Name and Role of Bogie Components (including brake system)
Topics Covered

- Concept of suspension
- Concept of tractive effort and braking
- Requirements from suspensions + braking system
- Working of suspension systems
- Name and function of bogie components
- Understand the working of brake system.
- Name & function of Braking System Components
- The latest development in bogie+braking system
Concept of Suspension

- **Spring Mechanism**
  - Linear
  - Step/ non-linear
  - Bumps (Limiters)
  - Progressive spring characteristics
Spring Types

- Coil Springs
- Flexi-coil springs
- Air springs
- Solid Springs
Suspension Systems in Railways

- **Single stage system**: Consists either of
  - Primary suspension or
  - Secondary suspension

- **Two stage suspension system**: Both
  - Primary suspension and
  - Secondary.
Diagram: Two Stage Suspension System
Dampers/ Shock Absorbers

- Hydraulic
- Friction
- Pneumatic
- Rubber/ composite
Kinematic Elements in Suspension

- Track
- Wheel-set
- Primary suspension
- Bogie frame
- Secondary suspension
- Lateral suspension
- Tractive & braking effort transfer components.
Simple DOF of a Single Body

- 3 linear
  - Shuttling
  - Lurching
  - Bouncing

- 3 rotational
  - Rolling
  - Pitching
  - Nosing or Yaw
Complex Support of a Single Body
Roll and it’s Prevention

- Effect of roll on human body
  - Type of roll: UCR and LCR
- Prevention not available in ICF bogie.
- Anti-Roll bar mechanism in LHB bogie.
- Air suspension system case.
REQUIREMENTS FROM BOGIE
Requirements from a Bogie

- Linear/Curving requirement.
- Energy transmission and control:
  - Linear: vertical, lateral, longitudinal.
  - Rotational.
- Roll prevention requirement.
- Ability to filter out the irregularity between track and bogie:
  - Concept of offloading.
- Ability to bear the static load.
Controlled clearance required
Lateral Energy Transfer Mechanism

- **ICF**
  - Spring-tilt mechanism with BSS Hanger & equalising stay arrangement at secondary suspension.
  - Much limited at primary suspension.

- **LHB**
  - Flexi coil springs at secondary suspension.
  - Control arm arrangement at primary suspension.

- **Casnub**
  - Much limited (spring nest & friction wedge block).
Longitudinal Load Transfer Mechanism

- Tractive/Braking force transfer mechanism.
- Concept of traction centre.
- Effect of buffer height on traction centre.
Components for Longitudinal Load Transfer

- **ICF**
  - Centre pivot arrangement
  - Anchor links.
    - Anchor link silent block.
  - Rigid type axle guides.

- **LHB**
  - Body-bogie connections.
  - Traction assembly.
  - Control arm arrangement.
Anchor Link (ICF Coach)

- Fitted with silent block.
- Transmits the tractive and braking forces.
- Can swivel universally
  - To permit the bolster to rise & fall and to sway sidewards.
Centre Pivot Arrangement

ICF

FIAT

CASNUB
Centre Pivot Arrangement (ICF Bogie)

- Facilitates body-bogie joint.
- Transmits the tractive & braking forces.
- Rubber silent block
  - Injection moulded type
  - Tends to centralise the bogie w.r.t. the body
  - To some extent, control and damp the angular oscillations of the bogies.
Springs and Off-loading

- **Frame twist flexibility**
  - 25 mm offload.
  - 50 mm offload.

- **Softer secondary**
  - Not possible due to space constraint in ICF.
  - Used in FIAT bogie.

- **Variation in buffer height.**
Static Load Transmission

- Side Bearers and Centre Pivot

**ICF**
Side Loaded

**FIAT**
Side Loaded

**CASNUB**
Centrally Loaded

Wearing piece: hemispherical for self-aligning characteristic
Bogie Frame with Axle Guides (ICF)

- Rigid type Consists of
  - 2 sole plates (side frames).
  - 2 headstocks.
  - 2 transoms at centre.
  - 4 longitudinals.

- 8 axle guides welded to the side frame with close dimensional accuracy.
Axle Guide Arrangement

ICF

FIAT

CASNUB
Function of Axle Guides (ICF)

- Guides the axle w.r.t. bogie frame laterally as well as longitudinally.
- Transmits tractive & braking force between bogie frame & axle box.
- In ICF, acts as a single acting hydraulic vertical shock absorber for primary spring.
- In FIAT bogie, provides control flexibility between frame and axle.
Axle Box Bearing

- CASNUB bogie
  - CTRB

- ICF bogie
  - Spherical type roller bearing with self-align feature.
    - Automatically adjust to the deviation in the centre line of the axle during run.

- FIAT bogie
  - CTRB
Nomenclature

- **Axle**
  - Journal
  - Collar
  - Wheel seat

- **Disc**
  - Tread
  - Hub
  - Tyre profile
Wheel Gauge

 Newly assembled wheels should be checked in the distance between inner faces of hubs at 1000 + 2.2 mm using Wheel Distance Gauge.

The wheels to be gauged are level taking off from coaching vehicle.

Underloaded conditions are not applicable.

WHEEL DISTANCE GAUGE

FIGURE 10.6
Wheel Tyre Profile

- Standard wheel profile
- Worn wheel profile (Conforming profile)
- No Intermediate profile now.
**Difference in Wheel Diameter**

<table>
<thead>
<tr>
<th></th>
<th>On the same axle</th>
<th>On the same trolley</th>
<th>On the same wagon</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Wagon</td>
<td>0.5</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>For Coach</td>
<td>0.5</td>
<td>5</td>
<td>13</td>
</tr>
</tbody>
</table>

- Prescribed in
  - Rule No. 2.8.14.2 IRCA Part III and
  - Rule No. 2.9.4 IRCA Part IV

- These limits do not form a part of train examination.
- The rejection of wheels worn beyond service limits will continue to be determined by the normal wear limits specified in IRCA Rules (Rly. Bd. letter No. 86/M(N)960/8 Dated 22.8.86).
Wheel Profile Defects

- Flat tyre
- Hollow tyre
- Sharp flange
- False flange
- Deep flange
- Thin flange
- Root radius

Diagram:

- All coaches (Including EMU & DMU) 50 mm

Note:
1. Condemning mark 'C' to be stamped on both side of gauge.
2. Condemning marks for type of stock on line only needs to be stamped.
3. Distance 'X' at which condemning mark 'C' for various type of wheels to be stamped are as below:
   - i) Solid wheel of ICF & BEML main line coaches 6.5 mm.
   - ii) Solid wheel of IRS main line coaches 5 mm.
   - iii) Tyred wheel of IRS, ICF & BEML main line coaches 26 mm.
   - iv) Tyred wheel of ac & dc EMU motor coaches 38.5 mm.
   - v) Tyred wheel of ac & dc EMU trailer coaches 28.5 mm.
SPECIAL FEATURES OF CASNUB BOGIE
CASNUB Bogie

Main components

- Side frames with friction plates
- Bolster with wear liners
- Friction shoe wedges
- Centre pivot arrangement & Side Bearers
- Load bearing springs and snubber springs
- Spring plank
- Adapter, Elastomeric Pad
Versions of CASNUB Bogie

- The various versions developed
  - CASNUB -22W (not in use)
  - CASNUB -22W(M)
  - CASNUB -22NL
  - CASNUB -22NLM
  - CASNUB -22NLM
  - CASNUB -22NLB
  - CASNUB -22HS
CASNUB -22W

- Wide jaw category without elastomeric pad.
- No locking at Centre pivot and bolster pin.
- Clearance type side bearer with two rollers.
- The brake beam “pocket or sliding type”.
  - The brake head, integral part of the brake beam, slides in the pocket provided in the side frame.
- Maximum speed 75 KMPH, 22.9 T Axle load.
CASNUB 22W(M)

- EM pad introduced alongwith the adapter.
- Side frame with negative camber
  - For getting same buffer height while using EM pad.
- Spherical type centre pivot
  - fitted with bolster pin with castle nut and split pin.
- Constant contact type side bearer
  - metal bonded housed in modified housing.
- Hanger type Brake beam introduced
  - Discontinued in the later versions of the bogie.
CASNUB -22NL

- The side bearer, centre pivot, bolster
  - similar to 22W(M) version.
- “Narrow jaw” category introduced.
  - Therefore the adapter used of smaller size.
- Side frame modified to accommodate
  - sliding type b/beam hanger similar to 22W version
- Centre pivot pin is locked by shackle lock.
Similar to 22NL version, except for bolster.

- The shape of the bolster is “fish belly” at the centre to reduce the weight of bogie.

- However only a marginal weight reduction compared to NL type has been possible.
CASNUB 22NLM

- Similar to NLB version in relation to dimension.
- Material of the side frame and bolster is changed.
  - Resulted in reduction of the bogie weight.
- The weight of the NLM version bogie is 5.125T whereas the weight of NL version is 5.5T.
CASNUB 22HS

- Developed for operation at speed 100 Kmph.
- Almost same as NLB type except
  - Outer gib opening increased to 241 from 234 mm.
  - higher diameter spigot for the spring seat.
- The side bearer used was spring loaded type.
  - Now PU type used.
<table>
<thead>
<tr>
<th>Type</th>
<th>Outer</th>
<th>Inner</th>
<th>Snubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.3 T non HS</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>20.3 T HS</td>
<td>7</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>22.9 T</td>
<td>7</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>
## Springs Arrangement

### Annexure - IIA

#### Springs Groups for Various Axle Loads

<table>
<thead>
<tr>
<th>Axle Load</th>
<th>22.9 Tonnes</th>
<th>20.32 Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image.png" alt="Diagram of Springs Arrangement" /></td>
<td><img src="image.png" alt="Diagram of Springs Arrangement" /></td>
<td></td>
</tr>
</tbody>
</table>

#### Spring Group for Each End of Bogie Bolster

<table>
<thead>
<tr>
<th>Number of Springs Per Group</th>
<th>Outer (7)</th>
<th>Inner (7)</th>
<th>Snubber (2)</th>
<th>Outer (7)</th>
<th>Inner (6)</th>
<th>Snubber (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Load on Bogie Pivot &amp; Height of C.P Top from R.L</strong></td>
<td>LOAD (t)</td>
<td>HEIGHT (mm)</td>
<td>LOAD (t)</td>
<td>HEIGHT (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tare</td>
<td>6.066</td>
<td>932 +3/8</td>
<td>6.066</td>
<td>932 +3/8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross</td>
<td>40.38</td>
<td>892 +3/8</td>
<td>35.22</td>
<td>895 +3/8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% Over Load</td>
<td>60.57</td>
<td>870.5 +3/8</td>
<td>52.83</td>
<td>874.5 +3/8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Details of Springs**: WD-92058-S/5, Outer Item-1, Inner Item-2, Snubber Item-3
SPECIAL FEATURES OF FIAT BOGIE
Main Feature of FIAT Bogie

- An adoption of EUROFIMA design
  - manufactured by FIAT/SIG Switzerland.
- Maximum operating speed is 160 kmph
  - Up to 200 kmph with minor modification.
- Permanent earthing connection
  - To safeguard axle bearings.
- Excellent ride index, superior ride quality.
## Comparison of FIAT with ICF Bogie

<table>
<thead>
<tr>
<th>Features</th>
<th>FIAT</th>
<th>ICF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed Potential (kmph)</td>
<td>160</td>
<td>140</td>
</tr>
<tr>
<td>Ride Index (max.)</td>
<td>2.75 at 180kmph</td>
<td>3.5 at 140kmph</td>
</tr>
<tr>
<td>Weight (t)</td>
<td>6.5</td>
<td>5.72 (13t) 6.5(16.25t)</td>
</tr>
<tr>
<td>Wheel base(mm)</td>
<td>2560</td>
<td>2896</td>
</tr>
<tr>
<td>Inner axle distance (m)</td>
<td>12.34</td>
<td>11.89</td>
</tr>
<tr>
<td>Wheel dia new (mm)</td>
<td>915</td>
<td>915</td>
</tr>
<tr>
<td>Wheel dia wom (mm)</td>
<td>845</td>
<td>825</td>
</tr>
<tr>
<td>Axle box guidance</td>
<td>Articulated</td>
<td>Rigid</td>
</tr>
<tr>
<td>Dampers – Primary</td>
<td>Hydraulic damper</td>
<td>Dashpot</td>
</tr>
</tbody>
</table>
Primary Suspension (FIAT Bogie)

- Nested steel coil springs.
- Control arm axle guidance.
- Lateral flexibility-reduced wheel root wear.
- Bump stop (rubber spring) over steel spring.
- Hydraulic dampers.
Primary Suspension Bump Stop

Upper part of bump stop at bogie frame ends

Lower centering disc with bump stop at Axle Box
Secondary Suspension (FIAT Bogie)

- **Consists of**
  - Nested flexi-coil steel spring.
  - Minor pads
    - Helps the two bogies to align equally.
  - Rubber spring
    - Inside coil springs for progressive characteristic.
Marking on Springs

- **Al. Tape** – Indicates positive direction of the alignment deviation
- **Copper Band** – Gives length of the spring under test load and the value of the alignment deviation
- **Stamping on flat portion** – Gives month & year of manufacture and running serial number.
The difference between alignment deviations

- Outer springs 4mm max
- Inner springs 8mm max.

Coupling such as

- Greater outer with greater inner and vice versa.
  - If A greater than B, C should be greater than D
  - \(A - B = 4\text{ mm max, } C - D = 8\text{ mm max}\)
Secondary Suspension Components

Minor pad

Upper centering disc with rubber spring
- Rigid type connection.
- Consists of disc spring.
- Easy buffer height adjustment.
Buffer Height Adjustment (FIAT Bogie)
Transmits traction and braking forces between body and bogie frame.

- Two traction rods
- One traction lever on the bolster pin.
Bush of Traction Rod and Rod Link
Control Arm Assembly (FIAT Bogie)

- By articulated control arm system.
- Also utilized to transmit traction and braking forces between bogie frame and axle assembly.
Anti Roll Bar Mechanism (FIAT Bogie)
Wheel Balancing

- For speed ≥130 Kmph.
- RCF’s spec.no. MDTS-168
- 320 rpm is maintained.
- Unbalanced moment on wheel is balanced by glueing the needed weights.
## Imported Items (Rubber Joints)

<table>
<thead>
<tr>
<th>Description</th>
<th>Drg.No.</th>
<th>Photo</th>
<th>QPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axle Box Pivot Bush</td>
<td>1247488001</td>
<td><img src="image" alt="Axle Box Pivot Bush" /></td>
<td>08</td>
</tr>
<tr>
<td>Ball joint roll link</td>
<td>C53 973 REB BRED 8416</td>
<td><img src="image" alt="Ball joint roll link" /></td>
<td>08</td>
</tr>
<tr>
<td>Traction center Elastic joint</td>
<td>C53 973 REF BRED 8397 rev 02</td>
<td><img src="image" alt="Traction center Elastic joint" /></td>
<td>02</td>
</tr>
<tr>
<td>Ball joint traction lever</td>
<td>C53 973 REF BRED 8403 rev 02</td>
<td><img src="image" alt="Ball joint traction lever" /></td>
<td>08</td>
</tr>
</tbody>
</table>
## Imported Other Rubber Items

<table>
<thead>
<tr>
<th>Description</th>
<th>Drg.No.</th>
<th>Photo</th>
<th>QPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral Bump Stop</td>
<td>C53 973REB BRED 8374 rev. 02</td>
<td><img src="image1.png" alt="Image" /></td>
<td>04</td>
</tr>
<tr>
<td>Rubber Spring</td>
<td>1268685 Ver ‘01’</td>
<td><img src="image2.png" alt="Image" /></td>
<td>04</td>
</tr>
<tr>
<td>Miner Pad</td>
<td>1903149 alt ‘a’</td>
<td><img src="image3.png" alt="Image" /></td>
<td>08</td>
</tr>
<tr>
<td>Primary Vertical Bump Stop</td>
<td>1227081</td>
<td><img src="image4.png" alt="Image" /></td>
<td>08</td>
</tr>
</tbody>
</table>
# Imported Primary Springs

(T.S.17.248 100 05)

<table>
<thead>
<tr>
<th>Coach Type</th>
<th>Descr</th>
<th>Drg. No.</th>
<th>QPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC-CCar (1st &amp; 2nd), Hot buffet, AC-2T/EOG, FAC/EOG</td>
<td>Outer</td>
<td>1 267 411</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Inner</td>
<td>1 267 412</td>
<td>8</td>
</tr>
<tr>
<td>Gen-Van</td>
<td>Outer</td>
<td>1 277 142</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Inner</td>
<td>1 277 143</td>
<td>8</td>
</tr>
<tr>
<td>AC-3T EOG</td>
<td>Outer</td>
<td>1 267 411</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Inner</td>
<td>1 277 143</td>
<td>8</td>
</tr>
</tbody>
</table>

**Sources:**

i) M/s Grueber, Germany
ii) M/s LANGEN and SONDERMANN GMBH, Germany
## Imported Secondary Springs (T.S.17.248 100 05)

<table>
<thead>
<tr>
<th>Coach Type</th>
<th>Description</th>
<th>Drg. No.</th>
<th>Qty Per Coach</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC- CCar (1st &amp; 2nd), Hot buffet, AC-2T/EOG, FAC/EOG</td>
<td>Outer</td>
<td>1 269 514</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Inner</td>
<td>1 269 513</td>
<td>4</td>
</tr>
<tr>
<td>Gen-Van</td>
<td>Outer</td>
<td>1 277 146</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Inner</td>
<td>1 277 145</td>
<td>2</td>
</tr>
<tr>
<td>Gen side</td>
<td>Outer</td>
<td>1 268 836</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Inner</td>
<td>1 268 837</td>
<td>2</td>
</tr>
<tr>
<td>AC-3T EOG</td>
<td>Outer</td>
<td>1 268 836</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Inner</td>
<td>1 269 513</td>
<td>4</td>
</tr>
</tbody>
</table>
## Imported Dampers

<table>
<thead>
<tr>
<th>Description</th>
<th>Drg. No.</th>
<th>QPC (nos.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Vertical</td>
<td>LW05102</td>
<td>8</td>
</tr>
<tr>
<td>Secondary Vertical</td>
<td>LW05101</td>
<td>4</td>
</tr>
<tr>
<td>Secondary lateral</td>
<td>LW05100</td>
<td>2</td>
</tr>
<tr>
<td>Lateral damper for Air spring bogie</td>
<td>LW 05122</td>
<td>2</td>
</tr>
<tr>
<td>Yaw</td>
<td>LW05103</td>
<td>4</td>
</tr>
</tbody>
</table>
# Imported Wheel Disc & Brake Disc

<table>
<thead>
<tr>
<th>Description</th>
<th>Photo</th>
<th>QPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheel Disc</td>
<td><img src="image1" alt="Wheel Disc Photo" /></td>
<td>08</td>
</tr>
<tr>
<td>Brake Disc KB’s drg no. 1B83756/1</td>
<td><img src="image2" alt="Brake Disc Photo" /></td>
<td>08</td>
</tr>
</tbody>
</table>
## Periodicity of Maintenance Schedules

<table>
<thead>
<tr>
<th>S N</th>
<th>Schedule</th>
<th>Periodicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Trip Sch. D1</td>
<td>7 days ± 1 day</td>
</tr>
<tr>
<td>2.</td>
<td>Monthly Sch./D2</td>
<td>30 days ± 3 days</td>
</tr>
<tr>
<td>3.</td>
<td>Six Monthly Sch./D3</td>
<td>180 days ± 15 days</td>
</tr>
<tr>
<td>4.</td>
<td>Shop Sch. I/ IOH</td>
<td>18 Month /6 Lakhs Kms earned whichever is earlier</td>
</tr>
<tr>
<td>5.</td>
<td>Shop Sch. II/ POH</td>
<td>3 Years/12 Lakhs Kms earned whichever is earlier</td>
</tr>
<tr>
<td>6.</td>
<td>Shop Sch. III/ POH</td>
<td>6 Years/24 Lakhs Kms earned whichever is earlier</td>
</tr>
</tbody>
</table>
NAME AND FUNCTION OF BRAKING SYSTEM COMPONENT
Interplay between Braking & Load Transfer

- Primary Suspension short-circuiting
- Emergency braking issues
- Shuttling (longitudinal) effect
- Weight Transfer
Basic Requirements from Brake System

- Controlled braking
  - Braking control to loco pilots and guard.
  - Passenger communication system in coach.
- EBD (Emergency Braking Distance) within limit.
- Fail safe i.e. automatic braking when train parts.
- Brake inexhaustibility.
- Less fading of brake power during long run.
- Easy maintainability.
- Reliability
- Multiple operation
Schematic Diagram (ICF with BMBC)
Major Components

- Common pipe bracket (CPB)
- Distributor valve (DV)
- Control reservoir (CR)
- Auxiliary reservoir (AR)
- Brake cylinder (BC)
- Brake pipe & feed pipe
Major Components

- Air hose with palm end coupling
- Cut off angle cock
- Dirt collector
- Isolating cock (2-way and 3-way)
- Check valve with choke
- Brake riggings
Common Pipe Bracket (CPB)

- Mounted on the underframe of a vehicle.
- Facilitates fitment of any make of DV.
- The DV along with the intermediate piece (sandwich) and the CR mounted on it’s two opposite faces.
- Facilitates easy removal of DV without disturbing the pipe connections.
Dirt collector

- Placed in BP and FP line.
- A trap & store house for the dust and dirt.
- The air strikes against the wall of centrifugal housing.
- Dust, dirt and scales etc. entrapped and collected in the dirt chamber.
WORKING STAGES OF AIR BRAKE SYSTEM
Three Working Stages

- **Charging stage**
  - Brake pipe (BP) charged with 5 Kg/cm$^2$ air pressure.

- **Application stage**
  - BP pressure dropped for brake application.

- **Releasing stage**
  - BP pressure again raised for brake release.
Air Flow: Charging Stage

Feed Pipe

Brake Pipe

AR
200 LTR

Non Return Feature
Inside DV

atmosphere
Pressures: Charging Stage

- Feed Pipe: 6.0 atmosphere
- Brake Pipe: 5.0 atmosphere
- AR: 6.0

Features:
- Non Return Feature Inside DV
Air Flow: Application Stage

- Feed Pipe
- Brake Pipe
- AR
  - Non Return Feature
  - Inside DV
Air Flow: Application Stage
Air Flow: Application Stage

- Feed Pipe
- Brake Pipe
- Pressure Limiter
- Atmosphere
- AR 200 LTR
- Pressure Limiter
- PEAS
- GBV
Pressures: Application Stage

Feed Pipe: 6.0 atm
Brake Pipe: < 5.0 atm
AR: 6.0 atm
Pressure Limitter:

atmosphere
Pressure Level: Charging Stage

- LOCO
- FP \(\gg\gg\gg\gg = 6.0\)
- AR \(\gg\gg\gg\gg = 6.0\)
- BC \(\ll\ll\ll\ll\ll = 0.0\)

BP \(\gg\gg\gg\gg = 5.0\)

Charging

CR \(\gg\gg\gg\gg = 5.0\)
atmosphere

- Charging Stage: BP is charged at 5 Kg/cm\(^2\).
 Pressure Level: Application Stage

- Application Stage: BP pressure is reduced.

- LOCO
- FP = 6.0
- AR = 6.0
- BC >>>>>3.8 max
- BP < 5.0
- CR = 5.0
- atmosphere
• Releasing Stage: BP pressure is again raised.
Single Pipe vs Twin Pipe System

**BRAKE PIPE**

- **AR**
  - Volume: 100 Ltrs
  - Pressure: 4.2 Kg/cm²

- **BC**
  - Pressure: 3.8 Kg/cm²
  - Volume: 15 Ltrs
  - Piston Stroke: 15 cm

Recharging of air from 4.4 to 5 Kg/cm² requires 30 seconds.

Releasing of air from 3.8 Kg/cm² to 0.4 Kg/cm² within 15 to 20 seconds.

Note: AR is not recharged before the air from BC is released.
## Modes of Brake Application

<table>
<thead>
<tr>
<th>Description</th>
<th>Reduction in B. P. Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Brake Application</td>
<td>0.5 to 0.8 Kg/cm²</td>
</tr>
<tr>
<td>Service Brake Application</td>
<td>0.8 to 1.0 Kg/cm²</td>
</tr>
<tr>
<td>Full Service Brake Application</td>
<td>1.0 to 1.5 Kg/cm²</td>
</tr>
<tr>
<td>Emergency Brake Application</td>
<td>Brake pipe pressure fully exhausted</td>
</tr>
</tbody>
</table>
MAJOR BRAKE COMPONENTS AND THEIR FUNCTIONS
Three designs of DV’s are in use on IR:

- KE type.
- C3W Type.
- P4aG type.

A decision has already been taken that new stocks manufactured henceforth will only be fitted either with C3W or KE type DV.
Function of DV

- Charges the system to regime pressure:
  - During normal/running condition.

- Helps in all types of brake application:
  - Graduated, full service as well as emergency type.

- Helps in brake release:
  - Graduated as well as manual.

- Controls the brake application & release time:
  - As per service conditions.

- Limits max. designed BC pressure.
Function of DV

- Accelerates propagation of initial reduction of BP pressure throughout the length of the train
  - By arranging local vent of BP pressure inside the DV till BC pressure maintained at 0.8 Kg/cm$^2$.

- Protects overcharging of CR up to some extent
  - When the BP is overcharged after full service application for quick brake release.

- Facilitates to isolate the system if required, and
- Complete system can be evacuated manually.
KE type DV

- **Main subassemblies:**
  - Three pressure valve
  - U-controller
  - ‘R’ charger & isolating valve with handle
  - Choke cover
  - Minimum pressure limiter
  - Maximum pressure limiter
  - ‘A’ controller
  - Quick release valve.
Working of Three Pressure Valve

When BP Pressure is less than 5Kg/Cm²
Three Pressure Valve

- Housed in the vertical central bore between the top and bottom face.
- Controls charging and discharging of BC in accordance with the change in BP pressure.
Exploded View of Three Pressure Valve
Housed with R-charger & choke cover on one face of the DV.

Taps off a small amount of BP pressure from DV during initial brake application till BC pressure reaches 0.8 kg/cm².

This action increases initial pressure reduction & causes simultaneous rapid propagation of braking impulse throughout the length of the train.
Exploded View of U-controller

(33) VALVE HEAD
(36) FLAT SEALING RING
(35) GROOVED RING
(34) SCREWED PLUG

(37) SPRING

DIAPHRAGM PLATE (32)
DIAPHRAGM (31)
DISTANCE RING (30)
SEALING RING (27)
SCREWED PLUG (29)
‘R’ Charger

- Supplies compressed air from BP to AR when BP pressure is raised.
- Also separates AR from BP through a check valve (located inside) when BP pressure is less than AR pressure.
Isolating Valve with Handle

- Isolating valve with handle

- Two positions:
  - Vertical – NORMAL
    - Connects BP to three pressure valve and R charger
    - Keeps AR isolated from ATM.
  - Horizontal – ISOLATED
    - Isolates three pressure valve and R charger from BP.
    - Connects AR to Atmosphere.
‘R’ Charger & Isolating Valve with Handle
Minimum & Maximum Pressure Limiter

- **Minimum Pressure Limiter**
  - Housed with max. pressure limiter and 'A' controller.
  - Provides passage without choke to charge BC during initiation of brake application.
  - Helps in rapid charging of BC up to a pressure of 0.8 Kg/cm² to overcome rigging resistance.

- **Maximum Pressure Limiter**
  - Limits the maximum BC pressure to the required value irrespective of the BP pressure drop and AR pressure.
Exploded View

Minimum Pressure Limiter

- DIAPHRAGM PLATE (50)
- GROOVED RING (35)
- SPRING PLATE (63)
- SCREWED PLUG (51)
- FLAT SEALING RING (47)
- VALVE HEAD (33)
- SPRING (62)

Maximum Pressure Limiter

- (84) DIAPHRAGM PLATE
- (66) SCREWED PLUG
- (47) FLAT SEALING RING
- (70) SPRING PLATE
- ADJUSTING RING (67)
- GROOVED RING (35)
- VALVE HEAD (65)
- SPRING (68)
‘A’ Controller & Quick Release Valve

❖ ‘A’ Controller:
• Charges CR by BP pressure during charging stage,
• Isolates CR when brakes are applied i.e. BP pressure is reduced.
• Also protects CR to be overcharged.

❖ Quick Release Valve:
• Allows CR to be fully released by means of manually pulling of handle.
Functioning of KE type DV

- **Charging stage**
  - Charging of control reservoir
  - Charging of auxiliary reservoir

- **Application stage**
  - Emergency application
  - Graduated application

- **Release stage**
  - Graduated release
  - Manual Release
Charging Position of KE type DV
Charging Position of KE type DV

DISTRIBUTOR VALVE (ESCORTS)

CHARGING POSITION

PRESSURES
- CONTROL CHAMBER
- BRAKE PIPE
- BRAKE CYLINDER
- AUX. RESERVOIR

QUICK RELEASE
Brake Riggings (Brake Gear)

- **Coaches**
  - ICF Coach
    - Conventional BC fitted (Underframe Mounted)
    - BMBC fitted (Bogie Mounted)
  - LHB Coach
    - Axle mounted disc brake
  - Some other examples
    - Brake applying on wheel disc or wheel trade.

- **Wagons**
  - Conventional BC fitted with
    - ELB device or
    - Load Sensing Device (LSD)
  - BMBC fitted wagons with
    - Load Sensing Device (LSD)
    - Automatic BC Pressure Modification Device (APM)
Brake Rigging of ICF Coach

Underframe Mounted

Bogie Mounted

INLET PLUG
compressed air is supplied from loco
Brake Rigging of Conventional ICF
Braking Force Calculation (ICF Convensional)

\[ P_3 = 2.6 \text{ T (13 T Bogie)} \]
\[ 3.6 \text{ T (16 T Bogie)} \]
Total force available on one brake block

\[
\text{Total force} = \frac{\pi}{4} \times (8 \times 2.54)^2 \times 3.8/1000 \times 1.9 \text{ or } 2.1 \times \frac{1}{2}
\]

\[
= 1.17 \text{ T for 13 tonnes or } 1.29 \text{ T for 16 tonnes}
\]
Clearance in Brake Rigging (Slack)

- Brake block clearance.
- Brake gear bush-pin clearance.
- Scope of increase or decrease in clearance.
- Effect of slack on brake system.
- Std. gap between brake block & wheel tread
  - whether required and how much?
Slack Adjustment

- Necessity of adjustment of gap (wear aspects).
- Slack adjustment to be taken up
  - Equivalent of total wear of wheel & brake block.
- Automatic slack adjuster: two types
  - External SAB slack adjuster
  - In-built slack adjuster
    - Single acting
    - Double acting
Fitted in Underframe mounted system stocks

Dimension ‘e’: Slack adjustment capacity
- $375 \pm 25$ mm for coach.
- $575 \pm 25$ mm for wagon.

Dimension ‘A’: Control dimension to maintain Std. gap.

Rapid action double acting.

Maintainability much poor.
IN-built slack adjuster

- Much better maintainability
- Piston stroke is control dimension to maintain Std. gap
- Adjustment capacity:
  - 305mm (ICF coach) against 395mm requirement.
    - Therefore one time manual adjustment required in whole life of wheel i.e. after reaching wheel dia 839mm
  - 500 mm (wagon) against 456 mm required.
    - Manual adjustment not required at all.
DEVELOPMENTS IN BRAKE SYSTEM
Developments in wagon

- U/frame mounted to bogie mounted system.
- Fitment of automatic load empty device.
  - Load Sensing Device (LSD) in U/f mounted system.
  - Automatic Pressure (BC) Modification (APM) Device in bogie mounted system.
Developments in coach

- U/frame mounted to bogie mounted system.
- Axle mounted disc brake system in LHB coach.
  - WSP (Wheel Slide Protection) fitted.
- EP brake system in DEMU coach
LHB COACH BRAKE SYSTEM
Salient Features

- Almost no brake rigging.
- Microprocessor based WSP.
- Wheel turning frequency reduced.
- Centralised control for complete coach.
- Use of Emergency Brake Accelerator for sharp emergency application in complete train set.
Schematic Diagram: ICF vs LHB

From microprocessor
MECHANICAL AND PNEUMATIC SYSTEM OF LHB BRAKE
Brake Equipments on Under frame

Brake Container

- **Consists of**
  - Brake control panel
  - Reservoirs
    - One 125L for brake application only (Protected by check valve)
    - One 75L for toilets as well as brake
    - One Control reservoir 6L for DV

- **Weight** - 350 kg (with all equipment)
Brake control panel

- **Consists of:**
  - Test fittings (To Check FP, BP, CR & BC Pressure)
  - Isolating cocks for FP, Toilet, Bogie-1 and Bogie-2.
  - Filters for BP and FP
  - Distributor valve
  - Pressure switch (to operate WSP)
  - Check valve.
Brake Components on Axle
Brake Disc

- **Consists of**
  - A gray cast iron friction ring(a) with integral
    - Crosswise cooling ribs
      - Carry off the heat.
    - Hub (c)

A gray cast iron friction ring(a) with integral crosswise cooling ribs carry off the heat. The hub is also present.
Emergency Brake accelerator

- Actuates on any rapid pressure reduction in BP, equivalent to emergency application.
- Allows the BP to vent locally via a large orifice.
WHEEL SLIDE PROTECTION
Concepts of Motions

- Roll
- Slip
- Slide
- Skid
 Requirement of WSP

- Poor Adhesion

- Because of high speed as 160 km/h and the EBD of 1200 m, the adhesion could be insufficient to sustain the brake rate demanded during emergency breaking, especially when the surface of the rail is wet and slippery.
Introduction of WSP

- A BC pressure regulation device.
- Adjusts the braking force to the wheel-rail friction (adhesion) so as to
  - Make optimum use of available adhesion
    - To optimize the braking distance and
    - To prevent wheel sliding.
- For 160 kmph & above WSP is recommended as must requirement.
Main Components

- The system consists of:
  - Speed sensor,
  - Anti skid valve/dump valve,
  - Microprocessor control unit and
  - Pressure switch.
Main Components

- Phonic wheel and Speed sensor
- Anti skid valve/dump valve
- Pressure switch
- Microprocessor control unit
Pneumatic & Electrical Connections

Speed Sensor

WSP-Electronic

Electric Connections

From DV

WSP-Valve

Pneumatic connection
Speed Sensor (pulse generator)

- Comprises
  - A magnetic sensor and
  - A teethed gear.
- Gap is maintained between teethed gear and sensor.
- No wear.
Microprocessor Control Unit

- Analyse all 4 input speed sensor’s signal frequencies.
- Evaluates all the frequencies.
- Generates signals for anti-skid valve to control the BC pressure.
Braking Distance w.r.t. Speed of Train

Composition of Train

2 Loco+
2 Powercar+
16 C/Car
Braking Distance Test Results

- Designed Braking Distance: 1200m at 160 kmph
- Results of braking distance trial of 18 coaches loaded-16 C/car+1EC/car+1P/car at 160kmph
  - Dry rail condition,
    - Emergency application- 1077 m.
    - Full service application- 1312 m.
  - Wet rail condition
    - Emergency application- 1094 m.
Wheel Slide Protection Principle

- Operates as a BC pressure regulation device.
- Made up of two micro processor-
  - Driven modules which control the state of adhesion of the axles.
  - Supervisor module for diagnostic purposes.
- In the case of change of state of the adhesion, the device
  - does not interact with the pneumatic system, but
  - every moments, it adjusts the braking force to the present adhesion conditions.
Wheel Slide Protection Principle

- System implements 4 axles-4 channels configuration and visualizes the use of 4 pneumatic devices for each axle.
- The intervention affects one axle at a time and is of the tachometric (speed comparison) and accelerometer type.
- Speed signal derived also for CDTS.
Development Of The Threshold Speed

- **Upper threshold speed**
  - Above which the axle involved is loosing adhesion.
  - A fixed 1.5km/h + approx. 6% of the real speed is referenced.

- **Lower threshold speed**
  - The threshold speed gap according to the real speed of the vehicle, above which the axle involved is considered as “skidding” by the system,
  - The air pressure is discharged from the respective BC.
  - A fixed 2.5km/h + approx. 25% of the real speed is referenced up to app 100km/.
Development Of Deceleration Criteria

- **DEC**
  - The maximum allowed deceleration for each axle above which the BC pressure is modulated.
  - The discharge of the BC may take place although the V2 threshold was not exceeded.

- The V1, V2 and DEC are a function of the instant speed of the vehicle.

- The ACC criterion is a fixed value.
Real Speed to V1, V2 and DEC Gr
Speed and Acceleration Criteria

- **Speed comparison (V1):**
  \[ V1 = Vr - (1.5 \text{ km/h} + 6 \times Vr) \]

- **Speed comparison (V2):**
  \[ V2 = Vr - (2.5 \text{ km/h} + 25 \times Vr) \]

- **Axle negative acceleration criterion (DEC):**
- **Axle positive acceleration criterion (ACC):**
Speed Computation

- **Reference speed (Vr):**
  - An estimate of the real speed of the vehicle.
  - Device takes the fastest axle’s speed as Vr.
  - If all the axles lose adhesion simultaneously,
    - The DEC criteria is followed until at least one axle regains adhesion.

- **Peripheral speed measurement (Vp):**
  - BC pressure is regulated by ASV,
    - In order to keep Vp between V1 and V2, i.e. the most favourable zone for restoring adhesion.
Pneumatic Assembly Control Logic

- **Reduce BC pressure if**
  - $Vi \leq V2$ or
  - $Ai \leq DEC$

- **Restore BC pressure if**
  - $Vi \geq V1$ or
  - $Ai \geq ACC$

- **Maintain BC pressure if**
  - $V2 \leq Vi \leq V1$ or
  - $DEC \leq Ai \leq ACC$
Control Logic Of Pneumatic Device
WSP - Field Test Data

- Measured speed of wheels
- Calculated speed of vehicle
- Actuation of WSP valves
Thank You