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## Indian Railways Passenger Coaches: Safety Features and Technologies Adopted

**Dr. Suresh D. Mane**

Assistant Divisional Mechanical Engineer (Rtd.),

Principal, Girijabai Sail Institute of Technology, Karwar, Karnataka, India

*ABSTRACT: Indian Railways (IR) is the lifeline of transportation in India. Post independence IR tied up with Swiss Car and Elevator Company for transfer of technology to manufacture steel bodied passenger coaches and thus the Integral Coach Factory was established at Perambur, Chennai. These coaches are termed ICF coaches and have two ICF bogies each. The maximum tare of these coaches is 50 tones and the maximum speed potential is 140 kmph. Due to the need for new technology state of art coach technology was procured from Alsthom LHB of Germany in 2000 and the production of these coaches is on the rise. Both the ICF coaches and the LHB coaches are rendering reliable service to the nation and have many a safety features incorporated. The design of ICF coaches has been evolved over the year which has incorporated features to enhance the speed potential. The layout has been reviewed and the toilets which were earlier located in the mid span have now been moved to the ends. The coaches are anti telescopic and have crump le zones to provide safety to the passengers during accidents. ICF coaches have mechanical features whereas the Alsthom LHB have electronic features added to the mechanical features. This paper provides a fair comparison between the two technologies adopted and also illustrates the various safety features and technologies used by the passenger coaches over IR.*

**Keywords: Indian Railways, Passenger Coaches, ICF Coach, LHB Coach, Safety features**

### INTRODUCTION

Earliest coaches in England were wooden coaches which consisted of open trucks mounted on wooden under frames, in which passengers used to travel, exposed to weather. Coaches were chained together loosely and ran into each other when the train stopped; giving serious knocks to the passengers. Benches, lighting, toilets were absent in the earlier coaches and the brakes had to be applied by hand which can be seen even today in Darjeeling Himalayan Railway. In India the earlier coaches were wooden bodied ones with vacuum brakes. In 1949 all steel coaches were standardized by the Railway Board. Integral design coaches were initially imported from Switzerland and later were produced in India at Integral Coach Factory, Perambur in Madras (Chennai). These integral coaches had the under frame and the body welded together and were light in weight. Helical coil springs and roller bearing axles with hydraulic dash pots and rubber pads were new introductions which improved the ride quality.

In late 90's IR entered into contract with Linke Hofmann Busch (LHB) Germany and purchased 24 broad gauge AC Chair Car coaches. Rail Coach Factory (RCF) started manufacturing these LHB coaches from 2001 and the first indigenous LHB coach was rolled out in Dec 2002. Since 2009-10 RCF is manufacturing only LHB coaches and so far has manufactured more than thousand LHB coaches.

IR follows multi pronged approach with focus on new technologies, mechanization of maintenance, early detection of flaws; reduce human dependence, up gradation of skills of its human resource. IR conducts Railway Safety Audits both internal and inter railway wherein multi disciplinary teams of zonal railways conduct regular audits. To avoid accidents and improve safety performance, training facilities for drivers, guards and staff are provided and IR has set up dedicated training facilities for the staffs at all levels. New technologies such as Train Protection Warning System, Anti Collision Devices (ACD), and Modified ACD have been provided on 1736 route km. These technologies are having improved efficiency, reliability and availability.

IR understands the importance of loco pilots in running the trains safely. Hence it has elaborate training programmes to ensure that the loco pilot is trained well initially and periodically to discharge his duties properly. Medical examination is undertaken at regular intervals which include strict vision test to check for night vision and colour blindness at its own hospitals spread over all its divisions.

Maintenance practices are also undertaken meticulously by all the railway workshops to maintain the coaches as per laid down schedule. Proper written communications are available about the dimensions and the deviations allowed. Proper training is provided for the maintenance personnel in undertaking the maintenance practices as per laid down standards.

Third party inspection is also adopted to ensure proper maintenance standards are maintained by all the workshops.

Manufacturing of the critical components and the final assembly and testing of coaches is undertaken by IR at its own manufacturing plants. This ensures that the coaches manufacture comply with the strict regulations and meet the confirming standards. Proper testing facilities like destructive and non destructive testing is undertaken for all the components whether manufactured in house or procured from outside sources.

1.1. ICF COACHES: ICF Chennai plant was built in 1955 which started manufacturing coaches of ICF design provided by the Swiss Car and Elevator Company, Switzerland. The design concept of the ICF coach stipulates that the roof, side wall, end wall and the under frame are joined together by welding, to form a fully integral coach shell. From the basic design handed down by the collaborators, ICF has diversified having established its expertise and skill in this field, to design and manufacture more than 350 different types of coaches for Indian Railways and export market. Every time a new type of coach is launched, emphasis is laid on improving passenger comfort, passenger safety and higher speeds. ICF follows standard inspection procedures to ensure quality from raw material stage to the finished coach. In 2015 the 50,000<sup>th</sup> coach built was rolled out from ICF Chennai. This is a testimony to the reliability of the ICF built coaches which are in service. The codal life as per IR finance code of ICF design coaches is 25 years and based on the condition it's either used for departmental use or scrapped and sold out by auction. RCF Kapurthala too started in 1995 has produced more than 25,000 coaches by 2015 in various configurations.



**Fig 1. ICF Bogie**

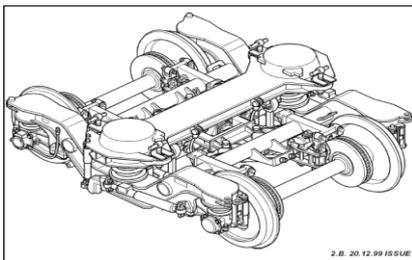


**Fig. 2 LHB Bogie**

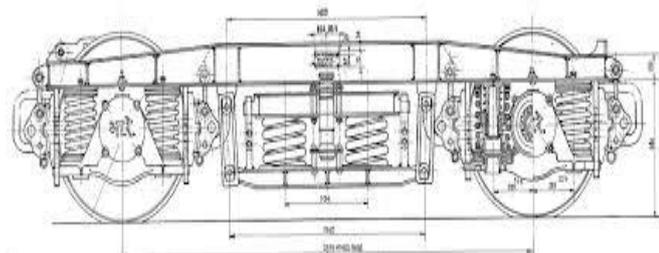
1.2 LHB COACHES: In 1995, after a global selection process, Alstom-LHB received the order from Indian Railways to design and develop a new passenger coach under a transfer of technology agreement. These coaches are basically broad gauge coaches and are in service for the past 15 years. They were initially manufactured at RCF and of late ICF Chennai too has started manufacturing these coaches. The new coach manufacturing facility at Rae Bareilly is undertaking manufacturing LHB coaches. In 1998 the company was renamed Alstom LHB GmbH after it was taken over by Alstom. LHB coach is light weight construction made from low corrosive stainless steel. The weight of the coach is about 10 percent less as compared to the conventional coach resulting into lower haulage cost. The modular construction and the integration of lights into interior ceiling and luggage racks are characteristics features of modern interior design. The car body

shell is of economical weight steel construction with interlocking technique developed by M/s Alstom. Roof is of beaded sheet construction and floor sheet is corrugated made of austenitic stainless steel. Roof structure, side wall and end wall are made of ferritic stainless steel. IRSM-41 CORTEN steel has been used for under frame and other parts. These coaches were initially introduced in prestigious trains such as Rajdhani Express, Shatabdi Express and now being introduced in Duronto Express and other premium trains. The coaches are made out of stainless steel exterior and have aluminium interiors to reduce weight and are lighter than ICF coaches. The coaches are 23.5 m long and 3.24 m wide and have higher carrying capacity compared to ICF design coaches. The operating speed is 160 kmph and can be enhanced to 200 kmph. The coaches are state of art coaches with introduction of microcontrollers and electronic circuitry which were not present in ICF coaches.

**1.3 DESIGN CONSIDERATIONS:** Both the type of coaches have bogie type design and the body of the coach rests on the two bogies. The bogies have primary suspension as well as secondary suspension with coil springs. Suspension: Both the coach design involves primary and secondary suspension. The weight transfer of the body is through the bolster and secondary suspension to the rails via the primary suspension. Earlier ICF design included leaf springs which have now been replaced with helical coil springs. Due to the designs the ride index of ICF coaches is 2.6 at 140 kmph in vertical modes and 3.5 in lateral modes. LHB coaches have 2.5 but not exceeding 2.75 ride index both in vertical & lateral modes.



**Fig. 3 LHB (FIAT) Bogie**



**Fig. 4 ICF Bogie**

**Bogie design:** ICF bogie has box type design with headstock. LHB bogie is FIAT bogie with Y frame without headstock. ICF wheelbase is nearly 2900 mm and is longer than the FIAT bogie wheelbase of 2560 mm. ICF bogies are fitted with spherical roller bearings whereas the FIAT bogie has cartridge bearings which are more reliable and require lesser maintenance. Rigid joint exists between the ICF bogie frame and the axle whereas in FIAT bogie the joint is articulated by a control arm. In FIAT bogies the secondary suspension springs are directly mounted on the frames whereas we find hangers in ICF bogies. Anti roll bar is provided in FIAT bogies and this feature is not available on ICF coaches. A torsion bar having two forks is provided between bogie frame transverse beam with the help of two links to resist rolling motion of LHB coach.

#### 1.4 SAFETY FEATURES:

The coach design includes safety features to ensure reduced impact on the passengers during untoward accidents. The design features include the coach body and the coach interiors. The various safety features are as follows.

1. Anti telescopic construction
2. Crumple zones
3. Fire retardant materials: Upholstery
4. Emergency Windows
5. Couplers
6. Injury free interior features
7. Bogie Design

8. Brakes

9. Wheel slip protection

1.4.1 Anti telescopic feature: The end-wall construction has been made especially strong to make it anti-telescopic to ensure maximum safety to passengers. The end walls have been provided with box section stanchions which absorb the impact energy and deform and thus do not allow the coaches to get into one another during heavy impact accidents

1.4.2 Crumple zone (also called crush space) is a structural feature in rail coaches which is mainly used in automobiles. Crumple zones are designed to absorb the kinetic energy from the impact during a collision by controlled deformation. In the coaches the layout design of the toilets are reengineered and placed at the ends to deform during accidents. Earlier designs had toilets even in the centre of the coach which has since been discontinued. The under frame near the end walls below the toilets contains pipe structures which deform and absorb the impact energy during collisions.

1.4.3 Fire Safety in coaches: IR is continuously enhancing fire worthiness of coaches by using more fire retardant furnishing materials such as Compreg Board/PVC for coach flooring, laminated sheets for roof, ceiling wall & partition paneling, fire retardant rexene (Vinyl coated fabric) and cushioning material (Densified Thermal Bonded Polyester block) for seats and berths, FRP windows and UIC vestibules. IR is periodically upgrading specifications to incorporate the fire retardant parameters in line with UIC/other international norms. ICF and RCG where the new coaches are built ensures that furnishing is being carried out with fire retardant specifications of the furnishing materials.

A pilot project for provision of Comprehensive Fire and Smoke Detection System has been taken up in one rake of Rajdhani Express on East Coast Railway. Portable fire extinguishers are provided in all the Guard vans, AC coaches and Pantry Cars in all trains to cater for emergencies due to fire accidents. Improved materials for electrical fittings and fixtures such as MCB, light fittings, terminal boards, connectors, etc., are being used progressively.

1.4.4 Vehicle Evacuation: Both ICF and LHB coaches have emergency window provision on either side walls for evacuation of passengers during accidents. The LHB coach emergency windows are wider in size and also easy to open thus permitting improved vehicle evacuation. The emergency window markings are made prominently in type of coaches. Four units are provided in each coach to allow emergency evacuation of passenger in LHB coaches. A handle is connected to the rubber profile to open the glass unit of the emergency window. The breakage of glass unit while opening is prevented by a restraining chain.

1.4.5 Couplers: Presently the ICF design coaches have screw couplings. The screw couplings too have been redesigned and the diameter of the screw has been enhanced from safety point of view. Central buffer couplers (CBC) have been introduced in LHB coaches to minimize impact on passengers during accidents/derailments. These CBC are vertically interlocked.

1.4.6 Anti Injury free features: ICF has introduced various injury free features in its coaches to ensure that the passengers to do get hurt in coach while travelling. The following are the injury free features introduced.

- All the soap holders in toilets and near wash basins have been converted into sunken type from projecting type.
- Mirror frame corners rounded off.
- Seats and berths corners rounded off.
- Fans protective cage flat ribs changed to round section ribs to avoid head injury
- Luggage hooks made out of wire rope
- Bottle holders changed from steel ones to nylon ones
- Bottle holders changed from fixed type to collapsible type
- Coat hooks changed from fixed ones to swiveling ones.
- Tray corners rounded off and made collapsible
- Side lower berth joining latch made flat to avoid projection

1.4.8 Brakes: Earlier hand brakes were introduced followed by vacuum brakes. IR has dispensed with vacuum brakes and now all the coaches are fitted with air brakes i.e. pneumatic brakes which are very effective even with higher speeds and higher loads. The blue colour on present day coaches indicates air brake. Earlier red colored coaches signified vacuum brake coaches. LHB coaches are provided with advanced pneumatic disc brakes for efficient braking at high speeds. Clasp type tread brake are available on ICF bogies which result in tread wear during braking and axle mounted disc brakes are provided on FIAT bogies.

1.4.9 Wheel slip protection: LHB coaches have speed sensor for all the wheels and any variation in the wheel rpm is recorded in the microcontroller which allows for brake application/ release as need be to ensure that the brake binding or wheel slip is avoided.

## CONCLUSION

ICF coaches have been serving the railways since 1955 and have proved themselves beyond doubt. Due to advancements in technologies and higher aspirations of travelling public for speed, safety and comfort, IR has adopted LHB design and now is all set to continue with this design in all its coach production units.

Both the coaches have numerous safety features both in terms of exterior as well as coach interiors. The advancement in materials, processes and technologies have been adopted in LHB design coaches as well as retrofitted in ICF design coaches to the extent possible.

The features mentioned above clearly indicate that IR has changed with times and is giving utmost importance to passenger safety. New coach manufacturing units being built at Rae Bareilly, Kerala and Kolar in Karnataka are expected to build only LHB coaches. The state of art technologies being adopted by air carriers and premium road transporters are incorporated in rail travel to assure greater comfort and safety of the travelling public.

## REFERENCES

1. Indian Railways Safety Performance Fact sheet: March 2013
2. M.A. Rao, "Indian Railways" National book Trust, ISBN 81-237-2589-2
3. Ministry of Railways, Centre for Advanced Maintenance Technology, "Maintenance Manual for BG coaches of LHB design"
4. Ministry of Railways, Centre for Advanced Maintenance Technology, "Maintenance Manual for BG coaches of ICF design"
5. Suresh D. Mane and D. Ghosh Roy, " Carriage Repair Workshop- Hubli" Indian Railways 2008 July
6. Suresh D. Mane and N. Nagesha," Carriage Repair Workshops on Indian Railways : Study on Energy Consumption and Conservation Potential", International Journal of Emerging Technology and Advanced Engineering, IJETAE Vol 3 Special Issue Feb 2013 pp 1-9, ISSN: 2250-2459 (www.ijetae.com)
7. Training material developed by Rail Coach Factory, Hussainpur, Kapurthala