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Research Paper

Automated Maintenance System of Solar Panel For Wild (Wheel Impact Load Detector)

Engineering

KEYWORDS : Solar panel,GPRS,WILD

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ABSTRACT

The project titled WHEEL IMPACT LOAD DETECTOR (WILD) is being actively done in the Organization APNA TECHNOLOGIES AND SOLUTIONS for Indian railways. The organization is the only Indian developer and supplier of this system for Indian Railways. The Internship program consists of intelligent software algorithms that have been developed to identify the Wheel Impact and Impact Load Factor along with other parameters like time & speed of the train, axle number, average dynamic wheel load and maximum wheel load. The sensors on the track senses the dynamic impact load caused by the wheels, the high speed data acquisition system acquires the data and the embedded controller does the signal processing & analysis to identify the impact load data. The same is transferred to a remote centralized server through GPRS and Optical Fiber Communication, i.e. how information traverses through network from source to destination based on the OSI reference model, routing basic , structure of the network, the basic functionality of the devices, tools and process and a brief session on performance management. It also includes hands on experience on the live project at their installed sites.

1. INTRODUCTION

"WILD" (Wheel Impact Load Detector) is a useful 'wayside detection system' for safety and asset reliability in train operation. The main purpose is to bring objectivity in Railway's functioning in respect of defect detection. With due incorporation of proven technologies in the areas of safety & asset reliability; so that while accidents are avoided, the life of assets (of all departments) also gets increased, thereby helping Railways on the fronts of expenditure & budget availability as well. Indian Railways still have the system from time immemorial of manual detection/finding of unusual/culprit rolling stocks at 'rolling in examination' points etc.; but such detections are with element of subjectivity. Now, IR has its own indigenous proven technology in the form of 'WILD', which objectively detects/identifies the defective wheels, rolling stocks, imparting loads beyond the thresholds (already approved by Board - MM, ME & ME). These detections are on real time and 24X7 basis and the reports get generated, uploaded & communicated automatically within 2 to 3 minute of passing of train over 'WILD' WILD has the instrumented rails (strain gauged) through which data acquisition for all the wheels of trains under moving conditions at all speeds is done and processed through very sophisticated & intelligent software for report generation and its subsequent uploading to server and for other prescribed communications.

The Intelligent software algorithms have been developed to identify the Wheel Impact and Impact Load Factor along with other parameters like time and speed of the train, axle number, average dynamic wheel load and maximum wheel load. The sensors on the track senses the dynamic impact load caused by the wheels, the high speed data acquisition system acquires the data and the embedded controller does the signal processing & analysis to identify the impact load data. The same is transferred to a remote centralized server through GPRS and Optical Fiber Communication

2. Wheel Impact Load Detector (WILD)–How It Works

As the Train passes over the instrumented rail, data is collected and sent to the system in real time. The data collected is tested, all extraneous noise removed and the pure raw data analyzed. Analyzed data is converted to a report form and sent through GPRS network to central Server. A PC in C&W Control room (or anywhere as desired) continuously scans for report every 2 minutes/lesser and displays the newest report as and when released by the system. If defective axles found, an audio visual alarm is activated. All reports can be viewed and consolidated period wise in the dedicated website

Figure 2.1 Wheel

2.1 IMPACT LOAD CAUSES

Well known Cause - Wheel Flats Wheel Flats – Not so well known fact Visual classification of wheel flat does not correspond to wheel impacts A combination of flat length, depth and radius of curvature of a flat determines wheel impact Other Impact Load Causes – Recent RDSO Notification dated 23 Mar 2011 based on WILD Data Analysis for past 2 year in IR.

Other Impact Load Causes:Uneven loading ,Coil spring weak ,Shell Tread ,Friction liner broken ,Snubber spring broken ,Axle box canting ,PU/CC/EM Pad Shifted/Pressed/Perished ,CC housing broken ,S/Bearer roof/Friction Liner welding open ,Bolster tilted one side ,Defect in suspension ,Broken spring And Skid mark, etc.

Figure 2.2 Wheel defect

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WILD Systems is used to Measure & Monitor Impact Loads caused by wheel defects according to the defined threshold and the severity of defect Number of Axles & Axle Condition Speed of each axle and average speed of train Average Dynamic Wheel Load for all Wheels System includes bonding sensors to the rail, Wayside rugged panel (IP67), Embedded Measurement & Analysis System Wireless Transfer of report to TXR station Remote server provide the reports of all the locations.

3. DEVELOPMENT & THE TECHNOLOGY

WILD has been developed indigenously in 2006 by RDSO in association with IIT Kanpur. Instrumented Rail of WILD' and 'Signatures of Normal &Defective Wheels' RDSO vide their Report No. R-105 of June 2011 have further concluded that 'WILD' project has been successful on Indian Railways and the points of success have also been detailed in its report with the mention of background note for the indigenous development of 'WILD' system by RDSO - IIT/Kanpur. AM/CE had inspected the WILD site way back on 02/5/06 and his comments, as recorded for reports of WILD were 'accurate, reliable & very useful'. Further mention from him had also been - The efforts of RDSO need to be complemented in bringing out such a system which is world class product.

Table 3.1 Important features of WILD

WILD Features	Version-2 : 2010
No. of Load Recording Channels	18 Per Rail; Total 36 Channels per WILD
Coverage of Wheels Circumference	100% Coverage For Wheels of 770mm to 1100mm Dia.
Sealing of Strain Gauges	Hermetic Sealing For Protection Against Dust & Water With High Temperature Grading
Earthing	Separate Maintenance Free Earth For Instrumented Rail
Surge Protection	Power Input & Power Lines Are Surge Protected; Rail Instrumentation is Isolated From Measurement System
Embedded System Processor	400 MHz, 128 MB RAM
Battery Backup	16 Hours
Diagnostics	Self Diagnostic of Strain Channels, On-Line System Health Monitoring
Data Transfer	Report Transfer to Server Via GPRS/CDMA
Web Reports	On-Line Reports within 3 Minutes
Alarms	Local, E-Mail & SMS Notifications
Enclosure	Shielded For Noise Reduction
Train Detection	From Both Directions

4. CURRENT SCENARIO ON INDIAN RAILWAYS

Based on communication from Mechanical Directorate of Railway Board, COFMOW was advised to procure and install 'WILD' systems on Indian Railways. Accordingly, these indigenous 'WILDs' have so far been installed at Mahalimarup (SER), Hospet (SWR), Arakkonam (SR), Guntakal (SCR), Bhilai (SECR), Mughalsarai-I (ECR), Mughalsarai-II (ECR), Asansol (ER), Vizag (ECoR), Dongagarh (SECR), Ajni (CR), Itarsi (WCR), Barwadih (ECR), Bina (WCR) & New Katni (WCR) and these are working alright. In this way, 15 'WILD' systems are presently in operation on Indian Railways (CR-1, ER-1, ECR-3, ECoR-1, SR-1, SCR-1, SER-1, SECR-2, SWR- 1 & WCR-3). Further, during PCEs' conference held on 29th and 30th Sep' 2010, the subject matter of 'WILD' was deliberated and as per its minutes : It was decided by Member Engineering that PCEs and their team should make full use of available 'on-line' and 'real-time' information of objective detection of culprit rolling stocks through existing 'WILD' systems for preventing damages to track structure. 'WILD', system helps in accessing 'assets reliability' & 'safety' and it thus more useful to Civil Engineers. Many more such systems should be installed,

Chargeable to track renewal estimates by respective Zonal Railways. Such minor investment will give dividend and would be beneficial to IR with reduced maintenance & replacement cost of both rails & rolling stocks and more importantly prevention of derailments, which at times cause loss of human life as well as that of other assets." Functioning of 'WILD'

There is no reason for reluctance to installation of WILD. The system needs to be explained and also understood precisely for keeping its real utility.

4.1 SALIENT FEATURES

i) It works automatically on '24X7' basis.
ii) System works for all speeds of trains.
iii) Detections with respect to thresholds are with complete objectivity for culprit wheels.
iv) Reports are generated on 'real-time' basis and communicated/uploaded within 2 to 3 minutes of passing of the train over 'WILD'358
v) It costs about Rs. 400 to Rs. 500 for scanning a complete train of about 480 wheels and generate/communicate the required report to all concerned. This amount is even less than one Scanning or X-ray report on a human body.
vi) System is completely reliable, because the same wheel when passed subsequently after one day or more, recorded similar loads.

4.2 ACTUAL DETACHMENTS

From the summary of Critical Alarms, recorded by the 15 WILD systems in a period of 143 days (July 01 to November 20) (extract of the Report at Annexure-I); total 459 trains were identified. It has been observed that on an average, each WILD site gets a 'worth detaching rolling stock' only after every 4.67 days. This is probably not an alarming situation for train operation, when such detachments are already happening presently on IR and the fact remains that such an objective detection helps everybody (maintainers of track & rolling stocks along with officials associated with train operation). Ultimately IR is gainer, because the asset failures are prevented and possible unfortunate accidents are avoided.

This is also a misnomer that only goods trains record high alarms/loads, in fact even coaching stocks which have normal wheel Loads of about 5T to 7T, are also recording values as high as 59T, while maximum wheel load recorded on Goods stocks is 57T, against The normal wheel load in loaded condition of about 11T to 12T. As could be seen from the Extract at Annexure-I, out of total 459 trains recording critical alarms in 143 days on 15 WILDs, 223 were for goods trains, whereas 236 were for the coaching trains. Due to defects in rolling stocks, wheel loads, as high as 55T or so are being passed on the rails, while the normally permitted wheel loads are maximum 12.5T (even if we take 25T axle load train operation). Such loads come to rails when defective portion/situation on wheel tyre circumference comes into contact with the rail surface. If we take wheel dia. as 1 metre, then at every 3.14m interval (π x dia.), this heavy load repeatedly hits the rail (about 300 locations in one km stretch of track).

4.3 HEAVY IMPACT LOAD ON TRACK

It goes to rail memory and at low temperatures or when rail is in tension, even smaller impact causes rail/weld failures. Subsequently, during analysis of such weld/rail failures, when USFD data etc. are also found o.k. in available records, the real reason is not traceable and such failures are mostly fatigue failures due to successive impact of very heavy loads already gone into the rail memory. Such failures are not only of track components, but also of various components of rolling stocks. For every action, there is reaction. Therefore, when there is heavy impact on rails, opposite force of similar magnitude acts on the rolling stock, thereby adversely affecting its life. Hence, timely detection of defective wheels/rolling stocks with objectivity, using the reliable

technology available, is in everybody's interest and in the overall interest of Indian Railways. Report Generation The reports are automatically generated and uploaded on the web within 2 to 3 minutes of the passing of the train over WILD.

4.4 REPEATABILITY AND RELIABILITY ANALYSIS

Reports of 15 'WILD' systems already installed and commissioned on IR have been analyzed & reviewed. The extract of status of recording of loads by the identified culprit wheels of the 360 running trains is summarized in Table at Annexure-I. Few salient features of these recordings and the report thereof are :

a) In a period of 143 days (from 01.07.11 to 20.11.11), total 459 trains recorded culprit wheels, having critical alarms (i.e. Wheel Load > 35 MT or ILF > 4.5), requiring detachments on IR :
   i) Goods Trains : 223 nos.
   ii) Passenger Trains : 236 nos.

b) Average detachments identified on IR : 1 every 4.67 days for each 'WILD' site.

c) Maximum Wheel Load recorded -
   i) On Goods Stocks : 57 MT
   ii) On Coaching Stocks : 59 MT

As far as repeatability and reliability of these systems is concerned, a few examples are given below.

Example-1 : Recording for freight train on two different WILD instruments on same day

a) Date: 06.08.11 Time: 00.32 hrs. WILD: Barwadih Train:Unchahar Coal Speed : 41 kmph

b) Date: 06.08.11 Time: 07.08 hrs. WILD: MGS-II Train: Unchahar Coal Speed : 54 kmph

- Total axles recorded 242
- Train composition 1 Engine + 59 eight-wheelers

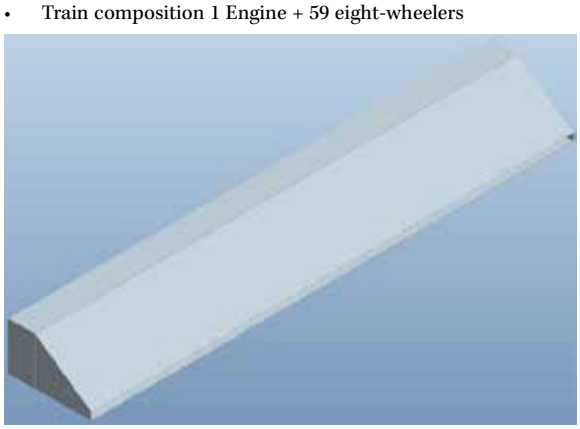

Figure 4.1 Cabinet of Blower

5. BLOWER DESIGN

A blower is a mechanical device that is used to suck air and blow air from one direction to the other. It is a mechanical device for moving air or other gases. These fans increase the speed of air stream with the rotating impellers. They use the kinetic energy of the impellers or the rotating blade to increase the pressure of the air/gas stream which in turn moves them against the resistance caused by ducts, dampers and other components. The axial fans accelerate air radially, changing the direction (typically by 90o) of the airflow. They are sturdy, quiet, reliable, and capable of operating over a wide range of conditions. The fan drive determines the speed of the fan wheel (impeller) and the extent to which this speed can be varied. There are three basic types of fan drives.

5.1 BLOWER ASSEMBLY

Mostly the designs consist of more than one component that is assembled together at their relative working positions. These assembly designs are created in the Assembly mode of Pro/ ENGINEER. To proceed to the assembly mode, choose the Create a new object button from the Top Tool chest. WILD system flags the defects purely based on the impact load measured The limits are set by the railway board Current limits >/=20T maintenance alarm or ILF >/=2.0 ~ <4.5 >/=35T critical alarm or ILF >/=4.5 The system however features a facility for the end user to set the limits as well. System capabilities Counts number of axles from various measurement channels Measures Average Dynamic Wheel Load for all wheels Determines Maximum Dynamic Wheel Load (WA) for all points of contact Calculates speed of each axle and the average speed of train Identifies and counts defective wheels as per specified thresholds and rates them according to the severity of defect Points out exact position of defective wheel from loco for easy examination Has solar panel providing a power backup. Identifies and count number of Engines, Coaches / Wagons and Brake Vans. Relates each axle with engine or coach / wagon or brake van. Also it's position in the identified rolling stock Operates 24x7 without any human assistance Transmits run reports to a central server that can be accessed by simple web browser. Can operate from a low speed of 30Km/hr

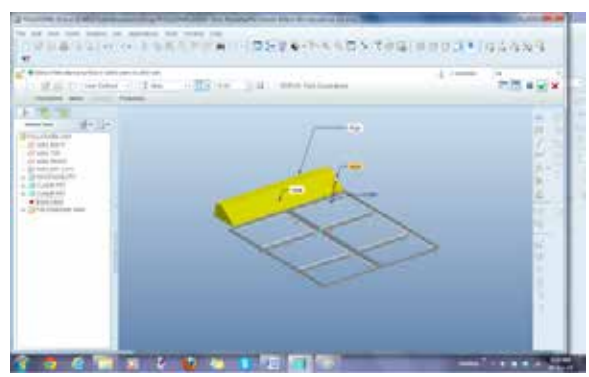

Figure 5.1 Blower assembly

5.2 BLOWER PROTOTYPE

A prototype is an early sample or model built to test a concept or process or to act as a thing to be replicated or learned from. It is a term used in a variety of contexts, including semantics, design, electronics, and software programming. A prototype is designed to test and trial a new design to enhance precision by system analysts and users. Prototyping serves to provide specifications for a real, working system rather than a theoretical one. In semantics, prototypes or proto instances combine the most representative attributes of a category. Prototypes are typical instances of a category that serve as benchmarks against which the surrounding, less representative members are analyzed.

Figure 5.2 Prototype testing

Popular misconception of WILD Wheel flat does not give critical alarm. The visual defect does not correlate to Impact load. Impact load is proportional to sharpness and depth than length. WILD gives a critical alarm and nothing could be found in visual inspection. The most critical defects damaging Railway assets are mostly not visible. Hence the need for WILD system..The visual defect does not correlate to Impact load. Impact load is proportional to sharpness and depth than length. WILD system depends on load condition of the wagon. As the system measures the impact load it directly depends on the load of the wagon. The system is likely to pass unloaded wagon with a defect as it produces munch lower impact loads. WILD system is directional dependent. The above statement is not true. It is more a perception if the there are more loaded wagons plying in one direction than the other.

6. CONCLUSION

The design of the automated solar panel maintenance system for this project facilitates in maintain the input to the solar panel hence maintaining the efficiency. By implementing this project the cleaning of panel from time to time has become easier and possible. Thus concerned authorities of Apna Technology & Solutions (ApnaTech), Chennai appreciated our project work. We gained more practical and industrial knowledge while carrying out this project. We finally thank everyone who helped us to complete this project successfully.

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