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GUIDELINES FOR TRAFFIC PREDICTION ON RURAL HIGHWAYS

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41.	The Secretary,	Indian Roads Congress (S.C. Sharma)	- Ex-Officio

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GUIDELINES FOR TRAFFIC PREDICTION ON RURAL HIGHWAYS

1. INTRODUCTION

1.1. The need for preparing draft "Guidelines for Traffic Prediction on Rural Highways" was suggested by the Traffic Engineering Committee in its meeting held on 30th September, 1994.

The draft was prepared by Dr. L.R. Kadiyali and was discussed by the Traffic Engineering Committee in its meeting held on 31st August, 1995 when it was felt that the draft may be reviewed and revised in view of the comments of the members.

The Traffic Engineering Committee (Personnel given below) in its meeting held on 29th January, 1996 approved the draft "Guidelines for Traffic Prediction on Rural Highways" :

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Secretary, IRC (S.C. Sharma)

The guidelines were approved by the Highways Specifications & Standards Committee and the Executive Committee in their meetings held on 19th March and 17th April, 1996.

The guidelines were considered by the Council in their meeting held on 24th May, 1996 when it was decided that the draft be modified in the light of the comments of the members and then be considered by the Executive Committee. The draft was finally approved by the Executive Committee in its meeting held on 4th September, 1996.

1.2. An estimation of future traffic on Rural Highways is required for a variety of purposes. The width of a pavement is decided on the basis of the traffic volume it can efficiently accommodate. A pavement needs to be widened when the traffic flow exceeds its capacity. Pavements are designed on the basis of volume of commercial vehicles using the facility, and more importantly the number of repetitions of standards axle loads during the design period. The manner in which pavements perform and deteriorate is governed by the volume of commercial vehicles and the repetitions of standards axles. The Economic Analysis of a highway project relies for its accuracy on the correct prediction of future traffic flows and the benefits enjoyed by different types of vehicular traffic from highway improvements. For a toll project, the stream of cash flow from toll collection is determined from the traffic that is likely to use the facility and the toll rates. In all the above situations, the accuracy with which future traffic is predicted is of prime importance.

The present guidelines are intended for predicting traffic on rural sections of highways, including intersections. They can not be used for urban situations, where the prediction is more complicated.

2. ESTABLISHING EXISTING TRAFFIC FLOWS

2.1. Measurement of Traffic Flow

Traffic flow or volume is measured in terms of number of vehicles per unit time. The common units of time are day and hour. Thus the flows are measured in terms of vehicles per day or vehicles per hour.

Since Indian traffic is heterogeneous in character, it is common practice to convert the traffic in terms of passenger car units (PCUs). The values of passenger car equivalency for different vehicles types are given in IRC:64-1990, Guidelines for Capacity of Roads in Rural Areas, and are reproduced in Table 1 for ready reference.

Table 1 : Recommended PCU Factors for various types of Vehicles on Rural Roads

S.No.	Vehicle Type	Equivalency Factor
	Fast Vehicles	
1.	Motor Cycle or Scooter	0.50
2.	Passenger Car, Pick up Van or Autorickshaw	1.00
3.	Agricultural Tractor, Light Commercial Vehicle	1.50
4.	Truck or Bus	3.00
5.	Truck-trailer, Agricultural Tractor-trailer	4.50
	Slow Vehicles	
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

* For smaller bullock carts, a value of 6 would be appropriate.

2.2. Traffic Census Data

Daily traffic volume is denoted by the term ADT or AADT. ADT (Average Daily Traffic) is the value when traffic counts are taken for a limited period of say 3-7 days, and the daily average determined. AADT (Annual Average Daily Traffic) is the value when traffic counts are taken for all the 365 days of the year and the daily average determined.

According to the present practice as detailed in IRC:9-1972, Traffic Census on Non-urban Roads, a repetitive 7 day count is taken twice every year, once during the peak season and the other during the lean season. The average of the peak and lean season census data can be approximately taken as the average for the year (ADT). If more accurate values are needed, the traffic census data obtained during a particular month can be used for estimating the average for the year by applying seasonal factors. Such seasonal correction factors will have to be arrived at for the particular location on the basis of a round-the-year traffic census.

3. TRAFFIC FLOWS AT INTERSECTIONS

3.1. Unit of Measurement

Traffic flows at intersections are generally expressed in terms of PCUs per hour. The values of PCUs should be as given in IRC Special Publication 41 on "Guidelines for the Design of At-grade Intersections in Rural & Urban Areas". The peak hour traffic is more relevant in the design of intersections than the daily flow.

3.2. Directional Census

For intersection design the directional counts showing the turning movements will be necessary to determine the carriageway width for each directions of flow.

4. ESTIMATION OF TRAFFIC GROWTH

4.1. Factors Governing Traffic Growth

Traffic growth is governed by a number of factors such as:

Economic

1. Gross National Product (GNP) or Gross Domestic Product (GDP)
2. Agricultural Output
3. Industrial Output

Demographic

4. Population
5. Rural/Urban mix of population

Since the above economic indicators vary widely across the country, traffic growth rate varies from State to State, and within a State from region to region. Traffic growth rate has to be established for each location by giving due considerations to the above factors.

4.2. Determination of Past Trends

Past trend of traffic growth is a valuable guide in determining the future trend. Past trends can be established from a variety of traffic growth indicators such as:

1. Traffic flow from census
2. Vehicle registration
3. Fuel sales

A comparison of the growth rates for each of the above will be useful.

For establishing reliable growth rates, the data should be for a number of years. The analysis can then be done for the entire period, and also for blocks of 5 years.

The best way to arrive at the rate of growth is through a regression analysis. The formula expressing the compound rate of growth of traffic is:

$$P_n = P_o(1+r)^n$$

Where P_n = Traffic in the n_{th} year
P_o = Traffic flow in the base year
n = number of years
r = annual rate of growth of traffic, expressed in decimals. Taking logs on both sides,

$$\text{Log}_e P_n = \log_e P_o + n \log_e (1+r)$$
$$Y = A_o + A_1 n$$

Where Y = $\text{Log}_e P_n$, $A_o = \text{Log}_e P_o$ and $P_o = {}_eA_o$
A_1 = $\text{Log}_e (1+r)$, and $(1+r) = {}_eA_1$

The above equation can be established from a data set of n values.

The following example gives the procedure.

The 10 - year data on traffic flow at a census point is given below. Calculate the annual rate of growth.

Year	Traffic (PCUs/day)
1983	6,250
1984	6,720
1985	7,650
1986	8,250
1987	9,320
1988	10,000
1989	11,300
1990	12,200
1991	13,200
1992	14,900

The data is retabulated as under:-

Year	n	P	$\text{Log}_e P (=Y)$
1983	0	6,250	8.74
1984	1	6,720	8.81
1985	2	7,650	8.94
1986	3	8,250	9.02
1987	4	9,320	9.14
1988	5	10,000	9.21
1989	6	11,300	9.33
1990	7	12,200	9.41
1991	8	13,200	9.49
1992	9	14,900	9.61

The regression fit obtained from computer or by manual method to the above data is $\underline{P} = 6228\ (1.101)^n$.

Thus $r = 10.1$ per cent

4.3. Extrapolation from Past Trends

One of the methods of estimation of future rate of growth is to assume the same rate of growth as in the past. This may be all right for short-term projects, say 5-10 years. But, for long-term projections, it would be erroneous to assume that the past rate of growth will prevail for a long time in the future. Economic conditions are bound to change over a long period, and it would be necessary to modify the rate of growth accordingly. Subjective assessments in this regard will have to be cautiously done.

4.4. Econometric Models

If the past data is available on traffic for a number of years and the corresponding data on some economic indicator such as GNP is also available, then the data can yield an econometric model of the following type:

$$\text{Log}_e P = Ao + A_1 \text{Log}_e GNP$$

where P = Traffic Volume

GNP = Gross National Product

Ao = Regression Constant

A_1 = Regression Coefficient

The value of A_1 is known as the Elasticity Coefficient. The Elasticity Coefficient is the factor by which the GNP growth rate has to be multiplied to arrive at the growth rate of traffic.

The following example illustrates how this analysis is carried out.

The time series data on Traffic Volume at a certain location and the corresponding data on GDP of the region are given in the following table. The GDP is expected to grow at a rate of 5 per cent during 1995-2005 and at 6 per cent during 2005-2015. Determine the possible rate of growth of traffic during 1995-2005 and 2005-2015.

Year	Traffic (PCUs/day)	GDP at constant prices (Rs. crores)
1985	6,250	49,500
1986	6,550	51,200
1987	7,000	52,850
1988	7,250	54,275
1989	7,650	56,000
1990	8,000	57,500
1991	8,500	59,450
1992	8,850	61,000
1993	9,350	64,000
1994	9,900	65,300

The data is retabulated as under:

Year	Traffic (P)	$Log_e P$	GDP	Log_e GDP
1985	10,000	9.21034	49,500	10.80973
1986	10,590	9.267665	51,200	10.84349
1987	11,210	9.324562	52,850	10.87521
1988	11,920	9.385973	54,275	10.90182
1989	12,640	9.444622	56,000	10.93311
1990	13,380	9.501516	57,500	10.95954
1991	14,200	9.560997	59,450	10.99289
1992	15,020	9.617138	61,000	11.01863
1993	15,980	9.679093	64,000	11.06664
1994	16,900	9.735069	65,300	11.08675

The regression equation obtained either through computer or manual method is

$$Log_e P = -11.3038 + 1.8976 Log_e GDP$$

This shows that the Elasticity Coefficient is 1.8976

Traffic growth rate in 1995-2005

= 1.8976 X Rate of growth of GDP
= 1.8976 X 5
= 9.49 per cent

Traffic growth rate in 2005-2015

= 1.8976 X 6
= 11.39 per cent

4.5. Modifications to Forecasts

Traffic forecasts have to be modified to take into account possible traffic diversions and generated traffic.

Traffic diversions include traffic that is likely to be diverted to the facility from other highway or railway or similar transport corridors, and also traffic likely to be diverted from the facility to other transport corridors.

Generated traffic is that which comes into being because of the construction of the new facility and the attractiveness of the new facility. This traffic would not have materialised had the facility not been built.

5. DESIGN PERIOD

5.1. Stage Construction

In India, roads are built on a stage construction principle due to lack of resources. In such cases, the design period can be 5-10 years. For large projects, where the construction is done in one stage, the design period can be 15-20 years. Traffic projections are done accordingly.

While projecting traffic, it may so happen that the projected volume exceeds the capacity. The capacity itself is calculated from hourly maximum value and using the value of ratio of the peak-hourly traffic to the daily traffic. While traffic cannot exceed the peak hourly value, the peak period itself may get extended in duration. This has to be kept in view and the traffic volume restricted to a reasonable value of daily traffic.