SECTION 4A

BRAKE SYSTEM

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DESCRIPTION AND OPERATION

BRAKING SYSTEM TESTING

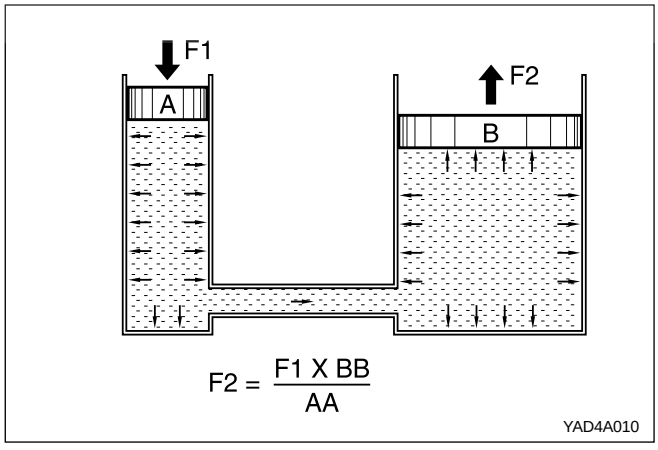
Brakes should be tested on a dry, clean, reasonably smooth and level roadway. A true test of brake performance cannot be made if the roadway is wet, greasy or covered with loose dirt which can cause tires not to grip the road unequally. Testing also will be inaccurate on a crowned roadway because the wheels tend to bounce.

Test the brakes at different vehicle speeds with both light-and heavy-pedal pressure; however, avoid locking the brakes and sliding the tires. Locked brakes and sliding tires do not indicate brake efficiency since heavily braked but turning wheels will stop the vehicle in less distance than locked brakes. More tire-to-road friction is present with a heavily braked, turning tire than with a sliding tire.

There are three major external conditions that affect brake performance:

- Tires having unequal contact and grip of the road will cause unequal braking. Tires must be equally inflated and the tread pattern of the right and the left tires must be approximately equal.
- Unequal loading of the vehicle can affect the brake performance since the most heavily loaded wheels require more braking power and thus more braking effort than the others.
- Misalignment of the wheels, particularly conditions of excessive camber and caster, will cause the brakes to pull to one side.

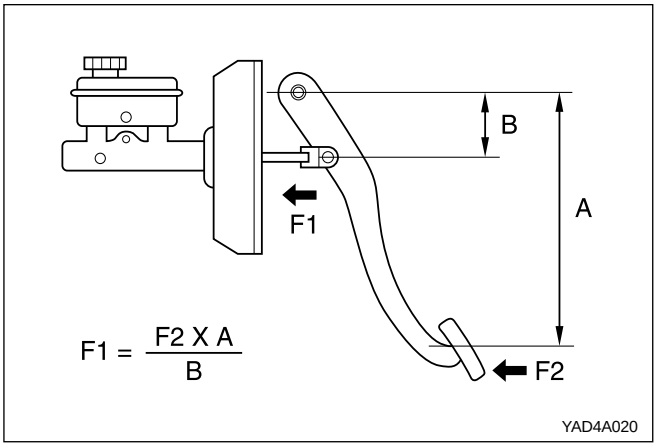
HYDRAULIC BRAKE SYSTEM



This system uses the principle of the leverage and PASCAL's. When you pushes the brake pedal, the pressure by adapting the pedal increases through the power booster and delivers it into the master cylinder to generate hydraulic pressure.

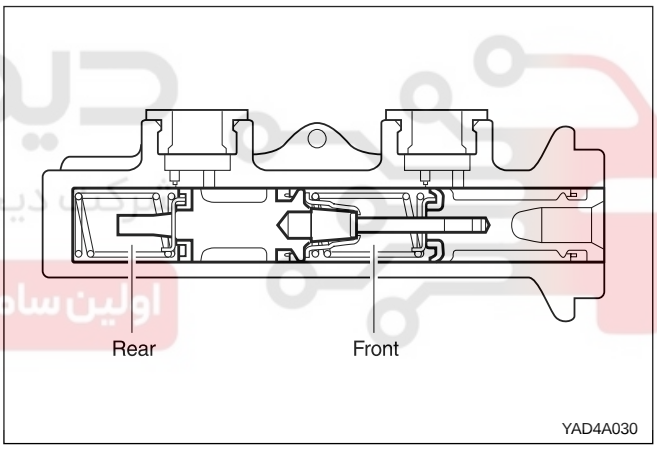
Hydraulic pressure generated by the master cylinder delivers to the caliper through the brake pipe or hose. This hydraulic pressure allows the caliper pad to push the disc plate. Thus it generates the braking forces.

BRAKE PEDAL



Brake pedal uses the principle of the leverage and increases the pressure into the master cylinder in order to generate the braking forces.

MASTER CYLINDER



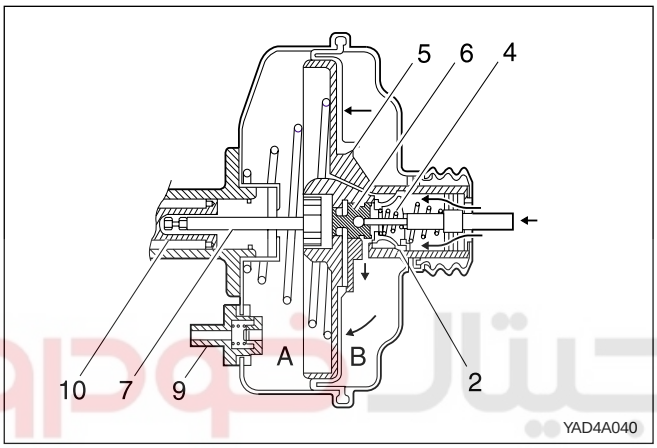
The master cylinder is designed for use in a diagonally split system. One front and one diagonally opposite rear brakes are served by the primary piston. The opposite front and rear brakes are served by the secondary piston.

The master cylinder incorporates the functions of the standard dual master cylinder, plus a low fluid level indicator and the proportioning valves in the non-antilock braking system. The proportioning valves limit the outlet pressures to the rear brakes after a predetermined master cylinder pressure has been reached. The brake master cylinder sensor is attached under the body of the plastic brake master cylinder reservoir.

BRAKE BOOSTER

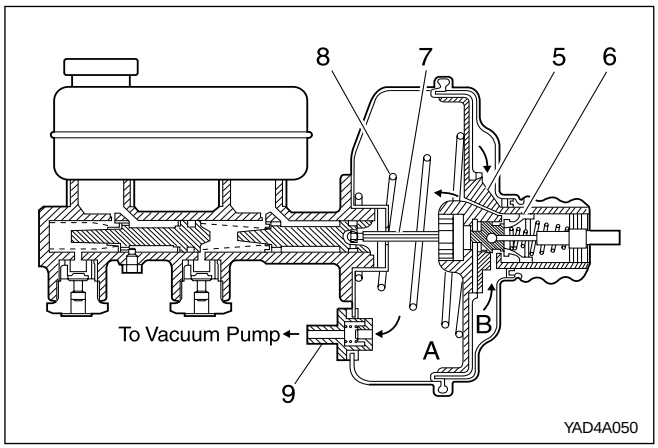
The brake booster is a double-diaphragm, vacuum-suspended unit. In normal operating mode, with the service brakes in the release position, a vacuum-suspended booster operates with a vacuum on both sides of its diaphragm. When the brakes are applied, air at atmospheric pressure is admitted to one side of the diaphragm to provide the power assist. When the brakes are released, atmospheric air is shut off from that side of the diaphragm. The air is then drawn from the booster through the vacuum check valve by the vacuum source.

1. Pressure Distribution At working



When it pushes the brake pedal, the booster pushrod (1) pushes the poppet (2) and valve plunger (3) and the poppet (2) goes closely to the power piston (5) resulting in closing the vacuum valve (9). The power cylinder (A) and (B) is isolated and the valve plunger (3) is separated from the poppet (2). And then the air valve (6) opens in order to flow air into (B) through the filter and thus, the power piston (5) enables to push the master cylinder pushrod (7) for pressure distribution.

2. Pressure Distribution After working



When it pushes off the brake pedal, the valve plunger (3) returns back to the original position by return spring (4) resulted in closing the air valve (6) and open the vacuum valve (9) in order to balance the pressures between (A) and (B) of the power cylinder. And then the power piston (5) returns back to the original position by the master cylinder reaction and the diaphragm return spring (8) pressure.

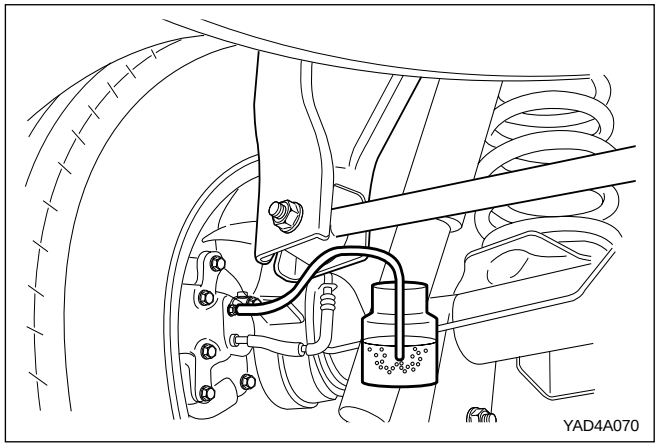
SPECIFICATIONS

Application		MANDO Brake		KDAC Brake	
		Drum Type	Disc Type	Drum Type	Disc Type
Brake Pedal	Pedal Ratio	4.3 : 1	←	←	-
	Pedal Stroke	138 mm	←	←	-
	Pedal Freeplay	1 ~ 4 mm	←	←	-
Master Cylinder	Type	Tandem Type (/W Lever Sensor)	←	←	-
	Inner Diameter	Ø 25.4 mm	←	←	←
Brake Booster	Type	Vacuum Booster Type	←	←	←
	Ratio	7 : 1	←	←	←
Front Brake	Type	-	Ventilated Disc Type	-	←
	I.D. of Caliper Cylinder	-	Ø 60 mm	-	Ø 60 mm
	Thickness of Brake Pad	-	10 mm	-	←
	Thickness of Disc Plate	-	24 mm	-	←
Rear Brake	Type	Drum Type	Solid Disc	Drum Type	←
	I.D of Drum	Ø 254 mm	-	Ø 254	-
	Shoe Type	Leading End Trailing Type	-	Leading End Trailing Type	-
	Lining	55 x 243 x 5 mm	-	55 x 243	-
	I.D. of Wheel Cylinder	Ø 23.87 mm	-	Ø 23.81 mm	-
	I.D. of Caliper Cylinder	-	Ø 42.9 mm	-	Ø 42 mm
	Thickness of Brake Pad	-	10 mm	-	10 mm
	Thickness of Disc Plate	-	10.4 mm	-	10.4 mm
Parking Brake	Type	Rear Wheel Internal Expansion			
	Type	Mechanical			
Brake Fluid	Spec.	DOT4 or DOT3			

DIAGNOSTIC INFORMATION AND PROCEDURES

Symptom	Check	Action
Noise Or Vehicle Vibration When Applied Brake	Incorrectly Mounted Back Plate or Caliper	Repair
	Loosened Bolt of Back Plate or Caliper	Retighten
	Crack or Uneven Wear of Brake Drum or Disc	Replace
	Foreign Material Inside the Brake Drum	Clean
	Pad or Lining Sticking to Contact Surface	Replace
	Excessive Clearance Between Caliper and Pad	Repair
	Uneven Contact of Pad	Repair
	Lack of Lubrication	Lubrication
	Loosened Suspension	Retighten
Pulls To One Side When Braking	Incorrect Tire Pressure Between Left and Right	Adjust
	Poor Contact of Pad or Lining	Repair
	Oil or Grease is Applied to Pad or Lining	Replace
	Bent or Uneven Wear of Drum	Replace
	Incorrectly Mounted Wheel Cylinder	Repair
	Faulty Auto Adjuster	Repair
Poor Braking	Dirty or Lack of Fluid	Replenish or Replace
	Air in Brake System	Bleeding
	Faulty Brake Booster	Repair
	Poor Contact of Pad or Lining	Repair
	Oil or Grease on Pad	Replace
	Faulty Auto Adjuster	Repair
	Over Heated Rotor Due to Dragging Pad or Lining	Repair
	Clogging Brake Line	Repair
	Faulty Proportioning Valve	Repair
Increasing Pedal Stroke (Pedal Goes To Floor)	Air in Brake System	Bleeding
	Fluid Leaking	Repair
	Excessive Clearance Between Push Rod and M/Cylinder	Adjust
Brake Dragging	Parking Brake is not Fully Released	Repair
	Incorrect Adjustment of Parking Brake	Adjust
	Weak Return Spring of Brake Pedal	Replace
	Incorrect Pedal Free-play	Repair
	Broken Rear Drum Brake Shoe Return Spring	Replace
	Lack of Lubrication	Lubrication
	Damaged Master Cylinder Check Valve or Piston Return Spring	Replace
	Insufficient Clearance Between Push Rod and Master Cylinder	Adjust
Poor Parking Brake	Worn Brake Lining	Replace
	Dirty Brake Lining Surface by Grease or Oil	Replace
	Binding Parking Brake Cable	Replace
	Faulty Auto Adjuster	Repair
	Excessive Lever Stroke	Adjust Lever Travel or Check the Cable

MAINTENANCE AND REPAIR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BLEEDING THE BRAKES

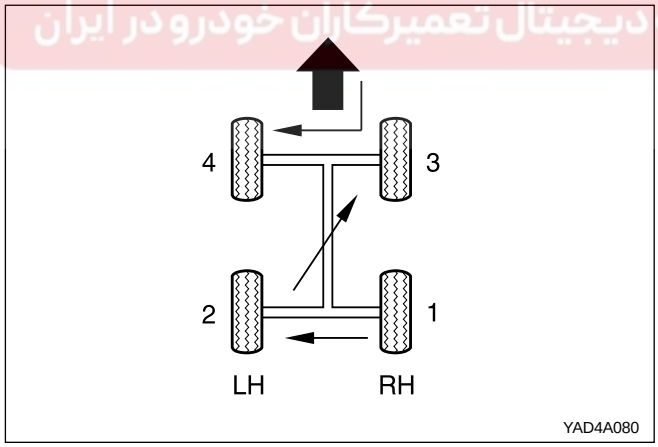
For Master Cylinder and Wheel Cylinder Replacement

Notice: The bleeding sequence is as follows; right rear, left rear, right front and left front.

Check the fluid level and add fluid during the bleeding operation.

1. Raise the vehicle with the assistance worker riding up to replenish the oil in the brake oil reservoir tank.
2. Remove the bleeder screw and cap.
3. Attach a transparent tube over the valve. Allow the tube to hang submerged in brake fluid in a transparent container.
4. Slowly push the brake pedal several times and hold the brake pedal.
5. Tighten the bleeder screw after loosening the bleeder screw and draining the fluid.

   Notice: Hold the brake pedal until tightening the bleeder screw.
6. Repeat the step 5, 6 until all the air is removed.
7. Check the leaks for the bleeder screw.



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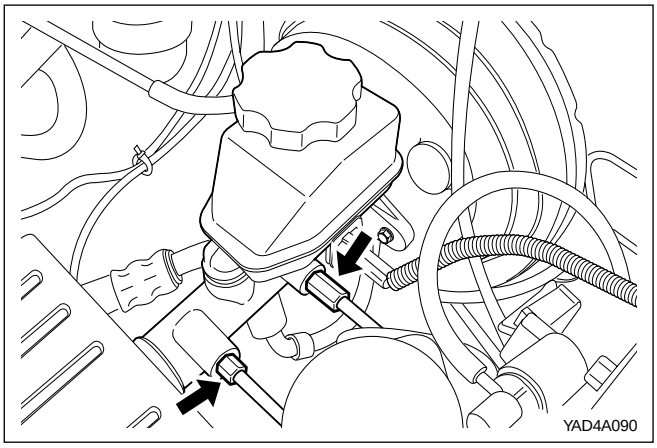
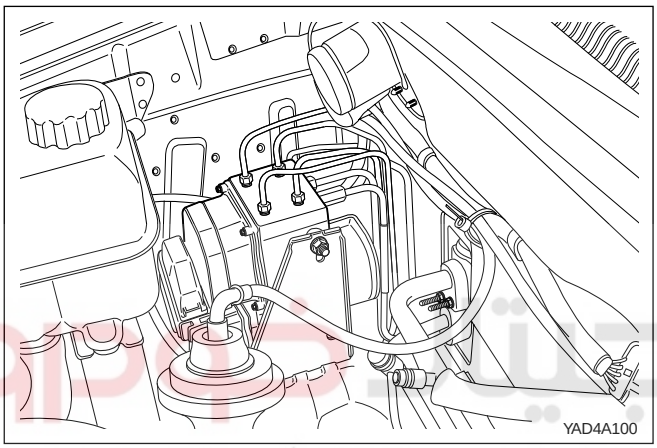
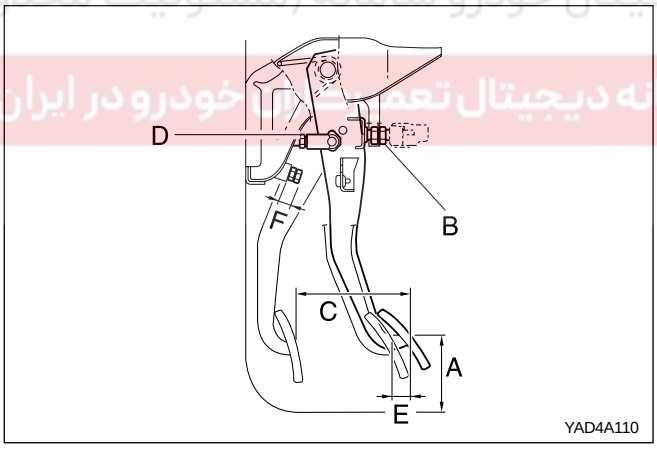
8. Bleed air in the system at four wheels in order as shown in the figure if pressure building is not enough by depressing the pedal after above air bleeding.

   Notice:
   - Always bleed the air after replacing brake fluid or master cylinder, caliper, brake hose and pipe.
   - Do not reuse the bled brake fluid.
   - Rapid pumping of the brake pedal pushes the master cylinder secondary piston down the bore in a manner that makes it difficult to bleed the system.
   - Care must be taken to prevent the brake fluid contacting any painted surface to prevent damage to the paint finish.
   - Check any leak for the applicable portion after bleeding.







For Master Cylinder Replacement

1. Add oil after master cylinder replacement.
2. Run the engine and depress the brake pedal several times to build pressure and then keep the pedal fully depressed.
3. Loosen the screw of primary and secondary pipe at the master cylinder outlets to bleed air.
4. Repeat above step No.3 several times until there are no more air bubbles.
5. Bleed air in the system at the hydraulic unit outlet pipe and wheel if pressure building is not enough by depressing the pedal only after above air bleeding.

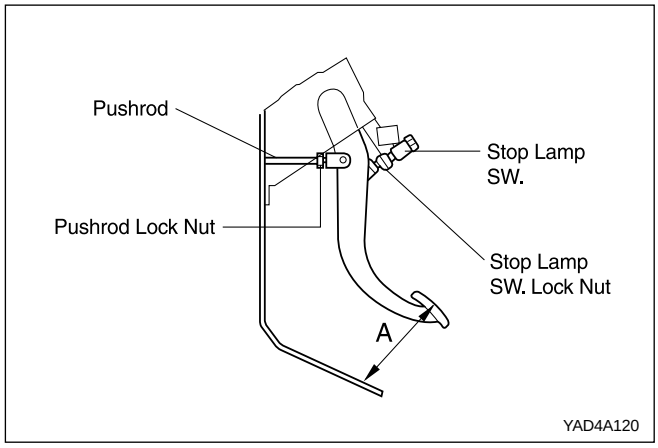
For Hydraulic Unit Replacement

1. Add oil after hydraulic unit replacement.
2. Run the engine and depress the pedal several times to build pressure and then keep the pedal fully depressed.
3. Loosen hydraulic pipe screws at the hydraulic unit outlets to bleed air.
4. Repeat above step No.3 several times until there are no more air bubbles.
5. Bleed air in the system from the wheel if pressure building is not enough by pressing the pedal only after above air bleeding.

BRAKE PEDAL

Pedal Travel Check

1. Start the engine.
2. Push the pedal three times.
3. With the brake depressed by about 30 kg (66.15 lb) load, measure the clearance between the pedal pad and the lower dash panel.
4. Check pad or shoe wear, any leak for the brake system when the measured value is below the specified value.
5. If the pedal height is not in the specified value, loosen the lock nut of the brake booster push rod and adjust the push rod length.



Pedal Height

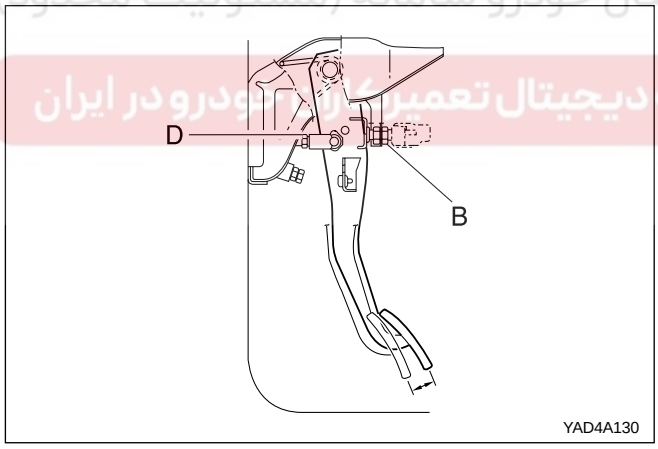
Specification (A)	177 mm (From the floor mat)

Notice: If the pedal height is not in the specified value, loosen the lock nut and adjust the height.

Pedal Free Play

Specification (C)	138 mm

Notice: If the pedal free play is not in the specified value, loosen the stop bolt and the lock nut and adjust free play up to max. travel.

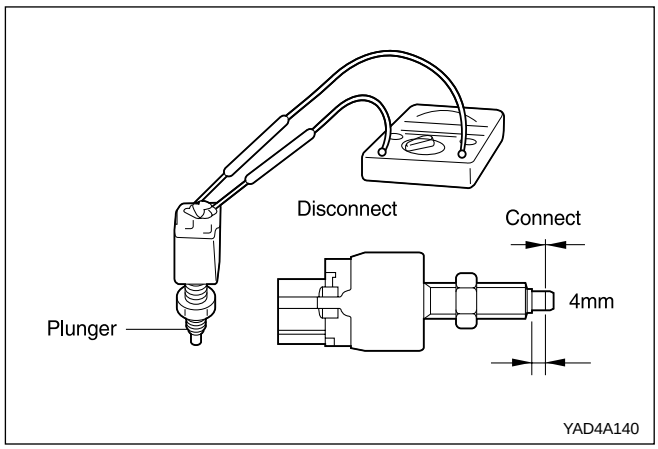


Brake Pedal Free Play

Push the brake pedal several times to discharge the vacuum of the power booster. Measure the pedal movement until the hardness is felt when pushing the brake pedal by hand.

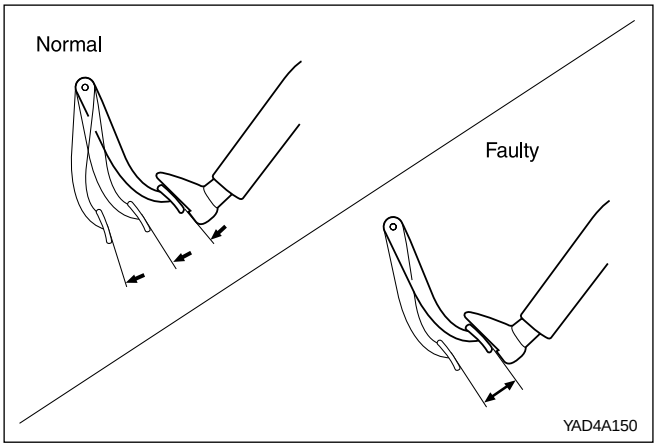
Specification	3 - 8 mm

If clearance is less than the specified value, verify that the clearance between the outer case of the stop lamp and the brake pedal within the specified value. If clearance is beyond on the specified value, it means that the clearance between the clevis pin and brake pedal arm is beyond. Check the faulty and repair, adjust as needed.



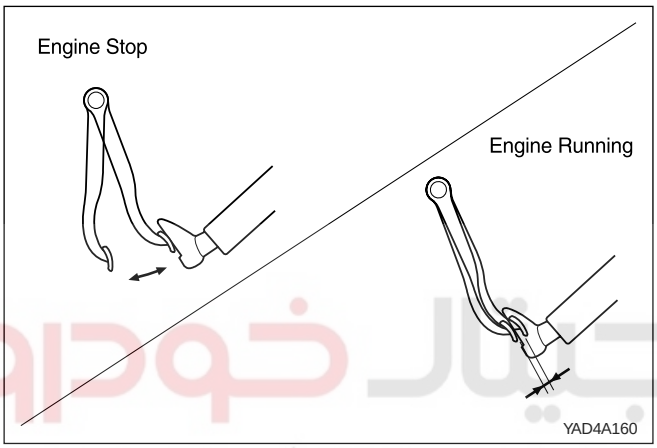
STOPLAMP SWITCH

The multi-meter connects the stoplamp switch connector and push the plunger. When the stoplamp switch does not connected with pushing the plunger, the stoplamp switch is normal.

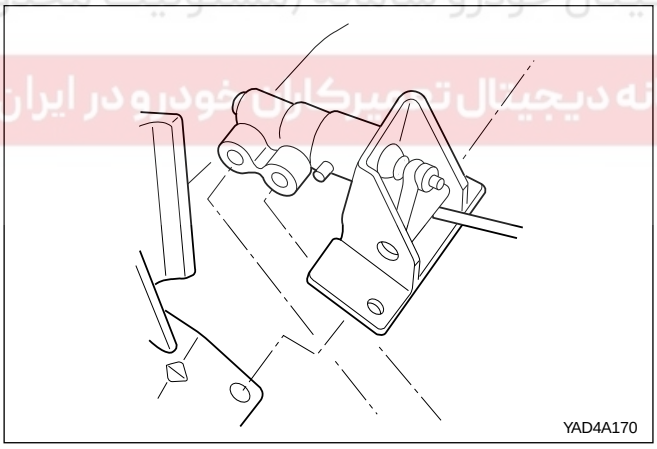


BRAKE BOOSTER FUNCTIONAL CHECK

1. With the engine stopped, eliminate vacuum in the booster by pumping the brake pedal several times.
2. Push the pedal down and hold in this position.
3. Start the engine.
4. The booster is OK if the pedal drops further because of extra force produced.



If the brake pedal does not drop, the vacuum system is probably defective and should be checked. If no defect is revealed by checking the vacuum system, the defect is in the booster itself.

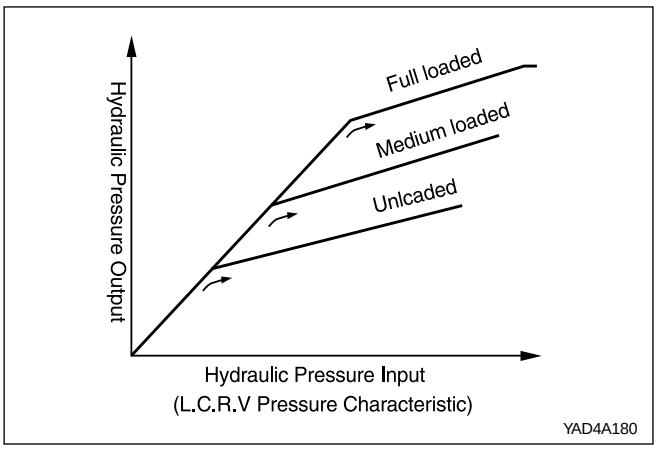


LCRV (LOAD CONSCIOUS REDUCING VALVE)

LCRV consists of sensing part and hydraulic control part.

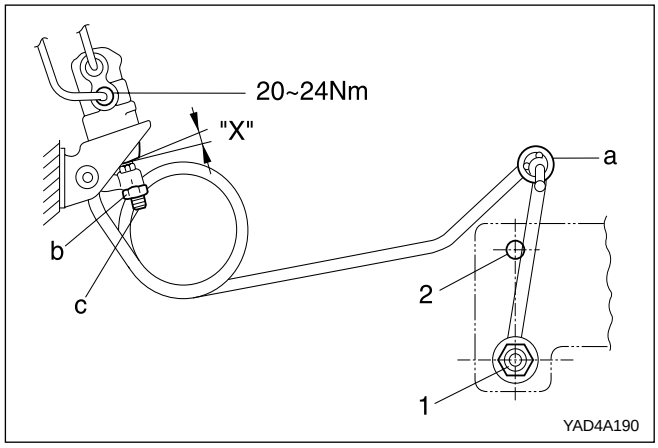
1. Sensing Part

   It detects the changes of vehicle height caused by vehicle load. It consists of load sensing spring and control lever which change according to vehicle load.



2. Hydraulic Control Part

   It consists of valve stem devices which controls hydraulic pressure according to load detected by sensing part.



Setting Method

1. Install the connecting rod (a) to the No.1 hole.
2. Adjust the clearance “X” to be 0mm and tighten the bolt (c) using the lock nut (b).

Installation Notice

Tightening Torque	14 - 18 N•m (10 - 13 lb-ft)

3. Remove the connecting rod (a) from the No.1 hole and reinstall it to the No.2 hole.

Installation Notice

Tightening Torque	14 - 18 N•m (10 - 13 lb-ft)

4. Place alignment marks between the lock nut (b) and adjusting screw (c) after the valve setting.
5. LCRV setting should be performed with unloaded vehicle condition.

Inspection

When it occurs the malfunction in the LCRV, the sensor spring, valve body assembly, rear axle or rear spring may be replaced. For these replacement, the following inspection should perform;

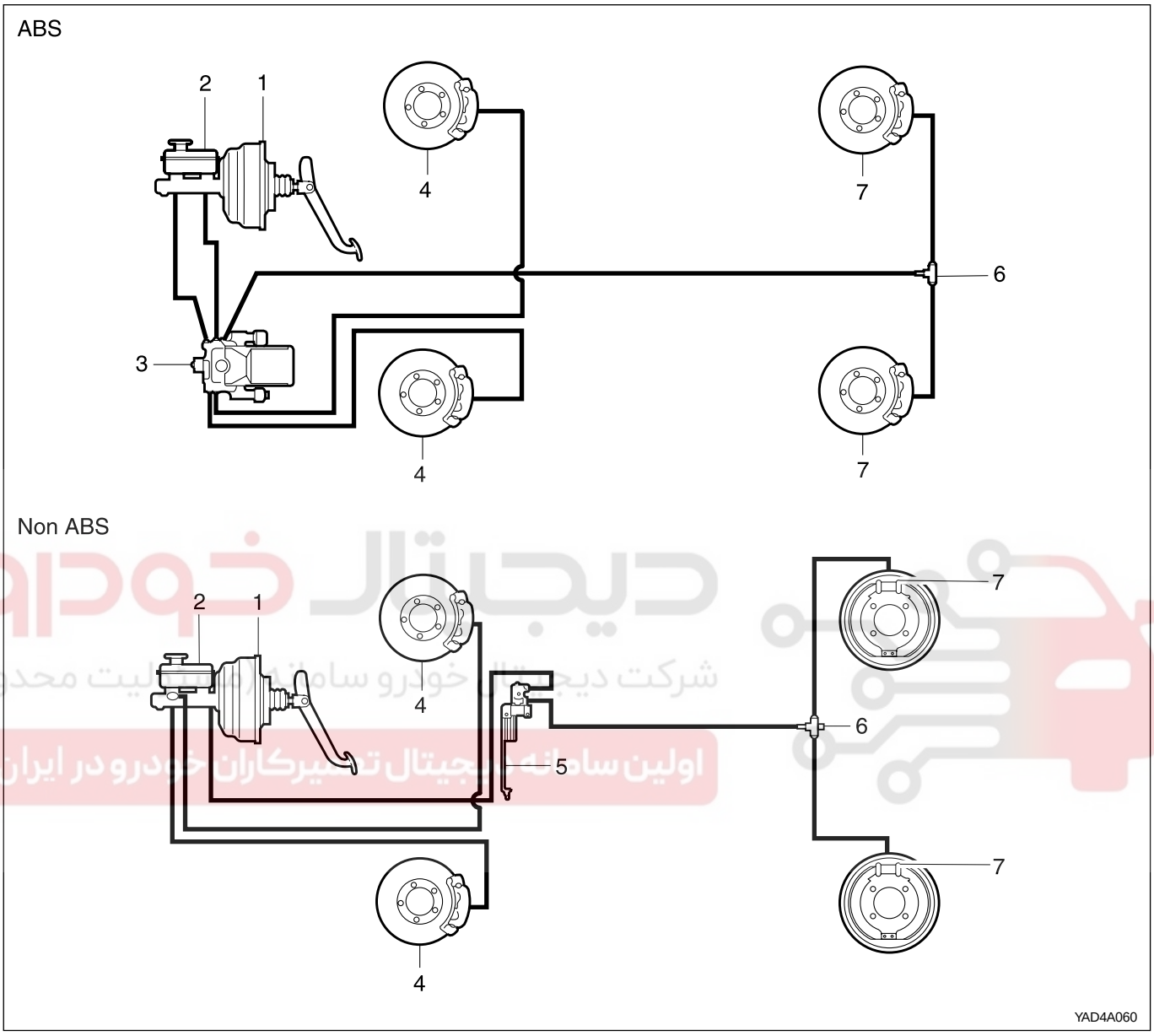
Symptom	Possible Cause	Action
Poor Braking Performance	Air in Brake System	Bleeding
	Poor Adjustment of Sensor Spring	Adjust
	Damaged Sensor Spring	Replace
	Fluid Leaking from LCRV	Replace
Rear Wheels Lock Early	Poor Adjustment of Sensor Spring	Adjust
	Internal Fluid Leaking of LCRV	Replace

Notice:

- Fluid leaking from LCRV results from poor valve open/close or sealing wear caused by the foreign materials in the LCRV.
- When you change or repair the LCRV, it may affect the braking performance. Thus, ensure to use the approved part.

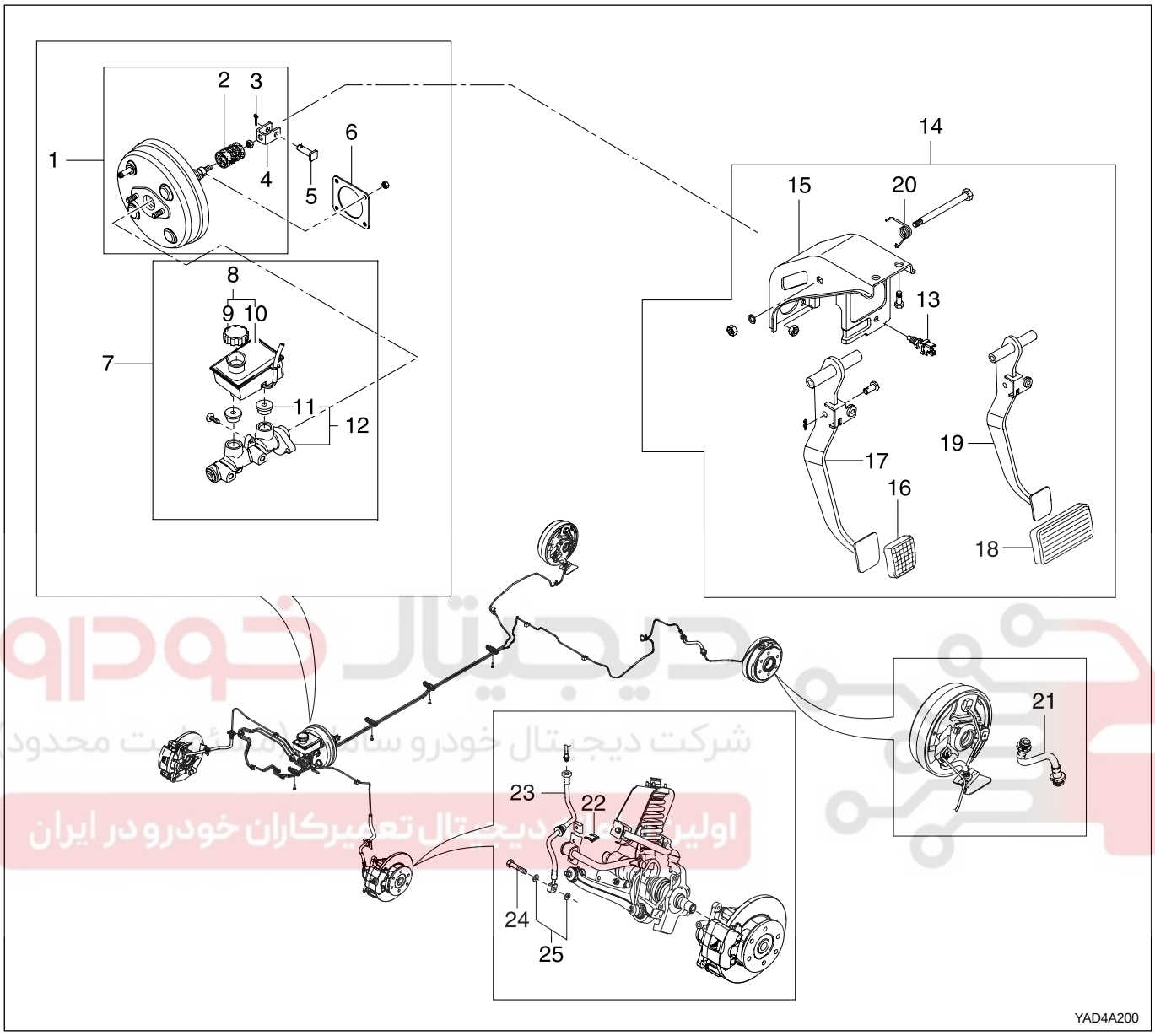
COMPONENT LOCATOR

HYDRAULIC LINE



1 Brake Booster
2 Brake Reservoir and Master Cylinder
3 ABS Control Unit
4 Front Disc Brake and Caliper
5 Hydraulic Pressure Control Valve (LCRV)
6 3-way Connector
7 Rear Drum (Disc) and Wheel Cylinder (Caliper)

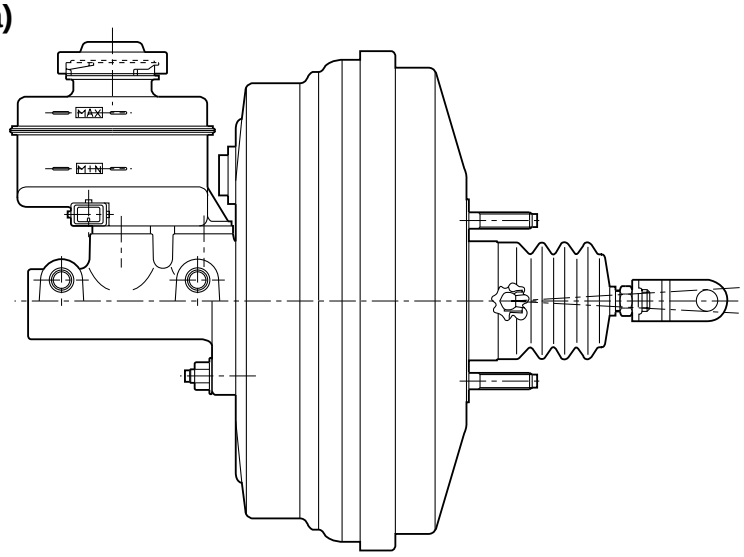
BRAKE SYSTEM (W/CBS)



1 Brake Booster
2 Brake Booster Boot
3 Cotter Pin
4 Clevis
5 Clevis Pin
6 Packing (1)
7 Master Cylinder Assembly
8 Brake Oil Tank Assembly
9 Brake Oil Tank Cap
10 Brake Oil Tank
11 Grommet Seal
12 Master Cylinder
13 Brake Stoplamp Switch
14 Pedal Assembly
15 Pedal Bracket Assembly
16 Clutch Pedal Pad
17 Clutch Pedal
18 Brake Pedal Pad
19 Brake Pedal
20 Brake Pedal Spring
21 Rear Brake Hose
22 Clip
23 Front Brake Hose
24 Union Bolt
25 Plain Washer

MASTER CYLINDER AND BOOSTER

KDAC (Delphi Korea)



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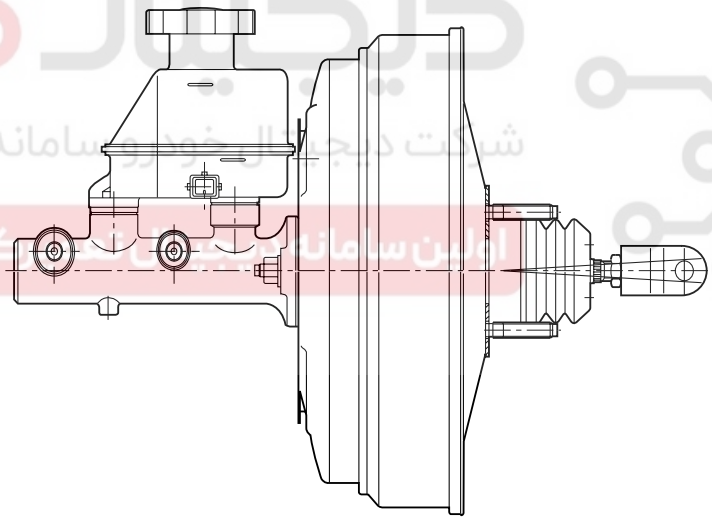
MANDO



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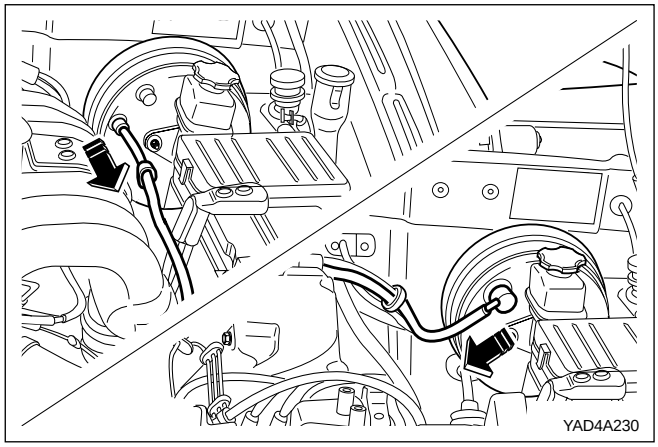
REPAIR INSTRUCTIONS

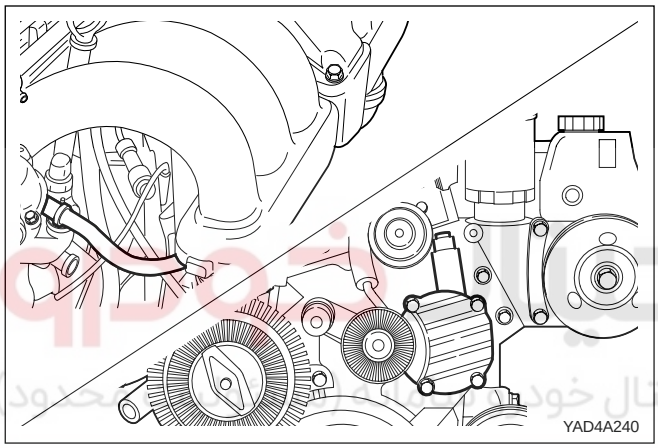


ON-VEHICLE SERVICE

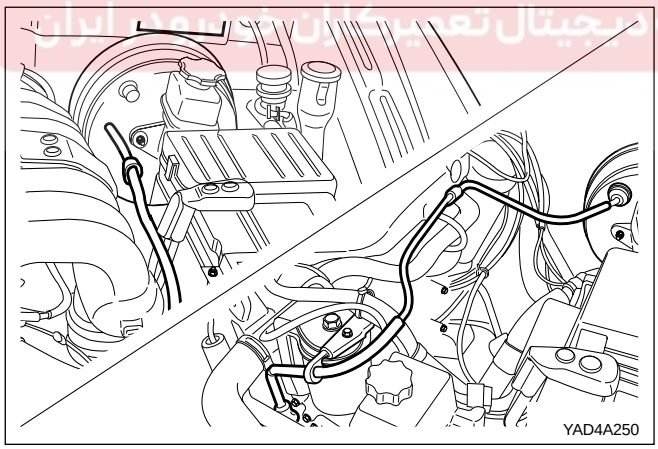
VACUUM HOSE

Removal Procedure

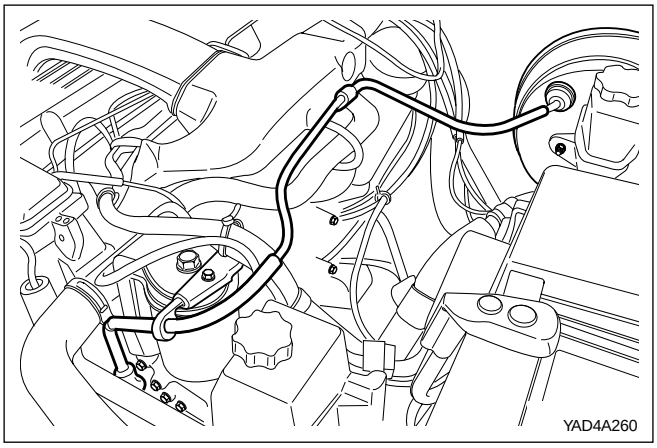
1. Disconnect the vacuum hose from the brake booster.



2. Disconnect the vacuum hose from the vacuum pump.



3. Remove the vacuum hose with the vacuum hose bracket.

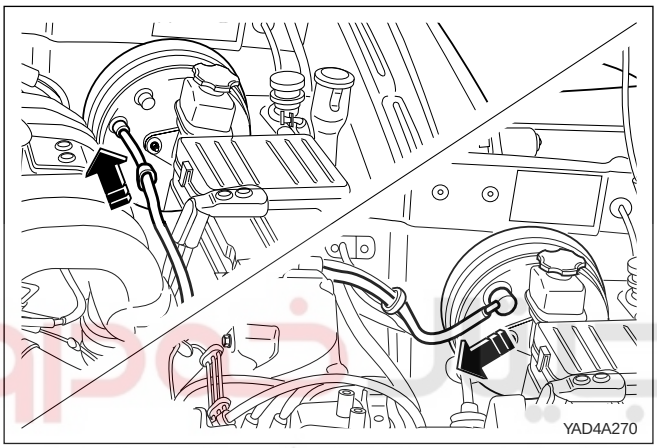


Installation Procedure

1. Install the vacuum hose between the vacuum pump and the power booster (Diesel Engine).

Tightening Torque

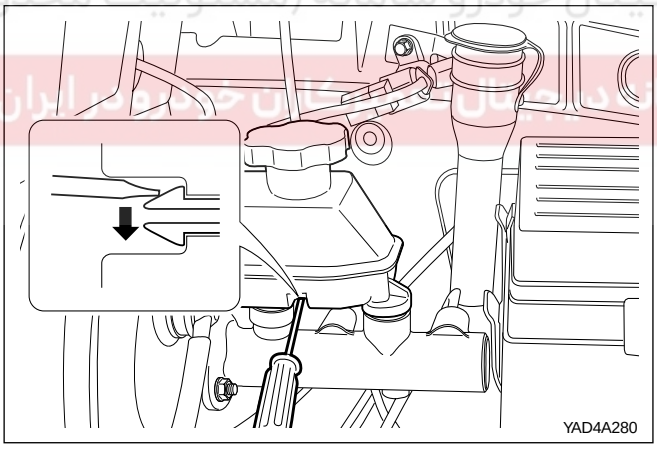
Bracket Mounting Bolt	35 - 45 N•m (26 - 33 lb-ft)
Union Bolt to Vacuum Pump	35 - 45 N•m (26 - 33 lb-ft)



2. Install the vacuum hose between the vacuum pump and the power booster. (Gasoline Engine)

Tightening Torque

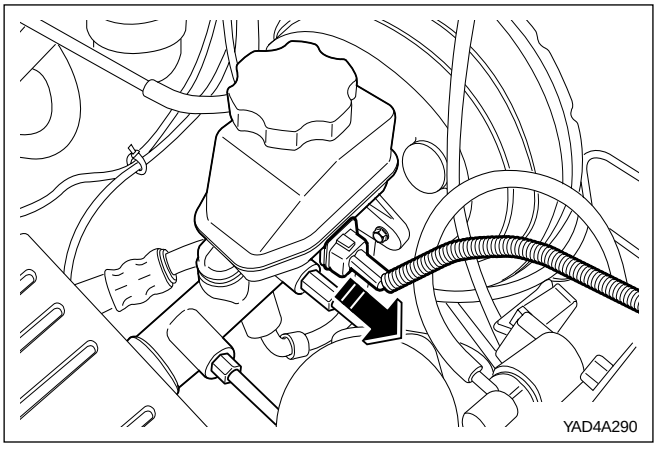
Bracket Mounting Bolt	35 - 45 N•m (26 - 33 lb-ft)
Union Bolt to Vacuum Pump	35 - 45 N•m (26 - 33 lb-ft)



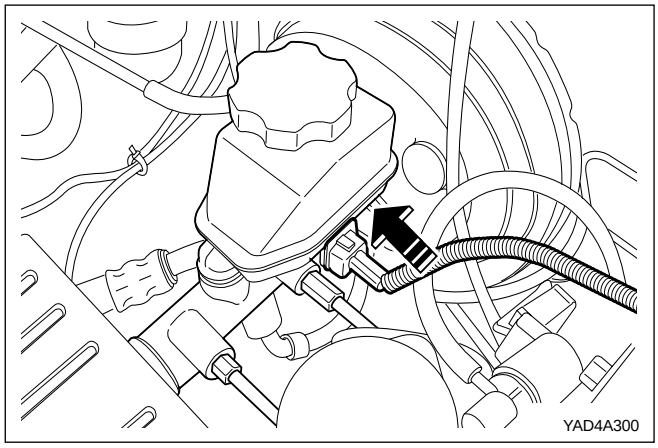
BRAKE OIL LEVEL SWITCH

Removal & Installation Procedure

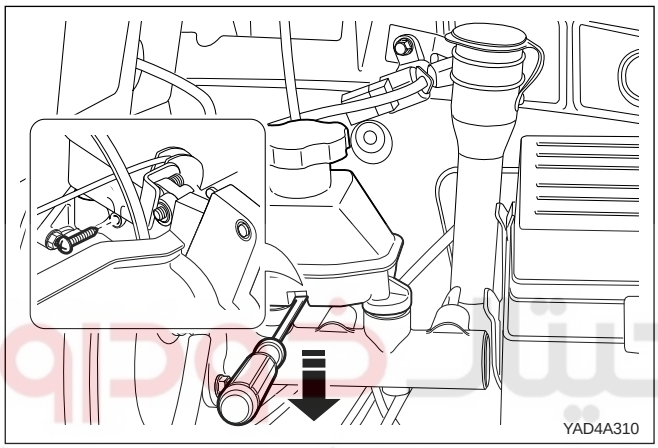
1. Disconnect the brake fluid level switch connector.



2. Disconnect the switch wiring connector.
3. Disconnect the switch from the brake oil tank.



4. Installation should follow the removal procedure in the reverse order.

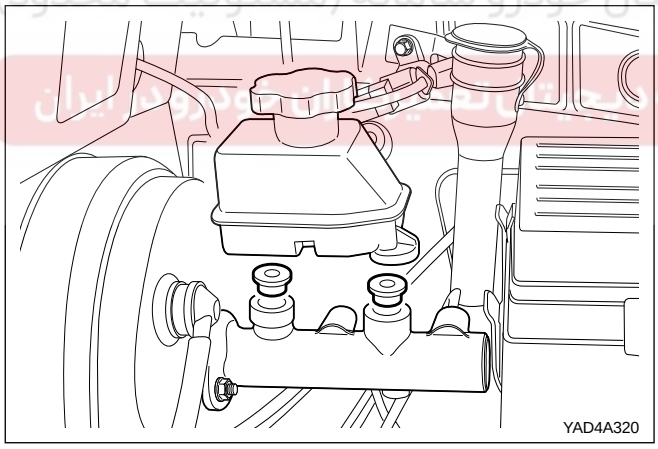


BRAKE FLUID RESERVOIR

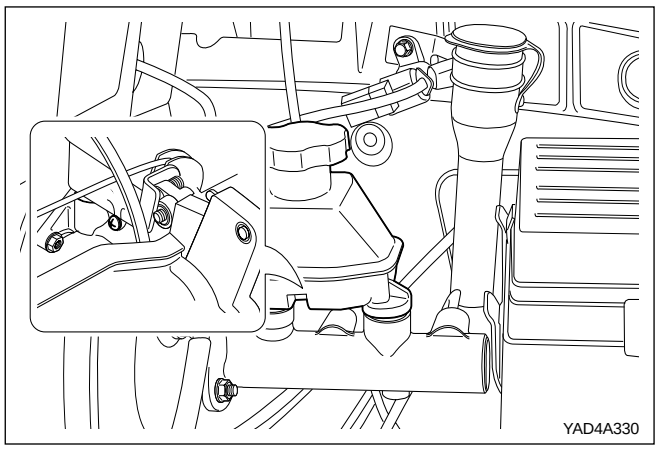
Removal & Installation Procedure

1. Remove the reservoir tank cap and drain the brake fluid completely.
2. Remove the brake reservoir tank using the driver.

   Notice: Note that pulling the reservoir tank out excessively result in damage of the tank on removal.



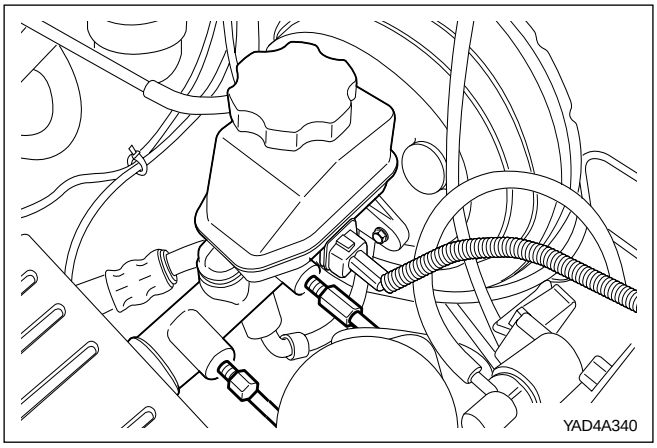
3. Remove the grommet from the master cylinder.



4. Installation should follow the removal procedure in the reverse order.

   Notice:

   - Lubricate the new brake fluid reservoir seals with clean brake fluid.
   - After the installation, bleed the brake system.

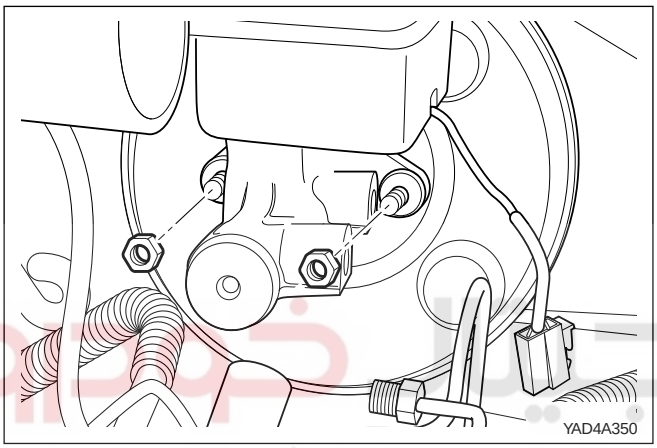


MASTER CYLINDER

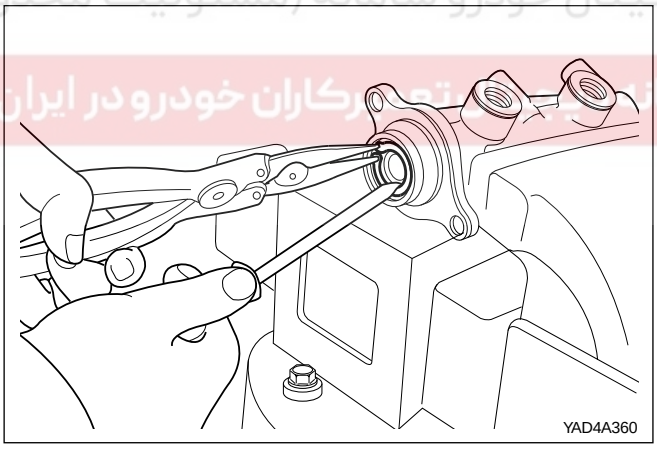
Removal Procedure

1. Disconnect the brake lines from the master cylinder.

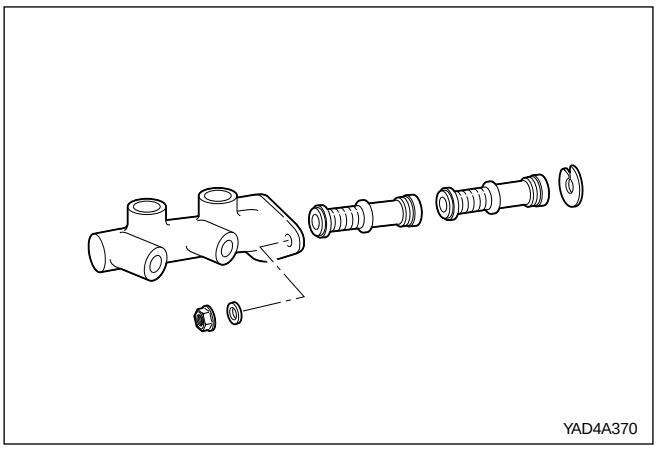
   Notice: The brake fluid may damage paintwork, if spillage onto paintwork, wash with cold water immediately.



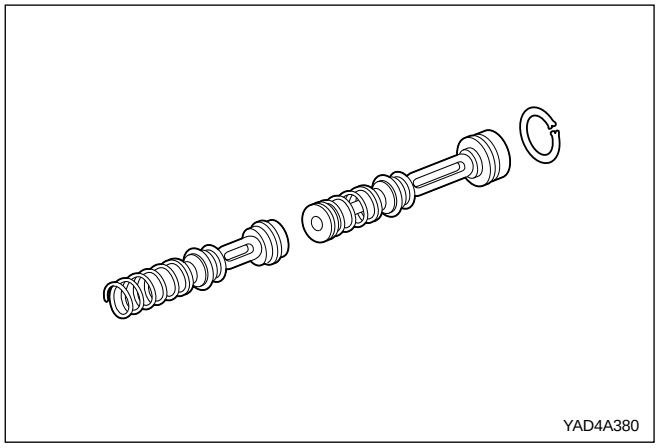
2. Loosen the mounting nut of the master cylinder and remove the master cylinder from the power booster.



3. Remove the master cylinder.
   - Retain the master cylinder in the vice and remove the retainer ring from the master cylinder using the snap ring plier.

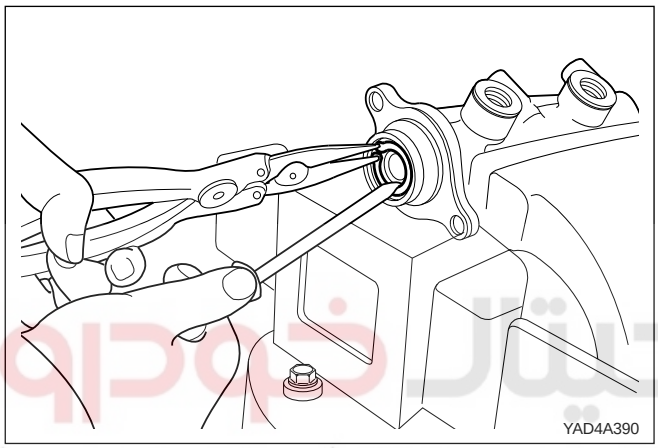


- Remove the 1st piston and 2nd piston assembly from the master cylinder assembly.


YAD4A380

- Check the cylinder for excessive wear.

  Notice:
  - Replace the cylinder assembly when there occurs any damage or wear in the cylinder.
  - Clean the contaminated oil of the assembly.
- Install the 1st piston and 2nd piston assembly from the master cylinder assembly.


YAD4A390

Installation Procedure

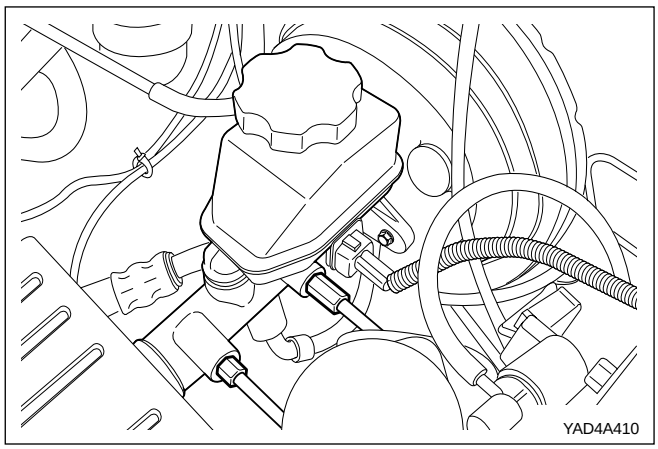
1. Install the retainer ring using the snap ring plier.


YAD4A400

2. Install the master cylinder into the booster.

Installation Notice

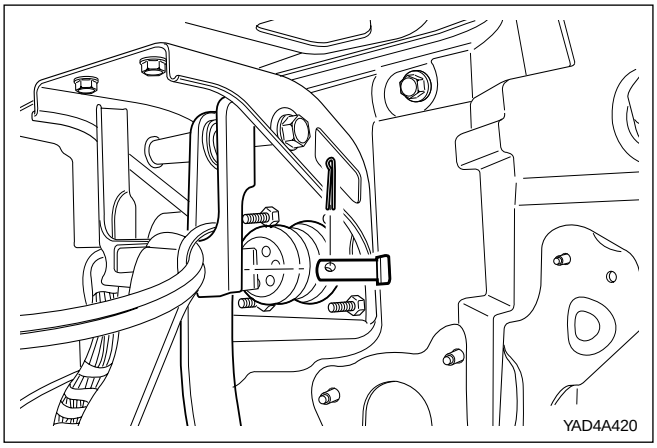
Tightening Torque	8 - 12 N•m (71 - 106 lb-in)


YAD4A410

3. Install the master cylinder completely and then connect the brake pipe.

Installation Notice

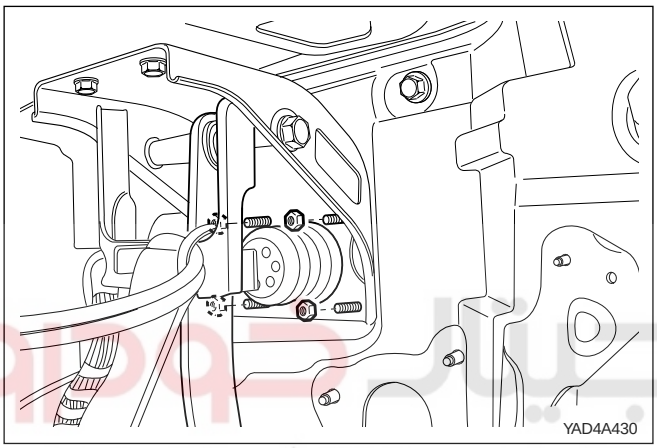
Tightening Torque	15 - 18 N•m (11 - 13 lb-ft)



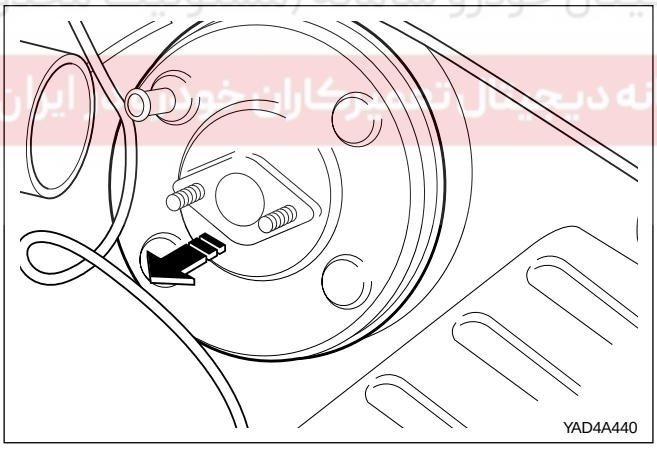
BRAKE BOOSTER

Removal Procedure

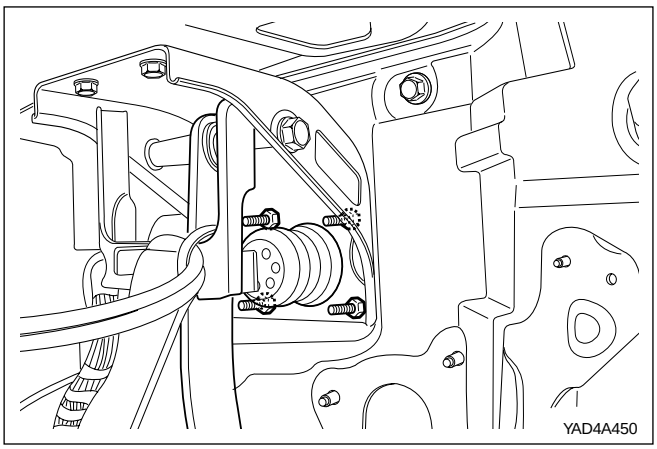
1. Remove the master cylinder assembly and pull out the cotter pin from the push rod of the brake booster.
2. Remove the clevis pin.



3. Remove the nuts mounting the booster.

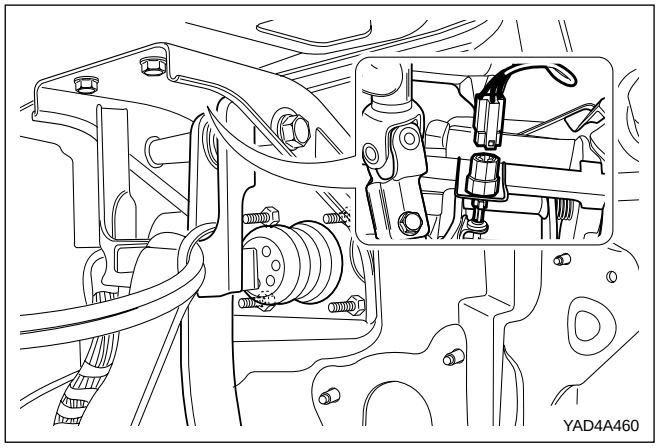


4. Remove the brake booster from the vehicle.



Installation Procedure

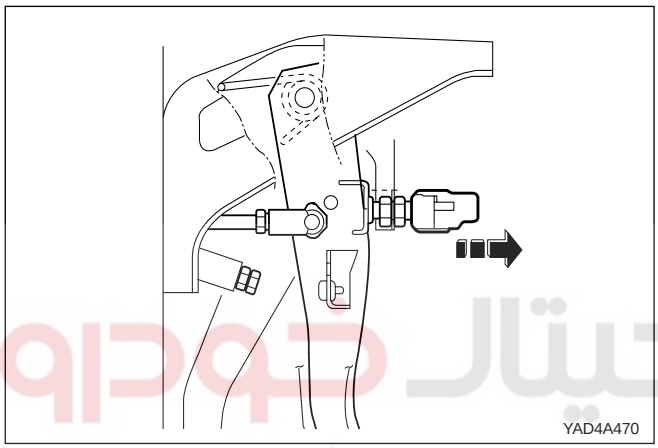
1. Installation should follow the removal procedure in the reverse order.
2. Bleed the brake system after the installation.



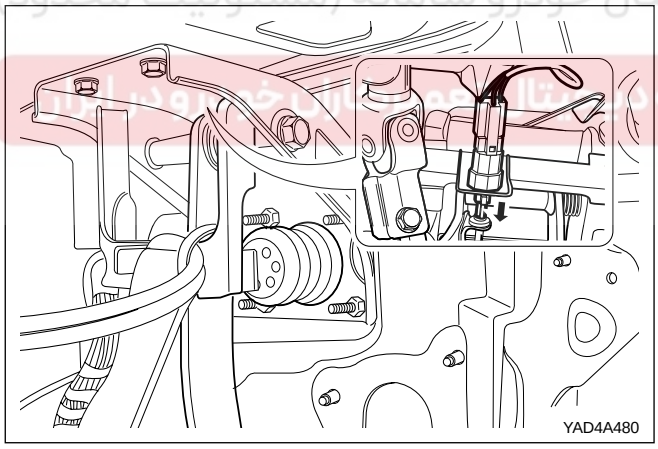
STOPLAMP SWITCH

Removal & Installation Procedure

1. Disconnect the negative battery cable.
2. Separate the stoplamp switch from the connector.

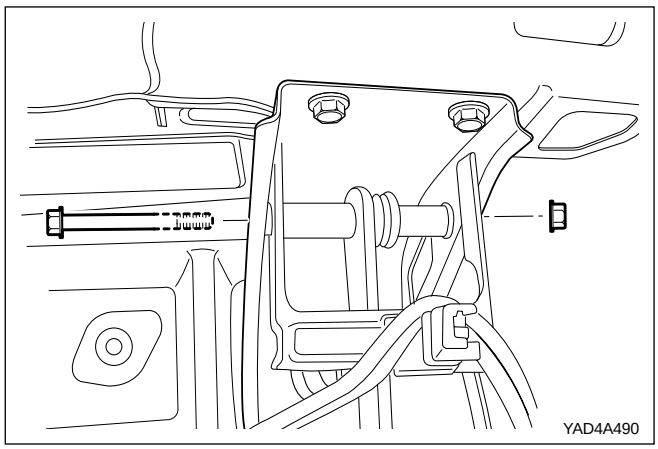


3. Remove the stoplamp switch nut and disconnect the switch.



4. Installation should follow the removal procedure in the reverse order.

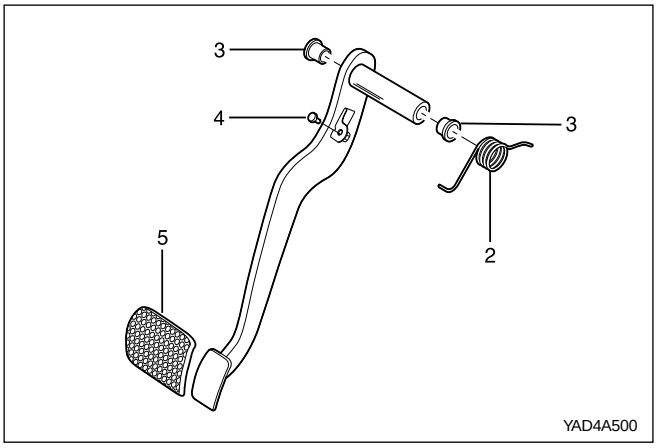
Tightening Torque	21 - 35 N•m (15 - 26 lb-ft)



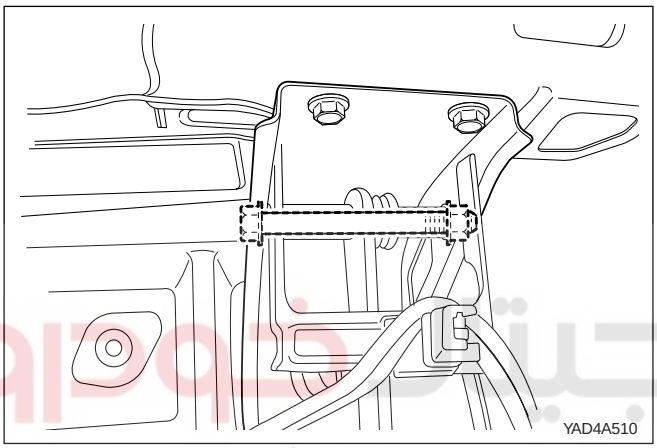
BRAKE PEDAL

Removal & Installation Procedure

1. Remove the bolts/nuts mounting the brake pedal and disconnect the cotter pin.



2. Remove the brake pedal assembly.

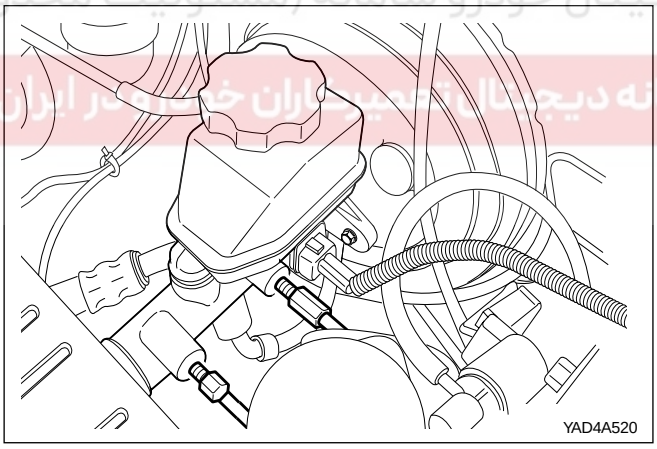


3. Installation should follow the removal procedure in the reverse order.

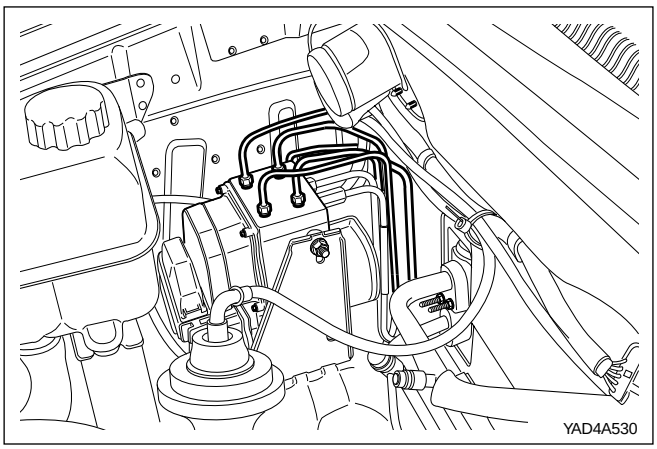
Tightening Torque	16 - 32 N•m (12 - 24 lb-ft)

BRAKE HOSE & PIPE

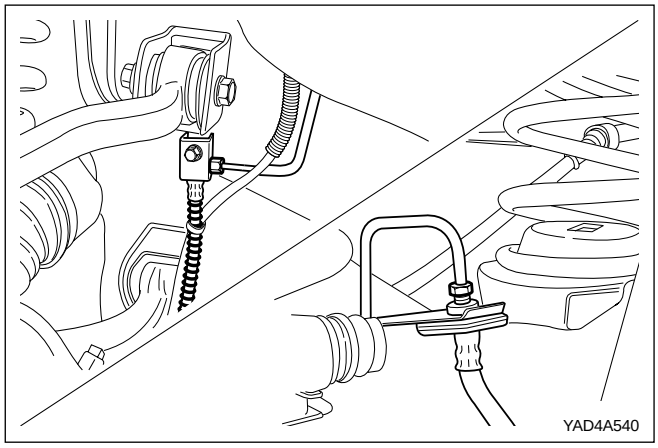
Removal Procedure



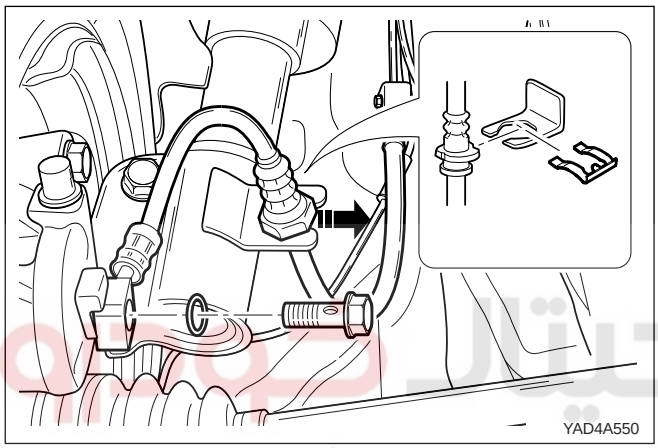
1. Remove the brake pipe.
   - Remove the pipe from the master cylinder.



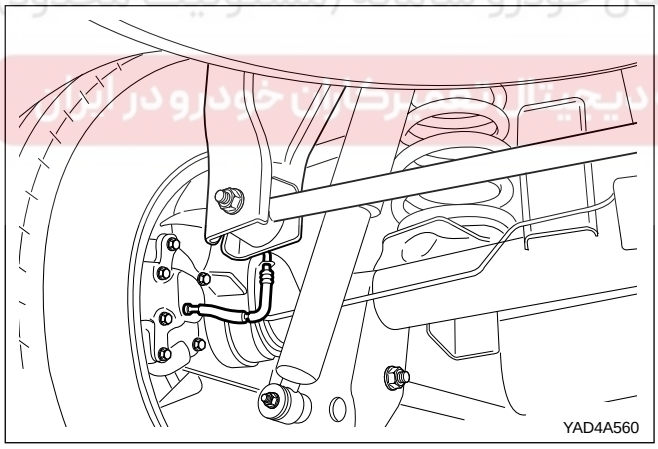
   - For ABS/ABD, remove the brake pipe from the control unit.



- Remove the bracket of the connecting pipe from the 3-way connector.

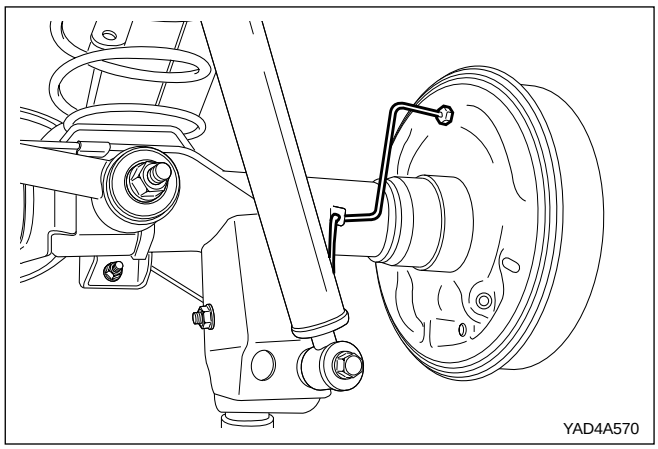


2. Remove the front brake hose.
   - Remove the brake pipe nut.
   - Remove the E-ring.
   - Disconnect the strut from the brake mounting.
   - Remove the union bolt from the caliper and remove the brake hose.

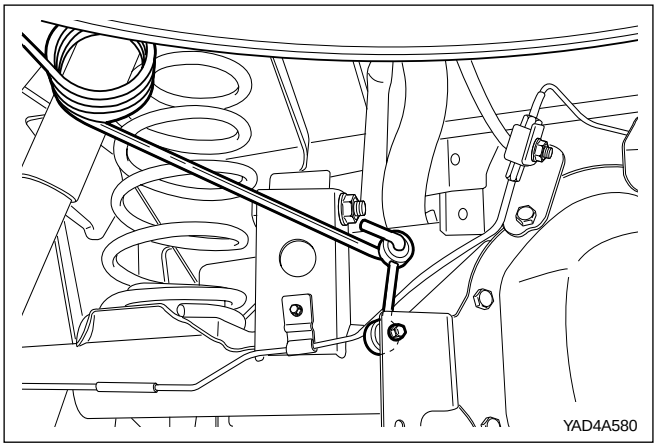


3. Remove the rear brake hose.
   - Remove the brake pipe nut.
   - Remove the E-ring.
   - Disconnect the strut from the brake mounting.
   - Remove the union bolt from the caliper and remove the brake hose.

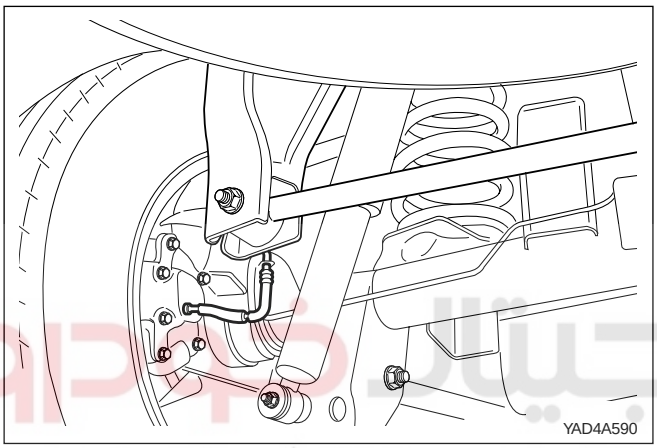
     - For disc type : from the caliper



     - For drum type : from the cylinder



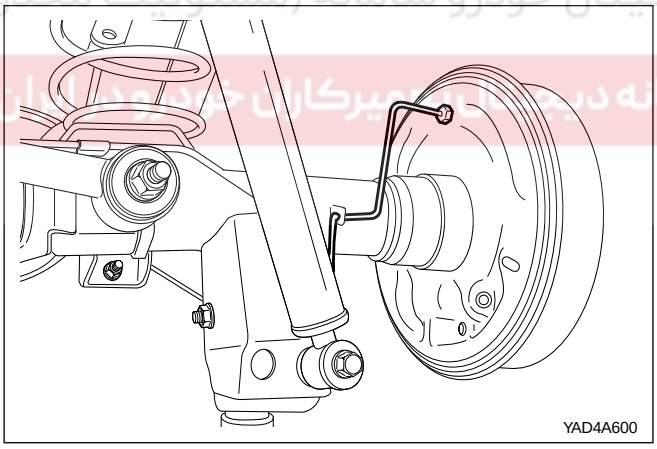
4. For non-ABS/ABD, remove the brake pipe to the rear brake at LCRV side.

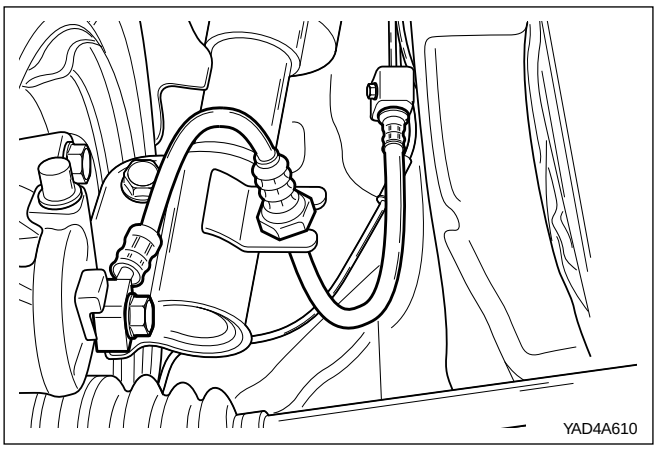


Installation Procedure

1. Install the rear brake hose and tighten the union bolts.

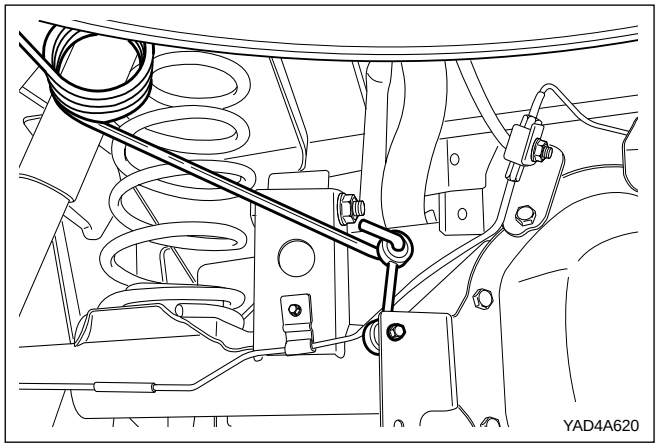
Tightening Torque at the caliper	15 - 18 N•m (11 - 13 lb-ft)
Tightening Torque at the wheel cylinder	15 - 19 N•m (11 - 13 lb-ft)





2. Install the front brake hose and tighten the union bolts.

Tightening Torque	15 - 18 N•m (11 - 13 lb-ft)



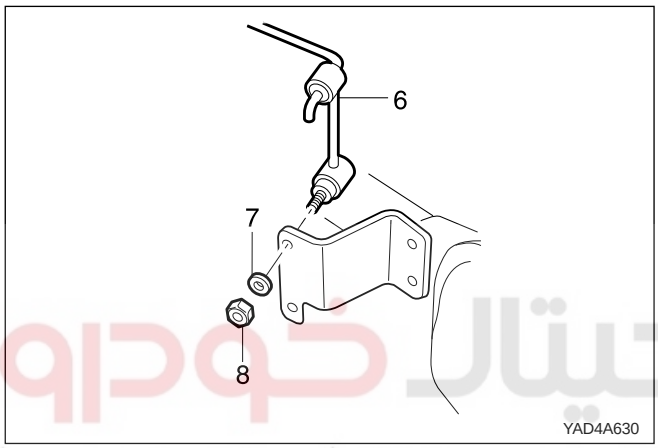
3. Install the brake pipe to the correct position.

3-way Connector	15 - 19 N•m (11 - 14 lb-ft)
LCRV System	15 - 19 N•m (11 - 14 lb-ft)
ABS/ABD Control Unit	15 - 19 N•m (11 - 14 lb-ft)
Port (M12)	20 - 24 N•m (15 - 18 lb-ft)

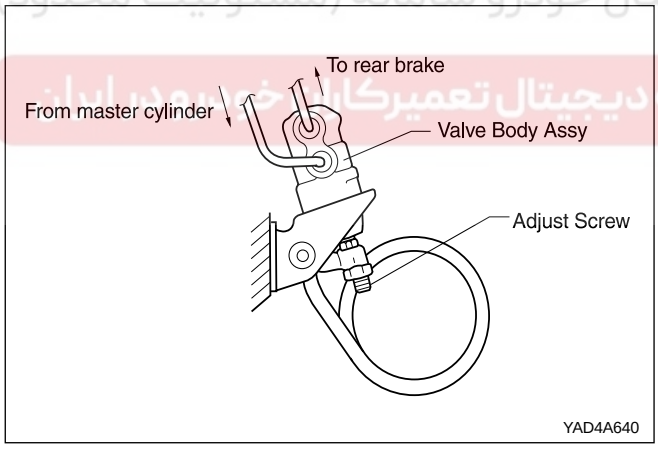
4. Bleed the brake system after replacement of the pipes/hoses.

LCRV (LOAD CONSCIOUS REDUCING VALVE)

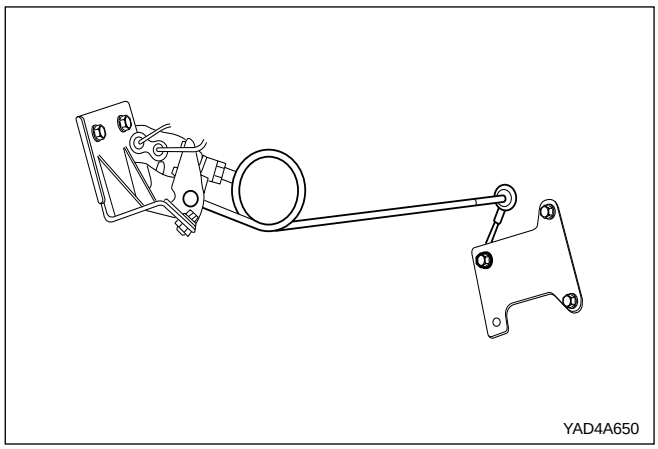
1. Remove the nut mounting the stud from the LCRV connecting rod.

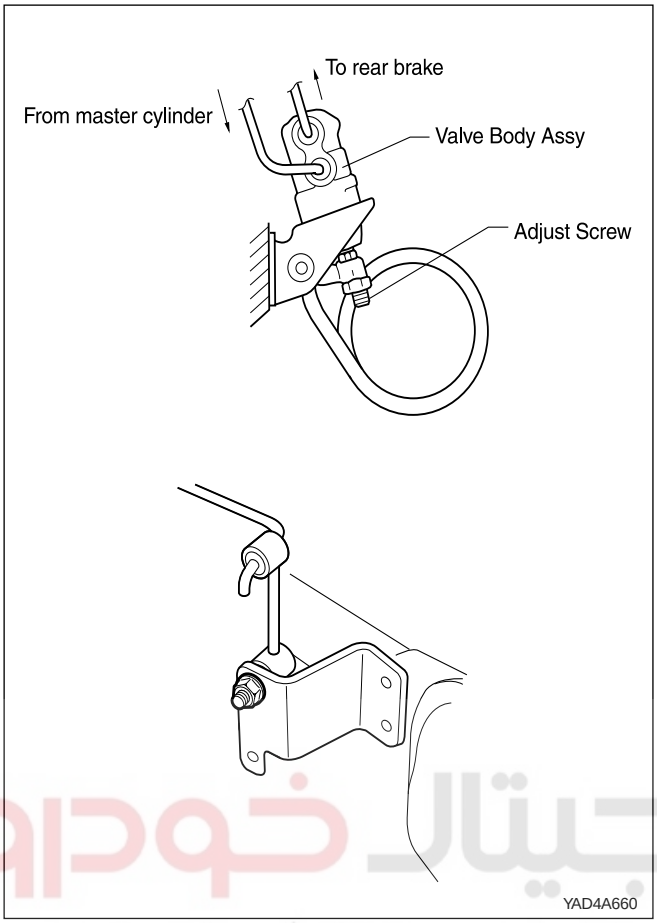


2. Remove the brake pipe retaining the LCRV.



3. Remove the LCRV mounting bolt from the LCRV bracket and remove the LCRV.





4. Installation should follow the removal procedure in the reverse order.

Valve Body Mounting nut	14 - 18 N•m (10 - 13 lb-ft)
Bracket Mounting Bolt	10 - 13 N•m (89 - 115 lb-in)
Stud Mounting Nut	14 - 18 N•m (10 - 13 lb-ft)

Notice: Bleed the brake system.