BOGIE DESIGN PARAMETERS

&

FIAT BOGIE

• RAVI NARULA
• Dy. Cme/Shell & Bogie
• Rail coach factory, Kapurthala
BOGIE DESIGN STEPS

- Layout calculations
  - Layout drawing
  - Interface with carbody
  - Gauge, Wheel base and wheel dia (customer)
- Proof layout calculations
  - Frequencies of suspensions
  - Bogie frame
  - Tilting coefficient
  - Derailment coefficient
- Exact calculations for springs, fasteners, brakes
BOGIE DESIGN STEPS

- Construction design on the basis of existing bogie
- FEM as per load case of UIC-515-4
- Refinement of suspension through vehicle dynamics
  - Data of track by user railway
Tilting coefficient

- Tilting coefficient = $\eta / \delta$

  - $\delta = \text{cant angle of track}$
  - $\eta = \text{tilting angle of coach body with respect to axle}$
Derailment coefficient

- Ratio of horizontal force to vertical force acting on rail wheel interaction
- Derailment coefficient $= \frac{Y}{Q}$

\[
\frac{Y}{Q} \leq \frac{\tan \beta - \mu}{1 + \mu \tan \beta}
\]

- $Y/Q$ should not be greater than 1.0 ---- IR limit
- $Y = \text{Flange force/lateral force for continuous min. 0.05 (1/20) sec.}$
- $Q = \text{Instantaneous wheel load}$
- $\beta = \text{Flange angle (68 degree)}$
- $\mu = \text{Co-efficient of friction between wheel and rail (0.25)}$
- $Y/Q = 1.4$
### CRITERIA FOR DESIGN EVOLUTION

<table>
<thead>
<tr>
<th>Safety against derailment coefficient</th>
<th>≤ 1.0</th>
<th>To prevent off loading of wheel on curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tilting coefficient</td>
<td>≤ .4 as per UIC</td>
<td>For max moving dynamic gauge</td>
</tr>
<tr>
<td>Separation of carbody bending frequency &amp; bogie frame pitching &amp; bouncing frequencies</td>
<td>By a factor ≥ $\sqrt{2}$</td>
<td>To avoid resonance</td>
</tr>
</tbody>
</table>
# CRITERIA FOR DESIGN EVOLUTION

<table>
<thead>
<tr>
<th>Buffer height drop from tare to loaded</th>
<th>≤75mm</th>
<th>To ensure safe coupling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary stage service deflection</td>
<td>10-15 mm(max)</td>
<td>For maintaining complete overlap of mounted disc brake</td>
</tr>
</tbody>
</table>
| Ride quality                        | Vertical frequency = 1 hz  
Lateral frequency = 0.5 hz  
Roll freq. = 0.5 Hz  
Riding comfort ≤ 2.75 | For good ride comfort |
CAR BODY PARAMETERS

• Center of gravity of X, Y & Z coordinates
  • Stability of multi modal system
  • Frequencies of oscillation of car body
  • Most off loaded wheel for safety criteria
  • Tilting coefficient due to lateral imbalance
• Layout drawing and interface drawing to car body
  • Deciding wheel gauge, wheel base and wheel dia
  • Check with max moving gauge
  • Body bogie interface concept
CAR BODY PARAMETERS

• Weight of carbody as per UIC in tare, gross & overloading
  • Calculate deflection of suspension system, buffer drop, interface in bogie components, mmd
  • Stress on bogie parts
  • Brake calculations
  • Vehicle dynamics analysis
• Moment of inertia of car
  • Multibody dynamics
• Interbody car distance
  • Vehicle dynamics and distribution of wheel load
  • Max rotation of bogie on curve
FIAT BOGIE

DESIGN FEATURES
BOGIE FRAME

- Y-FRAME-STEEL SHEETS (St-52)
- TWO SIDE FRAMES CONNECTED BY TWO CROSS BEAMS - SUPPORT BRAKE UNITS.
- BOGIE FRAME ON THE PRIMARY SPRINGS AND SUPPORTS VEHICLE BODY THROUGH BOLSTER.
- BOLSTER-BOGIE FRAME THROUGH SECONDARY SUSPENSION.
MATERIALS USED:

- STEEL CASTINGS (GS20Mn5V; DIN 17182):
  - BRAKE SUPPORT
  - PIN BRACKET
  - SPRING CENTERING IN SECONDARY (1268840)
  - BUMP STOP BRACKET LH/RH
- SGCI CASTINGS (IS:1865)
  - AXLE BOX FRONT COVER
  - CONTROL ARM TOP
  - CONTROL ARM LOWER LEFT/RIGHT
  - PRIMARY SPRING CENTERING LOWER AND UPPER
MATERIALS USED:

– FORGINGS:
  • TRACTION CENTER
  • CENTER PIVOT PIN
  • CONTROL ARM SUPPORT BKT LH/RH
  • ANTI ROLL BAR FORK
  • ANTI ROLL BAR BRACKET

– PLATE/TUBES (S355J2G3;EN10025)
  • BOGIE FRAME
  • BOGIE BOLSTER
  • CROSS SECTION
IMPORTED BOGIE ITEMS

- FORGED WHEEL DISCS
- BRAKE SYSTEM
- PRIMARY SPRINGS (indigenous also)
- SECONDARY SPRINGS
- DAMPERS
- RUBBER-METAL COMPONENTS (06 TYPES)
- MINER PAD
Primary suspension

• Four nos. each per bogie
  – Nested coil springs, primary vertical dampers, control arm, elastic joints-connecting the bearing on wheel-set to bogie frame.

• Flexible guidance.
Primary suspension

- Outer Spring
- Rubber Pad
- Spring Guide
- Inner Spring
- Lower Spring Guide
- Bump Stop
WHEEL SET:

- Two brake disks (4), diameter 640 mm and width 110 mm.
- Two wheel discs of dia 915 (New), 845 (worn).
Wheel Re-profiling and balancing

- DYNAMIC BALANCING
  320 RPM
- PERMITTED IMBALANCE - LESS THAN/EQUAL TO 50 gm
- WEIGHTS ARE GLUED AS REQUIRED
Axle bearings

- CARTRIDGE TAPER ROLLER BEARING
- PRE-ASSEMBLED UNIT
BRAKE UNITS

- AXLE MOUNTED DISC BRAKE
- INBUILT SLACK ADJUSTER IN BRAKE CYLINDERS
- CALIPER RATIO 1:2.17 FOR ALL COACHES EXCEPT POWER CAR, WHICH IS 1:2.48
- 35 mm BRAKE PADS
  - JURID 877/BECORIT984
SECONDARY SUSPENSION

- Nest of Flexi-Coil Springs Inner and Outer, Rubber Spring and Secondary Pad
- Vertical Dampers
- Lateral Dampers
- Yaw Dampers
- Anti-Roll Bar
- Anchor Links
(With Bolster Lifted)

- Bogie Bolster
- Sec. Vertical Damper
- Cross Section
- Nested Secondary Spring Assembly
- Yaw Damper
Lateral Damper

Lateral Bump stop

Longitudinal Bump stop

(Bolster removed)
ANTI-ROLL BAR

• A TORSION BAR WITH TWO FORKS - BETWEEN BOGIE FRAME & BOLSTER, CONNECTED BY ROLL LINKS.

• RESISTS ROLLING MOTION OF COACH.
ANTI-ROLL BAR:
Anti-roll Assly
BODY BOGIE CONNECTION
BOGIE BODY CONNECTION:

1. Threaded pin
2. Pin
3. Shims
4. Washer
5. Locknut
6. Nut bogie-carbody
7. Split pin
Principles of force transmission

• Vertical forces:
• BODY-BOLSTER-MINER PAD-SEC. SUSPENSION-BOGIE FRAME-PRIMARY SPRINGS/BALL JOINT CONTROL ARM-AXLES.
Lateral forces:

- BODY-BOLSTER-MINER PAD/SEC. SPRINGS/LATERAL BUMP STOP-BOGIE FRAME-BALL JOINT CONTROL ARM-AXLES.
Traction and braking forces:

- BODY-TRACTION CENTRE-TRACTION LEVER/LONGITUDINAL BUMP STOP-BOGIE FRAME-CONTROL ARM-AXLES.
CURVE NEGOTIATION:

- CONTROL ARM CONNECTING AXLE BEARING AND SIDE FRAME THROUGH ELASTIC CONNECTION.
- FLEXIBLE GUIDANCE TO WHEEL-SET
Main Data:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Axle distance</td>
<td>mm</td>
<td>2.560</td>
</tr>
<tr>
<td>Diameter of new wheels</td>
<td>mm</td>
<td>915</td>
</tr>
<tr>
<td>Diameter of max. worn wheel</td>
<td>mm</td>
<td>845</td>
</tr>
<tr>
<td>Distance between the wheels</td>
<td>mm</td>
<td>1600</td>
</tr>
<tr>
<td>Brake disc diameter</td>
<td>mm</td>
<td>640</td>
</tr>
<tr>
<td>Bogie width</td>
<td>mm</td>
<td>3030</td>
</tr>
<tr>
<td>Bogie length</td>
<td>mm</td>
<td>3534</td>
</tr>
<tr>
<td>Bogie weight</td>
<td>kg</td>
<td>6300</td>
</tr>
</tbody>
</table>
THANK YOU