# EVALUATION OF ROAD TRAFFIC NOISE AND REGRESSION MODELING OF TRAFFIC NOISE IN PATNA CITY

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**Abstract -** Noise pollution, in the current circumstances, has been all around perceived as one of the significant anxieties that effect the personal satisfaction in urban regions over the world. Patna, the capital city of Bihar has confirmed an extremely fast development in urbanization which brought about expanded interest for transportation and finally it brought about expanded rate of noise pollution. Here the noise levels have been evaluated for two long stretch roads for three time intervals on one side of the street at an interval of 5minutes. The number of vehicles have been counted. Prediction model of Noise is done in this paper. Multiple Regressions Method is used for the model development. The maximum noise level is obtained during 5:00 PM-6:00 PM for all nine locations. The minimum noise level is obtained during the morning hours 9:30AM-10:30AM for all location except Kendriya Vidyalaya and Patna Zoo. For these two locations the minimum noise level is at 1:00 PM-2:00 PM. These results show that evening hours 5:00PM-6:00PM is dominating the traffic noise for all locations. Here two wheelers dominate traffic volume (64.21%), while percentage of three wheelers (15.20%) is the second large on traffic count scale. The R2 value is 0.858 which represents good estimation for better prediction quality. Hence, the model can be used for predicting noise level at similar roads in India.

**Keywords** - Traffic Noise, Urbanization, Noise Level, Noise Prediction Model, Patna, Regression Method.

## I. INTRODUCTION

Noise is characterized as any undesirable sound. Noise can be characterized as the level of sound that surpass the acceptable level and causes disturbance. These days noise is a significant natural issue in urban territory. Noise contamination has numerous negative effects on human health. The analysis and modeling of traffic noise facilitates proper planning of environmentally friendly roads (Ozer et al., 2009). Appropriate prediction models can be used to develop various noise-control techniques before construction and to incorporate most effective control measures in the design. Counteractive action is constantly superior to the cure (Golmohammadi et al., 2009). Considering human ear's reaction to various levels of sound, weighting channels are utilized to gauge sound levels. The A-weighted sound level is detailed keeping in mind the end goal to describe all the more precisely the reaction of people to the variety of sound. This A weighted sound-level estimation in decibels, communicated as dB(A), is a generally acknowledged scale for estimating sound levels in transport area (Alam et al., 2006). Commotion levels created by vehicles along thruways are to a great degree variable after some time. So as to streamline this issue, an all-around utilized parameter Leq, the vitality identical clamor level, has been determined to get an important factual normal commotion level that depicts a similar extent of commotion introduction amid the estimating time frame. Along these lines, the Leq can substitute differing commotion levels with a solitary clamor level esteem, which is communicated in dB(A) (Hassan et al., 2013).

This study has been carried out in Patna, the capital city of Bihar which is a fast growing city. This work has been done from January 2017 to April 2018 in two road stretches of Patna.

### Objectives of This Study

The main objective of study is:

- To evaluate the Noise Level in Patna city and compare it with CPCB standards.
- To evaluate the Traffic volume of selected location.
- To develop traffic noise prediction model and to validate the model on statistical tests.
- To give suitable remedial measures.

## II. MATERIALS AND METHODOLOGY

### 2.1. Study area

The study is to be done for Patna City. Patna is located on the southern bank of the holy river Ganges in Eastern part of India. The location under my spotlight based on the two major connecting road of Patna city. The two stretches are selected for data collection. First road stretch of Ashok Rajpath Road consists of NIT intersection, Mahendru Post Office, Tripolia Hospital, Gai Ghat as four measuring locations. While second road stretch is Bailey Road stretch which consists of Shiv colony, Kendriya Vidyalaya, Patna Zoo, Bihar Museum, Vidyut Bhawan as location. These areas are crowded ones due to public gatherings in these areas so data could be easily obtained for people using different modes of transport and data has been collected at different timings from them.

**Selected Urban Stretch**

**The selected urban stretches are**
Ashok Rajpath: (NIT intersection to Gai Ghat)

Total four locations are selected, three intersections and three mid-blocks. Selected locations are listed below.

1) NIT More [A1]
2) Mahendru Post Office [A2]
3) Tripolia Hospital [A3]
4) GaiGhat (Tempo Stand) [A4]




**Figure 1: Study areas of Ashok Rajpath Road Stretch**

Bailey Road: (Shiv Colony to Vidyut Bhawan) Total five Locations are selected, five mid-blocks. Selected locations are listed below.

1) Shiv Colony [B1]
2) Kendriya Vidyalaya [B2]
3) Patna Zoo [B3]
4) Bihar Museum [B4]
5) Vidyut Bhawan [B5]




**Figure 2: Study areas of Bailey Road Stretch**

**2.2. Study period**
For establishment of the traffic noise model different information like traffic information, noise information is collected. Noise levels were measured using Sound Level Meter (traceable SLM Model no. 11-661-6A, 11794266). Noises were measured from 9:30 A.M. to 10:30 A.M., 1 P.M. to 2 P.M. and 5:00 P.M. to 6 P.M. at all nine locations as given above. At same time traffic count was also done for model prediction analysis. For showing the variation of noise, five days data of noise and traffic are collected.

**2.3. Field studies**
In view of the above objectives, a field data collection program was designed to collect the following parameters.
a) Traffic volume,
b) Noise level,

**2.3.1 Traffic volume**
For the gathering of traffic data ordered volume count about is conveyed for the day and age of 9:30 AM to 10:30 AM, 1 PM to 2 PM and 5:00P.M to 6P.M. for both side of the street at the interval of five minutes. Volume count is conveyed by individually with help of software. Vehicles are ordered into five classifications i.e. two wheelers, three wheelers, LCV (Light business vehicle), bus and car.

**2.3.2 Noise level**
For traffic noises, it is valuable to know Leq, Such data can be acquired utilizing a sound level meter. Noise information of any area is recorded at peak hours 9:30-10:30AM, 1:00-2:00 PM and 4:00-5:00PM on one side of the street and at an interval of 5 minutes. The information gathered for five days to indicate variations in noise data. The instrument was properly calibrated before taken reading at any place. Calibration was done with the help of screw pen provided with the sound level meter. Frequency weighting was set to „A" position and response was set to „F" position. Width of road is about 3.5 m and the receiver of Noise Meter was 5 m distance from the edge of the road.

**2.4 Development of Traffic Noise Prediction Model**
Prediction model of noise is produced by utilizing EXCEL programming. The model is produced for two road stretches of the Patna city. Model is checked for its approval on statistical test. Multiple Regressions is used for the model development.

**2.5 Mathematical Formulation**
**2.5.1 Inter-relation of parameters**
This model is developed for the selected road stretch. At these locations vehicle speed is not taken into account. By using the observed data, set the relation between dependent variables and independent variables by multiple linear regression analysis. The

dependent variable is observed noise level while independent variable is traffic count like; two wheelers, three wheelers, car, bus, light commercial vehicles. The relationship between the variables has been studied to find out the connection of dependent variables with independent variables. The discussed relation among variables is presented below.

**2.5.2 Model for prediction of an equivalent noise level** Traffic noise prediction model is based on the predictive analysis. Multiple linear regression method is used to prepare model prediction. By applying the analysis the following equation obtain for calculating equivalent noise level.

$$\mathbf{L_{eq}=0.21608\times X_1+0.131635\times X_2+0.088416\times X_3+0.00010\times X_4+0.079477\times X_5+53.25}$$

($R^2$=0.858)

Where,

$L_{eq}$=Noise level in dB

$X_1$= Volume of two wheeler

$X_3$=Volume of LCV

$X_4$=Volume of car

$X_5$=Volume of bus

## III. RESULTS AND DISCUSSIONS

### 3.1 Variation of Noise Level

In this section, the variation of noise over five days at every location is determined. During the survey, it is observed that each location has it observed maximum and minimum noise level. The maximum and minimum noise level at nine study locations and the time interval at which these values are obtained, presented from Figure 3 to Figure 12 as shown below;

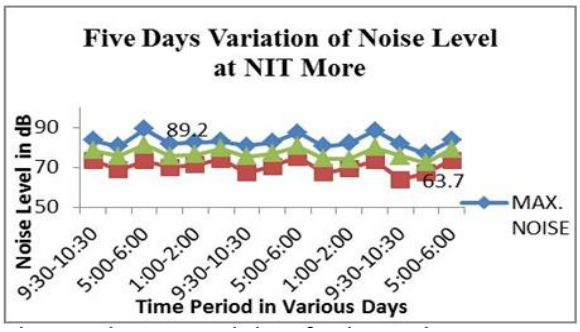



**Figure 3: Five Days Variation of Noise Level at NIT More**

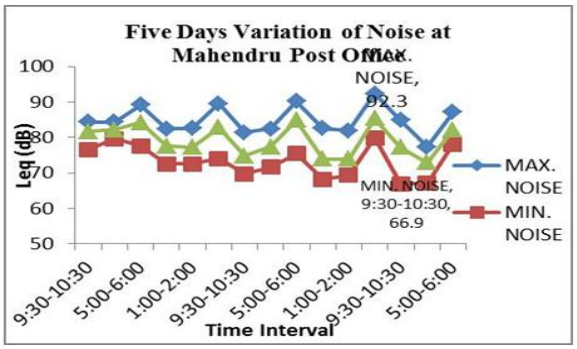



**Figure 4: Five Days Variation of Noise Level at Mahendru Post Office**

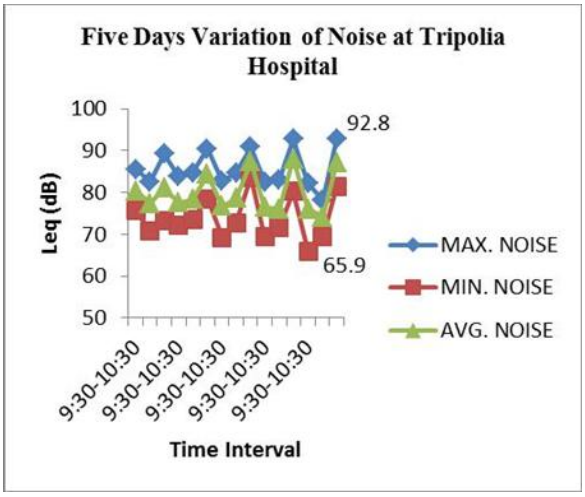



**Figure 5: Five Days Variation of Noise Level at Tripolia Hospital**

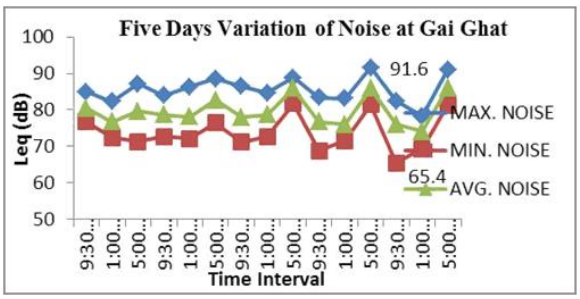



**Figure 6: Five Days Variation of Noise Level at Gai Ghat**

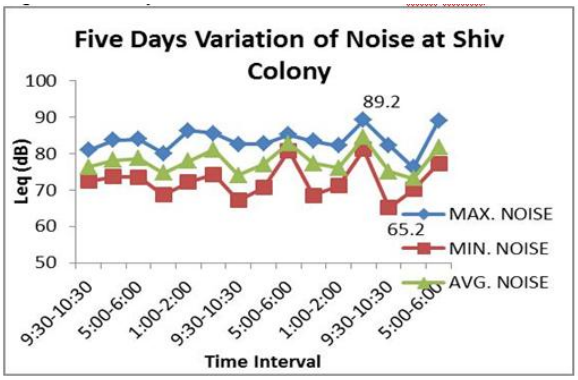



**Figure 7: Five Days Variation of Noise Level at Shiv Colony**

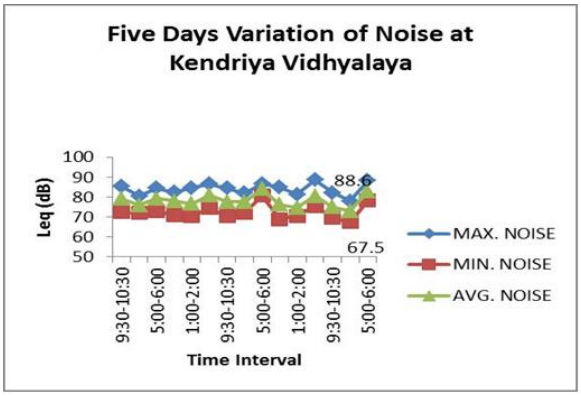



**Figure 8: Five Days Variation of Noise Level at Kendriya Vidyalaya**

The noise level of all locations were determined and compared with CPCB. At all locations, the value of

Leq are considerably high as compared to CPCB standards. The prescribed limit by CPCB under outdoor noise level in urban area is 65 dB. Since at all location the noise level exceeding the prescribed limit. Therefore remedial measures should be provided.

The graphical representation of the Noise Level of all selected urban locations is as follows;

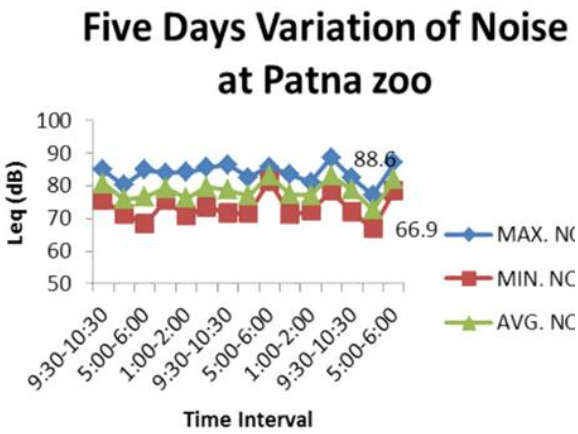



**Figure 9: Five Days Variation of Noise Level at Patna Zoo**

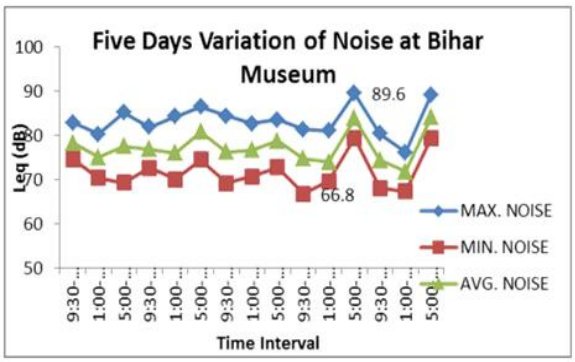



**Figure 10: Five Days Variation of Noise Level at Bihar Museum**

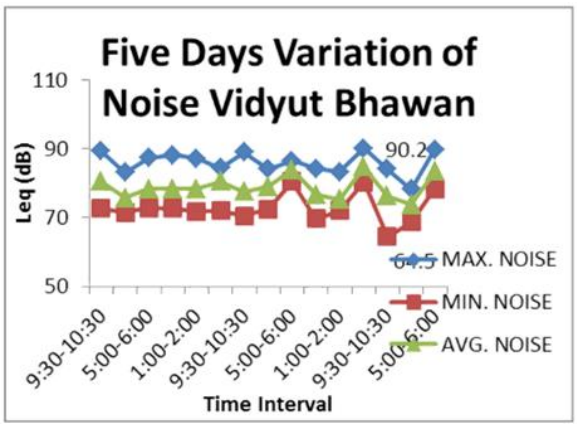



**Figure 11: Five Days Variation of Noise Level at Vidyut Bhawan**

The above Figures shows the maximum noise level, minimum noise level and average noise levels of selected nine study locations. The maximum noise level is obtained during the evening measurement hours of 5:00 PM-6:00 PM for all nine locations. The minimum noise level is obtained during the morning hours 9:30AM-10:30AM for all location except Kendriya Vidyalaya and Patna Zoo. For these two locations the minimum noise level is at 1:00 PM-2:00 PM. These results show that evening hours 5:00PM-6:00PM is dominating the traffic noise for all locations.

### 3.2 Equivalent Noise Level (Leq)

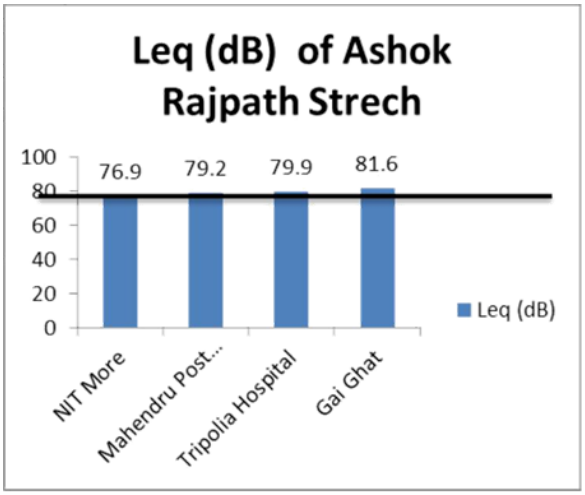



**Figure 12: Equivalent Noise Level of Ashok Rajpath Stretch**

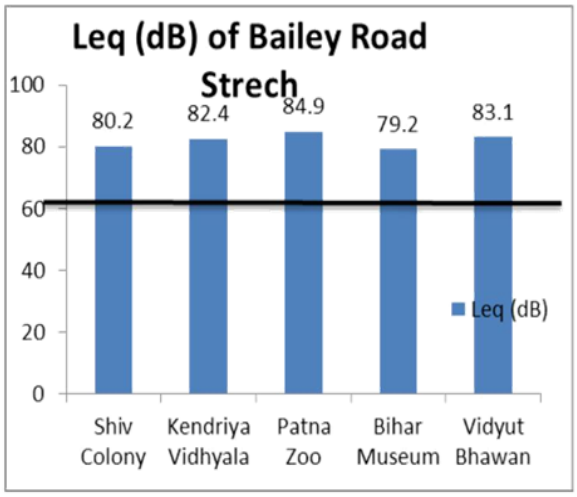



**Figure 13: Equivalent Noise Level of Bailey Road Stretch**

From the above Figure it is observed that at all the selected location; value of Leq is much higher than the acceptable limits for urban areas i.e.65dB

### 3.3 Model Development

Based on the data taken at different times and the equivalent level of noise, the analysis was done using the Excel Software, and a suitable model for the road traffic noise prediction is established. Equivalent level of noise is in dB(A).

$L_{eq}$=0.21608*X1+0.131635*X2+0.088416*X3+0.000 10*X 4+0.079477*X5+53.25

Based on the formula, the equivalent level of noise was calculated. Values for Leq (Observed) and Leq (Calculated) for the selected locations are provided in Table 1.

The above equation shows that the dominance of two wheelers and three wheelers on the traffic noise. If we increase the two wheelers count considering other traffic flow constant, we find Leq becomes 74.3 dB. This is the highest among all the traffic count.

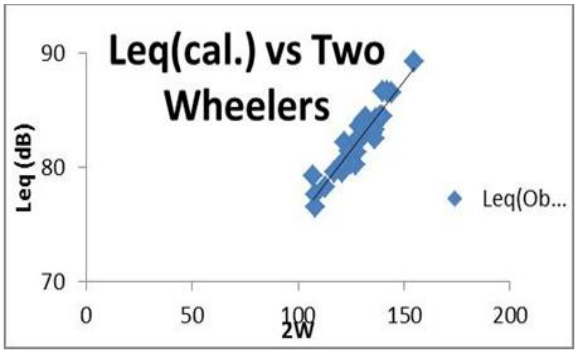



**Figure 14 Two wheelers in regard to equivalent noise level (Leq)**

So, Figure 14 shows that the equivalent noise level increases with an increase in the two wheelers. Hence, it is proven that the flow of two wheelers increases the equivalent noise level. 4.1 Model validation

The chi-square test for goodness of fit is used to determine the level of correspondence between the observed sample distribution and calculated distribution. The null hypothesis, $\mu = 0$, meaning that the mean value of the differences between the pairs of observed noise and predicted noise is equal to zero, is considered. The calculated value of chi-square is less than the observed value at 5% level of significance. Hence, the null hypothesis is accepted and it is concluded that there is no significant difference between the observed and predicted noise levels.The observed and predicted values of equivalent noise levels are compared in Table 1.

| Sl. No. | $L_{eq}$ (observed) [dB(A)] | $L_{eq}$ (calculated) [dB(A)] | Deviation [%] |
|---|---|---|---|
| 1 | 76.6 | 77.9 | -1.755 |
| 2 | 79.3 | 77.8 | 1.852 |
| 3 | 82.2 | 81.3 | 1.094 |
| 4 | 81.3 | 81.8 | -0.569 |
| 5 | 84.2 | 84.0 | 0.181 |
| 6 | 79.6 | 80.8 | -1.496 |
| 7 | 78.3 | 78.5 | -0.264 |
| 8 | 83.4 | 83.1 | 0.390 |
| 9 | 83 | 84.0 | -1.196 |
| 10 | 83.4 | 83.4 | -0.032 |
| 11 | 84.4 | 83.2 | 1.399 |
| 12 | 83.7 | 83.9 | -0.188 |
| 13 | 83.3 | 84.0 | -0.828 |
| 14 | 80.2 | 81.9 | -2.169 |
| 15 | 83.3 | 83.3 | -0.038 |
| 16 | 84.2 | 82.7 | 1.819 |
| 17 | 83.6 | 82.7 | 1.085 |
| 18 | 82.5 | 84.0 | -1.759 |
| 19 | 81.3 | 82.1 | -0.958 |
| 20 | 80.4 | 81.8 | -1.710 |
| 21 | 79.6 | 79.9 | -0.389 |
| 22 | 82.5 | 83.2 | -0.863 |
| 23 | 84.3 | 84.4 | -0.109 |
| 24 | 80.4 | 80.8 | -0.510 |
| 25 | 84.5 | 85.0 | -0.574 |
| 26 | 83.9 | 84.2 | -0.328 |
| 27 | 86.5 | 86.0 | 0.563 |
| 28 | 82.4 | 82.3 | 0.136 |
| 29 | 86.7 | 85.2 | 1.679 |
| 30 | 77.6 | 78.3 | -0.926 |
| 31 | 84.5 | 84.9 | -0.474 |
| 32 | 83.4 | 83.1 | 0.308 |
| 33 | 86.6 | 85.8 | 0.929 |
| 34 | 83.5 | 84.0 | -0.625 |
| 35 | 89.2 | 88.3 | 1.020 |
| 36 | 81.4 | 81.8 | -0.538 |

**Table 1: Observed and Predicted values of equivalent noise levels**

Chi-square test of independence is done to check the hypothesis. Since predicted values deviated by not more than 5% (Significance Level), this model can be efficiently used in the prediction of road traffic noise in Patna. For Model the value of $R^2$ is 0.858, which indicates the good probability of approval of independent variable with the dependent variable.

## IV. CONCLUSION

Noise level (Leq) is assessed at all chosen site, and additionally the parameter which influences the noise level like traffic volume is assessed at every area. In view of the information gathered model is developed and validated. Model is created with the help of traffic data. The traffic data consists five categories in which two wheelers, three wheelers, Car, LCV (Light Commercial vehicle) and Buses. In model, the higher positive estimations of coefficient for bikes and three wheelers shows that these two parameters will influence the traffic noise more as compared with other parameters. Increment in volume of bikes and three wheelers will enhance the traffic noise more.

Created Model is approved on statistical test. The average noise level (Leq) at all area is found and it is significantly higher than prescribed limit. The chosen area is experiencing high measure of Leq so it is important to take some remedial measures. Some therapeutic measures are likewise recommended in this examination work.

The following conclusions were made on the basis of this study:

- Variation of noise over five days at every location is determined. During the survey, it is observed that each location has it maximum and minimum noise level. The maximum noise level is obtained during the evening measurement hours of 5:00 PM-6:00 PM for all nine locations. The minimum noise level is obtained during the morning hours 9:30AM-10:30AM for all location except Kendriya Vidyalaya and Patna Zoo. For these two locations the minimum noise level is at 1:00 PM-2:00 PM. These results show that evening hours 5:00PM-6:00PM dominating the traffic noise for all locations.
- It is observed that at all the selected location; mean value of Leq (Observed) is much higher than the acceptable limits for urban area.
- The multiple linear regression equation for predicting the equivalent noise level (Leq) was established using the following parameters: the number of vehicles (Q) per hour, Equivalent noise level (Leq). Percentage errors between observed and predicted volumes were negligible.
- The $R^2$ value for this equation was found to be 0.858.The higher estimation of $R^2$ for model demonstrates better prediction quality.
- The predicted model exhibited a very low percentage of error for the test data (i.e. for the data taken at the Vidyut Bawan location). Hence the model can be used for predicting noise level at similar roads in India.

## ACKNOWLEDGEMENTS

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