

Failure analysis of Spring and components of Under frame in Rolling stock

Pankaj Kumar/Professor (Admin) /Jamalpur

Type of Rolling stock in IR

- As a broad classification, Rolling stock are classified into following two groups, according to the availability of power source to move over the track.
 1. **Self-propelled Vehicles:** it do not require a separate power source or a pulling member to move over the railway track.
For example – Locomotives, Rail Cars, EMUs, DEMUs, Diesel break down Cranes, Tower Cars, Motor trolleys etc.
 2. **Non self-propelled Vehicles:** it need a separate power source like a locomotive to move over the track.
For example – Coaching Stock and Freight Stock.

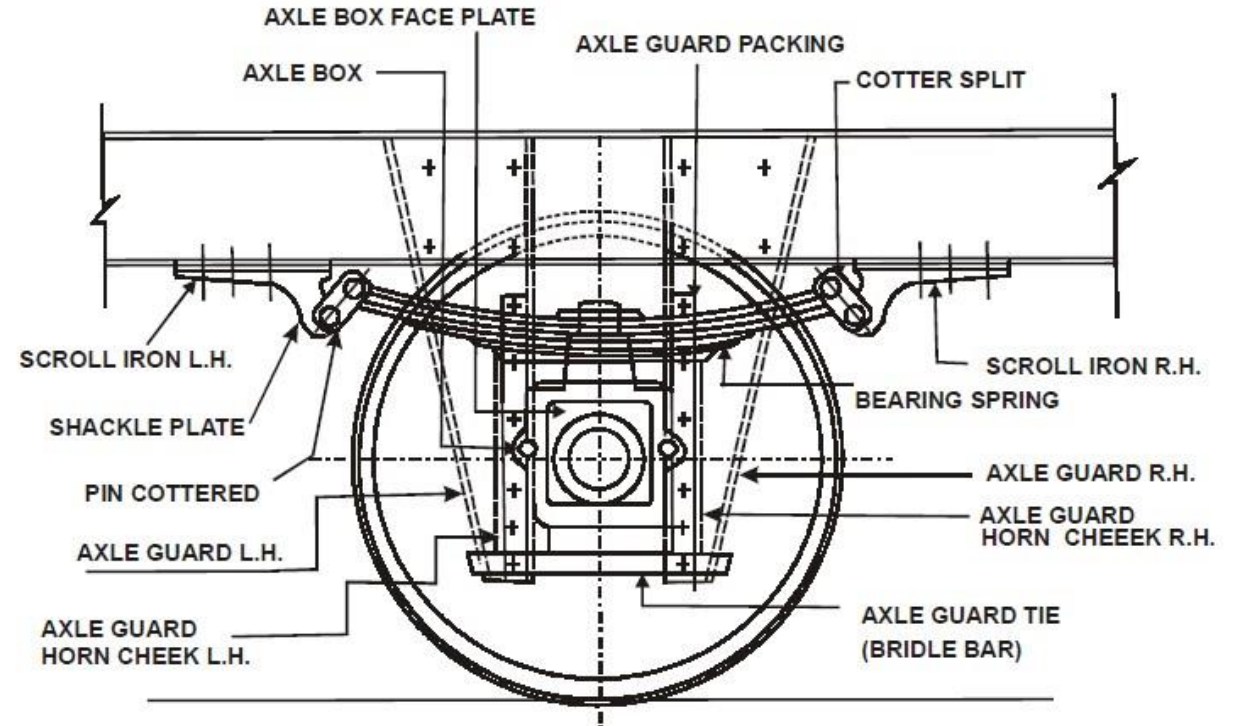
SPRINGS IN THE BOGIE OF ROLLING STOCK

- Spring is a very important element of safe railway operations, as it supports the railcar body, allows the train to run smoothly both on straight and on curved tracks, ensuring a comfortable journey, amongst other things.
- Typically, the types of springs found in bogies are-
 - Steel leaf/Laminated spring
 - Coil spring
 - Rubber spring
 - Air springs. (They reduce forces and vibrations and help to prevent derailment.)

Leaf Spring in Brake van

Steel leaf spring /Laminated in Four Wheeler Suspension

- ❑ In four wheeler wagons the load is transmitted in the conventional arrangement via the sole bar, scroll iron, shackles or shackle plates to the springs and axle box, axle box key plates and bearing journal.
- ❑ Brake van (four wheeler)



CAUSES FOR FAILURE OF SPRINGS

- The spring may fail in service for reasons described below. Action/ precautions to be taken in each case are being indicated item wise:
 - **Incorrect composition** of material: Different grades of steel plates some times get mixed up.
 - Sharp edges of nib/groove: **Sharp edges**, if any, should be removed by grinding or other means.
 - **Biting marks** at the rolled eye portion: Biting marks act as stress raisers.
 - **Punch marks** on plates: These marks, particularly on tension side of plates, act as stress raisers during service and lead to early failure of springs. No punching should be done on spring plates.
 - Accidental injury to plate: Sharp dents or notches caused during manufacture or in service act as stress raisers and reduce the life of spring.
 - Quenching cracks:-These are usually caused by (a) inadvertent use of **wrong grade of steel** for a given heat treatment procedure, (b) too **drastic** a quenching medium, (c) high **hardening temperature**, (d) insufficient **soaking period**, (e) surface defects such as seams laps, cluster of non-metallic inclusions occurring at or near the surface, (f) **sharp grooves** or dents on surface. In service, they act as stress raisers resulting in premature failure.
 - Corrosion:- Corrosion occurs either locally or throughout the section in the form of small shallow pits (**pitting corrosion**). These act as stress raisers under alternating stress conditions during service
 - Other causes: The following causes may lead to either fatigue crack formation or sudden fracture (a) **uneven** loading of wagons, (b) uneven bearing of pins on spring eyes due to use of worn out pins, (c) lateral shifting of spring plates due to **slackness of buckle**.

Quenching crack



REJECTABLE DEFECTS

- The following are the rejectable defects in springs:
 - i. Any plate of laminated bearing spring cracked or broken.
 - ii. Bearing spring **buckle loose**, broken, cracked and/or packing plated loose or deficient.
 - iii. Any plates of buckle are displaced from its central position by 13mm or more.
 - iv. Bearing spring buckle not sitting square in the axle box housing or crown packing when fitted.
 - v. Incorrect type of bearing spring for particular design of wagon.
 - vi. Bearing spring **eye or shackle plate touching the sole bar**.
 - vii. On meter gauge wagon bearing shoe fractured or with a rivet bolt or stud broken or deficient or bolt stud or wrong size.
- The following additional defects are also noticed in service:
 - i. **Loss of spring camber**
 - ii. Biting marks on rolled eye portion. There should be gap of 2mm between rolled and upper surface of the top plate other wise this may raise the stress and lead to fracture of the spring along the dent marks.

Coil Spring in Wagon (Casnub Bogie)

Coil Spring (wagon)

The spring shall be manufactured as per the schedule of Technical Requirement for hot coiled helical springs WD-01-HLS-94 (Rev. I May, 95 with latest amendment) by the spring manufacturers approved by RDSO.

Procurement of spring steel shall be done only from reputed manufacturers approved by RDSO. Only spring steel bars duly inspected and passed by RDSO shall be used for manufacture of springs.



Coil Springs in CASNUB bogie (maintenance practice)

- It is recommended that the springs should be so grouped that the free height variation in the group is not more than 3 mm.
- Mixing of new and old springs should be avoided.
- Coloured band should be provided for easy identification of group height as indicated in the table.



Coil Springs in CASNUB bogie (maintenance practice) -----

- The springs are condemned on the basis of free height.
- Springs should be replaced if minimum spring height is at or less as per RDSO guideline.
- The 'Casnub' bogie springs are manufactured out of Silica Manganese Steel to IS: 3195 Gr. 60 Si 7, Gr. 60Cr4V2. IRS Specification R2 & RDSO Specification WD-OI-I-ILS-94 (Rev. 1).

Bogie	Springs	Free height nominal (mm)	Recommended free condemning height (mm)
All versions except Casnub 22 HS	Outer	260	245
	Inner	262	247
	Snubber	294	279
Casnub 22 HS Bogies	Outer	260	245
	Inner	243	228
	Snubber	293	278

Maintenance Issues of Springs in wagon

1. Stacking System of Springs-

4-Tier system should be adopted for easy placement & removal of springs.

2. Spring loaded dial gauges-

Spring height gauges must be kept in spring section.

Spring loaded dial gauges may also be kept inline.

3. Transportation of set of Springs

For safe transportation from sub-store to shop, rectangular wheeled trolleys should be developed & kept in section.

4. Colour Coding/Provision of Band

As of now, only local colour coding is in practice in zonal Railways.

Marking of coloured band on springs is most commonly adopted system in ROH depots. It is recommended that marking of bands may be done for easy grouping of springs in the depots.

5. Cleaning of springs

Wire brush is being used for cleaning of spring. The practice is useful & be continued.

Spring Transport trolley



Coil Spring in ICF Coach

RDSO's view on safety of passenger coaches due to breakage of one axle box spring in ICF coaches during run.

- Derailment of passenger coaches can occur if there is sudden increase in lateral force or if there is excessive off loading of any wheel.
- The axle boxes of all coil ICF bogies are rigidly guided by the telescopic dash pot arrangement and no lateral force is taken by the axle box springs. Thus the breakage of one axle box spring will not affect the lateral force and would not cause derailment as the increase of lateral force is not possible.

RDSO's Guideline in case of ICF bogies with one axle box spring broken on run-

Train should not leave originating as well as terminating stations with a coach having any broken axle box spring.

A coach with one axle box spring broken enroute can continue its journey at its normal operating speed up to the terminating station. In case the operating speed of the train is above 100 Kmp/h, the coach shall only be permitted to continue its journey at restricted speed of 100 Kmp/h.

Axle box spring in ICF bogie

Secondary suspension



Primary suspension

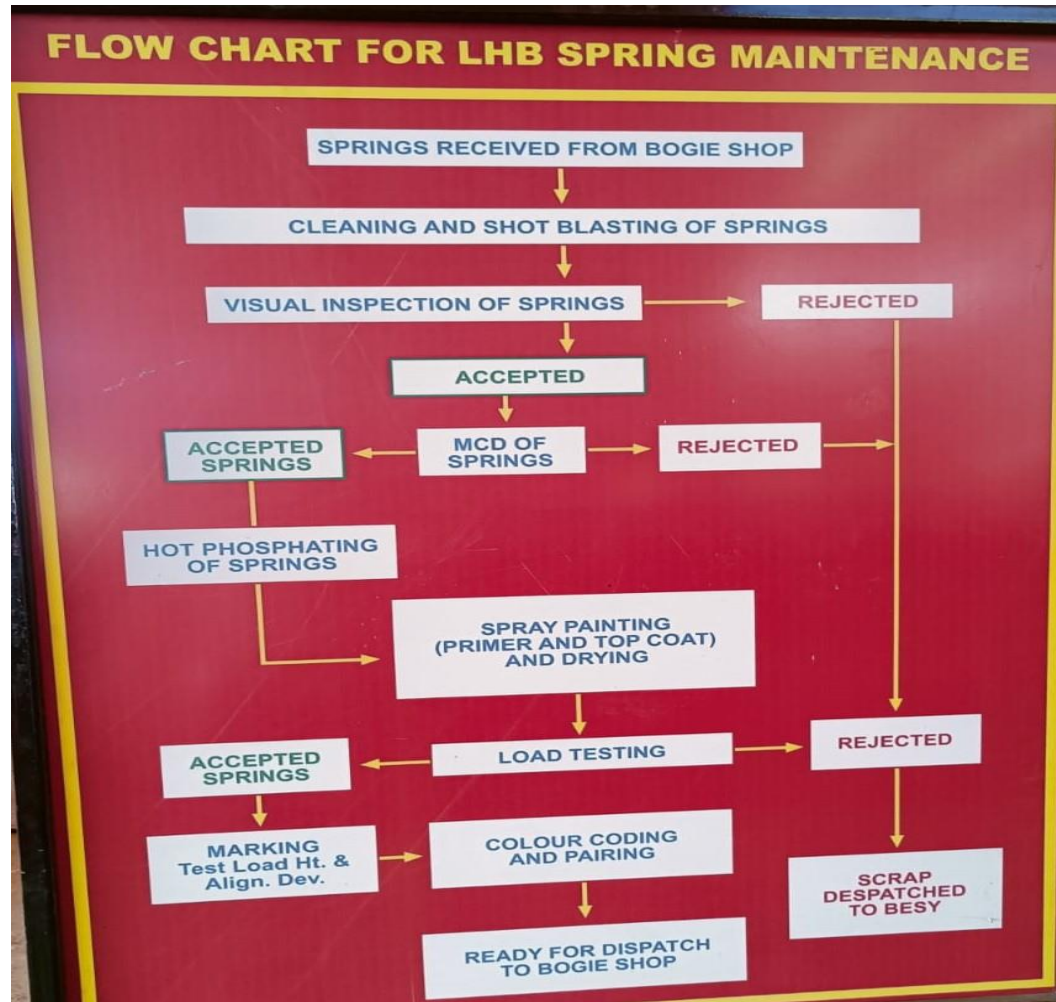


ICF Coil spring (Maintenance flow chart)



Coil Spring in FIAT Bogie of LHB coach

LHB coil spring (Maintenance flow chart)



Maintenance practices of Coil springs in FIAT bogies of LHB coaches (at workshop)

S.No	Instructions	Common deficiency
1	Clean the springs (both primary and secondary) thoroughly with suitable detergent water jet in dis-assembled condition.	Cleaning was not being done thoroughly as prescribed. In some workshop, dust is removed by brush instead of water jet cleaning.
2	Clean the contact line on the end coils and repaint the paint damaged areas duly following the proper paint procedure given in this instruction manual	Contact line on the end coils was not being cleaned properly. Painting was done by applying the top coat without following prescribed paint procedure .

Maintenance practices of Coil springs in FIAT bogies of LHB coaches (at workshop).....

S.No	Instructions	Common deficiency
3	Any damage to the coating (paint) in locations other than the contact lines may also be repaired. In case the paint damage is extensive, the spring may be taken for complete overhauling	Paint repair in locations other than contact line was also being done very casually without following prescribed paint procedure.
4	Test the springs on load deflection test machine. Replace the spring if the deflection obtained is beyond the load deflection characteristics given in Annexure-2 of maintenance instruction.	Load deflection testing facilities for secondary springs was not available. Parameters i.e. height under test load, alignment deviation and direction of alignment deviation were not being ensured properly.

Maintenance practices of Coil springs in FIAT bogies of LHB coaches (at workshop).....

S.No	Instructions	Common deficiency
5	Overhauling of springs on in SS3 schedule.	Complete overhauling of both types of springs was not being done. Infrastructure for complete overhauling of springs including load deflection testing for secondary springs, shot peening machines, painting-phosphating tanks etc. was not available.
6	Storage, Handling and Mounting of Springs: a) Springs should not be rolled on the floor for movement from one place to other. b) Forks, crane hooks etc. should be provided with soft material cover like rubber cover etc. to avoid damage during handling	a) Rolling marks were observed on the surfaces of primary and secondary springs. Handling of the springs was not being done properly and paint gets damaged during handling. b) Soft material cover etc. is not being provided during handling of springs in workshops. Handling of springs was found very poor.

Maintenance practices of Coil springs in FIAT bogies of LHB coaches (at workshop).....

S.No	Instructions	Common deficiency
7	Maintenance instructions of coil springs is issued by RDSO.	The relevant maintenance instructions of coil springs issued by RDSO were not available.
8	Analysis & reporting of spring failures.	Analysis & reporting of spring failures was not being done regularly.

Deficiencies noticed at Coaching depot during maintenance of Coil springs in FIAT bogies.....

S.No	Instructions	Common deficiency
1	<p>Activities to be performed in D1 Schedule (Every trip):</p> <p>a) Clean the springs where suspected crack is observed during examination.</p> <p>b) In case of replacement of any spring, the centering disk to be cleaned and painted if required.</p>	<p>a) It was observed that the coils of the springs are severely laced with dirt, dust and muck. Proper cleaning of the springs was not being done in maintenance schedule. It was difficult to identify the suspected locations of cracks on springs.</p> <p>b) b) Centering disc is neither cleaned nor painted.</p>
2	<p>Activities to be performed in D2 Schedule (Every 30 days):</p> <p>a) Clean the springs by Water Cleaning/compressed air blowing.</p> <p>b) Check for any point damage, particularly in the zone of contact between inactive and first active coil. In case of corrosion, paint damage is to be repaired.</p>	<p>a) Cleaning of bogie of coaches falling D2 Schedule was not being done by coach cleaning staff. It was also not included in relevant maintenance format.</p> <p>b) Check for paint damage & corrosion: Paint damage, particularly in the zone of contact between inactive and first active coil was observed. Corrosion in between inactive and first active coil was also observed.</p>

Deficiencies noticed at Coaching depot during maintenance of Coil springs in FIAT bogies.....

3.	Primary & secondary springs should be protected against corrosion by a paint coating.	Springs were not properly protected against corrosion by paint coating particularly in lower coils where failure occurs.
4.	Any paint damage/corrosion on primary & secondary springs is noticed/reported.	Paint damage/corrosion on primary and secondary springs has been noticed.
5.	<p>Storage, Handling and Mounting of Springs:</p> <p>a) Spring should be stored in unpacked and unwrapped condition in a dry covered place.</p> <p>b) Springs should not be rolled on the floor for movement from one place to other.</p> <p>c) Forks, crane hooks etc. should be provided with soft material cover like rubber cover etc. to avoid damage during handling</p>	<p>a) Most of the springs were observed with paint damage. Springs were rolled on the floor for movement from one place to another. (Fig.5, 6 & 7).</p> <p>b) Spring transport trolley was not provided with soft material like rubber cover etc. Crane hooks were also not provided with soft material cover. (Fig.8, 9 & 10).</p>

Deficiencies noticed at Coaching depot during maintenance of Coil springs in FIAT bogies.....

6.	RDSO instruction should be followed for repair of paint damage.	RDSO's instructions were not properly being followed in the right earnest for repair of paint damage
7.	Maintenance instructions of coil springs issued by RDSO.	The relevant maintenance instructions of coil springs issued by RDSO were not available.
8.	Analysis & reporting of spring failures.	Analysis & reporting of spring failures was not being done regularly.

Rolling marks on spring

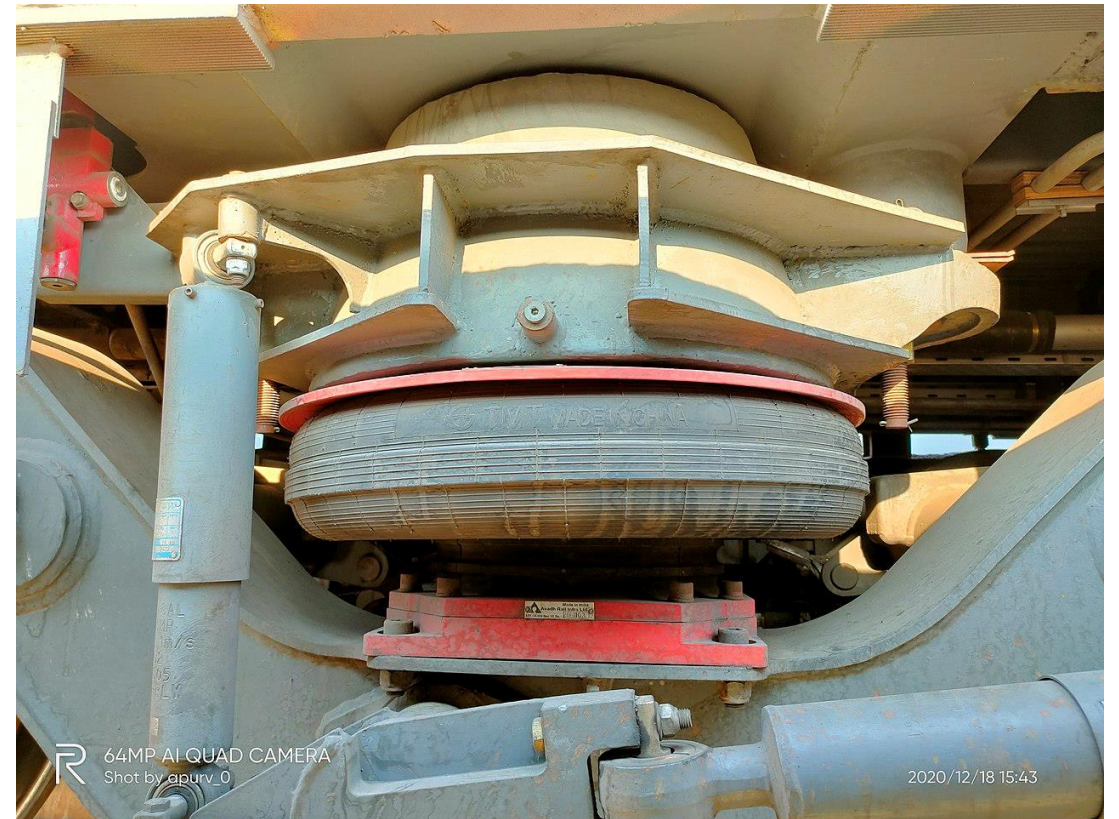


Air Spring in FIAT bogie of LHB Coach

Air spring – cleaning of air spring

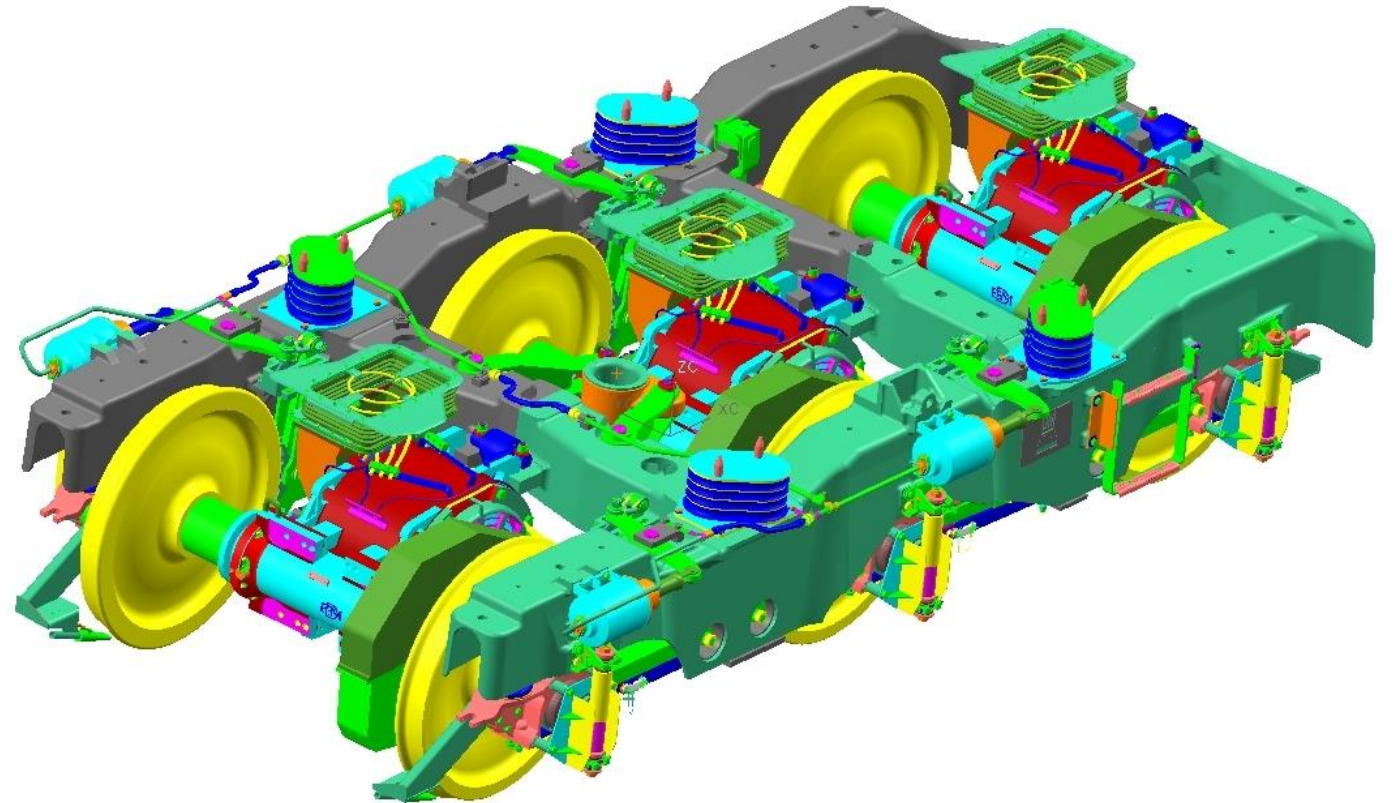
- **CLEANING OF AIR SPRINGS**

- Rubber products can be cleaned with soap and warm water. The cleaned articles should be dried at room temperature. After a fairly long period of storage (6 to 8 months) the product can be cleaned with a **1.5% sodium bicarbonate solution**. Remaining traces of the cleaning fluid should be rinsed off with water.
- Solvents such as trichlorethylene, carbon tetrachloride as well as hydrocarbons must not be used for cleaning purposes.
- Moreover, sharp- **edged objects, wire brushes, emery paper, etc should not be used**. Rubber metal bondings are to be clean using a glycerine-sprit mixture (1:10).



Failures analysis HTSC Bogie of HHP loco

- Axle Lock
- Break binding
- Gearcase leakages
- Hand break not working



Causes of Axle Lock

- Traction motor bearing seize (Free end bearing is grease lubricated)
- Traction motor Pinion teeth broken
- Bull gear teeth broken
- Gearcase oil leakage (in resultant rear end bearing may seize in lack of lubrication)



Causes of Axle lock

- CTRB lubrication lack/ Hot box
- MSU tube roller bearing seize
(usually greasing is to be done after 6 months as precaution)



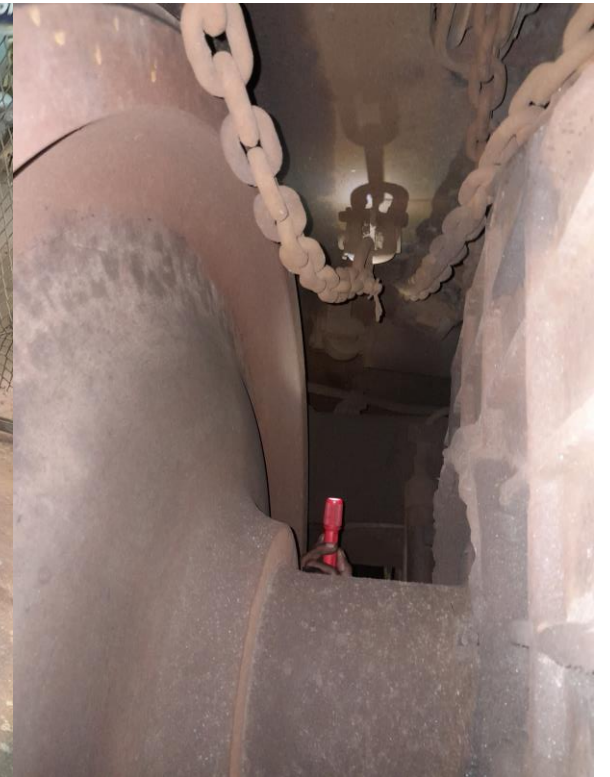
Causes of Break binding

- Hanger struck (sometime Bush piece is fallen in passage and stop the movement of hanger)
- Air pressure not released (C2 relay valve malfunctioning)



Causes of Break binding-----

- Hand break not released.
(in HTSC bogie hand break is provided on Right side of loco at wheel axle No- 4 & 5)
 - * Chain lock/ fastened at end may be broken.



Causes of derailment

- Less vertical clearance
(major reason of less vertical clearance is worn out of Rubber spring or side bearer (secondary suspension)
Minimum it should not be less than 3 mm.
- Each Bogie consists of 4 Rubber spring /Secondary suspension(also called as side bearer) and each carry 12.5% loco load.



Causes of derailment.....

- Excessive Lateral clearance

(In new condition of WDG4 loco, the maximum total lateral clearance at middle axle should be 0.74 inch or 18.8 mm)



Thanking you