WILD

(Wheel Impact Load Detector)

Introduction

- Wheel Impact Load Detector is a technology that is widely used in Global Railways to monitor the health of rolling stock.
- This presentation compares some of the WILD systems around the railways and the result patterns and utility

WILD: Global

- The largest percentage of railways use Strain Gauge based Wheel Impact load Detection due to:
  - It is extremely cost effective.
  - It does not require expensive maintenance tools or skills
  - The strain gauge technology is simple and easy to implement, even in-situ.
  - The data captured by the sensors can be directly correlated to the load applied on the tracks.
  - The algorithms used for detecting a wheel and identifying wheels with high impact load are simpler, therefore high capacity processing units are not needed.

- Some of the railways that use unmanned systems to monitor the health of rolling stock include:
  - American Railroads
  - Australian Railroads
  - Most of the European Railways
  - Chinese Railways
  - Russian Railways
  - Some railways in South America

WILD – Indian Railways

- Presently WILD is installed in 15 locations across 13 Divisions and 10 Zones on Indian Railways
  - CR
  - **ECR**
  - ECoR
  - **ER**
  - SER
  - SECR
  - SCR
  - SWR
  - SR
  - WCR
- The data from the 15 locations is stored in a central server at www.railman.in

Why is WILD needed

•Defective rolling stock produce high impact loads.
•These loads over a prolonged period of time leads to Rail/Wagon failure, wheel bearing failure etc..
•WILD measures the impact load independent of the cause.
•WILD system assists the railway engineer to attend to the defective rolling stock immediately.
•Reduces Service Failures and Unplanned Maintenance Cost of Rolling Stocks & Tracks.
•WILD is used to catch the defects in the early stage and thereby protecting Rail Infrastructure & avoids Catastrophic Failures.

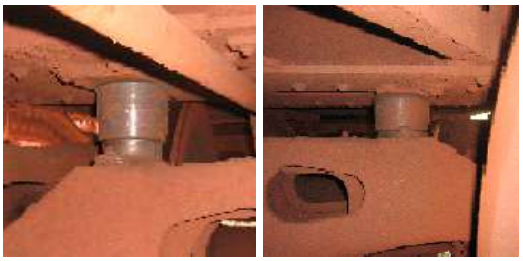
Defects that Cause High Impact Load

- 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
- Skid mark, etc.

Defects that Cause High Impact Load

Wheel Flat

Broken Spring



Unevenness in Side Bearer

Cone Defect

8

Defects that Cause High Impact Load

EM Pad

CC Housing

Axle Bx Cant

Friction Liner

Bolster

PU Pad

Components of WILD

- Instrumented Tracks
- Signal conditioning unit
- Train Trigger Sensor
- Real time Embedded controller
- Impact Load Analyzer Software
- Wireless data transfer
- Power back up
- Calibration Setup

Instrumented Track

- Tracks are instrumented with strain gauges to measure the load pattern of the wheel on the rail.

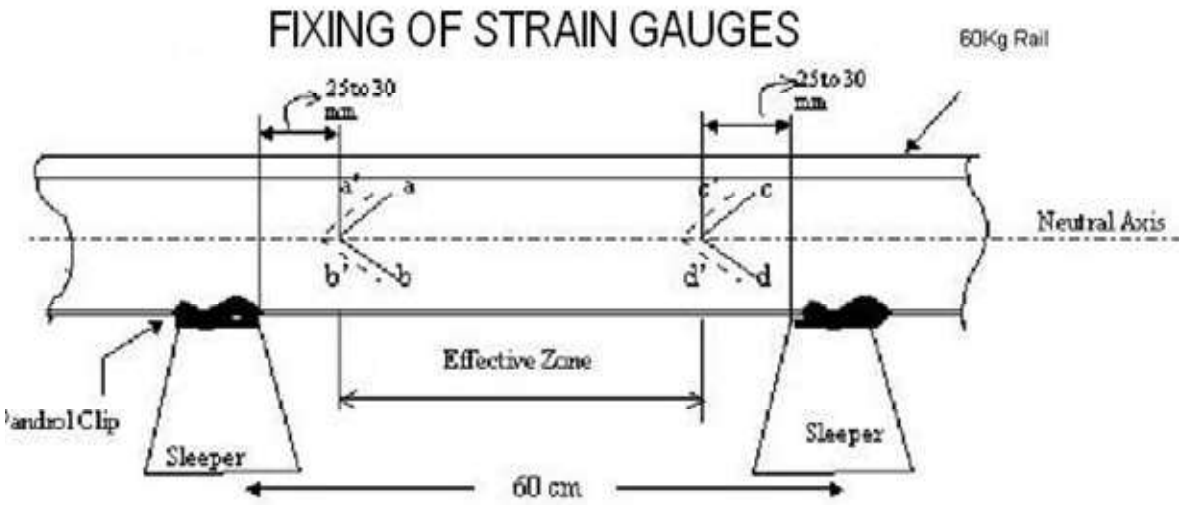
•Tracks are instrumented with strain gauges to measure the load pattern of the wheel on the rail.
•The track consists of 18 Strain gauge measuring channels.
Each channel has a full bridge consisting of 4 Rosette type strain gauges.

Strain Gauges on Instrumented Rail

(Strain Gauge Mounting)

•350 Ohm strain gauge.
•8 strain gauges electrically connected to give a full bridge configuration.
•Each arm of the bridge consists of two gauges.
•The individual arms & gauges wired in a way to measure vertical load.

Strain Gauges on Instrumented Rail



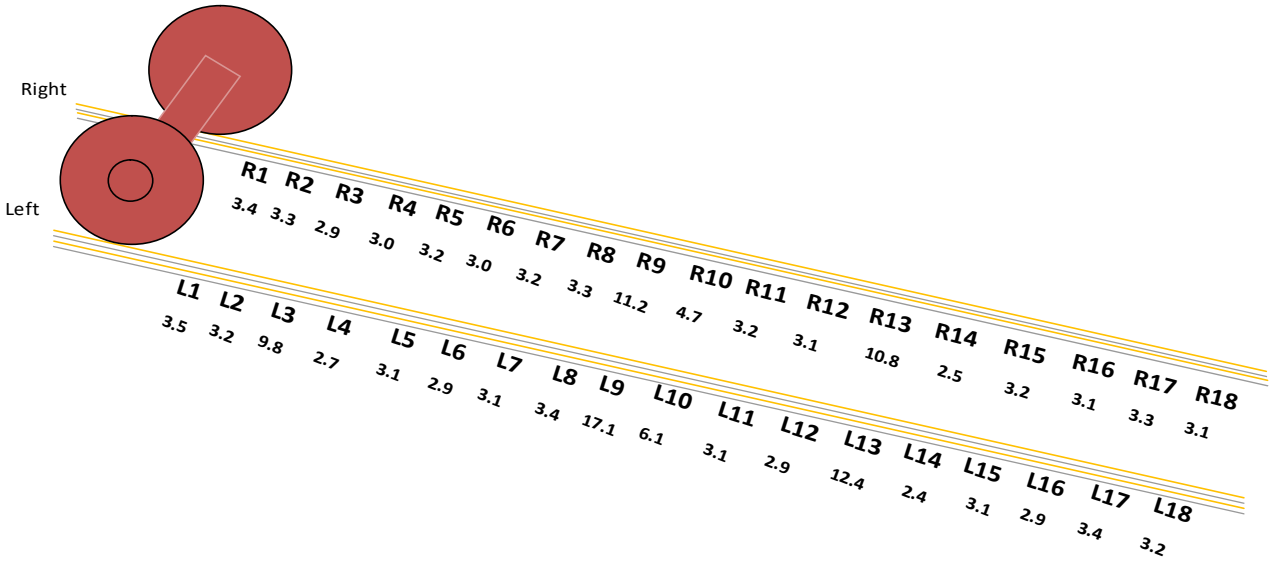
How Does it Work?

•Each channel produces a portion of load profile for all the wheels.
•Accumulating all the data, a complete load profile of the wheel is obtained.
•The maximum load detected by the channels is primarily used to flag the defective axle/wheel.

How does WILD system flag defects

•Signals from strain gauges are connected Signal conditioning unit.
•Inbuilt Surge Protection to meet harsh field conditions.
•Real time embedded controller analyze the conditioned signal and prepare the summary report for publishing in the
website

Calculation (WILD-II Ver. 36channel)



Calculation (WILD-II Ver. 36channel)

Left	Load (Tonne)	Right	Load (Tonne)
L1	3.5	R1	3.4
L2	3.2	R2	3.3
L3	2.8	R3	2.9
L4	2.7	R4	3
L5	3.1	R5	3.2
L6	2.9	R6	3
L7	3.1	R7	3.2
L8	3.4	R8	3.3
L9	17.1	R9	11.2
L10	6.1	R10	4.7
L11	3.1	R11	3.2
L12	2.9	R12	3.1
L13	12.4	R13	10.8
L14	2.4	R14	2.5
L15	3.1	R15	3.2
L16	2.9	R16	3.1
L17	3.4	R17	3.3
L18	3.2	R18	3.1

	Left	Load (Tonne)	Right	Load (Tonne)	
	L1	3.5	R1	3.4	Third Right Max
	L2	3.2	R2	3.3	
Third Left Max	L3	9.8	R3	2.9	
	L4	2.7	R4	3	
	L5	3.1	R5	3.2	
	L6	2.9	R6	3	
	L7	3.1	R7	3.2	
	L8	3.4	R8	3.3	
First Left Max	L9	17.1	R9	11.2	First Right Max
	L10	6.1	R10	4.7	
	L11	3.1	R11	3.2	
	L12	2.9	R12	3.1	
Second Left Max	L13	12.4	R13	10.8	Second Right Max
	L14	2.4	R14	2.5	
	L15	3.1	R15	3.2	
	L16	2.9	R16	3.1	
	L17	3.4	R17	3.3	
	L18	3.2	R18	3.1	

Calculation(WILD-II Ver. 36channel)

Left	Load (Tonne)	Right	Load (Tonne)
L1	3.5	R1	3.4
L2	3.2	R2	3.3
L3	9.8	R3	2.9
L4	2.7	R4	3
L5	3.1	R5	3.2
L6	2.9	R6	3
L7	3.1	R7	3.2
L8	3.4	R8	3.3
L9	17.1	R9	11.2
L10	6.1	R10	4.7
L11	3.1	R11	3.2
L12	2.9	R12	3.1
L13	12.4	R13	10.8
L14	2.4	R14	2.5
L15	3.1	R15	3.2
L16	2.9	R16	3.1
L17	3.4	R17	3.3
L18	3.2	R18	3.1

Left Maximum Dy Wheel Load = 17.1

Left Average Dy Wheel Load = 3.27

$$\text{Left Impact Load Factor} = \frac{\text{Left Maximum Dy Wheel Load (17.1)}}{\text{Left Average Dy Wheel Load (3.27)}}$$

(Avg. Of Lowest fifteen readings)

Left Impact Load Factor (LILF) = 5.23

Right Maximum Dy Wheel Load = 11.2

Right Average Dy Wheel Load = 3.49

$$\text{Right Impact Load Factor} = \frac{\text{Left Maximum Dy Wheel Load (11.2)}}{\text{Left Average Dy Wheel Load (3.21)}}$$

(Avg. Of Lowest ten readings)

Right Impact Load Factor (RILF) = 3.49

System capabilities

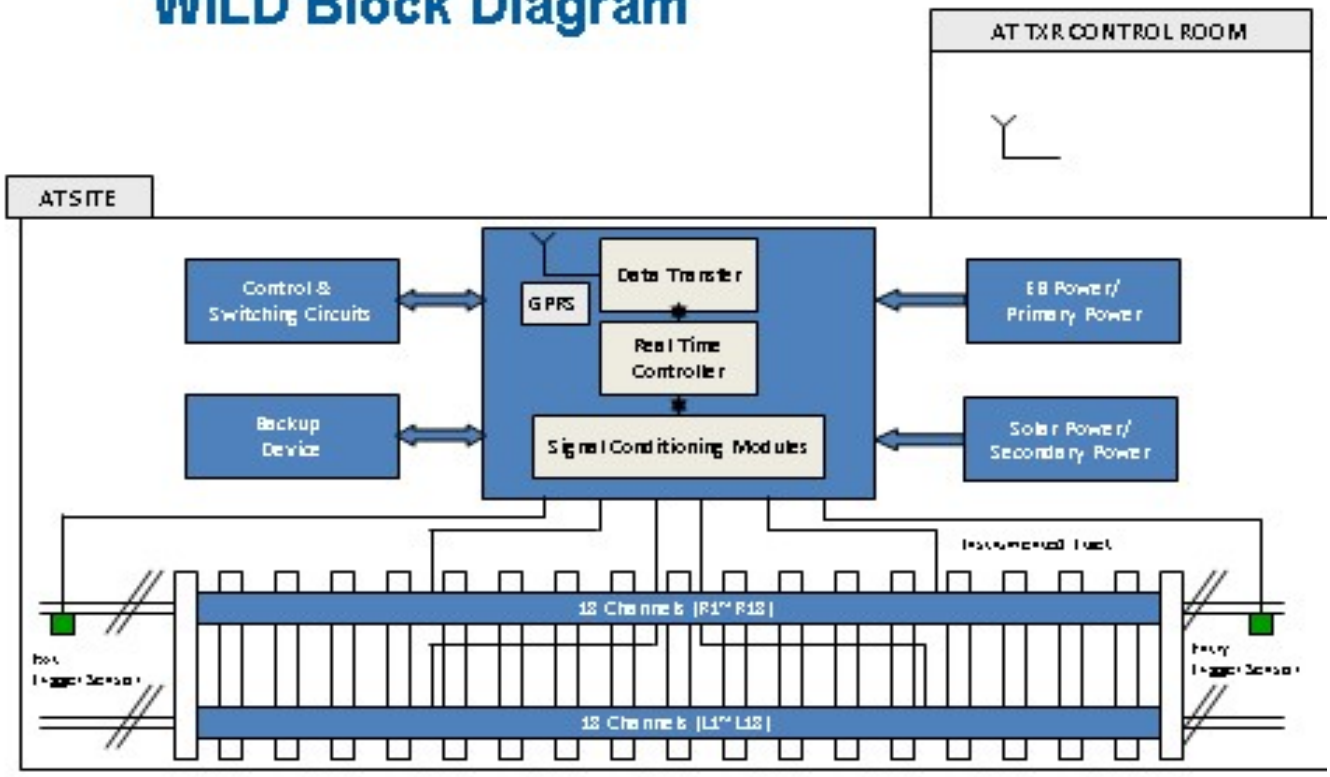
- Counts number of axles from various measurement channels.
- Measures Average Dynamic Wheel Load for all wheels.
- Determines Maximum Dynamic Wheel Load (WA) for all points of contact.
- Calculates speed of each axle and the average speed of train.
- Identifies and counts defective wheels as per specified 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.

Software Flow

•Starts acquisition once train trigger is received.
•Logs all the data in to file for analysis.
•Stops acquisition and logging after the train crosses the instrumented track.
•Calls an analysis program that loads each channel data and furnishes processed data.
•Summary report is produced and is transmitted to remote server.
•Server stores the report and publish in the website.

WILD Block Diagram



Site Selection Criteria (As per Tender)

These criteria are drafted out based on the site conditions given in COFMOW's WILD Specification no: COFMOW/IR/WILD/2006 and our recommendation.

•The system will be installed on **straight and level track of minimum 250m** length including approaches to the site.
•There **should not be any permanent speed restriction** at site of WILD system.
•The rail section shall be 60Kg/m with flat foot laid on Pre-Stressed Concrete (PSC) **sleepers at 60 cm spacing** with elastic fastenings viz. pandrol clips on rubber grooved sole and clean ballast cushion of 250/300 mm.
•The site will not be very close to any station or at the approach of a signal to **avoid acceleration or braking** over the instrumented rails.
•The Railways (DRM/Mechanical) shall ensure advance arrangement like sanction etc. to meet out recurring expenditure after one year of installation.
•The Railways shall ensure provision of reliable **230 V + 10% single phase electric power** supply anywhere in 3 Km along track from the site of installation of the system before system installation is taken up by the firm.
•Site should have **proper road** approach for taking 13m instrumented rail near site through trailer.
•Site should have **good GSM network connectivity** for sending the reports (Preferably TATA INDICOMM.)
•**Proper locality** to safe guard the system from Theft / untoward activities.
•At least one side of the ground area is **close to the level of Track** and soil is strong and good for earthing.
•Preferred **power connecting from OHE** through Auxiliary transformer or near by power resource from Railway infrastructure. Power taken from agriculture field will lead to lot of fluctuation and improper working.

Additional Installation Requirements

•In case of double line, system should be installed in a line where loaded trains **traffic is more**.
•Panel room should **not be placed** where area is marked as railways **future expansion area**.
•Old set of **sleepers** has to be replaced with **new ones**.
•Railways to provide 4 nos glued joint per system. Each **glued joint to be fixed at each end** of the two instrumented rails. Railways also to ensure the rails are welded on to the track.

•Railways to provide all permissions, **line blocks to work** on the site. All relevant departments to provide approval for the site, since once installation process begins, **changing of exact site** location (even by a few meters) would be **extremely difficult**.
•Railways to arrange for adequate **security for men and materials**.

Technical Details

Hardware:

The system comprises of following units :

- Two full length 52 kg/60 kg rail for instrumentation.
- Train sensor for automatic switching on&off of the system.
- Signal conditioners and amplifiers.
- 36 channel High Speed Data Acquisition System.
- 2 nos. of Pentium IV Computer with MODEM
- Reliable & dedicated telecommunication link capable of handling data transfer up to 64 KBPS.
- Uninterrupted stabilized power supply of 230 volts 50 Hz.
- 100 nos. of Rosette type strain gauges & associated wiring
- Hut at the site for installing the system

Software:

- Window based software on LAB VIEW and MATLAB plat form for data acquisition, analysis and transfer.

Causes which may affect the WILD system

- Trains stopping, stalling, accelerating/decelerating, braking hard on the system.
- GSM signals weak or erratic (Can be overcome by using Indian Railways' OFC Network).
- Huge Power surges, outages
- Theft
- Non-utilization of data trending features
- Unclear understanding of the system.

Recommendations Of The Committee of Sr.ED/Wagon, ED/Track, ED/Traffic & ED/Research At RDSO

(31st March 2005)

a) Medium Alarm Level (**) :

Impact Load Factor in the range of 3.0 – 3.5 or, Wheel Impact Load 20t – 25t

- Vehicle shall be examined at the nearest major C&W examination depot/station for identification of culprit wheel and vehicle for taking any remedial action and intimation to the destination station/base for taking any remedial action by the C&W staff.

The vehicle shall be permitted to run up to destination without any speed restriction, if nothing unusual has been noticed.

b) High Alarm Level (***) :

Impact Load Factor in the range of 3.5 – 4.0 or, Wheel Impact Load 25t – 30t

- In case of a **passenger vehicle** the train shall be examined at the next passenger convenient station/halt by Driver, Guard, SM/ASM and C&W staff (if available) for taking corrective action, if necessary and thereafter permit the train to move at normal speed.
- In case of **loaded goods train**, it shall be stopped at the next station and the vehicle examined by Driver, Guard, SM/ASM for physical verification of the defect and taking remedial action, if any. The loaded goods train will, however, be permitted to move up to the destination station

at a suitable speed not exceeding 50 kmph and the wagon after unloading shall be examined & attended to by C&W staff.

- In case of **empty wagons**, the train will be stopped at next station for identification of culprit wheel & vehicle; communicating the same to control & base maintenance depot/nearest ROH depot enroute and would be permitted to move up to destination at a suitable speed not exceeding 50 kmph.

c) <u>Emergency Alarm Level</u> (****) :

Impact Load Factor greater than 4.0 or,
Wheel Impact Load greater than 30t

- In case of a **passenger vehicle** it shall be stopped at the next station, examined by Driver, Guard, SM/ASM and will be permitted to move at a suitable speed not exceeding 75 kmph up to next passenger convenient station for detachment.
- In case of a **loaded goods train**, it shall be stopped at the next station and examined by Driver, Guard and SM/ASM. The vehicle may be detached, if after examination any evident defect which can contribute to the high load is found, otherwise the train be permitted to move at 30 kmph maximum up to next major C&W depot for examination and repair.
- In case of **empty goods vehicle** the train may be permitted to move up to next C&W maintenance depot at a suitable speed not exceeding 50 kmph where the vehicle shall be detached for repairs.

The above mentioned alarm levels will be reviewed after two years after gaining more experience from 'WILD' System at Ajgain and new such systems to be installed on IR.

<u>THANKS YOU</u>