SUSPENSION SYSTEM

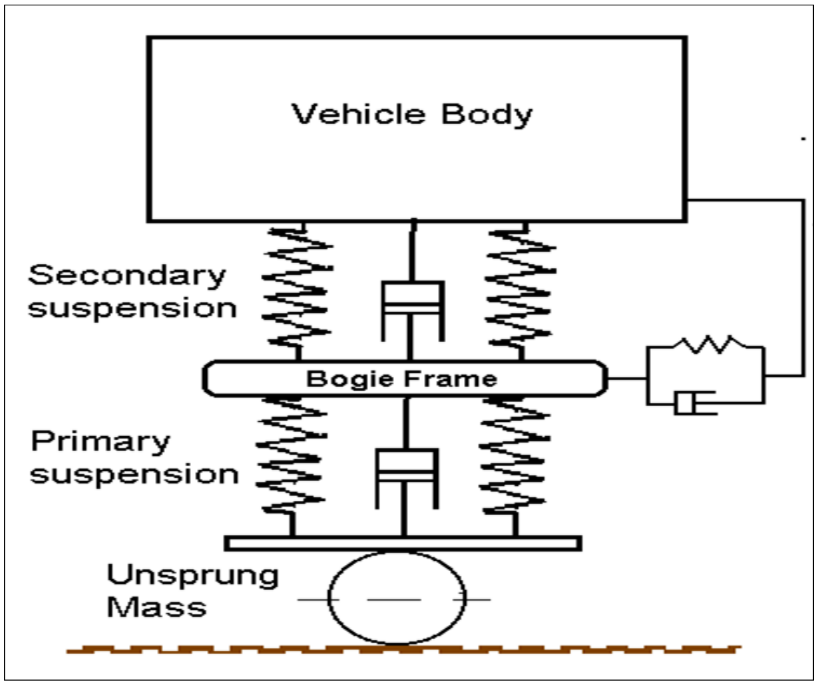
INTRODUCTION:- Suspension system is the term given to the system of springs, shock absorbers dampers and linkages that connects a vehicle to its wheels. It is basically cushion for passengers, protects the luggage or any cargo and also itself from damage and wear.

SUSPENSION SYSTEMS IN RAILWAYS:

1. **Single stage suspension system:** This system has either secondary or primary suspension but not both. Secondary suspension connects the vehicle body to the bogie frame while primary suspension connects the bogie frame to the axle. Most of the single stage suspension designs in existence today have secondary suspension.

   This system is used in vehicles where:
   - ❖ Comfort is not the primary criteria (for instance-wagons).
   - ❖ Simple construction and ease of maintenance are important considerations.
   - ❖ Payload is high as compared to tare weight.
   - ❖ Moderate speeds are required.

2. **Two stage suspension system:** This system has both secondary as well as primary suspension. Diagram of two stage suspension system is:



This system is used in vehicles where:

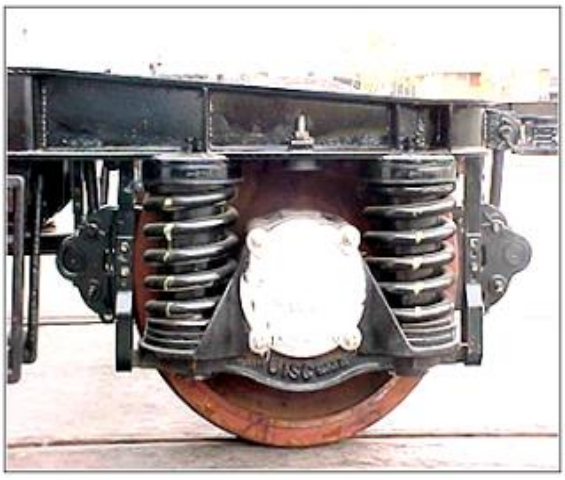
- ❖ Comfort level is an important consideration (for instance-passenger coaches).
- ❖ Payload is low as compared to tare weight.
- ❖ Moderate to high speeds are required.

It must be noted that two stage suspension is possible only in case of bogie vehicles. Four wheeler vehicles have only primary suspension, connecting the body directly to the axis.

PRIMARY SUSPENSION: -

ICF BOGIE:

The primary suspension in an ICF Bogie is through a dashpot arrangement. The dashpot arrangement consists of a cylinder (lower spring seat) and the piston (axle box guide). Axle box springs are placed on the lower spring seat placed on the axle box wing of the axle box housing assembly. A rubber or a Hytrel washer is placed below the lower spring seat for cushioning effect. The axle box guide is welded to the bogie frame. The axle box guide acts as a piston. A homopolymer acetyle washer is placed on the lower end of the axle box guide. The end portion of the axle box guide is covered with a guide cap, which has holes in it. A sealing ring is placed near the washer and performs the function of a piston ring. The axle box guide moves in the lower spring seat filled with dashpot oil. This arrangement provides the dampening effect during the running of the coach.



The main components of primary suspension are:

1. Dash pot
2. Dash pot spring
3. Dash pot protection tube
4. Air vent screw
5. Axle box safety bolt
6. Axle box wing & lug
7. Safety strap & safety loop
8. Axle box & axle box plate

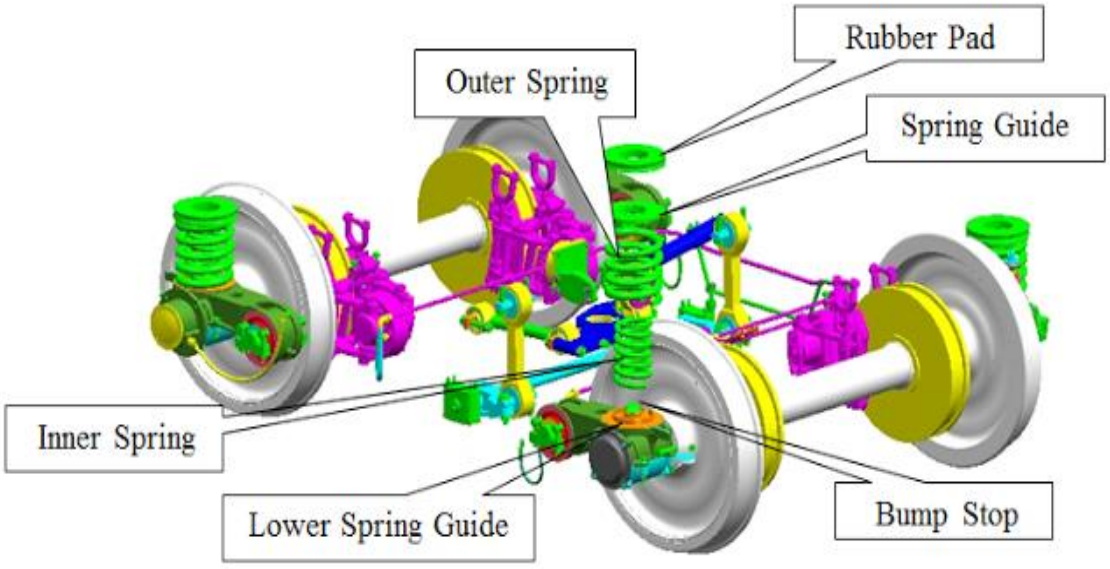
FIAT BOGIE:

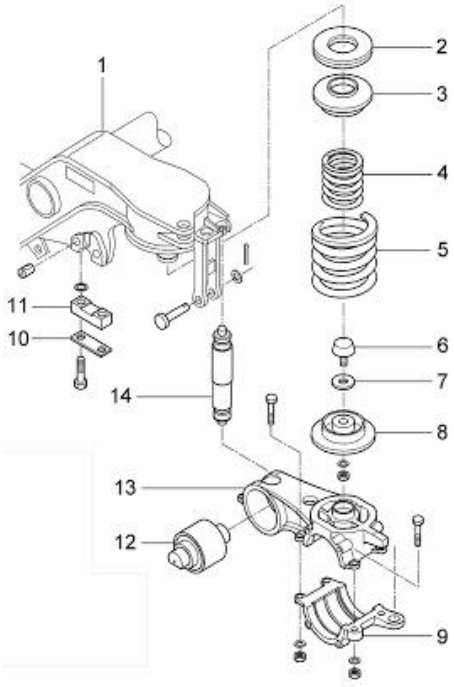
Primary suspension is implemented by two units of two steel coil springs internal and external laid out on the control arm upper part by a centering disk and adjustment shims, (if required).

The suspension is also completed by the following components:

- A control arm, fitted with twin-layer elastic joints, connecting the axle bearing to the bogie frame and transmitting, not stiffly, lateral, longitudinal and part of the vertical forces;
- A vertical damper, Rubber elements separate the primary suspension from the bogie to realize noise reduction.

Stops and protections are mounted on the bogie frame for the lifting.





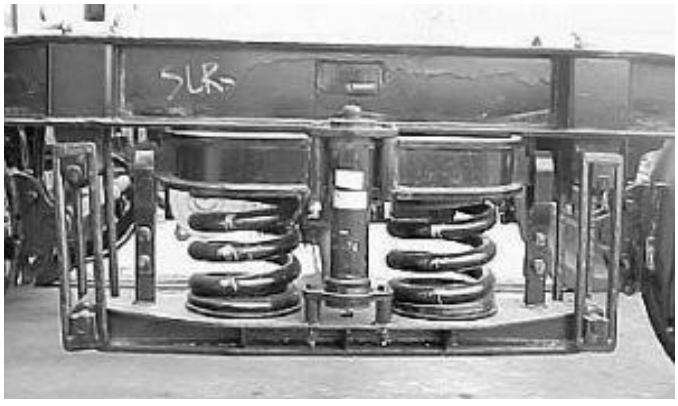
The main components of primary suspension are:

1. Bogie frame
2. Rubber disks
3. Centering disk
4. Internal spring
5. External spring
6. Bump stop
7. Shim
8. Centering disk
9. Control Arm Lower Part
10. Plate
11. Block
12. Rubber joint
13. Control Arm Upper Part
14. Damper

SECONDARY SUSPENSION: -

ICF BOGIE:

The secondary suspension arrangement of the ICF bogies is through bolster springs. The bogie bolster is not bolted or welded anywhere to the bogie frame. It is attached to the bogie frame through the anchor link. The anchor link is a tubular structure with cylindrical housing on both the ends. The cylindrical housings have silent blocks placed in them. The anchor link is fixed to the bogie bolster and the bogie frame with the help of steel brackets welded to the bogie bolster and the bogie frame. Both the ends of the anchor link act as a hinge and allow movement of the bogie bolster when the coach is moving on a curved track. Hydraulic shock absorbers with capacity of ±600 kg at a speed of 10 cm/sec. are fitted to work in parallel with the bolster springs to provide damping for vertical oscillations.

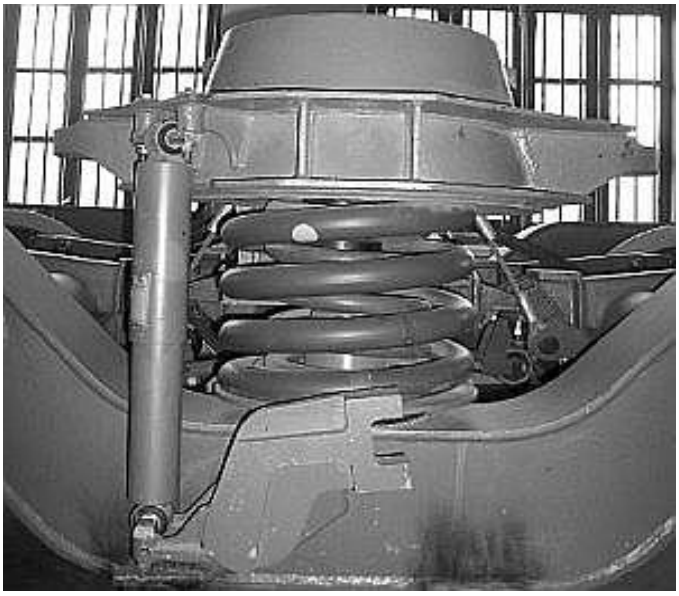


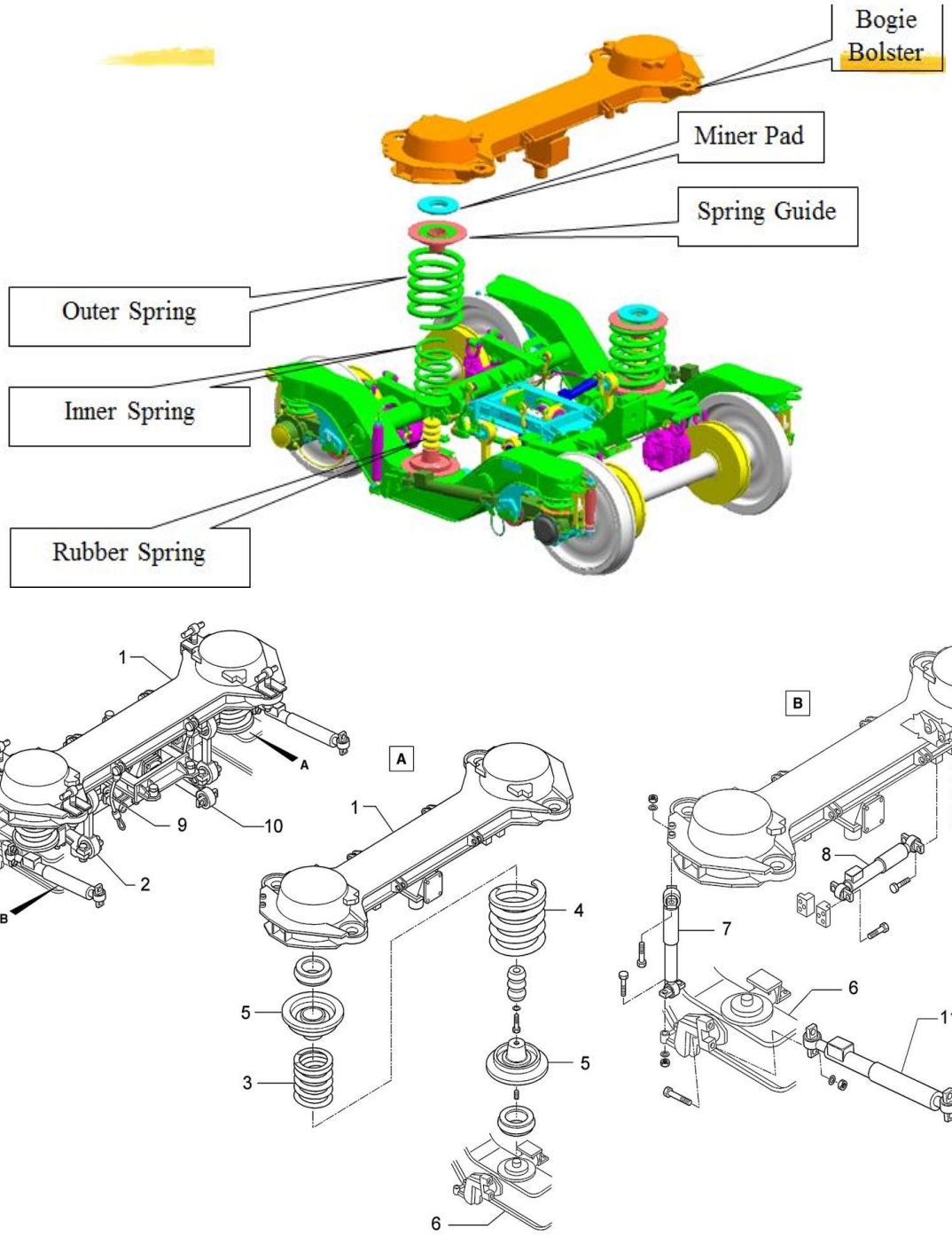
The main components of secondary suspension are:

1. Bogie bolster upper plank
2. Bogie bolster lower plank
3. Suspension link, link pin & stone
4. Bolster spring
5. Vertical shock absorber
6. Safety strap & safety loop
7. Equalizing stay rod
8. Anchor link
9. Centre pivot cotter, split pin & cup
10. Silent block
11. Side bearer housing
12. Side bearer metal plate
13. Side bearer bronze wearing piece

FIAT BOGIE:

The secondary suspension enables lateral and vertical displacements and bogie rotation with respect to body when running through curves. It is implemented by two spring packs which sustain the bolster beam over the bogie frame. Each spring pack is made up by an internal and an external spring, mounted and positioned through the centering discs. An anti-roll bar, fitted on the bogie frame, realizes a constant, reduced inclination coefficient during running. The bogie frame is linked to the bolster beam through two vertical dampers, a lateral damper, four safety cables and the traction rods. The bogie frame is also linked to the coach body through two yaw dampers.





The main components of primary suspension are:

1. Bolster beam
2. Anti-roll bar
3. Internal spring
4. External spring
5. Centering disk
6. Bogie frame
7. Vertical damper
8. Lateral damper
9. Safety cables
10. Traction rod
11. Yaw damper

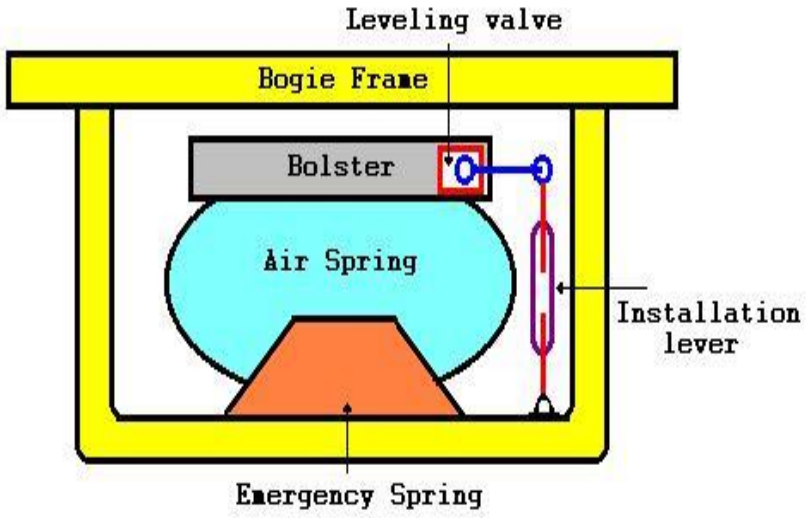
SUSPENSION SYSTEM IN HYBRID COACHES:

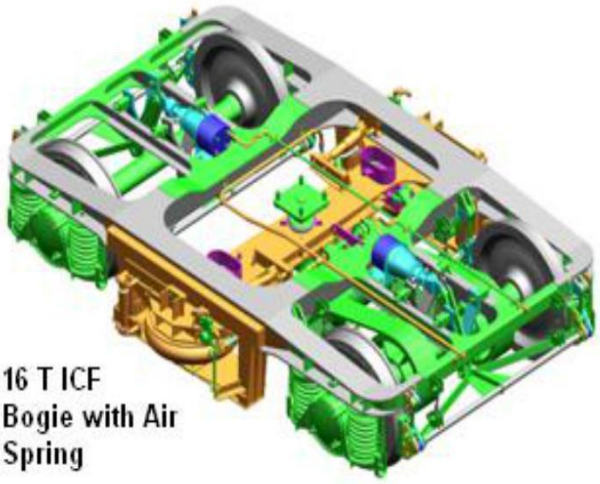
Primary suspension: The primary suspension in hybrid coaches is same as ICF coaches because ICF all coil bogie has been used after some modifications in such type of coaches.

Secondary suspension: The secondary suspension of hybrid coaches is fitted with Air spring in place of Bolster coil spring after some modifications in ICF all coil bogies. Air spring is used to maintain a constant buffer height irrespective of loaded condition to give comfortable riding to the passengers.

Modifications in ICF bogie for hybrid coach are:

1. Bottom bolsters are eliminated.
2. Use of modified Lower Bolster plank.
3. Stirrup links are eliminated.
4. Elimination suspension link, pin and stone on secondary suspension.
5. Equalizing stays are also eliminated.
6. Shifting of position of vertical shock absorber on secondary suspension.
7. It is provided with an emergency spring inside the air spring to support the bolster in case air spring fails.

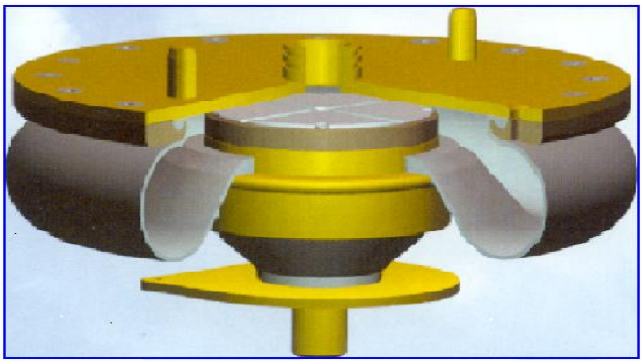




16 T ICF Bogie with Air Spring

Air Spring:

Air spring is a rubber bellow containing pressurized compressed air with an emergency rubber spring providing various suspension characteristics to maintain a constant Buffer height irrespective of the loaded condition.



<u>Advantages of Air suspension system:</u>

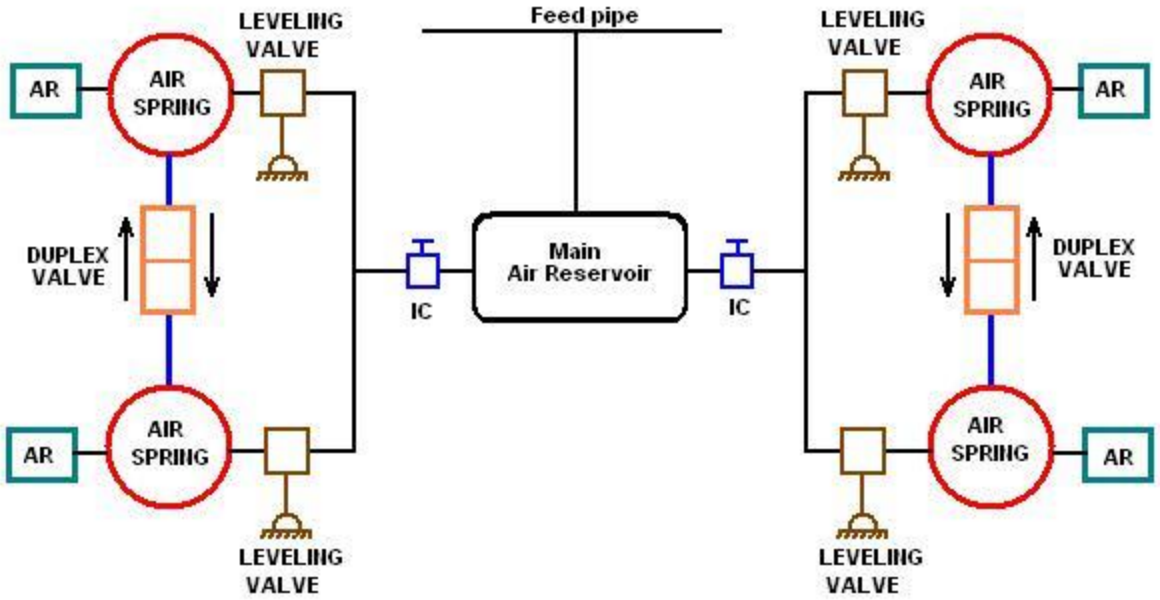
Air suspension system provides following advantages:-

- Common secondary suspension for all hybrid coaches for different loads.
- No compensating rings are required for buffer height adjustment.
- Easy buffer height adjustment by installation lever.
- Improved reliability and reduced maintenance effort.

- Increased wheel life due to improvement in lateral riding index.
- Capable to sustain Super Dense Crush Loads typical of suburban traffic.
- Maintain constant floor height of coach.
- Provide superior ride comfort.
- Virtually constant natural frequency from tare to full loads, reducing passenger fatigue.
- Isolation of structure borne noise, thus improving comfort.
- Flexibility to chose characteristics as per requirement at design stage.

Working principle:

In air suspension system, properties of air are used for cushioning effect. Enclosed pressurized air in a pre-defined chamber called Air spring, made up of rubber bellow & emergency rubber spring, provides various suspension characteristics including damping. These are height-controlled load leveling suspension devices for changing loads. With changing loads, air springs are reacts initially by changing the distance between air spring support and vehicle body. The levelling valve is in turn actuated, either taking the compressed air pressure to the air spring or releasing air pressure from it to the atmosphere. This process continues until the original height is restored. This mechanism ensures a constant floor height on coaches provided with air springs, irrespective of the load. This greatly reduces problems associated with low buffer /coupler heights.



Main equipments of Air suspension system:

1. Air spring -04 Nos /Coach
2. Levelling valve -04 Nos /Coach
3. Duplex check valve -02 Nos /Coach
4. 40 ltrs auxiliary reservoir -04 Nos /Coach
5. Bogie suspension isolating cock -02 Nos /Coach
6. Non return valve -01 No /Coach
7. 150 ltrs MR reservoir -01 No /Coach
8. Coach suspension isolating cock -01 No /Coach

Double Decker Coaches:

These coaches are provided with FIAT Bogie having air spring in the secondary suspension.

IMPORTANCE OF SUSPENSION SYSTEM:-

Suspension system allows the vehicle to travel over rough surfaces with a minimum of up and down body movements. It also allows the vehicle to corner with minimum roll or tendency to lose traction between the tires and road surface. The suspension provides a cushioning effect action, therefore, the passengers or move up and down they meets bumps and holes in the road.

THE MAIN IMPORTANCE OF SUSPENSION SYSTEM ARE:

- Support the weight of vehicle.
- Maintain traction between the tyres and the road.
- Provides smoother ride for the driver and passengers i.e. acts as cushion.
- Protects your vehicle from damage and wear.

- It also plays a critical role in maintaining self- driving conditions.
- It also keeps the wheels pressed firmly to the ground for traction.
- It isolates the body from road shocks and vibrations which would otherwise be transferred to the passengers and load.
- Good handling.
- Shields the vehicle from damage.
- Increases life of vehicle keeps the tyres pressed firmly to ground.

Q: What maintenance practices would you suggest for helical springs used in suspension of coaching stock to avoid its failures between POH to POH?

A: Following practices should be adopted:-

1. Proper handling of the springs during maintenance to avoid creation of stress raisers. Use palettes for transportation of springs.
2. Springs should be protected from rust by carrying out painting immediately after the inspection.
3. Cleaning of springs in a Bosch tank to remove oil, grease and scale etc. The cleaning should be done with the help of degreasing agents followed by rinsing with hot water/steam to clean off any residual chemicals.
4. Carry out grit/sand blasting on the springs to prepare surface.
5. Inspect visually for cracks, dents, tool marks, welding marks or corrosion pits. If found any, reject the spring.
6. Test the springs with the help of magna-flux machine to detect cracks.
7. All the springs passed above should be subjected to load deflection testing as prescribed for each type of spring. Reject springs whose loaded height is beyond the acceptable range.
8. Categorize springs passing above tests in 3 groups A, B and C on the basis of their height under test load. Springs belonging to each category should be segregated.
9. Paint the acceptable springs with paint to RDSO specifications as per colour code-yellow paint for group ‘A’, red for group ‘B’ and green for group ‘C’.
10. The spring inspection particulars viz. shop code, month and year, loaded height to be written on each spring with paint or tag.
11. Match the springs so that each is provided with a single category of springs.
12. Examine each breakage with care so that causes of failures are discovered and eliminated.

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