Chapter 4

Conditions of Freight Movement & Bottlenecks in IR

In previous chapter we had dealt with the conceptual understanding of the terms line capacity, throughput and various factors on which these two depends. We had also seen how line capacity gets adversely affected by speed differentials, heterogeneity and unscheduled working of trains. This chapter elaborates on the general condition of the train operation in Indian Railways, goods traffic in particular with a focus on line capacity/train speeds and go into the details of bottlenecks & peculiarities which affect traffic. After developing a good understanding about the ground conditions and underlying factors the effort will be to look into briefly at the alternatives available to the management to improve the system.

General Facts about Train Operations in IR

With more than 63,000 km of tracks, Indian Railways has one of the largest rail networks in the world. Among the main trunk lines are the "Golden Quadrilaterals", which links the four major metropolitan cities. About 24% of the entire route is electrified. As of 2008, there is a total of 12 million horsepower by diesel locomotives being used in comparison to 15 million horsepower by electric locomotives, showing that the bulk traffic has already moved towards electric traction[27].

Indian Railway moved 833 million tons of freight in 2008-09 covering 538226 million NTKM. Total 7046 million passengers were moved earning total 839296 passenger kilometers[28]. In 2008-9 IR earned 5343 billion rupees of freight revenue and 2193 billion rupees in passenger revenue. Total expenditure was 6893 billion rupees with operating ratio of 90.5%. Most of the freight transported is bulk items, of which 89% of the volume transported comes from coal, fertilizer, cement, limestone, grain, iron and iron ore.

Most railway lines in India have dual tracks with train travelling in one direction on each track. The inter-station distance in Indian Railways is typically small – averaging about 6 to 8 KMs. The stations can be of two types: railway junctions, where lines from multiple directions (more than two) meet at a station and ordinary railway stations with railway lines only in two directions. A railway junction is typically encountered every 100 to 150 KMs and joins railway lines which typically have 15 to 20 ordinary stations.

"Space Interval System" used in Indian Railway is a definite interval of space (also called Block distance) between trains moving on the same track, which is maintained at all times. For this purpose, the track is divided into sections (called block section) and only one train is allowed to be in one section at a time. In some section mainly suburban, automatic signaling is also available which permits much greater train density within the block section.

[27] Indian Railway Year Books

[28] White Paper on Indian Railway, 2009

The present line capacity (table 4.1) is much lower to the estimated line capacity of 140 by the JICA team using improved conditions[29].

Table 4.1 Illustrative Line Capacity of Indian Railways

	Without Maintenance Block	With Maintenance Block
Sections with absolute block system	65	54
Sections with automatic signaling system (Vadodara-Ahmedabad)	85	71

Source: Line capacity statement 2004-05 Western Railway

Conditions Pertaining to Freight Transportation in IR

The freight movement in India is point to point & bulk. The freight trains characteristically handle large transport units with container trains transporting 3,385 tonnes (carrying 90 TEU per train) and regular freight trains transporting 4,715 tonnes (3,400 tonne load) per train, which has now gone upto 5400 tonnes. Freight trains on Indian Railways do not use a schedule timetable & passenger trains have running priority over freight trains.

[29] JICA (Oct 2007). The Feasibility Study On The Development Of Dedicated Freight Corridor For Delhi-Mumbai And Ludhiana-Sonnagar In India Vol. 1

High Passenger Orientation

There is no doubt that IR is a passenger centric railway system due to its public utility nature, unlike most of the other Rail Networks of the World. It will not be wrong to say that it can be described as a passenger rail network where freight trains are also run. The passenger km to freight tone KM ratio in India is 144%[30], which is extremely high when compared to 31% in China and 8% in Russia (comparable railways in terms of track Km). It is also ironic that, freight rates in India are much higher compared to other countries like of USA, China, Japan and are subsidizing the passenger traffic.

Bottlenecks/Factors affecting the Line Capacity on IR

A line is composed of sections with various traffic capacity and some of them have exceptionally higher capacity than other sections. Line capacity on IR ranges from high of 120 on sections with automatic signaling to as low as 20 in some sections. Sections having the least traffic capacity become the bottleneck for the entire line. Major causes/bottlenecks of the low line capacity are:

1. **High Heterogeneity**

Heterogeneity in train type is one of the highest on IR (figure 4.1). There are a variety of trains that run on this huge Indian railway network. These include superfast and express passenger trains (stopping only at major

[30] White Paper on Indian Railways 2009

stations), local passenger trains (short distance trains stopping at most stations), ordinary passenger trains (stopping at most stations), goods trains fast & slow (normally slow to medium speed and stopping at very few stations). These large train mix share same infrastructure with wide difference in their characteristics.

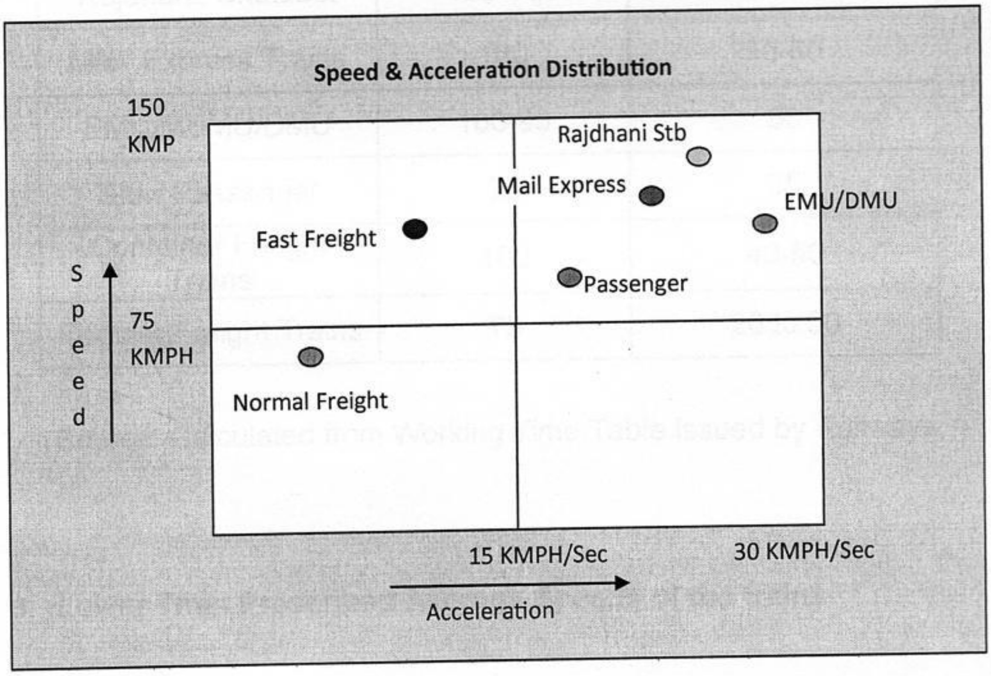

Figure 4.1 Speed & Acceleration Matrix of Trains in IR

2. Speed Differentials

It is well known that speed differential between the trains in the same section eats into the line capacity. In IR we have trains running with wide differential in maximum speed from 45 KMPH to 130 KMPH (table 4.1). A section with all train having same speed will theoretically have high line capacity even if the speed is moderate.

Table 4.2 Maximum & Average Speeds of the Trains in IR

Train type	Maximum Speed	Average Commercial Speed including Stops
Rajdhani, Shatabdi	120-130	85-90
Mail/ Express Trains	100	50-60
EMU/MEMU/DMU	100-90	50
Slow Passenger	75	35
Container Freight Trains	100	40-50
Regular Freight Trains	75	20 to 30

Source: Calculated from Working Time Table Issued by Railways

3. Lower Than Prescribed Average Speeds of the trains

There is variance between the theoretical & actual average speed of the trains both freight & passenger due to various factors. For example: unscheduled stops in case of the passenger trains, time lost in acceleration & deceleration, speed restrictions, gradients & rolling stock performances (which will be discussed in detail in subsequent chapters) etc. External factors, accidents etc also affects the flow and upsets the running of the trains. Major causality of such late running are freight trains, which are pulled off the main line to allow a passenger train because freight train has no time table.

4. Reliability of Rolling Stock

Failure of locomotive or the rake adversely affects the line capacity either by ways of reduced speeds or by blocking the line till relief is arranged. Delays at the starting stations due to lack of readiness of the wagons or the locomotive also adds to the overall delays.

5. Constraints at the Stations/Junctions

Another major reason of low speeds is crowding of trains at the stations or junctions where traffic merges. This could be due to occupation of the loop line/main line to provide schedule stoppages to the passenger train. Lengths of platforms for some of the loops are insufficient, so there is a tendency to use the only available longer platforms for handling passenger trains. Having trains queue at the home signals slows the operation of following trains even more. Manual operation also introduces the scope of individual decision making efficiency and possibility of avoidable delays.

6. Operational & Maintenance Requirements

Operational requirement such as changing/ reversing of the locomotive, change of crew, watering & sanitation needs of the trains, attentions to the complaints & safety checks may also delay the trains beyond schedule stop.

7. Traction Change

Though major trunk route have been electrified some of the critical sections still remains to be electrified. Therefore seamless run of the trains are not possible and loco have to be changed en-route. This introduces delays to the freight operations.

8. Permanent Speed Restrictions

There are large numbers of permanent speed restrictions exists on the IR network due to various constraints, for example weak bridges, low clearances, weak track etc. On average there is a speed restriction every 10 KM.

9. Incidental Cases

The other most common cause of operational constraints is incidental events during daily operations, incidental delays, off scheduled passenger trains & randomness of freight makes train operation very tricky. All this factors affects line capacity to great extent on IR. There are cases such as the excessive time required for the boarding and alighting of an unusually large number of passengers, additional time required for loading and unloading baggage or freight, chain pulling etc. to mention a few. Since the operation of freight trains on the Indian Railways is not according to a schedule, the incidental stopping of passenger trains normally delays freight trains.

10. Freight Trains Without Time Table

No fixed schedules are made for freight trains in Indian Railways. In principle, once a freight train is loaded and ready to depart, it is operated during an interval in passenger train operation. A major demerit of operating without a freight train schedule is that the date and time of arrival cannot is not specified in advance and there is no pressure on the controller[31] to give priority to the freight train.

11. Constraints at the Station Yards

Most of the yards are multifunction and are located in major cities where mainlines converge. Indian Railways normally does not use separate stations for passenger and freight services. These multifunction stations/yards provide a combination of facilities such as: passenger area, freight station (loading/unloading sidings, including private sidings/lead-in tracks), locomotive depot, passenger car depot and freight wagon depot. These yards though economically more viable but tends to be sub optimal in terms of operational efficiency. Such major yards further add to the speed restrictions at the turnouts and restrict movement for design & maintenance reasons. The overall speed in these locations are generally 15 km/hr (some places it is even 10 km/hr), forcing trains to take a long time to pass through a station, delaying the arrival time of both freight and passenger trains and thereby reducing the line capacity.

12. Travel speed at turnouts

Nearly all of the turnouts used by Indian Railways are either 1/12 or 1/8.5. The speed restrictions for these turnouts are set at 30 km/hr and 15 km/hr respectively. In practice, there are some locations where the restriction is 10 km/hr. And, in most of the large-scale multifunction station/yards where turnouts and DSS/SSS are extensively used, the speed restrictions for the

[31] Controller: a Railway official controlling the movement of the trains at the ground level via centralized control room

entire yard are set at 15 km/hr due to its complex arrangement and the necessity of maintenance.

13. External Factors

Other peculiarity of Indian Railway operation such as large number of unmanned level crossings & common access to the Railway track by human & animals, thefts & vandalism etc. results in uncertainties & accidents, which further adds to slowing of the trains.

What are the Alternatives to Improve Line Capacity?

Most of the above bottlenecks can be classified in four broad categories with little overlap in the three.

i. Demographic Conditions in India

ii. Infrastructural Constraints

iii. Operational Peculiarity of Indian Railway

iv. Speed Differential (heterogeneity)

Constrains of signaling, station yards, turnout are infrastructural in nature, passenger priority, incidental cases & external factor can be attributed to the Operational Peculiarity of IR & demographic conditions. Leaving aside first two: demographic conditions in India & infrastructural constraints, lower freight speed is a common denominator in remaining two categories: Operational Peculiarity of Indian Railway & Speed Differential (heterogeneity).

Two types of approaches can be adopted to increase line capacity:

i. Infrastructural Inputs (Hardware Inputs)
ii. Increase Operational Efficiency & Speeds (Software Inputs)

Increasing operational efficiencies, signaling improvement, speeding up the trains & augmenting infrastructure are some of the strategies put forwards by the experts. There is high degree of interdependency in most possible solutions & in fact they all complement each other. Aim of all the alternatives of increasing line capacity finally merge towards the outcome of mitigating heterogeneity by increasing speed of the sluggish trains and bring down the differentials.

The strategy of large scale improvement in infrastructure to bring in operational reforms is not feasible unless one is looking at the system *de novo*, the example being DFC (Dedicated Freight Corridor). The option of laying new lines is highly capital intensive and has long gestation period. The commercial/ economical impact of such a project is based on various future projections and will take time to yield. Moreover this option can only be considered for the 4 quadrilaterals due to the huge capital involved, for rest of the IR network different strategy has to be adopted.

Signaling Improvement in Isolation

Two type of signal improvement strategy are normally promoted by the signaling experts: Firstly Dynamic Block Section using automatic signaling where block section is divided into many sub-sections of 1 to 1.5 KM each by providing track networked auto signal. Theoretically this scheme has the potential to increase line capacity many fold and generally used for very busy suburban section. The second cheaper option is using Intermediate Block signaling (ISB) where block is divided into 2 sections without having a station in between. This scheme can improve line capacity upto 1.5 times. In both, numbers of trains follow each other back to back in a block section. As one can visualize this will work fine till all the trains run at the similar speeds. Higher speed differential will again negate the advantage of the signaling as sectional speed will be governed by the slowest moving train. Hence signaling improvement cannot bring the desired gains in line capacity in isolation & one will have to speedup the slowest train to bring the speed differentials down.

Summary

It was seen that in IR freight operations find secondary priorities compared to the passenger operations & is marred with problems of low average speeds and high speed differentials. Various infrastructural factors such as constraints at the station yards, signaling, low speed turnouts and operational factors, for example: traction change, maintenance requirements, freight trains without time table etc. are adversely affecting the line capacity. It was also seen that demographic conditions in India, external factors, incidents etc. tends to put road blocks in smooth operation. Finally we saw that various factors put together tend to increase already high train heterogeneity, cause speed differentials, maintain low average speed of the trains & compound the problem of reduced line capacity. It is a vicious circle where lower speeds of freight train further tend to push them behind compared to the passenger counterpart.

Possible solution lies in large scale infrastructural improvement coupled with radical operational reforms. Unless we are looking at new project like DFC, large scale infrastructural changes will not be practical on the existing lines. Radical operational reforms will not be possible for the mammoth IR setup. Piece meal approaches likes of signaling will not yield the desired result unless we increase the speeds of slowest moving vehicle on track: freight trains. In the near future scenario it finally boils down to reducing heterogeneity, reducing speed differentials by improving speed of the freight trains.