LOCOMOTIVE'S BOGIES
&
COMPONENTS

CONSTRUCTION, FUNCTIONING & MAJOR COMPONENTS

by J. P. Singh, Professor (Mech.)

OBJECTIVES

- Traction mechanics
- Bogies / Trucks
- Functional requirement
- Operational requirement
- Major components

TRACTION MECHANICS

- It is study of train motion
- Involves conversion of overhead diesel/electrical power/steam power in rail horse power to haul a train encountering acceleration, train, grade, curve resistance and similarly braking
- Traction Mechanics involves concept of
  - train resistance
  - tractive effort
  - braking effort
  - adhesion
  - balancing speed

SOME (OBVIOUS) REASONING

- Why Railways (or why Railway should be preferred mode of transport)
- Electrification of Railways
- High speed railways
- Locomotives hauled Vs. Trainset/EMUs

HOW FAR CAN A LITRE OF DIESEL TAKE YOU ?

12 Tonne X Km (most efficient prop.), 4 Tonne X Km (Jet)

22 Tonne X Km (most efficient common rail)

30 Tonne X Km (fuel injection common rail)

300 Tonne X Km

900 Tonne X Km

Research: www.seagrant.umn.edu

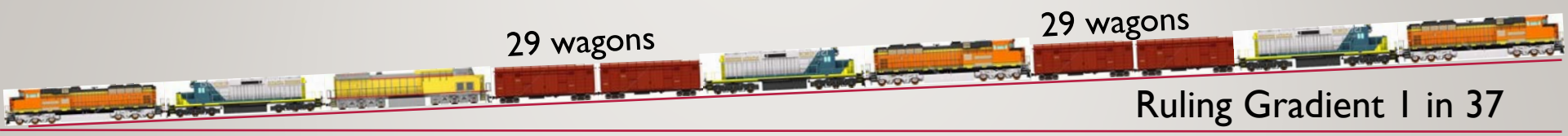
REASONS FOR HIGH ENERGY EFFICIENCY

- Rolling friction is very low between steel rail and steel wheel
- Rolling resistance is [comparatively] higher between rubber tyre and asphalt/concrete/tar road
- Head-on wind resistance, per unit load, is less in Railways
- Despite being of older generation, the bigger engines are always more efficient then the smaller units

ARE THERE ANY CONSTRAINTS ?

- Low rolling friction means low adhesion
- Maximum gradients are limited, on which trains can run, climbing up/down due to altitude variations – geographically, is not easy
- Emergency braking distance is very high (upwards of 600 meters – up to 6000 meters, depending on speeds)
- Specialized mode of transportation, requirement of sophisticated control system/signal/traffic control

TRAIN OPERATIONS IN HIGH GRADES



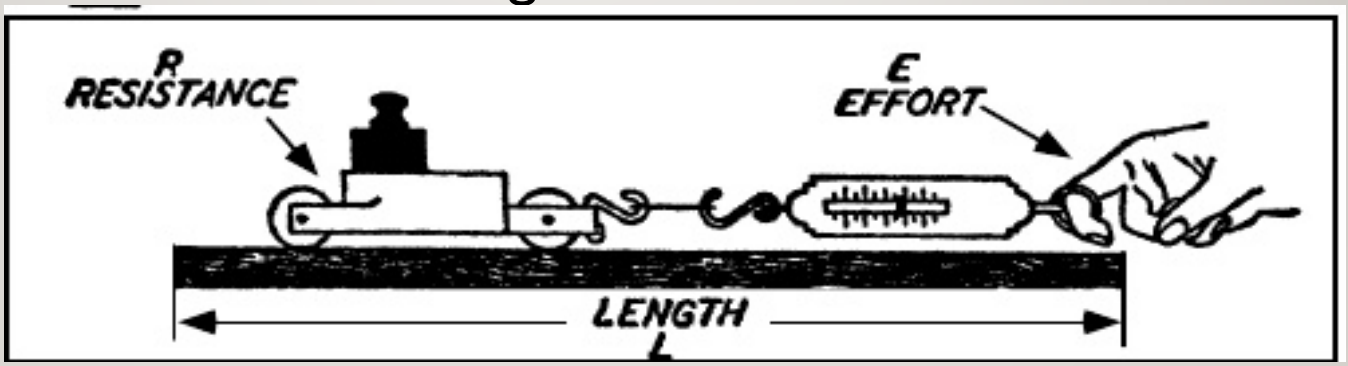
- 7 WDG3 Locomotives hauling one train 58 BoxN of 5200 Tonne (CLR-QLM), in Braganza ghat, SWR, between Karnataka and Goa

- Same train hauled by 5 WDG4 Locomotives

- 4 WDG4 Locomotives hauling a train of 5200 Tonne (SKLR-SBHR), in MYS div. SWR.

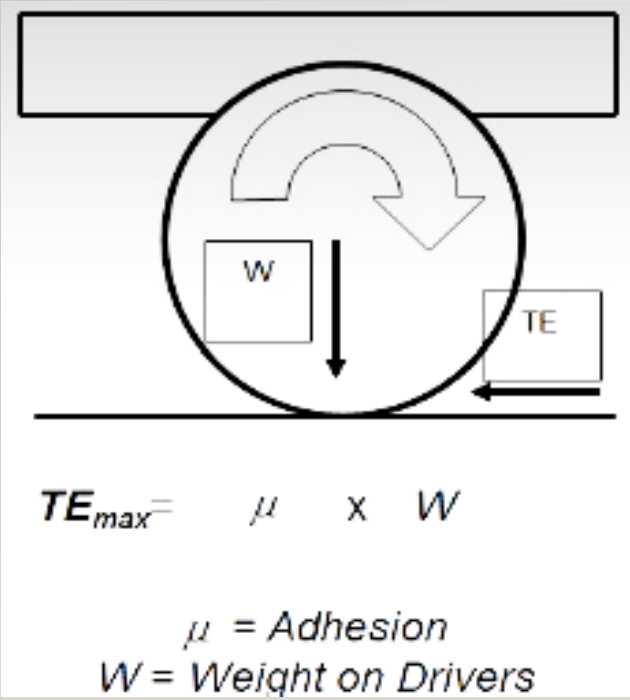
PULLING A TRAIN…

- **Tractive Effort** or **Tractive Force**, is the amount of force at the Loco coupler available for moving a train



- To pull a train, a force must be applied to overcome the **Train resistance** or inertia of the resting train
- The train remains at rest until sufficient force is applied
- Once movement occurs, the train will continue to move so long as the applied tractive force remains greater than the resisting forces reacting against the tractive force moving the train

TRACTIVE FORCE / TRACTIVE EFFORT



- TE is generated at each driving wheel
- It is product of coefficient of friction (between rail & wheel) X Weight on wheel
- Loco TE is sum of all TE at driving wheels

Coefficient of friction (adhesion) varies from 10% on wet and slimy rail to about 45% on dry and sanded rails

PULLING A TRAIN…

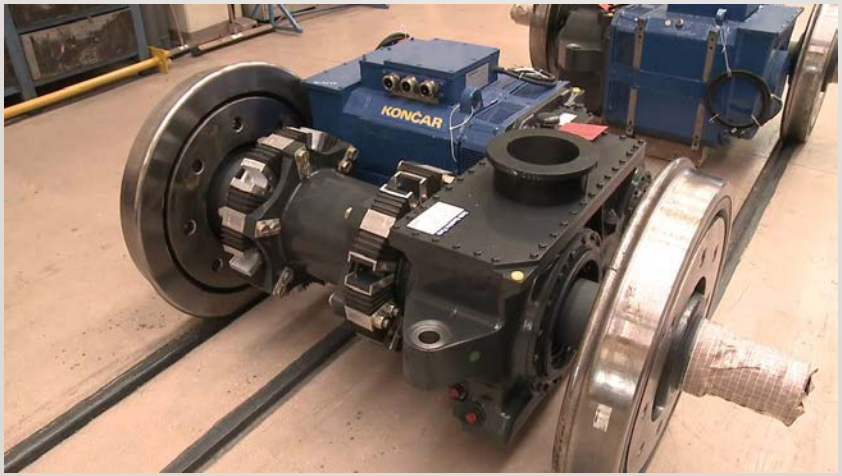
- All that is required is … a horizontal pulling force

Tonnes or KN

- **With all its complexity, state of art technology, the only real job a Locomotive has got is … produce a horizontal pulling force** (brake application is another – but that is not so complex)
- This horizontal pulling force is called Tractive force
- This tractive force is produced due to friction between rails and wheels (there has to be friction otherwise wheels would slip freely and no tractive force will be produced)
- **The tractive force is weight on the pulling/driving wheel X coefficient of friction X number of wheels (driving wheels) pulling the train**

DRIVING WHEELS & IDLING WHEELS

- Driving wheels are the ones, that are powered by a traction system (Motor/Hydraulics/Gear box)



- Idling wheels are not powered, and are for providing support superstructure/load (they may have brakes)

INCREASING THE TRACTIVE FORCES

- Increase the friction between driving wheel & rails
- Increase the weight (or load) on driving wheels

AND/OR

- Increase the number of driving wheels
  - Multiple units / EMU
  - Speeds beyond 200 kmph possible only with MU/EMU

SO… ONLY THING WE NEED IS HIGHER **TE**

- Tractive effort can be increased by:
  - Increasing the **friction between rail and wheel**
  - Increasing the **weight on each driving wheel**
  - Increasing the **number of Driving wheels**
  - Or a combination of above
- What about higher Horse Power (of Locomotive / Trainset) ?
  - Required for running at higher speeds

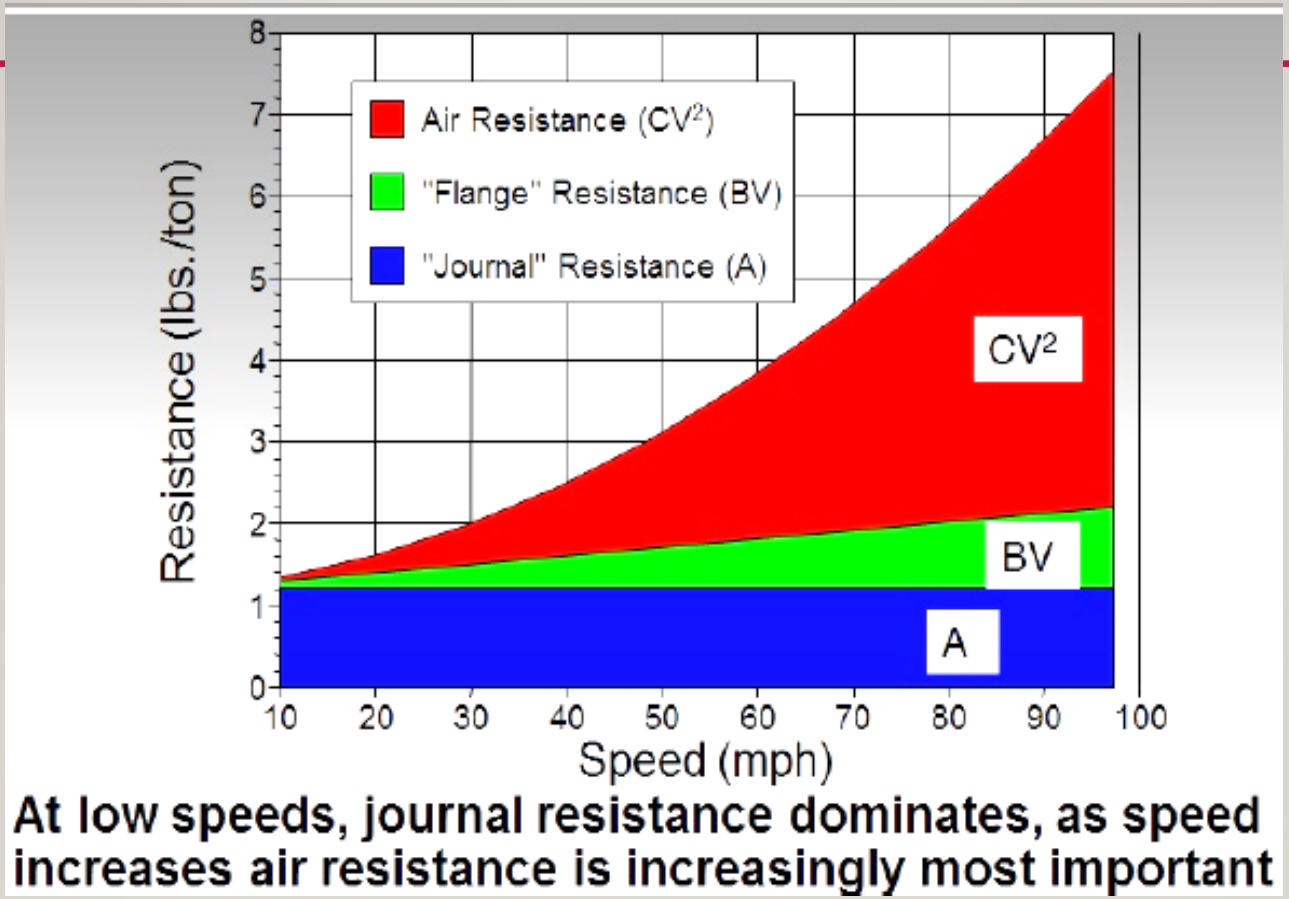
TRACTIVE FORCE / TRACTIVE EFFORT

- **Starting tractive effort**: Starting tractive effort is the tractive force that can be generated at a standstill. It determines the maximum train weight that a locomotive can set into motion

- **Maximum tractive effort**: Maximum tractive effort is defined as the highest tractive force that can be generated under any condition that is not injurious to the vehicle or machine

- **Continuous tractive effort**: Continuous tractive effort is the tractive force that can be maintained indefinitely, as distinct from the higher tractive effort that can be maintained for a limited period of time before the power transmission system overheats

TRAIN RESISTANCE



At low speeds, journal resistance dominates, as speed increases air resistance is increasingly most important

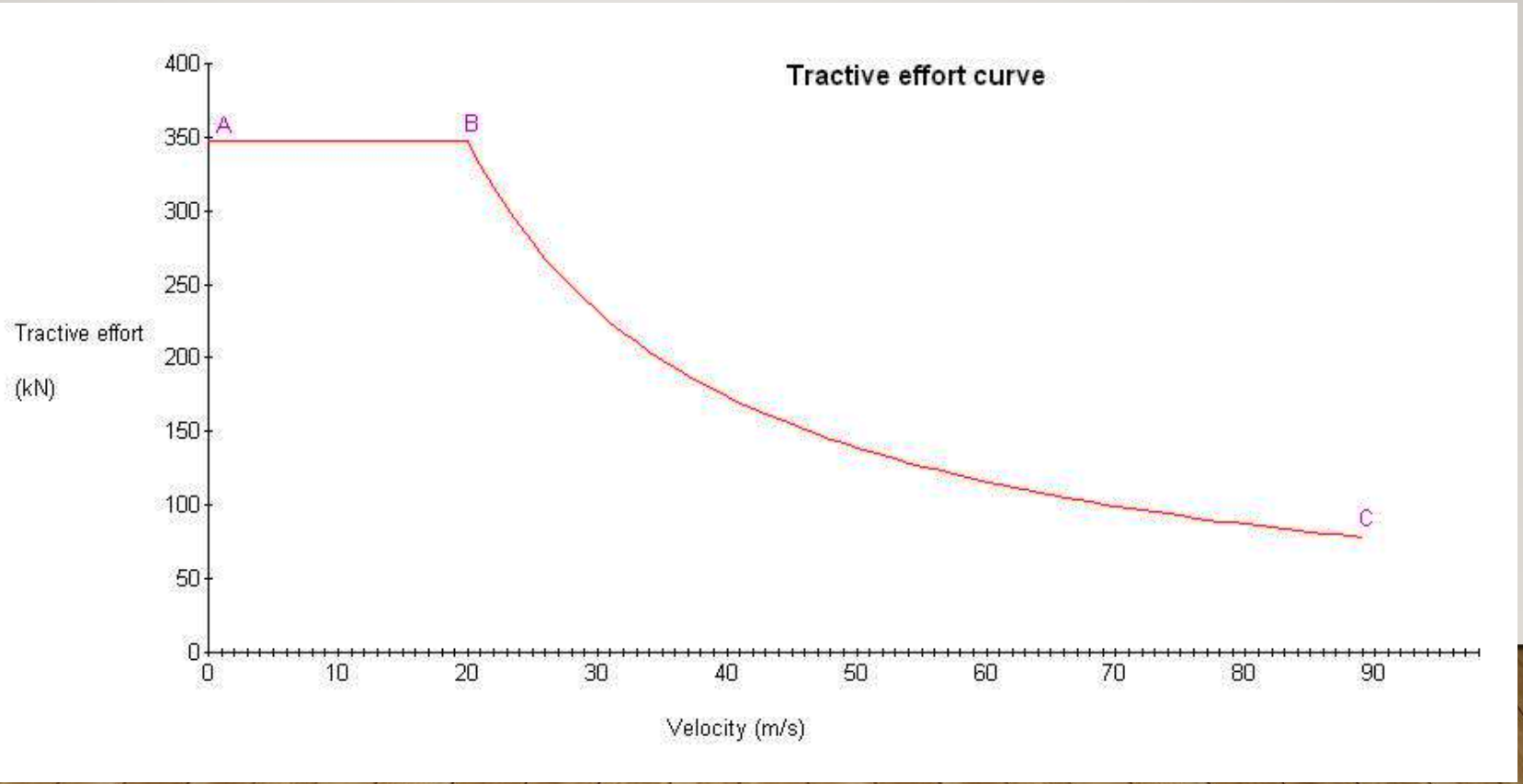
- Resisting forces are Rolling resistance (AW), Flange friction (BV) & Wind resistance (CV)
- $R = AW + BV + CV^2$ (where W = Weight, V = Velocity)

TRACTIVE EFFORT

- Due to the relationship between power (*P*), velocity (*v*) and force (*F*), described as:

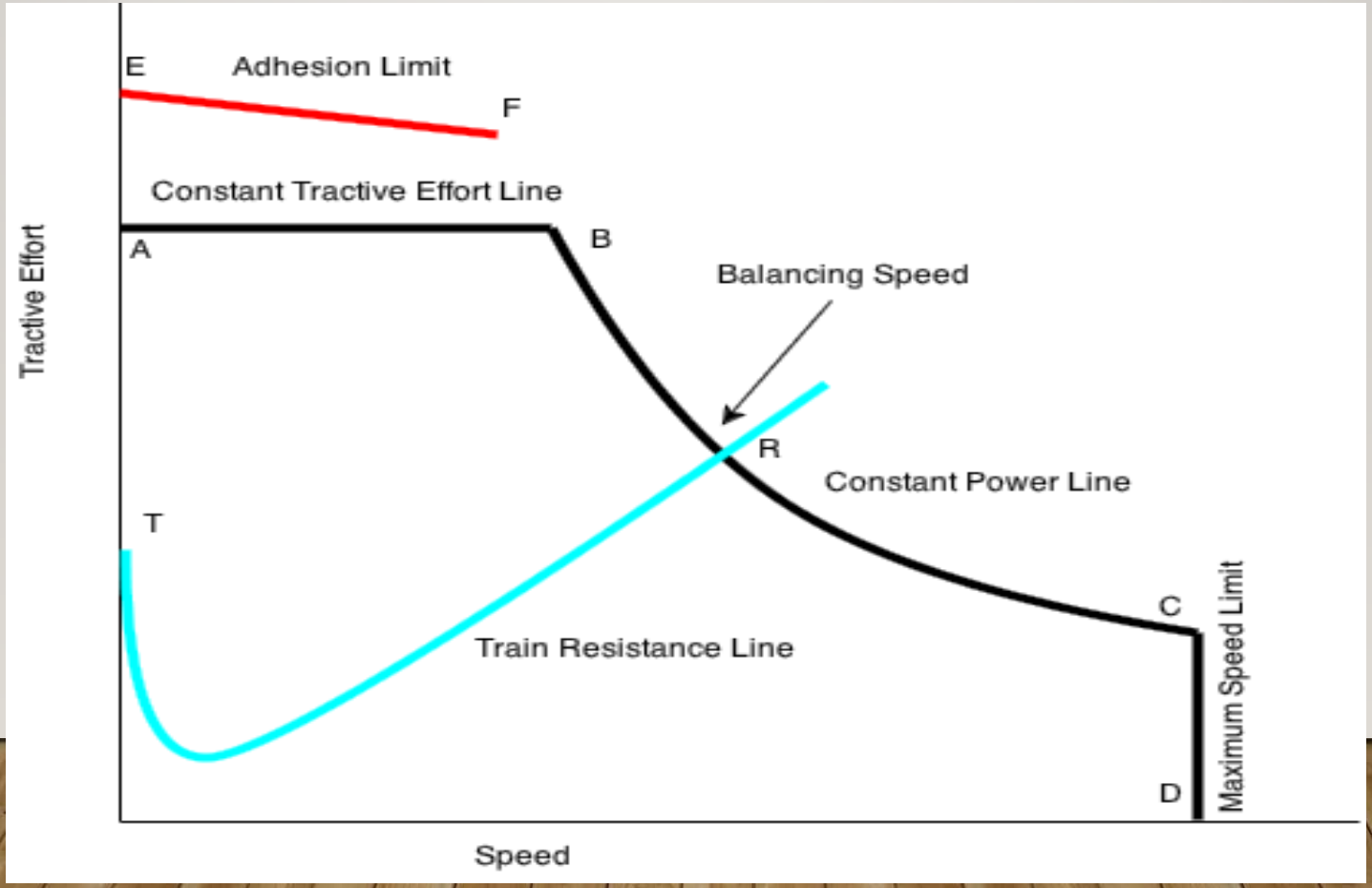
  $P = vF$ or $P/v = F$

- Tractive effort inversely varies with speed at any given level of available power



TRACTIVE EFFORT & BALANCING SPEED

- Balancing speed of train is the maximum achievable speed of a loaded train on the level track in normal environmental conditions
- Balancing speed of the train is calculated by the intersection of the total resistance-speed curve and the tractive effort-speed curve



CREEP

- Creep = $\dfrac{\text{Actual displacement} - \text{Rolling displacement}}{\text{Rolling displacement}}$

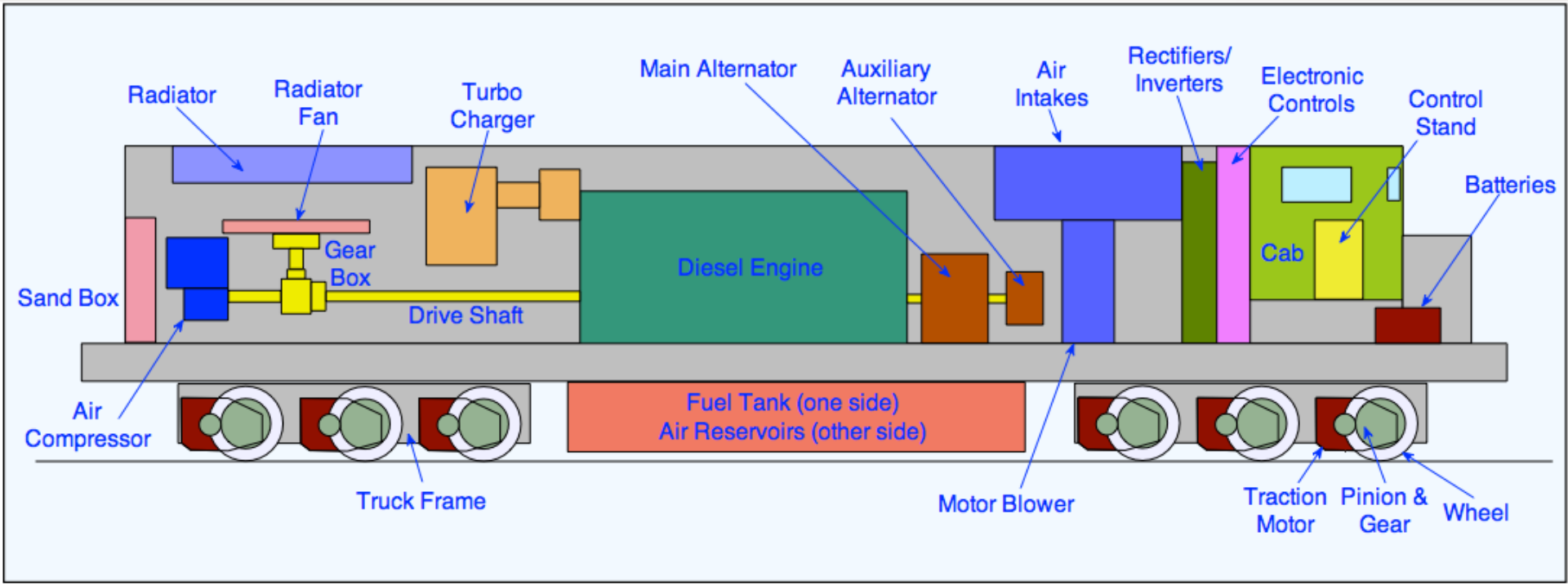
- Wheel slip

- Wheel skid

BRAKING DISTANCE

- Braking distance refers to the distance a train will travel from the point when its brakes are fully applied to when it comes to a complete stop
- It is primarily affected by the original speed of the vehicle and the coefficient of friction between the wheel rim surface and the rail surface
    - and negligibly by the rolling resistance and train's air drag
- The type of brake system in use also affect, if the brake system cannot supply enough force to match the static frictional force

LAYOUT OF MAJOR COMPONENTS IN LOCOMOTIVE



BOGIE & BOGIE LESS DESIGNS

WDS 4

BOGIE & BOGIE LESS DESIGNS

WDG 3A

BOGIE & BOGIE LESS DESIGNS

WDG 4D

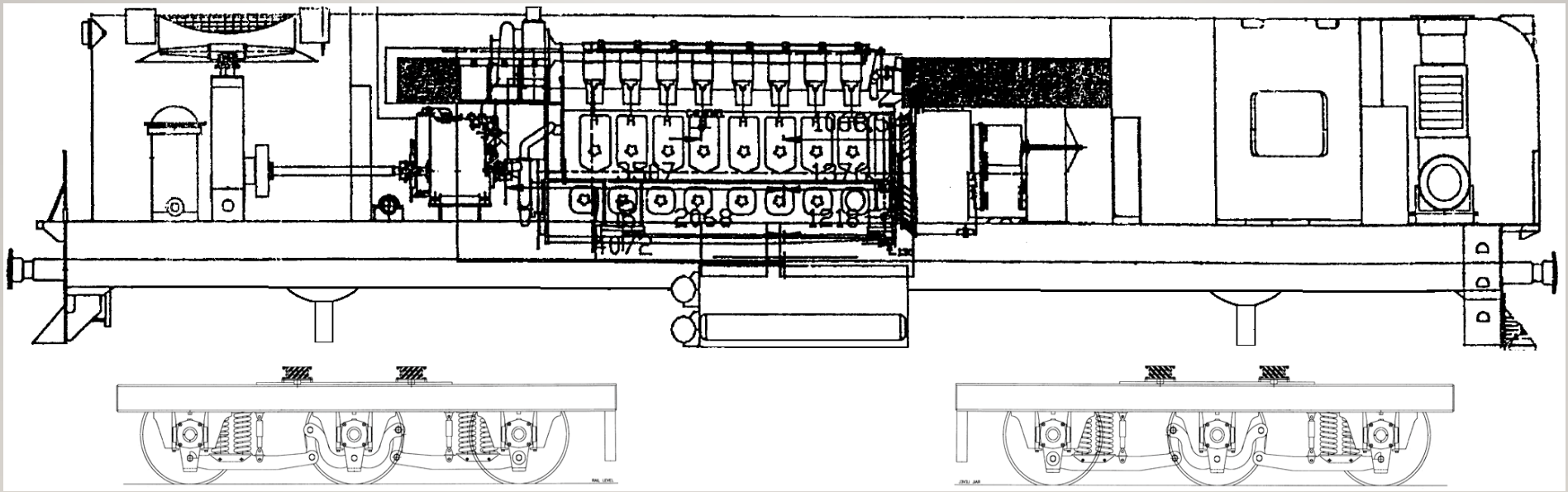
BOGIE & BOGIE LESS DESIGNS

WDG 5

BOGIE & BOGIE LESS DESIGNS

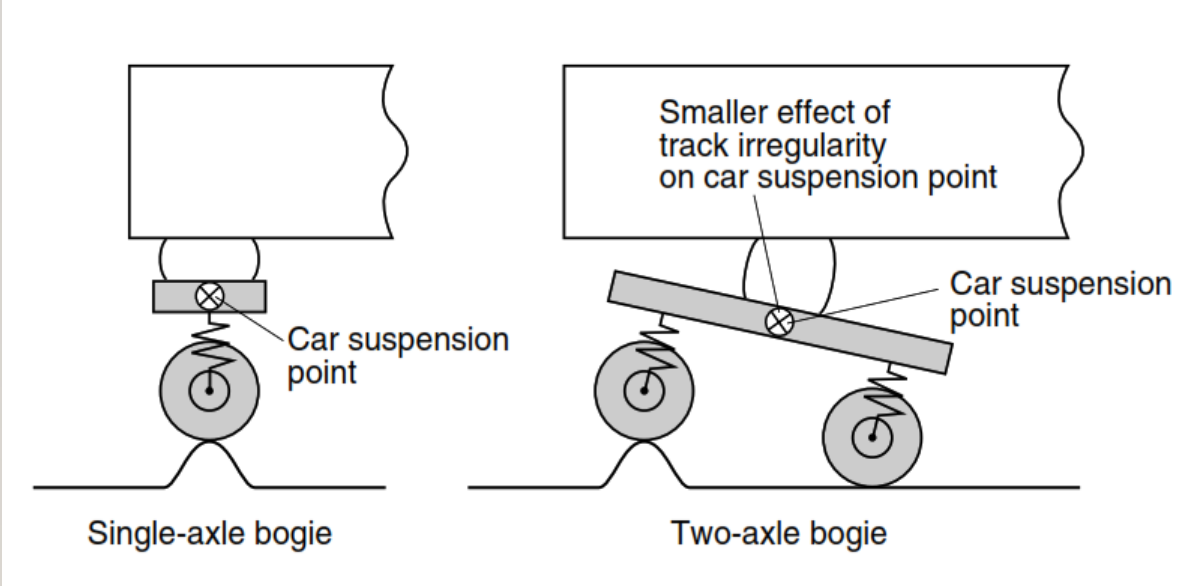
WDP 2

BOGIES WITH LOCO IN LIFTED CONDITION



WDG 3A

ILLUSTRATION OF SUSPENSION WITH BOGIE ARRANGEMENT



Bogie arrangement

FUNCTIONAL REQUIREMENT OF BOGIES

What is in design envelope

FUNCTIONAL REQUIREMENT OF BOGIE - I

- Supports the Locomotive's weight (Sprung mass)
  - Static Loads
  - Dynamic Loads
  - Impact Loads
- Supports/Holds together Bogie's own components (Un-sprung mass)
  - Wheelsets
  - Axle mounted equipment
  - Part weight of Traction Motor

FUNCTIONAL REQUIREMENT OF BOGIE - 2

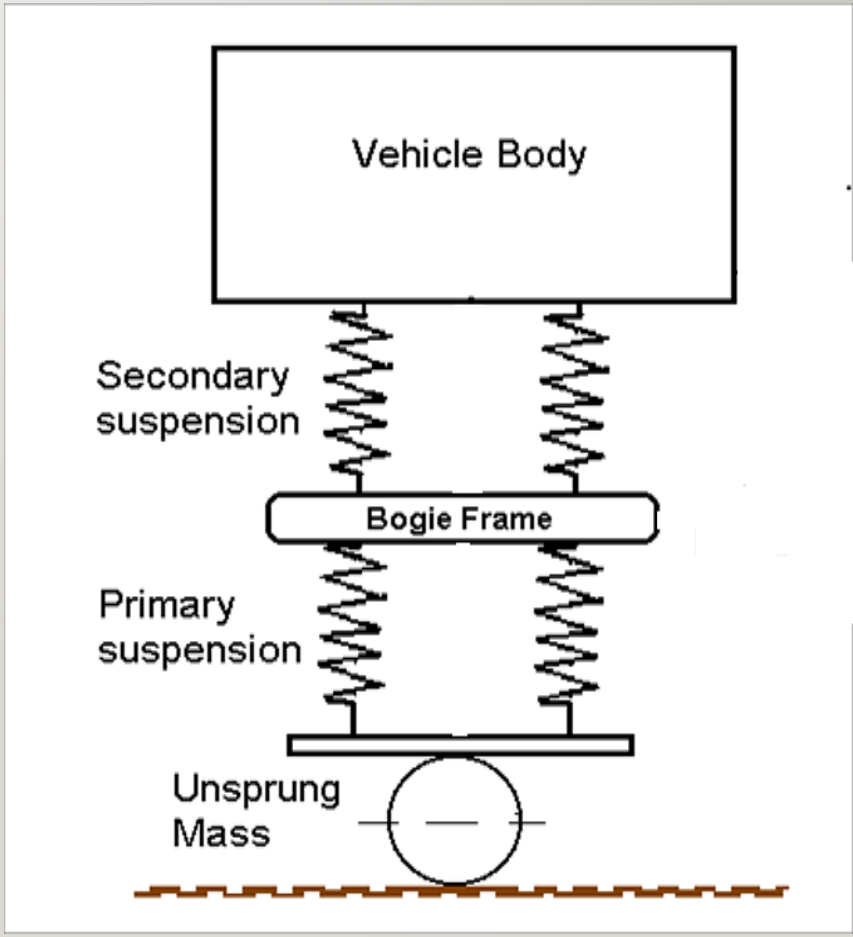
- Permits curve negotiation
  - Flexibility in axle alignment
  - Steering features
  - Compensates for track geometry
- Permits limited relative movement between superstructure and bogie
  - Yaw, Roll, Pitch
- Means for maintaining adhesion
  - Load distribution among axles

FUNCTIONAL REQUIREMENT OF BOGIE - 3

- Provides means for developing Traction and Braking forces for Locomotive operation
  - Wheel driving mechanism
  - Braking mechanism/Brake riggings
- Provides means for transmission of forces from wheel to superstructure
  - Traction forces
  - Braking forces

SPRUNG & UN-SPRUNG MASS

- Sprung mass
  - Components supported on suspension system
- Un-sprung mass
  - Directly connected to Rails
    - Should be minimized

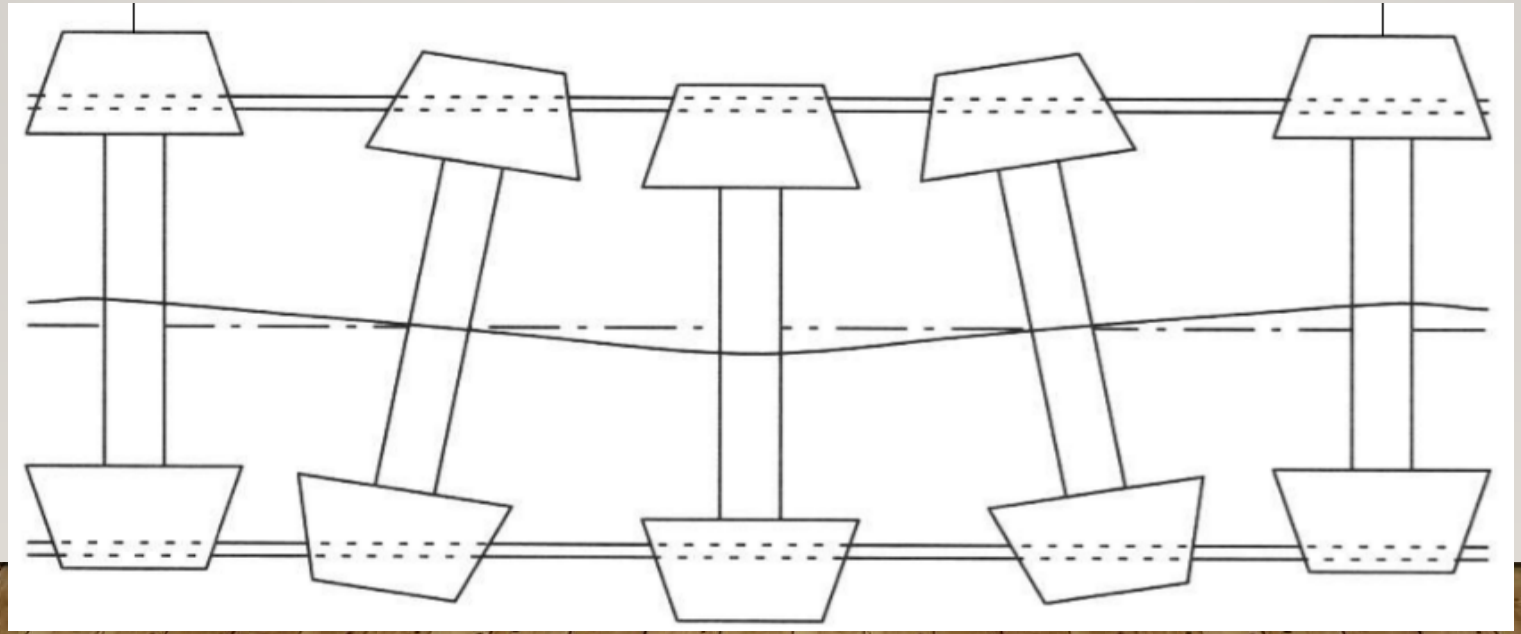


OPERATIONAL REQUIREMENT OF BOGIES

What does it do while running

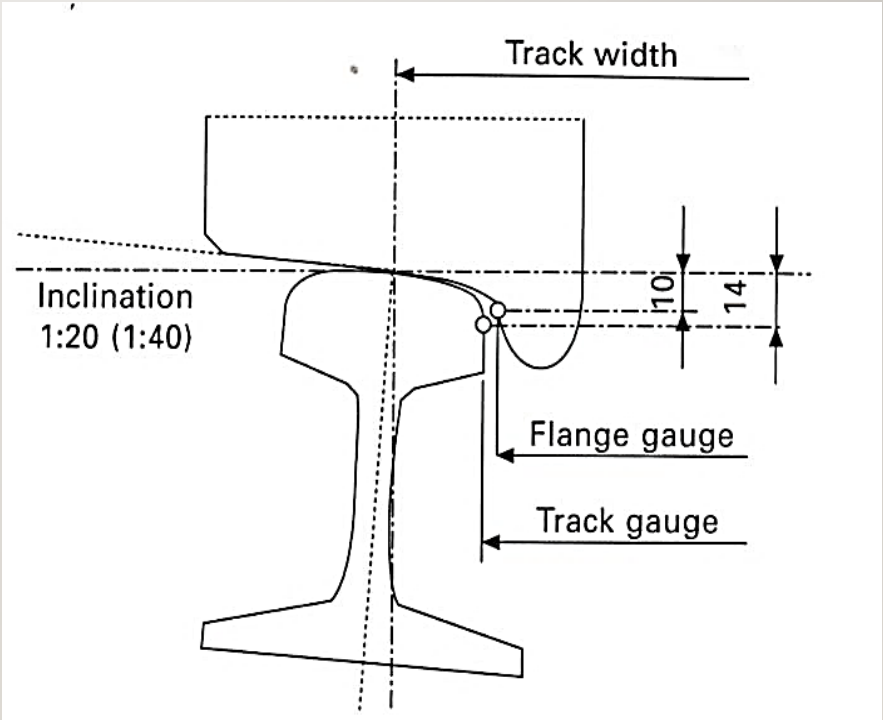
ADVANTAGE DERIVED FROM CONICITY OF WHEEL PROFILE

- Wheel treads are of conical shape, i.e. higher dia at inner side and lower dia towards outer side
- If wheel happens to shift towards left, left wheel would start rolling on higher dia and right wheel would start rolling on lower dia, this would automatically push wheel towards right side AND vice versa.



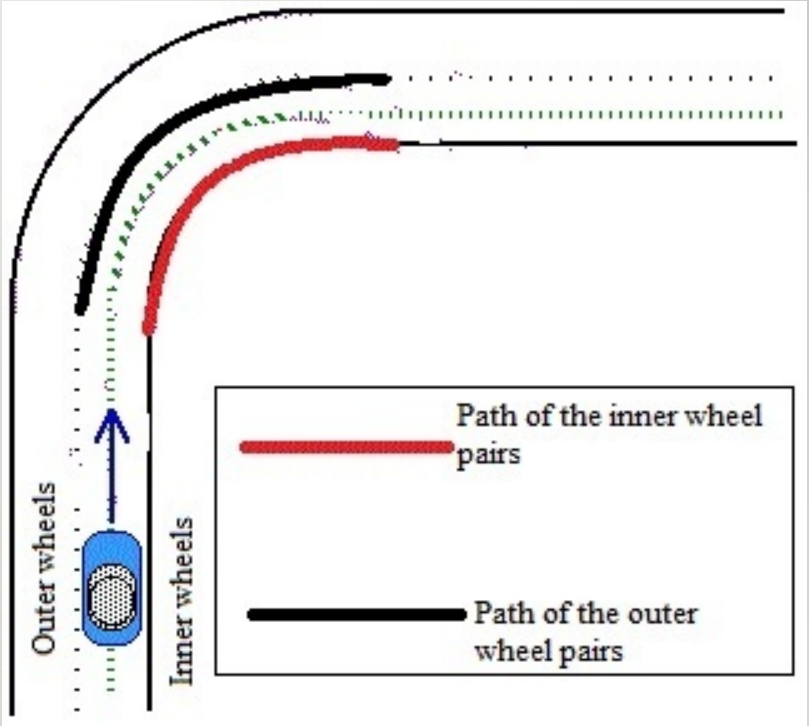
RAIL WHEEL INTERACTION

- Wheel flange ensures that, during hunting, and during curve negotiation, the wheel is never allowed to move beyond certain point



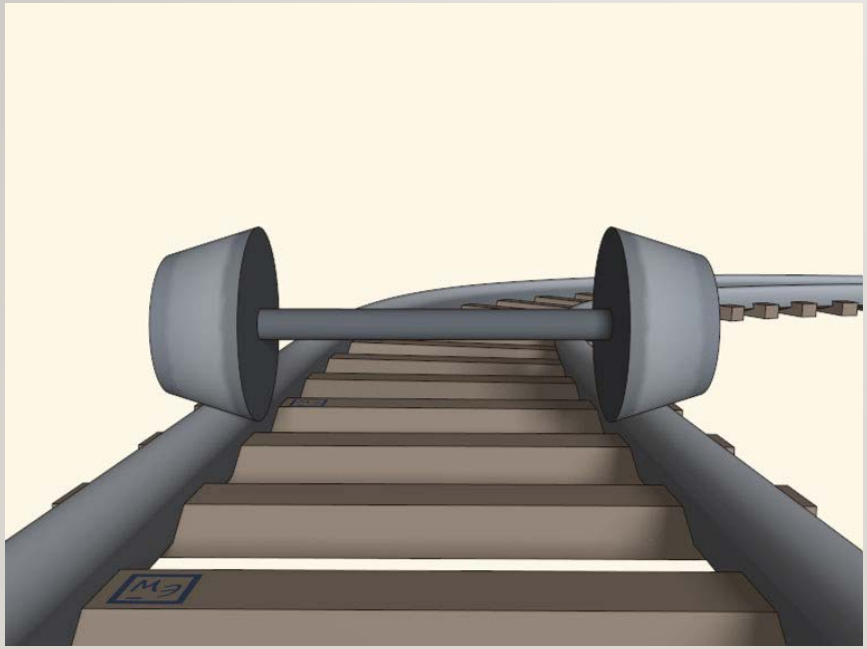
CURVE NEGOTIATION

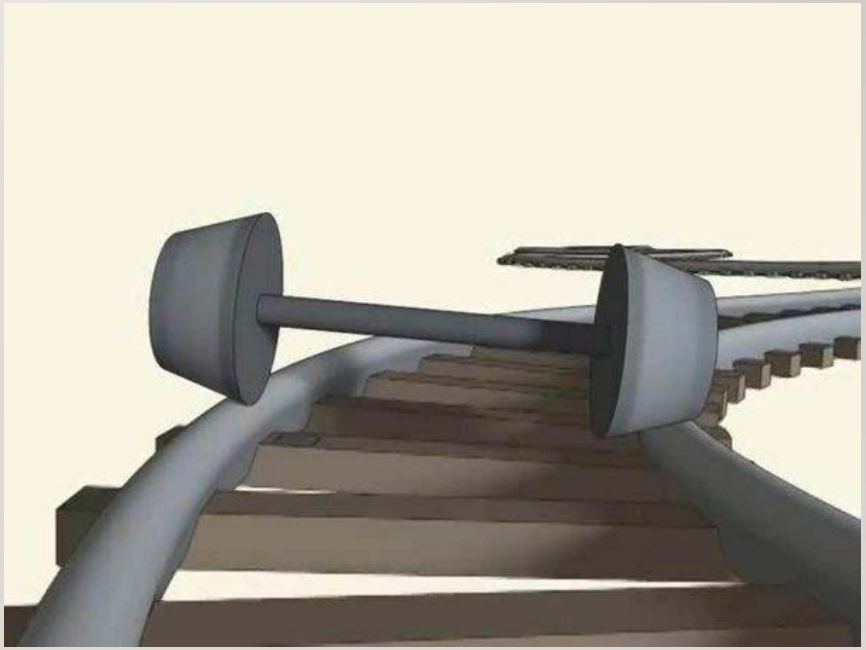
- During curve negotiation, outer wheel has to travel more distance and inner wheel has to travel less
- Since wheels are mounted on a solid axle, this poses a problem
- However, the conicity of wheel tread, solves this problem, by allowing the outer wheel to roll on higher dia and thus travel more



ADVANTAGE DERIVED FROM CONICITY OF WHEEL PROFILE

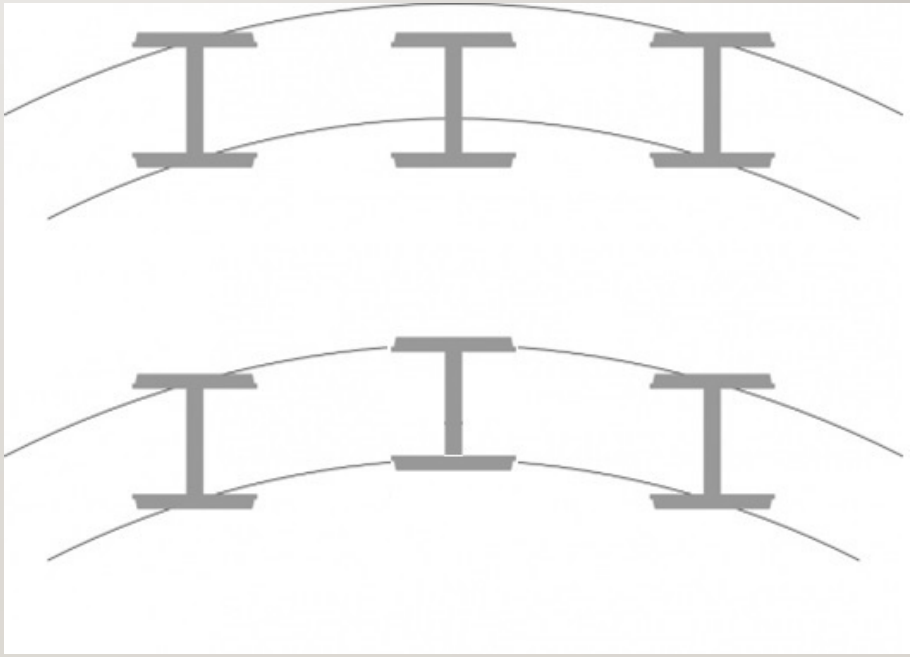
- On a curved track the wheel tread facilitates slide free negotiation





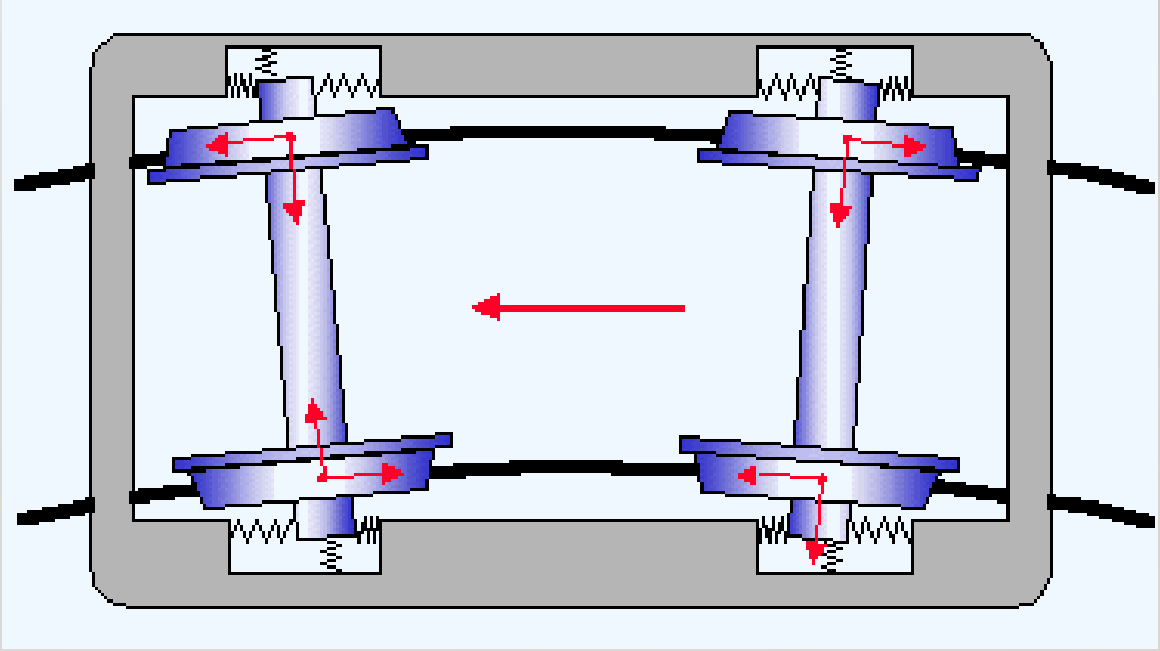
CURVE NEGOTIATION, LATERAL FLEXIBILITY PERMITTED IN BOGIE

- To negotiate the curves, wheels need lateral flexibility, the bogie permits this by providing higher lateral clearance for middle wheel



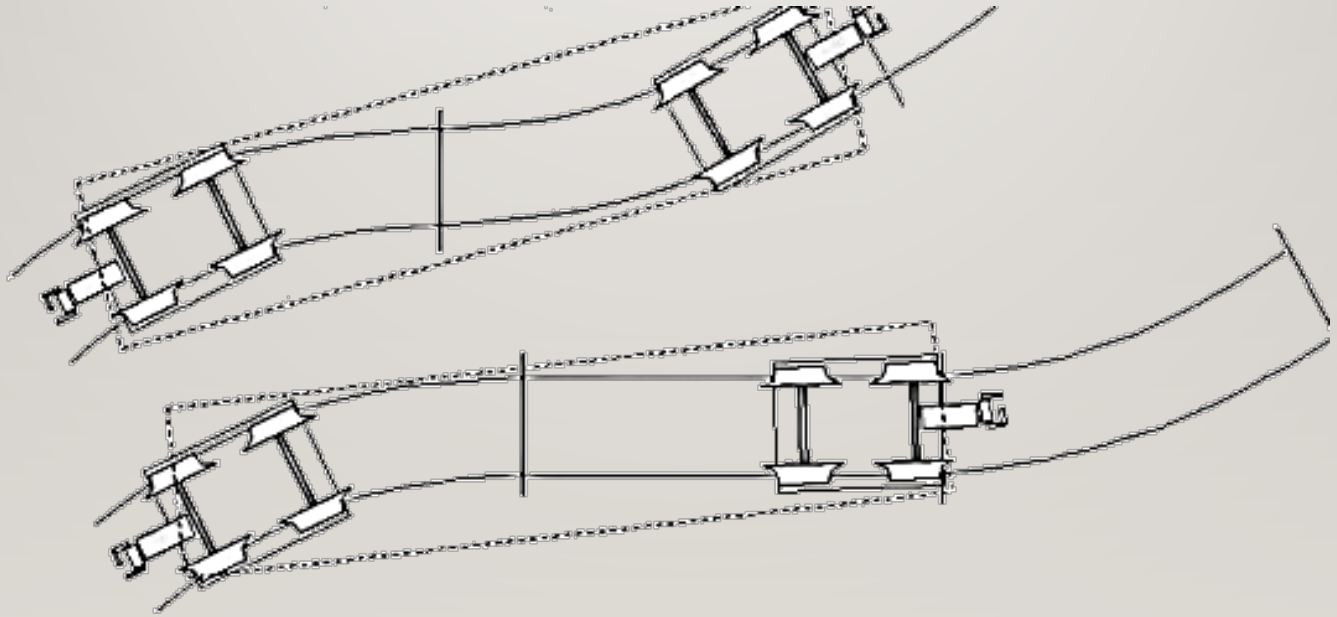
CURVE NEGOTIATION

- Combination of lateral and longitudinal clearances ensure slide free negotiation of curves



STEERING MECHANISM

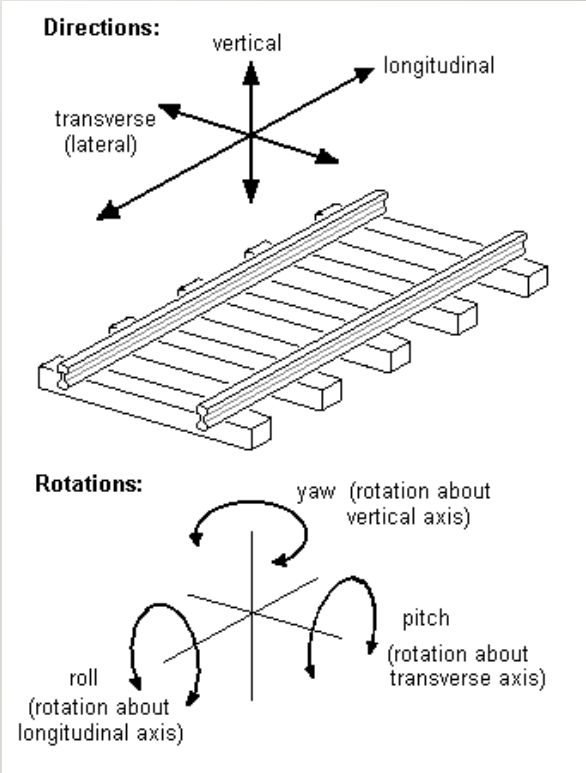
- The steering mechanism of bogie, adopts to curvature, irrespective of position of pairing bogie or body of locomotive



YAW, PITCH & ROLL

- Body roll: Rotation about longitudinal axis. The body rolls left to right and vice versa
- Yaw (nosing): Rotation about vertical axis. The front and rear of body rocks from left to right and vice versa
- Pitching: Rotation about transverse axis. The front and rear of body rocks vertically

All the above motions/movements are generated by variations in track geometry and operational dynamics. The bogies have to compensate for the same



COMPONENTS OF BOGIES

BASIC COMPONENTS OF A LOCOMOTIVE'S BOGIE

- Bogie Frame
- Wheel sets
- Primary Suspension
- Secondary Suspension
- Driving components
- Braking Components
- Steering Components

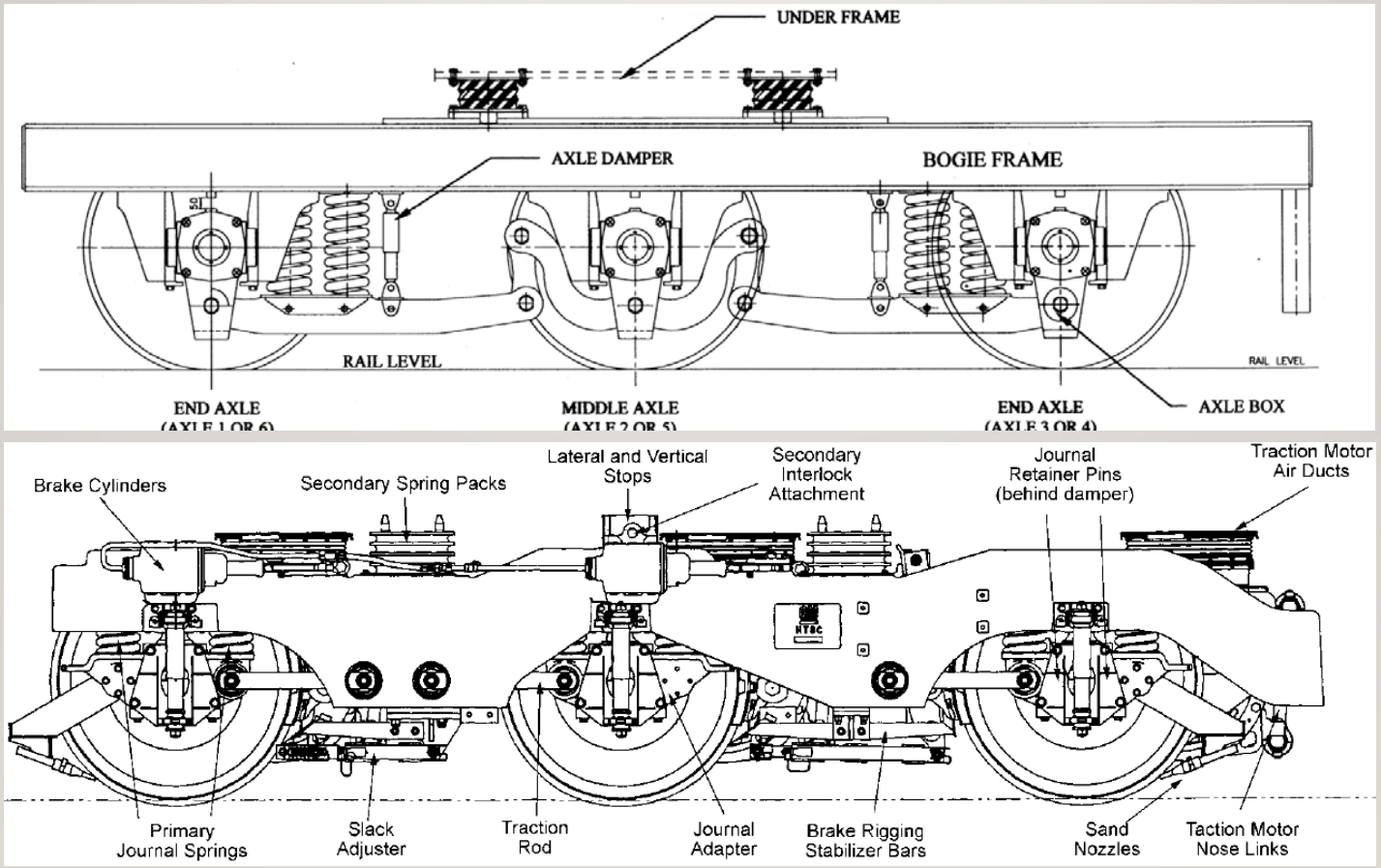
COMPARISON OF BOGIES

SN	DESCR.	WDM2/ WDM3A	WDG2/ WDG3A	WDP3A	WDG4	WDP4
1	Bogie	Cast steel	Fabri cated	Fabri cated	HTSC	HTSC/ Fabricated
2	Tractive Effort (T)	30.4	40.6	32.8	53	27.55
3	Axle Load(T)	18.8	20.5	19.5	21	19.5
4	Gear Ratio Pinion: Bull Gear	18:65	18:74	22:61	17:90	17:77
5	Max Speed (KMPH)	120	105	160	100	160 / 135
6	Weight transfer to wheels	Centre Pivot 60%, Side Bearer @20%	4 Nos. side bearers @25%		4 Nos. Side Bearers @25% each	4 Nos. Side Bearers @25% each

GENERAL LAYOUT OF BOGIE COMPONENTS

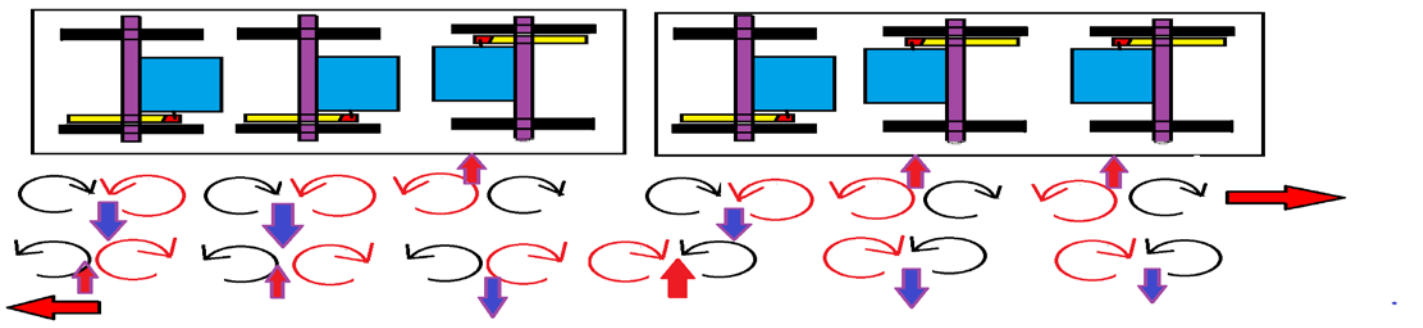
- ALCO
  - Frame: Fabricated & Cast
  - Linked Suspension
  - 3 Traction Motor
  - TM suspended on Axle and Resilient pads
  - Solid & Roller bearings for TM suspension
  - Cordium compound for Gear lubrication
  - Horn cheeks with wear liner
  - Taper Roller bearing with Axle box
- EMD
  - Frame: Fabricated, cast and Hybrid
  - Independently suspended
  - 3 & 2 Traction Motor
  - Nose link with rubber bushing
  - Roller bearing for TM suspension
  - Oil filled gear case
  - Traction rod with rubber bushing
  - CRB with bearing adopter

GA OF ALCO AND EMD BOGIES

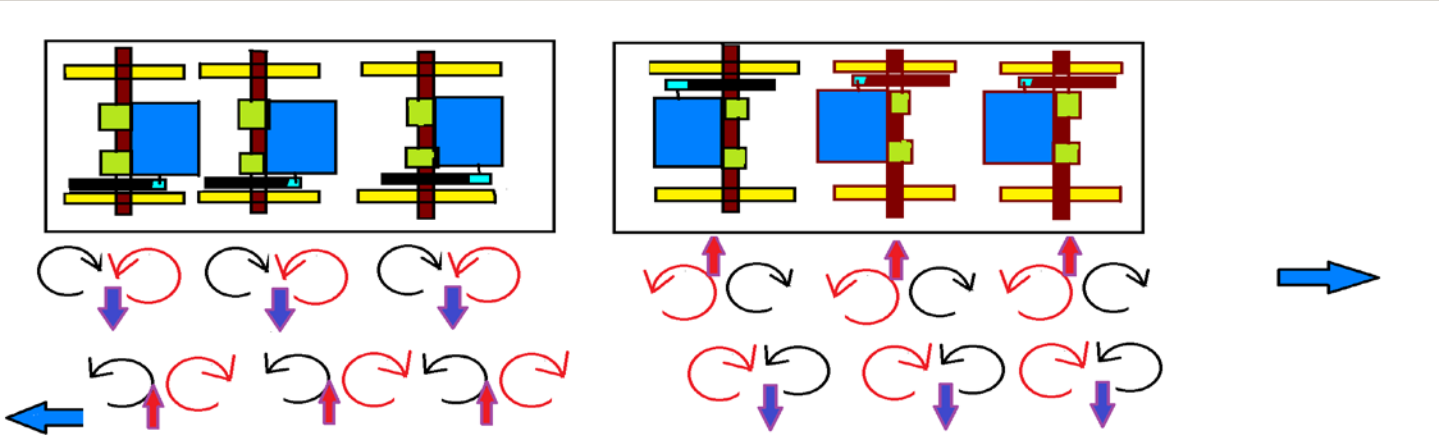


MOTOR ARRANGEMENTS

CONVENTIONAL ALCO – ORIENTED ON BOTH SIDE OF AXLE



HIGH ADHESION - UNI DIRECTIONAL

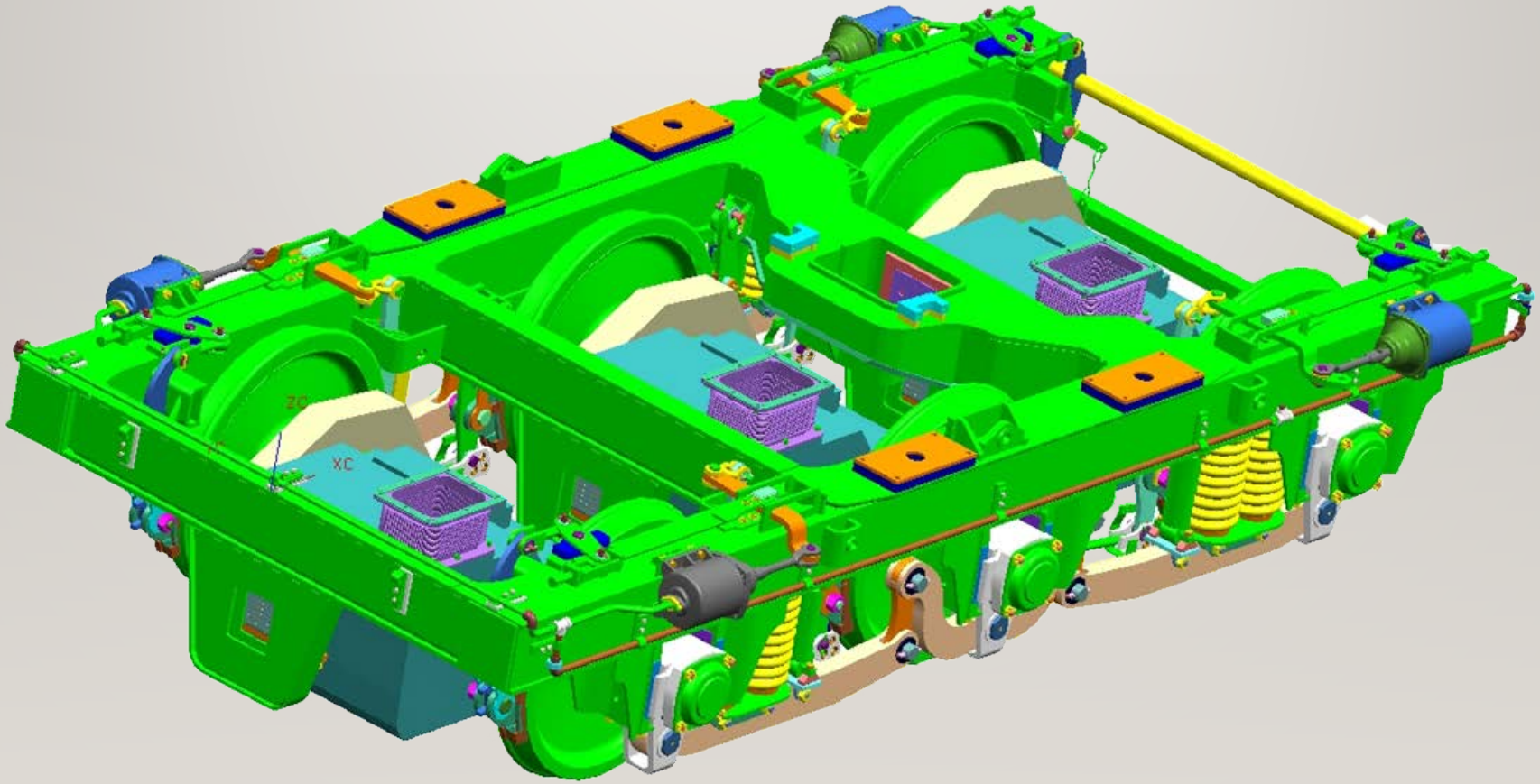


COMPONENTS OF BOGIES OF WDG3A/WDM3D

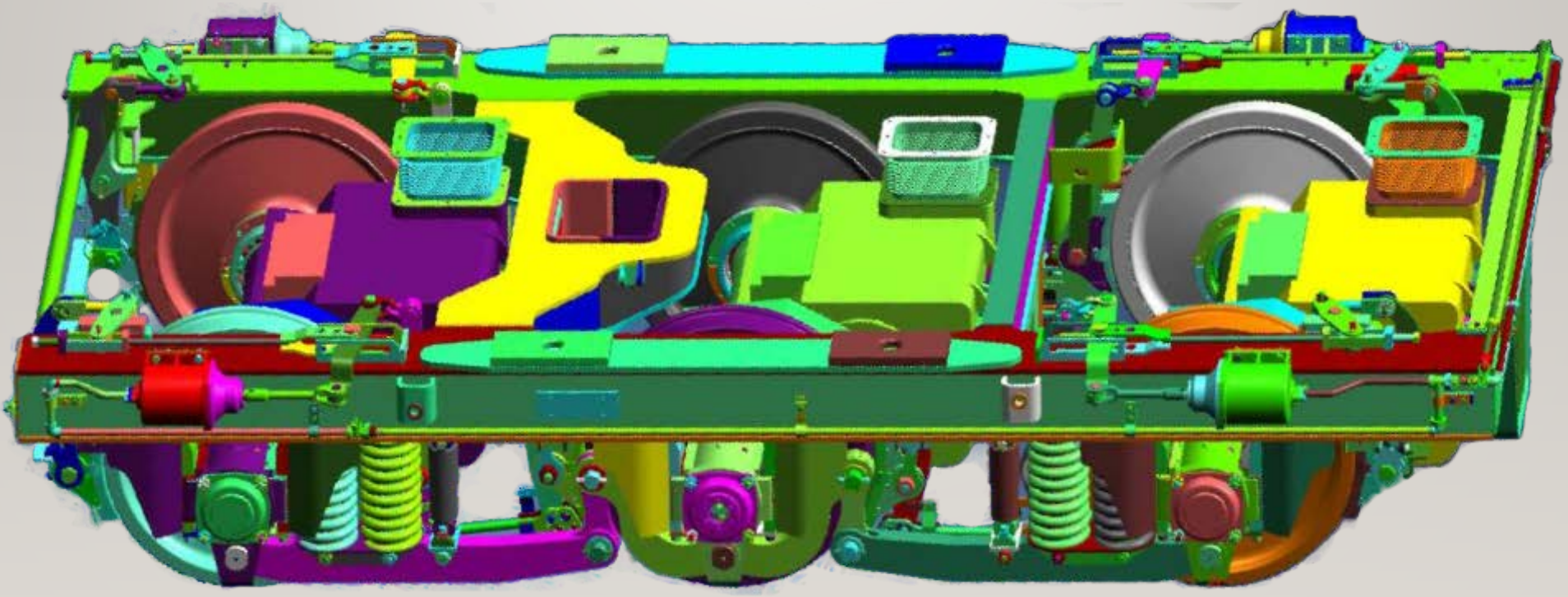
BASIC COMPONENTS OF A LOCOMOTIVE'S BOGIE

- WDG3A/WDM3D loco is provided with fabricated bogie. This is a three-axle, two-stage suspension with helical coil springs in primary stage and rubber compression springs in secondary stage of suspension & floating type center pivot arrangement.
- The bogie frame is fabricated in a box type construction, manufactured from steel plate to IS.2062 grade 'C'.
- The locomotive car body weight is transferred directly to the bogie frame through four rubber "Compression" spring assemblies.
- The bogie frame is supported through "soft primary" suspension consisting of eight pairs of helical coil springs(inner & outer). Two springs mounted on each equalizer, to provide ride quality and equalization of wheel-set loads.

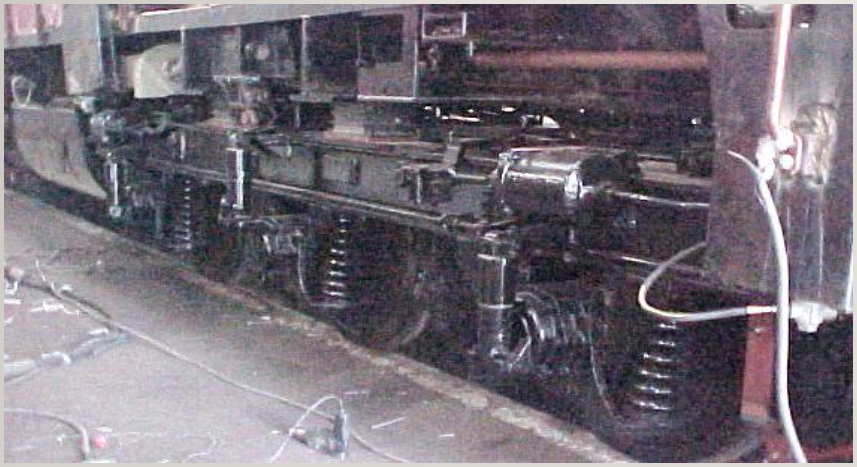
FABRICATED BOGIE IN ASSEMBLED CONDITION

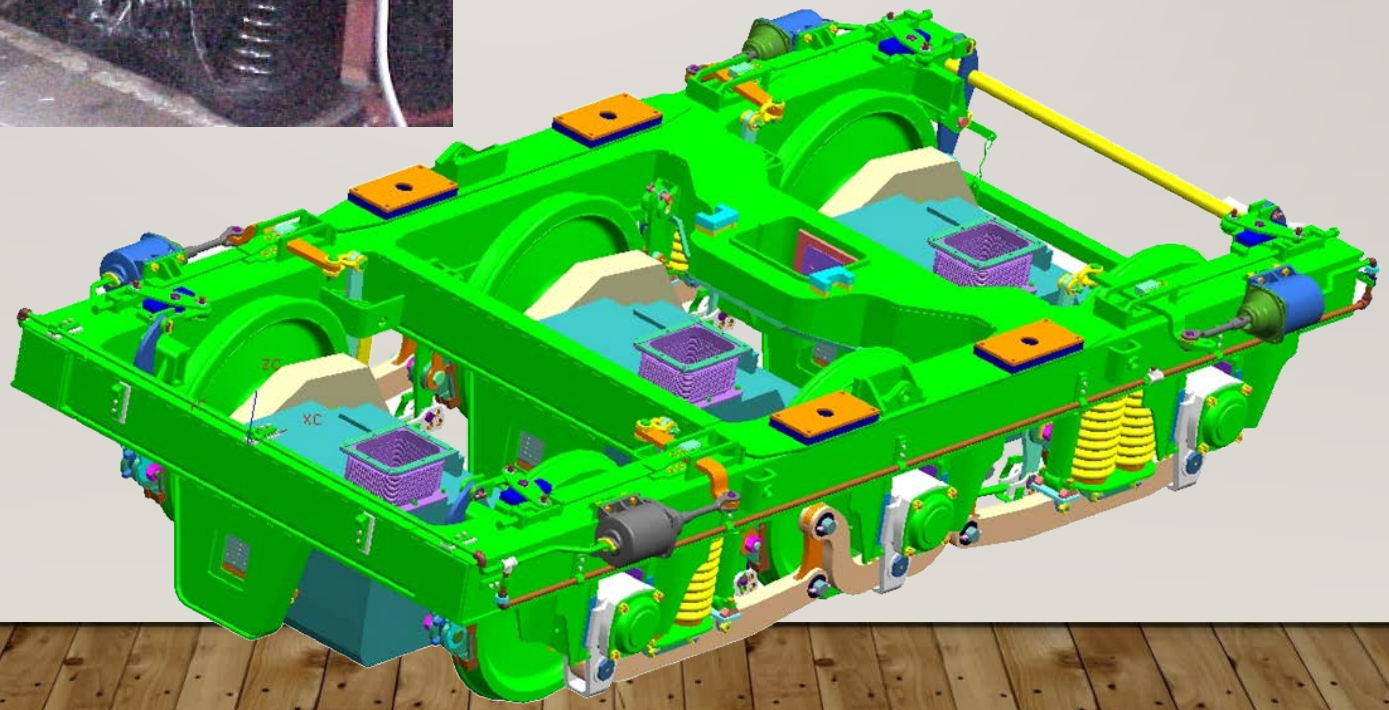


FABRICATED BOGIE IN ASSEMBLED CONDITION



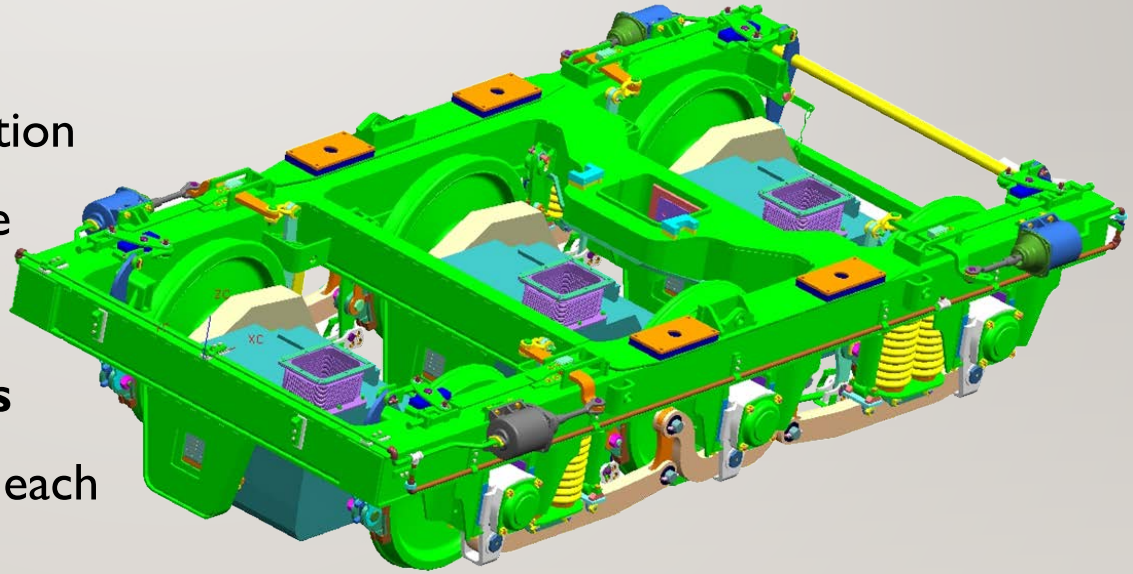
HIGH ADHESION BOGIES OF ALCO LOCOMOTIVES





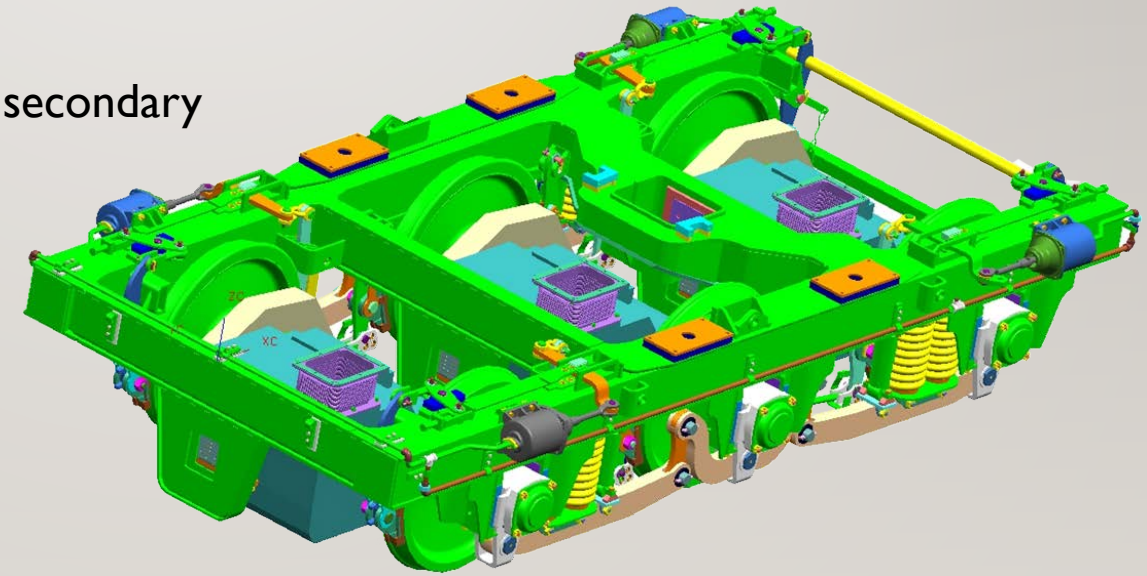
BOGIE FRAME CONSTRUCTION

- **Co-Co type**
  - Manufactured from steel plate to IS.2062 grade ‘C”
  - Fabricated box type construction
  - Three transoms to carry nose suspension,
- **Traction motor nose positions**
  - Oriented to the same side of each axle



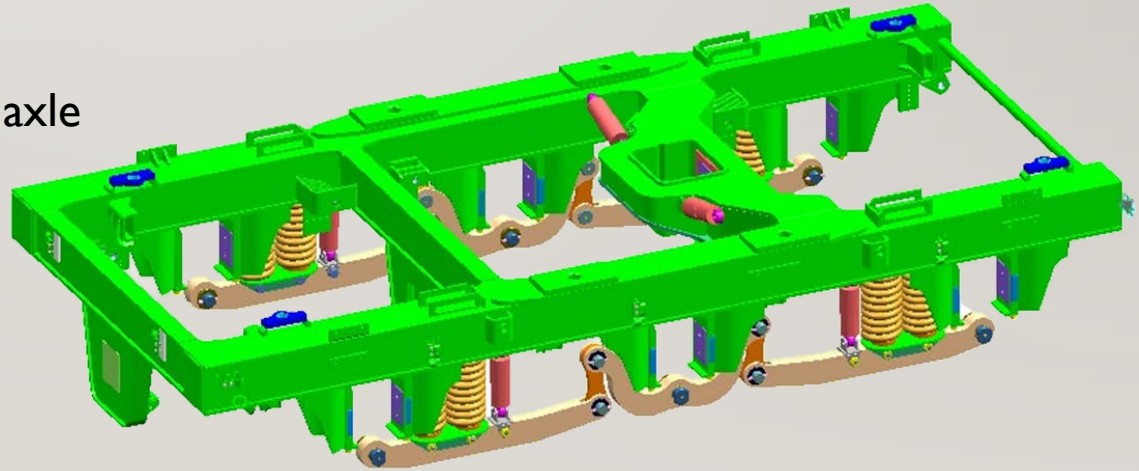
BOGIE DESCRIPTION

- **Bolster-less bogie**
- **Two-stage suspension,**
  - Helical coil springs and shockers in primary stage
  - Rubber compression springs in secondary stage of suspension)
- **Floating type center pivot arrangement**
  - Does not take any vertical load
  - Used only for transfer of
    - traction and
    - braking forces



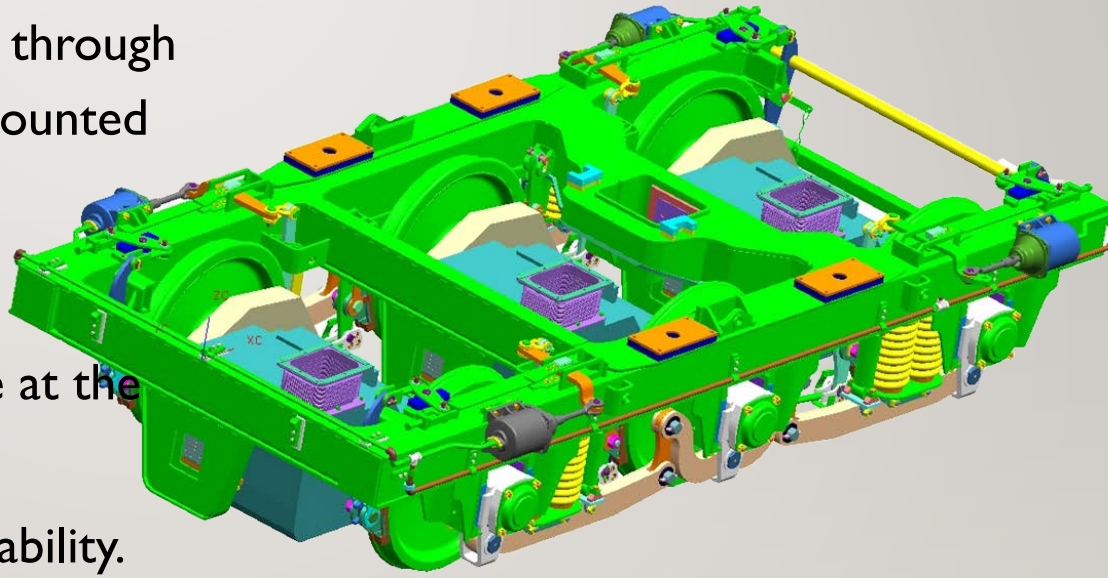
EQUALIZATION OF WEIGHT

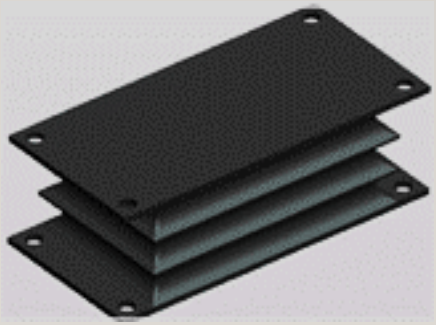
- **Bogie frame**
  - Supported on axles through helical coil spring mounted on equalizing beams.
- **Equalizing mechanism**
  - Enables achievement of equal axle loads
    - On uneven track.
  - Equalizers hung directly on end axle boxes
  - Supported on middle axle box
    - Link and
    - Compensating beam arrangement.



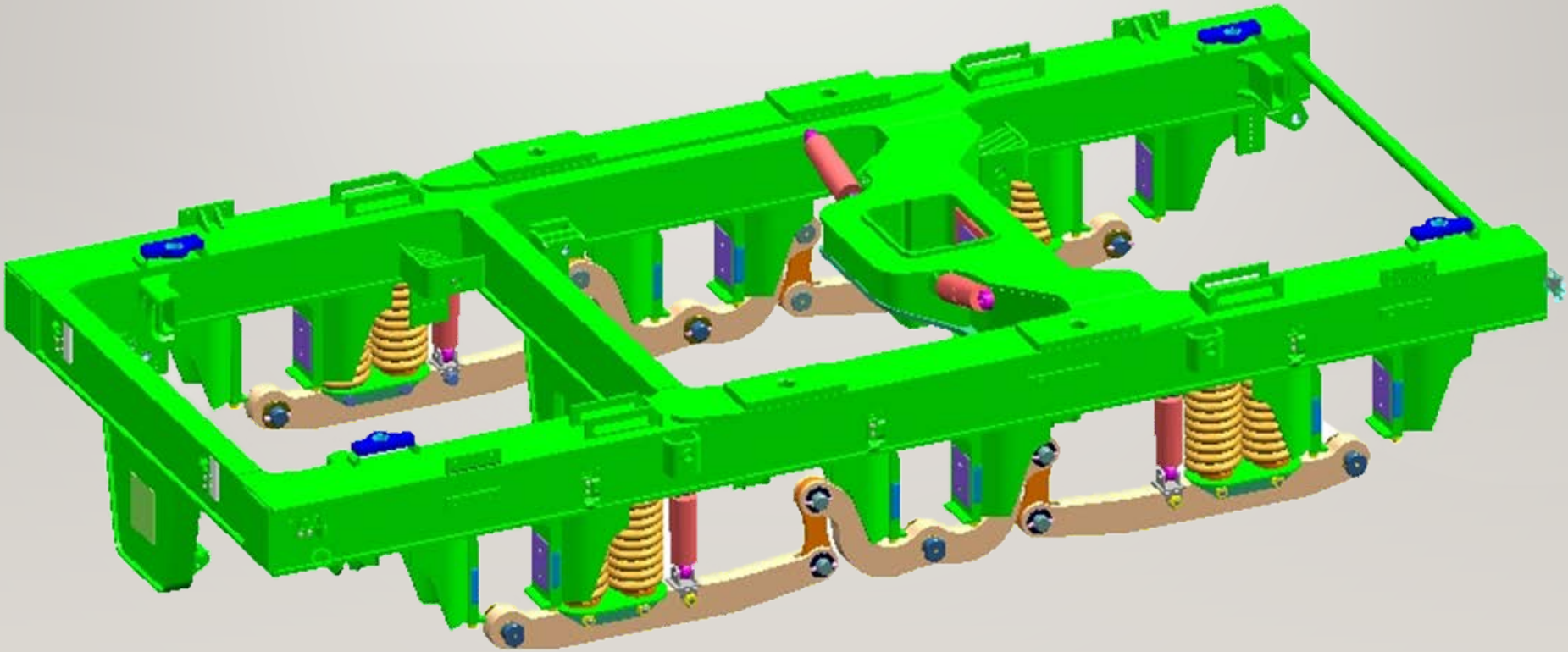
TRANSFER OF WEIGHT

- **Equally @25%** to the bogie frame through four rubber side-bearers directly mounted on bogie side bears.
- **Rubber Side Bearers**
  - Stiff to provide lateral guidance at the secondary stage
  - Provide the yaw stiffness for stability.
  - Spaced for stability of locomotive
  - Damping of track oscillations



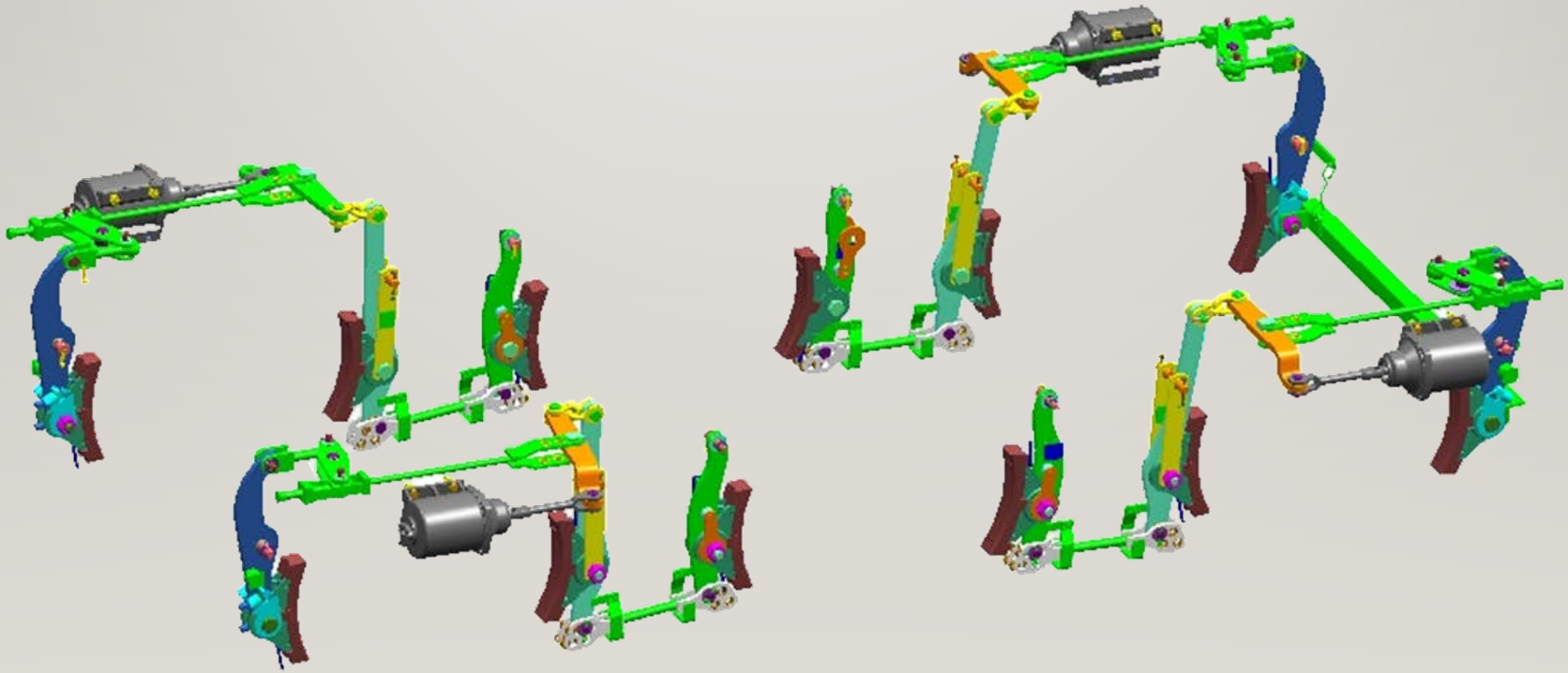


PRIMARY SUSPENSION COMPONENTS



BRAKE RIGGING ARRANGEMENT (ALCO)

- Conventional type brake rigging is provided with two shoe per wheel arrangement with composite brake blocks.
- Manual (screw) type slack adjusters are provided to adjust brake shoe-wheel gap

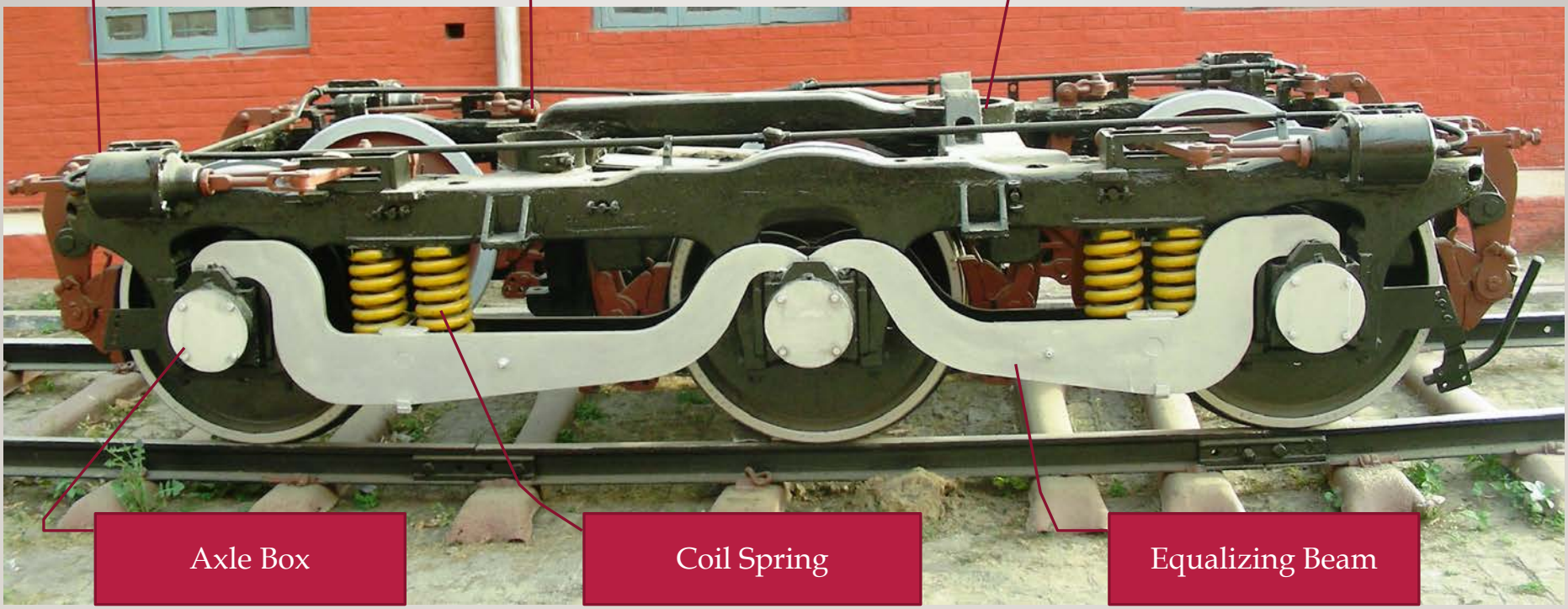


COMPONENTS OF BOGIES OF WDM2

TRI-MOUNT C0-C0 BOGIE FRAME

- Consists of a single piece cast steel frame, has a conventional bogie pivot, carried in the cross member located between the leading and middle axle and two load bearers which are carried in cross member of the frame
- The pivot carries approximately 60% of the vertical load and also receives and transmits traction and braking forces while the two load bearers share the remaining 40% of the vertical load. The load bearers are not designed to transmit any traction or braking forces
- The lateral spacing of the pads afford stability against the tipping forces of the locomotive and the frictional resistance of the pads prevent nosing
- Single stage suspension is used, consisting of long deflection helical springs; friction snubbers are fitted inside one nest of each group of springs
- Movable axle journal boxes are mounted in pedestals cast integral with the frame. The lateral play for negotiating passage over curves and turnouts is obtained by the movement of the boxes in the pedestals

PICTORIAL VIEW OF ALCO (WDM2) TRI-MOUNT BOGIE



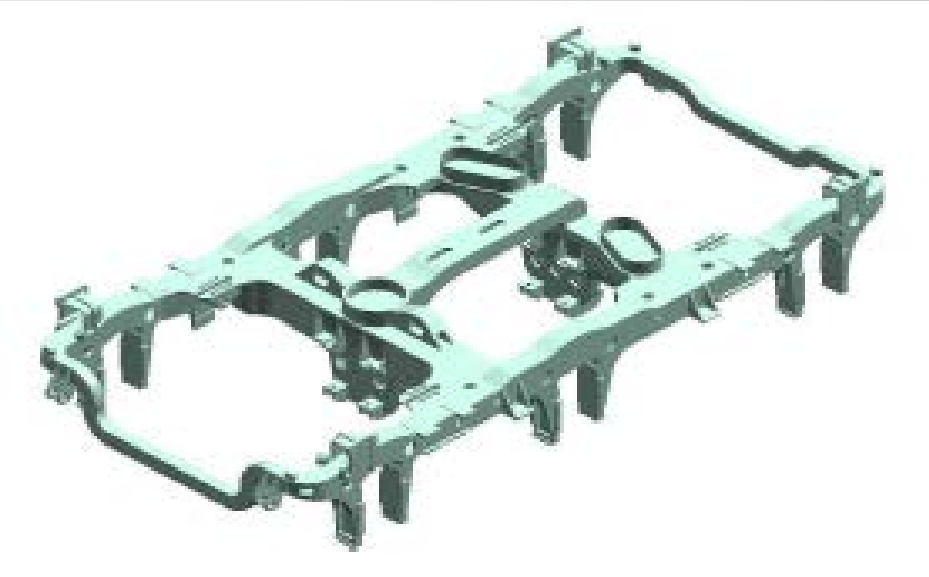
PICTORIAL VIEW OF ALCO (WDM2) TRI-MOUNT BOGIE

DETAILS OF TRI-MOUNT BOGIE

- Single Stage Suspension.
- Three Point Support
- RDSO Drg No. SK.DL - 1473
- Single piece cast steel frame
- A conventional bogie pivot
  - carried in the cross member located between the leading and middle axles
  - Carries 60% weight
- Two load bearers
  - carried in cross member of the frame between the middle and trailing axles
  - Carries 40% weight@20% each.

BOGIE LOAD TRANSFER

- Three point weight transfer
  - Bogie pivot
    - On cross member between the leading and middle axles.
    - Approximately 60% of the vertical load.
    - Transmits traction and braking forces.
  - Two load bearers
    - In cross member of the frame between the middle and trailing axles.
    - Each carries 20% of the vertical load.

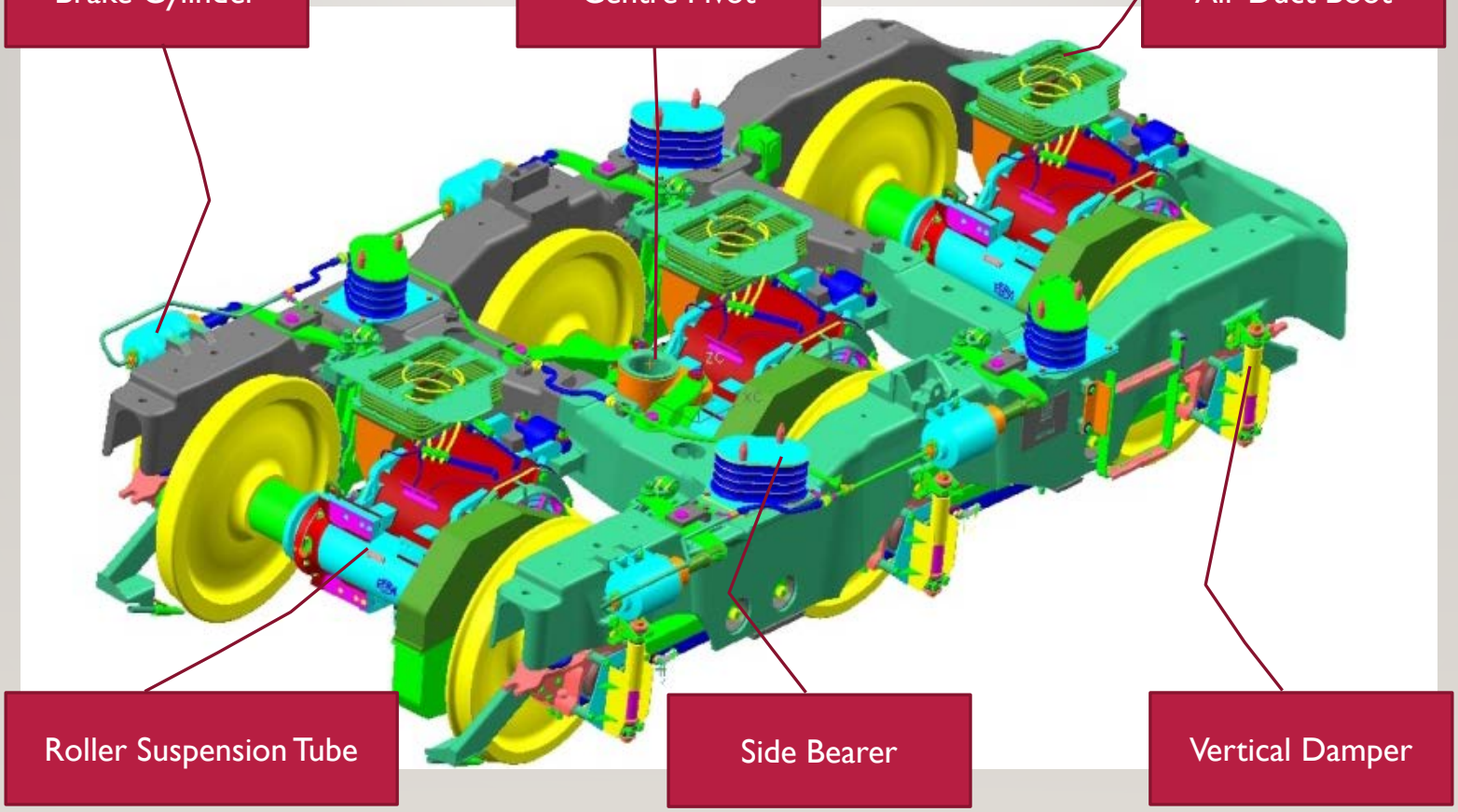


WEIGHT DISTRIBUTION

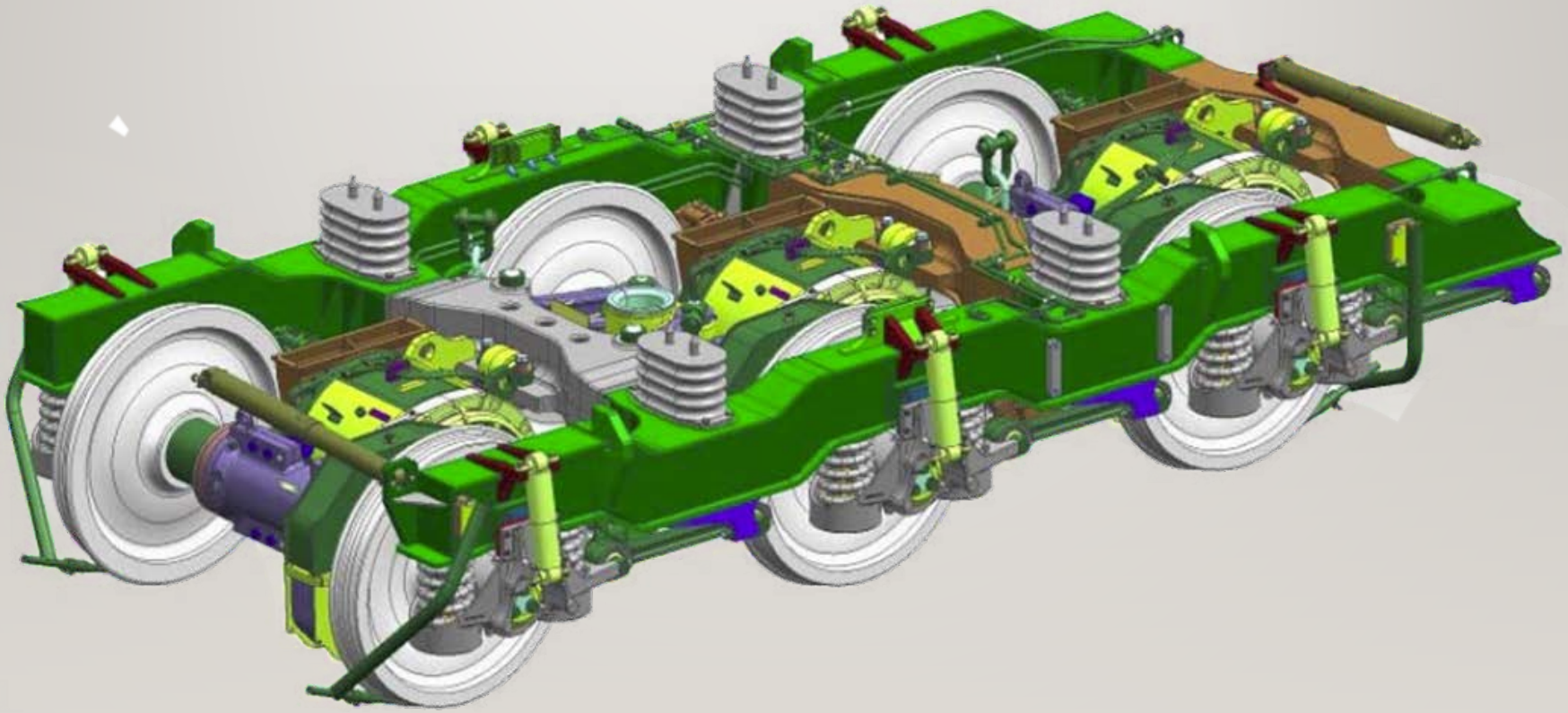
• Total weight of locomotive	112.8 Tonnes.
• Weight of two bogies@23 T each	46 T.
• Weight to be born by bogies	(112.8 - 46) = 66.8 T.
• Weight born by one bogie	66.8/2 = 33.4 T.
• Weight born by Centre pivot	60% of 33.4
	20.04 T.
• Weight born by each side bearer	20% of 33.4
	6.68 T.

COMPONENTS OF BOGIES OF WDG/P4/WDG/P4D

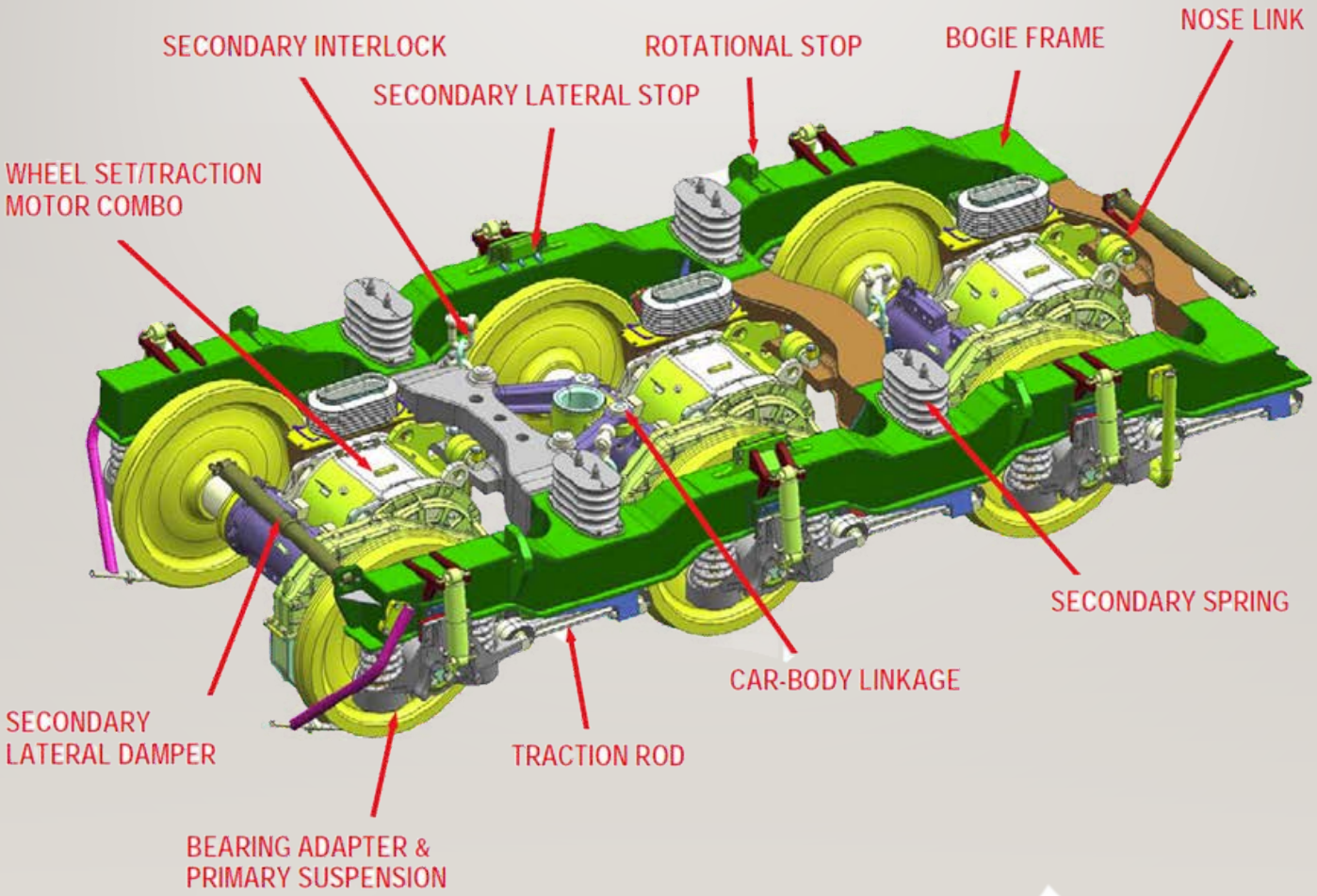
PICTORIAL VIEW OF HTSC BOGIES



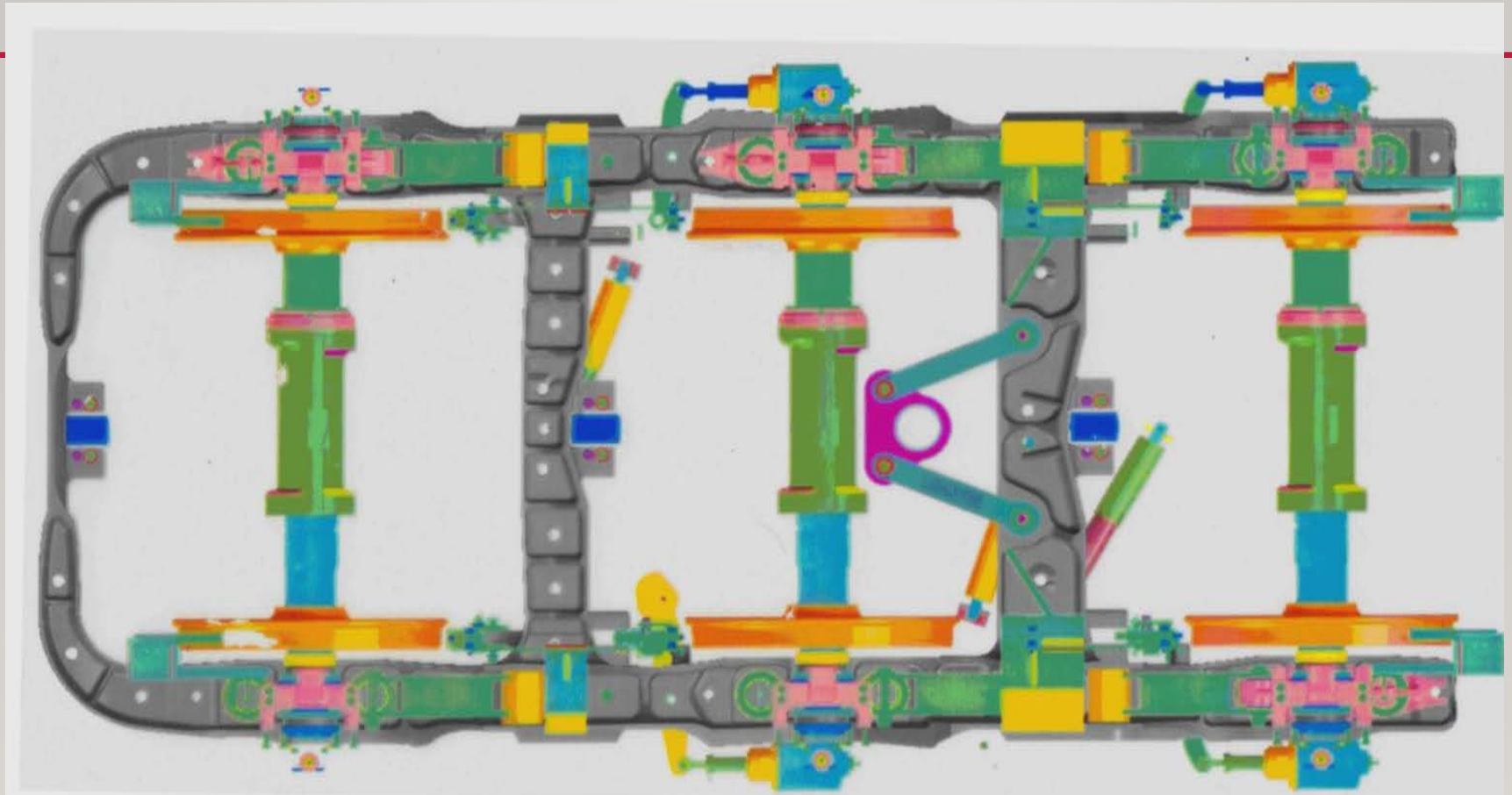
HYBRID BOGIE FRAME OF EMD



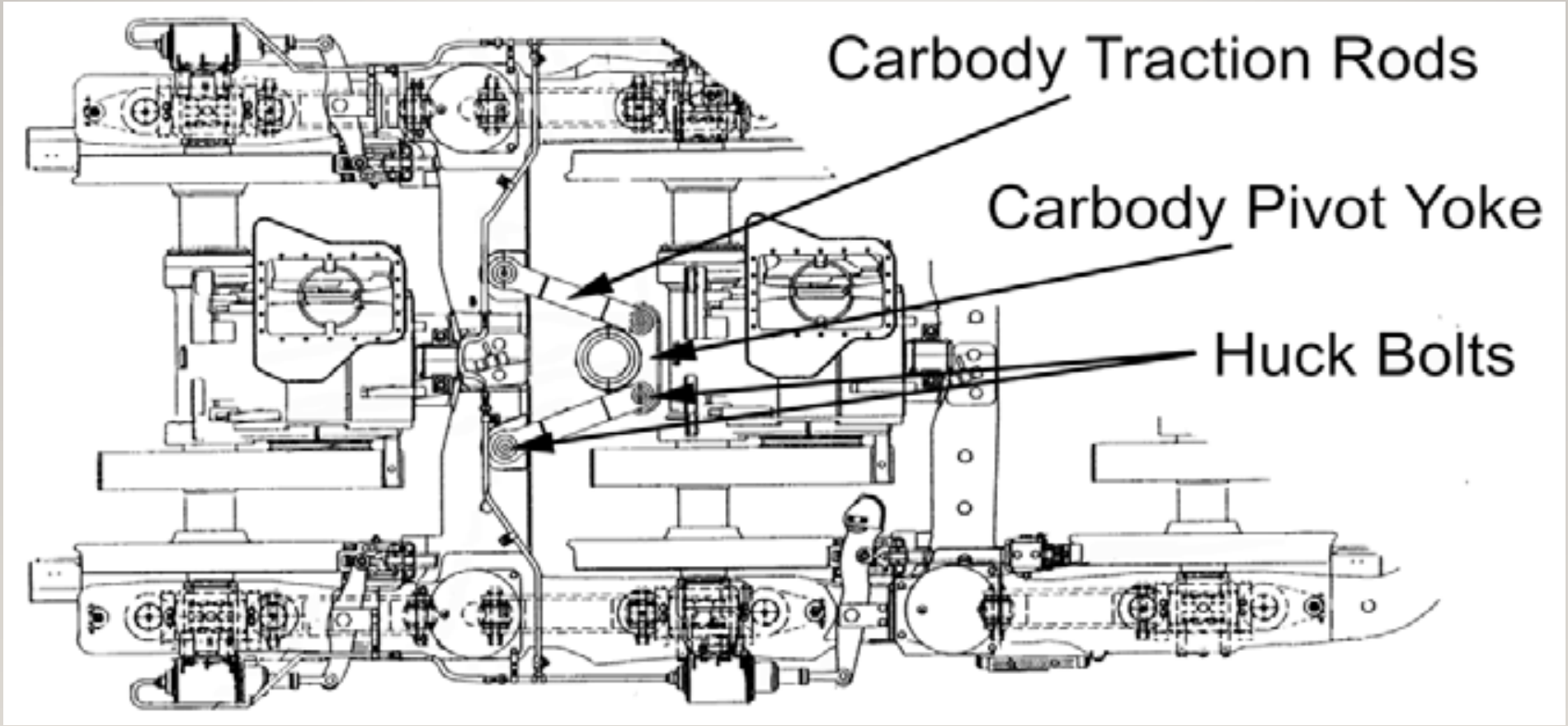
HYBRID BOGIE FRAME OF EMD



SIDE & TOP VIEW OF HTSC BOGIES



CENTRAL PIVOT CARRIER ASSEMBLY IN WDG/P 4 LOCO



SALIENT FEATURES

- Overhauling required after
  - 6 years or 14 lakh Kms for pass services.
  - 6 years or 10 lakh kms for freight services.
- Low flange force for longer wheel life.
- Cartridge bearing in axle boxes for higher reliability & service life.
- Light weight, high performance three phase ac traction motors with better reliability.
- Low un-sprung weight by use of lighter traction motors.
- Provision of wheel creep control to maximize adhesion.

SALIENT FEATURES (CONTD.)

- Rubber compression springs
  - Designed to adapt seat provided on the bogie.
- Suspension of traction motor.
  - By nose link fitted with rubber bushings.
  - Needs lesser maintenance as compared to rubber sandwiches used in ALCO locos.
- Provided with single composite type brake shoes.

WEIGHT TRANSFER IN HTSC BOGIES

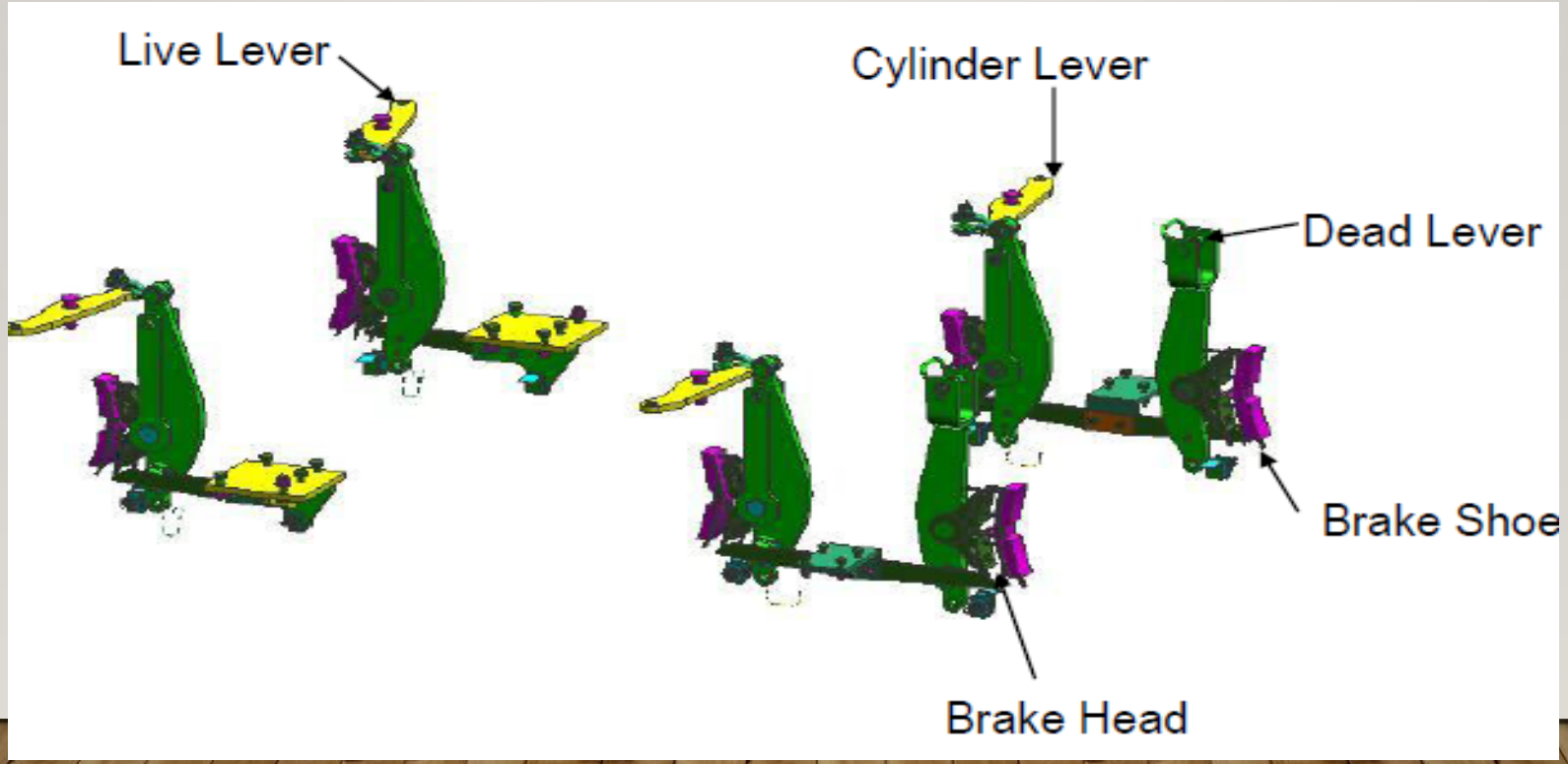
- Locomotive body weight
  - Transferred directly to the bogie frame
  - Through four rubber "Compression" springs.
- Bogie frame supported on axles
  - through twelve single helical coil springs,
  - provides ride quality.

SUSPENSION IN HTSC BOGIES

- Soft primary suspension
- Stiff secondary suspension
  - Controls pitching
- Less center pivot height
  - Lowers the Centre of Gravity.
- Traction motors
  - Oriented to the same side
  - Suspended by nose links

BRAKE RIGGING ARRANGEMENT (HHP)

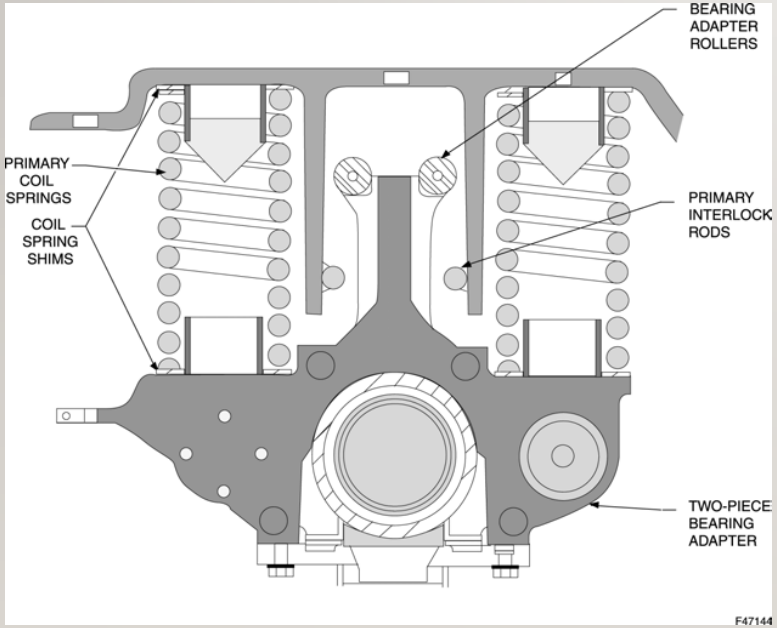
- Conventional type brake rigging is provided with single shoe per wheel arrangement with composite brake blocks.
- Manual (notch) type slack adjusters are provided to adjust brake shoe-wheel gap

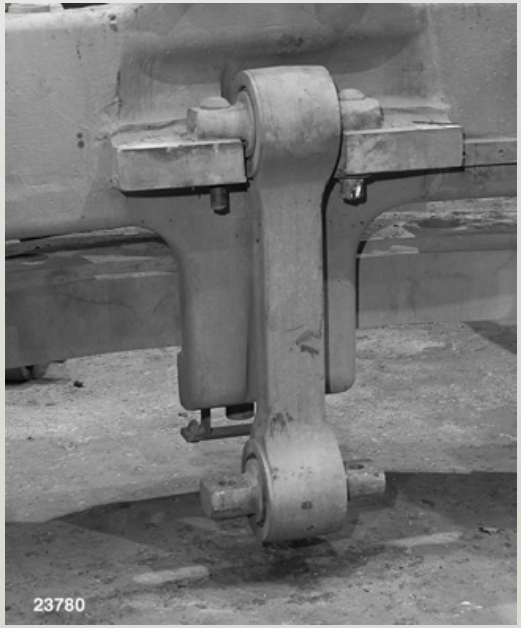


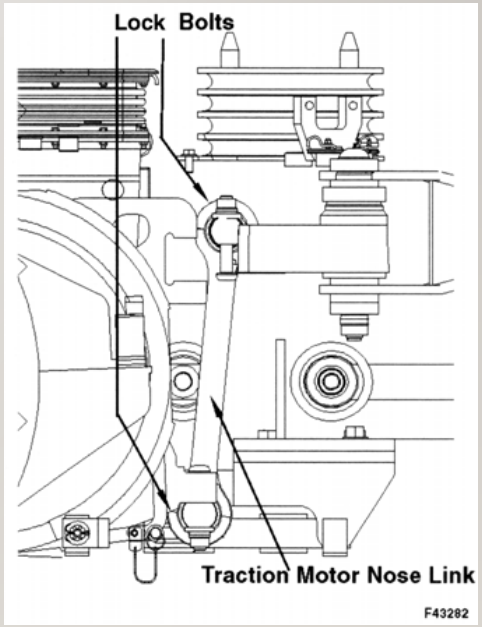
MAINTENANCE FREE

- Elimination of wearing parts
  - Pedestal & axle box liners,
  - Centre pivot liners,
  - Friction snubbers etc.
- No pedestal liners on bearing adaptor.
- Use of wear resistant liners
- Cartridge bearing
  - Fit & Forget
- Hydraulic damping – less attention required.

SALIENT FEATURES (MAINTENANCE FREE)

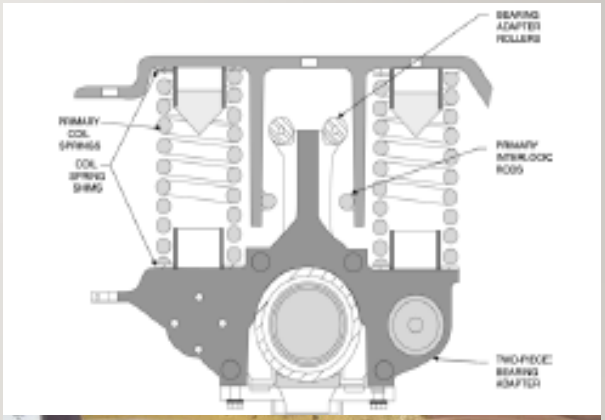


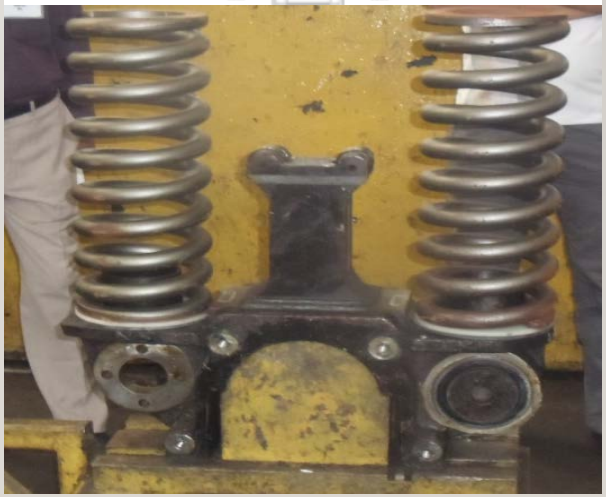




AXLE JOURNAL BEARING

- Cartridge type tapered roller bearings
- Integrated bearing adapter.
- Normal temp 56^0C above ambient
- Not allowed above 93^0C .

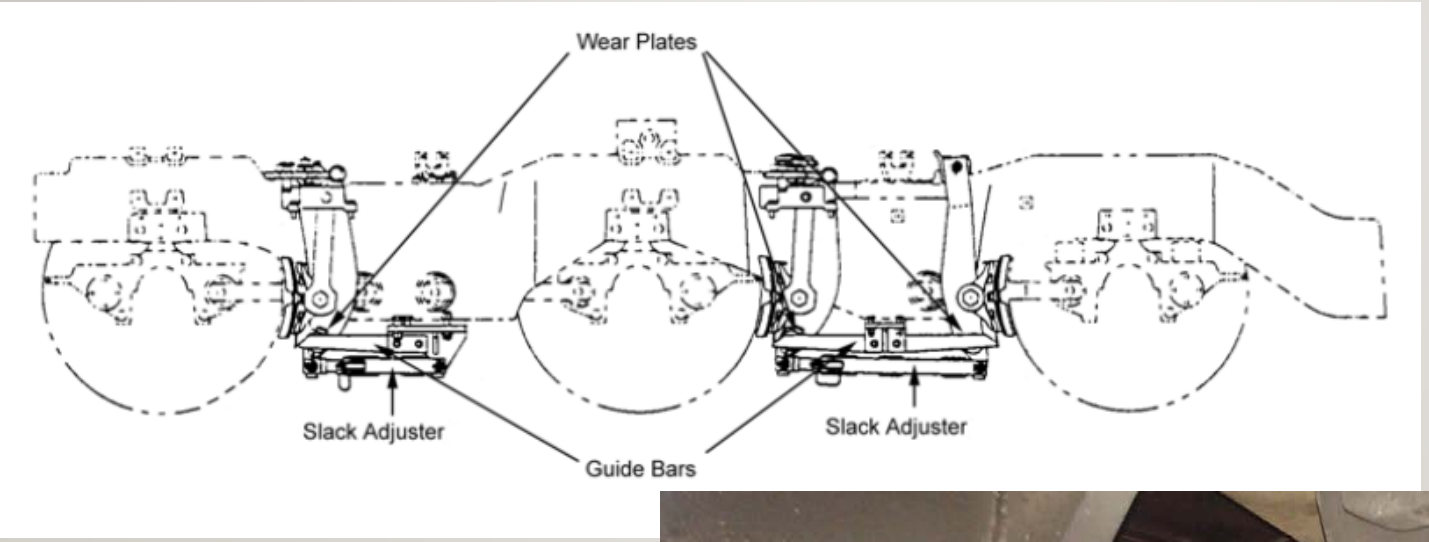




BRAKE RIGGING STABILIZING BARS

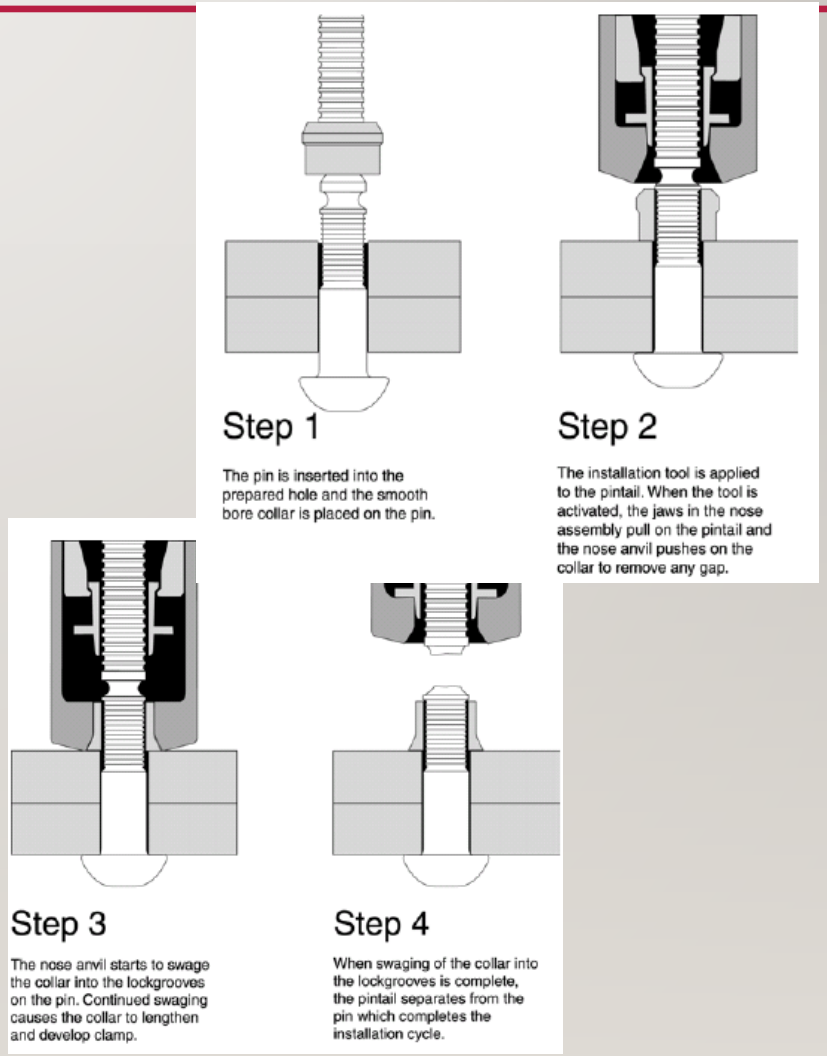
- Provided on the underside of the bogie frame at the "live" and/or "dead" block lever location.
- A 6.4mm (0.25") thick X 87.5 mm (3.5") diameter Nylon alloy wear plate is bolted to each brake lever which mates to a spring steel stabilizing bar.
- Maintains brake shoe to wheel alignment.
  - Reduces possibility of brake blocks climbing on wheel flange.
- The wear plates should be replaced when the thickness is half of the original, or 3.2mm (0.125").

BRAKE RIGGING STABILIZING BARS



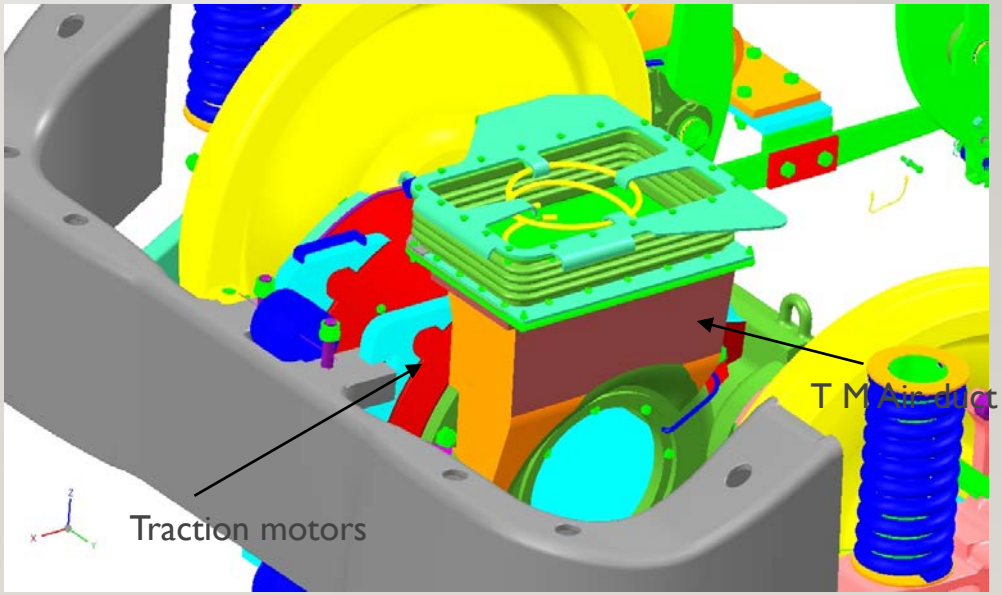
LOCK BOLTS (HUCK BOLTS)

- Used on this bogie at critical locations to make it a ZERO FAILURE unit (on the account of loose fasteners).
- Locations where used:
  - Car body traction rods at the bogie end,
  - Carboy traction rod connection at pivot pin end,
  - Axle traction rod connections (both ends) &
  - Traction motor nose link connections (both ends).



OTHER FEATURES

- Traction Motor cooling arrangement
- Yaw dampers
- Vertical dampers



SAFETY LINKS & SAND BOXES

- **Safety links**
  - Prevent separation of the bogie from the locomotive car body in case of derailment.
  - Provide means of lifting the bogie along-with the locomotive body.
- **Sand Boxes**
  - In WDG3A
    - four numbers Bogie mounted
  - In WDM3D
    - All four under frame mounted.

WEIGHT COMPARISON OF WDG5 & WDG4 BOGIES

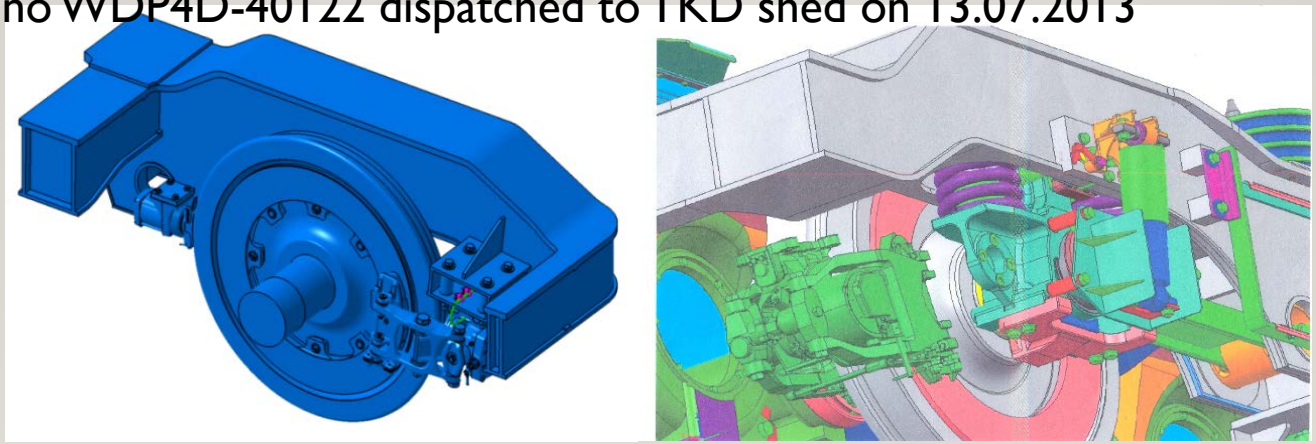
(EXCLUDING WHEEL AXLE COMBOS)

Sl. No.	Description of item	WDG5 Weight in Kgs	WDG4 Weight in Kgs	
1	Bogie Frame	3700	5000	
2	Bearing adapters, primary suspension & Traction rods	2000	1825	
3	Secondary suspension	450	400	
4	Brake system	400	700	
5	Nose link & Air ducts	200	250	
6	Car body linkage	200	160	
7	Misc. item	200	280	
	Total	**7150**	**9215**	

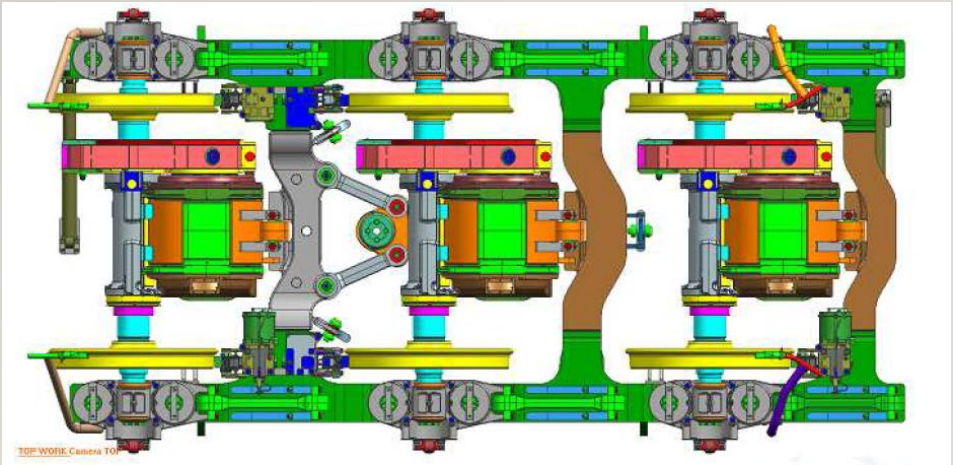
NEW/EXPERIMENTAL FEATURES OF WDG/P4/WDG/P4D

DISC BRAKE SYSTEMS FOR WDP4/WDP4B LOCOMOTIVES

- Low thermal load on wheel during braking , result in increased Wheel Life
- High speed operation
- Reducing braking distance
- High reliability & low Maintenance
- Elimination of conventional Brake Rigging Problems
- Loco no WDP4D-40122 dispatched to TKD shed on 13.07.2013



TREAD BRAKE UNIT



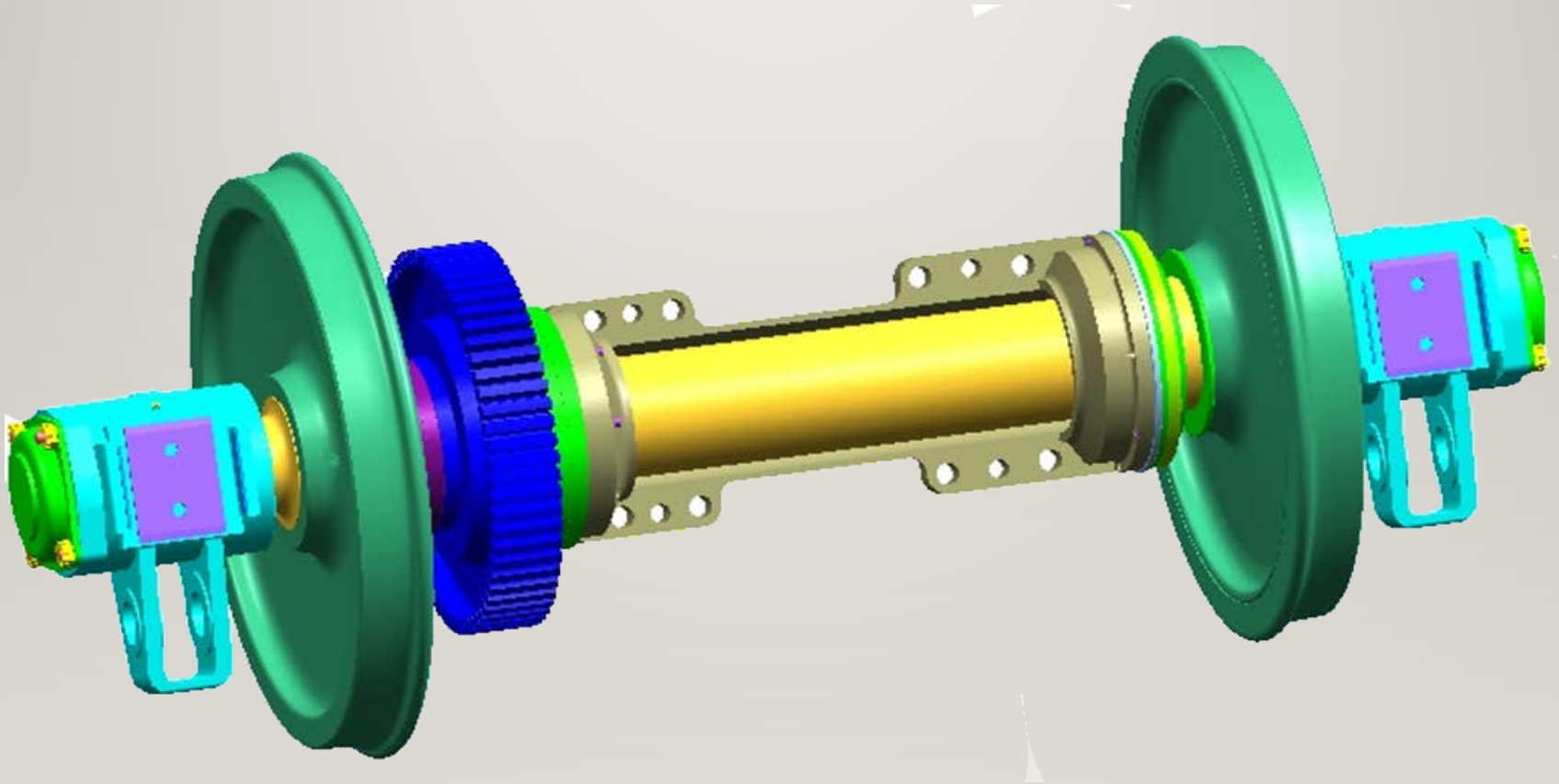
- Tread Brake Units are bogie mounted mechanical devices used to provide braking force to the locomotive.
- The brake unit converts pressurized air into mechanical movement and force on the brake shoe against wheel tread.
- Unitized tread brakes acting on one composition brake shoe per wheel provide the braking power for the locomotive.
- The tread brake units utilize integrated slack adjusters that compensate the full amount of wheel wear as well as the brake shoe wear.

WHEEL SETS

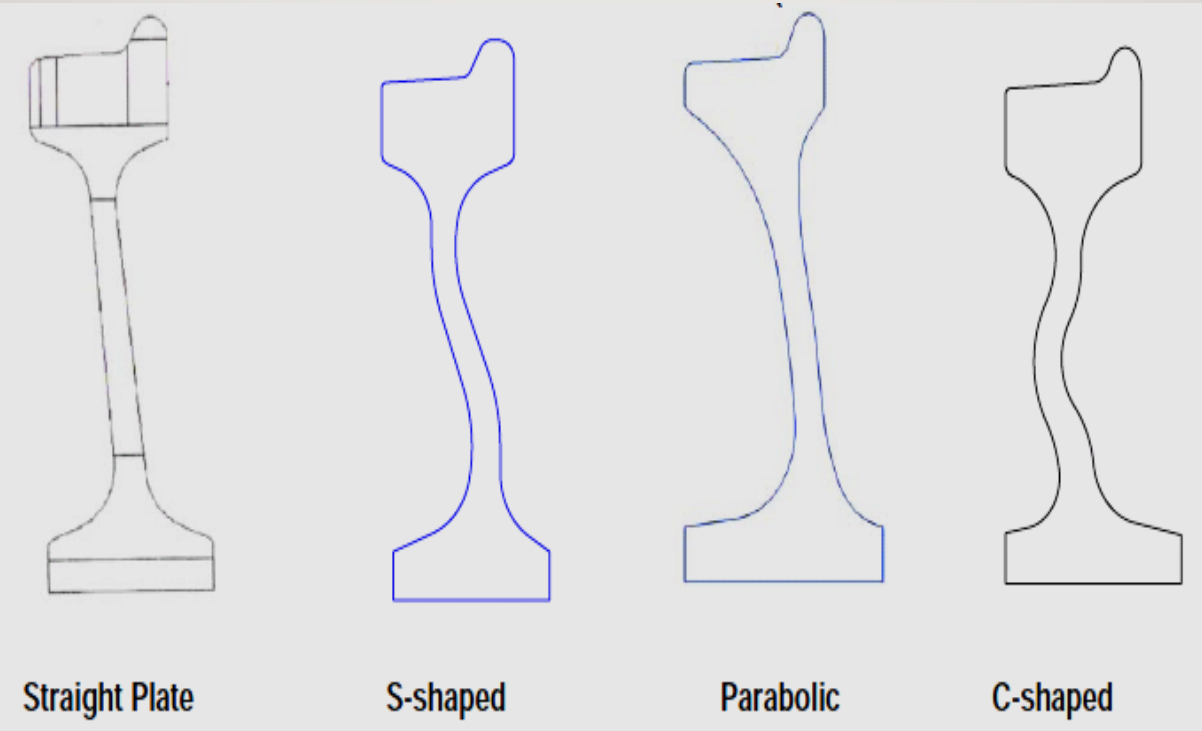
WHEEL SETS

- Two wheels rigidly mounted on single axle
  - Straight Plate, 'S' Shaped, 'C' Shaped
  - Hydraulically pressed disks on to Axle
- Roller bearings/Cartridge Roller Bearings
  - Conventional Roller Bearings
  - Cartridge Taper Roller Bearings
- Bull Gear
- Suspension Bearings/Suspension tube
  - Solid bearings, Taper Roller bearings

WHEEL SET IN ASSEMBLED CONDITION

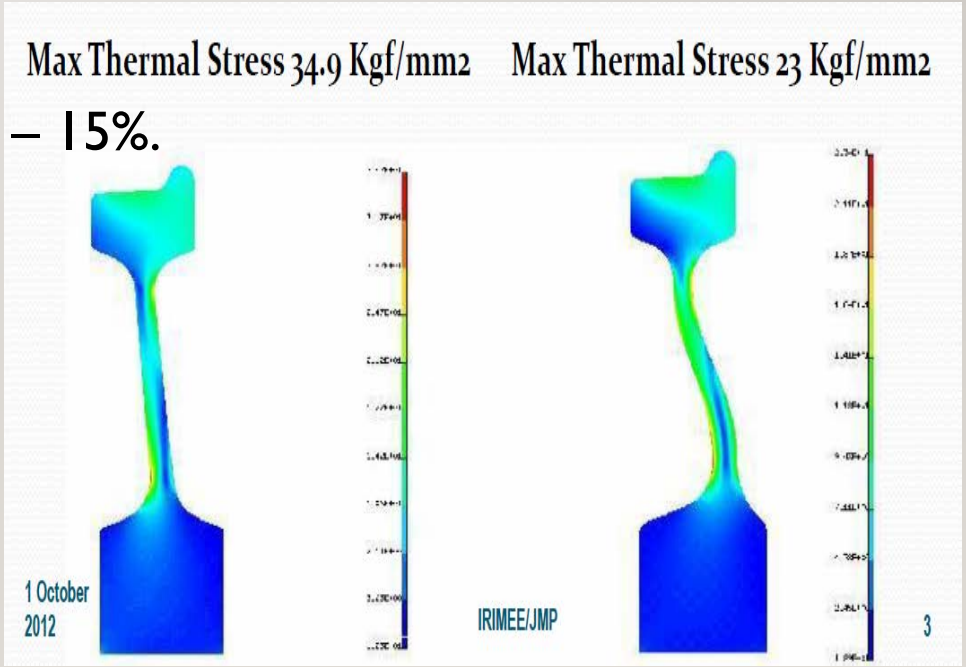


WHEEL DISK SHAPE



MERITS OF S TYPE PROFILE

- Suitable for axle loads up to 22.5 t & 200 kmph speed.
- Induced thermal stresses are 50% lesser and mechanical stresses are 15-30% lesser.
- Condemning diameter of 1000 mm.
- Service life will improve by at least 10 – 15%.



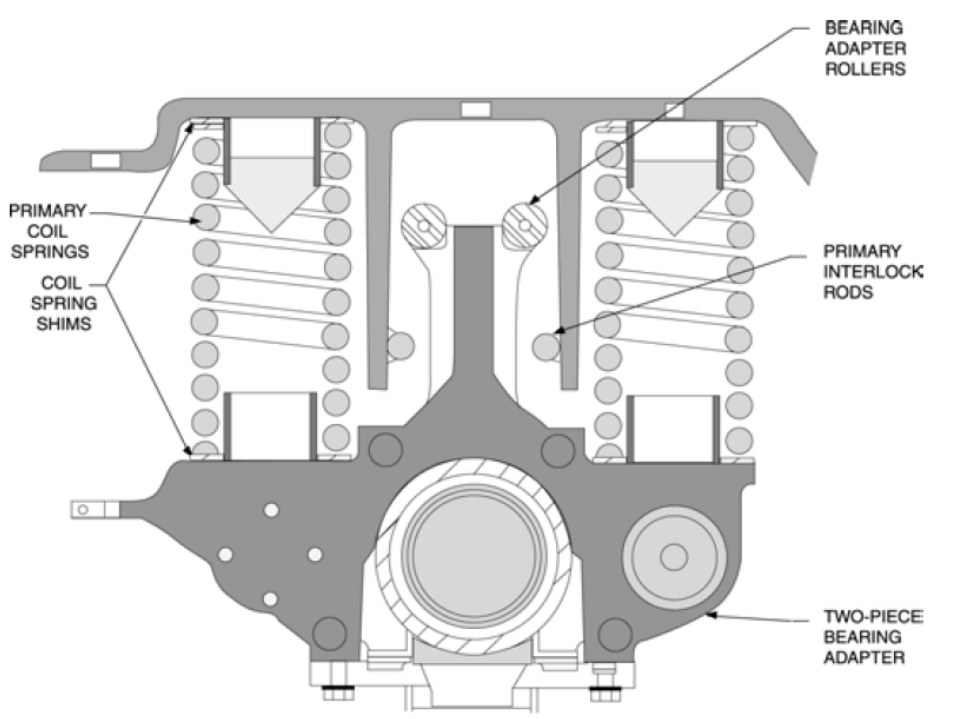
ON DATE SCENARIO

- Almost all major railways have switched over to curved plate design, such as S, C & Parabolic shaped
- S shaped wheels (mfd by DSP) are being used in HHP locomotives since inception.
- Recently it has been decided to introduce this in Alco locomotives to minimize cases of wheel gauge widening.
- RWF has been given a trial order for parabolic shaped web micro alloy cast steel wheels for diesel locos.

SUSPENSION COMPONENTS

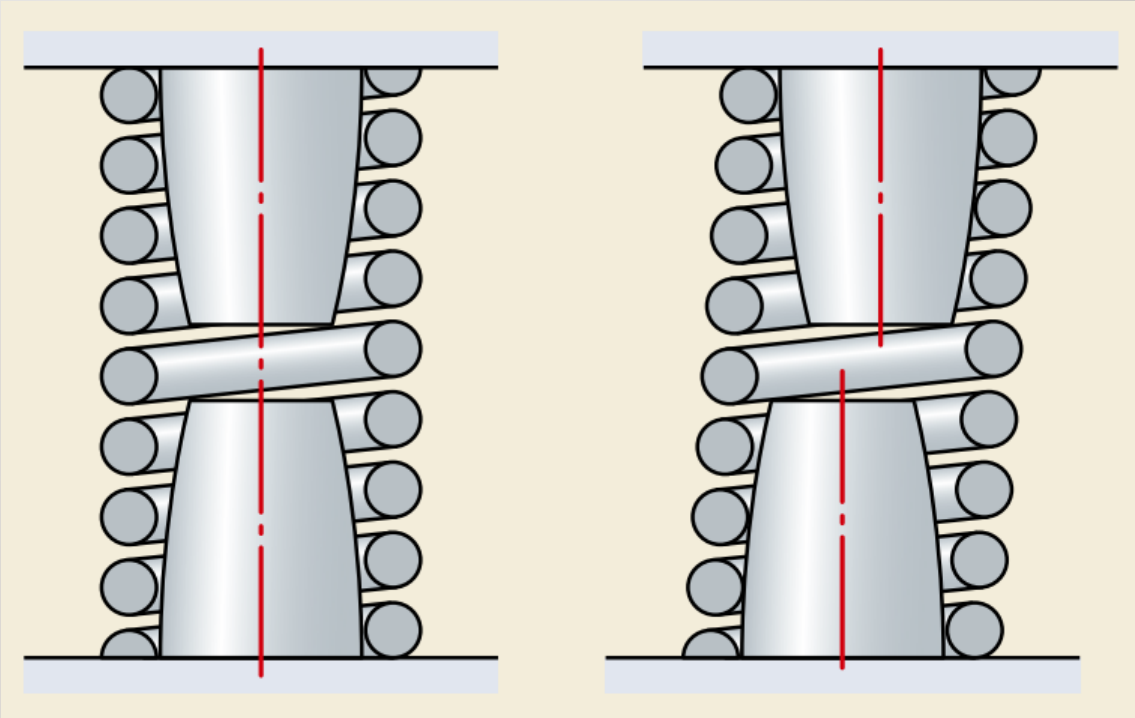
PRIMARY SUSPENSION

- A pair of helical (Coil spring) in each Axle Box
- Soft primary suspension



FLEXI COIL SPRINGS (PRIMARY SUSPENSION)

- Deflection in both Vertical and Horizontal axis



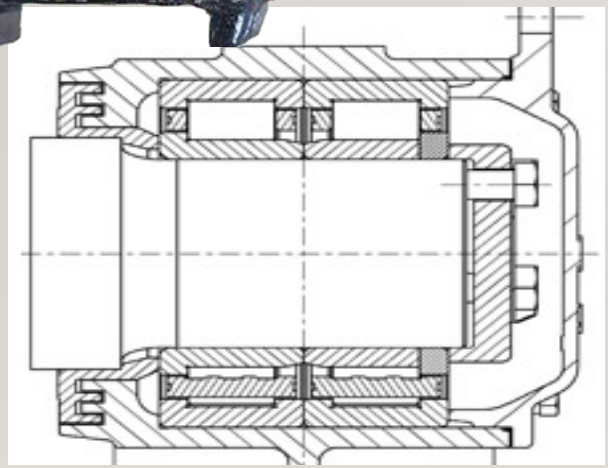
SECONDARY SUSPENSION

- Four nos. of Sandwiched rubber pads
- Equal distribution of Loads
- Hard secondary suspension

AXLE BOX BEARINGS

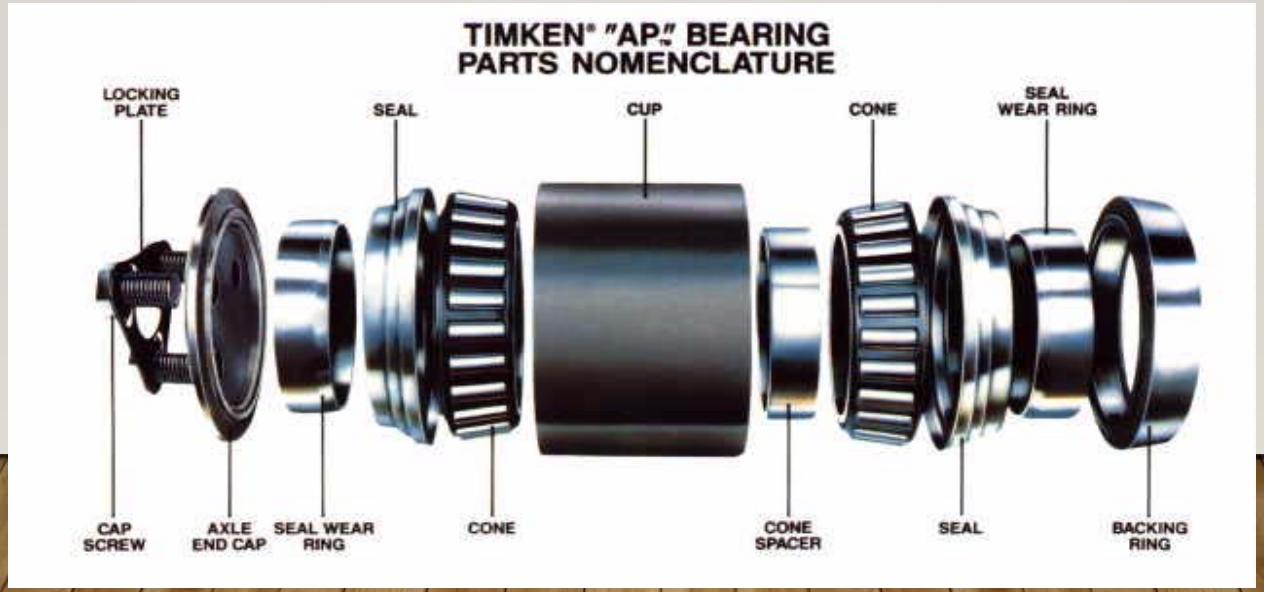
AXLE BOX BEARINGS

- Conventional



- CTRB

MAIN PARTS OF BEARING

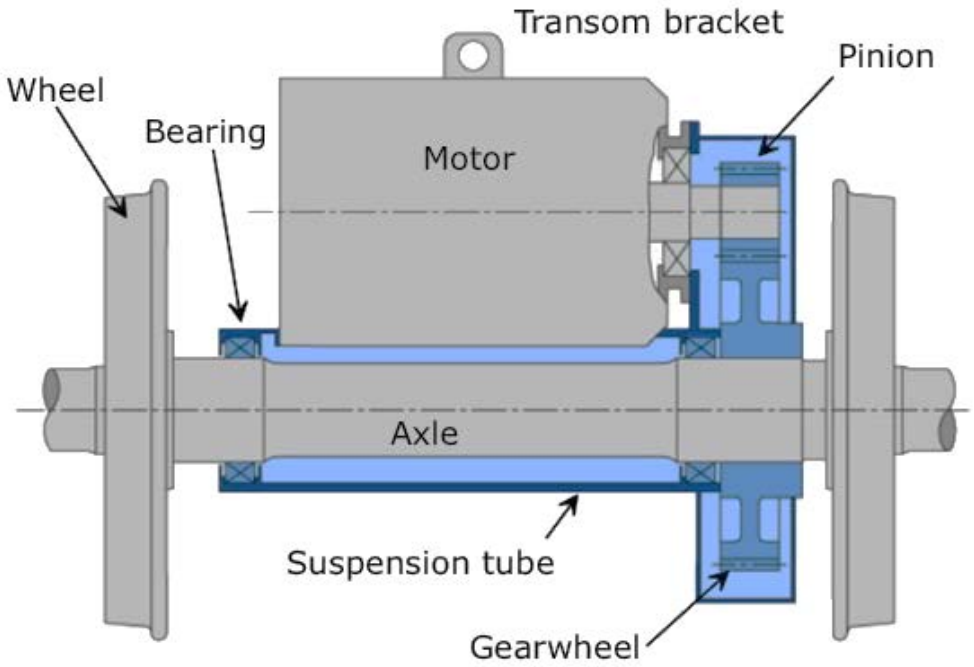


DETAILS OF AXLE BEARING

- TIMKEN make AP-2 class K (6 ½ X 9) bearing (Model no. E-49181 and Part no. NP633994 90019).
- Each cartridge bearing is
  - Self-contained,
  - Pre-assembled,
  - Pre- adjusted,
  - Pre-lubricated and completely sealed,
    - Not requiring any field lubrication **(No - Field - Lubrication)** or maintenance during the lifetime of the wheel.
- The bearings are applied and/or removed without exposing the bearing elements, seats, or lubricant to contamination or damage.
- The bearing assembly is pressed on the axle as a completely sealed unit.
- It is retained on the axle by one end cap which in turn, is secured to the axle by three cap screws and a locking plate.

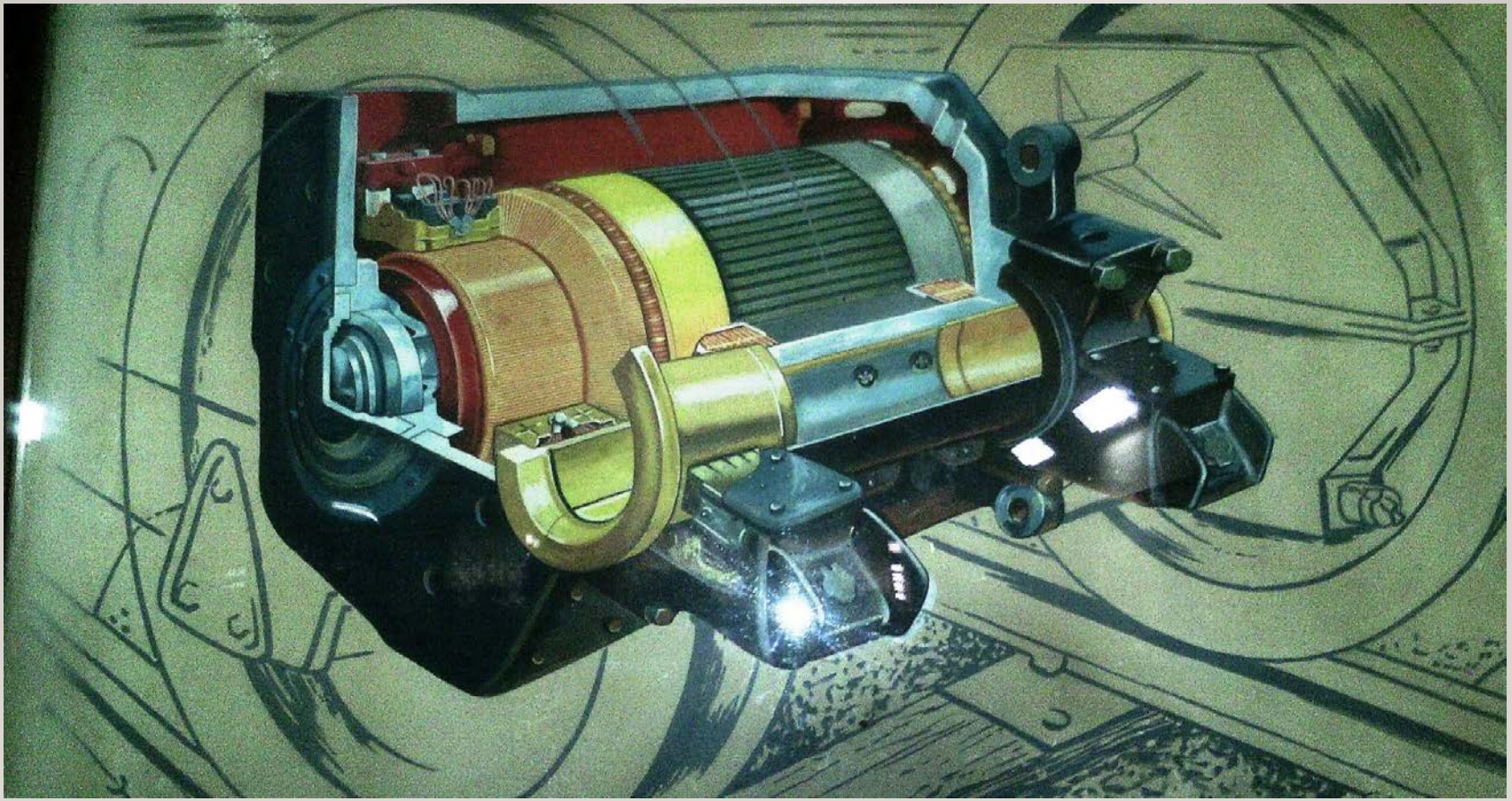
TRACTION MOTOR MOUNTING

TM MOUNTING


Transom bracket
Pinion
Wheel
Bearing
Motor
Axle
Suspension tube
Gearwheel

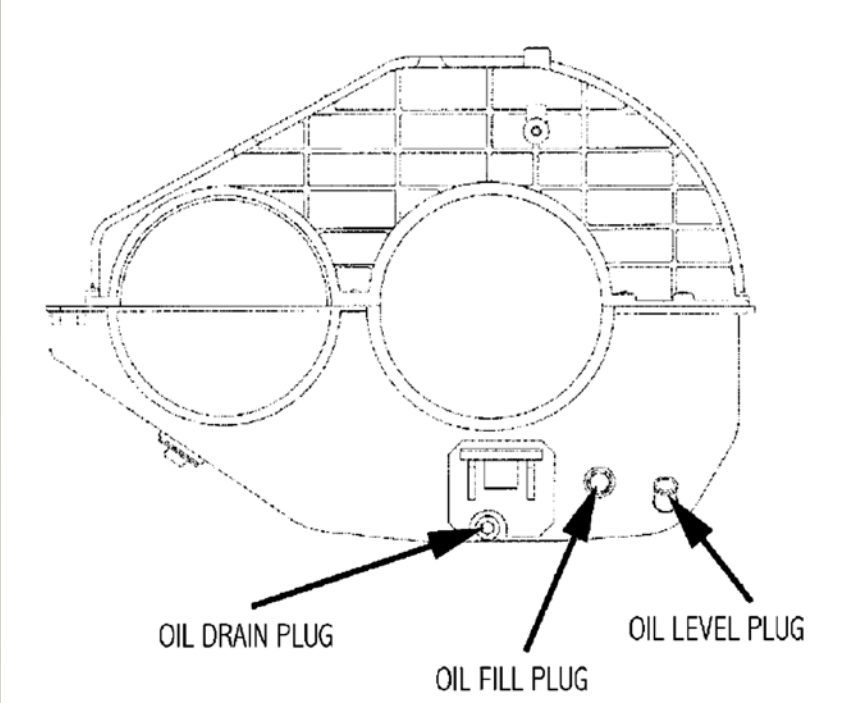
ALCO

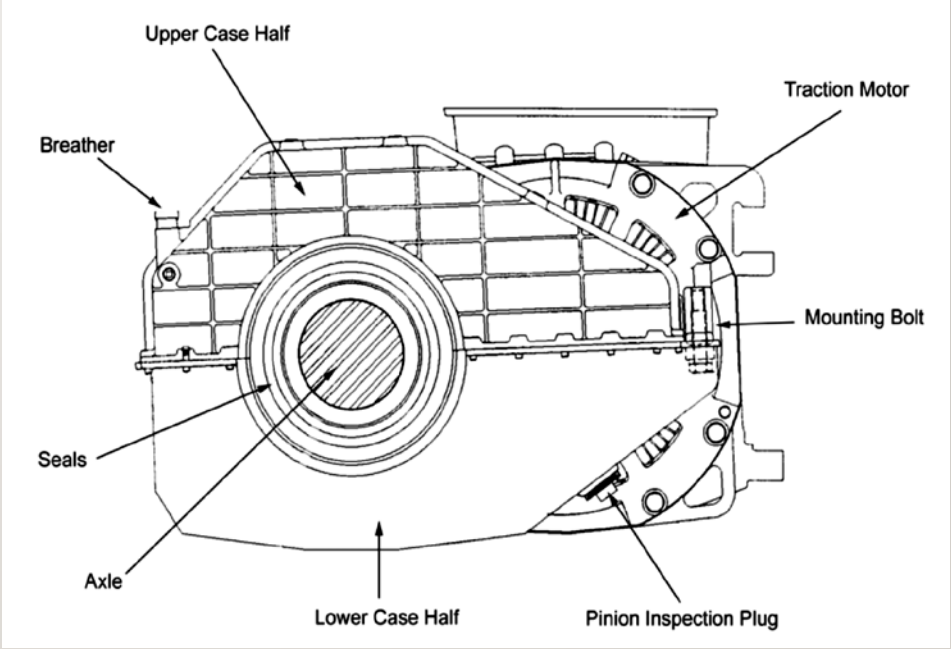
PLAIN BEARING SUSPENSION (ALCO)

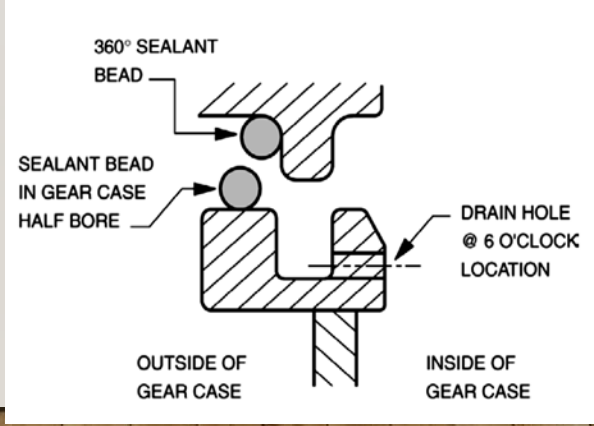


GEAR CASE (ALCO)

GEAR CASE (HHP)





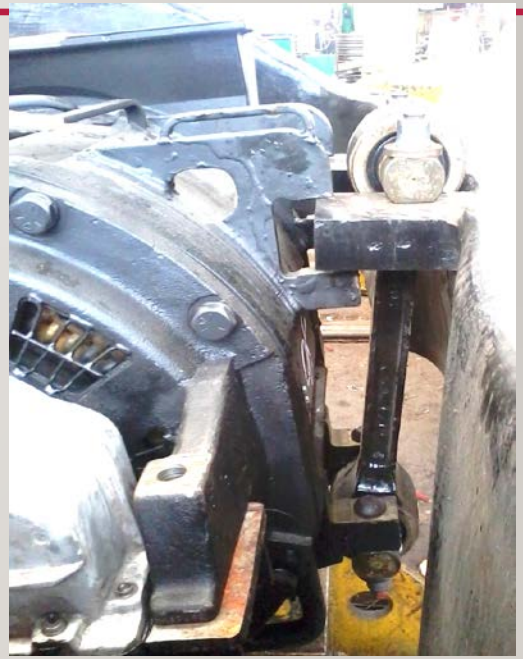


TRACTION MOTOR GEAR CASE

- Any loss of oil will directly cause failure of traction motor assembly.
- There should be no oil leakage.
- Approx Requirement
  - 7.5 ltrs (G4)
  - 8.5 ltrs (P4)
  - SERVO SYNGEAR 460 RR (IOC make)

TRACTION MOTOR NOSE LINKS

- Suspend the traction motors
  - On drive axles and
  - With the bogie frame
- Facilitates in position removal of wheel and motor assembly
  - DROP PIT TABLE required.
  - Not possible in Alco Bogies.
- Special LOCK BOLTS are used for securing.



LUBRICANTS IN USE

Application	RB Guidelines	Lubricants used
TM Gear case Oil (ALCO)	Spec. of approved vendors	Servocoat 170T
TM Gear case Oil (HHP)	EMD EMS 1044	Mobil SHC 634, Servo RR 460
Axle Box Grease (ALCO)	RB guidelines No. 2004/M(L)466/1102	Servo Gem RR3, Lithon 3, MAK RR Grease 3, Balmerol Multigrease LL3
Axle Box Grease (HHP)	EMD EMS 1032	Servo Gem RR3, Lithon 3, MAK RR Grease 3, Balmerol Multigrease LL3
Suspension Tube Grease	Spec. of approved vendors	Lithon 3, Shell Gadus S2 V 100 grease
Suspension Bearing Oil	RB guidelines No. 2004/M(L)466/1102	Servo Prime 76, Turbinol 77, MAK Turbol 78, Balmerol Protomac T-76
TM Sealed Bearing (ALCO)	Spec. of approved vendors	Servo Plex TM3, Balmerol Multigrease TM 3, Shell Gadus Rail S2
TM Sealed Bearing (HHP)	EMD EMS 1026	Shell Superena Shell Gadus Rail S3

SPECIFIC REQUIREMENTS (RELATED TO MAINTENANCE)

WHEEL / MOTOR CHANGING

- DROP PIT ARRANGEMENT is recommended for EMD locomotives as conventional lifting jacks (JAMALPUR or WHITING jacks) require a lot of components to be removed before lifting the loco on jacks.
- Use of DROP PIT also facilitates uncoupling of any one bogie or changing any one wheel / motor at a time.
- DROP PIT should ideally be used in every EMD loco shed to reduce the down time in case of individual motor / wheel set changing.

ENROUTE - OUT OF COURSE ATTENTION

- As per instructions contained in RDSO's instruction bulletin No. MP-IB-VL-03-14-10 (Rev.00) circulated vide L/No. SV.IB dt. 25.03.10
- Wheel set trolley as per Drg No. SK.VL 215 to 218
- Maximum permissible speed for a wheel lifted locomotive is 20 kmph on straight track and 15 kmph on curves
- Movement in night is not recommended

TOWING EQUIPMENT

Old Design

New Compact Design

AAR CLASSIFICATION

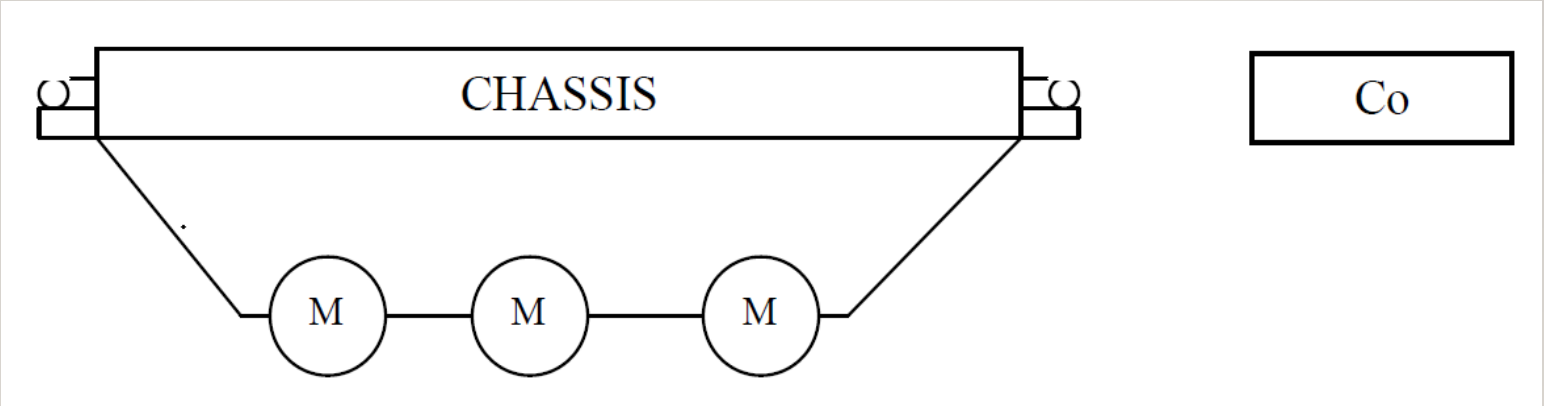
Classification of Locomotives based on wheel arrangements

ASSOCIATION OF AMERICAN RAILROADS (AAR)

- Deals with the classification of Locomotives based on wheel arrangements
  - Classification of wheels
    - Carrying wheels (0, 1, 2, 3)
    - Driving wheels (A, B, C, D)
  - Arrangements of wheels in the Locomotive
    - Independent driving wheels (A, B, C, D)
    - Coupled driving wheels (B', C', D')

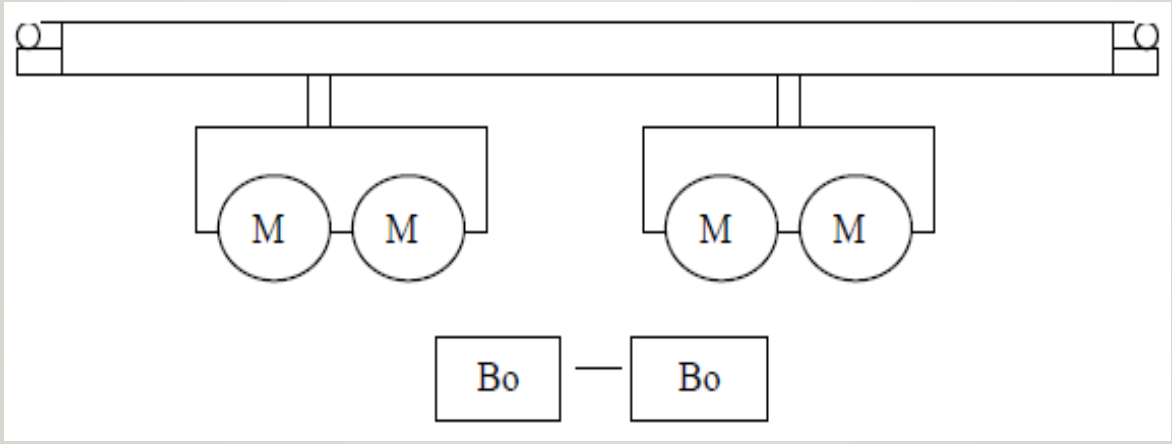
ARRANGEMENT OF WHEELS IN THE LOCOMOTIVE

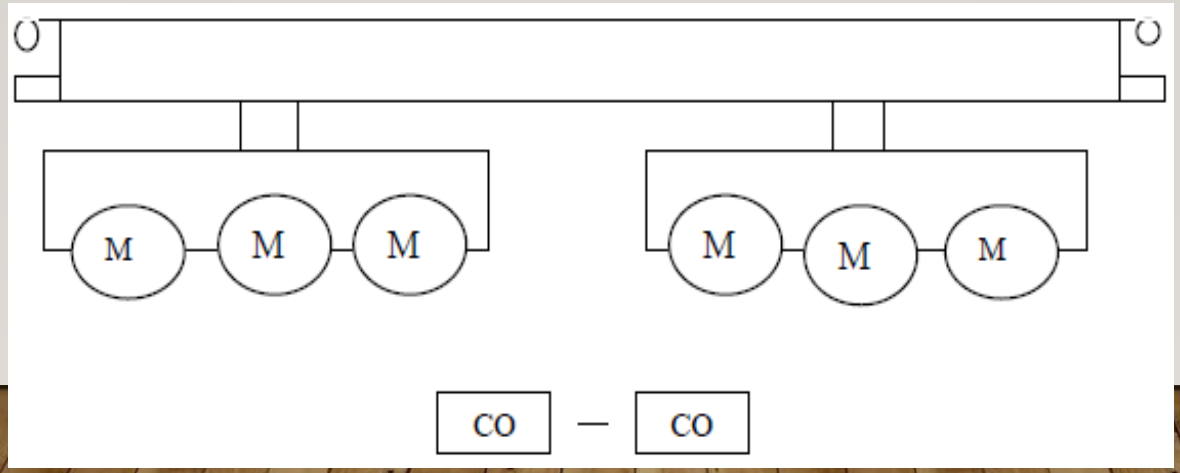
- Rigid frame locomotive: In rigid frame type of wheel arrangement, chassis is directly mounted on wheels, they are represented in single block



ARRANGEMENT OF WHEELS IN THE LOCOMOTIVE

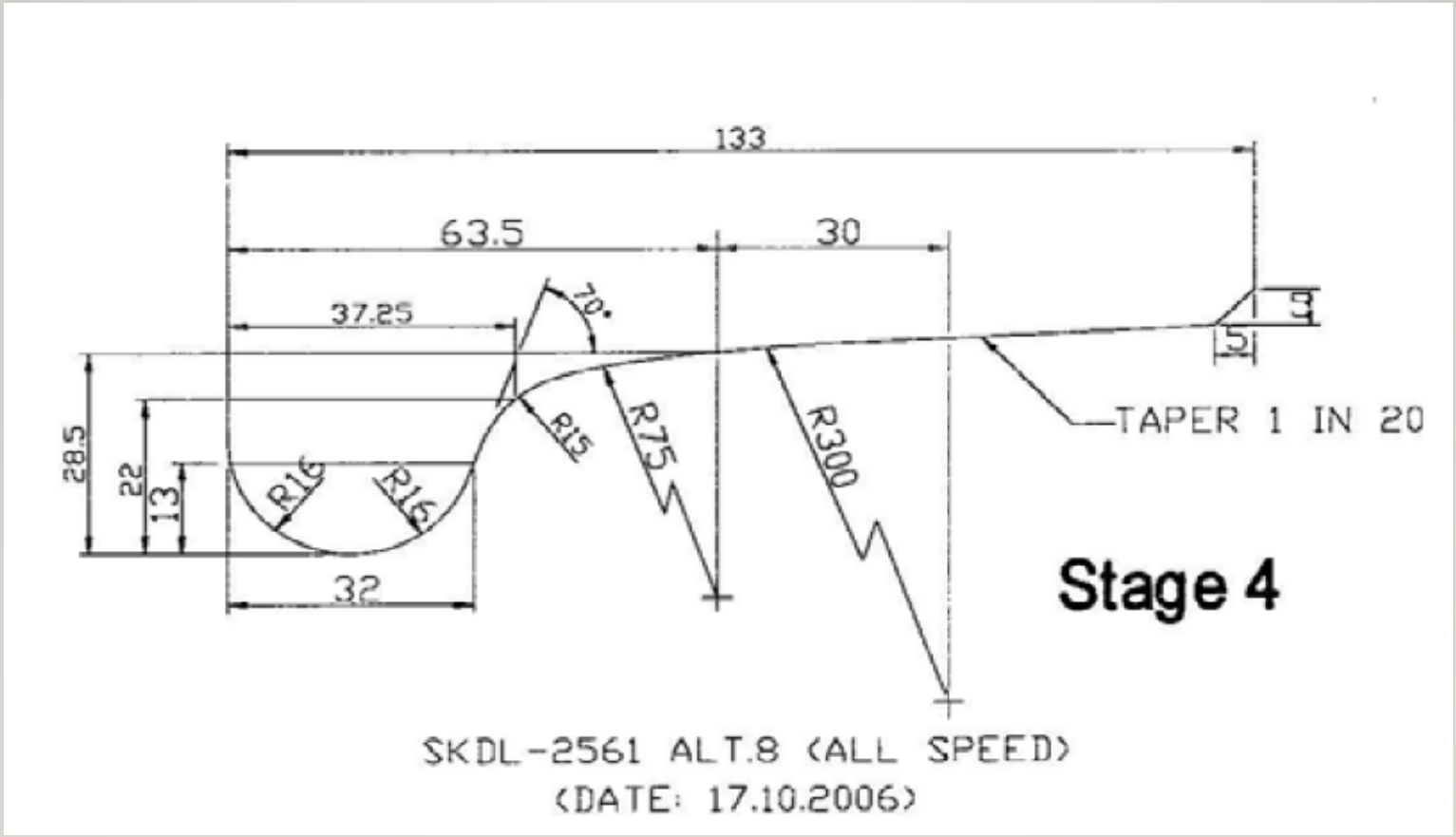
- Bogie type locomotive: In bogie type wheel arrangement, wheels are first arranged into bogies, and chassis is mounted on bogies. It provides greater flexibility then rigid frame arrangement for negotiating curves





WHEEL PROFILE

WORN WHEEL PROFILE



THANK YOU