Economics of TRR/TBR/TSR vis-à-vis CTR in Mixed Traffic Regime

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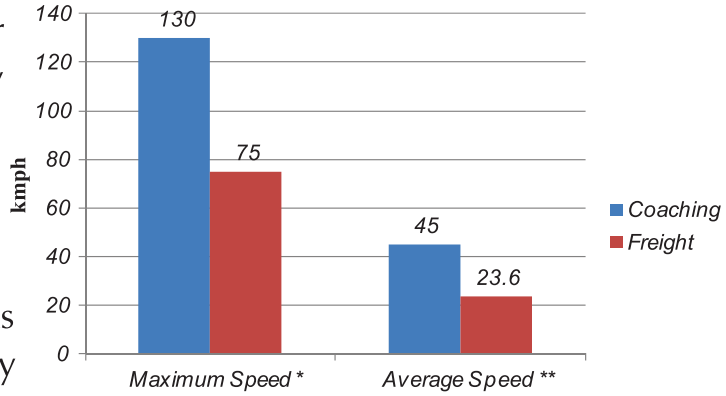
Synopsis

Traffic Block and Speed Restrictions are one of the most scarce and precious resources for the P. Way engineer in mixed traffic regime. However, cost of these resources is not added while taking investment decisions. In this paper, we analyze the cost of CTR, TSR, TBR and TRR and show that after the cost of traffic blocks and speed restrictions are taken into account, converting TSR and TRR into CTR makes a strong economic sense.

1. Mixed traffic regime poses peculiar problems to P. Way engineers. On the one hand they have to maintain track standards to satisfy requirements of two entirely different types of stocks; on the other hand speed differential between two groups of trains adversely affects block availability.

Fig. 1: Speed Differential on IR



*Coaching-Up to 160kmph/150kmph on select routes; Conraj-100kmph
**Source: Coaching-ICMS data; Freight-S&E Directorate's data

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On IR there is substantial speed differential between passenger trains and freight trains in both- maximum speeds as well as average speeds (Figure 1).

2. If all trains on a section run at the same average speed then theoretically speaking we can pass one train after the other at every time-span required to clear one block section and leave specified corridor for maintenance. This situation however gets complicated when another group of trains with lower speed are introduced in to the system, which run in between higher speed group of trains and thus eat into maintenance block margin. Coupled with the exponential growth of coaching as well as freight trains, maintenance blocks has become one of the most scarce and hence precious resource for the P. Way engineer. It is therefore ironical that the cost of this most precious resource viz. traffic block does not get factored into P. Way engineer's investment decisions. Cost of traffic repercussions is the opportunity cost that IR as a whole foregoes due to traffic blocks and speed restrictions and hence be an integral part of any robust investment decision scheme.

3. In order to factor the cost of traffic repercussions into our investment decisions, a realistic assessment is required for the cost of traffic blocks and speed restrictions associated with different type of maintenance activities. In this paper, we have focussed on four major types of renewal activities viz. Complete Track Renewal (CTR), Through Sleeper Renewal (TSR), Through Ballast Renewal (TBR), and Through Rail Renewal (TRR). Cost of traffic has been estimated for Golden Quadrilateral (GQ) routes (Delhi- Mumbai, Delhi- Howrah, Mumbai- Chennai and Chennai- Howrah) and its diagonals (Delhi- Chennai, Howrah- Mumbai). Taken together, GQ routes and diagonals constitute 9100 Route km but carry the lion's share of 58% of freight and 52% of passenger traffic. A simplified mathematical model has been developed for 10km of CTR work vis-à-vis work of TSR/TRR/TBR for the same length.

4. **Unit Cost of Traffic Block:** Cost of per hour traffic block on GQ route/ Diagonals has been worked out based on per hour earnings of Indian Railways (Table 1) suitably modified for GQ and Diagonals.

Table 1: Computation of Cost of Per Hour Traffic Block

	Earnings IR Per Year (In Cr. of Rs.)[1]	Earnings IR Per Hour (In Cr. of Rs.)	Earnings on GQ and Diagonals Per Hour (In Cr. of Rs.)[2]	Earnings on GQ and Diagonals Per Hour Per KM (In Rs.)[3]	Traffic Block Cost Per Hour on GQ & Diagonals (In Rs.)[4]
Freight Earnings	103100.15	11.77	6.83	3750.70	
Passenger Earnings	42189.61	4.82	2.50	1376.05	
Total	145289.76	16.59	9.33	5126.74	452945.23
					Say **Rs. 4.50 lacs per hour block**

Notes1-4
1Source: IR Year Book 2014-15, p.6
2@58% for Freight; @52% for Passenger
3 Route km on GQ and Diagonals

CR	ER	NR	SR	SCR	SER	WR	ECR	ECoR	NCR	SECR	WCR	IR
1870.6	260.2	84.0	269.1	1617.7	686.6	698.5	417.2	596.9	1231.2	616.4	765.8	9114.2

Running Track km ~ 9100*2 =18200km
4Section assumed blocked from Junction station to Junction station.
~9100km/103 Junction stations = 88.3km

5. **Unit Cost of Speed Restrictions:** Costs of Speed Restrictions (SR) have been worked out based on additional time taken to cover one GQ route due to presence of speed restriction vis-à-vis time taken to cover the same route if no restriction was imposed. (Table 2).

Table 2: Computation of Cost of Speed Restriction per Day

Speed Restriction	Freight		Passenger		Total Loss in Earning Per Day (In Rs.)
	Additional Time Required (min)[5]	Loss in Earning Per Day (In Rs.)[6]	Additional Time Required (min)[7]	Loss in Earning Per Day (In Rs.)[8]	
20kmph	12.00	868589.71	7.55	372618.47	1241208.18
30kmph	9.70	702538.35	6.07	299793.97	1002332.33
45kmph	7.53	545686.65	4.73	233766.55	779453.20

Say Rs. 12lacs, Rs. 10 lacs, Rs. 8 lacs per day for SR of 20 kmph, 30kmph and 45kmph respectively. Cost of speed restrictions higher than 45kmph has been ignored.

Notes5-8

5 As per acceleration chart of WAG7 for 5308T trailing load

6 Earning reduced in inverse proportion to time taken to travel one GQ route. For example:

Total Freight Earning per Yr = Rs. 103100.15 crore;

Freight Earning for all GQ Routes Per Day = 0.58*Rs.103100.15 crore/ 365 = Rs.163.8 crore;

Freight Earning per GQ Route Per Day = Rs.163.8 crore/6 = Rs.27.3 crore

Time taken by Freight train to travel one GQ route(=9100/6km) @24.2kmph* (*Source: Year Book 2014-15, p.43) = 62.67hrs

Revised Time taken by Freight train to travel one GQ route with one SR of 20kmph = 62.67hrs+12min

Revised Freight Earning Per GQ Route Per Day = Rs. 27.3 crore*{(62.67hrs/62.67hrs)+7min} =Rs.27.22crores

Loss in Freight Earning= Rs.27.3 crore- Rs.27.22crores=Rs. 8.68lacs

7 P.35 WTT NCR, ALD Division for WAP5, 21 Coaches. Average length of restriction assumed as 1km.

8 Similar calculations for passenger trains @ average speed of 45kmph* (*Source: S&E Directorate no 2016-Stat IV/10/1 date 21/7/16)

6. Traffic Repercussions for Various Renewal Works: We will now take a sample case of 10km and work out traffic repercussions based on use of standard machines and standard machine outputs as specified by Railway Board. Traffic repercussions will include traffic blocks and speed restrictions.

6.1 Requirement of Traffic Blocks for Renewal Works: Requirement of traffic blocks for 10km of CTR/ TSR/ TBR and TRR has been worked out in Table 3.

Table 3: Requirement of Traffic Blocks for Renewal Works

Track Renewal Work	Machine Type	Min Rqmt of Traffic Block Per Spell (Hrs)	Ineffective Time for Each Block (Hrs)	Output Per Effective Hour (km)	Effective Time for Each Block Per Spell (Hrs)	Output Per Traffic Block Spell (km)	Total Block Rqmt for 10 km Work (Hrs)
CTR[9]	TRT	4.0	1.25	0.4	2.75	1.1	36.4
TSR[10]	PQRS	3.0	0.75	0.2	2.25	0.45	66.7
TBR[11]	BCM	3.0	1.0	0.2	2.0	0.4	75.0
TRR[12]	Manual	1.0	0.0	0.26	1.0	0.26	38.5

Notes9-12

9-11 Requirement of Block, Ineffective Time and Output as per railway board letter No. 98/Track-III/Tk/27-Pt.dated 20.05.2003

12 As per field enquiry from WCR. 20 rail panel each side in one hour block.

6.2 Requirement of Speed Restriction for Renewal Works:

Requirement of speed restriction for 10km of CTR/ TSR/ TBR and TRR has been worked out in Table 4.

Table 4: Requirement of Speed Restriction (Days) for Renewal Works

Renewal Work	Machine Type	20 KMPH	30 KMPH	45 KMPH	75 KMPH
CTR[13]	TRT	10	0	12	9
TSR[14]	PQRS	23	0	25	22
TBR[15]	BCM	27	0	29	27
TRR[16]	Manual	0	38	0	0

13-15 Requirement of SR calculated based on adequate TTM availability assumption, para 308 IRPWM, Table II, and renewal output as per railway board letter No. 98/Track-III/Tk/27-Pt.dated 20.05.2003

16 20 rail panel, each side, per day.

7. Economics of TRR/TBR/TSR vis-à-vis CTR: After assessing the unit cost of traffic blocks and speed restrictions and their requirement for various renewal works, we can analyze the economics of TRR/TBR/TSR vis-à-vis CTR by incorporating opportunity cost of traffic repercussions in our model. Our objective is to assess on purely economic grounds whether component renewal (TRR/TBR/TSR) is a sound economic strategy to optimize cost of maintenance. Cost of converting component renewal

(TRR/TBR/TSR) into CTR after incorporating opportunity cost of traffic repercussions has been worked out in Table 5.

Table 5: Economics of TRR/TBR/TSR vis-à-vis CTR

Track Renewal Work	Rate Reference	Sanction Cost for 10km	Cost of Traffic Block	Cost of SR	Additional Cost to Convert to CTR[20]	Saving in Block and SR Cost if Converted to CTR	Net Cost of Converting to CTR
All costs in lacs of Rupees							
CTR	CR WP 31002 (2016-17)	1675	164	216	0	0	0
TSR[17]	CR WP 31013 (2016-17)	716	300	476	1174	1447	-273
TBR[18]	CR WP 31047 (2016-17)	202	338	556	1688	1329	359
TRR[19]	CR WP 31007 (2016-17)	972	173	380	918	1670	-752

Notes17-19

17 Cost of converting TSR to CTR = Add Cost of (TRR+ TBR)

18 Cost of converting TBR to CTR = Add Cost of (TRR+ TSR)

19 Cost of converting TRR to CTR = Add Cost of (TSR+ TBR)

20 Saving in Cost of (Block + SR) = Cost of (Block + SR) for CTR - Cost of (Block + SR) for individual works put together

8. Going strictly by economics, it can be seen from the above, that there is actually a net saving to railway system if we convert TSR and TRR works into CTR. The intuitive approach to economize maintenance cost is to maximize the life of assets. However, when we add the opportunity cost of traffic blocks and speed restrictions, we realize that maximizing the life of assets is costlier to system. By going for CTR in place of TSR and TRR, we save much more in terms of opportunity cost of traffic repercussions than what we lose in terms of premature replacement of track components.