Determination of AADT from Short Period Traffic Volume Survey

M. Sabry, H. Abd-El-Latif, S. Yousif and N. Badra

Public Works Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.
2Department of Structural Engineering, Faculty of Engineering, Ain Shams University, Cairo, Egypt.
3Department of Physics and Engineering mathematics, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

Abstract: The average annual daily traffic volume AADT is the total volume passing a point of a road facility, in both directions, during a 24-hour period. It is obtained during a given time period, in whole days greater than one day and less than one year, divided by the number of days in that time period. This paper investigates the determination of AADT from certain peak hours design volumes for certain intercity road in Egypt. Traffic data of year 2002 for a selected station was used in the predict traffic volume. Actual and theoretical AADT are calculated from both one beak hour and the percentage of the four peak hours and compared to each other. By this way, the AADT can be estimated or forecasted for the Station by using certain few peak hour traffic volumes records and this will reduce the cost of recording traffic volumes and make it cheaper. The statistical package SPSS was used for the regression analysis of this study and several Excel Macros are made in this paper. Comparison of estimated AADT with actual AADT is presented for different months.

Key words: Traffic volume, Average annual daily traffic, Regression analysis, peak hour volume.

INTRODUCTION

Studies on traffic volumes have been developed [1-5]. The average annual daily traffic volume AADT is the total volume passing a point of a road facility, in both directions, during a 24-hour period. It is obtained during a given time period, in whole days greater than one day and less than one year, divided by the number of days in that time period. The volume is then adjusted for seasonal variations using the Seasonal Adjustment Factor. Peak hour volume data consists of hourly volume relationships and data location. The hourly volumes are expressed as a percentage of the Average Annual Daily Traffic (AADT). The percentage are shown for both the AM peak hours (from hours H1 to H12) and the PM peak hours (from hours H13 to H24) periods.

This paper investigates the determination of average annual daily traffic (AADT) volume from peak hour volumes for a special road on Egypt, Station 12. Traffic data of year 2002 for the selected station was used in the predict traffic volume. Actual and theoretical AADT are calculated from both one beak hour and the percentage of the four peak hours and compared to each other. By this way, the AADT can be estimated or forecasted for the Station by using only four peak hour traffic volumes records. The statistical package SPSS was used for the regression analysis of this study and several Excel Macros are made in this paper. Comparison of estimated AADT with actual AADT is presented for different months.

Study Data: Daily traffic volume statistics of Station 12 from a period of January 2002 to December 2002 were considered in this paper. The average annual, monthly and weekly daily traffic volumes were calculated for the data.

Estimation of AADT from One Peak Hour: The design hour volume DHV is the volume of traffic during one hour that is used as an acceptable operating condition for highway planning and design purposes. The average annual daily traffic (AADT) is defined to be the total volume passing a point or segment of a road facility, in both directions, during a 24-hour period. The volume is then adjusted for seasonal variations using the Seasonal Adjustment Factor. A commonly used relationship to synthesize DHV that has been suggested in the literature [6-8] is

\[
30HV = C + K * \text{AADT}
\]

where 30HV and AADT are the same as defined earlier and C and K are the model parameters.

When the y-intercept (C) of this DHV model is set equal to zero, the following relationship is obtained [9]:

\[
\text{DHV} = K * \text{AADT}
\]

Corresponding Author: N. Badra, Department od Physics and Engineering mathematics, Faculty of Engineering, Ain Shams University, Cairo, Egypt
The average annual daily traffic (AADT) can be estimated from short period traffic volume for each month of the year for the station. The selected short period traffic volume to represent the AADT is the four hours between Hour 15 (H15) and Hour 18 (H18). The AADT can be obtained from these four hours as follows:

$$\text{AADT} = \frac{\text{traffic volume of the short period}}{\text{Percentage of this period}}$$  \hspace{1cm} (4)

The selected short period traffic volume to represent the AADT is the four hours between Hour 15 (H15) and Hour 18 (H18). Results of actual and estimated AADT from the selected short period are summarized on Table 5.

**Estimation of AADT from Regression of Short Period Traffic Volume:** Regression analysis is used to predict the response variable from knowledge of the independent variables. At other times, regression analysis is utilized primarily for examining the nature of the relationship between the independent variables and the response variable\(^{10}\). Regression models containing one independent variable are called simple regression models. While, Regression models containing two or more independent variables are called multiple regression models. The general form of the multiple regression models can be set in the following form:

$$y = f(x_1, x_2, ..., x_n)$$  \hspace{1cm} (5)

where,

- $y$ is the response variable and
- $x_1, x_2, ..., x_n$ are the independent variables.
The simple linear regression model can be set in the following form:
\[ y = A_0 + A_1 \times X_1 + A_2 \times X_2 + A_3 \times X_3 + \]

where, 
\[ A_0, A_1, A_2, A_3 \ldots \] are the regression model parameters.

These model parameters are estimated using the least square error approach. Goodness of fit measures available for the least squares regression analysis such as coefficient of determination \( R^2 \) and \( t \) – test should (6be also estimated. The average annual daily traffic (AADT) can be estimated from regression analysis of the short period traffic volumes for each month of the year for the station. The selected short period traffic volume to represent the AADT is the four hours between Hour 15 (H15) and Hour 18 (H18).

Thus, the AADT can be obtained from these hours as follows:

**Table 5:** Actual and estimated AADT from short period for each month for station 12.

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
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<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual ADT</td>
<td>16660</td>
<td>19259</td>
<td>18953</td>
<td>17119</td>
<td>21708</td>
<td>26579</td>
<td>36347</td>
<td>33813</td>
<td>26600</td>
<td>28643</td>
<td>28916</td>
<td>20600</td>
</tr>
<tr>
<td>Est. ADT</td>
<td>16607</td>
<td>19259</td>
<td>18953</td>
<td>17119</td>
<td>21708</td>
<td>26579</td>
<td>36347</td>
<td>33813</td>
<td>26600</td>
<td>28643</td>
<td>28916</td>
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</table>

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<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
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<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>% H 15</td>
<td>16</td>
<td>6.51</td>
<td>6.42</td>
<td>5.87</td>
<td>6.74</td>
<td>5.11</td>
<td>4.89</td>
<td>4.64</td>
<td>4.78</td>
<td>4.89</td>
<td>4.92</td>
<td>5.35</td>
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<tr>
<td>% H 16</td>
<td>6.82</td>
<td>6.77</td>
<td>6.16</td>
<td>6.75</td>
<td>5.41</td>
<td>5.08</td>
<td>4.70</td>
<td>4.98</td>
<td>5.08</td>
<td>5.26</td>
<td>4.80</td>
<td>4.64</td>
</tr>
<tr>
<td>% H 17</td>
<td>6.65</td>
<td>6.86</td>
<td>6.44</td>
<td>6.18</td>
<td>5.79</td>
<td>5.41</td>
<td>5.09</td>
<td>5.57</td>
<td>5.41</td>
<td>5.86</td>
<td>5.47</td>
<td>5.82</td>
</tr>
<tr>
<td>% H 18</td>
<td>6.93</td>
<td>6.86</td>
<td>6.44</td>
<td>6.18</td>
<td>5.79</td>
<td>5.41</td>
<td>5.09</td>
<td>5.57</td>
<td>5.41</td>
<td>5.86</td>
<td>5.47</td>
<td>5.82</td>
</tr>
</tbody>
</table>

**Table 6:** Actual and estimated AADT from regression analysis of short period for station 12.

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
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<th>Jul</th>
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<th>Dec</th>
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<tbody>
<tr>
<td>AADT</td>
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<td>19259</td>
<td>18953</td>
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<td>21708</td>
<td>26579</td>
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<td>26600</td>
<td>28643</td>
<td>28916</td>
<td>20600</td>
</tr>
</tbody>
</table>

The simple linear regression model can be set in the following form:
\[ y = A_0 + A_1 \times X_1 + A_2 \times X_2 + A_3 \times X_3 + \]

where,
\[ A_0, A_1, A_2, A_3 \ldots \] are the regression model parameters.

These model parameters are estimated using the least square error approach. Goodness of fit measures available for the least squares regression analysis such as coefficient of determination \( R^2 \) and \( t \) – test should (6be also estimated. The average annual daily traffic (AADT) can be estimated from regression analysis of the short period traffic volumes for each month of the year for the station. The selected short period traffic volume to represent the AADT is the four hours between Hour 15 (H15) and Hour 18 (H18).

Thus, the AADT can be obtained from these hours as follows:
AADT = \(a_1 + a_2 \cdot H_{15} + a_3 \cdot H_{16} + a_4 \cdot H_{17} + a_5 \cdot H_{18}\) 

(7)

where, 

\(H_{15}, H_{16}, H_{17}, H_{18}\) are the traffic volumes in hours 15, 16, 17 and 18 respectively, 
\(a_1, a_2, a_3, a_4, a_5\) are the regression model parameters.

The statistical package SPSS was used for regression analysis of equation (7) to determine theoretical AADT for each month of the year of Station 12. Results of actual and estimated regression parameters and the corresponding estimated AADT from regression analysis of the selected short period for each month of the year of the four hours between Hour 15 (H15) and Hour 18 (H18) are summarized on Table 6. (Appendix)

Comparison Between the Three Models: The predictions of traffic volume in the testing period are done using the three presented models. Table 7 illustrates the comparison between the actual and estimated values of AADT for each month of the year. To compare the prediction performance of the three approaches for the period from January 2002 to December 2002, Standard Error Deviation (STDEV) was calculated.

The standard deviation error (STDEV) is defined as follows(8):

\[ \text{STDEV} = \sqrt{\frac{\sum e_i^2}{n}} \]

(8)

Results with minimal errors, seems to give the best performance of the three models.

where, 

\(e_i\) (\(V_{i\text{ - actual}} - V_{i\text{ - forecast}}\)) is the error in estimating traffic volume.

Figures 1-3 show the percentage of errors in estimating AADT for each month of the year by using Models 1, 2 and 3, respectively. While, Figure 4 shows the standard deviation error (STDEV) of estimating average annual daily traffic volume (AADT) of the whole year for the three models.

Results of the percentage of errors in estimating AADT by using the three models show that Model 1 (estimation from only one peak hour) is the worst model in estimating AADT since it has the highest value percentage of errors in all months, while, Models 2 (estimation from short period survey) and Model 3 (estimation from regression of the short period) have approximately same values of percentage of errors. It can be concluded from the figures 1-3 that percentage of errors in estimating AADT of Model 2 is slightly less than of Model 3 in January, February
and November. The percentages of errors in estimating AADT of Model 2 are approximately the same of Model 3 in April, May and July. While, the percentage of errors in estimating AADT of Model 3 are better than that of Model 2 in March, June, August, September, October and December.

Results of the standard deviation error (STDEV) in estimating AADT by using the three models show that Model 1 (estimation from only one peak hour) is the worst model in estimating AADT since it has the highest value of STDEV, while, Models 2 (estimation from short period survey) and Model 3 (estimation from regression of the short period) have approximately same values of STDEV. It can be concluded from the figure 4 that standard deviation error STDEV for estimating AADT of Model 2 is slightly less than of Model 3 and both are less than that of Model 1.

**Conclusion:** This paper investigates the determination of average annual daily traffic (AADT) volume from peak hour volumes for a special road on Egypt, Station 12. Traffic data of year 2002 for the selected station was used in the predict traffic volume. Three models are presented for determining the AADT.
for each month of the year for the station. Model 1 estimates the AADT from only one peak hour traffic volume. Results show that this model is not suitable for estimating the AADT since it has the highest value of standard deviation error STDEV. Model 2 estimates the AADT from short period survey of traffic volumes. The selected short period traffic volume to represent the AADT is the four hours between Hour 15 (H15) and Hour 18 (H18). Results show that this model is more suitable than that of Model 1 to represent the AADT since it has less value of standard deviation error STDEV. Model 3 estimates the AADT from regression of short period traffic volumes. The statistical package SPSS was used for regression analysis of Model 3 to determine theoretical AADT for each month of the year of Station 12. Results show that this model is also more suitable than that of Model 1 and approximately the same of Model 2 in representing the AADT since it has nearly the same value of standard deviation error STDEV. Results of the percentage of errors in estimating AADT show that Model 1 is the worst model in estimating AADT since it has the highest value percentage of errors in all months. It can be concluded that percentage of errors in estimating AADT of Model 2 is slightly less than of Model 3 in January, February and November. The percentages of errors in estimating AADT of Model 2 are approximately the same of Model 3 in April, May and July. While, the percentage of errors in estimating AADT of Model 3 are better than that of Model 2 in March, June, August, September, October and December. The statistical package SPSS was used for the regression analysis of this study and several Excel Macros are made in this paper.

APPENDIX

The regression models in estimating average annual daily traffic volumes AADT for each month of the year of Station 12 are as follows:

<table>
<thead>
<tr>
<th>Month</th>
<th>AADT Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan:</td>
<td>605.229 + 16.771 H15 + 7.120 H16 + 8.501 H17 + 1.396 H18</td>
</tr>
<tr>
<td>Feb:</td>
<td>5351.293 + 6.736 H15 - 1.519 H16 + 4.960 H17 + 1.217 H18</td>
</tr>
<tr>
<td>March:</td>
<td>8434.225 + 2.449 H15 + 1.109 H16 + 0.408 H17 + 5.122 H18</td>
</tr>
<tr>
<td>April:</td>
<td>5276.620 + 3.351 H15 - 1.140 H16 + 6.482 H17 + 2.015 H18</td>
</tr>
<tr>
<td>May:</td>
<td>11527.432 + 5.132 H15 - 0.033 H16 - 0.729 H17 + 4.313 H18</td>
</tr>
<tr>
<td>June:</td>
<td>1861.280 + 4.831 H15 + 2.175 H16 + 4.300 H17 + 2.448 H18</td>
</tr>
</tbody>
</table>

**January**

- AADT = 998.267 + 23.747 H15 - 6.313 H16 - 0.520 H17 + 3.568 H18
- AADT = 1419.448 + 22.982 H15 - 5.865 H16 + 0.923 H17 + 2.125 H18
- AADT = 3487.818 + 14.524 H15 - 0.033 H16 + 1.498 H17 + 4.813 H18
- AADT = 1911.619 + 3.334 H15 - 2.802 H16 + 15.685 H17 + 2.991 H18

**REFERENCES**