Railways and Rolling Stock Engineers- Challenges Ahead

by

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Synopsis:

Indian economy is set to grow at a blistering pace. A sustained growth of 7% to 8% is in the realms of possibility. This would require 8.4% to 9.6% growth in the transport sector to be contributed by the Rail, Road and the Maritime sectors. The Road and the Ports have launched their respective plans for meeting the traffic demands. In this context the Indian Railways have an unfinished agenda of expanding system capacity, reducing cost of transportation, dealing with the problem of traffic mix and addressing safety concerns. The paper charts the way forward and recommends setting up of a network of Dedicated Freight corridors built to liberalised moving dimensions and capable of operating a new series of high axle load high productivity Rolling Stock and Double Stack containers. This corridor apart from enhancing system capacity would considerably bring down the cost of Freight transportation. The paper emphasizes that this mega project should be meticulously planned and all crucial issues carefully debated and determined before launching construction so that the original objectives are not distorted or diluted.. The article is based on the K.C.Lal Memorial Lecture delivered by the author in the 55-Batch Reunion at Jamalpur on the 28th March 2005.

Introduction

From all accounts the Indian economy is set to grow at a healthy pace. In the year that has gone by, a GDP growth of 6.9% was achieved. Spurred by a projection of 7.6% growth in industry and 8.6% growth in the services sector a growth of 7.2% is expected in 2005-06. There are strong indications that given normal monsoons and infrastructural support from the Energy and the Transport Sectors, a growth rate of 7% to 8% is sustainable in the long term. Based on these projections, the Transport Sector which in our context

comprises predominantly Railways, the Roadways and the Maritime Sectors have to sustain a growth rate of at least 8.4%. This is a huge task.

Road Sector

In the recent years exciting things have been happening in the Road Sector. Setting up of National Highway Authority in 1995 and Road Development Corporations by some of the states are the key milestones of putting in place institutional mechanism with greater autonomy and faster decision making capability. Levying of cess on Petrol and Diesel to generate the Central Roads Fund has lent financial teeth to the execution of road development projects. A National Highway Development Project has been launched which envisages 4/6 laning of the Golden Quadrilateral (5846km), construction of North-South, East-West Corridors (7300 km), NHDP Phase IIIA(4000km) and connectivity to the Ports etc. (1200 km), entailing a network of over 18,000 kilometers. The Golden Quadrilateral Project is expected to be completed by December, 2005 and the contracts for the East West and the North South corridors as well as the Port Connectivity constructions are also progressing to a predetermined schedule. While executing these projects, issues relating to Traffic Management, Encroachments, Overloading, Road Safety, Corridor Management, Financing and removal of Non Physical Barriers are receiving attention. Investments of over Rs 54,000 crores at 1999 prices have been committed for these projects. These along with an appropriate institutional mechanism backed by a strong political support and commitment have lent impetus to the project execution. Induction of Multi Axle Vehicles (MAVs) has considerably enhanced the payload carrying capacity of trucks. The road sector in India is now poised to witness a vastly improved service delivery in the coming years.

Ports

Concurrently, the Indian Ports, both on the Western and the Eastern coasts, have launched their programme of upgrading the berthing and handling capacity, particularly in respect of ISO containers. This has started delivering results. In the year that has gone by Traffic handled by the Ports along the 7617km Indian coast line has grown by a record 11.3%, the highest in the last decade. A National Maritime Development Plan has been

launched for enhancing capacity for handling traffic in Ports from the existing 458 million tonnes to 962 million tonnes by the year 2013-14 at a Compound Annual Rate of Growth (CARG) of 7.69%. Apart from enhancing the Port infrastructure, these investments comprise setting up of International Container Transshipment Terminal at Cochin, Third Container Terminal at JNPT and 2nd Container Terminal at the Chennai and the Tuticorin Ports. Container Traffic is projected to grow at a CARG of 17.3% to 251.40 million tonnes (20.90 million TEUs) by 2013-14. This would constitute 35% of the total traffic handled. Rs 60,000 Crores have been allocated for this development Plan focused primarily on the Major Ports. As expected 64% of the investments are allocated for the Ports in western India dealing with Container Traffic. A stage has now been reached wherein the bottleneck would be evacuation of Containers from the Ports rather than the capacity of the Ports for berthing and handling the Containers. Railways need to correct this deficiency.

Growth of Freight Traffic on the Railways

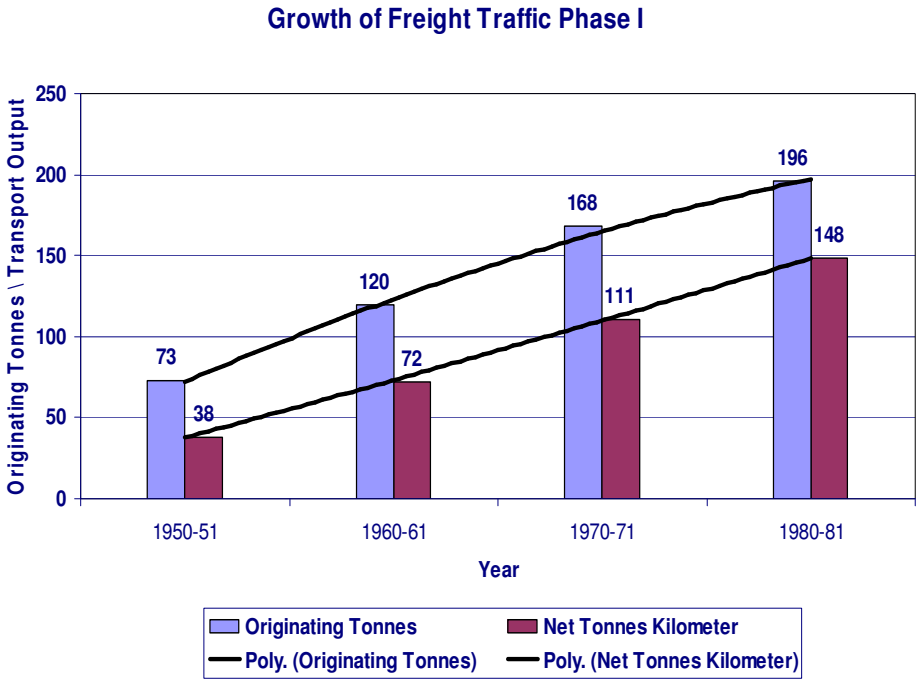
It is appropriate that at this juncture Railways come up with a firm plan for meeting the traffic demands arising from the projections of economic growth and appropriately integrate these with the developments in the Road and Maritime Sector**s.** In order to determine the action plan for the future, it would be necessary to conduct a quick appraisal of the past performance of the Indian Railways in respect of freight business. The growth of Freight Traffic on the Indian Railways since launching of the 5 Year Plans encompasses three distinct phases.

Phase I (1950-80)

Advent of Independence found the Indian Railways in a poor shape. The Railways inherited chaos in the shape of 42 motley Railways systems with dilapidated assets, multiplicity of rolling stock designs and plethora of interchange points. Partition of India, formation of East Pakistan leading to cutting off Assam from the rest of India and the Kashmir War posed major challenges to the Railways in Independent India. In order to fulfill the aspirations of the newly freed people the Government launched a series of 5year Plans aimed at improving the quality of life of our people. In the first 5 year Plan

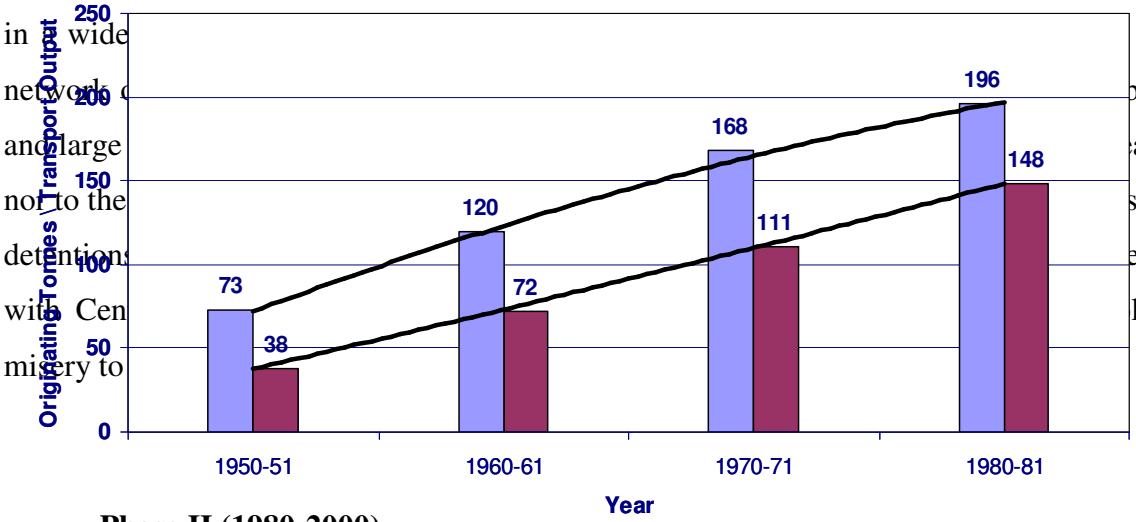
launched in 1950, 80% of Railways developmental needs was provided through budgetary support.

The first phase comprising 30 years from 1950 to 1980 witnessed construction of the Assam link to restore communication interrupted due to formation of East Pakistan and regrouping of the 42 Railways into six viable zones. Significant initiatives during the period comprised, launching of a programme of rehabilitation of dilapidated assets, ushering in of Diesel and Electric Traction, modernization of signalling system along with replacement of 4 Wheeler Stock by Bogie Stock and progressive induction of Centre Buffer Couplers in replacement of Screw Couplings and Side Buffers. These measures were largely instrumental in breaking the transport bottleneck in the coal steel complex in the Eastern sector. Post Independence Railways got off to a flying start and impressive growth was achieved in the First 2 Plans. Perceptible slowing down was witnessed in the period 1968 to 1980. Overall the Traffic Demands were met and a modest growth was achieved despite industrial recession and the labour unrest of the seventies. During this period from 1950 to 1980 originating loading increased from 73 to 196 million tonnes reflecting a growth of 2.68 times and Ntkm increased from 38 to 111 reflecting a growth of 2.92 times. This is represented in the Chart placed below.



Growth of Freight Traffic Phase I

In this phase, the Railways tried to move all kinds of traffic; bulk and piece-meal in a wide a network o by and large al nor to the sit detentions ed with Cen ld misery to



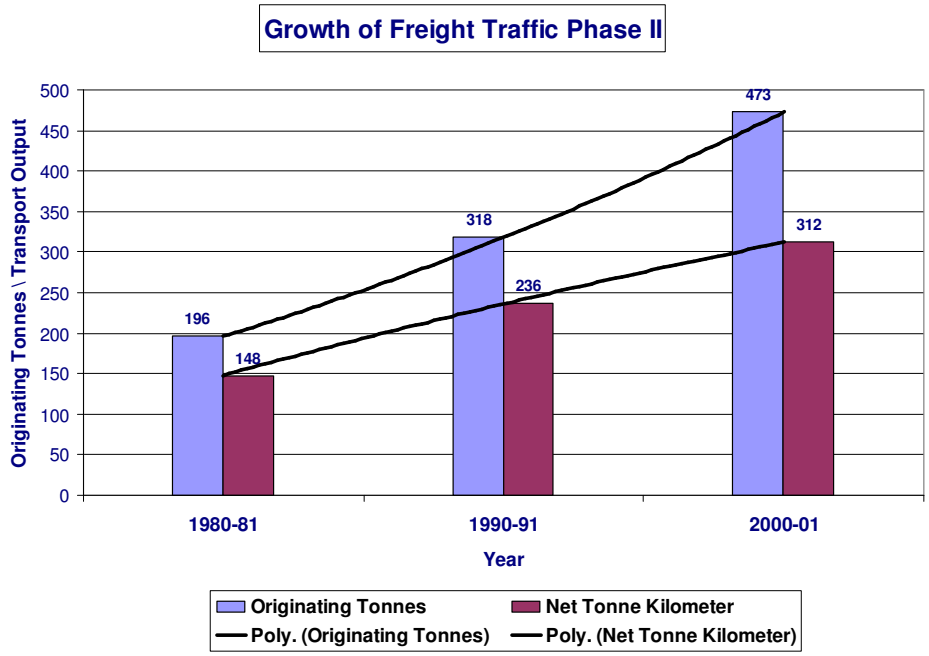
Phase II (1980-2000)

The 2nd phase was characterized by a set of significant policy initiatives. The performance of Bogie Wagons of UIC design equipped with Roller Bearings was beset with frequent instances of Bogie cracks and Roller Bearing failures. In order to rectify this deficiency in 1980, the Indian Railways took a decision to adopt Cast Steel Bogies and Cartridge Bearings, which could meet the rigors of service without such failures.

Induction of this design of wagon designated as N Stock, along with replacement of Vacuum Brakes by Air Brakes brought about a sea change in the operating capability of the Indian Railways.

Concurrent with modernization of Freight Cars the concept of end to end running of Freight Trains was introduced in the eighties. Block rakes ran through from loading point to the unloading destination bypassing intermediate yards mostly without change of motive power.

Modernization of Freight Cars and the related operating innovations delivered the desired result. In the last two decades of the 20th century a quantum jump from 196 million tonne to 474 million tonne in originating loading and from 148 BTKM to 317 BTKM in transport output was achieved. This is performance is represented in the following Chart.

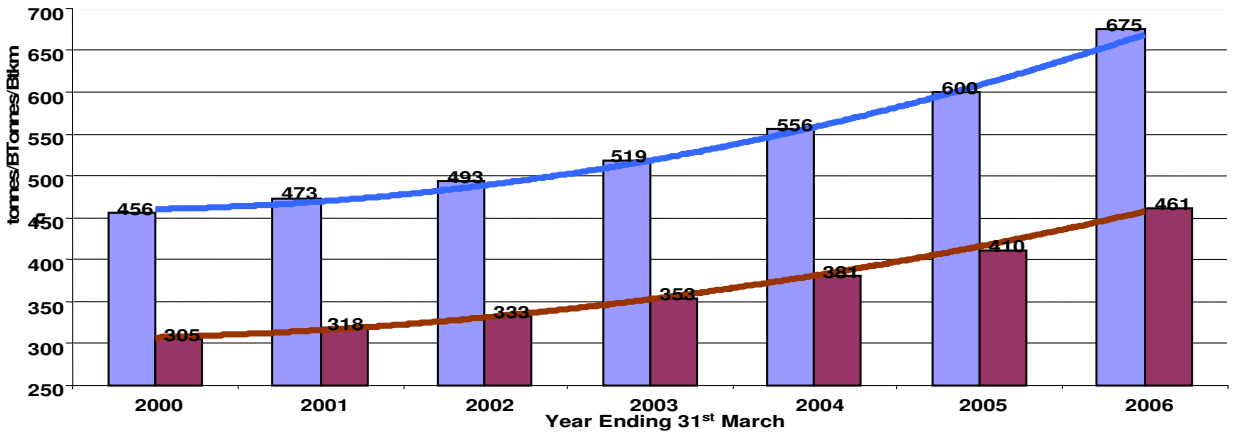


Phase III (21st Century)

The third phase is coterminous with the dawn of the 21st Century. Following the gratifying performance of the last 2 years of the 9th Plan (growth of 54 million tonnes) the

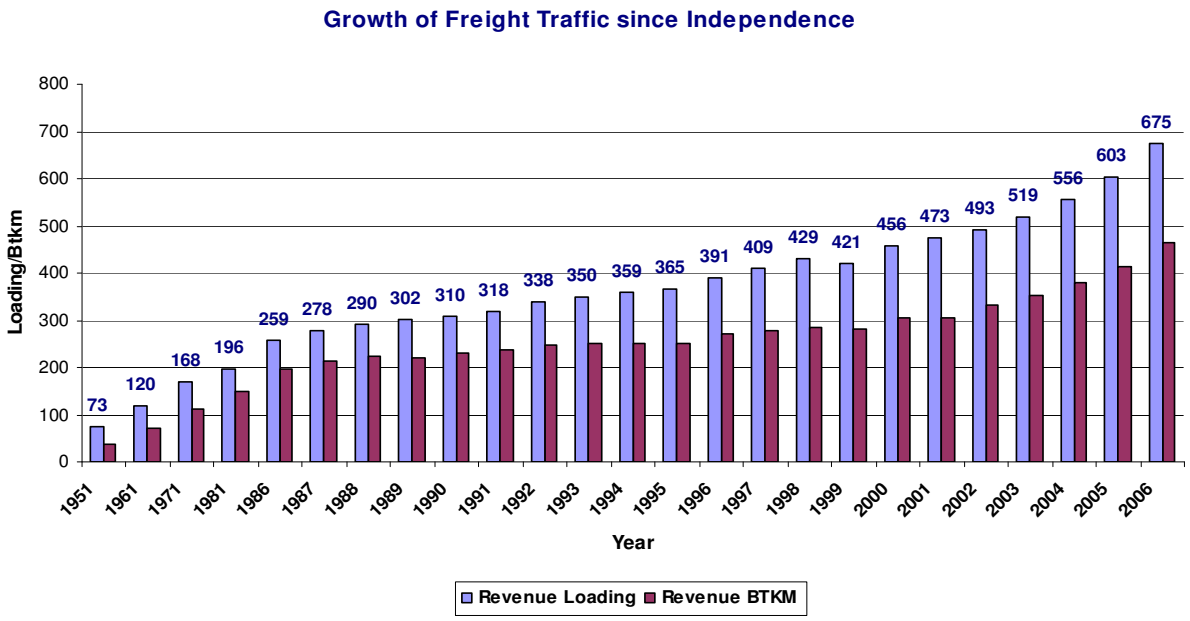
10th Plan got off to a Flying start The very first year witnessed an increment of 25.5 million tonnes in originating loading and 17 BTKM in Transport Output. The performance in the 2nd year was equally impressive. An unprecedented increment of 39 million tonnes in originating loading and 28 BTKM in Transport Output was achieved. The third year of the 10th Plan has broken all records with a quantum jump of 43 million tonnes and 30 Btkm in transport output. The performance could have been even higher but for inadequate Wagon availability and other capacity constraints. Target for the entire 10th Plan has been surpassed in the First three years itself. The prophets of doom have been proved wrong. New heights are expected to be scaled in the 4th year with a quantum jump of 72 million tonnes in originating loading and 50 btkm in Transport output.

Growth of Traffic in the 21st Century



Decline in share of Traffic

The pattern of growth of Freight Traffic from the commencement of the first 5-Year Plan is displayed in the chart placed below



While the growth pattern has been impressive, it has been characterized by a steep decline in the share of the Railways in the total Freight Traffic matrix. From a share of 89% in 1950-51, the rail share has dropped to around 30% at present with commensurate gain in the share of road traffic. Rail transport is claimed to be 4 times more energy efficient and 6 times more efficient in land use. In addition the safety record of Railways is much superior to that of the Railways. Much higher operating speeds and throughput are permissible with the Railways. Despite these obvious advantages in favor of the Railways there has been a trend of the shipper opting for the Road service. This preference primarily emanates from the flexibility offered by the Road Transport in rates and tariff, choice of originating and destination points and minimum acceptable weights and sizes of consignments. A reasonable definitiveness about the delivery schedule also makes the service attractive to the shipper who eventually passes on the higher cost to the end user of the product. Unlike Railways settlements of claims for damages and pilferages en route are relatively swift and hassle free.

These qualitative aspects though relevant do not fully explain the significant magnitude of decline in the traffic share of the Railways. There are certain structural deficiencies that need to be addressed for the Railways to restore their due share in the freight traffic matrix. These are identified as:

- **Inability to generate adequate system capacity.**
- **Problem of Traffic Mix**
- **Sub optimal Productivity of our Freight Stock.**

Capacity Creation

The Railways have lagged behind the Road sector in creation of transport capacity. According to a rough estimate in the decade of the nineties, Railways created 135 Btkm against 368 Btkm by the Road Sector. The situation is no better in the 21st Century with Railways creating 58 BTKM against 240 BTKM by the Roadways. As a result, the incremental traffic has been drifting away from the Railways to the Roadways. While the data is very approximate and subject to corrections, the trend is too disquieting to be ignored. The situation is likely to worsen with the progressive completion of the National Highway Development Project. The Railways need to sit up and take notice and immediately launch a programme for expanding system capacity.

Problem of Traffic Mix

The traffic matrix of the Indian Railways basically comprises the following

- Bulk Transport of heavy haul Freight Traffic
- Containerised Transport of Non Bulk and piece meal Traffic
- Inter City and long distance Mail Express Trains
- Stopping Passenger Trains
- Commuter Services on the Suburban Sections

The infrastructural requirement for each of these services is different. Railways over the years have invested on a unified infrastructure to deal with these divergent operating requirements. No doubt the Railways have expanded the system capacity in the five decades since launching of the Five Year Plans, but the investments have not been

focused on any particular type of service. An amorphous system has been built that is optimised for none and is at best a compromise.

The Railways are now at a critical juncture and for them to sustain the growth and continue to be an effective instrument in lending impetus to the national economy; they need to put in place two sets of infrastructure within one system, tailored separately for transport of freight and passenger/commuter traffic. The mistake of the first 30 years of developing a unified infrastructure for dealing with all segments of traffic including bulk and piecemeal, possibly aimed at achieving a more intensive utilisation of assets, should not be repeated. The conflicting matrix of fast passenger services and heavy haul freight trains operating on the same infrastructure needs to be resolved. The results would be rewarding if lessons were learnt from this experience and investment decisions focussed upon this road map. A time has come to consider separation of corridors dealing with various services. In the first instance, the Heavy Duty Freight services need to be segregated from the Passenger and Commuter Services.

Productivity of Freight Stock

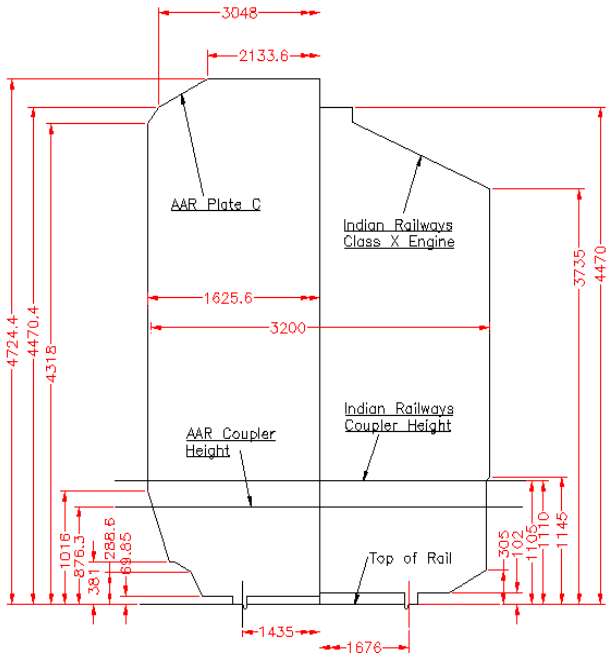
Rail Transport is claimed to be 4 times more energy efficient and 6.5 times more efficient in land use than road transport. Yet, it is not reflected in the Rail tariff that for most commodities and for many distant slabs is in excess of the road tariff. A comparative evaluation of freight tariff in India and U.S.A. conducted by Mr. David Burns, a former World Bank Consultant and presented in his paper in a Seminar in Kolkata on the 14th and the 15th May 2003, brings out interesting facts. According to this paper in respect of bulk commodities such as Coal, Iron Ore, Cement, Food Grain, Fertilizers, when corrected for the purchasing power parity, freight charged in India is substantially higher than the tariff charged by the U.S. railroads. Tariff for coal is 35 paise per NTKM in USA against 50 paise in India, which inflates to 250 paise on PPP basis. US Railroads make money in coal transport while we are forever complaining. Overall US Railroads have brought down the tariff from 3.5 Cents per Ntkm to 1.5 Cents per Ntkm in the last 25 years.

While the productivity of Freight Stock on Indian Railways since Independence has displayed an impressive growth from 700 Ntkm per wagon day to 2570 Ntkm at present, these fall short of the capability. With the exception of BOY (3.42) and BOXN LW (2.95) our Broad Gauge Pay load to Tare ratio ranges from 2.0 to 2.4 which suffers in comparison to 3.5 to 5.0 in many Standard & Meter Gauge systems.

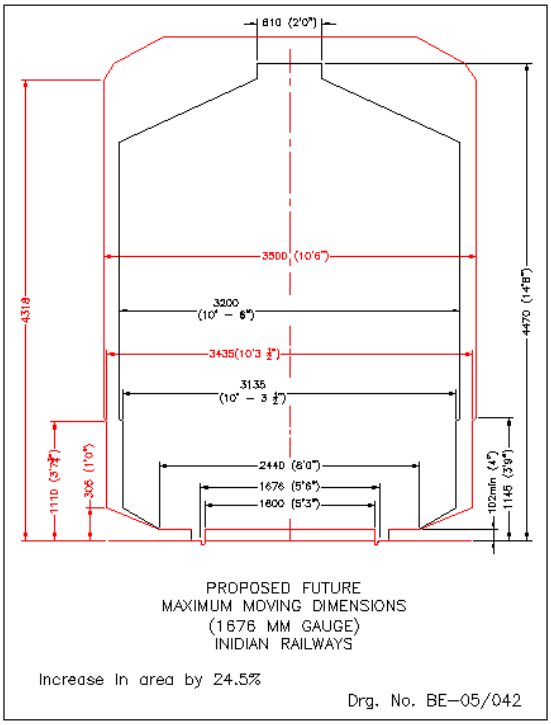
Maximum Moving Dimensions

This situation is ascribable to a rather restrictive maximum moving dimension adopted by the Indian Railways. We have not taken full advantage of our wide gauge of 1676 mm. Other railroad systems with narrower gauges pack in a lot more cubic content and weight of the consignment in their freight wagons. Comparative schedule of Moving Dimensions on the Indian Railways and the US Railroads laid to 1435 mm Standard Gauge are placed alongside. This leads to a high cost of bulk Freight Transportation which is as much as 5 to 7 times of that in the US Railroads on the Purchasing Power Parity basis. A large wheel diameter of 1000 mm and a coupling height of 1105 mm have also not helped matters.

IR and AAR Moving Dimensions



Adoption of liberalised moving dimensions along with reducing wheel diameter and coupling height to 840 mm and 850 mm respectively would permit substantial increase in cubic content and carrying capacity of wagons. A suggested profile of Moving Dimensions is shown in the attached sketch. Given our Broad Gauge it was possible to provide larger width of wagons but in order to ensure interoperability with the existing network, the width of the stock has been limited to that which is already available on the BOBRN Wagon.



Taking advantage of the higher volume of consignments that would be possible to accommodate in the Freight Car designed to liberalised moving dimensions, the axle loads could be increased from the prevailing 20 tonnes to 30 tonnes or thereabouts. These features would enable ushering in designs of high productivity freight stock on the Indian Railways with improved pay load to tare ratio of 4.2 (23 tonnes tare plus 97 tonnes pay load). This would constitute an effective way forward in not only expanding system capacity but bringing down the cost of transportation approaching those prevailing in other heavy haul railroad systems.

Increasing System Capacity through Network Expansion

For increasing system capacity, network expansion is one of the options yet to be seriously exercised by the Indian Railways. On the road sector, the network has witnessed an increase from 4 lakh km at the time of Independence to around 32 lakh km. now. It continues to grow at a fast pace, both quantitatively as well as qualitatively. This growth has delivered the expected results and the road sector is now poised for a vastly improved service delivery in the coming years.

In sharp contrast, the Railways network has stagnated. A review of the growth of infrastructure and the transport output delivered by the Railways in the last 50 years would indicate that increase of mere 17% in the network, coupled with modernization of traction systems, rolling stock, signaling and permanent way, has delivered a growth of over 800% in Freight and 600% in Passenger Traffic. It's nobody's case that Road Transport should not develop, but given such outstanding performance and cost benefit matrix, time has now come for the Railways to exercise the option of network expansion for increasing the transport capacity. Further quantum jump in system capacity as is required for meeting future challenges in transport demand would need this investment.

Measures for Increasing Productivity of Freight Stock.

1. Reduction in wheel diameter of freight stock from the prevailing 1000 mm to 840 mm.
2. Reduction in coupling height from 1105mm r to around 850 mm.
3. Review of Maximum Moving Dimensions to permit greater width and height of wagons.
4. Increase in Axle loads.
5. Net to tare should be improved from 2.45 to at least 4.
6. Present designs confined to one type each of open, covered, flat and hopper wagons are not enough to access the entire market. Commodity Specific

Wagons to increase the market access need to be ushered in. Development of wagons for bulk cement, food grains and chemicals need to assigned priority.

Concept of dedicated freight corridors

It may not be possible to permit unrestricted operation of such high productivity stock needing liberalized moving dimensions and higher loads on the existing network. In view of the above, it is suggested that a net work of dedicated freight corridors be constructed on the Indian Railways to address the aforesaid deficiencies. This will help capacity creation and reduce cost of transportation by ushering in high productivity freight cars and double stack containers. Progressive segregation of freight and passenger services will also deal with the problem of traffic mix and address the safety concerns of the Railways.

Container traffic in India is set to grow at 17% per annum. Out of 4000 containers received daily at JNPT, the Railways are able to evacuate only 1000 due to saturation of section capacity on the Ahmedabad – Tughalakabad – Amritsar route. For dealing with this bottleneck there is an urgent necessity of constructing a dedicated container corridor from Amritsar to JNPT capable of operating double stack containers. This corridor should also be linked to the ports in Gujarat.

Addressing Safety Concerns

With progressive diversion of heavy haul freight traffic to the dedicated freight corridor, the existing network could be developed for delivering high quality passenger services. This would ensure that future investment in system capacity are clearly focused and not a compromise as at present. This is the key to ensuring safety in operation.

Objectives of the Dedicated Freight Corridors.

It would be desirable at this juncture to clearly spell out the objectives of the dedicated freight corridor so that dilutions or distortions do not creep in at the stage of implementation.

1. To expand system capacity commensurate with the growth in the national economy.

2. To usher in high productivity freight cars and permit operation of double stock containers amid at reducing the cost of bulk transpiration by about 40%.
3. To address safety concern by separating fast passenger and heavy haul freight services.
4. Ensure focused service specific investments instead of the present amorphous catch all system.
5. To address the vexing problem of traffic mix.

Way Forward

This mega project however needs to be implemented after meticulous planning so that the original objectives are not distorted or vitalized. Identification of Routes, technical issues, institutional and funding mechanisms should be thoroughly debated and determined if need be by involving the best available talents amongst international consultants. Planning commission, Ministry of Finance and various shareholders should be actively involved in this process. Some of the crucial issues in this regard are discussed in the subsequent paragraphs.

Route Alignment

The network of Dedicated Freight Corridors should connect points of heavy traffic generation with areas of consumption through the shortest possible alignment. Collieries to Power Houses, Iron Ore Mines to Steel Plants, Cement and Steel to stockyards, Food grains from Mandis to usage points and Container hubs to Ports should be taken up on priority. Alignment should avoid urban conglomerates as far as possible. Traffic projections for major commodities should be assessed for the years 2015, 2025 and 2030. Areas of predominant traffic generation and consumption should be identified to generate streams of traffic and possible routes. Data base of LRDSS should be used.

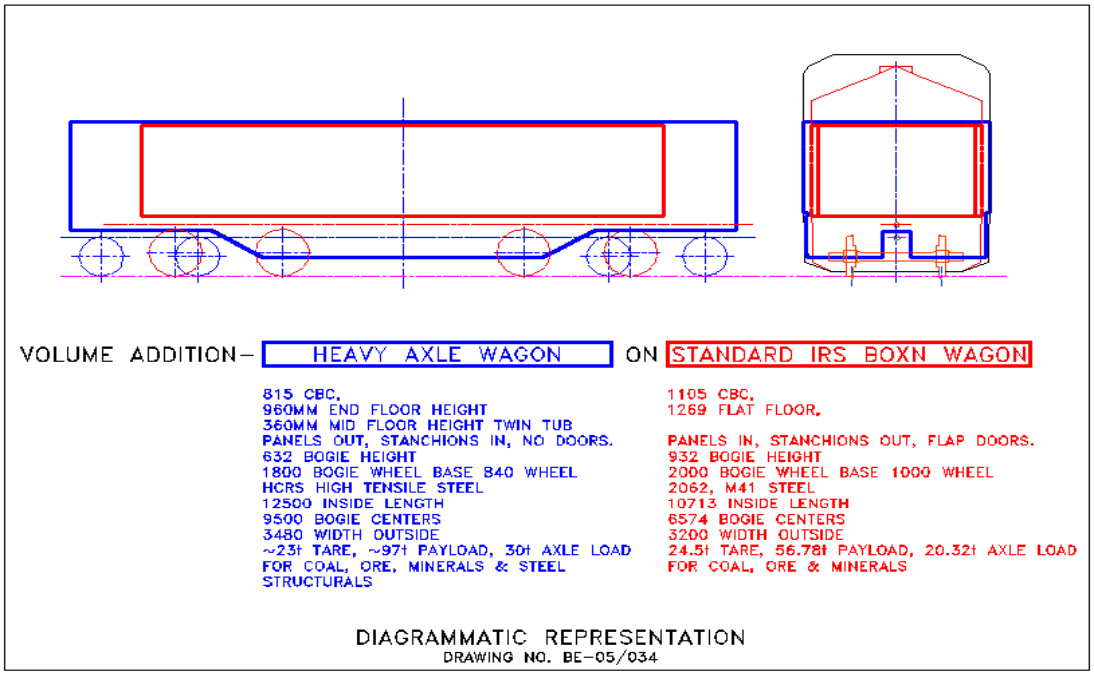
Exchange Yards

The Dedicated Freight cum Container Corridor would mainly be a stand alone system connecting areas of traffic generation with consumption sectors. Appropriate

connections between the existing and the new network may, however be needed at a few locations particularly in the vicinity of the terminals. A limited number of exchange yards would need to be provided for such inter connectivity and for splitting and consolidation of loads.

Axle Loads

This is a crucial parameter which has to be determined pragmatically. Once the maximum moving dimensions and the wheel diameter of the wagon are determined, the outline of a freight car takes shape. Based on the cubic capacity of the wagon and density of the commodity the maximum gross load of the wagon and the consequent axle load determines itself. According to a quick study the proposed moving dimensions would permit development of an open wagon with a tare of 23 tonne, payload of 97 tonne and a gross load of 120 tonne. This delivers an axle load of 30 tonne which could be adopted for the corridor. A purely illustrative design of Wagon for carrying coal, Iron Ore e and Steel structural is attached.



Track and Bridges

This would determine itself once the Axle Load is decided. For regular operation with 30 tonne axle load, a Track Structure comprising 68.5 kg AAR or 72 kg UIC 90 UTS Rails laid on Concrete sleepers with a density of 1660 per km and a ballast cushion of 350 mm would be adequate. Ruling gradient should be limited to 1 in 150. Bridges foundations could be designed for 40 tonne Axle load though initially girders and superstructures could be for 30 tonne axle load.

The inter track distance between the tracks of the Freight Corridor and the tracks of the existing Network wherever these are in close proximity or the pairing track of the Freight corridor should be adequately separated so that the derailed vehicles on one does not infringe the other.

Traction System

Traction System for the Freight Corridor should permit operation of wide bodied High Axle load High Productivity Freight Cars and Double Stack high cube Containers. The most cost effective option should be adopted. The Container corridor involving double stack operations should be on diesel traction with 6000 hp ac/ac Diesel Electric locomotives, in multiple units or distributed power system depending upon the length of train and the trailing load. In respect of the general service corridor operations should commence with 6000hp distributed power system of ac/ac diesel electric locomotives. Provision could be made for high contact wire electrification in future if financially justified and found technically feasible.

Operating Parameters

Remote Control Train Management System, Electronic Interlocking at Stations along with Cab Signaling and GSMR 880 MHz Communication system between Driver Guard and Control should be adopted for the freight corridor.

A trailing load of 14,000 to 16,000 tonnes comprising 120 to 130 high productivity freight cars operating at speeds of 80 to 100km/h is recommended. Loop length of 1800 m to 2000 m with crossing/precedence stations 20 to 25 km apart would be adequate.

Grade Separation

Despite best effort Rail Networks do criss cross human habitations. This tends to interference in community life and obstructs movement of Road vehicles both passenger and Freight. In cities the Rail borne commuter traffic totally paralyses the road traffic in peak periods leading to urban chaos. Conventionally the separation of Road and Rail Traffic is secured through .Level crossings and Road Over bridges. Level crossings can be unmanned, manned or Automatic. Unmanned are a safety hazard. There is pressure for manning such crossings running in thousands, entailing huge recurring expenditure. Manned crossings apart from recurring expenditure on staff, require signaling and Engineering infrastructure and have a crippling effect on the Operating speeds and efficiency. Specifications for the automatic crossings are yet to be firmed up.

Road over bridges are difficult to build. Sometimes it is difficult to find vacant land for approaches. These are rather costly and take a long time to build . For instance total grade separation through Flyovers on Delhi Mumbai Route may cost around Rs. 6000 crores.

To avoid Level Crossings and Flyovers, alternative system of Grade separation for the Freight Corridor should be considered. The alignment should avoid urban conglomerates and wherever not feasible the corridor could be constructed on stilts, columns and embankments. This should be on the pattern of the elevated Corridors of the NHAI in the vicinity of Kanpur City. The techno economic feasibility of this suggestion deserves examination.

Disaster Management

An independent Accident Relief and Restoration system would need to be set up. In addition the corridor should have its own network of captive service roads for routine maintenance as well as for rushing men and materials during emergencies.

Network length and costs

A network of around 9000 km including the container corridor to the ports in Western Indian is estimated. An investment of around Rs. 65,000 crores would be needed for completing the project in 5 to 7 years.

Concluding Remarks

Railways are at the Crossroads. Economy is looking up and the winds of change are blowing. Strategy for enhancing system capacity, reducing cost of Freight Transportation and addressing the Safety concerns of the Railways has to be primarily based upon progressive segregation of Freight and Passenger services through construction of Dedicated Freight cum Container corridors. The project should usher in High Productivity Rolling Stock with net to tare ratio of at least 4. Commodity Specific Wagons should be placed on line to improve market penetration.

The existing network should be progressively upgraded for Fast Passenger and Commuter Services. This Mega Project should be planned and executed with meticulous care so that the original objectives are not diluted or distorted and the dream of making IR world class railway system is realized in a compressed time span.