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Determination of AADT from Short Period Traffic Volume Survey

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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.

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

$$30HV = C + K * AADT \quad (1)$$

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]:

$$DHV = K * AADT \quad (2)$$

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Table 1: Estimating the K Factor for station 12.

Year	Hour1	Hour10	Hour20	Hour30	Hour40	Hour50	Hour100	AADT	Ratio DHV/AADT
2002	2963	2821	2714	2590	2522	2469	2273	24630	0.10515

Table 2: Excel Macros and their jobs that are used in the analysis of data for Station 12

Excel Macros No.	Job of Excel Macro
Macro 1	Sort the traffic volumes for the year descending from the highest value H1 to the lowest value H8760.
Macro 2	Determine the important traffic volumes: H1, H10, H20, H30, H40, H50 and H100 for the Station.
Macro 3	Calculate K factor for each year of the Station and the average value.
Macro 4	Calculate monthly factor (MF) traffic volume for each month.
Macro 5	Calculate daily factor traffic (DF) volume for each month.

Table 3: Actual and estimated AADT for each month for station 12.

	Jan	Feb	Mar.	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
MF	1.476	1.277	1.302	1.437	1.134	0.925	0.682	0.715	0.929	0.864	0.851	1.195
Peak	1575	1973	1486	1744	1720	2592	3427	3817	2592	2383	2522	1908
AADT=Peak / K	14979	18764	14132	16586	16358	24650	32592	36300	24650	22663	23985	18145
Actual AADT	16660	19253	18883	17112	21678	26571	36077	34411	26479	28447	28909	20578

Table 4: Daily factor (DF) for station 12.

Day	Sat	Sun	Mon	Tue	Wed	Thu	Fri
DF	0.967	1.013	1.065	1.064	1.021	0.904	0.986

In practice, the ratio of the DHV to AADT is often referred to as the K factor. The K factor allows the conversion from a peak hour volume to a daily volume and the reverse. Two Excel Macros are made to determine the important hourly traffic volumes. Macro 1 is made to sort the traffic volumes for each year descending from the highest value H1 to the lowest value H8760 for year 2002 of the traffic data. Macro 2 is made to determine the important values of hourly traffic volumes. Macro 3 is made to determine the K factor. Table 1 presents hourly traffic volume and calculation of the K factor for Station 12. While, Macros 4 and 5 are made to determine the monthly factor (MF) and the daily factor (DF), respectively. List of these Excel Macros and their jobs are summarized in Table 2.

The value of K factor in this year is 10.515 % on the Station. This value is used in estimating the AADT for each month of the year such that:

$$\text{AADT} = (\text{Peak hour traffic volume}) / \text{K} - \text{Factor} \quad (3)$$

Results of actual and estimated AADT from one peak hour for each month with the corresponding monthly factor (MF) are summarized on Table 3. Table 4 presents the daily factor (DF) for the Station.

Estimation of AADT from Short Period Traffic Volume Survey: 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:

$$\text{AADT} = (\text{traffic volume of the short period}) / (\text{Percentage of this period}) \quad (4)$$

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:

$$y = f(x_1, x_2, \ldots, x_n) \quad (5)$$

where,

y is the response variable and

$x_1, x_2, \ldots, x_n$ are the independent variables.

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

	Jan	Feb	Mar.	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Volume H15	988	1145	1030	1050	1088	1295	1694	1584	1295	1399	1474	1264
Volume H16	1081	1237	1113	1153	1110	1298	1682	1609	1300	1407	1547	1343
Volume H17	1132	1303	1167	1155	1175	1350	1708	1685	1352	1505	1388	1327
Volume H18	1105	1320	1221	1059	1257	1442	1856	1894	1442	1681	1580	1201
Volume H15:H18	4306	5005	4531	4416	4629	5386	6940	6771	5390	5993	5989	5135
% H15	5.95	5.94	5.44	6.13	5.01	4.88	4.66	4.69	4.88	4.89	5.10	6.14
% H16	6.51	6.42	5.87	6.74	5.11	4.89	4.64	4.78	4.89	4.92	5.35	6.53
% H17	6.82	6.77	6.16	6.75	5.41	5.08	4.70	4.98	5.08	5.26	4.80	6.44
% H18	6.65	6.86	6.44	6.18	5.79	5.41	5.09	5.57	5.41	5.86	5.47	5.82
% volume H15:H18	25.93	25.99	23.91	25.80	21.32	20.26	19.09	20.03	20.26	20.93	20.71	24.93
Est. AADT	16607	19259	18953	17119	21708	26579	36347	33813	26600	28643	28916	20600
Actual AADT	16660	19253	18883	17112	21678	26571	36077	34411	26479	28447	28909	20578

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

	a_1		a_2		a_3		a_4		a_5				
	Value	t	value	t	value	t	value	t	value	t	R^2	AADT Est.	AADT Actual
Jan	1861.2	2.279	4.831	2.249	2.175	0.905	4.3	1.943	2.448	1.406	0.936	16559	16660
Feb	5351.2	4.316	6.736	2.461	-1.519	-0.43	4.595	1.595	1.217	0.552	0.850	18779	19253
Mar.	8434.2	15.01	2.449	2.543	1.109	0.845	0.408	0.325	5.122	3.865	0.935	18920	18883
Apr	5276.6	2.411	3.351	0.746	-1.140	-0.23	6.482	1.230	2.015	0.709	0.564	17098	17112
May	11527.4	17.05	5.132	2.868	-0.033	-0.02	-0.729	-0.49	4.313	3.996	0.904	21638	21678
June	609.22	0.244	16.771	5.028	-7.12	-1.6	8.501	1.688	1.396	0.557	0.859	26573	26571
July	998.26	0.243	23.747	6.827	-6.313	-1.28	-0.52	-0.07	3.568	0.701	0.833	36353	36077
Aug	1419.4	0.27	22.982	4.582	-5.865	-1.18	0.923	0.136	2.125	0.374	0.891	33971	34411
Sep	514.94	0.206	16.811	5.020	-7.355	-1.63	8.646	1.706	1.491	0.594	0.861	26568	26479
Oct	3487.8	0.938	14.524	3.332	-3.936	-1.02	1.498	0.291	4.813	1.505	0.710	28620	28447
Nov	1911.6	0.506	3.334	0.543	-2.802	-0.57	15.685	4.101	2.991	1.329	0.755	28987	28909
Dec	3638.1	2.040	9.814	2.477	-1.370	-0.34	1.377	0.326	3.790	1.802	0.799	20583	20578

The simple linear regression model can be set in the following form:

$$y = A_o + A_1 X_1 + A_2 X_2 + A_3 X_3 + \quad (6)$$

where,

A_o, A_1, A_2, A_3 … 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 be 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 7: Actual and estimated AADT and error for the three models each month for station 12.

		Model 1		Model 2		Model 3	
		By using one hour		By using four hours		By using regression	
	Act. AADT	Est. AADT	% Error	Est. AADT	% Error	Est. AADT	% Error
Jan	16660	14979	10.090	16607	0.318	16559	0.606
Feb	19253	18764	2.540	19259	-0.031	18779	2.462
Mar.	18883	14132	25.160	18953	-0.371	18920	-0.196
Apr	17112	16586	3.074	17119	-0.041	17098	0.082
May	21678	16358	24.541	21708	-0.138	21638	0.185
June	26571	24650	7.230	26579	-0.030	26573	-0.008
July	36077	32592	9.660	36347	-0.748	36353	-0.765
Aug	34411	36300	-5.490	33813	1.738	33971	1.279
Sep	26479	24650	6.907	26600	-0.457	26568	-0.336
Oct	28447	22663	20.333	28643	-0.689	28620	-0.608
Nov	28909	23985	17.033	28916	-0.024	28987	-0.270
Dec	20578	18145	11.823	20600	-0.107	20583	-0.024
STDEV	------	14.200		0.615		0.880	

$$AADT = a_1 + a_2 H15 + a_3 H16 + a_4 H17 + a_5 H18 \quad (7)$$

where,

H15, H16, H17, H18 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[11]:

$$STDEV = \sqrt{\frac{\sum e_t^2}{n}} \quad (8)$$

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

where,

n is the number of testing points and

e_t $(V_{t\text{ - actual}} - V_{t\text{ - forecast}})$ 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

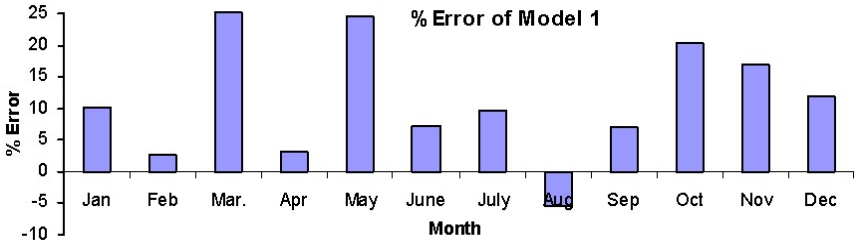

Fig. 1: Percentage of errors in estimating AADT by using Model 1.

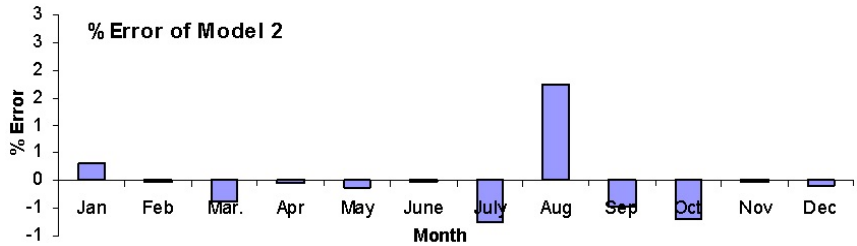

Fig. 2: Percentage of errors in estimating AADT by using Model 2.

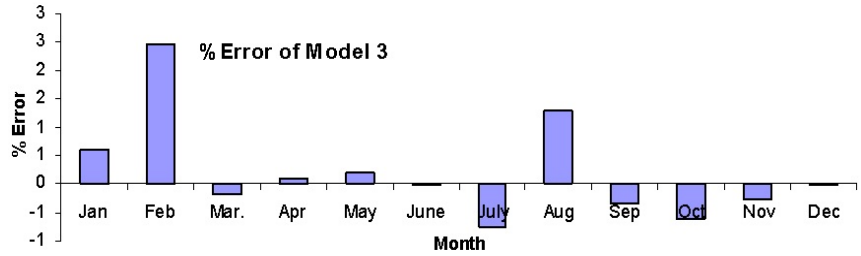

Fig. 3: Percentage of errors in estimating AADT by using Model 3.

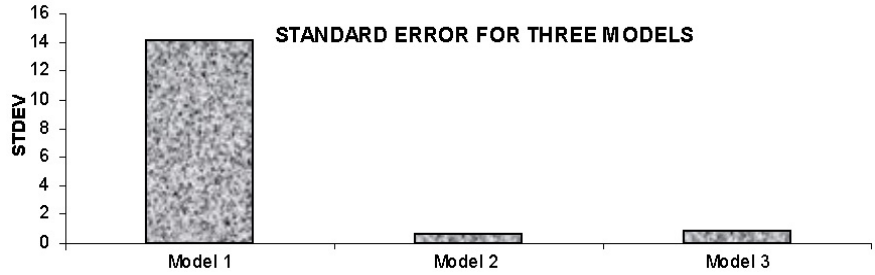

Fig. 4: STDEV of estimating average annual daily traffic volume for the three models.

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:

Jan: AADT = 1861.280 + 4.831 H15 + 2.175 H16 + 4.300 H17 + 2.448 H18

Feb: AADT = 5351.293 + 6.736 H15 - 1.519 H16 + 4.960 H17 + 1.217 H18

March: AADT = 8434.225 + 2.449 H15 + 1.109 H16 + 0.408 H17 + 5.122 H18

April: AADT = 5276.620 + 3.351 H15 - 1.140 H16 + 6.482 H17 + 2.015 H18

May: AADT = 11527.432 + 5.132 H15 - 0.033 H16 - 0.729 H17 + 4.313 H18

June: AADT = 609.229 + 16.771 H15 - 7.120 H16 + 8.501 H17 + 1.396 H18

July: AADT = 998.267 + 23.747 H15 - 6.313 H16 - 0.520 H17 + 3.568 H18

August: AADT = 1419.448 + 22.982 H15 - 5.865 H16 + 0.923 H17 + 2.125 H18

September: AADT = 514.940 + 16.811 H15 - 7.355 H16 + 8.646 H17 + 1.491 H18

October: AADT = 3487.818 + 14.524 H15 - 3.936 H16 + 1.498 H17 + 4.813 H18

November: AADT = 1911.619 + 3.334 H15 - 2.802 H16 + 15.685 H17 + 2.991 H18

December: AADT = 3638.112 + 9.814 H15 - 1.370 H16 + 1.377 H17 + 3.790 H18

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