

DEMU C&W Maintenance

Objectives

- DEMU component design & functional operations
- Specifically bogie & Air suspension system
- DEMU interior's look
- Special J&K DEMUs
- Schaku couplers
- Newly introduced BEML SS DEMU/EMU

Special DEMU coaches introduced in J&K :

Each coach will run twice daily in both directions & 8 coach rakes will be plying in 12 service trips daily -



J&K DEMU DPC Special Engine

- Aerodynamic High Power diesel multiple units
- 1400 HP diesel engine in the train {peak speed = 100Kmph, Seating capacity/trailer coach = 576}
- Engine has heating system for quick & troublefree starts in the freezing winters {Engine OST=2000rpm}
- The driver's cabin has heating & defogging unit to take care of cold climatic conditions
- DPC has single lookout glass windows giving panoramic view
- Snowcutting type cattle guard attached at the driving end of the train for clearing snow on the tracks during winter

Salient features of J&K DEMU rake

- Public information system with display & announcement facilities included in the coaches having air suspension on bogie bolster giving 10% better riding comfort characteristics
- Compartment with wider doors for physically challenged people
- Broad view {panoramic} windows
- Overhead water tanks having side filling system in two lavatories at one end of the coach
- Coaches are vestibuled for passenger migration in the train {preventing uneven overcrowding in coaches} & maintained at 20 degree Celsius during winter

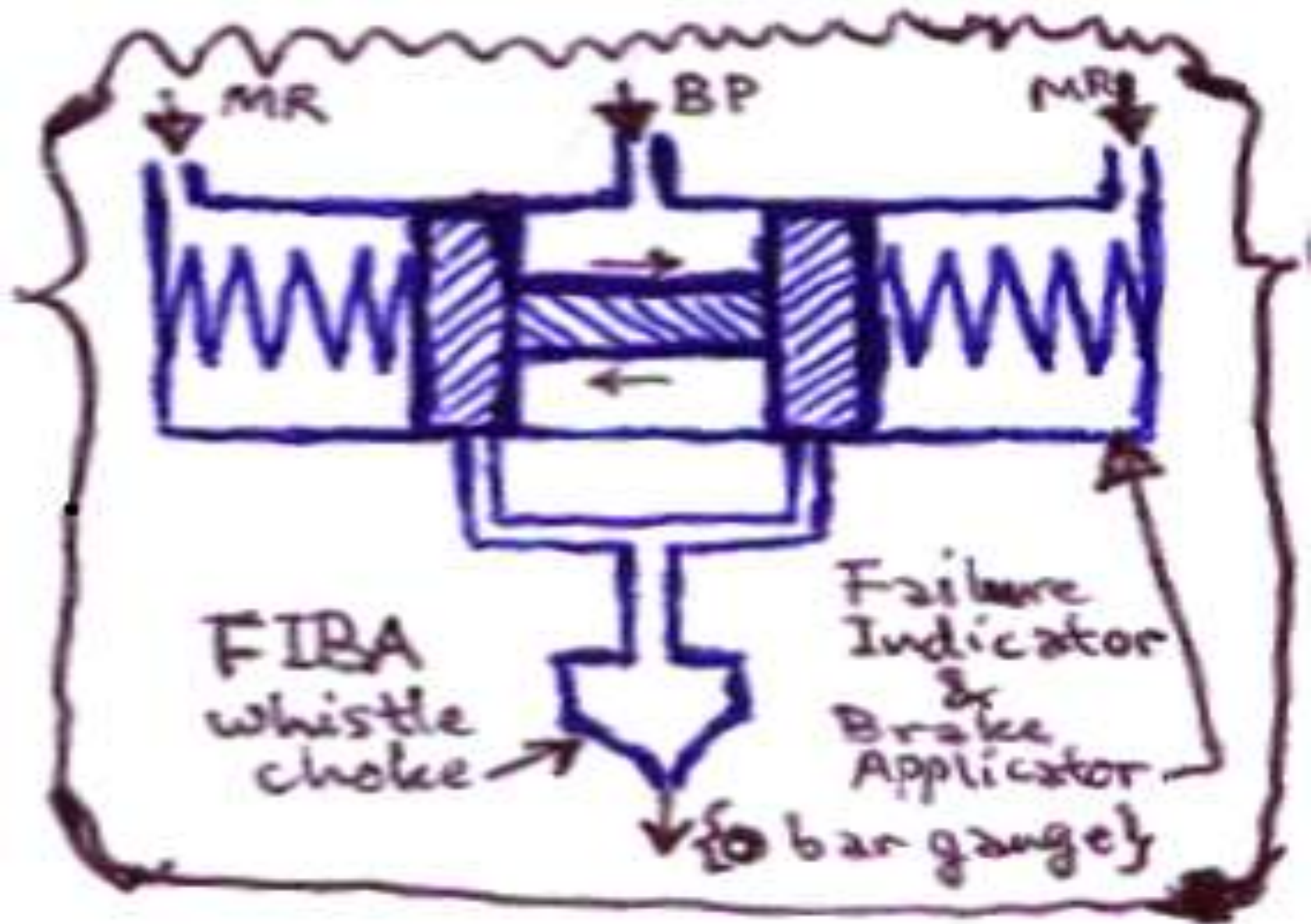
DEMU maintenance in J&K

- Maintenance of all ICF built rolling stock {DEMU} will be at newly built Badgam workshop just north of Srinagar in N.Rly. Ferozepur Division
- Frequencies for POH
 - Ist POH 3 yr.s following mfg.
 - Subsequent POH intervals = 18 months
 - Codal life = 25 yr.s
- Frequencies for IOH = 9 months at Workshops

Special Bogie components

- Air suspension system under bogie bolster
 - 4 point suspension on air filled rubber bellows
 - 4 Levelling valves per coach
 - 2 Duplex valves per coach
- EPU, Magnet valve, Relay valve in twin pipe Air Brake System connected to MR {FP NLB = 20mm dia. & BP NLB = 25mm dia.}
- Newly introduced Failure Indicator cum Brake Applicator {FIBA} as a fail safe mode function
- Duplex valve operates if pressure differential across 2 rubber bellows on a bogie bolster exceeds 1 +/- 0.5 bars in uneven loading on the bogie bolster
- Air bellows follow equation of state for open & closed systems
- Air pressure in bellow balances load
- Bogie bolster height is sensed by the Levelling valves & the levelling lever remains insensitive within +/-10 degrees angular deflections
- Air bellow height is dependent on its air volume

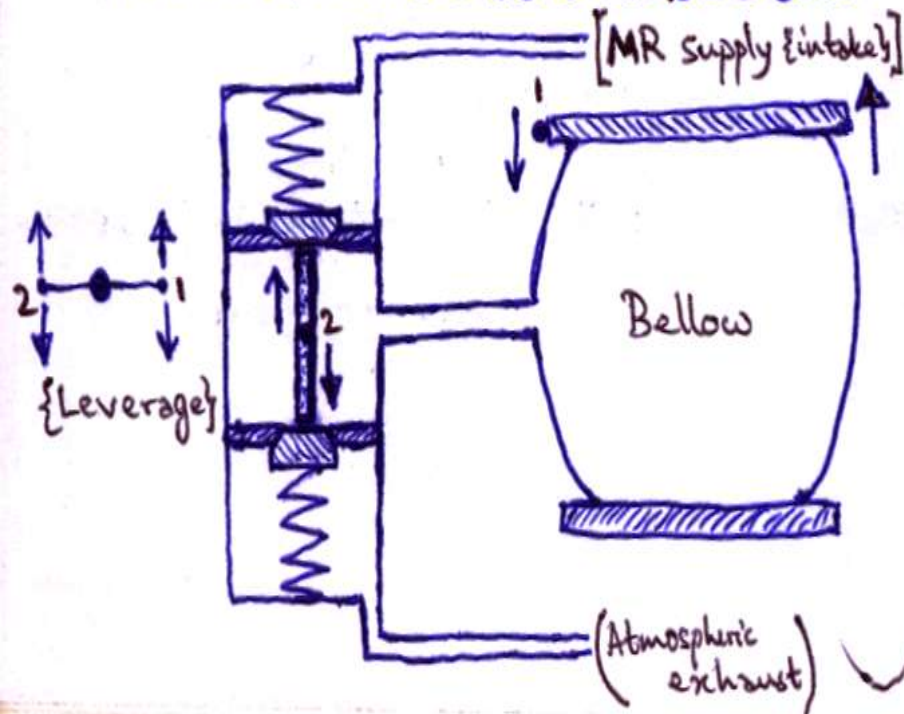
Newly installed FIBA



Duplex valve & Levelling valves

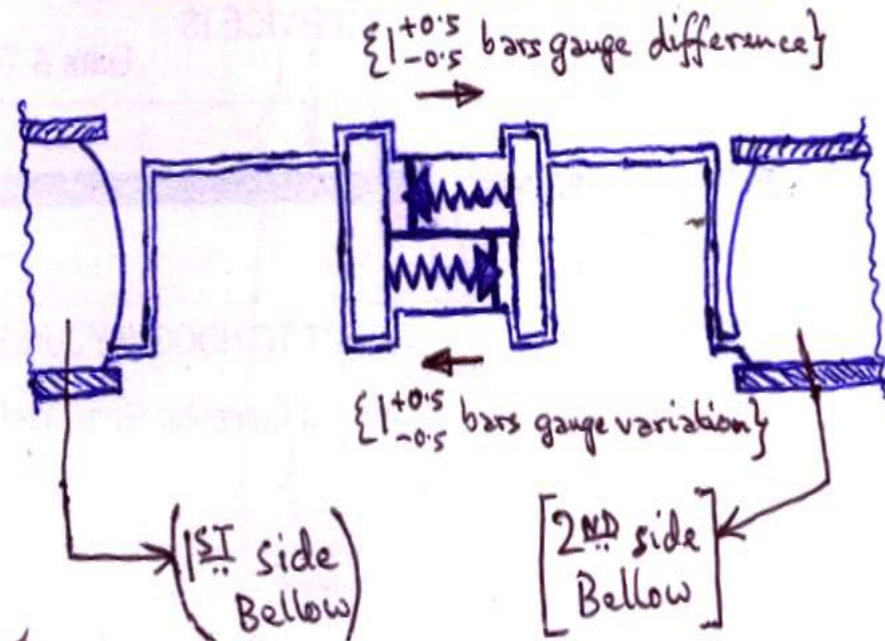
DEMU DPC :

Air suspension-Levelling Valve.



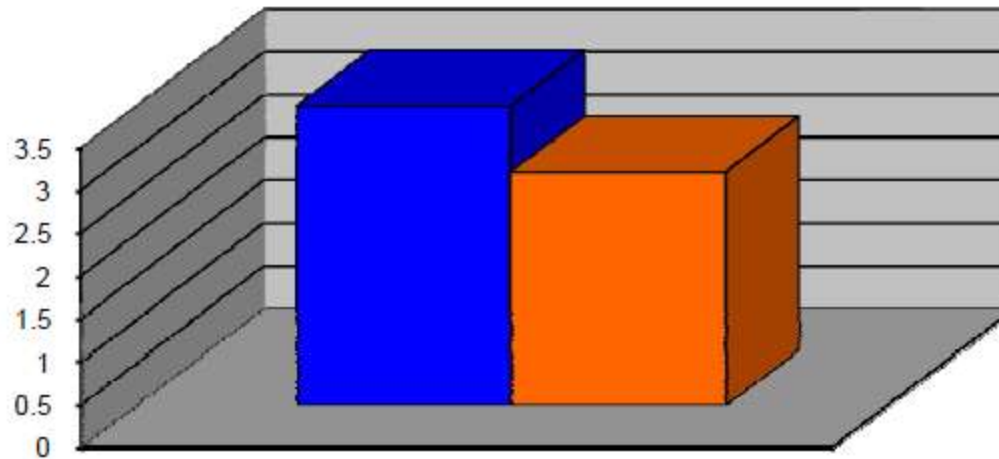
DEMU DPC:

Levelling system-Duplex Valve.



Vertical Ride Index Comparisons :

Trial speed - 70 Kmph.

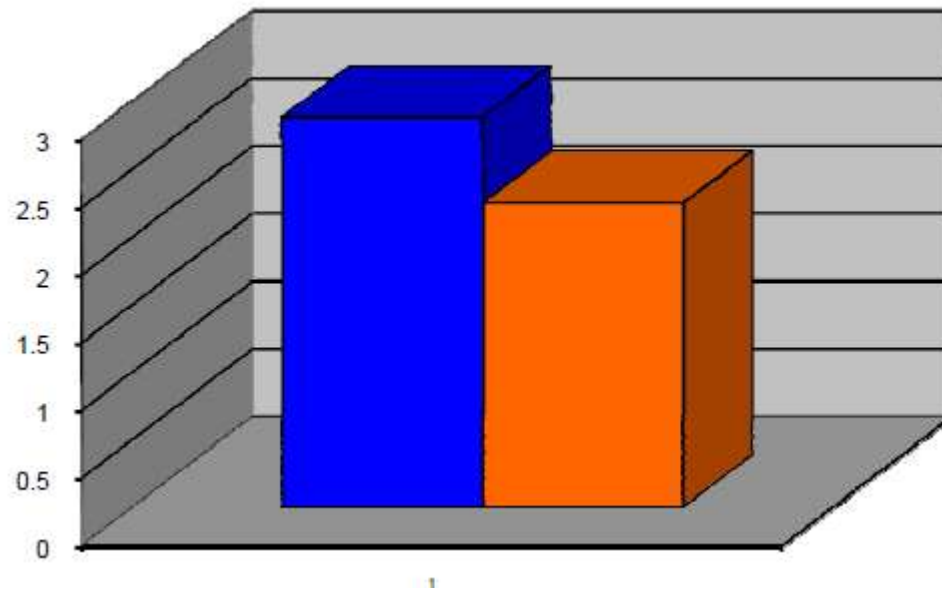


Pneumatic Suspension on modified ICF Bogie

Existing Suspension on all coil ICF Bogie



Side horizontal Ride Index comparisons between air suspensions & coiled springs in DEMU bogie bolsters



Air Springs' technical data

Supplied by “**Contitech**” and “**Firestone**”

Static Vertical Load on Air Spring:

Tare: 51 KN, Full load: 142 KN

Vertical Stiffness:

Tare: 550 N/mm, Full load: 975 N/mm

Horizontal stiffness:

Tare: 325 N/mm, Full load: 430 N/mm

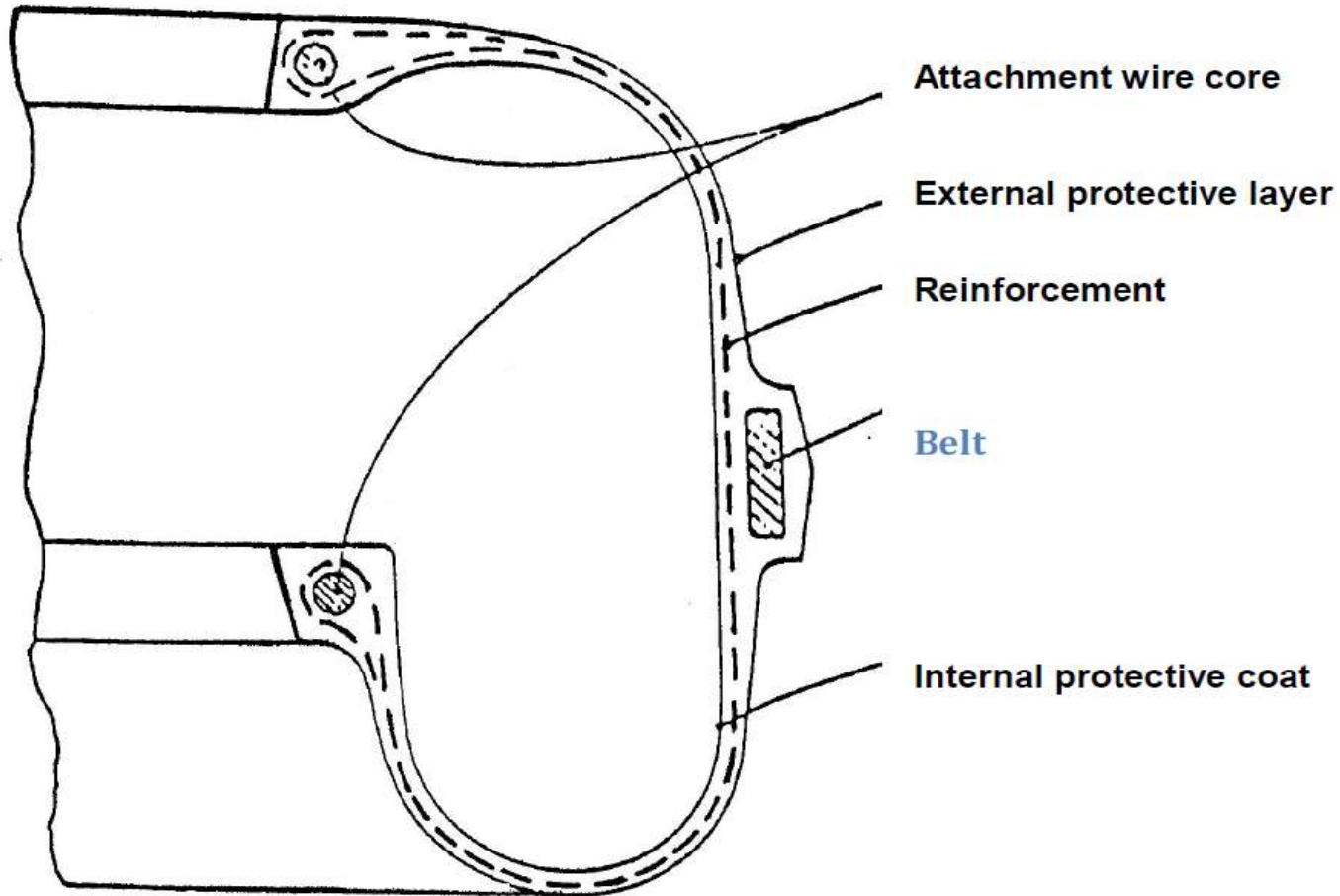
Emergency Spring vertical stiffness:

Tare: 4000 N/mm, Full load: 6000 N/mm

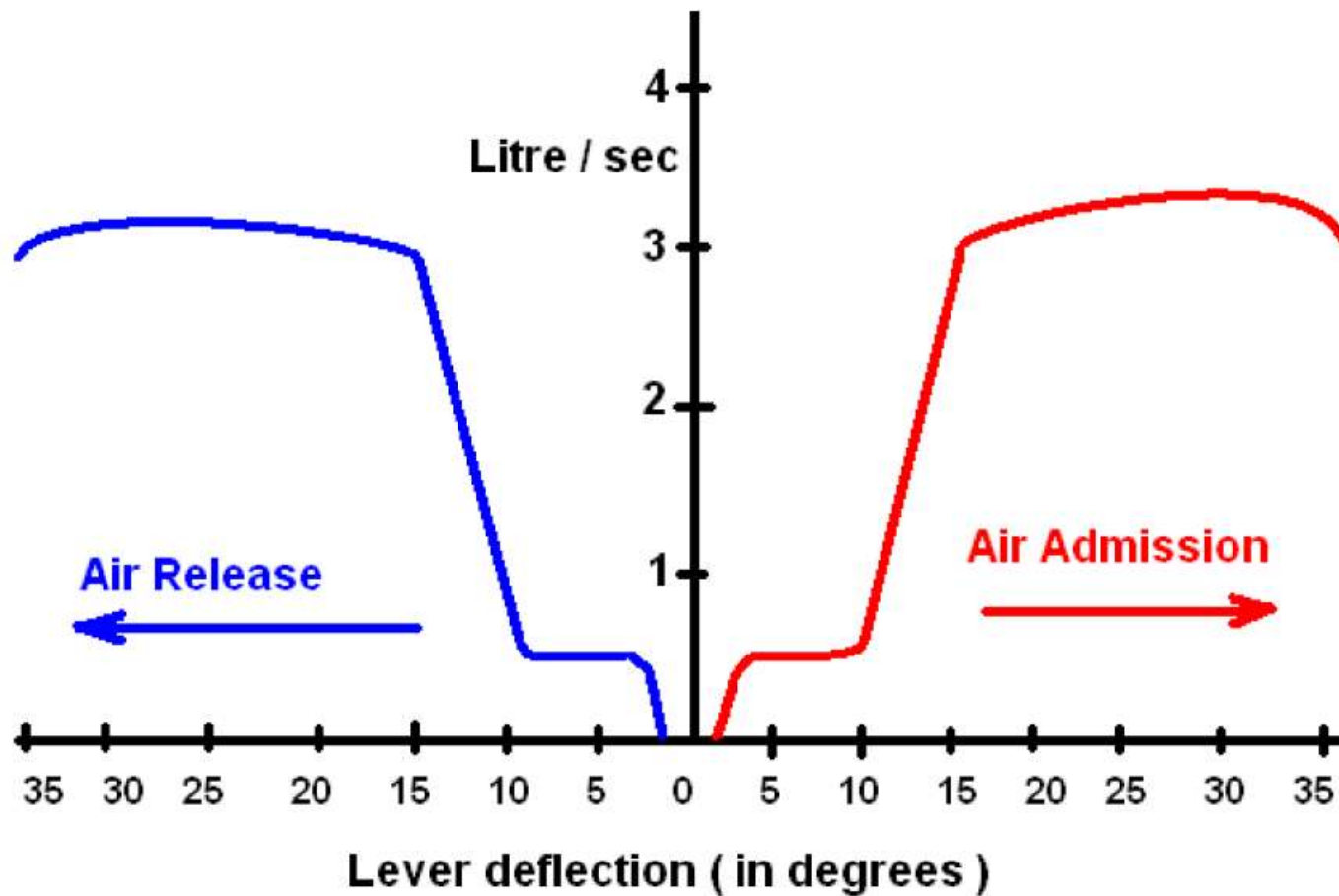
Air spring volume: 26 litres

Design height of air spring: 255 mm

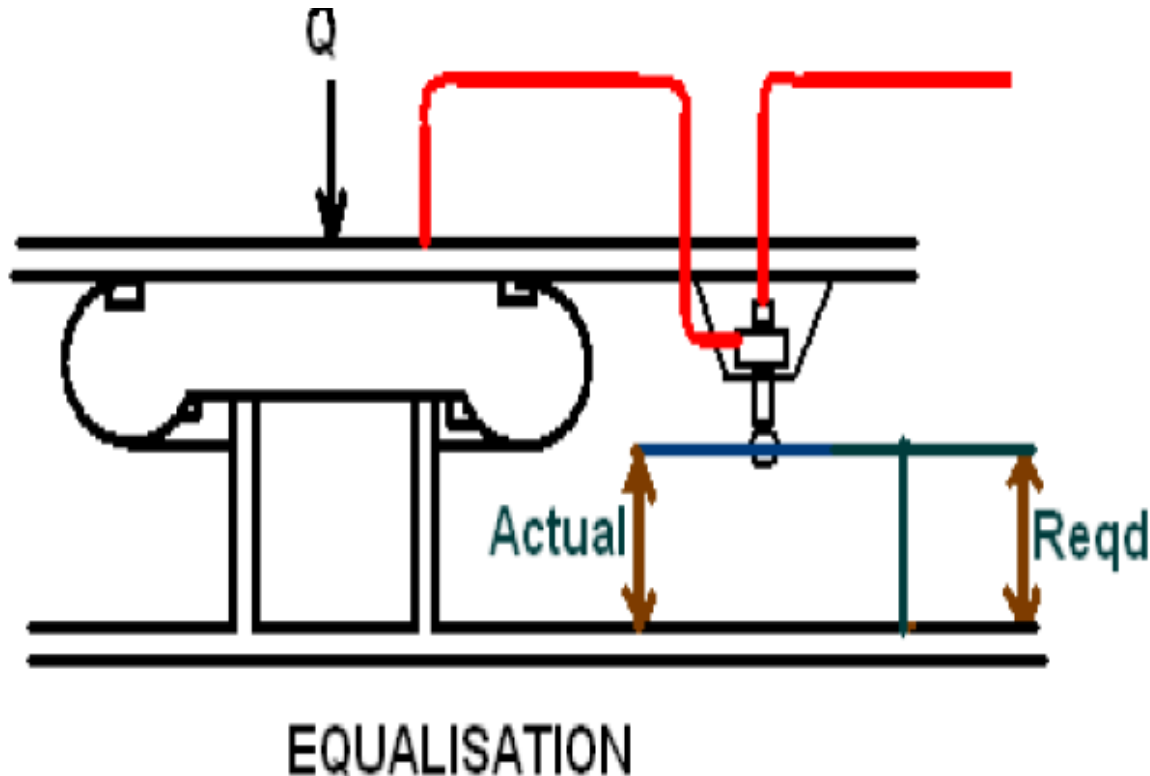
Air Spring's structural details



Levelling valve's delayed reactions

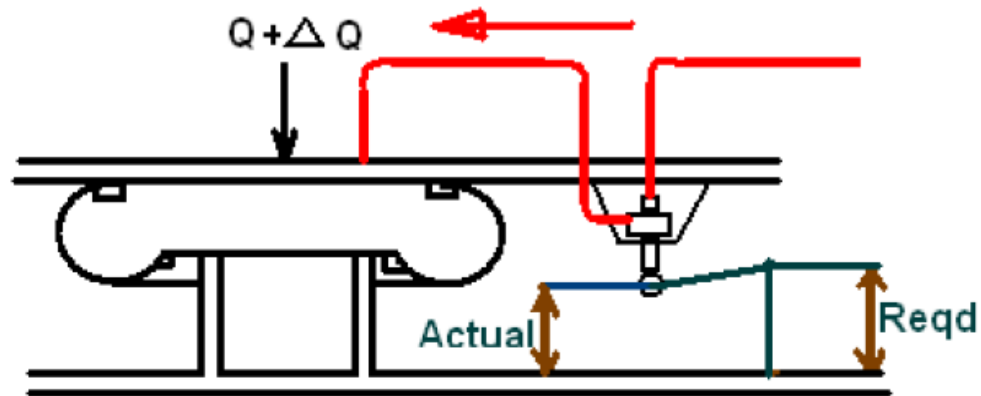


Air spring's working principle

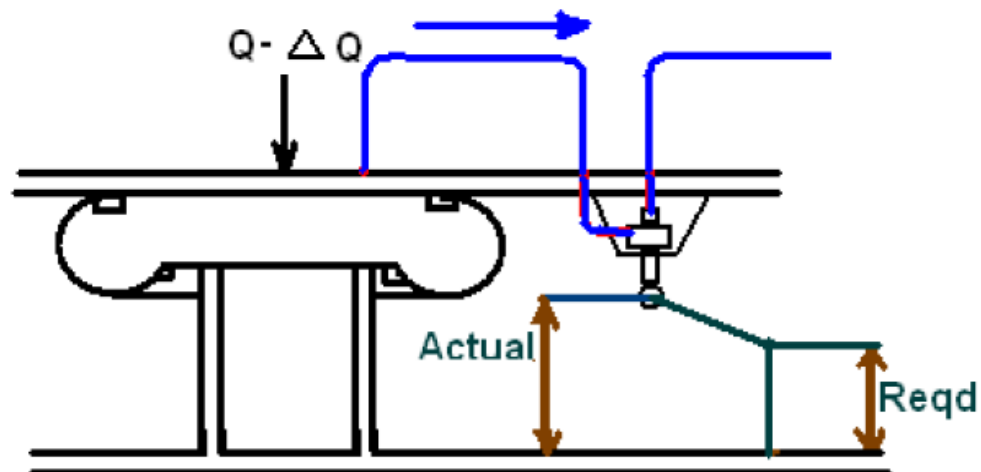


When the actual height is the same as the required height, no air flows into or out of the air spring.

Air spring adjusting deflections

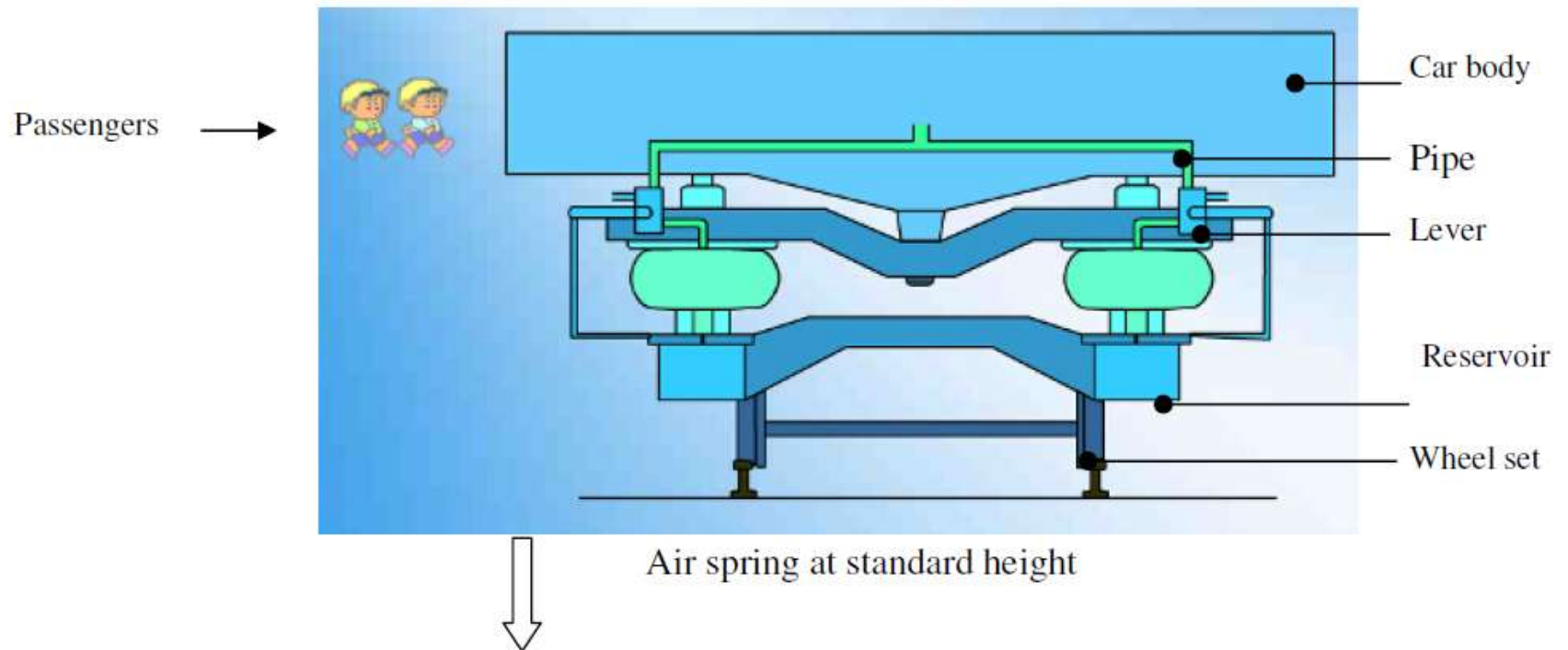


LOADING

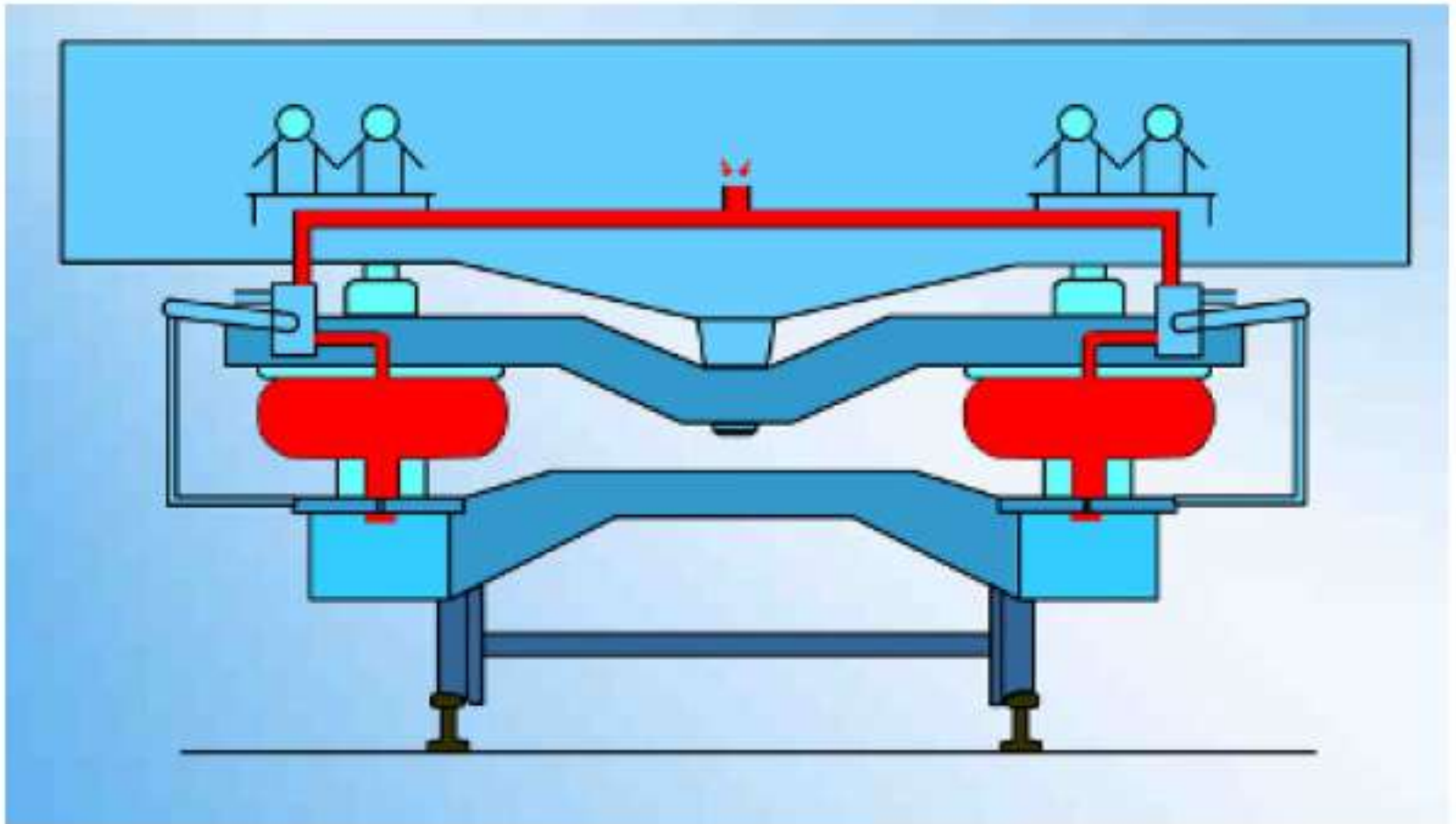


UN-LOADING

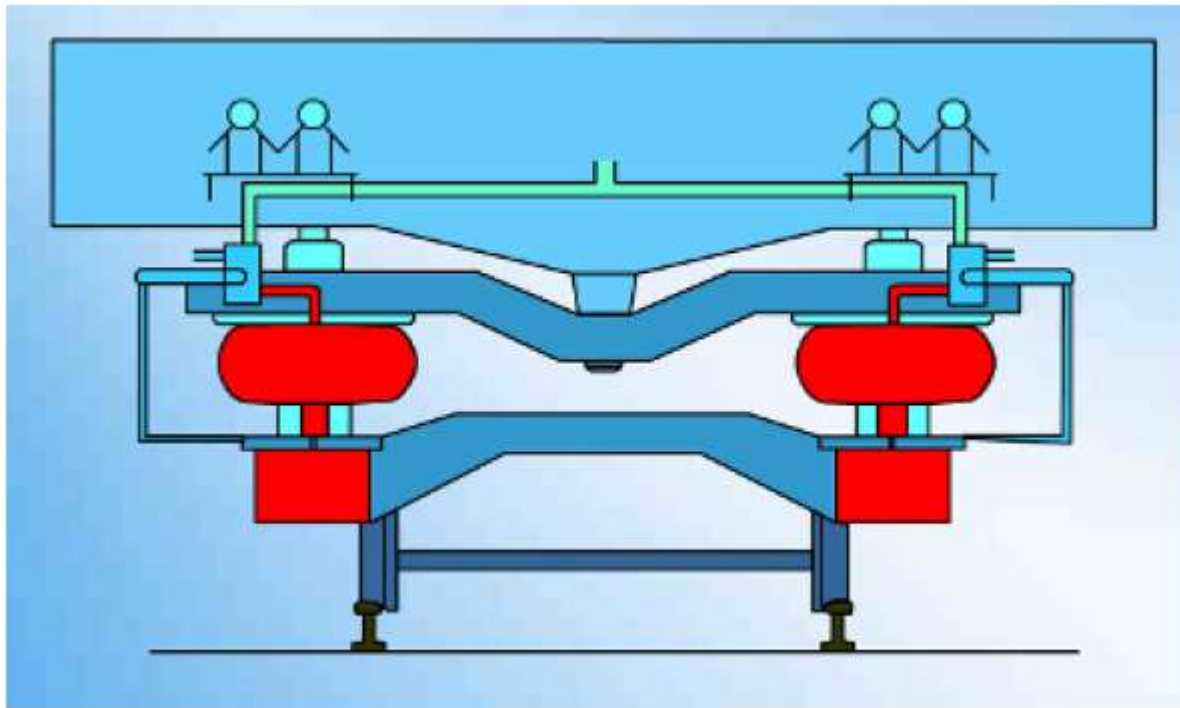
Air Suspension spring loads



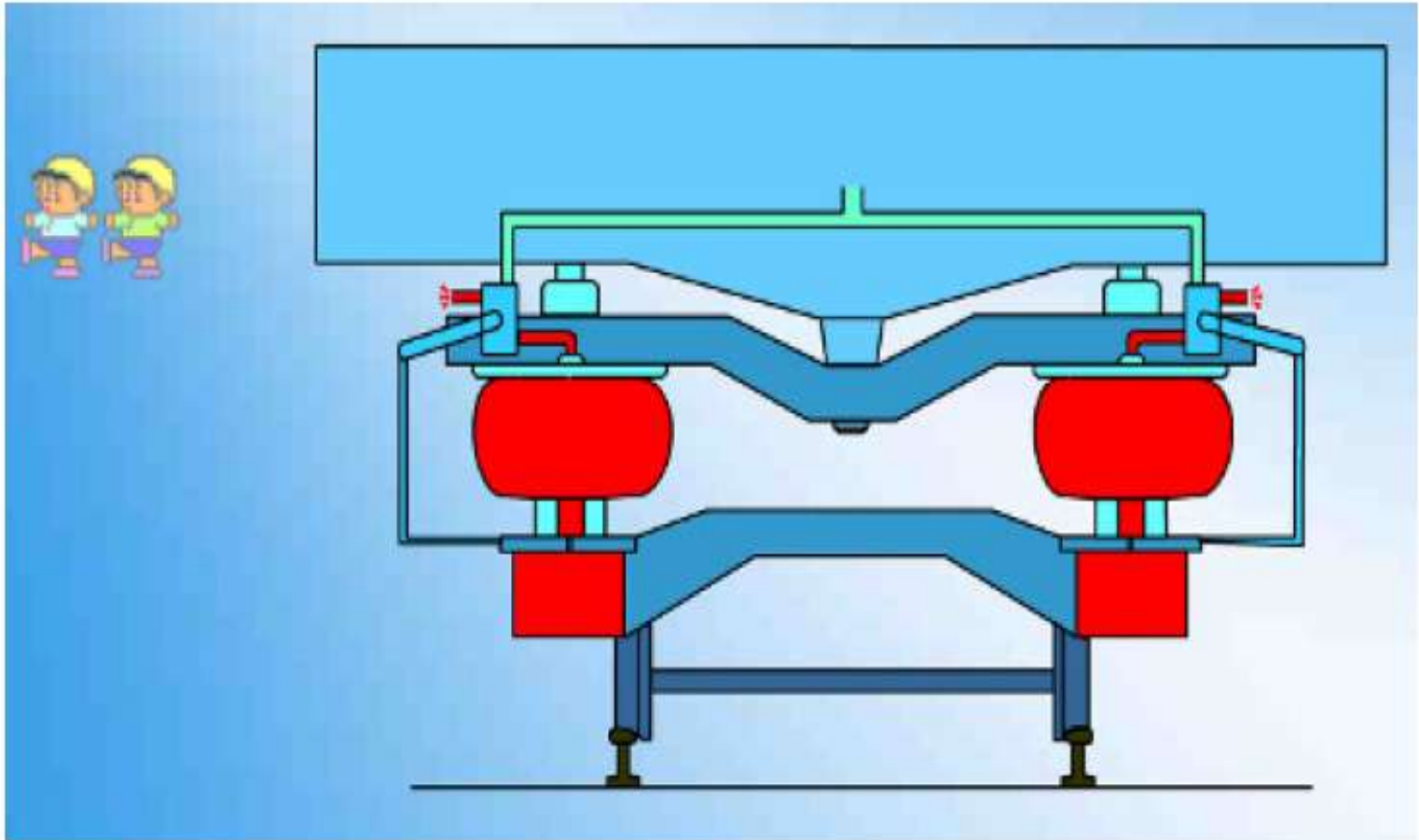
Air suspension spring overloaded



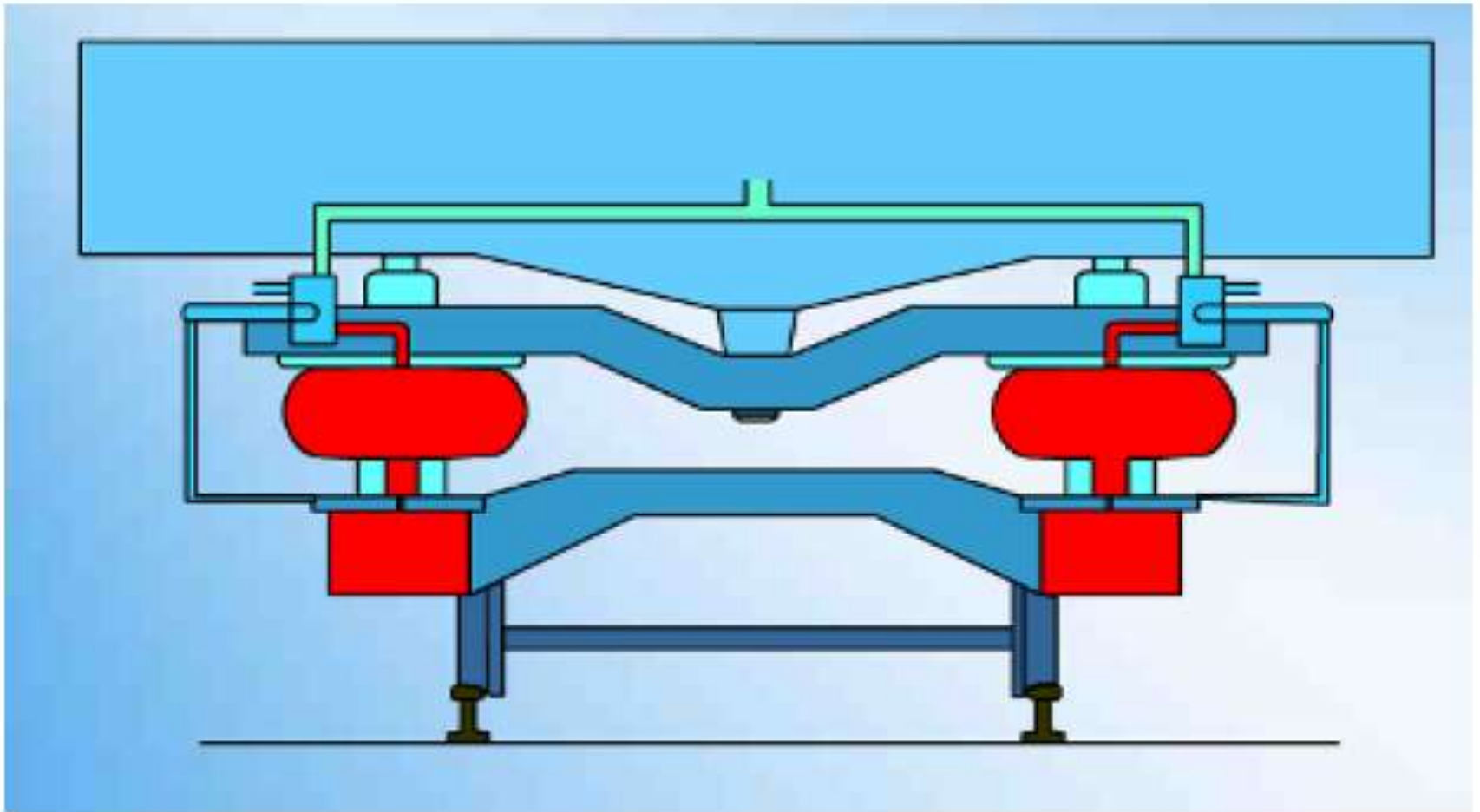
Height adjustment



Air suspension spring offloaded



Height readjusted



Air spring technical parameters

Max. Load(kN): 120

Max. horizontal displacement(mm): ± 80

Effective diameter(mm): $\Phi 700$

Circumstance temperature: $0^{\circ}\text{C} \sim +60^{\circ}\text{C}$

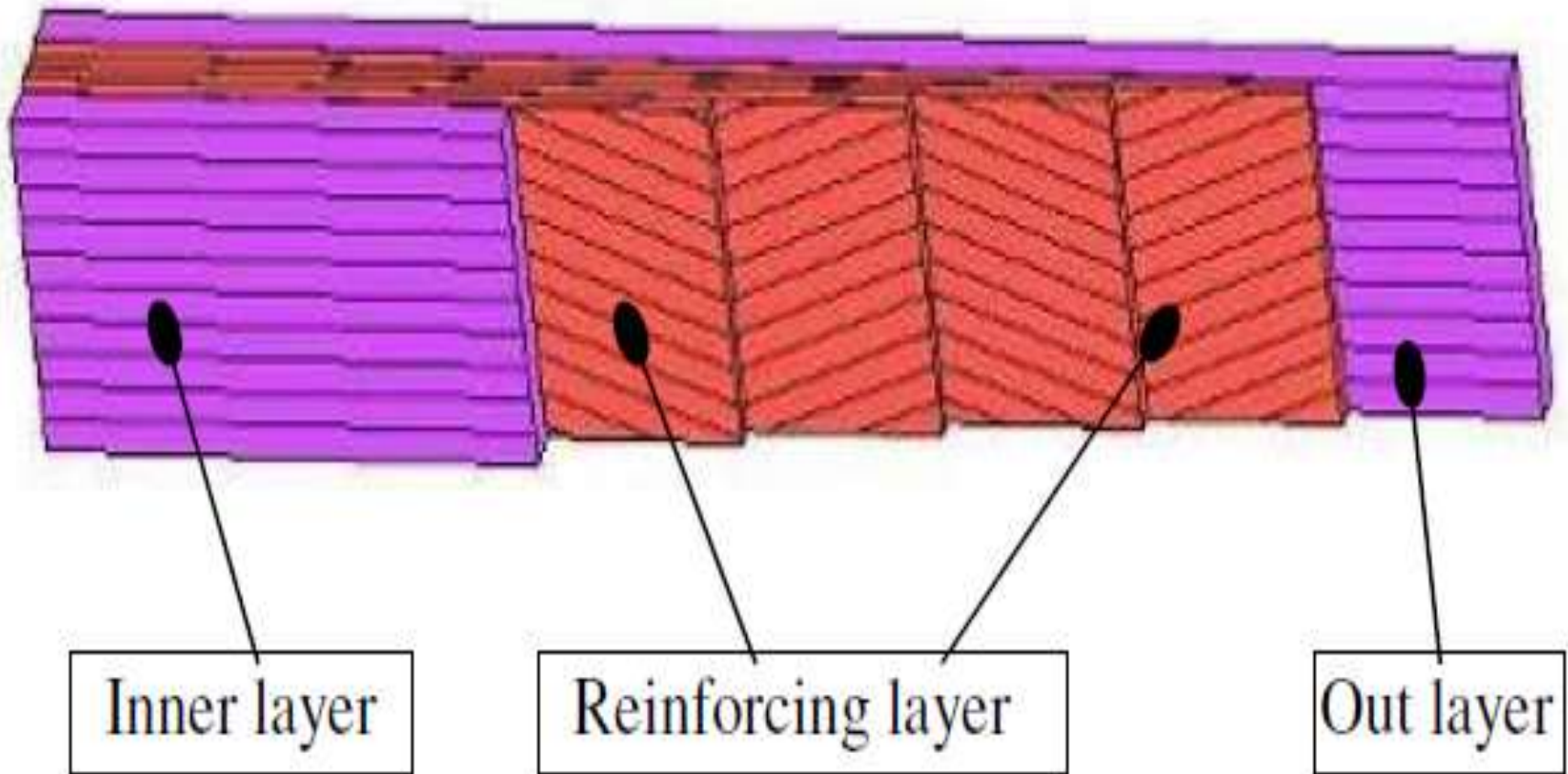
Max. vertical displacement (mm): ± 30

Friction ratio: ≤ 0.15

Air spring testing at 6 bars {gauge}:
Inflation heights {255-260}mm



Air spring rubber bellow wall structure



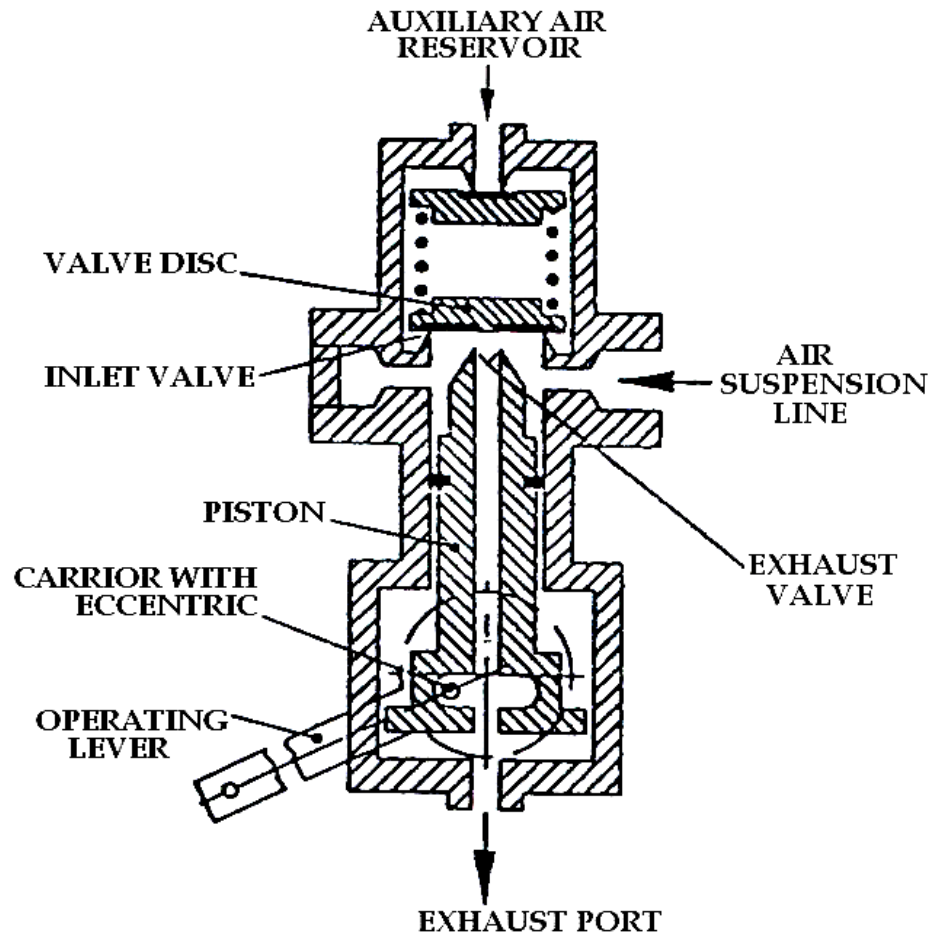
Duplex Check Valve



Duplex Check Valve



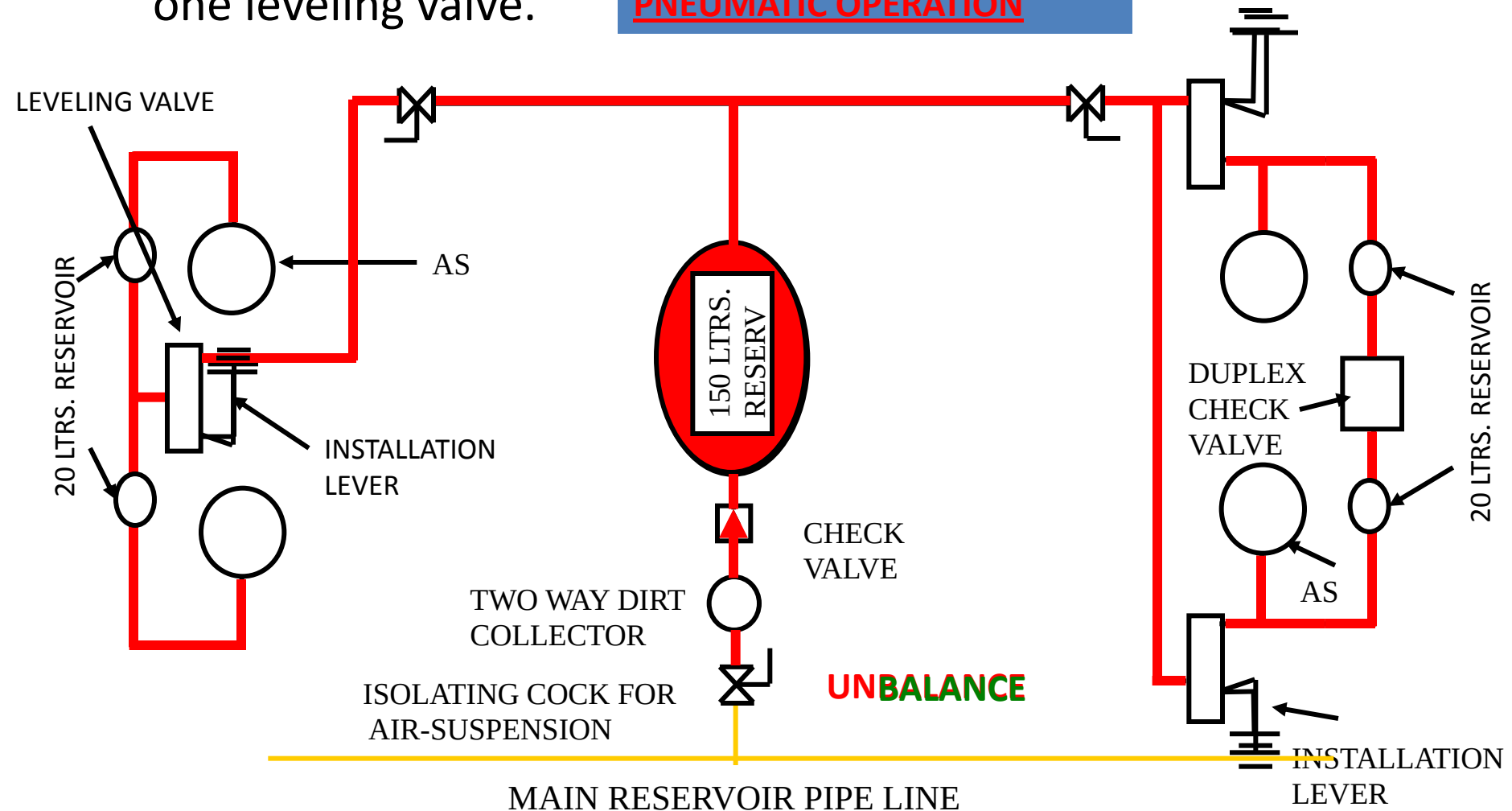
Levelling valves



3 – POINT AIR SUSPENSION SYSTEM

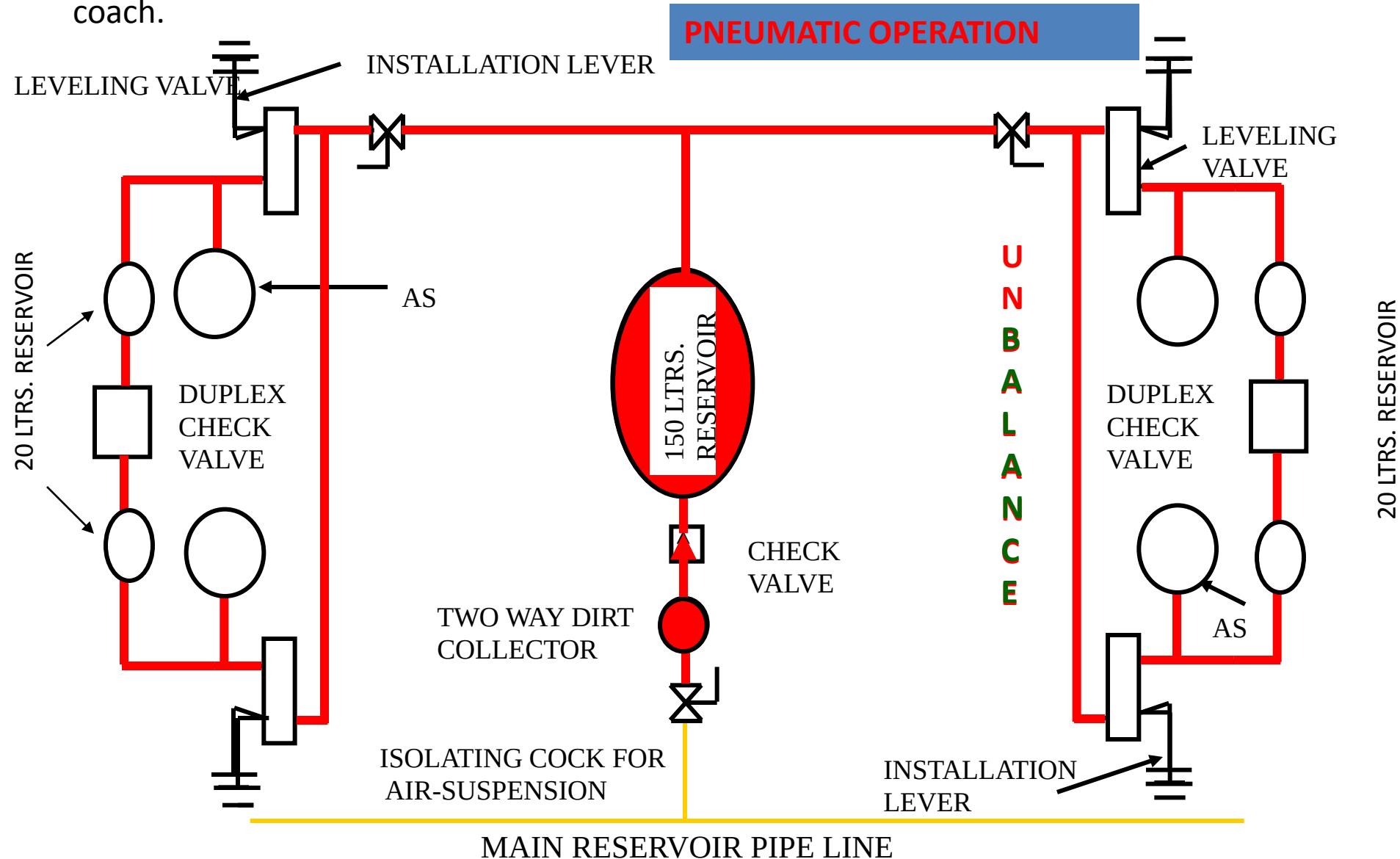
- In this system the bellow of one bogie is controlled by individual levelling valves.
- But the bellows of other bogie are controlled by only one leveling valve.

PNEUMATIC OPERATION



SCHEMATIC DIAGRAM FOR 4-POINT AIR-SUSPENSION

In this system the each bellow is controlled by individual leveling valve. So, there are four levelling valves & Installation levers, four bellows and two duplex check valves in each coach.

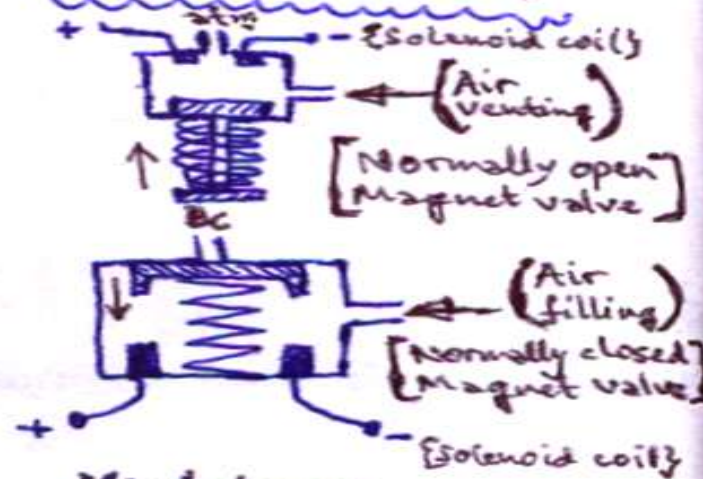


Air Brake system controls & Cut off Angle Cocks

RELAY COILS :-

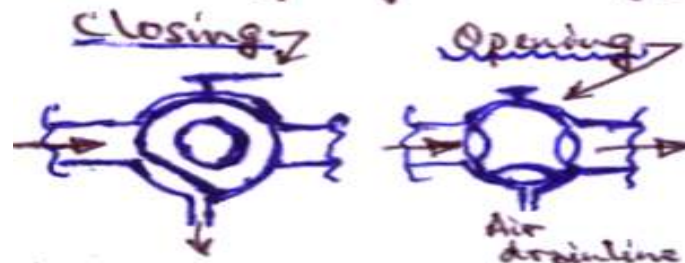


EPU - DEMU :-

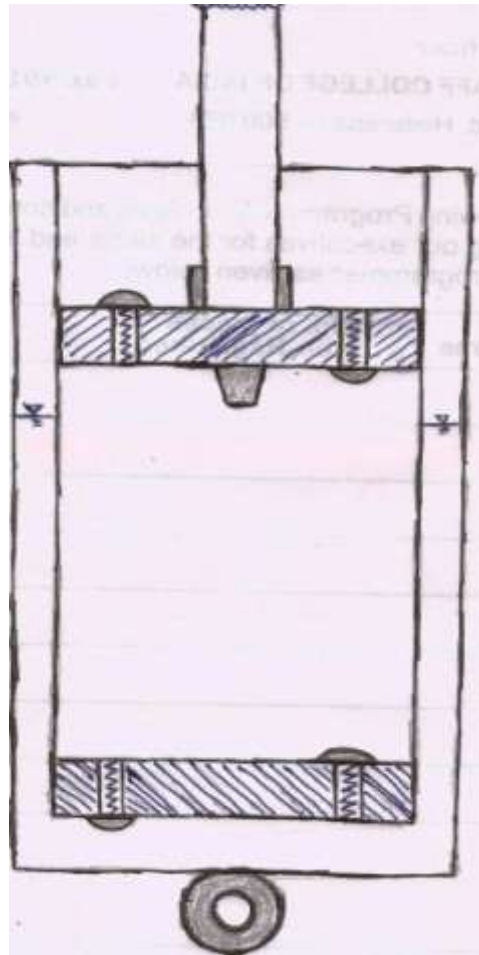


Vent type:

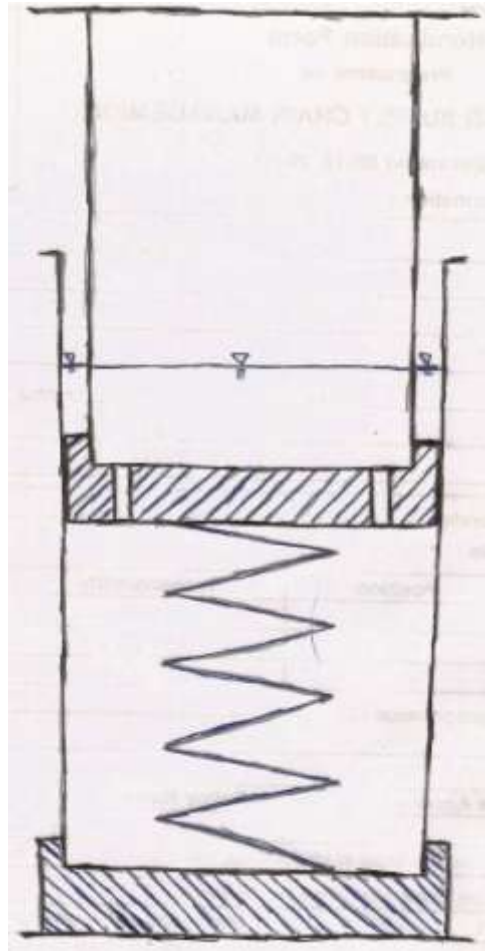
Cut off Angle {isolation} cocks -



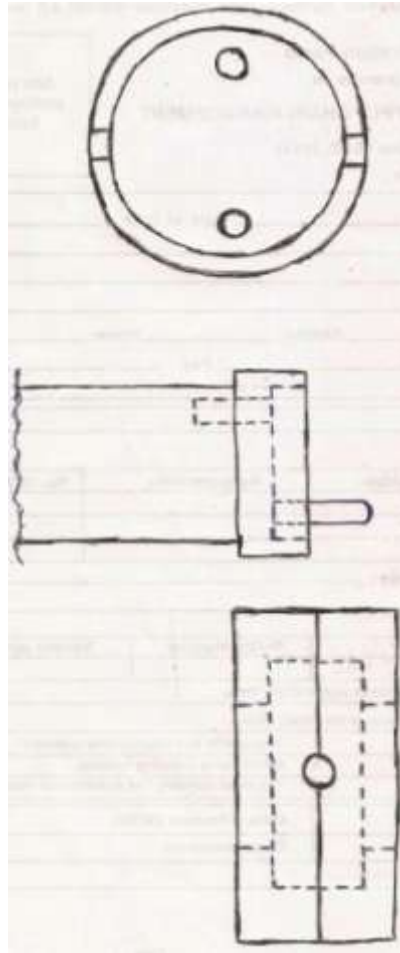
Hydraulic Shock Absorber supporting Bogie Bolster



ICF Axleguide Dashpot



DEMU Schaku Couplers having Split Sleeved Collar



ICF DEMU Solebar Cambering

- +12 mm hogging camber at headstock ends
- 0 mm hogging/sagging at Body Bolster points
- +24 mm hogging camber at carriage centreline
- -10 mm deflection at headstock ends in reverse solebar cambering
- -20 mm deflection at carriage centreline in reverse solebar cambering

SS EMU/DEMU



PROJECT BACKGROUND



- The present existing Electrical Multiple Units (EMU's) running on sub-urban rail network in metropolitan cities, are 3.66 m wide coaches manufactured with Mild Steel material and painted.
- These EMU's are prone to corrosion, especially in harsh environmental conditions in coastal cities of Mumbai, Chennai & Kolkata.
- This results in frequent body repairs, increased down time and less availability thereby reducing the revenue to Indian Railways.

- ✓ With the above background, a pro-active step was taken up by M/s BEML Ltd, Bangalore Complex, R&D team to design the conventional mild steel body coaches with corrosion resistant austenitic stainless steel material (life of 35 years). The new body design which is modern, clean, aesthetically appealing and more importantly which does not require any painting, provides world-class interiors.

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DESIGN & DEVELOPMENT OF STAINLESS STEEL EMU FOR INDIAN RAILWAYS

New SS EMU/DEMU by BEML



DETAILS OF PRODUCT

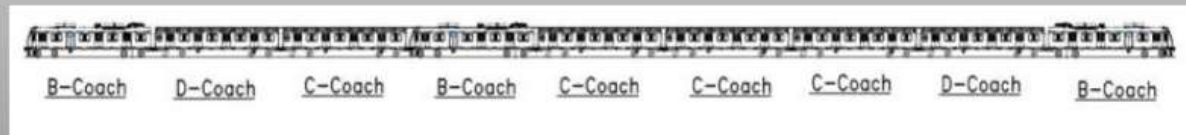


BRIEF SPECIFICATIONS:

- Track Gauge-Broad Gauge: 1676 mm,
- Max Speed : 100 kmph
- Coach length over body: 20726 mm,
- Max. width over body side: 3660 mm,
- Coupler height from rail level: 1035mm,
- Height of coach from rail level: 3618 mm,
- Maximum permissible axle load (Driving Motor coach & Trailer coach): 20.32 T,
- Max. height of the comp. floor from rail level under tare condition: 1230 mm,
- Rake Formation-9 Coaches: B-C-D-B-C-C-D-C-B



PRESENTED AT Motor Coach, C- Trailer Coach with Ladies Comp, D- Trailer Coach with Vendor Comp)



DESIGN & DEVELOPMENT OF STAINLESS STEEL EMU FOR INDIAN RAILWAYS

SS EMU BEML



DETAILS OF PRODUCT



SUB SYSTEMS:

Sub – system	Features
➤ Carbody	Austenitic Stainless Steel carbody with unpainted exteriors
➤ Coupler arrangement	High capacity semi permanent coupling (Schaku couplers)
➤ Bogie	Primary Coil Spring & Secondary Air suspension for good riding comfort
➤ Propulsion System	Electric propulsion system
➤ Brake System	Electro pneumatic brake system.
➤ Front end	FRP cab mask and cab skirt which provides a modern aesthetic appeal to the coach.
	Designed to be on par with that of the world-class coach interiors. FRP panels have been used extensively to provide pleasant ambience for the passengers
	Ergonomically designed passenger seats with polycarbonate material and with dual tone shade to match the FRP interiors
	Anti-skid stainless steel floor cover sheets

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DESIGN & DEVELOPMENT OF STAINLESS STEEL EMU FOR INDIAN RAILWAYS

SS EMU Design



DESIGN INNOVATIONS



- **Design of wide bodied SS carbody structure with 16 passengers / sqm loading (double of International & Indian metro standards) was a challenging task**
- **Interior design was made with aesthetics & cost effectiveness in mind, FRP panels used**
- **New design of window with wider opening. Design is having provision for converting to Air-conditioned type with minimal changes**
- **Passenger seats with polycarbonate material & dual tone shade to match the interiors.**

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FRP mask incorporated in the front to give a better look. FRP desk ergonomically designed.

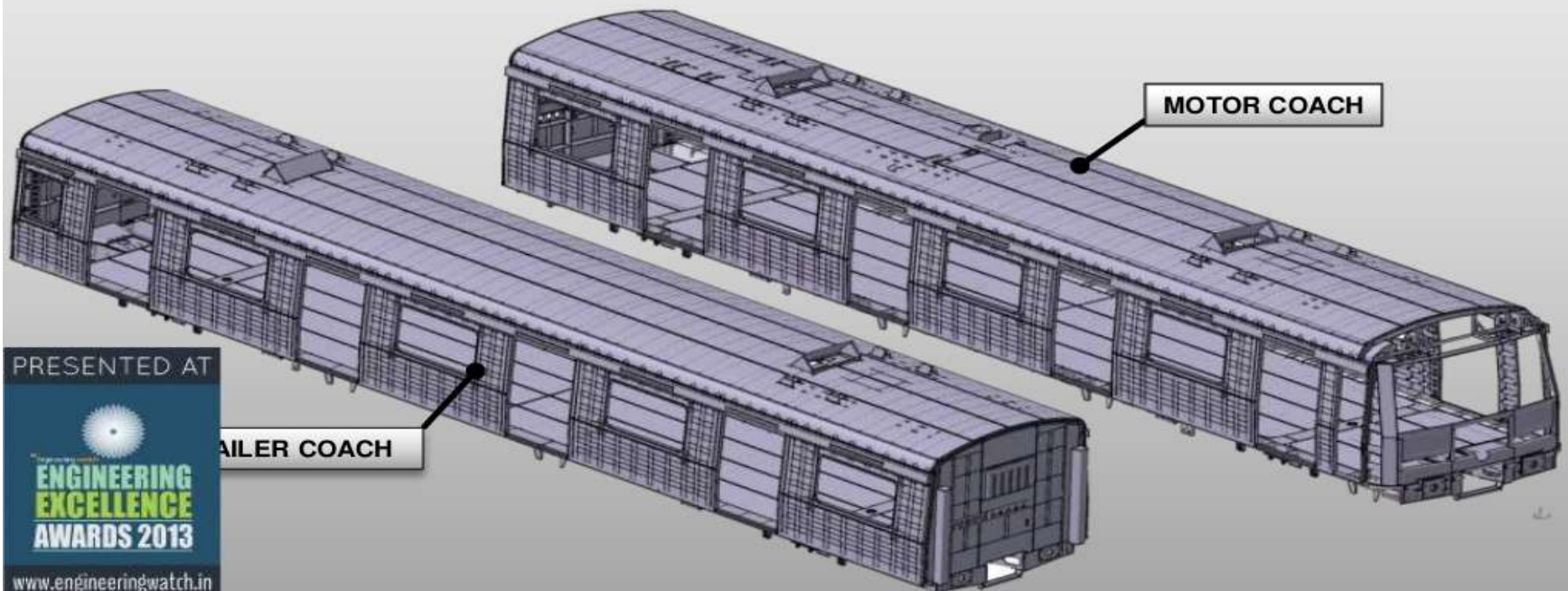
SS DEMU Car body models



DESIGN MODELING OF CARBODY



- Complete carbody modeled using CATIA V5 software.
 - ✓ Carbody section to be within the allowable maximum moving dimensions.
 - ✓ Weight reduction by 2 Tonnes



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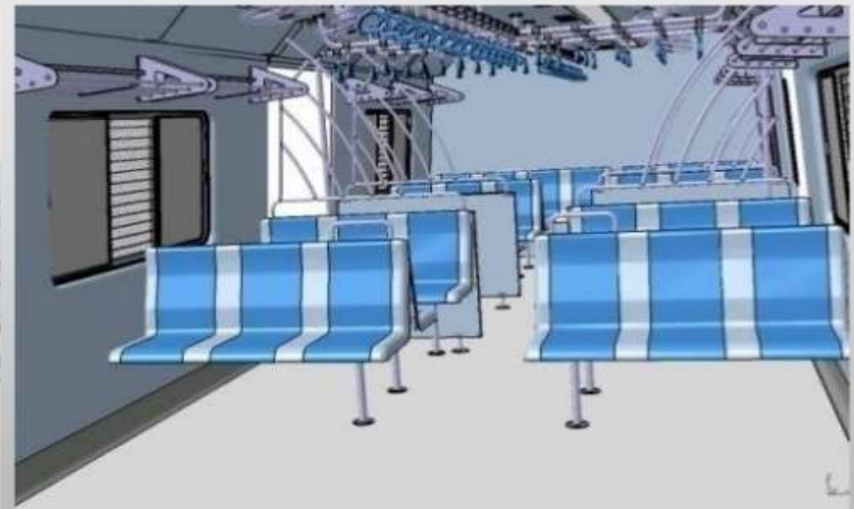
SS DEMU furnishing development



DESIGN OF INTERIORS



- CAD model of interiors, driver's desk & cab mask prepared
- Interferences checked



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DESIGN & DEVELOPMENT OF STAINLESS STEEL EMU FOR INDIAN RAILWAYS

SS EMU Interior & Exterior



CAR FURNISHING & ASSEMBLY



- Furnishing of Stainless Steel EMU in production line.



EXTERIOR VIEW



INTERIOR VIEW



DRIVER DESK

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SS DEMU DPC & TC

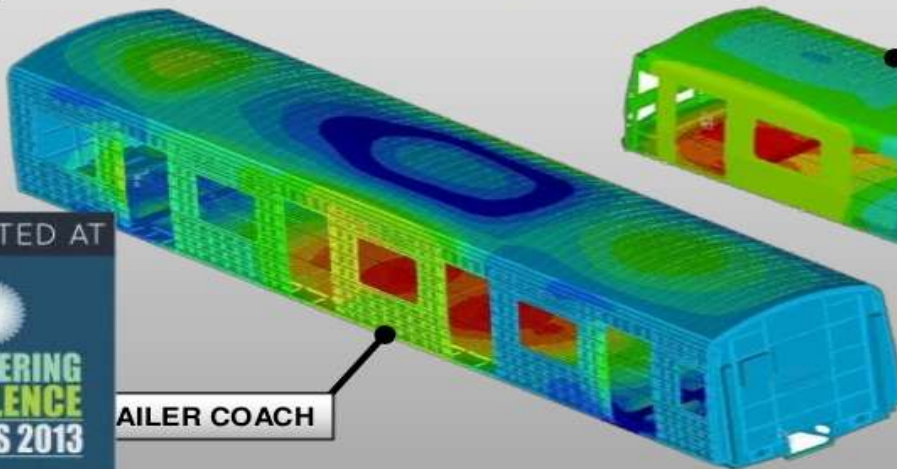


STRUCTURAL STRENGTH VERIFICATION



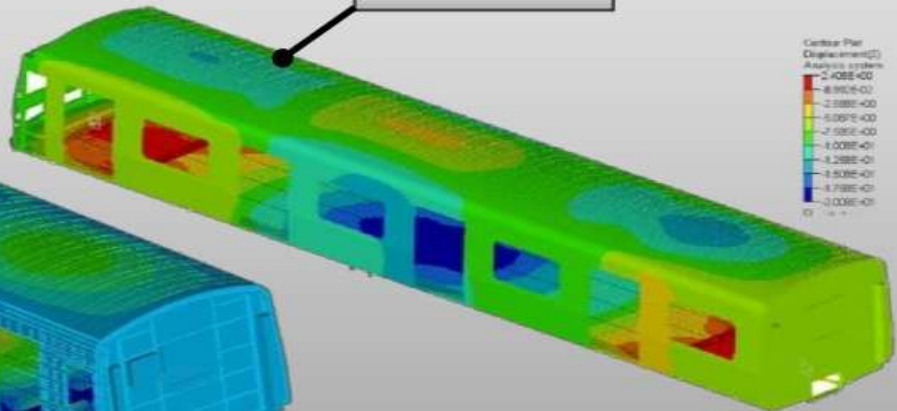
- **Structural Integrity & Strength Analysis of the carbody checked**
 - ✓ To meet UIC 566 standard,
 - ✓ Analyzed using MSC Nastran software,
 - ✓ Super dense passenger loading of 16 passengers / sqm
 - ✓ Stress levels within acceptable limits.

Centaur Plot
Displacement(Mag)
Analysis system
1.415E+01
1.362E+01
1.288E+01
1.146E+01
9.502E+00
8.002E+00
7.427E+00
6.188E+00
4.911E+00
3.716E+00
2.476E+00
1.238E+00
2.918E+00



MOTOR COACH

Centaur Plot
Displacement(2)
Analysis system
2.408E+00
8.992E+00
2.888E+00
6.007E+00
2.588E+00
1.008E+01
4.288E+01
4.808E+01
4.788E+01
0.008E+01



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DESIGN & DEVELOPMENT OF STAINLESS STEEL EMU FOR INDIAN RAILWAYS

SS DEMU TC & DPC



CARBODY DESIGN VALIDATION – PHYSICAL TESTING



- Validation of carbody carried out by squeeze testing as per UIC-566 standard with the following loads

- Vertical Load L1: 75 Tonne
- Compressive Load L2: 1200KN
- Combined Load: L1+L2



**DATA ACQUISITION
UNIT**



PROTOTYPE MOTOR COACH CARBODY



PROTOTYPE TRAILER COACH CARBODY

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DESIGN & DEVELOPMENT OF STAINLESS STEEL EMU FOR INDIAN RAILWAYS

SS DEMU Manufacturing by BEML



MANUFACTURING INFRASTRUCTURE



5 AXIS SERIES SPOT WELDING



ROBOTIC SPOT WELDING



CNC PROGRAMMED STRETCH FORMING

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SS DEMU Underframe, Roof & Body walls manufacturing by BEML



MANUFACTURING INFRASTRUCTURE



UNDERFRAME MAIN ASSY JIG



ROOF MAIN ASSY JIG



SIDE BLOCK ASSY JIG



SIDE WALL MAIN ASSY JIG

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DESIGN & DEVELOPMENT OF STAINLESS STEEL EMU FOR INDIAN RAILWAYS

SS DEMU fabrication infrastructures



MANUFACTURING INFRASTRUCTURE



- To meet the requirement of developing a world class coach, BEML has established all the infrastructure required for manufacturing carbody and it's assemblies for SS EMU cars.
 - Robotic spot welding technology,
 - 5 axis series spot welding,
 - CNC programmed Stretch Forming,
- Dedicated special Jigs & Fixtures.
- Custom built test facilities like water leak test, bogie load testing and test tracks to ensure quality requirements.

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DESIGN & DEVELOPMENT OF STAINLESS STEEL EMU FOR INDIAN RAILWAYS

SS EMU Production planning



CARBODY MANUFACTURE



- Manufacturing of Stainless steel EMU carbody in production line.



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DESIGN & DEVELOPMENT OF STAINLESS STEEL EMU FOR INDIAN RAILWAYS

RDSO/RITES passed SS EMU at BEML



INHOUSE TESTING



- Testing of furnished SSEMUR rake in test track witnessed by RDSO/RITES.



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DESIGN & DEVELOPMENT OF STAINLESS STEEL EMU FOR INDIAN RAILWAYS

SS EMU 1st Prototype Rake



FIRST PROTOTYPE RAKE



- First Rake Stainless Steel EMU rolled out from BEML Limited, Bangalore Complex to Eastern Railways, Sealdah, Kolkata



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THANKS

