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PREDICTION OF TRAFFIC NOISE POLLUTION AT A HETEROGENEOUS TRAFFIC CONDITION – A STATISTICAL ANALYSIS

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ABSTRACT

Noise pollution on roads as traffic noise creates problems for surroundings that can have negative effects on animals, human health and environmental quality. The main reason behind the noise pollution is uncontrolled volume and speed of vehicles running on roads which lead to overcrowded roads and increase in traffic. With 1.3 billion of population rate in India, 23.24 crores of vehicles are registered in India and 2.05 crores vehicles have been registered in 2019. The prediction model has been prepared by conducting road traffic survey on Volume count, Spot speed and Noise level for achieving the objective in two locations. This model is developed for each location separately and the Statistical analysis is done.

KEY WORDS : Noise pollution, Volume count, Speed, Statistical analysis, Regression equation

INTRODUCTION

The most important part of India's economy is the highway network. India has about 4.32 million kms of roads in its highway network and also the second largest highway network next to United States has about 7.0 million kms of roads. Indian roads carry about 65% of freight traffic and 35% of passenger traffic with vehicle population growth of about 12%. The road traffic is increasing at the rate of about 10% in India. Among all the types of pollutions, noise pollution is the least eyed upon and an unattended issue lately by the majority of the respective personals (Yugananth and Baskar Govindaraj, 2013).

Depending on the duration and volume of exposure the effects of physical effects, such as hearing defects, psychological effects such as high blood pressure, irregularity of heart rhythm, ulcers and going to sleep late and stress (Karthik and Partheeban, 2015).

The World Health Organisation (WHO) considered the Noise as the third most hazardous type of pollution right after Air and Water pollutions (WHO, 2005) (Aditya Kamineni *et al.*, 2019). Also according to WHO sound levels less than 70db is not a detriment to living organisms.

A model was developed for traffic noise predictions in heterogeneous traffic conditions. In this study noise mapping parameters such as Ld, LN, Lden have been arrived by taking into consideration the geometrical features of the road and varying heights of the building (Gollamandla Sukeerth *et al*., 2017). A study on analysis of day time traffic noise level (Halesh Koti *et al*., 2016), for Kolkata city at 26 locations was monitored. Correlation analysis among equivalent continuous sound pressure level for hour duration has revealed that Leq 1hr, noise level exceeds for 10, 50 and 90% of the time of the measured duration. (L10, L50 and L90). L10 the peak noise level generally resulted from honking of cars (Mosa Al-Mosawe *et al.*, 2018).

The permissible noise level specified by Tamil Nadu Pollution Control Board (TNPCB) is given in Table 1.

Table 1. Noise levels

Type of Area	TNPCB CPCB Day time	Night time	FHWA AASHTO Day time	Night time		
Industrial area	*75 dB*	70 dB	75 dB	70 dB	75 dB	75 dB
Commercial area	65 dB	55 dB	65 dB	55 dB	75 dB	75 dB
Residential area	55 dB	45 dB	55 dB	45 dB	70 dB (Interior Max 55)	70 dB (Exterior) 55 dB (Interior)
Silence zone	50 dB	40 dB	50 dB	40 dB	60 dB	55-60 dB

The traffic noise prediction model were recognised by manual Volume count method followed by the Spot speed method of two point rule and further was continued for the Noise level measuring by using the Digital Noise Meter at two different locations being one of the most crowded and highly heterogeneous traffic junctions i.e., Madhya Kailash and Tidel Park in OMR, Chennai, Tamil Nadu.

OBJECTIVES AND STUDY AREA

1. To identify study location where congestion is maximum and initiate the study experiments.
2. To conduct traffic volume count survey. (Peak and Non-Peak)
3. To conduct spot speed survey using speed measuring techniques.
4. To conduct noise level measurements using noise meter.
5. The surveys were done with respect to the type of roads and also as per environmental aspects.
6. To analyze the collected data and undergo the same for statistical analysis using software tools.
7. To prepare the prediction model for traffic noise.

The city being a hub of commercial and business activities is facing a ever increasing vehicular traffic. The road network of Chennai city is of radial pattern having major highways to North, West and South-West. State highway 49A also known as Rajiv Gandhi Salai is a major road connecting Chennai, Tamil Nadu with Mahabalipuram in Kanchipuram district, Tamil Nadu. It is stretched up to 45 km long and initiates from Madhya Kailash temple on Sardar Patel road in South-East Chennai and dismisses on East Coast Road (ECR) near Mahabalipuram. The widely spread and esteemed TIDEL Park, home to a number of BPO and IT/ITES companies situated on Rajiv Gandhi Salai and also with other technical and educational institutions, National research Laboratories that are located besides the corridor. The cyber city Zone1 is from Madhya Kailash to Sholinganallur and Zone 2 is from Sholinganallur to Kelamabakkam. To develop the traffic noise prediction model, the very first task was the site selection. Later followed by the Volume count, Spot Speed and Noise Level surveys at two different locations they are,

1. Madhya Kailash
2. TIDEL Park

Field Investigation and Data Collection

The two very busy commercial corridors of OMR Road were selected for the present study. The study

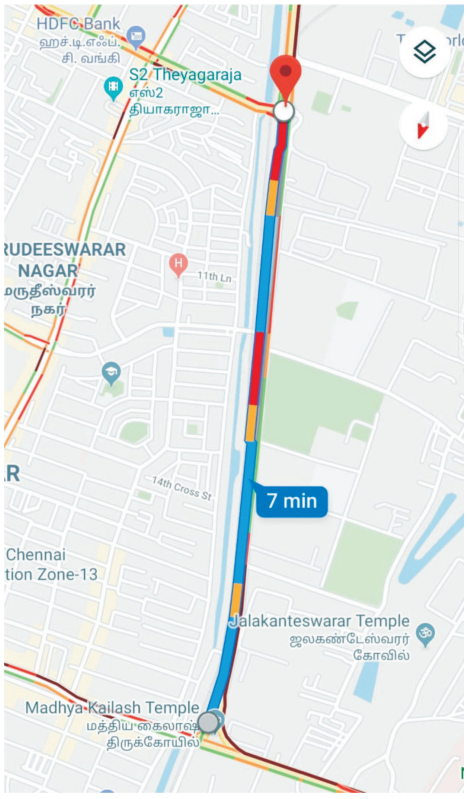

Fig. 1. Arial view of study location.

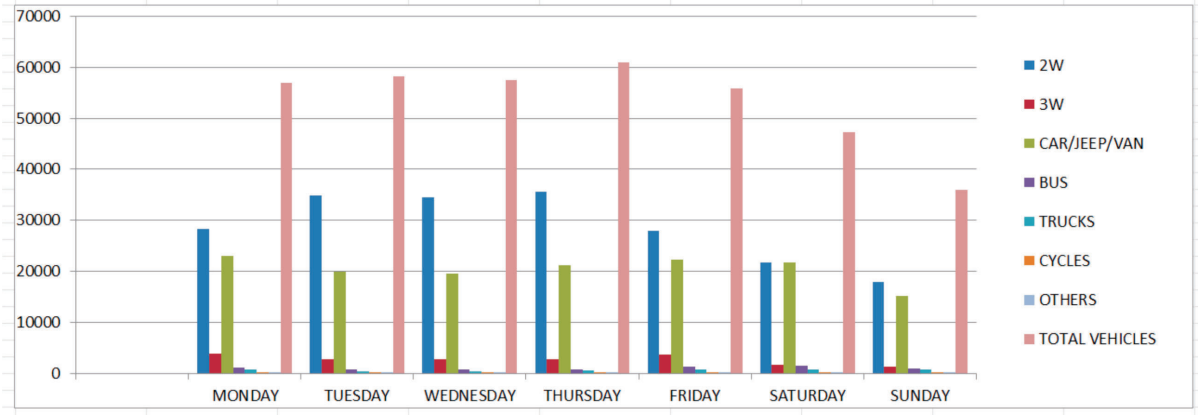

Fig. 2. Graphical representation of Volume of Vehicles (MADHYA KAILASH)

road extends from Madhya Kailash (O.M.R Road) to TIDEL Park (O.M.R Road). Each site has its unique characteristics, i.e., having typical road width, roadside housing pattern and also the traffic flow pattern. At each of these locations, manual surveying were being made when there was usual traffic activity (in general from 7 a.m. to 10 a.m. and 4 p.m. to 7 p.m.). Sound Level Meter having digital display was used to record the equivalent noise level at different selected locations also with a distant variation in order to check if any changes in Noise level values (Halesh Koti *et al.,* 2016). Noise levels were recorded at these locations and simultaneously the volume and speed of traffic streams were also monitored.

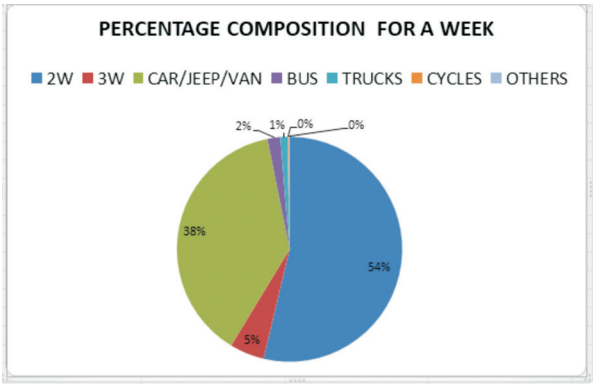

Fig. 3. Graphical Representation of Weekly Percentage composition (MADHYA KAILASH)

Noise levels were recorded at these locations and simultaneously the volume and speed of traffic streams were also monitored. Noise levels were taken for the highest Volume count as per hourly basis of the survey period. It is observed that the noise level and also he volume count is maximum duringmorning peak hours between 9:00pm and 10:00pm. It is also observed that the noise level is being influenced by both the volume and speed, such that according to the type of flow of Traffic and with increase in speed respectively. Similarly for the other two locations, noise, traffic volume and speed data were collected and analysed.

Speed is the rate of movement of traffic of specified components of traffic and is expressed in

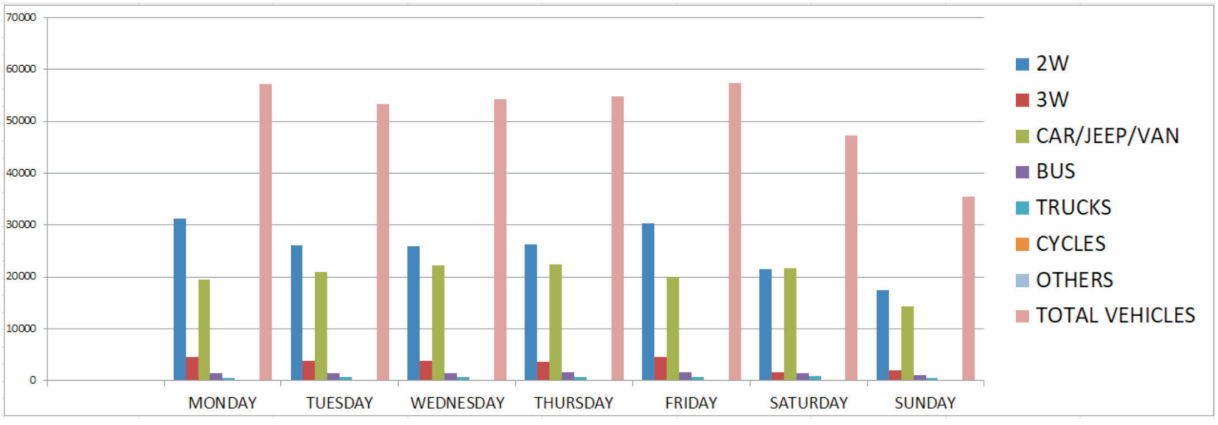

Fig. 4. Graphical Representation of Volume of Vehicles (TIDEL PARK)

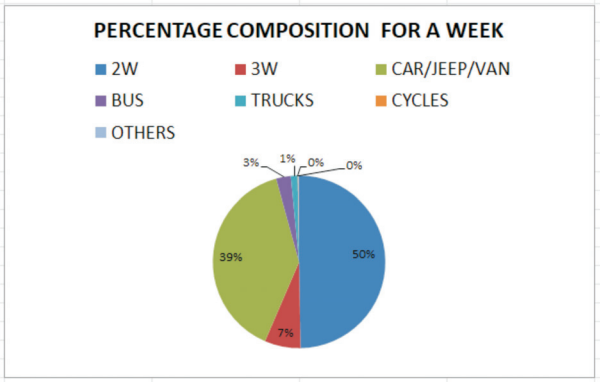

Fig. 5. Graphical Representation of Weekly Percentage composition. (TIDEL PARK)

metric units in kilometre per hour (K. P. H). Spot speed data is collected using direct timing procedure method. The total vehicle volume in PCU per hour, spot speed in km/h and noise level measurements are taken in survey and calculated. The following is data collected for prediction mode.

DEVELOPMENT OF REGRESSION MODEL

The basic prediction procedure involves consideration of nature and noise level of sources, propagation along the paths between sources and receivers and the location of receivers (Khair and Abdelqader, 2016). Each vehicle in the stream having mixed traffic system has different noise generation characteristics and this fact makes the road traffic noise problem little complex (Kumar *et al.*, 2011). In order to understand the behaviour of road traffic noise or to understand the various relationships, it is necessary to convert all vehicles into some equivalence based on their noise generation characteristics. The passenger car noise equivalence PCNE of particular vehicles represents that, how many times the vehicle is noisier than car (Monazzam Esmaeelpour *et al.*, 2014). For model

Table 2. Calculated and Observed Noise level values for Two-wheelers

Tidel Park			
Sl. No.	Two Wheelers		
	Speed in Kmph	Noise Level Observed in dB	Noise level Calculated in dB
	y = 0.0514x + 87.996		
11	33.3	86	89.7
2	23	89	89.2
3	27.5	88	89.4
4	45	98	90.3
5	33.7	95	89.7
6	64.2	89	91.3
7	51	85	90.6
8	39.9	82	90.0

Table 3. Calculated and Observed Noise level values for Car

Sl. No.	CAR		
	Speed in Kmph	Noise Level Observed in dB	Noise level Calculated in dB
	y = 0.0048x + 90.135		
1	75.7	86	90.5
2	74.8	89	90.5
3	75.7	88	90.5
4	81.7	98	90.5
5	65.4	95	90.4
6	80.8	89	90.5
7	79	85	90.5
8	94.7	82	90.6

Table 4. Calculated and Observed noise level values for Three wheelers

Sl. No.	Three Wheelers		
	Speed in Kmph	Noise Level Observed in dB	Noise level Calculated in dB
	y = 0.0162x + 91.172		
1	35.8	86	91.8
2	48.9	89	92.0
3	35.8	88	91.8
4	28.8	98	91.6
5	63.6	95	92.2
6	50.6	89	92.0
7	27.5	85	91.6
8	29.1	82	91.6

Table 5. Calculated and Observed noise level values for Bus

Sl. No.	BUS		
	Speed in Kmph	Noise Level Observed in dB	Noise level Calculated in dB
	y = 0.4165x + 77.794		
1	24	86	87.8
2	23.9	89	87.7
3	32.7	88	91.4
4	25.7	98	88.5
5	36	95	92.8
6	35.9	89	92.7
7	24.2	85	87.9
8	24.1	82	87.8

processing different types of vehicles are used to quantify noise produced into a common unit in which PCNE values are used (Rahul Singh *et al*., 2014).

From Fig. 6 to 8 it depicts the relationship between an average spot speed of the following type of vehicles and the equivalent noise level for Madhya Kailash location, where it shows that the Two wheelers, Cars and Three wheelers having an overall speed varying from 20-90 km/h results in a noise level of about 80.2 dB - 92.2 dB, since the volume and the flow of the vehicles were high in frequency.

From Fig. 9 and 10 it shows that the Buses and Trucks having a higher noise level as per the increase in speed of the vehicle. The noise level increased at lower speeds can be due to frequent honking or ill management of vehicles running condition (Satish *et al*., 2018). Hence it is proven that

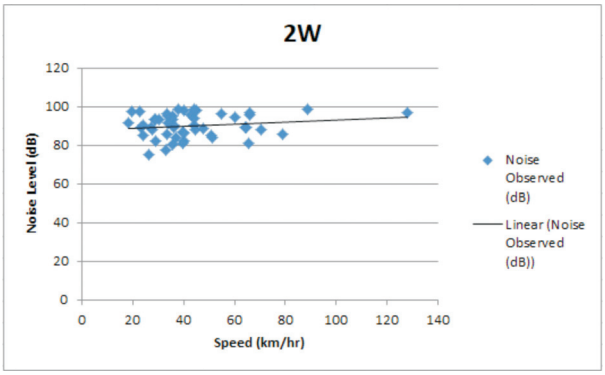

Fig. 6. Average spot speed of two wheelers in regard to equivalent noise level(MADHYA KAILASH)

Table 6. Calculated and Observed noise level values for Truck

Sl. No.	TRUCK		
	Speed in Kmph	Noise Level Observed in dB	Noise level Calculated in dB
		y = 0.5473x + 70.1	
1	23.9	86	83.2
2	38.4	89	91.1
3	38.1	88	91.0
4	39.9	98	91.9
5	35.9	95	89.7
6	34.7	89	89.1
7	34.2	85	88.8
8	30.8	82	87.0

Table 7. Noise level observed for volume in Madhya Kailash

Sl. No.	Madhya Kailash	
	Volume of Vehicles	Noise Level Observed in dB
	y = 0.0003x + 73.416	
1	56212	96.5
2	58560	98.5
3	57005	88.5
4	60929	92.8
5	55160	93.5
6	47336	95.1
7	36162	89.1

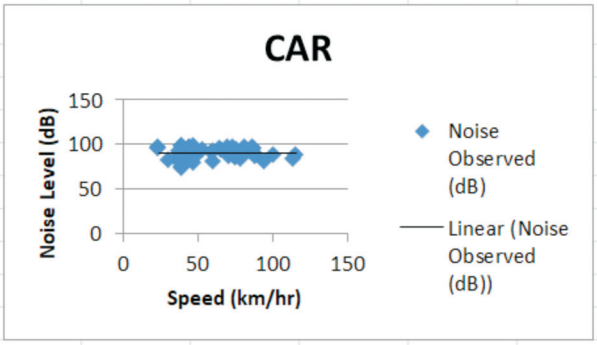

Fig. 7. Average spot speed of car in regard to equivalent noise level (MADHYA KAILASH)

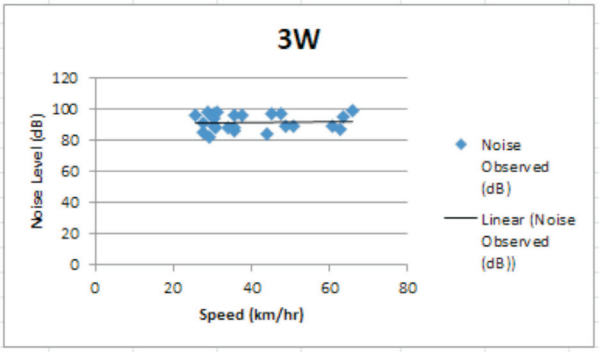

Fig. 8. Average spot speed of three wheelers in regard to equivalent noise level (MADHYA KAILASH)

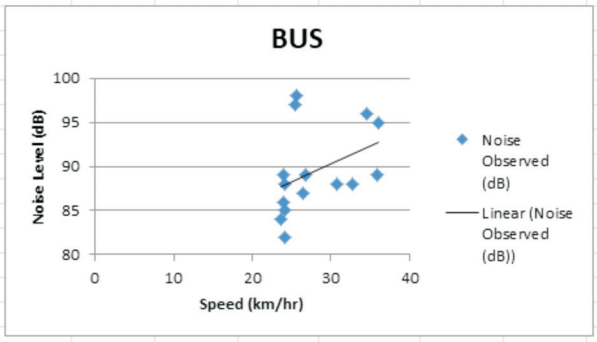

Fig. 9. Average spot speed of bus in regard to equivalent noise level(MADHYA KAILASH)

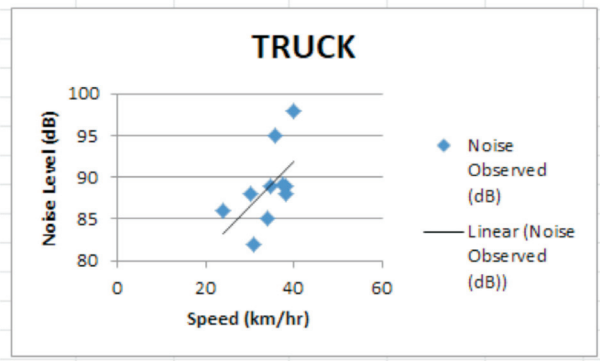

Fig. 10. Average spot speed of truck in regard to equivalent noise level(MADHYA KAILASH)

the noise is influenced by the varying speed of vehicles.

Fig. 11 and 12 gives an idea showing a relationship between the Volume of vehicles for a week with the total volume per day count and the noise levels simultaneously. The graph predicts that the noise level is highly increasing as the volume

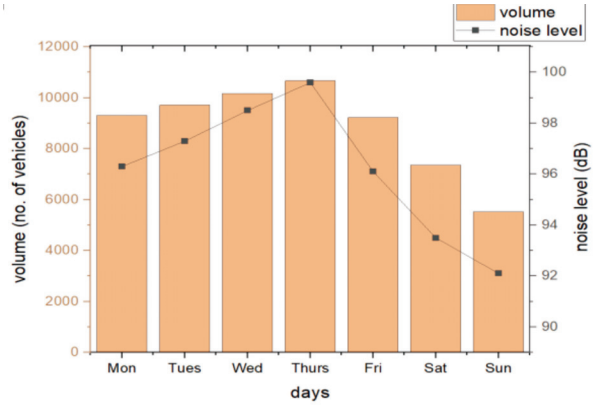

Fig. 11. Per day weekly volume of vehicles in regard to equivalent noise level. *(3.5m from edge of the service lane)* (MADHYA KAILASH)

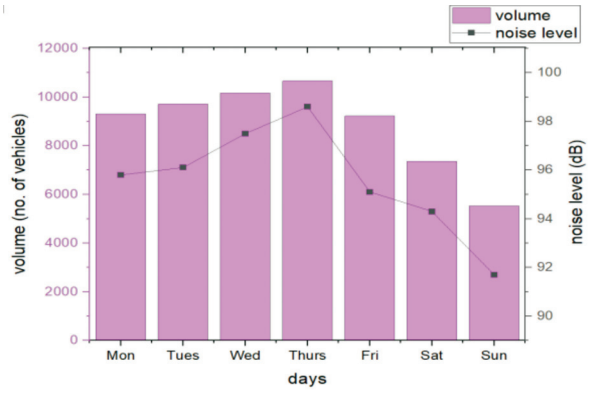

Fig. 12. Per day weekly volume of vehicles in regard to equivalent noise level. *(4m from edge of the service lane)* (MADHYA KAILASH)

count of vehicles, counts greater regardless of distant variations as shown in the above fig.

Also, Fig. 13 shows that the greater number of vehicles raises the noise levels higher in rate. It can therefore be observed that the greater volume of vehicles does influence the noise level in turn.

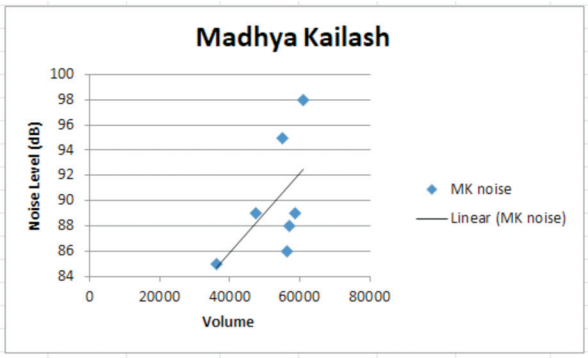

Fig. 13. Per day total volume of vehicles in regard to equivalent noise level

CONCLUSION

The linear regression equation for predicting the equivalent noise level (Leq) was established using the following parameters: Noise level, Traffic volume count and Vehicle spot speed. The R^2value for the following,

i. Noise vs. Speed (types of vehicles) equation was found to be varying from 0.2561 to 0.3914
ii. Noise vs. Volume (total vehicles) equation was found to be 0.3164 (Madhya Kailash)

It can be thus concluded that the model gives significantly higher correlation coefficient values and hence can be applied to the calculation of road traffic noise under interrupted traffic flow conditions in urban areas of Indian cities (Vij et al., 2016). It was found that the equivalent noise levels at the selected sites were found to be higher than that prescribed by the CPCB. The noise levels are observed in the range of 88-95dB (A) for Madhya Kailash during peak and non-peak hours. These noiselevels are in excess of the prescribed limits given in Table 1.

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