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FROM THE DIRECTOR GENERAL'S DESK

Dear Readers,

It's a pleasure to unveil the 2021 Edition of IRIMEE Journal during the Railway week.

There is continual innovation and change within Indian Railways and in the surrounding ecosystem. If we are to succeed, it requires us to keep abreast of these changes. Information about new technologies or ideas, however, tends to remain with those who are involved with it, and it doesn'tget disseminated to others in the organisation. As a Centralized Training Institute, it is our responsibility to provide a medium of exchange for ideas, innovation and best practices.

This issue contains articles about a diverse set of topics, such as the eco-smart stations, automatic sanding machines, additive manufacturing, etc. Research oriented articles such as lithium-ion battery application in rolling stock and vibration control in railway carbodyare included in this journal.

I am happy to note that several articles have been contributed by young officers who are currently on the faculty of the institute. Such writing must be encouraged because it fosters a desire to learn and to be thoughtful in presenting one's ideas.

The Journal has been published in digital format keeping in view the restrictions imposed byCovid19pandemic. I hope the readers find the selected articles relevant and useful. Please do share feedback with IRIMEE about the parts you like, the parts you don't and what you would like to see more of in the future.

Sunil Bajpai
Director General

Chapter A

Efforts Towards Eco Smart Stations of Central Railway

by

Ashok Kumar Gupta
PCME/Central Railway

Brief History: Central Railway owns the pride of running the first passenger carrying train of Indian Railways on 16th April 1853. Presently Central Railway (earlier known as GIPR) owns 4152 route kms in three states with five divisions and 468 stations. Majority of stations are now on broad gauge except Neral – Matheran and Pachora – Jamner section.

(A) Classification of Stations: Stations were earlier categorized according to earnings only and had seven categories A1, A, B, C, D, E and F. Earning norms for classification was A1 –Rs. 60 Cars & above, A – Rs. 8 to 60 crs, B- Rs. 4 to 8 Crs.. In December 2017 station classification was redefined based on earning and number of passengers handled for the purpose of commercial activities, and passenger amenities by ministry and this will be valid up to 2022-23. The classifications as per latest norms are NSG1,NSG2,NSG3,NSG4,NSG5 and Suburban Group stations are classified to SG1,SG2 &SG3 and Halt Groups-HG1,HG2 and HG3.

As per the latest norms; Non Suburban Group stations are-

NSG1- Rs. 500 Cr and above with footfall more than 20 million;
NSG2- 100 to 500 Crores with footfall 10 to 20 Million;
NSG3- 20 to 100 Crores with footfall 05 to 10 Million;
NSG4- 10 to 20 Crore with footfall 02 to 05 Million;
NSG5- 01 to 10 Crores with footfall 01 to 02 Million;
NSG6- Up to 01 Crores with footfall Up to 01 Million.

Suburban Group stations :

These stations are classified to three groups, SG1 More than 25 crores with footfall More than 30 Million, SG2 10 to 25 with footfall 10 to 30 Million crores, SG3 upto 10 crores with footfall Upto 10 Million.

Halt Group stations are also classified to three stations :

HG1- More than 50 lakh and footfall More than 3 lakhs;
HG2- 05-50 lakhs with footfall 01 to 03 lakhs,

Environment and Housekeeping Wing came into existence from 2016 and it was planned to look after the housekeeping of all A1& A category stations by EnHM wing Housekeeping of stations improved drastically with this inputs.

Stations Role in Train operation: CR operates about 2500 passenger trains daily (1800 suburban & ap; 700 Mail Exp, Passenger trains). Mumbai Suburban deals with 43 lakh passengers daily and one of largest network in the world. CR also deals with freight operation of important commodities like coal, cement, petroleum, fertilizer, onion and containers. Major portion of Trains
are operated on Automatic and Absolute block system to ensure safety. Stations play very important role in running of trains.

(B) National Green Tribunal Orders: Vide O.A. 141/ 2014 Hon. NGT passed orders on 01.10.2018 focusing on solid waste disposal, littering of solid and plastic waste, defecation along the track and removal of encroachment to improve cleanliness of stations and track. It has issued detailed list of 24 items for monitoring by Railways. Some of the major items are:-

ISO 14001, Water and Energy audit, water management, provision of dual dustbins, plastic bottle crushing machines, composting plants, MRF facility, rag picking and cleaning contracts, cleanliness monitoring through CCTV, Public awareness, provision of websites/ web link for Eco Smart stations to public. Total 87 stations are nominated as Eco Smart Stations on Central Railway by NGT which is the highest number of Eco Smart Stations nominated to any Zonal Railway.

Brief details of some importantinitiatives taken over Central Railway to achieve NGT targets are as follows:

1. ISO 14001:2015 Certification of Eco Smart Station

Central Railway owns the highest number of Eco Smart stations on Indian Railway i.e. 87 stations. As per NGT orders all such stations should be certified with ISO 14001:2015 certification. ISO 14001:2015 certification deals with environment friendly practices, it reduces waste generation and promotes conservation of natural resources like air, water, fuel etc. It is the international standard that specifies requirements for an effective environmental management system (EMS) for a unit or station. Apart from stations CR has many Workshops, Depots, Accident Relief trains etc.which are ISO 14001 certified.

Total 38 stations in five divisions have achieved ISO 14001 certification and Nagpur station has received GreenCo Certificate with Gold standard.

2. ENERGY AUDIT FOR ECO SMART STATION

An energy audit is an analysis of a facility, indicating how and where that facility can reduce energy consumption and save energy costs thereby improving its energy efficiency. As per NGT, Energy Audit is made mandatory for all these 87 stations within specific time line in which it has to be achieved.

Energy Auditing has been done at 27 stations and it is under process on remaining stations on Central Railway .Central Railway has provided 62 Energy Efficient lifts (with gearless motors and Variable Voltage Variable Frequency (VVVF) drives, 105 Escalators. All 432 stations, 2650 buildings and 9668 staff quarters have been fitted with LED lights.

3. WATER MANAGEMENT

Water Policy of Indian Railways is implemented on Central railway to improve efficiency by upgrading water supply system, introduction of SCADA, use of water efficient fittings, setting up water recycling plants, rainwater harvesting plants, sewage treatment plants and effluent treatment plants on railway land,

groundwater recharge, reuse of Grey water and recycling waste water.

A water audit is a "Systematic approach of identifying, Measuring, Monitoring and Reducing the Water Consumption by various activities in an Industry". National Green Tribunal (NGT) has directed Indian Railways to convert stations into eco-friendly stations. Central Railway is dealing with 87 Eco Smart Stations. Water Audit is mandatory at all these stations within specific time line, in which it has to be achieved.

During the year 2019-20 - Water Audit has been achieved at 25 stations and is under process at remaining stations. Total 251867 KL fresh water is saved in water consumption. Central Railway is having scope for recycling of 11421 KLD water for this 13 WRP and 01 STP already installed having capacity of waste water recycling 2946 KLD and 1200 KLD and total 80 WRPs & 1 STP are planned at stations. Rain Water Harvesting (RWH) is done at 128 locations' on Central Railway. 565 Drinking water Coolers and 8200 Drinking water taps have been provided over Central Railway.

4. SOLID WASTE MANAGEMENT

Solid Waste Management has started on Central Railway as per the Solid Waste Management Rule 2016 and also implementing NGT directives. Some of the major achievements on Central Railway in Solid Waste Management are as under:

Segregated waste transportation is introduced on 67 stations and planned for remaining stations on Central Railway. Total 5196 pairs of Steel/Plastic DUSTBINS of different sizes are provided on 77 stations for segregated collection of solid waste. Total 70 nos. of Plastic Bottle Crushing Machines are installed on 42 stations. 126 Nos. PBCM are to be purchased and to be installed through CSR. Composting Plant at Railway Station – 10 Vermi Compost Pits are developed at BSL to process wet garbage to compost manure which is used in Rail Garden. 01 Compost Pit has started at MTN W/S. A 250 Kg capacity plant is installed at Lonavala. Other small 16 nos. of In-vessels Organic Waste Compost tumbler plants are put up at 12 stations.

5.CLEANING CONTRACTS

As per the directives of Hon'ble NGT it was advised to introduce Mechanized cleaning and Rag picking for improving cleanliness at railway stations. Rag picking comes as a solution for a comprehensive waste collection system where the waste can be reused, recycled and also generate revenue for Indian Railways.

All 87 Eco Smart and other stations of Central Railway have been awarded with mechanized cleaning contracts including Rag picking and garbage segregation.

6.CCTV MONITORING FOR STATION CLEANLINESS

The CCTV (Closed Circuit Television Cameras) is installed at railway stations for round the clock surveillance by Railway Protection Force for the security of the passengers.

July 2014 the railway ministry announced introduction of CCTV again for monitoring cleanliness operations and also to honour the Hon'ble NGT directives.

71 stations have been installed with 2400 Nos. CCTV as per the requirement and are now monitoring cleanliness activities.

7. ANTI LITTERING MEASURES ON CENTRAL RAILWAY

In a major move and as a great relief to the Indian Railways The Hon'ble National Green Tribunal (NGT) announced a fine of Rs. 5000/- on persons spotted littering or throwing wastes on tracks. This enforcement has paved the way for helping the railways in maintaining cleanliness and sanitation to a great extent.

Teams of RPF, TTEs & CHIs are formed to check littering in Railway premises and open defecation on track. Innovative posters with film dialogues are provided at all important locations. Total 21003 cases were registered and penalty of Rs. 29.46 were recovered from these polluters in the year 2019-20.1187 point of sale machines have been provided for paperless tickets through electronic transaction. WiFi system provided in 313 stations also help in paperless ticket booking.

8. ACTION ON ENCROACHMENT

National Green Tribunal (NGT) has made mandatory to free Encroachment along the Track which are creating nuisance in all these stations with specific timeline in which it has to be achieved.

Central Railway has achieved the target and 85 stations are free from encroachment along the track.

9. ILLEGAL DUMPING ALONG BOUNDARY WALL

NGT in its order has suggested observing CPCB guidelines, polluters pay etc. The Railways has decided to deal with the menace once and for all by building concrete walls along the tracks. Concrete walls are more durable and long lasting.

As on date only 04 locations with illegal dumping in railway premises are there and action is underprocess to remove them. 84 locations require the Boundary Wall to prevent unauthorized dumping on railway land. Authorities are nominated to tackle the polluter on railway Land. 174 Nos. large size Garbage bins are installed.

10. TOILETS ON CENTRAL RAILWAY

Having access to toilets is very important in terms of health. It is one of the key factors for hygiene and sanitation. In its initiative to provide clean toilet facilities central railway adopted Pay and Use policy of toilet. This was an initiative to bring awareness about cleanliness, prevent misuse of railway toilet property and keep toilets clean.

Central Railway has provided 141 toilets on station premises including 58 Pay and Use toilets, some Deluxe toilets, air-conditioned luxury toilet, toilets for Divyangjana and separate ladies toilets etc.

11. BIO-TOILETS

Vide Parliamentary Accounting Committee (PAC) report of 2014, with 1.4 Crore passengers on 9000 trains, Indian Railway was generating about 4000 MT human waste every day which directly dropped on track polluting the environment. As on World Environment Day i.e. 05.06.2020 more than 99% coaches of Central Railway have been fitted with bio-toilets., i.e. about 18000 Bio toilets in 5000 coaches are provided.

The provision of Bio-toilets has brought about a drastic change in cleanliness of platforms and tracks. These Cleanliness sustained Bio- toilets have helped in minimizing the use of water for platform cleaning and also reducing bad odour resulting in clean – green railway tracks and platforms. Central Railway observes World Toilet Day every year on 19 December. Bio toilet cut models are displayed at all major stations with Videos and pamphlets for awareness of passengers.

12. DEVELOPMENT OF GREEN PATCHES

1. Nurseries opened at 15 places on Central Railway in October 2019. This will help in improving self dependency related to plantation activities. Quality saplings will be produced in house.
2. Everhighest Plantation of 6.74 lakhs saplings done in 2019-20 all over Central Railway.
3. Smruti Udyan in Solapur and plantation at Chink Hill Railway station near Kur duwadi is a good development of green belt in SUR division.
4. GIPR dam at Ambernath 55 acres of land has been developed for plantation showing good survival.
5. Railways has entered into MOU with the state Forest Department with a view to increase Afforestation and improve the Eco system.
6. Bhusaval division has made arrangements of solar pump for watering plants and also made provision for drip irrigation for bare minimum water consumption. Mass and dense plantation is done near Raver station.
7. Plantation locations are regularly inspected by Environmental officers and more than 90% survival is achieved.

13. OTHER INITIATIVES

1. Web Link for all 87 Eco Smart stations is provided with web link of Central Rail way site for receiving complaints and suggestions.
2. Provision of battery operated E-vehicles having zero air and noise pollution at stations for movements of senior citizens, divyangjanas, pregnant ladies and other needy passengers.
3. Central Railway has developed 8 green stations where renewable energy sources like Solar panels, Wind mills are in use.

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Chapter B

Condensed Steam Recovery System of Mechanized Laundry Malda Town

by

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Malda Town

Washing of linens by mechanized Laundry have involves a number of chemical reactions – reactions that go faster at higher temperatures. So, along with chemicals and mechanical energy, the thermal energy is also equally important for laundry. Thermal energy has been produced in laundry by help of the Boiler. Boiler is an integrated part of the mechanized Laundry system. The steam generated in the Boiler is being utilized in washer cum extractor, dryer and calendaring /Ironing Machines of laundry. The latent heat of saturated steam use to energize the chemical (Washing) at different temperature of washer cum extractor machine, apart from that, steam also boosts the temperature of inside the washer drum, causing fibres to relax and more efficiently absorb water by releasing deep- down dirt and stains of linen. Steam softens the fabric of the linen and also work as wrinkle reducer.

Diesel oil/HSD is being used as fuel to generate the steam from the boiler at 10 kg/cm2 pressure and 185 degree centigrade temperature.

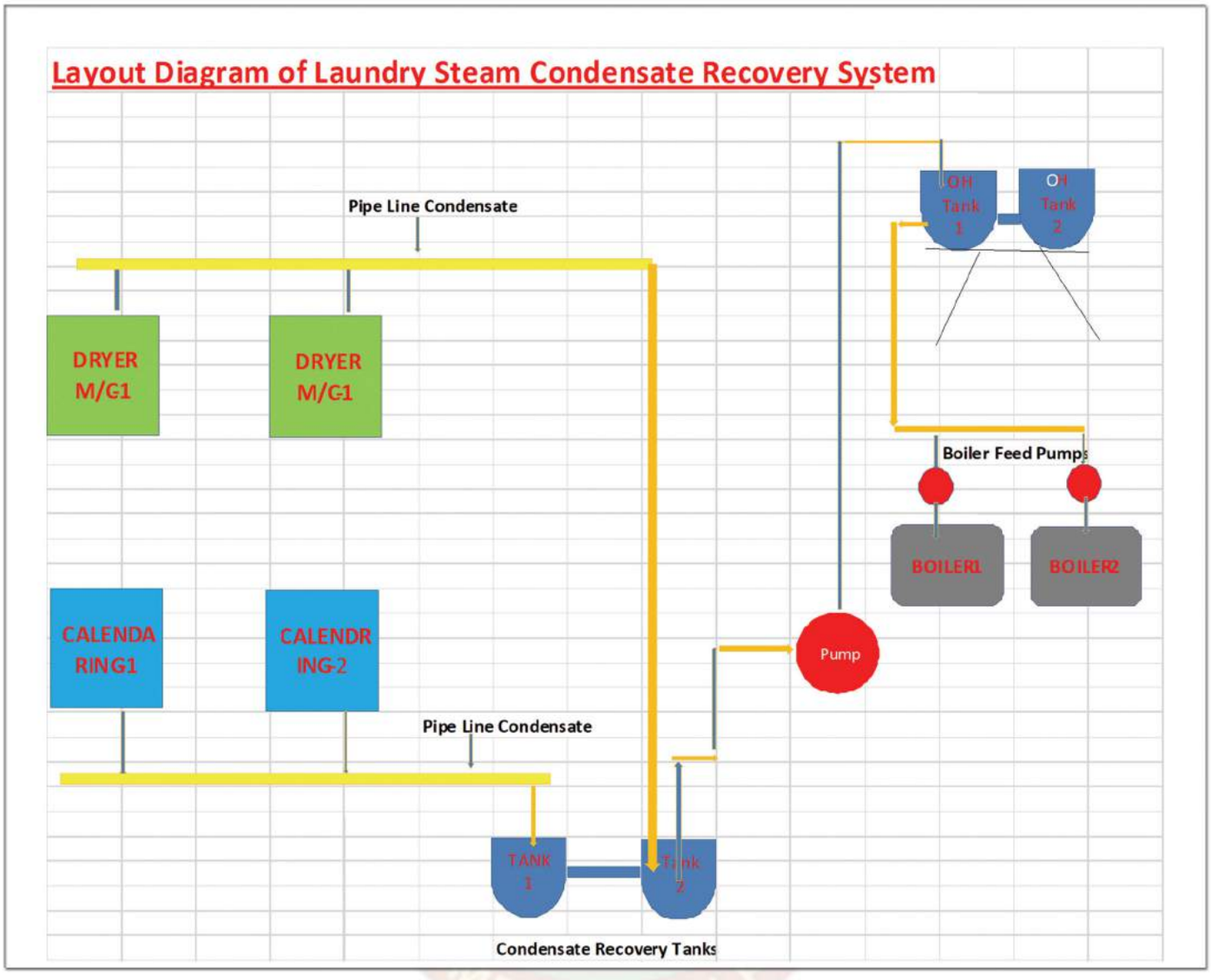
After processing of steam in Dryer & calendaring machine the temperature & pressure of steam become reduced and being released to atmosphere in the form of low pressure semi saturated steam as a waste water. These exhaust steam (after Processing) having a lot of thermal energy which was exhausted to atmosphere in the form of waste. Mechanized laundry Malda have locally developed a system condensate recovery system by utilizing the scrap material of coaching depot to recycle the waste condensed steam of laundry in closed system for save the energy & water.

Working Principle

The exhaust & by pass steam of 02 Nos calendaring Machine ,02 Nos Dryer Machine and all pipe line condensate are being collected in a set of 02 Nos Aluminium made Roof mounted coach water tank which are connected in series by common header pipe. The low pressure exhaust steam is being condensed in these tank. The whole collected condensate is pumped to a 900 litre overhead tank (02 Nos Aluminium made Roof mounted coach water tank which are also connected in series) with help of an automated booster pump (1to 1.5HP). The condensed feed water is being utilizing in a continuous feed water for boiler because the Boiler feed water pipe is connected to condensate water over head tank with help of bypass valve. MLDT

STEAM BOILER

Lay Out Diagram:-



Steam Condensate Tank:-

Calculation of savings :-

Savings in water requirement of Boilers:-

Steam condensate is collected in 0 2 nos. of water tanks interconnected together.
Volume of each tank = 450 Litres.
Total volume of tanks together = 450 x 2 = 900 liter
Collection of condensate per day = 04 times (Depend upon working Hrs of Laundry and capacity)
Therefore total collection of condensate per day = 4.0 x 900 liter = 3600 liter.
Considering a loss of 7% to compensate for evaporation and to account for the empty space in each tank = 252 liter
Therefore total collection of condensate per day = (3600-252) = 3348 liter
Cost of supplying one liter of water to MLDT/Laundry = Rs.0.50/-
Therefore total savings in water = 0.50 x 3348 per day = Rs.1674 per day.

Savings in fuel requirement of Boilers:

Quantity of recovered water per day = 3348 liter
Temperature of recovered water = 55 oC
Sensible heat required to raise temperature of water from room temperature of 25 oC to 55 oC = m s (t2-t1)
Where m= mass of recovered water
= 3348 K.G. (Assuming Sp. Gravity to be 1)
S= Specific heat of water = 1 Kcal/kg/ oC
t2-t1 = raise in water temperature = (55-25) = 30 oC
= 3348 x 1 x 30 = 100,440 Kcal

Quantity of diesel required to produce this heat = 100440/ (Cal. Value of Diesel x Efficiency of Boiler)

Calorific value of Diesel = 45 MJ/KG
= 45/4.1868 x 103 Kcal/KG
= 10,748.06 Kcal/KG

Efficiency of Boiler = 90%

Therefore quantity of diesel saved = 100440/ (10748.06 x 0.9)
= 10.38 K.G.
= 10.38/0.83 Litre (Density of diesel 0.83 KG/Liter)
= 12.5 litre

Cost of Diesel per liter = Rs. 77 (As per latest Market rate.)

Cost of Diesel saved = Rs. 12.5 x 77 = Rs. 962.50/- =963.00

Total Savings per day = Rs. 963.0 + Rs. 1674 = Rs. 2637/-

Total savings per month = 2637 x 365/12 = Rs. 80208.75/- =80209/-

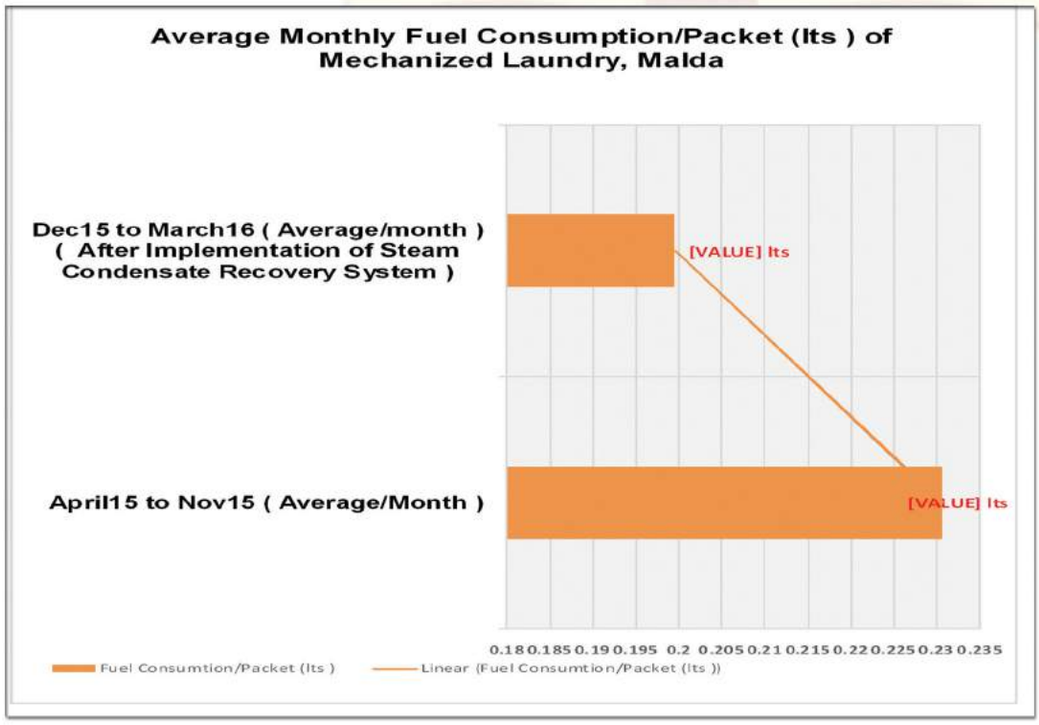
Total Savings per year = 80209 x 12 = Rs. 962508/-

Mechanized Laundry

Benefits:-

1. Annual savings of Rs. 9,62, 508/-in respect of Diesel cost and working Hrs of laundry may varies.
2. Water conservation for recycling of condensed steam.
3. Boiler Maintenance cost will be reduced due to use of condensate water.
4. Reduction of water treatment cost.
5. Per packet Linen Washing Cost will be reduced

Performance Report of the system:-



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Chapter C

Lithium-ion Batteries in the Rolling Stock Technology

by

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/IRIMEE

Abstract: Lithium-ion batteries have brought about a revolution in the modern world. In 2019, the sales of Battery electric vehicles crossed a total of 2 million units worldwide. While the road transport sector moves towards electric vehicles, rail transport worldwide is also looking towards cleaner and cost-effective alternatives. This article introduces the various battery-operated trains being developed across the world and compares it with fuel cell technology.

Introduction

According to the International Energy Agency (IEA), only 0.3% of global CO2 emissions from fossil fuel come from the rail transport sector. However, the emission differs for the individual train, depending on whether it is electrical or diesel-powered. In the case of an electrically powered train, the source of electricity generation determines the amount of carbon emission it will produce. A comparison of emission produced through different fuel sources is shown in Fig 1 [1].

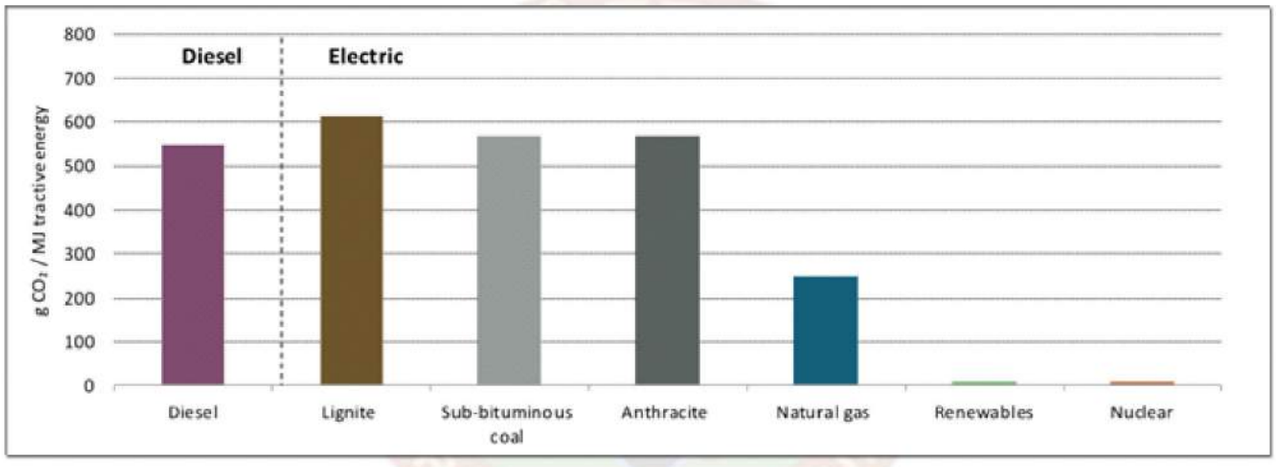

Fig. 1 gmCO2 emission per MJ of tractive energy produced with different fuels.

In addition to being a cause of major environmental concern, electrification is sometimes financially unviable as well. Electrification requires high fixed costs for installing the transmission lines, transformers and for generating power. As a solution for low-density passenger and freight lines, new carbon efficient alternatives are coming up. The most viable as it seems are rechargeable energy storage systems such as batteries or hydrogen fuel cells. These can be used to power the traction motor or auxiliaries as per the load requirement [2].

Battery Powered Trains

Li-ion battery technology finds a wide application in our day to day lives. From smartphones and laptops to portable gadgets, it is ubiquitous and also presents a solution for cleaner rail transport in the form of battery-electric hybrid trains. The reason for such huge applicability of the battery is the advantage that it offers over other rechargeable batteries, such as high energy density, no self-discharge, low-maintainability, longevity etc.

Aside from emitting no NOx, battery-powered trains are 50% quieter than diesel. They can run reliably on non-electrified parts of the network, or portions that are prone to power outages. The catenary-free operation has already exceeded a range of over 100 kilometres on battery power during tests. According to a Norwegian study, partial electrification combined with traction batteries is the preferred solution for non-electrified routes [3].

A battery-electric multiple unit (BEMU) is an electrically driven multiple unit or railcar whose energy is derived from rechargeable batteries that drive its traction motors.Fig. 2 illustrates the working of a catenary-Battery hybrid train.

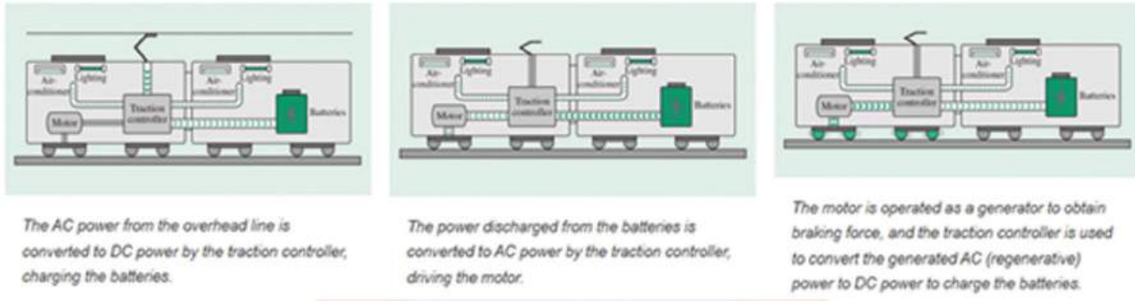

Fig. 2 Operation of battery electric trains: a) Energy flow on electrified line sections, b) energy flow on non-electrified lines during powered travel, and c) energy flow on non-electrified lines during power regeneration. Source: Nagaura et al. (2017).

On the electrified section, batteries get charged through a traction controller housing a rectifier and an inverter. When the train reaches non-electrified section, the batteries drive the traction motors through the traction controller which converts the DC power to AC. The regenerative braking power is also stored in the battery.

The current status of battery-electric trains in commercial service (top) and as prototypes (lower) is depicted in Table 1.[2][4]. The displayed range is the length of line segment operated.

Year	Producer	Operator	Series/Model	Development Stage	Segment	Battery Size (kWh)	Range (Km)
2014	J-TREC	JR East	EV-E301	Commercial operation	Passenger	190	20.4
2016	Hitachi	JR Kyushu	BEC819	Commercial operation	Passenger	360	10.8
2017	J-TREC	JR East	EV-E801	Commercial operation	Passenger	360	26.6
2020		JR Central	Shinkansen N700S	Commercial operation	Passenger		
2015	Bombardier		Electrostar modified Class 379	Prototype	Passenger	500	50
2018	Stadler		Flirt Akku	Prototype (Production ready)	Passenger		150
2018	Vivarail		Class 230 D-Train 30002 variant	Prototype	Passenger	424	64
2018	Bombardier		Talent 3	Prototype	Passenger	300	40
2018	Siemens Mobility	ÖBB	Desiro ML Cityjet	Prototype	Passenger	528	80

JR-East is operating the EV-E301 and EV-E801 series BEMUs, produced by Japan Transport Engineering Company (J-TREC) on commercial lines since 2014. Are-charging facility is built at the last station of the electrified section, enabling the train to be recharged via its pantograph. The BEMU then continues its journey on the non-electrified section on battery power. Similar arrangements are available for the other lines. In the Shinkansen N700S series launched in July 2020, the purpose of Lithium-ion batteries is to power the train till the next station in case of a power outage.

Bombardier developed and tested a modified version of the existing Electrostar Class 379 trains by equipping it with lithium iron magnesium phosphate (LFMP) batteries. In 2018, a Bombardier Talent 3 electric-battery hybrid prototype train was introduced at Henningsdorf [5]. The prototype is equipped with four traction lithi-um-ion MITRAC batteries with a range of 40 km, and total capacity of 300 kWh. There are multiple ongoing projects across Europe with a plan to launch BEMUs into commercial service as soon as possible.

Fuel Cell trains

Many types of fuel cell are available, but the proton exchange membrane fuel cell (PEMFC) is the most suitable for transport applications due to its low operating temperatures, high efficiencies and energy densities, and low emissions[6]. Table 2 lists the fuel cell trains (hydrail).

Year	Producer	Operator	Series/Model	Development Stage	Segment	Hydrogen storage (kg)	Range (Km)
2018	Alstom	LNVG	Cordia iLint	Commercial operation	Passenger	89	1000
2017		JR group		Prototype	Passenger		
2018	BCRRE/ Porterbrook		Hydroflex	Prototype	Passenger	20	
2018	Vivarail		Modified Class 230	Prototype	Passenger		1050
2018	Siemens Mobility		Mireo Plus H	Prototype	Passenger		

Table 2. Status of Hydrail in commercial operation and prototype testing.

The hydrail is a relatively new concept in contrast with the BEMU. However, Alstom has succeeded in putting hydrail named Coradia iLint into commercial op-eration since September 2018. The iLint has underframe-mounted traction motors driven by a traction inverter. On the roof is a Hydrogenics HD200-AT power pack containing six HD30 fuel cells and hydrogen tanks. With a polymer inner liner, cov-ered with carbon fibres soaked in resin and wrapped in fibreglass, these tanks store 89 kg of hydrogen (on each car) at 350 bar. Also mounted on the underframe is a lithium-ion (NMC) battery pack and an auxiliary converter,

to provide drive power and store braking energy (111 kWh battery system power at 800 V) [7]. The HD30 fuel cell has an output of 33 kW and weighs 72 kg. On a full tank, it can run up to 1000 km. Various other prototypes are being tested in Japan, UK etc.

Comparison between BEMU and Hydrail

The battery-electric hybrid trains and hydrogen fuel cell both offer their own set of advantages and disadvantages. The battery-operated trains have a shorter range of operation as compared to hydrail, but it offers the possibility of modification in the existing train sets, thereby cutting on cost. Besides, the investment needed in infrastructure is considerably lower. The BEMUs are therefore suited for shorter non-electrified sections. It also makes it an ideal choice in the case of city transport (subway or tram etc) as it provides NOx free power.

The hydrail, on the other hand, maybe more suitable than BEMU for the heavier loads and longer journeys, which may or may not be associated with freight. Due to non-catenary operation, the interoperability in different countries is also possible. However, the production, storage and distribution of hydrogen is a hazard and needs to be taken care of.

One important factor in hydrogen power fuel cell is the way hydrogen is produced. Currently, 98% [8] of the Hydrogen is derived from reforming of natural gas, conveying high life cycle emissions. Clean methods of Hydrogen production are therefore needed in order to achieve the zero emission target.

Conclusion

Battery as well as hydrogen fuel cell technology have the potential to be technologically mature in the next decade, and there may be some degree of complementarity between them, as the Lithium-ion battery offers the storage solution for excess energy production by the hydrogen fuel cell. Using hybrid BEMUs can be a particularly good solution for short, non-electrified routes where diesel needs to be done away with and electrification is not financially justified. However, a major change in transport technology is only possible with the support of adequate infrastructure.For now, the Fuel Cell train is more suited to a longer range of operation. The prospect of the Lithium-ion battery may improve in the future with an improved range of the batteries.

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Chapter D

Vibration Control in Rolling Stock Carbody using Piezo-electric Patch Configuration

by

Silabhadra Das,
Professor, IRIMEE

Abstract: Lighter Railway car-bodies are preferred for High Speed Rail Transport due to its fuel efficiency. Vertical bending vibrations in low frequency range of 0-10 Hz become prominent in light car-bodies. This study summarizes some of the research carried out in the field of vibration control in train car-bodies. Further, a semi active vibration control methodology for suppressing multiple modes of vibration of a car-body shell model is elucidated.

Key Words: Vibration control, Piezo-electric patch configuration, Railway car-body, Simulation analysis

1. Introduction

Vibration control in a railway coach or car-body is a big challenge which railway engineers are facing off late. Vibration in trains causes discomfort and fatigue to the passengers seated in the train car-body. The vibration in railway trains emanates from wheel to rail interaction and the rail track irregularities. These give rise to lateral and vertical vibrations.Bogies act as a connection between the axle and wheel set and the car-body. They may contain primary and secondary suspensions, vertical, lateral and yaw dampers etc. The suspensions and dampers are designed to damp the lateral and vertical vibrations originating from the wheelsets. These bogie suspensions and dampers effectively damp high frequency vibrations but are ineffective in damping low frequency vibrations [1].

In order to achieve higher speeds and improved specific fuel consumption, railway production units are manufacturing lighter railway car-bodies. Lighter car-body structures have prominent low frequency bending vibration modes. These low frequency bending vibrations are transmitted to the car-body further causing structural noise. Studies in the field of ride comfort for passengers in railway applications mention that the human body is most sensitive to vertical vibrations in the frequency range of 4-10 Hz [2].Therefore,it is important to control the elastic vibration of the car-body train in order to improve passenger comfort.

2. Literature review

The conventional method for reducing elastic vibration is to increase the stiffness of the car-body; however, this method also causes the car-body mass to increase. There have been quite a few studies in the field of car-body vibration suppression in the past few years. Carlbom [3] stated that the car-body flexural modes have a significant contribution towards vertical vibrations. These vertical vibrations can be controlled by active control which involves utilizing a feedback/feed forward control system along with a controller to suppress vibration. Sugahara et al. [4] controlled car-body elastic vibration by using damper control system for vertical dampers dampers based on Linear

Quadratic Gaussian (LQG) control and sky-hook damper control, respectively, and the vibration reduction was compared. Foo and Goodall [5] installed a PI control-based hydraulic servo actuator below the middle part of the car-body in order to control the car-body flexural vibration, thereby achieving a good control effect.

Gong et al. [6] used secondary active suspensions which designed based on optimal control method that considering track irregularity spectrum in order to reduce the vibration transfer from the track to the middle part of the car-body. Schandl et al. [7] utilized multiple piezo-stack actuators, which were respectively installed in the car-body side beam. Then, the elastic flexural vibration of the car-body was suppressed through the design of the controller based on the optimal control theory. These active control systems for reducing car-body vibration are structurally more complex, expensive and the maintenance is also difficult. As a result, active vibration control systems are not yet widely applied in the railway industry.

Passive vibration control methods may employ Tuned mass damper/Dynamic vibration absorbers, dampers or structural modification to tackle vibrations in coaches. Takigami et al [8] used piezo-electric elements (PZT) bonded to the floor of a 1/5th scale railway car-body model and conducted passive vibration control. Passive control measures are less expensive and easier to maintain. On the downside, the damping performance obtained is limited and the robustness towards system parameter changes is poor. Irrespective of the control strategy adopted, the first step of vibration control is the determination of target bending modes and target bending frequencies. This can be done on simulation platforms, which perform Finite element modelling, such as ANSYS or SIMPACK. In ANSYS, the car-body is designed on a Design modeler window. After meshing/discretization, the modal analysis of the objective structure is carried out. The results of modal analysis provide the bending modes. The modal analysis result from a study conducted by Gong et al. [9] on a high-speed EMU is depicted in Fig. 1.

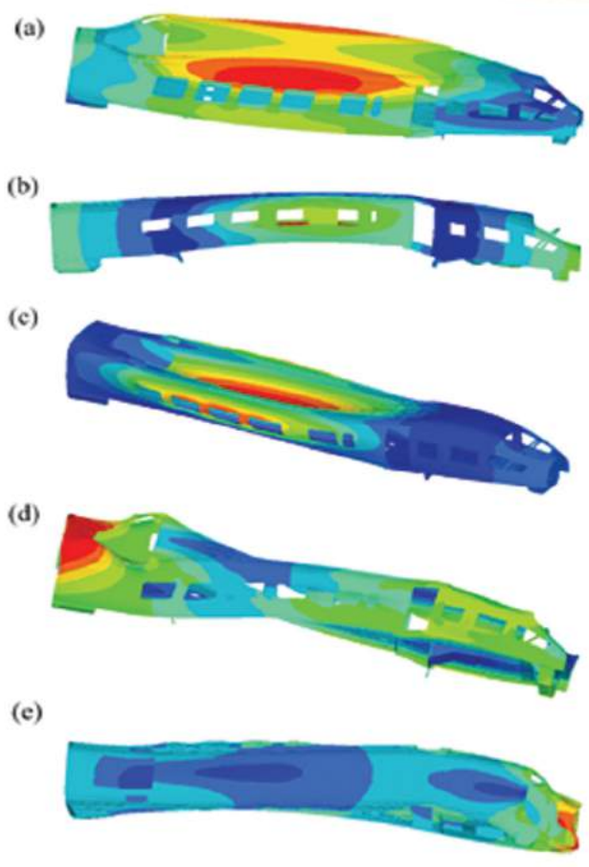

Fig. 1. The first 5 modes of the car-body of an EMU trainset:
(a) diamond-shaped deformation mode at 7.817 Hz;
(b) first-order vertical bending mode at 9.243 Hz;
(c) breathing mode at 10.222 Hz;
(d) first-order torsional mode at 10.569 Hz;
(e) first-order lateral bending mode at 12.079 Hz[9]

The next step is harmonic analysis to obtain the frequency response of the car-body. The frequency response plots the vibration acceleration amplitude versus the frequency of vibration. The harmonic analysis aids in identifying the target modes for vibration control. The target modes are the modes that make the greatest contribution to the vibration energy and ride quality of the car-body.

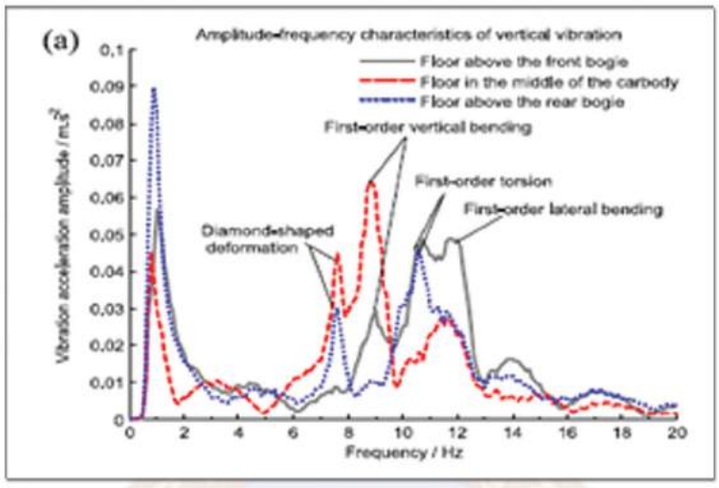

Fig. 2. Vertical vibration acceleration spectra at car-body centre for an EMU at 200 kmph[9]

3 Semi active vibration control of scaled car-body model

In this section, the research study conducted by the author is briefly summarized. In this study, the problem of car-body vibration suppression was addressed for a double shell car-body model. A semi-active vibration control methodology employing a Piezo-electric Patch Configuration (PPC) and a multi-mode shunt circuit is proposed to suppress the low frequency vibrations around the railway car-body bottom floor center. Finite Element method was used for modelling, modal and harmonic analysis of the car-body structure in ANSYS 19.1. Coupled Field Analysis was done to simulate the PPC and the shunt circuit integrated with the car-body model. Experiments were carried out on the 1/12th scale railway car-body model to validate the simulation results.Double shell model consists of an inner shell hanging within an outer shell by an intermediate clamping mechanism, as in “Fig. 3”.

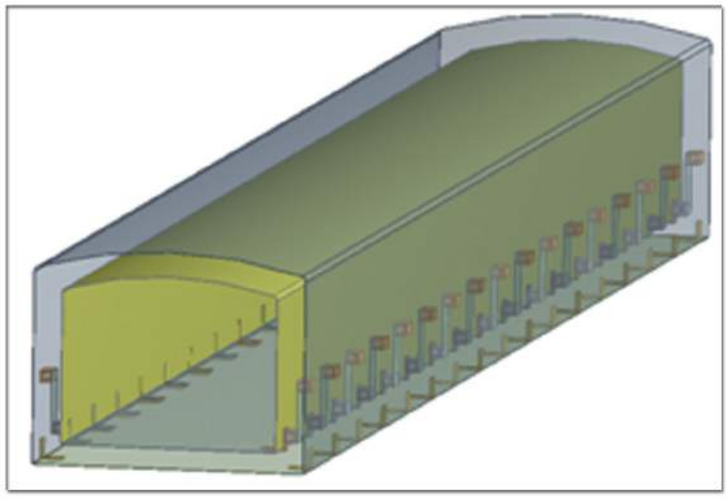

Fig. 3 Double shell Car-body model

A Piezo-electric Transducer (PZT) has electrical properties similar to that of a capacitor. It has two terminals. The PZT absorbs the strain energy in the objective structure caused due to bending deformations. The absorbed energy causes a charge distribution inside the PZT leading to potential difference across its terminals. A shunt circuit is connected across the PZT terminals, the current may be dissipated across the resistive elements of the shunt circuit in the form of joule heating resulting in suppression of vibrational deformation. To damp multiple modes in the model, a single piezo-electric element (PZT) would not be enough. An array of piezo-electric elements, electrically connected in parallel configuration, localized around the point where we intend to suppress vibrational deformation, is termed as a Piezo-electric Patch Configuration (PPC). The standard PPC in this study consists of 10 C-6 PZT of Fuji ceramics corporations symmetrically localized around the floor plate center of the car-body.

In order to suppress bending vibrations on the floor of railway car-body, the proposed PPC is shunted by an electrical impedance. This technique is known as a semi-active shunt damping employing a shunt circuit. The simplest type of shunt circuit is the series L-R shunt circuit capable of damping a single bending mode only. Since, the objective is to damp multiple bending modes i.e. 3 modes , a multi-mode shunt circuit is utilized. The principle of this circuit is to parallely connect three branches, each branch consiting of a current blocking circuit i.e. a parallel L-C circuit, in series with a L- R shunt circuit.

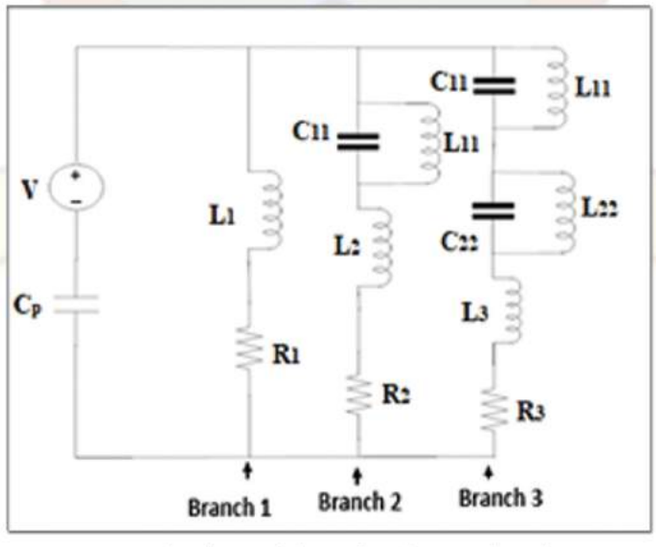

Fig.4. Multi-mode shunt circuit

4 Simulation analysis

The modelling of a single shell car-body was done in design modular window of ANSYS workbench. The finite element analysis in this study requires a structural electrical coupled field analysis. Modal analysis feature in ANSYS workbench gives us information about the bending modes of a continuous system. Simply-supported boundary conditions for car-body were defined. Harmonic analysis provides the amplitude of car-body acceleration and displacement.

5 Experimental analysis

The experimental setup has been depicted in Fig.5.Since the inductance values required in the shunt circuit are on the higher side, Gyrator circuits were used to virtually realize inductances. These gyrator circuits are made using combination of LF-356N operational amplifiers, resistors and capacitors. Op-amps require constant voltage power input of ±12 V, thus making it a semi-active shunt circuit. The shunt circuit is fabricated on a Printed circuit board, as in fig. 6, for experimental trials.

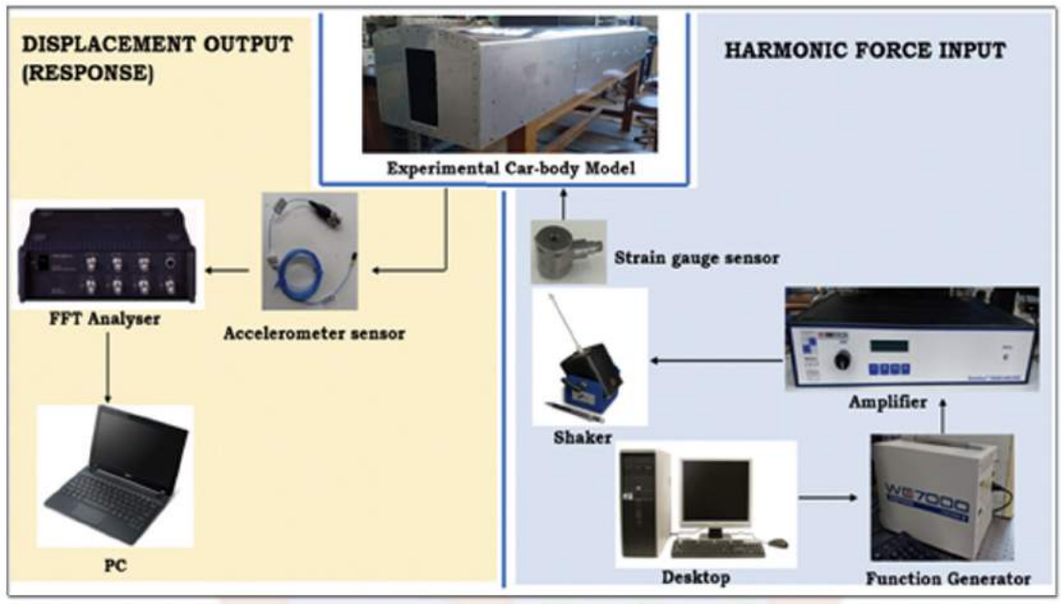

Fig.5 Experimental set up

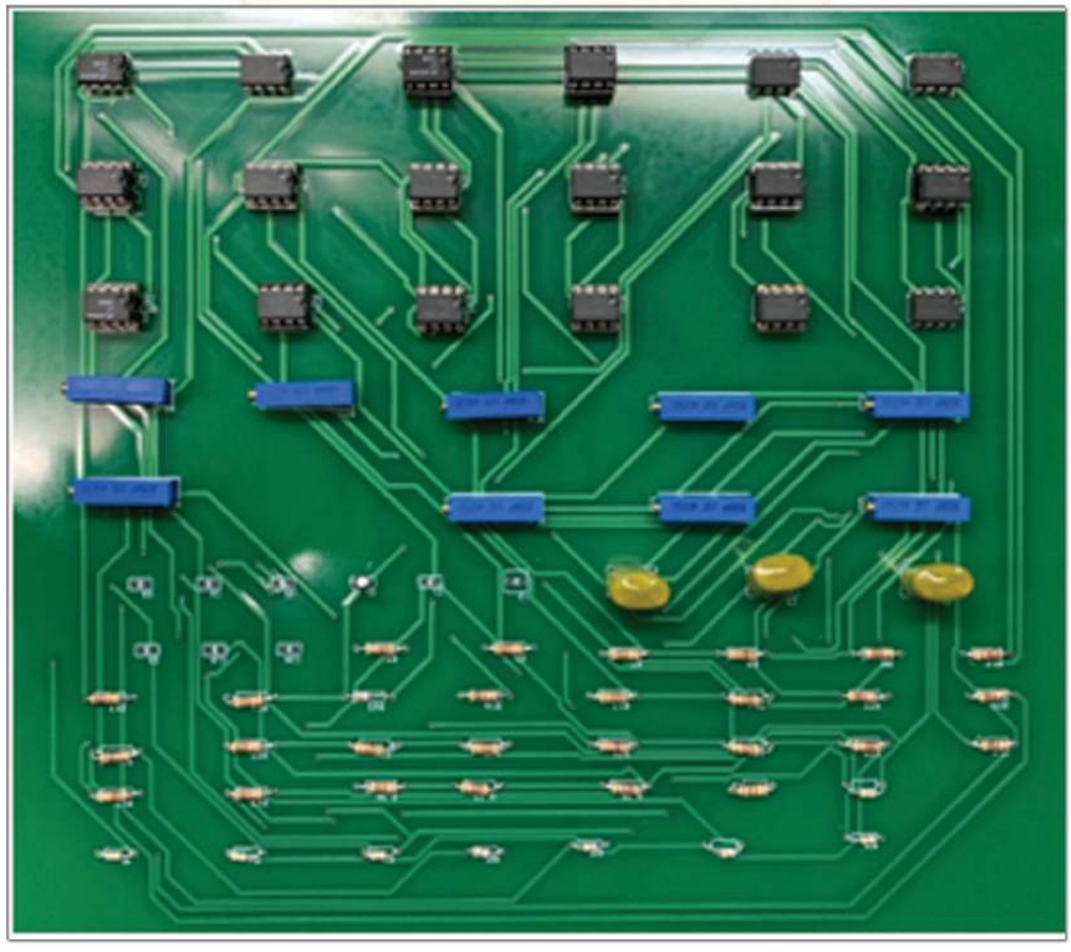

Fig.6 Printed Circuit Board layout of shunt circuit

6 Conclusion

The multi-mode shunt circuit simulated in ANSYS 19.1 effectively produced vibration suppression of 4.6 dB, 4 dB and 4.1 dB of the first, third and fifth modes whereas the same for experimental analysis produced damping of 3.2 dB, 4.1 dB and 2.5 dB. The experimental analysis and simulation analysis results show a reasonable correlation with each other across the damped and undamped models. The variation in modal frequency and amplitude can be attributed to slight difference between actual car-body and modelled car-body. Moreover, shunt circuit losses and hysteresis loss of PZT element cause the difference in percentage of vibration suppression across experimental and simulation models.

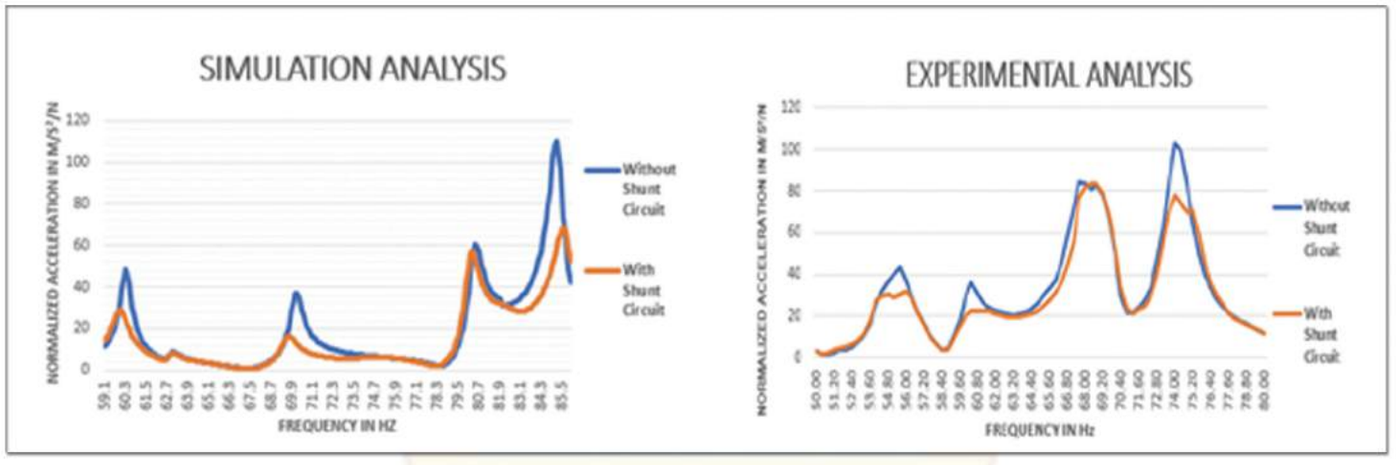

Fig.7. comparison of damped and undamped frequency response

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Chapter E

In House Development of HOG Simulator Testing Kit

by

Ashok Kumar
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Coach Complex

Abstract: The objective of this paper is to present the innovative effort by the team of Rajendra Nagar Coaching Depot to develop Head On Generation (HOG) Simulation Kit for LHB Power Cars. Thispaper highlights the purpose of the developed Kit viz.HOG compliancy, test of automatic re- closing of contractors for automation restoring of power supply after crossing the neutral section. This paper also highlights the communication through UIC cable between power car and locomotive and other circuitry related to HOG and their proper working.

Introduction

In HOG scheme, power is fed from the electric locomotive to the train to caterfor the Hotel Load of the train. In electric locomotives, power is taken from theOHE through pantograph to traction transformer of the locomotive which isprovided with a hotel load winding of 945 kVA, at nominal voltage of 750 Vsinglephase, which varies with the OHE voltage variations. This 750 Voltssingle-phase supply is fed to Hotel Load Converter, which gives 750 Volts 3-phase 50 Hz supply as output, for feeding the hotel load of the train.The three-phase ou put supply of the hotel load converter i.e. HOG system istransmitted to both the feeder of the existing EOG train through IVcoupler.

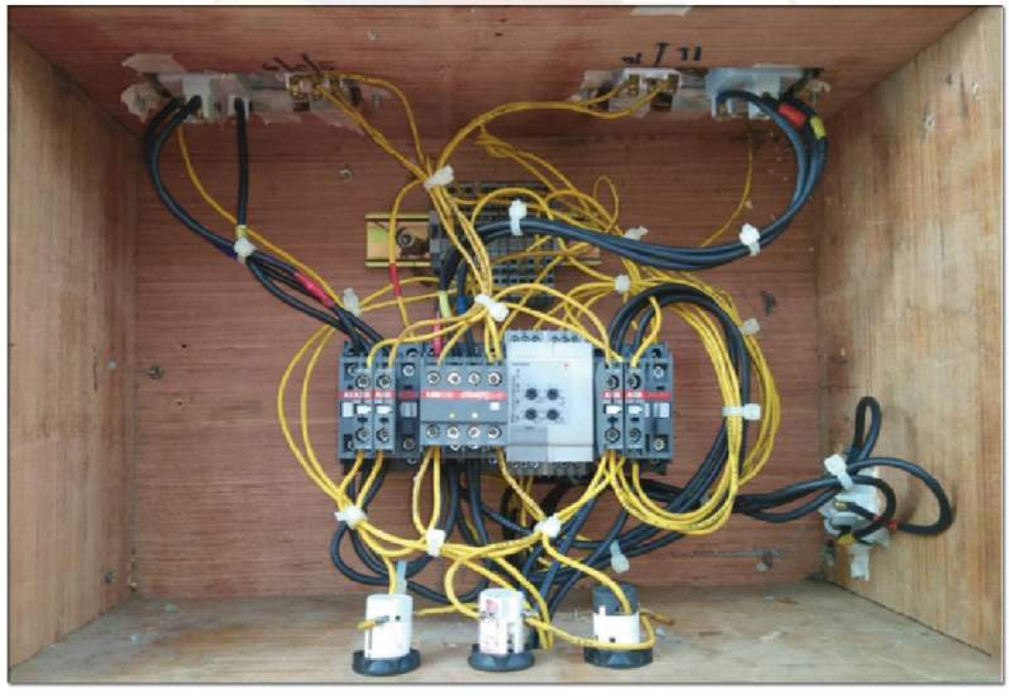

Fig1. Internal View of the Kit

At present more than 50 Numbers of HOG compliant power cars are in service for LHB rakes at RNCC Depot. As per Railway Board's directive the entire LHB fleet of ECR was converted into HOG compliant mode by October 2019. Other zonal railways have also achieved 100% conversion thereafter. The operation of trains in HOG mode is important to save the cost of HSD, reduce noise and environment pollution and reduce the wear and tear of power car generators leading to reduced maintenance cost. Therefore, the reliability of HOG circuitry had to be ensured before the rakes were to be turned out for service. This could be ensured during testing when electric locomotives were attached to the

rake either on the pit line or at stations. Sometimes when the rakes were attached to electric locomotives, there were doubts as to whether the HOG circuits of loco or rake were functional or not. Many OEMs were contacted to provide means for testing the rakes independent of locomotives. Since, there was no positive response, there was no testing facility to check whether HOG circuitry of power car is healthy or not before service. Coaching depot RNCC has developed a highly portable HOG testing simulator kit to resolve this problem.

Fig2. Arrangement of Simulation Kit

Function of HOG Simulation Kit

- Tests the HOG function of powercar
- Test the automatic re-closing functionality of contactors for automatic restoring of power supply after crossing the neutralsection
- Tests the communication through UIC cable between power car and locomotive and other circuitry related to HOG and their properworking.

Scope of HOG Simulation Kit

All HOG compliant power cars can be tested for HOG working by using this kit.

Working Principle of the HOG Simulation Kit

The testing kit basically consists of transformer, LT & HT MMR, MCB, contactors, rectifier, female ZS couplers, UIC socket for communication etc. After the transformer of the kit gets energized, 750V, 3 phase power supply through HT MMR is available on input side of the HOG contactor 1 &2. These contactors close when 110V DC supply energize the closing coil of the contactor separately. When rotary switch of the HOG control panel provided in power panel of power car, is turned to HOG mode, 110V DC circuitry gets completed through UIC cable & the closing coil of the contactor energized and hence contactor-1 gets closed. Similar operation can be done for contactor-2 also. After this operation we get 750V supply in power panel of the power car through both male ZS couplers. This supply can be extended to feeding end of the power car.

Testing Procedure

1. Before testing ensure there is no power supply in power panel of power car as well as testingkit.
2. Ensure 415V MCB of testing kit to be in offcondition.
3. Connect both the male ZS couplers of power car to the female coupler of testing kit properly.

4. Connect UIC cable between UIC socket provided on power car & testingkit.
5. Switch on 415V, 3 phase external supply to feed MCB of the testingkit.
6. Switch on MCB. Indication will glow to show the availability of power supply. Transformer will get energized through LT MMR after closing of input contactor & 750V will be available at input side of contactor 1 &2.
7. Switch on 24V DC supply in powercar.
8. Turn the rotary switches SW-1 & SW-3 on HOG mode. Contacotor-1 get closed and convertor A - ON Indication will glow in power car as well as testing kit. This ensures converter A is healthy.
9. Turn the rotary switches SW-2 & SW-4 on HOG mode. Contacotor-2 get closed and convertor B - ON Indication will glow in power car as well as testing kit. This ensures converter B is healthy.
10. Switch ON both feeders A & B. The supply will extend upto feeder junctionbox.
11. For testing of auto reclosing, 415V input supply through MCB may be switched OFF. The same may be switched ON.

Benefits

HOG Simulator testing kit is highly useful as: -

1. It can be fabricated in-house using available material thus saving onexpenditure.
2. The knowhow is in-house and the design has been shared with other zonal rail ways thus scope of further improvement isopen.
3. The kit being highly portable like a briefcase and therefore can be used anywhere for confirmatory test of HGOworking.
4. It eliminates the need for loco to test working of power car onHOG.
5. It confirms whether the power car is fit for HOG operation ornot.
6. It tests the working of automatic re-closing of contactors for automatic restoring of power supply after crossing the neutralsection.
7. It tests working of control circuits provided for HOG operation in powercar.
8. It tests the communication through UIC cable between power car and lococonverters.
9. It supplies 750V to power panel of power car, hence proper working of 750V contactors, MMRs, metering and other circuits of the panel can also be checked and rectified without operating DAsets.

Materials Used

Table 1

Sl. no	Items	Qty
1.	3 Phase distribution transformer 9KVA, 415V/750V, 110V	01 no.
2.	ZS IVC Socket 400 Amp.	02 nos.
3.	UIC Socket & plug	01 set
4.	Contactor 3 phase, 16 Amp. (Coil voltage 415 V AC)	01 no.
5.	Contactor 3 phase, 16 Amp. (Coil voltage 110 V DC)	03 nos.
6.	MCB 4 pole/3 pole, 63 Amp.	01 no.
7.	LT MMR (415V)	01 no.
8.	230V AC to 110V DC converter	01 no.
9.	N-O connector for indication	04 nos.
10.	Indication lamp 110V DC	04 nos.

Cost of the KIT

Sl.No.	Item	Qty (Nos.)	Rate (in Rs.)	Total Value (in Rs.)
1.	CONTACTOR 16 Amp	03	3000	9000
2.	HT MMR	01	7500	7500
3.	15A Socket & plug, MCB etc.	01	1500	1500
Total Cost				18000

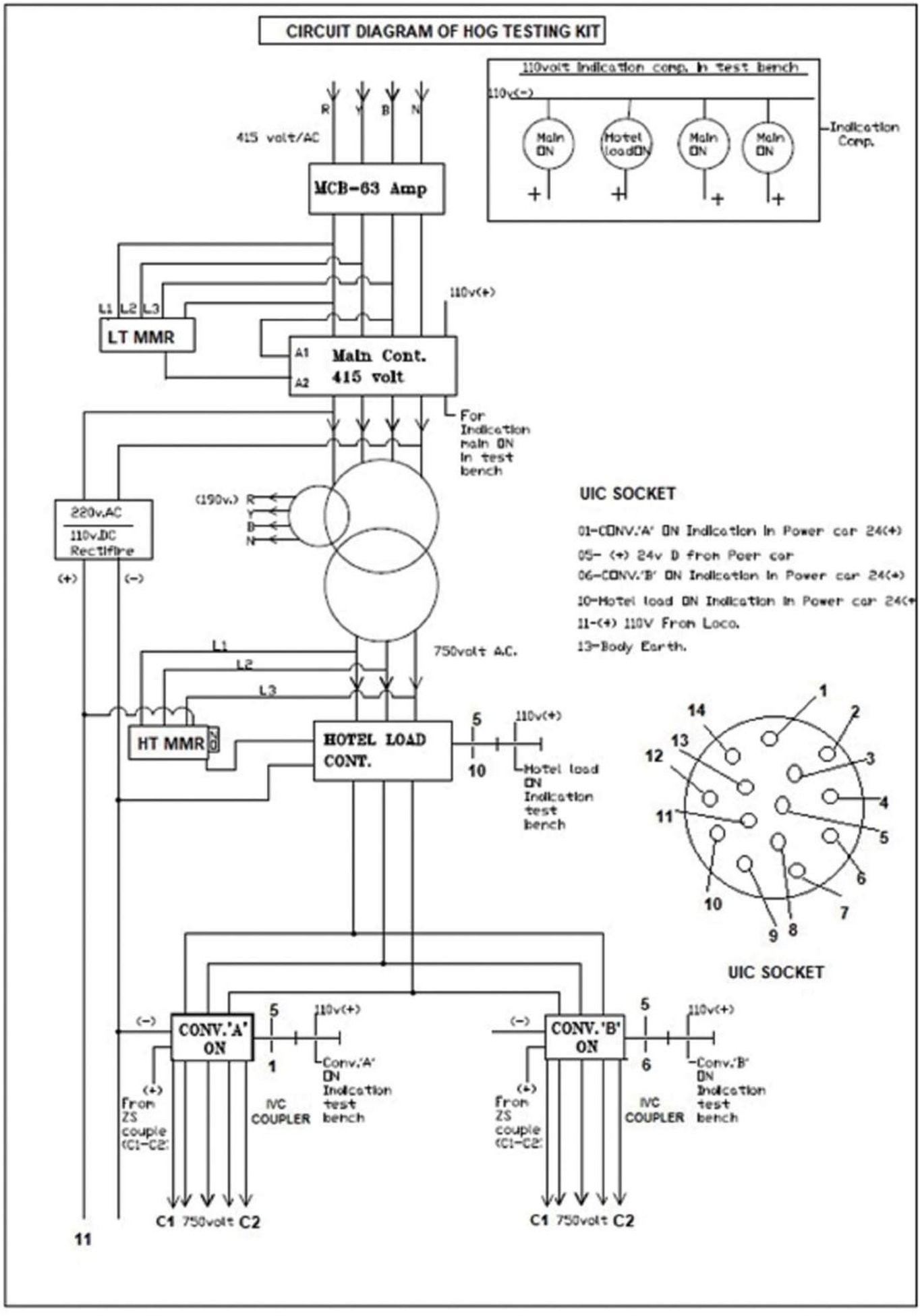

Fig3. Circuit diagram of HOG Kit

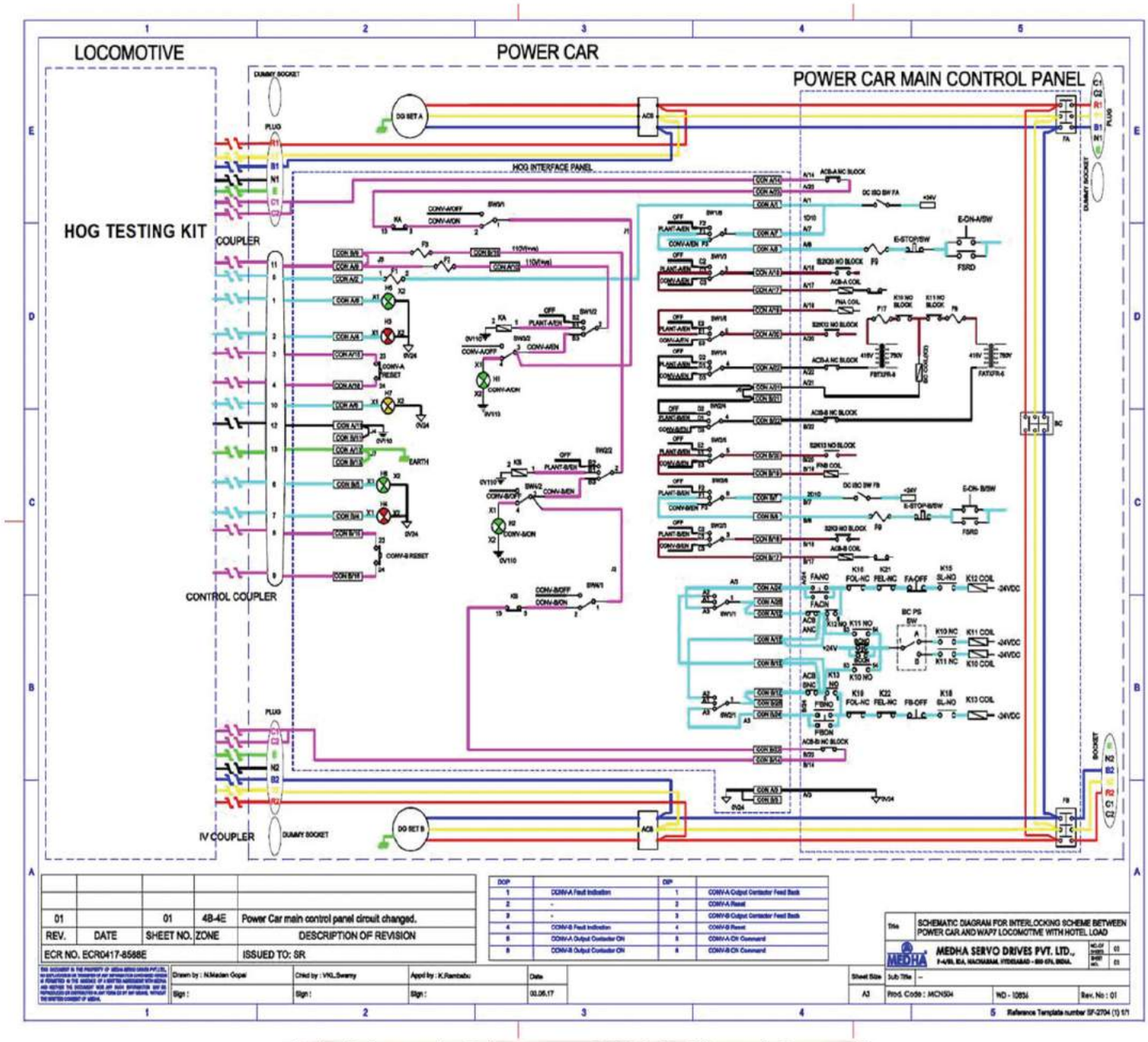

Fig4. Schematic Diagram of HOG Kit and Power Car

Conclusion

The HOG Simulation Testing Kitwas aimed at developing a highly portable facility for ensuring HOG compliancy and reliability of the LHB power car at coaching depots before it is put to service. The kit has been developed with in-house resources. Use of this kit in all depots of Indian Railways is recommended as it will increase the reliability of HOG operation during service.

About the writer

B.Tech.(Mechanical Engineering)Graduate joined Indian Railways as IRSME-2011 Batch. He works in field of technical issues pertaining to Planning,Rolling Stock Maintenance, Failure analysis of WSP and Store management.

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Chapter F

Automatic Sanding Machine

by

Suryakant B Munjewar
DME / Solapur

Introduction

For creating adequate amount of friction between rail and wheel standard procedure of application of sanding is adopted in all locomotives of Indian Railways.
For this process sand is being filled regularly into the provided sand boxes of the locomotives at all maintenance sheds/depots & at railway station also.

Problem Statement (sand filling in sand boxes – existing Process)

The nominated staff takes the sand bags (25 kgs) on his shoulders & carries it from sand storage place to locos , which is in itself at least 20m in length having sand boxes at minimum 12-15m apart on one side of loco. Thus leading to large amount of unnecessary fatigue & unsafe (being very tiresome and painful process) situation for staff.

It was also noticed that while filing the sand boxes from gunny bags, large amount of sand used to get spilled over the sand box & on the tracks owing to the reason of different sizes of the two (size of mouth of sand box is very small than that of the sand bags). Such spillage of sand lead to considerable loss to Indian Railway (appx. 2-3 kgs/sand box= 8-12 Kgs/loco). Also thus spilled over sand had potential of loco derailment as is evident from various derailment enquires.

It is matter of great technical & safety concern that the sand being filled in the sand boxes must be dry & not wet at any given instance and also should not carry any hard stone of bigger size. So that the purpose of creating adequate amount of friction between the rails and wheels should not be defeated at any instance.

Solution

A system be designed and developed to curb all the aforesaid problems, creating an undesired situation, with minimum investment of financial expenses in minimum time to get maximum benefit for Indian Railways.

Research

To design & develop such a system following critical points were taken into consideration.

1) Availability of material
2) Achieve optimum mixture of sand and air to make the sand travel a distance of at least 30 meters (As locos length is in the tunes of 20 meters and the pipe should be able to go on both sides of locos) without any trouble.
3) To restrict moist air and hard stones, if any, entry in the system.

Theory

1. To restrict entry of moist air in the system, an air dryer is used just before the entry of the air in the system.
2. To restrict the entry of hard stones/rocks in the system, a sieve is placed right at the top of the designed hopper.
3. The design of this specialized hopper works on the principle of vorticity of fluid mechanics.

Vorticity :- It is mathematically defined as the curl of velocity field and is hence a measure of local rotation of the fluid.

i) Any fluid element that occupy that point having a non zero vorticity , that point is called rotational.

ii) Vice versa, any fluid element that occupy that point having a zero vorticity, that point is called irrotational which means particle is not rotating.

For the flow of sand the concept of vortex formation is applied.

The compressed air of about 5.5 to 6 Kgs is passed through the first nozzle which makes an angle of 60 degree with horizontal. The horizontal component of this jet of air forms the vortex at diameter of 540 cm whose flow velocity is about 6cm/sec. And simultaneously, the vertical component of the jet and weight of sand together pushes this planer vortex downwards.

Vorticity, w =Del operator X flow velocity

The angle of 60° , at which first nozzle no.1 is placed is an angle of attack of air which helps the fluid (sand) for an irrotational vortex so that flow velocity is inversely proportional to the distance of center of the vortex.

At the same time nozzle no.2, at 60°, helps the vortex formed to grow revolution per second around the axis of vortex with increased flow velocity up to 8cm/sec. It forms vortex at diameter of 40 cm. At this point as the area is less, as is evident from principle of continuity, velocity becomes proportionally higher.

Nozzle no.3 help to push the sand down which is fixed at an angle of 45° so that the irrotational vortex formed can be stabilized under pressure and fill up container.

Nozzle no.4 is used to initially create suction and later push the sand through the pipe of 30m.

During the above gradual vortex flow of the sand, the vertical component of all the pressurized air jets from the respective nozzles alongwith the gravitational component of the weight of the stored sand at a given time-plays an important role of enhancing the overall downward flow of the sand.

For getting adequate amount of mixture of sand with air, the diameter of the hopper end at bottom is designed as 10 cms and the inner diameter of the flexible dispensing pipe is taken as 3.175 cms.

At the end, through the pipe of 30m, a discharge of 95 gms/second is obtained.

PICTURE

Problems faced during the entire work:

1. Availability of parts.
   (Solved from scrap directly)
2. To achieve the optimum mixture of sand and air to make the sand travel the distance of atleast 30 mtrs(as loco length is in tunes of 20 mtrs and pipe should go both sides of the loco) without any trouble .
   (Solved by calculating(applying various laws of fluid dynamics) proper angle and positioning and implementation of adequate qty of nozzles in the system).

Picture Gallery

" During Installation "

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Chapter G

Sustainable manufacturing at RWF through Thermal Sand Reclamation Plant

by

Ashwini Kumar D,
AWM/RWF

Abstract: Silica sand(AFS 45) is one of the major consumable in wheel casting process. It is a scarce natural resource which needs to be procured through mining. Sand mining is banned in some states due to govt's policy of conservation on natural resources. A proportion of the sand used for casting gets collected and was being dumped in the yard since inception of RWF in 1984 which also poses an environmental concern. There is a dire need to search for alternatives to reduce its consumption and disposal. Thermal Sand Reclamation Plant installed at RWF in March 2020 is a step towards sustainable manufacturing by re-use of sand.

Introduction:

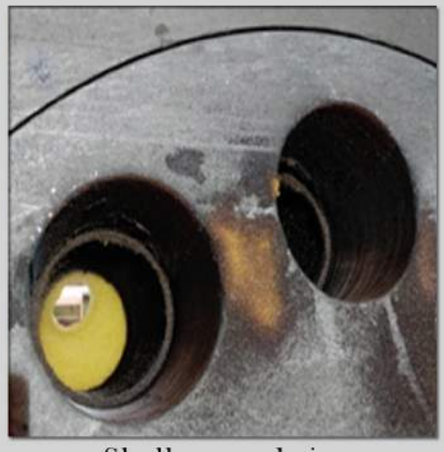
Rail Wheel Factory, Yelahanka (RWF) is a manufacturing unit of Indian Railways, producing wheels, axles and wheel sets of railroad wagons, coaches and locomotives for the use of Indian Railways and overseas customers. This factory uses cast steel technology developed by M/s Griffin Co USA to manufacture wheels which utilizes scrap steel collected from Railways' own workshops as raw material. RWF manufactures cast steel wheels by a controlled pressure pouring process in which hot liquid metal enters into graphite moulds through a ceramic pouring tube. The scrap steel is melted in electric arc furnaces and desired chemistry is achieved through spectrometer. The wheels get cast in graphite moulds made up of cope and drag which are pre-heated and sprayed.

Problem Definition:

Risers are provided on the wheels to take care of metal shrinkage during cooling. The risers are insulated from graphite mould by a shell made out of Resin coated sand. Sand is one of the major consumable for manufacturing wheels. Every day about 27 MT of sand is used for coating. The shell formation is done at core baking station where the sand is heated and a layer of sand(8-10 mm) gets coated on the riser cavity of the mould. Remaining sand is collected in basement by tilting the mould at rollover station. After pouring, the riser shell gets burnt and becomes black . Around 18 MT of the coated sand is collected in bins at the basement and was being dumped in the yard. The sand is coated with Phenol Formaldehyde resin to get the properties required to form a shell around riser holes. The annual consumption of sand is around 6000 MT which costs RWF about Rs 2.2 crores.

Core baking station


Baked sand


Shell around riser

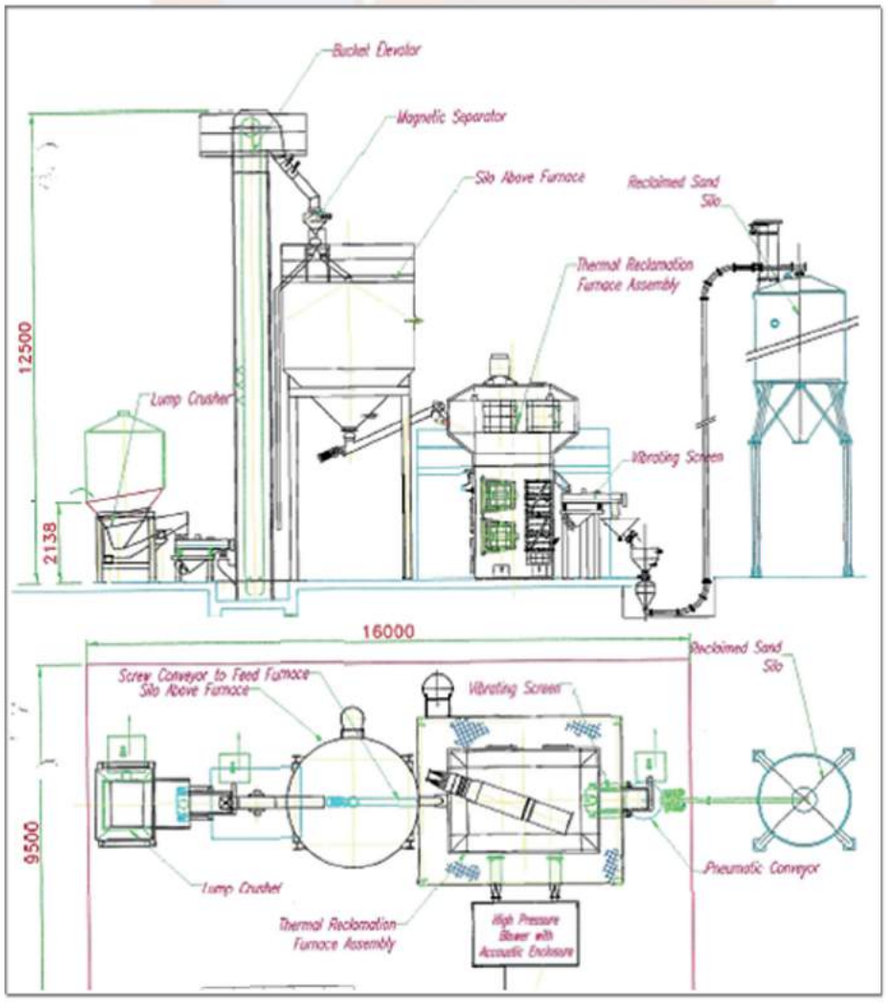
Proposed solution:

A Thermal Reclamation Sand Plant costing about Rs. 4.25 cr has been commissioned at RWF in March 2020 which has reduced the requirement of procuring fresh sand through mining. The resin sand is heated at high temperature and is converted back into sand which can be used again with 10% loss. The annual reclamation cost is about Rs 1.6 cr leading to huge cost savings about Rs 60 lakhs/annum apart from the positive environmental impact. Electricity, PNG are the only major consumables required to run the reclamation plant. The capacity of the reclamation plant commissioned at 100 % efficiency is 2 MT/hr

Thermal Reclamation process of used resin sand:

The used resin sand collected in bins at basement is sieved and after removing impurities like metal particles, it is accumulated in an overhead sand hopper. This accumulated sand is then passed into gas fired furnace whose temp. Is maintained at 650-700 deg. The used sand is fluidised in the furnace. Due to high temp, the resin coating gets removed and sand becomes as good as fresh sand. The average fuel consumption is around 18 SCM/MT of output sand.

TSRP Schematic



The major assemblies are:

Mechanical Reclamation system - For transporting of sand without impurities

1. Magnetic separator
2. Belt conveyor
3. Lump reducer
4. Pneumatic Transporter
5. Hopper

Thermal Reclamation system – For reclamation through heating

1. Fluidised bed combustion chamber
2. Cooling chamber

Physical Properties of Reclaimed Sand:

S NO	DESCRIPTION	AS PER TECHNICAL SPECS	RECLAIMED SAND
1	Grain fines	40-45 AFS	42-46 AFS
2	Clay content	0.3% max	0.2-0.3%
3	Fines	Traces	Traces
4	Grain shape	Round/Sub angular	Sub angular
5	Reclaimed sand Loss of Ignition(LOI)	Less than 0.1%	0.02-0.1%
6	Output sand temp. in deg C	< 50 deg C at output of plant	29.4-38 deg C
7	Moisture	Nil	0-0.2%
8	Sand yield	Minimum 90 %	90-96%

BENEFITS OF TSRP:

- Conservation of natural resource by reducing sand mining
- Minimising land pollution by avoiding dumping into yard
- Less dependence on vagaries of sand suppliers
- Drastic reduction in purchase of fresh sand as yield of TSRP is more than 90%. The same sand can be re-used at 10% loss each time. This will save direct and indirect cost of purchase of fresh sand
- Reducing pollution, green house gas emission through reduced requirement of transporting fresh sand
- Improvement in the quality of sand. It is assessed by experts that due to repeated re-use of same sand, the sand particles become round and form better shell. Further sand attains better thermal properties by Fluidising process of reclamation.

Aerial view of TSRP

Discussions:

The operation of TSRP requires sand to be fed into the input feeder. Keeping the commissioning of the project, collected sand at basement was stopped being dumped into the yard and was kept separately for re-use. Around 6000 MT of used sand is available for reclamation which can easily meet the requirement for more than a year. It is to be ensured that input sand is free from impurities and moisture for proper functioning of the TSRP. There have been instances of choking in hopper due to usage of wet sand. Since the used sand is kept out in the open, it needs to be dried out before usage.

Conclusion:

Sustainable manufacturing is the creation of manufactured products through economically-sound processes that minimize negative environmental impacts while conserving energy and natural resources. Alternatives like TSRP needs to be explored in the current era which reduce the requirement of natural resources as a consumable in manufacturing.Thermal Sand Reclamation Plant is a project which has not only led to savings but is also a major step towards conservation of natural resource. It has resulted in less requirement for procurement of fresh sand through mining and eliminated its disposal.

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Chapter H

Effect of Varying Voltage Pulse on Dump Valve Functionality

by

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Abstract:- The objective if this paper is to highlight the effect of varying voltage pulse signal on the Dump valve terminals in the normal operations. This also highlights the effect of any leakage of voltage or current in the system and the behaviour of dump valves as per the voltages across its terminals. The article first introduces the basic principle of working of dump valve and its use in LHB coaches in Indian Railways. Article was made after collecting data from the test bench developed in house in Matunga Workshop, Central Railways. A discussion on the data collected is been carried out along with conclusion at the end.

Keywords – Dump valve, LHB coaches, Solenoid valves, Wheel slide protection system (WSP)

1. Introduction

Dump valve is the most critical component in whole Wheel slide protection system (WSP) system of LHB coaches. LHB coaches are designed for higher speed potential and hence are very prone to wheel slip stick mechanism. It is operated at 24 V DC pulse from WSP system. WSP is meant to control the wheel slip by allowing variable braking force on the wheel brake disk. This is achieved by either venting the brake pressure even when other wheel sets are in braking or retaining the brake pressure even when other wheels are in released condition.

As shown the braking pressure is feed into the brake cylinder via Dump valve. Hence as per the position of the dump valve inner plunger arrangements, ether the pressure goes in the brake cylinder or is exhausted in environment or the brake cylinder pressure is locked.

Below is the Cut diagram showing various components of a Knorr Dump valve. It has 2 coils (Solenoid) which can be energized to control the movement of plungers. The coils are energized by a pulse of 24V from the main WSP system as per the logics and slip values allowed in the system. Value of 1-2% slip is warranted for achieving maximum traction or braking due to slip and slide behaviour of rolling contact at wheel and rails.

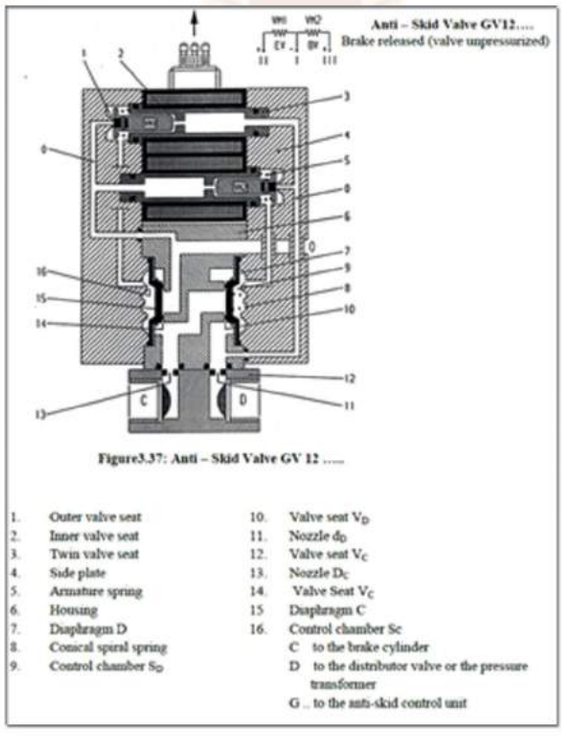


Figure3.37: Anti – Skid Valve GV 12 .....

1. Outer valve seat
2. Inner valve seat
3. Twin valve seat
4. Side plate
5. Armature spring
6. Housing
7. Diaphragm D
8. Conical spiral spring
9. Control chamber S_D
10. Valve seat V_D
11. Nozzle d_D
12. Valve seat V_C
13. Nozzle D_C
14. Valve Seat V_C
15. Diaphragm C
16. Control chamber Sc

C to the brake cylinder
D to the distributor valve or the pressure transformer
G .. to the anti-skid control unit

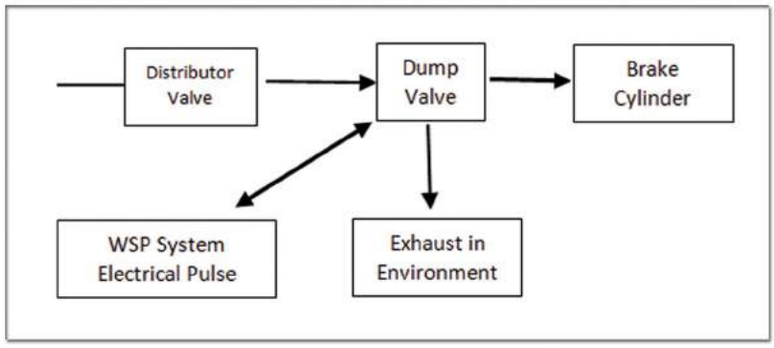


Fig1. Basic brake system functionality in LHB coaches

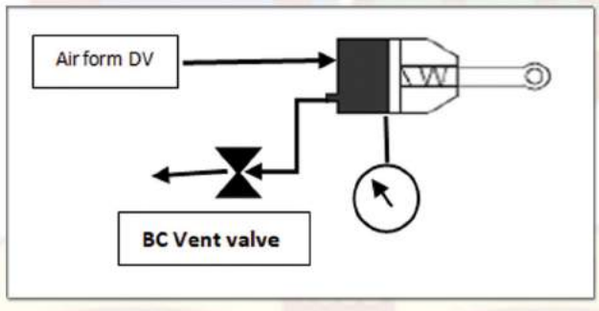
2. Test bench arrangement for the trials

The Distributor valve (DV) test bench available in Matunga Workshop was modified for added functionalities to test the Dump valves. These benches are of same type which are commonly available in most of the workshops for testing DV.

Additional Functions to the Test benches

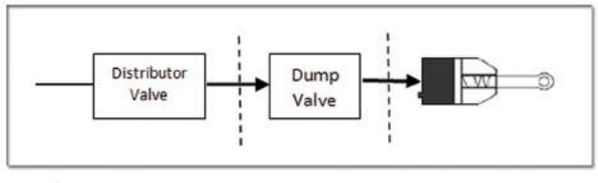
a. Brake cylinder Vent arrangement

A choke was provided on a line for exhaust of brake cylinder (BC) with a manual operated valve. The rate of exhaust is low compared to the feed of air form the DV in brake application condition. Hence the BC pressure will not change even if this valve is opened. But if feed from DV is stopped, a drop in BC pressure will be noticed if this valve is kept open.



b. Arrangement for Dump Valve

In the test bench an additional set up was added to integrate dump valve in the loop of air movement form DV to BC.

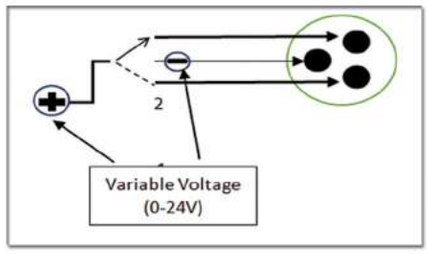


c. Variable voltage pulse arrangement

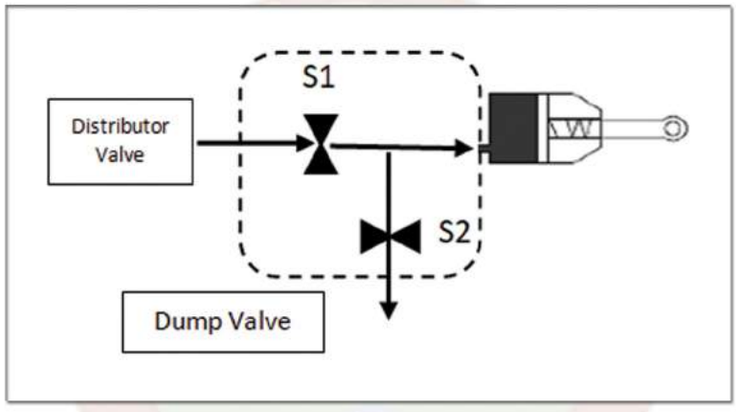
The major change made was making an arrangement of a variable voltage regulator in the system sending the pulse of voltage at the dump valve electrical terminals. Here Resberry pi was used to integrate a voltage regulator in the system which enable the operator to give voltage anywhere in between 0 to 24 V simply by rotating the knob. Its just like present fan regulators at home. A digital display was also added do see the voltage and current at the terminals of the dump valve.

d. Provision to energize individual Solenoid of the Dump valve

Dump valve is a three terminal device where one terminal is a common terminal, where as other two are separate coil terminals. This test bench been made on Resberry Pi platform, so the Human Interface is been programmed in the display where individual command can be given to each coil. Hence if one coil is energised, the voltage will only be given to one coil terminal.



3. Test Protocols



S1 – Solenoid Valve connecting DV air line to BC (Normally Open Valve) NO

S2 – Solenoid Valve connecting brake cylinder to exhaust to dump BC pressure (Normally Close) NC

When energized, solenoid valve change their states form either NO to NC or NC to NO .

S1 (NO)	S2 (NC)	Effect
0	0	Normal operation of Brake system
0	1	DV air exhaust out leading to no or partial application of brakes
1	0	No brake application or BC is in locked state
1	1	BC exhausted. No brake application

Table 1

The above table shows the effect of various states of solenoid valve. Here 1 means coil is energized and 0 means, no energisation. In no energisation state coil continues in its normal position.

It can be seen that for brake application, the S1 coil needs to remain in its normal state that is normally open.

a. Testing Coil S1 for variable Voltage

Since this connect DV to BC, we use the BC vent valve here.

Brake application is carried out and kept in Lap position. In lap position no further reduction in brake pipe pressure takes place and DV is connected to BC.

After that, BC vent is opened. As explained earlier, by opening BC vent, air form BC is vented in atmosphere via a choke at small rate compared to charging. Hence no change in BC pressure will be noticed in dial gauges.

Now command for operation of S1 is given. The knob is rotated to increase the voltage applied from 0 to 24 V. At one point, S1 is operated (NO to NC) and No more DV will be able to feed BC , but since BC vent is open, one can notice drop in BC pressure and pressure gauge dial will move. This is the Pick up voltage for the S1 coil . Knob is rotated further till 24 V is attained. It is again rotated in opposite direction to reduce the voltage. At one point, S1 will drop and valve will open, connecting DV to BC and BC pressure will pic up. This is the drop voltage of S1.

This process is repeated to get more values of Pick and drop voltage of S1 coil.

b. Testing Coil S2 for variable Voltage

This valve connects BC to exhaust.

Brake application is carried out and kept in Lap position. In lap position no further reduction in brake pipe pressure takes place and DV is connected to BC.

Now command for operation of S2 is given. The knob is rotated to increase the voltage. At one point there is a blow or exhaust of BC pressure form the dump valve. This will be quite audible and BC pressure decreases in gauge. This is the Pick voltage of S2. Here BC is connected to exhaust.

The knob is rotated further to attain 24 V. It is then rotated in opposite direction to reduce the voltage. At one point the exhaust of air will stop. This will be the drop voltage of S2 and BC will no more be connected to exhaust.

This process is repeated to get more values of Pick and drop voltage of S2 coil.

Voltage values can be seen on digital display.

For test purpose, 2 new dump valve of Knorr make and 1 dump valve Knorr and 1 of FTIL make from scheduled maintenance coach (after 3 yrs) are been used.

4. Test result

New Valve (Knorr make)

Valve 1

S1		S2	
Pick	Drop	Pick	Drop
11.4	3.2	12.3	3.26
11.2	3.2	11.5	3.2
11.2	3.2	11.5	3.3

Valve 2

S1		S2	
Pick	Drop	Pick	Drop
9.7	2.4	10.1	2.5
9.6	2.4	9.8	2.36
9.6	2.5	9.8	2.2

Old Valve

1. FTIl Make

S1		S2	
Pick	Drop	Pick	Drop
10.8	5.8	9.8	5
10.8	5.62	9.78	4.6

2. Knorr Make

S1		S2	
Pick	Drop	Pick	Drop
9.2	3.32	15.1	6.8
9.5	3.2	14.7	6.7

5. Discussion on results

The dump valve is a critical component in WSP. It is clear form table1 that application of brake or release pretty much depends on dump valve solenoid positions. Any malfunctioning may leads to failure of brake system which can be either in form of poor brake power or brake binding of coaches. In both case, there is a loss to rolling stock and safety of passengers is compromised.

As the dump valve is designed to work on 24 V pulse and the duration to which the pulse remains . These are controlled by the WSP system. But what appears from the test results that even brand-new valves have very low values for pick and drop voltages. All it means in lay man language is that, the valve can be operated on voltages as low as 10 V rather 24 V, and once energized, it only need near about 5 V to be operated . This small voltage may come from the leakages in the system itself. Since is it very much possible to have leakage currents which in turn will causes a voltage to appear at the terminal of the dump valve and may operate it even if the system don't want it to .

Also the pulse which ideally should be a square in nature , if is skewed or spread in nature , the valve will be energized for longer duration than what was expected due to pic up and drop at low voltages.

The EP brake system of train sets have Application and holding magnetic valves in it which also shows same phenomenon of picking and dropping at low voltages. This is a contributing factor in brake binding too.

Hence the role of this phenomenon in dump valves can't be ruled out as one of the factor for brake binding and heavy wheel shelling in coaches.

Ideally the valve should be picked or dropped to voltages near to the designed (24V) voltage. OEM should see into the design aspect of dump valves to rule out such issues in rolling stock.

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Chapter I

Additive manufacturing in Coach Maintenance Depots

by

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Abstract:- 3D printing or additive manufacturing has been in vogue since a long time now. From being just a concept as described by Raymond F. Jones in 1950s to printing functional electronics in 2014, additive manufacturing has forayed into many territories. Manufacturing small scale items of complex shapes to even complete houses, 3D printing has proven itself to be fast and reliable technique of manufacturing. However, use of 3D printing has been very limited in railway sector if we talk about Indian Railways specifically.

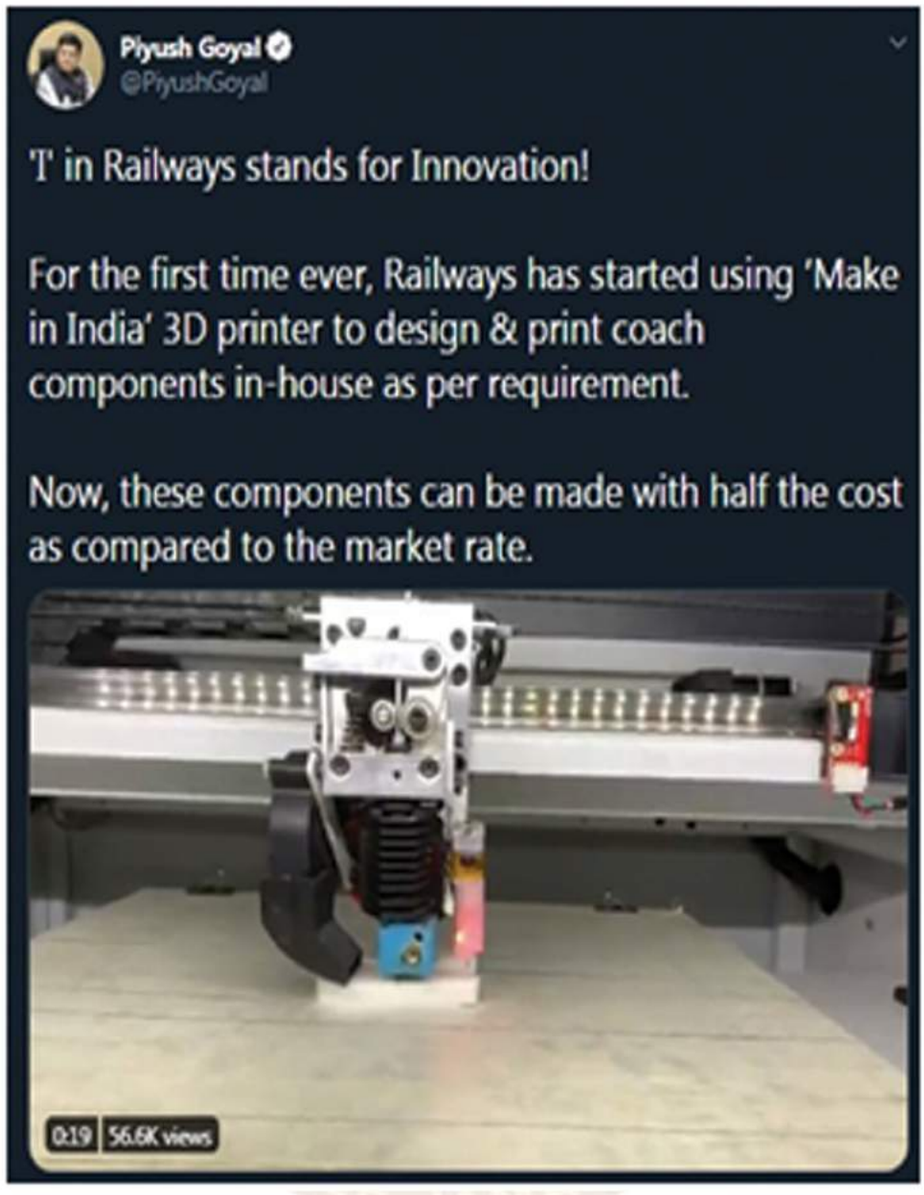
Coach Maintenance Depot, Guwahati has taken a big leap by installing first 3D printer ever in Indian Railway to manufacture coach components in-house. Guwahati being in Northeastern part of the country is not having enough private manufacturing units which cater to railway sector. Most of the spares required are sourced from other parts of the country which are higher in cost due to large transportation distance and limited number of suppliers. Also, there are certain components which were costing very high due them being utilized in a very limited type of passenger cars (Like Janashatabdi Express).

Considering above problems, Coach Maintenance Depot, Guwahati ordered 3D printer which costed around Rs 271400/-. The 3D printer installed is Pratham 3.0 which is a very fast and versatile printer. It supports multi material like PLA, ABS, Flexible TPU, PETG, Composites etc. With multiple options of printing through WiFi, LAN, USB and SD Card it can be easily installed anywhere and doesn't require any computer to remain attached to it all the time. It can be used to print anything up to 300*300*300 mm3in volume.

Using the printer, we have been able to print many passenger amenities items and other items which do not have any safety implication. For start, we manufactured knob for snack tray for installation in Janshatabdi Express which runs between Guwahati and Johrat.

Per knob cost came down to around 1/17th of last purchase price if we ignore the fixed cost of the printer. Since knob was a frequently used item, having 3D printer made it readily available resulting in better passenger experience. Later on, we also started manufacturing alarm chain pull handle and also spray painted it to resemble to the originally procured item. Till now total 25 knobs and 35 handles have been printed, out of which 15 knobs have already been installed. More number of items will be printed and installed as the train services resume.

Although since limited number of 3D printed parts have been installed in trains till now, the shelf life and robustness of the printed parts is expected to be very near to those procured from open market. Since this machine was installed as an experiment, if more such components are required in future in higher numbers, faster machines can be planned for procurement in future. Till now we are only considering printed items which are not related to safety or undergear parts of coaches, therefore, most of the items are non-metallic and of plastic base.



Seeing this initiative of our depot, Hon'ble Minister of Railways Shri Piyush Goyal tweeted about this innovation on his personal twitter handle praising our efforts. Also, many other maintenance units across Indian Railways are planning to have 3D printer as an alternative to open market procurement various feasible

Although on micro-scale, Coach Maintenance Depot has shown the path to whole rail sector in India on wide possibilities of using additive manufacturing as an alternative to conventional techniques. Other developed railways like Deutsche Bahn is using 3D printingeven to manufacture metallic components rather then procuring forged or casted components. Indian Railways has huge potential to use additive manufacturing in its production units like DLW, ICF, RWF etc. which will help not only in fastening the processes but also better product quality.

• CAST IN JAMALPUR SHOPS, THIS INSIGNIA DECORATED THE SPECIAL TRAIN OF LORD MAYO, THE FOURTH VICE ROY OF INDIA IN 1870