

DESIGNING OF INTERIOR OF RAILWAY
COACH FOR LONG JOURNEYS

DIPLOMA PROJECT

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INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY
1974

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Designing of Interior Railway Coach for Long Journeys

Diploma Project

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Industrial Design Centre
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for Long Journeys

Diploma project

Submitted in partial fulfilment of the
requirements for the postgraduate diploma in
industrial design

by

P.K. Narain

Industrial Design Centre
Indian Institute of Technology
Bombay
1974

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Co-guide:

Shri U.A. Athavankar

Approval sheet

Diploma project entitled.

Interior of 3rd class Railway coach
for long journeys

by P.K. Narain is approved for the
postgraduate diploma in industrial design

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and my friends

PREFACE

"Designing of Interior of Railway Coach for Long Journeys" was undertaken as the diploma project in partial fulfilment of the requirements for the postgraduate diploma in industrial design. Even though the problem has immense practical and factual background, it could be treated only in a limited way due to the constraints of time and inadequacy of technical data.

There is scope for detailed study for further improvements to make the design appear more practical and feasible for adoption.

It is earnestly hoped that whatever little could be achieved within these constraints would commend itself to the examiners.

Contents

1. Problem statement
2. Introduction
3. Problem background
4. Information
5. Analysis
6. Hypothesis
7. Synthesis
8. Design decision and solution
9. Communication
10. Bibliography

1. PROBLEM STATEMENT

To design the 'Interior of 3rd class Railway coach for long Journeys', with the consideration of following constraints.

- No major change in the outer dimensions of shell.
- Railway standards should be followed as far as possible.
- Existing reservation system should be regarded suitably.
- Existing accommodation capacity should preferably be maintained.

2. INTRODUCTION

Transportation and travelling are the set of activities involved with the movement of passengers and goods into, out of, and within rural and urban areas. Travelling is an essential ingredient in the functioning of our society, which has the great variety of functions having social, cultural, political and military repercussions.

India being a vast country, has seven different zonal railways and all of them cover a long range of distances, requiring two or more nights for travel. Basically, however, the problem is lack of well-equipped transit system and availability of accommodation to the common people. Present system neither functions properly nor operate at the expected level.

Railways being the major source of revenue there exists a need for regional arrangements and planning to bring innovative improvements in moving people and goods within our technological capabilities.

3. PROBLEM BACKGROUND

A large percentage of population in India, travels by railroad. Present system of rail transportation has been observed for lack of accommodation and comforts to the passengers of 3rd class. Even the advanced reservation system has not been proved very fruitful in solving the problem of space availability to the majority class of people. In India, it is a need to perform long distant journeys by train, whereas it could be considered an alternative choice in other advanced countries. For long journeys, passengers seek a place to get in comfortably at the time of boarding the train and a space should preferably be available to them. Availability of seat might relieve them from their physical and mental stresses.

Existing movement pattern of passengers and their luggage need to be revised. A layout plan for compartments can be worked out to resolve entry, exit class points, and making the system more comfortable.

4. INFORMATION

4.1

Four main types of accommodation are existing on the broad gauge of Indian railways.

- Air-conditioned class

- First class

- Second class

- Third class

A proposal to convert present 3rd class into 2nd class is going to be introduced very shortly.

4.2

Categories of 3rd class accommodation.

- Ordinary 3rd class compartment

- 2-tier sitting-cum-sleeping compartment

- 3rd class break van and luggage compartment

A new double decker design is to be introduced shortly.

4.3

The latest datas are not available, however, following is the schedule of amenities provided by railway board as upto 1965 for various 3rd class categories:

S.No. Amenities	3rd : class	2-tier:	3-tier:	Break van
1. Sleeping capacity	-	24	75	-
2. Seating capacity	80	80	75	40
3. Doors aside	4	3	2	2
4. Lavs. aside	4	4	4	2
5. Pass./door	20	27	38	20
6. Pass./lav.	20	20	19	20
7. Seating arrangement	Trans.	Trans. & long.	Trans. & long.	Trans.
8. No.of fans	16	17	20	8
9. No.of fans per bay	2	2	2	2
10. No.of lights	22	19	24	12
11. No.of blue lights	-	4	6	-
12. Alarm pull	8	9	9	4

4.4

Other compartment fittings as prescribed are

- a) Roof ventilators in compartment and lavatory
- b) Notices
- c) Fixed ladder/notch
- d) Wash basin and water cock plug point (110V)
for sleeper compartments only.

4.5

Material for interior furnishing of couches.

- a) Partitions and side wall - Laminated plastics
panelling (Sunmica)
- b) Roof panelling - Limpet asbestos
or P.V.C.
- c) Flooring - Mag.oxychloride
- d) Seats and berths - Wooden planks
over a steel
underframe.

Only 2-tier berths are foam cushioned and covered with rexin.

- e) Luggage racks - Steel and timber

4.6 :

Toilet fittings and amenities as prescribed are

- a) Wash basin
- b) Towel rail
- c) Flushing pan
- d) Flushing wall protractor
- e) Lotah tap and shelf
- f) Commode rail
- g) Mirror and shelf

A minimum area of 1.45 sq.m. is prescribed, capacity of water tank per lavatory is 270 - 320 litres and number of passengers per lavatory shall be 20.

4.7

Dimensions of berths and seats as prescribed by railway board schedule of amenities.

- a) Min. hip width per passenger - 495 mm
- b) Min. depth of seat from face
of partition to the edge - 535 mm
- c) Min. depth of berth for sleep - 572 mm
from centre of partition to edge
- d) Height of seat - 405 mm
- e) Min. knee room - 535 mm
- f) Min. height of upper bunk - 1250 mm
from the seat
- g) Min. clear space below seat - 305 mm

Pull-out type lower berths for longitudinal arrangements and folding 'backrest-cum-bed' type lower berth for the transverse arrangement are being used for 3-tier sleeping compartments.

Two luggage racks over the lower bunk in ordinary 3rd class, one immediately above the lower bunk suitable for lying down and the upper most rack suitable for light luggage only.

4.8

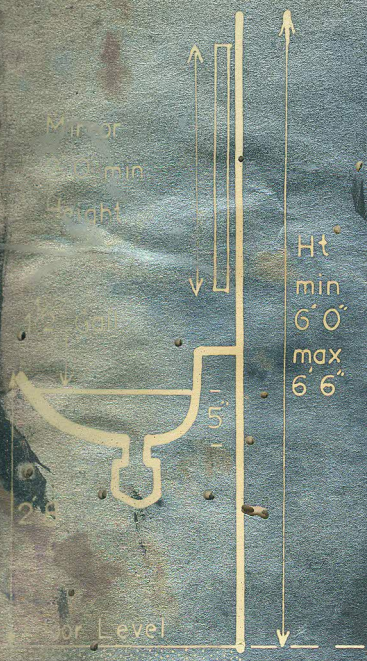
Dimensions of toilet fittings

- a) Width of flushing pan - 578 mm .
- b) Side clearance - 422 mm
- c) Distance between wall - 355 mm
protractor & centre of lav.
chute.

4.9

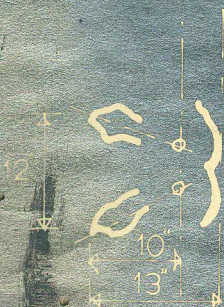
An average weight of a person is taken 63.5 kgs and it's 40% is considered as luggage weight.

ANTHROPOMETRIC DATA OF TOILETS



The wash basin

Average body dimensions male female for lav pans





General observations

- It has been observed that ordinary 3rd class compartments are generally overcrowded, and public is, therefore, attracted towards 2-tier and 3-tier compartments.
- Worst effected is 2-tier because of the chances of getting available seats, which creates a feeling of insecurity amongst the genuine passengers.
- The 3-tier is found comparatively more secure and attractive for the passengers which is entirely for sleeping minimum for one night.
- Narrow corridor space is the cause of clash between passengers and luggage in 2 & 3-tier compartments, at the time of boarding the train specially when four or more people accompany a single person to see him off.
- Middle bunk of 3-tier compartment causes unrest to the passengers of lower berth, as its height above the lower seat is very less.
- Due to lack of ventilation, suffocation is caused to the passengers specially in summer.
- Fans and light points are provided as per bay and are not to the individual requirements.





- Storing the luggage becomes a problem right from the time of boarding the train as no special space is provided for that in 3-tier compartments.



- The luggage racks provided in 2-tier compartments are mostly misused for sleeping by unreserved passengers and some times by staff.

5. ANALYSIS

5.1 Structural analysis

5.1.1

Seats and berths are called bunks in sleepers. Bunks consist of steel underframe, and timber planks on top. The 2-tier bunks are foam cushioned. Steel underframe is for strength, and wooden planks are providing a uniform surface and foam cushioned bunks provide better comforts against jerks.

5.1.2

Luggage racks are steel frames with steel bars or wooden strips. Wooden strips need more detailing like screws, nuts, etc. Luggage racks provided in ordinary 3rd class over transverse seats, are used as sleeping planks by passengers. Longitudnal luggage racks are provided over single seats.

5.1.3

In old couches ply was used for side wall panelling, which has more chances of fire catching. Laminated plastics are used in new couches which are good in appearance and permit easy maintenance.

5.1.4

Limpet asbestos was generally used for roof panelling but P.V.C. has started replacing that. It is easy for maintenance but an extra note 'Not to be painted' has to be provided.

5.1.5

Traditionally Mag. oxychloride plaster is provided for floor finish over compressed cork and wooden fibres mixed with tar. This floor finish develops cracks easily and is liable to decay soon, resulting the visibility of lower layer. It doesn't provide any uniform appearance, and sweeping doesn't make it completely clean.

5.1.6

Doors are heavy and equal to side walls in section, they are openable inside and the opening size is 782 mm.

Windows are provided with bars from outside for sleeper compartments. One sliding louvre and one glass with minimum two stops is provided. Louvres are of aluminium to protect against sun, and glass to protect against wind, drizzling, etc. Glass shutters are invariably inside.

5.1.7

Sixteen light points of minimum 840 mm lux above the floor, are prescribed in each compartment. Holder take is fitted to ceiling with reflector around it and covered with a bowl shape transparent glass.

Size of the fans in compartment is 400 mm.

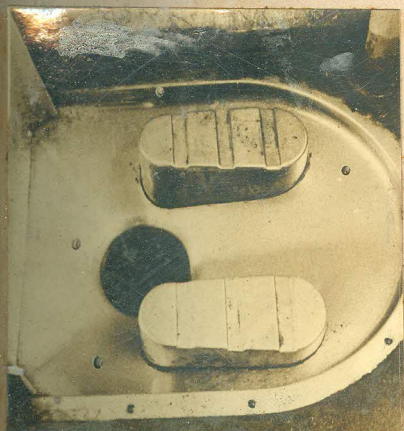
No fan is provided in the lavatory. Switches for lights and fans are provided on each side wall of the compartment.

5.1.8

Lavatory pans and wall protractors behind them, are made up of stainless steel.

Aluminium has been used for trial only in wall protractors because the lav. pans are load bearing members.

Wash basins are either of steel or aluminium, with an outlet at the bottom and tap fitted above it. A few latest coaches are having FRP wash basins also.





5.2. Functional analysis

5.2.1

Seats and berths are not flexible according to the variable requirements of comforts.

Keeping the legs on the opposite seat, squatting and leaning are very common postures of Indian sitting behaviour. Present design of seats

doesn't allow to change the postures frequently. Adjustable head-rests and arm-rests are not provided which are essential for long journey seats.

In case of 3-tier compartments, height of middle bunk is very less above the lower seat.

5.2.2

Luggage racks above transverse berths are not fixed suitably and obstruct the space for sitting.

5.2.3

Width of door openings is 782 mm which is less and is not suitable to give easy access to the passengers and their luggage. Hinged and inside openable doors occupy extra space and need a wall-rest.

Size of windows is fixed as 610 mm which is less for proper outside view and ventilation.



5.2.4

Lights are fitted to corridor space and in the compartments which are hurting to the eyes of passengers during sleep.

Fans are fitted at particular angles and provide ventilation at particular points.

Switch boards are generally provided inside the inner panelling and have been observed exposing their wires and fuses outside. They are easily removable also.

5.2.5

Following drawbacks have been observed in the functioning of lavatory pans.

- 1. In case of improper use water is unable to flush the waste out.
- 2. Flushing is from one side only and not throughout the circumference of the pan.
- 3. It's use is for more than one purpose which makes the pan more dirty and gives bad smell.
- 4. Tap is supposed to be pressed with one hand and other hand is used for taking water. In actual practice it is not so.
- 5. Hand grip is not always on the right hand side.

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- 7 . Because of movement of the train enough water is scattered around in the use of wash basin.

Actual

- . Standard dimensions are not followed in the fixing of wash basins.

Ergonomic

5.2.6

Mag. oxychloride flooring is rough textured, sweeping is not sufficient to clean it well. It absorbs water which might cause corrosion to the underframe.

*Hygienic
maintenance
(cleaning)
Safety
structural*

5.3 Ergonomical analysis

5.3.1

Dimensional seat proportions adopted by British Railways are shown in fig.

Back-rest is adjusted at an angle of 105° and nicely contoured according to thoracic region.

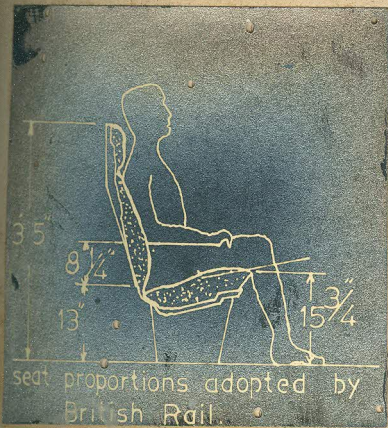
5.3.2

Following body dimensions of seats and berths are prescribed by railway board.

Min. hip width	- 495 mm
Min. depth of seat from partition to the edge	- 535 mm
Min. depth of berth for sleeping from centre of partition to the edge	- 572 mm
Height of seat	- 405 mm
Min. clear space below seat	- 305 mm

5.3.3

Squatting is very common in Indian sitting habits, which requires a lesser seat height for frequent changes in postures.



5.3.4

People tend to change postures in order to be at ease, present furniture design is not flexible enough to allow more changes in posture. Angle of back-rest from the seat is 100° which is less for a comfortable posture.

5.3.5

Uncushioned seats and berths do not protect the body against jerks.

5.3.6

No head-rest is provided separately and people in sleep are falling to their sides.

5.3.7

Major points of consideration in ergonomics of lav. pans.

- . Dimensions of lav. pan are more than required and hence need more toilet area.
- . Dimensions are not to the standards, that makes its use more inconvenient while the train is in motion. *Standards*
- . Posture required for using lav. pan doesn't suit to all passengers specially to the old people. *Functional Ergonomics*
- . The slope of lav. pan is not sufficient to keep the waste out. *Functional Ergonomics*
- . Side tap is very hard to press which requires the involvement of both hands. *Structural Functional*

5.4 Visual analysis

5.4.1

Seats and berths are of straight wooden planks, uncushioned and roughly painted, which gives a rigid and uncomfortable feeling. Edges are not very sharp but they are prominently visible.

In sleeper compartments planks are painted yellow, light blue or light green, whereas in ordinary 3rd class they are left in wooden texture only.

Colour of furniture and side walls is generally kept same which makes the inner environment monotonous.

5.4.2

For side wall panelling, most of the design in laminated plastics do not give a uniform appearance. Laminates used for partition are dark coloured, light absorbing, and do not illuminate the compartment.

5.4.3

Roof finishing is of PVC white painted, which is required for good illumination during day and night.

6. HYPOTHESIS

6.1 Structural

6.1.1

Structure of furniture should be simplified to avoid unnecessary detailing operations.

6.1.2

Luggage racks should be of single material for easier fabrication.

6.1.3.

Doors and windows should be spring loaded and light in structure. A wire mesh should be provided with shutters for preventing heavy dust particles.

6.1.4

Flooring in corridor space should be rough textured and sound absorbing. A proper outlet for water is essential.

6.1.5

All electrical fixtures should be concealed.

6.1.6

Lav. pans and wash basins should be strong and of lighter material. Pans should be able to keep the waste and water away from the surface.

6.2 Functional

6.2.1

Flexibility of furniture is required for comfort adjustments of passengers. Additional fixtures should be provided to the furniture for a multi use in various conditions.

6.2.2

For sleeping accommodation 2-tier arrangement should be followed which provides better comforts.

6.2.3

Door and window openings should be more wide for proper ventilation, easy access of passengers and their luggage.

6.2.4

For better visibility indirect, incandescent lights should be provided.

6.2.5

Fans should be revolving type for uniform ventilation.

6.2.6

In the design of lav. pans and wash basin, standard anthropometric dimensions should be followed.

6.2.7

Lav. pans should be of Indian style W.C. of steep slope, for clearance. Wall hung wash basin of concealed outlet shall occupy a lesser space.



6.3 Ergonomical

6.3.1

A lesser height of seat should be provided in order to change the postures easily according to optimum comfort.

6.3.2

All seats should be provided with adjustable head and arm rests.

6.3.3

Berths and seats should preferably be cushioned for minimising the jerks.

6.4 Visual

6.4.1

All sharp edges and corners of furniture should be provided with suitable curvatures.

6.4.2

Bright colours should be used for furniture.

6.4.3

Roof and side wall panelling should be painted suitably in light colours for distributing uniform illumination.

7. SYNTHESIS

7.1 Layout and interior arrangement

7.1.1

The new layout should provide more flexibility and accommodation capacity should be increased. Increased capacity will accommodate passengers on waiting list as per provision of reservation system.

7.1.2

The new design of double decker should be adopted and existing standards are to be maintained.

7.1.3

Sleeping accommodation may be limited, but seating capacity should be increased and hence more number of seats should be provided.

7.2 Furniture and fixtures

7.2.1

The basic form of furniture should be according to physiological functions and needs of passengers, the shape should be attractive and in proportion to standard sizes, with bright colours and soft texture.

7.2.2

Folding type berths and seats are to be provided for better flexibility. Other fixtures should be prominent against the light colours of panelling.

7.3 Toilets

7.3.1

A toilet space should sufficiently be minimum for accommodating one lav. pan and a wall hung type, concealed wash basin.

7.3.2

One additional toilet space for sleeper class is to be provided.

7.3.3

A changing-cum-dressing room is required to minimise the queue in toilets.

7.4 Doors and windows

7.4.1

- All doors should be sliding type
- Main doors and windows should be spring loaded and easily operating.
- A normal door opening should be between 1000 to 1400 mm.
- A normal window opening should be between 550 to 1000 mm.

7.5 Materials

Following plastic materials could be used for railway compartments :

a) Thermoplastic resins

- P.V.C. - flooring and roofing.
- Polyvinylidene chloride - roller blinds on windows.
- Polyvinyle alchohol - seat coverings and berths.
- Polymethyle methacrylate - plates are used for electric lamps and name plates.
- Polystyrene - plates for lamp gloves, foams for heat insulation.
- Polyamide (nylon) - mouldings for door sheaves of sliding doors, fibres for seat coverings.
- Cellulose acetate - coated steel pipes are used as horizontal bars of baggage racks, and hand holds, arm rest (injection moulded with steel core).
- Polycarbonate - grill of air exhaust, ceiling, arm rest.
- Polyurethane foam - cushions, sound absorband.

b) Thermosetting resins

- Phenol resin - moulding made with paper cloth, armatures, etc.
- Urea resin - flaps of lavatory pedestals, paper towel holders, hand traps, sockets of fluorescent lamps, small parts.
- Melamine resin - laminated aluminium decorated sheets used on inside walls, where non-inflamability is required. Walls of toilets for waterproof quality.
- Alkyde resin - painting material on exterior.
- Polyester resin - insulated roof sheets, polyester film, lined on the back side with aluminium by vacuum evaporation, lace window curtains.

c) F.R.P.

- Roof ventilator
- Wash basins
- Water and fuel tanks

8. DESIGN DECISION AND SOLUTION

The study revealed that main emphasis in the design of interiors of 3rd class railway coach should be placed on, apart from technical aspect, the comfort and convenience of the passengers.

The suggested solution consists of three main parts, viz. interior arrangement and layout, a folding type seat and toilets. Other suggestions regarding the size and shape of interior fixtures, doors and windows are also been made in the solution.

Because of high invested cost of about Rs.3.5 lakhs, new suggestions won't cause much variations to its economy.

The changes envisaged in the new design are as follows :

1. Layout and interior arrangement.

In order to accommodate more passengers, the structure of shell has been chosen as that of a double decker compartment. Keeping the entrance level at the same position, space available between the two boggies has been lowered to provide two decks. The lower deck is for sleeping accommodation, having a 2-tier type arrangement. An additional toilet-cum-changing room is provided within this sleeper.

Upper deck is entirely for seating accommodation with luggage storing space above the seats.

Seats are specially designed, folding type to allow frequent changes in postures during the journey. All seats are facing towards the same direction and hence a minimum knee room is

required for sitting. For easy access and

movement the corridor space is increased upto 600 mm which is 100 mm more than the existing space. Two separate intermediate compartments above each bogie having W.Cs. and entrance vestibules are provided for seating. Luggage storing is on overhead longitudinal racks and below the seats.

Window width of lower deck is 915 mm and upper deck is 500 mm. Lower windows are break up into two glass panes of which upper is sliding over the lower one and lower is fixed inside invariably to avoid any splash from the platform. Two pairs of sliding doors on each side, having an opening of 1200 mms are provided.

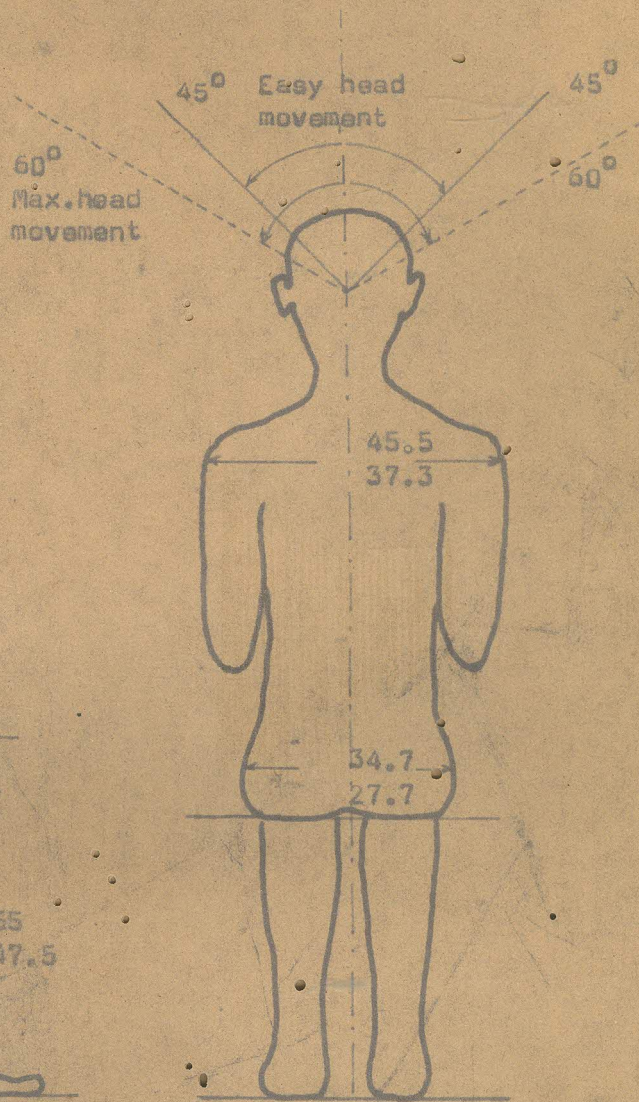
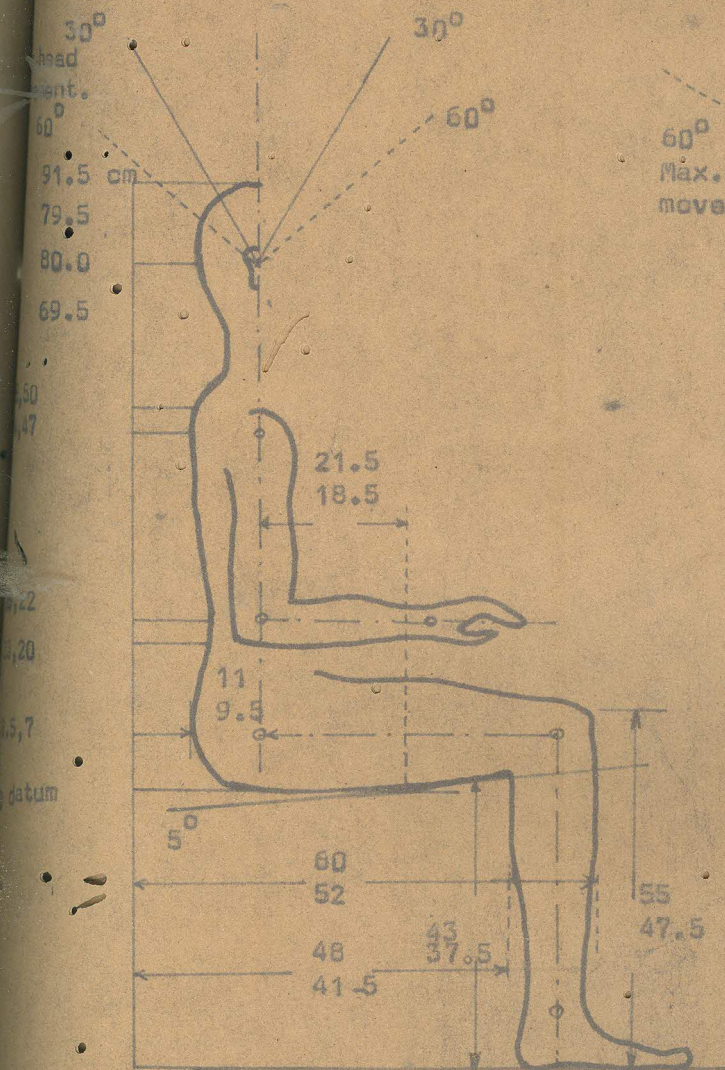
2. Folding type seats for upper deck

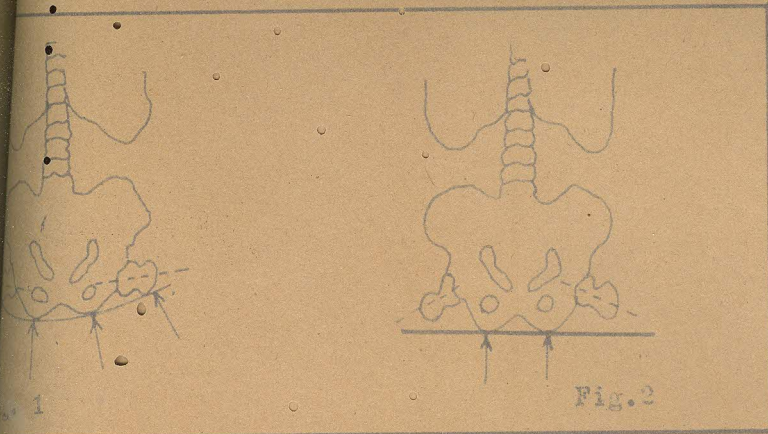
The seats are of FRP having adjustable folding type head rests. The rests can be brought forward for using as a tablet or tea table.

It will also enable various comfortable sleeping postures. The head rest can be taken back to its original position in order to relax against

Anthropometric data of Indian adult men at sitting posture.

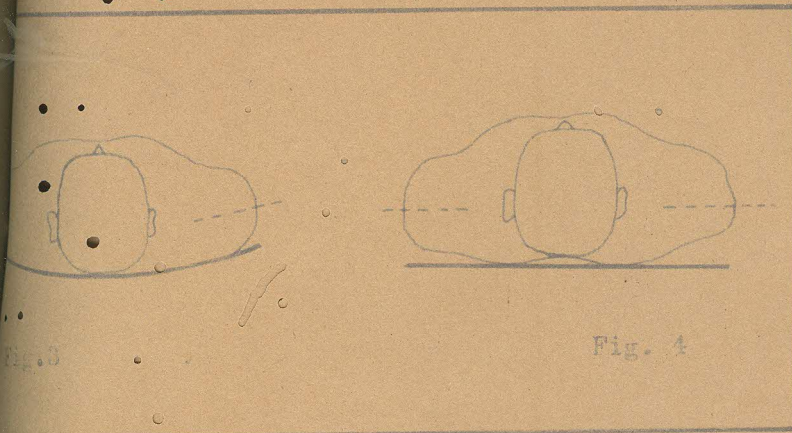
Easy head movement





L.H. Figure.

A very soft seat will cause fatigue by placing pressure on thigh joints and other areas (Fig. 1). A flat firm seat (Fig. 2) allows weight to be concentrated on the two bony joints of the pelvis.



L.H. Figure.

The shoulders should rest against reasonably flat surface (Fig. 4). If the back is too concave (Fig. 3), the shoulders will be rolled inward, this compresses the lungs and impairs breathing efficiency, thereby causing fatigue.

Figure.

Seat should be placed so that elbows can support some of weight of the upper body (Fig. 5). If they are too low (6) or too far apart (7) the passenger will have trouble. If they are too high (8) the shoulders should be slumped.

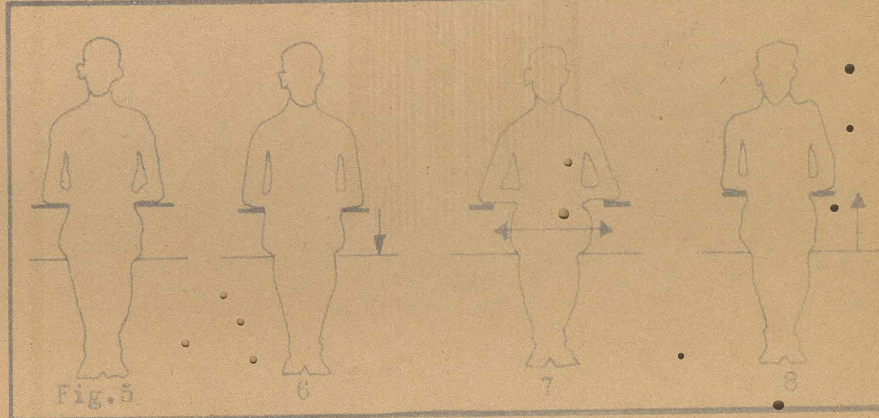
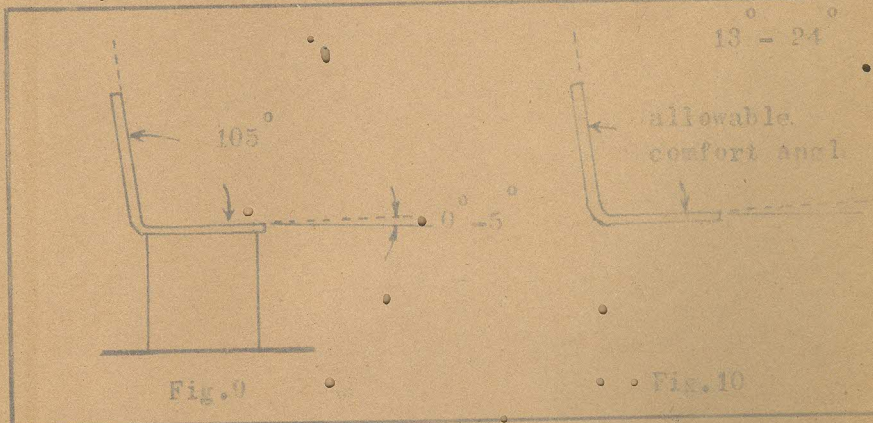


Figure.

Fig. 9 shows the conventional straight chair.

Fig. 10 shows the minimum and maximum comfort angles for a chair.



back completely. The back rest is contoured according to average thoracic region of passengers. The seat can be slid forward for relaxing.

3. Toilets

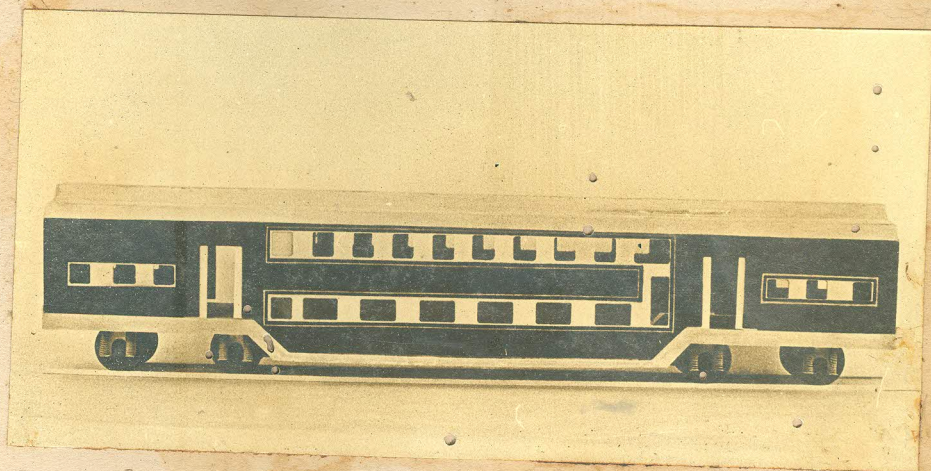
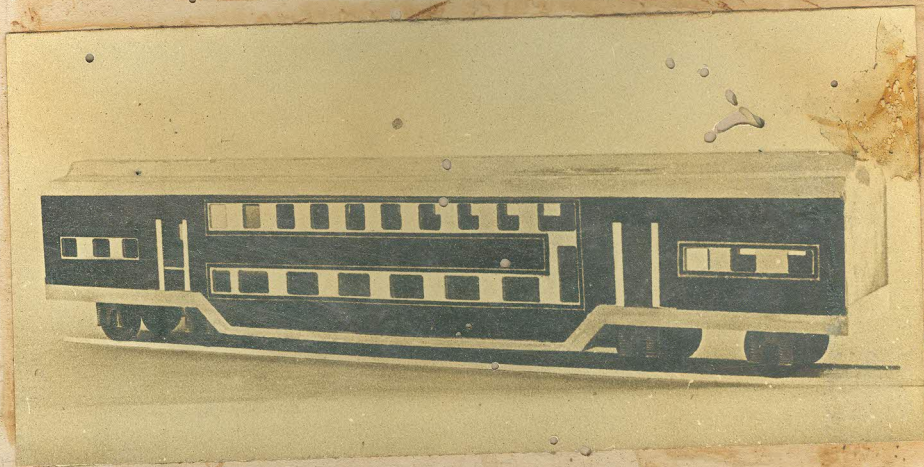
Four toilet spaces are provided at the extremities of compartment. Two spaces are having specially designed lav. pans and wash basins, while the other two are to be used as changing and dressing rooms. The hand grip in lav. spaces is invariably on right hand side which also operates a lever for tap water. The lav. pan platform is raised from the floor and properly sloped to avoid the water splash inside the lavatory. An additional hinged seat of FRP is provided over the lav. pan which can be folded against the wall. This shall be useful for old people. Cloth hangers are to be provided on sliding door which will act as locking latch.

4. Materials

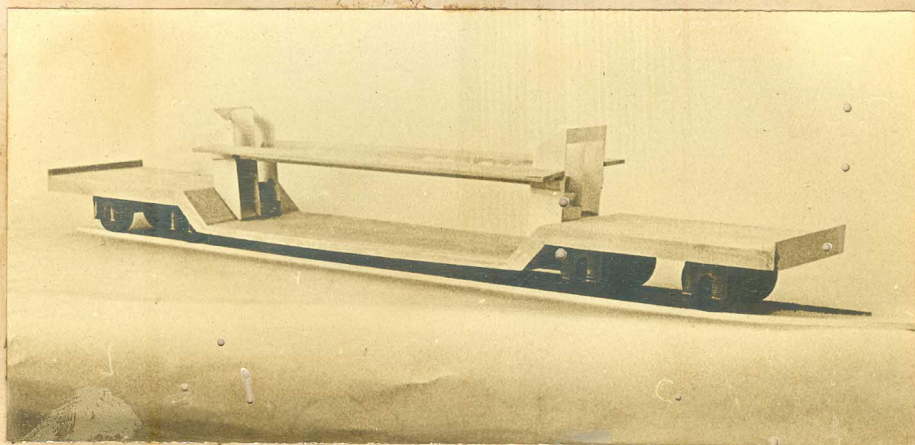
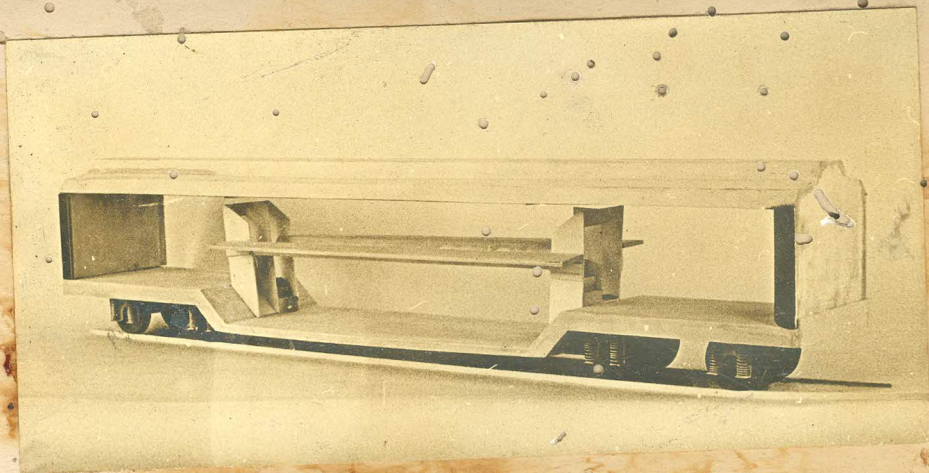
- i) Melamine resin coated laminated plastic sheets are used for inside panelling with foam polystyrene and glass wool for heat insulation.
- ii) P.V.C. is used for flooring and roofing.
- iii) Timber frames covered with nylon moquettes are to be used for berth coverings. The berths will be cushioned with polyurethane foam.
Seats are of F.R.P., foam cushioned with rexin cover.
- iv) Rigid P.V.C. will be used for window sash.
- v) Urea resin will be used for various toilet fixtures like towel rail holders, hand traps etc.

9. COMMUNICATION

- . Photographs
- . Drawings



I. D. C. Library
L. L. T. Bombay.



10. BIBLIOGRAPHY

1. International Railways Journal, 1971
2. International Railways Journal, 1972
3. Industrial Design, 1971
4. Ergonomics, Part I, 1967