

# Design of toll-plaza: a case study of Bengaluru–Chennai highway

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**Abstract:** This study aims to calculate the number of bays needed in the design year 2037 for a toll plaza on the Bengaluru – Chennai Highway (National Highway No. 48). Data on the classified traffic volume count was gathered from the National Highway Authority of India (NHAI) office and relates to the "Nemili toll plaza" on the Bengaluru – Chennai Highway (NH-48). Average daily traffic is calculated using the tollable traffic data that has been gathered as a base. A suitable seasonal correction factor was assumed in order to estimate the annual average daily traffic. Using growth elasticity values derived from the Annual Average Growth Rates (AAGR) of Population, Per-Capita Income, and Net State Domestic Product of the influencing states collected from credible sources and state influencing factors, traffic in the horizon year (2037) was estimated. The necessary number of Electronic Toll Collection (FASTag) bays at the Nemili toll plaza was determined in accordance with Indian Road Congress standards based on the traffic flow forecast for the upcoming year.

## 1 Introduction

Toll booths, also known as toll houses, toll stations, toll gates, or toll barriers, are mandatory stops for drivers on national/ state highways. These booths collect toll taxes from both domestic and commercial vehicle users, excluding pedestrians. In India, the tolling is generally under the open system, whereby fee payable is a fixed amount based on the length of stretch under one project which is normally 60 kilometers. The Delhi-Gurgaon section has

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three toll plazas. Out of these, the toll plaza at km 24 (between Delhi and Gurgaon) is busiest and has 32 toll lanes, as shown in Fig. 1. The km 24 toll plaza with 32 toll lanes is the largest toll plaza in India.



**Fig. 1** Aerial view of Delhi – Gurgaon Toll Plaza

## 2 Role of National Highways in India

The national highways link up significant cities and towns, enabling the efficient transportation of goods and people throughout the nation. At present, India has a total of approximately 1,42,126 km of national highways, with ongoing projects aiming to expand the network further.

### 2.1 About National Highway No. 48

The National Highway No. 48 (NH48) spans seven states in India from Chennai to Delhi. It has a total length of 2,807 km (1,744 miles). NH48 passes through the states of Delhi, Haryana, Rajasthan, Gujarat, Maharashtra, Karnataka and Tamil Nadu. Figure 1 shows a map with NH48 highlighted.

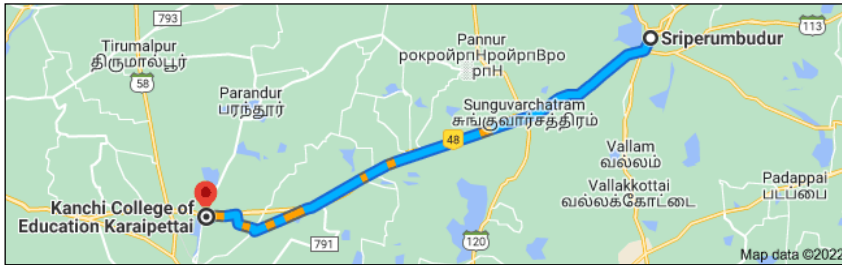


**Fig. 2.** Alignment of National Highway No. 48

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## 2.2 Sriperumbudur–Karapettai Section

Sriperumbudur–Karapettai Section is a part of Chennai–Bengaluru Industrial Corridor (CBIC) and also a part of Golden Quadrilateral, Chennai–Mumbai–Delhi Corridor. It starts at Chennai passes through many industries and educational institutions. The map showing Sriperumbudur–Karapettai section is presented in Figure 2. The 34 km project road between Sriperumbudur and Karaipettai is widened to six lane divided road with two lane service lanes on either side by S A Infrastructure Private Limited.



**Fig. 3.** Map of Sriperumbudur–Karapettai Section

## 3 Literature Review

Literature relevant to the present study is reviewed here:

Toll plaza design (Kai, 2020; Vaibhav, 2019) can be done to fulfil multiple objectives. Once designed and implemented, it is impossible to modify the design. While planning a toll plaza, features influencing the safety of vehicles (Muamer, 2018); toll lane choice behaviour (Parmar, 2013); expected queue length (Abdul, 2016); and the expected level of service (Lin, 1994; Jack, 2002) in the horizon year need to be studied thoroughly.

Traffic simulation software (Liu, 2017; Caldas, 2016) like VISSIM is helpful in the design of toll plazas and possible scenarios can be studied to arrive at an optimal design.

**It is evident from the literature review that more thorough research was done overseas to design toll plazas. Such advanced studies have never been conducted in India; this study is the beginning of such studies.**

## 4 Methodology

The methodology adopted for this study is as follows:

- The purpose of this study is to estimate the number of bays required for a toll plaza in the horizon year.
- To attain this, a classified volume count (CVC) survey for at least a 7-day period at the toll plaza location needs to be conducted.
- From 7-day traffic data, it is possible to estimate the ‘Average Daily Traffic’ (ADT).
- During the CVC survey, parallel site inventories were also conducted to collect information on the existing industries, institutions, etc. along the study corridor.
- Seasonal variation of traffic at the study location can be assessed using a factor known as the ‘Seasonal Correction Factor’ (SCF).

- SCF can be estimated from petrol and diesel sales data. (Since petrol, diesel sales data were not available, SCF is assumed as 1.10)
- Using SCF data, the ‘Annual Average Daily Traffic’ (AADT) can be estimated. This is the base year traffic.
- For traffic forecasting, it is necessary to calculate elasticity values, which can be obtained from population data, per-capita income, and Net State Domestic Product (NSDP) of influencing states.
- The above data must be obtained from reliable government sources.
- Once elasticity values are obtained, future traffic can be predicted.

The flowchart (Fig. 4) that follows shows the activity link that was used in the toll plaza design.

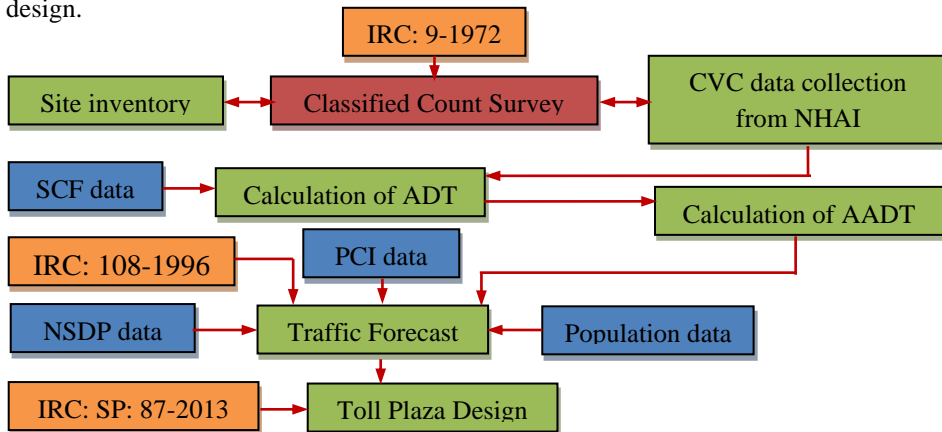


Fig. 4. Study Methodology

## 5 Site Appreciation

Based on the site visit following salient features of the project road were observed:

*Start and End Points:*

Project road starts at Sriperumbudur and ends at Karapettai. Start and end points of the project road are shown below:



Fig. 5. Starting & End Points of the Project Road

*Existing Toll Plaza Location:*

A toll plaza is located on project road at Nemili (near Sriperumbudur) and is operated by NHAI. The detail of the toll plaza is presented in Table 1.

**Table 1.** Toll Plaza Location

| S. No. | Toll Plaza Name   | Chainage |
|--------|-------------------|----------|
| 1.     | Nemili Toll Plaza | 37+500   |



**Fig. 6.** Nemili Toll Plaza near Sriperumbudur

*Major Settlements:*

Major settlements such as Sriperumbudur, Sunguvarchatram etc. are located along the project road. These settlements influence project road as major trip generation/attraction points. Chainages of the major settlements are given in Table 2.

**Table 2.** List of Major Settlements

| S. No. | Name of the Settlement | Chainage | S. No. | Name of the Settlement | Chainage |
|--------|------------------------|----------|--------|------------------------|----------|
| 1.     | Sriperumbudur          | 39+200   | 6.     | Neervalur              | 59+500   |
| 2.     | Pondhur                | 45+500   | 7.     | Vedal                  | 63+500   |
| 3.     | Mambakkam              | 46+500   | 8.     | Enathur                | 66+700   |
| 4.     | Sunguvarchatram        | 48+500   | 9.     | Chettiyarpettai        | 69+700   |
| 5.     | Santhavellore          | 51+500   | 10.    | Ponnerikarai           | 70+000   |



**Fig. 7.** Major Settlements

*Major Junctions*

The details of Major Junction located along project road are presented in **Table 3**.

**Table 3.** List of Major Junctions

| S. No. | Junction                     | Chainage |
|--------|------------------------------|----------|
| 1.     | Sriperumbudur Entry Junction | 39+200   |
| 2.     | Sriperumbudur Exit Junction  | 41+000   |
| 3.     | Oragadam Junction            | 42+100   |
| 4.     | Kancheepuram Junction        | 70+000   |



**Fig. 8.** Sriperumbudur Entry/ Exit Junctions



**Fig. 9.** Kancheepuram Junction

**Fig. 10.** Oragadam Junction

*Lane Configuration:*

Project road predominantly constitutes four lane divided road in all sections. Six lane divided road plus two lane service roads on both side is under construction.

*Minor Bridges and Flyover Locations:*

Seven minor bridges and eleven flyovers (under construction) are located along the project road. The details are presented in **Table 4**.

**Table 4.** List of Flyovers / Bridges

| S. No. | Existing Chainage | Bridge/Flyover | S. No. | Existing Chainage | Bridge/Flyover |
|--------|-------------------|----------------|--------|-------------------|----------------|
| 1.     | 39+300            | Minor Bridge   | 10.    | 48+500            | Flyover        |
| 2.     | 55+500            | Minor Bridge   | 11.    | 51+500            | Flyover        |
| 3.     | 56+500            | Minor Bridge   | 12.    | 55+500            | Flyover        |

|    |        |              |     |        |         |
|----|--------|--------------|-----|--------|---------|
| 4. | 56+600 | Minor Bridge | 13. | 60+500 | Flyover |
| 5. | 57+500 | Minor Bridge | 14. | 63+100 | Flyover |
| 6. | 61+500 | Minor Bridge | 15. | 65+500 | Flyover |
| 7. | 67+500 | Minor Bridge | 16. | 66+500 | Flyover |
| 8. | 45+100 | Flyover      | 17. | 68+500 | Flyover |
| 9. | 46+500 | Flyover      | 18. | 69+500 | Flyover |



**Fig. 11** Flyovers @ 56+500



**Fig. 12** Flyover @ 63+100

*Accident Prone Zones:*

There are few accident-prone zones (observed from information sign boards) along the project road. A list of such locations is presented in **Table 5**.

**Table 5.** Accident Prone Zones

| Sl. No. | Existing Chainage |        | Sl. No. | Existing Chainage |        |
|---------|-------------------|--------|---------|-------------------|--------|
|         | From              | To     |         | From              | To     |
| 1.      | 38+900            | 39+900 | 3.      | 48+400            | 49+400 |
| 2.      | 43+000            | 44+000 | 4.      | 69+100            | 70+100 |

## 6 Traffic Survey and Analyses

A classified volume count study was conducted to comprehend and analyse the existing traffic volume and pattern on the project road. Details of these traffic surveys, such as the schedule, location of survey points, and results, are discussed in this chapter.

### 6.1 Traffic Survey Location and Schedule

Traffic survey schedule is presented in **Table 6** and the survey locations are shown in a line diagram (**Figure 13**).

**Table 6.** Traffic Survey Schedule

| Sl. No.                                     | Type of Survey | Existing Chainage | Location | Schedule | Duration |
|---|----------------|-------------------|----------|----------|----------|
| <b>Classified Volume Count (CVC) Survey</b> |                |                   |          |          |          |

| Sl. No. | Type of Survey | Existing Chainage | Location | Schedule            | Duration           |
|---------|----------------|-------------------|----------|---------------------|--------------------|
| CVC1    | 5 Day CVC      | Km 37+500         | Nemili   | 25.07.22 – 30.07.22 | 10:00 am – 1:00 pm |



**Fig. 13.** CVC Survey Location

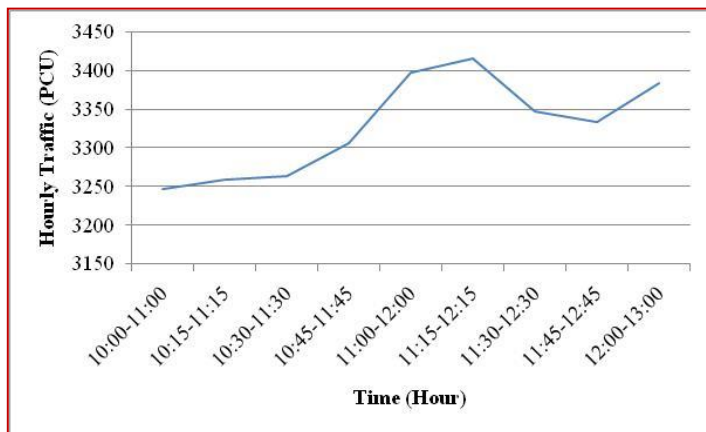
### 6.2 Passenger Car Units (PCUs)

Different types vehicles with a wide range of physical and traffic characteristics play on Indian roads. A way of accounting for the interaction of various kinds of vehicles is to express the capacity of roads in terms of a common unit, generally identified as the ‘Passenger Car Unit (PCU)’. Tentative equivalent factors for the conversion of different types of vehicles into equivalent PCUs based on their relative interference values are given in **Table 7**.

**Table 7.** Recommended PCU Factors for Various Types of Vehicles on Rural Roads

| S. No. | Vehicle Type                                    | Equivalency Factor |
|--------|---|--------------------|
| 1.     | Motor Cycle or Scooter                          | 0.50               |
| 2.     | Passenger Car, Pick-up Van or Auto-rickshaw     | 1.00               |
| 3.     | Agricultural Tractor, Light Commercial Vehicles | 1.50               |
| 4.     | Truck or Bus                                    | 3.00               |
| 5.     | Truck-trailer, Agriculture Tractor-trailer      | 4.50               |
| 6.     | Cycle   | 0.50               |
| 7.     | Cycle-rickshaw                                  | 2.00               |
| 8.     | Hand cart                                       | 3.00               |
| 9.     | Horse-drawn Vehicle                             | 4.00               |
| 10.    | Bullock cart                                    | 8.00               |

Based on the 3-hour traffic count, the hourly variation of traffic is estimated and presented below:



**Fig. 14.** Hourly Variation of Traffic

From the hourly variation of the traffic curve, it is observed that the maximum hourly traffic is 3,415 PCU, which falls between 11:15 am–12:15 pm.

### 6.3 Average Daily Traffic (ADT)

Since the above traffic data is insufficient to calculate Average Daily Traffic (ADT) and subsequently Annual Average Daily Traffic (AADT), traffic data from NHAI was collected for a period of 7×24 hours and ADT was estimated as given below:

**Table 8.** Average Daily Traffic (ADT)

| Vehicle Type       | Traffic Volume on |               |               |               |               |               |               | Average No.   |               |
|--------------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
|                    | 22-Feb (Tue)      | 23-Feb (Wed)  | 24-Feb (Thu)  | 25-Feb (Fri)  | 26-Feb (Sat)  | 27-Feb (Sun)  | 28-Feb (Mon)  | Vehicles      | PCU           |
| Car                | 12,115            | 13,722        | 13,026        | 13,248        | 16,628        | 16,766        | 13,885        | 14,199        | 14,199        |
| LCV                | 4,506             | 4,671         | 4,647         | 4,546         | 4,976         | 2,739         | 4,464         | 4,364         | 6,546         |
| Bus                | 3,911             | 3,824         | 3,886         | 3,927         | 4,312         | 2,943         | 3,900         | 3,815         | 11,444        |
| 2-Axle Truck       | 5                 | 17            | 1             | 2             | 7             | 2             | 6             | 6             | 18            |
| 3-Axle Truck       | 1,455             | 1,419         | 1,512         | 1,435         | 1,816         | 1,100         | 1,489         | 1,461         | 4,383         |
| HCM                | 2,961             | 3,181         | 3,244         | 3,266         | 3,461         | 2,712         | 2,844         | 3,096         | 13,930        |
| Oversized Vehicles | 5                 | 5             | 5             | 5             | 12            | 5             | 6             | 6             | 28            |
| <b>Total</b>       | <b>24,958</b>     | <b>26,839</b> | <b>26,321</b> | <b>26,429</b> | <b>31,212</b> | <b>26,267</b> | <b>26,564</b> | <b>26,946</b> | <b>50,547</b> |

### 6.4 Annual Average Daily Traffic (AADT)

For calculating AADT, the seasonal correction factor is assumed to be **1.10**. Based on the assumed seasonal correction factor, AADT was estimated, and the same is given below:

**Table 9.** Annual Average Daily Traffic (AADT)

| Vehicle Type       | Average No.   |               |
|--------------------|---------------|---------------|
|                    | Vehicles      | PCU           |
| Car                | 15,619        | 15,619        |
| LCV                | 4,800         | 7,200         |
| Bus                | 4,197         | 12,591        |
| 2-Axle Truck       | 7             | 21            |
| 3-Axle Truck       | 1,607         | 4,821         |
| HCM                | 3,406         | 15,327        |
| Oversized Vehicles | 7             | 32            |
| <b>Total</b>       | <b>29,643</b> | <b>55,611</b> |

## 7 Traffic Forecasting

### 7.1 Socio - Economic Profile

From the map of the project corridor, it was observed that **Tamil Nadu** is the major influencing state. Karnataka, **Andhra Pradesh and Maharashtra (Mumbai)** states also have a significant influence on traffic in the project corridors other than Tamil Nādu. Hence, the socio-economic data of all the above states is collected and presented below:

**Table 10.** Share of NSDP and Growth Trends of Influencing States

| Financial year | Tamil Nadu |            | Karnataka |            | Andhra Pradesh |            | Maharashtra |            |
|----------------|------------|------------|-----------|------------|----------------|------------|-------------|------------|
|                | NSD P      | % Growth   | NSD P     | % Growth   | NSDP           | % Growth   | NSD P       | % Growth   |
| 2020-21        | 10.12      | -          | 8.70      | -          | 5.13           | -          | NA          | -          |
| 2019-20        | 9.98       | 1.4        | 8.92      | -2.5       | 5.25           | -2.4       | 16.18       |            |
| 2018-19        | 9.47       | 5.3        | 8.47      | 5.5        | 4.89           | 7.4        | 15.41       | 5.0        |
| 2017-18        | 8.89       | 6.5        | 7.99      | 6.0        | 4.70           | 4.1        | 14.61       | 5.5        |
| 2016-17        | 8.25       | 7.8        | 7.55      | 5.8        | 4.25           | 10.5       | 13.89       | 5.2        |
| 2015-16        | 7.74       | 6.6        | 6.74      | 12.0       | 3.99           | 6.6        | 12.67       | 9.6        |
| 2014-15        | 7.13       | 8.5        | 6.07      | 11.1       | 3.60           | 10.9       | 11.79       | 7.5        |
| 2013-14        | 6.75       | 5.6        | 5.77      | 5.1        | 3,28,710       | 9.4        | 11.12       | 6.0        |
| 2012-13        | 6.43       | 5.1        | 5.29      | 9.2        | 3.12           | 5.5        | 10.45       | 6.4        |
| 2011-12        | 6.16       | 4.3        |           | 5.5        | 3.10           | 0.4        |             | 5.5        |
| <b>AAGR</b>    |            | <b>5.7</b> |           | <b>6.4</b> |                | <b>5.8</b> |             | <b>5.6</b> |

Source: RBI Statistics

**Table 11.** Population Growth Rate of Influencing States

| Year     | Tamil Nadu  | Karnataka   | Andhra Pradesh | Maharashtra |
|----------|-------------|-------------|----------------|-------------|
| 2001     | 6,24,05,679 | 5,28,50,562 | 7,62,10,007    | 96,752,247  |
| 2011     | 7,21,47,030 | 6,10,95,297 | 8,45,80,777    | 112,372,972 |
| % Growth | <b>1.56</b> | <b>1.56</b> | <b>1.09</b>    | <b>1.51</b> |

Source: Population Census of India

**Table 12.** Per-capita Income of Influence States

| Year    | Per Capita Income (Rs.) |          |          |          | Growth Rate (%) |            |            |            |
|---------|-------------------------|----------|----------|----------|-----------------|------------|------------|------------|
|         | TN                      | KA       | AP       | MAH      | TN              | KA         | AP         | MAH        |
| 2020-21 | 1,50,990                | 1,49,825 | 1,10,453 |          |                 |            |            |            |
| 2019-20 | 1,49,329                | 1,54,861 | 1,13,927 | 1,52,566 | 1.1             | -3.3       | -3.0       | 2.13       |
| 2018-19 | 1,41,844                | 1,48,690 | 1,07,286 | 1,47,097 | 5.3             | 4.2        | 6.2        | 3.7        |
| 2017-18 | 1,33,029                | 1,41,229 | 1,03,177 | 1,39,958 | 6.6             | 5.3        | 4.0        | 5.1        |
| 2016-17 | 1,23,206                | 1,31,186 | 94,115   | 1,33,686 | 8.0             | 7.7        | 9.6        | 4.7        |
| 2015-16 | 1,15,875                | 1,16,813 | 88,609   | 1,22,889 | 6.3             | 12.3       | 6.2        | 8.8        |
| 2014-15 | 1,07,117                | 1,05,697 | 79,174   | 1,15,058 | 8.2             | 10.5       | 11.9       | 6.8        |
| 2013-14 | 1,02,191                | 1,01,858 | 72,254   | 1,09,597 | 4.8             | 3.8        | 9.6        | 5.0        |
| 2012-13 | 97,257                  | 94,375   | 68,865   | 1,04,008 | 5.1             | 7.9        | 4.9        | 5.4        |
| 2011-12 | 93,112                  | 90,263   | 69,000   | 99,597   | 4.5             | 4.6        | -0.2       | 4.4        |
| Average |                         |          |          |          | <b>5.5</b>      | <b>5.9</b> | <b>5.5</b> | <b>4.9</b> |

Source: Population Census of India

## 7.2 India–Economic Growth Trend

The Indian Economy has grown 5% on a compound annual average basis from 2011-12 to 2021-22. Past growth trends of India’s GDP are presented in **Table 3**.

**Table 13.** Growth Rates of GDP (2004-05 prices)

| Financial Year | Gross Domestic Product | % Growth |
|----------------|------------------------|----------|
| 2021–22        | 1,47,35,515            |          |
| 2020–21        | 1,35,58,473            | 7.99     |
| 2019–20        | 1,45,15,958            | -7.06    |
| 2018–19        | 1,40,03,316            | 3.53     |
| 2017–18        | 1,31,44,582            | 6.13     |
| 2016–17        | 1,23,08,193            | 6.36     |

|                |             |             |
|----------------|-------------|-------------|
| 2015–16        | 1,13,69,493 | 7.63        |
| 2014–15        | 1,05,27,674 | 7.40        |
| 2013–14        | 98,01,370   | 6.90        |
| 2012–13        | 92,13,017   | 6.00        |
| 2011–12        | 87,36,329   | 5.17        |
| Average Growth |             | <b>5.01</b> |

Source: Reserve Bank of India

### 7.3 Estimation of Traffic Growth Rate

Growth rates were estimated separately based on different components like NSDP and state-wise influence. The final base year growth rates for both commercial and passenger traffic have arrived by giving different weights to each of these components.

#### 7.3.1 Growth Rate Based on NSDP and State Influence Factors (Elasticity Method)

Goods traffic growth rates were predicted based on past growth trends in the Net State Domestic Product (NSDP) of the influencing states as well as future growth prospects. Since the project road passes through Karnataka and Tamil Nadu States, the influence of the two states was considered. Based on O-D data, it was observed that Andhra Pradesh and Maharashtra (Mumbai) also have a significant influence on the project corridor. Therefore, the influence of those zones is also considered to arrive at growth rates separately for each mode–LCV, 3A, HCM and Oversized Vehicles. Though 2A truck traffic was growing negatively, the growth rates were assumed uniformly as 5% (*since the code doesn't support less than 5%*). An elasticity of 1.1 for commercial truck traffic was considered as recommended by the Asian Development Bank (ADB) for Traffic projection in India. Based on the above discussion, the location-wise goods traffic growth rates for the base year (2012) are estimated separately for LCV, 3A, 2A, HCM and Oversized Vehicles traffic. In future years, the growth rate is expected to reduce gradually therefore, the growth rate is assumed to decrease by 10% every 5 years up to 2025 and uniform thereafter (2026-32). Sample calculation of growth rates for LCV, 3A, 2A, HCM and Oversized Vehicles traffic at Km 37+800 is presented in **Table 14**, **Table 15**, **Table 16**, **Table 17**, **Table 18**, **Table 19**, and **Table 20** respectively. Mode-wise growth rates for study location is estimated and presented in **Table 21**.

**Table 14.** Estimation of Growth Rates for LCV at Km 37+800

| Influencing State                        | Influence Factor (%) | Growth Trend in NSDP |
|--|----------------------|----------------------|
| Tamil Nadu                               | 80                   | 5.69%                |
| Karnataka                                | 15                   | 6.4%                 |
| Andhra Pradesh                           | 5                    | 5.82%                |
| Maharashtra                              | 0                    | 5.63%                |
| Weighted NSDP                            |                      | 5.803%               |
| Elasticity                               |                      | 1.1                  |
| Growth Rate (Weighted NSDP x Elasticity) |                      | <b>6.38%</b>         |

**Table 15.** Estimation of Growth Rates for 2-Axle at Km 37+800

| Influencing State                          | Influence Factor (%) | Growth Trend in NSDP |
|--|----------------------|----------------------|
| Tamil Nadu                                 | 90                   | 5.69%                |
| Karnataka                                  | 10                   | 6.4%                 |
| Andhra Pradesh                             | 0                    | 5.82%                |
| Maharashtra                                | 0                    | 5.63%                |
| Weighted NSDP                              |                      | 5.76%                |
| Elasticity                                 |                      | 1.1                  |
| Growth Rate (Weighted NSDP x Elasticity) * |                      | <b>6.33%</b>         |

\*Assumed uniformly 5%

**Table 16.** Estimation of Growth Rates for 3A Truck at Km 37+800

| Influencing State                        | Influence Factor (%) | Growth Trend in NSDP |
|--|----------------------|----------------------|
| Tamil Nadu                               | 75                   | 5.69%                |
| Karnataka                                | 10                   | 6.4%                 |
| Andhra Pradesh                           | 10                   | 5.82%                |
| Maharashtra                              | 5                    | 5.63%                |
| Weighted NSDP                            |                      | 5.77%                |
| Elasticity                               |                      | 1.1                  |
| Growth Rate (Weighted NSDP x Elasticity) |                      | <b>6.34%</b>         |

**Table 17.** Estimation of Growth Rates for HCM at Km 37+800

| Influencing State                        | Influence Factor (%) | Growth Trend in NSDP |
|--|----------------------|----------------------|
| Tamil Nadu                               | 75                   | 5.69%                |
| Karnataka                                | 10                   | 6.4%                 |
| Andhra Pradesh                           | 10                   | 5.82%                |
| Maharashtra                              | 5                    | 5.63%                |
| Weighted NSDP                            |                      | 5.80%                |
| Elasticity                               |                      | 1.1                  |
| Growth Rate (Weighted NSDP x Elasticity) |                      | <b>6.38%</b>         |

**Table 18.** Estimation of Growth Rates for Oversized Vehicles at Km 37+800

| Influencing State | Influence Factor (%) | Growth Trend in NSDP |
|-------------------|----------------------|----------------------|
| Tamil Nadu        | 60                   | 5.69%                |
| Karnataka         | 15                   | 6.4%                 |
| Andhra Pradesh    | 10                   | 5.82%                |
| Maharashtra       | 15                   | 5.63%                |
| Weighted NSDP     |                      | 5.87%                |

| Influencing State                        | Influence Factor (%) | Growth Trend in NSDP |
|--|----------------------|----------------------|
| Elasticity                               |                      | 1.1                  |
| Growth Rate (Weighted NSDP x Elasticity) |                      | <b>6.45%</b>         |

The methodology for the estimation of growth rates for passenger traffic is also similar to the above, the only change being, that the population and per capita income data were taken as indicators that influence the growth instead of NSDP. An elasticity of 1.6 for car traffic and 1.2 for bus traffic was considered as recommended by ADB for Traffic projection in India. Based on the above assumptions, location-wise growth rates for passenger vehicles (Car & Bus) were estimated. Sample calculations of growth rates for Car & Bus at Km 37+800 are presented below:

**Table 19.** Estimation of Growth Rates for Car at Km 37+800

| Influence State  | Influence Factor (%) | Growth Trend in Population (%) | Growth Trend in Per Capita Income (%) | Combined Growth Trend of Indices (80:20) |
|--|----------------------|--------------------------------|---------------------------------------|--|
| Tamil Nadu   | 90                   | 1.56                           | 5.53                                  | 4.74%                                    |
| Karnataka  | 10                   | 1.56                           | 5.88                                  | 5.43%                                    |
| Andhra Pradesh   | 0                    | 1.09                           | 5.47                                  | 0%                                       |
| Maharashtra  | 0                    | 1.51                           | 4.88                                  | 0%                                       |
| Weighted NSDP  |                      |                                |                                       | 4.81%                                    |
| Elasticity as recommended by ADB for Traffic projection in India |                      |                                |                                       | 1.6                                      |
| Growth Rate (Weighted NSDP X Elasticity)                         |                      |                                |                                       | <b>7.9%</b>                              |

**Table 20.** Estimation of Growth Rates for Bus at Km 37+800

| Influence State  | Influence Factor (%) | Growth Trend in Population (%) | Growth Trend in Per Capita Income (%) | Combined Growth Trend of Indices (20:80) |
|--|----------------------|--------------------------------|---------------------------------------|--|
| Tamil Nadu   | 95                   | 1.56                           | 5.53                                  | 2.36%                                    |
| Karnataka  | 5                    | 1.56                           | 5.88                                  | 2.42%                                    |
| Andhra Pradesh   | 0                    | 1.09                           | 5.47                                  | 0%                                       |
| Maharashtra  | 0                    | 1.51                           | 4.88                                  | 0%                                       |
| Weighted NSDP  |                      |                                |                                       | 2.36%                                    |
| Elasticity as recommended by ADB for Traffic projection in India |                      |                                |                                       | 1.2                                      |
| Growth Rate (Weighted NSDP X Elasticity)                         |                      |                                |                                       | <b>2.83%</b>                             |

Similarly, growth rates were estimated at other proposed toll plaza locations (weights given for past growth rates also) and recommended growth rates are presented in the next section.

### 7.3.2 Recommended Growth Rate

Based on the above discussion, the growth rates for the base year (2022) were estimated on the following assumptions and presented in **Table 21**.

- Car/Bus–Using Per Capita Income (PCI) and population
- LCV/2-Axle/3-Axle/HCM/Oversized Vehicles–Using NSDP of the influencing states
- To estimate the final growth rates, weights were given for past growth rates.

**Table 21.** Recommended Growth Rates in Percentages (%)

| Vehicle Type       | Km 37+800 (Nemili Toll Plaza) |           |           |
|--------------------|-------------------------------|-----------|-----------|
|                    | 2022-2027                     | 2028-2032 | 2033-2037 |
| Car                | 7.9                           | 6.74      | 5.77      |
| Bus                | 2.83                          | 2.59      | 2.12      |
| LCV                | 6.38                          | 5.80      | 5.22      |
| 2 Axle             | 6.33                          | 5.76      | 5.18      |
| 3 Axle             | 6.34                          | 5.77      | 5.19      |
| HCM                | 6.38                          | 5.80      | 5.22      |
| Oversized Vehicles | 6.45                          | 5.87      | 5.28      |

### 7.4 Traffic Forecasting

With the above-estimated growth rates, traffic for the next 15 years was estimated and shown below:

**Table 22.** Forecasted Traffic (2022–2037)

| Year | Car    | Bus   | LCV   | 2-Axle | 3-Axle | HC M  | Oversized Vehicles | Vehicle s | PCU           |
|------|--------|-------|-------|--------|--------|-------|--------------------|-----------|---------------|
| 2022 | 15,619 | 4,197 | 4,800 | 7      | 1,607  | 3,406 | 7                  | 29,643    | <b>58,021</b> |
| 2023 | 16,853 | 4,316 | 5,106 | 7      | 1,709  | 3,623 | 7                  | 31,622    | <b>61,510</b> |
| 2024 | 18,184 | 4,438 | 5,432 | 8      | 1,817  | 3,854 | 8                  | 33,742    | <b>65,228</b> |
| 2025 | 19,621 | 4,564 | 5,779 | 8      | 1,932  | 4,100 | 8                  | 36,013    | <b>69,190</b> |
| 2026 | 21,171 | 4,693 | 6,147 | 9      | 2,055  | 4,362 | 9                  | 38,446    | <b>73,413</b> |
| 2027 | 22,843 | 4,825 | 6,539 | 10     | 2,185  | 4,640 | 10                 | 41,053    | <b>77,915</b> |
| 2028 | 24,383 | 4,950 | 6,919 | 10     | 2,311  | 4,909 | 10                 | 43,493    | <b>82,182</b> |

| Year   | Car    | Bus   | LCV    | 2-Axle | 3-Axle | HC M  | Oversized Vehicles | Vehicles | PCU             |
|--------|--------|-------|--------|--------|--------|-------|--------------------|----------|-----------------|
| 2029   | 26,026 | 5,079 | 7,320  | 11     | 2,445  | 5,194 | 11                 | 46,085   | <b>86,697</b>   |
| 2030 # | 27,781 | 5,210 | 7,745  | 11     | 2,586  | 5,495 | 11                 | 48,839   | <b>91,478</b>   |
| 2031   | 29,653 | 5,345 | 8,194  | 12     | 2,735  | 5,814 | 12                 | 51,765   | <b>96,540</b>   |
| 2032   | 31,652 | 5,484 | 8,669  | 13     | 2,893  | 6,151 | 13                 | 54,874   | <b>1,01,900</b> |
| 2033   | 33,478 | 5,600 | 9,122  | 13     | 3,043  | 6,472 | 13                 | 57,741   | <b>1,06,879</b> |
| 2034   | 35,410 | 5,719 | 9,598  | 14     | 3,201  | 6,810 | 14                 | 60,765   | <b>1,12,117</b> |
| 2035   | 37,453 | 5,840 | 10,099 | 15     | 3,367  | 7,166 | 15                 | 63,954   | <b>1,17,628</b> |
| 2036   | 39,614 | 5,964 | 10,626 | 15     | 3,542  | 7,540 | 16                 | 67,316   | <b>1,23,427</b> |
| 2037   | 41,900 | 6,090 | 11,180 | 16     | 3,725  | 7,933 | 16                 | 70,862   | <b>1,29,528</b> |

#Design Period

## 8 Toll Plaza Design

Toll plazas are constructed to collect tolls from road users, especially in public-private-Partnership projects. The electronic toll collection method (*FASTag*) is widely used for toll collection in India due to the following reasons:

- The time to complete toll collection is faster compared to the manual method
- Required less land space

As per the IRC:SP:87-2013, the rate of toll collection for ETC bays is 1,200 vehicles/ hour. Based on these guidelines, the number of toll lanes required for the year 2030 is calculated as follows:

Total number of vehicles expected to use the road (both directions) = 48,839 vehicles

Total number of vehicles expected to use the road (one direction) = 24,420 vehicles

Peak hour traffic assuming 12% of daily traffic = 2,930 vehicles

So, number of bays needed for one direction =  $2.44 \approx 3$  bays per direction = 6 bays TP

## 9 Conclusions

From the above traffic study, the following conclusions were arrived:

- The 34 km project road between Sriperumbudur and Karaipettai is widened to six-lane divided road with two-lane service roads on either side by SA Infrastructure Private Limited.
- From the hourly variation of the traffic curve, it is observed that the maximum hourly traffic is 3,415 PCU which falls from 11:15 am to 12:15 pm.
- Total number of vehicles expected in the year 2037 at Nemili toll plaza will be 70,862 (i.e., 1,29,528 PCUs).

- The number of electronic toll collection toll lanes needed for the year 2030 is six.

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