. Manually steering is connected to the front axel. On the front axle, wheels are mounted, and with the help of steering wheel, the driver can turn the vehicle in right, left or straight directions.[2]

II. CUNSTRUCTION AND OPERATION

A. Rear Axle

This is most commonly used rear axle drive having a simple construction as shown in fig 1. The propeller shaft is provided with two universal joints and also a sliding joint. The spring is fixed rigidity in the middle, to the rear axle. The front end of the spring is fixed rigidity on the frame, while the rear end is supported in a shackle. The driving thrust is transmitted to the frame by the front half the springs.

Due to the torque traction, the spring deflects. The up down movement of the rear axle induces. Variation in the length of propeller shafts which gets compensated by the slip joint. Consequence of the rear axle movement and deflection of the spring is, to alter the position of the final drive shafts also. This shafts is position may result in bending of the propeller shafts which is avoided by using a universal joint at the rear end of the propeller shaft.

The Rear axle assembly includes in the differential assembly, the rear drive axles and the rear axle housing. Rear axle assemblies are subjected to heavy loads from the engine and road. They are ruggedly constructed and seldom fail. The most common rear end failures are axle bearing failures. A typical rear axle assembly is shown in fig 1. In a rear axle assembly, engine power enters the drive pinion gear from the drive shaft assembly and differential pinion yoke/flange. The drive pinion gear, which is in mesh with the ring gear, causes the ring gear to turn. The interaction of the ring and drive pinion gears turns the power flow at a 90 angle. The difference in the number of teeth on the ring and pinion gears causes a reduction gear ratio. This reduces turning speed, while increasing torque. Power from the ring gear flows through the differential case, spider gears, and side gears to the drive axles. The drive axles transfer power from the differential assembly to the rear wheels. The bearings and rear axle housing are key components of the rear axle assembly. They are designed to support and align the differential assembly and the drive axles. Notice that the bearings and axle housing are large, heavy-duty parts. This is to ensure they will stand up under hard usage. Seals and gaskets are also very important to the operation of the rear axle assembly. Seals are used at the differential pinion yoke/flange and at the outer drive axles. Gaskets are used at housing interfaces, such as between the differential cover and the housing, to provide a tight seal from the outside. Common type of rear axle assembly. Notice the relationship of the internal parts to the housing and to each other. Note that the rear axle housing and drive axle designs will be different, when the vehicle has independent rear suspension. Also, when the rear axle assembly is equipped with a limited-slip differential.[3]

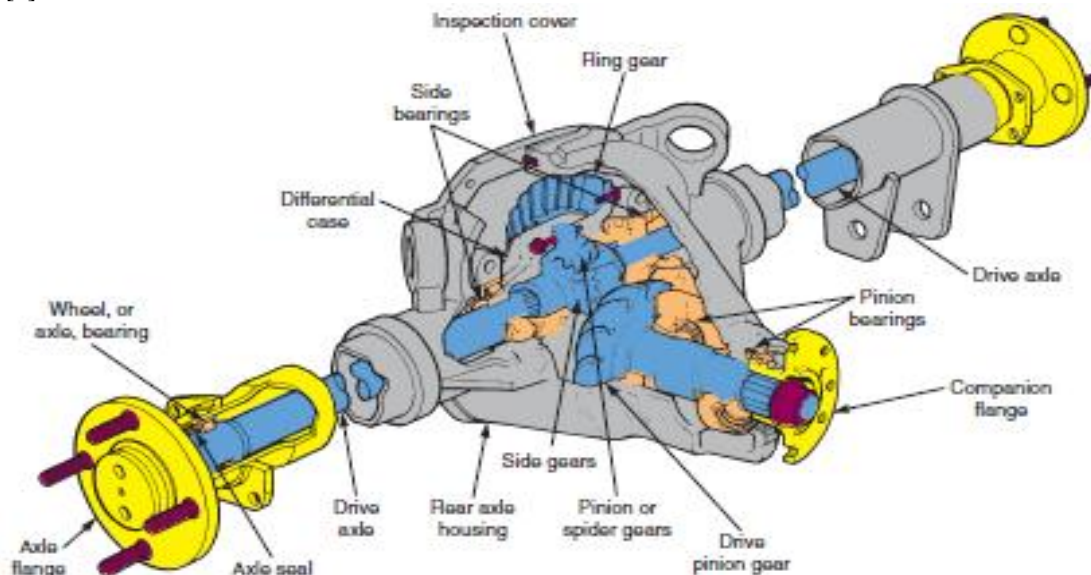


Fig. 1: Rear Axle[3]

1) *Type Of Rear Axle*

Rear axles on the basis of method of supporting them and mounting of rear wheels. These axles can be classified into three types:

- (1) Half floating axle
 - (2) Three-quarter floating axle
 - (3) Fully floating rear axle
- Half Floating Axle

The half floating rear axle, the axle is at the centre of the axle casing and the bearings are inside the axle casing. The weight of vehicle is transmitted first to suspension spring, then to axle casing, then to axle and finally to ground.

- Three-quarter Floating Axle

The 3-quarter floating rear axle, bearings are on the outer side of axle casing, i.e. between casing and wheel. In this case, major part of vehicle weight is taken by axle casing and not by axle. This is the main advantage of 3-quarter floating type over half floating type. Thus, axle breakdown is less in this case compared to the previous type.

- Fully Floating Rear Axle

In fully floating rear axle, the bearings are provided between axle casing and the wheel. In this case, all the vehicle weight is transmitted to ground through axle case and wheel. The axle is not supported by bearings but it is supported at both ends. This type of axle is very strong and therefore, which are used for heavy duty vehicles. In the event of breakdown of axle, wheel cannot come out.[1] To assembling part which have transmit different torque.

The following specification torque of rear axle are :

Table - 1
Torque Specification of Rear Axle[4]

PART TIGHTENED	N-m	Kgf-cm	ft-lbf
Tie rod end lock nut	47	475	34
Steering knuckle X shock absorber	80	820	59
Steering knuckle X brake caliper	123	1250	90
Steering knuckle X tie rod end	255	2600	188
Axle hub nut	29	300	22
ABS speed sensor set bolt	7.8	80	69in-lbf
ABS speed sensor wire x shock absorber	5.4	55	48in-lbf
Suspension upper support x body	39	400	29
Suspension upper support x piston rod	49	500	38
Lower suspension arm X suspension member	181	1850	134
Lower suspension arm X rear axis carrier	181	1850	134
Strut rod X body	113	1150	83
Strut rod X rear axle carrier	113	1150	83
Suspension member X body (17 mm)	51	520	38
Suspension member X body (14 mm)	38	390	28
LSPV spring X lower suspension arm	13	130	9.4
Stabilizer bar bushing retainer	19	195	14
Stabilizer bar link set nut	64	650	47

B. Front Axle

To carry the weight of the front part of auto mobiles as well as for steering and to absorb shocks due to road surface variation a unit is known as 'front axle'. Fig.2 shows the front axle and its main components : (a) Damper (b) Anti-roll bar (c) Wheels bearing (d) Coupling rod (e) Stub axle arm.

In order to accommodate a swivel pin connecting to the stub axle portion of the assembly, the ends of the beam are shaped suitably. Swivel pin connecting the stub axle portion of the assembly, the ends of the beam are usually shaped either as a yoke or plain surface with drilled holes. The axle has to take bending loads due to braking of the wheels. That why front axle made of 'I-section' in the central portion and the end portion is made of circular. The main axle beam is connected to the stub axle by means of kings pins. The front road wheels are mounted on these stub axles.

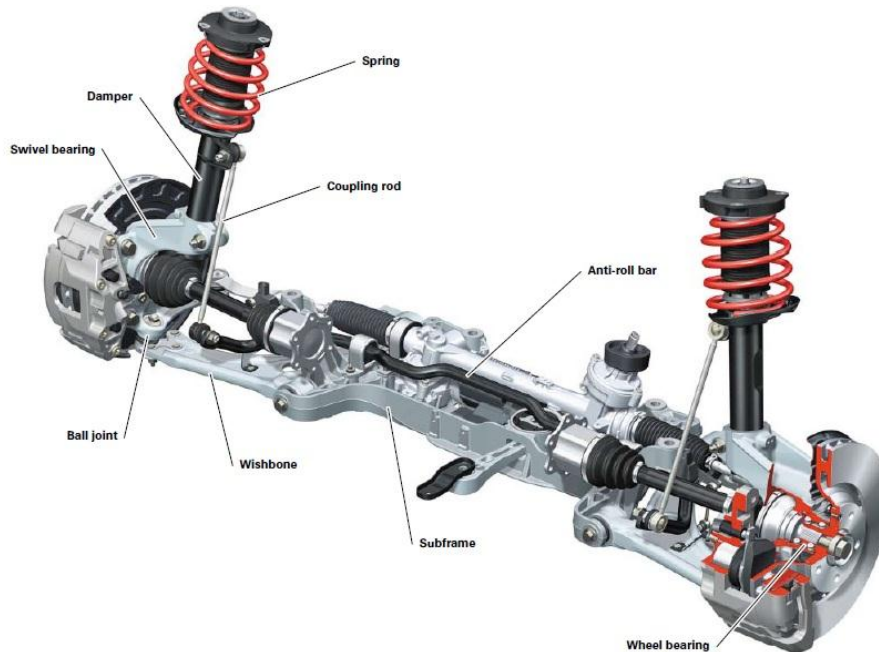


Fig. 2: Front axle[5]

– Type of Front Axle

Three types of front axle:

- (1) Live-front axle
- (2) Dead-front axle
- (3) Stub-front axle

1) Live-front Axle:

In Live-front axles are used to transmit power from gear box to front wheels. Live-front axle although, front wheels. This axle although resemble rear axles but they are different at the ends where wheels are mounted. Maruti-800 has live-front axle[2]. And it is connected through the differential mechanism. By which the engine power towards the front wheels.

For steering the front wheels, constant velocity joints (C.V.) are contained in the axle shafts. Without affecting the power flow through the half shafts, these joint help in turning the stub-axles around the king pin.

2) Dead-front Axle:

In Dead-front axles are those axles, These axles have sufficient rigidity and strength to take the weight. The ends of front axle are suitably designed to accommodate stub axles[2]. In which there is no connection with the engine and having no differential mechanism. These axle do not rotated with the engine like live-front axle. The front dead axles are four types : (i) Elliot axle, (ii) Reverse type, (iii) Lemoine, (iv) Reversed lamoine type.

3) Stub-front Axle:

A stub axle, which is provided in the ends of the axle beam of a front axle. A fixed vertical pin is known as king pin secures the stub axle and its forked arms to the axle and by means of a lock pin passing through a hole in the side of the king pin hole. Thrust should be provided between the lower machine face of each axle hole and the upper face of the stub axle fork hole because the weight of the front portion of the car is to be taken on the lower fork arms of the stub axle.

For steering with a minimum of effort, roller thrust bearing is employed. This helps the stub axles to be rotated in rotation to the fixed king-pin. Stub axle are following four types :

- (1) Reverse elliot
- (2) Elliot stub axle
- (3) Reversed lamoine stub axle
- (4) Lamoine stub axle

To assembling part which have transmit different torque. The following specification torque of front axle are :

Table - 2
Torque Specification of Front Axle[4]

<i>PART TIGHTENED</i>	<i>N-m</i>	<i>Kgf-cm</i>	<i>ft-lbf</i>
<i>Tie rod end lock nut</i>	74	750	54
<i>Steering knuckle X shock absorber</i>	211	2150	156
<i>Steering knuckle X brake caliper</i>	107	1090	79
<i>Steering knuckle X tie rod end</i>	49	500	36
<i>Axle hub nut</i>	294	3000	217
<i>Ball joint X lower arm</i>	127	1300	94
<i>Ball joint X steering knuckle</i>	123	1250	90
<i>Steering knuckle X disk gear cover</i>	8.3	85	74in-lbf
<i>Drive shaft X side gear shaft (1MZ-FE)</i>	65	650	48
<i>Drive shaft center bearing lock bolt</i>	32	930	24
<i>Suspension upper support X body</i>	80	820	59
<i>Suspension upper support X piston rod</i>	49	500	36
<i>Break hose X shock absorber</i>	29	300	22
<i>ABS speed sensor wire X shock absorber</i>	5.4	55	48in-lbf
<i>Lower arm set bolt</i>	206	2100	152
<i>Lower arm X stabilizer bar link bracket</i>	56	570	41
<i>Stabilizer bar bushing retainer</i>	19	195	14
<i>Stablüzzer bar link set nut</i>	39	400	29
<i>Stablüzzer bar link set bolt</i>	181	1850	134
<i>Front exhaust pipe stay X clamp (1MZ-FE)</i>	29	390	22
<i>Front exhaust pipe stay X body (1MZ-FE)</i>	21	210	15

REFERENCE

- [1] Automobile engg. Unit[5-6] by internet source
- [2] Automobile engg. unit[7] by internet source
- [3] Chapter 16, rear axle assembly, construction and operation by internet source
- [4] Suspension and axle by internet source
- [5] Internet source.