# Design And Development Of FailureDetection Surveillance System For Traction Motor Dropping InLocomotive.

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***Abstract*—**On 13 January 2022, at 16:55, of the 18 coaches of the Bikaner– Guwahati Express derailed as one of the traction motors fell off the locomotive, prompting the drivers to apply emergency brakes to the speeding train causing the last two assemblies of the locomotive to derail. Currently there is no system to detect the failure in traction motor arrangement. To avoid such accidents in future we are designing a system that will detect the above problem and give prior warning to the loco pilot. Also this project is Patentable. Large structures can be simulated for welding, which consists of an analytical thermal model combined with a non-linear structural finite element model that uses shell elements. A manufacturing analysis is conducted on the anticipated clamping forces, distortions, and residual stresses for varying clamping circumstances and plate thicknesses. Bolts are frequently used to link steel structures, and when they become loose, the structural integrity of the steel and cause accidents. A bogie, which functions as a modular subassembly of wheels and axles, is a chassis or structure with wheels that is fixed to the train. The initiative also looks into forced vibrations that cause tension, which is studied using simulations. In order to do this, ANSYS, a finite element program, is chosen, and load criteria from EN standards are taken into account. These standards are then thoroughly assessed for overall safety and dependability.

## I. INTRODUCTION

In this project we are developing a surveillance system of sensors and camera that will keep a record of all these factors and as soon as it detects any unusual motions it will create a signal and alert the loco pilot by giving a warning. After the warning the pilot can check the under truck of locomotive and take required action. Hence it will avoid further mis-happenings. Any object between 2.5 cm and 10 meters can be detected by an ultrasonic proximity sensor, sometimes referred to as an ultrasonic level sensor or ultrasonic distance sensor.

Mis-happenings occurring due to dropping of traction motor) of our project also depends on the suspension arrangement of the Traction motor. The efficiency and seamless operation of the transmission between the motor shaft and the wheel set axle are fully maintained under all operating conditions when the proper geometric arrangement between the rotor shaft and the axle of the wheel set is maintained. Axle hanging Nose Suspended Traction motor is utilized in ABB traction motor type 6FRA 6068, which is used in WAP-7/WAG-9, 9H, and 9HC Locos. (Fig 1).

R. N. Lal studies the traction motor arrangement, which is mounted in the bogie frame with its armature shaft parallel to the axle. The axle is rotated on one side of the motor frame, which is supported by two suspension bearings housed in a motor suspension unit, while the other side of the motor is equipped with a "nose" that rests on a bracket fastened to the bogie's transom. The traction motor mounting solution in question offers reduced shock resistance due to the motor's nearly 50% stiff axle installation. Because of the traction motor support's poor robustness, motors are directly subjected to high levels of shocks produced at the tire treads by abnormalities in the track. [1]

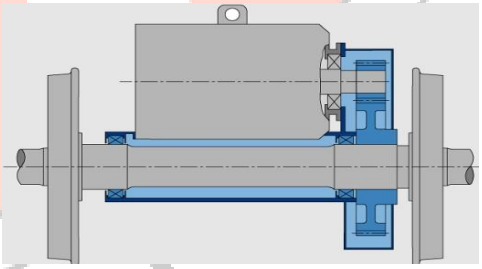

**Fig. 1 : Axle hung and nose suspender traction motor**

**Fig. 2. Traction Motor arrangement in chassis (Diesel loco shed Ghorpadi Pune)**

Fig. 2 shows Actual arrangement of Traction Motor.

A. Traction mechanism-

- Due to the relationship between power, velocity, force, described as: P=V/F or P/V= F.
- Tractive Effort or Tractive Force, is the amount of force at the Loco coupler available for moving a train.
- To pull a train, a force must be applied to overcome the Train resistance or inertia of the resting train. The train remains at rest until sufficient force is applied.

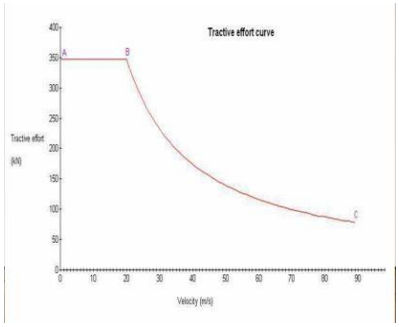


**Fig 3. Tractive Effort Curve.**

B. Torque Wrench Method:

- The relationship between the torque and the bolt preload is close to linear. Based on this, an empirical equation has been developed.[2]

$$T = \frac{F}{2}\left(\frac{d_2}{\cos\alpha}\mu_s + \frac{P}{\pi} + d_w\mu_w\right),$$

where T is the applied torque, F is the bolt preload, d2 is the pitch diameter, α is half of the thread angle, μ is the frictional coefficient of screw threads, P is the pitch, dw is the equivalent friction diameter of the support surface of nut and μw is the frictional coefficient of the interface between nut and support surface. The torque wrench method relies on the linear tension-torque relationship of bolt fastening.[3]

C. Finite Element Method-

The CAD model is analysed before a prototype is constructed. Hyper mesh divides the CAD model into many nodes and elements; the more nodes, the more accurate the results, but processing such models requires higher-end computers due to the size of the database file.

- A continuous body is discretized into basic geometric shapes in analysis, which are referred to as finite elements.
- Every element's corner considers the material properties and regulating relations over these elements, expressing them in terms of unknown values.

D. RTDT Method:

Several studies (Park et al., 2015b; Huynh et al., 2019; Ta & Kim, 2020) have shown how successful vision-based techniques are at estimating bolt rotation. Specifically, the HT algorithm used in these investigations would not be able to recognize lines and circles in complicated photos with background noise, washes, light reflections, or different hues of surrounding objects. Initially, the YOLOv3-tiny method is used to create the bounding box, or ROI, for every bolt in the video's first frame. Secondly, the original video frame will be used to extract these ROIs, and the Shi-Tomasi method will then be employed to produce FPs inside the ROIs. By concentrating on the ROIs instead of processing the entire video frame, this phase significantly reduces the computational load. The Gaussian filter dimension and the minimum quality measure are the two key parameters in the Shi-Tomasi algorithm.[4]

## II. PROBLEM DEFINITION

Cases of Traction motor dropping on-line over Indian Railway in WAP-4/WAG-7/WAP7/WAG-9 Electric Locomotives had happened due to breakages of traction motor nose/motor support. In regard to accident of train no. 15633 UP (Bikaner-Guwahati Express) in Alipurduar of Northeast Frontier, the traction motor (in WAP-4 locomotive) comes to rest on the bogie transom with its lifting lugs in case of failure of top nose stay. This intermediate position can be detected electrically which can send alarm to driving cab and ALP/LP can immediately stop the train. This shall be implemented in passenger locomotives immediately. To design and develop a future failure detection system for traction motor dropping using sensors and cameras that will detect the failure and indicate the same to the loco driver.

## III. METHODOLOGY

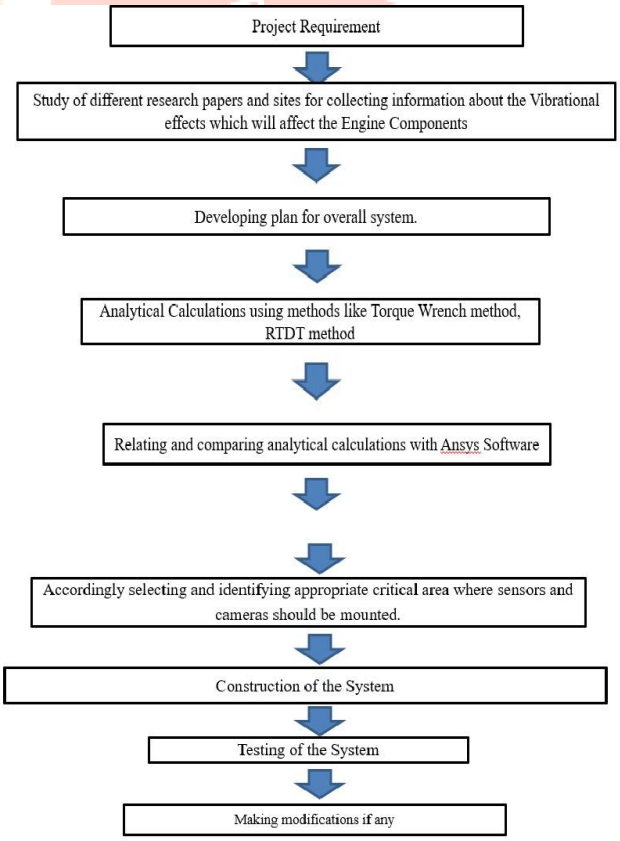


**Fig. 4. Flowchart.**

A. Working:

There is no indication for loco crew in three phase Electric Locos regarding falling of TM on-line. In view of criticality of the issues it has been felt necessary to develop Traction Motor Dropping Detection System (TMDDS) in WAP-7/WAG-9, WAG-9H, and WAG9HC type of Electric Locomotives. The ABB traction motor type 6FRA 6068 used in WAP-7/WAG 9/9H/9HC Locos are suspended in the bogie frame from torque arm through motor support and TM holder plate and on the individual axles through suspension tube. In this project, we're building a sensor-and camera-based surveillance system that will record all of these variables. It will also detect any unexpected motions and send out a signal or warning to the loco pilot. Following the alert, the pilot can inspect the locomotive's undercarriage and take the necessary measures. Therefore, it will stop more mis happenings. utilized sensor Any object between 2.5 cm and 10 meters can be detected by an ultrasonic proximity sensor, sometimes referred to as an ultrasonic level sensor or ultrasonic distance sensor. With exceptional accuracy, adaptability, and dependability, ultrasonic proximity switches are utilized to identify items with varying materials, forms, colors, or concentrations. A 16x2 LCD screen is provided in the loco cabin which will indicate the Traction Motion Number with the condition of traction motion and distance of the Traction motor with reference to the sensor.

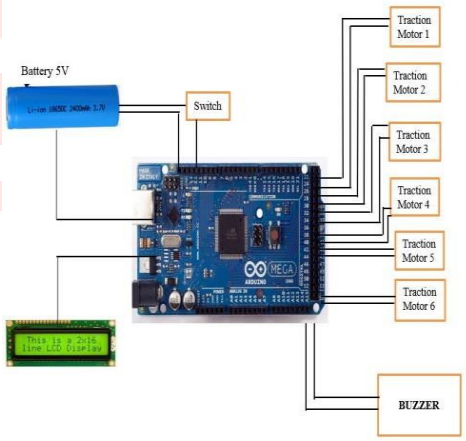


**Fig. 5 Circuit Diagram**

## IV. EXPERIMENTAL TEST SETUP

- Ultrasonic Sensors - By directing an ultrasonic sound pulse beyond the range of human hearing against the target and timing the return of the sound echo, one can determine the proximity to or presence of an object.


**Fig. 6 Ultrasonic**

- Arduino MEGA - It contains 16 analog inputs, 4 UARTs, a 16 MHz crystal oscillator, 54 digital input/output pins (14 of which can be utilized as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. To begin, use a USB cable to connect it to a computer or an AC-to-DC adapter or battery to power it.


**Fig. 7 Arduino**

- Buzzer - Used to transform the audio signal into sound.

**Fig.8 Buzzer**

- LCD Screen – It in an electronic display.


**Fig.9 LCD Display**

## V. RESULTS AND DISCUSSION

Dimensions:
For Bolt Thread size M30
Dia. = 30mm
Lenght = 140mm
Pitch = 3.5mm
Height = 19.12mm
TM Weight of TM = 2100 kg = 20601N
Factor Of Safety = 1.25
Direct Compresive Stress= 4.7728N/mm per bolt.
Torsional Shear Stress = 21.3444N/mm2 per bolt
Maximum Shear Stress = 21.4774 N/mm2 per bolt

## CONCLUSION

In this study, studied the factors affecting failure of bolt, Suspension arrangement of the traction motor and accordingly decided critical areas for sensor arrangement and thus the system will detect the system will detect the movement of the Traction Motor with distance and display it on the LCD screen and if any change in position of Traction motor buzzer will indicate it.

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