CHAPTER 7

VACUUM BRAKE SYSTEM

701. GENERAL

Brakes are essentially meant for controlling the speed and stopping the train. Different brake systems exist world over depending upon the requirements laid down by individual railway systems. The brake system should meet the following basic requirements:-

- Should be automatic and continuous i.e. in the event of train parting, brakes should automatically apply
- Shortest possible emergency braking distance
- Maximum possible braking force
- Shorter brake application time
- Shorter brake release time
- Low exhaustibility of brake power under continuous or repeated brake application
- Ease in maintenance
- Minimum "run in" and "snatch" action during braking

The vacuum brake system derives its braking force from the atmospheric pressure acting on the lower side of the piston in the vacuum cylinder while vacuum is maintained above the piston. The nominal vacuum is 510 mm which gives an effective pressure of 0.7 kg/cm^2 on the piston. The vacuum is created in system by the ejector or the exhauster mounted on the locomotive.

702. CONSTRUCTIONAL DETAILS

A. The main parts of vacuum brake system are:

I. The vacuum cylinder suspended by trunions from the underframe
II. Brake shaft
III. Brake rigging i.e. pull rod, levers etc.
IV. Train pipe and pipe connections
V. Hand brake (Lever or screw type)
VI. Empty-Loaded Tie Rod
VII. Slack Adjuster

B. VACUUM BRAKE CYLINDER

There are two basic types of vacuum brake cylinders in use on goods stock namely "E" type and "F" type. In "E" type brake cylinders, the volume of upper chamber is enhanced by provision of a dome or casing which forms an

integral part of the vacuum cylinder. In "F" type vacuum cylinder, the top is kept flat but a separate vacuum reservoir is provided, which is connected to the upper chamber by a syphon pipe to achieve the same purpose. The higher volume of the upper portion ensures higher efficiency of the vacuum cylinder.

Both E and F type brake cylinders are further sub-divided according to the cylinder diameter. Types and size fitted on various standard wagons are as under:

S. No.	Type	Size (in mm)	Drg. No.	Stock where fitted
1.	E	457	VBA-7/M	All 16 ton Axle load wagons except BVG & BVM
2.	E	533	VBA-8/M	On BWL,BWT,BOB,BOBX, BOBS
3.	F	533	VBA-15/M	On BWS,BRS,BRH,BVG and BVM
4.	F	560	VBA-20/M	On BOX,BCX and BOI.

703 "F" TYPE CYLINDER

In "F" type cylinders the volume of upper portion of the vacuum cylinder is kept much larger as compare to "E" type cylinder. Larger volume of the upper portion ensures higher efficiency of the vacuum cylinder

In E type cylinders the upper portion volume is provided by giving sufficient annular space between barrel, casing and a dome on top. In F type cylinder the top is kept flat and there is no casing to give annular space. A separate cylindrical shaped vacuum chamber of larger volume is suspended on the underframe. Theupper portion of the vacuum cylinder is connected to this chamber thought double branch release and siphon pipe. "E" type cylinders have a barrel and a casing whereas in F type cylinders a back and a bottom pan. Their shapes are also different. The barrel and the bottom pan are joined sides by means of studs on lugs provided in circumferences. The barrel is of cylindrical shaped with closed top. The pan is also of cylindrical shape with closed bottom. On F type cylinders double branch release valve is provided near the joint instead of single barrel cylinders. A separate passage from the top of the barrel to the release valve is provided side the barrel. This passage is connected through the release valve to the vacuum reservoir and lying separately from the underframe. The most advantages of F type cylinders over E type cylinders are as under:

i. Larger volume of upper portion of vacuum cylinder increasing the efficiency of vacuum cylinder.
ii. The renewal and examination of rolling ring is extremely easy as the bottom can be removed easily from joint. In E type cylinders the complete cylinders is required to be taken off for examination of rolling ring.
iii. The life of rolling ring increases due to more even milling or serration and the rolling ring is not required to be forced and skidded in to position while fitting the piston head.

Except barrel bottom pan and release valve other parts of the F type cylinders are identical with E type cylinders of same size. The three parts and vacuum chamber are described severally.

Barrel:

It is made of cast iron. It is cylindrical in shaped. At the bottom there are 4 lugs for securing the bottom pan with 4 studs. Near bottom there is a circular vertical flange with 4 studs of M-10 size at 82.5mm P.C.D. for securing the double branch release valve it. On the body at a suitable height there two integrally cast trunions. From the top portion of the barrel a 16 mm dia passage is provided outside the barrel leading to vertical flange. This passage connects the top of the barrel with vacuum chamber through the release valve. The top portion of the barrel has strengthened by 4 integrally cast ribs starting from the circumference and extending up to the central boss having 10 mm thickness and increasing height from zero to 32 mm upto the central boss. The inside and outside dia of central boss is 102 and 122 mm respectively. On the top portion of the barrel above the passage leasing to the release valve a hole is required to be provided to facilitate manufacturer. This hole should close by FP 3/8 "A" plug.the hole should therefore, be tapped accordingly. Manufacturers can, however omit it at their option. On the centre of the circular flange a 19 mm dia horizontal hole is drilled on the barrel leading to the lower portion of the cylinder. At the bottom of the barrel there are two recess; the first one is of 2 mm height and the second on 10 mm in height. The vertical surface of the second recess is fine finished machined and the horizontal surface rough machined. The horizontal surface of the first recess and the bottom flange is finish machined. Inside of the barrel is finished machined except on the radius portion where it is rough machined. The vertical circular flange is finish machined. The bottom pan is secured with barrel by means of 4 studs and nuts. The thickness of the barrel is 8 mm.

The trunnions of the barrel of 'F' type cylinders are integrally castwith the cylinder. In 'E' type a separate trunnion is fillet welded to the barrel. Due to casting there is a slight change in the shape of the portion around trumion. 'F' type of cylinders of 457 mm dia have solid pin of size 51 + 0.5 mm dia x 41 mm long. 'F' type cylinders of 533 mm dia have a hollow pin of dia 51 + 0.5 mm and length 51 mm. The hollowness of the pin starts from the end having 25 mm dia at the face and 16 mm at the end of the hole. The hole extends up to a length of 35 mm. The decreasing hole is suitably curved inside along the length of the pin.

Pan:

It is made of cast Iron. It is cylindrical in shape with closed bottom paving flange and four lugs near the top for securing it with the barrel. The shape of the bottom is identical to 'E' type cylinder. The vertical wall of the flange where the barrel comes in contact is kept 1 mm more on the top compared to the bottom. Starting from top the wall is projecting out 1 mm for a height of 1 mm, followed by inward taper of 1 in 8 for a height of 8mm, and again a vertical surface 1 mm in height. The total height of the wall is 10 mm. The vertical surface is rough machined and the horizontal surface finish machined. Starting from top, the other out surface of the pan is parallel up to a height of 3 mm followed by a tapered surface of 3 in 10

for a 10 mm height. Following this surface there are 4 equal holes on the circumference at a resembling to an oval shape. The size of the hole is 102 mm long x 22 mm height. The sides of the holes are at a radius of 6 mm. The bottom is flat and the top portion is lightly oval, keeping the maximum height as 22 mm. Those four holes are made for connecting the train pipe with the lower portion of the vacuum cylinders viz. the space between the bottom of the pan and piston up to the rolling ring. Though at a time only one hole is required but 4 identical holes on the circumference enable the bottom pan to be fixed in any one of the position out of 4 in relation to the barrel. Outside circumferencial surface above the hole is rough machined. Immediately following the hole portion, the lug portion commences. Other inside and outside surfaces of the pan are not machined. Surfaces around the boss is machined in the same manner as for 'E' type cylinders. The total height of the pan for 457 mm 'F' type cylinder is 140 mm. It is important that the surfaces are machined to the standard laid down in the drg.; otherwise there will be difficulty in assembling the parts and an air-tight joint would not be possible.

The recess made in the barrel fits on the corresponding portion of the flange of the pan. A rubber joint ring is inserted in between to make the joint air-tight. Thereafter the two parts are tightened together by means of studs and nuts. Piston rod used for box wagon brake cylinders are different from the cotter key type.

Vacuum Reservoir:

It is a hollow cylinder having its both ends closed. Both the ends are dished by pressing 5 mm thick plates. The cylindrical portion is made by rolling 3.15 mm thick plate in circular shape and then welding the joint. The dished ends extend inside by 25 mm and are welded to the main body by fillet welding around. The dished radius is of 1525 mm. On the circumference of the cylinder at mid length there is a 19 mm hole in which a boss of 32 dia x 6 mm height outside the barrel and 19 dia x 3 mm height inside the cylinder is fillet welded alround. This boss has a tapped hole to suit FP 3/8 A Plug, which keeps the hole closed. As and when required the plug is removed to drain out water from the reservoir. Similarly one of the dished ends has a hole of 38 mm dia in the centre. A boss 13 thick x 50 mm dia is kept outside the end is fillet welded alround with the end. The size of the boss inside is 5/6 mm length x 38 mm dia. This boss has a tapped hole to suit FP¾ In the tapped hole a syphon nipple is fitted. Nipple is connected by a flexible hose pipe to release valve. On the cylindrical surface rear the dished ends having syphon nipple, 4 pads are tack welded, two at one location and the other two diametrically opposite. The size of pads are 40 wide along the length x 75 mm long along the circumference x 20 mm thick. These pads are kept at a distance of 45 mm to enable fitting of suspension strap between them. The pads prevent shifting of cylinder in relation to straps. The centre of these straps is at a distance of 127 mm from the outer most point of the dished end. The reservoir whose size is 700 long x 560 mm outside dia has a capacity of 0.1596 Cu Metres.

These vacuum reservoirs are provided on those wagons, which are fitted with 457 and 560 mm size cylinders on BG and MG stock.

The vacuum reservoir is suspended from the under frame by two straps. One strap is held between pads. The other strap is used near the other end of the reservoir. Each strap is secured with the under frame at suitable locations by means of 2 bolts and 2 rivets one each on either side. Bolt which is kept below the rivet hole joins two pieces of straps together besides securing the strap with the under frame.

Double branch round flange release valve:

All its parts are same as in 'E' type cylinder except the body and the flange joint washer. In 'E' type the washer is oval shaped whereas in 'F' type it is round shaped. In relation to the cover of the release valve the flange joining the cylinder in 'F' type cylinders is at the bottom against on top in 'E' type and it is round against oval. In 'F' type cylinders, flange is kept vertical against horizontal on 'E' type. There is no change in the first and the second space. The passage for the central space i.e. the first space instead of going upwards goes downwards for connecting it with the lower portion of the vacuum cylinder. The third space leads to the vacuum reservoir. In the body of the cover an annular space has been provided connecting the passage of vacuum reservoir with the flange of the body. Thus the third space always keeps the upper portion of the vacuum cylinder and the reservoir connected together through the rectangular hole on the release valve flange. Similar to 'E' type cylinder when the release spindle is pulled out the seating washer gets pulled and the first and third space get connected.

Release valve round joint washer:

It is of size 2 mm thick x 105 outside dia. It has 4 holes of 11 mm dia at 18.3 pitch C. Dia for studs. It has a hole in the centre of 19 mm for the passage of lower portion of vacuum cylinder. It has 4 rectangular shaped holes at 90^0, 19 mm long, 12 mm high. The top edge of this hole is curved to a radius of 27 mm from the centre of the washer. These 4 holes are meant for connecting the vacuum reservoir with the upper portion of the vacuum cylinder. Though only one hole is required yet 4 holes enable fitment of washer in any one position. The material of the washer is rubber with a single ply of cotton fabric insertion. The washer should pass gauge.

Release valve 20 mm single branch round flange:

These type of release valves are used on BOX, BCX and BOI, B.G. bogie wagons. It is similar in construction to that of 'F' type double branch round flange 20 mm release valve except that it does not have a passage leading to the vacuum reservoir. The third space remains connected with the hole in the circular flange leading to the upper portion of the vacuum cylinder. Other parts are same as for double branch release valve 'F'type.

Reservoir Suspension Strap – Top & Bottom:

It is made by bending steel flat 40 x 6 mm to shape. The bottom strap is bent to a semicircle. In the central portion, the two ends are kept parallel to each other and are 305 mm long. The top strap is bent to a part of circle in the centre and its ends are bent to reverse circular shape. The radius at the bent is 25 mm. The top of the reversed end is kept at a distance of 140 mm from the transverse centre line of the

reservoir. Its height from the lowest point is 100 mm. At a distance of 70 mm from the lowest point of the reversed end and 95 mm from the end of the top strap a 12 mm dia bolt hole is drilled on both the straps. A rivet hole of 12 mm dia is also drilled in the bottom strap at a distance of 30 mm from its top end. The bolt joins bottom and top strap together as well as it secures them with the under frame. Through the top hole the bottom strap is riveted to the under frame.

704. PRINCIPLE OF OPERATION

The cross section of a "F" type brake cylinder is shown in fig 7.1. The piston and rolling ring together divide the brake cylinder in two airtight chambers, which are known as "Upper Chamber" and "Lower Chamber". The volume of the two chambers varies with the position of the piston. When the piston moves up during brake application, the volume of the upper chamber reduces. Since the reduction in vacuum level of upper chamber is more if its volume is low, the volume of this chamber is kept as large as possible by providing a dome or reservoir. A higher level of vacuum in upper chamber helps the piston to move up faster resulting in quicker brake application. A release valve, connected to both upper and lower chamber, is mounted on the cylinder and is connected to the train pipe by a flexible syphon pipe.

The lower end of the piston rod is connected to the brake shaft arm. When vacuum is created in the train, air is exhausted from both upper and lower chamber of the vacuum cylinders, the piston by its own weight comes to rest at the bottom of the cylinder and the brakes are fully released. When vacuum in the train pipe destroyed due to brake application by the driver, air enters the lower chamber of the cylinder raising the piston and piston rod. This lifts the brake shaft arm causing the brake shaft to rotate and transmit the brake force through pull rods and levers to the brake blocks.

Since all the air enters the train pipe from locomotive end, the brakes on the leading wagons of the train get applied earlier than those on the rear portion. To accelerate the process, "Direct application" or "Quick Application" valves are used on some stock. These valves sense pressure difference in the train pipe and permit direct entry of atmospheric air into the brake system of each wagon.

The release valve is provided to ensure complete release of brakes on a standing load by connecting the upper and the lower chamber and thus equalising the pressure in them.

A schematic arrangement of vacuum brake equipment fitted on a typical wagon in shown in fig. 7.2. The piston being connected by a suitable linkage to the brake blocks, causes the later to bear against the wheel tread. In order to release the brakes, vacuum is regenerated in the lower chamber of the brake cylinder permitting the piston to drop and brake blocks to disengage from the wheel tread. The standard vacuum is 510 mm Hg, which gives a theoretical piston effort of 0.703 Kg/Cm^2. The ejectors / exhausters provided in the locomotive produce the vacuum.

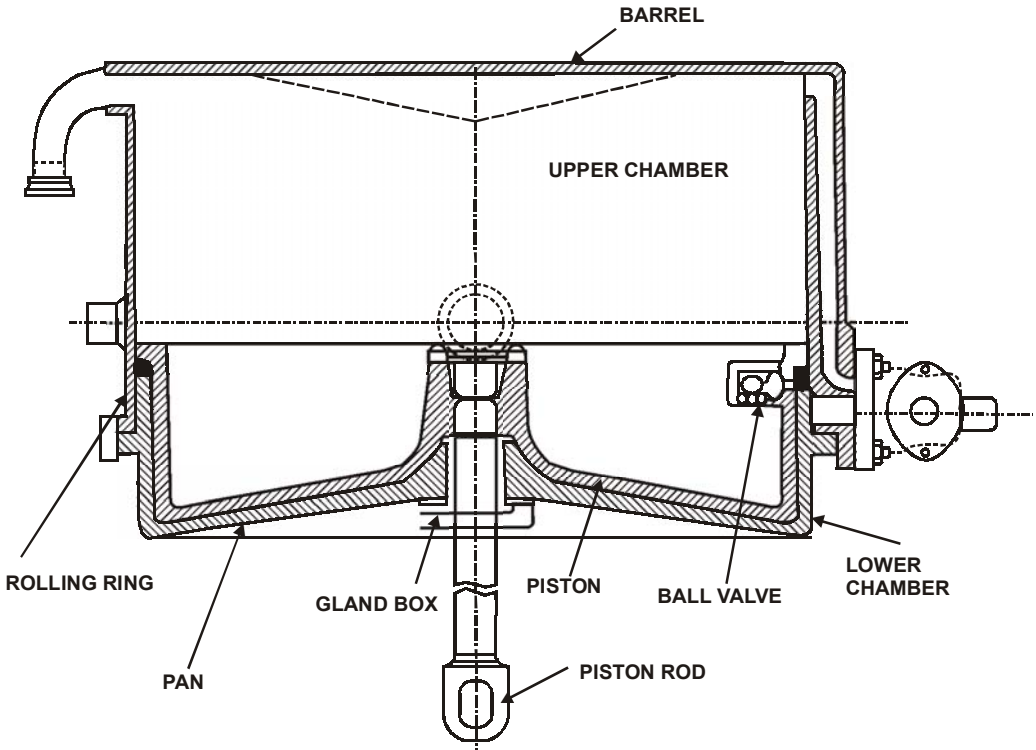

FIG. 7.1 : VACUUM BRAKE CYLINDER ("F" TYPE)

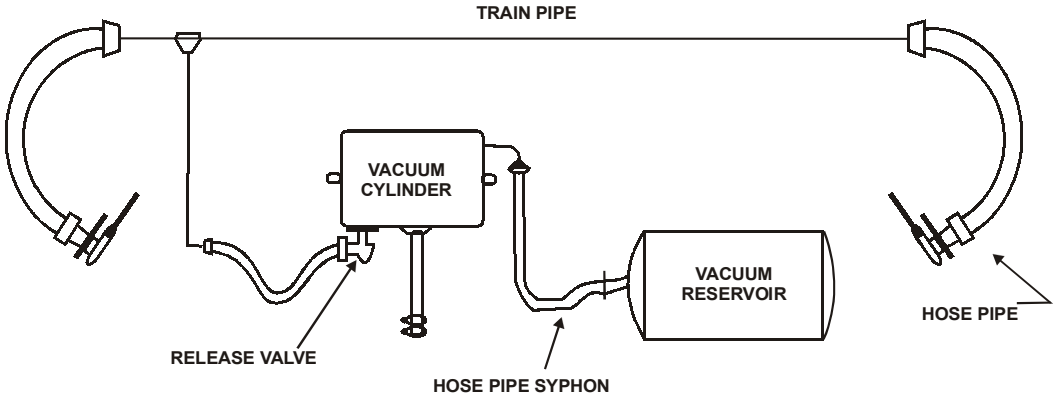

FIG. 7.2- Schematic arrangement of Vacuum Brake Equipment

705. LIMITATION OF VACUUM BRAKE

Some adverse features impose limitations on extending its application on heavier and faster trains. These limitations are as under:-

A. BRAKE POWER

The brake power on vacuum brake is determined by the size of brake cylinder and the leverage. The 560-mm brake cylinders on BOX wagon are found to be the maximum size, which can be accommodated in the underframe. An increase in size would require redesign of underframe. The studies

conducted in this area revealed that this proposal is not worthwhile. BOX has a leverage of 13.11 in loaded and 7.38 in empty condition. An increase in the leverage further leads to reduction in cylinder efficiency.

B. PROPAGATION RATE

The rate of propagation of impulse of brake wave through the pipe on conventional wagon was found to be 104 m/sec, where as for wagon fitted with QAQR valve, it was found to be 229m/sec. This value, however, is less than the limit of 250m/sec set by UIC. There is no further scope to increase this rate.

C. BRAKE FADE AND EXHAUSTIBILITY

Brake fade occurs due to leakage of air into the vacuum space above the piston when the brake is kept applied for a long period resulting in loss of brake power. Tests have indicated that for an emergency brake application, the brake fade rate is 3 to 3.5 mm/ minutes.

Brake exhaustibility is the extent of deterioration of brake power due to repeated controlling of train by train brake while descending steep gradients. For safe running of trains, the brake must have sufficient reserve brake power after controlling so as to stop the train under emergency. Vacuum brake has very high exhaustibility. This necessitates stopping of the trains in order to replenish the brake power after a certain period of control during cyclic application.

D. RELEASE TIME

Laboratory test on 4500t train of 600m length indicated that the release time for the last wagon would be about 310 sec in case of train fitted with conventional vacuum brakes. With the fitment of QAQR valve, this was found to be about 114 sec. However, this adversely affects the available brake power for a subsequent application on the wagon by 60%, since the upper chamber vacuum is equalised with the lower chamber/train pipe. This feature has been found unsafe for train running on ghat section where controllability is to be done by means of train brakes only.

E. BRAKING DISTANCE

The braking distance obtained on a train is not dependent on brake power alone. This also depends upon propagation rate, brake application time etc. It has been worked out for a trainload of 4500t with improved vacuum brake (with QAQR valve), that the braking distance would be 1780 meter from a speed of 75 km/h on level track. This is higher than the intersignal distance of 1400 metres. It would be even higher for higher speeds.

F. BRAKE POWER DETERIORATION DURING RUN

Owing to inherent limitations of vacuum brake system, the brake power of a train during extended run reduces considerably. The trials conducted by railways and RDSO show that up to a distance of 400 kms, the reduction of brake power was between 6.5% and 16%.

706. MODIFICATIONS

The vacuum brake system has been the standard on Indian Railways till recently. This system has been improved gradually over the years. Major improvements incorporated in the system are given below:-

A. Following improvement and modification have been done to improve the effectiveness of the vacuum brake system in the vacuum cylinder;

- Hole in ball valve seat increased to 10 mm
- Number of 6-mm diameter holes in ball cage increased to four.
- Diameter of three holes in piston head increased to 6 mm
- Slack adjuster DRV-2-600

While adjusting control dimension 'A', it is important that vacuum cylinder piston and fork arm of the brake shaft are in the lower most position.

B. LARGER BRAKE CYLINDERS WITH SEPARATE VACUUM RESERVOIR

The upper chamber volume has been considerably enhanced by the adoption of "F" type 560 mm diameter cylinder with separate vacuum reservoir. This has resulted in improvement of cylinder efficiency from 76% to 84% at a stroke of 160 mm, due to reduced drop in upper chamber vacuum.

C. IMPROVED BALL VALVE PASSAGE

The original size of the ball valve passage was 7.2 mm dia. The passage has been increased to 8 mm dia. resulting in a further improvement in the minimum stabilised vacuum in the upper chamber of last wagon brake cylinder.

D. ROLLING RING

The diameter of the rolling ring has been increased from 12.7/13.0 mm to 12.9/13.15 mm. This has reduced the leakage of air into vacuum space above the piston when brakes are applied continuously.

E. IMPROVED DESIGN OF CAGE

Hose pipe cage design has been modified to increase the flow area from 72% to 86% and wire construction instead of pressed plate design has been used to reduce the turbulence in the air stream. For a BOX wagon train of 350 metre length, provision of these modified cages results in 10 to 13% reduction in braking distances, which can be seen on figure at next page.

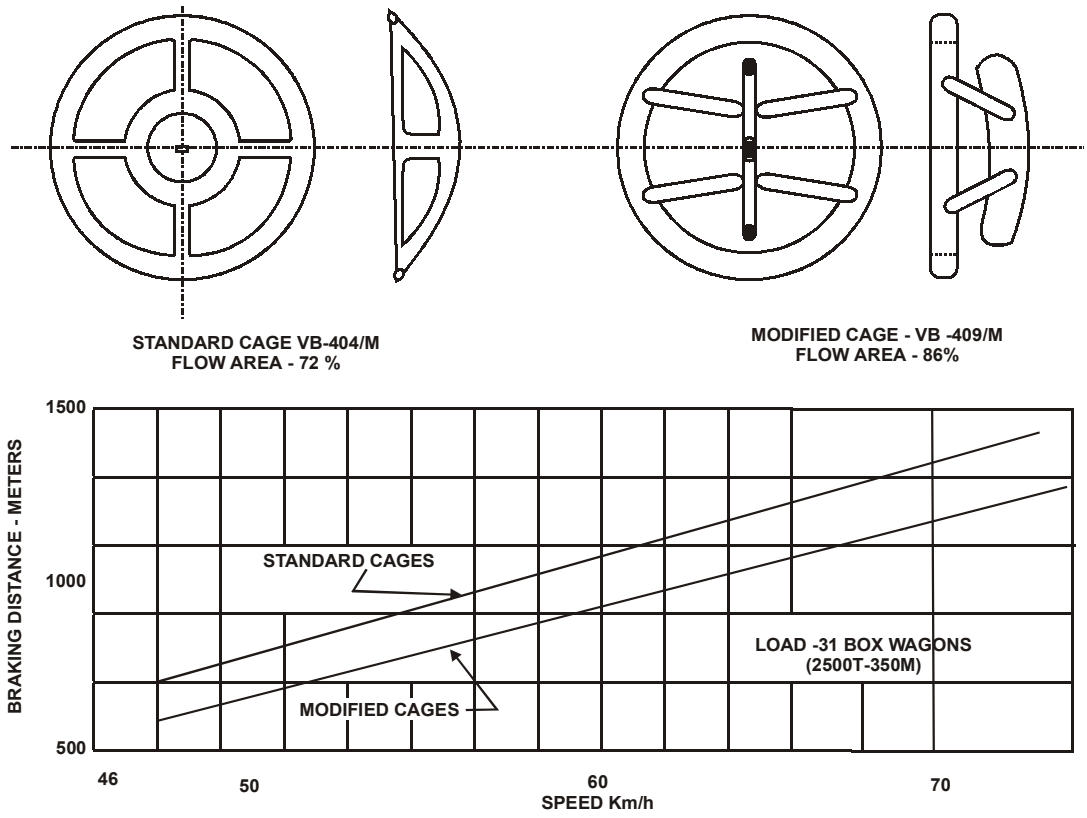

Fig. 7.3 : DESIGN OF CAGE

There is also a corresponding improvement in braking application and release time.

F. OTHER DESIGN IMPROVEMENTS

The following improvements have also been incorporated in the brake system:

- Double acting slack adjuster to maintain pre set clearance between brake block and wheel. This eliminates manual adjustment of pull rod length to ensure constant piston stroke.
- Empty-Load change over device to obtain high brake ratio in loaded condition.
- Clasp brakes having higher co-efficient of friction so as to reduce unit brake block pressure.

707. MAINTENANCE & REPAIR

A. INSPECTION OF RUBBER HOSE PIPE AND SYPHON PIPE

- Renew the Hose pipe and syphon pipes if they are cracked or the bonding between various components is loose.
- Useful Hose pipes should be tested using vacuum retaining test.
- The hose pipe should be connected by means of a cylindrical nozzle, to suit the corresponding vacuum with syphon hose bore.
- Connect the chamber of 1640 cu. cm. volume with the free end, close with a cylindrical plug identical in external dimensions with the nozzle and with 510 mm of vacuum throughout the assembly.
- On isolation from the source of vacuum, record drop of more than 75 mm in one hour on the chamber gauge.
- The pipe shall not be clipped or otherwise bound to the chamber nozzle or plug.
- The hose shall be bent around the 228 mm diameter mandrel until ends are parallel without any displacement or permanent distortion of wire.

Crack, porosity and tears etc. of the hose can also be detected by stretching and holding the hose 20 % more than its original length. Serviceable hose pipe should be secured on swan neck (after applying the rubber solution on swan neck) with clip.

The corroded or damaged hose pipe clips to be renewed. The broken, damaged or distorted cages should be replaced with modified cage to Drg No.VB 409M Universal coupling should be examined for broken/cracked/ distorted lugs and renewed on condition base. Rubber solution should be applied on the mating surfaces and cages fitted before the couplings are inserted in the hose holes. They should be clipped firmly.

B. EXAMINATION AND MAINTENANCE OF VACUUM RESERVOIR STRAPS

Replace the damaged or corroded straps by modified or new straps. If the securing holes in the underframe are worn by 3 mm, build up by welding and re-drill the holes. The reservoir straps should be double secured with spring washer and check nuts. After all repairs, the reservoir straps should be given a coat of anti-corrosive paint.

C. EXAMINATION AND MAINTENANCE OF VACUUM RESERVOIR

The vacuum reservoir should be examined for corrosion, damages, distortion, cracks, etc. If the extent of corrosion is about 5 % of total area, it should be cut and replaced with another plate by welding. Otherwise the whole barrel should replaced. Open the drain plug and blow compressed air in the reservoir to remove dust, dirt, water particles etc. accumulated inside the reservoir. After thorough cleaning, replace the drain plug smeared with small quantity of graphite grease on the threads and tighten it firmly. Clean the pipe threads in both disc ends and fit the syphon nipples. Replace the missing or damaged syphon nipples in the disc ends of the reservoir.

After attending the defects and before painting the reservoir, a pneumatic pressure of 2.0 kg/cm² should be applied to it for the purpose of ensuring sound fabrication and finish. The welded seams all over the body should be thoroughly checked for leakage.

Vacuum retaining capacity test

Vacuum reservoir with 510 mm of vacuum source with isolating cock between the source and reservoir after creating 510 mm of vacuum by closing isolating cock, record drop of vacuum in 30 minutes on test gauge. After all repairs, the reservoir should be given a coat of anti-corrosive paint.

D. EXAMINATION AND MAINTENANCE OF GUARD VAN VALVE

During overhaul of Guard van valve, its rubber diaphragm and rubber washer should invariably be changed. The Passage, connecting train pipe to its chamber, should be cleaned. If the passage hole diameter exceeds more than 6 mm, the valve should be replaced.

The chamber space of the Guard van valve should be checked for leakage, cracks, damages etc. and repaired / replaced if necessary. The valve itself should be checked for easy and correct lift. The blocked holes to be opened and to be cleaned. The bent / deficient lever to be replaced. The vacuum gauge nipple provided on the Guard van valve chamber to be checked for damaged or worn out threads. The loose nipple should be secured firmly on the chamber.

All studs and nuts with worn or damaged threads should be replaced. The threads in the body of the chamber should be good enough to prevert any leakage. The Guard van valve body threads on which train pipe is secured, should also be checked for damages & wear and the body replaced if the threads are bad. After overhaul, the entire Guard van valve assembly should be tested for satisfactory functioning.

a. Vacuum Retaining Capacity Test

Guard van valve connected to a chamber of 1640 cu. cm volume with 510 mm of vacuum throughout the assembly, on isolation from the source of vacuum, should not record a drop of more than 25 mm in 1 minute on the chamber gauge.

b. Operation Test

On release of operating handle, the valve should, with atmospheric pressure throughout the assembly, re-set itself by its own weight.

With 460 to 510 mm of vacuum throughout the assembly, and the source of vacuum isolated, gradual admission of air to the train pipe should show a corresponding drop in vacuum on the van valve gauge.

The Guard van valve should automatically lift on a rapid destruction of the vacuum in the train pipe of approximately 225 mm of vacuum. When the operating handle of the test apparatus is put in the " running " position, the Guard van valve should re-set itself within 3 to 5 seconds.

E. EXAMINATION AND MAINTENANCE OF VACUUM CYLINDER TRUNION BRACKET

The brackets, where bushes are provided, should be renewed and a light coat of graphite grease applied before fitting a cylinder. Trunions of the cylinder must not either be too loose or too tight in their brackets. Lateral clearances on the trunions (on each side) should not exceed 3 mm after P.O.H. It should be adjusted by renewing the bushes. If bushes are not already provided, the trunion bracket should be bored and bushes of correct size are fitted to get the required clearance.

F. CLEANING, INSPECTION AND MAINTENANCE OF VACUUM BRAKE CYLINDER

I. Dismantle the vacuum cylinder and clean thoroughly.
II. A wire brush should be used for cleaning the serrations in the bore of cylinder as well as on the periphery of piston head.
III. Piston heads and cylinders with excessive clearance due to worn serrations (cuts) should be rejected and replaced.
IV. Check for defects like cracks, damages, worn, etc.
V. Replace the cracked Barrel.
VI. Cracked or broken lugs may be replaced with new lug by welding and grinding. Replace the Barrel if cracks are found on the trunions.
VII. Clean the release valve seat .
VIII. The holes should be cleaned for proper seating and free passage of air.
IX. Barrel should be painted with one coat of anti-corrosive paint excluding the serrated surface.

G. BALL VALVE

The ball valve should be opened, thoroughly cleaned to make it free from dust, dirt and sediments and lightly lapped. The ball valve cage cover should be checked for threads. The ball should be replaced if worn even. The ball valve should be changed if found cracked, pitted, or having any other surface defects.

H. EXAMINATION AND MAINTENANCE OF RELEASE VALVE

The release valve helps in releasing the brakes on rolling stock. The vacuum does not get destroyed during release of brake. It releases brakes whenever necessary, without the use of ejector or exhuaster. Without release valve, it is not possible to release the brakes of rolling stock on a terminating train. It helps in keeping the brakes on for about 48 hours after destruction of vacuum.

During overhaul, open the release valve and renew all the rubber items like diaphragm, seating washer and joint washer. Dry the release valves, if found wet after wiping out. Check the release valve operating lever and renew if found cracked. The release valve studs should be cleaned and replaced if found damaged or worn. While assembling, the valve nut should be smeared with graphite grease. It should also be ensured that all the sharp edges on the seat of the spindle washer are rounded off.

a. Vacuum Retaining Capacity Test

Connect the release valve through the cylinder port to chamber of 1640 cu. cm volume with 510 mm of vacuum. Isolate from the source of vacuum. Record the drop of vacuum. It should not be more than 20 mm in one minute on the chamber gauge.

b. Operation Test

Connect release valve through the chamber port to a reservoir with vacuum throughout the assembly. When the vacuum is destroyed in the train pipe and the valve remains in the open position too long, there is pull on the lever wire. Re-set immediately.

On re-creation of not more than 205 mm of vacuum, the valve shall re-set itself. Replace the cracked/broken cylinder cover. The lugs having more than 50% crack are to be replaced with new lugs by welding and grinding. After attending the defects, paint with one coat of anti-corrosive paint.

Renew all the rubber items of Gland box (Stuffing box) like Gland packing ring, Gland box joint washer etc. Renew the worn/loose guide bush. Replace the worn, threaded, damaged, broken studs.

I. PISTON HEAD & PISTON ROD

Renew the bent, damaged, dented, worn, corroded, pitted and thread damaged piston rods. The cracked piston should be replaced. The piston skirt serration should be cleaned for dust, dirt and sediments etc. dried with hot air. If the serration is worn, replace the piston. After attending the defects, barrel should be painted with one coat of anti-corrosive paint excluding the serrated surface. Stencil the station code, date, staff number of the technician inside the piston rod.

J. ASSEMBLY OF VACUUM CYLINDER

Select the serviceable/new piston assembly components. Assemble the piston assembly. After attending the defects of vacuum cylinder parts and assemble the parts. Care should be taken to replace all the rubber items like rolling ring, joint ring, release valve joint washer, piston cap washer, etc. during P.OH. After complete assembly, the vacuum cylinder should be tested on the test bench, Stencil the date of overhaul, date of testing and shop code on the vacuum cylinder body.

K. MAINTENANCE OF BRAKE SHAFT

Brake shaft should be examined for straightness, bending and wear on its bearing surfaces. The shaft bearings worn beyond 3 mm should be built up by welding and machined to its original size. Before the shaft is fitted into its brackets, its bearing surfaces should be smeared lightly with grease. The fork arm should also be examined for bending, distortion and wear on its forked ends and restored to its original shape and size as required. The brake shaft mounted with brackets under a coach should be parallel to the trunnions on which the cylinder swings to avoid side or cross stresses and hence damages to the arm. The brake shaft should not have side play of more than 2 mm in its bracket bushes after POH.

L. BRAKE SHAFT BRACKET

Brake shaft bracket bolts and nuts should be examined for rusting, wear, looseness, damaged threads etc. and replaced, if necessary. Good bolts and nuts should be reused after greasing their threads. The brackets should be checked for cracks, corrosion and damage and repaired/replaced as required. The brake shaft bracket bushes should invariably be changed.

M. PINS & BUSHES

In wagons built earlier, steel class IV pins were provided in unbushed holes of the brake rigging but the latest practice is to provide class IV/class I case hardened steel bushed and pins made from steel class II (IS-226 St 42S). The maximum permissible wears on the pin diameter and bush inside diameter is limited to 1.5 mm.

708. REPAIR AND MAINTENANCE IN SICKLINE

The brake gear system shall be examined and repaired as under:-

I. The pins/bushes shall be examined for wear and repaired/replaced to maintain prescribed minimum clearances as per para 707 M.

II. Safety brackets provided for brake gear should be in proper condition and secured firmly.

III. Special care shall be taken to ensure proper condition of trunions and their bracket as per para 707 E. A light coat of graphite grease should be applied on trunion bracket.

IV. Inspection of rubber hose pipe and syphon pipe to be done as given in para 707 A.

V. Replace the damaged or corroded straps by new straps as per para 707B

VI. The vacuum reservoir should be examined for corrosion, damages, distortion, cracks, etc. as per para 707 C.

VII. The Passage connecting train pipe to its chamber should be cleaned. If the passage hole diameter exceeds 6 mm, the valve should be replaced.

VIII. Vacuum gauge in Guard van should be removed and calibrated with master gauge before refitting. The vacuum gauge guard must be invariably provided to protect the gauge from damage or theft.

IX. Testing of brakes shall be done according to the methods laid down in IRCA Part III (2000) rule 2.12.2.4.

709. REPAIR AND MAINTENANCE DURING ROH

In addition to all the items attended in sickline, the following items should also be checked and repaired :-

I. Vacuum reservoir : After all repairs, the reservoir should be given a coat of anti-corrosive paint.

II. During overhaul of Guard van valve, its rubber diaphragm and rubber washer should invariably be changed.

III. The chamber space of the Guard van valve should be checked for leakage, cracks, damages etc. and repaired/replaced.

IV. The valve should be checked for easy and correct lift. The blocked holes to be opened and cleaned.

V. The bent/deficient lever to be replaced.

VI. The vacuum gauge nipple should be checked for damage/wear on threads. The loose nipple should be secured firmly on the chamber.

VII. The brackets, where bushes are provided, should be renewed and a light coat of graphite grease applied before fitting a cylinder. Trunion of the cylinder must not either be too loose or too tight in their brackets.

VIII. Cleaning, inspection and maintenance of vacuum brake cylinder should be done as per IRCA Part III.

IX. The ball valve should be opened and thoroughly cleaned to make it free from dust, dirt and sediments and lightly lapped. The ball valve cage cover should be checked for threads. The ball valve should be changed if found cracked, pitted, or having any other surface defects.

X. Open the release valve and renew all the rubber items like diaphragm, seating washer and joint washer. Check the release valve operating lever and renew if found cracked. The release valve studs should be cleaned and replaced if found damaged or worn.

XI. Piston rod if bent, damaged, dented, worn, corroded, pitted or thread damaged should be renewed. The piston skirt serration should be cleaned for dust, dirt and sediments etc. dried with hot air. If the serration is worn, replace the piston. After attending the defects, barrel should be painted with one coat of anti-corrosive paint excluding the serrated surface.

XII. Brake shaft should be examined for straightness, bending and wear on its bearing surfaces. The shaft bearings worn beyond 3 mm should be built up by welding and machined to its original size.

XIII. Brake shaft bracket bolts and nuts should be examined for rusting, wear, looseness, damaged threads etc. and replaced, if necessary. Good bolts and nuts should be reused after greasing their threads. The brackets should be checked for cracks, corrosion and damage and repaired/replaced as required. The brake shaft bracket bushes should invariably be changed.

XIV. Testing of brakes shall be done according to the methods laid down in IRCA Part III (2000) rule 2.12.2.4.

710. REPAIR AND MAINTENANCE DURING POH

During POH, all components of the brake gear system shall be examined, repaired and replaced as necessary. The following item should be checked and repaired in addition to all the items attended in RCH as above:-

I. Vacuum cylinder to be removed, overhauled and tested. Special care shall be taken to ensure proper condition of the trunion and their brackets. Date of overhaul, name and ticket number of overhauling staff shall be written at the inside bottom of the cylinder.

II. Vacuum reservoirs and train pipes shall be dismantled, examined and tested to ensure elimination of leaks. Rubber hoses and siphon pipes shall be examined and replaced, if necessary.

III. Crack, porosity and tears of the hose to be detected by stretching and holding the hose 20 % more than its original length.

IV. The corroded or damaged hose pipe clips to be renewed. The broken, damaged or distorted cages should be replaced with modified cage.

V. Universal coupling should be examined for broken/cracked/distorted lugs and renewed on condition base.

VI. The vacuum reservoir should be examined for corrosion, damages, distortion, cracks, etc. If the extent of corrosion is about 5% of total area, it should be cut and replaced with another plate by welding. Otherwise the whole barrel should be replaced.

VII. Open the drain plug and blow compressed air in the reservoir to remove dust, dirt, water particles etc. accumulated inside the reservoir. After thorough cleaning, replace the drain plug smeared with small quantity of graphite grease on the threads and tighten it firmly.

VIII. Clean the pipe threads in both disc ends and fit the syphon nipples. Replace the missing or damaged syphon nipples in the disc ends of the reservoir.

IX. All studs and nuts with worn or damaged threads should be replaced.

X. The brackets, where bushes are provided, should be renewed and a light coat of graphite grease applied before fitting a cylinder. Trunions of the cylinder must not either be too loose or too tight in their brackets. Lateral clearances on the trunions (on each side) should not exceed 3 mm after POH. It should be adjusted by renewing the bushes. If bushes are not already provided, the trunions should be bored and bushes of correct size are fitted to get the required clearance.

XI. The cracked piston should be replaced. The piston skirt serration should be cleaned for dust, dirt and sediments etc. dried with hot air. If the serration is worn, replace the piston. After attending the defects, barrel should be painted with one coat of anti-corrosive paint excluding the serrated surface.

XII. Brake shaft should be examined for straightness, bending and wear on its bearing surfaces. The shaft bearings worn beyond 3 mm should be built up by welding and machined to its original size.

XIII. Before the shaft is fitted into its brackets, its bearing surfaces should be smeared lightly with grease. The fork arm should also be examined for bending, distortion and wear on its forked ends and restored to its original shape and size as required. The brake shaft mounted with brackets should be parallel to the trunions on which the cylinder swings to avoid side or cross stresses and hence damages to the arm. The brake shaft should not have side play of more than 2 mm in its bracket bushes after POH.

XIV. Brake shaft bracket bolts and nuts should be examined for rusting, wear, looseness, damaged threads etc. and replaced, if necessary. Good bolts and nuts should be reused after greasing their threads. The brackets should be checked for cracks, corrosion and damage and repaired/replaced as required. The brake shaft bracket bushes should invariably be changed.

XV. Testing of brakes shall be done according to the methods laid down in IRCA Part III (2000) rule 2.12.2.4.

711. STORAGE OF RUBBER FITTINGS

The adoption of rubber fittings in the vacuum brake cylinder serves the purpose of making the joints airtight. The correct storage of such rubber fittings is equally important. The rubber fittings, if badly stored, leads to deterioration and their use in the vacuum cylinders will not fulfil the desired objective. RDSO vide letter no. M&C/RH/1/1 of 29.9.75 has circulated some useful instructions as under:-

i. Rubber fittings should be kept away from direct sun light.

ii. They should be stored in a cool place preferably below 30 degree centigrade.

iii. They should be kept away from the contact of copper and manganese.

iv. Rubber fittings, under no circumstances should be kept stressed else it will lead to deformation and permanent set.

v. Contact of oil and grease to be avoided.

vi. Prolonged storage should be avoided.

vii. To avoid deterioration of rubber fittings, every C&W depot should have adequate and effective arrangement for storing the rubber fittings.

712. SPECIAL TOOLS, JIG & FIXTURES

The tools, equipment and other facilities required for overhauling vacuum cylinders are given below.

i. Vacuum pump of capacity 200 CF/Minute or more.
ii. Forklift or plat form truck for transporting cylinders to and from repair shed.
iii. Pipe line connecting the exhauster and test bench and test stands
iv. Balance vacuum testing apparatus
v. Portable electrical drill for drilling out broken studs
vi. Wire brush attachment to electric drill
vii. Hand tools like hammers, chisels, punches, and spanners of assorted sizes.
viii. Overhead electric pulley block for movement of cylinders from workbenches to test benches.
ix. Building/structures for overhauling and testing 8 to 10 cylinders
x. Room/shed of size 10 m x 10 m with hardonite flooring. Part of the shed may be used to store overhauled cylinders.
xi. Room of size 5 m x 5 m for housing vacuum exhauster
xii. Test stand for holding 4 cylinders simultaneously.
xiii. Workbench for overhauling cylinder, release valve, guard van valves, vacuum gauges, etc.

713. BRAKE POWER CALCULATIONS FOR BOX WAGON

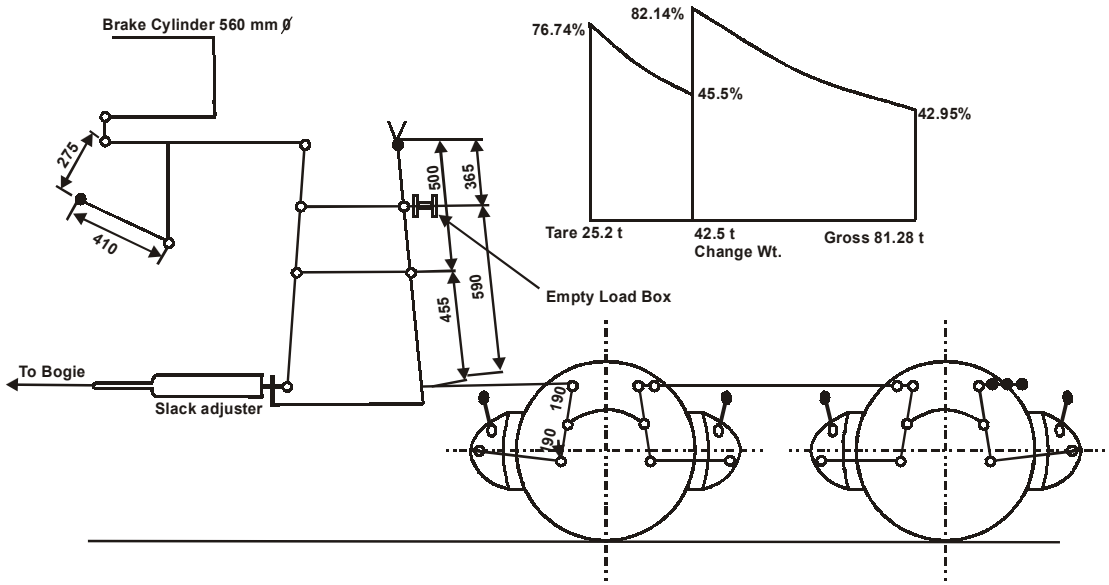

Fig 7.4
BRAKE POWER CALCULATIONS FOR BOX WAGON

TYPE OF BRAKE SYSTEM = VACUUM

BRAKE CYLINDER DIA = 560 mm

NO OF CYLINDERS = TWO

TOTAL EFFECTIVE PISTON FORCE (K)AFTER SUBTRACTION OF RESTORING SPRING FORCE AT A STORKE OF 135mm = 3020 KG

LEVERAGE i,

EMPTY = $\frac{410}{275} \times \frac{365}{590} \times 8 = 7.38$

LOADED = $\frac{410}{275} \times \frac{500}{455} \times 8 = 13.11$

TOTAL BRAKE BLOCK PRESSURE P = (K i - 8Q) η

RIGGING EFFICIENCY η = 0.9

FORCE OF SLACK ADJUSTER SPRING Q = 100 Kg

P Empty - 19339 Kg
P Loaded - 34913 Kg

7BRAKE PERCENTAGE = $\frac{P \times 100}{\text{Tare or gross}}$

BRAKE PERCENTAGE EMPTY = $\frac{19339 \times 100}{25200} = 76.74\%$

BRAKE PERCENTAGE LOADED = $\frac{34913 \times 100}{81280} = 42.95\%$

BRAKE POWER AT CHANGE WEIGHT = $\frac{19339 \times 100}{42500} = 45.5\%$

$\frac{P(\text{TARE}) \times 100}{\text{CHANGE WT}}$

$\frac{P(\text{GROSS}) \times 100}{\text{CHANGE WT}} = \frac{34913 \times 100}{42500} = 82.14\%$

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