एयर सस्पेंशन सिस्टम
AIR SUSPENSION SYSTEM

- **INTRODUCTION**
- To take advantage of superior technological standard of LHB
- coaches and keeping the cost low, stainless steel body coach on ICF bogie with Air Spring as secondary suspension (Stainless steel SG coaches) have been introduced. With increase in load and speed the existing coil spring ICF type bogie suspension of coaches, the bogies clearance basically meant for absorbing dynamic movement of the coach, just vanish resulting into severe hitting between various bogie components. This leads to premature failure of bogie components and poor riding behavior of the coach.

To overcome this problem, air (pneumatic) suspension (air spring) at secondary stage has been taken up with optimized values of stiffness and damping characteristics.

Advantages of air suspension

Constant floor height of coach.

Excellent ride comfort.

Capable to sustain Super Dense Crush Loads of suburban traffic.Safe running of train.

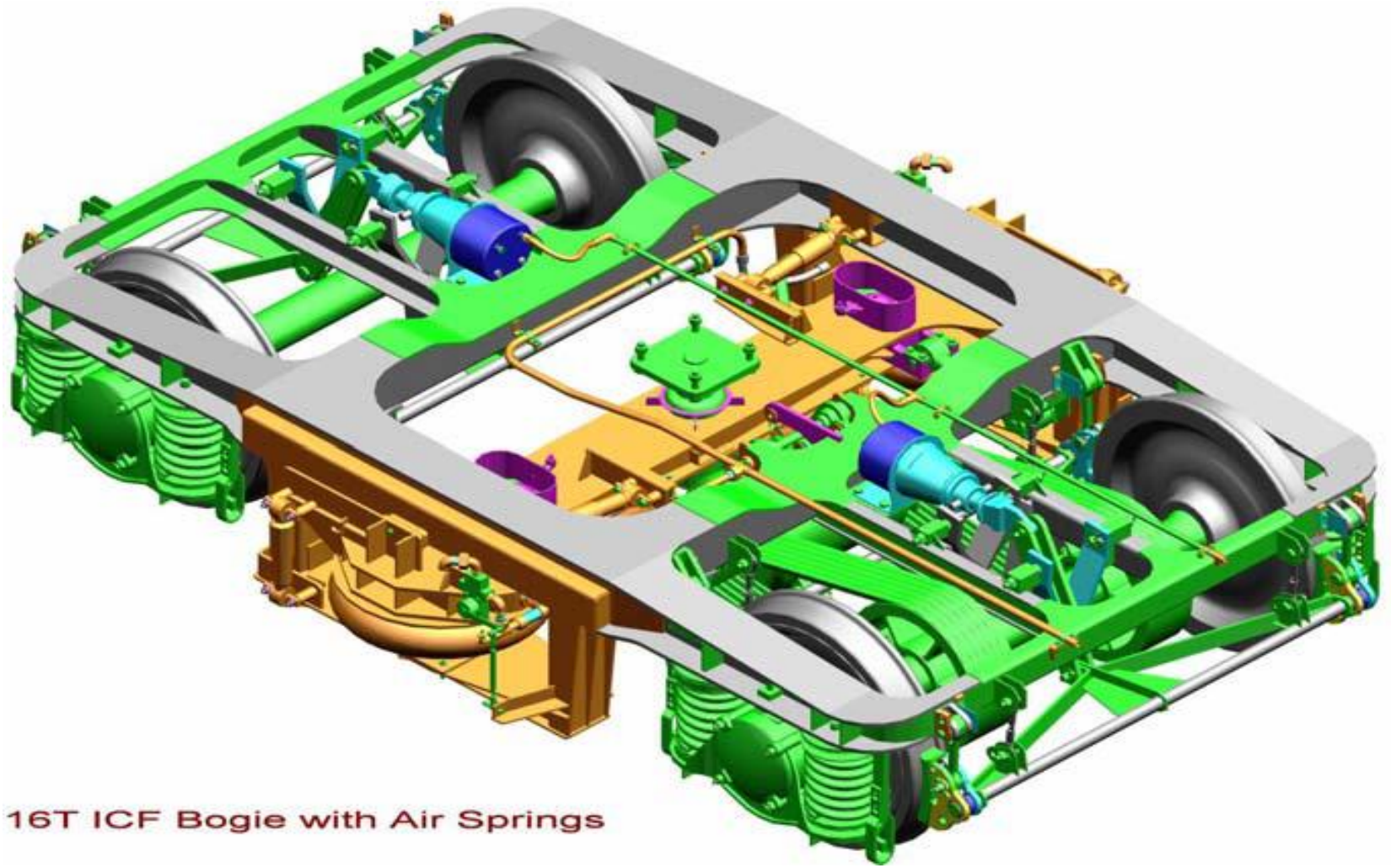
Virtually Constant natural frequency from tare to full loads. Integral input signal for load dependent braking and acceleration.

Isolation of structure borne noise.

Improved reliability, reduced maintenance.

High durability.

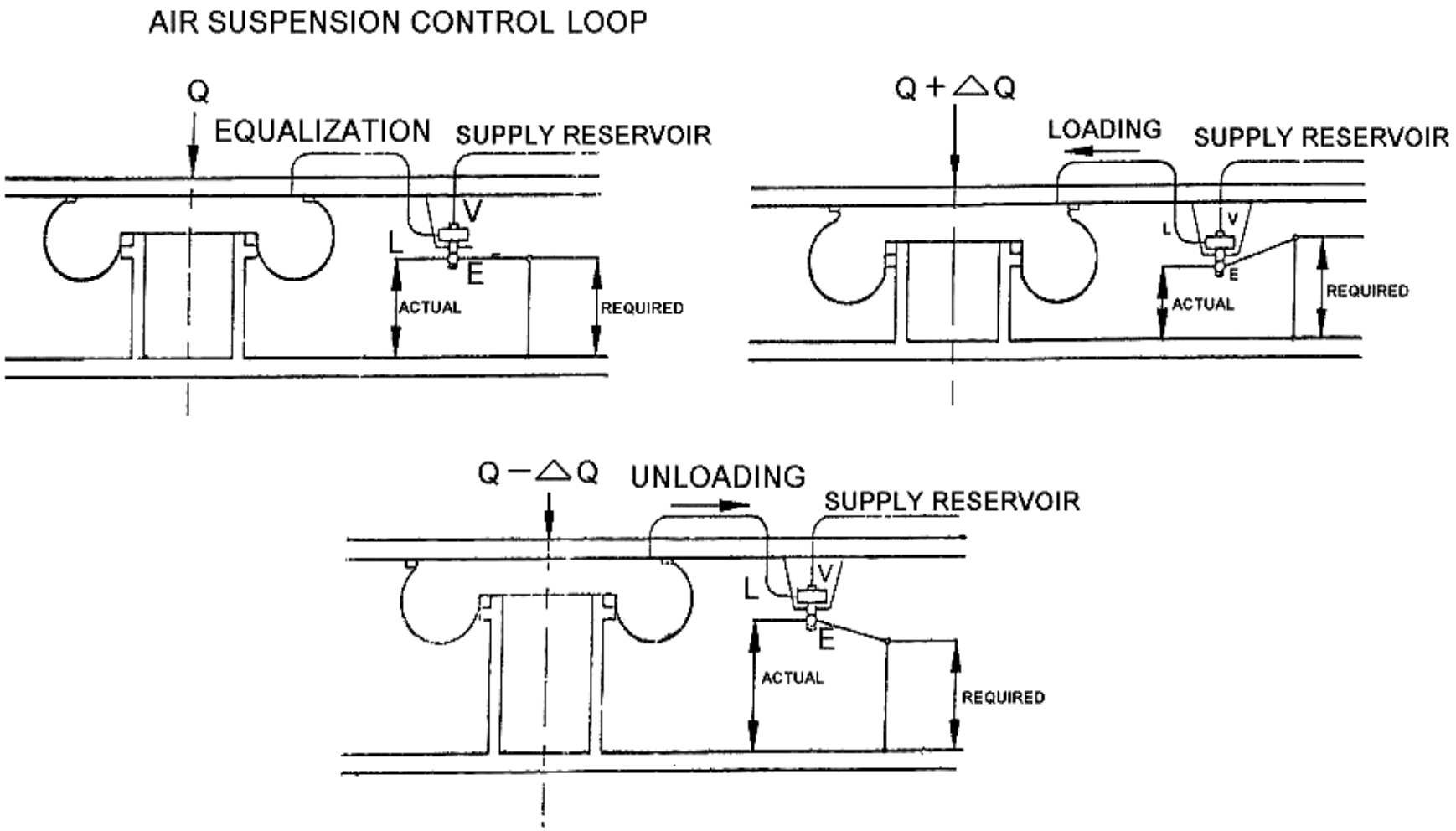
Possibility of voluntarily choosing air spring characteristics.



3D View of ICF Bogie fitted with Air suspension system

कार्य का सिद्धान्त /WORKING PRINCIPLE

In this system the properties of air are used for cushioning effect (springiness). Enclosed pressurized air in a predefined chamber called air spring, provides various suspension characteristics including damping. Air spring is height controlled load leveling suspension device. With changing loads air spring reacts initially by changing the distance between air spring supports and vehicle body. The leveling valve is, in turn, actuated, either by getting the compressed air pressure to the air spring or releasing air pressure from it to the atmosphere. This process continues until original height is restored.



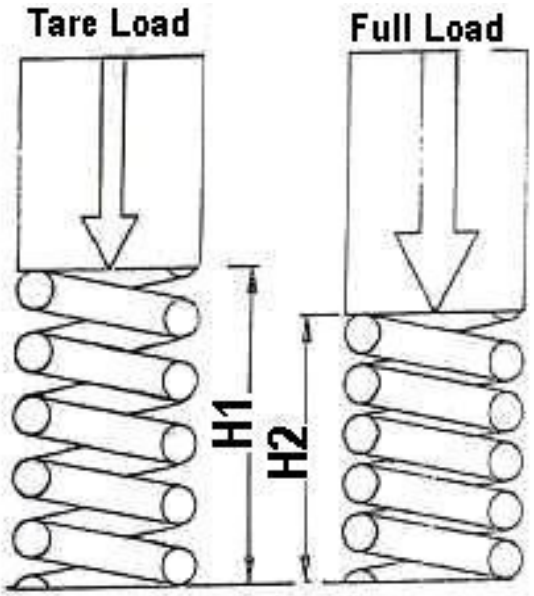
Working principle of Air spring

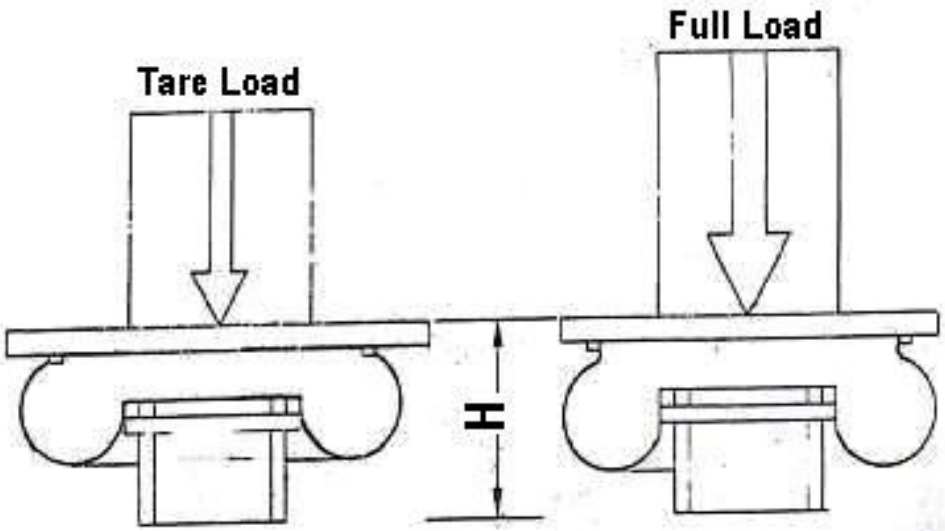
Comparison with existing coil suspension:

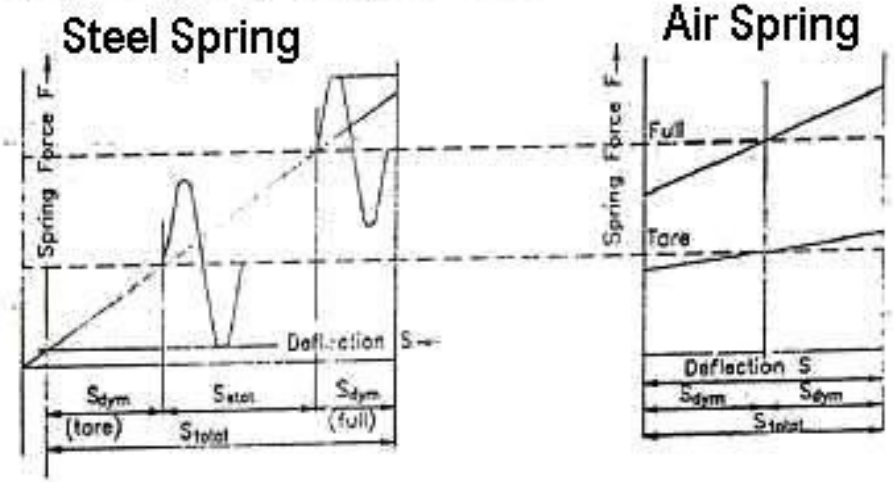
Unlike steel spring, air springs retain their height under changing loads. The low natural frequency of air spring suspension remains virtually constant.

In case of coil spring, deflection is proportionate to the load, therefore, under high payload situation, space constraint become critical, leading to the use of stiffer springs resulting in unsatisfactory ride behavior and reduced speed potential.

Air springs through their control mechanism, offer a load proportionate stiffness, constant floor height and prospects of better ride behavior with higher speed potential.







Air Spring vs Steel Springs

Unlike steel springs, air springs retain their height under changing loads. The low natural frequency remains virtually constant. Thus, air suspension is especially suitable where passengers or fragile goods are to be transported.

AIR SPRING vs STEEL SPRINGS

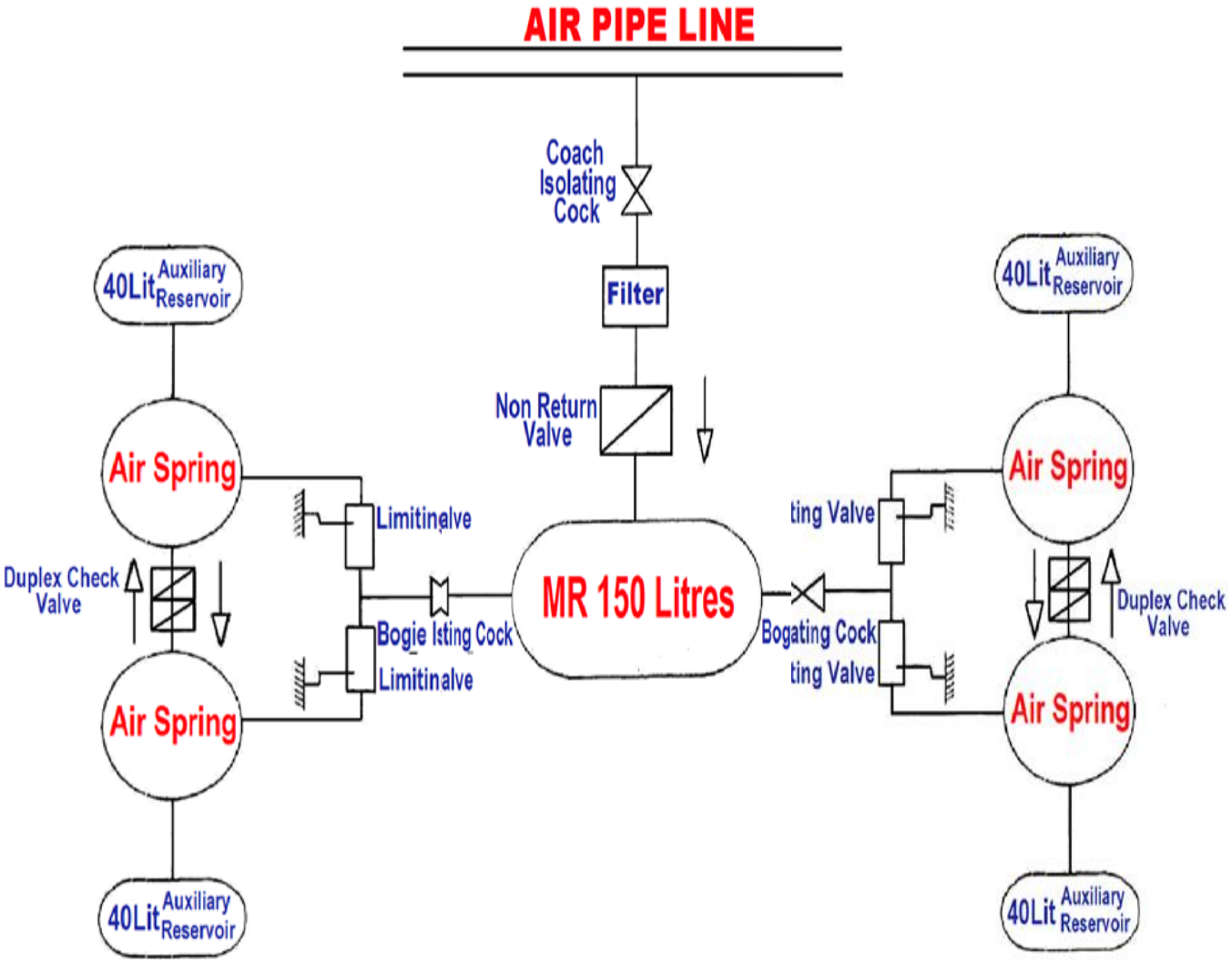
विशेषताओं को प्राप्त करना

ACHIEVING OF ITS CHARACTERISTICS

A soft flexible characteristic under vertical direction is achieved by compression of the air.

An excellent lateral spring characteristic is achieved by variation in effective area in lateral direction. Good self damping is achieved by placing an optimized orifice between air spring and additional reservoir.

To avoid unnecessary air consumption due to all modes of vehicle oscillation or change in air pressure is achieved by designing delayed reaction of leveling valve.

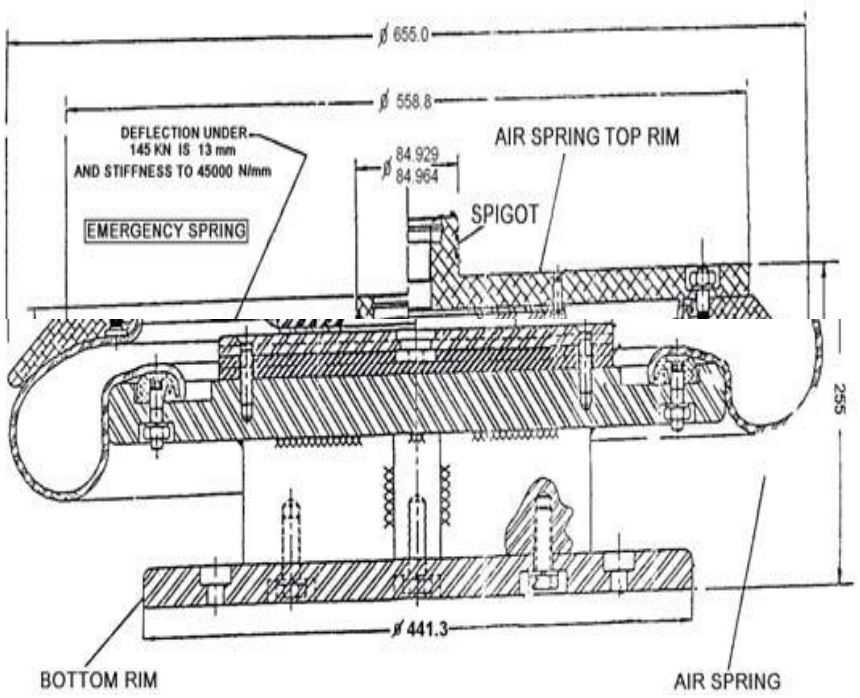


SCHEMTIC DIAGRAM OF AIR SUSPENN EQUIPMENTS

एयर स्प्रिंग की बनावट का विवरण **Constructional details of air spring**

This Air spring is a cylindrically shaped bellow that rolls over a custom contoured pedestal. This Air spring has nine major parts.

1. The Air Spring (or Elastomeric Rubber Part)
2. The Bead Skirt
3. The Upper Mounting Plate
4. The Bead Ring



Constructional details of air spring

The Pedestal Assembly (or Piston)
6. Emergency Spring
7. Bumper Support Plate
8. Spacer Plate
9. Base Plate

The brief description of each part of the total assembly follows:

Air spring (Elastomeric Rubber Part)

The Air Spring is a highly engineered pneumatic cylinder. It is made of elastomeric material and is nearly cylindrical in shape. It contains nylon cords that are laminated with elastomeric rubber and cured together for an airtight seal. At each end of the Air Spring there is a bead wire for reinforcement and sealing purposes.

बीड स्कर्ट /Bead skirt

The bead skirt is made of aluminum and a bead groove is machined for a precision circumferential fit to assure the bead wire seats properly to seat with the top or upper mounting plate.

This aluminum is high grade and more than strong enough to be used in any application, since the air spring carries the load. Yet it is very lightweight for ease of handling, as well as overall weight reduction. This bead skirt will help provide the horizontal or lateral characteristics the Firestone customers require.

अपर माउन्टिंग प्लेट /Upper mounting plate

Upper mounting plate is made of steel or aluminum. The upper plate is to be placed upon the bead skirt with the elastomeric rubber part bead wire seating in the bead skirt and to be bolted together to form the upper seal.

This is engineered with a specific mounting arrangement as specified. The mounting plate is fitted with an air entrance for inflating the parts to a desired pressure. The air passage is designed such that an orifice could be added to attain additional air damping if so desired. The upper plate, further more, acts as a shield to keep foreign material, oil and grease off the rubber part.

बीड रिंग **/Bead ring-**The bead ring is also made of aluminum and is located at the bottom of the assembly and serves the same purposes as a bead skirt, and forms the lower seal. The bead ring is bolted to the pedestal. पैडेस्टल असेम्बली या पिस्टन **/Pedestal assembly (or piston)** The pedestal (or piston) serves the purpose, as a component in the lower sealing procedure and support member. This steel part act as a lower mounting surface. The pedestal (piston) is tall enough to let the air spring oscillate with the given load conditions placed upon the spring. Vertical dynamic stiffness is obtained with either a contoured pedestal or a reservoir.

इमरजेन्सी स्प्रिंग **/Emergency spring**

The emergency spring (on bumper) provides an auxiliary spring system in the event of an air system failure. It is an integral feature of the air spring assembly and is secured to the upper mounting place with four bolts. It also has a rulon pad bounded to its contact surface to help facilitate lateral motion in the zero pressure condition.

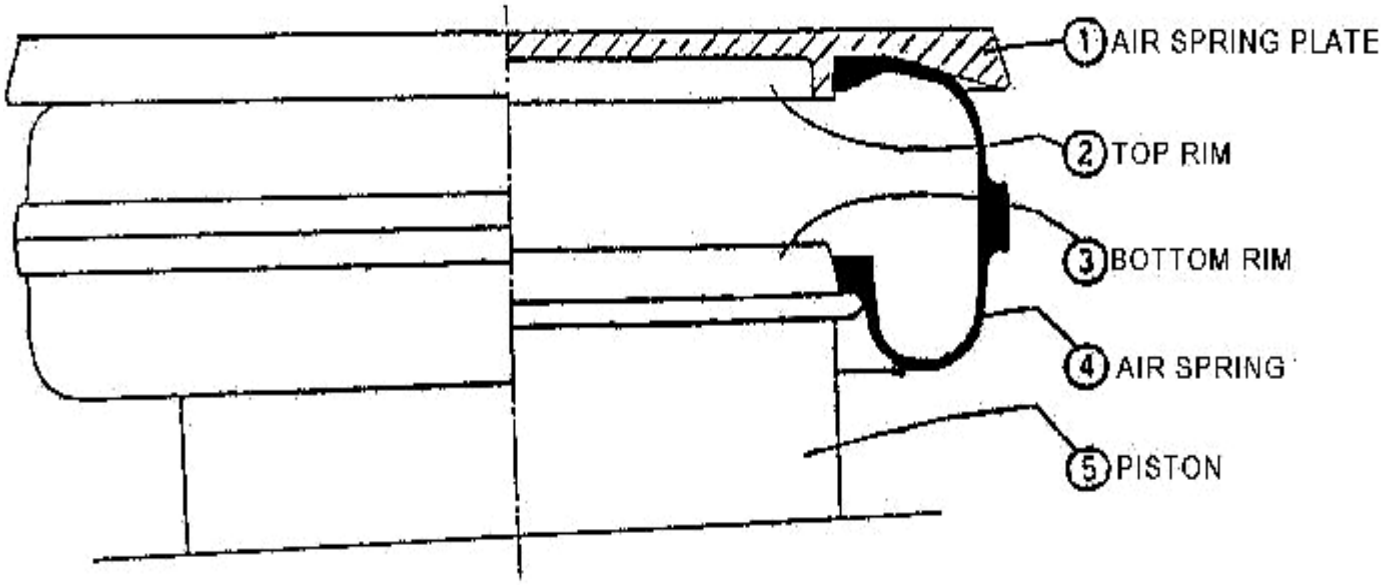
बम्पर सपोर्ट प्लेट और स्पेसर प्लेट

Bumper support plate and spacer plate

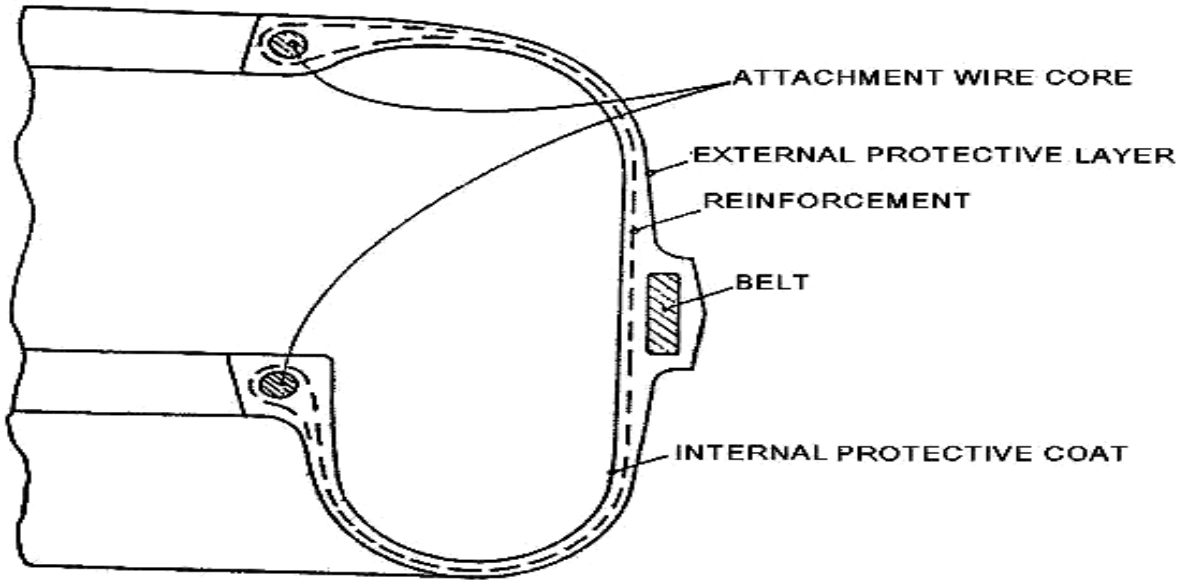
The bumper support plate is a steel plate (with two grooves and a hole in the center) which goes on top of the spacer plate (with two grooves and NO hole in center). These two plates are bolted to the top of the pedestal assembly with four bolts. The bumper support plate provides smooth surface for the emergency spring with rulon pad to slide on laterally in the zero pressure condition. In zero pressure condition, the grooves allow for the introduction of air to the assembly.

बेस प्लेट **/Base plate**

The base plate is a steel plate, which is bolted to the bottom of the pedestal assembly with 6 bolts. This plate has three counter bore holes, which allows for the attachment of the assembly.


1 AIR SPRING PLATE
2 TOP RIM
3 BOTTOM RIM
4 AIR SPRING
5 PISTON

Basic structure of rubber part of an air spring



Constructional details of rubber part of air spring

मरम्मत के लिये शेड्यूल /MAINTENANCE SCHEDULES:

Periodical inspection of air springs system on coaches are as under: **Primary/ Secondary Schedule:**

Inspection site: **Pit line** Visual check of general condition which includes any external damages, air leakage, infringement of any fittings etc.Draining of 150-liter air reservoir of air spring.

Schedule 'A':

Inspection site: **Pit line**

Carry out Primary/ Secondary Schedule

Draining of 40-liter reservoir**.**

Cleaning of leveling valve filter.

Schedule 'B':

Inspection site: **Pit line**

Carry out Schedule 'A'

Checking of installation lever with inflated air spring for normal function, tightening of installation lever nuts and protection screen nuts.

Tightening of brackets of all flexible hoses.
Cleaning of air filter of 150 liters reservoir.

Schedule ‘C’:

Inspection site: **Sick line**

Carry out schedule ‘B’ Thorough checking of air spring, bulging of bellow, air leakage.

Air suspension pipe leakage check by using soap water.

Removing dust mud & oil deposit if any, on air spring & control equipment Thorough checking of lower spring beam for any crack and deformation.

Tightening of air spring bottom plate bolts and nuts.

Measurement of bogie clearances related to air springs.

IOH/POH : Inspection site: **Depot /Work shop**

Carry out ‘C’ and Thorough visual check of air spring as per para “INSPECTIONS OF AIR SPRING” after dismantling Ref:

Para “Dismantling of air spring from lower spring beam (cradle) and bogie bolster”.

Checking securing arrangement of steel pipeline.
Carry out leakage test as follows-

Testing procedure for leakage

Connect the hose pipes on the under frame piping with the levelling valve of the bogies. Connect the pressure gauges to the drain plug locations of 150-litre reservoir.

Provide packing in the gap between bolster & bogie frame. Connect the 150-litre reservoir on the under frame to the compressed air source of pressure 6 kgf/sq.cm. Allow air into the air springs to a value of 6 kgf/sq. cm in the pressure gauge adjusting the horizontal lever of the leveling valve and keep it in the same position. Close the isolating cock connecting MR pipe with 150-litre reservoir.

Test all pipe joint for leakages.

Check the pressure gauge readings after one hour. The pressure drop should be within 0.1 kgf/sq.cm.Release the air completely by dropping the horizontal lever.Remove the packing.

Release the air completely by dropping the horizontal lever.Remove the packing.

Adjustment of installation lever is essential for proper levelling of coach body. The adjustment needs to be carried out in this schedule or intermediate dismantling of leveling valve system. The procedure to be follows is as under:

Procedure for Adjustment of installation lever

Adjustment of installation levers is essential for proper levelling of coach body. The adjustment needs to be carried out in AOH/POH or intermediate dismantling of levelling valve system. The procedure to be followed is as under:

Keep the coach on a level track.

Connect pressure gauges to the drain plug locations of all 40-litre reservoirs in the bogie.

Place the car body on the two bogies and hook it up to the air supply (by opening the isolating cock).

First open only the isolating cock (thereby releasing the air supply for “1st ” bogie and affix the level control rod assembly to the valves).

On the rod assemblies set the general level (-5mm) that the car body is ultimately to have above the bogie frame and the upper edge of the bogie.

Insert the suitable block (10 mm under the nominal height and preferably of hardwood) centrally between the bogie frame and the car body and lower the car body onto the block by removing the valve rod assembly.

Shut the isolating cock again, thereby interrupting the supply of air to “1st ” bogie and open isolating cock, and thereby releasing the air supply to “2nd” bogie.

Affix level control rod assemblies to the valves and set the assemblies to desired level.

Insert a suitable block (preferably hardwood) centrally between the bogie frame and the car body and lower the car body onto block by removing the valve and assemblies.

Shut isolating cock again, thereby cutting off the air supply to “2nd” bogie and open isolating cock, and thereby releasing the air supply to “1st ” bogie. Attach level control rod assemblies to the valves and, after aeration, carefully adjust settings on both rod assemblies simultaneously (proceeding from below) until the desired car body height has been attained.

Remove the block from “1st ”bogie.

Reopen isolating cock, thereby releasing air to “2nd” bogie, and while at the same time hanging the rod assembly back in place in “2nd”bogie.

Remove the block from “2nd”bogie.

Recheck the height at all measuring points.

Tighten the installation lever lock nuts with the horizontal lever, so that the setting will not be disturbed.

Repeat the above procedure for the second bogie.

Disconnect the pressure gauges and replace the drain plugs.

CAUTION: *If the difference in pressure of the air in the air springs of the same bogie is more than setting pressure of the duplex check valve i.e. 1.5 bar, then the air will continuously escape from one air spring to the other through the duplex check valve and then to atmosphere.*

लोअर स्प्रिंग बीम (क्रेडल) और बोगी बोलस्टर से एयर स्प्रिंग की डिसमैन्टलिंग

Remove all body Bogie connection.

Remove duplex check valve from bolster.

Remove lateral & vertical shock absorber.

Remove equalizing rod connection from both ends of lower spring beam if provided.

Remove connection between arm of leveling valve & installation lever. Remove all 4 No. bolts and nut with the help of M16 Allen key and spanner from bottom plate of air spring & lower spring beam.

Lift bolster up to bogie frame to clear the spigot of the air spring. Slide air spring from lower spring seat.

लोअर स्प्रिंग बीम का निरीक्षण एवं ओवरहॉलिंग

Inspect all welding joints of the lower spring beam (cradle) and repair if required.

Inspect air spring fixing holes of lower spring beam for elongation. If elongated reclaim them to diameter 17 mm or 26 mm.

Inspect the top surface of lower spring beam for corrosion; remove the corrosion paint with primer and black paint.

Air suspension pipelines:

The air spring piping may be checked for any leakage/ damage by soap test and repair if required.

लोअर स्प्रिंग बीम और बोलस्टर पर एयर स्प्रिंग को लगाना

"O" rings provided on air spring spigot must be changed.
Mount air spring on lower spring beam and match the holes of bottom plate of air spring and holes of lower spring beam.
Tight all 4 nuts and bolts with the help of suitable Allen key and spanner.
Place the bolster on air spring ensuring no damage to spigot of air spring.
Connect leveling valve arm with installation lever Mount vertical and lateral shock absorber.
Connect all flexible /fixed pipe connections of bogie.
All the threaded joints of air spring be sealed with thread sealing tape to avoid air leakage.
The filter of levelling valve must be cleaned.

एयर स्प्रिंग लगे एसी एवं नॉन एसी कोचों की बोगी के क्लीयरेन्स चैक करने की क्रिया विधि-

Firstly find out the type of bogie as AC EOG (16 T), AC SG (16T), or NON AC (13 T) coaches and make RCF or ICF.

The coach should be placed at leveled track.

The primary springs should be grouped which indicate grouping of different type of primary springs for air spring bogie and other types of bogies.

Place the proper primary springs and compensating rings in AC EOG,AC SG and NON AC coaches with air spring bogie.

After the bogie corner height is maintained, adjust the air spring height as per relevant suspension diagram with the help of installation lever.

वर्कशॉप मे सेन्टर बफर कपलर की उँचाई के समायोजन की क्रिया विधि-

After POH and before assembling the bogie, measure the wheel diameter.

Depending upon the wheel diameter, place wooden packing of required thickness under the flange of lower spring seat as indicated in the following table:

Average wheel diametre of the two wheels on the same bogie.	Thickness of hard packing ring (mm)
889 mm to 864 mm	13
863 mm to 840 mm	26
840 mm to 825 mm	38