DPRS

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DPRS

- Stands for Distributed Power Rolling Stock
- Class of vehicles fit to move on Railway systems and one where the Propulsion systems and Powered wheels for providing tractive force are distributed over more than one and mostly large number of vehicles
- This is opposed to locomotive hauled trains where the equipment and powered wheels producing Tractive effort are contained in vehicle/ vehicles which are non-passenger carrying and are coupled to passenger cars through mechanical coupling

Internal Power Source - Diesel Electric and Hydraulic Multiple Unit with AC-DC or AC- AC Drive or Hydraulic Drive.

External Power source - EMU/ MEMU Train sets drawing power from AC OHE with DC Motors or AC Motors OR DC OHE or third rail with AC Motors.

The advent of IGBT's on a large scale has made the AC-AC drives very popular in terms of energy efficiency and maintenance. IGBT based inverters have also made regenerative braking on a large scale feasible and improved energy efficiency.

Difference between DPRS and Trainsets ???

DELHI METRO

SHINKANSEN

- 100 % powered trainset
- All axles in a bullet train are propelled by a traction motor

DPRS Types in Indian Railways

Diesel Multiple Units-DMU/DEMU

Electrical Multiple Units-EMU

Mainline Electrical Multiple Units-MEMU

Battery electric multiple unit & hybrid EMU

Train sets -Semi High Speed and High Speed

DMU

DMU(Diesel Multiple Unit) is a multiple-unit train powered by on-board diesel engines.

A DMU requires no separate locomotive, as the engines are incorporated into one or more of the carriages.

- DIESEL MECHANICAL MULTIPLE UNIT(DMMU)

  rotating energy of the engine is transmitted via a gearbox and driveshaft directly to the wheels of the train

- DIESEL HYDRAULIC MULTIPLE UNIT(DHMU)

  a hydraulic torque converter, a type of fluid coupling, acts as the transmission medium for the motive power of the diesel engine to turn the wheels.

- DIESEL ELECTRIC MULTIPLE UNIT(DEMU)

a diesel engine drives an electrical generator or an alternator which produces electrical energy. The generated current is then fed to electric traction motors on the axles

1600 HP 1DPC+4TC

1400 HP 1DPC+3TC

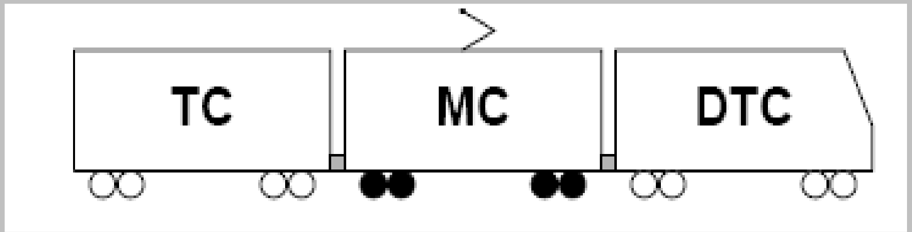
Diesel Electrical Multiple Unit (DEMU)

- Manufacturer : ICF
- Engine: Kirloskar Cummins, Caterpiller in 1600 HP DEMU
- Transmission: Electric AC- DC in 700 & 1400 HP DEMU,

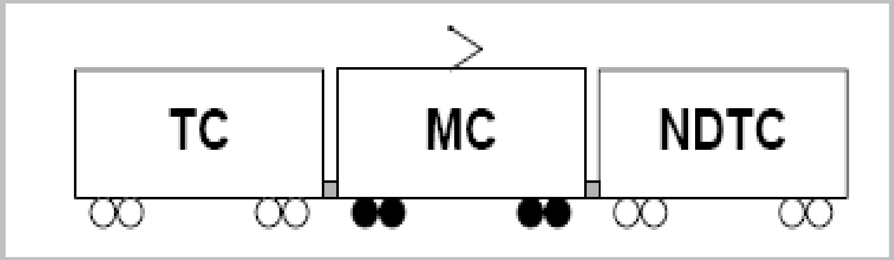
- AC-AC in 1600 HP DEMU
- Bogie: BO-BO (All 04 wheels are powered parallelly)
- Mostly operates in non-electrified plain regions & low traffic density branch line services

EMU (Electrical Multiple Unit)

- Manufactured at ICF & BEML
- Self propelled electric vehicles
- Obtain power from overhead OHE 25KV single phase AC or 1500 V DC
- Basically consists of
- End basic unit- Motor coach + driving trailer coach + trailer coach
- Middle basic unit – Motor coach + trailer coach + non driving trailer coach
- 3-4 units in train formation
- Generally used in sub-urban railway transport
- Designed for super dense crush load



End basic unit



Middle basic unit

DC EMU

AC-DC EMU

THREE PHASE AC EMU(SIEMENS)

MEMU (Mainline Electrical Multiple unit)

Manufactured in ICF & RCF
Employed for main line medium distance operations
Consists of a motor car and three trailer cars
Propulsion system, control circuit similar to EMU but dimensional differences are there
Maximum axle load of trailer coach 16.25 T – Not designed for super dense crush load
2 units in a train formation

EMU v/s MEMU

GENERAL DATA

S/ no	Description	EMU		MEMU		Reference
		M/C	T/C	M/C	T/C	
1	Type of Stock	AC BG EMU WAU4		AC BG MEMU		
2	Coach Builder	ICF & BEML		ICF & RCF		
3	Manufacturer of Traction equipments including Tr. Motor, Transformer etc.	BHEL & CGL		BHEL		
4	Unit formation	DMC+TC+TC		DMC+TC+TC+TC		
5	Train formation	3/4 units		2 units		
6	No. of Driving Cabs	2		2		
7	Type of Traction	25 KV AC		25 KV AC		
8	Wheel arrangement	Bo-Bo		Bo-Bo		
9	Brake system	Self lapping electro pneumatic brake system				
10	Axle Load capacity in Tonnes i) Conventional EMU/MEMU ii) HCC	 20.32 20.32	 13.0 20.32T	 20.32 --	 13.0 --	RDSO specification no. K3-B-01, Feb'03 & for EMU T/C- EMU-2/A-9-0-501 and EMU-2/D-9-0-503.
11	Wheel Diameter (New) mm.	952		952		RDSO manual no. CMI-K001 (Apr'2000)
12	Wheel Diameter (Condemning) mm. HCC	877 865	857 865	877 --	857 --	
13	Gear ratio	20:91		20:91		
14	Train performance per unit rating Horse power Tractive effort (T)	Cont. 1 hr. 896 1004 4.8 5.8				ACTM Volume-III, 1994
15	Traction motor rating: Type Volts (V) Current (A) Output (KW) RPM	4601AZ/BZ/BX/BY 4303AZ/CZ Cont. 1hr. 535 535 340 380 167 187 1260 1182	4303BY (BHEL) Cont. 1hr. 535 535 425 465 207 227 1170 1120	C1005 TM (CGL) Cont. 1hr. 563 563 415 455 210 228 1170 1135		ACTM Volume-III, 1994 & Manufacturer's maintenance manual.
16	KVA rating of transformer	1000				
17	Normal acceleration to 40 Kmph Level track, CLR set at 500 Amps.	1.6 Km/Hr./Sec				BHEL Maintenance Manual no. MM/AC-M/EMU/003, Jan'01
18	No. of pass./unit - Normal Crush Dense crush	400 774 1148				ACTM Volume-III, 1994

S/ no	Description	EMU		MEMU		Reference
		MC	TC	MC	TC	
19	Tare weight	59.3T	C-30.5T D-31.5T	61 T	33.15T	For MEMU (M/C)-Drg. No. MEMU/DMC-9-0-012
20	No. of Seats Vendor Coach	98 --	112 (C type) 88 (D type)	68/81 --	80/108 No Vendor	(i) Drg. No. MEMU/TC2-9-0-201, (ii) MEMU/DMC2-9-0-201, (iii) MEMU/TC-9-0-001, (iv) EMU-2/A-9-0-501, (v) EMU-2/D-9-0-503
21	Max. height above rail to top of roof	3810 mm		3886 mm		i) Drg. No. MEMU/DMC2-9-0-201 ii)EMU/M-9-0-006
22	Max. length of the body	20726 mm		21567 mm	21337 mm	i) EMU/M-9-0-006 ii)EMU-2/A-9-0-501 iii)MEMU/DMC2-9-0-201 iv)MEMU/TC-9-0-001
23	Max. width of the body	3658 mm		3245 mm		-- do --
24	Floor height from rail level	1197mm		1278mm		i) Drg. No. MEMU/DMC2-9-0-201, ii) EMU/M-9-0-006.
26	Height of coach (rail level to panto at home)	4398mm		4255mm		i) Drg. No. MEMU/DMC2-9-0-201, ii) EMU/M-9-0-006.
27	Min. height above rail level to the lowest fitting on under frame under tare	210^{+5}_{-0} mm 188 (for air spring coaches)		210^{+5}_{-0} mm		i) Drg. No. DMU/DPC3-2-6-301, ii) Drg. No. EMU-2-6-046.
28	Length of 9 car rake Length of 8 car rake Length of 12 car rake	194.12m 172.638m. 258m.		 177.616m.		As measured.
29	Distance between front & rear pantographs: 12 car rake 9 car rake 8 car rake	 226.5 m (approx.) 162 m (approx.) --		 -- -- 140 m (approx.)		-Do-

BEMU

- A **battery electric multiple unit (BEMU)**, **battery electric railcar** or **accumulator railcar** is an electrically driven multiple unit or railcar whose energy is derived from rechargeable batteries driving the traction motors.
- Prime advantages of these vehicles is that they do not use fossil fuels such as coal or diesel fuel, emit no exhaust gases and do not require the railway to have expensive infrastructure like electric ground rails or overhead catenary. On the down side is the weight of the batteries, which raises the vehicle weight, and their range before recharging of between 300 and 600 kilometres.

T-18

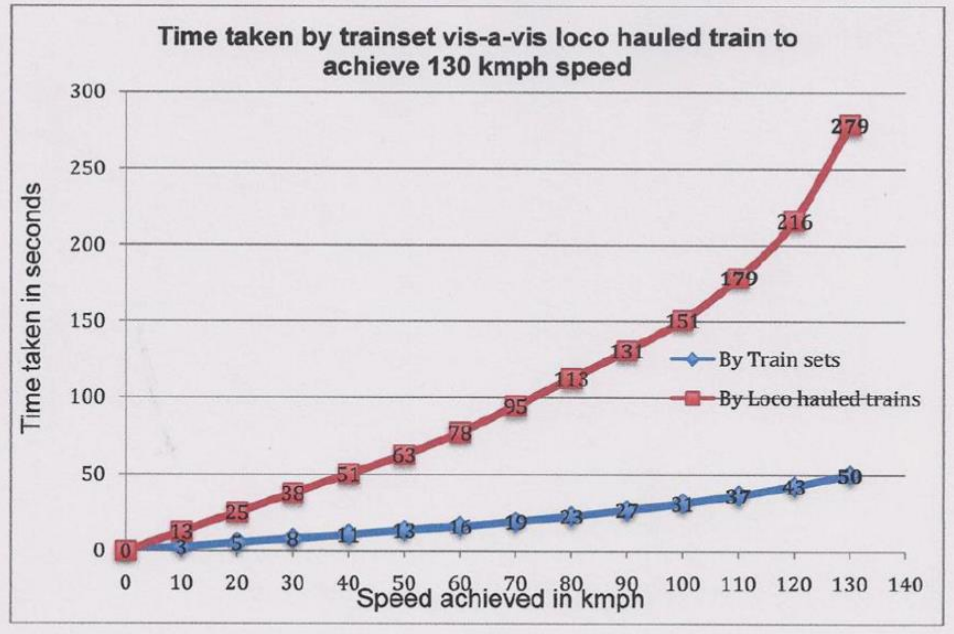
- Train-18 is 16 car train with 4 basic unit i.e. Two number of end basic unit (DTC-MC-TC-MC) and two number of middle basic unit (NDTC-MC-TC-MC)
- Semi-high speed (160 kmph) multiple unit train-set.
- Train-18 is provided with **IGBT** based energy efficient 3 phase propulsion system and regenerative braking
- **Stainless steel c**ar body with **continuous window glasses**
- All **propulsion equipments** are shifted from **onboard to under-slung**. All power components such as **line & traction converters**, **auxiliary converter**, **air compressor, battery box, battery charger, brake chopper resister** are mounted **under the frame**
- **Zero discharge vacuum-based bio-toilets**
- Modern **bolster-less** design bogies with **fully suspended traction motors**,
- Train-18 has 50% powering i.e. Every alternate coach is powered
- Ethernet backbone

Advantages of DPRS

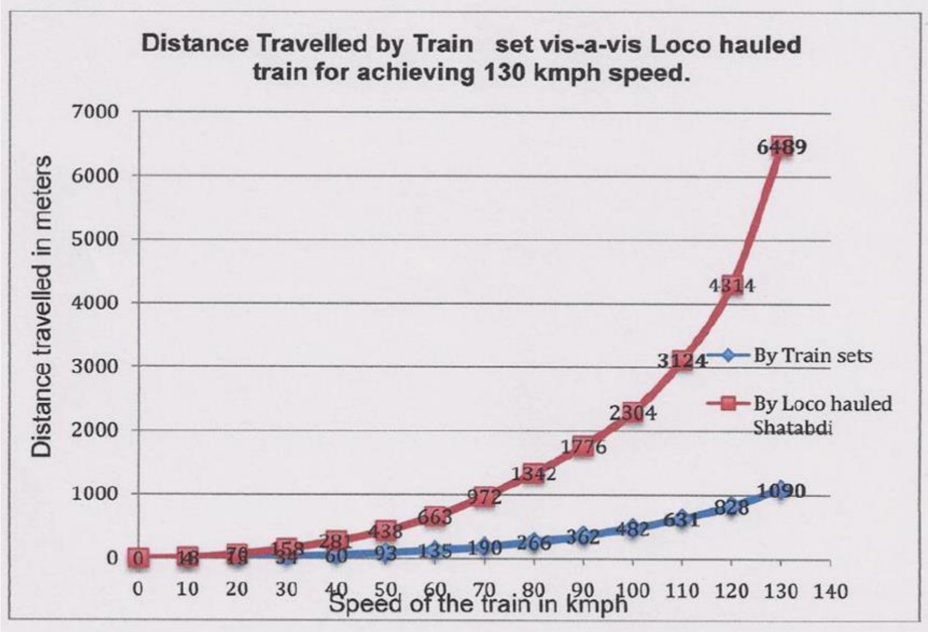
- Better acceleration and deceleration
- Saving in run time
- Energy efficient
- Enhanced safety
- Reduced maintenance
- Improved reliability
- Reduction in pollution
- Improved passenger comfort
- Improved line capacity
- Designed to handle super dense crush load

Better acceleration and deceleration

Operational Characteristics	**Loco Hauled 21 coach Rajdhani Train**	**Rajdhani run with EMU Train set**
Acceleration (Starting)	0.22 m/s^2	1.0 m/s^2
Deceleration	0.20 m/s^2	1.0 m/s^2
Time to achieve 130 kmph	279 seconds	50.3 seconds
Distance required to travel to attain a speed of 130 kmph	6489 meters	1089.7 meters
Additional time required for acceleration and deceleration for a halt with maximum speed of 130 kmph	216 seconds	41 seconds



Time taken by trainset vis-a-vis loco hauled train to achieve 130 kmph speed
Time taken in seconds
Speed achieved in kmph
By Train sets
By Loco hauled trains



Distance Travelled by Train set vis-a-vis Loco hauled train for achieving 130 kmph speed.
Distance travelled in meters
Speed of the train in kmph
By Train sets
By Loco hauled Shatabdi

Reduction in run time between New Delhi and Howrah with Train sets

Speed Restrictions kmph	Time Loss in Acceleration and deceleration		Time saved by Train sets vis-a-vis Loco hauled train (Sec)	No of speed restrictions	Total time Saving with train sets(in sec)
	By Loco hauled trains (Seconds)	By Train sets with acceleration and deceleration @ 1 m/s^2 (Sec)			
Halts	216	41	175	6	1050
10	198	36	162	6	972
20	180	30.	150	13	1950
30	162	24.	138	31	4278
40	144	20	124	6	744
50	126	16	110	6	660
60	111	13	98	4	392
70	93	10	83	19	1577
80	75	7	68	4	272
90	57	5	52	4	208
100	39	3	36	17	612
110	27	2	25	5	125
120	9	1	8	14	112
Total Time savings				135	12952

Savings in run time **216 minutes or 3 hours and 36 minutes**

Energy efficiency

- Propulsion equipment is mounted on coach, hence requirement of locomotives and power car is eliminated.
- Weight of locomotives and power cars is 1/3rd of the total formation. Hence, removing them saves energy.
- The space of locomotives and power cars may be utilized to augment more coaches in DPRS leading to greater Passenger Km
- Aerodynamically much more stable and lesser air resistance

Enhanced safety

- Most DPRS have regenerative and Electro pneumatic braking features, Emergency braking distance is reduced
- Reduce jerks due to smoother acceleration and deceleration due distributed power and traction forces
- Anti-telescopic design

Reduced maintenance

- Reduced wear of track and wheels since power is distributed
- Regenerative & EP braking improves wheel life
- 3 phase IGBT VVVF propulsion
- AC asynchronous traction motor

Improved reliability

3 PHASE IGBT TECHNOLOGY IS HIGHLY RELIABLE

DISTRIBUTED POWERING HAS A LOT OF IN BUILT REDUNDANCY, SINCE 50-60 % OF AXLES ARE POWERED.

MAN MACHINE INTERFACE GIVES APT FEEDBACK ABOUT ANY ISSUES IN THE PROPULSION SYSTEM.

IN-BUILT FAULT DIAGNOSTICS.

Improved line capacity

Faster acceleration & deceleration leads in time required to clear a critical section

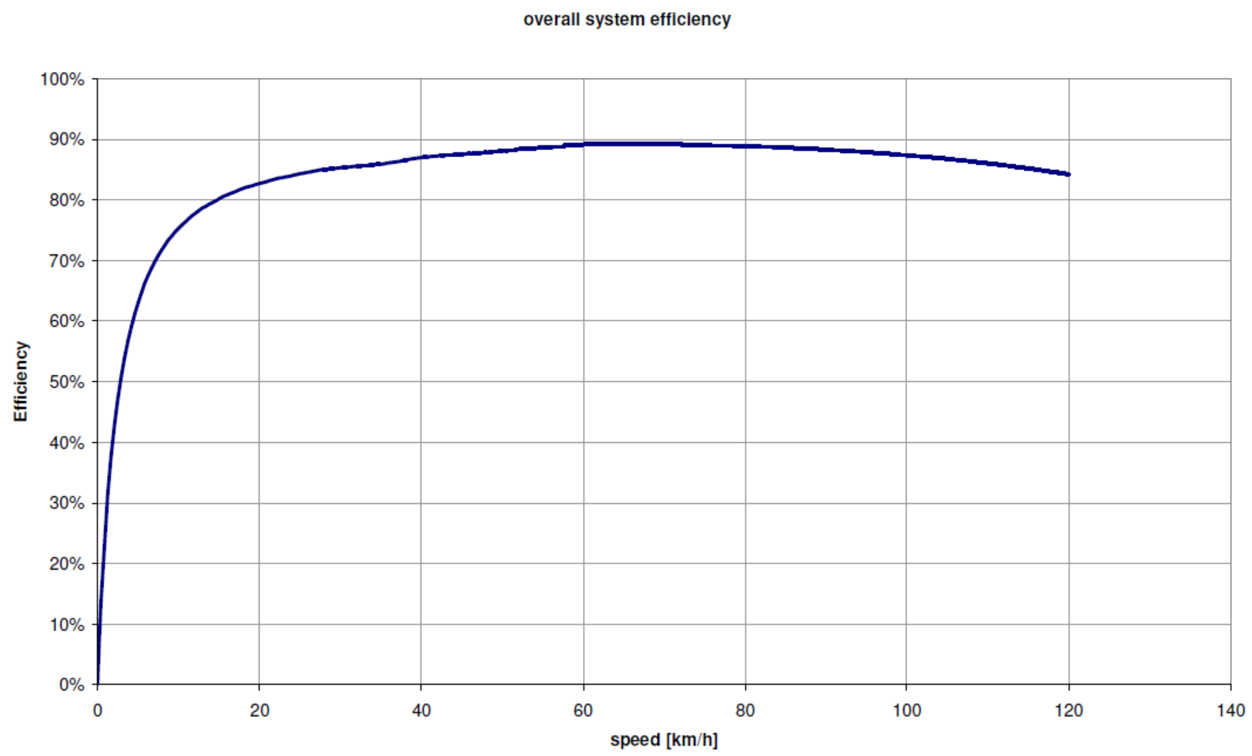
Higher carrying capacity of DPRS will reduce number of trains required for same throughput.

Specific Energy Consumption (SEC)

- It is the net energy consumption of a train per 1000 Gross Ton per km (GTKM)
- It can be an indicator of energy efficiency, only if two trains of similar weight & auxiliary load are running in the same section for given time table.
- Energy efficacy of two trains can be compared based on the % regeneration for one all-out run cycle up to a maximum service speed under loaded condition.

Factors Affecting SEC

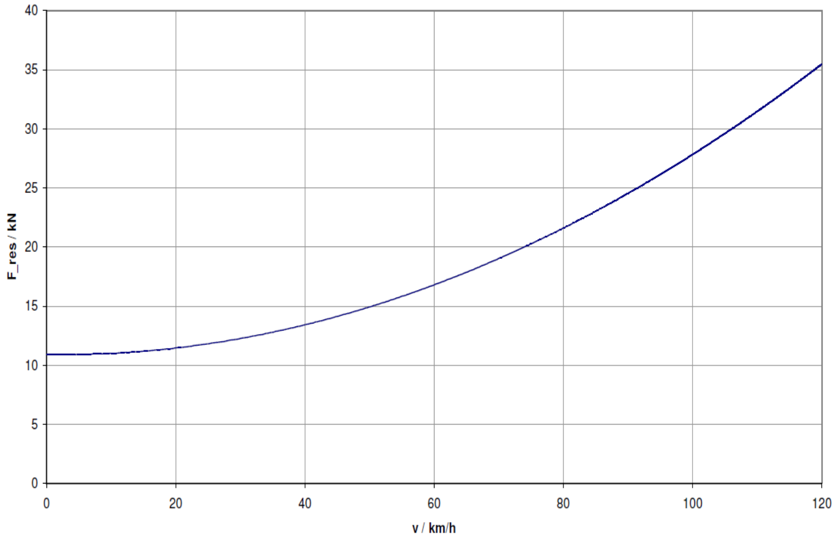
Efficiency of propulsion equipment:



Factors Affecting SEC

Train Resistance (TR):

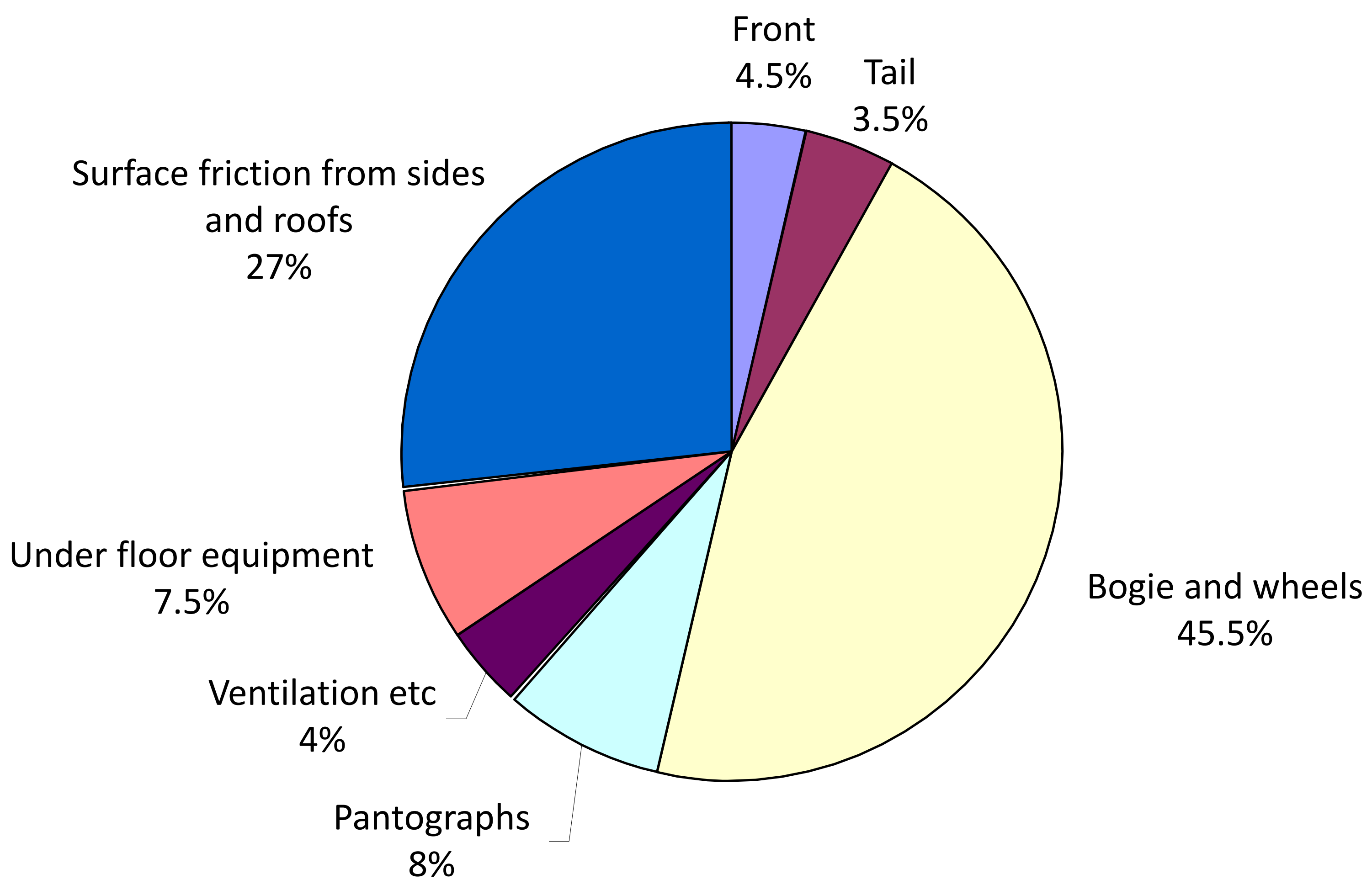
Improved aerodynamic profile of the train results in lower value of TR, especially at higher speeds. This reduces the net energy consumption of the train.



SEC versus Regeneration

- SEC of two different trains can't be compared without knowing the boundary conditions.
- With the increase in train weight, SEC generally reduces. Thus, it conflicts with the energy saving needs.
- Measurement of SEC in actual section is difficult.
- The best way is to define the regeneration requirement for one all-out run cycle.
- It is easy to measure and validate the %regeneration at pantograph level.

Aerodynamic drag of a typical train



THANK YOU