NORTH WESTERN RAILWAY

SUPERVISOR'S TRAINING CENTRE, AJMER

COURSE TEXT BOOK

MSE/MJR – II (C&W Open Line)

उत्तर पश्चिम रेलवे
North Western Railway

सत्यमेव जयते

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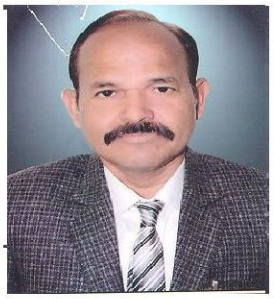

FOREWORD

I am extremely happy to know that STC, Ajmer is publishing this text book which will be useful for newly recruited SSEs and JEs. This book will surely help in imparting required knowledge to improve their awareness on safety and work areas.

This Course Text Book (MSE/MJR- IInd Session) as per prescribed Railway Board Module contains updated common topics of Tender and Contract, Accident and Disaster Management, Supervisory Skill and Stream Specific Theory i.e. C&W, DSL and Workshop in each book separately.

I hope this Text Book will be very beneficial to Mechanical Supervisors. I wish to congratulate the Principal and his team of STC/Ajmer for their Endeavour under the valuable guidance of CWM/Ajmer.

(Virender Kumar)
PCME/NWR

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North Western Railway

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FOREWORD

As per instructions from Railway Board, study material should be provided to trainees so that they can use it for their study, comparison and reference. STC/Ajmer has taken initiative and it is going to publish a Course Text Book for Mechanical Senior Section Engineers and Junior Engineers for 2nd Session with the objective to provide guidelines for incorporating the technological up-gradation in their field.

I learnt that this Course Text Book contains latest relevant topics as per training module 2011. I am sure that this book will update the knowledge of all induction course training for their respective trades i.e. DSL, C&W and Workshop and common topics for all supervisors i.e. Tender and Contract, accident and disaster management, supervisory skill etc.

I appreciate and congratulate the Principal/STC and his team for sharing their knowledge and bringing the relevant information in the form of Text Book.

(**Sudhir Gupta**)

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FOREWORD

Mechanical Department is responsible for maintenance of rolling stock including passenger coaches, freight wagons, diesel locomotives, DMUs and cranes. Besides, it maintains large number of machinery & plant in workshops, sheds and other work centers. In this regard STC/AII plays a vital role in imparting qualitative and effective theoretical training to the newly recruited Supervisors to develop their professional aptitude.

I am glad to know that STC/AII is constantly publishing the Course Books on latest developments in some more significant topics of maintenance. In continuation a Course Text Book for MSE/MJR IInd Session is being published as per Railway Board's Training Module. I believe that this Course Book will enhance the Supervisor's theoretical knowledge and should make him a master of his job which will result efficient Train Operation, Maintenance, reduction of line failure and punctuality will improve.

My whole-hearted congratulations to the principal and the team of lecturers for incredible efforts.

(R.K. Moondra)

PROLOGUE

Once again in the series of course books for direct recruited MSE/MJR II Session as per prescribed module of Railway Board with the inspiration of our CWM/AII Shri R.K.Mundra is prepared in the form of book.

You will find that various chapters in this course book have not only been updated, they provide more in depth information, as also touch upon new areas of Railways.

I feel happy in presenting this book. As this book has been receiving excellent reception from the faculty of STC Ajmer S/Shri Umesh Kumar Nema, Mahesh Sharma, B.L. Gupta, Suresh Jharotia, Srikant Yadav, Prakash Kewalramani and Amar Chand Gaharwar as they have deep knowledge of their field.

The complete figure work has been done on Computer. The format of the book has also been changed. For all this and for the excellent getup of the book, I must thank Shri Surendra Tak, Chief typist and Specially Smt. Manisha Khandey, CA as chief coordinator of this edition.

Any errors, omissions and suggestions for the improvement of this book brought to our notice will thankfully the acknowledged and incorporated in the next edition.

Thanks.

(J.P. Sharma)

MODULE AND INDEX

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TENDER AND CONTRACT

ESTIMATES

Introduction

The Execution of work in railways include various stages of processing, starting with the preparation of Abstract Estimate, its concurrence and sanction; preparation of detailed estimate, its concurrence and sanction and finally the tender and the agreement.

Financial concurrence includes the financial viability with respect to the total cost of the work. Concurrence and verification of an estimate is a part of financial function.

Definition

An estimate is a statement prepared to gauge an idea of expenditure to be incurred on a work in order to obtain sanction of competent authority and also to see that work is financially justified.

All proposals for:

- The construction and purchase of new work or asset.
- The renewal and replacement of existing works or assets chargeable to DRF, DF, RSF, SRSF, OLWR, and capital fund when estimated to cost more than Rs. 200000/-.
- The scrapping, dismantling or abandonment of the existing works or assets.
- Repairing or reconditioning if estimated to cost more than Rs. 100000 of the existing works or assets.
- Temporary and experimental works.
- The renewal and replacement on worked lines.
- Renewal of ballast should ordinarily be scrutinized by the authority competent to sanction them before any expenditure of liability is incurred thereon. This scrutiny is exercised through what are called Estimates for the works.

Exception to this Rules/Commencement of work without estimate:

- Works which are considered to be urgently necessary to safeguard life or property or to repair a damage to a line caused by flood, accident or other unforeseen contingencies, so as to restore or to maintain through communications.

- For new minor works costing Rs. 50000 and less; for replacement and renewable chargeable to revenue costing Rs. 200000 and less; for repairs and reconditioning works costing Rs. 100000 and less, for detailed estimate need not be prepared. A rough estimate should be prepared and kept on record.

Different kind of estimates:

Abstract Estimates

These estimates are prepared for the purpose of obtaining the administrative approval of the competent authority to the scheme of work. These estimates should be prepared in such a way that the competent authority may be enabled to form a reasonable accurate idea of the expenditure involved as well as other data sufficient for the purpose of gauging adequately the financial prospects of the proposal. As such, as abstract estimate should contain a brief report and justification for the work, specification and should mention weather funds are required in the current year and to what extent. The cost of work subdivided under main

heads and sub-heads of specific items should be shown, together with allocation of each such item under capital, DRF, DF, RSF, SRSF, OLWR and capital fund.

Administrative approval to a work or scheme should be accorded by the authority competent to do so, after a thorough examination of its necessity, utility and financial prospects.

In regard to works which are specified in the sanctioned budget of a year i.e. in the Works, Machinery and Rolling Stock Programme accompanying the budget orders, the total estimated cost shown against each work should be regarded as the abstract estimates. The inclusion of work in the sanctioned budget should be deemed to carry with it the administrative approval of the railway board except that in the case of structural work, other than track renewal work, costing more than Rs. One Crore each, the administrative approval of the railway board should be obtained by submission of separate Abstract Estimate not withstanding their specific inclusion in the sanctioned budget; however estimates costing over Rs. 5000000 and upto Rs. 1 Crore will be certified and sanctioned personally by the GM after obtaining FA&CAO's concurrence.

Detailed Estimate:

On receipt of administrative approval to the scheme or project, other than construction of new lines, detailed estimate for various works included in the abstract estimate are to be submitted for **Technical Sanction*** of the competent authority. No work included in the abstract estimate should be commenced till detailed estimate has been sanctioned. Detailed Estimate should be prepared in sufficient degree of detail and should provide for all items of works required. The estimate should show the allocation of heads of accounts and should be accompanied by a report giving full justification for the work, the details of the work to be done and also stating whether or not necessary funds exist for the work in budget. The detailed estimate of an open line work will comprise:-

- Statement showing the details of estimated cost; and
- An outer sheet giving the abstract of cost of work, the report, the financial justification and the allocation.

Technical Sanction

The sanction of the competent authority to the detailed estimate of a work is called 'Technical Sanction'. The authority according technical sanction should satisfy that:

- The details of the scheme as worked out are satisfactory;
- The method proposed for the execution of the work is adequate; and
- The cost has been estimated from reliable data and is reasonably accurate.

Supplementary Estimate:

These are prepare for the items of the work which ought to have been included in the first instance but have not been so included or which it is found later, should be considered as being a part of the original estimate already sanctioned, if it cannot be met out of contingencies. These estimates are to be prepared in the same form and in the same degree of details as the original estimate and will be considered for all purpose as a part of the main estimate.

Revised Estimate:

When during the process of work, it becomes the evident that expenditure on the same is likely to exceed the amount of the sanctioned estimate; a revised estimate should invariably be prepared and submitted for the sanction of competent authority. It should be prepared in the same degree of details as the original estimate except that unaffected items may be shown

in lump sum. The revised estimate should accompany a comparative statement showing the excess or saving under each sub-head of account against the latest sanction.

It sometimes happens, however, that the work is in advanced stage of completion and it is likely to be complete by the time Revised Estimate is got out. In such cases, the sanction of the competent authority may be obtained to the incurring the excess expenditure on the work and the excess explained in the Completion Report of work.

Project Abstract Estimate:

This is an abstract estimate for construction of project and should be submitted for approval of Railway Board accompanied by:

(i) An abstract estimate for the construction of junction arrangements;

(ii) A narrative report explaining the salient feature and major items of the proposed expenditure under workshop, store buildings, plant and construction etc. ; and

(iii) Detail estimate of cost of construction under various heads of work classification:
   a) Preliminary Expenses(1110)
   b) Land (1120)
   c) Structural Engineering Works (1132), Tunnels (1151) and 1152 major bridges, (1140 Ballast and permanent ways) (detailed estimate for 1 Km.)
   d) Equipment
   e) Rolling Stock(2000)
   f) General Charges(1180 and 1190)

Construction Estimate:

On the basis of final location survey, detailed estimate for all the works in the project of new line as whole, are prepared. These detailed estimates are collectively known as "Construction Estimate" and should be prepared in sufficient details to enable the work being started straightway. These should also provide for all building and equipment to the standard of working required to meet the requirements of traffic anticipated, during the first year or two after opening the lines. It is the basis on which technical sanction to the various works included in the construction of a project s accorded.

The construction estimate of project should be prepared in form E. 553 prescribed for the purpose. It should be divided into convenient sections In accordance with the following principles.

a) When, as usually the case, certain works within the limit of a junction station are incidental top the project, these works should form a distinct section.

b) When a project comprised a 'main line 'and a 'branch' should form at least one distinct section.

c) When the country traversed by a line is such that it may readily be divided into tracts of distinctive topographical character, the length through each class of country may comprise a section, or a project may be divided into 'engine runs' or into lengths suitable for ''Construction Division".

d) Where there is likelihood of different sections of a project being opened to traffic at different intervals, the estimate for each such section should be keep distinct.

e) When an estimate for any alternative alignment of importance is included, the estimate for alternative alignment and for the length which it would supersede, if adopted, should each be comprised in a distinct section.

Completion Estimate

A completion estimate is prepared in supersession of a construction estimate as provided in para 1701-E. the Construction or a Project Estimates of works costing over Rs. 1 Crore will have to be closed at the end of one of the first three financial half years after the opening of the line and the completion estimate is prepared. The completion estimate is a stock taking estimate and all works not started on that date are excluded from the scope of work/project and are to be dealt with separately. This will show:

- Amount of sanctioned estimate.
- Actual expenditure of all the works up to the date of the closing of the Construction Estimate.
- Commitments in that date.
- Anticipated further outlay.
- Total estimated cost.
- Difference between the sanctioned estimate and total estimated cost.

An abstract of the completion estimate showing the above particulars against the various heads of capital classification should be submitted to Railway Board together with the brief explanations for the excess of not less than Rs. 25000 or 10 % over the estimated provision under sub-head of accounts and for saving of 20% or Rs. 1 Lakh whichever is less, occurring under any sub-head of accounts.

The completion estimate should reach the Competent Authority within 4 months after the close of the financial half year up to which it shows the actual expenditure. Provision for further outlay on only those works as are in progress on the date of closing of the construction estimate should be included.

The date of opening in the case of new line should be held to be the date of opening for passenger traffic of the whole line included in a Construction Estimate.

If different sections of a project are likely to be opened at intervals exceeding one year, separate completion estimate should be submitted for each section. In the case of open line project, the date of opening should be held to be the date on which the project fulfils the purpose for which it was sanctioned.

Completion Estimate involving material modification or excess over estimate beyond the power of the GM should be submitted to Railway Board for sanction. Those which do not involving such modification or excess should be submitted to Competent Authority for sanction, normally GM of Zonal Railway and the Railway Board being informed.

Points to be taken into consideration while preparing and checking estimates:

A. **Proprietary of Expenditure**. The accounts officer in his capacity as Financial Advisor has to Examine all proposals for expenditure with a view to see:

a) That the expenditure proposed to be charged to Railway Funds in the estimate is properly and legitimately so chargeable;
b) That proper financial justification is forthcoming in the case of all works requiring such financial justification and they are absolutely necessary and cannot be avoided or postponed; and
c) That in the case of estimate for staff quarters and other rent-returning buildings the anticipated yield of rent as shown in the rent statements will have the effect of reducing the return on the cost (excluding land) of each class of quarters to less than 6% per annum.

B. **Incidence and Classification of Charges.** Incidence and classification provided in the estimate should be verified with the reference to the extent provision in Financial Code and a specific certificate of verification should be recorded by Accounts Officer. Submission of an estimate to the sanctioning authority should not be delayed when there arises any doubt as to the correct allocation of estimated cost. In such cases, approximate allocation between Capital, DRF, DF, RSF, SRSF, OLWR and Capital Fund should be certified by Accounts Officer, as far as it is possible for him to do so, and the sanctioning authority may sanction the estimate, if otherwise in order, leaving over the question of allocation for subsequent consideration.

C. **Budget Provision.** The existence of budget provision for the proposed work should be verified from the sanctioned allotments for the year, it should be ensured that such certificate is recorded in the estimate.

D. **Competency of Sanction.** The Competent Authority who has to sanction the estimate has to be indicated and is verified. The verification should be done in accordance with para 748E and delegation of powers as well as the powers re-delegated by the GM to the lower Authorities.

E. **Freedom form Errors and Omission.** Errors and omission noted during the course of Accounts verification of the estimate should be got corrected by the executives responsible for preparation of estimates.

F. **Subsidiary Points.** In the check of estimates the following subsidiary points should be checked to see:

- That the particulars of work are giver in sufficient details ;
- That a proper distribution is made of the estimated outlay between Cash and Stores;
- That the allocation of each item is given and that an abstract allocation is made;
- That the reason or necessity of undertaking work is furnished;
- That all incidental expenditure that can be foreseen has been provided for;
- That in case of renewal, replacement and dismantlement credit for released materials has been provided for;
- That in case of rent-returning buildings and staff quarters, a rent statement accompanies the estimate;
- That in case of estimate for manufacturing operation the outlay and outturn are distinctly shown;
- That in case of work undertaken for private bodies and other Government Departments provision has been made for necessary department charges and the amount is deposited or acceptance obtained as required under the rules; and
- That the provisions of paras 732 E to 735 E and 1137 E to 1140 E etc. have been kept in view while framing estimates of deposit works and works for other Government Departments.

TENDERS

Main Steps of Procurement

1. Preparation of Demand
2. Approval of competent authority
3. Vetting from Accounts.
4. Budgeting.
5. Issue of Tender.
6. Receipt of Tender and Opening.
7. Brief note and comparative statement.
8. Rates reasonability and technical suitability.
9. Issue of Purchase order.
10. Inspection.
11. Receipt of Material.
12. Verification of bill.
13. Warranty Certificate.
14. Return of Security Deposit.
15. Performance certificate.

Definition:

The Tender is a notice to all business concerns to enable them to give quotations for supply of stores as well as for execution of engineering works. Such notice in case of large - works should not be less than one month and for other works should not be less than 14 days.

In order to obtain the cheapest, economic and competitive rates tender system is adopted. Therefore, while adopting this effective method very careful and serious consideration shall be made.

As per practice in vogue on Railways, such notice should be given in leading newspapers i.e. two English and one in Regional language for big works and for small works one in Regional language. Publicity should also be given at Railway stations and offices, other divisions apart from the division from where invitation of tender is sponsored.

Once it is decided to, execute the work through the agency of contractor by calling tenders, the following, conditions should be fulfilled:-

a) That the Railway is in a position to handover the site of work and plan to the contractor
b) That the Railway should be ready with full knowledge of character and scope of work.
c) The Railway is ready with design of work, detailed drawings, and schedule of quantities.
d) Soil exploration should have been carried, out at sites which are located on filled up tanks or hollow ground so as to avoid any changes in the design of foundation and structures at a later date;
e) That tender documents for sale will be ready from the date notified.

The tender forms supplied to intending tenders on the payment of specified amount should specify:

- The amount of Earnest Money to accompany the tenders and the nature of Security Deposit, if any, required in case of accepted tender.
- The place where the Earnest Money is to be deposited.
- The place and time where the blank tender forms can be obtained and the contract documents can be seen.

- The date time and place of opening of tenders.
- The nature of work to be executed and approximate value of tender.
- With whom or what authority the acceptance of tender will rest.
- Whether or not tenders containing erasures and alterations of tender documents will be considered.
- The amount to be paid for tender documents.

Kinds of Tenders:

(a) Open Tender,
(b) Limited Tender,
(c) Single Tender, and
(d) Global Tender.

These are explained as under:

Open Tender

This system of invitation of tenders by public advertisement in the most open and public manner possible, should be used as a general rule and must be adopted in all cases in which the estimated value of tender to be received is Rs. 25,000 and over subjected to certain exceptions (limited tenders, single tender or dispensing with tenders).

In regard to Stores department this system is adopted in the same manner subject to the exceptions given in paras 331S and 332S in normal circumstances in which the estimated value of the Tenders to be received is Rs. 3 lakhs and over and over Rs. 25 lakhs in emergencies.

Limited Tender

In case of Stores department, except in the case of safety items, this system may ordinarily be adopted when it is considered to be advantageous, in case of orders the estimated value of which is less than Rs. 3 lakhs. In case of safety items, this system may be adopted in case of purchases, the estimated value of which does not exceed Rs.1 crore. Where for reasons which should be in public, interest, it is considered not possible to call for open tender, limited tender may be invited with the concurrence of Financial-Adviser, and approval of competent authority. The reasons for inviting limited tenders from the firms/contractors should be kept on record while approaching Finance for concurrence.

The procedure for inviting limited tender has been approved as a regular measure and works up to a limit of Rs. 1Crore can be awarded on limited tender basis. This will also apply to construction projects. Finance concurrence is not necessary in case contractors are borne on the approved list. However, if the limited tenders are proposed to be invited from the contractors not borne on the approved list, prior financial concurrence will be necessary. Same procedure shall apply even if one of the contractor is outside of the approved list only. Limited tender should be invited from the contractors borne on the approved list only.

Single Tender

Calling of single, tender for works should be resorted to only in exceptional circumstance after recording necessary certificates:

(a) The certificate with proper justification should be given that it is not in the public interest to call for tender by advertisement.

(b) It should be certified that the demand is so urgent that any saving likely to be achieved by elimination of the open competition must be ignored.

(c) Certify that the work is of such a nature that there is no other suitable agency/contractor to execute the work.

(d) The reasons as to why single tender is being resorted to in preference to limited tender.

(e) The proposal must have prior financial concurrence and personal sanction of General Manager except when the power has already been redeligated.

(f) In case of ST, Tender Committee and the accepting authority should be one step higher than in case of Open Tender/LT for works.

Global Tender

This system is adopted by Railway Board or the Government of India for purchases throughout the world. For this type of tenders the General Managers of Zonal Railways and the Administration under they have no powers.

List of Approved Contractors:

No work or supply should ordinarily be entrusted for execution to a contractor whose capability and financial status has not been investigated beforehand and found satisfactory. For this purposes a list of approved contractors is to be maintained in the Headquarters and the Divisional offices of a Railway.

1. Limited Tender should be invited from the contractors borne on the approved list only. Notice for inviting Limited Tenders shall be published in local newspapers and displayed on the Notice Boards kept in the concerned Railway Office and also put on the internet wherever possible. It will be the duty-of the prospective tenderer to keep track of the tender notices issued through any one of these media.

2. Individual Railways may decide the "category of works" for which list of approved contractors should be maintained for each monetary slab.

3. The Approved List will be in Four monetary slabs only as below :
   - Class 'D' - up to Rs. 10 lakhs.
   - Class 'C' - More than Rs. 10 lakhs and uptoRs. 25 lakhs.
   - Class 'B'- More than Rs. 25 lakhs and uptoRs. 50 lakhs.
   - Class 'A' - More than Rs. 50 lakhs and up to Rs. 1 crore.
4. The Approved List will be valid for 3 year.

5. The list will be reviewed every year for deletion which will be effective from lst July and additions, if any, will be done once in 6 months and which will be effective from 1st January and 1st July.

6. Once the contractor is borne on the Approved List, it will be valid for 3 years, unless already deleted during the Annual Review, or the expiry of the validity of the "Approved List" as-a whole, whichever is earlier.

7. There will be separate Approved Lists for Open Line and Construction Organizations for each identified category of work.

8. In Open Line, Approved List for classes 'B', 'C', and 'D' will be maintained Division wise and for Class 'A', there will be one common list for the Railway as a whole. In Construction Organization, Approved List for Classes `B', 'C' and 'D', Will be for a particular pre-determined geographical area or Dy. C.E.(Con.)- wise and for Class 'A', it will be CAO(C)/GM(C)-wise.

9. Selection of contractors for enlistment in the Approved List should be done by a Committee to be nominated by the authority not below the Accepting Authority as given below. The composition of the Committee will be as follows:

Class of Contractors	**Select committee Composition**	**Accepting Authority**
Class 'A'	One SAG Officer each of executive Department and PHOD finance Department	Executive Department PHOD
Class 'B' and 'C'	One JAG Officer each of Executive Department & Finance Department	DRM in the Division/ SAG Officer of the Executive Department
Class 'D'	One Senior Scale Officer each of Executive Department and Finance Department	Sr. DEN (Coordination) in Division and Dy. CE (Construction) in Construction.

Note: Normally, in Construction, no contract below Rs. 10 lakhs value should be called.

10. For registration in Approved List, the contractor will have to furnish a non-refundable fee of Rs. 5,000 for Class 'D', Rs. 7,500 for Class, 'C', Rs. 10,000 for Class 'B'andRs. 15,000 for class 'A'. This fee will cover the entire period of 3 years or part thereof. Contractors desirous of registration should submit the application in the proforma prescribed by the Railway with the prescribed fee for each 'category of work' in each slab.

For considering enrolment of contractors in the various categories, the following criteria may be followed:

(a) Class 'A'

- They should have a permanent Engineering Organization with at least a graduate engineer having 10 years' experience plus an engineering diploma holder having 5 years' experience and should maintain a minimum complement of transport equipment, construction tools and plants required for the works.
- At the time of enlistment, they should have satisfactorily executed at least two works, each individually costing not less than Rs. 25lakhs.

(b) Class 'B'

- They should have a permanent Engineering Organization with at least a graduate engineer having 5 years' experience and should maintain a minimum complement of transport equipment, construction, tools and plants required for the works.
- At the time of enlistment, they should have satisfactorily executed atleast two works, each individually costing not less than Rs. 10 lakhs.

(c) Class 'C'

- They should have an Engineering Organization with an engineering diploma holder having at least three years experience.
- At the time of enlistment, they should have satisfactorily executed atleast two works, each individually costing not less than Rs. Five lakhs.

(d) Class 'D'

At the time of enlistment, they should have satisfactorily executed at least two works, each individually, costing not less than Rs. 1 lakh.

Tenders for Zonal works and Supply of Materials:

The zonal tenders are mainly intended for doing the usual repairs and maintenance works like white washing, painting, re-roofing, re-flooring and repairs to drains and road and sanctioned work up to Rs. 2 lakh at a time and also for supply of materials like Bamboos, sand, moorum, ballast, cost of any item not exceeding Rs. 10,000 At a time during the currency of contract for particular zone. It is often advantageous to allot all works of repairs and maintenance, special works and supply of materials in a particular zone to zonal contractor's separately for each of the above category and during the currency, care should be taken that work order in excess of Rs. 2lakh for repair and maintenance works and Rs. 10,000 in case of supply at a time should not be issued.

Time lag for Supplying Closing and Opening of Tenders

The following are instructions in order to adopt uniform procedure which should be followed in respect of all tenders:

a) Time lag, between the cessations of sale of tenders and closing time for submitting the tenders should be four hours.

b) Time lag between closing time for submission of tenders and opening of tender's box should be five minutes.

i. It will be up to contractors to obtain tender papers by post or in person, in time. The, sale/issue, of tender papers may therefore continue unabated up to the time notified for closing the sale/ issue of tender papers irrespective of any consideration whether the tender papers are required to be sent by post or issued in person to a contractor.

ii. Under no circumstances tender papers should be issued after the time notified in the tender notice or the cessations closing the sale of tender papers

iii. If the time and date for submission of tender is to be extended on accounts of any reason this should be done well in advance giving necessary notification and also advising all tenders those who have purchased the tender papers. Once the sale of tender is ceased, closing time should not be extended thereafter under any circumstances.

iv. in case it is found not feasible to open the tender box within 5 minutes of the time notified, for closing the submission of the tenders, a slip duly signed by an Officer preferably Sr. Scale Officer of the convening department should be pasted on the tender box to prevent further deposition of tenders.

Opening of tender:

Sealed tenders are deposited by the tenderers in a sealed box kept for this purpose at the advertised place. This box is sealed duly signed by the accounts representatives if available at the advertised place. Opening of tenders is done by the tender opening committee consisting of an executive officer and accounts representative in the presence of tenderers. It should be seen that the earnest money is deposited in the proper form and if the same is not in order, the tender of such tenderers should be rejected as per the conditions in the tender form and the rates are read out. The tender form are checked mainly with reference to the rates of non-stock items, percentage of M.S items, completion period, validity period of tender and any other conditions quoted anywhere in the tender form. These all particulars are initialed by both representatives. Each department which deals with tenders should maintain tender registers. The register is to be signed by all tender opening members as well as by the contractors. The tenderer shall be required to deposit the earnest money, which is 2% of estimated value.

Delayed tender:

It is the tender which is received after appropriate time but before opening of tenders by the tender opening committee and this tender is acceptable and dealt with in the same manner as in the case of tenders received in time.

Late tenders

It is a tender which is received after the opening of tenders. It should be prominently marked in Red ink and also on the cover by the tender opening committee and although unacceptable, the rate of such tender could be read out. These tenders should not be accepted. However, such late tenders can be accepted by the GM with the concurrence of FA&CAO in exceptional circumstances.

Evaluation of tenders and briefing notes

Executive officer after evaluating each tender viz.

a. Par value
b. MS items and percentage
c. Value of NS items. Verified by the section officer{accounts} along with his briefing notes should send original tenders to the accounts department for the finalization of tender by duly constituted committee as per extent rules.

The comparative statement of rates, amounts, and quantities etc. for the consideration of tenders should be prepared by the departmental office from where the tenders are invited and checked in the account office. Each and every page of the comparative statement should be signed by the staff preparing it and also by the officer checking the same.

While making briefing notes the following specific points should be commented upon:

(a) The position with regard to the previously accepted rates.
(b) Remarks vis-à-vis the special conditions stipulated by the tenderer, if any.

(c) Any lacuna or omissions coming to the notice of the section preparing the briefing notes.

(d) The experience, capability and the financial status of the contractors either new or already working with the railways in such case details are available or obtained from contractors.

(e) The basis for arriving at the all-in-one cost of the tenderand their respective positions such as lowest, second lowest etc.

(f) Any other points which may be considered of interest to the tender committee for dealing with a particular tender.

Scrutiny in accounts:

a) That a briefing note has been received together with a copy of all comparative statements indicating all-inclusive cost duly checked by the section officer(Accounts) of Finance section. In the case of uneven and unusual conditions the tenders have to be brought at par for correct evaluation;

b) That in every respect of the advertised tenders, there has been proper publicity in the local newspapers with adequate notice;

c) That in respect of limited tenders, whether there has been sanction of the competent authority and tenders have been issued to all firms on the approved list.

d) That the purchase being made is covered by a proper demand in the form of a requisition/estimate sheet duly vetted by the workshop accounts officer at the appropriate level for all the demands exceeding 25000;

e) That the item proposed is a Workshop manufacture item or not and in the case of former, why is this being off-loaded to trade.

f) That the offers received in response to tenders are attested by the Accounts representative at the time of opening of the tenders.

g) That the item proposed for purchase should not appear in the latest computer overstock statements or as non-moving items.

h) That the proposed rate for acceptance should invariably be the lowest.

i) That in the case of request for advance payments ranging from 90% onwards, whether the firms are of repute and their past performances justify the acceptance of the term of payment of such advances on such inspection.

j) That in the case of purchases involving foreign exchange, whether the items are not indigenously available and there is proper clearance for importing such items;

k) That in the case of single tenders, whether the indent is covered by the issue of a PAC signed by an Officer at the appropriate level.

l) That the tenders should not contain unusual conditions relating to the delivery terms, warranty etc. and if so whether the same will affect the interest of Railway Administration adversely;

m) Whether the lowest offer/offers are bypassed in consideration of the earlier delivery date;

n) That the conditions of earnest money deposits/ITCs etc are fulfilled and the firm is not blacklisted/suspended or removed from the approved list of suppliers;

o) In case of works all the above points are to be seen. The calculation of M.S.N.G items, the percentage above/below/par MS items to be checked;

p) The special conditions of contracts are commented upon.

Tender Committee

As an adhoc Tender Committee of not less than 3 members (for tenders costing above Rs.10, 000 and above) shall be constituted by the authority competent to accept the tenders for the purpose of considering the tenders. One of the members shall be nominated by the FA&CAO. One member of the executive department doing the same type of work.

Railway have decided that the work contracts up to the value of Rs.10 lakhs , the tender committee may hereafter be constituted consisting of a minimum of 2 members only and in case of works above 10 lakhs Tender Committee shall have 3 members.

The tender accepting committee should be independent of the tender committee and should not work as a member of the Tender Committee. Otherwise the recommendations of the Tender Committee should be put up for acceptance to the next higher authority.

S. No	Value limit of the tender	Accepted by	Stores	Consum. Deptt.	Finance
1.	Rs.45 lakhs to Rs. 01 Cr	JAG	Sr. Scale	Sr. Scale	Jr. Scale
2.	Rs. 01 Cr to 05 Crs	SAG	JAG	JAG	Sr.Scale
3.	Rs. 05 Crs to Rs. 200 Crs	SAG	SAG	SAG	JAG
4.	Rs. 200 Crs to Rs. 500 Crs	AGM	PCMM	PHOD	PHOD
5.	Above Rs. 500 Crs	GM	PCMM	PHOD	PHOD

In all tender cases, recommendation of the Tender Committee (TC) should be put up to the next higher authority for acceptance. The practice of putting up the TC'S recommendation to a colleague of the same grade level is in gross violation to the instructions issued by the Board's vide letter no. 2004/CEI/CT/13dated 24.8.2004.

Constitution of Tender Committee for execution of works:

The constitution of the Tender Committees for considering the tender and power of acceptance of tenders for executing works, Railway Board have left to Zonal Railways, for formation of Tender Committee and power of acceptance of tenders in consultation with FA&CAO. Therefore each zonal railway has to finalize the constitution of tender committees at various levels and powers for the acceptance of tenders.

Undertaking by the member of tender committee:

Members of the tender committee should give undertaking at the appropriate time, that none of them has any personal interest in the companies / agencies participating in the tender process.

Disposal of tenders:

The target dates have been fixed for disposal of tenders that is from the date of opening of tenders till the date of finalization of tenders/ negotiations.

S. No.	Items	T.C. to be held on division	T.C. to be held at headquarter
1.	Opening	D	D
2.	Notes of Headquarters	---	D+5
3.	Notes to FA&CAO/ DAO	D+5	D+9
4.	Tender committee meeting	D+15	D+15
5.	Tender committee proceedings at headquarters	D+15	---
6.	Tender committee proceedings put upto competent authority (in case negotiations is required)	D+17	D+17
7.	Case to GM for sanction of negotiations	D+18	D+18
8.	Receipt of GM's sanction	D+21	D+21
9.	Negotiated tender invited	D+23	D+23
10.	Negotiated tender considered by the tender committee	D+31	D+31
11.	Negotiated tender received	D+31	D+31
12.	Negotiated tender proceedings put upto competent authority	D+33	D+33

In the case of complicated tenders containing a number of special conditions etc. such as steel work tenders, four more days will be allowed for the preparation of notes and sending to FA&CAO/DAO/Headquarter. In such cases all the dates will be put back by four days.

The agreement for execution of work or purchase order eventually issued should be checked by Section Officer(Accounts) attached to Executive Officer or by the Section Officer(A) of finance branch of accounts department if tenders are finalized at Headquarter level.

Points to be seen by Tender Committee for Finalization of Tenders

The following main points are to be seen by the Tender Committee while finalizing tenders-

- The type of publicity given.
- Number of tenders sold and returned.
- Sanction to the work and detailed estimate.
- Provision made in the estimate for the items included in the tender schedule.
- Earnest money paid in proper form and the proof thereof.
- Validity period of offer is current.
- A comparison of tender value and all in cost as per accepted tender with the estimated provision.
- Reasonableness of rates i.e. %, N.S items quoted by tenderers with reference to last trade accepted for similar work.
- Completion period should be commented upon.

- If a late or delayed tender is to be accepted, it should be seen that sanction of competent authority exists for doing so.
- For inclusion of NS items rates analysis should be made out on the basis of M.S. items and accounts concurrence obtained.
- Recommendation of tenders whether:
  (a) Accepted lowest tender ,
  (b) Bypassed lowest tender, or
  (c) Negotiations and reasons therefore.
- In case of tender for supply of materials where samples are required to be submitted alone with the tenders, the samples shall be tested and tender committee's proceedings should contain the specific comments on the samples.

Role of Tender Committee Members: The tender committee consists of:

- A technical member, who is normally known as convenor.
- A finance member, a person from associate finance.
- A third member drawn from any other technical department.

The Role of Convenor:

(a) The convenor has normally full knowledge of work to be executed, all special features, site conditions, specifications of the work, credentials of the tenderers, time frame, urgency etc.
(b) Market survey for the rate analysis and Implications of special conditions, if any, are also to be evaluated by the convenor.
(c) The convenor must fully brief the tender committee.

The Role of Finance Member:

Finance Member must ensure that all tenderers have fulfilled the prerequisite conditions, i.e.

(a) Tenders are in properly issued form.
(b) Tenders are signed by authorized persons.
(c) Tenders have been opened correctly.
(d) Earnest money is requisite and in acceptable form.
(e) All valid tender offers are serially placed and put up in a comparative statement along with a briefing note, dully vetted.
(f) The arithmetic accuracy of the offer.
(g) The funds position and if work is sanctioned.
(h) All special conditions having financial repercussion have been examined.

The Role of Third Member:

The third member must ensure that rules are followed in general i.e.:

(a) Reasonableness of rates have been properly examined.
(b) A uniform and consistent approach has been adopted in dealing with the tenders.

Responsibility of TC as a whole:

It is collective responsibility of the tender committee to give definite recommendations with full facts and reasons bringing out all the known facts, background, valid apprehensions which have formed the basis for its recommendations.

Role of Tender Accepting Authority:

TAA, while considering the TC proceedings, should examine whether

(a) Work is essentially required and is covered by sanctions and funds are available.
(b) In case of open tenders, full opportunity has been given to all the tenderers.

(c) Response has been adequate, i.e. no. of tenders sold vis-à-vis no. of offers received.
(d) Reasonableness of offers has been properly examined by the tender committee.

Rejection of Tenders

It is within the competence of accepting authority to reject the tenders recording his reasons for such action but the accounts concurrence should be obtained in all such cases except where TC has recommended rejection.

Negotiations

Calling for negotiations: it should be clearly understood that selection of contractors by negotiation is an exception rather than the rule and may be resorted to:

(a) Where all the tenders are considered to be unreasonably high in value and it is felt that retendering would not serve any better advantage to the railway; and/or
(b) Where the lowest tender is technically unacceptable or is rejected because of unsatisfactory credential, capacity or unworkable rates
(c) Where in the case of proprietary items of stores, the price quoted is considered to be unreasonably high.

Restrictions

(a) Competent authority after receiving recommendations of T.C. should decide with whom to negotiate.
(b) In no case negotiations should be extended to tenderers who had either not tendered originally or whose tenders were rejected because of unsatisfactory credentials, capacity or unworkable rates.
(c) The above instructions may not be applied rigidly to tenders for specialized works and equipments where the tenderers may quote accordingly to their own specifications and design for various reasons such as improvements to technology.
(d) Procedure for conducting negotiations should be decided on the merit of each case in consultations with FA&CAO.

Tenders can be dispensed with:

(a) General Manager may dispense with tender procedure in the public interest, upto Rs.25000 in value when it is not practicable or advantageous to call for tenders.
(b) For works based on schedule of rates the General Manager may decide not to call for tendersupto a value of Rs50000 without recording reasons.
(c) In all other cases when General Manager decides not to call for tenders the reasons should be recorded and financial concurrence obtained.
(d) Works which are considered to be urgently necessary to safeguard life or property or repairs, damaged to the line caused by flood, accidents so as to restore and maintain through communications.

Solitary Tender:

In response to open tenders, the only one tender returned is called solitary tenders. This tender can be accepted under the normal rules.

CONTRACTS

Definition

Under Indian contract act 1872, when two or more persons have a common intension communicated to each other to create some obligation between them it is said to be an agreement. Such agreements which are enforceable by law are known as contract. Only those agreements are enforceable by law which are made by free consent of parties.,

Free consent of parties: An unqualified acceptance of a tender constitute a binding contract until a final agreement is constituted and in order to ensure this fact the acceptance letter should be suitably worded. However if the acceptance of tender by railway is a conditional acceptance, It requires the consent of tender before binding contract takes place.

Authority competent to contract (railway side):for entering into any contract, the approval/acceptance of authority is necessary who is competent to accept as delegate under SOP by railway board to GM annexure II to chapter 5 of financial code and further by GM to subordinate authority. The contracts are signed by authorities competent to sign under SOP, on the behalf of president of India and attested by witness.

Competent authority to contract on contractor side

(1) in case of partnership the person, who is authorized by partnership deed
(2) in case of company, the MD who is authorized by a resolution or by article of association, and
(3) in case sole proprietor, proprietor himself or the person to whom power of attorney is given

The above aspects should be decided only after taking legal opinion on the contractor document from law officer and for such opinion a fee of RS. 50 per case is to be charged from contractor

Lawful consideration for a contract to be legal, there must be a lawful consideration for performance. Such consideration may take a positive form or negative form. Such an agreement to order a certain quantity of work or material. An agreement not to order certain work or material from anyone but the contractor. The negative form of consideration may be advantageously being employed in case of:

- Supply of material of perishable nature.
- Material which are not necessary to stores.
- Requirement which is not possible to estimate, and
- Where a contractor offers to carry out all work on a division at a fixed percentage below the schedule of rates (para 422S)

Forms of contract

There are following forms of contract.

Work contracts:

(i) **Lump sum contract**: lump sum contract is a contract under which the contractor engages to carry out a work or effect supply as specified and within a given period for

a fixed total sum, and time, irrespective of actual quantities and kind of work done. His receipt of sum being dependent on his completing the work to the specification in the time.

(ii) **Schedule contract:** in this contract the contractor engages to carry out a work or effect supply as specified within a given period, at fixed unit rates for each of the various items comprising such work or supply. The sum he is to receive depends on the actual quantities and kind of work done or supply made to specification and time

(iii) **Piece work contract:** Piece work contract is contract under which only unit rates are fixed for various kinds of work or material are agreed upon, without reference either to total quantities of work to be done or material supplied or to the quantity of the work to be done or material supplied within a given periods.(zonal contract fall under this category).

(b) Stores Contract:

(i) Rate contract: Rate contract is a contract under which only during the period of its currency, the contractor engages to supply materials on demand, irrespective of quantity, at fixed unit rates within given period of the receipt of such demand (Rate contract is purely a rate agreement with certain stock obligation on the part of the rate contract holder)

(ii) Running contract: it is a contract under which during the period of its currency, the contractor engages to supply and other party to the contract to take a specified quantity with a percentage tolerance of material as and when ordered, at fixed unit rate within a given period of the receipt of such order.(it is a guarantee that 75% of the quantity covered by the running contract will be drawn during the currency of the contract with an option up to 125% of the quantity covered by the running contract)

Works contracts:

All works and supplies relating to works executed through the agency of contractor are classed as under-

(a) Zonal works: The works of ordinary repair/maintenance and other petty nature in a particular zone such as white washing, reroofing, re-flooring, repairs to roads and drains.

(b) Special works or construction works: construction of bridges, foundation an embankment and other than zone work.

(c) Supply of building material: for supply of all building materials such as bricks, tiles, lime, bamboos, ballies, matting.

It is often advantageous to allot all minor works and all works of repairs and maintenance in a particular zone, for a define period, to one contractor. It may be likewise advantageous to make this contractor who can be called a zonal contractor responsible for the conveyance or supply of engineering materials as and when required in a particular zone during a specified period. The executive officer should take steps to select suitable contractor for zone contracts which shall include:

(a) New works, addition and alterations to existing structures, special repair works and supply of building materials subject to contract value of each such work not exceeding two lakh.

(b) All ordinary repair and maintenance works and,

(c) Conveyance of materials e.g. bricks, lime, sand etc. which are likely to be required in a zone during the year.

Contract Documents

i. The contract documents are important tools of project management. These documents play a pivotal role in determining scope, time, cost, quality, risk apportionment, communication and matter related to human resource development in the contract. The main documents are the standard & special conditions of contract, the specifications, drawings, the schedule of items, quantities and rates, the agreement form, instructions to the tenderers and the tender forms etc.

ii. All contract documents exist as a crucial part of risk mitigation, the scope definition and the project communication to all the parties. They should not contain any material that does not apply to the work. They should be prepared in a timely manner and should set the appropriate quality level.

iii. Normally, the contractor should be supplied with the complete documents. These should be ready at the stage of inviting tenders. That means the drawings and the specifications, should be final and fully coordinated before inviting the tender.

iv. Aim should be to accomplish dispute free completion of the work. The documents should be clearly understood by all the parties involved. The pre-bid conference should be utilized for ironing out any differences in understanding the content of the contract documents. The standard forms and formats should be used, which keep on getting improved with the experience.

v. A document prepared by the Federation of International Consulting Engineers (FIFIC) has gained wide popularity in International Competitive Bidding and is considered a model, which can be used in many situations. Some of the projects are receiving external aid and assistance. The funding agencies insist on following the FIDIC or other conditions for contract management to ensure equality and fair play. The parties involved in such projects have to study these documents thoroughly before the bidding.

Specifications and Drawings

The specifications address the project quality and the processes. The drawings define the scope and quantity of work. The standard conditions establish the general rules specially the risk allocation. The execution of works and the supply of materials on contract should be according to the standard specifications and drawings. The specifications could be IRS, BIS or other international standards. If no standard specification exists for any item of work or the supply, complete specification for the same should be prepared by the executive and attached to the tender forms. The drawings wherever required should be prepared, showing the general dimensions and details. These drawings should be made available for reference by the intending tenderers.

If there is a likelihood of some minor changes in the tender drawings, a clause may be added in the tender conditions that the tender drawings are for guidance and not for the actual execution.

Tender Forms

The tender forms should completely embody either directly or by reference the content of the contract documents such as the schedule of quantities, unit rates, the general conditions/ the special conditions of contract, completion period, site details etc. The tender forms should also state:

i. The amount of earnest money to accompany the tender and security deposit, if any (in case of accepted tenders.)
ii. Whether or not tenders containing erasures and alterations of the tender document will be considered.

Such alterations constitute fresh proposals and cannot be disregarded but must definitely be accepted or rejected.

Agreement Form

After tenders are finalized, all the elements; schedule of quantities, rates, conditions etc. are put together as agreement form. The agreement form may be tender form itself. The conditions of contract, specifications etc. are embodied/ annexed to the tender form itself. They are readily accessible to contractor for reference. On behalf of the contractor the signature of only such persons/ or person as are competent to bind him legally shall be accepted on the agreement form. Adequate copies of the agreement are prepared and given to the section engineer, ADEN and account's officers.

Rates, Quantities, Nomenclature

All the rates should be entered in the agreement in words as well as the figures. What items are covered in the quoted rates should be clearly specified in the conditions and the specifications. Quantities and units of the measurements are entered in the tender schedule. Regarding the nomenclature, as far as practicable the standard forms of nomenclature or the description should be used. The terminology should be such as to show without ambiguity or doubt, what exactly is required.

The engineering department is having a 'Master Schedule of Rates' and the 'Standard Specification'. This facilitates preparation of the tender schedule. Every time new items, basic rates etc. are not required to be prepared. Electrical, S&T and other department should also prepare 'Master Schedule of Rates' and the 'Standard Specifications'.

Conditions of Contract

Rates and specifications are qualified by the conditions of contract. These can be standard, general conditions or special conditions.

General principles to be followed to enter in to contract

The general principles to be followed to entering into contracts are as under:

(a) The term of contracts must be precise and definite and there should be no room for ambiguity or misconstruction and the matters to be agreed upon should include in details the following:
- What contractor is to do, when,where and to whose satisfaction it is to be done.
- What payment is to be made,what is it to cover,to whom it is to be made, and the method and the basis.
- What the railway administration is to do and on what terms.
- The responsibilities of contractor in respect of adequate supervision care of government property, and the protection of outside interest and those of the staff and workmen.
- The methods of setting disputes.

(b) As far as possible, legal and financial advice should be taken in drafting contracts before finalization.

(c) Standard form of contract should be adopted wherever possible, the terms to be subjected to adequate security.

(d) The term of contract once entered into should not be materially varied except in consultation with the competent legal and financial authority.

(e) Provision must be made in contract for safeguarding govt properties entrusted to contractor.

(f) In long term contracts provision must be made for desirability of preserving for Railway Administration unconditional power to cancel the contract at any time after expiry of six months' notice to the effect.

Form of agreement with contractors for execution of work/supply

The following terms of agreements are to be used to execute agreements with contractor, for the execution of work and supply to be made.

Form A: This standard form is utilized for agreement to be executed for work and supply when costing Rs. 10,000 and above.

Form B: This standard form is utilized for agreement to be executed for works and supply when cost is more than Rs 5000 and up to Rs 10,000.

Form C: This standard form is utilized for agreement to be executed for a zone for works and supplies.

Rate Slip: For all works and supply costing below Rs 5000 a rate slip should accompany with work order based on limited quotations which should not be less than three.

Results of execution of work and supply made by contractor

- Either work/supply completed satisfactorily, or
- Contractor failed to carry out the work completely, or
- Contractor failed to carry out the work during the current period of contract, or
- There is dispute/disagreement/difference between the Railway Administration and the contractor.

Work/Supply completed satisfactorily:

If the work/supply are completed satisfactorily by contractor and unqualified no claim certificate is give in the measurement book as well as on contractor's bill, his final bill should be passed and security deposits/retention money should be paid to him. a certain amount can also be kept for recovering possible losses, in case maintenance period is not over.

The guidelines regarding refund of retention money have been given in railway board letter no 59/AC/III/28/5. Dated 18/5/1960 where in it has been decided that it is for Railway Administration. To determine on the merit of each case, what potion of security deposit need continue to be held by railway to cover possible loss due to contractor failure therefore the following decisions has been made to refund the security deposit(on the basis of guideline railway board letter no 59/AC/III/28/5. Dated 18/5/1960).

a. The amount of earnest money converted into initial security should be retained till all the work order against the sectional contract are completed and the maintenance period of all such work order where prescribed are also over

b. Where tender are accepted against standing earnest money and contractor instead of depositing the initial security separately request for the collection of such amount by way of 10% deduction through on account bill, an amount equal to initial earnest should be retained out of the retention money, till the final completion of all work order and the expiry of maintenance period

Contractor failed to carry out the work completely

When the contractor fails to carry out the work, the engineer on the behalf of the railway may serve with a notice under clause no. 62 of GCC, in writing to that effect and if the contractor does not within 7 days after the delivery to him of such notice, proceed to make good his fault in so far as the same is capable of being made good and carry on the work or comply with such directions as aforesaid to the entire satisfaction of the engineer, the railway shall be entitled after giving him 48 hours' notice in writing under the hand of engineer, the contract as whole or in part or parts and adopt either or both of the following courses

i. To carry out whole or part of work from which the contractor has been removed by employment of the required labour and material and the cost of which shall include lead, lift, freight, supervision or all incidental charges.

ii. To measure up the whole or part of the work from which the contractor has been removed and to get it completed by another contractor, the manner in which such work is completed shall be at the entire discretion of the engineer whose decision shall be final.

Contractor failed to carry out the work during the period of currency of contract

Completion period is always given in the contract agreement, if the contractor could not complete the work during the prescribed period than such cases should be dealt with as under

i. In case the contractor could not complete work due to fault of railway i.e. late handing over site or the late supply of material by railway and so on, then extension of time limit should be given without levy of penalty.

ii. In case the contractor could not complete the work due to circumstances beyond his control even then extension of the time limit may be granted without levy of penalty but in the both above case the engineer should give following certificate.

"Certified that railway has suffered no loss due to late completion of work and the conditions of para 445S are satisfied."

In case there is dispute/disagreement or difference between railway and contractor

i. All disputes and differences of any kind whatsoever arising out of or in connection with the contractor whether during the progress of the work or after their completion and whether before or after the determination of the contract, shall be referred by contractor to the railway and railway shall within a responsible time after their presentation, make and notify decision there on in writing. The decision, direction, classification, measurements, drawing and certificates with respect to any matter the decision of which is specially provided by the engineer on behalf of railway or matter which are referred to

hereinafter has excepted matters and shall be final and binding upon contractor and shall not set aside on account of any informality, omission, delay or error in proceeding in or about the same or any other ground or for any other reason and shall be without appeal.

ii. In the event any dispute or difference between the parties as to the construction or operation of contract, or the respective right and liabilities of the parties on any matter in question, dispute or difference in any account to which the contractor may claim to be entitled to, or if railway fails to make decision within a reasonable time, the contractor after 90 days of presenting his final claim on disputed matters may demand in writing that dispute may be referred to arbitration giving details of claim.

In regard to appointment of arbitrator clause no. 64(3) of general condition of contract may be referred.

ARBITRATION

Arbitration may be termed as a device for settling up the differences of the two parties of a contracts agreement i.e. the administration and contractor through intervention by third person called arbitrator without the help of the court of law.

As per clause 63 of GCC all dispute in connection with contract shall be referred by the contractor to the railway administration in writing. The executive engineer is required to notify the decision of railway in the matter to the contractor within a reasonable time.

Clause 64 of GCC provide that in the event of any dispute, the contractor may demand for referring the matter arbitration after 90 days of the presenting his final claim on disputed matters to be refereed to arbitration.

There will be no objection to the work being continued during the arbitration and payment arranged in a normal course unless the arbitrator decides otherwise.In case where the claim in question is below Rs. 5lakh and if no complicated issue are involved the issue will be referred to as sole arbitrator nominated by GM.

Railways appoint one or more gazetted officer one rank above for arbitration and send it to contractor. The contractor can choose one officer for arbitration. When there will be two members in arbitration then one will have to be chairman.

Type of Dispute

Following types of disputes are possible in the contracts

- Claims for extra items of the work, quantum, rate of the payment, etc.
- Claims for the variation in the scheduled quantities.
- Delay in completion of the works.
- Compensation for prolonged duration of the works.
- Delay in payment of the bills.
- Delay in giving decisions on the matters referred.
- Disputes regarding non-scheduled items.
- Disputes regarding termination of the contract at contractor's risk and cost.
- Disputes regarding certain aspects of the measurements, specifications, drawings, defective workmanship, etc.
- Hire charges for the plant and machinery.
- Lacunae in contract conditions.
- Disputes regarding interpretation of any clause of contract.

INDEX

ACCIDENT AND DISASTER MANAGEMENT

RAIL WHEEL INTERACTION

Normally a vehicle follows the track geometry both in the vertical and lateral directions. Vertical guidance is obtained by the weight of the bogie of the vehicle (and the load inside the vehicle) transferred to the wheel through suspension. Lateral guidance is ensured by the wheel flange.

The design of a 4-wheeled railway vehicles consists of an under frame. The under fame a has tow sole bas and two head stocks. The wheel sets are housed inside four axles guards. Springs are provided between the under frame and wheel at the four axle guards. These are generally laminated springs.

In Bogie Vehicle, the vehicle body is placed on two bogie truck having a pair of sole bars and head stock and housing two wheels sets.

The under frame of a 4 - wheeler and the bogie truck of an 8-wheeler can be compared to a table with four legs. A table will start rocking in one of its legs is short or is placed on uneven surface.

The wheels of a vehicle have similar tendency, but the suspension provided between the wheel and under frame helps the wheel to follow the unevenness of the rail table.

For instance, if the right leading wheel of a 4-wheeler or bogie truck negotiates a dip in the rail table, the wheel will follow the rail table since the spring placed above this wheel opens out, simultaneously with the diagonally opposite spring and keep the wheel in contact with rail table.

Let the track is newly laid to correct gauge, i.e. 1676 mm. Let a vehicle with a new wheel be placed on the track. The gauge for a new wheel is 1600 mm. The thickness of flange when measured at the root is approximately 34 mm. Adding the thickness of the two flanges, the flangeto flange distance measured at root of flange will be 1600+68 = 1668 mm. Thus, there is a clearance of 8 mm. When the gauge of the track reduced to -5mm, the clearance gets reduced to3 mm and thus helps to improve riding comfort. Let us assume that one of the wheel flanges is reduced to 20 mm thickness. Then the slope of lin2.5 of the flange is also lost.

Therefore, the thickness of the flange at the root of flange will also be approximately 20 mm. Now, the distance between the root of flanges will be 1600+20+34 mm = 1654 mm. Thus, the clearance between standard track gauge and the wheel flange becomes 22 mm. This will increase the lateral oscillation make the riding uncomfortable and unsafe.

PERMANENT WAY PARAMETERS

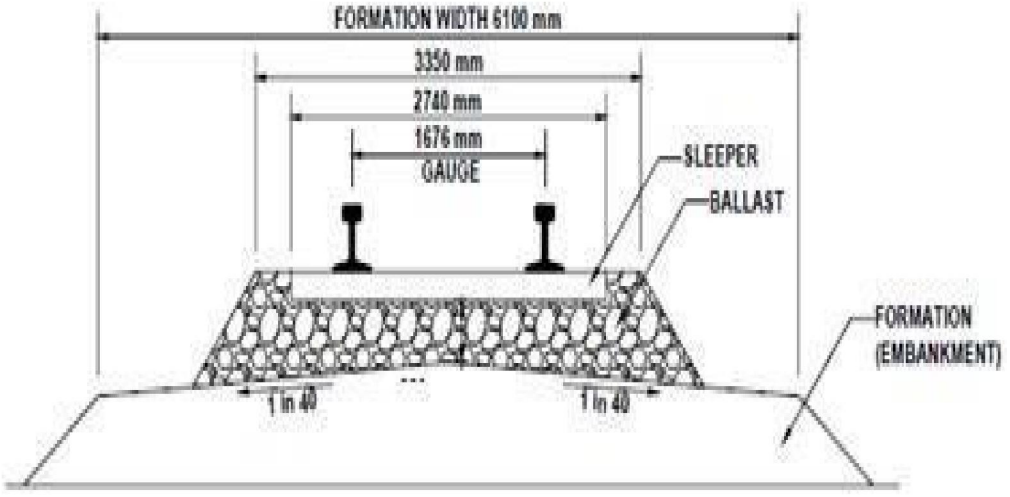
Introduction - TRACK

Track or Permanent Way is the Rail Road on Which Trains Run. It is basically consists of two parallel rails having a specified distance in between and fastened to sleepers , which are embedded in layer of Ballast . The Rail are jointed each other by fish plate and bolted and these are fastened to the sleepers by various fitting like keys and spikes etc. The sleepers are spaced at a specified distance and are held in position by getting embedded in ballast.

Each of the components of track has a basis function to perform. The Rail act as girder to transmit the wheel loads of train to sleepers. The sleepers hold the rail in proper position and provided a correct gauge with help of fittings and transfer the load to the ballast. The Ballast is placed on level ground known as formation .The Sleeper are embedded in ballast , which gives a level surface provides drainage and transfer the loads to a larger area of formation. The formation gives a level surface, where the ballast rest and takes the total load of the track and that of the trains moving on it.

Track Consists of:

1. Rail
2. Sleepers
3. Fitting and fastenings
4. Ballast
5. Formation



Cross Sectional view of Indian Railway track

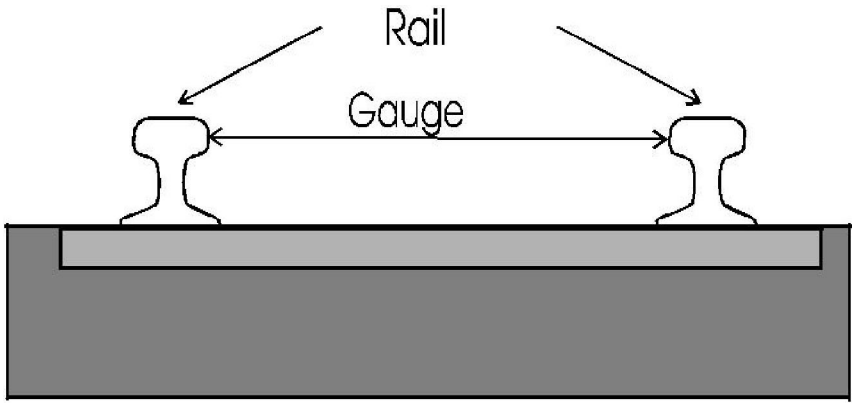
Requirement of Good Track

- The gauge should be correct and uniform
- The Rail should have perfect cross level. In curves , the outer rail should have proper super elevation to take into the centrifugal forces
- The track should be resilient and elastic in order to absorb shocks and vibration of running train
- The track should have good drainage so that the stability of the track is not Affected due to water logging

- The track should have good lateral strength so that it can be maintain its stability due to variations of temperature and other such factors
- There should be provision of easy replacement and renewal of various track components
- The track should have such structure that not only initial cost is low , but its maintenance cost is also minimum

Track Gauge

Gauge of track is normally defined as the minimum distance between rails forming track. It is measured at 13 mm below from the rail table with the help of P. Way Gauge called CGLI (Combined gauge cum leveling instruments).



Track Gauge Tolerances

- **On straight Track** 1676 ±6 mm

- **On Curved Track**
  - When Curved radius more than 440 M 1676 mm tight 6 mm and Slack 15 mm
  - When the curved Radius less than 440 M 1676 mm tight 0 mm and Slack 20 mm

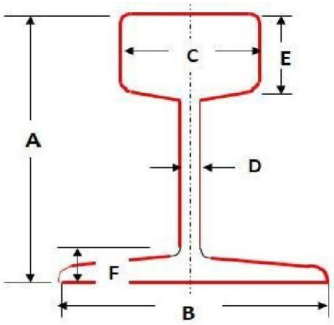
Rail

The rolled steel section (Steel girder) laid end to end on sleeper to forma track is called Rail

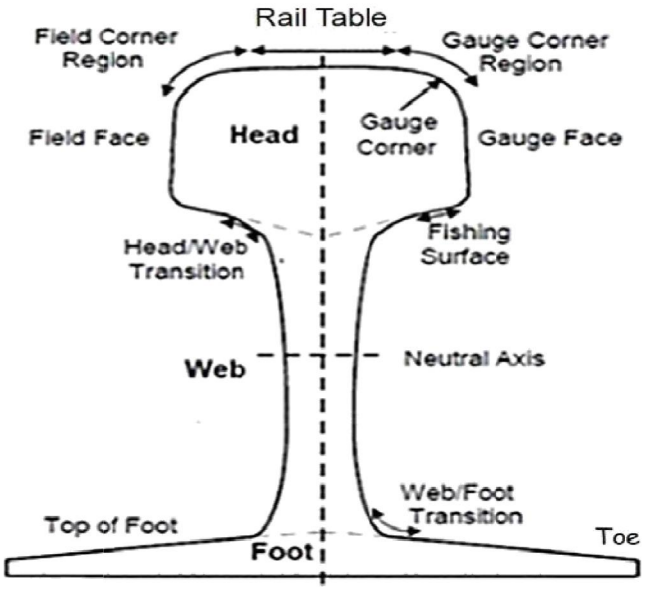
Rails Function

- The rails provide continuous and level surface for movement of trains
- The Rail provide a pathway which is smooth and has very less friction
- The Rail bear the stresses developed due to vertical loads transmission and due to braking force and thermal stresses
- The Rails transfer the Lad to the wider area of formation through sleepers and ballast

The Standard Rail Sections (BG) used in Indian Railways are 60 KG, 52 Kg and 90 R



Rail Section	Wt/M (in kg)	Area Of section mm^2	DIMENSIONS IN mm.					
			A	B	C	D	E	F
60 kgs	60.34	7686	172	150	74.3	16.5	51	31.5
52 kgs	51.89	6615	156	136	67	15.5	51	29
90 R	44.61	5895	142.9	136.5	66.7	13.9	43.7	20.6



RAIL NOMENCLATURE

SLEEPERS

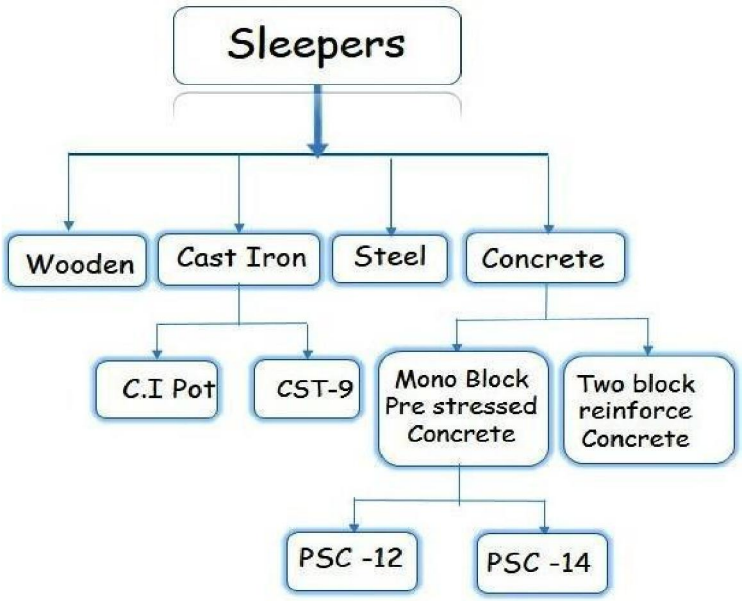
Sleeper is a load distributing component of track structure which is laid transversely to hold the rail.

FUNCTIONS

1. To transfer the load from rail to the wider area of ballast
2. To hold the rail to correct gauge and alignment
3. Other function of sleepers are :
    a) To provide satisfactory rail seat
    b) To Permit rail fastening being maintained in tight condition
    c) To maintain inclination of rail
    d) To provide adequate insulation between two rails in track circuited area
    e) To provided lateral and longitudinal stability to Track

The sleeper is required to embedded into the ballast upto the top of sleepers so as to optimise the longitudinal and lateral resistance from sleeper ballast interface.

TYPES OF SLEEPERS



Presently Mono Block Pre stressed Concrete sleepers beingutilized.There are two types of Mono Block Pre stressed Concrete

1. PSC -12 2. PSC -14

PSC -12 Sleepers is used with 52 Kgs Rails and PSC -14 sleepers is used with 60 Kgs Rails. The PSC -14 (60 Kg rail sleeper) can be utilized with 52 Kgs with different thickness of Liners.

SLEEPER DENSITY

The Sleeper density for all track renewal (Complete track renewal and trough sleeper's renewal), doubling gauge conversion, and new line constructions works shall be 1660 Nos /KMs

For LWR /CWR Even on Loop Lines or sidings minimum sleepers density shall be 1540 Nos /Kms In case of SWR Sleeper density is fixed as 1340 Nos /Kms

BALLAST

In the track geometry, ballast plays an important role. It absorbs noise, shocks, and vibrations and distributes the load transmitted by the wheels over the formation. The ballast provides a flexible base to the track and controls the lateral and longitudinal movement of track. It keeps the track in position and at required level. If sufficient quantity of ballast is not available, track may get distorted and or buckled. The recommended ballast size is 50 mm. The profiles and minimum depths should be as given in Para. 263 of IRPWM.

Types of Ballast

a) **Cushion Ballast**: The depth of ballast below the bottom of sleeper, normally measured under the rail seat, is termed as cushion ballast.(Fig.)

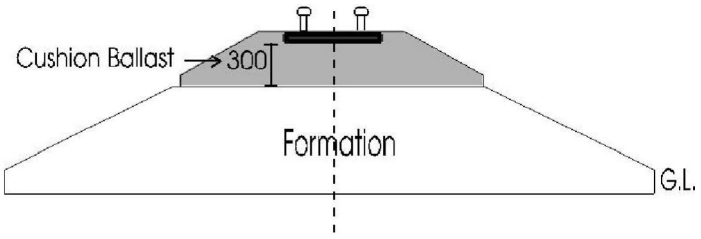
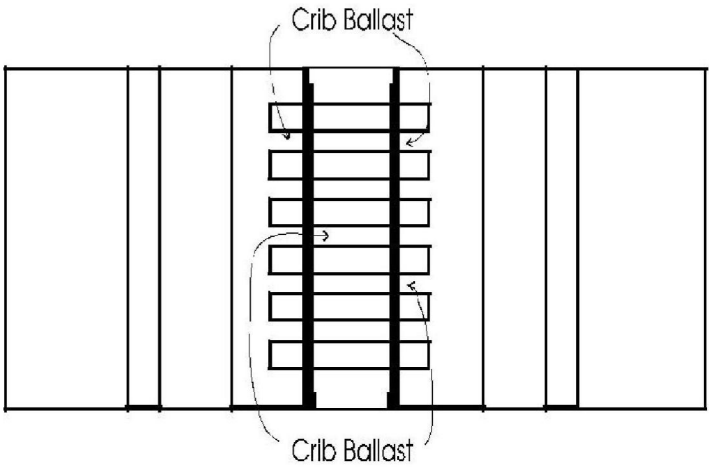
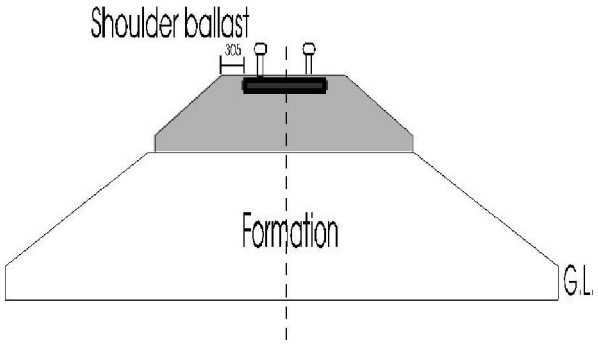


Fig.

b) **Crib Ballast**: Ballast provided in between the sleepers is termed as crib ballast. (Fig.)



c) **Shoulder ballast**: Ballast provided beyond the sleeper edge is called shoulder ballast.



At deep screening and relaying spots, the top table or gauge face of the rail gets smeared by ballast. This enhances friction at the flange contact area and encourages mounting of wheel especially in case of empty stock. The running surface of rail should therefore be maintained clear of ballast particles.

Ballast Resistance

The ballast plays an important role in absorbing shocks. The factors affecting the ballast resistance are:

- Ballast material
- Size
- Shape of ballast particle
- Ballast profile
- State of consolidation
- Type of sleeper

FORMATION

The railway track is laid over a formation (having Inclination 1:40) prepared on soil (Fig. 4.1). The strength of formation depends upon the type of soil i.e. sandy, loam clay etc. and it serves the following purposes:

- Distributes the weight of train, track and ballast over a wide area of natural ground
- Facilitates good drainage.
- Provides a smooth and regular surface on which the ballast and track can be laid
- The formation is affected by following factors:
- Sudden subsidence of embankment
- Base failure
- Ballast puncturing due to heavy rains, Muddiness etc.

The inadequate care taken in maintaining the formation may cause derailments as failure of formation results in disturbance of track geometry. The steps to be taken for avoiding derailments on account of formation failure include measures to prevent sinking of track during diversions and use of new formations especially during rains.

The geometry of track should be maintained as per laid down standards for passage of traffic at stipulated speeds. Where abnormal behavior of formation or supports is expected, the track geometry and packing/supports must be checked regularly or as often as warranted.

CREEP

Creep is defined as longitudinal movement of rail with respect to sleepers. The rails have a tendency to move gradually in the direction of traffic.

Causes of Creep

- Rails not properly secured to sleepers
- Less Ballast resulting in inadequate ballast resistance to the movement of sleepers
- Improper expansion Gaps
- Badly maintained rail joints
- Rail seat wear in metal sleeper track
- Rail too light for the traffic carried by them
- Skidding and Slipping of Wheels
- Sharp gradient and sharp curves
- Other miscellaneous cause of improper maintenance of track such as lack of drainage, loose packing uneven spacing of sleepers

Effect of Creep

- Sleepers get out of square affecting gauge and dittoing alignment
- Rail Joint get opened out resulting bolts holes getting elongated and premature fracture of fish plate and bolts
- The joint gets continuously jammed
- The suspended joints start becoming supported joint and rail ends get battered
- Buckling takes place in extreme cases of creeps

BUCKLING

Buckling of track occurs when high compressive forces are created in the rails associated with inadequacy of lateral resistance in the track at the place.

SUPER ELEVATION OR CANT (Ca)

Super elevation or cant is the difference in height between the outer and inner rail on a curve. It is provided by gradually lifting the outer rail above the level of the inner rail. The inner rail is taken as the reference rail and is normally maintained at its original level.

The main functions of the super elevation are

- To ensure a better distribution of load on both rails.
- To reduce the wear and tear of the rail and rolling stock.
- To neutralize the effect of lateral forces.
- To provide comfort to passengers.

CANT DEFICIENCY (Cd): Cant deficiency occurs when a train travels around a curve higher than the equilibrium speed. It is the difference between the theoretical cant required for such high speeds and the actual cant provided.

CANT EXCESS (Ce): Cant excess occurs when a train travels on a curve at a speed lower than the equilibrium speed. It is the difference between the actual cant provided and theoretical cant required for such a low speed.

EQUILIBRIUM SPEED

When the speed of a vehicle negotiating a curved track is such that the resultant force of the weight of the vehicle and of radial acceleration is perpendicular to the plane of the rails, the vehicle is not subjected to any unbalanced radial acceleration and is said to be in equilibrium. This particular speed is called the equilibrium speed. The equilibrium speed as such is the speed at which the effect of the centrifugal force is completely balanced by the cant provided.

EFFECT OF LESS SUPER ELEVATION

Due to less super elevation, there is possibility of outer rail getting worn out as it will bear more strain due to tendency of wheel more away from the centre of the curve under the influence of centrifugal forces.

EFFECT OF MORE SUPER ELEVATION

- Inner rail will have to bear maximum strain and there is every possibility of this rail giving.
- Due to excessive super elevation, there is every possibility of slow moving goods trains getting derailed.

READINGS IN PERMANENT WAY

Derailment on straight Track and curved track

Causes of derailment can be broadly divided in two groups.

1. Distortion of track parameters.
2. Failure of track components.

Track parameters.

(a) Gauge
(b) Cross Level (called Super Elevation on curve)
(c) Twist
(d) Alignment (Versine on curve)

Gauge

On straight track	- 6 mm to + 6 mm.
On Curve with radius more than 440 m.	- 6 mm. to + 15 mm.
On Curve with radius less than 440 m.	- Up to + 20mm.

Gauge should be uniform as a good practice. Slack gauge beyond above limit causes angularity, while tight gauge causes thrust to the fittings and ultimately results track distortion.

Cross Level

In respect to a reference rail, variation in level of other rail is called cross level. The resultant effect of cross-level is twist. On straight track it is called cross-level and on curved track it is called superelevation.

Super elevation: Super elevation is also known as Cant.

Maximum super elevation which can be provided are as under.

B.G. High speed route (A, B& C): 165 mm
B.G. Other route (D&E) : 140mm

Cant deficiency

B.G. 75mm (100mm on high speed route)

Cant excess

B.G. 75mm

Twist: Algebraic difference of cross-level per metre length of track is called Twist. Service tolerance for Twist for B.G is 2.78 mm. per metre for 'D' class route

Versine: On straight track it is known as alignment whereas on curved track it is known as versine.

Alignment on Straight Track: On straight track tolerances limit for alignment is 5mm measured on 7.2 metre chord

DERAILMENT ON POINTS & CROSSING (TURNOUTS)

Track parameters to be inspected at the turn out.

Gauge	+ 6mm. preferred at the toe of switch.
Switch Opening	95 mm. to 115 mm.
Clearance of check rail and at the nose of crossing	Max. 48 mm. Min. 44 mm.
wear at the crossing nose	Max. 10 mm.
Switch wear	Max to a length of 200 mm

Derailment on points & crossing (turnouts)

Followings are the causes of derailment on points & crossings.

- Improper setting of points causing gap.
- Failure of interlocking arrangements.
- Lifting of toe of switch.
- Sharp flange splitting through the point or mounting the same.
- False flange may force open the switch in trailing direction which would cause derailment, when a movement in the opposite direction takes place immediately.
- Bursting of point.
- Tight gauge at the nose of crossing due to burring of crossing nose or wing rail.
- Slack clearance at the check rail and nose of crossing.
- Badly maintained turn in curve.

Failure of track components

(I) **Rail failure:** Incidences of frequent rail/weld failure due to rail defect like. Hogging, Battering, scabbing, wheel burns, Corrosion (Vertical wear, lateral wear) beyond limit. Loss of section and expected Service of rails. Detail in transparency.

(II) **Fish plate failure**:-This defect develops in a badly maintained joint and excess gap at joints

(III) **In effective and deficient fittings**:- Due to such fittings vertical lateral and longitudinal stability of track is badly affected.

(IV) **High percentage of unserviceable sleepers**:- Due to high percentage of unserviceable sleepers it becomes difficult to retain packing, hold Gauge& Alignment ultimately track geometry is disturbed. Percentage of unserviceable sleeper should not be more than 25%.

(V) **Un-serviceable joints sleepers or two consecutive sleeper un-serviceable**:- In such condition gauge holding become poor at these location joints are the weakest link of the track. If joint sleepers etc. are un-serviceable maintenance of joints are disturbed causing low, hogged, and battered joints and spread of gauge etc.

(VI) **In adequate ballast**:- Main functions of the ballast are as under

(a) To give lateral stability (which arrest alignment defects buckling)
(b) To give longitudinal resistances (which arrest creep)
(c) To provide cushion (to give resiliency)
(d) To facilitate drainage.
(e) To transfer load from sleeper to formation.

(VII) **Formation failure: -**Bearing capacity of certain (such as black cotan sail) is reduced in rainy season. Formation failure can happen due to heavy breach subsidence's scour slip and sinkage.

(VIII) **Improper Formation width and slop:**-It formation is not of proper width it cannot retain shoulder ballast and ultimately lateral stability of track is reduced which may cause misalignment and buckling in worst case. Due to Improper slop of bank drainage is affected.

(IX) **Buckling of track: -** Buckling of track is a serious incidence there are various defects which contribute buckling.

ROLLING STOCK PARAMETERS AND READINGS

The rolling stock involved in accident must be inspected in the presence of nominated team of supervisors and results should be recorded in the prescribed formats.

The main items of inspection are as under:

WHEEL GAUGE

Wheel gauge is the distance between inside faces of the flange on the right and left side wheels of an axle. There should be no variation in the values of wheel gauge measured at four point 90 degrees apart on a wheel set. However the actual value of the wheel gauge can vary as per given below.

	Standard	Maximum	Minimum
BG	1600 mm	1602 mm	1599 mm

If the wheel gauge is more than permissible limit, there exists a possibility of a relatively newer wheel hitting the nose of crossing. This happens because the wheel gauge is one of the parameters affecting the clearance at check rail opposite the nose of crossing.

If the wheel gauge is less than minimum value, there is a possibility of wheel hitting at the back of a tongue rail while passing through the switch and thus damaging the tongue rail.

WHEEL DEFECTS

The following aspects should be checked on the suspected wheels:

a. Condemning limit
b. Flat places on tyre/skidding
c. Flanges - Sharp / Deep/thin
d. Radius too small at the root of the flanges
e. Gauge Slack/ tight
f. Cracks

The above mentioned defects can be detected with the help of **Tyre defect gauge** and **Wheel gauge** meant for this purpose.

Thin Flange

When the flange thickness reduces to less than 16 mm for B.G., the flange is called a thin flange. It should be measured at the distance of 13mm below the flange tip. **A** thin flange increases lateral play between the wheel set and track and increases:

Sharp Flange

This occurs when the flange wears in such a way that radius at the tip of the flange becomes less than 5 mm. The flange forms a fine sharp edge. Due to this, the wheel set can take two roads at slightly gaping point or wheel may ride over the chipped tongue rail.

Less Radius at Root

When radius at the root of the flange becomes less than 13 mm, it is called worn out flange. A worn out flange increases the value of frictional forces

Deep Flange

When the depth of flange, measured from the flange top to a point on the wheel tread (63.5 mm away from the back of B.G. wheel), becomes greater than 35 mm, it is called a deep flange (35-28.5=6.5 mm). Under this condition, the wheel flange would tend to ride on the fish plate and check-block and may damage the track components.

Hollow Tyre

When the projection of outer edge of the wheel tread below the hollow of the tyre exceeds 5 mm, the outer edge of the wheel forms a false flange and the worn tread is called hollow tyre.

The hollow tyre has the danger of developing a false flange. The wear on tyres has the effect of increasing the conicity of the wheel tyre. This reduces the critical speed of the rolling stock beyond which excessive hunting and oscillations take place and the chances of derailment.

Flat Places on Tyre

The maximum permissible value of flatness on a B.G. wheel tyres is as under

- Goods Stock IRS - 60 mm
- Coaching Stock - 50 mm

Buffing gear

Buffer projection limits from head stock

Max. 635 mm Min 584 mm

Buffer Height variation between adjacent Coaches Should not be more than 75 mm.

ACCIDENT AND DISASTER

ACCIDENTS

Accident is an occurrence in the course of working of railway which does or may affect the safety of the railway, its engine, rolling stock, permanent way and works, fixed installations, passengers or servant or which affect the safety of others or which does or may cause delay to train or loss to the railway.

For statistical purposes accidents have been classified in categories from "A" to "R" excluding "I" and "O".

CLASSIFICATION OF ACCIDENTS

Accidents are classified under following heads

- Train Accidents
- Yards Accidents
- Indicative Accidents
- Equipment Failures
- Unusual Incidents

Train Accidents: The Train Accidents is an Accident that involves the trains. The Train accidents are further divided as:

- Consequential Train Accidents
- Other Train Accidents

Consequential Train Accidents includes train accidents having serious repercussion in terms the loss of human life, human injury, and loss to Railway Property or interruption to Railway traffic.

Other Train Accidents all other Accidents which are not covered under the definition of consequential Tr4ain Accidents are to be treated as other train Accidents.

Yards Accidents all Accidents that take place in a yard and do not involve a train are termed as Yard Accidents

Indicative Accidents: In real terms they not Accidents but are serous potential hazards and include all cases of train passing signal at danger, Averted collision, breach of block rules.

Equipment Failure: These include all failures of Railway Equipment that is failure of Locomotives, Rolling Stock, P way, OHE, S & T equipment.

Unusual Incidents: These includes cases related to law and order but not resulting in Train Accidents and other incidents under classification and N, Q and R

Detailed Classification of Accidents

S.No	Class	Types of Accidents
1	A	Collision
2	B	Fire in Train
3	C	Accidents at Level Crossing
4	D	Derailment
5	E	Other Train Accidents
6	F	Averted Collision
7	G	Breach of Block Rules
8	H	Train Passing Signal at Danger
9	J	Failure of Engine and Rolling Stock
10	K	Failure of Permanent Way
11	L	Failure of Electric Equipment
12	M	Failure of S & T Equipment
13	N	Train Wrecking
14	P	Causalities
15	Q	Other Incidents
16	R	Miscellaneous

Threshold Value: For the Purpose of Accidents Threshold Value is the minimum Value beyond which the Accidents will be treated as having serous repercussion on the basis of loss to Railway Property or interruption to communication, it shall constitute two portions

A. Threshold value of Railway Property: Loss which is fixed at One Lac Rupee.
B. Threshold value of interruption to communication either partial or total where duration of interruption is equal to or more than Numbers of hours specified as under

Interruption	BG- A , B , C , DSpl (in Hours)	BG - D – E Spl (In Hours)	BG – E (in Hours)
Total	3	4	6
Or	Or	Or	Or
Total + Partial	6	8	12

Duration of Interruption is defined as duration from the time of Accidents till starting of first train on line clear from the adjacent station for movement over the affected Line in that section

RELIEF TRAIN ARRANGEMENTS

Sounding of Accident Alarm Signals/Hooters/Sirens: The Accident Alarm Sirens/Hooters must be sounded immediately when ARME/ART is ordered. Following codes are prescribed for sounding the accident alarm/ Sirens/Hooters:

Sr. No.	CODE	CIRCUMSTANCES
1.	Two long blasts each of 45 sec Duration with 5 sec break in between.	Accidents in loco sheds/ traffic yards at Home station requiring only ART.
2.	Three long blasts each of 45 sec Duration with 5 sec break in between.	Accidents outside the home station Requiring only ART.
3.	Four long blasts each of 45 sec Duration with 5 sec break in between.	Accidents requiring both ARME and ART.
4.	One long blasts of 90 sec duration.	Cancellation of ARME/ART.

Note:

1. The alarm hooters requiring ARME/ART shall be sounded as prescribed above and shall be repeated once more after interval of five minutes.

2. The SSE (Loco), SSE(C&W) and all other supervisory staff concerned must ensure that the relief train gangs break down gangs and other staff who is required to go to the accident site in the ARME or ART, thoroughly understand alarm hooter and that their names and addresses are displayed at conspicuous places.
   In case of medical staff required to attend the accidents, a phone message is also to be sent to the ADMO/AMO concerned.

   On listening to these hooters, the SSE (Loco), the ADMO/AMO will immediately report himself to ASM on duty with his staff, ready to proceed to the site of accident with the relief medical van. The target time for reporting to the ASM after hearing the hooter is 15 min. during the day and 25 min. during the night.

Accident relief medical equipment and auxiliary van

The accident relief medical equipment (ARME SCALE-1) and auxiliary van are stabled in station yard. The function of ARME SCALE-1 is to carry medical equipment and personnel to the site, for prompt medical relief. The auxiliary van has provision of emergency tools for removing the injured persons from the debris etc. In case of accident involving or likely to involve injuries or deaths, these shall be rushed to the site immediately.

A. Target time for turning out of medical relief van from the siding and their dispatch from the stations:

In case of double exit siding:

Time for turning out	= 15”
Time for Dispatch	= 5”
Time from ordering dispatch	= 20”

In case of single exit siding:

Time for turning out	= 25”
Time for dispatch	= 5”
Time from ordering to dispatch	= 30”

Note: the above target time for turning out is reckoned from the time of ordering to the time they are taken out from the siding and kept ready for dispatch on a suitable running line plus 5 min. for dispatch.

B. Target time for turning out of accident relief train:

The target time for turning out of accident relief train (ART) with complete equipment and staff from the loco shed (or the place where it is stabled) and dispatch from the station, are under as:

During day:

Time for turning out	= 30”
Time for dispatch	= 15”
Target time from ordering to dispatch	= 45”

During night:

Time for turning out	= 45”
Time for dispatch	= 15”
Target time from ordering to dispatch	= 60”

Note:

1. Both the target times 30” and 45” for turning out accident relief train are to be reckoned from the time the accident relief train is ordered to the time the train reaches the loco shed exit point. 15” time is the time permitted for departure from the station. Any delay in ordering or departure of medical van/ART must be immediately examined and viewed seriously.

2. At stations where the layout of the loco and traffic yard are such as to permit a reduction in the time limits stipulated above, the divisional railway manager should lay down shorter time limits.

3. Accident relief train (ART) or break down train is equipped to deal with relief, rescue and restoration measures.

Promptness in movement of ARME and ART

1. If an engine is not readily available, the nearest engine of any train including mail/express trains should be released and utilized for expeditious dispatch of these.

2. ARME and ART must be given precedence over all other trains while proceeding to the site of accident.
3. ARME/ART should not be detained for want of guard but may leaves in the charge of any responsible loco/traffic official. A guard may be sent by the quickest possible means later on.
4. ARME/ART or any special relief train, carrying injured persons for removal to hospitals, must also be given top most priority.
5. The accident relief trains after completing relief operations must be worked back to their base stations without any delay and must be given precedence over all goods trains.

DISASTER

Disaster is an accident or an incident that would result in huge loss of human lives, animals and property e.g earth quake, floods, cyclone, drought and epidemic diseases etc . As far as Railway Concerned , major accident involving passenger train resulting in loss of human lives or grievous injury and affecting /dislocating the train services and causing damage to the goods , rolling stock and interruption to through traffic if lasting more than 24 Hours .

Disasters on Railways may be due to railway accidents or due to natural causes such as earth quake, cyclone and flood and some manmade causes such as fires, industrial accidents, bomb explosion etc. Disaster have the potential to cause extensive damage to life and property and adversely impact society at large.

Strengths of the Railways to handle a Disaster

In handling disasters, Indian Railways is in a unique position as it has a number of strengths not available with many other departments of Government of India. These include:

- Railways' own Communication Network.
- Operating Control on each Division linked with each Station.
- Territorial Army Units.
- Uniformed force of RPF/RPSF
- Railways' own Medical Infrastructure
- Civil Defence Organization
- An army of Gang men spread out all over the Indian Railways.
- Scouts and Guides (they can at best provide background support).
- Dedicated Rescue/Restoration and Medical Equipment on Rails.

Each of the above can be made use of to handle adversities depending upon requirement to handle the disaster.

Railway's shortcomings to handle Disaster:

There are, however, a few inadequacies in the Railways own resources which are very essential for handling a specific type of Disaster as under:

- Absence of Tunnel rescue equipment – in case of collapse of or mishap in a rail Tunnel, expertise and related equipment on this aspect is lacking.
- Non-availability of trained divers for extrication of passengers and/or casualties (dead

bodies and drowning/drowned passengers) from rolling stock fallen down in sea / river /lake etc. Limited help of sport persons (swimmers) can be taken for this , the time of their mobilization is a factor to be kept in view

- Non-availability of cranes operated from a ship/barge for lifting of the coaches/bogies from a water body.
- Ability to handle a CBRN Disaster and major fire.
- Limited resources to handle a terrorist attack on a train and/or a station, **other Railway Premises etc.**

Disaster on Railways Context:

The concept of a Disaster was, till the year 2005, not adequately and comprehensively defined on Indian Railways. It was accepted that a Disaster situation implies, on the railways, to cover only cases of serious rail/train accidents. It was, perhaps, due to this anomaly as late as the year 2008 DM on Indian Railways has broadly adopted this fact in the concept of disaster and has gone to examine the relief/rescue/mitigation and preparedness of Indian Railways based on the earlier concepts and has reviewed the facilities for handling disasters available with the Railways only on the report/recommendations of the HLC on DM of Mr. S. Dhasarathy.

Based on the definition of the Disaster Management Act 2005, Ministry of Railways has adopted the following definition of Railway Disaster:

"Railway Disaster is a serious train accident or an untoward event of grave nature, either on railway premises or arising out of railway activity, due to natural or man-made causes, that may lead to loss of many lives and/or grievous injuries to a large number of people, and/or severe disruption of traffic etc, necessitating large scale help from other Government/Non-government

TYPES OF DISASTER

Disaster in the Railway Context was traditionally a serious train accident, caused by human /equipment failure, which may affect normal movement of train services with loss of human life or property or both. This is now extended to include natural and other man-made Disasters. Different types of Disasters are describingalong with a few example below.

(a) Natural Disaster

Earthquakes, Floods, Cyclone, and Land slide, Snow avalanches, Tsunami etc.

(b) Train Accident related Disaster

Collision (with a huge no of causalities) Train Marooned (Flash floods) , derailments on a bridge over a river and coaches falling down , train washed away in cyclone , derailments of a train carrying explosive or highly inflammable material , tunnel collapse on a train , fire or explosion in trains , and other misc. cases etc .

(C) **Manmade Disaster**:

Acts of terrorism and sabotage i.e causing deliberate loss of life and / or damage to property, which includes; - Setting a train in fire, Railway installations etc,. Bomb blast at Railway station / Train, chemical (Terrorism) disaster, biological , radiological and nuclear Disaster

Golden Hours

The first responsibility in case of accidents is to keep the loss of life to minimum .The response team must be reach and extricate accident victims as early as possible and organize effective trauma care. The basic Principle of trauma management is speed and expediency. Thus the first hour after the accident is termed as “The Golden Hours”

Who should responds in golden Hours

- Public
- Social Workers
- Non-Government Organization (NGOs)
- Fire Fighting Units
- Local Police and army Units
- Govt. and Private Hospitals
- Railway Rescue teams

DUTIES OF OFFICIAL AT ACCIDENT SITE

ACTIONS TO BE TAKEN DURING SERIOUS ACCIDENTS

DRM will inform civil authorities & Police Department of concerned district to rush to help. He will ask for the medical team also from state Govt. DRM will demand for NDRF battalion through HQ and Rly. Board, if required for relief & Rescue operation as they are Medical First Responder (NFR)

ACTIONS AT THE SITE

Golden Hour

If a critical trauma patient is not given definite medical care within one hour from the time of accident, chances of his ultimate recovery reduces drastically, even with the best of Medical attention thereafter. This one hour period is generally known as The Golden Hour.

During this Golden Hour period every effort should be made to:

- Render definite medical care to the extent possible preferably by qualified medical practitioners.
- Stop bleeding and restore Blood Pressure.
- Persons under shock should be relieved of shock immediately.
- Transport casualties to the nearest hospital so as to reach within this Golden Hour period.
- For being effective, any Disaster Management system should aim at recovering as many critical patients as possible and rushing them to hospital within this period.

Disaster Syndrome:

A victim's initial response following a Disaster is in three stages, viz. Shock stage, Suggestible stage and Recovery stage. These initial responses are called Disaster Syndrome.

- Shock stage: In which victims are stunned, dazed and apathetic.
- Suggestible stage: In which victims tend to be passive but open to suggestions and willing to take directions from rescue workers and others.
- Recovery stage: In which individuals may be tense and apprehensive and may show generalized anxiety.

Different phases of Disaster Response

Disaster Response in case of a railway accident constitutes of 3 phases. These 3 phases are determined both by the time factor, as also by the extent of specialized assistance available. Firstly, it begins with the spontaneous reaction of men available on the train at the time of the accident. Thereafter the second phase continues with contributions made in rescue and relief work by men and material available locally in nearby areas of the accident site. The third and longest phase consists of meticulously planned action by trained DM teams who arrive at the accident site to carry out rescue and relief operations.

The first phase which is of shortest duration last for about half an hour. It is an amateurish, poorly equipped effort; but is nevertheless the most important phase. In most cases, this is the only help available for a major part of the 'Golden Hour'.

The second phase which is of 2-3 hrs. duration is comparatively less amateurish and much better equipped. Their contribution is vital since the 'Golden Hour' period comes to an end during the working of this group. How many critically injured passengers can finally be saved depends solely on the efficiency of this group.

The last and final phase of Disaster Response by railway's DM team continues for a few days. It comes to an end not only with the restoration of traffic but with the departure of most relatives and next of kin from the accident site and disposal of all bodies. Few of the grievously injured who continue to be hospitalized for comparatively longer spells are then the sole responsibility of railway's medical department.

With the above scenario in mind, it is necessary to take firm and quick decisions to save lives and property. To achieve these objectives Railways have a well-defined action plan that is successfully executed by the coordinated efforts of different disciplines, all of whom function as a team. The three groups which are active during the above mentioned 3 phases of Disaster Response may be classified as follows:

- Instant Action Team (IAT)
- First Responders (FR)
- Disaster Management Team (DMT)

INSTANT ACTION TEAM (IAT): Instant Action Team comprises of:

- The Guard, Crew, TS, TTEs, AC coach attendant, Asstt. Guard, RPF and other railway staff on duty on the accident involved train.
- GRP staff traveling on the train on duty.
- Railway staff traveling by the accident involved train either on duty or on leave as passengers.
- Doctors traveling by the train.
- Passengers traveling on the train who volunteer for rescue and relief work.
- Railway staff working at site or available nears the site of the accident.
- Non- Railway personnel available at or near the accident site.

Pre- accident check list of preparation for Members of Instant Action Team.

- Generally, about 15" time elapses before information regarding occurrence of an accident reaches the Divisional control Office. In case information can be conveyed immediately this time can be saved. . This 15" time is of vital importance since it constitutes 25% of the 'Golden Hour'.
- In case they have a Mobile, ensure that telephone numbers of all relevant officials such as those of divisional control offices etc. have been permanently fed into the Mobile for immediate use in an emergency.
- These important telephone numbers should cover all those sections where they are required to work their train either within their own division or even those of adjoining divisions.
- Divisions will get printed and circulate a DM Telephone Directory containing all such telephone numbers that are likely to be required in an emergency.
- Whenever they are traveling at night they should keep a torch handy and secure it by some means. The torch will be of no use in an emergency if it cannot be taken out from inside the suitcase at that point of time; or if the torch cannot be located since it has fallen off due to severe jerk.

Duties of the Guard of the affected Train

- Note the exact time of the accident and kilometer.
  - Protect the adjacent line(s)and the train as per GR. and SRs thereto;
  - Secure the vehicles as per rules.
  - Ascertain if adjacent line (s) is/ are fouled.
- Make a quick survey, for an immediate action, of the causalities, injuries and assistance required;
- Relay the information giving details of the accident and assistance required to the control by the most expeditious means.
- Render first aid to the injured person(s) taking assistance of all available Railway Staff, Doctors and volunteers on train or near the site of accident;
- Illuminate the affected area as much as possible with EL Box fittings (if accident occurred as night time).
- Get the particulars of damage to the rolling stock, permanent way etc.
- Arrange to shift the injured persons to the nearest hospital with the help of all available staff and other volunteers, also keep their particulars;
- See that water, tea etc, are supplied to the affected passengers as far as practicable;
- Arrange protection of Railway and public property with the help of available police and Railway staff.
- Preserve all clues relating to the possible cause of accident;
- Post an available Railway employee on the field telephone to ensure regular- flow of information;
- Check the unaffected portion of the train and arrange to clear the same safely to the adjacent station(s) as per rules and in consultation with the control/station Master(s) concerned;
- Remain in overall charge till replaced by a senior Railway official and permitted by the Competent Authority;

Notes: In the event of any disability of the Loco pilot the duties devolving on the Loco pilot, for protection of the line/ line(s) shall devolve on the Guard or on a Railway servant deputed by him.

Duties of Loco Pilot of the affected train

- Note the time of the accident, and kilometre;
- Protect the adjacent line (s) at the front end of the train as per GR 6.03; 9.10 and SRs thereto, as the case may be ;

Note: In the event of any disability of the Guard, it will be the responsibility of the Loco Pilot to ensure protection of obstructed adjacent line(s) and the train in the rear as per GR 6.03 and SRs thereto and to give quick information to the Control/ Station Master;

- Take such precautions as may be necessary or as prescribed by special instructions to render his locomotive safe,
- Render all possible assistance to the Guard in rescue and relief measures.

Duties of Assistant Loco Pilot of the affected train.

- Assist the Guard/ Loco Pilot in conveying accident messages to all concerned.
- Help the Loco Pilot in protection of the site of accident.
- Render all possible assistance to the Guard in rescue and relief measures.
- Carry out any other job assigned relating to accident by the Loco Pilot of the train.
- Man the engine in absence of the Loco Pilot.

Duties of the Train conductor/ Train superintendent.

- Assist the Guard in rendering first aid to the injured persons(s) and shifting them to the Hospital.
- Look after the comfort of the passengers, injured and un-injured alike.
- Assist the passengers for protection of their luggage.
- Make out a list of injured/ dead passengers.
- Preserve reservation charts to know the particulars of injured/ dead passengers.
- Organize to transship/ transfer passengers and their luggage to the passenger special.
- Assist for arranging snacks, tea, coffee & drinking water to the injured and other passengers detained at the site of accident.
- Collect the addresses of the relatives of the injured/dead passengers to send information regarding accident.
- Look for the assistance of any Doctor or para Medical staff (Railway. Non – Railway) traveling in the train.

Duties of Coach Attendant

The coach attendant shall work under the guidance of Train conductor/ Train Superintendent.

Duties of Travelling Ticked Examiner (TTE)

- The TTE should work under the guidance of the train Conductor/ Train Superintendent.
- Similar actions as mentioned in (4) above should be initiated by the TTE for his nominated coach.

Duties of A.C. Mechanic

- He should immediately "Switch Off" the current where necessary to avoid short circuiting.
- He should also assist Commercial staff i.e. Train conductor/ Train Superintendent/ TTEs in their duties at the accident site.
- See that the emergency lights inside the Coaches are in working order.

The Senior most RPF Officer available

- Segregate the area of incidence by establishing temporary barriers by use of nylon ropes (if available) or any other make shift device available at the site to protect the area against the entry of spectators into the affected place.
- Luggage of passengers should be isolated and protected and consigned goods are taken care off till they are handed over to claimants or taken over by the Railway.
- He should respond to any call for assistance to rescue victims and transport them to nearest Hospital.
- He shall maintain close liaison with the Officers of various departments of the Railways, GRP, Local Police and Officers of Civil Administration.

Railway Staff travelling on the accident affected train:

- Whenever a train is involved in a serious accident with casualties/injuries to passengers, all railway staff travelling on the train either on duty or on leave are deemed to be on duty with immediate effect.
- Under no circumstance should any of them leave the accident site unless and until divisional officers arrive, take over charge of rescue and relief operations, and permit them to leave.
- Railway staff on train/at site shall volunteer themselves to render assistance and report to TS/TTE/Guard of the Train.
- The senior most officers travelling on the train will assume charge as Officer-in-Charge Site
- Normally the senior most officers will be travelling in either the 1AC or in 2AC coach and most probably in the HOR quota section of the coach. The HOR section of 2AC is invariably in the center of the coach (berth nos. 19 – 22). In any case the TS/TTE would know who the railway officers are travelling in 1AC or 2AC.
- Similarly, other railway staff will be travelling in 3AC coach; and most probably in the HOR quota section of the coach.
- Similarly, some Group 'D' railway staff may be travelling in Sleeper coach; and probably in the HOR quota section of the coach.
- In the absence of any officer, the TS or senior most TTE/Guard will discharge duties listed out for OC Site.

Duties of OC Site – Immediately after the accident:

- Note down the time of accident.
- Ensure protection of traffic by Guard and Driver.
- Ensure reporting of accident to nearest Station/Control.
- Roughly assess the extent of damage and likely number of casualties.
- Collect railway staff and volunteers from amongst the passengers and form different groups. Each of these groups should be assigned work as detailed at item 6 below.
- Maintain a log of events.
- Till Divisional Officers arrive and take over charge of the situation, continue to discharge duties of OC Site.
- After Divisional Officers arrive, fully brief the DRM hand over charge to him.
- The on-board OC Site should ensure issue of a detailed message with following information before leaving the site of the accident.
- Time/Date of accident.
- Location Km./between stations.
- Train number and description.
- Nature of accident.
- Approximate number of killed/injured.
- Extent of damage.
- Assistance required.

- Condition of the adjacent line, if any.
- Whether OHE is involved.
- From here onwards, the DRM of the accident involved division takes over charge as OC Site.

Formation of Groups comprising members of Instant Action Team:

- OC Site shall immediately collect all Railway staff on train/at site and form separate groups.
- Passengers travelling by the same train who volunteer for rescue and relief work should also be drafted into these groups.
- Passengers from accident involved coaches should be directed towards their own coach.
- Passengers from coaches which are not affected can be distributed amongst other accident involved coaches.
- In the absence of OC site, TS/TTE shall take steps to form such groups.
- In the absence of TS/TTE the Guard/Assistant Guard shall take steps to form such groups.
- 5 or 6 groups should be formed depending on number of coaches involved.
- Ideally, one group should be formed for handling each coach.
- In case sufficient numbers of officers are present, then one officer should be made in-charge of each group.
- Otherwise, Sr. Supervisors travelling by the accident involved train should be nominated as in-charge of each group to co-ordinate its working.
- In case sufficient numbers of Sr. Supervisors are also not present, one TTE should be nominated as in-charge of each group to co-ordinate its working.
- Each group should rescue injured, entrapped passengers.

Duties of members of Instant Action Team – Till arrival of Divisional Officers

- If a person is bleeding and loosing blood, or if he is unconscious, then in that case you have to act quickly. 'Golden Hour' should be kept in mind. You may have at the most only one hour's time on hand.
- In such cases, immediately administer First Aid to the injured passenger and try and stop further loss of blood.
- Persons trained in first aid may do 'Cardio Pulmonary Resuscitation'. This may save several lives.
- If the door is open and is accessible, then uninjured passengers should be helped to come out from the door.
- In AC coaches the windows panes should be broken open in order to let in fresh air for the occupants, and thereafter to evacuate them.
- Non – AC coaches have one emergency exit window on each side. The position of this emergency window is 5^{th} from the left when facing the line of windows from inside the coach. They are opposite berth nos. 23 and 57. In case the door is locked and jammed, try and open these windows so that some of the uninjured passengers can come out through the emergency exit.

- Special care should be taken while evacuating the old, infirm and children in order to ensure that they are not separated from their family members.
- Extrication of critically injured should be done under medical supervision as far as possible.
- In case medical supervision is not available, then critically injured passengers should be made to lie down on a bed sheet and thereafter taken out by 4 persons holding the four corners. This will ensure that no further damage takes place. (Bed sheets will be available in AC coaches).
- Passengers who are bleeding from open cuts should be tied up with strips of cloth so as to reduce if not stop the bleeding altogether.
- It is better not to take out the luggage from inside the coaches at the first instance, for two reasons. Firstly, passengers both injured and uninjured should get preference in this evacuation process. Secondly, it may be safer for the luggage to be left inside where there are less chances of their being stolen or pilfered.
- After passengers have been evacuated from your coach, cross check with the reservation chart and against the name of each passenger note down as to whether he/she is injured or not.
- After all passengers have been evacuated; water and eatables can be taken out gradually.
- Building up confidence of injured passengers by suitable advice is of great importance.
- After helping evacuate all passengers from your coach go over to the unreserved coaches and provide similar help to those passengers also.
- Railway officials from divisional HQ generally arrive at the site of the accident within 2 to 3 hours, depending on the distance of the accident site from the divisional HQ qrts. Wait for them to come and make further arrangements.
- Grievously injured passengers who are bleeding or those who are unconscious require immediate hospitalization. In case some local people have arrived by that time, their help should be taken in shifting the grievously injured to the nearest hospital.
- In case your train has been involved in an accident but neither has your coach derailed nor are any passengers of your coach injured, then you should go to the unreserved coaches and carry out the duties as listed above.

Duties of OC Site - till arrival of divisional officers

Having formed different groups consisting of available railway staff on the train and volunteers from amongst passengers, the rescue and relief work should be got started in right earnest. This entire exercise would take about 30" time. Once the rescue and relief work by the **Instant Action Team** has got underway, the OC site should then devote his attention to contacting **First Responders**.

- Locating nearby villages:
- Locating the nearest manned level crossing gate :
- Organizing assistance from local people available in nearby villages

Relief & Rescue Operation

Duties of Official- in charge at the site

The senior most official present at the site of the accident shall be in overall charge of the relief operation till he is relieved by another official deputed by the Administration to take over the charge. However, the senior most official of the Mechanical Department shall be in charge of the relief train. The senior most official present at the site of a serious accident, shall-

- Take general charge of the situation and take action to provide all possible assistance;
- Depute Officers/ senior subordinates and all other staff on specific duties in-
  - Assisting the rescue operation, if any;
  - Assisting the preservation of clues;
  - Assisting the transshipment work, if any;
  - Taking action to remove the obstruction as soon as possible;
  - Ensuring the protection of adjacent line (s) and the affected train as per rules.
- See that the portable telephone is installed and manned constantly by a responsible staff, and ensure adequate lighting of the accident area at night;
- See that the injured persons if any are rendered first aid and shifted promptly for medical aid;
- Ensure to get clearance from Police authorities in case of suspected sabotage;
- Make an immediate assessment of the following, with the help of the available doctors and / or others;
  - The number of persons killed, and of those sustaining grievous, simple and trivial injury;
  - extent of damage;
  - The expected period of suspension of traffic.
  - Assistance required;
  - Prima facie cause of accident;
- See that dealing centre is opened at the site of accident and manned-
  - To keep the details of persons killed, injured , and action taken in each case;
  - To relay the above information in details to the Divisional Headquarters'
  - To attend to public enquiries and
  - To relay the progress of relief work;
- Ensure recording of all information at the dealing centre concerning the accident and the relief operations in the form of an Accident Log Book;
- See that immediate action is taken to protect and safeguard property;
- See that proper assistance is given to the injured, ladies children and the aged;
- Arrange for transporting the stranded passengers preferably to stations where drinking water, catering arrangements etc. are available, unless they can be sent to their destinations;
- See that the arrangement is made for preservation and proper care of dead bodies, if any, till further disposal'

- See that obstruction is cleared in the minimum possible time, and every action taken for this purpose;
- Arrange. For speedy ex- gratia payment as per extant rules.

Duties of Railway Medical Officer

The nearest Railway Medical Officer, on receipt of the report of a serious accident with injury to person. Shall-

- Reach the site of accident with the Medical Relief Train or by the quickest available means, with all men and material commensurate with the serious of the accident;
- Render medical aid to the injured at site;
- Make timely and adequate arrangements for shifting the injured persons to suitable hospitals as considered necessary for further treatment;
- Keep detailed particulars of the dead and injured e.g. their name, address etc. as far as available.
- Deal with the dead and injured as per extant rules and instructions.

Duties of Medical Superintendent/ Divisional Medical Officer

- Ensure the availability of prompt and adequate medical facilities;
- Co- ordinate with Civil/ Military/ State/ Private medical authorities for the purpose;
- In case of an accident to a passenger carrying train, reportedly attended with casualties and / or grievous injuries, unless otherwise advised by the Divisional Railway Manager, proceed to the site of the accident by the first available means.

Duties of Commercial officer at site

The Sr. Divisional Commercial Manager or in his absence the Divisional/ Assistant Commercial Manager, on receipt of information of a serious accident, shall:

- Reach the site of accident by the quickest available means;
- See that immediate arrangements are made to protect the area and safeguard the property;
- Look after the comfort of the passengers, injured and un- injured alike;
- Ensure prompt supply of refreshments, free of charge, to the injured persons and also make adequate arrangement for refreshment and drinking water for the passengers detained at the site of accident for any reason;
- Ensure, in co- ordination with Medical officer (s) at site, preparation of a complete list of injured and dead persons;
- Arrange for adequate number of porters for carrying luggage and parcels in case of transshipment etc.
- See that the doctors are assisted by porters and other staff in attending to the injured and for shifting them to the hospital;
- Ensure the making over to the dead bodies to the Police for disposal;

- Arrange preparation of a complete list of damaged consignments;
- See that the proper arrangements are made for the transhipment of passengers and their luggage at the site of accident if required, as also for transshipment/ unloading of parcels/ affected wagons, if required;
- Ensure preservation of documents of damaged parcels, Mails and Goods etc.
- Senior most railway officer at the site of the accident shall be the designated Site Manager.
- Management of rescue operations- Primarily Mechanical and Medical departments. Assistance to be provided by all railway men (irrespective of their department) as needed.

Preservation of clues

- Officer or senior subordinate of any department who may happen to be present at the time of an accident took place or who first arrives at the scene of an accident shall, irrespective of whether he is on or off duty, record the statements of the staff concerned and take whatever steps maybe necessary to record or preserve evidence which subsequently might not be available. All clues shall be preserved with a view to enabling reconstruction of the scene at a later date. This is essential even though the civil and police officials may have inspected the scene of the accident and photographs may have been taken. For this purpose, the concerned official shall specially take steps to note the condition and exact position of (i) Vehicles, (ii) Track, (iii) Points, (iv) Signals, (v) levers operating the points and signals,(vi) Breakage of axle, spring , locking bolt and cotter etc, (vii) Any obstruction, (viii) Any tampering , (ix) Engine and its speed recorder, etc. This should be done before commencement of actual restoration operation.
- A complete and accurate dimensioned sketch of the accident showing the position of vehicles and their condition, permanent way including any detached damaged components, should be made out by the Engineering official and signed by made out by the Senior Engineering and Operating official of the Railway as also by the Senior Police official present. In the case of any signal or level crossing at the site of the accident, a detail position of the same should be indicated in the sketch.
- In case of sabotage and suspected sabotage, every possible action shall be taken to ensure that any finger prints or foot prints observed at the site of accident are not obliterated.
- Statements of responsible passengers or eye –witness with their names and addresses who may have witnessed the accident should be recorded. These statements should be signed jointly by the passenger /eye-witness, Railway Official and Civil or Police authority.
- The Railway Official /Inspectors /Supervisors who may happen to be present at site at the time of accident or who arrives first at the site of accident ,shall also scrutinize ,the train register /Logbook , Station Diary ,Line Clear Message book ,Private number book ,Caution Order, Line admission book , etc. and initial them with date and time indicating the irregularities noticed. In the cases where these records are connected

with the cause of the accident, immediate action must be taken to seize the relevant records and seal. In cases where defects of any instrument or /and interlocking gear may have caused or contributed to an accident ,the instrument of /and the interlocking gear concerned shall be sealed and not be opened /used except on the authority of the Divisional Railway Manager or his duly authorized representative .

- In cases of serious accidents with loss of human life or grievous hurt, the restoration work should normally be limited to the removal of dead bodies and injured persons from the debris, if any, and wherever by laying a diversion, if it is expected that the Commissioner of Railway Safety may have the benefit of personal examination of the site of accident undisturbed.

- Wherever possible, photographs of the wreckage shall be taken, which may afford the clue to the cause of the accident .For this purpose, the procedure laid down in para 7.05 of the accident Manual should be followed.

- In all case of derailments, the marks on the wheels of engine and /or vehicles and marks on the permanent way (rail, sleepers, fishplates etc.) in respect of the wheels mounting on and dropping from the rails, the wheels riding on the ballast etc. shall be specially looked for and recorded. The position of rails, sleepers, fish bolts turnouts etc which bear marks as a results of the accident, especially between the points of mount and drop shall be marked and numbered serially with chalk or paint and carefully preserved .A defects and damages to rolling stock shall be examined in details and recorded immediately after the accident as also the details of the loads i.e. weight, contents, evenly or unevenly loaded etc.

- Any, engine, vehicle or other material involved in an accident which is likely to be required for exhibition before any higher official or enquiry committee must be set apart and must not on no account be utilized for the purpose of the working of the Railway, till it is examined by the said official

- Speed recorded in the locomotive should be examined including its chart. The same may be seized with the signature of the Loco Pilot

- In case of serious fire accident in train, after the fire is put out, the affected coaches/wagons or the portion of the Railway property which caught fire should be preserved carefully for inspection by Forensic Scientist.

- Railway Officials/Inspectors/Supervisors who may happen to be present at the time of accident or who arrive first at the site of accident shall see that the fire is completely put out and nothing which can lead evidence for the cause of fire including affected Coaches/Wagons is disturbed. However, the Coaches/Wagons may be drawn out from the site cautiously, in order to clear obstructed section and be kept on the siding nearest tothe accident spot with the permission of competent authority.

- One photographer with camera and necessary equipment should form integral part of the group of staff who accompany the ARME and ART.

The Accident Relief Medical Van must be dispatched to the site of accident within 15 minutes from the base station after sounding of the hooter.

Supply of Refreshments, foods and beverages to the passengers and staff at the site of accident

(a) Refreshment, food and beverages may be supplied free of charges to all the affected passengers, injured or uninjured, stranded at the site or at the station where they are shifted for further action..

(b) The senior most officer at the site shall have the powers to

- Arrange conveyance for the affected passengers free of charge.
- Incur expenditure, if necessary, for supplying free food to the affected passengers.
- The Sr. DCM or in his absence DCM/ACM shall be responsible to take necessary action in this regard.

Dispatch of free messages/ sue of dot telephones/ mobile phones free of cost

(a) Messages to the close relatives conveying the news of safety of those traveling by the train involved in a serious accident should be dispatched free of cost.

(b) The passengers of the affected train, may be provided to use mobile phones/ Dot phones, where ever feasible, free of cost. Station Master/ Railway officers at the site of accident may hire cell phones for this purpose.

Accommodation of the relatives of the deceased.

As an additional relief measures; the relatives, of the deceased/ grievously injured passengers may be allowed to use the waiting rooms and retiring rooms free of charge if considered necessary, without detriment to the convenience of other passengers**.**

Issue of Complementary passes.

Complementary passes may be issued to the victims who are discharged from the hospitals and their close relatives, to return to their destinations.

Safe Custody and appropriate disposal of the luggage.

RPF and Commercial staff at the site of accident should co- ordinate their activities regarding safe custody and appropriate disposal of the luggage of the dead and injured passengers. These luggage should be guarded by the RPF personnel and thereafter can be handed over to the rightful claimants.

Care for the trapped/ injured

(a) Officers and staff of all departments, at the site of accident shall keep close co-coordinating with one another for taking all necessary actions to extricate injured passengers from the debris.

(b) On arrival at the site of accident, the Railway medical officials shall offer medical aid as best as possible & shall arrange for the transport of the seriously injured persons to the nearest available hospital promptly.

(c) A Railway medical officer must as far as possible accompany the injured to the hospital and see that they are properly accommodated for further treatment.

(d) Each of the seriously injured persons must be given a ticket, showing his name, address, name & address of nearest relative, the time and place of accident probable

diagnosis and treatment given. This ticket may be placed round the neck of the person for the guidance of the hospital.

(e) Officer of all departments shall render all possible assistance to the medical officer in his effort to reach the site of the accident with his medical team and to give treatment to the injured.

(f) Train carrying injured persons from the site of the accident shall be given priority over all other trains. The controller and Deputy Chief Controller of the concerned division shall be responsible for this.

(g) In the event of injured persons being treated at non-railway hospitals, the senior most medical officer of the division will maintain close liason with the hospital authority, in order to keep information's of latest developments.

Video Coverage at Accident site.

Prior to undertaking restoration measures at an accident sites, suitable video film overage should be arranged where ever feasible. Outside trade may be hired for the purpose. DRMs shall take suitable actions accordingly.

Commercial, Safety, Medical and Mechanical officers are authorized to withdraw money from the station earnings in these cases.

DUTIES OF ON BOARD RAILWAY STAFF AFTER ACCIDENT

- Don't panic. Once the accident has already occurred and the train has come to a standstill nothing worse can happen.
- In case you have a Mobile and it is working, inform the divisional control office immediately about the accident.
- Observe the position in which your coach has stopped; whether it is standing upright or turned upside down or lying on its side.
- Try and see whether your coach has stopped on a bridge or whether there is level ground on both sides.
- In case the coach is on a bridge or very high embankment or in case it is raining heavily, then it is better to wait for some time and not be in a hurry to leave the coach. You may be jumping from the frying pan into the fire.
- Search your coach with your torch and try to determine the general position.
- See that passengers don't panic either. Passengers sometimes make things worse for themselves by panicking at this critical moment. Try to calm them and build up their confidence.
- Ascertain whether passengers are injured or not; and whether any of them are trapped or pinned down inside the debris.
- Call out aloud and find out whether there are any doctors present.
- Doctors who are travelling in the coach should be asked to announce their presence so that they can attend to and help injured passengers.
- Call out aloud and find out whether there are any railway staff present.
- Railway staff who are travelling in the coach should be asked to announce their presence so that they can attend to and help other passengers.
- For each coach, form a core team comprising of railway staff available, doctors and 3 or 4 uninjured passengers from the same coach. This core team should take the lead in helping remaining passengers both injured and uninjured.

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SUPERVISORS SKILL

LEADERSHIP AND LEADERSHIP STYLE

Leadership Definition:
Leadership is a quality of leading a group of people or an organization or ability to do this.

Leadership involves:

- Establishing a clear vision
- Sharing that vision with others so that they will follow willingly
- Providing the knowledge, information and methods to realize that vision
- Coordinating and balancing the conflicts of all members

Difference between Leader and Manager:

- Manager have employees but leaders win followers
- Manager react to change but leaders create change
- Manager have good ideas but leaders implement them
- Manager communicate but leaders persuade
- Manager direct groups whereas leaders create teams
- Manager tries to be hero but leader make heroes of everyone around them
- Manager take credit but leaders take responsibilities
- Manager are focused but leader create shared focus
- Manager exercise power over people but leader develop power with people

Qualities of Good Leaders:
A successful leader should have following qualities in his behavior:

(i) Sense of objective/mission
A good leader should have knowledge of objectives of organizations, rules and regulations of organization etc. he should be committed towards the job, workers and fulfilling the objectives of organization.

(ii) Educational competency
A leader or supervisor should have complete knowledge of the job done under his supervision. Also he should be a technically competent person.

(iii) Exemplary character
It is of utmost importance that a leader is trustworthy to lead others. True authority is born from respect for the good character and trustworthiness of the person who leads.

(iv) Maturity
Good leaders are tolerant of ambiguity and remain calm, composed and steadfast to the main purpose. Storms, emotions and crisis come and go and good leader take these as a part of the journey and keeps a cool head.

(v) Administration
A good leader as well as keeping the main goal in focus is able to think analytically not only does a good leader view a situation as a whole but is able to break it down into subparts for closer inspection. Also a good leader can break it down into manageable steps and makes progress towards it.

(vi) Attitude and confidence
A good leader is confident, enthusiastic, energetic and healthy. He should always keep a positive attitude and try to motivate his gang.

(vii) Knowledge of industrial psychology & human relation

A good leader will be enthusiastic about their worker. People will respond more openly to a person of passion and dedication. Leader should understand the workers problem and should know how to deal with it.

(viii) Team player and socialize

A leader should be a good team player and also he should be socially in touch with his team members.

(ix) Communication

Being able to clearly and successfully describe what you want done is extremely important. If a supervisor can't relate his vision with his team member, they won't all be working for same goal. Communication skills of a leader should be perfect.

(x) Vision

A good leader should have the ability to anticipate the situation or problems that may arise in future and also he should work accordingly.

(xi) Open mindness & flexibility

A good leader will not be affected by the negative conditions arise while work. Also he will neglect small mistakes done by his team members.

(xii) Cheerfulness

A good leader should always be cheerful. A cheerful and open minded person can motivate workers easily.

TYPES OF LEADERSHIP

Following are the types of leadership

(i) Authoritative or autocratic leadership

An autocratic leader assumes all the responsibility for decision making for initiating action and for directing, motivating and controlling his subordinates.

Autocratic leader thinks he is the only competent and capable person to make decisions. The autocratic accomplish his duties through fear of penalties.

Advantages:

- Fast decisions
- Can control those people who are not willing to work in normal way.

Disadvantages:

- No workmen participation in decision making process
- Too strict control on workers
- Workers feels insecurity

(ii) Democratic leadership

A democratic leader practices leadership by consultation. Even though workers participate in decision making process. The final decision is taken by the leader only. The leader becomes more supportive in his contact with workers.

Advantages

- Least no. of disputes
- Workers will be encouraged
- Workers get motivated
- Increase team spirit

Disadvantages

- This type of leadership is only possible when the workers are not biased

(iii) Free Rein Leadership

In this type of leadership, leader depends completely on his subordinates to establish their own goals and to make their own decisions. This leader assumes the role of just another member or the group.

Supervision/Managerial Functions:

Works are of two types as follows

- Job centered supervision
- Employee centered supervision

Advantages of good leadership:

- Increases workers motivation to do work
- Increases workmen's confidence
- Workers involvement to fulfill objectives of organizations
- Increases productivity
- Increases production
- Increase in profit
- Better working atmosphere
- Increases bonus to workers
- Improvement in workers living condition/lifestyle
- Improvement in quality of work
- Reduce/stop spend thrift

MOTIVATION

Main objective of motivation is to produce an effect of self-involvement of workers in work and to attain the aim of organization.

It is important to motivate workers. If a supervisor wishes to ensure good quality of job and better productivity from his gang or team he has to encourage or motivate his workers.

Types of Motivation

(i) Positive Motivation

Following points are involved in positive motivation

- Appreciation of workers
- Provision of increments
- Provision of Promotion
- Provision of Incentives
- Provision of Bonus schemes
- Provision of job security to workers
- Various amenities/privileges
- Improvising methods of work
- Providing privileges to workmen's family
- Workers involvement in decision taking

(ii) Negative Motivation

Following points are involved in negative motivation

- Punishes the workers
- Disciplinary action on worker
- Withholding of increment
- Withholding of promotion
- Reduce incentives
- Reduce bonus
- Reduce privileges or amenities
- Make workers feared about removal from job
- Reduce privileges to workers family
- Transfer
- Fine on workers

Techniques of Motivation

(i) The carrot and stick method
(ii) Motivation through good leadership principles
(iii) Mosh laws theory
(iv) Herzberg's two factor theory
(v) X & Y theory

(i) Carrot and Stick method

This is an oldest method. In this system workers are motivated by giving awards (carrot) and also if not fulfilled the workers get punished (stick). Even though the method is older, is still in use.

(ii) Motivation through good leadership principles

A good leader should be role model to his workers. He should be committed towards work and also possess good behavior, confidence and technical as well as practical knowledge. An energetic & cheerful leader motivates his subordinates to do work.

(iii) Mosh law's theory

Mosh law put forward a theory on human needs in 1934 which categorized human need in 5 levels. Lowest level is basic needs & highest level is need of self-actualization. According to Mosh law, as soon as the workers attain one level, he will try to attain the next level & it will continue up to the fifth level.

These five levels are:

(a) Physiological need:

It includes basic needs of a human i.e. food, accommodation, clothing etc. everyone try to attain these basic needs.

(b) Security & safety needs:

Once a worker attains basic needs, tries to be safe & secure

- His job
- Working safety
- Security of salary, food, clothes etc.

Human Needs as per Mosh Law

(c) Social needs:

When all the above said needs of an employee get fulfilled, the need of social status arises. Human is a social being & they wish to get a better position in the society.

(d) Esteem need:

This need is a related to self-respect, confidence, experience, power & control which is essential to motivate an employee. This also satisfies the ego of worker.

(e) Needs of self-actualization:

Here the worker is allowed to work as he desired in his desired post/position. And this is the last level in Mosh laws theory.

(iv) Herzberg's two factor theory of motivation

Difference between Mosh law's theory and Herzberg's theory is the difference in number of levels i.e. in Mosh law's theory there are 5 levels whereas in Herzberg's theory levels are 2.

Maintenance Factor	A	Salary
	B	Job Security
	C	Working Conditions
	D	Company Policy & Administration
	E	Quality of Supervision
	F	Interpersonal Relations
	G	Status
Motivators	A	Recognition
	B	Advancement
	C	Responsibility
	D	Growth in the job
	E	Achievement
	F	Challenging Work

(v) X & Y Theory

X in this theory means that the worker who is not willing to work is to be assigned to such a work which he desired not to do. Y denotes the assignment of a good worker to a good & desired job by him.

COMMUNICATION

Communication is the activities of conveying information through the exchange of thoughts, messages or information as by speech, visuals, signals, writing or behavior. Communication plays a vital role in an organization.

Communication gap is a serious problem in organizations and even in families. Never stop communicating with your enemy too, because doing so will stop the chance of compromise. Communication requires –

- A sender
- A message
- A recipient

MEDIUM FOR COMMUNICATION:

Following are the most common medium of communication

- Communication through letters.
- Through emails.
- Through telephonic conversation.
- Face to face or group communication.
- Notice board.
- Organization's journals and magazines.
- Through surveys.
- Through complaint register.
- Organization's performance review.
- Through unions.
- Through organization's own communication system.

Medium for communication is chooses according to below said factors:

a) Price/ cost
b) Confidentiality of communication
c) Necessity of feedback
d) Trustworthiness of medium
e) Clarity of medium
f) Necessity of record keeping of communication

TYPE OF COMMUNICATION

(i) Formal communication

(ii)Informal communication

Formal Communication

This type of communication is a major factor involved in an organization. Formal communication is written, oral or graphic communication which follows the lines of authority and accountability. Formal communication has three channels-

a) **Upward Communication (vertical)**: Upward communication flows from lower levels to the higher levels of the organization. E.g.:- A SSE communicating to Dy. CME.

b) **Downward Communication:** It involves flow of communication from higher level to lower level. E.g.:- Dy. CME is communicating to a SSE.

c) **Horizontal Communication**: It is information exchange between departments as means of coordinating their activities. It occurs across same levels. E.g.:- A SSE to another SSE.

Informal Communication

The communication arising out of all those channels of communication that fall outside the formal channel is known as Informal Communication. It takes place due to the individual needs of the members of the organization. It may be upward, downward or horizontal.

Barriers to Successful Communication

The below mentioned barriers obstructs the communication, due to which information interchange is interrupted.

a) In every organization there will be certain levels through which information is to be passed. Example JE ->SSE->AWM->WM->DEPUTY CME->CWM.

b) In equal distribution of work i.e. difference in amount of work to be done by individual workers.

c) Attitude: some people do not listen to others and thus only listen or pay attention to such things which they like to hear.

d) Prestige and superiority complex: due to superiority complex and proud, some people do not pay attention to others and do not like to communicate with others and they think that no need to consider suggestions of worker lower to them.

e) Prejudiced: for people always keep a prejudicing mentality .they consider others suggestions to be wrong even though that may be right.

f) Biased nature: any officer /supervisor /worker should be impartial. Partiality causes communication gap.

g) Emotionally upset receiver

h) Receiver interprets his own meaning.

i) Ignorance of points /disputed points.

j) Not to communicate at proper time.

k) Mobile phone

l) Disturbances and noises.

Techniques to Improve Communication

- Use simple language and words or indecent.
- Do not use improper language or slangs.
- Use face to face communication.
- Use least number of mediums.
- Try to get feedback from receiver.
- Think before communicating.
- Maintain friendly and calm atmosphere in organization.
- Always try to stress on the important points.
- Emotional and mental condition of receiver should be considered while communicating.

- Use actions with words where it is necessary.
- Worker should be well instructed at the time of job distribution.
- Get feedback from workers in several intervals while doing a job.
- Discuss with the workers about the work soon after lunch interval.
- Instruct workers in groups also.
- Try to communicate with all workers at least once a day.
- Keep a record of communication where ever is necessary.
- Make notes of telephonic communications when necessary.
- Use minimum number of sentences and clear words while writing letter.
- Only talk when needed and do not talk in vane & do not deviate from topic.
- Be a good listener and do not interrupt others while talking.
- Do not involve in personal talk & do not hesitate to communicate.
- Do not get involved in meaningless talks.
- Be focused while attending a meeting.
- Switch off your mobile phone while attending meeting.
- Do not communicate in between noise and disturbance.
- Be impartial and behave impartially.
- Do not undergo influences & do not become prejudice.

TIME MANAGEMENT

Time management is the act or process of planning and exercising conscious control over the amount of time spent on specific activities specially increases effectiveness, efficiency or productivity.

In every project time management is an important factor which decides the total duration of the project. Below mentioned are the factors involved in the time management.

Factors involved in the time management

(i) Creating an effective environment

Keep things in neat and orderly at home and workplace so that effective utilization of time can be done. In order to make this possible better housekeeping technique to be brought into use.

(ii) Setting priorities and goals

Keep an aim for each project and try to attain that aim. Note down the aims and divide it into small fragments and plan accordingly. Set the priority while planning and fix a dead line for each action.

Analysis used in Time Management

(i) ABC ANALYSIS: This is used in business world.

A-Urgent works and works of importance

B- Important work but not urgent.

C- Neither important nor urgent.

(ii)PARETO ANALYSIS: In this method the total work is divided according to time taken.

80% of time to do 20% of work and

20% of time to do 80% of work.

Work is classified or divided into two groups and accordingly decide in which group the work falls in. this method increases productivity.

(iii) Implementing Goals: In this, a task list is made. Task list can help to memorize the important works. This is a type of self-management. The time required for each job is specified in the task list and is followed.

Simple Techniques of Time Management

(i) Daily Planning: A detailed plan of works to be done each day is to be made. This will make life orderly and help in self-control.

(ii) Prioritize your Task: Set priority for each and every task & set according to priority of job.

(iii) Say "NO" to Nonessential Jobs: Learnto say no those work which are not related to us. This will enable us to find enough time to do essential jobs.

(iv) Delegate: before doing any job, review it and understand the job and decide whether the job can be distributed to someone else or not.

(v) Take time to do quality jobs: take enough time to do quality works. These works consume more time. After getting experience this time can be reduced.

(vi) Break time consuming large jobs into small tasks: Break large work into small task and plan the job accordingly. This will help in easy completion of big and complicated tasks.

(vii) Practice 10 minutes rule: Allocate 10 minutes for dreaded works. This will reduced the effort to be put to complete these tasks.

(viii) Evaluate how you are spending time: Make a diary and evaluate utilization of time for a period of three days. This will help us to understand which all activities are necessary and which are unnecessary. Also this will enable us to decide priority of job.

(ix) Limit distractions: While doing works which need higher degree of concentration, try to avoid distractions by keeping the doors and windows shut, mobile phone switched off.

(x) Get plenty of sleep, eat a healthy diet and exercise regularly: in order to maintain equilibrium in life it is necessary to get enough sleep. A healthy body bears a healthy mind. Regular exercise and healthy diet make a healthy body and mind.

(xi) Take a time management course: It will help us to maintain time keeping in our life.

(xii) Take a break when needed: Too much stress will cause mentally unfit for doing jobs. So it is better to take break whenever you feel frustrated or in stress.

(xiii) Ask for professional Help: Even after applying all the above said methods, you cannot manage time properly. It is better to take help of a professional who is well experienced in time management.

Advantages of Time Management

a) Better utilization of time
b) Saves money.
c) Stops spend thrift.
d) Increases profit.
e) Increases production.
f) Increases productivity.
g) Increase quality of product.
h) Improves relation between worker and management.
i) Better working conditions.
j) Increases salaries of workers
k) Increase bonus.
l) Helps in nation's development.
m) Lesser stress level.
n) Stops unnecessary works.
o) Improves personal and family life of worker.

STRESS MANAGEMENT

In this era, everyone is busy. All are busy with family, society or work. All these may induce stress. If this stress not manages properly, it may cause the worker not able to perform his daily duties effectively.

Definition

It is a technique which will help to reduce or control stress levels induced in a person from his daily activities.

1. **Source of Stress in Your Life:** This is the first step in stress management. Review the habits or behavior of self, which causes stress. Identify what causes you more stress and how you manage it and what is its effect on your health.
2. **Look at How You Currently Cope the Stress:** After knowing the source of stress, analyze how you are dealing with it and the way you are dealing with it in healthy or unhealthy manner. Below mentioned are some of the unhealthy ways of stress relieving:
   - **a)** Smoking
   - **b)** Drinking Liquor
   - **c)** Overeating
   - **d)** Less eating
   - **e)** TV or computer addiction
   - **f)** Avoid friends and family
   - **g)** Taking drugs
   - **h)** Sleeping for long durations
   - **i)** Being angry unnecessary''

3. **Dealing with stressful situations:** Lot of people take help of four a technique to get a relief from stress.

Change situation	**Change your reaction**
1A. Avoid stressor	3A. Adopt to stressor
2A. Alter the stressor	4A. Accept the stressor

4 **Stress management strategy:** Below mentioned 6 strategies are involved in this-

- **a)** Avoid unnecessary stress.
- **b)** Alter the situation.
- **c)** Adopt to the stressor.
- **d)** Accept the things that you cannot change.
- **e)** Make time for fun and relaxation.
- **f)** Adopt a healthy life style.

Avoid Unnecessary Stress: It is not possible to avoid all kinds of stress. Still some of these stresses can be avoided as mentioned below-

i. **Learn to say "NO":** Do not accept jobs which do not come under your responsibilities.

ii. Avoid people who induce stress in you.

iii. **Control situation/atmosphere around you:** If TV news/ radio news makes you stresses, try to avoid them. If traffic makes you stressed, travel when there is less traffic.

iv. Avoid disputed subjects in talk.

v. Make a list of works according to priority.

Alter the Situation: If you can't work in a stressful situation, try to change it and think how you can change it so that it will not produce stress again.

i. Do not suppress your feelings.
ii. Be ready for compromise.
iii. Face the situations.

Adopt to the Stressor: If you can't alter the situation or stressor, try to adopt the stressor and change self.

i. Learn the problem: Understand the problem and seriousness of problem.
ii. Positive attitude or be optimistic: instead of being pessimistic, thinking of failure of past, try to be optimistic by recalling the success of part and increase your confidence.

Accept the thing that you cannot change.

Find time for rest and entertainment: it is necessary to take rest and entertainment, in order to keep our self-energetic. Below mentioned activities are:

1	Jogging	9	Exercising
2	Going to garden	10	Yoga and aerobics
3	Keeping pet	11	Wear good clothes
4	Reading	12	Pray to the god
5	Listening music	13	Meet friends and family
6	Watching good movies	14	Sense of humor
7	Agarbattis or fragrances	15	Do not be jealous
8	Playing sports and games	16	Go for picnic with family

Adopt a healthy life style: Resistance to stress can be increased by adopting a healthy life style.

i. Exercise: Exercise for 30 minutes for 3 days in a week.
ii. Balanced Diet: Have a balanced diet. Over eating and less eating are symptoms of stress. Sleep a while after lunch, walk a mile after dinner.
iii. Avoid taking drink and smoking.
iv. Have enough sleep.

Advantages of Stress Management

a) Workers improve interest in job.
b) Happy workers.
c) Less spend thrift.
d) Increased production.
e) Increased productivity.
f) Increased profit.
g) Improved life style of worker.
h) Good worker-management relation.

What is Stress

It is natural reaction of thinking.

Symptoms of Stress

i. Repeating the same thing again and again.
ii. Muttering
iii. Being depressed
iv. Fainting
v. Acidity
vi. Head ache
vii. Painful muscle
viii. Shivering
ix. Diarrhea
x. Sleeplessness
xi. Being over exhausted
xii. Impotency

Causes of Stress

i. Death of spouse
ii. Divorce
iii. Death of family member
iv. Sickness/ accident of self or family member.
v. Bachelorship
vi. Unemployment/ removed from job
vii. Retirement
viii. Sexual problem
ix. Change in diet

Life is Experiences

i. Past is Experience
i. Present is Experience
ii. Future Experience

Use your experience in your experiment to achieve your expectation.

INTERPERSONAL SKILL

DEFINITION

Interpersonal skills are the skills which we used in our daily life when we interact with others and society. People with interpersonal skills are more successful in life than others.

Types of interpersonal skills

(a)**Listening skills:** this is the art of listening and understanding any message conveyed by speaker because of listening skills any company can keep their customer happy and satisfied. This increases productivity, sales and reduce errors.

10 principles of listening are:

- Stop talking
- Prepare yourself to listen
- Allow the speaker to speak
- Remove distractions
- Empathize
- Be patient
- do not be prejudice
- Understand the tone of speaker
- Do not respond spontaneously. Keep a wait and watch policy
- Understand the idea behind the words of speaker

(b) **Verbal communication:** discussed in lesson 3.

Non-verbal communication: it involves the followings points-

- Body movement
- Posture
- Eye contact
- Closeness of personal space
- Facial expression
- Physiological change

(c) **Problem solving and decision making**

In day to day routine of a supervisor, he has to face of lot of difficulties or problems in works. It can be arouse from men, machine, money, time etc. he has to face the problem and solve it efficiently so as to have a successful carrier. These problems' solution can be achieved by making and implementing a proper decision.

- Define the problems
- Evaluate the alternatives
- Select suitable alternative

(d) **Stress Management and Assertiveness:** (Discussed in Chapter -Stress Management)

TYPES OF DECISION

(i) Programmed & non-programmed decision
(ii) Major & Minor decision
(iii) Routine & strategic decision
(iv) Organizational & Personal decision
(v) Individual & Group decision
(vi) Policy & Operational decision
(vii) Long term, departmental & non-economic

Programmed & Non-programmed decisions

It is the decision which is made according to some rules & regulations etc.
e.g.:- DA to employees
It is the decision which is taken at a disputed situations/ problems etc.
e.g.:- Unexpected break down of a machinery

Major & Minor decisions

Major decisions are those which taken for buying or selling of precious machineries or plants. Minor decisions are those which taken for buying or selling of not too costly items.

Routine & strategic decisions

Routine decisions are those taken during the routine jobs. Strategic decisions are related to various policies. It involves decisions which made for spending organization's money or to decide price of products.

Organizational & personal decisions

Organizational decisions are those decisions which are taken by a manager in his work related to the organization. Personal decisions are those taken in personal life.

Individual & Group decisions

Individual decisions are taken by a single person keeping in mind that the rules are followed. Group decisions are those which are taken by a group or panel of people.

Policy & Operational decisions

These are the decisions taken by higher management of organization. Operational decisions are those which are taken by the middle management.

Long term, departmental &non-economic decisions

Long term decisions are those which are taken for a long duration. Departmental decisions are taken by any department of organization. On-economic decisions are those which are related to morality/ moral behavior.

PROCESS OF DECISION MAKING

This involves the following:

a) Define problem
b) Analyzing problem
c) Develop the alternative
d) Choose the best alternative
e) Converting the decision into effective action
f) Implementing & verifying the decisions

Define the problem: Managers or supervisors will meet with many problems like increase in cost of production, decreasing sales etc. in these situations one have to take decisions by keeping in mind the organization's interest/policy. Before any such decision making, identify the problem.

Analyzing the problem: Learn the problem carefully and analyze what kind of problem is and who is responsible for solving it.

Develop the alternative: Find out all possible alternatives for solving and note it down. Also analyze the effect of each alternatives effect on the organization.

Choose the best alternative: From all possible alternatives, choose the apt alternative so that the work can be done with limited time and high profit.

Convert the decision into effective action: While directly choosing the solution, involve all of them who are involved in the work. This will make easy to attain a unique solution. Once all the workers involved studies/understand the solution to the problem, the work can be started.

Implementing and verifying the decisions: Once the work started according to the solution/decision, the supervisor has to ensure that the method evolved is being followed on job.

ENERGY CONSERVATION

Energy conservation refers to reducing energy through using less of an energy source/service. It has also effect on nature. Energy conservation reduces the atmospheric pollution as it reduces the usage of energy services.

Considering the necessity of energy conservation, 14 December of every year is celebrated as energy conservation day. If we do not reduce /regulate the utilization of energy sources, it will end up with in few years and will cause huge energy prices.

ENERGY SAVING TIPS:

30% energy needs of a country is for domestic usage. So energy saving should begin at home. Below mentioned are common techniques.

- While building home, proper ventilation should be ensured.
- Window should be provided in such a way that the natural light illuminates inside of house.
- Use light coloured paint inside the house.
- Use light coloured curtains on windows.
- Switch off all electric equipments when not in use.
- Clean up all the illuminating equipments.
- Use energy saving CFL instead of conventional incandescent.
- Use electronic cokes/ballast.
- Use electronic regulators.
- Place exhaust fan above ceiling fans.
- Use automatic iron box for ironing clothes.
- Set geyser temperature at 120°F.
- Before igniting the stove, be ready for cooking and ensured all items are ready.
- Ensured that gas stove burner is clean and the flame is blue in colour.
- While cooking, close the utensils with lids.
- Do not boil/heat up the things directly after taking out from refrigerator.
- Use solar water heaters.
- Unplugged the chargers when not in use.
- Keep good clearance between fridge and wall.
- Do not set too low temperatures in fridge.
- Ensured that fridge door is air tight.
- Always keep fridge door is closed.
- Do not keep hot materials in fridge.
- Use timers on washing machines.
- Use hot water for washing dirty clothes.
- Use adequate water and soap powder.
- Use automatic cut off in AC.

SAVING ENERGY ON ROAD

- Use more energy efficient vehicle or methods for transportation.
- Try not to travel while heavy traffic occurs.
- Use cycle or walk for shorter distances.
- Turn off vehicle at signals.
- Maintain required air pressure inside tyres.
- Carry out regular maintenance services.
- Do not travel on irregular roads.
- Shift gear according to speed of vehicle.
- Do not use brake frequently.
- Do not drive on half clutch.
- Do not overload the vehicle.
- Replace fuel & oil filters yearly.
- Replace engine oil & gear oil regularly.
- Close windows while using AC or heaters.
- Do not drive continuously.
- Turning off AC while travelling save 20% fuel & energy.
- Buy energy efficient vehicles.

ENERGY SAVING TIPS IN WORKSHOP/ OFFICE

- Buy energy efficient equipments.
- Buy BEE certified equipments.
- Use both side of paper.
- Implement paper less working.
- Turn off equipments which are not in use.
- Use natural ventilation and lighting.
- Stop water leakage from pipes.
- Stop air leakage from compressed air lines.
- Engage trained workers on machines.
- Machines are to be used according their efficiencies.
- Reduce idle time of machines.
- Turn off computers when not in use.
- Display posters on energy saving tips.
- Conduct energy audit.

ADVANTAGES OF ENERGY CONSERVATION

- Control spendthrift
- Increases productivity and profit
- Helps in development of nation
- Preserves nature
- Less stress
- Fuel for future generations.
- Increases savings.

ROLE OF VIGILANCE

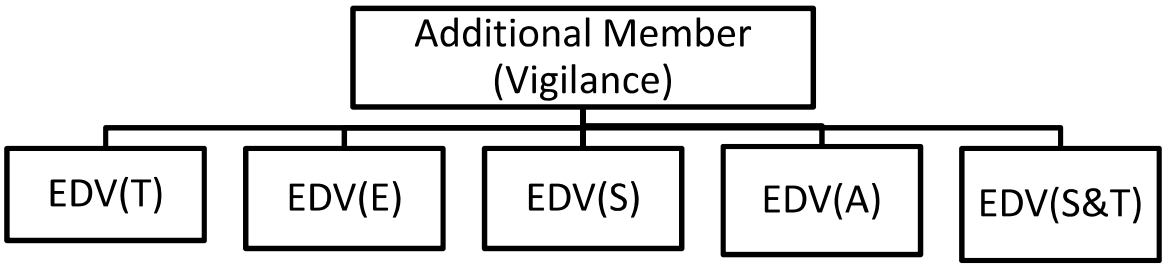
CENTRAL VIGILANCE COMMISSION was established in 1964 by the government of India. The main objective is of CVC is to stop bribery and corruption in government sector. It is an institution under governance of central government.

First CVC was N. SHRINIVASA RAO. This commission submits an annual report to the central government of India regarding the jobs done by CVC and the corruption in various departments of government.

CVC carries out their work through CBI or a CHIEF VIGILANCE OFFICER**.** Chief vigilance commissioner and vigilance commissioner are appointed by president of INDIA**.**

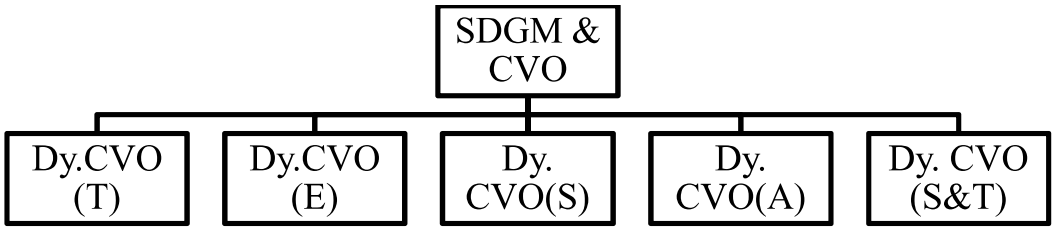
VIGILANCE DEPARTMENT

In INDIAN Railways vigilance department is under member vigilance in Railway Board.

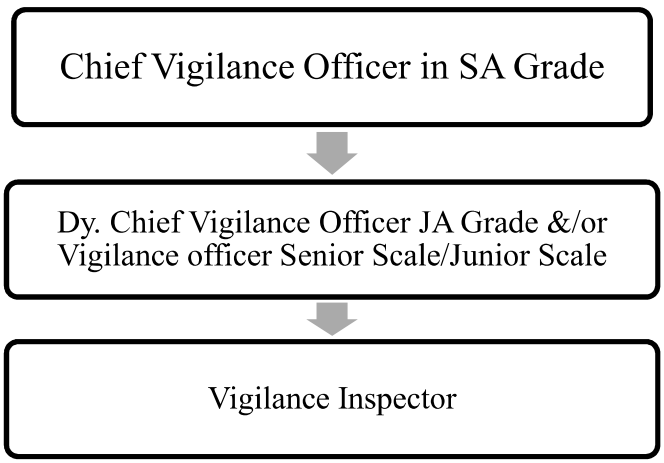


VIGILANCE DEPARTMENT AT ZONAL LEVEL

SDGM heads the vigilance department at zonal level.



ORGANIZATION OF VIGILANCE DEPARTMENT IN PRODUCTION UNITS/OTHER UNITS



VIGILANCE BULLETINE

It is issued twice yearly by Railway Board.

VISION OF VIGILANCE DEPARTMENT

- Bribery
- Partiality
- Differentiating Mentality

Above said points/ factors are considered while vigilance department working. If any kind of complaint is received by vigilance, they act upon it suddenly and the culprit will get punished immediately.

DUTIES OF VIGILANCE DEPARTMENT

- Conduct enquiry on complaints related to corruption and bribery.
- Enquiry on serious unlawful activities.
- Speedy closure of vigilance cases.
- To check whether charge sheet is made properly and no loopholes are left.
- Ensure that D & AR enquiry is being conducted properly.
- Helping CBI with providing data.
- Develop secret services so as to get news regarding corruption.
- Keep an eye on concern officers and employee.
- To understand and feedback with suggesting related to Railway rules and working.

Below mentioned are directions from the vigilance department to the worker:

- Do not misuse Railway's privileges.
- Do not misuse Railway's assets.
- Follow Railway conduct rules.
- Do not misuse your post & powers.
- Do your duty properly.
- Obey establishment rules.
- Do not use short cut methods of working.
- Provide data to vigilance on demand.
- Do not tamper the documents.
- Do not involve in corruption.
- Motivate loyal workers.
- Keep record of all your works.
- Be loyal and trustful to your job.

INDEX

WELDING AND NDT

INTRODUCTION

Welding is the process of joining two pieces of metals by application of heat. The heat may developed in several ways, along with the application of heat, in some way pressure is also applied in order to have better action of joining. For additional strength, sometimes filler material is also added. It is very old and this is started with joining of two metals by heating them to a very high temperature and then hammering. The various ways of applying pressure in order to affect welding are hammering and rolling.

In welding without the application of pressure the metals are brought to fluid state and joined by some filler materials. This is the most rapid and the easiest way of fabrication and assembly of metal parts. The research carried out in this field has given various ways and method to weld practically all metals. Devices have also been found out to weld dissimilar metals.

Most important quality of welding as compared to other methods of joining is in this process we can have more than 100% strength of joint and it is a very easy process.

It is divided into two main sub-classes:

1) Plastic Welding
2) Fusion Welding

Plastic Welding

In this process the piece of metals to be joined are heated up to the plastic state and then forced together by external pressure without addition of filler material. e.g. Forge welding, Resistance Welding, Thermit Welding etc.

Fusion Welding

In this case, the metal at the joint is heated to its molten state and allowed to solidify. In this case filler material is used during welding process. E.g. Gas welding, arc welding, Thermit welding.

Advantages of welding

- A good weld is as strong as base metal.
- General welding equipments are not very costly.
- Portable welding equipments are available.
- Welding permit considerable freedom in design.
- A large number of metal/alloys both similar and dissimilar can be joined by welding.
- Welding can join work piece through spots as and in number of other configurations.
- Welding can be mechanized.

Disadvantages of welding

- Welding creates harmful radiations (light), fumes and spatters.
- Welding results in residual stresses and distortion of work piece.
- Jigs and fixtures are generally required to hold and position the parts to be welded.
- Edge preparation of work piece is generally required before welding them.
- A skilled welder is a must to produce the good welding job.
- Welding heat produce metallurgical changes.
- A welding joint for many reasons require stress relief heat treatment.

DEFINITIONS OF WELDING TERMS

Alternative current or AC: -In this kind of electric current, polarity of the current changes its directions from positive to negative and from negative to positive 50times in a second.

Direct current or DC: - Electric current which flows only in one direction.

Arc Voltage:-The voltage across the welding arc.

Open circuit voltage: - The voltage between output terminals of welding machine when no current is flowing in the circuit.

Base weld: - The metal to be welded, brazed, soldered or cut.

Flux:-A fusible material or gas used to dissolve and prevent the formation of oxides, nitrites or other undesirable inclusions formed in the weld metal.

Bevel:- an angular type of preparation .

Weld:-A localized merger of metal or non-metal either by heating the material to welding temperature, with or without the application of pressure and with or without the use of filler materials.

Fillet weld:-A weld of approximately triangular cut section, joining to section approximately at right angle to each other.

Groove weld:-A weld made between to member to be jointed. The standard types of groove welds are as follows-

- Double – V
- Double –U
- Double –J
- Single – V
- Single – U
- Single – J etc.

Root of weld:-The point at which the bottom of the weld intersects the base metal surface.

Root opening: - The separation between the members to be joined at the root of the joint.

Face of weld: - The exposed surface of the weld.

Weld toe:-The junction of the weld face and base material.

Throat of Fillet Weld:-Shortest distance from the root of fillet weld to be face.

Weld Reinforcement: - It is added to ensure that the net throat of weld is not less than that of plate welded. In fatigue or under vibrations the weld joint has the higher strength.

Penetration: - The distance, the fusion zone extended below the surface of the part or parts being welded.

Heat affected zone:-The portion of base metal which has not be melted but the structural properties of which have been altered by the heat of welding or cutting.

Crater: - A depression at the terminations of the welds.

Post heating: - Heat applied to the work after welding or cutting.

Reversed Polarity: - The arrangement of arc welding load where in the work is of the negative pole and the electrode is the positive pole of the circuit.

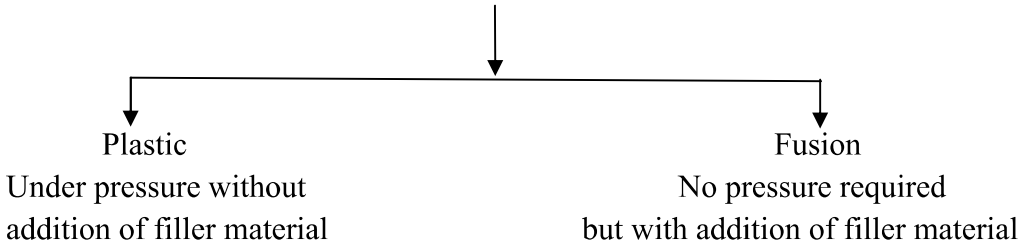
Straight Polarity:-The arrangement of arc welding load where in the work is of the positive pole and the electrode is the negative pole of the circuit.

Tack Weld: - A weld generally of short length made to hold parts to be welded in proper alignment before fully welding.

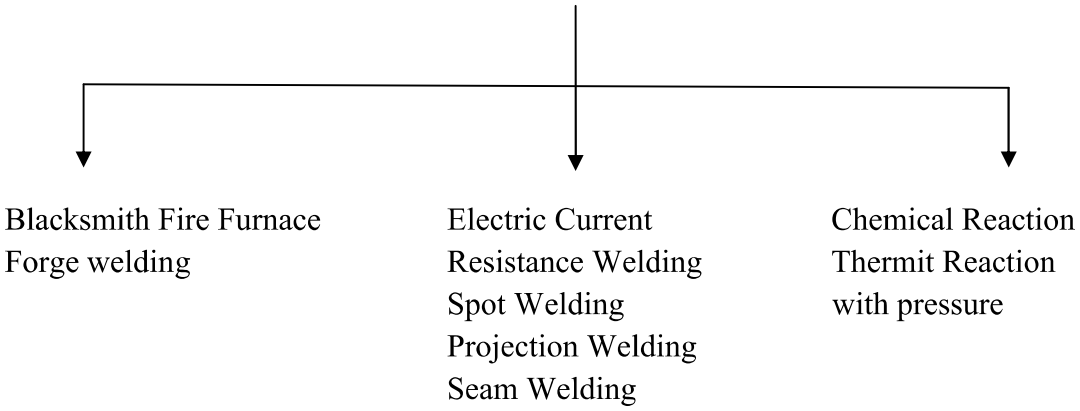
Arc blow: - The deflection of an electric arc from its normal path because of magnetic forces.

Arc Length: - The distance from the end of the electrode to the point where the arc makes contact with work surface.

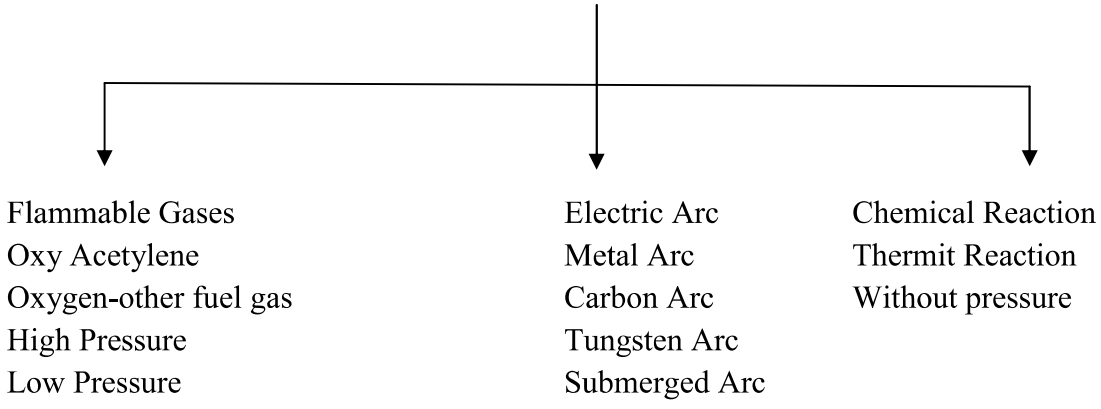
WELDING METHODS



Plastic Welding Method (Heat Generation)



Fusion Welding Method (Heat Generation)

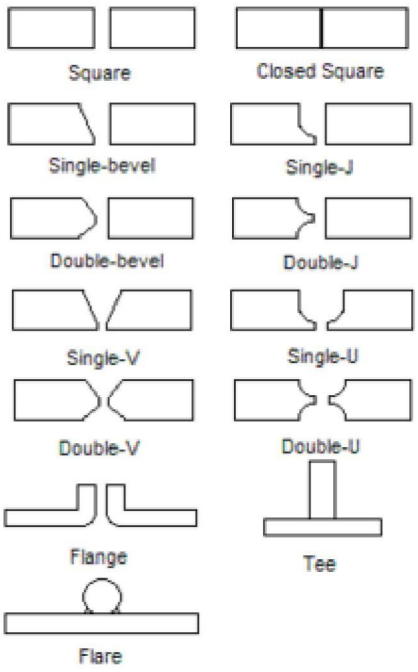


Edge Preparation: For obtaining good results it is necessary:

- It is desirable that two surfaces to be weld should be clean and free from foreign particles/materials.
- The cleaning can be done by wire brushing, machining or sand blasting.
- Impurities of present trend to make the joint weaker as the weld portion is fitted with gas and slag inclusion and metal become brittle and the deposition between the metals is poor.

The various possible edge preparations for butt joints are:

1. Square
2. Single V
3. Double V
4. Single U
5. Double U



In this cleaning of the metal faces from dust, sand, grit, oil and grease is very important.

In square butt weld, the distance between two faces is kept about 3mm and it is used for sheet about 1 to 5mm thick.

Single V and Single U butt weld are used for sheet of about 5 to 15mm thickness. The angle between the edges is kept about 70 to 90 degrees, as depending upon the welding techniques.

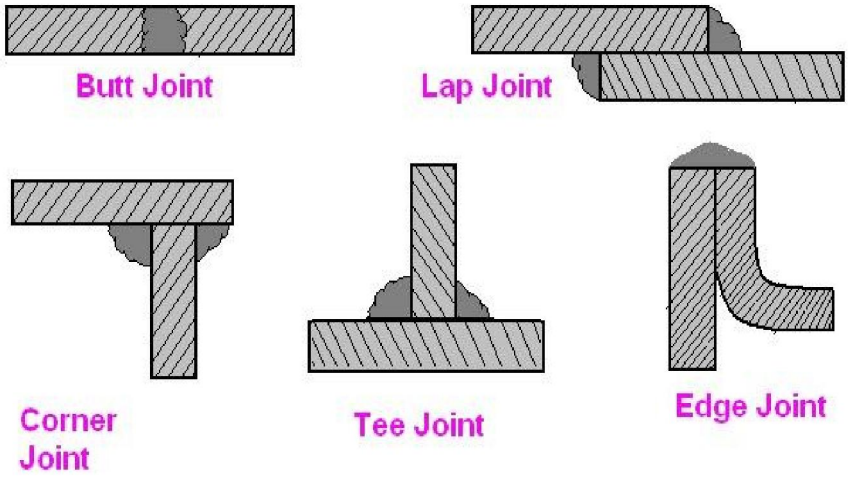
Double V and double U butt welds are used for sheet of thickness over 15mm.

Welding Joints

These types of joints are determined by the relative position of two pieces being joined. There are about five principal types of joints mostly used in welding processes:

a) Butt joint
b) Lap joint
c) T-joint
d) Corner joint
e) Edge joint

Welding Joints



Gas cutting: The cutting of metallic sheet by means of oxygen and other fuel gas with the help of cutting torch is called Gas cutting.

Principle of gas cutting: In this method, the oxygen flame heats the metal up to its melting point and convert the metal into oxide. The molten oxide is removed by the gas pressure and the metallic sheet gets divided into two pieces.

There are different methods of oxygen cutting.

a) Oxy fuel gas flame cutting
b) Metal Powder cutting
c) Chemical flux cutting (Injection cutting)
   Typed of cutting torches:
   a) Injection type cutting torch
   b) Medium or uniform pressure type cutting torch

Welding positions – These are different position of welding

a) Flat position
b) Horizontal position
c) Vertical position
d) Overhead position
e) Inclined position

Arc Welding

Arc welding tools and equipments

The principal tools and equipments used in arc welding are as follows:

1. Welding machine (DC motor generator, AC Transformer set, etc.)
2. Welding cable
3. Electrode holder
4. Earth clamp
5. Welding table
6. Cable connector
7. Clamp
8. Chipping hammer
9. Welding cream
10. Welding safety goggles
11. Hand gloves
12. Apron, boiler suit
13. Leather safety shoes
14. Hand sleeves

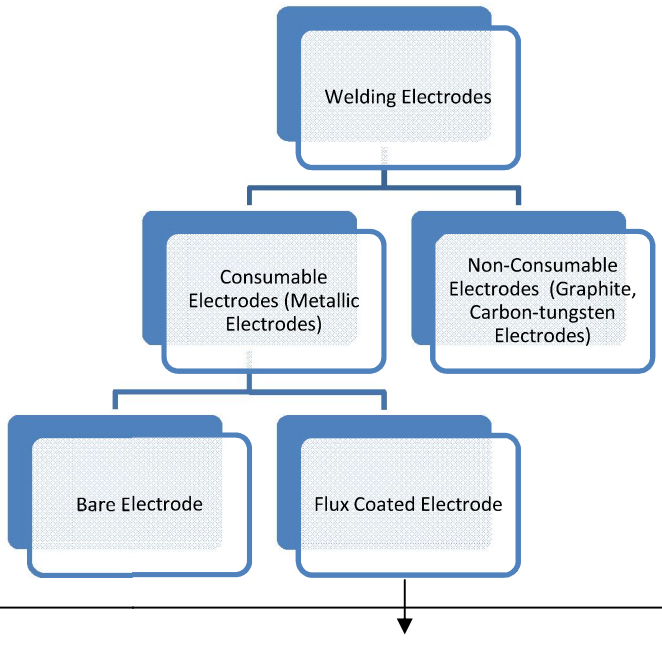
Function of an electrode in an arc welding

The arc welding is done with the help of an electrode. It is metallic bar or wire which carries the current from the electrode holder to the job, the arc is produced by the electrode.

Types of electrodes:

a) Flux coated electrodes

b) Bare electrodes



1. **Light Coated Electrode**
2. **Medium Coated Electrode**
3. **Heavy Coated Electrode**

Non- ferrous Electrode
Cast Iron Electrode
Alloy and mild steel Electrode

Selection of electrode

Selection of electrodes for particular application is very important to achieve desired properties in the welding joints.

a) Chemical composition of base metal
b) Thickness of work piece
c) Nature of electrode coating
d) Position of electrode
e) Type of joints
f) Type of power sources
g) Type of polarity
h) Weld bead geometry and shape of weld bead surface.
i) Amount of weld metal to be deposited and deposition efficiency of electrodes.
j) Surface finish and quality of weld metal.
k) Mechanical and other properties required in the weld joints
l) Cost of electrodes.

Care and storage of electrodes

Care is required in handling and storage of electrodes. Electrode coating should neither get damped nor be damaged or broken. Electrode with clamp coating will produce a violent arc, porosity and cracks in the joints. Electrode with damaged coating will produce joint of poor mechanical properties. To avoid damage of coating

a) Electrode during welding should neither bend nor deflected.
b) Electrode packet should not be thrown or placed over each other.

Electrodes should be stored in dry and well ventilated store rooms. Before use, electrode be dried as per manufacture recommendations. Storage temperature should be about 12 degree Celsius about that of normal air temperature with 0.601 humidity. Cellulose electrodes are not so critical but they should be protected against condensation and stored in a humidity of 90%. All electrodes especially costlier ones should be used till they left hardly 40 to 50mm.Electrodes should preferably be refrained in original packing for identification. Electrodes may be dried at 150 degree Celsius for one hour before use.

CO_2 AND MIG WELDING

CO_2 Welding

Introduction

MIG (CO_2), MAG welding is a variation of the standard MIG process. In MIG process, generally argon, helium or their mixture are used for shielding the molten weld pool whereas in CO_2 welding process, CO_2 is used as the shielding gas.

- CO_2 being an active gas, this process is known as MAG process.
- CO_2 welding is used for welding of carbon and low carbon sheets from 16 gauge (0 to 0.54 inch) to ¼ inch.
- It produces deeper penetration than argon.
- CO_2 have become widely popular for arc shielding or welding of sheets.
- CO_2 is basically a semi automatic process, ion which the arc length and the feeding of electrode wire into the arc automatically controlled.
- Less skilled welding is required in compare to TIG and SMAW produced.
- CO_2 may also be used in mechanized and automatic forms where productivity is to be increased and consistent quality in weld object is demanded.

Welding Equipments

- A DC power source and controls.
- A wire feeder which consists of DC motor, speed reduction box, $2/4^{th}$ roll drive, gas solenoid wall, and potentiometer.
- The welding gun.
- Shielding gas
- Gas pressure regulator
- Flow meter
- Control cable
- Welding cable
- Hoses for gas and water
- Gas pre heater
- Welding helmet
- Gloves
- Apron
- Anti spatter spray etc.

Welding procedure

- Correct edge preparation and joint fit up.
- Joint surface to be cleaned of rust, scale, grease or any other foreign matter.
- Assembling the weld equipments and setting the welding parameters.
- Selecting correct gun nozzle size.

- Setting electric extension on the bases whether short circulating or spray type welding is to be done.
- Passing on the CO_2 gas supply to remove air from the holes and then setting CO_2 flow rate as per base metal and joint design.
- Fillet, vertical, horizontal and over head welds can also be made using CO2 welding.
- After the weld is complete the end crater should be filled.

Advantages

- Higher welding speed.
- Better and deep joint penetration with good bend control and little tendency to undercut as compound to argon.
- Sound weld deposits which can be made consistently.
- Lower associated cost as CO_2 is relatively inexpensive.
- Despite the oxygen is CO2, porosity is not a issue when a suitably deoxidized wire (electrode) and reasonably short arc used.
- Good mechanical properties.

Disadvantages

- Co_2 produces a rather harsh arc.
- Spatter is expensive unless a very short, uniform arc length is maintained keeping the tip of the electrode below the surface of the work properly adjusting the power supply. Inductance setting also minimize spatter.
- High impact properties in weld metal cannot be achieved.

METAL INERT GAS ARC WELDING (GMAW)/ MIG

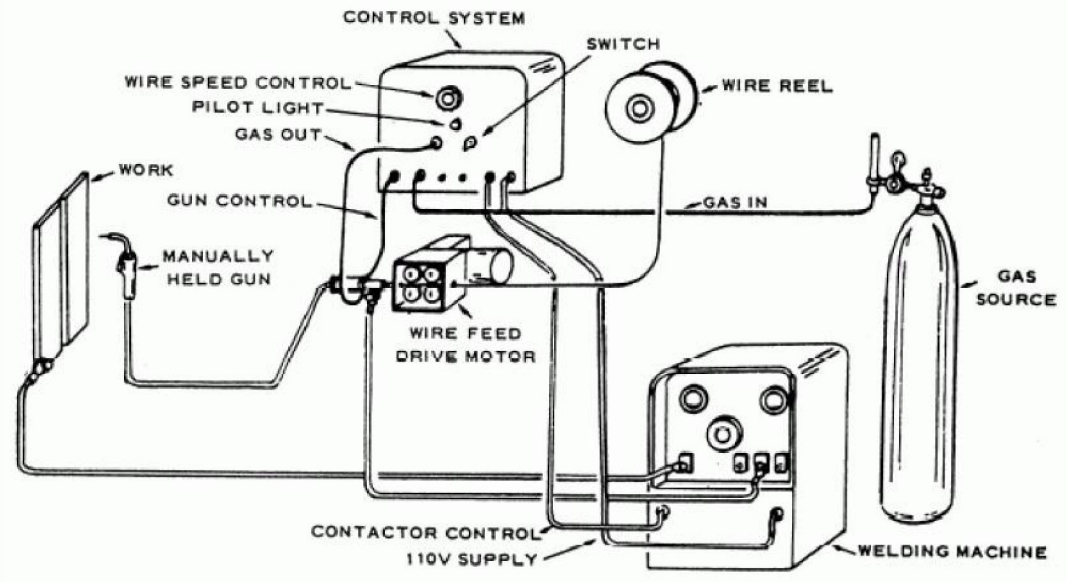
Introduction: - It is an arc welding process where in coalescence is produced by heating the job with an electric arc established between continuously fill metal electrode and the job. No fluxes is used but the arc and the molten metal arc shielded by an inert gas , which may be argon ,helium, carbon dioxide or a gas mixture.

Principle of operation: - Before igniting the arc, gas and water flow is checked. Proper current and wire feed is set and the electrical connection are ensured. The arc is strike by any of the two methods.

In the first method, current and shielding gas is switched 'on' the electrode is scratched against the job as usual practice for striking the arc.

In the second method, electrode is made to which the job is retracted and then moved forward to carry out welding, but before striking the arc shielding gas, water and current is switched on. About 15 mm. Length of the electrode is protected from the torch before striking the arc during welding, torch remain about 10 to 12 mm away from the job and arc length is kept between 1.5 to 4 mm.

Arc length is maintain constant by using the principle of self adjusted arc and self controlled arc in semiautomatic welding and automatic welding sets respectively.



Equipment

a) A welding power source and cables
b) Welding torch and wire electrode coiled on a spool
c) Wire feed mechanism and controls consisting of a pairing driving roll, electric motor
d) Shield gas cylinder, pressure regulator and flow meter.
e) Controls for switching ON and OFF the current, electrode wire and inert gas.

Metals that can be welded by MIG

- Carbon and low alloy sheets
- Stainless steel
- Heat resisting alloys
- Aluminum and its alloys
- Copper and its alloys
- Magnesium alloys

Joint Design

MIG welding is applicable to following joints

- Butt Joint
- Lap Joint
- Corner Joint
- Edge Joint
- T joint

Advantages of MIG

- Because of continuously feed electrode, MIG welding process is much faster as compared to TIG or stick electrode welding
- Produce joints with deep penetration
- Thick and thin type of work pieces can be welded effectively
- Large metal depositions rates are achieved by MIG welding process
- The process can be easily mechanized
- No flux is used, MIG welding produces smooth neat and clean and spatter free welding surface which requires no further cleaning and hence welding cost reduces.
- Higher arc travel speed associated with MIG welding reduces distortion considerably.

Disadvantages of MIG

- The process is slightly more complex as compared to TIG or stick electrode welding because number of variable like electrode stick out, torch angle, welding parameters etc. are required to be controlled effectively to achieve good results.
- Welding equipment is more complex, more costly and less portable.
- Since air defect may disperse the shielding gas, MIG welding may not work in outdoor welding applications.
- Weld metal cooling rates are higher than the processes that deposits slag over the weld metal.

Applications of MIG:-

- The process can be used for welding of carbon, silicon, alloy steels, stainless steel, aluminum, magnesium, copper, nickel and their alloys.
- For welding tool sheets and dies.
- For the manufacturing of refrigerator parts.
- It is being used in the industries like craft, automobile, pressure vessels etc.

TUNGSTEN INERT GAS ARC WELDING (TIG)

Introduction: - it is an arc welding process where in coalescence is produced by heating the job with an electric arc established between tungsten electrode and the job. A shielding gas is used to avoid atmospheric contamination of the molten weld pool. A filler metal may be added, if required.

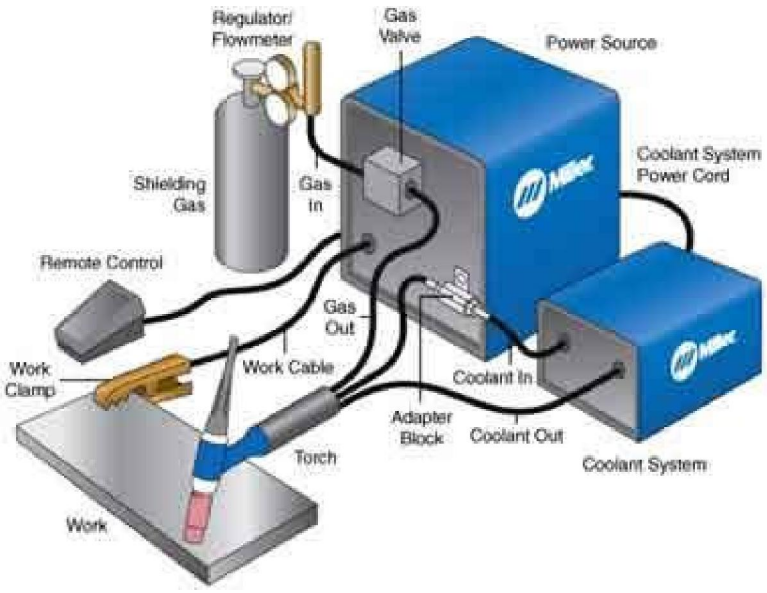
Principle of operation:-Welding current, water and inert gas supply are turned on. The arc is stuck either by touching the electrode with a scrap metal tungsten piece or using a high frequency unit.

In the first method, arc is initially on a scrap metal piece and then broken by increasing arc length. This produce repeated twice or thrice warm ups tungsten electrode. The arc is struck between the electrode and pre cleaned job to be welded. This method avoids breaking electrode tips, job contamination and tungsten loss.

In the second method, a high frequency current is superimposed on the welding current. The welding torch is brought nearer to the job. When electrode tip reaches within a distance of 2 to 3 mm from the job, a spark jumps across the air gap between the electrode and the job. The air path gets ionized and the arc is established.

1. Weld puddle is developed due to arc action on job.
2. Welding torch is moved back
3. Filler rod is moved ahead and filler metal is added to the weld puddle.
4. Filler rod is withdrawn.
5. Torch is moved to the welding edge of the puddle.

Note: job before welding is cleaned off from oil, grease, paint, rust etc. either mechanically or chemically.



Equipment

a) Welding power source, high frequency unit, DC suppressor unit and cables
b) Welding torch, tungsten electrode, filler material
c) Inert gas cylinder, pressure regulator and flow meter.
d) Cooling water supply.
e) Water and gas solenoid valves.

Advantages of TIG

1. No flux is used, hence there is no danger of flux entrapment; when welding, refrigerator and AC components
2. Because of clear visibility of arc and the job, the operator can work easily
3. This process can be weld in all positions and produce smooth and sound weld with less spatter.
4. TIG welding is very much suitable for high quality welding of thin materials (too thin as 0.125mm)
5. It is very good process for welding non ferrous metals and stainless steel.

Disadvantages of TIG:-

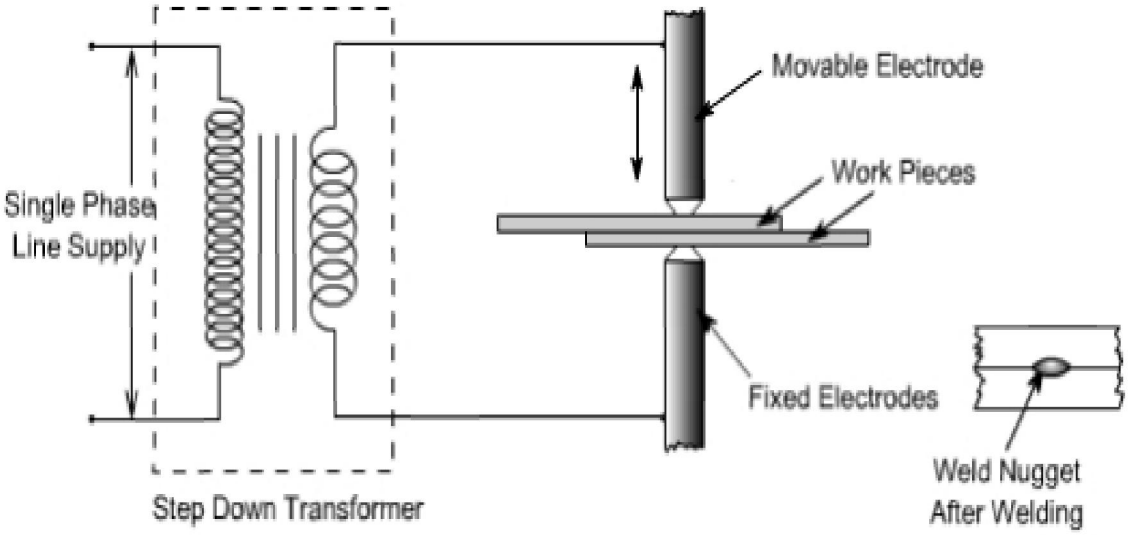
1. Under similar applications MIG is much faster process as compared to TIG welding, since TIG requires a separate filler rod.
2. Tungsten if it transfers to molten weld pool can contaminate the same. Tungsten inclusion is hard and brittle.
3. Filler rod end of it by chance come out of the inert gas shield can cause weld metal contamination.
4. Equipment cost is higher than for shield metal arc welding.

Applications of TIG:-

1. Welding aluminum, magnesium, copper, nickel and their alloys, high temperature and hard surfacing alloys like zirconium, titanium etc.
2. Welding sheet metal and thinner sections
3. Welding of expansion bellows, transistor cases, instruments, diaphragms and cam-sealing joints.
4. Precision welding in atomic energy, aircraft, chemical and instrument industries.
5. Motor chamber fabrication in launch vehicles.

RESISTANCE WELDING

In this metals are joined by the application of heat which is produced by the electrical resistance generated between work piece and electrode. No filler material is used in this kind of welding, but use of pressure (mechanical) is done, while joining metals. In this welding two electrodes of low resistance i.e. copper electrode are used. The work piece is kept between the two electrodes, which complete the circuit.



The resistance of work piece is far more than that of the electrodes thus a high resistance path is created for current flowing in circuit which in turn lead to generation of high heat and it leads to formation of weld pool.

The heat generated during the process can be calculated by-

$$H = I^2RT$$

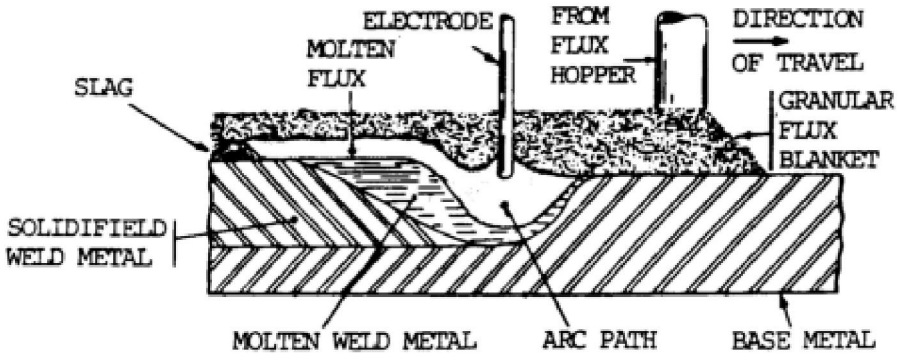
H = heat generation,
I = Current,
R= Resistance,
T = time

Submerged arc welding

Introduction: It is an arc welding process where coalescence set up between base metal electrode and the job. The arc, end of electrode and molten metal pool remain completely hidden and are invisible being submerged under a blanket of granular material (flux). The continuously feed base metal electrode melts and acts as a filler metal rod. No pressure is applied for welding process.

Principle: In submerged arc welding process, instead of a flux, covered electrode, granular flux and a base electrode is used. Arc between the job and the electrode is the heat source

and remain buried under the flux. The flux serves as a shield and protects the molten weld pool from atmospheric contamination.



Equipment:-

1) Welding leads to feed flux and as filler metal to joint.
2) Flux hopper – it stores the flux and controls the rates of flux deposition on the joint.
3) Welding power source.
4) Flux.
5) Electrodes.

Operation:-

- Trigger is pulled and the flux shoots depositing on the joint to be welded.
- The arc may be struck either by touching the electrode with the job or by placing steel wool both electrodes and the job before switching on the welding current.
- In all the cases the arc is struck under a cover of flux.
- Flux is insulated but become highly conductive so current passes between electrode and job.
- The electrode of a predetermined speed is continuously fed to the joint.
- The arc length is kept constant.
- Producing plate of steel or copper may be used to control penetration and to support large amount of molten metal associated with the process**.**

Advantages:-

- Molten flux provides suitable condition for high current flow.
- Higher welding current may be used.
- Due to high heat concentration and faster welding speeds, weld destruction is much less.
- High metal deposition rate can be achieved.
- Welding is carried out without sparks, smoke, flash and spatter.
- Uniformity, good conductivity, corrosion resistance and good impact strength can be achieved.
- It can be used for welding in exposed area with relatively high winds.
- No edge production required for materials under 12 mm thickness.

Disadvantages

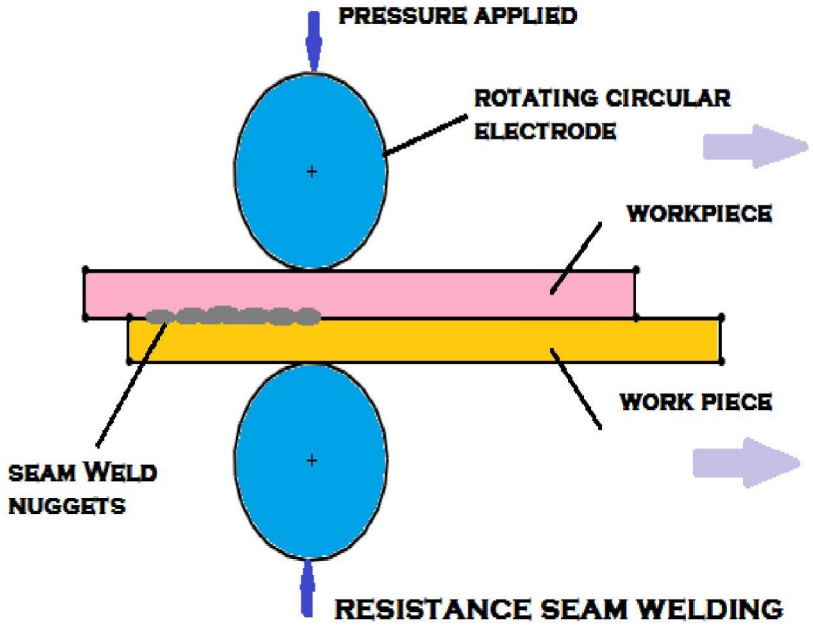
- Cannot judge accurately the process of welding , so extra equipment like jig, fixtures, painter, light beam etc. required
- The flux always needs preplanning of the same on the joint.
- Possible zero welding in flat position only.
- Flux may spill through the gap and arc may burn the work piece edges.
- Contaminated flux caused the porosity in welding.
- Weld metal chemistry is difficult to control.
- Cast iron, Al alloys, Mg alloys, Pb and Zn can't be welded by this process.

Application

- Fabrication of pipes, penstocks, pressure vessels, boilers, structural shapes, rotary railroads and earth moving equipment, cranes , bridges, grinder and under structures of railway coaches and locomotives.
- Automobile, aviation, ship building and nuclear power industry.
- Rebuilding of worn out part and depositing wear resisting alloys, crane pulleys.
- For welding metals like mild steel, medium and high tensile low alloy steel.

Seam welding

Introduction: - it is a resistance welding process where coalescence at the facing surface is produce by heat obtained from resistance, electric current (flow) through the work parts held together under pressure by the electrodes .the resistance weld is a series overlapping resistance, spot welds made progressively along a joint by rotating the circular electrode.



Methods of seam welding

- One involves continuous motion.
- The other intermittent motion during welding operation
  - In continuous motion method, the electrodes rotate at a constant speed and the current flow continuously or interrupted.

- In the intermittent motion welding, the electrode travel the distance necessary for each successive weld and then stop. The current is then switched on end the weld made. The whole process being controlled automatically.
- In continuous motion welding work piece is less than 4.5mm thickness.
- In intermittent motion above 4.5mm thick job is done.

Seam welding equipment

1) Power supply
2) Electrode force and support.
3) Electrode or work drive.

There are three general types of seam welding machines.

1. **Circular**: - In which the faces of the electrode wheels are at right angle to the throat of this machine. This machine is used for circular work, such as welding the continuous or for flat work requiring long seams.
2. **Longitudinal: -**In which the faces of electrodes of what are parallel to the throat of the machine and throat depth is typically 30cm to 90cm. This machine is used for welding short seems in containers.
3. **Universal: -** in which the electrode wheels may be set in either the circular or longitudinal position by the use of swivel type upper head in which the upper wheel ends its bearing can be swiveled 90 degrees. The lower mounting may consist of two interchangeable lower arms or both may be attached permanently to the machine. By means of hinges or a swinging column, so that either may be swing into place.

Metals Welded

- Low carbon, high carbon and low alloy steels.
- Stainless and many coated steels.
- Aluminum and its alloys.
- Magnesium alloys.

Advantages

- It can produce gas tight or liquid tight joints.
- Overlap can be less than for spot or projection welds.
- Single seam weld or several parallel seams may be produced simultaneously.

Disadvantages

- Welding can be done only along a straight or uniformly curved line.
- It is difficult to weld thicknesses greater than 3mm
- A change in the design of electrode wheels is required to avoid obstruction along the path of wheel during welding.

Application of Seam Welding

- Gritweld can be done in round, square or rectangular parts.
- Except for copper and high copper alloys, most other metals of common industrial use can be seam welded.
- Besides lap welds, seam welding can be used for making butt seam welds too.

Flash Butt Welding

Introduction: - The term flash welding derived its name from the flash produced during the process. Probably, flash welding process was developed from resistance butt welding by accident it attempts to increase the capacity of butt welding machines by raising the voltage and apply pressure intermittently.

Definition :- flash welding is a resistance welding process where in coalescence is produced, simultaneously over the entire surface of a butting surface, by the heat obtained from resistance to electric current between two surface substantially completed. Flashing and upsetting are accomplished by expulsion of metal from the joint.

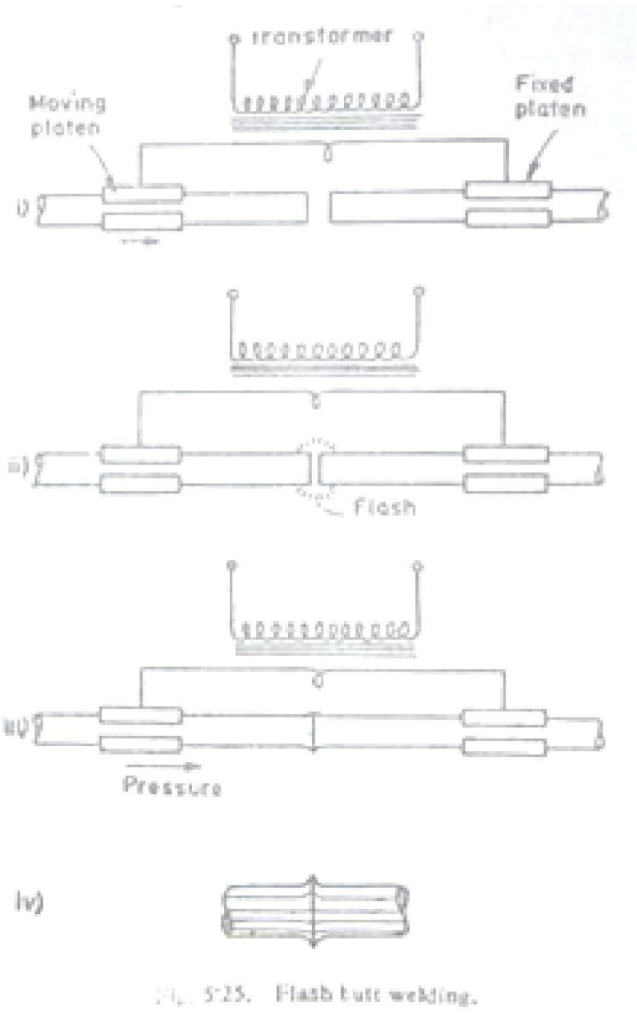


Fig. 5.25. Flash butt welding.

Operation: - The sequence of operation required for flash welding given below:

- Flash butt weld are made on a machine having one stationary and one opposing movable plates on which flash welding dies and clamps are mounted. These clamps separately held the two work pieces to be welded while simultaneously serving to conduct the welding current through the work pieces.

- The work piece held is a movable pattern is brought toward the one gripped in the stationary platen until the two cone on light contact & as the welding current is turned on and thus flash is established. The movable plates keeps on moving constantly towards the stationary one at a carefully and accelerate rate.

- As the flashing continues the end of the two work pieces burn off as they reach such a higher and higher temperature until finally they attain the welding temperature.

- At this stage, the pressure of a moving clamp is quickly and greatly increased to (upset) forge the parts together and expel the molten metal and slag out of the joint, thereby making a good solid weld. The metal expelled from a ragged fin or flush round the joint which is removed latter on by cutting or grinding.

Metals welded by flash welding

- Low carbon steel.
- Medium and high strength low alloy steels.
- Tool steels.
- Stainless steel.
- Aluminum alloys (with thickness > 1.25mm).
- Copper alloy (with high zinc content).
- Magnesium alloys.
- Molybdenum alloys.
- Nickel alloys.
- Titanium alloys.

Flash welding equipments

- A main frame.
- A stationary plate.
- A movable platen.
- Water cooled clamps.
- Transformer, as used on other welding machines.
- Tap switch.
- Electrical controls.
- A flashing & upsetting mechanism.

Advantages

- Many dissimilar metals with different melting temperature can be flash welded.
- Flash welding offers strength factors up to 100%.
- Generally no special preparation of the surface is required.
- Flash welding can be used for the welding of those highly alloyed steel which cannot be welded satisfactorily by any other process.
- The process is cheap i.e. the cost of current per weld is small
- Flash welding is faster than many other methods.
- Flash welding gives a smaller upset.

Disadvantage

- The most undesirable feature of flash welding is the flushing operation during which it is impossible to protect the welding machine and the surrounding area zoom these particles.
- The process present a considerable fire hazard, operation need to protected from flying particles.
- Concentricity and straightness of work piece during welding is often difficult to maintain.
- Metal is cast during flashing and upsetting.
- Shape of the work piece to be flash welded should be similar.

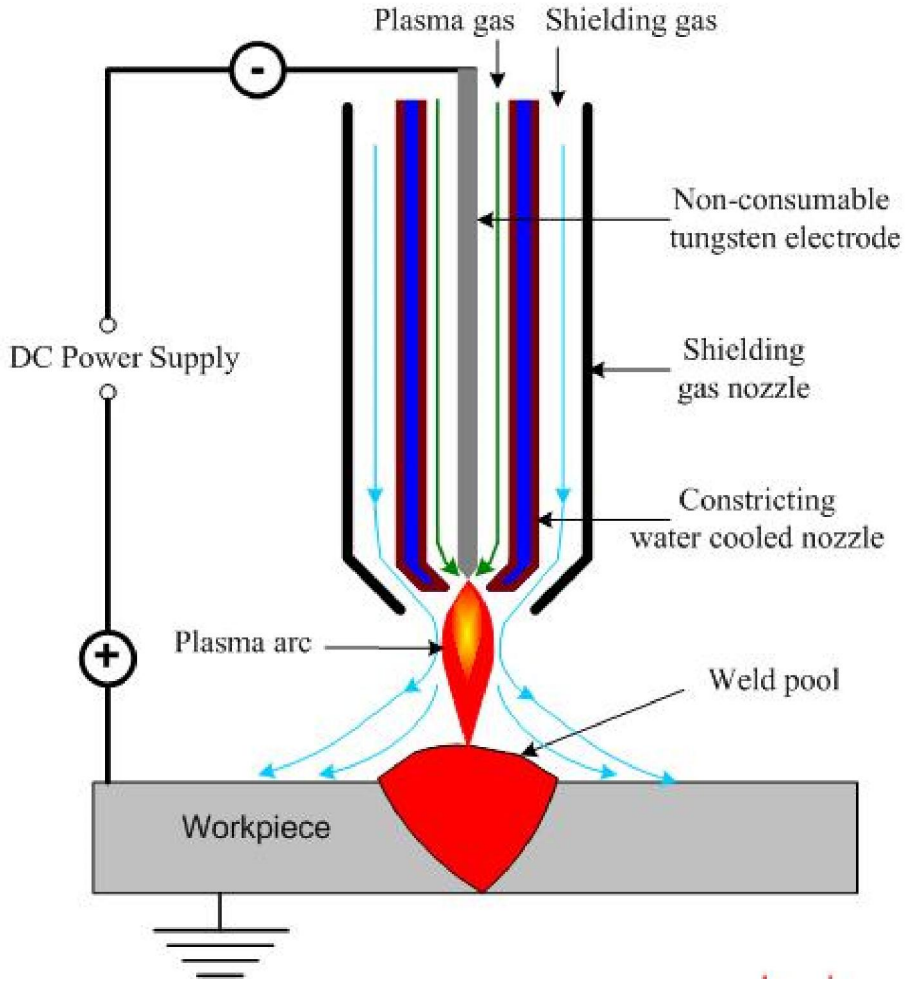
- It is generally not recommended for welding zinc and to alloys cast iron, lead and its alloys.

Application

- Flash welding is applied primarily in the butt welding of metal sheets, tubing, bars, rods, forging, fitting etc.
- Flash welding finds application is automotive and aircrafts products, household appliances, refrigerating and farm equipment.
- The process is also used for welding the band saw blades into continuous loops, and joining of steel drill, tap and reamer, bodies to low carbon steel and alloy steel shanks.
- Flash welding is used to produce assemblies that otherwise would require more costly forging or casting.

PLASMA ARC WELDING AND CUTTING

Definition:- It is an arc cutting process where in the serving of the metal is obtained by melting a localized area with a constricted arc and removing the molten material with a high velocity job of hot, ionized gas issuing from the orifice.



Principle of operation

Plasma arc cutting makes use of DCSP (electrode negative) with a constricted transferred arc struck between tungsten electrode situated within (and not protruding) the torch & the work piece to be cut.

The cutting arc between the electrode and the work piece is initiated by a pilot arc between electrode and the nozzle. The nozzle is connected to ground (+) through a current timing resistor & a pilot arc in contact.

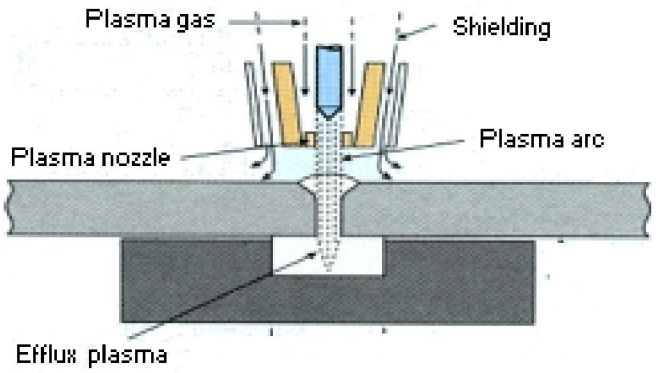
The pilot arc is initiated by high frequency generator connected to the electrode and nozzle ionized orifice gas from the pilot arc is blown through the constructing nozzle orifice. This forms a low resistance path to guide the main arc between the electrode and the work piece. Once the main arc is ignited the pilot arc is ignited the pilot arc goes off.

A high frequency electric arc thus established passed through a stream of inert gas (usually nitrogen) the latter is ionized. Both the ionized gas column and the arc forced through the small orifice in the torch nozzle. The nozzle, having a relatively small orifice,

constricts the arc and thus increases current density and arc temperature. This high temperature arc is localized and concentrated upon a small area of the plate where its intense heat melts the metal to be cut.

- The gas which is heated by the arc cannot expand due to the constriction of the nozzle orifice and it emerges in the form of a supersonic jet.
- The base metal continuously melted by the intense heat of the arc is removed by the jet – like gas stream (issuing from the torch nozzle) to form a narrow kerf and smooth surface.

The combined heat & force of the arc stream produces a high quality, saw like cut.



Cutting torch

- Plasma cutting torch may be either manually operated or machine operated in which case the torch is mounted on an automobile travel mechanism.
- Torch consists of an electrode holder which centers the electrode tip with respect to the orifice in the constricting nozzle. The tip of the electrode within the nozzle. Orifices in the nozzle constrict the arc.
- Plasma arc is injected into the torch around the electrode and it emits through the nozzle orifice.
- The electrode and nozzle are water cooled to prolong their lives.
- Nozzle with varies orifice diameters available. Large diameter orifice is required at higher current.
- Plasma arc cutting makes use of both single and multiple port nozzles.
- Most plasma cutting torches impose a swirl on the orifice gas flow pattern by injecting the gas through tangential holes. gas will help more efficient transfer of arc energy to one side of the kerf with the clockwise swirl the right side of the cut (facing in the direction of travel) will be reasonably square, but the left side will be beveled. Thus select the travel direction such that a scrap material is placed on the lift.

Gas cylinder, regulators, flow meters and gas supply hoses

- N_2, $N_2 + H_2$ or $Ar + H_2$ mixtures are used for cutting non ferrous metal and stainless steel.
- Carbon steel are cut by using compressed air and nitrogen.

Power source

- Open circuit voltage 100 to 400 volts.
- Current 250 to 1000 Amp.
- Power source with drooping characteristics (DCSP).
- Heavy cutting requires high DC voltage.
- Pilot arc and high frequency power source circuit
- A system to circulate cooling water.

Control

Relay and solenoid valves to turn gases and cooling water on and to operate the high frequency power supply is required for a starting.

Typical Plasma Cutting Parameters

To cut 25 mm thick	Orifice diameter (mm)	Current DCSP (Amp)	Cutting speed (mm/s)	Power (KW)
Aluminum Alloys	4	400	38	80
Stainless Alloys	4	400	21	80
Carbon Steel	4	425	21	85

Metals Cut

I. Carbon steel
II. Cast iron
III. Magnesium
IV. Brass
V. Stainless steel
VI. Aluminium
VII. Nickel
IX. Copper etc.

Advantages of Plasma Arc welding and Cutting:

- It cuts carbon steel up to 10 times faster than any fuel cutting equality more economically.
- It leaves a narrower kerf.
- Plasma cutting, being primarily a melting process, can cut any metal.
- Arc plasma torches give the highest temperature available from many practical sources. The energy seems to be unlimited in this method.

Disadvantages of plasma arc welding and Cutting:

- A major limitation in implementing a plasma welding process is the relatively high startup costs. Plasma welding equipment tends to be expensive. Because it is a more specialized welding process, the training and expertise required is also more intense.

Application of plasma arc welding and Cutting

- Plasma cutting used to cut particularly those non-ferrous and stainless metals that cannot be cut usual rapid oxidation induced by ordinary flame torches.
- Plasma cutting can be used for stock cutting, plate beveling, shape cutting and piercing.
- With some modifications, plasma arc cutting can be used under water.
- Plasma arc cutting finds applications in many industries such as shipyard, chemical, nuclear and pressure vessel.
- It is used for removing gates and risers in foundry.
- It cut hot extrusions to desired length.
- It is used to cut any desired pipe contour.
- It is also employed for gauging applications.
- It finds use in the manufacture of automobile and railroad components.

METALLURGY OF WELDING, BRAZING AND SOLDERING

The study of welding metallurgy is very useful because of the overall mechanical properties of a weldment are determined by the characteristics of the individual microstructure present in the weld deposit and the weld heat affected zone.

- Weld metal is quickly melted and then it re-solidifies under the equivalent of chill casting conditions.
- Parent metal is subjected to a complex thermal cycle with a temperature gradient extending from the melting range to ambient temperature and followed by a cooling induced by the surrounding cold water.
- Temperature changes and change in micro-structure introduced volume changes in the area surrounding the weld and hence cause straining, plastic flow, residual stress or even cracking.

Welding metallurgy is concerned with

- Melting of electrode and parent metal,
- Solidification of weld metal,
- Gas absorption and gas metal reaction,
- Slag metal reaction,
- Surface phenomena,
- Solid state reaction.

Welding Arc: - A large number of welding processes made use of flame or an electric arc to melt the base metal and the filler metal to the electrode.

Heat flow in and around weld metal:-

- The sufficiently high temperature of the welding arc quickly heat up the base metal and the electrode or filler metal melt to form the molten weld pool.
- For controlling metallurgical events in welding, the thermal condition in and near the weld metal must be established.

Important facts are:-

- The distribution of maximum temperature in the weld heat affected zone.
- The length of time of temperature.
- Cooling rate on the weld metal and in affected zone.
- The solidification rate of weld metal.

Metallurgical effects of welding:-

- Weld metal,
- Absorption of gases by weld,
- Slag inclusion,
- Hot cracking of welds,
- Heat affected zone,
- Corrosion of welds
- Dilution.

NON DESTRUCTIVE TESTING METHODS (NDT)

Inspection of Welding

Inspection necessary on welding: Defective welding reduces the utility of job and it may cause an accident even.

Principal method of Inspection

a) **Non Destructive Test:** In this test, the job is tested without damaging or destructing it.

b) **Semi Destructive test:** In this test, a part of the job is damaged which requires repairing.

c) **Destructive Test:** In this test job gets damaged completely. This test is meant for measuring the mechanical property of the job.

Various types of Non Destructive Test

a) Visual Inspection
b) Paraffin Oil test
c) Magnetic Test
d) Stethoscope Test
e) Hydraulic Test
f) Air test
g) X-Ray test
h) Gamma ray test
i) Ultrasonic test
j) Dye penetration test

Various types of Semi Destructive Test:-

a) Cutting test
b) Acid test
c) Drilling test

Various types of Destructive Test

a) Hardness test
b) Impact test
c) Bending test
d) Tensile test
e) Neck Break test

Non destructive test

It may be used to detect defects that would be difficult or impossible to detect by visual examination. The techniques are used during manufacturing as a quality control tool to determine the quality of work. The intent of NDT depends upon the application and criticality of the joint is generally specified in the relevant application standards or contract specifications. It is important for NDT to be included in the planning of the fabrication process as it can require substantial time and resources. Full account of this must be taken in description of production and delays to the programme are to be avoided.

The requirement to perform NDT must also be taken into account during the design phase. As with welding, access for NDT must be planned into the component. The

application of this is that both welding engineer and designer must be conversant with the techniques and their limitations if the processes are to be used effectively.

Dye Penetrate examination

This is a technique that is capable of detecting surface breaking defects only. It relies upon a colored or fluorescent dye sprayed upon the surface, penetrating these defects. After cleaning the excess from the surface by spraying on a developer in the case of the colour contrast dye or by exposing the surface to ultraviolet light. The defect is revealed by the dye straining the developer or by fluorescing.

The fluorescent dye gives greater sensitivity than the color contrast dye. It does requires the use of an UV light and preferably a darkened room. It must be capable of penetrating narrow cracks. It must be high contrast with the developer. It is also important that the test piece is thoroughly pre-cleaned. Degreasing should also be carried out.

Advantages

- It can be used on both ferrous and non-ferrous materials.
- It is very portable.
- Large area can be examined very quickly.
- It can be used on small part with complex geometry.
- It is simple, cheap and easy to use and interpret.

Disadvantages

- It will only detect defects open two surface.
- It is not possible to retest a component indefinitely.
- Careful surface preparation and cleanness are required.
- There may be health and safety problems with some of chemicals.

Eddy current examinations

It is a process that may be used in any material that will pass on electric current. A coil carrying alternating current is placed close to item to be examined, including an eddy current in the specimen. Defect in the specimen will interrupt this eddy current glow and these perturbations can be detected by second search coil. The equipment is calibrated using a defect free specimen. The accuracy can be affected by metallurgical conditions standoff and coil dimensions for these reasons eddy current testing is used only rarely on welded components. It is of limited use for interrogating welds.

Ultrasonic Examinations

The ultrasonic examination of welds uses the same principle as when sonar is used for the detection of submarines. In welded components this is usually done by moving a small probe, contouring both transmitter and receiver, over the item be examined and displaying the echo on oscilloscope screen. The probe transmits a beam of ultrasonic that passes through metal and is reflected back from any defect.

The success of the technique depends upon the use of the trained experienced operators who knows precisely the characteristics of metal being examined, the beam direction, its amplitude & frequency and the weld geometry. The frequency of ultrasonic waves is generally in the range of 2-5MHz, the lower frequency is used for the detection of fine defects.

Probes can be obtained that project beam into the test piece at an angle, the most common being 45', 60', & 70'. The angled probe are best suited for the detection of defects at an angle to the plate surface such as lack of side wall fusion to ensure that all of defects are detected by probe must be scanned over the full cross section & the full length of the weld.

Advantages

- It is very good for detection of planer defects.
- It can easily determine defect depth.
- It is readily portable.
- Access is requiring to one side only.

Disadvantages

- Very skilled operators are required.
- Surface breaking defects are difficult to detect.
- No permanent objective records are available.
- The process can be slow and laborious.

Radiographic examination

Electromagnetic radiation has properties that are useful for industrial radiography purpose. The rays travel in straight lines and can't be deflected or reflected by mirrors or lenses. They have wavelengths that enable the radiation to penetrate many materials.

To radiograph a welded joint a suitable source or radiation a film in a light proof cassette of some method of processing the film are required. This later generally requires a dark room where the film can be developed fixed, washed, dried, and viewed. The radiation can be produced from an X-ray tube, the energy generally being described by the voltage, current at which tube is operated. These may vary from 20mV – 30mV and 10mA-30mA. Although the normal limit for the commonly available industrial unit is around 400 KV. A 400 KV unit is capable for penetrating upto 100 mm of steel sheets.

The quality of radiograph is affected by source of the film distance, the greater this is the sharper the image; the size of radiator source. Higher the energy, the less sharp is the image; film grain size and quality and the correct film processing.

Advantages

- A permanent receiver is available.
- Both buried and surface defects can be detected and the technique is particularly good for finding volumetric defects such as slag and porosity.
- The equipment is portable, particularly the gamma ray source.
- All materials can be examined.

Disadvantages

- The capital cost of equipment includes the processing and viewing qualities.
- Health and safety considerations.
- Access is required to both sides of component, the source on one side, the film on the other.
- There is the limitation on the thickness that can be radio graphed and defects easily detected.
- Skilled and experienced radiographers are required.

WELDING DEFECTS

a) **Internal Defects:** which are invisible in nature.
b) **External Defects:** which are visible in nature?

Various types of external defects

- **Spatter:** The deposition of weld metal around the joints in the form of small pills is called spatter defects.
- **Overlap:** The formation of an excess layer bead on the joint is called overlap defect.
- **Undercut:** The defect is reverse to overlap defect. In this defect, deep slot are left behind in the joint.
- **Inclusion:** The pressure of foreign material in the weld metal is called inclusion defect.
- **Blow hole:** Large sized holes left behind in the weld bead are called blow holes. They are produced due to gas bubbles.
- **Incomplete Penetration:** Insufficient approach of a weld metal into the job is referred as incomplete penetration.
- **Crack:** The development of the crack in the weld metal is referred as crack defect. It may be external or internal type. It makes the job incapable to bear the load.
- **Crater:** The development of the pit at the end of the weld line is called a crater. In order to eliminate this defect the electrode should be kept on the weld line so long as the pit does not get filled completely.
- **Porosity:** The formation of the number of small holes in the weld bead is called porosity defect.
- **Lack of fusion:** The defect due to which the main metal and the weld metal do not mix properly on account of insufficient melting is called lack of fusion.

SAFETY RECOMMONDATION FOR INSTALLATION AND OPERATING OF ARC WELDING AND CUTTING EQUIPMENT ARC

Welding Machines

- Arc welding machines should be of suitable quality.
- Arc welding machine should be properly grounded (earthed).
- Proper terminals should be used on the arced welding machines for the power line voltage connection.
- One should not work on the wiring of an arc welding machines unless qualified to do so.

In the case of AC arc welding machines

- In transformers, the secondary circuit shall be thoroughly insulated from the primary.
- Welding (secondary) terminals shall be so arranged that current carrying parts are not exposed to accidental contact.
- In a transformer the welding circuit should be quite separate from the power circuit, so that there is no risk of worker suffering serious shocks or burns through power voltage appearing across the electrode holder.
- Control apparatus provided with the welding machines shall be enclosed except for the operating wheels, levers etc.
- Transformer welding be suction or compressed air cleaned periodically.
- Greasing points need attention periodically.
- Switch contacts should be cleaned periodically.
- Before under taking any maintenance work on welding machines, disconnect them from the main supply.

OTHER ARC WELDING EQUIPMENTS

Electrode Holder

- Electrode holder should be soundly connected to the welding lead. They should be of adequate rating for the maximum welding currents to prevent them from heating up and becoming too hot to handle.
- Insulation of all metallic and current carrying parts, including the jaws which grip the electrodes, is recommended.

Welding Cables: Welding Cables shall be of completely insulated, flexible type.

- The body or the frame of the welding machine shall be efficiently earthed.
- Earthing cable should be connected to the job as nearest as possible.
- Avoid earthing cable connection at rail lines, wheels, bearings, CBC and other Sensitive parts of coach & wagon.

PROTECTION OF WORKERS: Workers need to be protected from:-

- The welding rays.
- Flying sparks, metal globules (spatter), hot slag particles and hot electrode stubs.
- Fumes and gases when welding in confined space.
- Falling when welding at a height from the ground.

So workers should wear personnel protective equipments (PPE) to protect from hazardous happenings.

INDEX
ROLLING STOCK THEORY (C &W Open Line)

DESIGN AND CONSTRUCTION OF COACHES

ICF coach shell/body

Construction of coach body which forms big tubular hollow construction which is light in weight. The shell consists of pressed steel section welded together with sheet covering. The skeleton of the shell consists of a series of hoops each consisting of floor cross beam, body side pillars and roof carlines.

The sole bar, waist rail, light rail, cant rail and roof purlines hold these hoops together. This is covered by roof sheet on top, side panels on sides and corrugated trough floor. ICF COACH Shell Bogie The trough floor offers considerable resistance to longitudinal crushing loads, but cannot take high vertical load. On each end, specially designed head stock with compression/destruction tubes is welded.

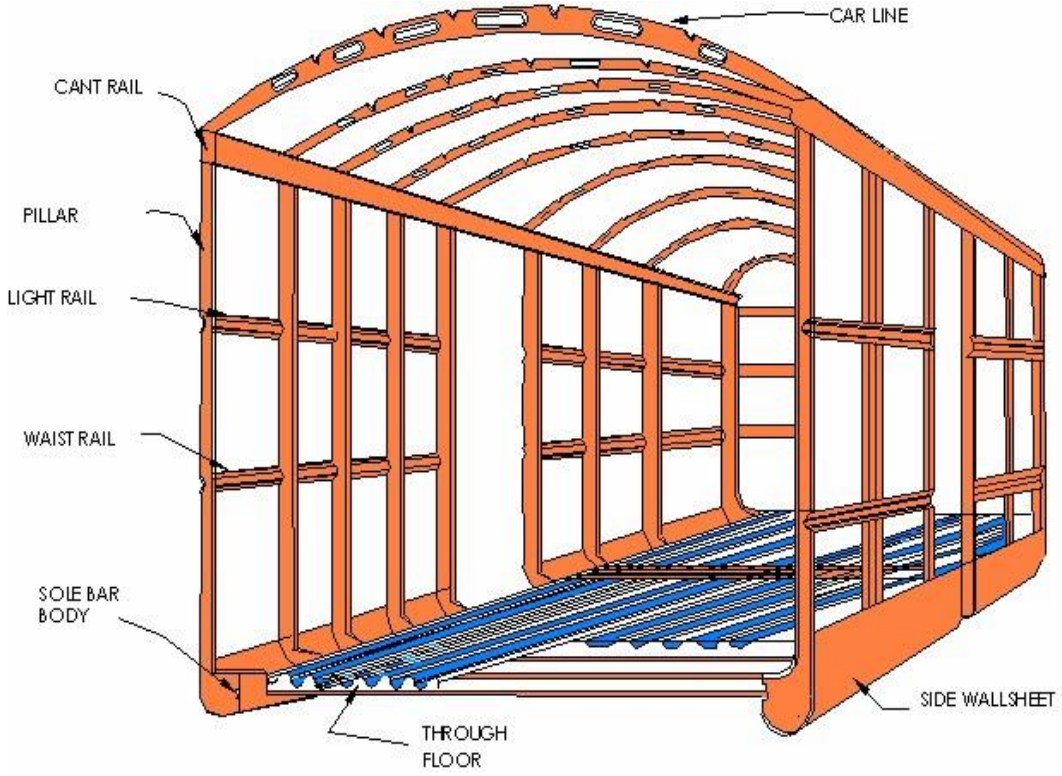


Figure: ICF coach shell design

These tubes when subjected to collision shock, gets deformed absorbing most of energy hence reducing the adverse effect of impact. Body bolsters are welded on bottom side of trough floor. The coach ends consist of 4 vertical stanchions box section, transversely connected by Z sections and are welded to the head stock. Collision impact is first received by end stanchions which absorb a large part of it.

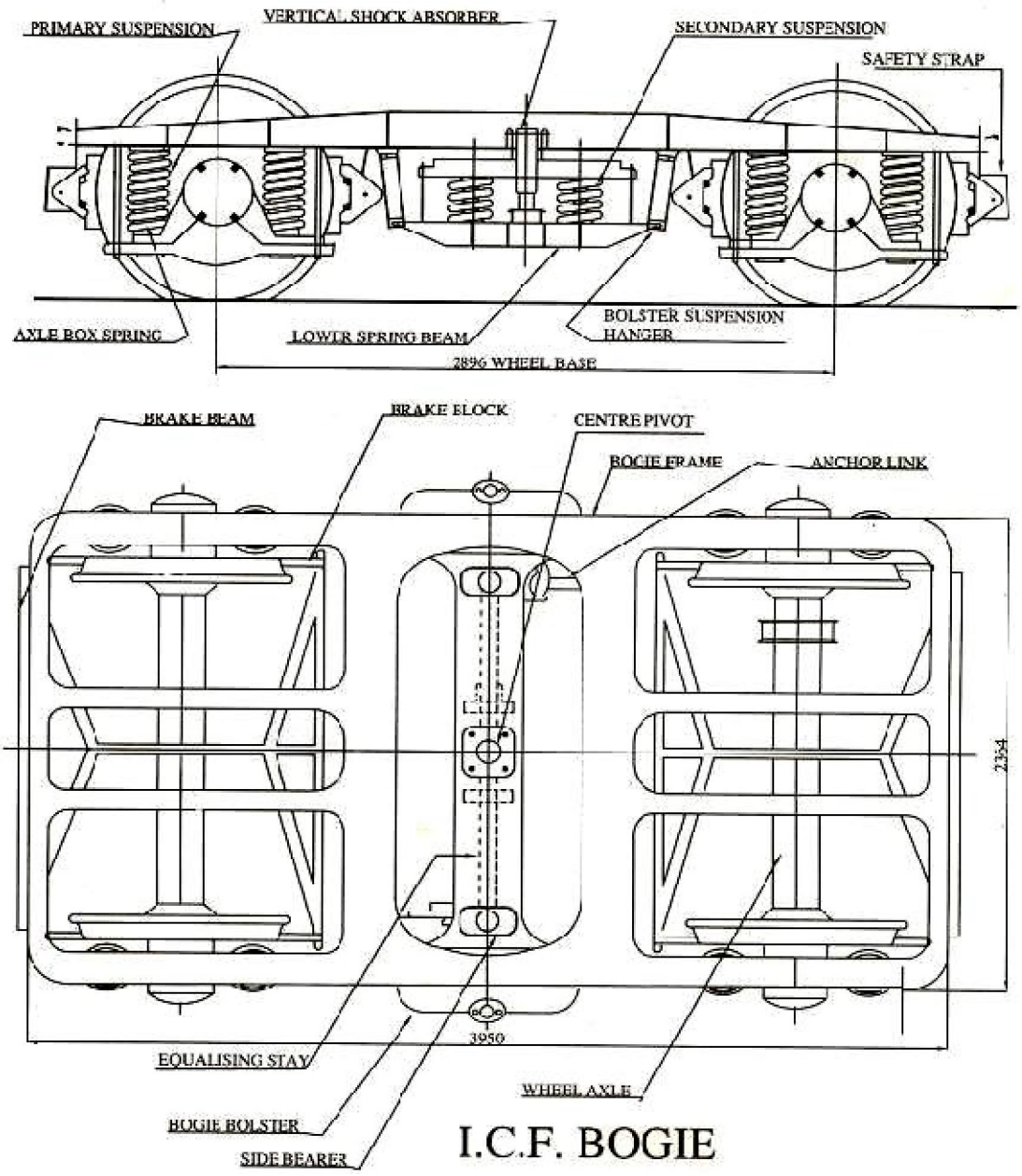
The residual shock is absorbed by deformation of compression/destruction tubes. These features make ICF coaches anti-telescopic. The windows are made separately and screwed on to the double chamber. The coaches can be provided with vestibules for passage from one coach to another in a running train.

COMPARISON BETWEEN SPECIFICATION OF ICF AND LHB COACH

S.NO	SALIENT FEATURE	LHB	ICF
1	Overall length over CBC in LHB and Over Buffer in ICF	24000	22297
2	Overall length of Body	23540	21337
3	Overall width	3240 D/ Deckor 3050	3245 BEML 3250
4	Overall height from Rail Level	4039	4200
5	Centre Pivot Distance	14900	14783
6	Inner Axle distance	12345	11887
7	Wheel Base	2560	2896
8	Bogie Weight	6.33T	NAC (13 T) 5.9T AC (16 T) 6.2 T
9	Buffer Height in tare condition	1105	1105
10	Buffer height in load condition	1030	1030
11	New Wheel Dia	915(+4 , -0)	915 (+3 , -0)
12	Condemn Wheel Dia	845	825
13	Shop Minimum Issue Wheel Dia	857	837
14	Coupling	Tight lock H type coupler	Screw Coupler (75 T)
15	Brake System	Disc Brake	BMBC
16	Size of Brake Cylinder	10 Inches	8 Inches
17	Nos of Brake Cylinders per Coach	08	04
18	Max. Pressure in Brake Cylinder	3.8 Kg/cm^2	3.8 Kg/cm^2
19	Max permissible Speed	160 KMPH	110KMPH
20	Ride Index	2.5 and not more than 2.75	3.15 and not more than 3.75
21	Axle Guidance	Articulated	Rigid
22	Bogie frame	Y – frame BOX with Head Stock	H – type and I type with Head stock
23	Damper	Hydraulic 8	Dash Pot
24	Defection Ratio Sec.to Pri.	67:33	50:50
25	Suspension type	Flexible	Normal
26	Coach Body material	3 Type steel SS- 304 SS- 309 IRSM- 41	2 Type IRSM – 44 IRSM- 41
27	Water Tank	685 Ltrs OHT – 30 Ltrs	452 Ltrs
28	Corrosion	LOW	High

COMPARISON BETWEEN SPECIFICATION OF ICF AND LHB COACH

S.NO	ICF	FIAT
1	Max. operating Speed – 130KMPH Tested speed – 140 KMPH	Max . Operating speed – 160 KMPH Tested Speed – 180 KMPH Potential for Operation – 200 KMPH
2	Bogie Frame – I type	H- Type Construction
3	Wheel Base – 2896 mm	Wheel Base – 2560mm
4	Wheel Dia.- 918 mm Condemn – 825 mm	Wheel Dia. -918 mm New Condemn – 845 mm
5	Clasp Type brake	Axle Mounted Disc Brake
6	Spherical Roller bearing	Tapered Roller Bearing
7	Primary suspension –Single Spring	Primary Suspension Spring – Nested Spring 2 Nos
8	Limited Noise control Features	Noise control by using thick rubber Pads
9	Secondary spring rested on lower plank	Secondary spring directly mounted on side frame
10	Coach Load is transferred through side bearer	Through bogie body connection to side frame via secondary springs
11	Centre Pivot transfers traction and braking load	Pivot Assembly on transverse beam and bracket on dome take traction/ braking load
12	Ride index 2.5 to 3.5	Ride Index 2.5 to 2.75
13	Dash pot Guides are provided to control the tendency of Rolling	Anti-Roll Bar has been provided to control the tendency of rolling
14	Weight of Bogie with Wheel 6.2 T	Weight of Bogie with Wheel 6.3T



I.C.F. BOGIE

SALIENT FEATURES OF ICF ALL COIL BOGIE

- Bogie is designed to run on Indian Broad Gauge Track (1676 mm).
- Provision of coil spring at primary & secondary suspension so that bogie is known as All Coil Bogie.
- Bogie Head Stock is provided with pressed T- section and sole bar is with pressed I-section, but at the location of link brackets it is in box section.
- Transom – Previously it was in C-section but now a day it is in Box section to be more robust.
- Wheel Base of bogie is 2896 mm.
- Weight Transmission - By 2 side bearer located at distance of 1600 mm.

- Guidance of bogie Lateral and Longitudinal both with the use of Centre Pivot pin located at the center of bolster.
- Wheel Guidance lateral and longitudinal both with the use of 2 nos. of Dash Pot guide per Axle Box Wings welded at sole bar.
- Axle Capacity - 13 T – For Non A/C coach
- 16 T – for A/C coach and WLRRM coach
- Roller Bearing – Double Roll Self Aligned Spherical Roller Bearing.
- Axle – Solid and Straight
- Wheel Diameter – 915 mm + 3 mm and – 0 mm (New)
  825 mm (Condemn) – 834 mm (workshop release)
- Shock Absorber – Provided on Secondary suspension between Bolster and lower plank (2 nos. in each Bogie). 2 nos. of lateral shock absorber are being provided in ICF Bogie to be utilized for Hybrid Coach.
- Vertical Hydraulic Dampers – 2 nos. per Axle Box Vertical telescopic hydraulic Dashpots are provided.
- Fitment of brake block –K type high p\friction coefficient brake block is provided with the use of brake shoe head and brake beam.
- 2 nos. equalizing stay rods per bogie are utilized to maintain the distance between both the lower planks and to maintain lateral thrust occurring during run.
- Provision of Anchor link – 2 nos. per bogie with the provision of silent bushes are provided diagonally between bogie transom and bolster to work as a media to transmit the draw and braking force from trolley to body and body to trolley vice versa.
- Piston Stroke –BMBC within 32mm should be maintained.
- Provision of Running Clearance:-

'A' Clearance: - mm (For 13 ton) and (For 16 ton) . It is a clearance to be provided between axle box crown & safety bolt.

TYPES OF COACHES	CROWN CLEARANCE
GS, SCN, WCB, WGSRJ	45± 3
SLR, SDC	48±3
WFAC,WACCW, WCBAC	25±3
ACCN	34±3
WGFAC,WGACCW,AGSCZAC, GFACCW,AGSCZACJ	36±3

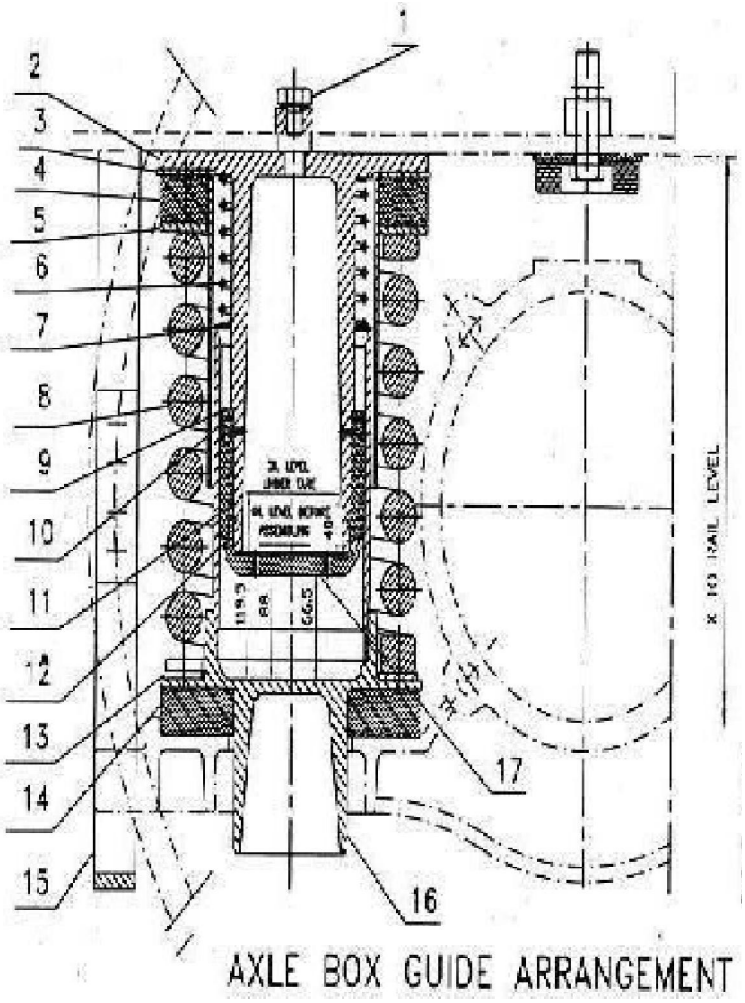
'B' Clearance: - It is a clearance to be provided between bolster top & bottom of sole bar that should be 40± 5 mm to all type of bogie.

- Riding index: - ICF bogie – 3.25 to 3.50
- Truss bar Hanger: - Strength with double eye hole.
  Length: 235 mm (New), 205 mm (Old)
- Journal Size: - Dia. – 120x113.5 mm (sleeve mounted), 120x130.5 mm (direct mounted)
- Journal Centre: - 2159.5 mm
- Speed: - Fit to run up to 110 KMPH.

Axle Box Guide with Dashpot Arrangement

Axle box guides are of cylindrical type welded to the bottom flanges of the bogie side frame with close dimensional accuracy. These guides together with lower spring seats located over the axle box wings house the axle box springs and also serve as shock absorbers. These guides are fitted with guide caps having nine holes of diameter 5 mm equidistant through which oil in the lower spring seat passes under pressure during dynamic oscillation of coach and provide necessary damping to primary suspension to enhance riding quality of coach.

This type of rigid axle box guide arrangement eliminates any longitudinal or transverse relative movement between the axles and the bogie frame. The quantity of oil required for maintaining 40 mm oil level above the guide cap in modified arrangement is approximately 1.6 litres and in unmodified arrangement is approximately 1.4 litres. As it is not possible in open line to distinguish between modified and unmodified arrangements, 40 mm oil level is standardized for both.



AXLE BOX GUIDE ARRANGEMENT

1. Screw with sealing Washer
2. Guide
3. Protective tube complete
4. Upper Rubber Washer
5. Top Spring Seat
6. Dust Shield Spring
7. Dust Shield
8. Helical Spring
9. Guide Ring
10. Rubber Packing Ring
11. Guide Bush
12. Spring Clip
13. Compensating Ring
14. Lower Rubber washer
15. Safety Strap
16. Lower Spring Seat
17. Guide Cap

Common Defects Found in Axle Guide Assembly, Causes and their Remedial Action

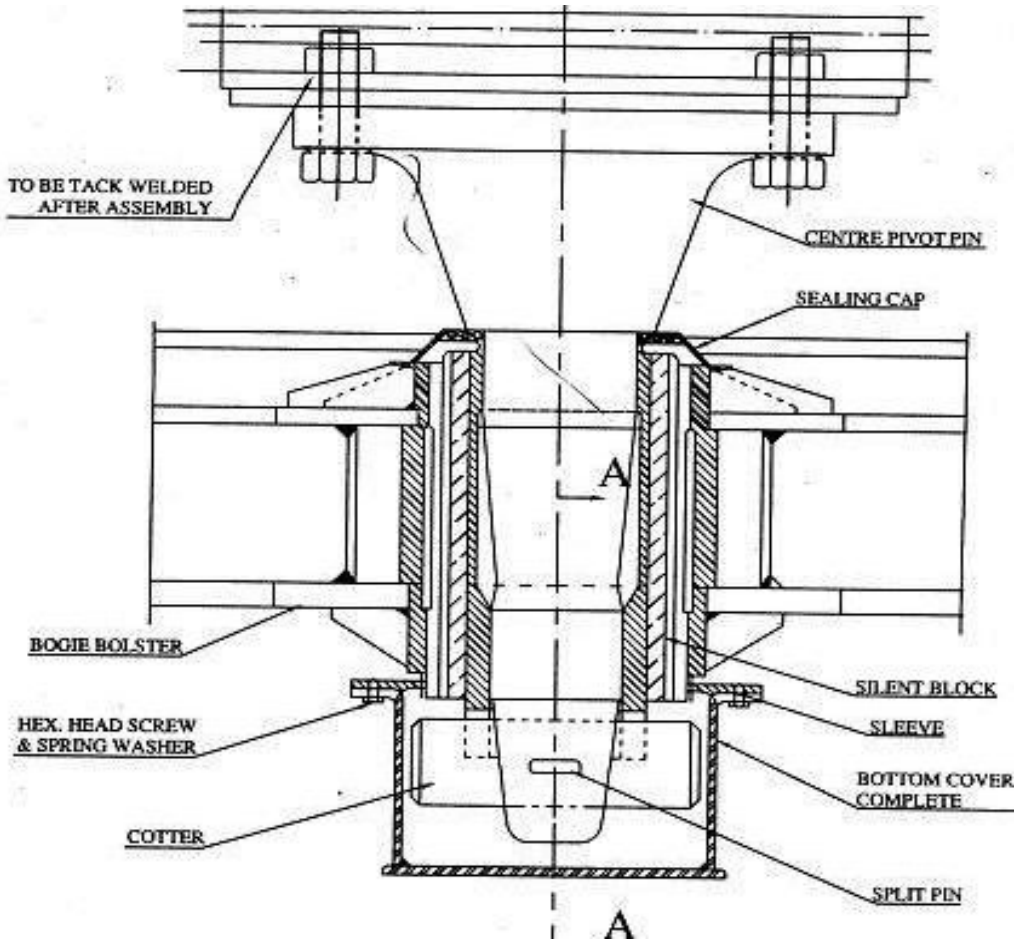
Sr. No	Defect	Reasons	Remedies
1.	Perished Rubber packing ring.	Poor quality of rubber packing ring	Replace rubber packing ring at every examination involving lifting of coach. Use only rubber packing rings conforming to IRS specifications.
2.	Axle guide found worn on one side	Initial difference in wheel dia. on same axle more than 0.5 mm. Coach is not levelled.	Maintain difference in wheel diameters on same axle within 0.5 mm, during wheel turning. Use wheel diameter gauge with minimum 0.2 mm accuracy. Level the coach. The squareness and alignment of axle box guides should be checked with alignment gauges and corrected. Vent holes should be sealed with gaskets & screws tightened well after topping.
3.	Axle box upper spring seat (protective tube) worn out/broken	-do-	-do-
4.	Guide bush worn.	-do-	-do-
5.	Lower spring seat surface worn.	-do-	-do-
6.	Guide bush/ring broken	Axle guide is hitting lower spring seat.	Guide securing bolt should not project out of guide cap for non modified Axle guide. Use good quality upper and lower hytrel washers and ensure correct number of compensating rings in the axle box guide assembly. Adjust ABC clearance on levelled track.
7.	Broken/ distorted cir-clip of guide bush.	-do-	-do-
8.	Lower spring seat scored/ dent mark on guide cap.	-do-	-do-
9.	Dust shield spring broken/ distorted.	-do-	-do-
10.	Dust shield twisted or damaged.	-do-	-do-
11.	Leakage from Lower spring seat	-do-	-do-

Air Vent Screws: On the bogie side frames, directly above the dash-pots, tapped holes are provided for replenishing oil in the dash pots. Special screws with copper asbestos washers are screwed on the tapped hole to make it air tight.

Bogie Bolster Suspension: The bolster rests on the bolster coil springs - two at each end, located on the lower spring beam which is suspended from the bogie side frame by means of bolster-spring suspension (BSS) hangers on either side.

Springs: In ICF bogie, helical springs are used in both primary and secondary suspension. The springs are manufactured from peeled and centre less ground bar of chrome vanadium/chrome molybdenum steel.

Centre pivot arrangement: The centre pivot pin joins the body with the bogie and transmits the tractive and braking forces. It does not transmit any vertical load. It is equipped with rubber silent block bushes which tend to centralize the bogies with respect to the body and, to some extent control and damp the angular oscillations of the bogies.



Centre Pivot Arrangement

Side Bearers: The side bearer arrangement consists of a machined steel wearing plate immersed in an oil bath and a floating bronze wearing piece with a spherical top surface, kept on both sides of the bogie bolster. The coach body rests on the top spherical surface of these bronze-wearing pieces through the top side bearer at the bottom of the body-

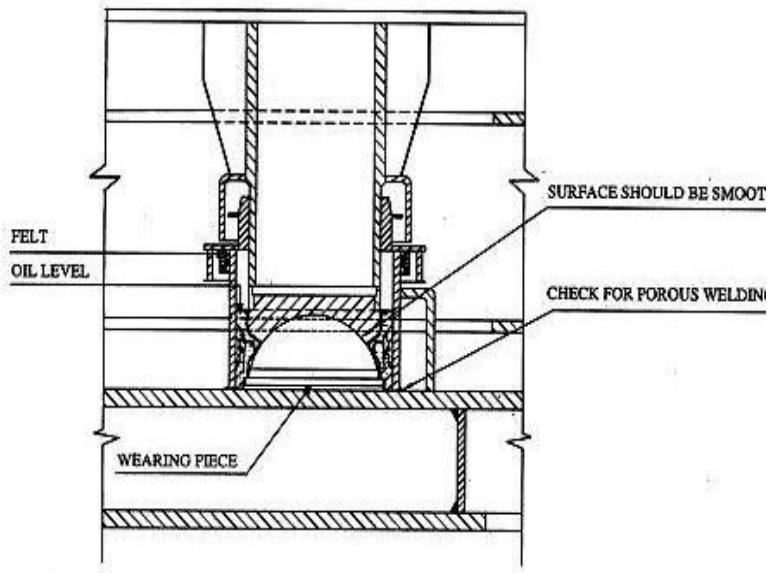
bolster. The whole arrangement is provided with a cover to prevent entry of dust in the oil sump.

- **Wear limit for wearing plate**

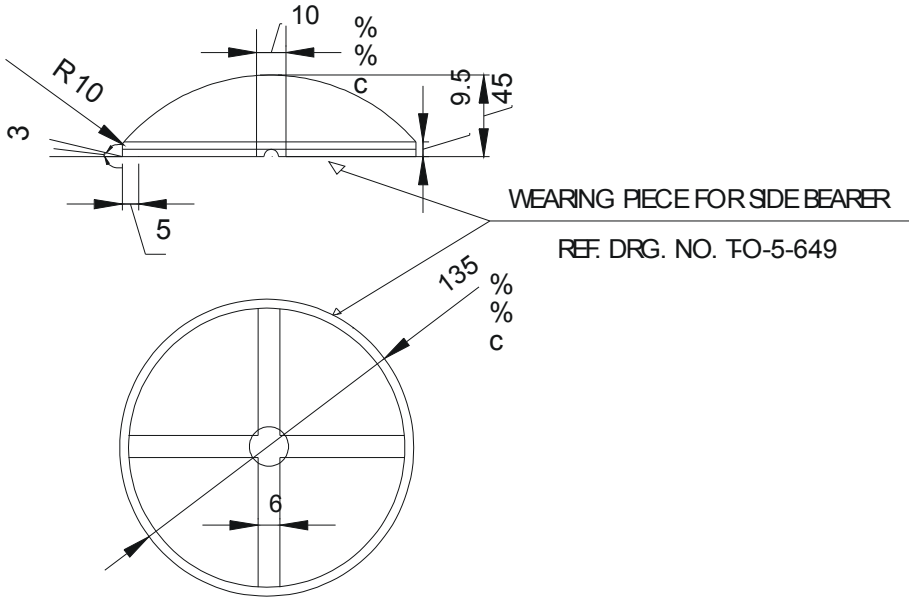
New size	Shop renewal size	Condemning size
10 mm	9.5 mm	8.5 mm

- **Wear limit for wearing piece**

New size	Shop renewal size	Condemning size
45 mm	43.5 mm	42 mm

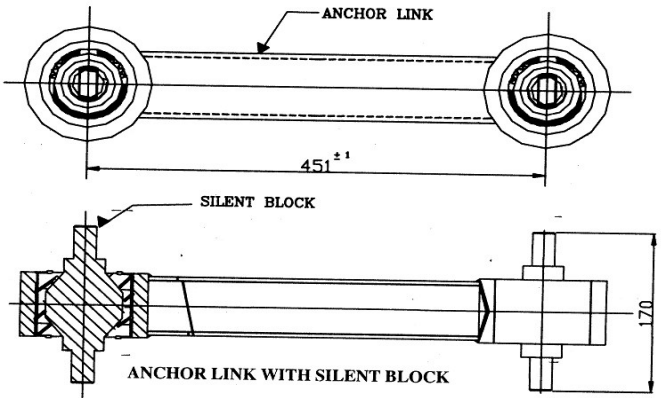


SIDE BEARER ARRANGEMENT



Anchor link

The floating bogie bolster which supports the coach body is held in position longitudinally by the anchor links which are pinned to the bolster sides and the bogie Transoms. One anchor link is provided on each side of the bolster diagonally across. The links can swivel universally to permit the bolster to rise and fall and sway side wards. They are designed to take the tractate and braking forces. The anchor links are fitted with silent block bushes

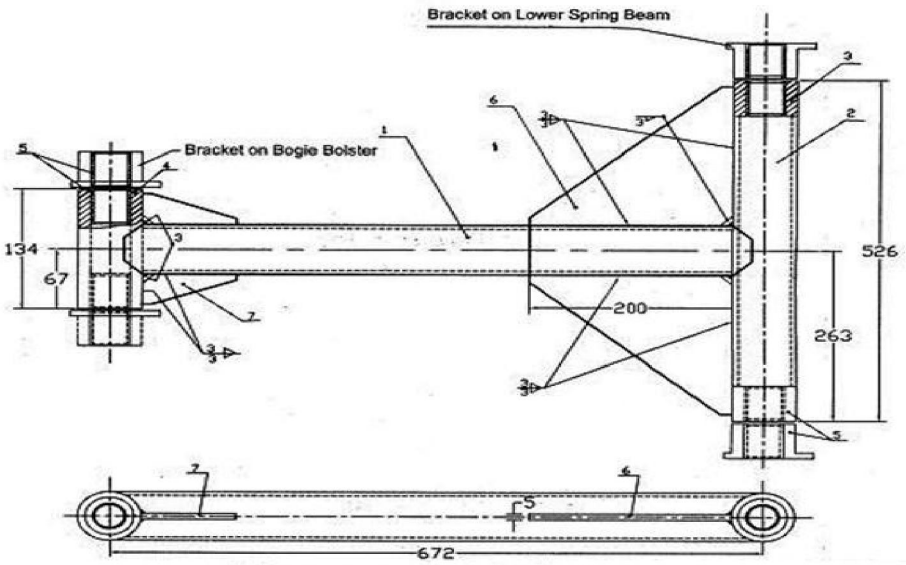


Anchor Link

Silent Block: The two anchor links diagonally positioned are provided with silent block bushes. The links prevent any relative longitudinal movement between the bogie frame and coach body. This is a synthetic rubber bush fitted in anchor link and Centre pivot of ICF bogies to transmit force without shock and reduce noise.

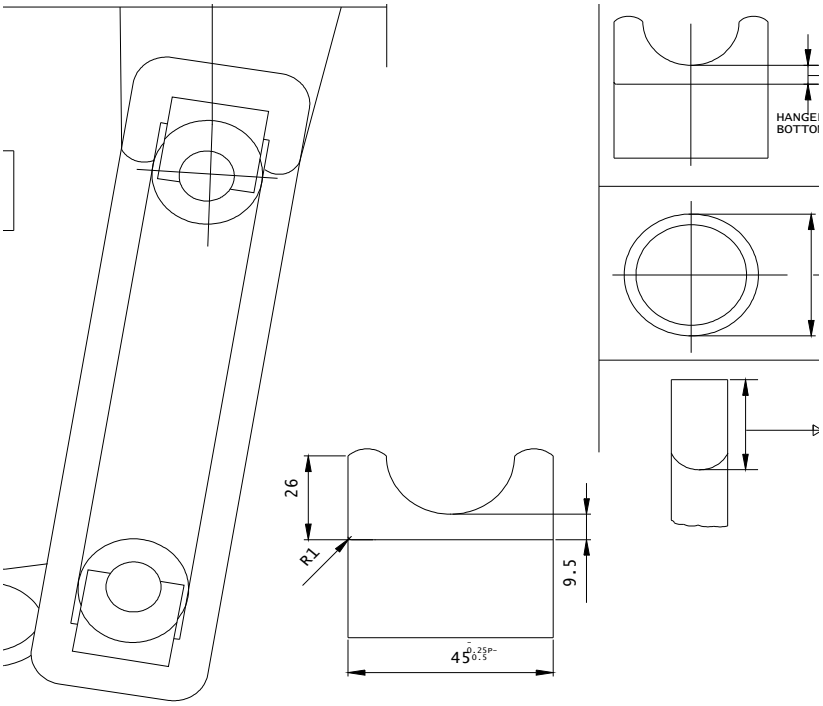
Shock Absorbers: Hydraulic shock absorbers with capacity of 600 kg at a speed of 10 cm/sec. are fitted on 13 ton bogie & 900 kg at a speed of 10 cm/sec. are fitted on 16 ton bogie work in parallel with the bolster springs to provide damping for vertical oscillations.

Equalizing Stays: This device has been provided on bogies between the lower spring plank and the bolster to prevent lateral thrust on the bolster springs as these springs are not designed to take the lateral forces. These links have pin connections at both ends and, therefore, can move vertically.



EQUALISING STAY FOR LOWER SPRING BEAM
(16.25 t Axle Load Bogie) (RDSO Sketch 88105)

Bolster Spring Suspension (BSS) Hangers: In the secondary suspension, the bolster is supported on helical coil springs which are placed on the lower spring plank. The lower spring plank is suspended from the bogie side frame through BSS hangers on hanger blocks.



SHOCK ABSORBERS

Hydraulic shock absorbers with capacity of **± 600 kg** at a speed of 10 cm/sec. are fitted to work in parallel with the bolster springs to provide damping for vertical oscillations.

SPRINGS

In bogie, helical springs are used in both primary and secondary suspension. The springs are manufactured from peeled and centre less**ground bar of chrome vanadium/chrome molybdenum steel.**

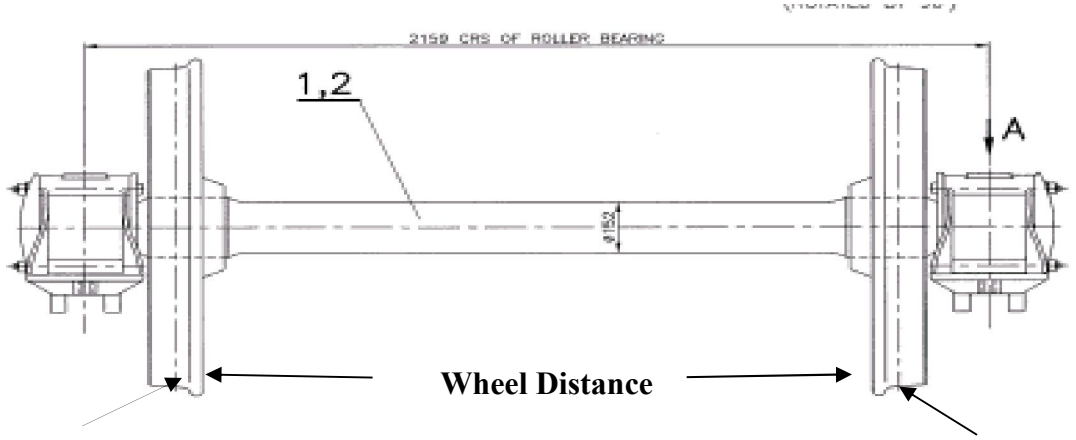
LOAD DEFLECTION TESTING AND GROUPING OF AXLE BOX SPRING

Code	Wire dia	Free height	Test Load	Acceptable height under test load	Groups as per loaded spring height		
					A	B	C
					Yellow	Oxford Blue	Green
A01 NAC ICF	33.5	360	2000	279-295	279-284	285-289	290-295
A03 AC ICF	33.5	375	2800	264-282	264-269	270-275	276-282
A04Power Car	35	372	3000	265-282	265-270	271-276	277-282
A06 Double Decker	36	337	2400	269-284	269-273	274-279	280-284
A09 High Cap. Parcel Van	37	360	3000	277-293	277-282	283-288	289-293
A10 Parcel Van	39	315	1800	276-289	276-279	280-284	285-289

LOAD DEFLECTION TESTING AND GROUPING OF BOLSTER SPRING

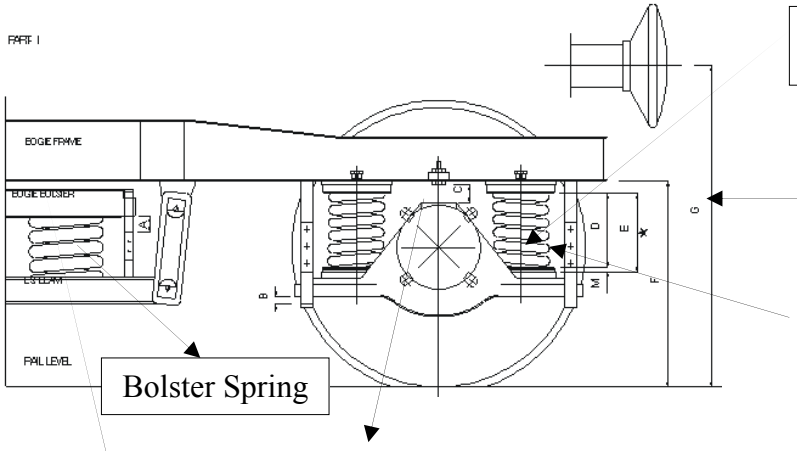
Code	Wire dia	Free height	Test Load	Acceptable height under test load	Groups as per loaded spring height		
					A	B	C
					Yellow	Oxford Blue	Green
B01 NAC	42	385	3300	301-317	301-305	306-311	312-317
B03AC	42	400	4800	291-308	291-296	297-303	304-308
B04Power Car	47	400	6100	286-304	286-291	292-297	298-304
B06Double decker	36	416	4200	280-299	280-286	287-292	293-299
B11High cap. Power Car	47	386	6700	306-322	306-311	312-317	318-322
B13 High cap. Power Car	34						
B15 VPH	40	393	6000	256-272	256-261	262-267	268-272
B16VPU	32.5	286					

IMPORTANT DIMENSIONS OF COACHING STOCK



Wheel Diameter Flange Thickness

Wheel Diameter (ICF) - Max -915 +3 -0mm, shop Min. size – 834 mm, condemn size – 825 mm.
Wheel Diameter (LHB) -Max -915 +4 -0 mm, shop Min. size – 857 mm, condemn size – 845 mm
Wheel distance- - 1600 mm, + 2, - 1 mm (ICF), - 1600 mm, + 1, - 1 mm (LHB)
Flange Thick ness – 29.4 mm. (worn wheel profile) and 25 mm (intermediate worn wheel profile)
Axle capacity- 13 T (Non AC – Axle dia Ø145 mm), 16.25 T (AC & non AC –Axle dia. Ø152 mm)



Spring group-Axle & Bolster Spring Green, Oxford Blue & Yellow

Buffer Height –Max. In Tare - 1105 mm,
Min. in Tare – 1090 mm
Min. in Load - 1030 mm

Height of axle spring including compensating ring – 295 mm max

Bolster Spring

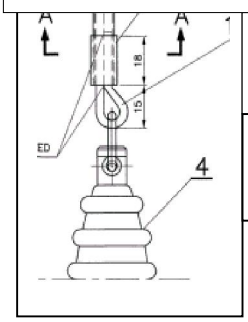
Upgraded Materials for 18 months POH- A. Bogie – HYTREL – Upper / Lower washers, Phenolic Brake gear bushes and Injection moulded Silent block. B. Body- PVC Flooring (Vynatile), Polyester block cushion, PVC upholstry cloth (Rexine) and LP sheet.

Crown clearance – 45 plus or minus 3 mm for Non AC , 36 plus or minus 3 mm for AC

Bolster clearance- 40 plus or minus 5 mm

Permissible difference in Diameter on wheels of Coach
0.5 mm on a same axle,5mm on same bogie, 13 mm on a Coach
Distance between Side Bearers –1600 mm
Overall Height of Coach- 4025 mm,
Overall Width of Coach- 3245 mm
Overall Length of Coach- 21337 over body
Overall Length of Coach- 22297 over buffer
POH periodicity–18 Months for all coaches except Departmental coaches (RA, BD Special, NMG etc.,) – 2 years.
ART/ARME Coaches 3 ½ Years
First POH of new built coaches – 24 Months
Bogie mounted Brake Cylinder - Min - 32 mm, Max - 95 mm.
Side Buffer Stroke- 127 mm Plus zero, Minus 5 mm
Buffer Projection 600 mm to 635 mm
Buffer Face Plate wear Limit at Centre – 11 mm

Codal life of Coach
ICF Coaches - 25 yrs, OCV - 35 yrs or 10 yrs after conversion whichever is earlier, LHB Coaches - 35 Years



Alarm chain force – 7 to 10 kg

Screw Coupling capacity 75 T

WHEEL AND WHEEL DEFECTS

Wheel derailment

There are two broad categories of derailment

a) Sudden derailment – Instant dismounting of wheel from rail

b) Gradual Derailment – Gradual climbing of flange on the rail.

Derailment Mechanism:

Nadal has derived the formulae as follows –

$Y = R \sin \beta - \mu R \cos \beta$

$Q = R \cos \beta + \mu R \sin \beta$

So,

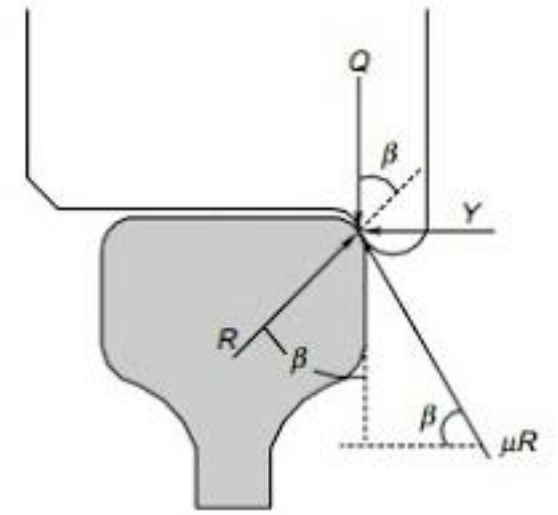
$Y/Q \leq \tan \beta - \mu / 1 + \mu \tan \beta$

Value of Y/Q should lie between 0.8 to 1, for safe running

Y is lateral force.

Q is vertical force.

β is flange angle.



Forces at rail–wheel contact with positive angularity

Causes of derailment

The cause of derailment can be largely classified into following two major categories

(i) Equipment failure

(ii) Human failure

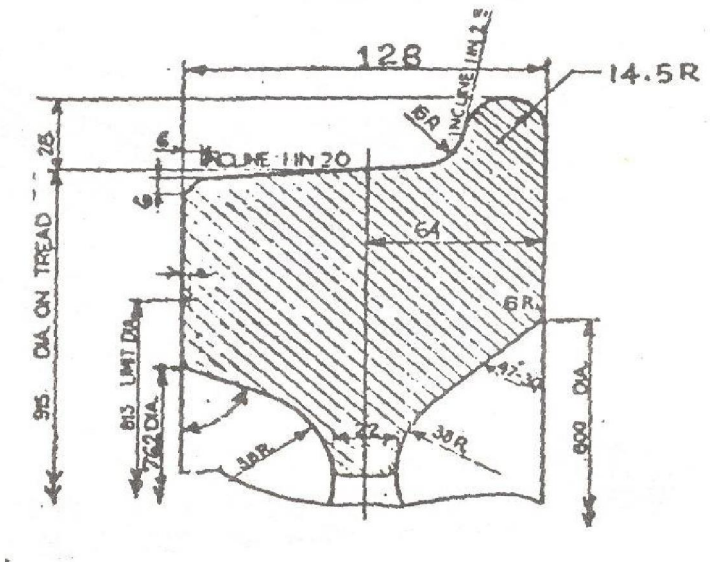
Apart from the above cattle run over, sudden falling of boulders, trees etc. on the track, sinking of track also may be the cause of derailment of rolling stock which do not require thorough investigation.

Salient features of wheel

1. Width of wheel – 127 mm.
2. Wheel diameter – 915^{+3}_{-0} mm (new), 825 mm (Condemn)
3. Axle capacity – 13 T(NAC) and -16 T(AC).
4. Journal – Direct mounted 120 x 130.5 mm
5. Journal centre – 2159.5 mm
6. Permissible diameter variation in wheel
   a. **Coaching**
      i. On same axle – 0.5 mm (for machining purpose only)
      ii. On same bogie – 5.0mm
      iii. On same coach – 13.0 mm
   b. **Goods**
      i. On same axle – 0.5 mm (for machining purpose only)
      ii. On same bogie – 13.0 mm
      iii. On same coach – 25.0 mm

Wheel profile

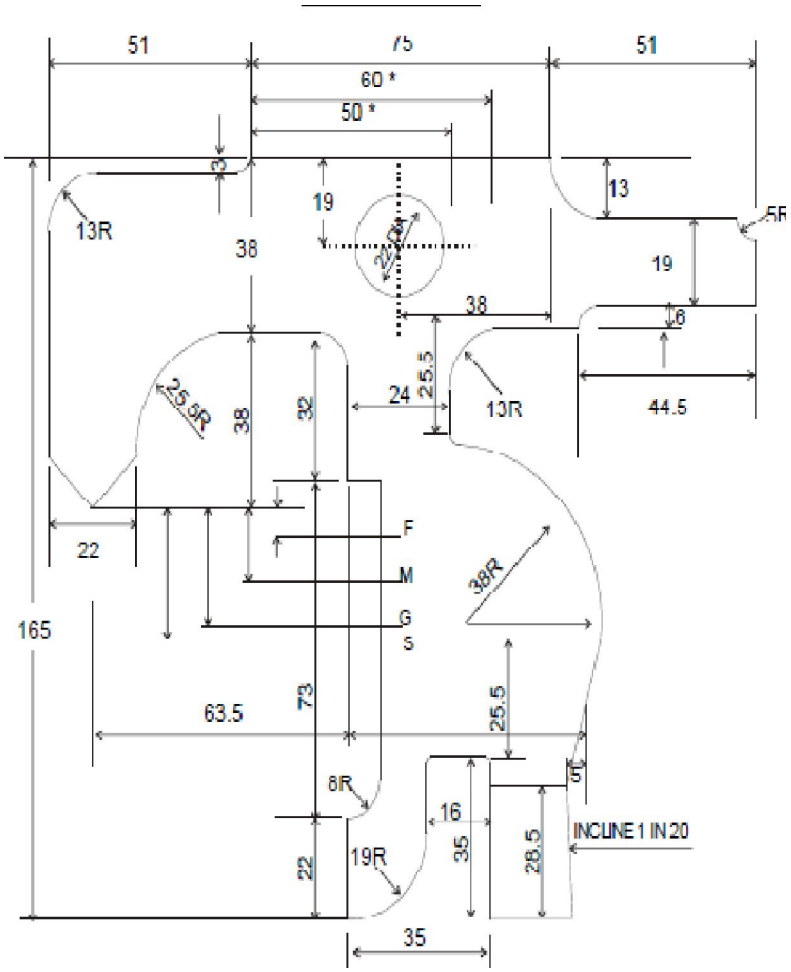
All the important dimensions are shown in figure below:
[**Ref: IRCA Rule Book Part – IV (Plate 29)]**

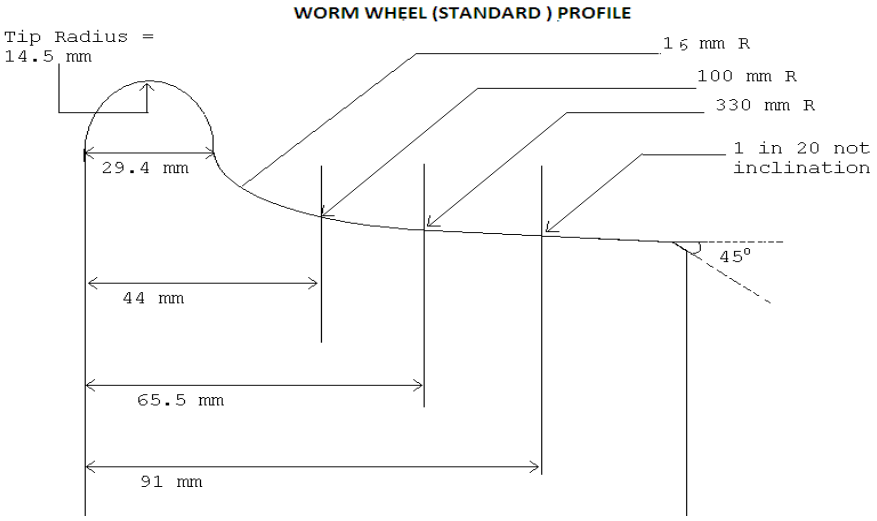


Wheel Defects

Various defects observed in wheel by using Tyre defect gauge are as shown in below.

[Ref: IRCA Rule Book Part – IV (Plate 39)]





WHEEL DEFECTS AND THEIR CONDEMN LIMIT

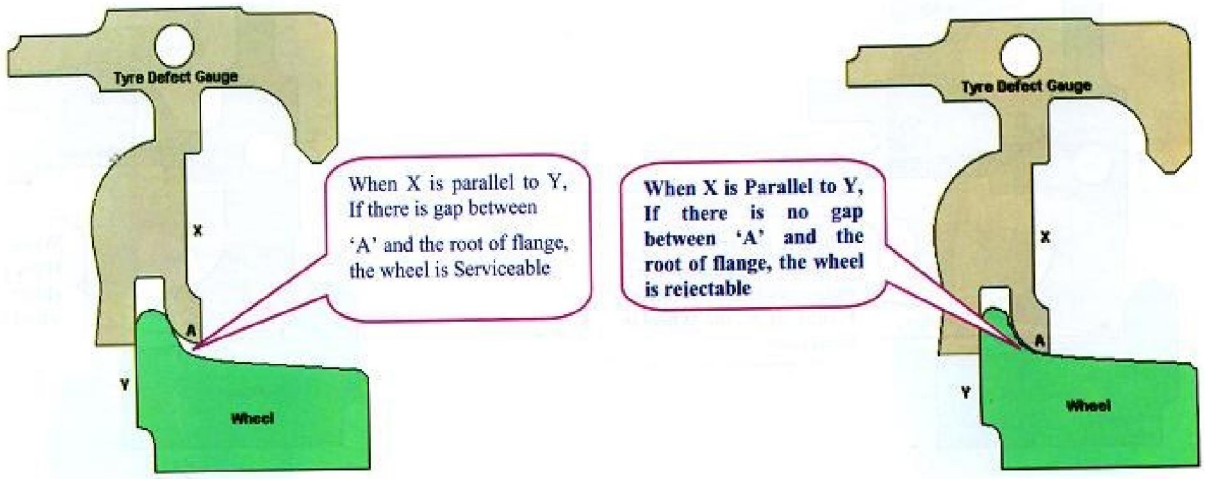
Wheel defects	Standard	Condemning Limit
Sharp Flange	14.5mm	5 mm or Less
Thin Flange	29.4mm	22 mm or less for Coaching and 16mm or Less for Goods
Less radius at root of flange	16mm-IRS 14mm-WWP	13 or Less
Hollow Tyre	-----	5 mm or above
Deep Flange	28.5mm	35mm or more
Thin Tyre	-----	28 mm or Less
Flat Tyre	-----	50 mm or more-Coaching 60 mm or more –Goods

Wheel defects

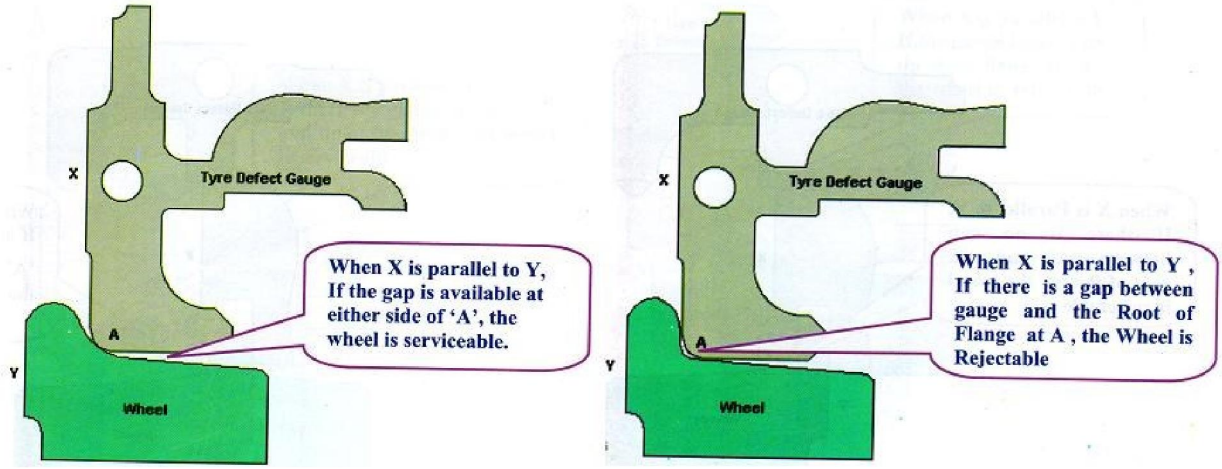
Wheel Defects	Causes
Thin Flange	When the flange thickness reduces from 28.5mm (New) to 16 mm (Condemn) or less, then the flange is called thin flange. Flange thickness is measured at a depth of 13 mm from the tip of the flange. **Repercussion**: - Chances of bursting of point due to entering of flange between Tongue rail and Stock rail.
Sharp Flange	When the radius given at the tip of flange is worn out from 14.5mm (New) to 5 mm (Condemn) or less is called Sharp Flange. **Repercussion**: - change of inserting flange between tongue rail nad stock rail at point
Less Radius at root of flange	New Radius of flange at the root is 16R, when it is reduced to 13R or below, it is called Radius too small at the root of flange. **Repercussion**: - Excessive lateral play result in chances of mounting of flange over rail.
Deep Flange	The New height of the flange is 28.5mm, when it increased up to 35mm or more is called Deep Flange **Repercussion**: - Hit the Fish plate bolts , distance block , heel block and wheel may jump off from rail
Flat Tyre	Flatness on wheel circumference is called Flat faces on tyre. 1. For Coaching Stock it is allowed up to 50 mm 2. For Goods Stock it is allowed up to 60 mm **Repercussion**: - Chances of rail fracture due to hammering on rail.
Hollow Tyre	If the groove on the wheel tread is up to 5 mm or more, it is called Hollow tyre. **Repercussion**: -More Oscillations.
Thin Tyre	If the remaining thickness of tyre is less than 25 mm, it is called thin tyre. **Repercussion**: - probability of breakage of tyre.

Application of Tyre Defect Gauge

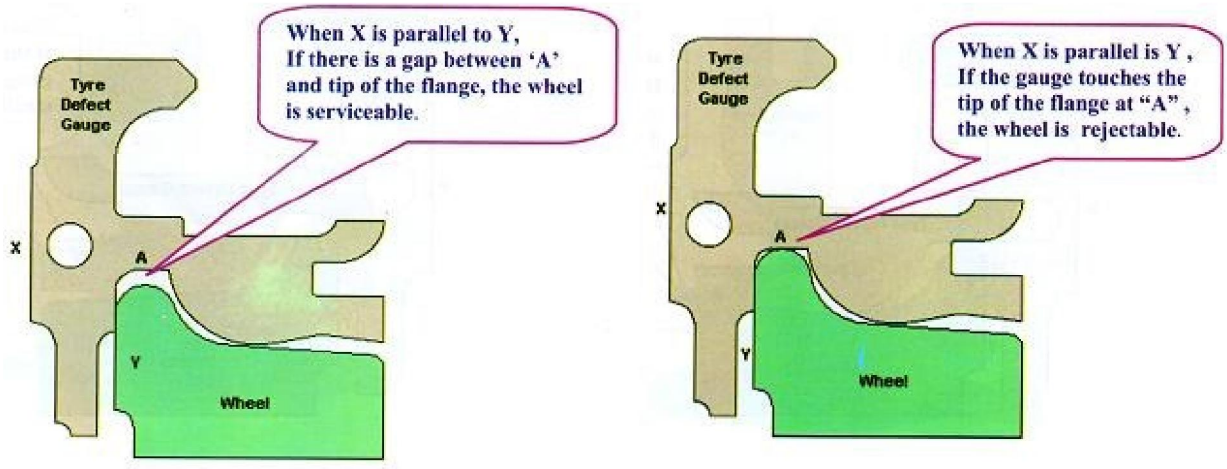
Thin Flange



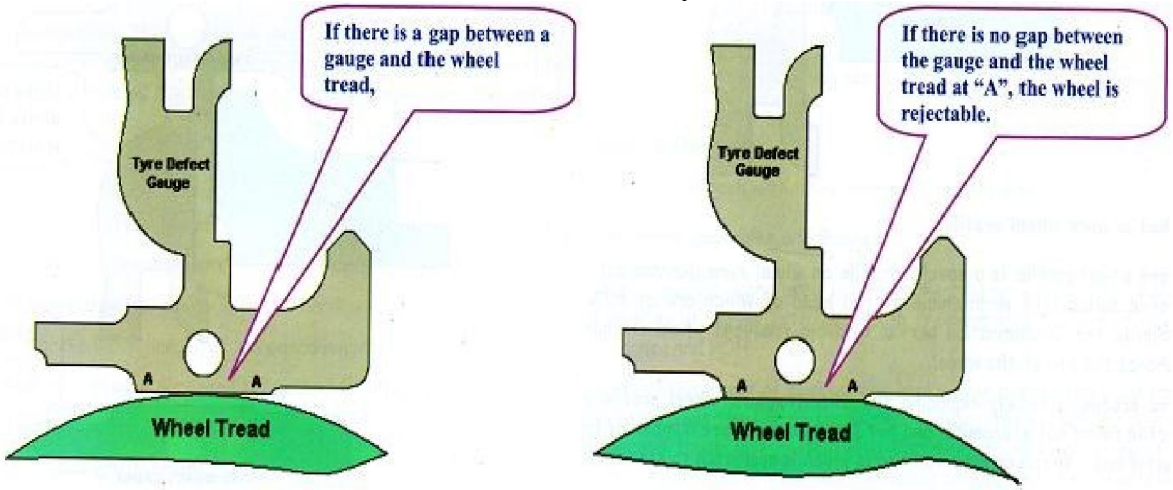
Less Radius at Root of flange



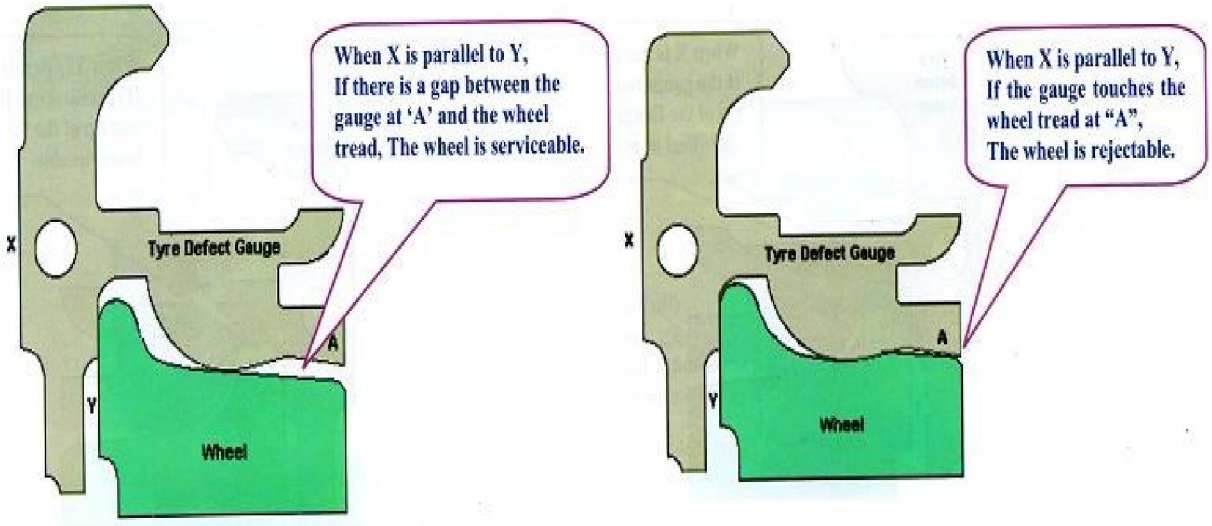
Deep Flange



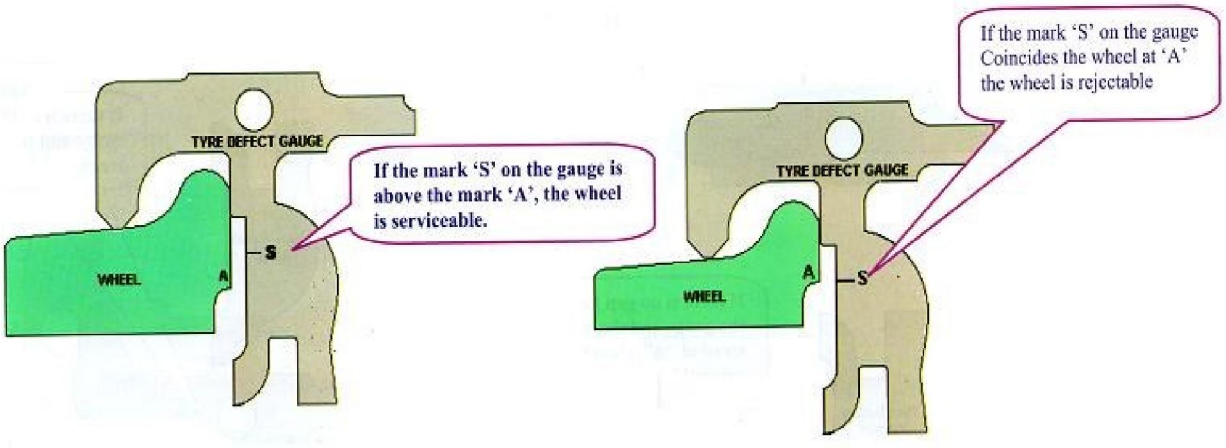
Flat faces on Tyre



Hollow Tyre



Thin Tyre



INTERMEDIATE WORN WHEEL PROFILE FOR COACHING STOCK

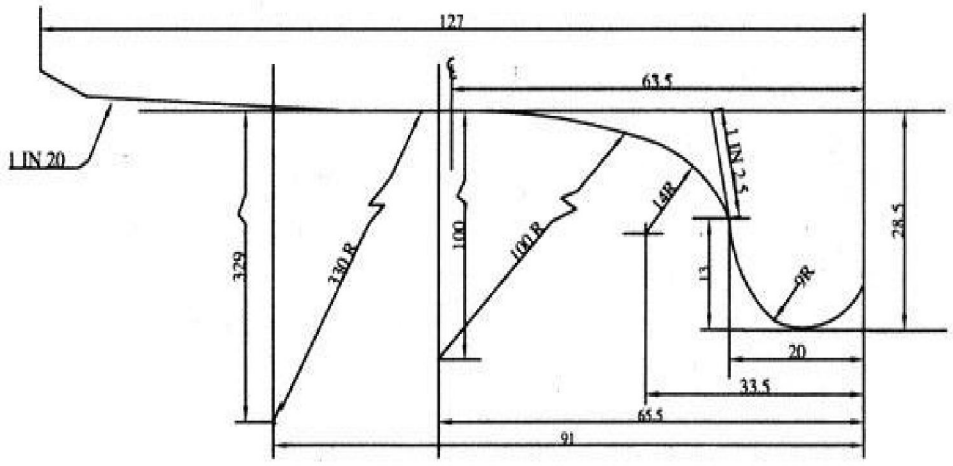
Worn Wheel Profile: -Worn wheel profile is a special profile on wheel disc derived out of standard wheel profile suitable to worn shape of rail head (which are of 80% track).

This is to minimize condemnation of disc to avoid frequent wheel changing re-profiling & enhance the life of the wheel. Average Wheel Wear*:* 2.5 to 3 mm per year for mail/Exp train. The followings intermediate worn wheel profiles are developed to increase the life of wheel.

INTERMEDIATE WORN WHEEL PROFILE

Thickness of Flange (mm)	D1 (mm)	D2 (mm)	D3 (mm)	R1 (mm)	R2 (mm)	R3 (mm)	R4 (mm)
28	42.23	65.5	91	13.5	14	100	330
27	41.29	65.5	91	13	14	100	330
26	40.34	65.5	91	12.5	14	100	330
25	38.41	65.5	91	11.5	14	100	330
24	37.44	65.5	91	11	14	100	330
23	36.42	65.5	91	10.5	14	100	330
22	35.49	65.5	91	10	14	100	330
21	34.50	65.5	91	9.5	14	100	330
20	33.5	65.5	91	9	14	100	330

Worn Wheel Profile 20 mm flange Thickness



Benefits of Worn Wheel Profile:

1) It increases the life of wheel.
2) It decreases machining cost.
3) Less fuel consumption of the engine.
4) It increases the wheel lateral oscillation

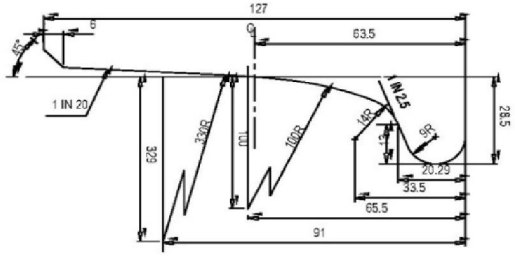


FIG.1: 20mm THICK FLANGE

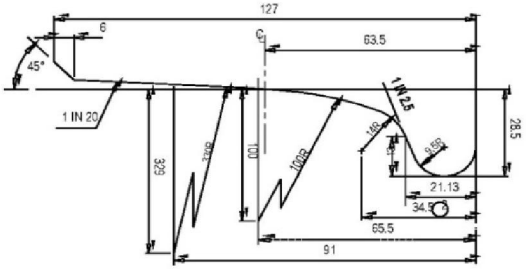


FIG.2: 21mm THICK FLANGE

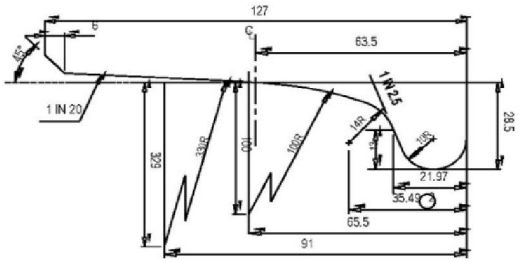


FIG.3: 22mm THICK FLANGE

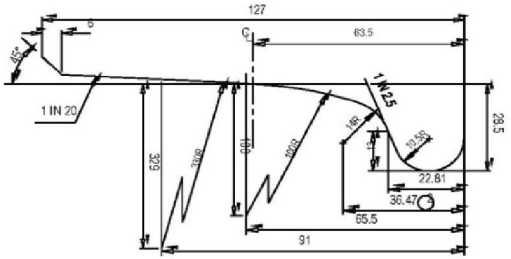


FIG.4: 23mm THICK FLANGE

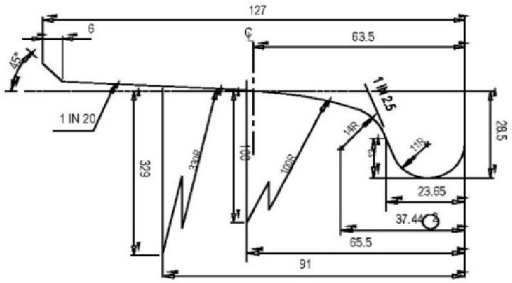


FIG.5: 24mm THICK FLANGE

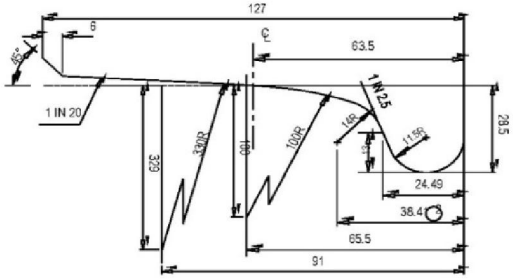


FIG.6: 25mm THICK FLANGE

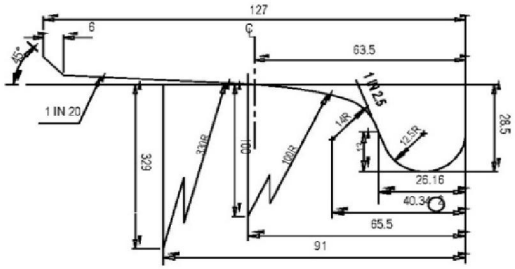


FIG.7: 26mm THICK FLANGE

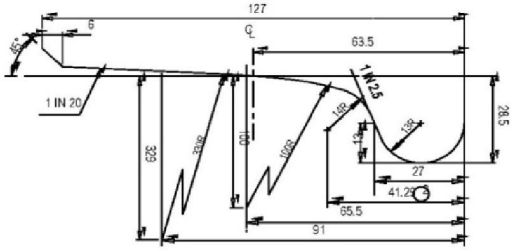


FIG.8: 27mm THICK FLANGE

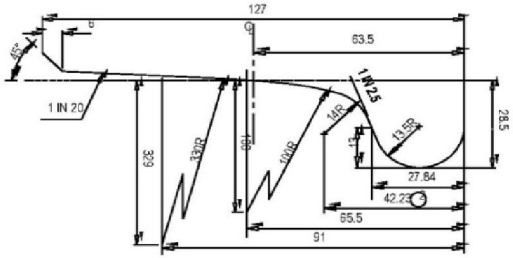


FIG.9: 28mm THICK FLANGE

NOTE:–

1. INTERMEDIATE WORN WHEEL PROFILES OF 25mm TO 28mm THICK FLANGE (FIG.6 TO 9) SHOULD ONLY BE USED FOR THE COACHES TO RUN AT MAXIMUM PERMISSIBLE SPEEDS OF 110 kmph AND ABOVE.
2. ALL THE 9 INTERMEDIATE WORN WHEEL PROFILES (FIG.1 TO 9) CAN BE USED FOR THE WHEELS FOR OTHER TYPE OF COACHES.

ALT.	ITEM	AUTHY.	DESCRIPTION	DATE
2	-	SS/01/12	DIMENSION 34 (FIG.2), 35.5 (FIG.3), 36.34 (FIG.4), 37.32 (FIG.5), 38.5 (FIG.6), 40.21 (FIG.7), 41.17 (FIG.8) AND 42.11 (FIG.9) CORRECTED AS 34.5, 35.49, 36.47, 37.44, 38.41, 40.34, 41.29 AND 42.23 mm RESPECTIVELY.	01/12
1	-	SS/01/10	INTERMEDIATE WORN WHEEL PROFILES OF 21,23,24 26,27 AND 28mm THICK FLANGE ADDED AND EXISTING PROFILES OF 20,22 & 25mm THICK FLANGE MODIFIED. NOMENCLATURE OF FIG.1, FIG.2, FIG.3 DELETED AND FIG.1 TO FIG.9 ADDED FOR ALL 9 PROFILES. NOTE 1 AND 2 MODIFIED.	03/10

	SUPERSEDED BY
ASSY. DRGS	SUPERSEDES
REFERENCE	SCALE 1:1
FLOPPY No.	B.G. R.D.S.O. [C]

INTERMEDIATE WORN WHEEL PROFILE FOR COACHING STOCK

GROUP (X)(2) SKETCH–92082

Thermal Wheel Defects (As per technical pamphlet No CMI – K 003)

The following guidelines are issued to make the visual inspection of wheels during maintenance more focused and effective. The following wheel conditions should be paid special attention during the visual inspections of solid and tyred wheel discs used on coaches and EMU's.

In addition to normal checks exercised on wheel condition during primary / secondary maintenance of coaches, a detailed inspection of wheels should be done when the coaches are received in sick line for attention for either scheduled or out of course attention. The wheel sets shall be inspected for the following conditions and action taken as indicated for each condition:

Shattered Rim

Shattered Rim: a wheel with a fracture on the tread or flange must be withdrawn from service. This does not include wheels with localized pitting or flaking without presence of any other rejectable condition.

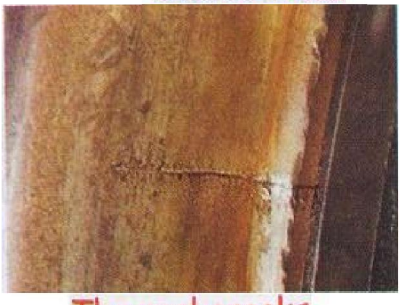
Spread Rim

Spread Rim - If the rim widens out for a short distance on the front face, an internal defect may be present. Spreading of the rim is usually accompanied by a flattening of the tread, which may or may not have cracks or shelling on the tread. Such wheels must be withdrawn from service.

This condition should not be confused with a uniform curling over of the outer edge of the rim around the entire wheel, which is called rim flow Rim flow is not a defect.

Shelled Tread

Shelled Tread -Shelling can be identified by pieces of metal breaking out of the tread surface in several places more or less continuously around the rim. Shelling takes place when small pieces of metal break out between the fine thermal checks. These are generally associated with small skid marks or "chain sliding." Such wheels should be withdrawn from service.



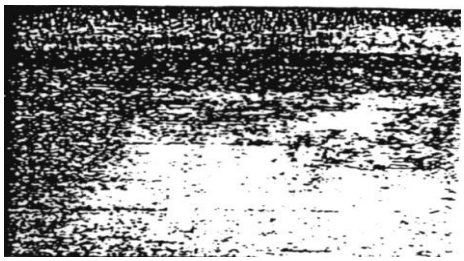
Thermal cracks

Thermal Cracks -Thermal cracks appear on a wheel due to Intense heating of the wheel arising out of sever brake binding. Such cracks occur on the tread and generally progress across the tread in a transverse & radial direction. Whenever such a crack becomes visible on the outer face of the rim or a tread crack has reached the outer edge (non-gauge face) of the rim; the wheel should be withdrawn from service. If a crack becomes visible on the outer flange face the wheel should be withdrawn from service.

Wheels involved in sever brake binding should be examined carefully during the maintenance to rule out the

possibility of reject able thermal cracks. Such wheels may be identified by presence of flats (even within acceptable limits) and severe discoloration or blue black heating marks on the tread.

Heat checks - Thermal cracks are deeper and need to be distinguished from fine superficial cracks visible on the tread on or adjacent to the braking surface. These are called heat checks, which are usually denser than the thermal cracks. Heat checks are caused on the tread due to heating and cooling cycles undergone by the wheel during normal braking. Such wheels do not need to be withdrawn but should be carefully distinguished from the reject able thermal cracks.



SUSPENSION SYSTEM IN COACHING STOCK

The arrangement provided in the rolling stock to absorb shocks and to minimize extra oscillation due to irregular joint in Track and extra wear and tear occurred in rolling stock is called suspension system.

There are two types of Suspension system used in rolling stock

1. Single stage Suspension System
2. Two Stage Suspension system

Single stage Suspension System: This system has only one suspension arrangement either Primary or secondary suspension.

Two stage Suspension System: This system both suspension arrangement Primary as well as Secondary suspension.

Single Stage Suspension is used in Vehicle where

- Comfort is not the primary criteria
- Simple construction and easy maintenance are important consideration
- Pay Load is high as compared to tare weight

Two Stage Suspension is used in Vehicle where

- Comfort is important criteria
- Payload is low compared to tare weight
- Moderate speed are required

SUSPENSION SYSTEM UTILISED IN ICF COACH:

Primary suspension system

Primary suspension arrangement is an arrangement between bogie frame and wheel for transmitting load .This arrangement is known as flexible medium of load transmission. This is also known as telescopic built in damper universal control of wheel Axle.

This arrangement is called Primary suspension because this is the first suspension arrangement comes in the passes of shock / jerk and as per study it is observed that about 70 % of shock/ jerk is absorbed by this suspension arrangement and remaining 30 % of shock/jerk absorbed by Secondary suspension arrangement .

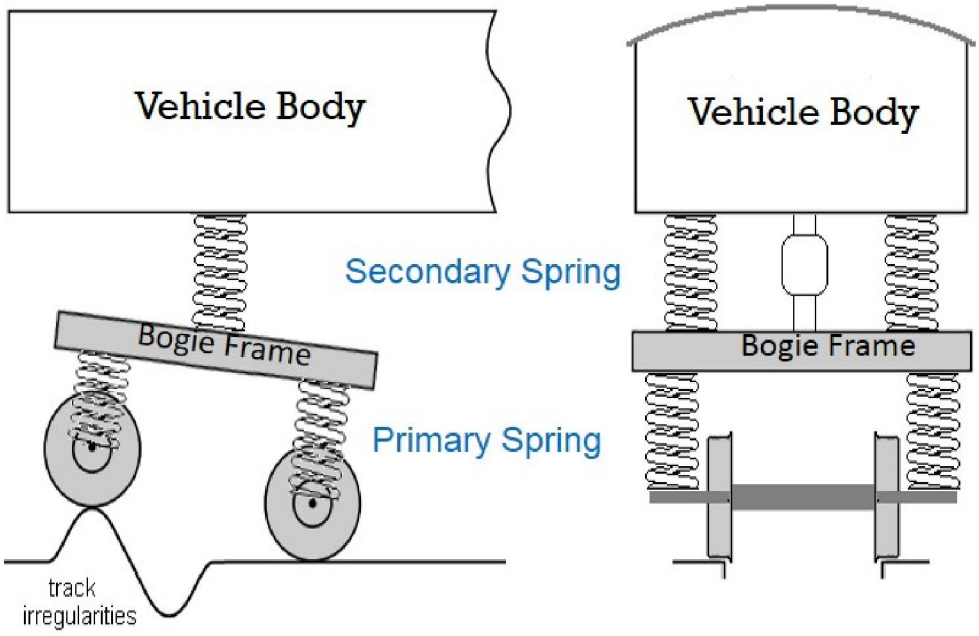
The steel coil spring is placed between two Washers called Hytrel washer and fibre packing rings (Compensating Rings) whenever diameter of wheel is reduce in order to compensate short fall of the buffer height.

There are two types of fibre compensating pickings are mostly used in BG ICF is 22 mm and 13 mm packing rings. The rings inserted proportionality to the reduction of the wheel diameter. These packing are inserted below the dashpot and above the bottom of Hytrel washer

The primary coil spring or axle guide springs should be matched equally in the free height and tare height however there is a tolerance of ±2mm allowed.

The dash pot assembly is assemble in the concentric to the spring and it consist of lower spring seat which to be filled with 1.6 litres of damping Oil (Dashpot oil). The Axle guide with bush is inserted in the oil bath from the web of the bogie.

At the Bogie frame, there is a hole of vent screw for the purpose to measure the oil level in dash pot guide that should be 40 mm above guide cap. This should be measured by inserting dip stick from vent hole available at web of bogie frame. The Vent screw should be provided with lather washer for oil leak proof and Air tight



Secondary suspension system

Secondary suspension arrangement provided between coach body and bogie frame is known as secondary suspension arrangement. In this system two Nos Bolster helical spring are seated on lower plank with the use of one vertical absorber and suspension link , pin and stone assemblies .

It is suspended by means of our stirrup ling (BSS hangers). Each side BSS hanger assembly is inclined 7° to the vertical and 11° to the horizontal for the purpose of centralizing feature and good riding and swinging comfort. The Lower bolster planks further hinged to the upper bolster by means of equalising stay rod. There is a centre vertical shock absorber connecting top and bottom bolster which absorbed the shock and dampen the vertical oscillation. The Lower bolster has got two U- Clamp to prevent drooping of lower bolster in the event of breakage and working out of stirrup link.

The upper Bolster which has a common spring plank which seat on the four springs is have a central hole with silent block bush, where the centre pivot of the coach body passes. This pivot assembly is a centre of rotation fitted to the under frame transom by means of four bolts and forces not vertical forces. Pivot pin is cotter head bottom and **cotter is held by split**

pin. To prevent the entrance of dust and water on the top centre pivot rubber sealing washer is provided.

Upper Bolster is diagonally connected to bogie transom by means of two silent block bush anchor link .The Anchor Links are fitted in Brackets with Locking plate .

On the upper Bolster there are two side bearer sump in which hard grounded Mn steel plate is immerged in oil bath at bottom of wear piece hemi spherical bronze wear piece with groove which slide over the wearing plate when negotiate the curve . Grooves are provided for uniform lubrication. On the curvature bronze wear piece side bearer guide piece with concave matching surface is sitted. The guide piece is welded to body transom .The side bearer assembly four in One coach and two on each bogie are provided through which vertical load is transmitted. The guide has got dust cover which will normally sit on the mouth of the side bearer sump to prevent entry of dust and water. There is oil filling spout is provided with screwed cap to indicate the oil level to the marking provided in it.

2.0 Litres oil has to fill at the time of IOH and POH. The dust cover of the top should be free, if it is tight it indicate displacement of hemispherical wear piece or the breakage of fibre wearing piece in side bearer sump. This aspect should be examined during trip scheduled in pit Line.

Whenever the coach is lifted and lower special care should be taken to check the perfect seating of side bearer guide and side bearer hemispherical wear piece. This also indicate the dust cover should be free should not be tight.

The main function of the Side bearer is to transmit the load and provide smooth and easy negotiation of track over the curve geometry of track.

AIR BRAKE SYSTEM

The brake system in which compressed air is used in the brake cylinder for the application of brake is called air brake.

The existing vacuum brake has got its own limitations like brake fading, increased application and release timings etc., in practice it is not reliable to run trains in higher altitudes due to insufficient vacuum levels in brake van and train engine.

So, to overcome all these, it has become necessary to introduce Air brake system to control the speed of the train and to stop it within a reasonable distance, irrespective of length, load of the train, distance covered and altitude of the train.

The advantages of Air brake over Vacuum brake are:

- Uniform brake power is possible throughout the train in air brake, but it is not possible in case of vacuum brake, since the pressure drop at the rear of the train is up to 20%.
- The propagation rate of compressed air is 260 m/sec to 280 m/sec. when compared to 60 to 80 m/sec. in the case of vacuum brake.
- The Air brakes have potentiality to run trains longer than 600 metres length.
- The air brake trains have potentiality to run heavier trains than 4500 tons.
- Shorter braking distance
- Suitable for higher altitudes.
- Compact and Easy to maintain.
- Consumption of spare parts is very less
- Simple brake rigging.
- Quicker application and release, so better punctuality can be achieved.
- Better utilization of rolling stock since less maintenance and pre departure detention.

Differences between Air Brake and Vacuum brake

S.N	Air Brake	Vacuum Brake
1.	Air brake works on compressed air at 5 Kg/Cm^2 maintained in brake pipe	Vacuum brake works on atmospheric pressure at 1.03 Kg/Cm^2
2.	At the time of brake application compressed air is admitted in to the brake cylinder up to 3.8 Kg/Cm^2	In vacuum brake air at atmospheric pressure is admitted
3.	Distributor valve is the main functioning unit in the air brake system	Vacuum cylinder is the main functioning unit in the vacuum brake system.
4.	Brake application is caused by the outward movement of the piston	The inward movement of the piston causes brake application.
5.	Brake cylinder is connected to auxiliary reservoir during brake application and to exhaust during brake release through the distributor valve.	Vacuum cylinder is directly connected to train pipe during brake application and release.
6.	For any reason, if the cylinder has to be made inoperative, it can be conveniently done by closing the isolation cock.	For any reason if the cylinder has to be made inoperative, the train pipe nipple or the syphon pipe has to be dummied.
7.	On either ends of brake pipe and feed pipe angle cocks are provided for closing and opening.	No angle cocks are provided in the train pipe.

Sl.No.	Air Brake	Vacuum Brake
8.	Air hoses are used to provide flexible connection between adjacent vehicles.	Hosepipes are used to provide flexible connection between two adjacent vehicles.
9.	Palm ends (or) coupling heads are used on the coupling side of air hoses.	Universal couplings are used on the coupling side of hose pipes.
10.	M.U washers are used to make airtight joints on palm ends.	I.R washers are used to make airtight joints on universal couplings.
11.	In case of train parting, brake application is automatic by venting out air pressure from BP through air hoses.	In case of train parting brake application is automatic by admission of atmospheric air in to the vacuum cylinder through hosepipes.
12.	Emergency braking distance is 632 metres. (4500 tonnes trailing load, level track at 65 KMPH speed)	Emergency braking distance is 1097 metres. (4500 tonnes trailing load, level track at 65 KMPH speed)
13.	No brake power fading.	There is always a brake power fading to the extent of 20 %.
14.	Uniform brake power is possible throughout the train due to the higher propagation rate.	Uniform brake power is not possible due to the lower propagation rate of atmospheric air in the vacuum.

TYPES OF AIR BRAKE

There are two types of air brakes namely:

- Direct release (Mainly used on American Rail Road)
- Graduated Release (Used on Indian Railways)

DIRECT RELEASE SYSTEM: In direct release system the brake cylinder pressure cannot be reduced in steps by increasing the brake pipe pressure in steps during release. The brakes are released immediately, as soon as releasing of brake is initiated.

Brake pipe pressure in Kg/cm^2	Brake cylinder pressure in Kg/cm^2
3.5	3.8
3.8	0
4.0	0
4.2	0
4.5	0
5.0	0

GRADUATED RELEASE SYSTEM: In this system the brake cylinder pressure can be reduced gradually in steps in proportion to the increase in brake pipe pressure.

Brake pipe pressure in Kg/cm^2	Brake cylinder pressure in Kg/cm^2
3.5	3.8
3.8	3.0
4.0	2.5
4.2	2.0
4.5	1.25
5.0	0

Note: In both the types brake application is directly proportional to the reduction in brake pipe pressure.

TYPES OF GRADUATED RELEASE AIR BRAKE

There are two types of graduated release air brakes

- Single pipe air brake system.
- Twin pipe air brake system.

Single pipe system: There is only one pipe called brake pipe running from loco to the brake van in order to get continuity of air for the application and release of brakes.

Twin pipe system: In addition to the brake pipe, there is one more pipe called feed pipe, running from loco to the brake van to charge the auxiliary reservoir continuously to 6 Kg/cm2.

IMPORTANT COMPONENTS OF AIR BRAKE EQUIPMENT

.

Sl. No	Description	Twin pipe system		Single pipe system
		U/F MOUNTED	BMBS	GOODS STOCK
1.	Brake pipe	01	01	01
2.	Feed pipe	01	01	-
3.	Cut off angle cocks	04	04	02
4.	Brake cylinders	02	04	01
5.	Distributor valve	01	01	01
6.	Auxiliary reservoir Capacity	02 100 litres	01 200 litres	01 100 litres
7.	Isolating cock	05	05	01
8.	Centrifugal dirt collector	02	02	01
9.	Check valve	01	01	-
10.	Air hoses	04	04	02
11.	Palm ends	04	04	02
12.	Control Reservoir	01	01	01

DISTRIBUTOR VALVE ASSEMBLY

The distributor valve assembly consists of a valve body, a common pipe bracket, and a control reservoir. All the pipe connections from brake cylinder, auxiliary reservoir and brake pipe are connected to distributor valve through the common pipe bracket. The pipe bracket remains on the wagon/coach when the distributor valve is removed for overhaul and maintenance without disturbing the pipe connections.

The control reservoir is directly connected to distributor valve through common pipe bracket. An isolating cock is provided either on the distributor valve or on the adaptor to isolate the distributor valve when found defective. A manual release valve is provided at the bottom of the distributor valve by which the brakes in a particular vehicle can be released manually by pulling the handle.

BRAKE CYLINDER

The brake cylinder receives compressed air from auxiliary reservoir after being regulated by the distributor valve and develops mechanical brake power by outward movement of its piston assembly. The compression spring provided in the brake cylinder brings back the rigging to its original position when brake is released.

CUT-OFF ANGLE COCK

Cut off angle cocks are provided on either ends of the brake pipe and feed pipe. These cocks are used at the time of uncoupling of wagons/coaches. This has a vent feature. Once the cock is closed it allows the air trapped in the air hose to atmosphere. When MU washer or hose assembly itself has to be changed, the cut off angle cocks are closed which in turn isolates the brake/feed pipe from further charging and allows the entrapped air in the hose to flow out, to carry out the repairs easily. It also serves as dummy for the rear of the wagon/coach and the front of engine. When the handle is parallel to the pipe the cock, it is in open position and when at right angles to the pipe, it is in closed position.

CONTROL RESERVOIR

Control reservoir is mounted on the common pipe bracket. It always maintains a pressure of 5 Kg/Cm2. It works as a reference pressure to operate the different sub-assemblies/valves provided in the distributor valve to facilitate application and release of brakes. The brake pipe pressure acts in the top of the diaphragm and control reservoir pressure acting at the bottom of the diaphragm.

AUXILIARY RESERVOIR IS NECESSARY FOR THE AIR BRAKE SYSTEM

.In air brake system, the brake cylinder should get compressed air during brake application. But in case of accident such as train parting, it is not possible for the brake cylinder to get compressed air from the atmosphere. So it has become necessary to ensure sufficient quantity of compressed air with required pressure is always available in every rolling stock before the trains are despatched. That is why all the rolling stocks are provided with Auxiliary reservoirs to store the compressed air.

CAPACITY OF AUXILIARY RESERVOIR

Coaching Stock

ICF -U/F Mounted	-	02 Nos Each 100 Ltrs
ICF -Bogie Mounted	-	01 No 200Ltrs
LHB-Axle Mounted	-	02 Nos 125 Ltrs& 75 Ltrs
Goods Stock	-	100 Ltrs
Goods Stock BVZC	-	75 Ltrs

FUNCTION OF A DIRT COLLECTOR

Dirt collectors are provided at the junction of the main pipe and branch pipe in both feed pipe and brake pipe. These are meant for removing dust, moisture and scale particles from air before it enters the distributor valve and auxiliary reservoir. This is achieved by centrifugal action.

FUNCTION OF CHECK VALVE WITH CHOKE

This is a one way valve / non-return valve which allows the compressed air from feed pipe to auxiliary reservoir and it prevents the back flow of air from auxiliary reservoir to the feed pipe to avoid fall in auxiliary reservoir pressure in the event of failure of air supply from feed pipe. The choke provided in the check valve controls flow of air so that auxiliary reservoirs on the entire train can be filled uniformly. This is provided between the feed pipe and auxiliary reservoir.

ISOLATION COCKS AND THEIR LOCATIONS

There are five isolation cocks provided in the coaching stock. Locations of these cocks are given below.

Location	Nos.	Remarks
Between brake pipe and DV Between Distributors valve and brake cylinders. Between feed pipe and auxiliary reservoir. Between passenger emergency valve and brake pipe	01 02 01 01	(2 Cylinders)

SIZES OF BRAKE CYLINDERS USED FOR THE AIR BRAKE STOCK

Size of the cylinder	Mounted on	Stock
355 mm diameter / 14 inches	Body	Coaching & Goods Stock
304 mm diameter / 12 inches	Body	Brake Van
203 mm diameter / 08 inches	Bogie	Coaching Stock

DIFFERENCES IN AIR BRAKE SYSTEMS COACHING AND GOODS STOCK

S.No	Description	Coaching Stock	Goods Stock
1	System	Twin pipe	Single pipe
2	Size of Brake pipe	25 mm	32 mm
3	Size of feed pipe	25 mm	-
4	Number of brake cylinders	02 (U/F Mounted) 04 (BMBS)	01
5	Auxiliary reservoirs	02 (U/F Mounted) 01 (BMBS)	01
6	Capacity of each AR	100 Ltr (U/F Mounted) 200 Ltr (BMBS)	100 Ltr 75 Ltr (BVZC)
7.	PEAS	Available	Not available

TWIN PIPE AIR BRAKE SYSTEM ADOPTED FOR PASSENGER STOCK

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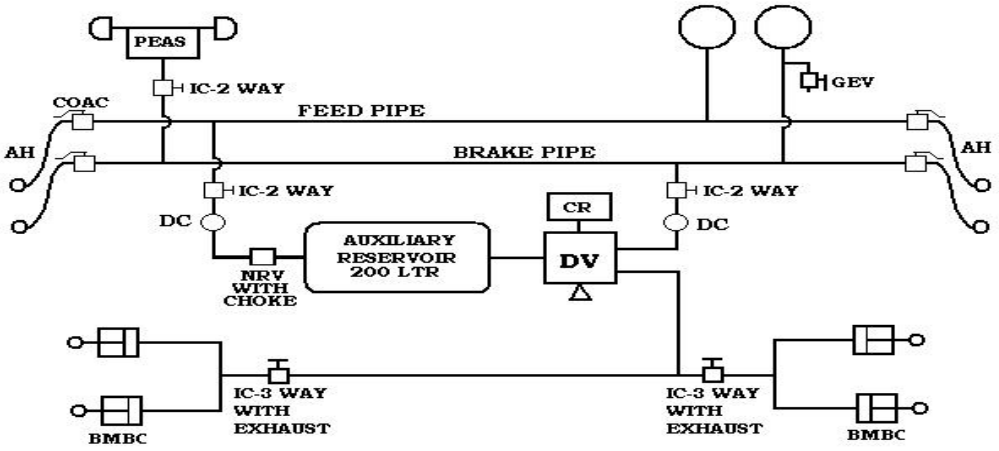


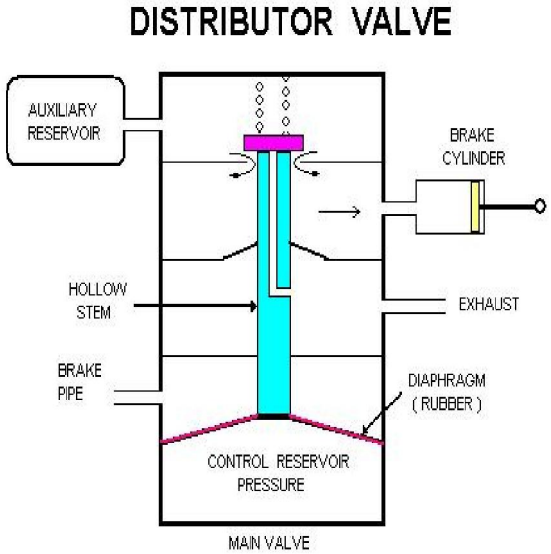
SCHEMATIC DIAGRAM OF TWIN PIPE AIR BRAKE SYSTEM

WORKING PRINCIPLE OF AIR BRAKE

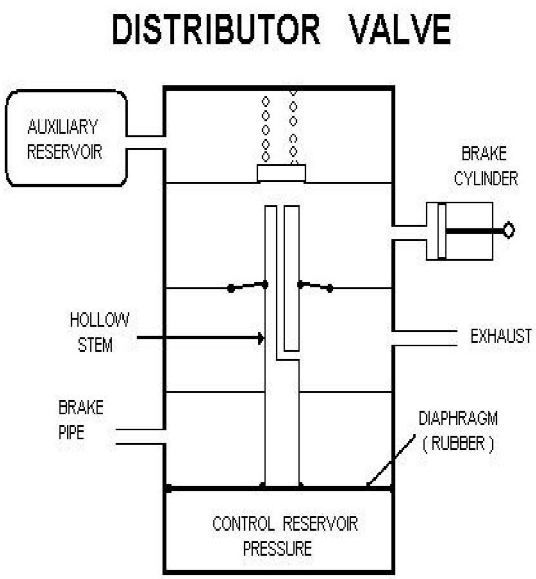
Under normal conditions the Brake pipe is charged with 5 kg/cm2 from the Loco. The control reservoir and the Auxiliary reservoir are also charged with 5 kg/cm2 from BP through Distributor valve in case of single pipe system. In twin pipe system the auxiliary reservoir is charged to 6 kg/cm2 through feed pipe.

When the brake pipe is 5 kg/cm2, the brake cylinder is connected to exhaust through distributor valve in order to keep the brakes in released position fully.

Whenever the brake pipe pressure is reduced below the CR pressure, the DV connects the auxiliary reservoir with the brake cylinder and the air from AR is sent into the brake cylinder to apply the brake. Whenever the brake pipe pressure is equal to CR pressure, the DV disconnects the BC from AR, and in turn connects the BC with Exhaust for the release of brakes fully.



WHEN BP PRESSURE IS LESS THAN 5Kg/Cm^2



WHEN BP PRESSURE IS 5Kg/Cm^2

PROCESSES INVOLVED IN WORKING OF AIR BRAKE SYSTEM

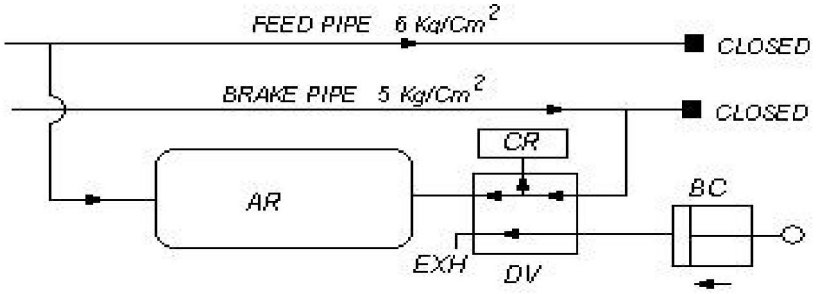
The processes involved in working of Air brake are,

a. Charging
b. Application
c. Release.
d. Manual Release

CHARGING

During charging,

a. Brake pipe is charged with 5 Kg/Cm^2 by the drivers brake valve from the Loco.
b. Feed pipe is charged with 6 Kg/Cm^2.
c. AR is charged with 6 Kg/Cm^2(Up to 5 Kg/ Cm2 it is charged by both brake pipe and feed pipe. Beyond 5 Kg/Cm^2& up to 6 Kg/Cm2 it is exclusively charged by feed pipe.)
d. The CR is charged through the distributor valve to 5 Kg/sq cm from BP
e. During charging Brake cylinder is connected to exhaust through distributor valve, to keep the brakes in released condition.



AIR FLOW DIAGRAM- CHARGING

BRAKE APPLICATION

During Brake Application., the brake pipe is reduced in steps as given below.

Stages	BP pressure is reduced by
Minimum Reduction	0.5 to 0.8 Kg/Cm^2.
Service application	0.8 to 1 Kg/Cm^2.
Full service application	1 to 1.5 Kg/Cm^2.
Emergency application	Above 1.5 Kg/Cm^2.

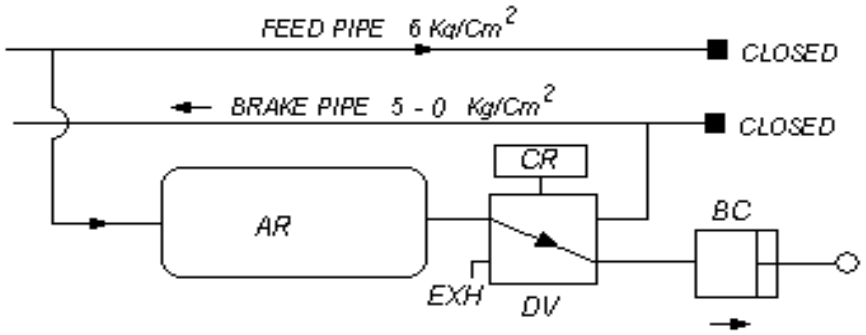
When the brake pipe pressure is reduced in steps as shown above, the air from AR is sent into BC to a maximum pressure of 3.8 Kg/ cm2, during full service application as well as emergency application.

During minimum reduction and service application the admission of air from AR in to BC is directly proportional to the reduction in the BP pressure.

Note:

- Before AR is connected to BC, the AR and CR are disconnected from BP, and BC also is disconnected from Exhaust.
- The AR is continuously charged to 6 Kg/cm2 during brake application by Feed pipe.

- The CR pressure should remain at 5 Kg/cm2. However there may be a little drop in CR pressure during brake application, due to the design.

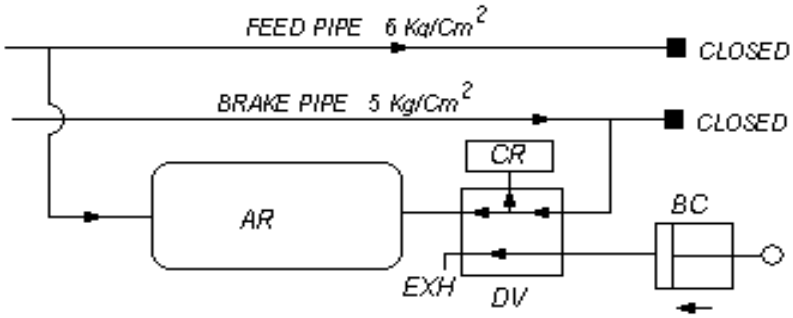


AIR FLOW DIAGRAM- APPLICATION

The application time for Goods stock 18 to 20 seconds and Coaching 3 to 5 seconds

RELEASING/RECHARGING.

During release, the BP pressure is increased in steps. When the BP pressure is increased in steps, the brake cylinder is disconnected from AR and in turn connected to exhaust. The air from Brake cylinder is released / vented progressively depending upon the increase in the brake pipe pressure. When the brake pipe pressure is brought to 5 Kg/Cm2 the air from brake cylinder is completely exhausted and the brakes are released fully.



AIR FLOW DIAGRAM- RE-CHARGING

The releasing time for the Goods Stock 45 to 60 Seconds and Coaching Stock is 15 to 20 seconds

MANUAL RELEASE.

Whenever the loco is detached, BP pressure is brought to zero and brake application takes place due to the existence of CR pressure at the bottom of the main diaphragm. To release the brakes manually, the hollow stem in the DV should be brought to the normal position by releasing the air from CR. To facilitate this, the release valve provided at the bottom of the DV is given a brief pull. During this operation, the air from CR is released which in turn

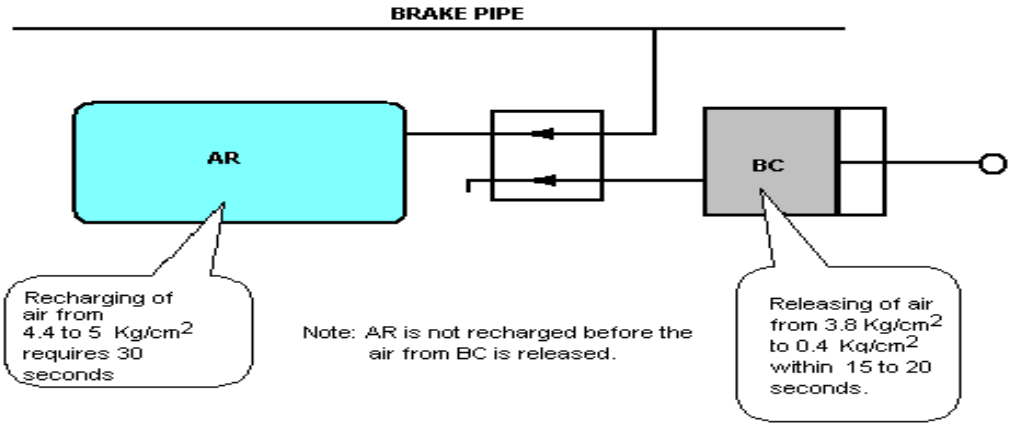
brings the hollow stem to the normal position to connect BC with exhaust for releasing of brakes.

Distributor Valves are not interchangeable because the application and release timings are different for coaching and Goods stock.

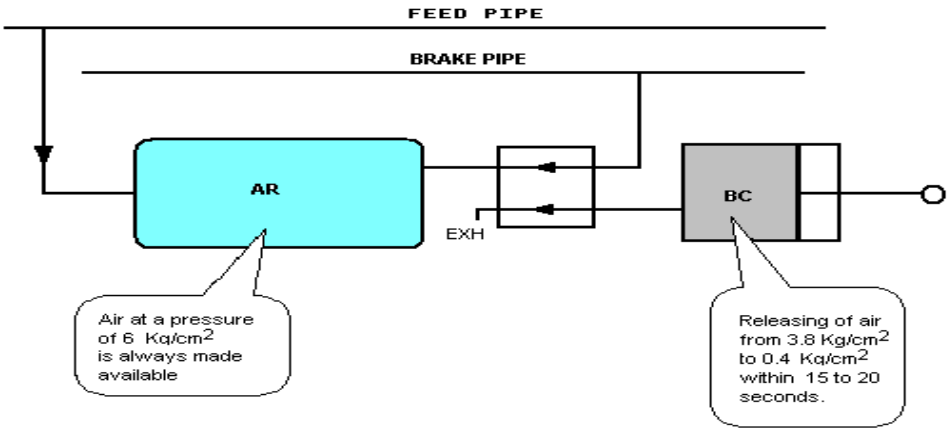
NECESSITY TWIN PIPE SYSTEM FOR COACHING STOCK

During brake application, as the air from Auxiliary reservoir is sent in to brake cylinder, always there is a reduction in the AR pressure, and it is likely to drop to 4.4 Kg/Cm^2. So it must be ensured that before the air from brake cylinder could be released completely, the AR should be recharged to 5 Kg/Cm^2, so that the system can be kept ready for next brake application.

We also know to charge the AR from 4.4 to 5 Kg/Cm^2 the DV takes approximately 30 Seconds, and to release the air from BC from the pressure of 3.8 Kg/Cm^2 to O.4 Kg/Cm^2 the DV takes 15 to 20 Seconds.



From the above fact, it is clear that it is not possible through DV to recharge the AR from 4.4 to 5 Kg/Cm^2 within the releasing time of 15 to 20 seconds for the Coaching stock.



So it has become necessary to introduce one more pipe called feed pipe to recharge the AR always to 6 Kg/Cm^2, from the other end of the AR within the release time of 15 to 20 seconds and there by auxiliary reservoir pressure **is maintained to optimum level for repeated brake applications.**

DISTRIBUTOR VALVE

FUNCTIONS OF DISTRIBUTOR VALVES

The functions of Distributor valves are,

- It connects AR with BC during Brake application.
- It connects BC with Exhaust during brake release.
- It charges AR to 5 Kg/Cm^2 from BP during charging.
- It disconnects the AR from BP during brake application.
- It charges the CR to 5 Kg/Cm^2 from BP during charging.
- It disconnects the CR from BP during brake application.
- It admits a maximum pressure of 3.8 Kg/Cm^2 during emergency as well as full service application.
- It admits the air from AR into BC in steps gradually, in proportion to the reduction in the Brake pipe pressure to facilitate graduated brake application.
- It releases the air from BC in steps gradually, in proportion to the increase in the brake pipe pressure to facilitate graduated brake release.
- It reduces the BP pressure further by 0.4 Kg/Cm^2 in addition to the brake pipe pressure reduced by the driver from the loco to accelerate the brake application particularly during minimum reduction.
- It admits air from AR into BC to a pressure of 0.8 Kg/Cm^2 immediately during brake application to overcome the resistance offered by the brake rigging.
- It applies the brake during sensitivity range, when the brake pipe pressure is reduced at the rate of 0.6 Kg/Cm^2 in 6 seconds.
- It does not apply the brake during insensitivity range when the brake pipe pressure is reduced at the rate of 0.3 Kg/Cm^2 in 60 seconds.
- It releases the air from CR, AR and BC during manual release.
- It isolates the brake system of the Rolling Stock when ever necessary.

DIFFERENT TYPES OF DISTRIBUTOR VALVE

Sl.No	Type	Manufacturers
01.	C_3W	M/s. Geysham and Co, Delhi.
		M/s. Railway Product India Ltd, Hosur.
		M/s. Stone India Ltd, Kolkota.
02.	KEO (EK)	M/s. Escorts, Faridabad.
		M/s. Knorr-Bremse India Ltd, Faridabad,
03.	P4aG	
		M/s. Westing house, Saxby,Farmer,Ltd, Kolkota

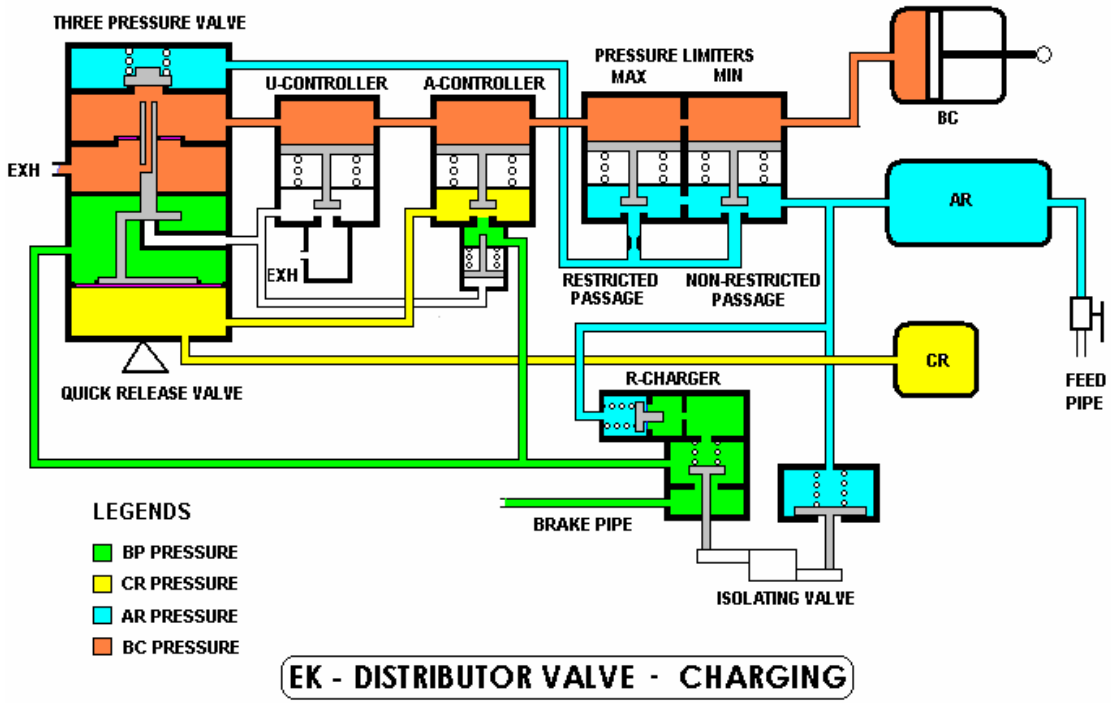
DV MAINLY USED IN INDIAN RAILWAYS

- EK Distributor Valve
- C3W Distributor valve.

DIFFERENT SUB- ASSEMBLIES OF EK TYPE DISTRIBUTOR VALVE

The different sub-assemblies of EK type distributor valve

1.Three pressure valve
2.A-Controller
3.U-Controller
4.R-Charger
5.Minimum pressure limiter
6.Maximum pressure limiter
7.Quick release valve
8.Isolating valve.



EK - DISTRIBUTOR VALVE - CHARGING

FUNCTIONS OF THREE-PRESSURE VALVE

The functions of three-pressure valve are,

a. It connects AR with BC during brake application.

b. It connects BC with Exhaust during brake release.

c. It admits BC pressure in steps, when the brake pipe pressure is reduced in steps, to facilitate graduated application.

d. It releases air from BC in steps, when the brake pipe is pressure is increased in steps, to facilitate graduated release.

FUNCTION OF U-CONTROLLER

The function of U-Controller is to reduce the Brake pipe pressure further by 0.4 Kg/Cm^2, in addition to the brake pipe pressure reduced by the driver from the Loco, to accelerate the brake application.

Working

During brake application, particularly during minimum reduction, as soon as three pressure valves is lifted from its normal position, the BP chamber of three pressure valve is connected to exhaust through the U-Controller. The air from BP chamber of three pressure valve is exhausted immediately. This exhaust of BP pressure causes quicker reduction in BP pressure, which in turn helps to lift the three pressure valve quickly, to facilitate quicker application of brakes during minimum reduction.

As soon as BC gets a pressure of 0.4 Kg/cm^2, the U-Controller closes the passage between BP and exhaust, which in turn prevents any further drop in BP pressure.

FUNCTIONS OF A-CONTROLLER

The functions of A-Controller are,

a. It charges Control reservoir to 5 Kg/Cm^2 from BP during charging.
b. It isolates the CR from BP, when the brake pipe pressure is reduced at the faster rate, during sensitivity range.
c. It connects CR with BP, when the brake pipe pressure is reduced at the slower rate, during insensitivity range.

Note: This valve is normally kept in open position and synchronised with BC pressure. As soon as BC gets a pressure of 0.2 Kg/Cm^2 A-controller closes the passage between CR and BP during the brake application.

The additional check valve provided at the bottom of the A-Controller closes the passage between CR and BP temporarily to prevent any loss in the CR pressure with the help of BP pressure, before it is permanently by the BC pressure.

FUNCTION OF R- CHARGER

The functions of R- Charger are

- To charge the auxiliary reservoir from B.P. to 5 kg/cm^2 in single pipe system during charging.
- To charge the auxiliary reservoir from B.P. upto 5 kg/cm^2 in Twin pipe system during charging
- It prevents back flow of air from AR to BP during brake application.

FUNCTION OF MINIMUM AND MAXIMUM PRESSURE LIMITERS

The function of Minimum pressure limiter is to admit a pressure of 0.8 Kg/Cm^2 immediately in to the brake cylinder during brake application to overcome the resistance offered by the brake rigging. The function of Maximum pressure limiter is to admit a maximum pressure of 3.8 Kg/Cm^2 even after emergency application.

Working:

Initially during brake application the air from AR is sent in to BC through two passages. One with restrictions and another without restrictions. As soon as BC gets a pressure of 0.8 Kg/Cm^2 the minimum pressure limiter closes the non-restricted passage and further admission of air from AR is sent in to BC through restricted passage. When the BC gets a pressure of 3.8 Kg/Cm^{2,} the Maximum pressure limiter closes the non-restricted passage also. As both the passages are closed, the AR is completely disconnected from BC, and further admission of air from AR in to Brake cylinder is stopped.

FUNCTION OF QUICK RELEASE VALVE

The function of Quick release valve is to release the air from CR manually to facilitate manual release.

FUNCTIONS OF ISOLATING VALVE

The functions of isolating valve are,

a. To isolate the DV in case of malfunctioning.
b. To release the air from AR manually
c. To release the air from BC manual

Working

When the handle is in vertical (working) position the brake pipe is connected with DV.When the handle is in horizontal position,

a. The Brake pipe is disconnected from DV.
b. The AR and BC are connected to exhaust through the exhaust port provided in the isolating valve.

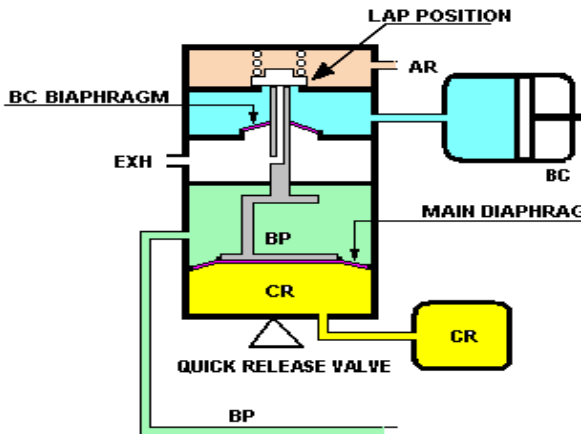
Note: Initially brake application will take place and after sometime the brake will release automatically, since BC is connected to Exhaust.

'LAP POSITION' in terms of distributor valve

This is the position of the Hollow stem of the Main Valve / Three pressure valve, in which the Brake cylinder is connected neither to AR nor to exhaust, during brake application / Release for the purpose of facilitating Graduated brake application / Release.

The hollow stem is designed to take LAP POSITION up to full service application in case of EK DV and even after Emergency application in case of C_3W.

The Hollow stem takes LAP POSITION as soon as Brake cylinder gets sufficient pressure in proportion to the reduction in the BP pressure to facilitate graduated brake application and release, for this purpose in addition to the Main diaphragm one more diaphragm called BC diaphragm is connected with the hollow Stem.



During brake application, initially the hollow stem gets lifted, due to the difference of forces offered across the main diaphragm. The lifting hollow stem allows the air from AR into BC. As soon as BC gets sufficient pressure, which will offer a down ward force on the BC diaphragm equivalent to the upward force offered by the main diaphragm. Once the down ward force offered by the BC pressure on the BC diaphragm, equals the upward force offered by the main diaphragm, the hollow stem which is lifted initially, comes down to take LAP POSITION as shown in the figure.

DIFFERENT SUB- ASSEMBLIES OF C_3W DISTRIBUTOR VALVE

The different sub-assemblies of C_3W type distributor valve

1. Main valve
2. Cut off valve
3. Quick service valve
4. In shot valve
5. AR check valve
6. Double release valve
7. Isolating valve.

FUNCTIONS OF MAIN VALVE

The functions of Main valve are,

1. It connects AR with BC during brake application.
2. It connects BC with Exhaust during brake release.
3. It admits BC pressure in steps, when the brake pipe pressure is reduced in steps, to facilitate graduated application.
4. It releases air from BC in steps, when the brake pipe is pressure is increased in steps, to facilitate graduated release.
5. It also acts as a maximum pressure limiter, to admit a maximum pressure of 3.8 kg/cm^2 into BC during emergency brake application.

FUNCTIONS OF CUT OFF VALVE

The functions of Cut off valve are,

1. It charges Control reservoir to 5 Kg/Cm^2 from BP during charging.
2. It isolates the CR from BP, when the brake pipe pressure is reduced at the faster rate, during sensitivity range.
3. It connects CR with BP, when the brake pipe pressure is reduced at the slower rate, during insensitivity range.
4. It also charges AR to 5 kg/cm^2 during charging.

Note: This valve is normally kept in open position and synchronised with BC pressure. As soon as BC gets a pressure of 0.2 Kg/Cm^2Cut off valve closes the passage between CR and BP during the brake application, which inturn prevents any further drop in CR.

FUNCTION OF AR- CHECK VALVE

The functions of AR- Check valve are,

- To charge the auxiliary reservoir from B.P. to 5 kg/cm^2 in single pipe system during charging through cut off valve.
- It prevents back flow of air from AR to BP during brake application.

FUNCTION OF QUICK SERVICE VALVE

The function of Quick service valve is to reduce the Brake pipe pressure further by 0.4 Kg/Cm^2, in addition to the brake pipe pressure reduced by the driver from the Loco, to accelerate the brake application.

Working

During brake application, particularly during minimum reduction, as soon as the brake pipe pressure is reduced, the BP chamber of Main valve is connected to Quick service bulb through the Quick service valve. The air from BP chamber of Main valve is allowed to expand suddenly by sending the air into the Quick service valve. This sudden expansion of air from BP chamber of DV causes the BP pressure todrop by 0.4 kg/cm^2, which in turn helps to lift the Main valve quickly, to facilitate quicker application of brakes during minimum reduction.

The air, which is sent into the Quick service bulb during brake application, is released through the exhaust port provided in the quick service valve during re charging.

Note: This valve is exactly opposite to that of Main valve.

FUNCTION OF IN-SHOT VALVE

The function of in-shot valve is to admit a pressure of 0.8 Kg/Cm^2 immediately in to the brake cylinder during brake application to overcome the resistance offered by the brake rigging.

Working

The In- shot valve is provided with two passages. One with restriction and another without restriction. Initially during brake application the air from AR is sent in to BC through two passages. As soon as BC gets a pressure of 0.8 Kg/Cm^2 the In-shot valve closes the non-restricted passage and further admission of air from AR is sent in to BC through restricted passage.

FUNCTION OF DOUBLE RELEASE VALVE

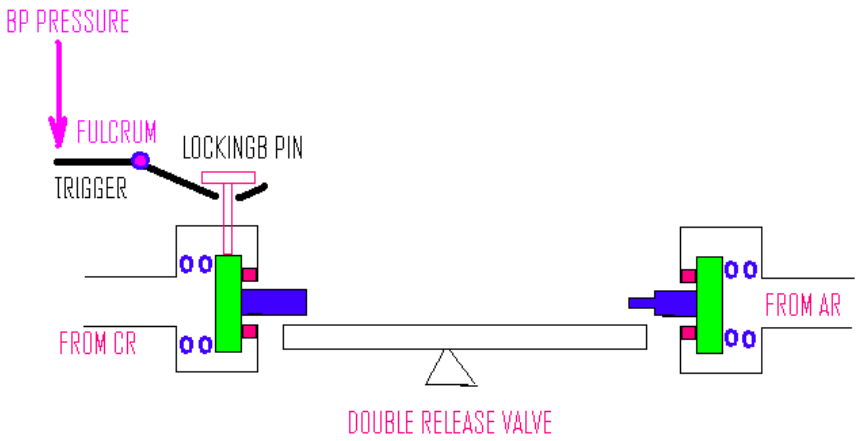
The function of Double release valve is to release the air from CR as well as from AR manually to facilitate manual release.

Working:

This valve is provided with two check valves.

- CR check valve
- AR check valve

When the release valve is pulled only once (Short pull) the air from CR is released completely.On continuous release, the air from AR can also be released.



Note:

The CR check valve is provided with a Locking rod arrangement, which enables the releasing of air from CR completely for a short pull. When the handle is pulled only once, the locking rod which is kept over the CR check valve drops in front of CR check valve, which in turn keeps the CR check valve remains in open position till the air from CR is released completely.

The AR check valve is not provided with the Locking rod arrangement, why because, it not necessary to release the air from AR during manual release.

FUNCTIONS OF ISOLATING VALVE

The functions of isolating valve are,

- To isolate the DV in case of malfunctioning.
- To release the air from BP chamber of main valve.

Working:

When the handle is in vertical (working) position the brake pipe is connected with DV.
When the handle is in horizontal position,

a. The Brake pipe is disconnected from DV.

b. The BP chamber of main valve of DV is connected to exhaust. The BP pressure in the main valve is brought to zero immediately, and the brake application will take place due to the existence of CR pressure.

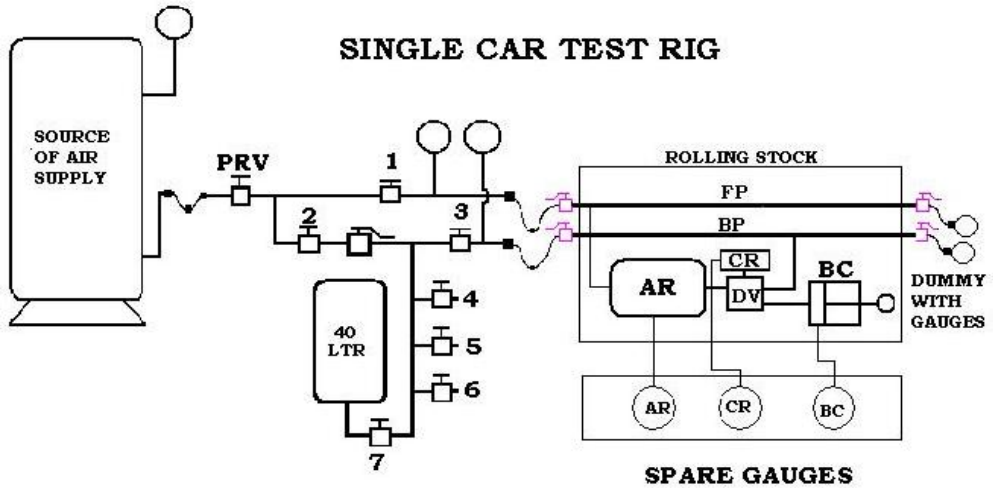
It is not possible to release the brakes by isolating the DV with the help of isolating valve C3W DV.

SINGLE CAR TEST RIG

. The different tests that should be conducted for an Air brake Rolling are,

1. Leakage in Feed pipe.
2. Leakage in Brake pipe.
3. Brake cylinder filling time.
4. Brake cylinder releasing time.
5. Sensitivity test.
6. Insensitivity test.
7. Emergency application test.
8. Piston Stroke.
9. Leakage in the Brake cylinder.
10. Graduated Application test.
11. Graduated release test.
12. Working of PEAS.
13. Working of GEV.
14. Check the vent hole of Cut off angle cock
15. Manual release Test.

Procedure for conducting various tests for air brake stock



PROCEDURES

1& 2. LEAKAGE IN FP AND BP

a. Charge the system fully.
b. Close the Cock No. 1 and 3.
c. Observe the pressure drop in FP and BP for three minutes. The leakage rate in the FP and BP should not be more than

0.2 Kg/cm^2 in one minute in FP
0.2 Kg/cm^2 in one minute in BP for coaching stock
0.1 Kg/cm^2 in one minute in BP for goods stock

3. BC FILLING TIME.

a. Charge the system fully
b. Bring the A-9 valve to full service application position.
c. Observe the BC pressure.
d. The BC pressure should reach to 3.6 Kg/cm2 within
e. Observe the maximum pressure. It should be 3.8 Kg/cm2.

3 to 5 seconds for Coaching stock
18 to 30 seconds for Goods stock.

4. BC RELEASING TIME.

a. Bring the A-9 valve to release position.
b. Observe the BC pressure.
c. The BC should drop from 3.8 Kg/cm2 to 0.4 Kg/cm2 within

15 to 20 seconds for Coaching stock
45 to 60 seconds for Goods stock.

5. SENSITIVITY TEST.

a. Open the cock No.7 and Charge the system fully.
b. Close the Cock No.2 and Open the cock No.4.
c. Wait for 6 seconds and close the cock No.4. (This will reduce the BP pressure by 0.6 Kg/cm2 in 6 sec automatically)
d. Observe the Brake cylinder. The brake should be in applied condition.

6. INSENSITIVITY TEST.

a. Open the cock No.7 and Charge the system fully.
b. Close the cock No.2 and Open the cock No.5.
c. Wait for 60 seconds and close the cock No.5. (This will reduce the BP pressure 0.3 Kg/cm2 in 60 seconds automatically)
d. Observe the Brake cylinder. The brake should not be in applied condition.
e. Observe the BP and CR pressure. Both should be at 4.7 Kg/cm2

7. EMERGENCY APPLICATION TEST

a. Close the cock No.7 and Charge the system fully.
b. Close the cock No.2 and Open the cock No.6.
c. Observe the Brake cylinder pressure. The maximum BC should be 3.8Kg/cm2.

8. PISTON STROKE

After the emergency or full service application measure the piston stroke. It should be within

Standard Piston Stroke for BMBC 32 mm

9. LEAKAGE IN BC.

a. After the emergency brake application observe the leakage in the Brake cylinder.
b. The leakage in the BC should not be more than 0.1 KG/cm2 in 5 minutes.

10. GRADUATED APPLICATION TEST.

a. Charge the system fully.
b. Reduce the BP pressure in steps through A-9 valve.
c. Observe the BC pressure. The pressure should increase in steps.

For Example

BP	BC
5.0	0
4.5	1.25
4.2	2.0
4.0	2.5
3.8	3.0
3.5	3.8

11. GRADUATED RELEASE TEST.

a. Increase the BP pressure in steps through A -9 valve.
b. Observe the BC pressure. The pressure should decrease in steps.

For Example

BP	BC
3.5	3.8
3.8	3.0
4.0	2.5
4.2	2.0
4.5	1.25
5.0	0

12. WORKING OF PEAS.

a. Charge the system fully.
b. Pull the alarm chain from inside the coach.
c. Observe the BP pressure and BC.
d. BP pressure should drop and brake should apply.
e. Reset the PEASD.
f. Observe the BP pressure and BC.
g. BP pressure should reach to 5 KG/cm2 and brake also should release.

13. WORKING OF GEV (Guard Emergency Valve);

a. Charge the system fully.
b. Operate the GEV handle.
c. Observe the BP pressure and BC.
d. BP pressure should drop and brake should apply.
e. Bring back the GEV to normal position.
f. Observe the BP pressure and BC.
g. BP pressure should reach to 5 KG/cm2 and brake also should release.

14. CHECK THE VENT HOLE OF CUT OFF ANGLE COCK

a. Drop the Pressure of BP and FP by he Cut off Angle cock
b. Pressure should drop and hissing sound of Air should come

This test is carried out to test the working **of Angle cock to ensure continuity of Air to ensure brake power.**

15. MANUAL RELEASE TEST.

a. Disconnect the test rig from the rolling stock.
b. Pull the release valve handle.
c. Observe the CR pressure and BC.
d. The CR pressure should drop to 0 KG/cm2 and Brake should release without any jerks.

BOGIE MOUNTED BRAKE SYSTEM

Necessity for introducing bogie mounted brake system

In order to overcome the problems faced due to the breakages and malfunctioning of SAB enroute, and also due to the frequent breakages and replacement of Cast Iron brake block, a new system called Bogie Mounted Brake System is introduced. In this system, the SAB's are eliminated by providing the cylinders directly mounted on the bogie frames itself, and the High friction composite K type brake blocks minimises the frequent replacement and breakages of brake blocks.

The main purpose of providing the High friction composite brake block is to overcome the deficiency in brake power in the Bogie mounted system

Special features of bogie mounted brake system

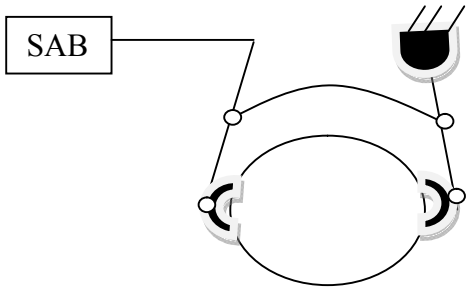
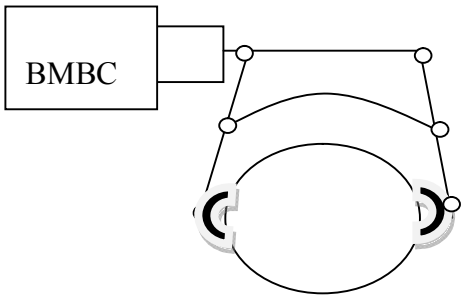
- External slack adjusters are eliminated.
- High friction composite "K" type brake blocks are used, whose life is increased by 5 to 6 times than that of cast iron brake blocks.
- It has an in-built slack adjuster by which the effective length of the piston rod can be increased by 305mm automatically; whenever the piston stroke exceeds 32mm due to wear on the brake blocks and the wheel.
- Totally 4 Nos. of 8" size brake cylinders (2 per bogie) are used in place of two Nos. of 14" cylinders in standard body mounted air brake system.
- The cylinders are mounted between central longitudinal members connecting the bogie transom and the head-stock on either side.
- Unusual noise emitted by the anti-vibration bracket in case of SAB, on run is completely eliminated.
- It is provided with less No. of brake fittings, therefore easy to maintain.
- The forces acting on the levers and truss beams is only 40% when compared to 100% in under frame mounted system, therefore the wear on the brake gear components are less, and hence the frequent replacements of these components are minimised.
- As the forces acting on the Truss beam is only 1 tonne, when compared to 3.2 tonnes in the under frame stock, 13 tonnes capacity truss beams are sufficient.

DIFFERENCE BETWEEN U/F MOUNTED & BMBC BRAKE SYSTEM

Sl.No	Description	U/F Mounted System	Bogie Mounted System
1	Slack Adjuster	External	Internal
2.	Type of Slack adjuster	Double Acting	Single Acting
3.	Capacity of Slack adjuster	450 mm	305 mm
4.	Size brake cylinder	14 Inches	08 Inches
5.	Number of Cylinders	02/Coach	04/Coach
6.	Brake Force available on the Brake head	3 Tonne (Non mod) 2.2 Tonne (Modified)	1 Tonne
6.	Brake Force available on the Brake head	3 Tonne (Non mod) 2.2 Tonne (Modified)	1 Tonne
7.	Type of Brake block	Low friction Composite L-Type brake block	High friction Composite K- Type Brake block

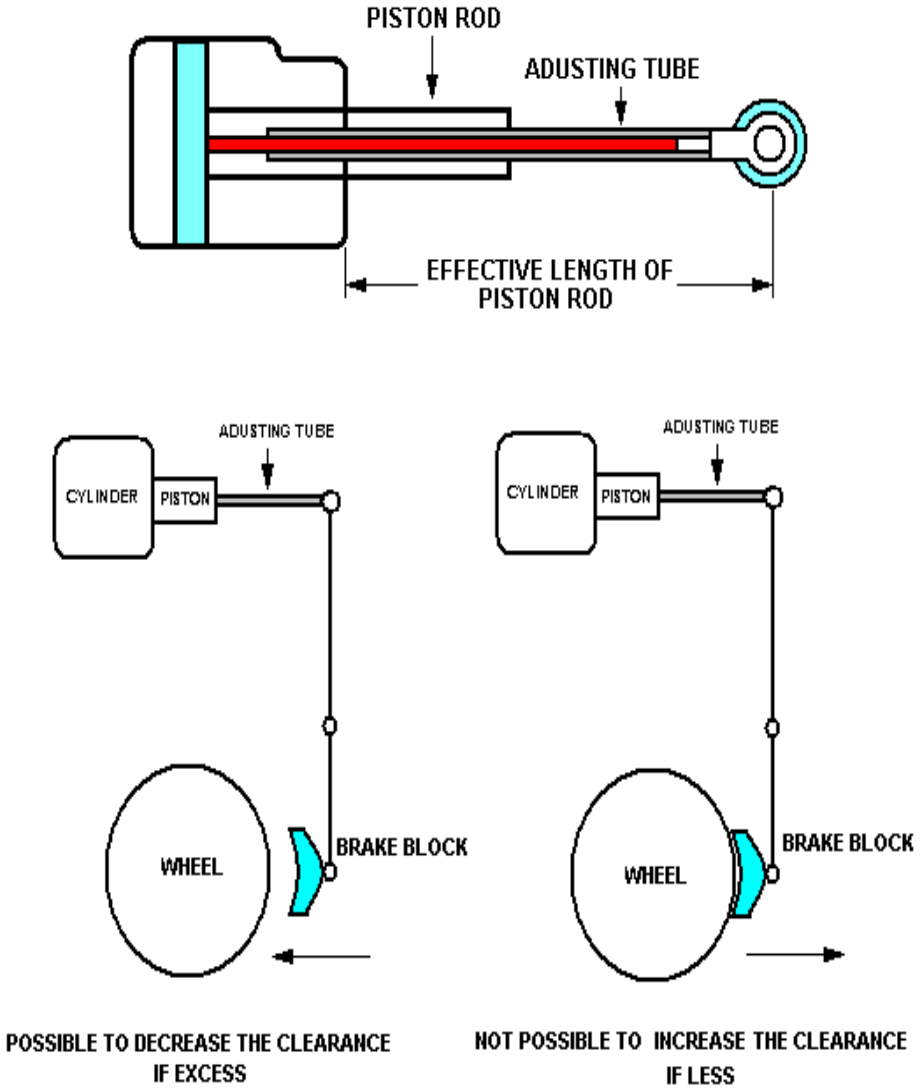
Sl.No	Description	U/F Mounted System	Bogie Mounted System
8.	Co-efficient of brake block	0.16 – 0.18	0.28 – 0.30
9.	Thickness of brake block	60 mm	50 mm
10.	Piston Stroke	80–100 mm (Non mod) 60-70 mm (Mod H/L)	Working Stroke-32 mm
11.	Capacity of Truss beam	16 Tonnes	13 Tonnes
12.	Weight of brake block	3.06 Kgs	2.5 Kgs
13	Anti-vibration Bkt	Required	Eliminated
14	Horizontal lever	Required	Eliminated
15.	Bogie pull rod	Required	Eliminated
16.	Number brake gear adjustments	07	02

DIFFERENCE BETWEEN SAB & INBUILT SLACK ADJUSTER OF BMBC

SAB	INBUILT SLACK ADJUSTER OF BMBC
It is double acting. It can both take up & pay out the clearance automatically between the wheel and brake block	It is single acting. It can only take up the clearance automatically between the wheel and brake block.
The effective length of pull rod is decreased during take up the clearance between wheel & brake block. 	The effective length of piston rod is increased during take up the clearance between wheel & brake block. 
The effective length of pull rod is increased or decreased with reference to the control rod 'A' dimension.	The effective length of piston rod is increased only when the piston stroke exceeds the par determined or working stroke of 60 mm.
The piston stroke of the cylinders are not uniform throughout the formation and varies up to 60 mm.	It maintains a uniform piston strokes for all the cylinders throughout the formation.
Spindle is made up of triple start thread	Adjusting screw (spindle) is made up of double start thread.
To adjust the slack, the length of the pull rod is increased or decreased during forward stroke.	To adjust the slack the length of the piston rod is increased during return stroke.
When length of the pull rod increased manually the clearance between the wheel & brake block increases.	When the effective length of piston rod is increased manually, the clearance between the wheel & brake block decreases.
It does not require adjustment of piston stroke every trip.	Every trip the piston stroke requires to be adjusted.

BOGIE MOUNTED BRAKE CYLINDERS

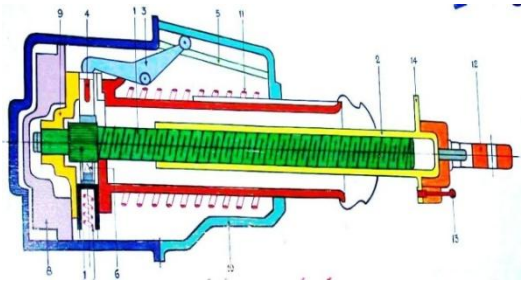
The Bogie Mounted Brake Cylinders are provided with an in-built slack adjuster to maintain a constant brake block clearance automatically. It is a single acting slack adjuster by which the clearance between wheel and brake block can be decreased automatically by increasing the effective length of piston rod whenever the piston stroke exceeds 32mm due to wear on the brake block and the wheel. During return stroke, the adjusting movement takes place.

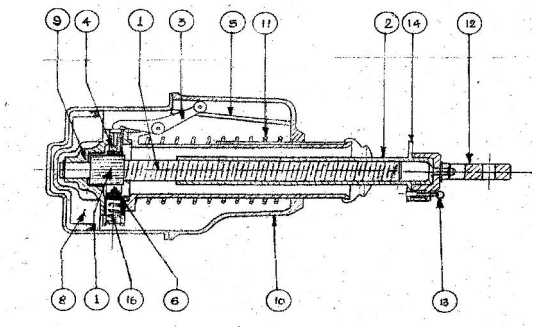


If the clearance between wheel and the brake blocks is less due to any reason, it does not bring the required clearance automatically.

MAIN PARTS OF BOGIE MOUNTED BRAKE CYLINDER

The main parts of the Bogie Mounted Brake Cylinders are:





PART LIST

1	Adjusting Screw With Ratchet	9	Trunnion Body
2	Adjusting Tube	10	Front cover
3	Rocker Arm	11	Piston return spring
4	Plunger Pin	12	Cross Head
5	Roller Plate	13	Latch
6	Pawl Housing Ring	14	Resetting Plate
7	Pawl	15	Pawl Spring
8	Piston	16	Plunger Spring

FUNCTIONS OF ADJUSTING SCREW AND THE SPINDLE

The function s of adjusting screw and the spindle are

1. It increases the effective length of piston rod automatically, whenever the piston stroke increases 32 mm due wear on the wheel and the brake block.
2. It facilitates to increase or decrease the effective length of piston rod manually, whenever brake blocks are changed or piston stroke is adjusted.

ADJUSTING SCREW AND RATCHET ASSEMBLY

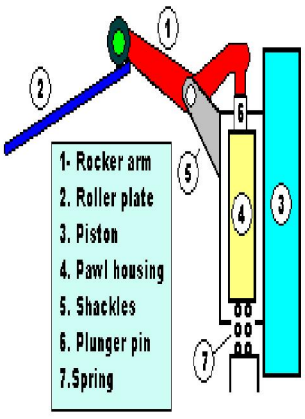
The adjusting screw is connected with a ratchet and forms a single unit. The adjusting screw is provided with a double start thread with a pitch of 1/8" (3.15mm). The ratchet is provided with 18 numbers of teeth.

When the adjusting screw completes one full rotation, it makes the adjusting tube to move forward by 2x1/8" = ¼" (6.33mm). If the ratchet is moved/turned by one tooth, the adjusting screw is turned by $360^0 \div 18 = 20^0$, which inturn moves the adjusting tube outward by ¼ x 1/18 = 1/72" (0.33mm).

From the above, it is clear that, to move the adjusting tube forwards automatically by ¼" it requires 18 return strokes.

FUNCTION OF ROCKER ARM

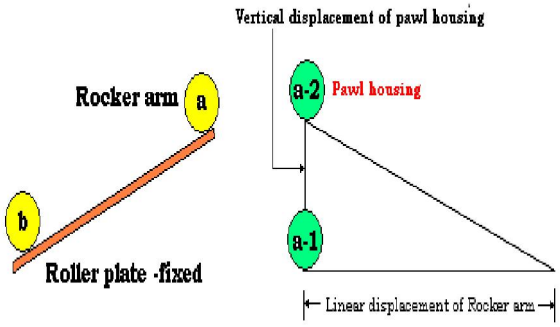
The Rocker Arm is fitted with piston head by means of shackles and it moves along with the piston head.



The roller end of the rocker arm slides over the roller plate, and on the other end of rocker arm rests on the pawl housing through the plunger pin. The function of rocker arm is to press the pawl housing ring downward during return stroke and it allows/permits the pawl housing ring to move upwards during forward stroke.

FUNCTION OF ROLLER PLATE

The Roller plate is fixed at an angle with the front cover by means of bolts. The function of Roller plate is to displace the pawl housing vertically when the rocker arm moves horizontally. (OR) it converts the linear displacement of rocker arm **into vertical displacement of pawl housing.**



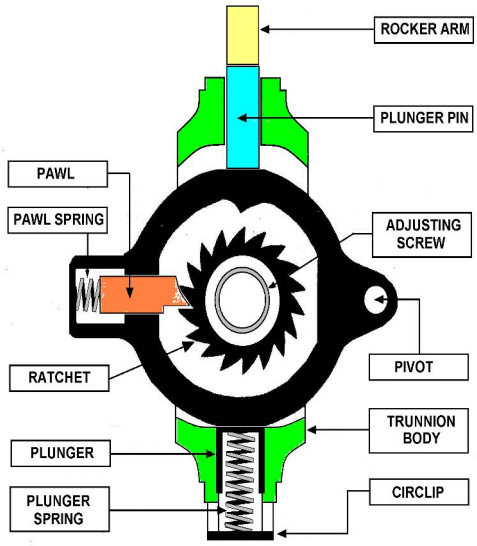
Note: When rocker arm at 'a' , the pawl houssing ring at 'a-1'

PAWL HOUSING RING / PAWL

The pawl-housing ring is pivoted with pivot pin of trunnion body at one end and the other end of the pawl housing ring moves/turn freely.

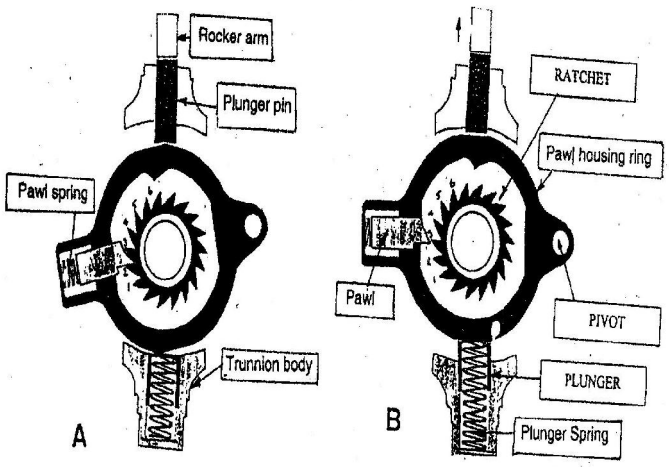
A spring-loaded pawl is housed at the free end of the pawl housing. At the bottom of the pawl housing a spring loaded plunger/sleeve is kept between trunnion body and the pawl housing to move the pawl housing upwards/outwards during forwards stroke. At the top, a plunger pin iskept between the rocker arm and the pawl-housing ring to move the pawl ring downward/inward during return stroke.

The function of pawl housing and the pawl is to turn the ratchet by one tooth whenever the piston stroke exceeds 32mm**to increase the effective length of piston rod during return stroke automatically.**



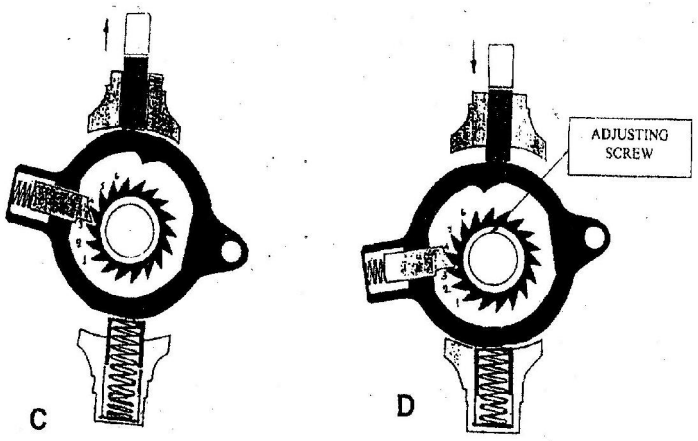
WORKING OF IN-BUILT SLACK ADJUSTER

When the piston stroke is within 32mm, the spring-loaded pawl in the pawl housing moves between the two teeth of the ratchet and keeps the effective length of piston rod unaltered.



A. POSITION OF PAWL & RATCHET, WHEN THE BRAKE IS IN RELEASED POSITION

B. POSITION OF PAWL & RATCHET, WHEN THE PISTON STROKE IS WITH IN 80mm.



When the piston stroke exceeds 32mm during the forward stroke due to the wear on the brake block and the wheel, the pawl slips and takes the position of next tooth in the ratchet.

During the return stroke, the rocker arm pushes the plunger pin inwards/downwards which inturn turns the pawl-housing ring clockwise. The pawl which is housed in the pawl housing turns the ratchet with the adjusting screw by 20^0 causing the adjusting tube to move forward by 1/72" to increase the effective length of the piston rod.

COACH MAINTENANCE SCHEDULES TO BE ATTENDED IN DEPOTS

To maintain coaching stock in good condition, the following preventive maintenance schedules are prescribed to be carried out in carriage depots on divisions where rake has been based for primary maintenance.

Trip schedule- After every trip by primary maintenance depot.

Schedule A- Monthly (**1 month ± 3 days**)

Schedule B - Quarterly (**3 months ± 7 days**)

IOH

- **IOH -** $9\ months\ ^{+30}_{-0}$ days for Coaches having POH periodicity of 18 Months , and Old Bogies of Coaches will be replaced by overhauled new Bogies
- **IOH -12 Months** $^{+30}_{-0}$ daysfor the coaches having POH periodicity of 24 Months, and only old wheels will be replaced by new overhauled wheels

POH SCHEDULES OF ICF COACHES

Coach category	Periodicity in Months		
	IOH in Depot	IOH in Work Shop	POH in Workshop
New Coaches Turned out by PU or Coaches turned out after MLR	12	---	24
Rajdhani /Shatabdhi	---	9	18
Mail/Express , GaribRath , JAN Shtabdhi& OCV forming part of standard Rake composition of M/Express	9	---	18
Other OCV	12	---	24

Primary maintenance schedules are required to be carried out by the base depots to which coaches are allotted. In emergency, when due to any reason coaches cannot reach their base depots and primary maintenance schedules become due, A & B schedules should be undertaken by the carriage depots where the coaches are available. All schedules should be carried out by primary maintenance depot.

TRIP SCHEDULE:-

Trip schedule is attended per trip of the rake. The trip is being attended by Primary depots. No need to detach the coach from the rake during trip schedule. Total distance travelled by passenger rake in a trip up and down is more than 3500 km. Following procedure is adopted during the trip schedule.

- All under gear parts are thoroughly examined.
- All moving parts are lubricated.
- Complete examination of draw & buffing gear for its proper functioning. Lubrication is essential.
- Coupling should be free in its screw i.e. ensure easy movement of coupling.
- Proper examination of primary suspension arrangement.
- Ensure the leakage of dash pot and oil level of dash pot.

- Proper securing of safety strap and safety loop.
- Proper examination of secondary suspension. Ensure the working of spring, shock absorber, safety strap & safety loop.
- Proper examination of wear in suspension link bracket, pin & shackle stone.
- Examine the proper function of shock absorber & securing bolt.
- Examination of equalizing stay rod for its proper securing.
- Examination of proper securing of bolts & cotters & silent bushes of centre pivot.
- Ensure the proper function of side bearer or its oil level.
- Changing of worn brake blocks & pin & adjustment of brake power.
- Proper cleaning of coach from inside & outside & disinfections.
- Spraying of pesticides elements.
- Checking of all joints & pipe joints & other fittings & filling of water tank.
- Proper opening & closing of vestibule doors.
- Checking of amenity & safety items.
- All falls plate examination of vestibule.
- Testing of alarm signal, guard van valve & its gauge.
- Preparation of DRS card & brake power certificate.

New Policy (Recommendations) for enhancements of POH/IOH schedules of Coaching Stock.

- The revised POH periodicity from 12 to18 months is applicable to all Mail/Express coaches for which Railway shall arrange transportation of bogies from and to work shop.
- A marking on the coach below return date shall be specified to distinguish 18 months periodicity.
- The general sequence of coach will remain as per existing coaching maintenance manual.
- The items of trip schedules; 'A' and 'B' schedules will remain same. The coach will be given 2 quarterly 'B' schedules before IOH .The work specified for IOH schedule to mechanical & electrical work in appendix C & D respectively as specified by CAMTECH Pamphlet No CAMTECH 2008 coach POH/1.0in jan-2008.
- CMIs, SMIs and technical circulars/pamphlets issued time to time by RDSO schedules followed for necessary modification and replacements.
- As per requirement of bogie as unit exchange, the bogies should be collected from workshop considering transportation time plus two days before spare.
- The periodicity of overhauling of DV is changed from 24 months to 18 months (during POH)
- Work shop to switch over PU painting at workshop as advised by RDSO.

SCHEDULE `A' :** Schedule `A' is required to be given **every month ±3 days at the nominated primary maintenance depot within the normal primary maintenance time on a washing/pit line. A coach need not to be detached from the rake for Schedule `A'

examination unless it requires such repairs which cannot be attended to on the washing line or within the prescribed maintenance time on the washing line.

'A' Schedule maintenance:-

(i) All items of primary/secondary maintenance schedule.
(ii) Test the working of brake cylinders for proper application and release.
(iii) .Thorough inspection of brake pipe, feed pipe and their connecting pipes to brake cylinder, distributor valve, and Auxiliary reservoir and hose coupling for leakage and attention.
(iv) .Carry out manual brake release test on every coach to ensure proper functioning of release lever of distributor valve.
(v) Micro switch of ACP (Alarm Chain Pulling) should be tested by electrical staff for proper functioning.
(vi) Clean Dirt collector filter with kerosene and refit.
(vii) Test the working of slack adjuster in under frame mounted air brake system. Repair/Replace the defective slack adjuster.
(viii) Examine loops/ brackets and their securing devices and rectify.
(ix) Examine for wear and replace if required brake hanger pins, brake blocks and brake heads.

The following items of work should be attended during Schedule `A' examination, i.e., monthly examination:-

(i) All items of primary/secondary maintenance schedule.
(ii) Intensive cleaning of coaches.
(iii) Intensive cleaning of lavatory pans and commode with specified cleaning agent.
(iv) Thorough flushing of tanks.
(v) Checking of water pipes, flush pipe, flushing cocks, push cocks, etc., for ease of operation and free flow of water.
(vi) Thorough dis-infection of all compartments.
(vii) Thorough inspection and repairs of draw gear.
(viii) Thorough inspection and repairs of buffers.
(ix) Oil in hydraulic dash pots should be checked to detect oil leakage from them through defective seals or through vent screws. Add/replenish with specified grade of oil if oil level is below 40 mm in tare condition to ensure better riding comfort. Similarly oil in side bearer baths should be checked when the oil is below the plug and replenished with specified grade of oil so that wear plate is fully covered by oil.
(x) Inspection and repairs of commode chute.
(xi) Thorough check and repairs of sliding doors and vestibule doors for easy and smooth operation and correct alignment and all wearing parts, loose screws, etc.

**SCHEDULE `B':** Schedule `B' is required to be given every three months +7 days at the nominated primary maintenance depot within the normal time allowed for primary maintenance on a washing line in rake. Coach need not be detached from the rake for purpose of this examination unless it requires such repairs which cannot be attended to on

the washing line or within the prescribed maintenance time on the washing line. The following items of work should be attended.

Air brake system: Same as 'A' schedule

Other assembly maintenance

- Besides brake system other items should be attended as given below:
- All items of Schedule `A'
- Painting of lavatories from inside.
- Thorough inspection and repairs of brake gear components.
- Thorough checking of trough floor, turn under, etc., from underneath for corrosion.
- .Touching up of painted portion, if faded or soiled.
- Overhauling & testing of alarm chain apparatus.
- Testing of guard van valve.
- Greasing of equalizing stay rod.

Intermediate Overhauling (IOH)

- IOH is required to be given **every nine months ± 30 days** at the nominated primary depot.
- Coaches are required to be detached from the rake and taken to the sick line for examination and repairs.
- For maintenance of major break–down/ mal-functioning of any subassembly etc. the decision whether the coach is to be detached from the formation for attending to maintenance/replacement of major subassembly is dependent on maintenance requirements, operational convenience, time availability etc. The decision is taken by the Engineer (C&W). Coach failure report should be made.
- At depot, the coach that is detached for IOH is taken over to the washing line for cleaning, lubrication and minor maintenance. The coach that are detached due to a major defect in the distributor valve, brake cylinder, Auxiliary reservoir etc, is taken to the pit line for the replacement of such sub-assemblies, on unit exchange basis. The detachment of coach is carried out so as to make the maintenance or testing activities convenient and faster so that the coach is made ready for use without delay.

PROCEDURE: The activities performed to detach a coach with Air Brake system are as under-

- Safety precautions shall be taken to prevent injury while detaching/attaching a coach.
- Remove the clamps on the cut-off angle cocks. Close the cut-off angle cock of both feed pipe and brake pipe on both sides of the coach that has to be detached.
- Close the cut-off angle cocks of the feed and brake pipe of adjacent coaches. This is to ensure that the air pressure locked up in the air hose coupling gets vented to atmosphere through the vent hole of the cut-off angle cock.
- Observe above mentioned safety measures to close all the four cut-off angle cocks on either side of the coach to be detached so that while opening air hose coupling, it may not cause injury due to air pressure inside.
- Release the brake of the coach to be detached by pulling the manual release lever of the distributor valve.
- Open the Feed Pipe and Brake Pipe hose coupling from both sides of the coach.
- If the air pressure of brake cylinder does not vent by pulling the manual release valve of distributor valve, open the brake cylinder vent plug to drain the air pressure.

- Uncouple Screw coupling and detach the coach.
- Observe all other safety measures as prescribed.

The following items of work should be attended during IOH

Air brake system maintenance:

- Check brake cylinder for loose rocker arm plate and change on Bogie Mounted system.
- Brake cylinder should be checked for smooth functioning and prescribed stroke. Defective brake cylinders shall be sent for repairs.
- Guard's van valve should be tested.
- Test BP & FP air pressure measuring gauges with master gauge and replace if found defective. A set of two master gauges should be kept for this purpose at every Primary Maintenance Depot and each master gauge should be sent one after the other to the base workshops for testing, repairs and calibration.
- Thoroughly clean Dirt collector filter in kerosene or replace on condition basis.
- Check working of PEASD & PEAV by hearing the hissing sound of exhaust air. After resetting with the help of key the exhaust of air should stop. Replace the defective PEASD/PEAV.

Other assemblies' maintenance:

- All items of Schedule `B'
- Thorough repairs of running gear including running out of bogies where considered necessary. Bogies which are working on rake links earning more than **nine months** must be run out and unit exchanged with overhauled bogie received from workshop.
- Touching up damaged paint of coaches on outside as well as inside.
- Thorough cleaning and removal of dust, rust, dirt, etc., accumulated at the pillars through the turn under holes, with coir brush and compressed air.
- Thorough examination and repairs of upholstery, cushions, curtains, etc.
- Thorough checking and full repairs of all window shutters, safety catches, safety latches, staples and hasps of compartment, lavatory, and body side and vestibule doors for ease of operation.
- Thorough checking and repairs of UIC vestibules, their rubber flanges metal frames, doors, fall plate, locking gear, etc., for ease of operation and safety.
- Thorough checking and repairs of all cracks and worn out portions of flooring of the compartments.

Engineer (C&W) of Primary Coaching Maintenance Depots should be fully familiar with the vulnerable areas of ICF coaches for corrosion, viz., sole bar at doorways, lavatories and adjoining areas, corridor sides - more so in case of those SLRs which are used for Fish, Salt, etc. For facilitating inspection of sole bars even spaced elongated holes of (215x127 mm) are already provided in the turn under.

Special attention should be taken for the following:-

- Pocket between sole bars and turn under should be thoroughly cleaned through the inspection opening of the sole bars and inspected with the help of torch light or inspection lamps.
- Drain holes provided in the trough floors should be kept clean and unclogged. If during the cleaning of these drain holes any accumulation of water is observed, the affected area should be very carefully inspected for possible corrosion.
- A register should be maintained of the primary maintenance coaches on the subject.
- During this lifting schedule, bogies/under frame members and body including trough floors of integral type coaches should be thoroughly examined and all parts of running gears are repaired/ replaced as necessary. The bogie frames should be particularly checked to detect damage, cracks or deformation and necessary repairs carried out. Where it is not possible for the maintenance depot to do these repairs or are prohibited to be done in the maintenance depots, the bogies should be sent to the shops for carrying out these repairs.
- The detailed table of maintenance activities to be carried out during IOH schedule is enclosed as appendix-G.
- The date of intermediate lifting should then be stencilled at the appropriate place in schedule chart on the end panel

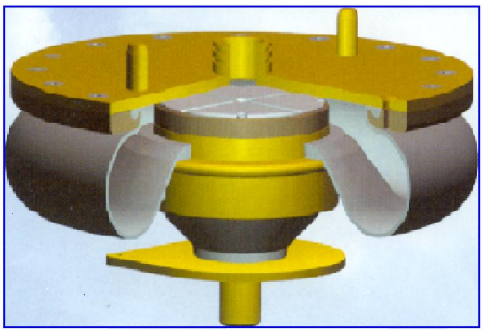
Intermediate Overhauling of Shatabdi/Rajdhanni Exp. Coaches is attended in nominated workshop only. Intermediate overhauling of newly built coaches are to be attended after 12 months only wheels are to be replaced

Difference between IOH, POH and NPOH

IOH	POH	NPOH
It stands for intermediate Overhauling	It stands for periodic Overhauling	It stands for Nominated Overhauling
IOH of coach is attended after 9 Months of POH	POH of Passengers carrying Vehicle M/Exp -18 Months	Time period is not fixed for any vehicle for NPOH
IOH of coach is allowed in sick line where facility to lift the coach is available	POH is allowed in Nominated workshops only	NPOH is done only in workshop or in nominated major sick line
During IOH all the parts of under gear are thoroughly examined and replaced if necessary	At the time of POH all parts under gear are dismantled and should be replaced if there is any wear and tear.	Only indicated defects and safety items are attended
At the time of IOH , Painting of the Coach is not Necessary , Only required places are touched up	Painting of Whole coach is necessary	Complete painting of coach is not necessary, only required placed are touches up.
Profiling of Wheel is necessary	Profiling of Wheel is necessary	On need Based

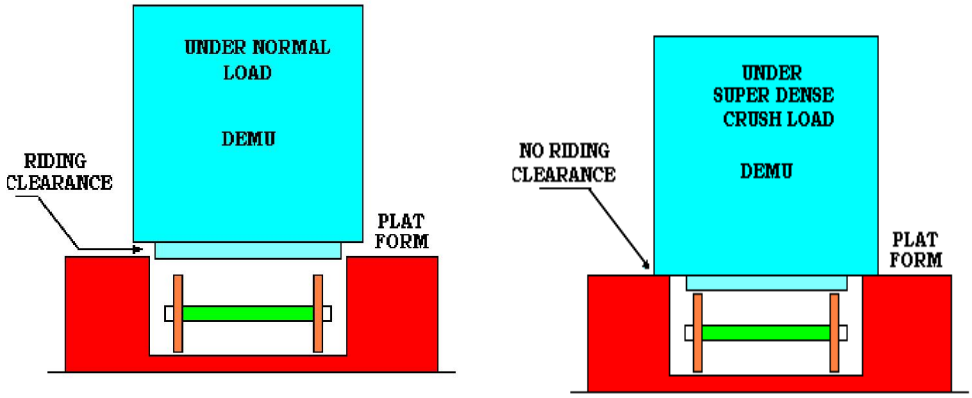
AIR SUSPENSION

Air spring is a rubber bellow containing pressurized compressed air with an emergency rubber spring providing various suspension characteristics to maintain a constant Buffer height irrespective of the loaded condition.



In suburban trains like DEMU, the number of passengers entraining **(Super Dense Crush Load)** in to the coach cannot be controlled and hence the payload of the coach increases from 18 tons to 34 tons. This abnormal increase of payload reduces the **Riding Clearances** between the **Coaches** and **Wayside platforms** and also reduces buffer height resulting in severe hitting of coach on the plat forms.

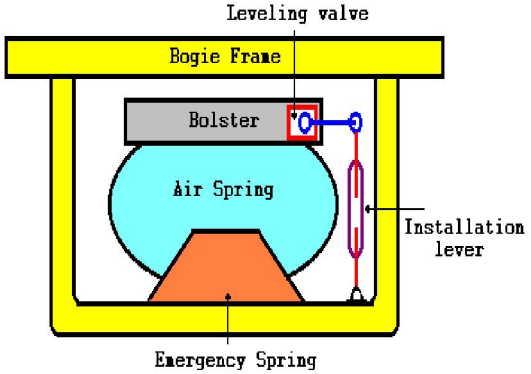
Due to the Super Dense Crush Load the bolster springs become solid, which in turn damages / breaks the Coil springs resulting in discomfort to the passengers

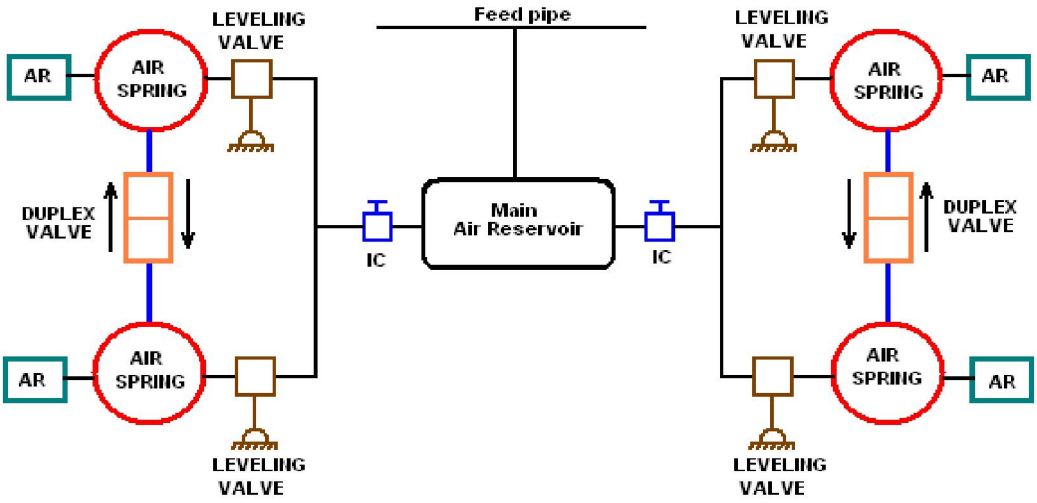


So to overcome the above problems an **Air Suspension** (Air spring) is introduced in the secondary suspension to maintain a constant buffer height irrespective of loaded conditionsby varying the pressure of air inside the air spring.

Air Suspension and label its parts

- Air spring
- Emergency spring
- Leveling valve
- Adjustable screw rod
- Duplex Valve
- Main Air Reservoir
- Auxiliary Reservoir
- Isolating Cock





Sketch for Air Suspension

Function of Levelling valve.

The levelling valve is fitted with Top bolster and is designed to move up and down along with bolster. Under normal condition, it is designed to take **LAP position when the actual buffer height is equal to the required buffer height.**

The function of leveling valve is to connect the main reservoir with the air spring to admit more pressure in to the Air spring, whenever the actual buffer height is less than the required buffer height due to abnormal increase in the Pay load (Super Dense Crush load).

It also connects the air springs with exhaust to release the excess air from air spring, whenever the actual buffer height is more than required buffer height due to reduction in the Pay load after detraining of passengers from the coach

.

Function of Installation lever

It is fitted between the levelling valve and bottom of the bogie frame. The function of installation lever is to operate the levelling valve automatically by moving the handle of the levelling valve up and down according to the condition of the load. The up and down movement of handle of levelling valve admits the compressed air in to the Air spring or releases the compressed air from **the air spring through levelling valve in proportion to the pay load of the coach.**

Function of the Duplex Valve

It is a double check valve provided between the Air springs of the same bogie .It operates with a Pressure differential of 1.5 bar. Basically it comprises of two check valves side by side, arranged so that air can flow in either direction whenever the air pressure differential exceeds the pre-set value of 1.5 bar. Whenever a burst of air spring occurs on one side, this valve will ensure that no severe tilt or twist occurs during movement of the coach.

Both the check valves of Duplex valve remains closed, if the pressure between the two springs is within 1.5 bars.

When the differential air pressure exceeds the preset value, the air at higher pressure overcomes the spring pressure and flows to the lower pressure via the check valve. The flow continues till the differential reaches the preset value.

In case of burst of Air Spring, the air leaks to atmosphere. Due to high-pressure differential, the Duplex check valve releases the air from the intact air spring through burst air spring. Thus complete coach will gradually come down and rest on the emergency rubber springs.

Function of Main Air reservoir

The capacity of the main reservoir is 150 ltrs and it is exclusively used for feeding the compressed air in to the Air Spring.

Function of Emergency Springs

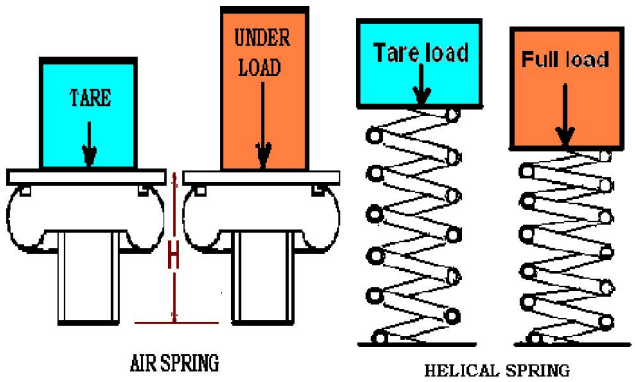
The function of emergency spring is to support the top bolster to prevent tilt of coaches whenever the Air spring burst.

Compare the Helical springs with Air Spring

Unlike steel springs, air springs retain their height under changing loads. The low natural frequency of air spring suspension remains virtually constant.

In case of coil spring, deflection is proportionate to the load, therefore, under high payload situation, space constraint becomes critical, leading to the use of stiffer springs resulting in unsatisfactory ride behaviour and reduced speed potential.

Air springs through their control mechanism offer a load proportionate stiffness, constant floor height and better ride behaviour with higher speed.



Advantages of Air Suspensions

- Capable to sustain Super Dense Crush Load of suburban traffic at high speeds.
- It maintains a Constant floor height of coach.
- It facilitates excellent riding comfort with riding index of 2.5.
- Safe running due to the excellent Air Damping.
- Low design height.
- Unusual noise emitted due to hitting of coaches on the plat forms is eliminated.
- The Stirrup links, Coil springs and equalizing stays are eliminated and therefore easy to maintenance.

DRAW AND BUFFING GEAR

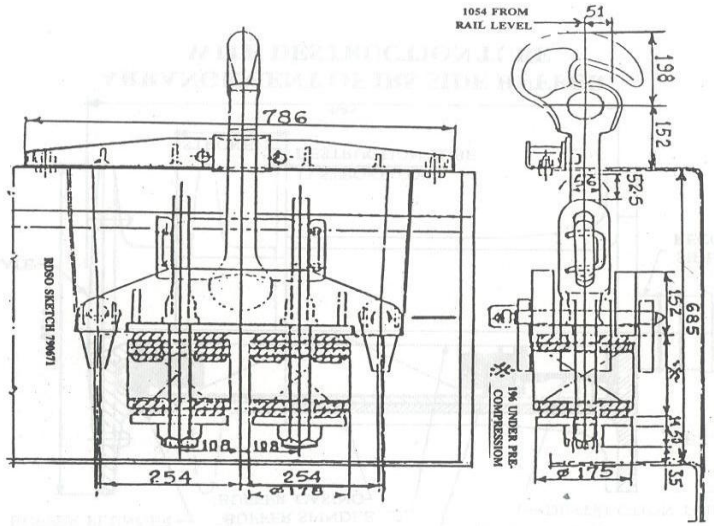
Draw Gear

It is a vital component of rolling stock, which is utilized to connect one rolling stock to the adjacent rolling stock to form a train & also to transmit draft forces from engine to last vehicle. It is provided in the centre of the body in the under frame head stock at both the ends. Mainly two types of draft gear are being utilized in Indian Railways.

Conventional Draft Gear and Centre Buffer Coupler

Main components of conventional draw gear

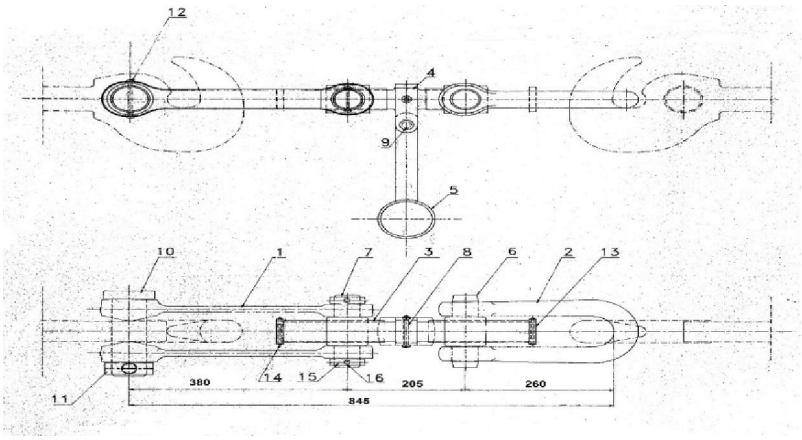
a) Draft Hook b) Draft Spring/ Draft Pad. c) Cotter d) Draft Links
e) Draft Key f) Washer g) Bent Pin (U-Pin)
h) Hexagonal Nut i) Screw Coupling



Draw Gear with Rubber Pad Spring

Parts of Screw Coupling.

1. Link 2) Bent coupling link 3) Screw
4. Bent coupling 5) Lever 6) Trunnion
7. Snap head rivet dia 8 x 85 8) Pin 60 x 218 9) Collar
10. Snap head rivet 12 x 95 11) Collar 12) Snap head rivet 6 x 70



In 1984 use of Enhanced Screw Coupling was started, which was again modified in 1998. To identify this coupling a Dumble mark is stencilled at both the side of coach end body.

Length of coupling when fully opened – 997 mm
Length of coupling when fully Tight – 751 mm

Modifications:

S. N.	Description	Non Modified	Modified
1	Working Capacity	36 Tonnes	36 Tonnes
2	Proof Load Capacity	60 Tonnes	75 Tonnes *
3	Breakage Capacity	Draw Bar – 108T S/Coupling – 112T	130T for both
4	Stamping Mark	C – 60.61	IS – 5517

BUFFING GEAR:

Two nos. of buffers are provided on body head stock on both ends to absorb the longitudinal impacts during run, these are fitted at a distance of 1956 mm. The buffers also transmit buffing forces during pushing to its trailing end stock

The main components of Buffing Gear are as under:-

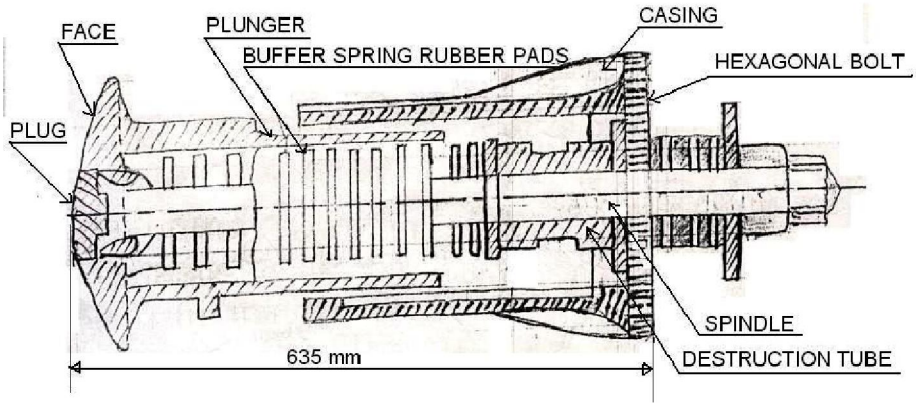
a) Buffer Plunger
b) Buffer Socket with securing bolt
c) Buffer Spindle & Plug
d) Buffing Pad
e) Destruction Tube
f) Recoil rubber Washer
g) Washer
h) Nut & Cotter

Mainly Buffers are of two types:-
Long Case Buffer – Length from head stock – 635 mm

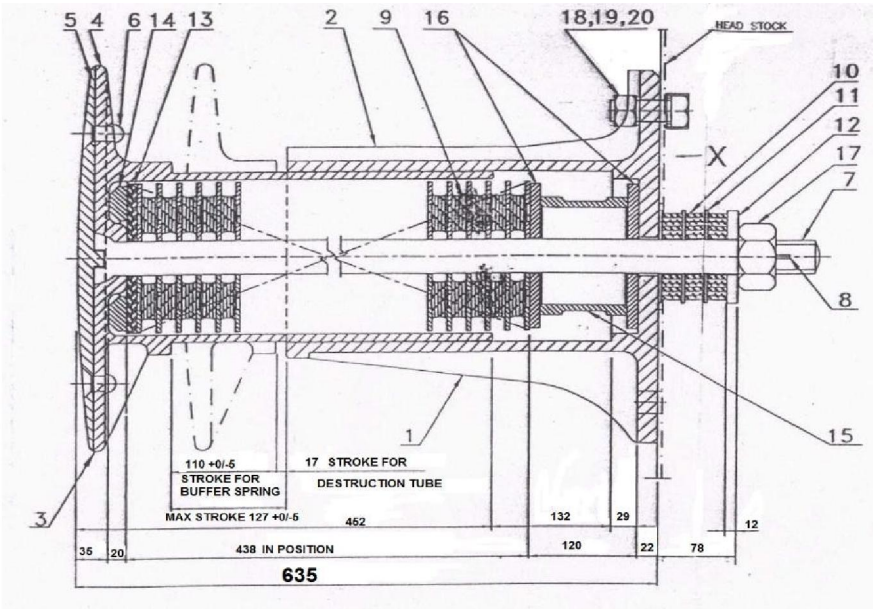
Short Case Buffer – Length from head stock – 458 mm (4 wheeler)

Important Data

- Maximum height in empty condition from rail level 1105 mm
- Minimum Height in Loaded Condition 1030 mm
- Allowed variation in height in same end 64 mm
- Allowed variation with adjacent vehicle 75 mm
- Maximum plunger travel 127mm
- Minimum Plunger travel 51 mm
- Numbers of buffing rubber Pad in each buffer 14 to 16 Nos
- Capacity to Buffing Pad 1030 Kgs M



BUFFER ASSEMBLY IN ICF COACHES



Part detail:

1	Side buffer Casing (casting)	2	Side buffer casing (Forging)
3	Buffer Plunger (Casting)	4	Buffer Plunger (Forging)
5	Face plate for buffer plunger	6	Flat CSK HD Rivet (Forged)
7	Buffer spindle	8	Bulb cotter
9	Rubber buffer spring	10	Side buffer recoil spring
11	Recoil spring parting plate	12	Recoil spring washer
13	Buffing spring parting plate	14	Washer
15	Destruction tube	16	End plate M 12 X 170 dia
17	Hexagonal nut M 39 x 3	18	Hexagonal bolt M 24 x 90
19	Lock nut M 24	20	Spring washer

PASSENGER NECESSITY ITEMS AND SAFETY FITTINGS

Necessity to provide passenger amenity and safety fittings

Passengers pay money to undertake the journey and so they have to be provided with some basic facilities required to undertake long distance travel to make it more comfortable. For this purpose each coach is equipped with many **fittings for the utility of the passenger. All these fittings are called as Amenity fittings.**

Some of the amenity fittings provided in a coach

Main Door	Door handle
Hand rails	Latches to close the door
Seat	Berth
Berth Chain	Window
Window bars	Roof ventilator
Coat hook	Light and fan
Alarm chain	Armrest, tea/snack table
Footsteps to climb to upper berth	Back rest with locking provision for the side berths
Glass and Venetian shutters with lock provision	Provision of securing arrangement below the seat for the luggage
Luggage rack in case of general compartments	Washbasin on either ends of the coach with mirror and mirror stand
Provision of night lamp for sleeper and upper class coaches	Vestibule with door and fall plate arrangement secured with pin
Provision of reading lamp in AC and First class coaches	Provision of Coupe system in First class coaches with door
Curtains for having privacy in AC class	
Provision of 3 Indian style and 1 western style toilet with the following fittings	
Door with turn over latch and locking arrangement	Squatting pan/Commode with commode lid and cover
Flushing cock with FO handle, FO pipe and fish tail	Provision of mirror, mirror stand and wash basin
Windows with Frosted glass for light and ventilation	Provision of push cock/ Jason cocks 2 nos
Mugs in the upper class coaches	Shower arrangement in first class coaches
Fan and Alarm chain arrangement in Upper class coaches	Air freshener in upper class coaches

The responsibility of a supervisor is to ensure that all the fittings provided for the use of passengers are to be in correct and good condition. Else, this invites public complaints.

Some of the Safety fittings provided inside a coach

Among these amenity fittings, a few are classified as safety fittings as their function forms a critical element.

The different safety fittings are

Berth chain to secure the berths	Latches in window shutters
Alarm Chain system	Hand rails at the entrance
Window shutters	Fall plate pin in the vestibule
Foot steps	Fire Extinguishers
Main door turn over latch for securing the door	Locking arrangement for locking Vestibule door and rolling shutter
Locking arrangement for the window shutters	Safety bars on window openings

LHB COACH

Introduction

LHB stands for LINKE HOFMANN BUSCH. It is a railway Coach Manufacturing unit situated at Germany. The coaches manufactured by LHB/Germany are called LHB coaches. These coaches are now being manufactured at RCF/ Kapurtala after getting the Transfer of technology from GERMANY.

SALIENT FEATURES OF LHB COACHES

The salient features of LHB coaches are:

- These coaches are longer by 1.7 meters than the ICF coaches and hence more number of passengers can be accommodated in a given coach. As the length of the coach is longer the number of coaches required to form a formation is reduced and hence overall cost of maintenance becomes less.
- These coaches are fitted with Axle Mounted Disc brakes to have an effective brake power to stop the train within the emergency braking distance. As the brake forces are acting on the Discs which are mounted on the Axles, the wear on the wheel tread caused due to tread brake is eliminated and hence the life of the wheels are considerably increased.
- These coaches are fitted with Wheel slide protection device to prevent the wheel from getting skid. Due to various reasons it is possible for any one of the wheel to have lesser speed when compared to the other three wheels and in such a case it releases the air from the brake cylinder of the affected wheel automatically to prevent the wheels from getting skid
- These coaches are fitted with Brake accelerator in the Brake pipe to bring BP pressure to zero during emergency brake application. The brake accelerator connects the Brake pipe with exhaust during emergency application to facilitate faster releasing of air from the brake pipe.
- These coaches are provided with FIAT bogies, which are designed to run at a speed of 160 KMPH.
- These coaches are fitted with Controlled discharge Toilet system designed to discharge the human waste when the speed reaches above 30 KMPH after completion of 15 flushing. The objective of this toilet system is to keep the station premises clean and hygienic.
- These are fitted with tight lock AAR centre buffer coupler with anti-climbing feature to prevent the climbing of one coach over another in case of accidents.
- The wheelbase of Bogie is 2560 mm.
- These coaches are fitted with earthling device to prevent damages to the Roller bearings.
- These coaches are fitted with roof mounted AC package units**.**
- The following equipments are operated by electronically operated control system (Computer)
    - Wheel slide protection device.
    - **Controlled discharge toilet system.**
    - **Water pumping device.**
    - **Roof mounted AC package units**

- **The riding index of LHB coach is 2.75 when compared to 3.25 in case of ICF Coaches**
- The passenger emergency alarms signal devices are provided inside passenger compartment. This is to avoid operation of PEASD by unauthorized persons from outside. There is no mechanical linkage like a chain and this handle directly operates the PEASD valve for venting the brake pipe pressure.

Overall Dimensions of Coach

- Gauge 1676 mm
- Length over body 23540 mm
- Length over CBC 24000 mm
- Height of the coach from rail level 4039 mm
- Wheel Base 2560 mm
- Height of the coach from rail level (AC three tier) 4250 mm
- Maximum width over body 3240 mm
- Maximum distance between inner wheels 12345 mm
- Window opening 1180x760 mm
- Distance between centre pivots 14900 mm
- Height of compartment floor from rail level 1303 mm

UNDER TARE CONDITION

- Maximum CBC drop under gross load and worn conditions 75 mm
- Minimum height from rail level 102 mm
- Maximum height of centre line of side CBC above rail level for empty vehicle 1105 mm
- Minimum height of centre line of CBC above rail level for loaded vehicle 1030 mm
- Wheels diameter(New) 915^{+3}_{-0} mm
- Maximum axle load permissible 16 tones
- Number of toilets 3(**for Shatabdi coaches**),

There is difference in the no. of toilets for different types of coaches.

- Higher speed potential 160Kmph upgradable to 200
- Ride index of coach* 2.5 at 160 Kmph but not >2.75

Codal Life of LHB Coaches

The service life of LHB coach has been fixed as 35 Years as against 25 Years for ICF design coaches. This coach is likely to have a higher codal life hence enhancement in existing codal life should be finalized after Zonal Railways get sufficient experience.

LIMITATIONS OF ICF ALL COIL BOGIE

- The longitudinal and lateral movements of the wheels cannot be controlled independently as generally required for High-speed bogies.
- As there are vertical space constraints between the top and bottom bolster, it is not possible to provide softer secondary suspension springs which are required for the high speed trains to control the dynamic movements of the bogie bolster and coach body.
- Headstocks increase the yaw inertia of the bogie frame and thereby, influence the tendency for hunting.
- The wheelbase of ICF all coil bogie is 2896 mm. This large wheelbase affects curve negotiations and thereby increases wheel flange wear.
- As the brake forces are offered on the wheel tread by clasp brake, it could not give sufficient retardation during brake application which in turn increases the emergency braking distances. The life of the wheel is also reduced due to tread wear.

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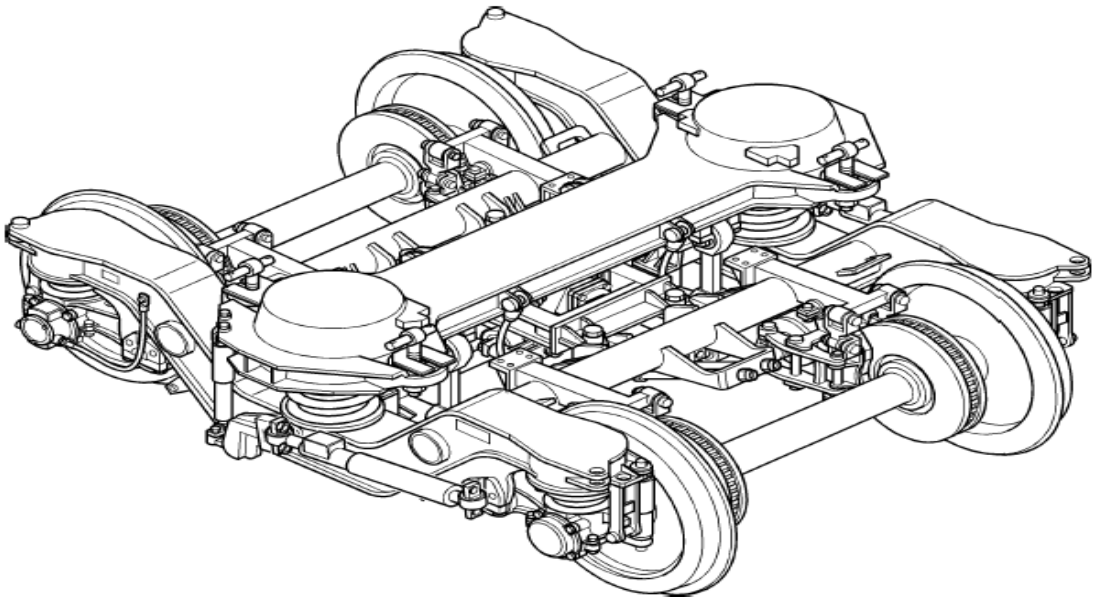
    - Water pumping device.
    - Roof mounted AC package units

- The riding index of LHB coach is 2.75 when compared to 3.25 in case of ICF Coaches
- The passenger emergency alarms signal devices are provided inside passenger compartment. This is to avoid operation of PEASD by unauthorized persons from outside. There is no mechanical linkage like a chain and this handle directly operates the PEASD valve for venting the brake pipe pressure**.**

Important Parameters of LHB Coaches

S. no	TYPE OF COACH	CODE	No. of seat /berth	weight	
				Tare	Gross
1	AC FIRST CLASS SLEEPER- (EOG)	LWFAC	24	40.87	43.34
2	AC FIRST CLASS SLEEPER- (SG)	LWGFAC	24	45.90	50.70
3	AC SECOND CLASS SLEEPER- (EOG)	LWACCW	54	41.60	46.72
4	AC SECOND CLASS SLEEPER- (SG)	LWGACCW	54	48.00	55.04
5	AC THREE TIER CLASS SLEEPER- (EOG)	LWACCN	72	43.00	48.80
6	AC THREE TIER CLASS SLEEPER- LACCN (SG)	LWGACCN	72	50.50	58.50
7	AC HOT BUFFET CAR	LWCBAC	18	42.20	48.20
8	NON AC SECOND CLASS GS	LGS	99	35.29	50.49
9	NON AC SECOND CLASS THREE TIER –(SG)	LWGSCN	78	36.28	42.91
10	NON AC- LUGGAGE CUM GUARD VAN(SG)	*LGSLR*	*36*	*35.40*	44.50
11	AC CHAIR CAR EXECUTIVE CLASS	*LWFCZAC*	*56*	*42.27*	48.51
12	AC CHAIR CAR	LWSCZ AC	78	42.27	50.27
13	GENERATOR CUM LUGGAGE& BRAKE VAN	LWLRRM	5(4CREWS+1 GUARD)	52.12	56.78

FIAT - BOGIE



The FIAT (**FabricaItalina de Automobil Torino**) bogie is an adoption of EUROFIMA design. This bogie belongs to the two-axle type, with a primary and a secondary suspension. The bogie frame consists of two side members of Y-shaped longitudinal beam connected by two tubular steel members. The Y- shaped side members consist of structural steel and welding is done to form box sections. Minimum strength of the structure is 52 kg/mm^2 with D- class weld. Bogie is designed for maximum operating speed of 160 kmph and has potential for operation upto 200 kmph. Axle guidance is provided by an articulated control arm through a resilient bush.

This is a two stage suspension bogie. The car body directly rests on the secondary stage helical springs, which rests on Y- shaped side beam. The bogie frame rests on primary stage helical springs which are resting above the axle box crown. The tracking and braking force from axle to bogie frame is transferred through articulated control arm system of primary suspension.

Bogie is capable to permit the coach body to negotiate curve of 175 m radius at minimum speed potential of 40 kmph and 1 in 8½ turn out in either direction at 30 kmph.

Dampers

Each FIAT bogie uses 4 primary vertical, 2 secondary vertical, one secondary lateral and 2 yaw dampers. These are hydraulic shock absorbers to damp the accelerations caused due to track irregularities and opposing force depending on the speed of the movement.

Axle bearing

LHB use TIMKEN and SKF make taper roller cartridge type bearings. These are self-contained, pre - assembled, pre-lubricated and are totally enclosed to avoid manual handling. These are applied and removed from the axles without exposing the bearing elements or lubricant to avoid contamination or damage. The axle bearings on the bogie are fitted with sensors for detecting speed (whose signal is elaborated by the anti slipping

system) and a current return device. The axle bearing is a maintenance free bearing. The overhaul cycle is 1.2 million km.

Anti-roll bar

A torsion bar having two forks is provided between bogie frame transverse beams with the help of two links to resist rolling motion of coach.

Rocker device

The traction and braking force between bogie and body is transferred through a rocker device located at the center of the bogie approximately in the plane of axle.

Body-bogie connection

A special type of body-bogie connection has been provided between coach body and bolster. This connection consists of disc spring, hemispherical ball, swinging link pin, link Pin, etc.

This connection is capable to cater for the acceleration value upto 0.5 g in lateral and longitudinal direction. Beyond that value, a bracket comes into action between bogie bolster and coach body.

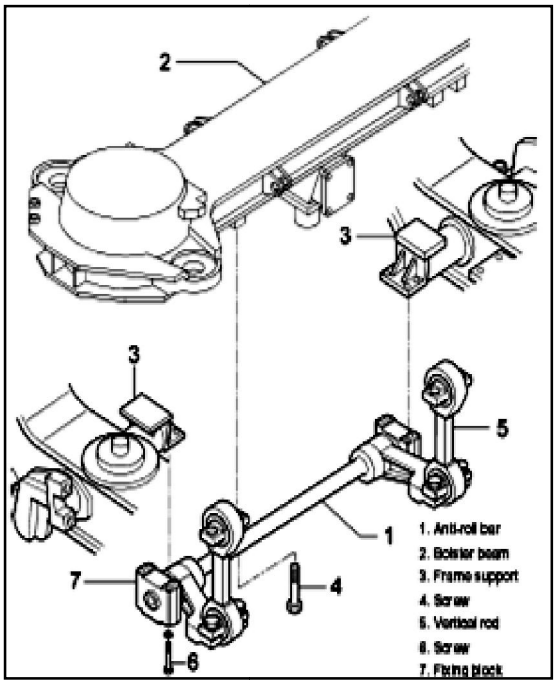


Figure: Anti-Roll Bar

Technical Description

The FIAT Bogie is two-axle type, with a primary and a secondary suspension. The bogie assembly is shown in fig. The Salient features of FIAT Bogie are:

- **Solid welded Bogie Frame** made up of two longitudinal components connected by two cross beams. The bogie frame rests on the primary suspension spring units and supports the vehicle body by means of Bolster beam. The Bolster beam is connected to the bogie frame by secondary suspension.

- **Primary suspension** consist of two steel coil springs (internal/external) laid out on the Control Arm upper part.

- **Secondary suspension** consists of two spring packs which sustain the bolster beam over the bogie frame. Each spring pack is made up by an internal and external spring. An Anti-roll bar fitted on the bogie frame realizes a constant, reduced inclination coefficient during running. The bogie frame is linked to the bolster beam through two vertical dampers, a lateral damper, four safety cables and the traction rods. The bogie frame is linked to the coach body through two yaw dampers.

- **Traction Centre** - The traction Centre transmits traction and braking forces between bogie frame and body by a traction lever on the bolster beam pin and two rods.

- **Disk Brakes** – The FIAT bogie is fitted with pneumatic disk brakes. The pneumatically operated brake cylinders are fitted with automatic device for taking up the clearances.

- **Taper Roller Cartridge Bearing–** Fiat Bogie is fitted with 130 mm Cartridge type roller bearings.

FORCE TRANSMISSION

Vertical forces:
Body – Secondary Springs - Bogie Frame – Primary Springs /Ball Joint Control Arm – Axle

Lateral forces:
Body – Secondary Springs - Bogie frame - Ball Joint control Arm – Axles

Longitudinal traction efforts and braking powers:
Body – Traction Center -Traction Rods - Traction Lever Bogie Frame – Control Arm –Axles

PRINCIPLES OF FORCES TRANSMISSION

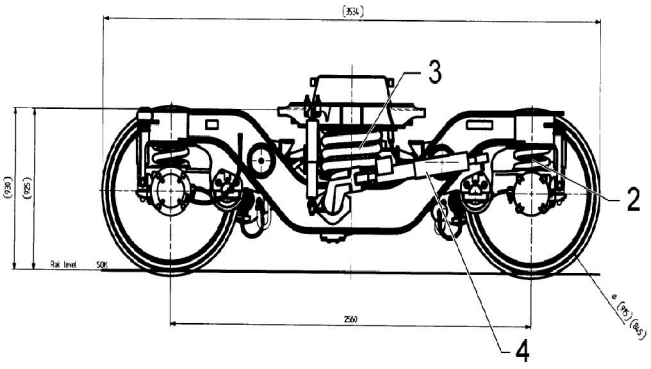
Forces concerning the bogie are transmitted as follows.

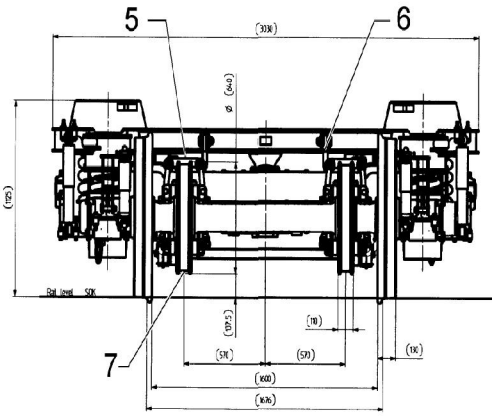
Vertical forces: from the body to the bogie frame through the secondary suspension springs; from the bogie frame to the axles through the primary suspension springs and frame - axle bearing control arm.

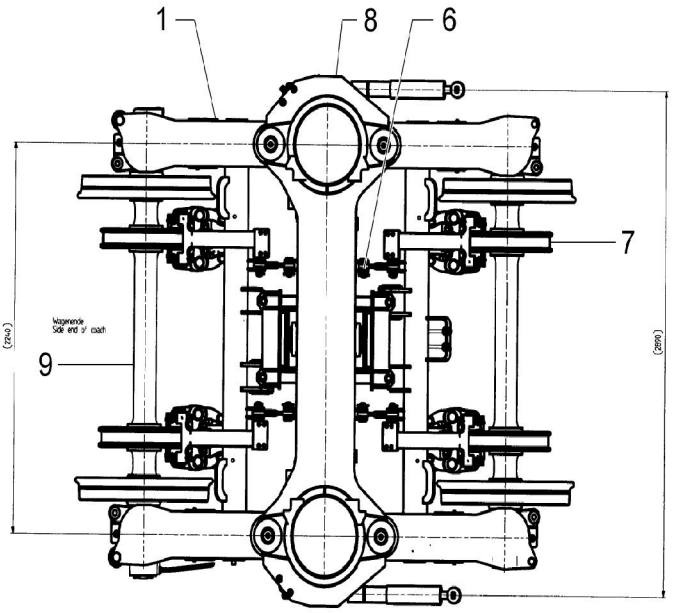
Crosswise forces: from the body to the bogie frame through the secondary suspension springs; from the bogie frame to the axles through the elastic elements of the frame - axle bearing control arm.

Longitudinal traction efforts and braking powers: from the body to bogie frame through the traction centre rods and the traction lever; from the bogie frame to the axles through the frame - axle bearing control arm.

FIAT BOGIE ASSEMBLY





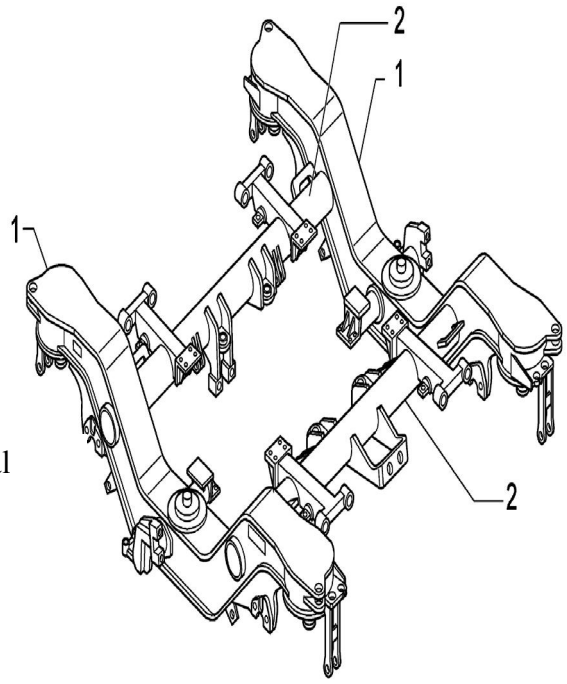


1. Bogieframe
2. Primarysuspension
3. Secondarysuspension
4. Yawdamper
5. Lateraldamper
6. Safetycables
7. Brakedisc
8. Bolster beam
9. Axle

Bogie Frame

The bogie frame is a solid welded frame made by steel sheets and forged or cast parts.
The frame is made up of two longitudinal components (1) connected by two cross-beams (2) which also support the brake units. The various supports which connect the different bogie components are welded to the frame. The bogie frame rests on the primary suspension spring units and supports the vehicle body by means of a bolster beam. The bolster beam is connected to the bogie frame by the secondary suspension.

BOGIE FRAME

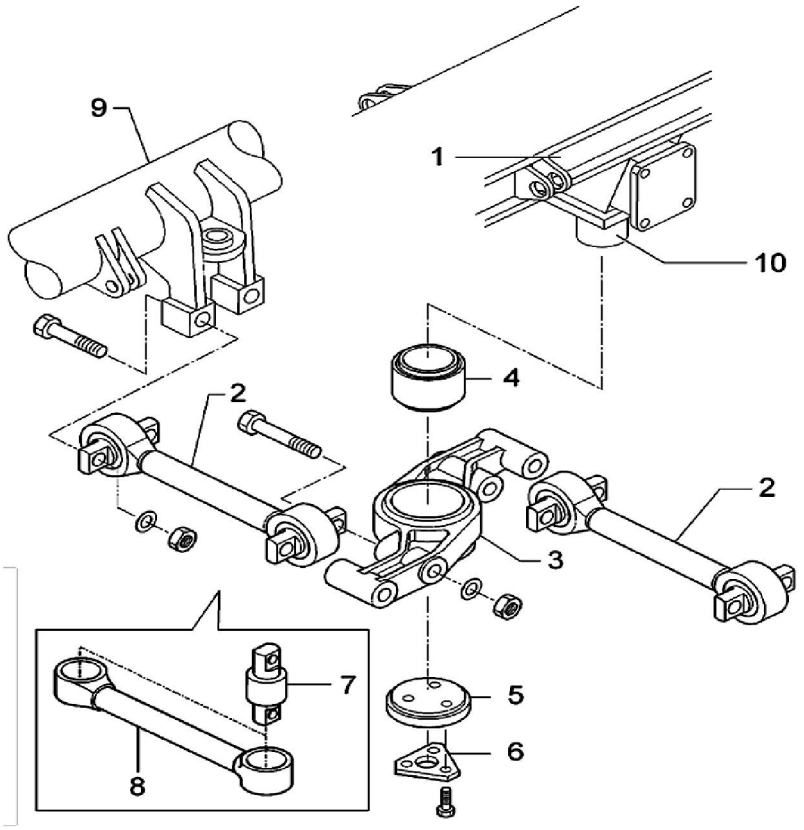


1. Bogie frame longitudinal component
2. Cross-beam

Traction Centre

The traction centre (see FIG.) Transmits traction and braking forces between bogie frame and body by a traction lever (3), on the bolster beam pin (10), and two rods (2).

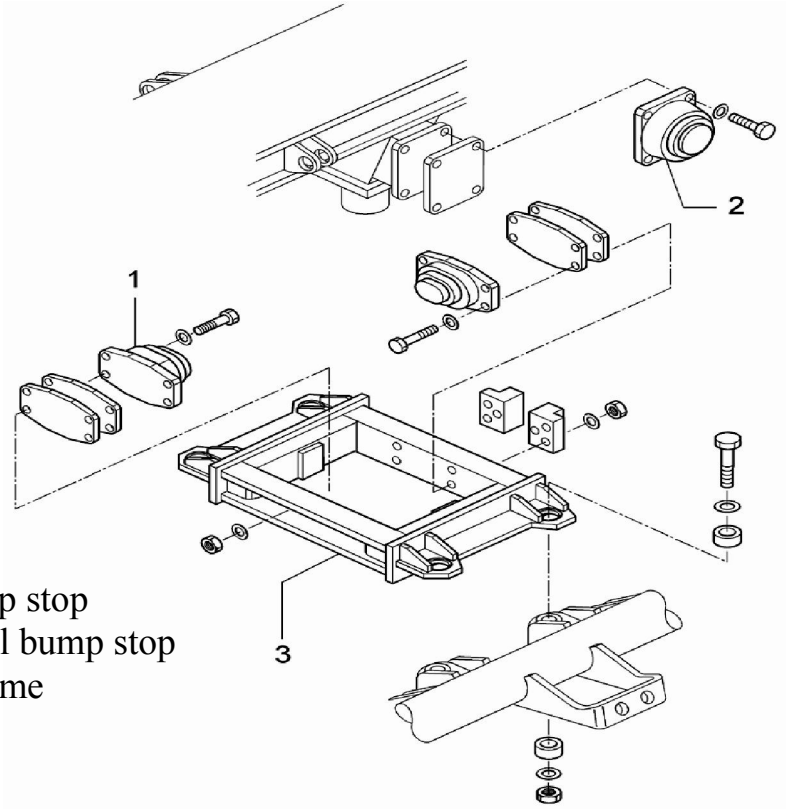
The traction lever is connected to the bolster beam by means of a rubber bush (4), two plates (5, 6) and screws, while rods are connected to the bogie frame and to the traction lever by elastic joints (7) and screws.



1. Bolster beam
2. Rod
3. Traction lever
4. Rubber bush
5. Plate
6. Plate
7. Elastic joint
8. Rod
9. Bogie frame
10. Pin

Auxiliary Components

The bogie is completed by a device for limiting the longitudinal and lateral displacements of the bolster beam, made by four bump stops (FIG.), two longitudinal (2) and two laterals (1).



1. Lateral bump stop
2. Longitudinal bump stop
3. Support- frame

The four of them are supported by a small frame (3) screwed to the bogie frame.

FIG. LONGITUDINAL AND LATERAL BUMP STOPS

At the two outer corners of the frame it is also mounted a roll (1-FIG.) which prevents excessive rotation of the bogie when under the car body. The roll (1) is fixed by a pin (2), a washer (3) and a safety split pin (4).

1. Roll
2. Pin
3. Washer
4. Split pin

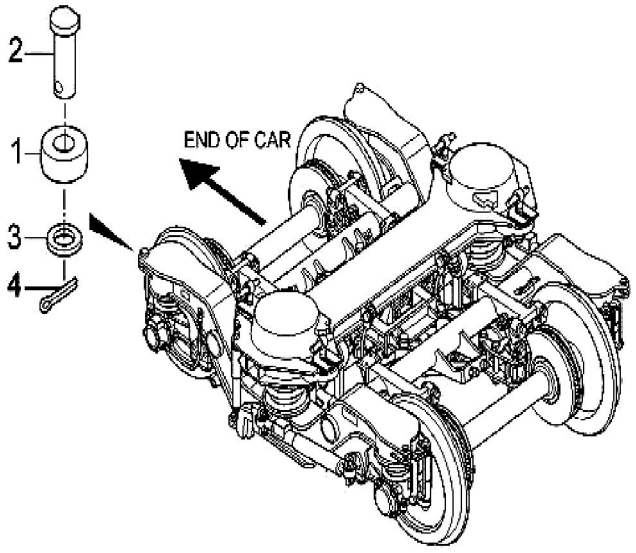


FIG. CORNER ROLLS

SUSPENSION SYSTEM IN LHB COACH

Primary Suspension

Primary suspension is implemented by two units (see FIG) of two steel coil springs (internal (4) and external (5)) laid out on the control arm upper part (13) by a centering disk (8) and adjustment shims (if required).

The suspension is also completed by the following components:

- A control arm (13), fitted with twin-layer elastic joints (12), connecting the axle bearing to the bogie frame and transmitting, not stiffly, lateral, longitudinal and part of the vertical forces;
- A vertical damper (14).
- Rubber elements (2) separate the primary suspension from the bogie to realize noise reduction.

1. Bogie frame
2. Rubber disks
3. Centering disk
4. Internal spring
5. External spring
6. Bump stop
7. Shim
8. Centering disk
9. Control Arm Lower Part
10. Plate
11. Block
12. Rubber joint
13. Control Arm Upper Part
14. Damper

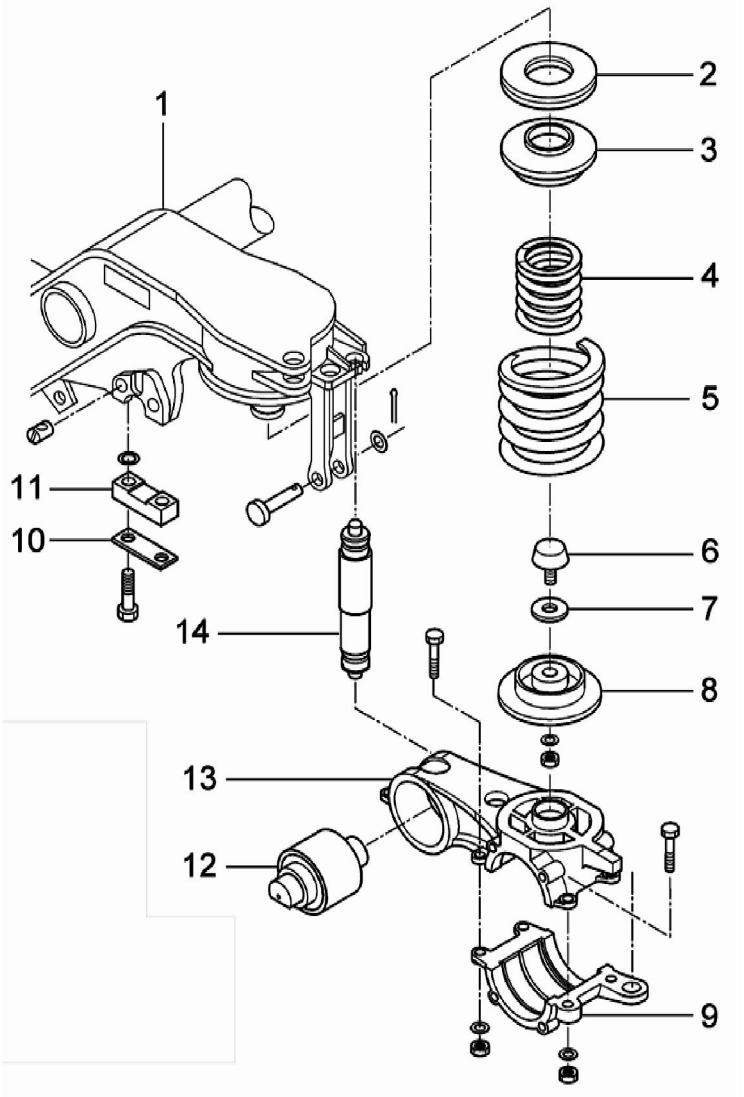


Fig Primary Suspension

Secondary Suspension

Helical Flexi Coil spring in secondary suspension stage

The secondary suspension enables lateral and vertical displacements and bogie rotation with respect to body when running through curves.

It is implemented by two spring packs (Fig.) which sustain the bolster beam (1) over the bogie frame (6). Each spring pack is made up by an internal (3) and an external spring (4), mounted and positioned through the centering discs (5).

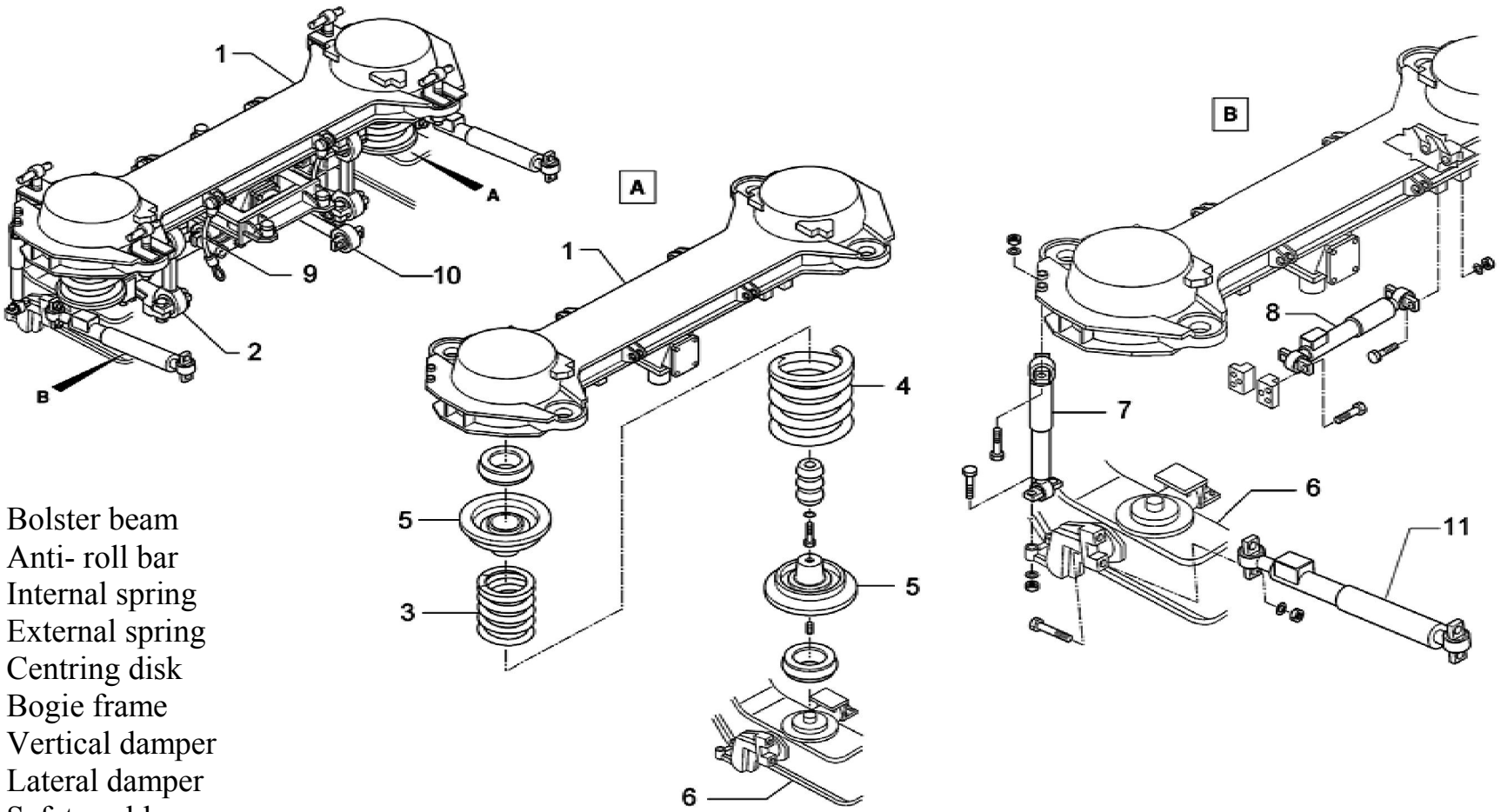
An anti-roll bar (2), fitted on the bogie frame (6), realizes a constant, reduced inclination coefficient during running.

The bogie frame is linked to the bolster beam through two vertical dampers (7), a lateral damper (8), four safety cables (9) and the traction rods (10).

The bogie frame is also linked to the coach body through two yaw dampers (11).

Followings dampers are provided on LHB coach

S.No	Types Of Dampers	Place of Provision	Nos/ Bogie	Nos/ Coach
1	**Vertical**	Primary Suspension , Between Axle Box and Bogie Frame	04	08
2		Secondary Suspension Between Bogie Frame and Bolster	02	04
3	**Lateral**	Between bolster and Support Frame	01	02
4	**Yaw**	Between Coach body and Bogie side frame	02	04
		Total Dampers	09	18



1. Bolster beam
2. Anti- roll bar
3. Internal spring
4. External spring
5. Centring disk
6. Bogie frame
7. Vertical damper
8. Lateral damper
9. Safety cables
10. Traction rod
11. Yaw damper

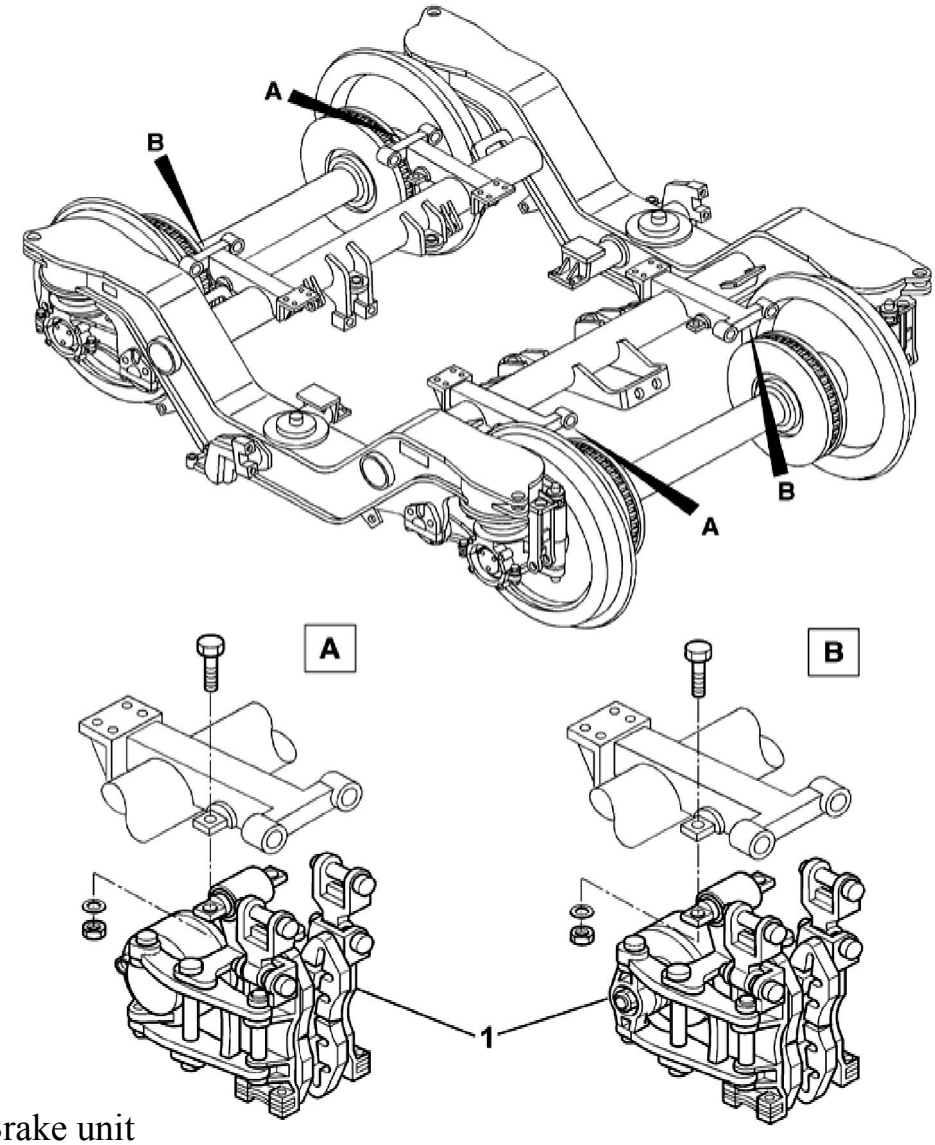
SECONDARY SUSPENSION UNIT

Installed Braking Systems

The pneumatic braking systems acting on the bogie are as follows:

- Pneumatic disk braking only (FIG.), covering the whole speed range and acting on both axles for bogies .
- Pneumatic disk braking and hand-operated brakes acting on both axles for bogie .

Pneumatic braking is implemented by pneumatically operated brake cylinders fitted with an automatic device for taking up clearances. Air to spring brake cylinders is supplied through two compressed air pipes, one for the brakes of the first axle, and the other for the second axle. Brake cylinder action is transmitted, through two levers and a balancing arm, to a pair of pad holders, which perform braking on relevant disk.



1. Brake unit

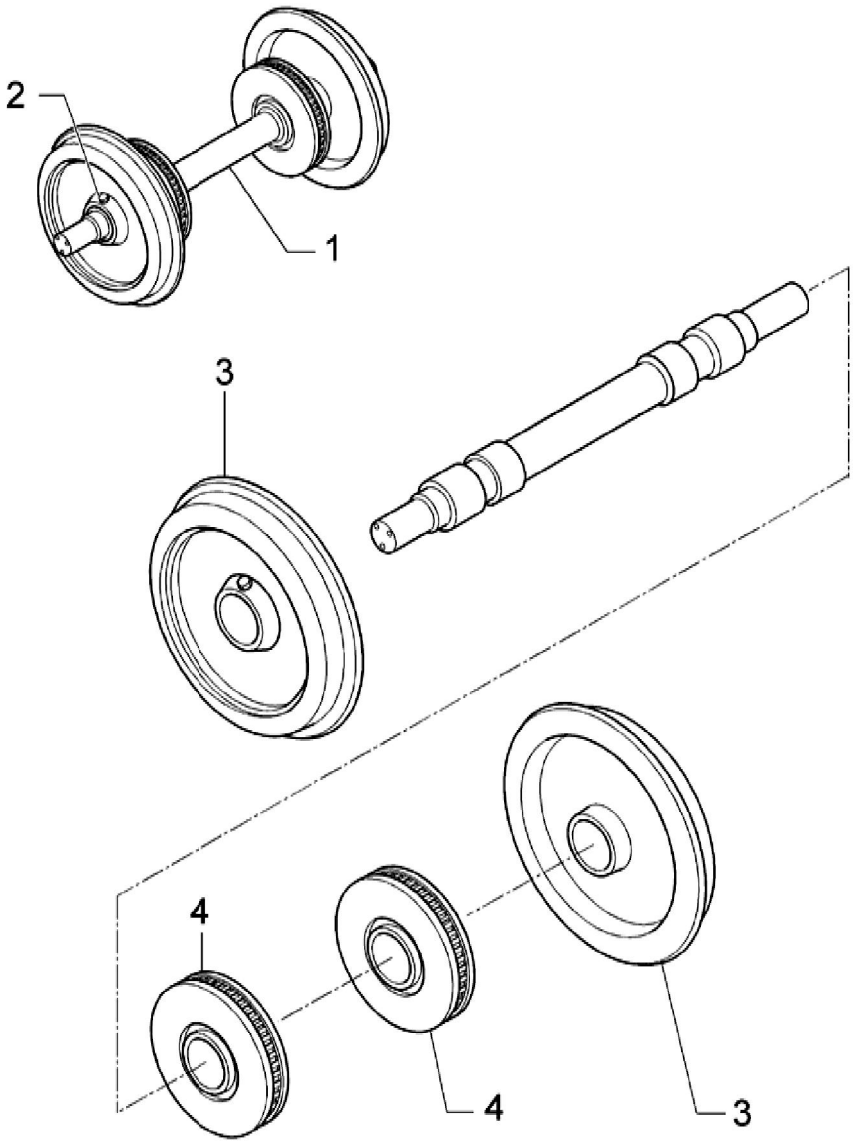
FIG. BRAKING SYSTEM FOR BOGIES

BRAKE DISCS

On the bogie each axle (1) is fitted with two brake disks (4), diameter 640 mm and width 110 mm. Disks belong to the type with a low ventilation; friction lining in organic material operate on each disk, by means of proper links, by the relevant brake cylinder fitted with an automatic device for taking up clearances.

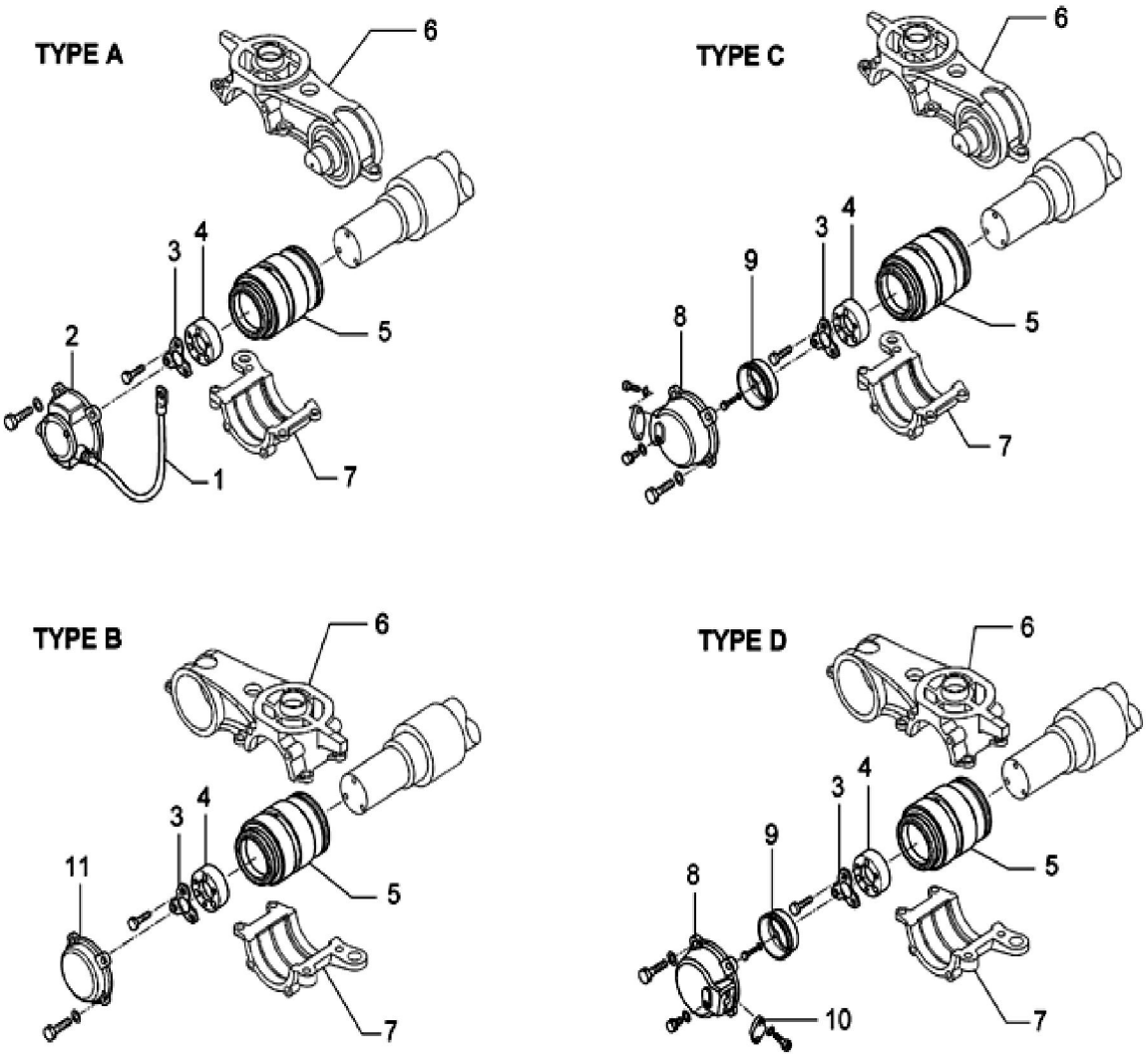
Wheels

At axle ends are fitted wheels (3). Wheels are fitted with a side pipe, sealed by a plug, for letting in high pressure oil during wheel removal.



1. Axle
2. Plug
3. Wheel
4. Brake disk

FIG BOGIE AXLES



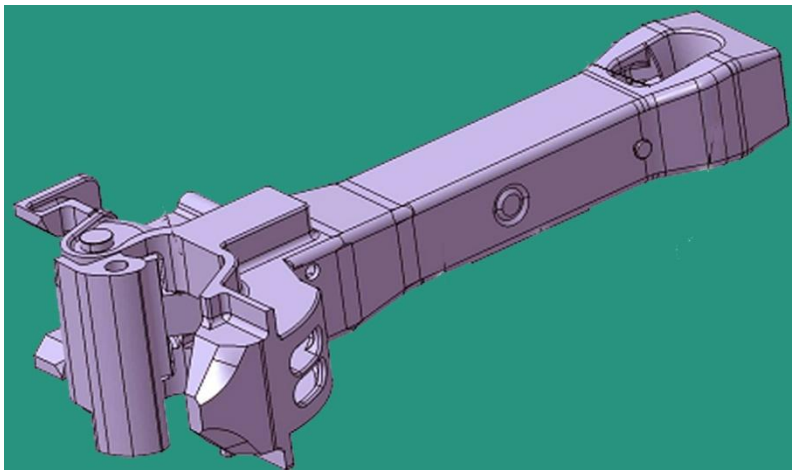
1. Current return cable
2. Cup
3. Connecting plate
4. Bearing cup
5. Bearing assembly
6. Control arm upper part
7. Control arm lower part
8. Cup
9. Phonic wheel
10. Cable
11. Cup

FIG. BEARING EQUIPMENTS INSTALLED ON THE BOGIES

CENTER BUFFER COUPLER

The coupler provides a means of mechanically connecting individual adjacent vehicles to make a train. The coupler is located at both ends of each vehicle. When connected to a coupler of an adjacent vehicle, it allows the vehicles to move independently to accommodate track curvature and elevation change while remaining connected (coupled) together.

The coupler is opened manually using the coupler operating rod and is closed automatically when the couplers on adjacent vehicles are mated. The coupler automatically locks when fully mated.



LHB coaches have been provided with tight lock centre buffer couplers instead of screw coupling. Couplers are AAR-H type and have anti- climbing features because of vertical interlocking. Couplers have adequate strength for:

- Satisfactory hauling of a train of 26 coaches at 110 kmph
- Satisfactory hauling of a train of 18 coaches at 160 kmph

Coupling is possible under angular misalignment both horizontally and vertically. The coupler permits coupled trains to negotiate vertical and horizontal curves and allows rotational movements. The draw gear ensures cushioning effective in both buff and draft.

MAINTENANCE SCHEDULES FOR LHB COACHES

General

The following maintenance schedules are to be carried out on LHB coaches

Coaching Depot Schedule

Schedule	Periodicity	Place to be carried out
Trip Schedule D1	Every Trip /Weekly	Pit Line
Monthly Schedule/D2	30 days ± 3 days	Pit Line
Six Monthly Schedule/D3	180 days ± 15 days	Sick Line

Shop Schedule

Schedule	Periodicity	Place to be carried out
(Shop Schedule I) /SS-I	18 Month±30 days/6 Lakhs Kms earned whichever is earlier	Workshop
Shop Schedule II / SS-II	3 Years/12 Lakhs Kms earned whichever is earlier	Workshop
Shop Schedule III /SS-III	6Years/24 Lakhs Kms earned whichever is earlier	Workshop

The details of activities to be carried out during these schedules are given below and a summarized checklist is enclosed as Annexure.

Schedule D1 (Every Trip)
The following items shall be attended during schedule D1.

Bogie Frame and Bolster Assembly

- Perform a visual check on longitudinal beams, cross beams & bolster for cracks, damages and corrosion.
- Perform a visual check on brake supports, damper supports, traction centre supports and anti-roll bar supports for cracks, damages and corrosion.
- Check bogie bolster sub-assembly and brackets for cracks, damages and corrosion.

Brake Equipments

- Check functionality of Air Brake equipment and Hand brake equipment. Checks flex ball cable arrangement for proper working.
- Perform a visual check on Brake cylinders/ brake levers and Hand brake equipment for damage, cracks and corrosion.
- Perform a functional test on pneumatic brake system. Make sure that no leaks are present.
- Check operation of passenger emergency valve & pull box.
- Perform a visual check on hoses for cracks/damages.
- Visually inspect steel piping for cracks/ damages/ ballast hitting and leakages, Repair/ replace as necessary.
- Perform a visual check on brake discs for damage/wear/broken ribs. Verify absence of axial movement along the axle.

Note: For attending Brake Discs with broken ribs, please refer to M/S Knorr Bremse's letter no. KBI/M&S/LHB/SER. Dt. 31.08.2007.

Axle Bearing Instruments

- Perform a visual check on all grounding cables & WSP equipment cables for breaks/ damages.
- Visually check equipment for absence of damages, cracks, and corrosion marks.
- Check functioning of WSP equipment. Verify that the signal arrives correctly to the diagnostic equipment.

Primary & Secondary Suspension

- Visually check springs for cracks, damages, corrosion or foreign objects presence.
- Check miner pads for cracks, damages and ageing.
- Visually check safety cables for damages, cracks and corrosion.

Primary/Secondary/Yaw dampers

- Perform a visual check on dampers for damage, cracks and oil leaks.
- Perform a visual check on all fixings for loosening and/or missing components.
- Perform a visual check on rubber elements for cracks and ageing.

Bearings

- Carry out bearing feeling for detection of hot bearing.
- Check bearings for grease leakage.

Wheel & Axle

- Perform a visual check on wheels for cracks, damages and tyre defects.
- Check by wheel profile gauge, the wheel flange thickness and profile.
- Check axle for cracks and signs of corrosion, if any.

Note: Please refer to RDSO CMI – K 003 (Guidelines for interpretation of wheel defects) and 'Maintenance Manual for ICF design BG coaches' for details.

Control Arm

- Perform a visual check on all fixings for loosening and / or missing components.
- Visually check control arm parts for damages, cracks or corrosion marks.
- Inspect the rubber joint until it is visible for cracks, damages and ageing.

Anti - Roll bar Assembly

- Perform a visual check on Anti roll bar, links and brackets for cracks, damages and corrosion.
- Perform a visual check on rubber joints for cracks, damage and ageing.
- Visually inspect for grease oozing out of anti roll bar bearings, which may result in bearing failure.
- Perform visual check on all fixings for loosening/missing fittings.

Traction Centre

- Perform a visual check on the traction centre lever and on the rods for cracks, damages and corrosion.
- The assembly should be free to move, and not blocked by any foreign objects.
- Perform a visual check on all fixings for loosening.
- Perform a visual check on rubber joints for cracks/damages.

Rotation Limiter

- Perform a visual check of rotation limiter- components.

Rubber and Rubber/Metal Bonded Parts

- Perform a visual check on rubber and rubber/metal bonded parts for cracks, damages and ageing.

SCHEDULE D2 (MONTHLY)

Perform all the items of schedule D1. In addition to this perform the activities- as given below.

Bogie Frame

- Wash the bogie frame thoroughly with water jet in washing line, making sure that water is not directed towards pneumatic / electrical connections and axle bearings.

Brake Equipment

- Verify that the clearance between each pad and disc surface is 1-1.5 mm.
- Check wear of brake pads/ brake discs. If groove depth is reached, it is necessary to replace the discs.
- Lubricate the brake levers, fixings and all moving parts using prescribed grease (Autol Top 2000 spray).

Axle Bearing Instruments

- Inspect the Earthing equipment for wear of slip assembly / carbon bars.
- Monthly / Quarterly inspection of WSP equipment to be carried out as per schedule given by OEM.

Wheel & Axle

- Checks tread diameter and wear of wheel profile. If necessary, perform re-profiling.

Pins and Bushes

- Lubricate all pins and bushes.

SCHEDULE D3 (HALF YEARLY)

Perform all the activities of schedule D2. In addition to this, perform the activities, as given below

Bogie Frame

- Examine the bogie frame for corrosion / damages, especially at critical locations.
- Carry out paint touch up with high built epoxy primer and paint as per RCF specifications MDTS – 166.

Wheel & Axle

- Check wheels offset on axle (1600 mm± 1 mm)

Control Arm

- Renew protection treatment with Tectyl / Cortec VC 1368 on the rubber joint on visible areas.

Sr.No		Schedule		
	Particulars	**D1** **Trip**	**D2** **Mthly**	**D3** **HYLY**
	Frequency of Examination	**Every Trip**	**30±3 days**	**Six Month±15 days**
	Maintenance to be done at:	On rake at nominated primary depot	On rake at nominated primary depot	Sick line at nominated primary depot
1.0	**Coach**			
1.1	Coach should be washed both from outside& inside.	√	√	√
1.2	Disinfect and spray insecticide at corner and crevices of coaches after washing all coaches (AC & PC- 15 Days)	-	√	√
1.3	Intensive cleaning of coach	-	√	√
2.0	**Coach Shell**			
2.1	Visually check body panels/end walls for damages	√	√	√
2.2	Visually inspect destination boards brackets.	√	√	√
2.3	Visually inspect window bars for damage/missing	√	√	√
2.4	Examine body side doors for working/ damages	√	√	√
2.5	Inspect door handles for damages/missing	√	√	√
2.6	Inspect vestibule and its Rubber fittings for damages/missing, repair if necessary	√	√	√
2.7	Visually check vestibule fall plate, mounting brackets, pins and lock lever for ease of operation, damages/ deficiency	√	√	√
2.8	Thoroughly clean and remove dust, rust accumulated at pillars with coir brush and compressed air	-	-	√
2.9	Examine for corrosion of sole bar and other under frame members with torch light or inspection lamp	-	-	√
2.10	Touch up damaged paint both inside & outside	-	-	√
2.11	Check roof ventilator for damages	-	-	√

Sr.No		Schedule		
	Particulars	**D1** **Trip**	**D2** **Mthly**	**D3** **HYLY**
	Frequency of Examination	**Every Trip**	**30±3 days**	**Six Month±15 days**
	Maintenance to be done at:	On rake at nominated primary depot	On rake at nominated primary depot	Sick line at nominated primary depot
3	**BOGIE & AIR BRAKE**			
	Bogie Frame and Bolster Assembly			
3.1	Perform a visual check on longitudinal beams, cross beams & bolster for cracks, damages and corrosion.	√	√	√
3.2	Perform a visual check on brake supports, damper supports, traction centre supports and anti roll bar supports for cracks, damages and corrosion.	√	√	√
3.3	Check bogie bolster such assembly and brackets for cracks, damages and corrosion	√	√	√
3.4	Wash the bogie frame thoroughly with water jet, making sure that water is not directed towards pneumatic / elect. Connections and axle bearings.	-	√	√
3.5	Examine the bogie frame for corrosion / damages, especially at critical locations.	-	-	√
3.6	Carry out paint touch up with high built epoxy primer and paint as per RCF specifications MDTS – 166.	-	-	√
4	**Brake Equipments**			
4.1	Check functionality of brake equipment and Hand brake equipment.	√	√	√
4.2	Perform a visual check on Brake cylinders/ brake levers and Hand brake equipment for damage, cracks and corrosion.	√	√	√
4.3	Perform a functional test on pneumatic brake system. Make sure that no leaks are present.	√	√	√
4.4	Perform a visual check on hoses.	√	√	√
4.5	Visually inspect steel piping for cracks/ damages/ ballast	√	√	√

Sr.No		Schedule		
	Particulars	**D1** **Trip**	**D2** **Mthly**	**D3** **HYLY**
	Frequency of Examination	**Every Trip**	**30±3 days**	**Six Month±15 days**
	Maintenance to be done at:	On rake at nominated primary depot	On rake at nominated primary depot	Sick line at nominated primary depot
	hitting. Repair/ replace as necessary.			
4.6	Perform a visual check on brake discs. Verify absence of axial movement along the axle.	√	√	√
4.7	Verify that the clearance between each pad and disc surface is 1-1.5 mm.	-	√	√
4.8	Check wear of brake pads/ brake discs.	-	√	√
4.9	Lubricate the brake levers, fixings and all moving parts.	-	√	√
5	**Axle Bearing Instruments**			
5.1	Perform a visual check on all grounding cables & WSP equipment cables for breaks/ damages.	√	√	√
5.2	Visually check equipment for absence of damages, cracks, and corrosion marks.	√	√	√
5.3	Check functioning of WSP equipment.	√	√	√
5.4	Inspect the Earthing equipment for wear of slip assembly / carbon bars.	-	√	√
5.5	Monthly / Quarterly inspection of WSP equipment to be carried out as per schedule given by OEM.	-	√	√
6	**Primary & Secondary Suspension**			
6.1	Visually check springs for cracks, damages, corrosion or foreign objects presence.	√	√	√

Sr.No		Schedule		
	Particulars	**D1** **Trip**	**D2** **Mthly**	**D3** **HYLY**
	Frequency of Examination	**Every Trip**	**30±3 days**	**Six Month±15 days**
	Maintenance to be done at:	On rake at nominated primary depot	On rake at nominated primary depot	Sick line at nominated primary depot
6.2	Check miner pads for cracks, damages and ageing.	√	√	√
6.3	Visually check safety cables for damages, cracks and corrosion.	√	√	√
7	**Primary/Secondary/Yaw dampers**			
7.1	Perform a visual check on dampers for damage, cracks and oil leaks.	√	√	√
7.2	Perform a visual check on all fixings for loosening and/or missing components.	√	√	√
7.3	Perform a visual check on rubber elements for cracks and ageing.	√	√	√
8	**Bearings**			
8.1	Carry out bearing feeling for detection of hot bearing.	√	√	√
8.2	Check bearings for grease leakage.	√	√	√
9	**Wheel & Axle**			
9.1	Perform a visual check on wheels for cracks	√	√	√
9.2	Check by wheel profile gauge	√	√	√
9.3	Check axle for cracks and signs of corrosion	√	√	√
9.4	Check tread diameter and wear of wheel profile. If necessary, perform re-profiling.	-	-	√

Sr.No		Schedule		
	Particulars	**D1** **Trip**	**D2** **Mthly**	**D3** **HYLY**
	Frequency of Examination	**Every Trip**	**30±3 days**	**Six Month±15 days**
	Maintenance to be done at:	On rake at nominated primary depot	On rake at nominated primary depot	Sick line at nominated primary depot
9.5	Check wheels offset on axle (1600± 1 mm)	-	√	√
10	**Control Arm**			
10.1	Perform a visual check on all fixings for loosening and / or missing components.	√	√	√
10.2	Visually check control arm parts for damages, cracks or corrosion marks.	√	√	√
10.3	Inspect the rubber joint until it is visible for cracks, damages and ageing.	√	√	√
11	**Anti Roll bar assembly**			
11.1	Perform a visual check on Anti roll bar, links and Brackets for cracks, damages and corrosion.	√	√	√
11.2	Perform a visual check on rubber joints for cracks, damage and ageing.	√	√	√
11.3	Visually inspect for grease oozing out of anti roll bar bearings, which may result in bearing failure.	√	√	√
11.4	Perform visual check on all fixing for loosening/missing fittings.	√	√	√

Sr.No		Schedule		
	Particulars	**D1** **Trip**	**D2** **Mthly**	**D3** **HYLY**
	Frequency of Examination	**Every Trip**	**30±3 days**	**Six Month±15 days**
	Maintenance to be done at:	On rake at nominated primary depot	On rake at nominated primary depot	Sick line at nominated primary depot
12	**Traction Centre**			
12.1	Perform a visual check on the traction centre lever and on the rods for cracks, damages and corrosion.	√	√	√
12.2	The assembly should be free to move, and not blocked by any foreign objects.	√	√	√
12.3	Perform a visual check on all fixings for loosening.	√	√	√
12.4	Perform a visual check on rubber joints for cracks/damages.	√	√	√
13	**Rotation Limiter**			
13.1	Perform a visual check of rotation limiter, components	√	√	√
14	**Rubber and Rubber/Metal Bonded parts**			
14.1	Perform a visual check on Rubber and Rubber/Metal bonded parts for cracks, damages and ageing.	√	√	√
15	**Pins and bushes**			
15.1	Lubricate all pins and Bushes.	-	√	√
16	**Body works -**			
16.1	General inspection of Vehicle body work (paint work, glazing).	-	√	√
16.2	Replenish supplies.	√	√	√

Sr.No		Schedule		
	Particulars	**D1** **Trip**	**D2** **Mthly**	**D3** **HYLY**
	Frequency of Examination	**Every Trip**	**30±3 days**	**Six Month±15 days**
	Maintenance to be done at:	On rake at nominated primary depot	On rake at nominated primary depot	Sick line at nominated primary depot
17	**Draw & Buffing Gear - (Ref: CMI No: RDSO/2006/CG/CMI/01 Rev No: Nil)**			
17.1	Visual Inspection of coupler head for damage.	√	√	√
17.2	Visual Inspection of Knuckle for damage.	√	√	√
17.3	Checking of coupler operating mechanism for damage, loose, bolts etc.	√	√	√
17.4	Greasing of glide rod of coupler operating mechanism.	√	√	√
17.5	Checking tell tale recess for ensuring proper coupling.	√	√	√
17.6	Inspection of coupler carriers/supporting device & its spring for cracks & breakage	√	√	√
17.7	Inspection of loose/broken/missing nuts & bolts (M-16) of coupler pin support plate & draft gear support plate.	√	√	√
18	**Corridor Connections -**			
18.1	Check corridor connections for external damage & foreign bodies.	√	√	√
18.2	Check vestibule connection for external damage & foreign bodies.	√	√	√
19	**Pressure Air Equipment**			
19.1	Safety valve check for correct function.	√	√	√
19.2	Dry out air - filter	-	√	√
19.3	Clean air - filter	-	√	√
19.4	Clean airline - filter	-	√	√
19.5	Drain air tanks.	√	√	√

Sr.No		Schedule		
	Particulars	**D1** **Trip**	**D2** **Mthly**	**D3** **HYLY**
	Frequency of Examination	**Every Trip**	**30±3 days**	**Six Month±15 days**
	Maintenance to be done at:	On rake at nominated primary depot	On rake at nominated primary depot	Sick line at nominated primary depot
20	**Interior fitting passenger accommodation-**		√	
20.1	General visual check for damage	√	√	√
20.2	Check for regulation provision of rubbish bins & operational fire extinguishers.	√	√	√
20.3	Check hand rails, sliding door, shutters, toilet doors, vestibule doors, functioning.	√	√	√
20.4	Check bath room fitting (visual)	√	√	√
20.5	Clean top & bottom guide rails of luggage doors of power cars & greasing of guide bearing.	√	√	
20.6	Inspect seats & check for completeness.	-	√	√
20.7	Inspect luggage racks & check for completeness.	-	√	√
20.8	Check handrails manually for fitment of fixing.	-	√	√
20.9	Inspect floors.	-	√	√
20.10	Checks stick-on notices and directions for condition & completeness.	-	√	√
20.11	1-leaf sliding door - general function check (ease of movement, how it shuts)	√	√	√
20.12	2-leaf connection door - general function check (ease of movement, how it shuts)	√	√	√
21	**Passenger Doors**			
21.1	General function checks (ease of movement)	√	√	√
21.2	Lubricate door seals with silicone paste.	-	-	√
21.3	Clean & lubricate door mechanisms.	-	√	√

Sr.No		Schedule		
	Particulars	**D1** **Trip**	**D2** **Mthly**	**D3** **HYLY**
	Frequency of Examination	**Every Trip**	**30±3 days**	**Six Month±15 days**
	Maintenance to be done at:	On rake at nominated primary depot	On rake at nominated primary depot	Sick line at nominated primary depot
22	**Water supply system -**			
22.1	Check tanks pipes for leakage.	√	√	√
22.2	Check tank mountings.	√	√	√
22.3	Rinsing the pipes & water tanks		√	√
23	**Pantry**			
23.1	Check for damages & deficiencies in the pantry construction & fittings	√	√	√
23.2	Check water supply & drainage of the pantry area.	√	√	√
24	**Sanitary Equipment**			
24.1	Check functioning of toilet system.	√	√	√

BEARINGS

INTRODUCTION

Bearing plays a vital roll between two rotary moving parts. Bearing work as an anti frictional element and reduce frictional losses, heat produced and improves service life. Roller bearing components are manufactured to very close tolerance.

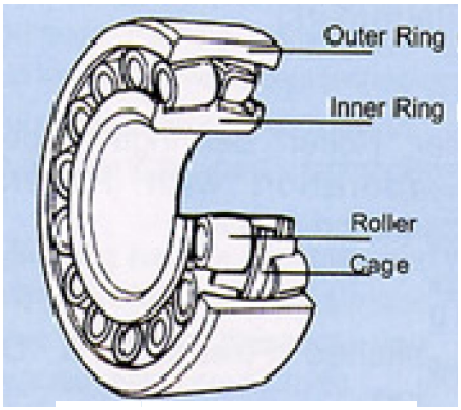


Fig.

The spherical roller bearing consists of a cylindrical inner and an outer race along with rollers and cages. The cage while carrying no load, keep the rolling elements axially apart and also prevent the latter from falling out while handling. The inner ring is interference fit on the axle journal forming part of the axle when in place. The rollers are plain, straight, solid cylinders and are flat on both ends. The bearing parts are made of nickel - chromium alloy steels.

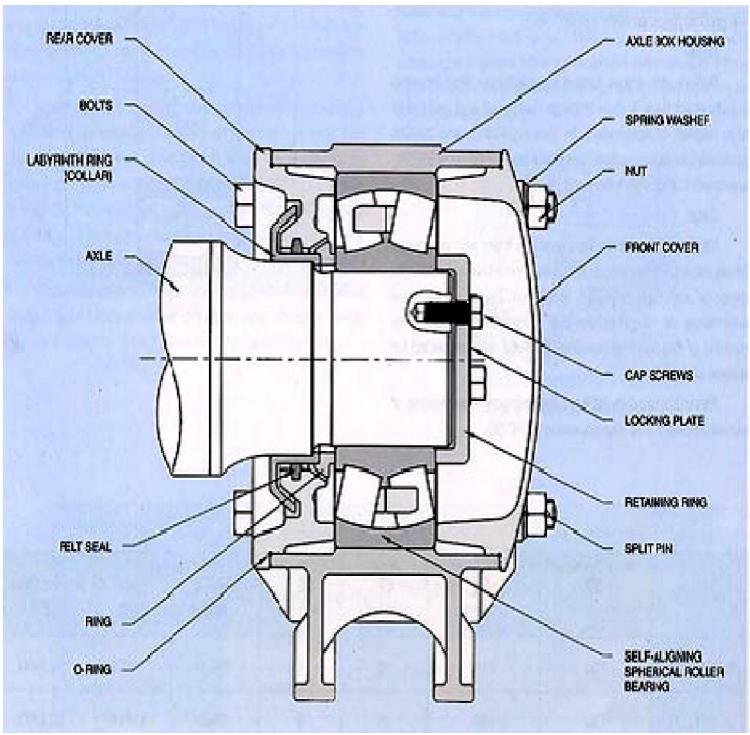
Axle Box Assembly

For spherical roller bearings, two types of axle box arrangements are commonly used. To take advantage of bearing's self aligning property, single bearing arrangement is used for higher load carrying capacity but without self aligning capability, double bearing arrangement is used**.**

In passenger coaches of Indian Railway system, only single bearing type axle box arrangement is used. The inner ring of the bearing is provided with a cylindrical bore (Direct Mounted type).

CONSTRUCTION FEATURE OF SPHERICAL ROLLER BEARING

Spherical roller bearing consist of an outer ring having a continuous spherical raceway within which it operates, two rows of barrel shaped rollers, which in turn are guided by an inner ring with two raceways separated by a centre rib. The spherical roller bearings have self-aligning properties and therefore can automatically adjust to any deviation in the centre line of the axle.



Spherical roller bearings have a large capacity for radial loads, axle loads in either direction, and complex loads. They are suited for the applications such as railway rolling stocks where vibrations and shock loads are encountered.

Roller Bearings are named according to the shape of rollers. Roller Bearings with spherical rollers are called as Spherical Roller Bearings (see Fig. 2.0 Spherical Roller Bearing and Axle Box Assembly)

Spherical Roller bearing no. 22326/C3 with **130 mm** parallel bore on the inner ring is being used on ICF type coaches. They are directly shrunk fit on the axle journals.

The following Marking Scheme for Spherical Roller Bearing of ICF Design Coaches is standardized.

1. Provide two aluminium tags on the axle box housing through axle box bolts, one on the front side of axle box and the other on the rear side. Mention workshop code, bearing overhauling date and bearing serial number by punching on the each tag.
2. Both the tags will be changed with new ones at the time of attending spherical roller bearing after dismounting. The two tags shall be provided with identical markings, so that bearing overhauling after dismounting will have identical date of attention on the front tag and rear tag.
3. The front tag will be replaced with new tag having new date of attention of spherical roller bearings by cleaning, examination and re-lubrication with fresh grease in-situ (without dismounting of bearing). The bearing attended in-situ condition will have different date on the rear and front tags. The front tag will indicate date of attention given in-situ whereas date on the rear tag will give the date of last attention after dismounting of roller bearing.

Life of Spherical Roller Bearing:

The codal life of spherical roller bearings type 22326 (16.25 t) used on BG main line coaches is fixed as 20 years. Railways should condemn the spherical roller bearings of type 22326 used on BG main line coaches which have completed the age of 20 years. For bearing less than 20 years of age, Railways shall continue the practice of rejection of spherical roller bearings on condition basis.

Bearing should be rejected for the following defects: -

- Pitted or flaked roller tracks and rollers.
- Cracked or deformed or badly worn out cage.
- Cracked inner or outer ring.
- Scored or damaged outer surface of the outer ring.
- Indentation on rings or rollers.
- Scoring of roller tracks or rollers.
- Rust/corrosion, damage or excessive fretting corrosion.
- Brinelling or false brinelling.
- Rings exhibiting deep straw or blue or purple colour indicating heat effect.
- Excessive or less radial clearance.

CAUSE OF BEARING FAILURE & ACTION TO BE TAKEN TO MINIMISE HOT AXLE

In general, if roller bearings are used correctly they will survive to their predicted fatigue life. However, they often fail prematurely due to avoidable mistakes. Failure of the rolling bearing can occur for a variety of reasons. Accurate determination of the cause of a bearing failure is must to make suitable recommendations for eliminating the cause. The major factors that singly or in combination may lead to premature failure during service include incorrect mounting, excessive loading, inadequate & insufficient lubrication, impact loading, vibrations, contamination, entry of harmful liquids.

It is difficult to determine the root cause of some of the premature failures. If all the conditions at the time of failure, and prior to the time of failure are known, including the application, operating conditions and environment, then by studying the nature of failure and its probable causes, the possibility of similar future failures can be reduced. Two or more failure pattern can occur simultaneously and can thus be in competition with one another to reduce the bearing life. Also a pattern of failure that is active for one period in the life of a bearing can lead to or can even be followed by another failure mechanism, which then cause premature failure. Thus in some instances, a single failure pattern will be visible and in other indications of several failure pattern will be evident, making exact determination of root cause difficult. So, when more than one bearing failure pattern has been occurred, proper analysis depends on careful examination of failed components. In contrast to fatigue life. This premature failure could be caused by:

1) In correct fit
2) Improper mounting
3) Improper handling
4) Poor lubrication
5) Contamination
6) Excessive heating
7) Excessive load

MAINTENANCE IN OPEN LINE& PRECAUTIONS TO AVOID HOT AXLE CASES

Visual Examination

During Rolling-in & Rolling out examination, inspect axle box for any indication of hot box. Any wheel set with axle box running hot in the coach, must immediately be removed from service and sent for replacement. Visually inspect the axle box housing, front cover, rear cover and other parts for any damage. Check for any missing or loose fasteners. Watch for any other reason that could be detrimental to the performance of roller bearing and could lead to unsafe condition in service.

Roller bearings and axle boxes damaged due to fire, overheating, water submersion or welding, must be removed from service and sent for detailed internal examination.

Running Temperature

Check operating temperature of axle box by non-contact type thermometers at top of the cast steel axle box (crown) housing. The limit of temperature of the axle box top crown will be 80^0 C. If the temperature of axle box is found above 80^0 C, the affected coach should be detached en-route from the train service.

Abnormal sound

In Rolling-in and Rolling-out examination, try to listen for any unusual /abnormal noise or grinding. Detach the coach & remove the wheel set / roller bearing axle box in case it produces abnormal sound and should be sent for internal part examination.

Grease oozing

During service, a small amount of grease leakage could be normal and comes from initial purging of grease and relieving of internal pressures. However, if fresh grease continues to leak, wheel set must be removed from service.

Axle boxes involved in Derailment / Accidents / Flood

All wheel sets of the coaches, involved in accident, fire, and flood or submerged in water, must be removed from service.

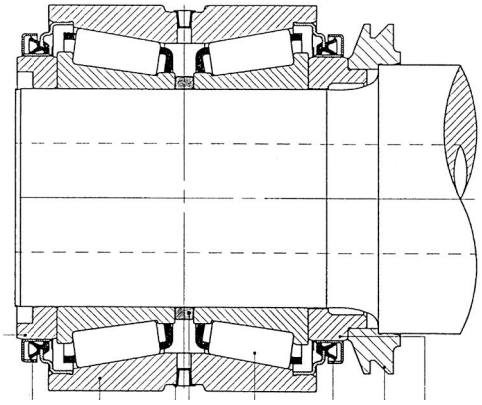
Bearing and parts must be identified separately by marking “ACCIDENT INVOLVED” and should not be reused. It is recommended that inspection of roller bearing is made together with parts including wheel sets, bogie etc.

CARTRIDGE TAPERED BEARING

CTRB: -As the name implies it is Cartridge Taper Roller Bearing unit being used for the wheels of LHB coaches. On the basis of their manufacturers there are two types of CTBUs. One is manufactured by M/s Timken& another by M/s SKF.They are the only suppliers of CTRB for Indian Railways.

Introduction

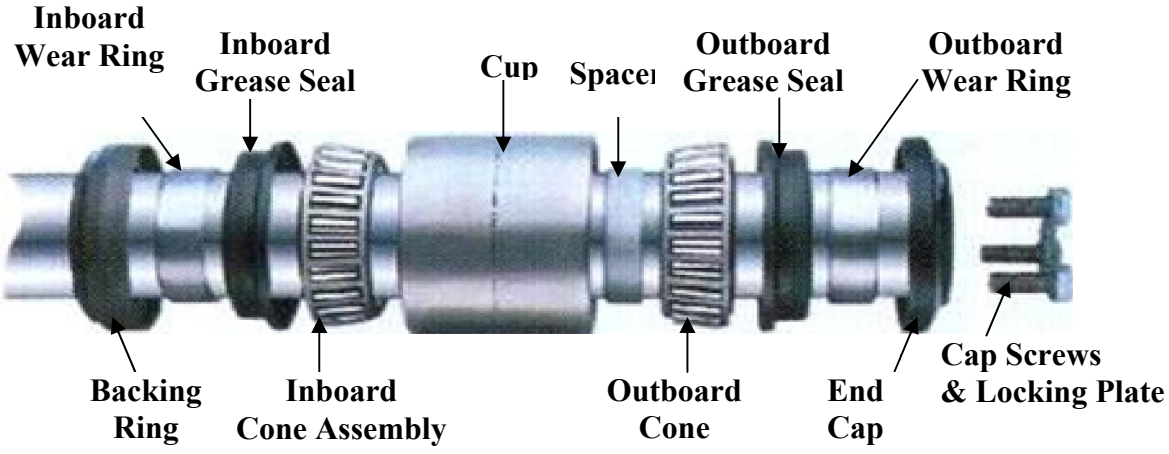
Cartridge bearing is a self-contained, pre-assembled, pre-adjusted, pre-lubricated tapered roller bearing unit, and is applied to and removed from the axle without exposing the bearing elements, or lubricant to contamination or damage. This pre-assembled cartridge bearing reduces the no. of separate parts to be applied to the axle assembly to a minimum. The CTBU is designed and manufactured according to high technical and safety standards.



Timken bearing unit sectional view

GENERAL INFORMATION

BASIC BEARING ASSEMBLY (CTRB): The Cartridge Tapered Roller Bearing is a self-contained, pre-assembled, pre-adjusted, pre-lubricated, completely sealed unit, and is applied to or removed from the axle without exposing the bearing elements, seals or lubricants to contamination or damage. The Cartridge Tapered Roller Bearings are manufactured in different sizes to fit on axles for all types of new and existing wagons.



NOMENCLATURE AND DESCRIPTION OF BEARING PARTS

1. **Cone Assembly**
   The cone, rollers and cage assembly is perfectly matched to ensure long service life. Assembly configuration is similar to standard single row tapered roller bearings. Both cone and rollers are manufactured from bearing quality case hardened steel.

2. **Cup**

The double cup is forged, rolled and machined from bearing quality case hardened steel. The cup has two tapered raceways. It also has seal grooves located at each end, precision machined to effect a leak-proof fit to provide positive locking for the grease seals.

3. **Spacer**
   The spacer width is precision ground and selected at the factory to achieve proper axial clearance in an assembled bearing. Subsequent adjustment or interchange at the time of installation should not be done.

4. **Wear Ring**
   The wear ring is a steel ring, heat treated & precision ground on the OD to provide a smooth, concentric mating surface for the grease seal. The bore diameter of the wear ring has an interference fit with the axle.

5. **Grease Seal**
   The seal is made of special synthetic rubber of superior oil resistance quality, bonded with metal casing by a special process. The primary function of the roller bearing seal is to keep vital lubricating grease inside the bearing and avoid ingress of water and foreign particles.

6. **End Cap**
   The end cap is affixed to the axle by three cap screws and is designed for sufficient rigidity to maintain proper cap screw tension, even after years of service. The wear ring should seat properly inside the recess of end cap to prevent ingress of water.

7. **Axle Cap Screws**
   The Axle Cap Screws affix the axle end cap with axle to provide sufficient clamping of the bearing on the journal. Both used & new cap screws should be lubricated with oil before installation.

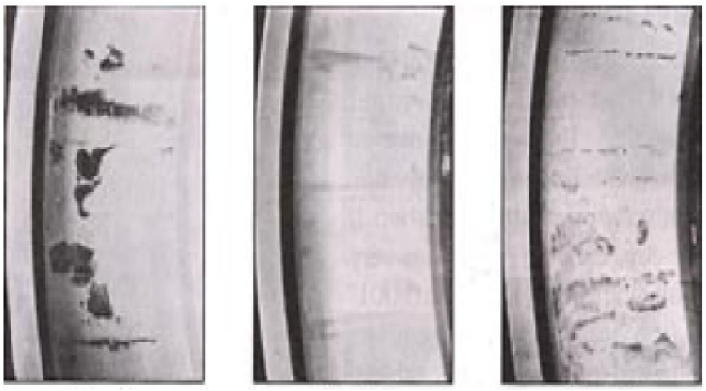
8. **Locking Plate**
   The locking plate provides tabs which are bent against the flats of the cap screws after tightening, thus preventing their undesired turning and subsequent loss of bearing lateral clamp. Two tabs provided for each cap screw must be bent against the flats of the screw heads for proper locking of the cap screws.

9. **Backing Ring**
   The Backing Ring positions the bearing, provides a firm base and helps prevent intrusion of dirt, water and other foreign substances. The backing ring collar must have an interference fit on the axle shoulder and should not rotate by hand-pressure after bearing installation.

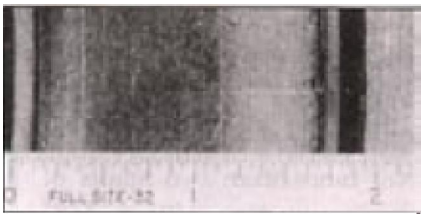
REJECTION OF CTRB DURING POH / IOH

Bearing should be rejected during refurbishing in the firm for following Defects/Damages in the presence of Railway representative

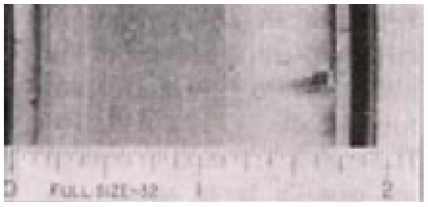
- **Stains, Dislocation and Water etching**: These are the three forms of surface damages.



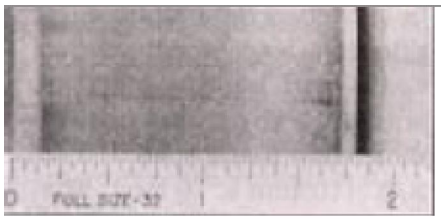
- **Brinelling:** Impressions in the roller paths of bearing cups or cones caused by the imbedding of rollers resulting from impact.



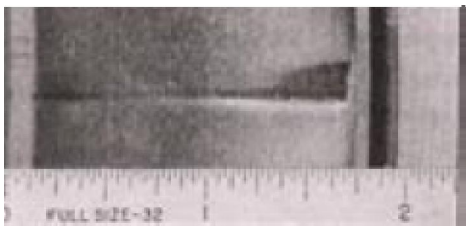
Acceptable Brinelling



Acceptable Brinelling

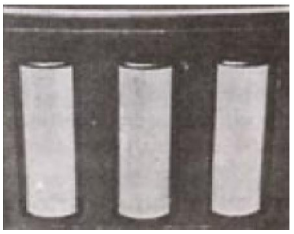


Acceptable Brinelling



Brinelling not acceptable

- **Spalling:** This is actually flaking of surface metals. Spalls larger than 9.5 mm x 3.2 mm are not allowable.
- **Peeling: Peeling** is just metal pickups. Peeling up to 0.025 mm deep is allowable.



Peeling-Acceptable

LIFE OF CTRB

Service life of these bearings is 30 lakhs Kms and the warranty period of new & refurbished bearing is 18 - 24 months.

REFURBISHING OF LHB BEARING:

Bearings should be refurbished after every 3 years or 12 Lakh Kms of running or whenever it is removed from axle journal for any reason.

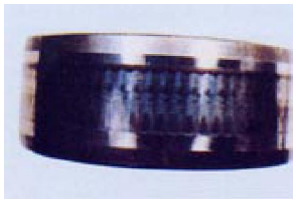
ONLINE CHECKS- BEARING DAMAGE

a. Monitor bearing temperature and compare with mate bearing on same axle and bearings on same coach. Any bearing with unusual high temperature should be suspect.
b. Check for looseness of front covers and also bottom strap of control arm.
c. Check for missing front cover screws and also screws holding top and bottom strap of control arms.
d. Check for displaced or cracked control arms.
e. Check for heat/burn marks on the control arm/covers.
f. Check for dislodged /open speed sensor cables.

Classification of Bearing damages and its Corrective measures.

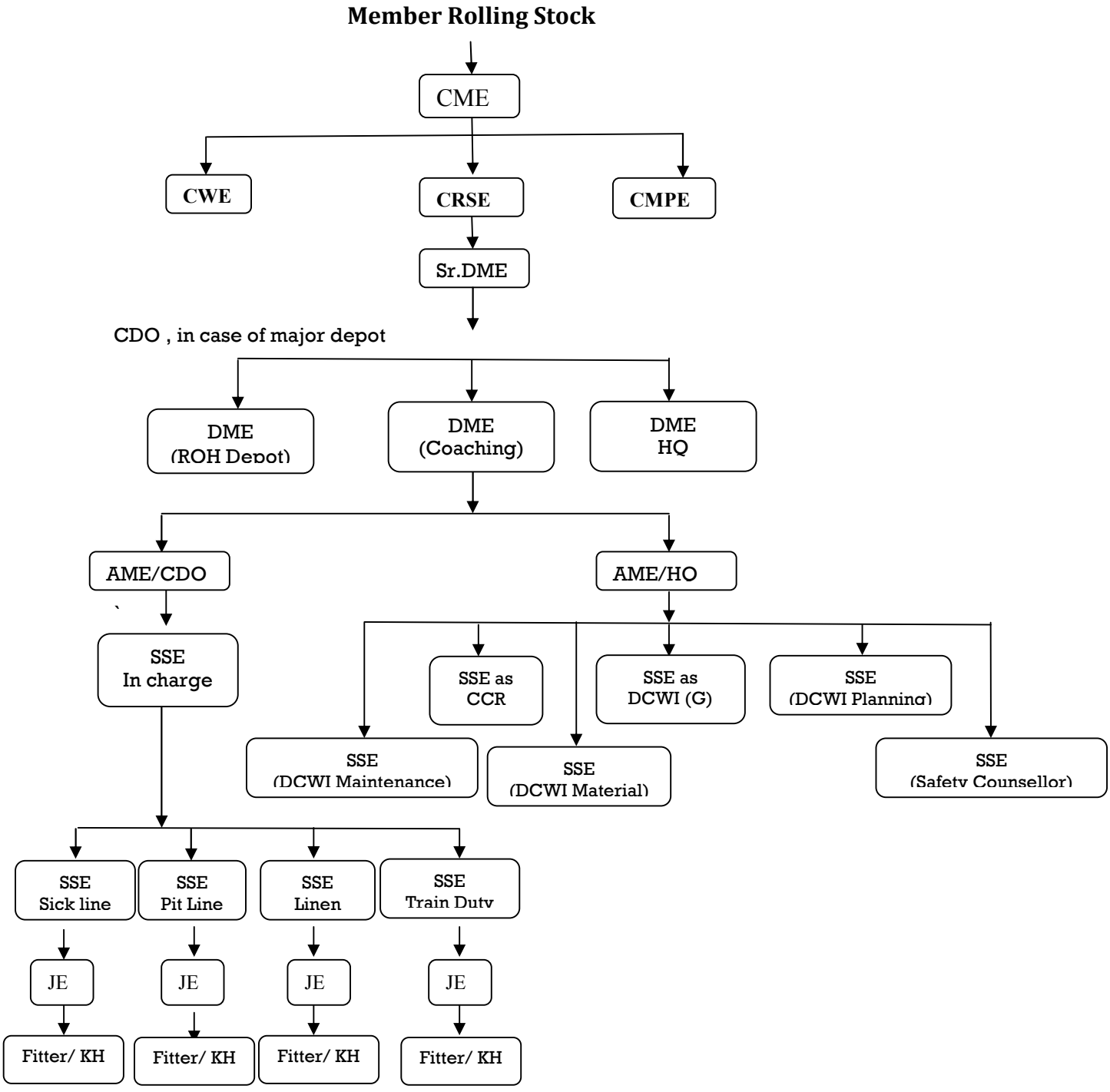
Condition	Causes	Corrective Measures
Rust and corrosion  Surface becomes partially or fully rusted. Sometimes rusted at spacing equal to distances between rolling element	• Improper storage • Improper packaging • Insufficient rust preventative oil • Invasion of moisture, acid etc. • Handling with bare hands	• Take measure to prevent rusting while in storage. • Improve sealing performance. • Improve method of assembly and handling. • Soak felt seal in worm oil before installation
Fretting  Fretting Surfaces wear producing red coloured particles that form hollows.	• Over size housing bore. • Insufficient interference • Insufficient lubrication • Fluctuating load • Vibration during transport or when not operating Conditions	• Use only those housing which have correct bore dia. • Improve fit • Check surface roughness of journal and housing • Check consistency of grease • Do not use worn out or damaged housings •
Flaking/ Spalling  Flakes form on the surfaces of the raceway and roller elements. When the flakes fall off, the surface becomes rough and uneven.	• Excessive loads, metal fatigue, improper handling. • Improper mounting. • Insufficient precision of journal or housing. • Insufficient clearance • Contamination. • Rusting. • Passing of electric current through bearing. • Softening due to abnormal temperature rise.	• Find the cause of heavy load. • Check internal clearance regularly. • Improve precision of journal and housing. • Improve operating conditions. • Improve method of assembly and handling. • Check grease and greasing method
Seizure  Bearing heats up, becomes discolored and eventually seizes up.	• Insufficient clearance (including clearances made smaller by local deformation) • Insufficient Grease. • Bad quality of grease. • Excessive load. • Roller Skewing. • Softening due to abnormal temperature rise. • Slippage of inner ring over journal due to failure of clamping arrangement.	• Check grease type and quantity. • Check internal clearance regularly. • Improve method of assembly and handling. • Use specified grade fasteners. • Apply specified torque.

Condition	Causes	Corrective Measures
Cracking  Splits and cracks in bearing rings and rollers	• Rapid heating during mounting. • Excessive shock load. • Improper handling, use of steel hammer and ingress of large foreign particles. • Surface deformation due to improper lubrication. • Excessive interference. • Over size housing bore and excessive ovality. • Large flaking. • Overheating due to creeping.	• Avoid rapid heating of bearing during mounting. • Reconsider operating condition. • Improve method of assembly and handling. • Prevention of creep • Do not use excessively worn out or deformed housing
Cage damage  Breaking or wear of cage.	• Excessive moment load. • Excessive fluctuation of speed. • Trapping of foreign objects. • Excessive vibration. • Improper mounting (misalignment)	• Investigate rigidity of system. • Reconsider operating conditions. • Improve method of assembly and handling. • Improve sealing efficiency. • Check for any grease contamination.
Rolling Path Skewing  Roller contact path in raceway surface strays or skews.	• Deformation or tilt of bearing due to insufficient precision of journal or housing. • Improper mounting. • Insufficient rigidity of journal and housing.	• Re-check internal clearance • Re-check precision of journal and housing. • Investigate rigidity of system.
Smearing and scuffing  Surface becomes rough with small deposits. “Scuffing” generally refers to roughness of the bearing ring ribs and roller end faces.	• Improper lubrication. • Ingress of foreign matter. • Rollers skew due to excessive misalignment. • Excessive surface roughness. • Excessive sliding of rolling elements.	• Check the quality/ quantity of grease. • Improve sealing performance. • Check operating conditions. • Improve method of assembly and handling. • Check for any grease contamination.

Condition	Causes	Corrective Measures
Indentations  Hollows in raceway surface produced by solid foreign objects trapped or impacts (False brinelling)	• Ingress of small solid foreign objects such as dirt, dust. • Trapping of flaked particles. • Impacts due to careless handling.	• Improve sealing performance. • Improvement in handling and mounting practices. • Check involved bearing for flaking if dents produced by metal practices. • Always use clean grease.
Electric Current Damages  Pits form on raceway and develop into ripples. Further development leads to corrugated surface. Sometimes spot or localized burns are also noticed.	• Electric current flowing through raceway.	• Create a bypass for current. • Insulate the bearing. • Follow proper instruction/ procedure for welding. Current must never be allowed to pass through bearing.
Discoloration  Change of raceways / roller colour	• Temper color by overheating. • Deposition of deteriorated grease on surface. • Improper lubrication.	• Use good quality of grease. • Replacement of grease after recommended Intervals. • Do not allow heating of bearing beyond 120^0C during mounting.
Peeling  Peeling is a cluster of very small spalls. Peeling can also include very small cracks which develop in to spalls.	• Ingress of foreign matter. • Improper lubrication.	• Control of surface roughness and dust. • Improve sealing performance. • Use only clean grease.

OVERVIEW OF C&W ORGANISATION

Organizational set up of Mechanical officers and Supervisors of C&W



This SSE (C&W) safety Counsellor is under the administrative control of the Divisional Safety Officers, but is responsible to Sr. DME (C&W) for all technical matters concerned with the safety of Rolling stocks.