Volume: 2 Issue: V Month of publication: May 2014
DOI:

ISSN: 2321-9653

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE AND ENGINEERING TECHNOLOGY (IJRASET)

An Application in Railway Derailment by Measuring Eye Blinking and Vibration Sensing for Safe Driving

Gopal Malakar [1], Upasana Sinha[2], Dr.Vishnu Kumar Mishra[3]

[1]*Dr.C.V.RAMAN UNIVERSITY, BILASPUR, INDIA,*
MPHIL SCHOLAR

[2]*Dr.C.V.RAMAN UNIVERSITY, BILASPUR, INDIA,*
PHD SCHOLAR

ASSOCIATE PROFESSOR
DEPTT.OF ENGINEERING (CSE)
[3]*RSR RUNGTA COLLEGE OF ENGINEERING & TECHNOLOGY, BHILAI (C.G)*

Abstract*—Railways are large infrastructures and are the prime modes of transportation in many countries. As it is closely associated with passenger and cargo transportation, it owns high risk in terms of human lives and cost of assets. New technology and better safety standards are constantly introduced but accidents do occur. There will always be some risk associated with derailments but it can be reduced by elimination of the root causes. A derailment is an accident on a railway in which a train leaves the rails, which can result in damage, injury and death. In the case of a railway vehicle running on track, irregularities in track geometry can lead to complex dynamic interaction between the vehicle and track. Therefore, Driver in-alertness is an important cause for most accidents related to vehicle crashes. This paper basically focused on Drowsy driver detection methods can form the basis of a system to potentially reduce accidents related to driver doziness that leads major accidents. Intel-Eye describes a real-time driver in alertness and shock related facial expression monitoring. Intel -Eye obtains visual cues such as eyelid movement; gaze movement, head movement, and facial expression that typically characterize the level of alertness of a person are extracted in real time and systematically combined to infer the fatigue level of the driver. Intel-eye distinguishes itself by the Two-Way Approach in eye gaze analysis. Shock analysis is done to identify the driver's expression and signals are sent for automatic braking system. A probabilistic model is developed to model in Intel-Eye and it is used for predicting human in-alertness based on the visual cues obtained.

***Keywords*—derailment, track, vibration sensing, Eye blinking, accidents free.**

I.INTRODUCTION

There has been a growing interest in the field of facial expression recognition especially in the last two decades. The primary contribution of this research is automatically initializing the eye blink detection in an image sequence for real time eye tracking applications. The never-ending saga of traffic accidents all over the world are due to deterioration of driver's vigilance level. Drivers with a depleting vigilance level suffer from a marked decline in their perception; recognition and vehicle control abilities & therefore pose a serious danger to their own lives and the lives of the other people. For this reason, developing systems that actively monitors the driver's level of vigilance and alerting the driver of any insecure driving condition is essential for accident prevention [1, 2]. Many efforts have been reported in the literature for developing an active safety system for reducing the number of automobiles accidents due to reduced vigilance. Though advance safety features are provided such as advances in vehicle design, including the provision of seat belts and airbags and improvements. One of the most damaging rail accidents is a derailment. A derailment is an accident on a railway in which a train leaves the rails, which can result in damage injury, and death.Derailment of a train occurs when

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE AND ENGINEERING TECHNOLOGY (IJRASET)

the wheels lift and slip out of the track. One of the major type of derailment has been studied is Excessive speed. However, future increases in Railway track will make it difficult to meet future casualty reduction target sunless more advaniced accident avoidance technologies can be introduced. Drowsiness [3] in drivers can be generally divided into the following categories:

[1] Sensing of physiological characteristics.
[2] Sensing of driver operation
[3] Sensing of vehicle response.
[4] Monitor the response of the driver.

II.OBJECTIVE

With reference to this paper, the main objective is to avoid sudden damages or accidents causes by wheel climb and rail roll that leads to derailment. Since, not all the faults described in this paper, the priority given to the error that comes due to either System fault or Human fault. The study of the derailment has been focused about the defects in the train itself, but in this paper, the main purpose is to prevent derailment to monitor the causes related to it and identify the actions related to it. The type of derailment described above have a common cause of high lateral force at the wheel-rail interface [4]. Therefore, any condition that leads to high lateral forces or lead to lower the ability of the system to sustain the force should be corrected. This is possible only when the vibration related to the forces should not cross the limit; otherwise the vibration that comes out due to broken rail is very high and can be computed using Simulation method to detect the level of derailment. The effect of vibration depends on the magnitude of acceleration suffered by a passenger, its direction and frequency [5]. To meet this condition, velocity, acceleration or jerk of vibration of train must be limited to certain extent. Among these methods, the techniques based on human physiological phenomena are the most accurate. This technique is implemented in two ways:

i. Measuring changes in physiological signals, such as brain waves, heart rate, and eye blinking.

The second technique is well-suited for real world driving conditions since it can be non-intrusive [6] by using image processing to detect changes. Driver operation and vehicle behavior can be implemented by monitoring the steering wheel movement, accelerator or brake patterns, vehicle speed, lateral acceleration, and lateral displacement. These too are nonintrusive ways of detecting drowsiness but are limited to vehicle type and driver condition. The final technique for detecting drowsiness [7] is by monitoring the response of the driver. This involves periodically requesting the driver to send response to the system to indicate alertness. The problem with this technique is that it will

Eventually become tiresome and annoying to the driver. The propose system is based on eyes closer count & yawning count of the driver. By monitoring the eyes and mouth, it is believed that the symptoms of driver fatigue can be detected early enough to avoid an accident [8]. The eye blink frequency increases beyond the normal rate in the fatigued state. In addition, micro sleeps that are the short periods of sleep lasting 3 to 4 seconds are the good indicator of the fatigued state, but it is difficult to predict the driver fatigue accurately or reliably based only on single driver behavior. Additionally, the changes in a driver's performance are more complicated and not reliable so in this system second parameter is also considered which a yawning counties In order to detect fatigue and shock expressions probability the facial expression parameters must be extracted first[9].

III.ANALYSIS AND RELATED WORK

The study and the analysis are totally based upon the criteria of safety against derailment. The various criteria can be applied in the assessment of the results of computer simulations but the most important are connected with the safety of the vehicle. The likely hood of derailment is affected by the vehicle suspension as well as the track condition, and assessment of derailment is not simple[10]. The ratio of forces that tend to produce and who oppose the derailment must be kept within certain limits. In some cases this system of forces is responsible of the boarding on track of the bandage rim and following the derailment of the axle. Forces that appear are of two types [11].

1) Vertical force.
2) Horizontal force (lateral force).

After the studies conducted by researchers as Nadal, Wagner, Heumann it has been found that the downwards vertical forces prevent derailing while the horizontal forces favours it [4]. In this paper, Nadal's formula has been given priority for the safety against derailment as it concentrated on wheel flangeclimb due to steady force. In the normal running of a railway vehicle, the only point of contact with the rail is in the tread part of the wheel. The flange only contacts the rail if the curving performance of the vehicle is exceeded and the condition of derailment normally occurs and it is referred to as flange climbing [12]. As described above, flange climbing derailment is a process by which lateral forces acting on the wheel set causes one wheel to climb up and over the rail.

ISSN: 2321-9653

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE AND ENGINEERING TECHNOLOGY (IJRASET)

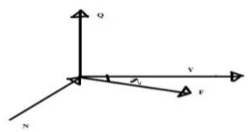

Fig 1: Force components at a wheel/rail contact

Where lateral (Y) and vertical (Q), normal force between the wheel and rail (N), lateral rolling-friction force (F), the cone angle of the force (λ) and, the coefficient of friction between wheel and rail (μ) [13].

Nadal expressions are [2]

$Y = N \sin\lambda - \mu N \cos\lambda$

$Q = N \cos\lambda - \mu N \sin\lambda$

The commonly used derailment quotient Y/Q can be calculated,

$Y/Q = (\tan\lambda - \mu)/(1+\mu \tan\lambda)$

This is called Nadal's formula where the criteria of the safety against derailment is,

Derailing forces < stabilising forces, i.e.[1,14] Y/Q should < (tan λ μ)/ (1+μ tan λ).This is possible only when, Y is low, Q is high and μ is low. The formula thus indicates that for safety, λ should be large; its maximum value could be 90. For a large majority of wheels, Nadal criterion admits that λ≈ 68° (for new wheel profile) and μ=0.25 and so it results:

$Y/Q \leq 1.4$ [1]

In other words, for safety against derailment, ratio Y/Q should not exceed 1.4. This is the threshold value. To allow for certain margin or factor of safety, a limiting value of 1.0 for ratio Y/Q has been laid down on the Indian Railways [15], as one of the criteria for assessment of rolling stock stability. The Nadal's criterion is easy to implement and it is widely used for the assessment of the safety against derailment. In particular, this criterion is applied in a modified form in the UIC 518 code which is used for testing and approval of railway vehicle. The main modification adopted in the UIC 518 code is the requirement that the ratio Y/Q exceeds the assumed critical value of 0.8 over 2m track interval in 0.05 second and when such duration is less than 5 second then the value of Y/Q is (0.04/t) [1][5]. This is done because derailment of a vehicle can take place only if the ratio Y/Q exceeds the limit value for a sufficiently long time interval. These modifications of the Y/Q limit by increasing its value for short duration of the lateral force impulse have been proposed by Japanese National Railways (JNR). The occurrence of wheel climbing also strongly depends on the angle of attack (ψ of the wheel set described above). The present paper is basically based upon the comparative study in which the safety against derailment is assessed with the safe Nadal criterion modified according to the UIC Code 518[5][7]. In the first step of the safety analysis, the ratio Y/Q can be obtained from simulations is averaged at each track point over the surrounding 2m track section. Thus, the running average (Y/Q) on 2m will be calculated – it is done to satisfy the discussed requirement of minimum flange climb distance necessary for derailment. Further, as it is recommended in the UIC Code 518, the 99.85 percentile vale (Y/Q) on 2m|0.9985 is found. The obtained values (Y/Q) on 2m|0.9985 will be compared to the limit value 1.0 adopted by the Indian Railways [1,16]. On the basis of this comparison, it has been analysed that the value of (Y/Q) on 2m|0.9985 grows with the increase of the ride velocity but they do not exceed the limit value 1.0, and this can be favourable aspect to avoid derailment.Furthermore the criterion of analysis of running safety is related with the ride comfort. The passenger ride comfort related to vibrations is of vital importance among a variety of other factors in comfort evaluation. The principle quantity that is relevant to the vibration aspect of the ride comfort is the acceleration that the passenger is subject to during the motion of a railway vehicle. The perception of the ride comfort depends on both amplitude and frequency of the suffered acceleration as well as on its lateral and vertical direction. The below formula has been referred [11] for the passenger ride comfort value.

$$N = 2 * \sqrt{(a^{W_d}_{YA95})^2 + (a^{W_b}_{ZA95})^2} + 4 * (a^{W_b}_{ZP95}) + 4 * (a^{W_c}_{XD95})$$

Where,
N is Ride comfort value (N≤1 very comfortable to N>5 very uncomfortable).
a is Acceleration R.M.S. value over 5 sec.
Wb is Weighing filter for vertical acceleration.
Wc is Weighing filter for longitudinal acceleration.
Wd is Weighing filter for lateral acceleration.
X, Y, Z is Direction of measurement (longitudinal, lateral and

ISSN: 2321-9653

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE AND ENGINEERING TECHNOLOGY (IJRASET)

vertical respectively.). P, A, D is Position of measurement (floor, seat interface, backrest interface, respectively). 95 is 95th percentile of sampled 5s r.m.s- values under 5 min duration of constant and representative condition.The above description shows that the frequency of the vibration depends on the vertical and lateral force. Therefore, the safe value of Y/Q should be matched with the cut-off frequency. It means that if Y/Q goes ahead of the value 1.0, the maximum vibration can be observed to monitor derailment.

IV.APPLIED METHOD

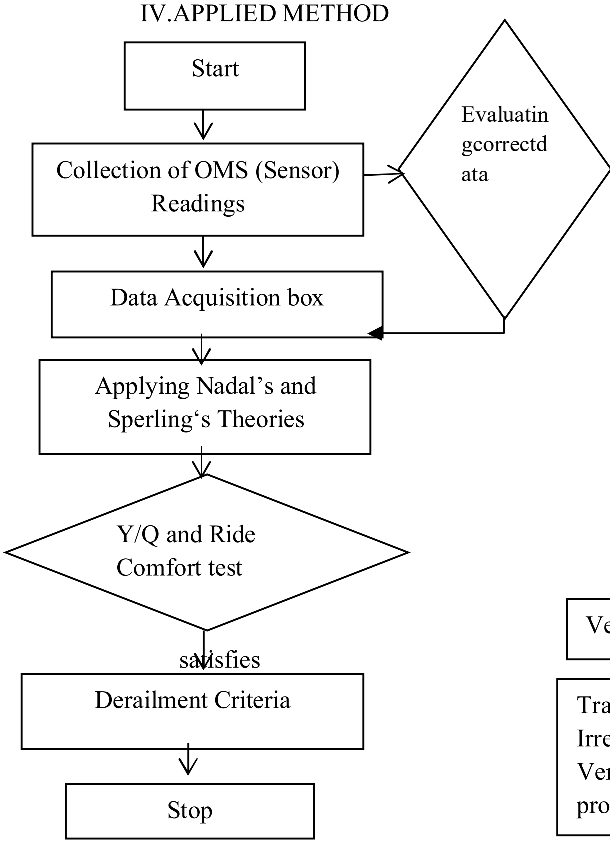

Fig 2: Work flow diagram

i. Nadal's Theory: The method that has been applied is based on the Nadal's derailment criteria .After the studies conducted by Nadal, it has been found that the downwards vertical forces prevent derailing while the lateral forces favors it. Nadal's formula has been given priority for the safety against derailment as it concentrated on wheel flange climb due to steady force.

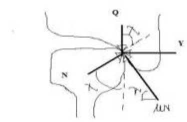

Fig 3:- Force component at a wheel-rail contact.

On resolving the forces along the flange angle, i.e.,

$Y \cos\lambda + \mu (Q \cos\lambda + Y \sin\lambda) < Q \sin\lambda$

For safety against derailment,

Derailing forces Stabilizing forces.

i.e. $Y/Q \;\; (\tan \lambda - \mu) / (1+\mu\tan\lambda)$.

This is called Nadal's Formula [6]. According to Indian Railways; for large majority of wheels, $\lambda = 68^{\circ}$ (for new wheels) and $\mu = 0.25$.

Therefore,$(\tan \lambda - \mu) / (1 + \mu \tan \lambda) \approx 1.4$.

1) Vibration Sensing

Track irregularity, vehicle characteristics and vehicle generate motion quantities that are perceived by passengers. The combination of these quantities affects the passengers' perception of ride quality and ride comfort as shown below:

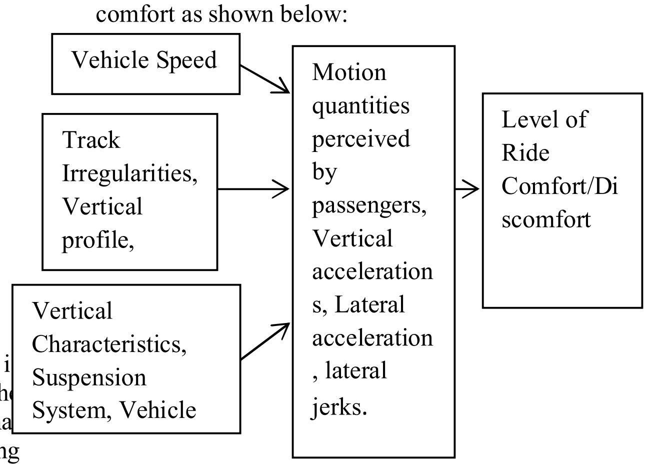

Fig 4: Significant track and Vehicle parameters for Ride Comfort

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE AND ENGINEERING TECHNOLOGY (IJRASET)

Whole body vibration occurs when the body is supported on a surface which is vibrating.The vibration frequencies of interest vary according to the environment and the effects.The vibration between frequencies (0.4 Hz – 20 Hz)is the area of interest nowadays as it has much severe effects on Human beings.The table shows the level of frequencies of vibration is given below [16]:

Table1:
.

Vibration Frequencies	Causes
Below 0.5 Hz	Symptoms of motion sickness, nausea.
Between 4 or 5 Hz	Interference of Hand Activities
Over 15 Hz	Vision is blurred
Between 10 or 20 Hz	Voice warble

In order to evaluate Ride quality and Ride comfort of a railroad, following equations has to be solved.
As the quality and Ride comfort of a vehicle is assessed according to the effect of mechanical vibrations.

Ride Quality, $W_{zrq} = (a^3B^3)^1/^{10}$.

Ride comfort, $W_{zrc} = (a^2B^2)^1/6.67$.Where a, is a peak acceleration in cm/s², f is frequency in Hz, B is the acceleration weighing factor. The frequency weighing factors are defined for ride quality and ride comfort in different directions.

The weighing function B for vehicle ride quality is

$$B = \underline{1.14\ [(1- 0.056\ f^2) + (0.0645)^2(3.35\ f^2)]\ ½}\ [(1- 0.252\ f^2)^2 + (1.547\ f - 0.00444\ f^3)^2]\ (1+3.55\ f^2)$$

The weighing factor B for ride comfort in the horizontal direction is

$$Bw= 0.737\frac{[1.911\ f^2 + (0.25f^2)^2\quad]\ ½}{[(1- 0.277\ f^2)^2 + (1.563\ f - 0.0368f^3)^2]}$$

The weighing factor B comfort ride comfort in the vertical direction is

$$Bs = 0.588\ \frac{[1.911\ f^2 + (0.25\ f^2)^2\quad]\ ½}{[(1- 0.277\ f^2)^2 + (1.563\ - 0.0368\ f^3)^2]}$$

The vehicle body vibration is not at a single frequency, and therefore the Wz ride factor is determined for each individual frequency and it is calculated as;

$Wz_{total}= (Wz1^{10} + Wz2^{10} + + Wz3^{10} + Wzn^{10})\ ^1/^{10}z.$

The categorization implementation was made in order to give our personal view on how vibration of a track attacks categories, which are based on the lateral/vertical forces and ride comfort index value of passengers.
An overview of the combination of Nadal's theory and Sperling's ride comfort value was given as introduction to the method that was implemented as part of the project.
Data sheet of the calculated values by dynamic frequency using Mat lab.

Table 2:

S.N.	F	B	B_w	B_s
1.	0.4	0.74	0.358186	0.210614
2.	0.6	0.54	0.47508	0.279347
3.	0.8	0.38	0.556041	0.326952
4.	1	0.28	0.61307	0.360485
5.	5	1.75	1.01881	0.59906
6.	8	2.094	0.801344	0.47119
7.	10	2.32	0.617891	0.36332
8.	15	2.42	0.374592	0.22026
9.	18	2.48	0.302387	0.177804
10.	20	3.92	2.468176	2.157688
11.	26	4.76	2.500809	2.218076
12	28	4.78	2.785429	2.509032

No.11 and no.12 are the Probability of accidents

Data sheet of the calculated values by static frequency using mat lab:
Table 3:

F	Acceleration	λ	μ	W_{zrq}	W_{zrc}	Y/Q
1	1.5	68	0.25	0.018374	0.011809	1
2	1.5	68	0.25	0.0015	2.76E	1.2
3	1.5	68	0.25	3.90E-04	3.65E-05	1.2
4	2	68	0.25	5086E-05	2.12E-06	1.4
5	2	68	0.25	-3.29E-06	-5020E-24	1.5
6	2	68	0.25	-1.35E-05	-4.34E-23	1.5

According to the rule, F=5 and F=6 are not acceptable for running.

ISSN: 2321-9653

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE AND ENGINEERING TECHNOLOGY (IJRASET)

The comparative values with respect to f, B, Acceleration and Y/Q are:

	F	B	B_w	B_s	Acceleration	Y/Q
Standard Graph	1.5 Hz	3.2	1.0	0.6	10	1.4
After simulating Input data	1.5 Hz	2.42	04	0.2	10	1.3

Putting against these values we gave the graph as shown:

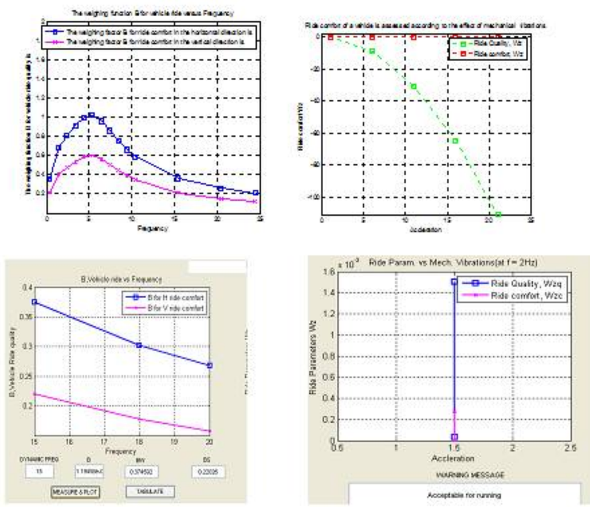

Fig 5: Putting against these values we gave the graph as shown

V. RESULT AT GLANCE

1. On calculating the value of Y/Q, for both the forces we have the threshold values i.e. 1.4 and it should not exceed this value.
2. There is range of frequencies within a limit of 0.4 to 20 Hz. This has been taken as input to see the variations.
3. Applying the Sperling's Ride index formula for both the lateral and vertical directions to maintain the ride comfort of the passengers.
4. On plotting the graph for the vibrations we could see the differences in safe and unsafe zone.

VI.APPLICATIONS

1. It can better use in the Railway Department for the safety and security of passengers.
2. It can be used as an online sensor so as to predict the possibilities of accidents.
3. As the combination of Nadal's and Sperling's theories is applied, the comfort level of the passengers can be analyzed with the forces.
4. The L/V values can help in predicting the derailment accident as the best possible solution using the threshold values.
5. Automobiles.
   - Securing Guard Cabins.
   - Operators at nuclear power plants where continuous monitoring os necessary.
   - Pilots of airplane.
   - Military application where high intensity monitoring of soldier is needed

VII.FUTURE ENHANCEMENT

Railway infrastructure is one of the fastest modes of transportation so it demands safety and security for their passengers. Therefore, Vibration sensing analysis is one of the major needs and requirement to monitor the condition the passengers. It is important to notice that when someone wants to travel through train, in our case, vibration sensing will most likely to be checked. The ability of detecting the vibrations through a sensor and using that real data as an input is the most important thing to monitor the accidents .Further work can address the subjective experiments and prediction of accidents Online using the above salient measures identified. Another possible avenue is to combine various fundamental metrics for better performance prediction.

ISSN: 2321-9653

REFERENCES

[1] R.K.Yadav, The Investigation of Derailments, 3rd Ed, March 2007,Indian Railways Institute of Civil Engineering, Pune.

[2] Parkinson H., Iwnicki S.D., An Intelligent Track Monitoring System, Rail Technology Unit, Manchester Metropolitan University, U.K.,2004.

[3] Rail track Group Standards GM/TT0087 'Resistance of Railway vehicles to derailment and roll-over', June 1993.

[4] Assoc. prof. dr. eng.Eugen GHITA, Issues on Maintenance and Modernization to Increase Safety Against Derailment of the Railway Transport, "Politechnica" University of Timisoara, April-September 2010.

[5] Eva Kardas-Cinal, Comparative Study of Running Safety and Ride Comfort of Railway Vehicle, Warsaw University of Technology, Faculty of Transport, November 2009.

[6] Nadal M.J.: Theories de la Stabilite des Locomotives, Pare 2, Movement de Lacet, Annales des Mines, vol. 10,232 (1896).

[7] UIC Code 518 OR: "Testing and approval of railway vehicle from the point of view of their dynamic behaviour- Safety –Track fatigue – Ride quality", International Union Of Railways, 2nd edition, April 2003.

[8] Griffin M.J.: Handbook of Human Vibration, Academic Press 1990.

[9] Kardas-Cinal E:" Investigation of ride comfort in a railway vehiclein the presence of random track irregularities", Archives of Transport, vol. 18, issue 1, pp 5-16, Warsaw, 2006.

[10] Seinosuke ARAI, Behaviour of Railway Cars in Running (Report1).

[11] Ger Maas, ArjenVos, Data Collection to meet Contract Requirements, ISARC, June 2008.

[12] UIC 513 Guidelines to evaluating passenger comfort in relation to vibration in railway vehicles, International Union of Railways, 1st edition, 1994.

[13] Ride comfort and motion sickness in tilting trains, Human response t motion environments in train experiment and simulator experiments Doctoral thesis by Johan Forstberg, Stockholm 2000, RAILWAY TECHNOLOGY DEPARTMENT OF VEHICLE ENGINEERING ROYAL INSTITUTE OF TECHNOLOGY.

[14] Kardas-Cinal E, Drozdziel J., Sowinski B.: Simulation study of a relation between the derailment coefficient and the track condition, Archives of Transport, vol. 21, issue 1-2, Warsaw 2009.

[15] Kalker J.J.,"A fast algorithm for the simplified theory of rolling contact", Vehicle System Dynamics vol.11, 1-3, 1982.

[16] K. V. Gangadharan, Experimental and Analytical Ride Comfort Evaluation of a Railway Coach, Mechanical Engg. Deptt., National Institute of Technology Karnataka, Surathkal.