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Study of the Railway noise level in Bolpur and Prantik Station, India

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Abstract

Railway noise is second largest sources of noise pollution. The main sources of railway noise are rolling noise caused by interaction between wheel and railway track, aerodynamic noise caused by unsteady air flow over the train, traction noise such noise created from the engine and gearbox and warning signal noise such as horn noise. In the present study measured the noise at the created by railways activities of the Bolpur station, Prantik station and outside the station where the train was thoroughly passed with full speed at the distance of 10m and 20m. The results indicated that the noise level created by railway activities was high, when the train passed. The result also indicated that the noise created by high speed train such as express train was made more noise than the passenger train.

Keyword: Railway noise, Noise pollution, Rolling, Aerodynamic, Traction, Warning noise, Horn noise.

Introduction

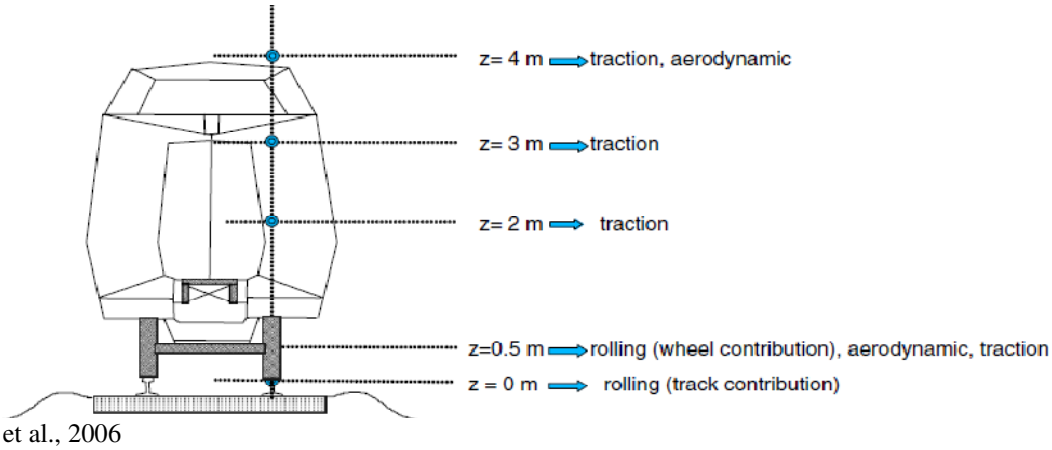
Noise pollution by railway is the second largest source of transport noise after road traffic noise. Human who travel in the rail and residents who live surrounding the railway line suffer very much from railway noise. Railway noise is a complex phenomenon. It depends on distance from railroad track, topography, weather condition, train type etc.

The noise and vibration created by railway can cause annoyance. The possible reason may be due to the feelable vibration, ranging between 2 to 80 Hz, or the radiation of low frequency sound wave transmitted through the ground, ranging between 30 to 250Hz.[1]

There are many sources of noise in the railway system (Figure-1 and 2). The main sources are: Rolling noise is induced at the contact of wheel and railway tract. It is increases with increasing train speed. The relation between sound pressure level and speed of train are calculated by following equation[1].

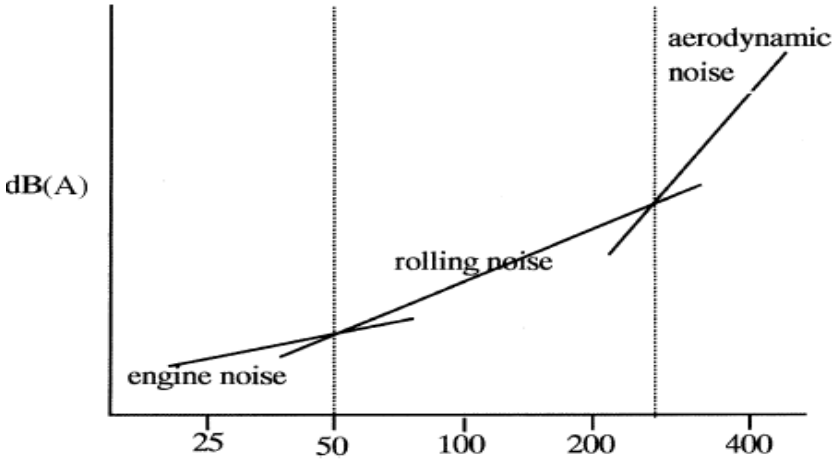
$$L_p = L_{p0} + N.\log_{10}(V/V_0)$$

Where: L_{p0} is A-weighted the sound level at the speed V_0. Values of the speed 'exponent' N, determined from measurement on the basis of linear regression. When the speed of the train is above 100km/h, the value of N is approximate 20 and when trains speed greater than 300km/h the value of N is approximate 30.[2] This mean that a doubling of speed corresponds to an increase sound pressure level of 8 to 10 dB. Aerodynamic noise is caused by unsteady air flow over the train[3]. Traction noise such as noise created by engine (diesel), gearbox noise cooling fan or equipment of air conditioning. These sources are dominant at standstill or at low speed levels[3]. Warning signals such as horn etc.



Sources: Talotte et al., 2006

Figure-1
Sources of Noise at heights



Source: Brons et al. 2003

Figure-2
Noise level of different noise sources at different train speeds

Indian railways is one of the largest railway networks in the world[4]. It is 115,000 km of track over a route of 65,000 km and 7,500 stations. As of December 2014-15, it transported over 8.38 billion passengers and 1050.18 million ton of freight annually[5]. Indian Railway holds over 239,281 Freight Wagons, 59,713 Passenger Coaches and 9,549 Locomotives among them 43 steam, 5,197 diesel and 4,309 electric locomotives[6]. Railway transport is one of the most cheapest transport vehicles.

Aim of the study: To measure the levels of noise caused by railway from 10 meter and 20 meter distance from the railway track. To estimate various Noise Pollution indices such as Equivalent Sound Level (L_{eq}), Day-Night Equivalent Sound Level (L_{dn}) from the observed data assesses. To determine the source and level of noise pollution in the studied area. To compare the results of noise measuring with allowable levels of noise standard by CPCB, 2000

Materials and Methods

Data were collected from the Bolpur Station (S1), Prantik Station (S2) and an area in-between Bolpur and Prantik Station (S3) at the distance 10m and 20 meters from the center of the main track. This railway line is not electrified, so only diesel locomotive are used. The railway transport was divided into two categories: passenger trains and freight trains while levels of noise were measured. Passenger trains were divided into two categories such as Express train which having a speed of 60 to 80 km/h and Local or passenger train with speed below 60 km/h. Sound Data were recorded at interval of 10second for a continuous sampling period of 1hour during under normal climatic condition in each study site. Noise levels were recorded at each station during the day (07:00 am to 11:00pm) and night (11:00pm to 07:00am).

All noise values were expressed in dBA unit. A digital Sound Level Meter, Type-2 with frequency weighting network as per IEC 651 specification, frequency range of 31.5 Hz to 8,000 Hz and measuring range between 0-130dB was used for the survey. Before and after use of Sound Level Meter, it was calibrated in 94.0 dBA[7]. All readings were taken on the A-weighting frequency network, at a height of about 1.5m from the ground level[8]. The various noise indices determined in the study included:

Equivalent Sound Level (Leq) is defined as the sound pressure level which over the same interval of time, contains the same total energy as the fluctuating sound[9,10]. It is energy mean of the noise level over a specified period.

Equivalent Sound Level, 'L_{eq}' can be estimated using the following equation:

$$L_{eq} = 10 \log_{10}[(1/N) \sum^{N}_{i=1} 10^{(Li/10)}]$$

Where: Li is the noise level of the i^{th} reading and N is the number of noise samples.

Day-Night Equivalent Noise Level (L_{dn}) - This is an average sound level taken over a 24 hour period, 10 dB is added account with equivalent sound level of night, because undesirable effect of noise is increased at night[11,12].

Day-Night Equivalent Noise Level, expressed as-

$$L_{dn} = 10 \log_{10} (1/24) [16(10^{Ld/10}) + 8(10^{(Ln+10)/10})]$$

Various factors such as temperature, relative humidity and wind direction has significantly impact on distribution of sound pressure level in the atmosphere, but these factors practically do not have a big influence for living building at a distance of 100 meters from noise sources[13].

Result and Discussion

From the study, it was found that in most cases of all measurement noise levels exceeded the standard level of CPCB, which listed in Table-1 when the train passed.

Table-1
Noise Quality Standard in report of Noise by CPCB, 2000

Area Code	Category of Area/ zone	Limits in dB(A)	
		Day	Night
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence zone	50	40

Day time shall mean from 6am to 10 pm, Night time: from 10pm to 6am, Silence zone is an area comprising not less than 100meter around hospitals, educational institute, courts, religious place or any other area which is declared as such by the competent authority, 2000.

Noise levels caused by railway transport depend on the train wheels, train speed and acceleration. Figure-3, 4 and 5 shows the hourly level of noise created by passenger local and express trains at a distance of 10 meters and 20 meters from the center of main track. Values of equivalent noise from 10m were between 44.9dBA to 57.7 dBA in S1, 43.2dBA to 55.2dBA in S2 and 44.9dBA to 47.8dBA in S3. Values of equivalent noise from 20m were between 41.2dBA to 54.0dBA in S1, 40.4dBA to 53.5dBA in S2 and 41.4dBA to 44.2dBA in S3. Background noise in S1, S2 station and S3 were 45.6, 39.7 and 40.1 respectively.

Table-2 shows that Equivalent noise level of day (Ld), Equivalent noise level of night (Ln) and Day-Night Equivalent Noise (Ldn) created by passenger local and express trains at a distance of 10 meters and 20 meters from the centre of main track. The value of the Ln is greater than the Ld value, because many express train and freight train are passed through during the night time which generated more noise.

Table-2
Lday, Lnight and Ldn noise level of the study area

Study Area	Noise indices	10M	20M
Bolpur	Lday	53.7	49.9
	Lnight	55.2	51.5
	Ldn	66.9	57.3
Prantik	Lday	49.4	47.1
	Lnight	53.0	50.8
	Ldn	58.6	56.4
Outside of the Station	Lday	45.7	40.4
	Lnight	46.3	43.2
	Ldn	52.2	48.9

Table-3
Railway Noise of various trains at 10m distance during train passing

Type of Train		S1	S2	S3
Passenger train	Maximum Noise	78.9-85.2	72.4-76.5	80.6-88.0
	Idling Noise	68.1-72.2	66.2-70.2	-
	Stating noise	75.4-81.3	74.0-80.2	-
	Horn noise	80.4-88.6	80.0-88.0	-
Express train	Maximum	83.9-88.6	77.7-83.2	84.2-93.2
	Idling Noise	70.2-75.1	68.8-72.2	-
	Stating noise	76.0-82.5	74.5-81.4	-
	Horn noise	80.4-90.1	80.2-90.3	-
Background noise	Leq	45.6	39.7	40.1

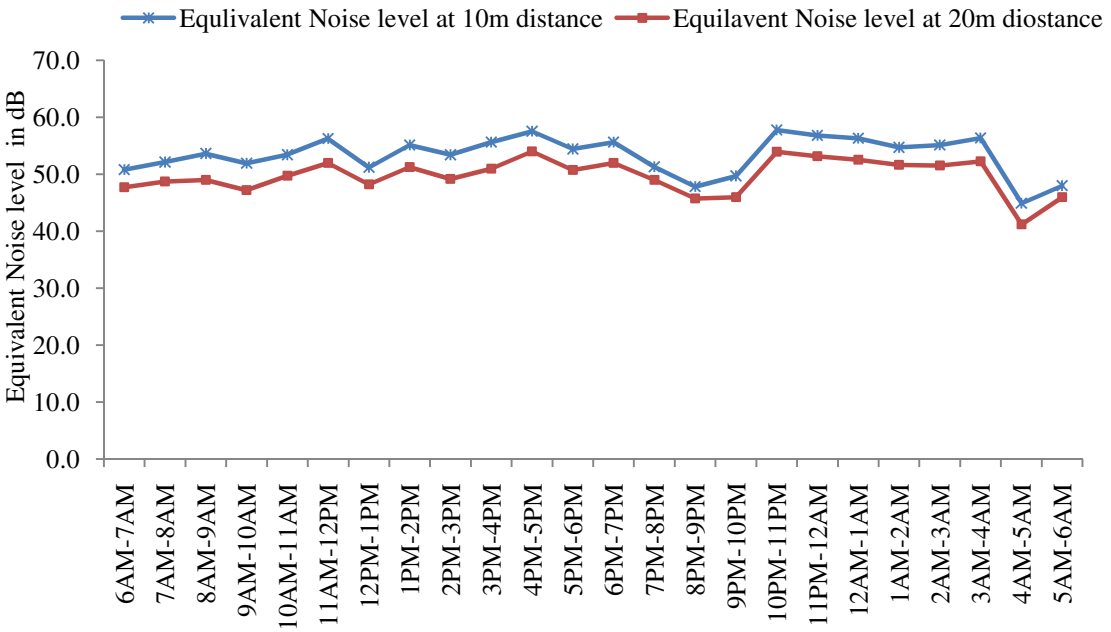


Figure-3
Hourly Equivalent Noise Level in Bolpur Station

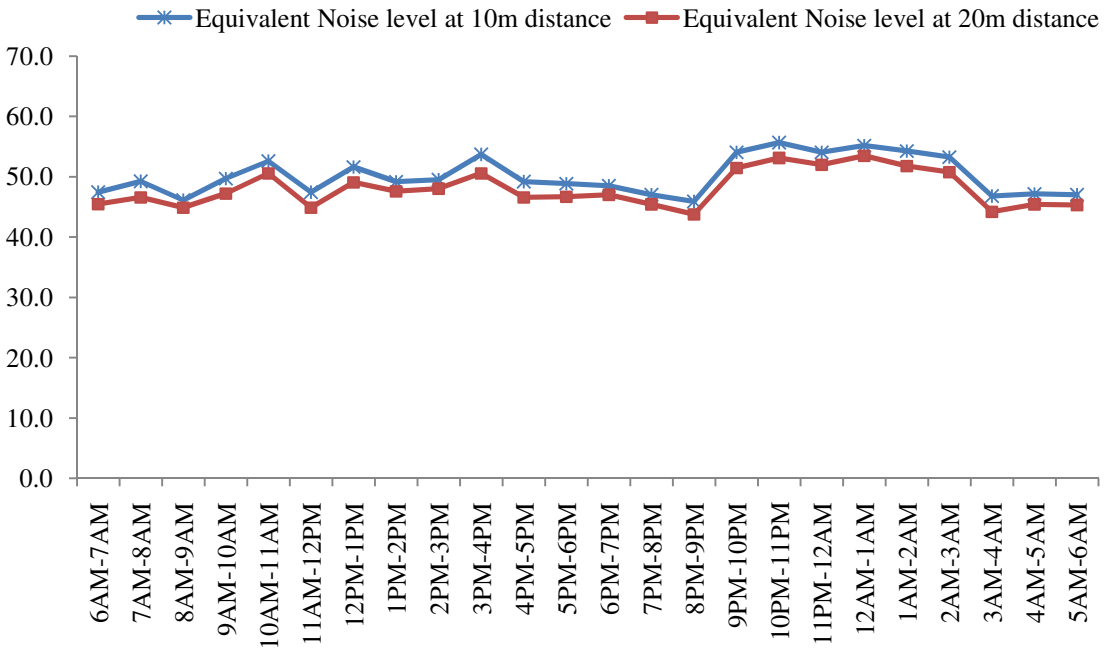


Figure-4
Hourly Equivalent Noise Level in Prantik Station

Ranges of maximum noise measured in S1, S2 and S3 were 78.9-85.2dBA, 72.4-76.5dBA and 80.6-88.0dBA respectively from the 10m distance and 65.7-73.2dBA, 65.0-73.5dBA and 64.1-76.4dBA from 20m distance (Table-3 and 4). The speed of the train is one of the factors of noise emission. Noise level emitted by Express train (>60km/hr) was about 3-5 dBA greater than the Passenger train. Again, thoroughly passed train made more noise because of its high speed.

Table-4
Railway Noise of various trains at 20m distance during train passing

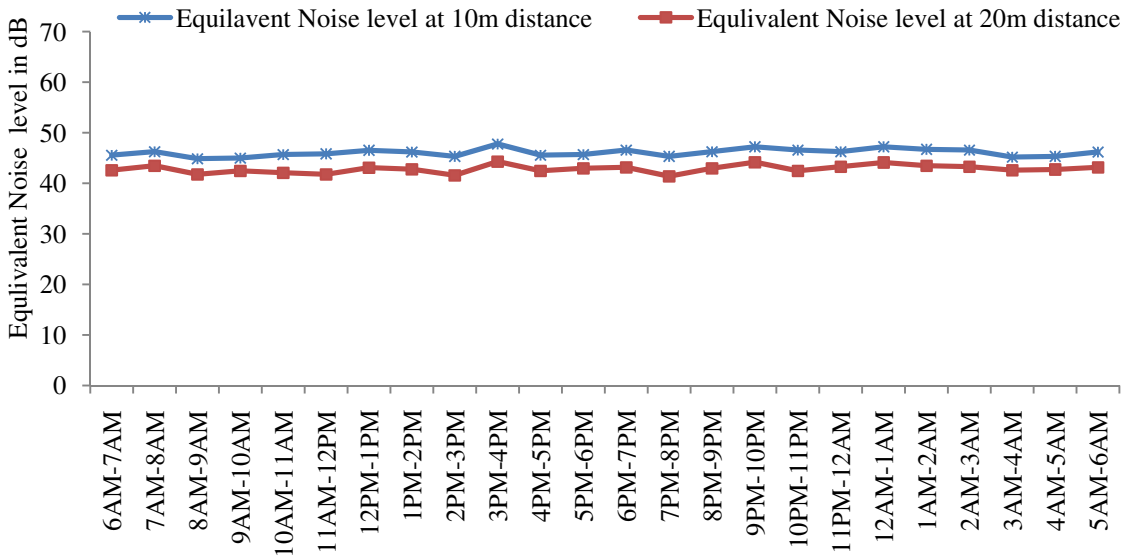
Type of Train		S1	S2	S3
Passenger train	Maximum Noise	65.7-73.2	65.0-73.5	64.1-76.4
	Idling Noise	60.5-71.7	60.8-70.1	-
	Stating noise	65.4-75.2	64.5-73.4	-
	Horn noise	75.6-84.8	75.9-85.5	-
Express train	Maximum	74.3-81.5	70.7-80.4	77.6-84.2
	Idling Noise	62.9-67.5	61.4-68.2	-
	Stating noise	66.7-75.4	65.8-75.4	-
	Horn noise	75.0-86.1	75.7-85.4	-
Background noise	Leq	44.2	41.7	40.1

Horn is one of the main sources of the railway noise pollution. It is used as for safety and warning. Horn noise recorded in range in 80.0-90.3 dBA from the 10m distance and 75.0-86.1dBA from 20m distance.

Running condition (acceleration-deceleration) of the train was influence on noise emission[14]. In the acceleration phase (starting noise), the noise emitted was about 5-10dBA greater.

In Freight trains, all noise measurement was done from 20 m distance at different speeds. When freight train passed with speed, approximate 20km/h mainly loaded generated an equivalent level of the noise ranging in 72.6-86.4dBA, maximum levels 83.0–101.1 dBA, which was generated by blowing horn.

The speed of this train was approximate 50km/h when empty. It generated an equivalent noise level ranging from 75.3-89.5dBA at the distance 20 meters from the railway track. Because of high speed, empty freight train generated much rolling noise than the loaded freight train. Rolling noise of empty freight train was also greater than the passenger train cause for heavy weight.



Figrue-5
Hourly Equivalent Noise Level in Outside of the Station

Conclusion

From the studies, it was found that the noise level exceeds the permissible level of 55 dB for residential and 65dB for commercial area when the train passed. On all studies at the selected location the maximum noise limits were ranging between 70.2-88.0 dBA from the distance of 10m and 60.5-86.1 dBA from the distance of 20m respectively which were approximately 2 times higher than the background noise level.

It was also found that the hourly equivalent noise level of the selected study areas were below the permissible level for residential area expect 11AM to 12PM, 4PM-5PM, 10PM-11PM, 11PM-12AM and 12AM to 1AM at the distance from 10m in Bolpur Station.

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