Mechanical Engineering
Lesson 1
Introduction to Railway Rolling Stock

What rolls on the permanent way is called Rolling stock. In this lesson, importance of Rolling Stock in a Railway System and various important terms used in the context of the Rolling Stock shall be described. Basic information shall also be provided on the objectives of a railway with regard to its rolling stock management.

1. RESPONSIBILITIES FOR MECHANICAL ENGINEERING DEPARTMENT ON INDIAN RAILWAY.

(i) The basic function is to manage the Maintenance and operation of Rolling Stock.

(ii) Standardization of designs of Rolling stock and its components through continuous absorption of latest technology in the fields of maintenance and production.

(iii) Production of coaches and wagons from production units and from the railway related industry.

(iv) Maintenance and operation of break-down cranes and other equipment such as Hydraulic re-railing equipment, Hydraulic Rescue Devices and mechanical jacks etc for restoration of traffic in cases of accidents by removing the infringing rolling stock and other obstructions.

(v) Management of workshops dealing with overhaul & rehabilitation of rolling stock and their components.

2. IMPORTANCE OF ROLLING STOCK

It is evident that no railways can exist without holding an adequate number of properly designed vehicles for transportation and further, cannot run profitably without making effective and efficient use of these vehicles. A Railway engineer or manager must, therefore, acquaint himself adequately about the important aspects of Railway Rolling Stock and their related aspects.

3. CLASSIFICATION OF ROLLING STOCK

As numerous types of Rolling stocks are in use on the railways, the important terms which should be known even to railway men not directly associated with the Rolling Stock are described below:

3.1 Rolling Stock

Any vehicle capable of moving on railway track is called rolling stock.

3.2 Locomotive

The vehicle containing the source of power to pull the train is called locomotive. It is usually attached in front of the train. It is capable of not only controlling its own movement but also of attached vehicles.

3.3 Coaches

Vehicles designed for carrying passengers are called coaches known as PCV's. In addition, certain other vehicles attached to passenger trains are also covered under the ambit of coaches. These include postal vans, luggage vans, inspection carriages etc. and are known as Other Coaching Vehicles (OCV's)

3.4 Wagons or goods stock

Vehicles designed for carrying various commodities are called wagons. These may be open, covered, flat, tank or other types depending upon the commodity to be transported.

3.5 Electrical Multiple Unit (EMU/MEMU)

Self-powered set of coaching stock run on electric traction for short distance commuter operation is called EMU/MEMU. These operate as multiples in sets of 3 or 4 coaches with each set incorporating usually one powered coach.

3.6 Diesel Multiple Unit (DMU)

These are self-powered set of coaching stock powered by a Diesel engine on the pattern of EMUs for operation on non-electrified routes. These are very popular in branch line operations.

3.7 Rail Cars/Buses

Self-powered coaches operating generally as a single coach used on such routes where traffic is limited but spread over the day.

3.8 Train

Train is a group of vehicles and one or more locomotives moving on rail which needs line clear to enter a block section.

3.9 Train load

Train load is defined as the total load (in tones) of the entire train. Good management ensures that the train load is maximized for the various types of trains. The train load is usually restricted by the tractive effort of the hauling unit, length of the loops on stations and the axle load of each vehicle in the train.

4.0 IMPORTANT SYSTEMS AND COMPONENTS OF ROLLING STOCK

4.1 Body

The body of the vehicle usually has a continuous underframe for carrying the weight of the body and commodities/passengers. The body comprising of the underframe, side walls and end walls and also the interiors are designed according to its use. Care has, however, to be taken that the body profile does not exceed the Maximum Moving Dimensions. (MMD)

4.2 Running Gear

This is the part of the vehicle which enables the rolling stock to run smoothly over the undulations in the permanent way. This comprises of the following main components.

(a) **Bogies:** Super structure (body) of any Rolling Stock normally rests on bogies through the medium of centre pivot and side bearers on the bogie bolster; the bolster normally is supported on the bogie frame. This arrangement provides independence of movement between the super structure and the bogie frame. Suspension provided between the axles and the bogies frame is termed primary suspension and between bolster and the bogies frame is called secondary suspension. Wagons are normally provided with single suspension while the coaches are normally provided with both primary and secondary suspension.

(b) **Wheels:** These may be solid forged/rolled or cast steel with conical surface to negotiate the permanent way. These carry the load of the vehicle. Some vehicles are still fitted with tyres of special steel shrunk fitted on the wheel centres.

(c) **Axle:** Two wheels are joined by an axle to form a wheel set. Axles are usually forged. A vehicle may have 2, 4 , 6,or 8 axles though some special vehicles with more axles are also available. See fig 1.1

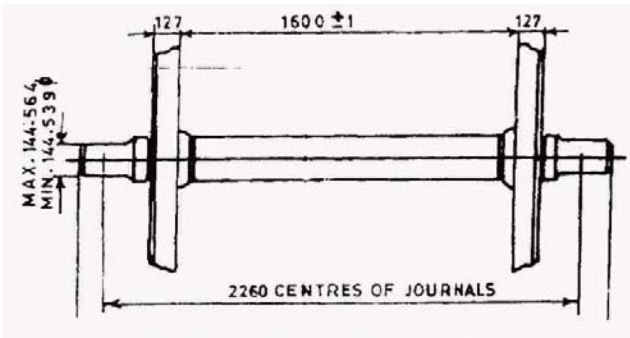

FIG. 1.1 WHEEL SET FOR WAGON

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x: This is the interface between a rotating wheel and the non-rotating vehicle body. Previously antifriction-based bearing surfaces were used but all current designs incorporate roller bearings.

(e) **Springs:** Various types of springs are provided between the vehicle and its wheel sets. The function of these springs is to absorb the vibrations and shocks induced by the permanent way so that the transportation of passengers and commodities does not exceed prescribed levels of vertical and lateral acceleration. Laminated & coiled springs are in use. Shock absorbers and hydraulic dampers are also in use in modern coaches to reduce shocks and jerks.

4.3 Coupling System/Draw gear

This is the system through which the various vehicles of train are connected to each other so that the pull exerted by the locomotive at one end of the train can pull the entire train. In the earlier design the connector was provided by forged screw couplings which could be joined to the hook of the adjacent vehicle and tightened by turning the screw. The side buffers incorporated rubber pad to absorb the energy caused by impacts during starting and braking. The tensile strength of this arrangement was low and attaching or detaching of vehicles necessitated person to go in between the wagons. The provision of automatic Centre Buffer Couplers (CBC) has overcome these problems and enabled operation of much longer and heavier goods trains. The strength of CBC is 85 tonnes as compared to 28t of screw coupling.

4.4 Braking System

In order to avoid jerks during braking, it is important to provide a centrally coordinated braking system. The current designs of Braking System fitted on the vehicles incorporate compressed air brake system. While specific braking systems shall be covered subsequently, the basic brake system comprises of the following components;

(a) **Brake Block:** (Fig. 1.2) shows composite brake Blocks.

(b) **Brake-Cylinder:** This is the equipment which converts the signal received through destruction of air pressure into the mechanical movement of the piston to enable application of brakes through brake rigging.

(c) **Brake-Rigging:** Brake-rigging is the mechanical linkage fitted under the vehicle body which transmits the movement of the brake cylinder piston the brake-blocks on all the wheels for simultaneous brake application. Slack adjusters are provided in these linkages to compensate for the wear in the brake blocks so that the braking force is not reduced.

(d) **Train Pipe/Brake Pipe:** It runs along the length of the vehicles and provides for interconnections by hose pipe. In the case of air brake system, a brake pipe running along the length of the vehicle is provided with rubber hose pipes, angle cocks and leak-proof universal couplings at the ends for connecting with adjoining vehicles.

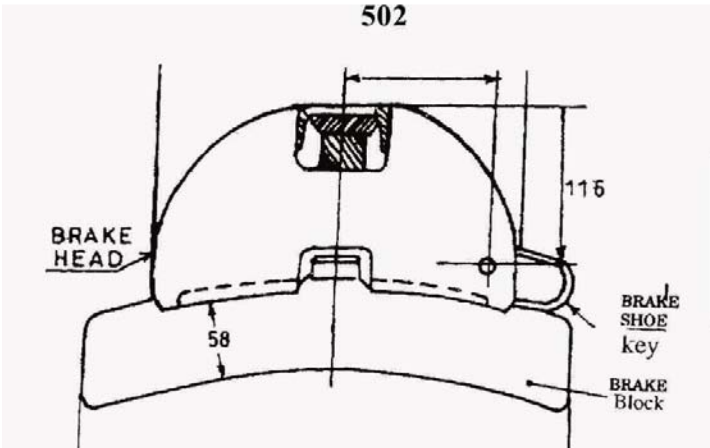


FIG. 1.2 BRAKE SHOE

5 IMPORTANT TERMS USED IN ROLLING STOCK MANAGEMENT

As we have already learnt, the rolling stock is a critical component of any Railway System since it is the ultimate revenue earning asset. Besides, the capital outlay the annual revenue expenditure on its upkeep and operation form a major portion of the Railways' total expenses. The financial viability of railway often depends upon the efficient use of its rolling stock.

It would be necessary to be acquainted with some of the more essential and basic concepts used in this context.

5.1 Gross Loads

This is the total weight of the vehicle when loaded to its maximum designed capacity. It is restricted by the number of axles, axle load, and axle load itself, is limited by the track structure and formation etc. On Indian Railways, the axle load is generally limited to 20t on Broad Gauge and 12t on Meter Gauge.

5.2 Carrying Capacity

Carrying capacity is the most significant feature of rolling stock since its optimization is the key factor of cost effective designing. It is represented as number of passengers or tonnes of commodity carried. Maximizing carrying is achieved through minimizing the tare weight of the vehicle without sacrificing its strength.

5.3 Speed Potential

Speed potential is the maximum speed at which the vehicle can run on the relevant track without jeopardizing the safety of operation. This is determined for all new designs after behavioral trials. The general level of speed potential for locomotive and coaches on B.G. is 110 kmph and for wagons 80 Kmph though special designs with higher speed potentials are now available in each case. The speed potential of locos and coaches for Shatabadi and Rajdhani Expressses is 130 kmph. Latest LHB Coaches have the potential to run upto 160 kmph.The speed potential for new designs of wagon is 100 Kmph. Diesel locomotives (GM) and electic locos (ABB) fit for 160 Kmph have recently been added to the fleet of locomotives.

5.4 Braking Distance

Braking distance is the distance traversed by a full train load before coming to a stop form the maximum operating speed. This distance is calculated by braking distance trials and to ensure safe operation, it must be less than the sighting distance of the first stop signal.

5.5 Rolling Resistance

Before starting the rolling motion of the wheel, the friction resistance at the axle box has to be overcome. Starting resistance is more than rolling resistance. The starting resistance is considerably less in the modern Roller bearing vehicles. The locomotive must produce tractive effort higher than the starting resistance of the full train to start the train. Further, when the vehicle starts moving, it is subject to wind resistance in addition to the frictional rolling resistance at rail level and at axle box level. The speed at which a locomotive can pull a train is determined by the surplus accelerating power after overcoming the rolling resistance.

5.6 Availability of Rolling Stock

In order to ensure that a certain number of rolling stock is always available to meet the transportation commitments, it is necessary to provide certain buffer for meeting the maintenance requirements. The ratio of the stock available for traffic to the total population is an important efficiency indicator and represents the index of availability of rolling stock. There are different statistical definitions of measuring this index for locomotives, coaches and wagons as also different yard sticks. Maximizing the availability of rolling stock is an important objective of any Rolling Stock Manager.

5.7 Reliability of Rolling Stock

Reliability of a Rolling Stock is measured in terms of its breakdown during the inter-maintenance period. Such breakdown could often result in detention to trains and sometimes necessitate detachment of the concerned stock. In extreme cases, it could even cause an accident. A well-managed system must aim at minimum breakdowns.

5.8 Utilization of rolling stock:

Efficient use of rolling stock when it becomes available after maintenance is the most important management aspect of any Railway system; it is measured in terms of Gross tonne kms, kms earned by a locomotives/vehicle in a day.

6. OBJECTIVE OF ROLLING STOCK MANAGEMENT

Having learnt the important terms used in the context of rolling stock management, It is also important to understand the overall objectives of the Rolling Stock Management in a railway system. The main objectives aimed to be fulfilled in this regard are discussed below:

6.1 Provide appropriate maintenance inputs so that the availability of rolling stock is maximized to ensure that the traffic commitments are met.

6.2 While maximizing the availability of Rolling Stock, it should be ensured that its reliability is not compromised and uninterrupted journey is performed to its destination

6.3 Utmost priority is to be given to the safe operation of the Rolling Stock to avoid any damage to life, property or commodities.

6.4 The inputs are needed to be optimized in such a manner that the above objectives are met at most economic costs in the area of maintenance, fuel consumption and manpower requirements,

7. PRESENT BRAKE SYSTEMS

To stop a moving train, the brakes are applied on complete train from the locomotive as indicated is Para 4.4. There are following types of brakes are in use:-

7.1 Air Brakes

A brake cylinder containing piston is operated with the use of compressed air and the movement of the Piston is transmitted to the Brake Block through brake rigging provided under each vehicle. A brake pipe running under each vehicle is connected to air reservoir of each vehicle and the brake pipe is connected to the brake pipe of the locomotive. Compressed air is supplied from the locomotive to feed the compressed air to the brake pipe and air reservoir on the trailing Vehicles. A pressure of 5 kg per sq. cm is maintained in the brake pipe in running position and a pressure of 6 kg per sq. cm is maintained in the feed pipe and when the driver wants to apply brakes, the pressure from the locomotive is dropped by discharging the air. The drop in air pipe pressure in the vehicles gives the signal to the valve distributor provided in the each vehicle which allows flow of compressed air from the air reservoir into/out of brake Cylinder. The pressure in the brake pipe is controlled by drivers brake valve in the locomotive and for releasing the brakes, the driver closes the valve so that brake pipe pressure is regained to 5 kg. per sq. cm. Air brake for wagons on Indian Railways is having a single pipe system and in the coaches a twin pipe brake system with graduated release has been adopted. Figure 1.3 & 1.4 shows the schematic diagrams of the system. The above arrangements are called conventional Air Brake system.

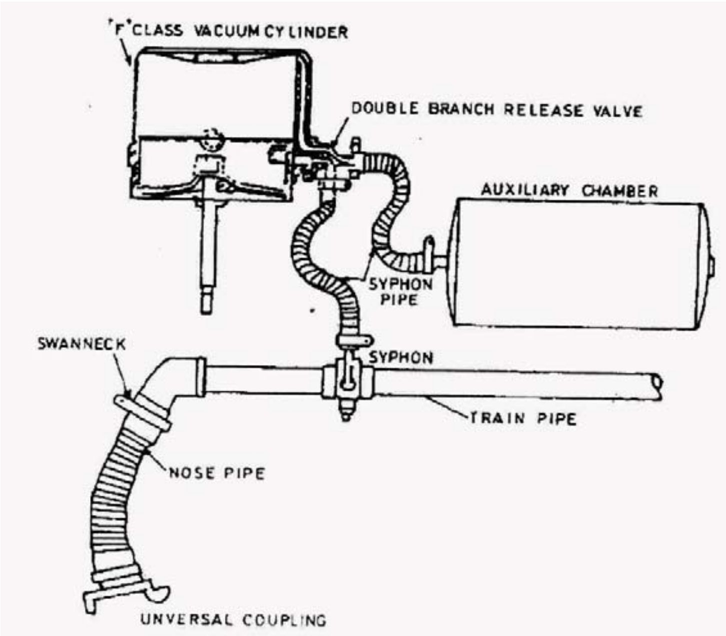


FIG. 1.3 : VACCUM BRAKE SYSTEM

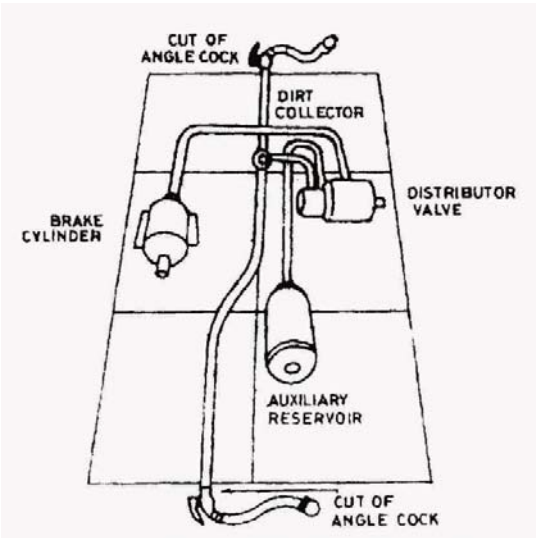


FIG. 1.4 SINGLE-PIPE AIR BRAKE SYSTEM

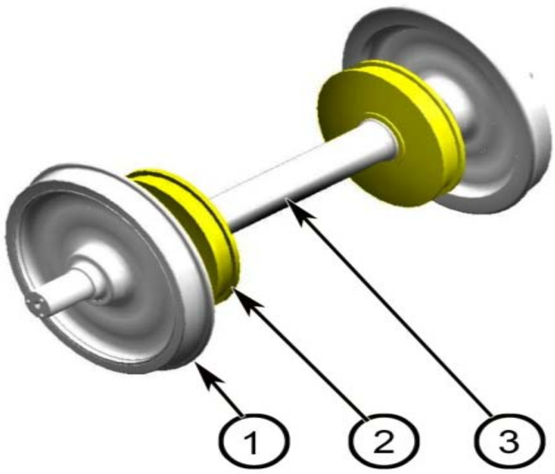
In order to overcome the problems of four slack adjuster as well as problems associated with cast iron brake blocks, a design of brake system incorporating 8" size cylinders (as being used EMU Coaches) along with 'K' type high friction composition brake blocks has been developed. This is fixed on individual bogies and is known as Bogie Mounted Brake system. (BMBC)

DESIGN FEATURES OF THE SYSTEM:-

(i) External slack adjusters have been eliminated.

(ii) A total of 4 Cylinders of 8" size have been used in place of two 14" Cylinders in standard air brake system.

(iii) High friction Composite brake blocks of 'K' type have been used.
(iv) Bogie brake rigging has been modified to incorporate a total mechanical advantage of 7.644 per bogie for non A-C coaches and 8.40 per bogie for AC coaches.



7.2 Disc brake system/ friction brake system

Bogie Brake Equipment on LHB Coaches: The Bogie Brake equipment includes brake cylinder, brake caliper, brake shoes with snap lock gates and brake discs. U-series brake cylinders with automatic slack adjustment are used to operate the friction brakes in rail vehicles. The automatic slack adjustment is provided to take care of loss in the clearance due to wear (abrasion) on brake pads and brake discs. In the Pneumatic braking system braking force is generated by charging the braking cylinder, which intern press the brake pad against the brake disc. Each axle is equipped with two brake discs. The brake energy is dissipated only at the brake discs, so the wheel set is only stressed by the weight of the coach.

(1) Wheel, (2) Brake disc, (3) Axle

Fig 1.5: Wheel and axle.

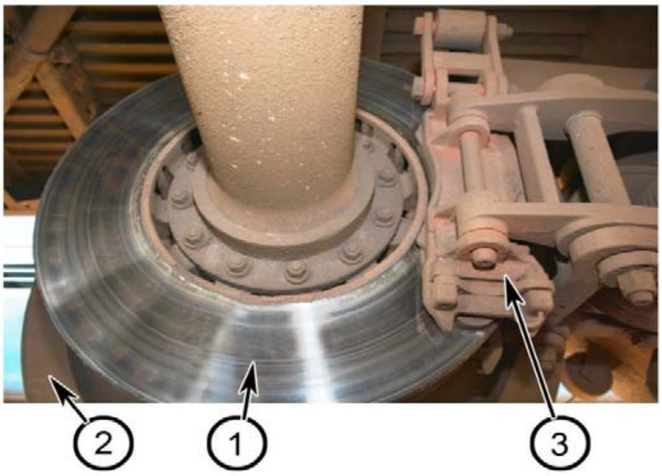


Fig 1.7 Photo of brake disc and caliper unit

1.Wheel	**2.Brake disc**	**3. Caliper unit**

(iii) The fundamental considerations which govern the performance of railway braking systems are:-

(i) Fast propagation of air along the entire train length to ensure uniform application. (Twin pipe system ensures such propagation faster even as compared to single pipe system).

(ii) A very rapid initial filling up of cylinder so that brake blocks are quickly brought into contact with the wheel to start the braking process.

(iii) A slower subsequent filling up of cylinders to give a gradual buildup of retardation of wagons to avoid wheel skidding and flats on wheel tyres.

(iv) A fast release of brakes throughout the train length so that train after having come to a stop, can be restarted by the train driver quickly. (Twin pipe system is faster)

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