6.2.3 Drawing Up of the Facility Improvement Plan for Coaches

Based on the current problems for rolling stock inspection/repair system and premises for the facility modernisation plan which were stated in the preceding chapter, improvement plan for inspection/repair facilities for coaches was drawn up as follows.

(1) Inspection/repair capacity and scale of facilities

This plan will be implemented in two phases. Table 6.2.13 shows inspection/repair capacity and the scale of facilities of each shop to be divided up for implementation in two phases under this plan.

Table 6.2.13 Scale of Facilities of each Shop

Shop name	Scale of facilities	
	Phase I (dealing with 2,450 coaches)	Phase II (dealing with 3,000 coaches)
In-coming inspection shed	8 cars x 2 tracks: for 16 coaches	Same as on the left
New car body shop	4 cars x 11 tracks: for 44 coaches	4 cars x 16 tracks: for 64 coaches
(Lifting/lowering section)	(4 cars x 3 tracks: for 12 coaches)	(4 cars x 4 tracks: for 16 coaches)
(Body repair section)	(4 cars x 8 tracks: for 32 coaches)	(4 cars x 12 tracks: for 48 coaches)
CR shop	4 cars x 6 tracks: for 24 coaches	Same as on the left
CB shop	(existing) for 6 coaches	To be converted into trimming shop, etc.
Paint shop	2 conveyor belt lines + for 15 coaches	Same as on the left
AC final adjustment shed	1 car x 2 tracks: for 2 coaches	1 car x 3 tracks: for 3 coaches
Ordinary final adjustment shed	4 cars x 4 tracks (existing) for 16 coaches	Same as on the left
Bogie shop	for 68 bogies	for 94 bogies
Wheel shop	(Existing)	for 62 wheelsets
Wheel park	(Existing)	for 207 wheelsets
Electrical parts repair shop	Approx. 5,000 m^2	Approx. 5,600 m^2
Ancillary repair shop	Approx. 5,200 m^2	Approx. 6,100 m^2

(2) Overall layout plan

The overall layout of the coach inspection/repair facilities for Phase I is shown in Fig. 6.2.5, and that for the Phase II in Fig. 6.2.6.

In devising the layout, emphasis was put on the enhancement of inspection/repair capacities and the shortening of the cycle time involved. Planning was carried out from various points of view to implement these primary objectives. The resulting plan is designed to facilitate the flow of cars while fully utilising the existing buildings.

The new car body shop will be set up along the stabling lines between traversers ① and ②. Accordingly, new stabling lines will be provided at the northern side of existing in-coming inspection shed. This will allow each car to go from the in-coming inspection shed to the new car body shop via traverser ①. The car will then be moved to the paint shop by traverser ②. After painting, the car will be sent to the final adjustment shed by traverser ①. The distance traveled by the cars will be minimised and rationalised in this way. On the other hand, each bogie will be detached from its car body at the new car body shop, and transferred directly to the bogie shop located along an extension of the lifting/lowering section without the aid of a traverser. This scheme is designed to reduce the distance traveled by the bogies and to facilitate their movement around the shop floor.

A similar layout is planned to smoothen and shorten the flow of wheelsets by locating a wheel in-coming track along an extension of the bogie shop.

The existing car body shop will be utilised as much as possible. However, the current location of the car body special repair shop is not optimal. Because this shop has proved to be an obstruction to expanding the AC deluxe shop, all work currently conducted on body panel there will now be performed at the new car body shop to be built.

Neither the CR shop nor the CB shop has an overhead crane, restricting the smooth flow of car bodies as needed. In particular, this interferes with the inspection and repair of corroded coaches because these coaches are known to show remarkable differences in their cycle times. This being the case, it is proposed that these shops be used for inspection and repair of ordinary coaches only. The CB shop will be converted to a trimming shop and other facilities when the new car body shop is extended during the Phase II period.
A final adjustment shed dedicated to AC coaches is planned to be built adjacent to the AC deluxe shop. This is to cope with AC coaches, whose number is expected to increase sharply in the future. This shed will make it possible to replace promptly any faulty air conditioning or electrical parts that may be found in AC coaches undergoing inspection at this shed. Some necessary track-switching arrangements are planned to let AC coaches go directly to the trunk line from the AC final adjustment shed.
Meanwhile, of the parts-related shops, the AC deluxe shop will be expanded to occupy the current site of the car body special repair shop, which will be eventually out of use. The general electrical parts shop (train lighting shop) will be expanded by erecting a new building on the west side of existing shop. Ancillary repair shop including sheet metal section and others will be set up between the current CR shop and CB shop. This will shorten the distances travelled to and from the car body repair shop.
This layout will simplify greatly the transfer routes of cars and parts on the premises and drastically shorten the travelling distances involved.

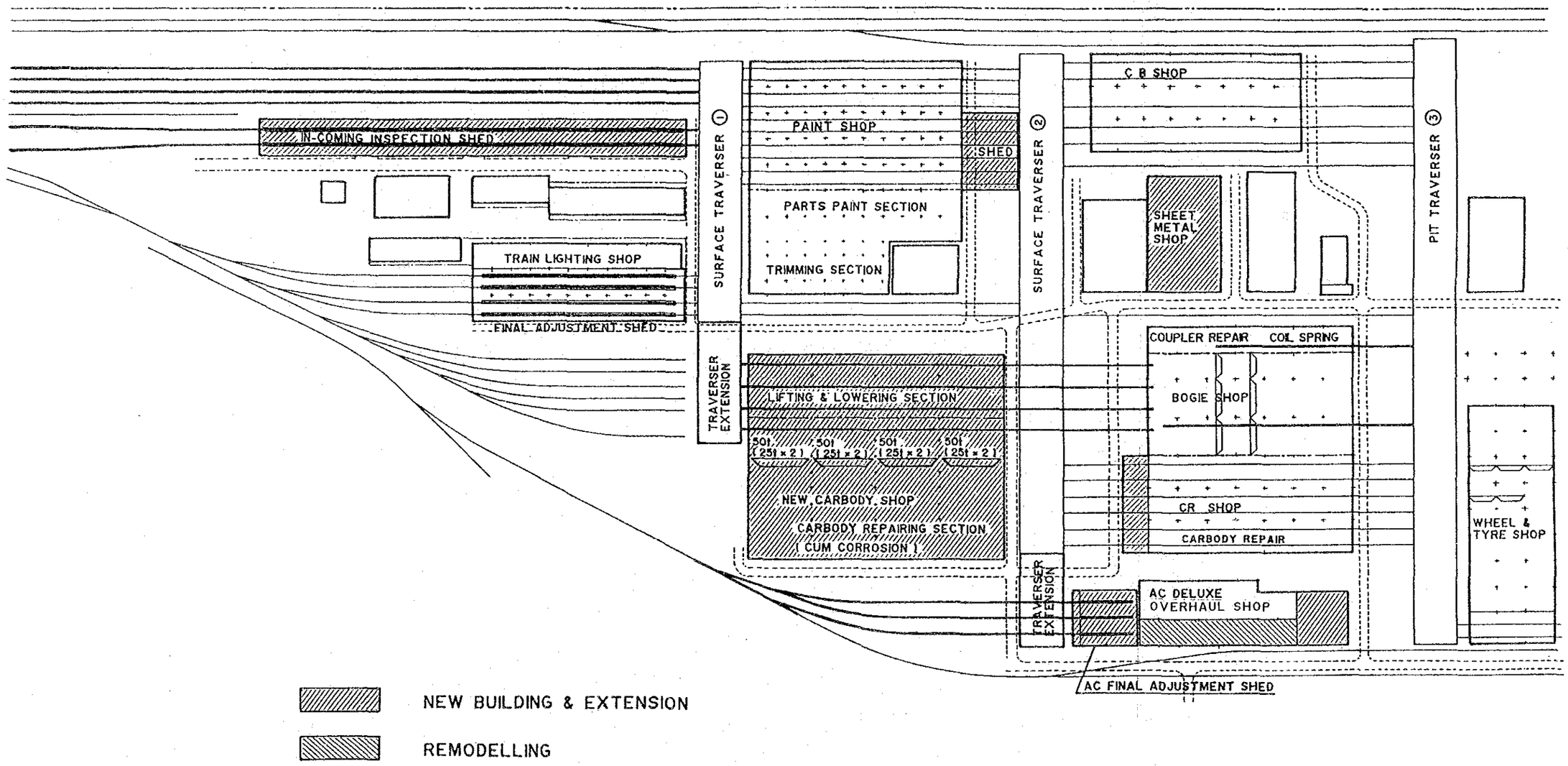


Fig. 6. 2. 5 LAYOUT PLAN OF CARRIAGE REPAIR AREA (PHASE I)

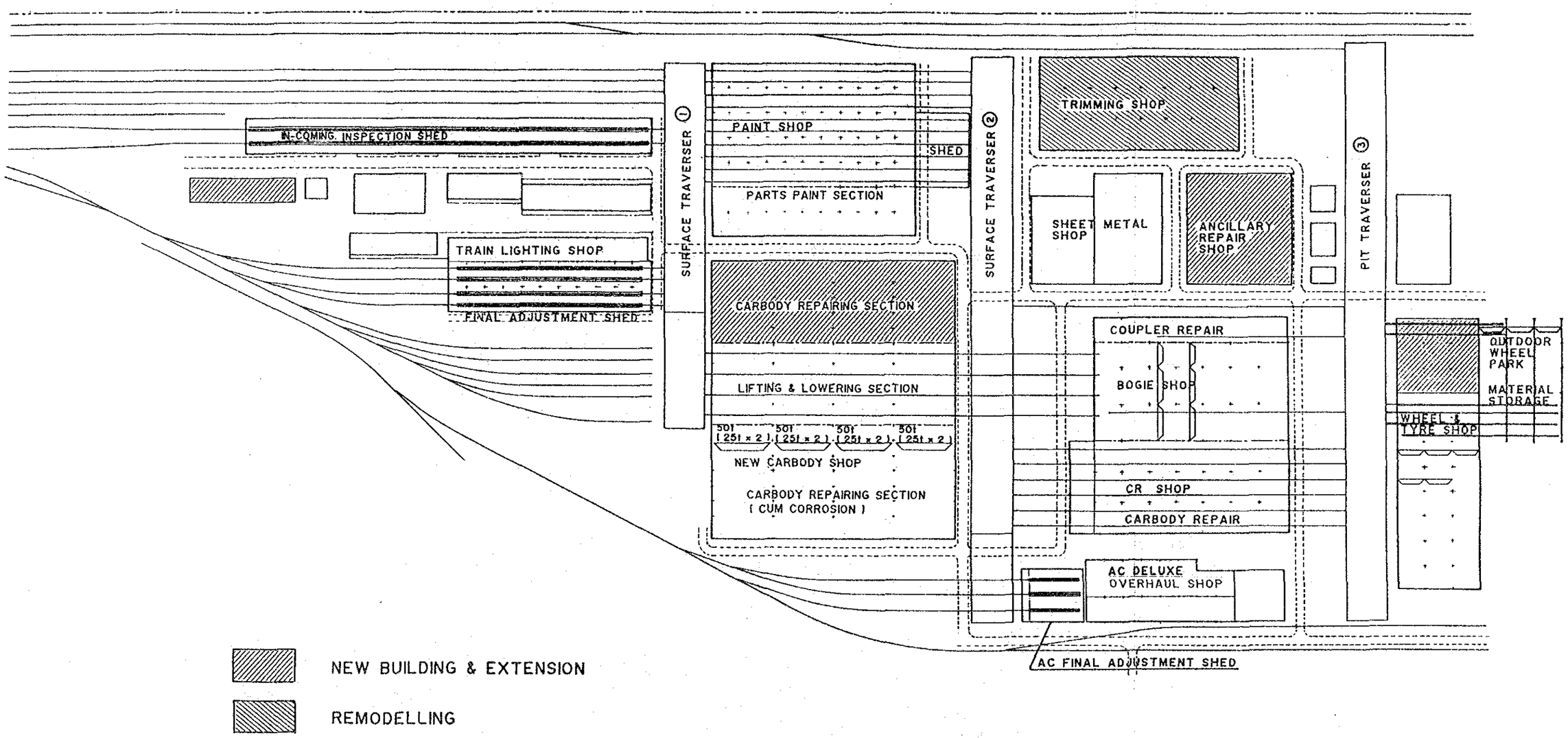


Fig. 6. 2. 6 LAYOUT PLAN OF CARRIAGE REPAIR AREA (PHASE Ⅱ)

(3) Plans for each shop

1) In-coming inspection shed

The in-coming inspection shed, at its final scale, will have a 16-car capacity. Because this shed will also have to deal with the unloading of electrical and other parts, it is necessary to consider measures to make the handling and transport of various parts more efficient. The current shed was not designed to let lorries and forklifts pass. This makes it necessary to establish a new in-coming inspection shed of 8 cars on 2 tracks each in capacity. The current shed will be demolished, and the vacant site will be used as passages for transport.

The in-coming inspection shed will have a single pit structure. A fixed platform will be set up all along the shed. Heavy components under the body floor are to be unloaded by forklift. All coaches to be inspected and repaired pass the in-coming inspection shed. This presents a difficulty in extending the shop while coaches are being processed on the shop floor. For this reason, the entire shed having 16-car capacity will be provided during Phase I work.

2) New car body shop

The new car body shop is the key shop in repairing coaches. It will be located along the stabling lines between traversers ① and ②. The shop building will consist of four tracks (lifting/lowering section) leading from traverser ① to traverser ② and of the body repair section proper aligned north to south. An overhead crane that runs perpendicular to the tracks will transport car bodies between the lifting/lowering section and the body repair section.

New facilities accommodating a total of 44 cars will be set up during the Phase I, within the extent of not interfering current trimming shop. During the Phase II, a 20-car capacity extension will be made at the site of the trimming shop.

The building is designed to accommodate the 26-metre cars that are expected to be introduced in the future.

All cars will be moved to the car body lifting track via traverser ①. Each car will then be transported perpendicularly by crane and placed on the trestle at the body repair section. There, corrosion-repair coaches and AC coaches will be inspected and repaired in this state.

On the trestle, ordinary coaches without corrosion will be inspected and repaired for their underfloor components only. After painting the underfloor portion, these coaches will be moved promptly to the car body lowering track. When assembled with repaired bogies, these cars will be moved to the CR and CB shops. It is at these shops that their bodies will be inspected and repaired.

The track-to-track spacing of car body lifting/lowering section is 10 metres. Although facilities comprising four tracks will be provided during Phase I work, one of the tracks will be used to inspect and repair car bodies during this stage.

For car body lifting, one track will be used during both Phase I and Phase II. For lowering, two tracks will be used during Phase I and three during the Phase II.

The lifting/lowering section was designed on condition that all necessary bogies will be positioned the day before the lowering operation on the lowering tracks.

AC coaches will be placed close to the deluxe shop on the premises of the new car body shop. Underfloor equipment fitting/removing device will be used to detach and attach compressors and other components under the body floor.

3) CR and CB shops

Plans call for the CR shop to accommodate 24 cars during the first and the second phase each. The CB shop will accommodate six cars at the Phase I alone. For this end, the CR shop will be extended by 12 metres on the side of traverser ② to be able to house four cars on one track each. Existing pit used for AC coaches will be buried in this plan.

At the CR and CB shops, repair work for ordinary-repair coaches and interior work for corrosion-repair coaches will be conducted. (After the Phase II work is completed, only ordinary repair coaches will be repaired.)

Inside of CR, CB shops coaches will be repaired with their bogies attached. It is also planned to be able to move the cars using traverser ③. No fixed platform will be established at the CR shop, CB shop or new car body shop. These shops will be equipped with a lifting platform vehicle each.

4) Paint shop

The existing paint shop will be fully utilised as a car body paint shop. To shorten the cycle time and enhance the painting capacity, some of the tasks will be carried out on a conveyor belt line. Adequate enhancements will be implemented during the Phase I work so as to obtain the envisaged benefits as soon as possible. In this way, painting capacity will be boosted earlier to meet the growing demand.

The paint shop will consist of a pre-paint treatment section and a conveyor belt line. In the pre-paint treatment section, peeling, puttying and outside plate-washing will be conducted. On the conveyor belt line, masking, automatic painting and accelerated drying will be carried out.

Upon leaving traverser ②, each car will enter the pre-paint treatment section. After undergoing pretreatment and washing, the car will be placed on the conveyor belt line for painting. Double coated painting will usually be applied. Each work unit on the conveyor belt will have a 50-minute tact time.

The current parts painting shop and paint mixing shop will be used as they are.

5) AC final adjustment shop and ordinary final adjustment shed

The AC final adjustment shed will be set up adjacent to the AC deluxe shop. Two-car facilities will be provided during Phase I work, and additional one-car facilities during Phase II work. (But the entire building will be erected during Phase I work.)

The AC final adjustment shed will have an all-pit structure so that faulty parts can be replaced there with a forklift.
The current ordinary final adjustment shed will be used without modification.

6) Bogie shop

The capacity of the existing bogie shop and bogie components shop will be supplemented with CR shop #5 through #10 (existing car body lifting/lowering section).
Under this plan in Phase I work, repair shop for couplers and coil springs currently transfered to loco works will be set up at the existing bogie components shop.
Construction of the bogie shop will be divided into two phases.
The lifting/lowering tracks of the new car body shop will be extended into the bogie shop. This will make it possible to move bogies without putting them on traverser ②. In addition, bogie washers, painting device and bogie setting press etc. will be installed along the logical flow of tasks on the shop floor.

7) Wheel shop

The existing wheel shop is thought to be capable of coping with its work load for the time being. For this reason, enhancements of this shop will be carried out during Phase II work.
For improvement, a new building will be erected on a northern part of the current wheel shop. This extended building will house a bearing inspection/repair section, plus lathes and other machines for light repairs on wheelsets. This will make it possible to locate a in-coming/out-going tracks for wheelsets very close to the bogie shop.
Wheel park will be relocated to the east side of the wheel shop. Completed wheelsets and other materials will be stored in this area.
The bearing inspection/repair section will be equipped with washers and other required facilities to boost efficiency in inspection and repair work.

8) Electrical parts repair shop

The car body special repair shop adjacent to the AC deluxe shop will be merged with the latter to provide a wider shop floor area. The expansion is intended to cope with servicing of growing number of AC coaches.

The existing train lighting shop seems to be reaching the limits of its capacity. So the shop will be added to its west side to increase its capacity in Phase II.

The existing car body special repair shop will be shifted to the new car body shop during Phase I work. Building extension of AC deluxe shop will be carried out at the resulting vacant site during Phase I work as well. Test equipment and other machinery will be mainly installed during Phase II work.

9) Ancillary repair shop

It is desirable for the sheet metal shop and the inspection/repair shops for miscellaneous parts be located close to the car body shop. For this reason, these shops will be concentrated in the area between the CR shop and the CB shop.

At present, work is under way to move the sheet metal shop to this area, during Phase I work, shops dealing with small-sheet metal, electro plating, etc. will be shifted to this area. During Phase II work, various parts shops will be shifted in from the CB shop and concentrated in this area.

At the same time, part of the bogie component shop will also be relocated to this shop from bogie shop in order to cope with the increasing work load.

Existing coaches with vacuum brakes are expected to be replaced gradually by air brake cars. To cope with this new development, an air brake inspection/repair shop will also be set up during Phase II work.

10) Workshop transport equipment

At present, parts to be inspected and repaired are mostly conveyed by forklift on the shop floor. Under the improvement plan, both roads and transport equipment like forklift will be added and enhanced. The improvements will make it possible to cope efficiently with the growing amount of transport work expected in the future.

Huge quantities of scrap from corrosion repairs on coaches and wagons are inefficiently disposed of at present. Steel plates and other scrap are heaped here and there on the workshop premises and on the shop floor, obstructing transport work.

What is proposed under the plan is probably the most practical solution to this problem. And that is scrap bins, distinguished by scrap type, to be positioned strategically on the shop floor where the scrap generates. These bins, filled with scrap, will be conveyed by forklift to a scrap yard every day. The scrap yard will be equipped with a magnet crane to boost efficiency.

11) Warehouses

Warehouse enhancements are the same as mentioned in connection with the Jamalpur workshop.

(4) Buildings, tracks and structures

1) Buildings

Table 6.2.4 shows the proposed areas of buildings to be erected/ renovated under this plan.

Table 6.2.14 Proposed Areas of the Buildings to be Erected/Renovated

Name of building	Current area	Phase I plan		Phase II plan	
		Required area	Remarks	Required area	Remarks
In-coming inspection shed	1,630	(3,400) 3,400	Existing building to be demolished.	3,400	
New car body shop	0	(11,520) 11,520		(4,920) 16,440	
CR shop	7,900	(550) 4,940	Only #11 through #16 to be used.	4,940	
CB shop	4,460	4,460		4,460	To be converted into a trimming shop
Paint shop	6,055	6,055		6,055	
AC final adjustment shed	0	(780) 780	To be built new	780	
Ordianry final adjustment shed	2,450	2,450		2,450	
Bogie shop	2,340	5,200		5,900	
Wheel shop	4,015	4,015		(1,505) 5,520	
Electrical parts repair shop	3,800	<1,200> 5,000	Special reapair shop to be renovated.	(620) 5,620	
Ancillary shop	3,900	(1,840) 4,700		(2,840) 5,500	
Total area of new buildings	-	18,090		9,885	
Total area of renovated buildings	-	1,200		-	
Total Area	36,550	52,520		61,065	

Note: Figures in parentheses ( ) are the areas of new buildings, and those in angle brackets < > are the areas of renovated buildings.

2) Tracks

(a) Car stabling lines will be provided on the north side of the in-coming inspection shed.

(b) Necessary tracks will be installed new and track switching arrangements will be made according to build the in-coming inspection shed, new car body shop (lifting/lowering section), AC final Adjustment shed, bogie shop, and wheel shop.

(c) When the new car body shop is installed and the existing in-coming inspection shed is demolished, the unnecessary tracks will be removed.

(d) Along with the floor improvement of the CR shop, its existing tracks will be renovated.

(e) Any tracks found to be markedly sunken or deteriorated will be renovated.

3) Structures

(a) Inspection pit

The in-coming inspection shed will be provided with a 16-car single pit, and the AC final adjustment shed with a 3-car all floor pit. Pits #5 through #10 and #16 currently operating inside the CR shop will be buried.

(b) Shop floor renovation and passage construction

The entire floor of the buildings to be renovated or built will be paved with concrete. (Part of the bogie shop floor will be paved with wood bricks.) The floor of the CR shop will also be paved with concrete.

(c) Passages and drainage inside the workshop

The passages inside the workshop are being paved at present and are excluded from the scope of this plan. Concrete-paved roads will be provided around the in-coming inspection shed and new car body shop. In addition, drainage ditches will be provided around the shops that are planned to be improved under this plan.

(d) Traversers

Surface traversers ① and ② will be extended in line with the proposed new construction of the new car body shop and AC final adjustment shed.

(e) Others

The buildings and pits to be renovated or built under this plan will be equipped with the necessary lighting equipment.

4) Effluent treatment facility

This facility will be for treating effluent generated from parts washing work, steel plate phosphating work and carbody painting work, etc.

Water treated through this facility will have the quality to satisfy water standard fixed by law. For this purpose, total flow volume in a day and one hour flow rate should be measured and chemical contents of effluent should be analysed. And functions and capacity of each treatment tank and device should be determined based on these data.

Flow sheet of effluent treatment of this facility is shown in the Vol. III Fig. 2-10.

Effluent will be collected in the pipe buried underground and flow into the effluent water receiver tank No. 1 for a while and then forced to flow into the receiver tank No. 2. In the receiver tank primary treatment that is adjustment of amount and quality of effluent and floatation and sedimentation of suspended solid will be carried out. After that water will be sent to the secondary treatment apparatus to trap coagulated suspended solid by flocculation process.

After treatment, treated water will be discharged into main drain pipe and taken out scum will be burned by scum incinerator.

(5) Machinery improvement plan

Table 6.2.15 shows the major machines to be replaced or installed new under this plan.

Table 6.2.15 Major Machines to be Replaced or Installed New (in units)

Shop name	Phase I plan			Phase II plan		
	Installed new	Replaced	Total	Installed new	Replaced	Total
In-coming inspection shed	14	0	14	-	-	-
Car body shop	103	0	103	35	0	35
Paint shop	54	2	56	-	-	-
AC final adjustment shed	3	0	3	1	0	1
Bogie shop	13	0	13	-	-	-
Wheel shop	-	-	-	18	5	23
Electrical parts repair shop	-	-	-	18	0	18
Ancillary repair shop	22	0	22	-	-	-
Others	9	0	9	1	0	1
Total	218	2	220	73	5	78

6.2.4 Drawing Up of the Facility Improvement Plan for Wagons

Based on the current problems for Rolling Stock inspection/repair system, premises for the facility modernisation plan which were stated in the preceding chapter, improvement plan for inspection/repair facilities for wagons was drawn up as follows.

(1) Inspection/repair capacity and scale of facilities

Table 6.2.16 shows the wagon inspection/repair capacity and the scale of the each shop to be provided by the year 2000 under this plan.

Table 6.2.16 Scale of the Shops

Shop name	Scale of facility	
	(8 wheeler wagon)	(4 wheeler wagon)
In-coming inspection/cleaning shed	2 cars x 2 tracks: for 4 cars	4 cars x 1 track: for 4 cars
4 wheeler repair shop	-	9 cars x 4 tracks: for 36 cars
4 wheeler lifting/lowering shop	-	9 cars x 2 tracks: for 18 cars
8 wheeler repair shop	6 cars x 4 tracks: for 24 cars	-
Paint/final adjustment shop	Common use for both 8 wheelers and 4 wheelers	Painting: 2 cars x 2 tracks = 4 Lettering/inspection: 6 cars x 2 tracks = 12
Bogie shop	for 47 bogies	
Wheel shop	for 98 wheelsets	
Ancillary parts shop	Sheet metal section, air brake section, etc.	

(2) Overall layout plan

Figure 6.2.7 shows the overall layout of the wagon inspection/repair facilities.

In view of the gradual change from 4 wheeler wagon into 8 wheeler wagon, the layout emphasised the enhancement of inspection/repair capacities for 8 wheeler wagons and the shortening of the cycle time involved. To begin with, the existing 4 wheeler repair shop will be renovated to deal with 8 wheeler wagons. Also as there are only a limited number of tracks for in-coming and out-going 8 wheeler wagons at present, a surface traverser will be installed on the west side of the wagon repair shop.

Moreover, dust of various kinds has accumulated on the floor of the wagon repair shop, interfering with transport work on the floor. To improve the situation, an in-coming inspection/cleaning shed is planned for cleaning wagons upon admission. The shed will be located on the west side of the surface traverser.

Of the wagon inspection/repair tasks, repairs on body panels is time-consuming but at the same time very important. With this fact taken into account, a sheet metal section will be located at the center of the wagon repair shop for higher efficiency in sheet metal transport.

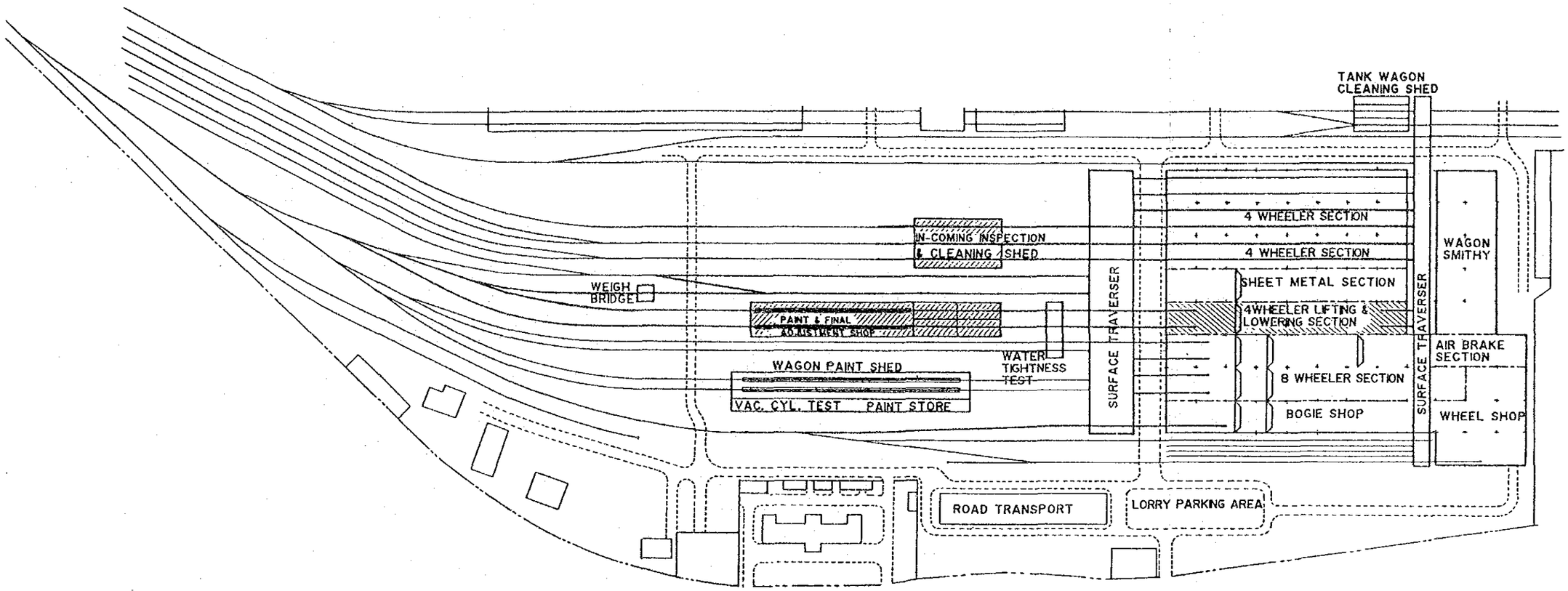
A paint shop that can house automatic painting equipment will be set up on the north side of the existing wagon paint shop. The new paint shop is intended to greatly shorten the painting cycle time. At the same time, an inspection shop will be established by extending the painting shop.

Test equipment will be provided so that covered wagon may be inspected for water tightness before they are painted.

An entire shed on the south side of the 8 wheeler repair shop will be used as a bogie shop. The wheel shop will be located to the east of the bogie shop.

If 8 wheeler wagons increase and 4 wheeler wagons decrease in the future, as expected, the increased work load made up of 8 wheeler wagons can be coped with by installing an overhead crane at the 4 wheeler repair shop. There is no need to alter the overall layout. In line with this arrangement, the in-coming inspection/cleaning shed and paint/final adjustment shop will be designed for shared use by 4 wheeler wagons and 8 wheeler wagons.

In the future, inspection and repair may be carried out on wagons equipped with air brakes. Therefore, an air brake section will be set up on the site from which the existing sheet metal shop will be shifted.



NEW BUILDING

REMODELLING

Fig. 6. 2. 7 LAYOUT OF WAGON REPAIR AREA

(3) Plans for each shop

1) In-coming inspection/cleaning shed

Under this plan, the in-coming inspection/cleaning shed will be able to handle four 8 wheeler wagons and four 4 wheeler wagons simultaneously in the year 2000. The facilities will be designed to be commonly used by both 8 wheeler wagons and 4 wheeler wagons so that future changes in 8 wheeler wagons work load may be accepted easily. The effective car length will be set at 20 metres for 8 wheeler wagons and at 10 metres for 4 wheeler wagons. The building will be 40 metres long, with three tracks installed inside. There will be no partition set up inside the building. The track-to-track spacing will be the standard 7.5 metres.

The work to be performed at this shed will include inspection of the various portion of wagons, removal of rust, iron powder and other dust from the car components, and cleaning of the car body. No pit will be provided at the shed for this purpose. Instead, a fixed platform will be set up for the roof inspection.

At this shed wagons will be moved by a rail-cum-road shunting vehicle.

Each 4 wheeler wagon, after inspection upon admission, can be led to an optimal track at the 4 wheeler repair shop depending on the amount of repairs required.

2) 4 wheeler repair shop

The capacity required in 2000 is 19 cars. Under this plan, allowances will be made for fluctuations in work load, four tracks (in two bays) will be provided for the 4 wheeler repair shop. Basically, inspection and repair will be carried out on wheel-equipped wagons as is done at present.

The four tracks will be used selectively depending on the inspection/repair work load so as to shorten the cycle time and to facilitate car movement. That is, wagons requiring about the same amount of inspection/repairs will be placed to the same track. This will minimise the waiting time for car movement inside the 4 wheeler repair shop.

The shop floor will be paved with concrete. And also, a lifting platform vehicle, CO_2 welder and other equipment that can also be used effectively on 8 wheeler wagons in the future will be provided. Inside the shop, cars will be moved by winch.

3) 4 wheeler lifting/lowering shop

The capacity required in 2000 is for six cars. Two tracks in one bay will be allocated to this shop. The existing 4 wheeler lifting/lowering shop will be converted into a 8 wheeler repair shop to cope with the expected increase in work load in 8 wheeler wagons in the future. One of the bays of the existing 4 wheeler repair shop will be renovated into a lifting/lowering shop where a 15-tonne overhead crane can be installed. At the lifting/lowering shop, wagons will be placed on a trestle to undergo wheel replacement and underfloor component repair.

The shop floor will be paved and a 15-tonne crane will be installed.

4) 8 wheeler repair shop

The capacity required in 2000 is for 22 cars. Four tracks in two bays will be provided to achieve this target. At present, the 8 wheeler repair shop is housed in a single bay. Under this plan, the adjacent 4 wheeler lifting/lowering shop will be remodeled for the use of as 8 wheeler repair shop. At this shop, wagons will be placed on a trestle. Bogies (wheelsets included) will be moved to the east side of the 8 wheeler wagon repair shop, where bogies are de-wheeled.

The major improvements proposed for this plan will comprise paving of the floor, installation of lifting platform vehicle, and introduction of a CO_2 welder.

5) Paint/final adjustment shop

To paint efficiently more than 3,000 wagons per year, it is absolutely necessary to introduce automatic painting equipment. The existing paint shop does not have sufficient track-to-track spacing, and there will be a number of factors obstructing the paint work during the construction period if this shed is to be used. To avoid these bottlenecks, a new building will be erected to the north of the existing paint shop.

The new paint/final adjustment shop will consist of an automatic painting booth, a drying booth and a lettering/inspection section. Under this plan, it will take 40 minutes to have one wagon automatically painted and compulsively dried.

During painting and drying, wagons will be separated from one another by partitions. At the lettering/inspection section, an open-space structure is planned so that a number of wagons may undergo a checkup simultaneously. A space wide enough to accommodate 12 wagons for a day's workload is proposed for this section.

Water tightness test equipment will be installed between the paint shop and the surface traverser. The equipment will be used to check cars for its waster tightness before they are painted.

6) Bogie shop

The areas of the existing bogie shop, as well as those of the adjacent wheel place and the coupler reclamation section etc., will be utilised for setting up a new bogie shop. This makes it necessary to relocate the existing wheel place to the wheel shop and to the outdoor wheel park. It is also necessary to move the existing coupler reclamation section, along with the sheet metal section, to the central part of the wagon repair shop.

Bogie will be de-wheeled and wheeled at the east end of the existing 8 wheeler repair shop.

Arrangements will be made to facilitate the in-coming and out-going of bogies supplied to outstation to and from the wagon depots. A bogie washer, painting equipment, bogie frame manipulator and other devices will be aligned logically along the flow of inspection/repair work.

7) Wheel shop

The roller bearing inspection/repair section is in a noticeably deteriorated condition and is being partially renovated by Shop authorities. Basically, the east side of the bogie shop (including the extended area) and the easternmost point of the 8 wheeler wagon repair shop will be remodeled into a wheel shop. Wheel sets supplied to outstation will be received where the outdoor yard crane is installed. Some of the completed wheel sets will also be stored at this location.

Only wheel sets scheduled for light repairs will be handled at this wheel shop. The shop layout will be thoroughly revised so that other tasks such as roller bearing inspection and repair can be mechanised.

8) Ancillary parts shop

Of the wagon inspection/repair tasks, repairs on corroded body panels is time-consuming but also very important. With this fact taken into account, sheet metal work currently done at various locations will be concentrated at one bay of the 4 wheeler wagon repair shop, where the work load for 4 wheeler wagon will decrease and vacant work place will supposedly arise.

This arrangement makes it necessary to store iron plates and other related parts under the outdoor yard crane at the south end of the wagon repair shop. A passage will be built for transportation from north to south through the centres of the 4 wheeler repair shop, 8 wheeler repair shop and the bogie shop.

At the same time, the coupler reclamation section, currently located at the bogie shop, will be relocated to the sheet metal section to shorten the distance travelled.

In the future, inspection and repair may be carried out on wagons equipped with air brakes. Therefore, an air brake repair section is to be set up on the site from which the existing sheet metal section will be shifted.

(4) Buildings, tracks and structures

1) Buildings

Table 6.2.17 shows the proposed areas of buildings to be erected/ renovated under this plan.

Table 6.2.17 Proposed Areas of the Buildings to be Erected/Renovated

Name of building	Current area	Required area	Remakrs
In-coming inspection/ cleaning shed	0	(920) 920	
4 wheeler repair shop	8,360	3,340	
4 wheeler lifting/ lowering shop	1,670	<1,670> 1,670	Part of the 4 wheeler repair shop to be renovated/diverted
8 wheeler repair shop	1,670	3,340	Existing 4 wheeler lifting/ lowering shop to be diverted.
Paint/final adjustment shop	2,010	(1,840) 3,850	
Bogie shop	1,220	1,900	Wheel place, etc. will be diverted.
Wheel shop	1,880	1,670	Excluding the outdoor wheel yard
Ancillary parts shop	2,710	4,380	One of the bays for the 4 wheeler repair shop will be diverted.
Total area of new buildings	-	2,760	
Total area of renovated buildings	-	1,670	
Total Area	19,520	21,070	

Note: Figures in parentheses ( ) are the areas of new buildings, and those in angle brackets < > are the areas of renovated buildings.
Both figures are included in the figures directly below them.

2) Tracks

(a) Necessary track-switching arrangements will be made on the west side of the wagon repair shop according to the erection of the new surface traverser, in-coming inspection/cleaning shop and paint/final adjustment shop.

(b) Along with the floor improvement of the 4 wheeler repair shop the existing tracks will be renovated.

(c) Any tracks found to be markedly sunken or deteriorated will be renovated.

3) Structures

(a) Inspection pit

The lettering/inspection section will be provided with a 12-car single pit structure.

(b) Traverser

A new surface traverser will be installed on the west side of the wagon repair shop.

(c) Shop floor renovation and passage construction

All floors of the buildings to be renovated or newly erected will be paved with concrete. Part of the bogie shop floor will be paved with wood blocks.

(d) Passages and drainage inside the workshop

The passages inside the workshop are being paved at present and are excluded from the scope of this plan. Concrete-paved roads will be provided around the in-coming inspection/cleaning shed and paint/final adjustment shop, and on the west side of the surface traverser. In addition, drainage ditches will be provided around the shops to be improved under this plan.

(e) Others

The buildings and pits to be renovated or built new under this plan will be equipped with the necessary lighting equipment.

(5) Machinery improvement plan

Table 6.2.18 shows the major machines to be replaced or installed new under this plan.

Table 6.2.18 Major Machines to be Replaced or Installed New (in units)

Shop name	Installed new	Replaced	Total	Remarks
Wagon repair shop	55	0	55	
Paint/final adjustment shop	12	0	12	
Bogie shop	11	0	11	
Wheel shop	8	1	9	
Ancillary parts shop	1	0	1	
Others	2	1	3	Indicates common facility
Total	89	2	91	

6.2.5 Spare Parts Enhancement Plan

Shortening rolling stock cycle time requires not only shortening car body inspection/repair time, but also introducing a unit exchange spare parts system, by which complete parts such as bogies and wheels are stored in ready-to-use condition. These parts are taken out of storage and mounted on car bodies at the time needed. What follows is a description of the optimum quantity together with the corresponding cost of each of the parts to be stored. The basis for the estimates is the concept discussed in connection with the plan for the Jamalpur workshop.

Because the facility improvement plan is to be implemented in two phases, the spare parts enhancement plan will also be executed in two phases.

(1) Contents of the spare parts enhancement plan

Table 6.2.19 shows those spare parts together with their costs which will be provided at the Perambur workshop during the period of plant investment at the first and second phases. Tables 6.2.20 and 6.2.21 give a breakup of the estimates made for the plan.

Table 6.2.19 Spare Parts Enhancement Plan

Type of car	Parts name	Q'ty of spare parts required	Q'ty of spare parts currently stored	Q'ty of spare parts to be added			Costs (in thousand Rs.)		
				Total	Phase I	Phase II	Total	Phase I	Phase II
AC coach	Wheel set	2	0	2	1	1	80	40	40
	Compressor for AC coach	4	29	0	0	0	0	0	0
	Others						1,000	500	500
	(Total)						(1,080)	(540)	(540)
Ordinary coach	Bogie (complete)	2	0	2	2	0	1,600	1,600	0
	Wheel set	48	4	44	34	10	1,760	1,360	400
	Others						2,000	1,000	1,000
	(Total)						(5,360)	(3,960)	(1,400)
4-wheeler wagon	Wheel set	2	5	0	0	0	0	0	0
	Others						0	0	0
	(Total)						(0)	(0)	(0)
8-wheeler wagon	Bogie (complete)	6	0	6	6	0	3,300	3,300	0
	Wheel set	5	5	0	0	0	0	0	0
	Others						500	500	0
	(Total)						(3,800)	(3,800)	(0)
Total costs							10,240	8,300	1,940

Table 6.2.20 (1) Breakup of Estimates of Spare Parts to be Stored at Parambur Workshop

Type of car	No. of cars inspected/ repaired with P and P'	Parts name	Cycle time for parts		Allowed time A	Estimating formula: (C'-A)/P'	Q'ty of spare parts required in units of cars	Q'ty of spare parts required			Q'ty of spare parts currently stored	Q'ty of spare parts to be added	Costs (in thousand Rs.)
			C	C'				Light repairs	Heavy repairs	Total			
AC Coach	185 nos/Yr P = 1.6 P'= 1.3	Bogie (complete)	0.8	0.88	7.0	(-4.7)-6.1	(0) 0	(0) 0		(0) 0	0	(0) 0	
		*Wheelset	0.6	0.72	5.5	(-3.7)-4.8	(0) 0	(0) 0	(1) 2	(1) 2	0	(1) 2	(40) 80
	250 nos/Yr P = 1.2 P'= 1.0	Alternator	2.3	2.53	4.5	(-1.5)-2.0	(0) 0	(0) 0		(0) 0	13	(0) 0	
		Compressor	5.8	6.38	4.5	(1.06) 1.4	(2) 2	(4) 4		(4) 4	29	(0) 0	
		Condenser	3.4	3.74	4.5	(-1.0)-1.3	(0) 0	(0) 0		(0) 0	6	(0) 0	
		Evaporator	3.7	4.07	4.5	(-0.7)-0.9	(0) 0	(0) 0		(0) 0	3	(0) 0	
		Comp. motor	2.8	3.08	4.5	(-1.5)-1.9	(0) 0	(0) 0		(0) 0	25	(0) 0	
		Cond. fan motor	3.1	3.41	4.5	(-1.2)-1.6	(0) 0	(0) 0		(0) 0	6	(0) 0	
		Evap. fan motor	2.4	2.64	4.5	(-1.8)-2.4	(0) 0	(0) 0		(0) 0	3	(0) 0	
		Battery	3.8	4.18	4.5	(-0.6)-0.8	(0) 0	(0) 0		(0) 0	0	(0) 0	
		Others											(500) 1,000
		Total											(540) 1,080
Ordinary coach	2270 nos/Yr P = 0.13 P'= 0.11	Bogie (complete)	0.7	0.77	0.7	(0.6) 0.8	(1) 1	(2) 2		(2) 2	0	(2) 2	(1,600) 1,600
		*Wheelset	0.6	0.72	0	(6.5) 8.0	(7) 9	(28) 36	(10) 12	(38) 48	4	(34) 44	(1,360) 1,760
	2750 nos/Yr P = 0.11 P'= 0.09	Alternator	1.6	1.76	5.3	(-32.0)-39.0	(0) 0	(0) 0		(0) 0	0	(0) 0	
		Others											(1,000) 2,000
		Total											(3,960) 5,360

Note: 1 P' and C' incorporate allowances for fluctuations.
2 The quantities of spare parts required in units of cars were obtained as follows.
- Parts for 1 car, if $0 \leq (C'-A)/P' < 1$
- Parts for 2 cars, if $1 \leq (C'-A)/P' < 2$
3 Asterisked (*) items in the table are the spare parts of which additional ones were estimated separately to provide for heavy repairs.
4 The quantities in parentheses are those for the Phase 1, included in the figures directly right of them.

Table 6.2.20 (2) Breakup of Estimates of Spare Parts to be Stored at Parambur Workshop

Type of car	No. of cars inspected/ repaired with P and P'	Parts name	Cycle time for parts		Allowed time A	Estimating formula: (C'-A)/P'	Q'ty of spare parts required in units of cars	Q'ty of spare parts required			Q'ty of spare parts currently stored	Q'ty of spare parts to be added	Costs (in thousand Rs.)
			C	C'				Light repairs	Heavy repairs	Total			
4-wheeler Wagon	(1600 nos/Yr P = 0.18 P'= 0.15)	*Wheelset	0.3	0.36	0.8	(-2.9)	(0)	(0)	(2)	(2)	5	(0)	
		Others											(0)
		Total											(0)
8-wheeler Wagon	(1920 nos/Yr P = 0.15 P'= 0.13)	*Bogie (complete)	1.2	1.44	1.8	(-2.8)	(0)	(0)	(6)	(6)	0	(6)	(3,300)
		*Wheelset	0.3	0.36	1.0	(-4.9)	(0)	(0)	(5)	(5)	5	(0)	
		Others											(500)
		Total											(3,800)
Total for the Phase I													8,300
Total for the Phase II													1,940
Grand total													10,240

Note:1 P' and C' incorporate allowances for fluctuations.

2 The quantities of spare parts required in units of cars were obtained as follows.
- Parts for 1 car, if $0 \leqq (C'-A)/P' < 1$
- Parts for 2 cars, if $1 \leqq (C'-A)/P' < 2$

3 Asterisked (*) items in the table are the spare parts of which additional ones were estimated separately to provide for heavy repairs.

4 The quantities in parentheses are those for the Phase 1, included in the figures directly right of them.

Table 6.2.21 Breakup of Estimates of Spare Parts to be Provided for Heavy Repairs at Perambur Workshop

Type of car	Parts name	Occurrence rate of heavy repairs	Q'ty of parts inspected/repaired		No. of days for repairs			Q'ty of spare parts for heavy repairs (A) x (B)
			Annually	Per day (A)	Heavy repairs	Light repairs	Add'l days (B)	
AC coach	Wheelset	25%	(185) 250	(0.76) 1.03	1.7	0.7	1.0	(1) 2
Ordinary	Wheelset	25%	(2270) 2750	(9.36) 11.34	1.7	0.7	1.0	(10) 12
4-wheeler wagon	Wheelset	10%	(320)	(1.32)	1.7	0.4	1.3	(2)
8-wheeler wagon	Wheelset	10%	(770)	(3.18)	1.7	0.4	1.3	(5)
8-wheeler wagon	Bogie	20%	(770)	(3.18)	3.3	1.4	1.9	(6)

Note 1: Occurrence rate of heavy repairs are the rates to the quantities of all parts inspected/repaired.

2: The quantities of spare parts inspected/repaired per day allow for a 20 percent fluctuation rate in each.

3: The numbers of repair days allow for a 10 percent delay each.

4: Figures in parentheses are for Phase I and are included in the figures below them.

6.2.6 Current State of Rolling Stock POH Techniques and Improvement Measures

(1) Coach

1) Defects in coach found at POH

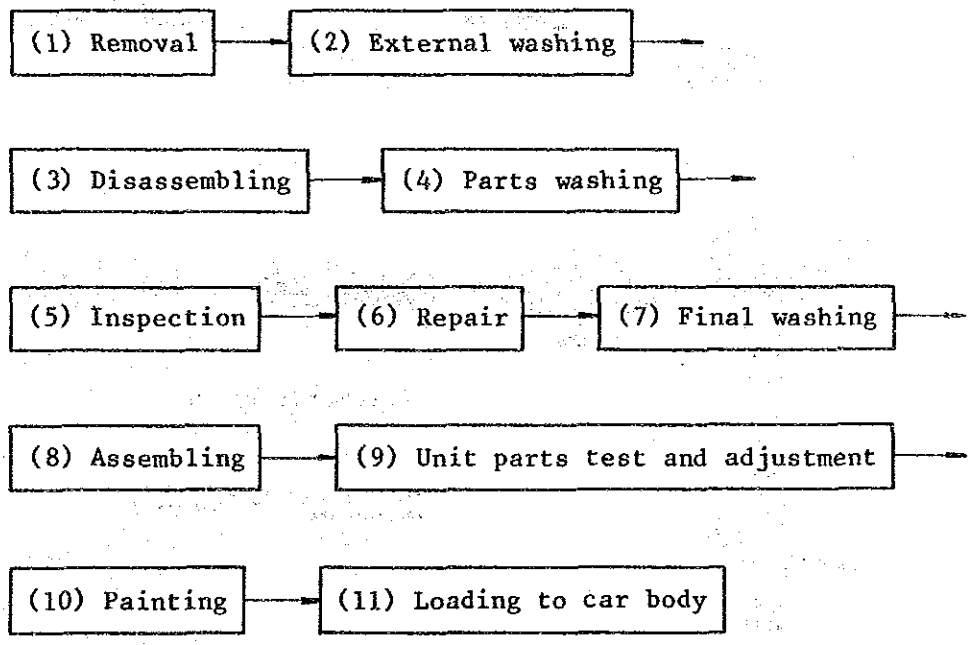
Table 6.2.22 shows main defects found out in coaches at POH.

Table 6.2.22 Main Defects in Coaches at POH

Component	Description
Car body	Corrosion of steel body (about 1/4 of all cars brought in), many cracks of coating on body panel of car body, many cracks and losses of floor finish material (color cement).
Bogie	Many flaws of bogie frame, many flaws deformations, and wears of bogie parts.
Axle bearing	Many burned and flawed bearings.
Others	Many erosions of water tank. Many bendings and flaws of shock absorbers, vacuum cylinders and pulling equipment.

2) Stripping and assembling

The general flow of repairing the parts is as follows.



Steps (1), (3), (8) and (11) require much labour and many man-hours. Although the Perambur Workshop has a large number of workers, the work efficiency is not high primarily due to a lack of tools. In Japan, everyone working in stripping and assembling individually carries various wrenches and screwdrivers, or when necessary, the tools shown in Fig. 6.2.8, thereby reducing the work fatigue and increasing the work efficiency. As a result, all parts are sent to the shop of the next process by the morning of the second day of in-coming, even on coaches.

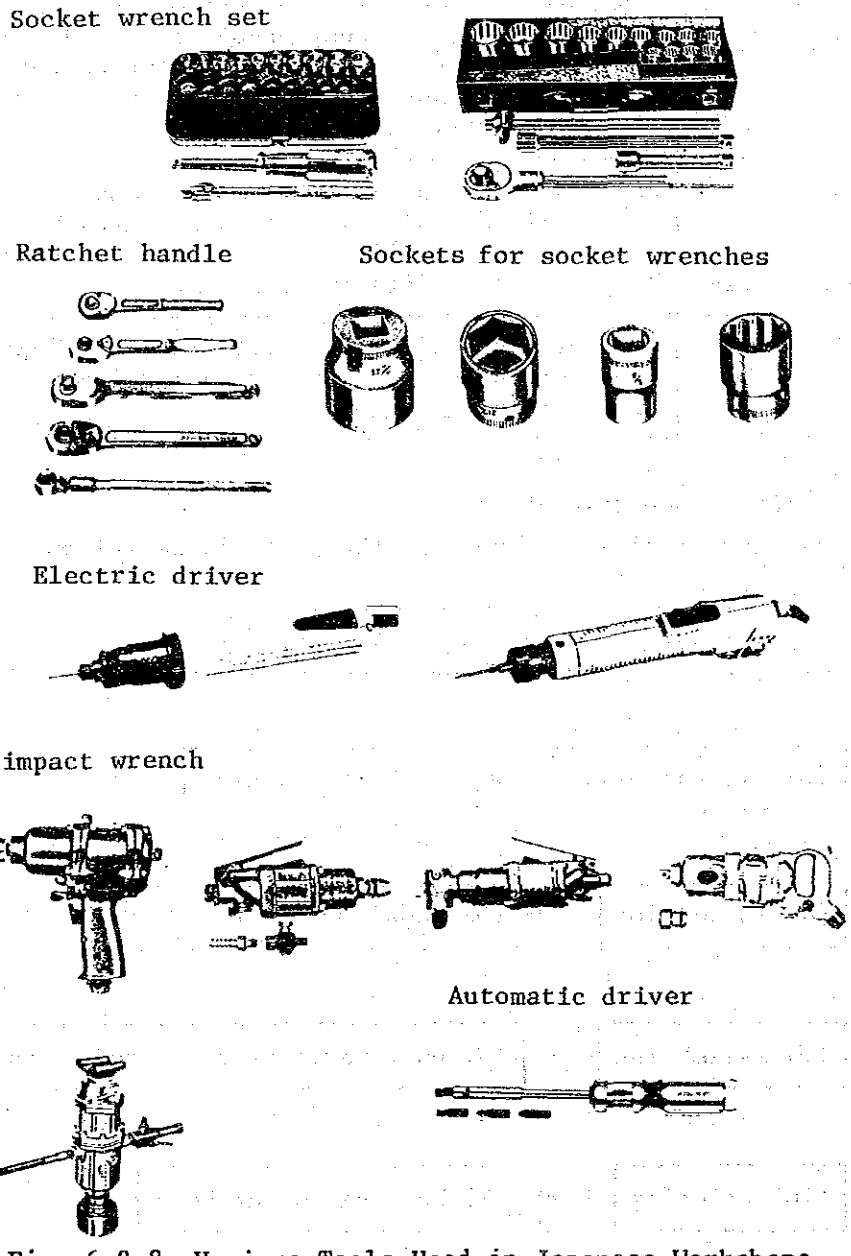


Fig. 6.2.8 Various Tools Used in Japanese Workshops

Measures to attain high efficiency other than tools are:

a) Provision of platform to facilitate person and parts up/down.
b) Mechanisation of parts transfer.
c) Provision of many parts transfer pallets according to the shape of parts. (Efficiency promotion)

3) Parts cleaning work

The most important thing in the repair work is to find out defective portions of the parts completely. The rolling stock coming in for POH is considerably dirty. Accordingly, cleaning is important for both discovering defective portions and recovering from contaminated condition.

In the Perambur Workshop, cleaning work is partially mechanised, such as bogie parts by soaking in chemical, however, most parts are cleaned manually using water or oil.

Particularly for dust inhibiting bearings, axle box, buffer, and brake parts, and bogie frame, wheel and axle, bogie parts, brake rigging parts, etc. from which even slight flaws must be discovered, appropriate cleaning equipment suitable for individual parts should be used. (Quality improvement and efficiency promotion)

4) Inpsection and measuring work

It has been noted that inspection/measurement is performed thoroughly, and recorded very well. However, for example, although the number of bogie frame cracks repaired is large in number, as shown in Table 6.2.23 strain is not checked due to lack of the surface plate. Provision of the surface plates is recommended.

Table 6.2.23 Number of Bogie Frame Crack Repairs (Wagon)

Year	Number of 8 wheeler wagons assigned	Number of cracks repaired
1980	5,437	126
1981	5,426	191
1982	5,401	435
1983	5,399	376
1984	5,489	284
1985	6,009	336

For the axle, ultrasonic flaw detection, and for some brake rigging parts, magnetic flaw detection and color check are performed. However, since fault of parts of running equipment causes serious accident, such as derailment, either a use of flaw detector of higher performance or the extension of flaw detection range must be considered referring to the past accident record or considering the importance of the parts. (Quality improvement)

5) Measures for corrosion repair

Corrosion repair in varied degrees is performed for about 25% of the coaches entering for POH.

The inspection record of each coach is kept and the repair history can be clearly known. Figures 6.2.9 and 6.2.10 show some examples of these records. As these records show, corrosion occurs at the same place in almost all cases and it is found on the trough floor each time of the repair. The sole bars, side panels and pillars are repaired very frequently. Figure 6.2.11 shows the repair records of corroded parts summarised by years. As it shows, corrosion starts 7 to 10 years after commencement of service. Once corrosion starts, it occurs repeatedly, and the repair range gradually expands.

Corrosion occurs on rolling stock in which the cement floor had cracks or holes. Also, corrosion tends to occur in many cases on rolling stock on which paint coat is cracked at the portion of welded beads which was repaired in preceeding POH.

The repair method must be studied by persuing the causal relations by each coach and from these corrosion histories. For example, a polyvinyl chloride material as is used in recent new rolling stock for the floor finishing should be used in the repair process instead of the cement material on which cracks easily occur. SUS or FRP material for parts surrounding the lavatory should be used instead of metal sheets.

The welding beads on the cut/joining part of steel plates on the body must be completely removed. The surface treatment and applying of putty, which increase the painting protection, must be conducted with special care. All these are very important elements to protect the rolling stock body from corrosion. Furthermore, adequate repair methods must be applied as needed. For example, the putty placement and drain discharging holes should be inspected or more drain discharging holes should be drilled according to each case, thereby preventing intrusion of rain water or chemical used in the depot into the rolling stock body. (Quality improvement)

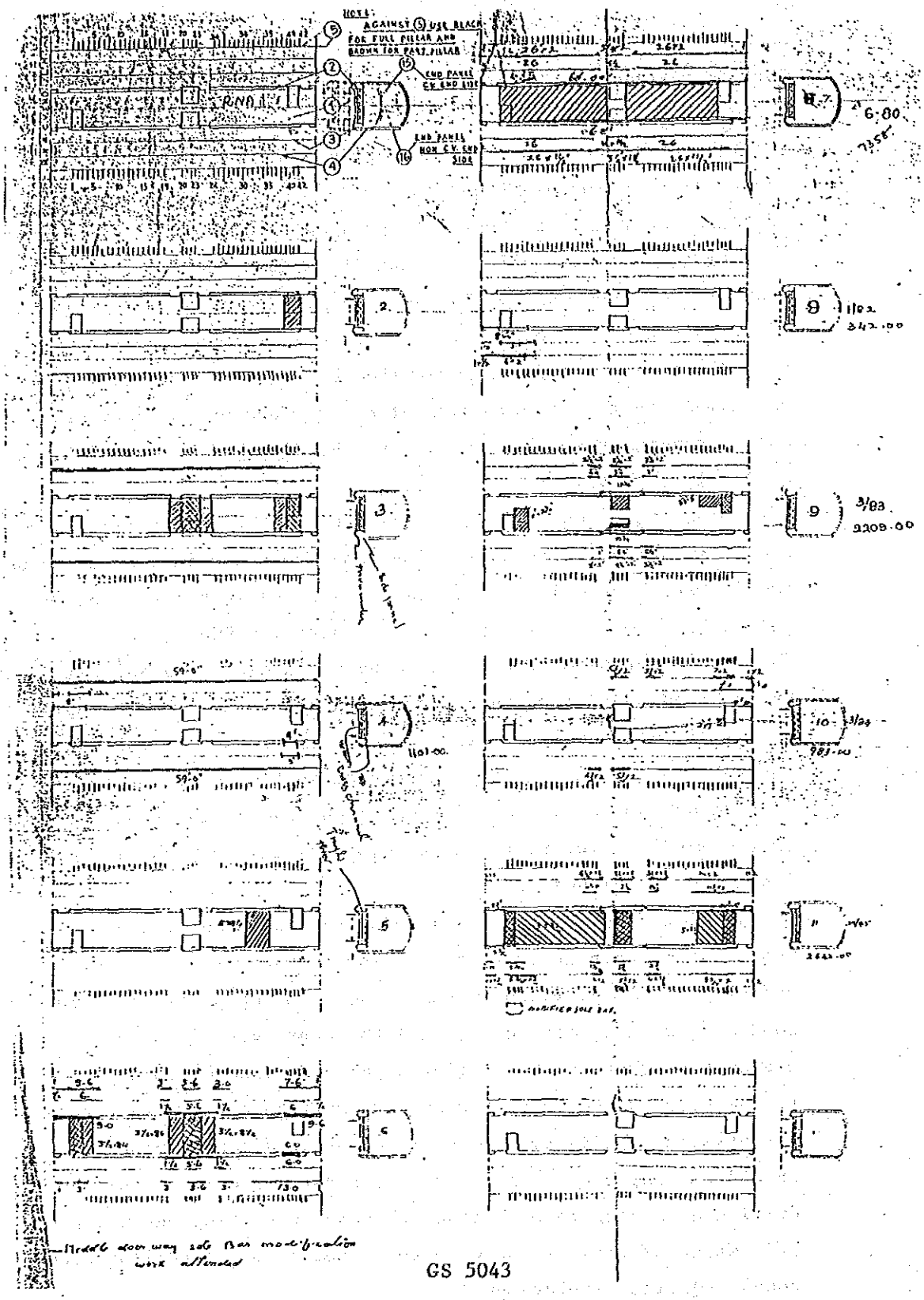


Fig. 6.2.9 Corrosion History of Coach

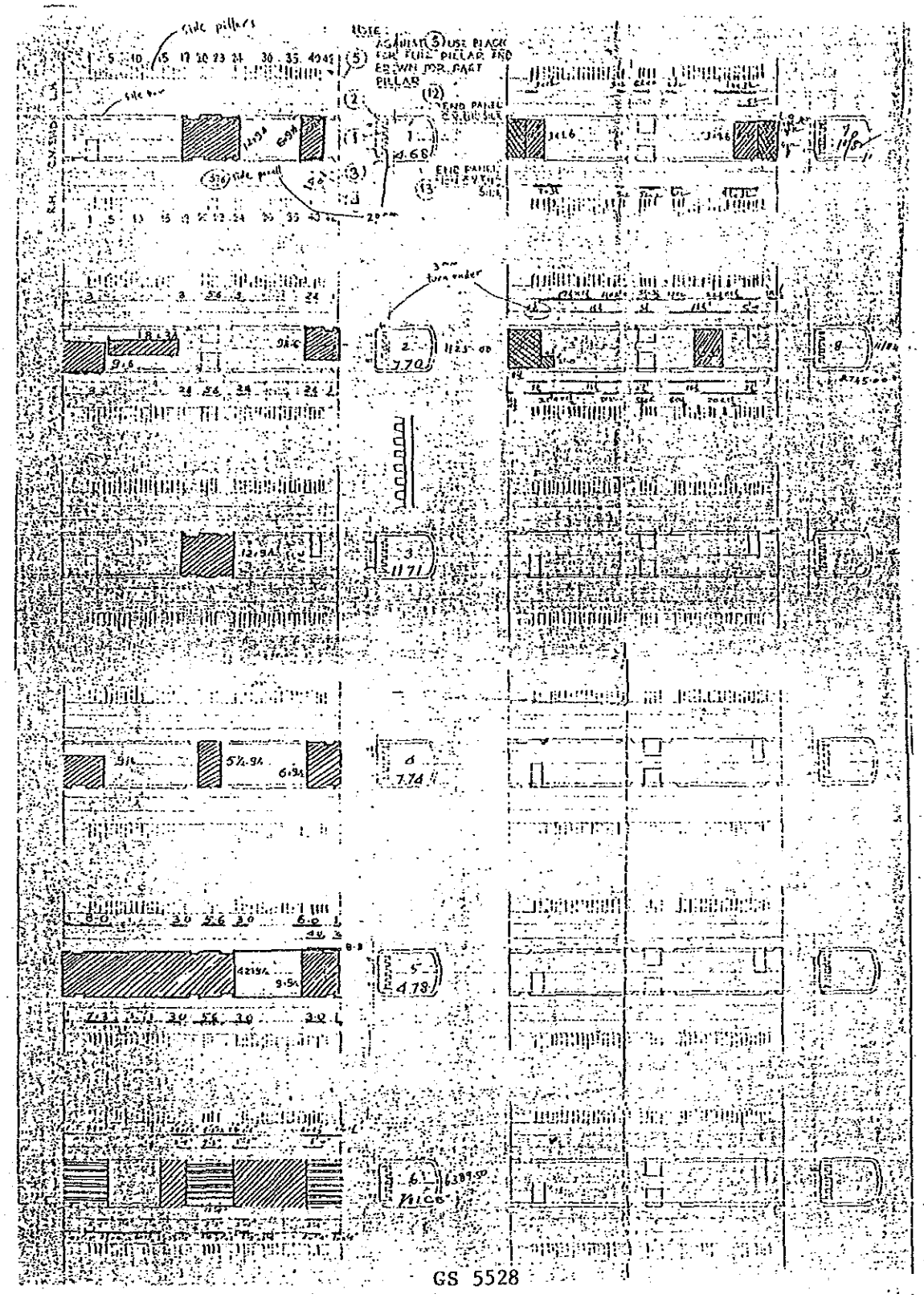
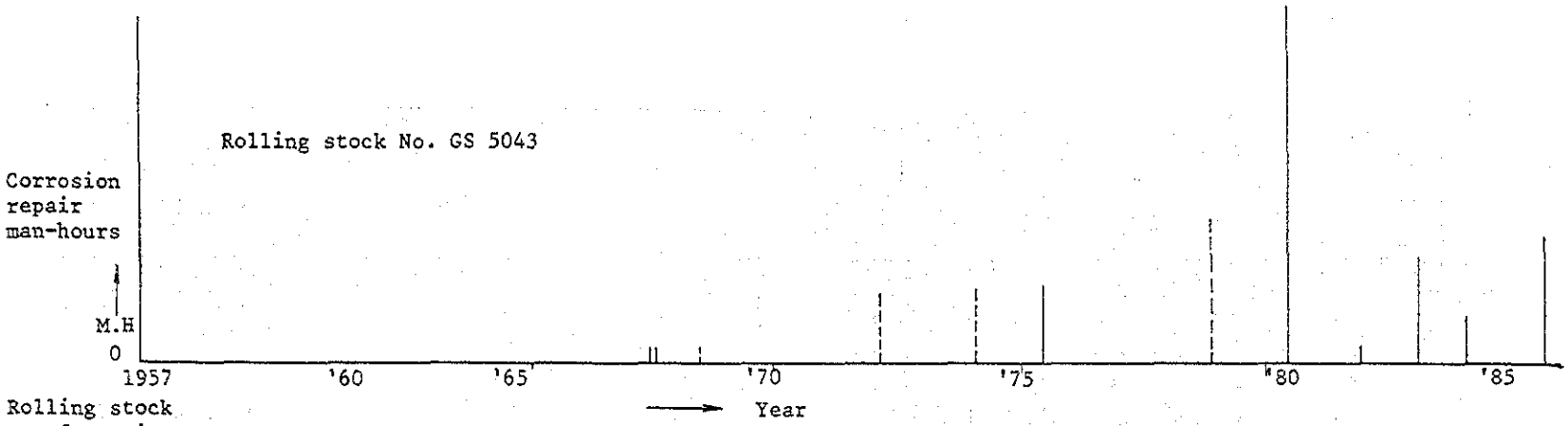
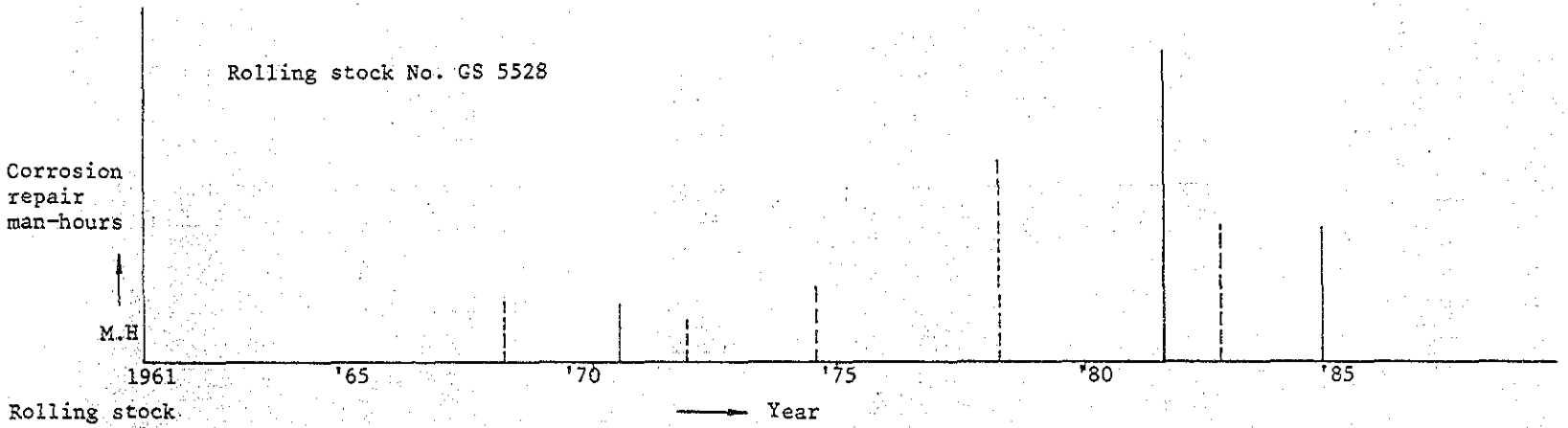


Fig. 6.2.10 Corrosion History of Coach



Note) Dotted line is estimation based on the repair range

II: Records are not available.



Note) Dotted line is estimation based on the repair range

Fig. 6.2.11 Corrosion by Years and Man-Hours Spent for Repair

6) Bearing inspection and repair

There are a large number of bearing problems and problems related with hot box, and the Perambur Workshop is paying close attention to these defects. Nevertheless, in addition to thorough washing of these parts, care must be paid to the following points in order to increase the accuracy of repair work:

a) The work standards, repair limit, and repair standards must be predetermined for the bearing assembling/disassembling, inspection washing and repair of axle boxes.

b) The fit between the roller bearing and axle must be controlled tightly. Therefore, when a bearing is used again, it must be mounted at the initial position, and when a new bearing is used, the same size bearing must be selected.

c) The combination of inner and outer races must be the same as it was initially. When either one is replaced with a new lace, it must be of the same size.

d) When an inner race is pulled out using an induction heater, the centre of the induction heater and the centre of inner race must match. If not, the temperature is distributed unevenly, resulting in deformation of the inner race.

e) The induction heater must match the inner race outer diameter. (The heating temperature is 120°C.)

f) When an inner race is pulled out, a specified puller must be used and the inner race must be pulled out slowly.

g) It is most important that the roller bearing be very thoroughly washed and cleaned to maintain the bearing performance.

h) The inner race must be heated in a heating oil bath. As soon as the oil temperature reaches 120°C, the inner race must be taken out quickly and inserted into the axle.

i) An induction heater must not be used for heating the inner race when inserting, because an induction heater increases the possibility of the inner race being forcibly inserted and distorted due to the difficulty of center matching, and non-uniform temperature distribution in the inner race because of the short heating time and quick temperature rise.

j) If the axle journal surface has scars where the inner race is fit, the journal surface must be smoothed using a fine paper file or the like.

k) The amount of grease to apply to the roller bearing must be predetermined according to the roller bearing types, and a special device must be used. (Quality improvement)

7) Electrical parts POH work

At Perambur, inspection and repair of electrical equipment are performed at the Deluxe Shop (A.C. equipment parts) and Train Lighting Shop (coach wiring and electrical rigging parts) under the leadership of the assistant chief electrical engineer. Those shops are narrow in building space, and some parts to be repaired (fan, cell, etc.) are placed outdoors in quantities. Since ordinary coaches and AC coaches to be inspected are increasing, the building must be extended to allow indoor storage of electrical parts.

Since electrical parts (light, fan, cell, etc.) must be installed/removed frequently, providing tools described in 2), parts transfer vehicles, and parts loading/unloading device, as well as parts individual tester should be provided to enhance efficiency. (Quality improvement and efficiency promotion)

8) Shop arrangement

Various data and slogans are posted in each shop to attract workers' attention on POH. However, scraps are piled here and there in the workshop. In some shops, disassembled parts and unrepaired parts are stacked high. As a result, wide space in shops are not utilised effectively. This is partly due to unpaved passage and shop area. Improvement of environmental condition will facilitate transporting work, make easy mechanisation, and promote efficiency. It is important to make it a point to carry out scraps and dust to the disposal area immediately after the end of one work. (Quality improvement and efficiency promotion)

(2) Wagon

1) Wagon defects found at POH

Table 6.2.24 shows main defects of wagons discovered at POH.

Table 6.2.24 Main Defects in Wagons at POH

Components	Description
Car body	Car body corrosion (about 40% of all coming in wagons and most of 4-wheeler wagons), bending and strain of body panel and door, end plate warping, sole bar bending, cast steel knees breaking, etc.
Axle bearing	Many defects immediately before burnout and flaws.
Wheel	Tire flange vertical wear.

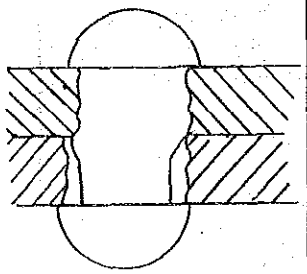
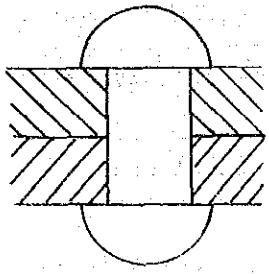
2) Parts cleaning Refer to (1) - 3).

3) Inspection/measurement work Refer to (1) - 4).

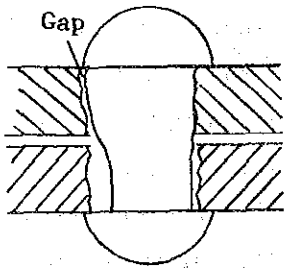
4) Measures for corrosion repair

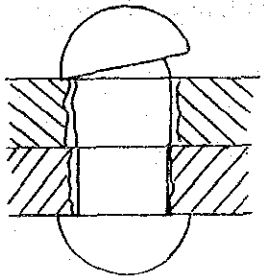
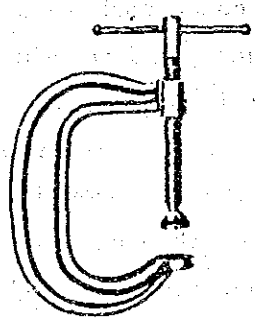
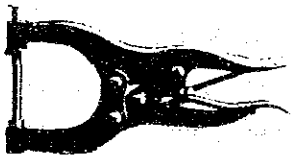
Many cases of corrosion are noted both in covered wagon and open wagon. Also many cases of end panel warping are noted. As a result, car body repair work is performed in very many cases including body frame patching work. End panel warpage is caused mainly by insufficient load shift preventive measure, and countermeasure should be taken thoroughly. (For example, when sending wheel set to the depot from the workshop, one side is supported by the end panel, and the other side is provided with the rotation stop wedge. In this case, both sides of wheel should be provided with the rotation stop wedge.) The corner post is patched, however, replacing with a new one is recommended for the reason of strength. There are many cases of diagonal, cast steel knee, etc. breaking due to end panel warpage, and also many cases of end buffer tilting down due to body frame bending. (Quality improvement and efficiency promotion)

Table 6.2.25 Problems and Improvement of Rivet Tightening Work

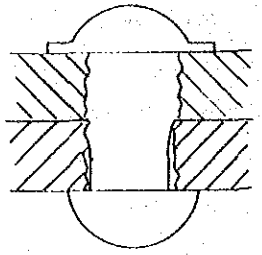
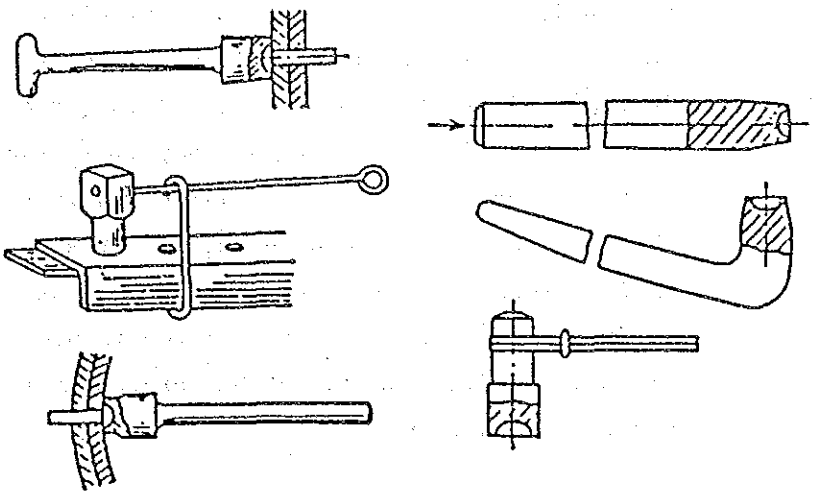
<table>
<tr><th>Poor Workmanship</th><th>Improvement</th><th>Remarks</th></tr>
<tr><td>1. Rivet hole is made by gas. Hole diameter is too large.
  </td><td>Rivet hole must always be made with motor drill, air drill or the like to a specified diameter.
  </td><td>When heated rivet is fitted closely into the rivet hole, 2 or more steel sheets contact tightly.

Relation between rivet and hole is as follows:
<table><tr><td>Rivet dia D mm</td><td>10</td><td>12</td><td>16</td><td>20</td><td>22</td><td>24</td><td>28</td></tr><tr><td>Rivet hole dia mm</td><td>11</td><td>13</td><td>17</td><td>21.5</td><td>23.5</td><td>25.5</td><td>29.5</td></tr><tr><td>Rivet length mm</td><td colspan="7">L = (1.3 to 1.6)D</td></tr></table></td></tr>
<tr><td>2. Incomplete rivet tightening.

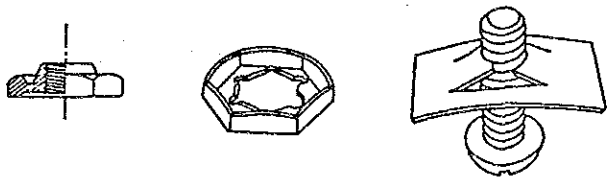
1) 2 or more steel sheets have a gap.
 

2) Round head of caulking side is not in close contact with steel sheet.
  </td><td>1) Use tightening jig.
 
Vise
 
 
Hand vises</td><td>1) Most important thing for joining surface is clean and flat surface.

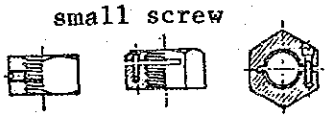
2) When rivet hole is too large, gap is created between rivet and steel sheet. As a result, tightening force is small, and steel sheets do not come into close contact. (Use specified rivet and rivet hole.)</td></tr>
</table>

Poor Workmanship	Improvement	Remarks
3) Rivet is too long. 	2) Use most suitable dolly and snap at the work location.  Dolly Snap	
3. Rivet is used at places where it should not be used. 1) 4-wheeler wagon axle box cover check bolt and axle box horn stay etc.	Use specified bolt. (Example of hard-to-loose nut is shown below.)	Oil status check. Oil supply cannot be performed. (Depot)

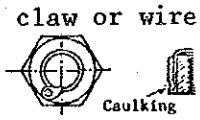
Method utilising force applied to seat surface



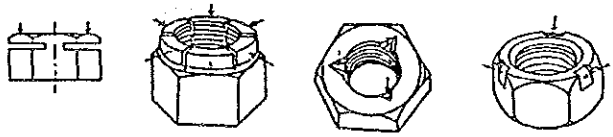
Method of using small screw



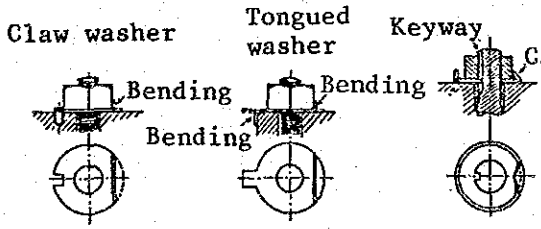
Method of using claw or wire



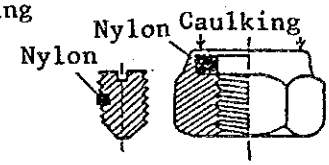
Method deforming nut portion by a hammer



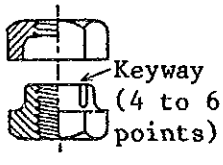
Method bending or caulking washer portion



Method filling nylon



Method utilising tightening force of check nut



5) Welding work

Corrosion repair is always accompanied by welding work. Many weld defects are noted in the condition after repair completion. Such defects are incomplete penetration, overlap (weak welding current), spatter, undercut (excessively strong welding current), bead surface irregularity, blowhole (inappropriate arc length or inproper electrode manipulation speed), remaining slag, etc. These weld defects affect car body life, and quicken need for repair. For the welding, individual welder must be instructed to observe the basic procedure and effort should be made to enhance skill through re-training. Higher welding technique, such as CO2 welding should be introduced in the future. In that case, investment effect would not be obtained without basic technique on the part of welder.

6) Rivet tightening work

Among the wagon repair works, rivet tightening work must be improved in many aspects. Table 6.2.25 shows problems and improvements.

7) Bearing inspection and repair (Refer to (1) - 6)

8) Shop arrangement (Refer to (1) - 8)

6.3 Modernisation of Laminated Spring Manufacturing/Repairing facilities

6.3.1 Existing State and Problems of laminated Spring Manufacturing and Repairing Works and Facilities

The current state of manufacturing/repairing works of laminated spring in Perambur Workshop is described below. The laminated springs manufactured and repaired in this workshop are used for wagons, coaches, locomotives and others and the annual production is shown in Table 6.3.1. About 38,700 laminated springs were repaired and about 2,000 laminated springs were manufactured in 1985.

The machine layout in the work sections and work flow is as shown in Fig. 6.3.1. The disposition of workers is shown in Table 6.3.2. Indian Railways have already established the improvement plan and the layout plan is already determined.

As shown in Table 3.2.24, the breakage of laminated springs accounts for 36% (the greatest) of all failures detected on all wagons in Indian Railways.

As the details of breakages of laminated springs show in Table 6.3.3, snapped-off spring leaves and cracks in buckles account for most of the laminated spring breakages, and snapped-off spring leaves concentrates near the eye roll of top leaf. It seems that some improvements are necessary as shown below.

(1) To decrease the manual works

Laminated springs are being formed manually and the manual work induces repetitive heating and leads to the risk of ill forming. Works to insert leaf-set into the buckle and works for debuckling are also being done manually.

To save labour and cost, to improve quality of the products and to assure safety of the works, some improvements are necessary.

(2) To remove the inadequate control of temperature

Control of temperatures in quenching and tempering is based on the worker's experience without using pyrometers or other temperature measuring instruments. Also, there is no temperature control measure for the quenching bath.

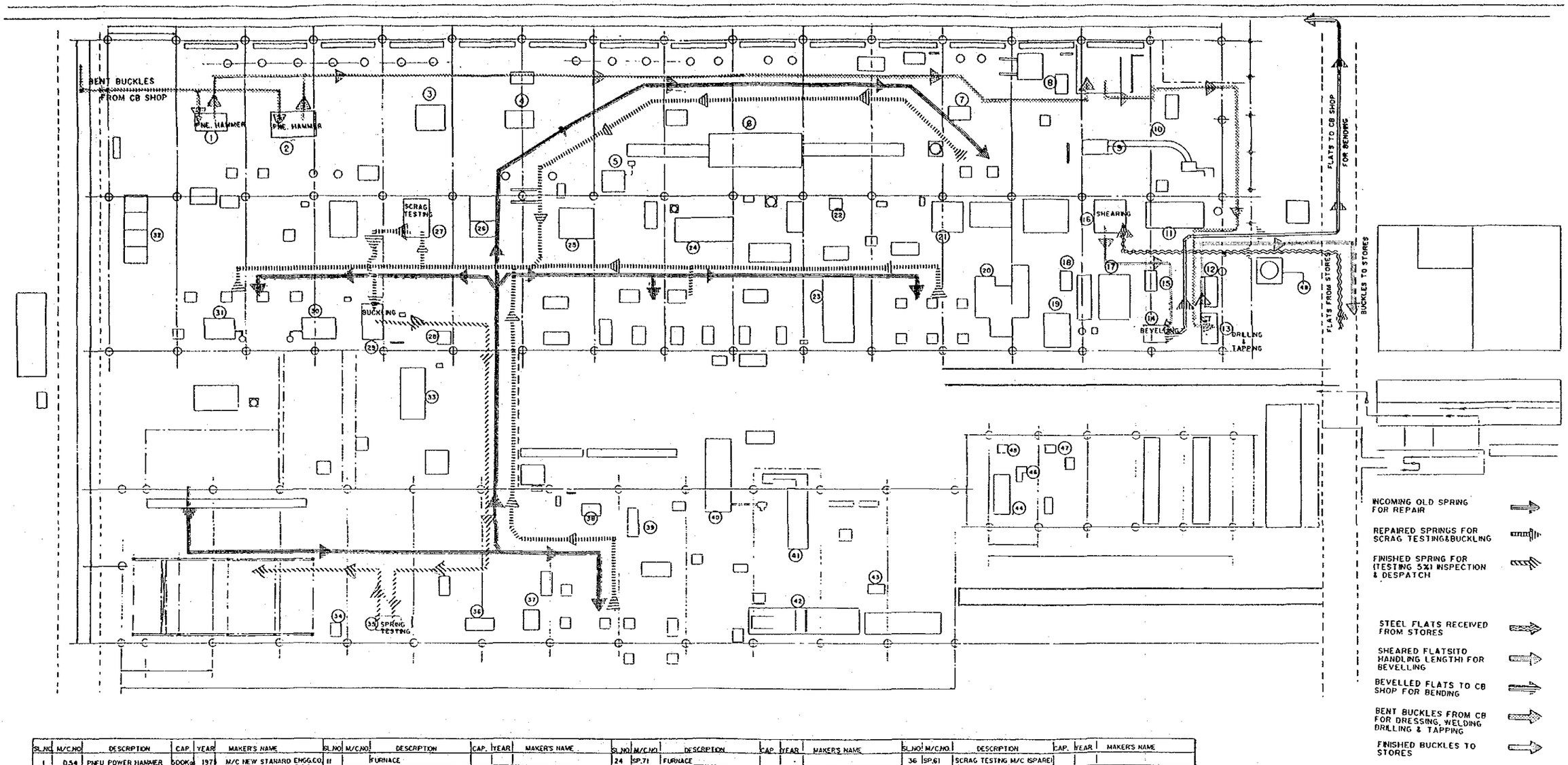
Elimination of artificial error will assure uniform quality of products.

(3) To change the shop layout

It seems that shop layout change is necessary for saving waste of time and energy, and for removing excessive labour to carry materials and products. This layout change will improve quality of products and safety of works.

Table 6.3.1 Annual Number of laminated Springs Manufactured and Repaired in 1985

Kind of spring		1985		2000	
		Mfd	Repaired	Mfd	Repaired
Wagon	IRS		18,800		22,800
	BOX		12,228		16,800
	CRT		7,126		8,400
Coach			217		217
Crane			44		44
Loco	WDS4B		213		213
		2,000		3,250	
Total		2,000	38,708	3,250	48,474



SL.NO	M/C.NO	DESCRIPTION	CAP.	YEAR	MAKER'S NAME
1	D.54	PNEU. POWER HAMMER	500Kg	1971	M/C NEW STANARD ENGG.CO.
2	PC/SP/150	PNEU. POWER HAMMER	750Kg	1985	" "
3	PC/SP/151	PNEU. POWER HAMMER	750Kg	1985	" "
4	D.75	PNEU. POWER HAMMER			
5		OIL FURNACE			
6		NORMOLIZING FURNACE			
			7CWT	1949	M/S B.S. MASSEY LTD.
7	SP.155	PNEU. POWER HAMMER	7CWT	1955	M/S BECHE & GROSS, GERMANY
8		DOUBLE END GRINDER			
9	SP.148	HYD. PUMP			
10	SP.152	SHEARING M/C	15HP	1952	M/S JAMES BENNA & SONS

SL.NO	M/C.NO	DESCRIPTION	CAP.	YEAR	MAKER'S NAME
11		FURNACE			
12		AIR COMPRESSOR			
13	SP.143	DRILLING M/C	3HP	1948	M/C KITCHEN & WADN
14	SP.32	BORING & SLOTTING M/C		1923	CRAVEN BROS
15		FURNACE			
16	SP.168	FORGING M/C	12HP	1958	M/C FAIR BANK BREARLY
17		SPRING EYE ROLLING M/C			
18		PIGEON HOLE FURNACE			
19	SP.15	FORGING M/C	BELT	1912	M/C SAMUEL PLATY LTD.
20	SP.38	ROLLING M/C	12HP	1925	M/C FAIR BANK BREARLY
21		FURNACE			
22	SP.043	HYDRAULIC PRESS			
23	SP.5	FURNACE			

SL.NO	M/C.NO	DESCRIPTION	CAP.	YEAR	MAKER'S NAME
24	SP.71	FURNACE			
25	SP.77	SPRING BUCKLING PRESS	HYD.	1933	M/S FAR BANK BREARLY
26	SP.60	STEAM SCRAG TESTING M/C		1932	" " "
27		PNEU. SCRAG M/C			
28		BUCKLE FURNACE			
29	SP.145	HYD. PRESS FOR BUCKLE	15HP	1955	M/C MACHINEN FABRICK CO.
30	FW.237	AIR COMPRESSOR			
31	GC.196	AIR COMPRESSOR			
32	SP.163	PRE. HEATING FURNACE			
33	SP.85	FURNACE			
34	SP.42	COLD SAW BLADE	5HP	1932	GERMAN M/C
35	SP.125	SPRING TESTING M/C	7HP	1956	EMMERCHER CO.
			10HP	1976	M/S PEECO HYD. LTD.

SL.NO	M/C.NO	DESCRIPTION	CAP.	YEAR	MAKER'S NAME
36	SP.61	SCRAG TESTING M/C (SPARE)			
37		FURNACE			
38	58/A	GRINDER			
39	GC.124	OLD LATHE CONVERTED COIL SPRING WINDING MACHINE			
40		FURNACE			
41	GC.70	ROLLING M/C			
42	SP.180	SHOT PEENING M/C	15HP	1970	M/S MARSHALL & SONS
43	SP.159	BRINELL HARDNESS TESTER			
44	SP.160	COKE BREAKING M/C	15CWT	1953	
45		COKE CRUSHING M/C			
46		SEVER M/C			
47		COKE CRUSHING M/C			
48	SP.63	ACCUMULATION PLANT	HYD.	1932	M/S RICE & CO.

Fig. 6.3.1.

PRESENT METHOD OF
L.B.SPRING REPAIR & BUCKLE MANUFACTURE
19-2-'87

LAYOUT OF SPRING SHOP AS ON. 11-01-85	SR.DRG.NO. PDC.L.O.SP.3.

Table 6.3.2 Disposition of Workers for Laminated Bearing Spring

Operation	No. of persons employed
1. Top plate manufacture (Shear, eye roll, centre board)	12
2. Strip, recamber, reharden, retemper & fit on false buckle	170
3. Scrag test	8
4. Fit permanent buckle	16
5. Load test	2
6. Retap and fit set-screw and rivet clips	3
7. Oil or paint (all types springs)	3
8. Miscellaneous work such as 4th plate clip manufacturing/reclamation, WAD packing piece manufacturing/reclamation spring buckle etc.	16
Total	230

Table 6.3.3 Details of Spring Breakages of BOX/CRT Springs from September '86 to January '87

(Southern Railway)

Month	No. of springs received for repair		Nature of repair required					
			Broken top plate		Broken other plate		Broken buckles	
	BOX	CRT	BOX	CRT	BOX	CRT	BOX	CRT
Sep.	(906) 1019	(686) 696	396	491	122	109	47	28
Oct.	(623) 713	(413) 429	238	296	86	57	35	24
Nov.	(873) 1004	(694) 703	332	533	126	94	51	23
Dec.	(525) 620	(467) 475	173	364	87	62	41	16
Jan.	(437) 549	(768) 774	300	594	63	104	19	22
Total	(3364) 3905	(3028) 3077	1439	2278	479	426	193	133

Note: ( ) failed

(4) To rearrange the laminated spring repair manual

The Indian Railways Maintenance Manual for Wagon is supposed to be followed in the laminated spring repair work. There is an instruction leaflet besides that manual, but a new manual must be made based on them and thoroughly understood and observed by all workers as an operation standard instructing work step concretely.

(5) To improve the transportation of laminated springs between the workshop and car depots

At present, the laminated springs are transported on wagons between the workshop and car depots as bulk cargo. In case of the palletisation, saving labour, improving work efficiency, and preventing accidents and damages during transportation can be expected.

6.3.2 Opinions on the Established Improvement Plan

(1) Estimation of number of laminated springs to be repaired in future

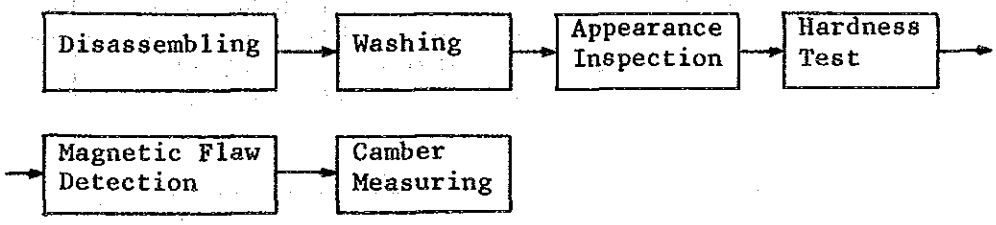
The number of 48,000 springs/year to be repaired in the year 2000 is the base for the established improvement plan.

The difference between the number of springs to be repaired in the established improvement plan and our estimated number of 47,800 springs/year described in Table 6.3.4 is only 200 springs/year and this figure is 0.4 percent of 48,000 springs/year. Accordingly, this number is adequate.

(2) As a result of this survey work, the following suggestions on the established improvement plan should be considered.

1) Use a conveyor and mono-rail system to carry laminated spring and spring leaves.

2) Disassembled spring leaves for repair should be treated in accordance with the following work order.



3) To simplify flaw detection and appearance inspection, spring leaves should be washed and washing work should be mechanised.

Table 6.3.4 Estimated Number of Laminated Springs Repaired in 2000

a. Wagon

	(1)	(2)	(3)	(4)	(5)
	Whole IR No. of wagons in '85	Perambur No. of springs repaired in '85	(2)/(1)	Whole IR No. of wagons in 2000	(4) x (3)
Bogie	92,222	12,228	0.133	238,800	31,760
4-W	193,876	26,006	0.134	115,400	15,460
	286,098	38,234	-	354,200	47,220

b. Coach

(1)	(2)	(3)	(4)	(5)
SR holding No. of coaches in '85	Perambur No. of springs repaired in '85	(2)/(1)	SR holding No. of coaches in 2000	(4) x (3)
2,671	217	0.081	4,400	356

c. Loco

(1)	(2)	(3)	(4)	(5)
SR holding No. of locos in '85	Perambur No. of springs repaired in '85	(2)/(1)	SR holding No. of locos in 2000	(4) x (3)
317	213	0.672	406	273

d. a + b + c = 47,849

4) The magnetic flaw detection of heat treated spring leaves should be carried out after hardness test.

5) To minimise decarborisation of spring leaves, only spring leaves with less hardness should be re-quenched and normal hardness spring leaves with less camber should be re-formed. For this purpose, a low temperature heating furnace (below tempering temperature) and a spring leaf forming machine should be necessary.

6) Camber correction of spring leaf should be carried out before shot peening.

7) After shot peening of spring leaves, measures to reduce friction between spring leaves and prevent corrosion should be carried out. (Anticorrosion Greasing machine, Anticorrosive Agent Baking Oven)

8) The laminated springs should be load tested at the time of in-coming inspection and sorted out into group to be disassembled and to be used after anticorrosive treatment.

9) The buckle insertion should be mechanised.

6.4 Construction Cost (Perambur Workshop)

Construction cost exclusing the education facilities is as follows.

Calculation of construction cost is based on the following.

Exchange rate : 1 Rs. = 11.4 Yen

1 US$ = 12.87 Rs.

1 US$ = 146.1 Yen (as of June 24, 1987)

Import tax rate: 85%

Table 6.4.1 Rolling Stock POH Facilities

Unit: Million Rs.

Item of Expenditure / Item		New Establishment			Replacement			Grand Total
		Domestic Currency	Foreign Currency	Total	Domestic Currency	Foreign Currency	Total	
Phase I	Machinery	84.28	89.2	173.48	10.65	22.87	33.52	207
	Civil & Building	169.57	-	169.57	-	-	-	169.57
	Sub-Total	253.85	89.2	343.05	10.65	22.87	33.52	376.57
	Import Tax	75.82	-	75.82	19.44	-	19.44	95.26
	Total	329.67	89.2	418.87	30.09	22.87	52.96	471.83
Phase II	Machinery	22.75	27.95	50.7	32.5	-	32.5	83.2
	Civil & Building	56.75	-	56.75	-	-	-	56.75
	Sub-Total	79.50	27.95	107.45	32.5	-	32.5	139.95
	Import Tax	23.76	-	23.76	-	-	-	23.76
	Total	103.26	27.95	131.21	32.5	-	32.5	163.71
Grand Total	Machinery	107.03	117.15	224.18	43.15	22.87	66.02	290.2
	Civil & Building	226.32	-	226.32	-	-	-	226.32
	Sub-Total	333.35	117.15	450.5	43.15	22.87	66.02	516.52
	Import Tax	99.58	-	99.58	19.44	-	19.44	119.02
	Grand Total	432.93	117.15	550.08	62.59	22.87	85.46	635.54

6.5 Construction Schedule

Modernisation project of the Perambur Workshop should progress by constructing and remodeling buildings, shifting tracks and roads, and also incidentally transferring repair shops while continuing the existing coach and wagon POH works. This has been scheduled as follows so as to be executed step by step in keeping with the POH works and not to affect the on-going repair works to a large extent.

6.5.1 Coach Inspection and Repair Facilities

It is desirable to start the construction work for modernisation of coach inspection/repair facilities from 1990. In order to resolve the insufficient carbody holding space, first of all, one carbody shop building with four shop bays provided with EOT crane having capacity to hold 28 coaches and four tracks for lifting and lowering of carbody will be constructed at existing location of coach stabling tracks located below the existing trimming shop as indicated in the drawing. Also the accompanying partial extension of paint shops will be conducted, and the existing panel plate shop building will be demolished and one shop building for ancillary works will be constructed at the evacuated site. An in-coming inspection shed having two tracks will be constructed in parallel with the existing in-coming inspection shed, and after completion, existing in-coming inspection shed will be demolished and the evacuated site will be paved. The existing three carbody shop bays not equipped with EOT crane will be extended by 12 metre, and also to cope with increase in the number of AC deluxe coaches, construction and extension of the AC deluxe shop will be undertaken. Thus the first stage of the construction plan will be completed, and with the training of employees in the new shops, the second stage will be started.

It is desirable to commence the second construction stage from 1994, first of all, the carbody shop which is constructed in the first stage will be extended so as to be able to hold twenty coaches more. The existing timber ward and Basic Training Centre (BTC) will be demolished and after demolition one more ancillary shop building will be constructed on the evacuated site in parallel with the ancillary shop which is constructed in the first stage. At the same time, extension of the wheel shop and transfer of the out-door wheel store yard will be carried out.

The rough construction schedule is shown in Table 6.5.1.

Table 6.5.1 General Construction Schedule for Modernisation of Facilities for Coach

Stage	Item \ Year	1989	1990	1991	1992
Phase I	Detailed Design	Mechanical and Electrical Equipment; Building			
	Procurement of Machines and Electrical Equipment				
	Construction of Carbody Shop and Partial Extension of Paint Shop				
	Installation of EOT cranes				
	Extension of three Carriage Repair Shop Bays				
	Extension of Traverser Run-way				
	Move and Demolition of Panel Plate Shop and Construction of In-coming Inspection Shed				
	Extension of AC Deluxe Shop				
	Installation of Carbody Painting Plant				

Stage	Item \ Year	1993	1994	1995	1996
Phase II	Detailed Design	Mechanical and Electrical Equipment; Building			
	Procurement of Mechanical and Electrical Equipment				
	Addition of Carbody Shop				
	Move and Demolition of Timber Ward and BTC and Construction of Electrical Paris Shop, Ancillary Shop				
	Extension of Wheel Shop and Move Outdoor Wheel Store Yard				
	Installation of Machines & Electric Equipment				

6.5.2 Wagon Inspection and Repair Facilities

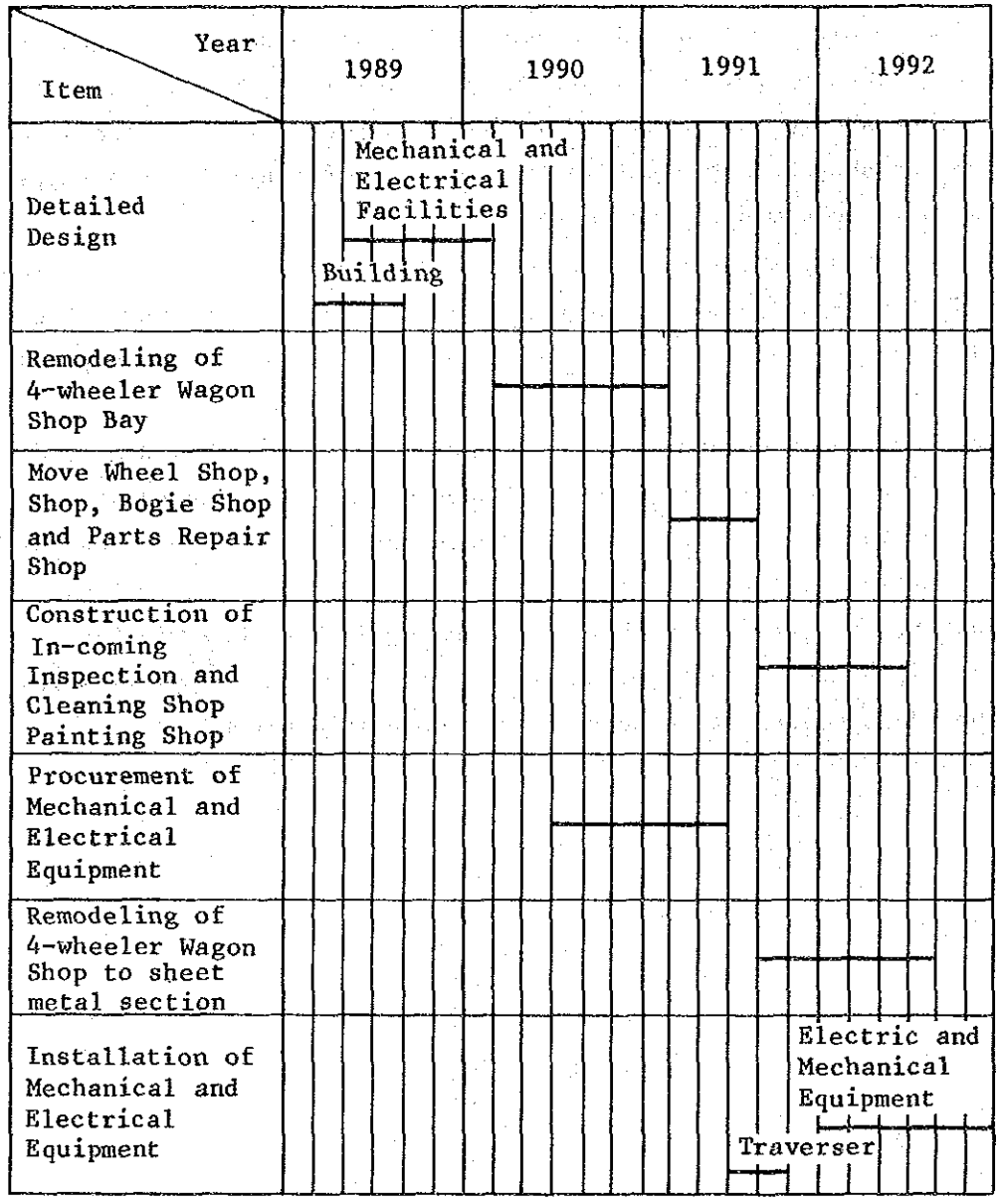
It is most desirable to start the modernisation of wagon inspection/repair facilities from about 1990 when a sharp increase in the number of 8-wheeler wagons is anticipated. Firstly, as a measure to cater for the increase in the number of 8-wheeler wagons, existing one 4-wheeler wagon repair shop bay neighbouring the existing 8-wheeler wagon repair shop bay will be remodeled so as to be equipped with 15 tonne EOT crane, and also a surface traverser will be installed at the location in front of the 4-wheeler wagon shop. After completion of the remodeling of the 8-wheeler wagon repair shop bay, the wheel shop, bogie shop and parts shop will be shifted.

Further, an in-coming inspection and cleaning shop building and a carbody painting and final inspection shop wil be constructed at the location on the opposite side of the wagon repair shop in between the newly installed surface traverser.

Lastly, the existing 4-wheeler wagon repair shop bay will be remodeled so as to be equipped with a 3 ton EOT crane for plate work.

The rough construction schedule is shown in Table 6.5.2.

Table 6.5.2 General Construction Schedule for Modernisation of Facilities for Wagon



6.6 Basic Plan of Personnel and Education

6.6.1 POH Workload and Manpower

When considering the transition of coaches/wagons POH workload in the Perambur Workshop up to 2000, it is necessary to estimate the workload resulting from doubling in the number of coaches, and replacement of 4 wheeler with 8-wheeler wagon.

Based on the same thinking as that of the Jamalpur Workshop (5.7.1), the cases when rationalisation by the introduction of new equipment, etc. is not made in the workshop during the period ending in 2000 and when the modernisation project is implemented are compared in terms of workload and Manpower (Table 6.6.1).

Table 6.6.1 Transition of Workload and Number of Personnel in Perambur Workshop

Classification		1985		2000		
					Non-modernised	Modernised
		Rolling-stock POHed	Total Man Hour *1	Rolling-stock POHed	Total Man Hour	Total Man Hour
			(Thousand Man Hours)			
Coach	AC	64	332	250	1,566	x 82.5% = 1,292
	ICF	1,155	3,117	2,540	6,854	x 81.4% = 5,579
	BEML	537	1,325	150	370	x 82.9% = 306
	IRS	35	22	60	37	x 82.2% = 30
	Sub-Total	1,791	4,796	3,000	8,827	7,207
Wagon	4 wheeler	3,384	1,715	1,600	810	x 73.7% = 596
	Bogie	981	827	1,920	1,618	x 74.9% = 1,211
	Sub-Total	4,365	2,542	3,520	2,428	1,807
POH Direct Workload Total			7,338		11,255	9,014
POH Direct Personnel			3,207		4,918	3,939
POH Indirect Personnel			4,918		7,541	x 90.0% = 6,786
Sub-Total			8,125		12,459	10,725
Ministral Electric, etc.			725		1,111	956
Total No. of Personnel			8,850		13,570	11,681

*1: Actual figure in 1985

As seen from this table, manhours directly related to POH work in 1985 are 7,338,000, while when modernisation project is not implemented, manhours in 2000 are 11,255,000, hence workload will be about 1.53 times the present workload.

When calculation is made on the assumption that POH workload is proportional to the number of personnel, total number of personnel in Parambur Workshop will become about 13,500.

On the other hand, when the modernisation project is implemented and mechanisation and POH method change takes place in each shop related to POH, workload reduction in 2000 will be about 82% - 83% in coaches as shown in Table 6.6.2, and about 73% - 75% in wagons as shown in Table 6.6.3.

From the work rationalisation rate and the number of POH rolling-stock in 2000, direct POH workload in 2000 is calculated to be about 9,014,000 manhours as shown in Table 6.6.1.

When the rationalisation rate of the personnel in the indirect department is assumed to be 90%, total number of personnel of entire Perambur Workshop in 2000 is estimated to be about 11,680.

Fig. 6.6.1 shows the transition of POH workload and the number of workshop personnel in the Perambur up to 2000.

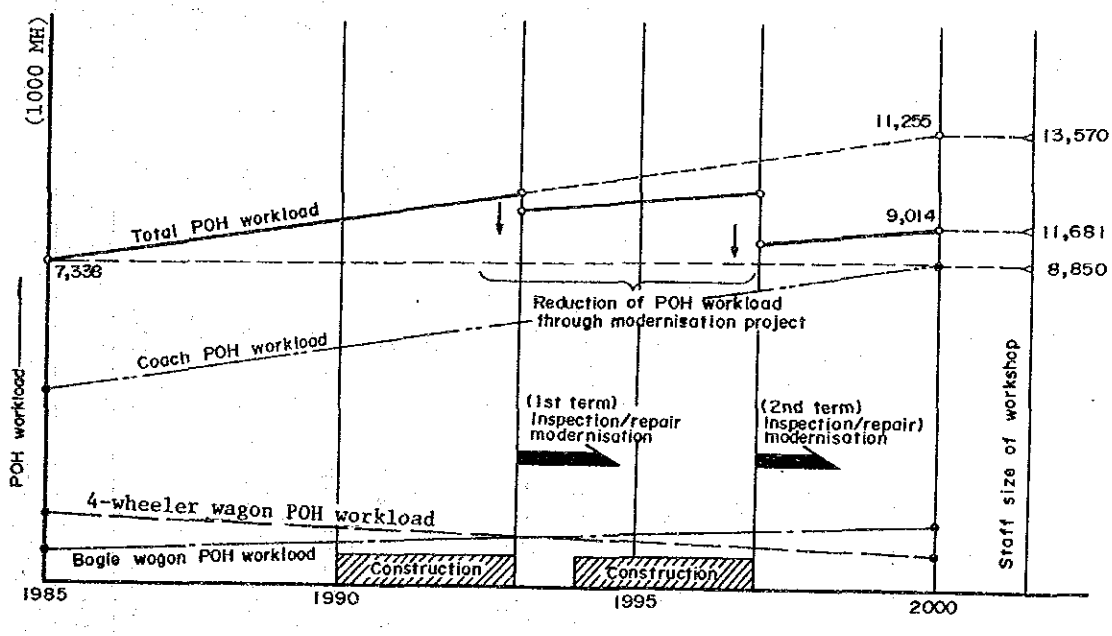


Fig. 6.6.1 Transition of POH Workload and Number of Personnel

Table 6.6.2 POH Manhour Reduction by Type of Coach

(Unit: Manhours/Coach)

Work Content	Work Rationalisation Rate	Man Hour							
		ICF A/C COACHES		ICF		BEML		IRS	
		Current	Project	Current	Project	Current	Project	Current	Project
1. Lifting Work	10%	550	495	550	495	900	810	450	405
2. Masonry Work	0%	20	20	20	20	40	40	20	20
3. Plumbing Work	10%	210	189	150	135	162	145	190	171
4. Roller Bearing Examination and Assy.	30%	90	27	90	27	90	27	90	27
5. Painting Incl. Preparing and Surface	50%	420	210	420	210	400	200	225	112
6. Lettering	80%	50	10	45	9	42	8	20	4
7. Body Repair Complete	20%	2,600	2,080	900	720	860	688	2,560	2,048
8. Repair Misc. Items Window from Complete	5%	460	437	350	332	280	266	375	356
9. Tinker and Fitting Bench	5%	200	190	200	190	240	228	75	71
10. Other Misc.	0%	180	180	180	180	240	240	180	180
11. Electrical Work	10%	936	842	159	143	159	143	159	143
Total		5,716	4,716	3,064	2,497	3,413	2,831	4,344	3,573
Workload Reduction Rate		82.5%		81.4%		82.9%		82.2%	

Table 6.6.3 POH Manhour Reduction Rate of Wagon

Car Type			No. of Rolling Stock in 2000 (Vehicle)	Current No. of Days Required for POH (Day)	Projected No. of Days Required for POH (Day)	Work Rationalisation Rate(%)	Weighted Mean Rationalisation Rate (%)
Wagon	4-wheeler	Corrosion	400	13.0	9.5	73.1%	73.7%
		Ordinary	1,200	5.0	3.7	74.0%	
	Bogie wagon	Corrosion	480	7.5	6.0	80.0%	74.9%
		Ordinary	1,440	4.5	3.3	73.3%	

6.6.2 Education and Training

(1) Personnel education

1) Education schedule

Since BTC building and education facilities are gradually deteriorating, new construction and replacement project is in progress. At present, two-storied building (about 800 m^2) is being built.

However, the above is to replace deteriorated facility, and education content, such as curriculum on this modernisation project, is not included.

Most important matter for the modernisation of workshop is the improvement of the quality of personnel corresponding to the introduction of new techniques.

Even if the latest facility is constructed, if ability to use it to the fullest extent and to maintain and manage it is laking, workshop modernisation cannot be achieved.

In the Perambur Workshop POH workload of coach and wagon will increase to a large extent, and it is essential to improve technical and skill levels of personnel and to extend the capacity of education facilities so as to meet personnel increase while modernisation is advanced energetically.

Total number of personnel in 2000 is estimated to be about 11,680, therefore, about 2,800 persons (11,680 - 8,850) must be educated within 9 years from 1991.

That is, separate from new employment of personnel to make up for the loss due to retirement, an average of about 310 persons must be employed and educated year after year, as workload increases.

On the other hand, the number of personnel directly related to POH at present is estimated to be more than 3,000 and around 50% of these persons must be educated afresh, and a total of about 450 persons will have to be educated afresh annually.

Required facilities and equipments should be completed as early as possible, and those must be ready in due time commencing in 1990, the first year of construction start-up.

2) Education content

As to POH ability enhancement by this modernisation project, there are two portions: the portion to perform large scale modification of equipment and the portion to require improvement of ability and POH accuracy by changing working method, though the equipment modification is slight.

Accordingly, basic education for the introduction of new equipment and for the introduction of new working method and techniques is required.

Particularly, in the elements related to POH of coach and wagon, re-education of personnel on the working method, machine operation, maintenance, etc. is very important.

To perform POH work more efficiently according to this modernisation project, at least setting up education courses shown in Table 6.6.4 is necessary. Particularly, supervisors must acquire overall basic knowledge, and understand new techniques and inspection system thoroughly so as to contribute to the improvement of technical level of entire workshop.

Table 6.6.4 Main Education Items in BTC

Education Course	Period	Trainees/ Class	Classes/ Year	Trainees/ Year
POH General Techniques (for Supervisor)	3 Months	20	2	40
Anticorrosion Knowledge and Improvement	3 Months	20	2	40
Work of Wheel & Axle POH Line	2 Months	15	2	30
Knowledge of Bearing POH and Operation of Line	3 Months	15	2	30
Workshop POH Schedule and Control	3 Months	20	2	40
AC Coach POH Techniques	3 Months	20	2	40
Inspection Method of Electrical Parts	2 Months	15	3	45
Unit Exchange Spare Parts Operation and Control	2 Months	15	2	30
Knowledge of Welding Techniques and Work	2 Months	20	3	60
Painting and Cleaning Techniques	0.5 Month	15	2	30
Basic Knowledge of Bogie POH	2 Months	20	2	40
Machine Operation and Maintenance Techniques	3 Months	30	1	30
Total			24	455

3) Facility scale required for education

Separate from current BTC, buildings and education material for personnel to be educated must be planned and provided.

a) Facility scale

The scale of facility required for education is supposed to be such that it can accommodate 5-6 classes simultaneously and 80-90 trainees at once, from the values shown in Table 5.6.4. The facility should be planned so as to accommodate classrooms with 20 trainees capacity, practice rooms, and instructor's room as shown in Table 6.6.5.

Table 6.6.5 Outline of Education Facilities

Item	Floor Space	No. of Rooms	Total Floor Space	Remarks
1. Classroom	50 m^2 (6m x 8m)	6	300 m^2	* Reinforced 2-Storied Building
2. Instructor's Room	35 m^2 (6m x 6m)	1	35 m^2	
3. Practice Room	65 m^2 (8m x 8m)	3	130 m^2	
4. Others	135 m^2	---	135 m^2	Passage/Lavatory Warehouse, etc.
Total		10	600 m^2	

b) Education material

Provision of education material required for the improvement of knowledge and skill required for the education should be planned as follows.

Table 6.6.6 Education Materials Required for Education

Item	Quantity	Item	Quantity
1. AC Parts POH Education Material	1	8. Microcomputer	3
2. Electrical Parts POH Education Material	1	9. Video Camera and Video Recorder	1
3. CO2 Gas Welder	2	10. Slide Projector	2
4. Plasma Cutter	2	11. Education Software	1 Set
5. Standard Lathe	2	12. Drawing Tools	1 Set
6. Milling Machine	2	13. Others	1 Set
7. Drilling Machine	2		

c) Education facility cost

Construction cost and procurement costs of education-related items are shown in Table 6.6.7.

Table 6.6.7 Construction Cost and Procurement Cost of Education Facilities

(Unit: Thousand Rs.)

Item	Domestic Currency	Foreign Currency	Total
Building	3,000	0	3,000
Material	2,350	255	2,605
Sub-Total	5,350	255	5,605
Import Tax	0	217	217
Grand Total	5,350	472	5,822

(2) Overseas training of personnel

1) Training content and schedule

For the machine and technique to be introduced newly for this modernisation project, particularly those to be introduced from overseas, to be used immediately after installation with high performance, responsible engineers must acquire much about basic structure and operation of those equipment, way of action to be taken in case of trouble, etc.

For a thorough grasping of these matters, training at the manufacturer before the introduction of equipment is indispensable.

On the equipment among the newly introduced machines shown in Table 6.6.8 and new POH techniques, overseas training must be planned.

Table 6.6.8 Overseas Training Courses

Training Subject	No. of Trainees	Period	Modernisation-related Item
(Main Equipment)			
1. Automatic Painting Device	2	2.5 M	Automatic Painting Device
2. Ultrasonic Flaw Detector	2	1.5 M	For Axle
3. NC Boring Machine	2	1.0 M	For Wheel
(Control & Technique)			
1. CO2 Gas Welding Techniques	2	1.0 M	
2. Plasma Cutting Techniques	2	1.0 M	
3. Roller Bearing Inspection/ Repair Techniques	2	1.5 M	
4. Process Control/Material Control Techniques	2	1.5 M	
Total	14	Total Man·Month 20.0 M·M	

2) Expenses for personnel overseas training

Expenses required for overseas training are shown in Table 6.6.9.

Basis of calculation

Total number of trainees: 14

Total period: 20.0 months

Overseas country: Japan

Table 6.6.9 Expenses for Personnel Overseas Training

(Unit: Thousand Rs.)

Travel Cost	Daily Allowance/Lodging	Total
528	1,052	1,580

Note: Overseas training expenses are all in foreign currency.