Konkan Railway Technologies for a paradigm shift in Rail-guided Transport: cut costs & improve safety and efficiency: do we have the courage to qualitatively improve our lives?

by

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The author is a First Class First with Distinction Engineering graduate and an M.Tech from IIT/Kharagpur. Having served a decade in railway open line in various capacities, another decade in Railway research at RDSO & IIT, worked abroad as consultant till 1990. He was involved with the Konkan railway project from the beginning of construction (1990) as a Chief Engineer, Director (Projects) and finally as the Managing Director till date. He has original contributions of new theories in rail-wheel and track-vehicle interactions in railway technologies recognized and published in the world forums. He holds several patents abroad and in India for his inventions. His inventions cover railway technologies, Anti-collision Devices, Sky Bus Metro- in all 17 patents are assigned by him to the President through Konkan Railway Corporation, the royalty streams valued (by PwC) at over Rs 8000 cr, if nurtured over next three years. He believes it is in the realm of reality to make food, travel, communication and dwelling virtually free to all humans on the planet through bold application of science and technology to infrastructure development.

Abstract: Engineers must get out of their current mould of constricted thinking to limit themselves to merely design an engineering component, to become just a cog in the wheel of infrastructure development. A holistic view to positively take the world to the next generation of thinking, through technology to improve quality of life at reducing costs, should be the cardinal principle for the lucky blessed persons, whom the society has chosen and trusted them to engineer the future for future generations. As a fellow Structural Engineer, the author shares his life of 38 years to show case his efforts in this direction, to set an example by practice, rather than words.

1. The Indian railways have seen 150 years of railway working and now to pitchfork into the next generation of rail guided system- time has come to quickly cause and implement technology break through to effect
   - 1.1. Improved quality of service
     - 1.1.1. Safer
     - 1.1.2. Reliable & available
   - 1.2. Reduced cost of service
     - 1.2.1. Through improved productivity of many orders more
     - 1.2.2. Improved benefit to cost ratio for the investments leading to maintenance free- safer systems
2. The pace of technology development and absorption by implementation is not encouraged by the current administrative structure in place – fragmented approach of each departmental unit as well as in-built “no-risk” attitude, is causing the Government railway become a drifting organization.
3. The advent of an independent Konkan Railway, created by the Railway Ministry, first time in history allowed an opportunity to try alternate model of railway working and development of rail-based technologies.

4. The corporation has developed in the short period of its existence of 5 years as an open railway line since 1998, the following technologies

4.1. **Railway Application Package**: Management methods for real time operation & train control, asset-management of track, rolling-stock, signal/ telecommunications, electrical, health care, medical and personnel , distance education & training, security; covers all the departments of railways: RAP –a unique Railway Applications package covering all aspects of railway management-the resulting superior operational performance of the Konkan Railway **received kudos from the World Bank!**

4.2. Technology solutions for conventional railways:

4.2.1. Track & Civil engineering

4.2.1.1. Boulder nets-special steel type

4.2.1.2. Tunnels & cuttings inspection and maintenance-special logical scientific procedures

4.2.1.3. Flexible flowing structures-economic platform structures

4.2.1.4. Self Stabilizing Tracks

4.2.2. Track-vehicle interaction-dynamic loads/ health of rolling stock and track

4.2.2.1. ROSHAN: on line real time health assessment and reporting for the rolling stock at wheel and suspension levels

4.2.2.2. On line real time reporting for the track- vehicle interaction service limits for guided track maintenance through networked ACD and mounted accelerometers "Track Vehicle Safety Monitor" TRAVELSAFE system.

4.2.3. **Safe and improved Train Control and station management**:

4.2.3.1. **ACD Ver 1.0 :** Anti Collision Device- a microprocessor based ***non-signal*** equipment with embedded knowledge network with other ACDs to prevent disastrous collisions involving human lives

4.2.3.2. **Satdham Safety Systems**- stations are made intelligent and automatic to safely handle receipt and dispatch of trains, first time providing positive interlocking between the route and the train using the ACD devices. The current signals and track circuits will become obsolete.

4.2.3.3. **Moving Block Systems**: The ACDs mounted on the trains implement intelligent control with each other as they move on the track, to provide a safe distance required to brake and stop – providing a variable moving block over the existing lines, enhancing capacity 3 fold.

4.2.3.4. **Real-time global information system**: By combining with the RAP the Moving Block System and Satdham Safety System will give a real time information system to operators as well as the customers.

4.3. Rail-based next generation technologies

4.3.1. **Sky Bus Metro**: Causes a paradigm shift in providing economic and financially viable futuristic, faster & safer urban transport without the ill effects of previous generation elevated and underground metros. Additionally being capable of handling containers, or RO-RO service, truck movement in urban areas get either eliminated or virtually non-existent. Time of construction is compressed to within two years! The capital cost is cut down by more than half to 3/4th!

4.3.2. **Sky Rail:** In very treacherous hilly terrain can provide economic and safe rail transport of high speed, giving flexibility to designers to adopt 1:1 gradient and minimum radius of curvature of 15 m! Can handle the heaviest of army loads! Can be set up quickly within two years!

4.3.3. **Sky Con:** An improved rail based system to handle in an integrated manner the entire port operations. The system provides for unloading and loading of containers and general goods in ships at 5 to 10 times the current available best system. Also all issues of inter modal transfers are handled in an integrated manner between the rail/road and ship, causing a paradigm shift in port design and operations.

4.3.4. **Sky Jet Service:** High speed 200 kmph safer inter-city travel with average speeds of 180 kmph- bringing all major metropolises within 8 hours of journeys at affordable prices- as the same lines can deliver cargo too, unlike existing high speed tracks in the world.

5. **Intellectual property– protection**: The property belongs to President of India through Konkan Railway Corporation Ltd.,

5.1. List of patent applications filed in India and abroad is attached..

5.2. As the sole inventor, B. Rajaram, has assigned all the rights to the Konkan railway Corporation Ltd.,

6. **The total business opportunity** to the Konkan Railway is estimated at current prices to be about Rs 100000 cr for all the above technologies, on a conservative basis. Being a public purpose serving company, even at modest royalty-fees of 10%, this converts as an earning of Rs 10000 cr to the Konkan Railway. Over next decade this can be realized, provided we quickly allow ourselves to implement and demonstrate pilot projects in each of the above areas.

6.1. The knowledge- based systems as detailed, will reinforce our country's position as an economic superpower to improve quality of life through technology of the new millennium and gives boost to our own industrial production in core sectors on a sustained basis.

6.2. **What is holding us back?** The single one point hurdle in gaining this advantage to our country is basically the processing time to take even a simple decision. The environment currently is paralysed by excessive analysis by people at various tiers of decision making, solely designed to avoid fixing any accountability nor responsibility by avoiding or doing their best to postpone any action during their tenure.

6.3. It is necessary to ensure financial prudence and observe the simple canons of financial propriety as public funds are utilized. But once the system has set the procedure for such expenditure to be monitored, there is no need for repetitive cycles of examination without any value addition.

6.4. We must unlock value of our assets both human and infrastructure, by re-orienting ourselves and take the policy initiatives.

6.5. A passionate commitment is needed to place our Indian Railways in the forefront, leading in the world with cutting edge technologies, which is well within our reach, given the core knowledge base our country is built on.

7. A 5 year plan of action with mile-stones to achieve tangible results:

7.1. Pilot Projects- implementation:

7.1.1. The ACD project: It has taken almost 4 years since presentation of concept and only one year actually was used in actual development with technical inputs, but 3 years have gone in to administrative processing without value addition because of our administrative structure based "on suspicious, no- risk , every-time- I am new- but I should be convinced" mind-set. The common man traveling on trains is continuing without the protection of Raksha Kavach- and of course no one can be held accountable for this avoidable delay! The system and procedures protect the decision makers, but the common man continues to be exposed to the risk of loss of life in a collision, even though we have a proven solution.

7.1.2. The Corporate Safety Plan of Railway envisages implementing the ACD based Raksha Kavach on Indian railways at a total cost of Rs 1600 cr. We may structure an execution plan based on BOT concept which made Konkan Railway a reality, for implementing the ACDs too

Year	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12
KRC spends	500	600	500						
MoR pays KRC	200	200	200	200	200	200	200	200	380
Debt raised by KRC	300	400	300	-200	-200	-200	-200	-200	-380
Interest@7%	21	50	75	66	57	47	36	25	0
Cum debt	321	771	1146	1013	870	716	553	377	-3
NPV of BOT option	**1228**								
NPV of Direct funding from MoF	**1899**	Payment of 12 years with dividend liability at 7%							

Figures in Rs crores.

7.1.3. In terms of NPV the BOT option saves Rs 600 cr to the railway.

7.2. Major Advantage: Once the system is in position, the ACD network will also help in continuous tracking of trains, providing the centralized on line information . Further the data of statistical information of their working will lay the foundation for the concept that multiple path concurrent decision systems based on low cost commercially available electronic equipment reinforced with the knowledge base, lead to functionalities associated with more expensive signal equipment . That means non-signal standard s of equipment will deliver functionality of signal equipment! This leads to cost cutting and better and safer operations.

7.3. The Self-Stabilising Track: The concept fundamentally uses the train energy to stabilize itself and so leads to many advantages. Directly it saves ballast amounting to 2 cum per meter, which itself contributes recurring saving in the annual recoupment. To implement over 25000 track km covering 10000 route

km of intensively used golden quadrilaterals, a BOT scheme is proposed. This is one case the railway will be paying only from the savings and realizes benefits even from the third year. Annually at current prices Rs 900 cr will be saved from the revenue expenditure, with significant positive impact on the operating ratio.

7.4. The typical costs for installing SST and savings are as under for 5000 km

25000 track km on core routes will be covered		
The cost of providing the SST at Rs 30 lacsper km over 5000km per annum		
Annually 5000 km means saving: Rs cr		
Ballast recoupment at 10% per annum At Rs 1000 per cum of ballst in track for 5000 km 5000x10%x2.5cumx1000	125	annually
Value of released ballast from existing track at Rs 500 per cum at the rate of 1.6 cum per meterfor 5000km	400	in the year SST is installed
Maintenance cost at 2% for the SST @ 2% of Rs 30 lacs perkm :	30	
Maint costs with machines at Rs 20000 per km for 5000 km	10	

7.5. Financial snapshot for the Konkan Railway-25000 km SST on BOT

Year	**03-04**	**04-05**	**05-06**	**06-07**	**07-08**	**08-09**	**09-10**	**10-11**	**11-12**
KRC spends Fig in Rs cr	1500	1500	1500	1500	1500				
MoR pays KRC	945	945	945	945	945	945	945	945	933
Debt raised by KRC	555	594	635	680	727	-722	-772	-826	-872
Interest@7%	39	80	125	172	223	173	119	61	0
Cum debt	555	1149	1784	2464	3192	2470	1698	872	0

7.6. .**For Indian Railways** BOT option saves Railway Rs 6000 Cr!

Year	**03-04**	**04-05**	**05-06**	**06-07**	**07-08**	**08-09**	**09-10**	**10-11**	**11-12**
Cashflows for Railways Rs Crores									
Outflow	945	945	945	945	945	945	945	945	933
Maint	30	60	90	120	150	150	150	150	150
Saving in recoupment	0	125	250	375	500	625	625	750	750
Value of released ballast	400	400	400	400	400				
Saving in O&M costs machine	10	20	30	40	50	50	50	50	50
Net cash-outflow for Railway	**-565**	**-460**	**-355**	**-250**	**-145**	**-420**	**-420**	**-295**	**-283**
NPV of BOT option	-2132								
NPV with MoF funds	-8284	Over 14 years							

7.7. Over next 8 years one can see that the preset method of maintenance practice will cost in NPV terms Rs 6076 cr, while if we adopt the SST. we spend only Rs 864 cr!

Current model									
Recoupment	1000	1000	1000	1000	1000	1000	1000	1000	1000
Machine maint	55	55	55	55	55	55	55	55	55
Total O&M	1055	1055	1055	1055	1055	1055	1055	1055	1055
NPV of costa over per	6076								
With SST									
Maintenance costs	150	150	150	150	150	150	150	150	150
NPV of costs	864								
Annual saving over 25000 km			**Rs Cr**	**905**					

7.8. Even during the BOT phase, the railway even though will be paying Rs 945 cr per annum over next 8 years to the KRCL, in reality only Rs 400 to 500cr is the true cash-outflow to Railways! But KRCL would have spent in the first 5 years at Rs 1500 cr per annum over 5 years and installed the SST on the 25000 km!

7.9. This is a truly a win-win scheme! With annual savings of Rs 900 cr the operating ratio will certainly look a little more better! Additionally track becomes safer and riding quality improves with cascading savings in costs of rolling stock maintenance.

8. **With Sky Bus technology**, having potential to earn royalty of Rs 7000 cr to Railways through Konkan Railway, if only we have courage to invest Rs 50 cr the financial status of Railways in India can be redefined to become totally self-sufficient, adding wealth to the nation, in the following areas:

8.1. **Urban Transport**: A business opportunity of Rs 70000 cr with potential to earn management fees of Rs 7000 cr in addition to royalty of Rs 7000 cr! If Railways execute on BOT basis, recurring profits after taxes, amount to another Rs 3000 cr per annum, considering only Indian projects! Why should we deny ourselves this opportunity, and choose to remain poor?

8.2. Inter-city High Speed (200 kmph) Sky Jet service: The Sky Bus technology provides for carriage of both goods in containers and people to move at 200 kmph between cities. Rs 4000 cr per annum is annual profit indicated even for one single route of Mumbai-Delhi. We score in terms of quality of service-delivering within 7 hrs cargo and people too! That too at fare of Rs 2500 per person and Rs 25000 per container.

Enter City

The Sky Jet Delhi Mumbai **: Structuring the SPV company**

Route length Double line	Enter 1200	Route Length km	Cost /route km Rs	55	cr incl Fin.cost	
Cost of the project is Rs cr	**66000**					
Ridership	**15000**	**per day bothways**		***Container***	**15000**	***nos***
Travel time	**7**	**hrs**	***Equity %***	**30%**	***Debt Service at***	**15%**
Project IRR (20yrs)	**18%**		***Return on Equity :***	**24%**	***after debt servicing & taxes***	

Summary

9. **The gain to the nation** is many folds more- estimated conservatively

9.1. The operating ratio of Indian railways can be improved to 85% from current 95%, assuming we do not reduce any employment: that means an annual saving of Rs 2500 cr!(Rs 1000 cr from infrastructure O&M ,additional revenues

from royalties Rs 1000 cr/annum, productivity factors tech driven Rs 500 cr plus Rs 5000 cr from exploiting Sky Jet and Bus)

9.2. On a continuing basis the capital investments required to augment the capacity in railways will be reduced by many orders, and the financially viable railways will be self-sustaining.

9.3. Collisions and accidents like derailments involving human lives and assets will be eliminated significantly contributing to loss-prevention.

9.4. The capital and operating costs at ports will be dramatically improved to gain competitive edge on global basis.

9.5. Inter-city rail travel at 200 kmph will boost the country's productivity by eliminating unproductive idle journey times during working hours. And cargo too is handled more efficiently at the same speeds!

9.6. Urban transport using Sky Bus will catapult our cities to be the least polluted and comfortable cities comparable to the best in the world, as well as stop the need to invest any more funds in economically white elephant road based improvement schemes or unviable expensive mill-stone metro rail systems.

10. **We need self-confidence and nothing else!** We do need a committed techno-savvy **quick decision making structure** to realize these benefits. Empty good words wont do. Has our country realized true independence to **shake off the fixed mind-sets enslaving us to an unseen monstrous collective psyche of clerical rule followers, preventing anything good to happen in our life-time?**

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