Indian Roads Congress
Special Publication 38

MANUAL FOR ROAD INVESTMENT DECISION MODEL

NEW DELHI 1992

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FOREWORD

Highway improvement programmes are assuming increasing importance in view of the fast growing road transport needs of the country. However, as resources are scarce it is essential that the projects should be economically justifiable. In this context, economic evaluation has become a handy tool for making correct investment decisions.

Indian Roads Congress had published in 1984 a Manual on Economic Evaluation of Highway Projects in India. This enabled the highway engineers to carry out economic analysis of road improvement projects in a scientific manner. The analysis of different options with this procedure by manual calculations is however, a time consuming task, due to which the technique has not been used to its full advantage. The computer model now developed overcomes this difficulty and enables quick detailed analysis of various alternatives.

The Manual for Road Investment Decision Model is the first Computer based manual published by the Indian Roads Congress. A programmed floppy which is enclosed with this manual will help the user to make use of computer for economic analysis. The model is very easy to use and caters to the requirements for analysing alternative proposals, evaluating alternate strategies and ranking schemes in order of priority.

The Manual fulfills a long felt need and its widespread use by highway engineers will have a beneficial effect on planning and preparation of highway projects in India.

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1. THE RIDM

1.1. Introduction

1.1.1. The Road Investment Decision Model (RIDM Version-1) is a computer based model designed to carry out economic evaluation of highway projects in accordance with the procedure described in the IRC Special Publication-30 "Manual on Economic Evaluation of Highway Projects in India" with modifications as described in para 1.2. Economic analysis involves quantification of the total transportation cost components for alternative strategies for road improvement and evaluating each of them against the "do nothing" alternative. Proper analysis of various options by manual calculations is a time consuming task, which makes it difficult to use the technique to full advantage manually. The computer model overcomes this shortcoming and enables detailed analysis of possible combinations of alternatives quickly. The Model has been developed using Lotus 1-2-3 Software and its advanced macro programming features. It has been tested and applied on a number of major national highway projects pertaining to widening, strengthening, construction of bypasses etc.

1.1.2. This publication is a user Manual for RIDM and describes the procedure for running the model based on the floppy disk which is enclosed with the Manual.

1.1.3. The Computerisation Committee of the Indian Roads Congress (personnel given below) in their meeting held at New Delhi, on the 6th February 1990, discussed the Package on Economic Analysis developed by the Ministry of Surface Transport and set up a working group comprising Dr. L.R. Kadiyali, S/Shri J.B. Mathur and M.K. Saxena to finalise the same. The draft as finalised by the Group, was placed before the Highways Specifications & Standards Committee in their meeting held on the 30th October, 1990. In light of the comments offered by the Members of Highways Specifications & Standards Committee during the meeting, the draft was further modified by S/Shri S.C.Sharma, M.K.Bhalla and J.B. Mathur.

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1.1.4. The modified draft was subsequently considered and approved by the Executive Committee in their meeting held on the18th November, 1990. Thereafter, the draft was taken up for discussion by the Council in their meeting held on the 8th December, 1990. The Council authorised the Convenor of Highways Specifications & Standards Committee to do the necessary modifications based on comments received. Accordingly the draft was finally modified by the Convenor, Highways Specifications and Standards Committee for printing as one of the IRC Publications

1.2. Modifications in IRC:SP:30-1984 'Manual on Economic Evaluation of Highway Projects in India'

The following modifications have been incorporated in the model:

(i) The IRC Special Publication-30 specifies the design service volumes for various pavement widths in terms of vehicles per day, whereas this Model considers the design service volumes in terms of Passenger Car Units (PCU) per day, in line with the revised IRC standard IRC:64-1990 'Guidelines on Capacity of Roads in Rural Areas'(First Revision)

(ii) The Speed-volume relationships given in Table 2 of IRC:SP:30-1984, which relate the speed and the hourly volume in terms of number of vehicles, have not been used in the model as new Speed- flow equations have become available through a recent research study *(Ref. 4)*. The new Speed-flow equations, which relate the speed and traffic volume in terms of PCU/hr. have been incorporated in the model. The equations are given in Table 1.

1.3. Capabilities and Applications of the Model

The RIDM carries out economic evaluation of highway schemes at project level for road investment decision making. Its major capabilities and applications are:-

(i) The model is very easy to use and adequately caters to the requirements of highway organisations for analysing alternative proposals to select the best option from a number of alternatives at project level. It is fully interactive for specifying input data and retrieval of results in proper report forms. The model

takes 4 to 5 minutes to load the programme, retrieve input data file and analyse a pair of alternatives and generate output reports.

(ii) The model can evaluate alternative strategies such as stage construction or full construction alternative specifications for carriageway width, pavement structure etc.

(iii) It can be used to rank schemes in order of priority.

(iv) The model can also analyse the sensitivity of the result to changes in unit prices of resources, traffic growth rate and design parameters.

(v) With a slight modification in the programme, the Model can also be used to generate vehicle operating cost tables.

1.4. Basic Relationships Incorporated into the Model

1.4.1. The model considers the following three cost components which constitute the total transportation cost:

(i) Construction cost
(ii) Maintenance cost
(iii) Road user cost

The road user cost is composed of vehicle operating cost (VOC), travel time cost and accident cost.

1.4.2. The construction cost and maintenance cost are specified by the user directly whereas the vehicle operating cost and travel time cost are calculated by the model endogeneously using the VOC equations and Speed-flow relationships.

1.4.3. The construction cost and maintenance cost of the facility are specified by the user in financial terms. The financial costs are converted into economic costs using the following relationship:

ECONOMIC COST = ECF * FINANCIAL COST

where:

ECF = Economic cost conversion factor.

A default value of 0.8 has been adopted for ECF. The user can specify a different value for ECF while feeding input data.

1.4.4. **Vehicle Operating Cost :** The vehicle operating cost relationship for cars, buses, and trucks formulated on the basis of the Road User Cost Study and used for preparing VOC Tables in IRC:SP:30- 1984, have been built into the model. The fuel consumption equations have been slightly modified to consider

the effect of road profile in terms of combined rise and fall (absolute values) instead of specifying rise and fall separately. The modified fuel consumption equations incorporated in the model are given in ***Appendix-1.*** The modification does not introduce any variation in fuel consumption values. A fixed value of 0.02 Rs/Km (at 1984 prices) is taken as lubricant cost for operation of a car in all conditions.

The model using the VOC equations predicts physical quantities of the resources consumed by cars, buses & trucks. These quntities are then multiplied by the unit prices of the consumables as specified by the user to give VOC. For two wheelers VOC is taken as 20 per cent of VOC of cars.

1.4.5. **Congestion effect :** When traffic volume exceeds the design service volume (para 1.4.8.), the vehicles are subjected to congestion effect resulting in higher VOC as compared to steady state conditions. To account for this the following congestion factors are used in the model:

VEHICLE	FACTOR
Cars	1.64
Buses	1.28
Trucks	1.31

In case of congestion the calculated values of the components for fuel, tyre, lubricants, spare parts and maintenance labour are increased by multiplying these values with the above factors.

1.4.6. **Speed volume relationships :** The Model calculates speeds of the vehicles for quantifying travel time savings using speed-flow equations for cars, buses, trucks and two-wheelers for operation on single lane, intermediate lane, two-lane, and four-lane wide paved roads in plain, rolling and hilly terrain. The speed-flow equations are given in Table 1. If the calculated speed for any category of vehicle is less than 10 km/hr, a minimum cutoff value of 10 km/hr is assigned for determining the travel time savings.

TABLE 1. SPEED- FLOW EQUATIONS

Road Type	Plain terrain	Rolling terrain	Hilly terrain
Single lane	Vc =49.98 - 0.041Q Vt =42.45 - 0.024Q Vb =46.92 - 0.032Q Vtw =42.98 - 0.035Q	Vc =47.48 - 0.039Q Vt =40.33 - 0.023Q Vb =43.63 - 0.030Q Vtw =40.83 - 0.033Q	Vc =41.48 - 0.034Q Vt =32.69 - 0.018Q Vb =35.66 - 0.024Q Vtw =36.96 - 0.030Q
Intermediate lane	Vc =64.04 - 0.020Q Vt =51.05 - 0.010Q Vb =58.85 - 0.017Q Vtw =53.10 - 0.017Q	Vc =60.84 - 0.019Q Vt =48.50 - 0.010Q Vb =55.32 - 0.016Q Vtw =55.97 - 0.017Q	Vc =53.79 - 0.017Q Vt =39.82 - 0.008Q Vb =45.31 - 0.013Q Vtw =49.49 - 0.016Q
Two lane	Vc =67.96 - 0.012Q Vt =58.96 - 0.008Q Vb =66.79 - 0.013Q Vtw =51.58 - 0.007Q	Vc =65.24 - 0.011Q Vt =56.01 - 0.008Q Vb =62.78 - 0.012Q Vtw =49.52 - 0.007Q	Vc =57.77 - 0.010Q Vt =46.58 - 0.006Q Vb =52.76 - 0.010Q Vtw =40.75 - 0.006Q
Four lane (Divided carriageway)	Vc =68.73 - 0.0049Q Vt =63.25 - 0.0047Q Vb =74.48 - 0.0042Q Vtw =57.21 - 0.0062Q	Vc =65.98 - 0.0049Q Vt =60.09 - 0.0045Q Vb =70.01 - 0.0039Q Vtw =54.92 - 0.0059Q	Vc =58.42 - 0.0042Q Vt =49.97 - 0.0037Q Vb =58.84 - 0.0033Q Vtw =48.63 - 0.0053Q

where :

Q = volume of traffic in PCU/hour = 0.10 PCU/day
Vc = speed of cars in km/hour
Vt = speed of trucks in km/hour
Vb = speed of buses in km/hour
Vtw = speed of two wheelers in km/hour

1.4.7. **Accident cost:** Accident costs are not calculated endogeneously but can be specified directly by the user by combining them with other cost parameters if required.

1.4.8. **Design service volume:** The design service volumes for the existing road (ALT 1) and the proposed facility (ALT 2) are to be defined by the user as input parameters. The design service volumes for both the alternatives are to be chosen carefully duly taking into account various factors such as pavement width, shoulder width, type of terrain, curvature etc. To assist the user to select the design service volume a built in help facility has been provided in the model. The help facility displays the recommended design service volumes as per the IRC 'Guidelines for Capacity of Roads in Rural Areas' **Table 2.** The help facility can be invoked by pressing the following keys in the given sequence:

Press 'Home' key
Press 'Enter' key
Press 'Alt and H' keys together
To revert to data input format press 'Alt and I' keys together.

TABLE 2. RECOMMENDED DESIGN SERVICE VOLUMES (DSV) IN PCU/DAY

Terrain	Plain		Rolling		Hilly	
Curvature	low *	high **	low *	high **	Low *	high **
Width						
Single Lane	2000	1900	1800	1700	1600	1400
Inter. Lane	6000	5800	5700	5600	5200	4500
Two Lane	15000	12500	11000	10000	7000	5000
Four Lane	35000		25000		16000	

	Plain	Rolling	Hilly
* low curvature (degrees per km)	<=50	<=100	<=200
**high curvature (degrees per km)	>50	>100	>200
Terrain (Rise + Fall metre per km)	0 - 15	15 - 30	30 - 50

Notes :

Single -Lane Roads

(1) Above values are applicable for paved carriageways with good quality shoulder of minimum 1 m width on either side. When the pavement is not black topped the DSV may be lowered by 20 to 30 per cent

(2) In case of low quality shoulders (earthen shoulders of plastic soil) DSV should be taken as 50 per cent of the value given above.

Two-Lane Roads

(1) In case of paved and surfaced shoulders of at least 1.5 m width on either side, the DSV can be increased by 15 per cent.

(2) In case of restricted lane width or restricted shoulder width apply the following capacity reduction factors to the values given in Table 2.

Capacity Reduction Factors Suggested for Substandard Lane and Shoulder Width on Two-lane Roads

Usable Shoulder* width	3.50 m lane	3.25 m lane	3.00 m lane
=> 1.8	1.00	0.92	0.84
=> 1.2	0.92	0.85	0.77
= > 0.6	0.81	0.75	0.68
=> 0.0	0.70	0.64	0.58

*Usable shoulder width refers to well maintained earth/moorum/gravel shoulder which can safely permit occasional passage of vehicles

Four-Lane Divided Roads

(1) The values relate to 4-lane divided carriageway roads with no control of access.

(2) In case well designed paved shoulders of 1.5 metre width are provided the DSV of four-lane dual carriageway road can be taken upto 40000 PCUs in plain terrain

1.4.9. **Traffic projections:** These are made using the following equation:

$$PT = LT (1+r/100)$$

where:
LT = number of vehicles in year n
PT = number of vehicles in year n+1
r = annual growth rate in per cent

For converting the different types of vehicles to 'passenger car unit' the following equivalency factors are used:

Car = 1 , Bus = 3 , Truck = 3 , Two wheeler = 0.5

1.4.10. **Unit cost of resources :**

(1) **Unit price of consumables**: The default values of unit prices of consumables (1984 price level) are taken from IRC:SP-30-1984

(2) **Passenger time value and time value of commodity :** For converting time in monetary terms, the default values for passenger time value and time value of commodity in transit are based on 1984 prices as per IRC:SP-30.-1984

The values adopted for occupancy of cars, two-wheelers and buses are:

Average occupancy of a car	4.8
Average occupancy of a two-wheeler	1.5
Average occupancy of a bus	43

(3) **Updating of prices :**The rates adopted as default values in respect of (1) and (2) above are given in ***Appendix 2.*** These values are required to be updated to current prices. This can be done either by (i) specifying current prices of each resource, or (ii) if current prices of consumables are not known, the 1984 values can be updated by specifying cost update factors for VOC and time values of passenger and commodity.

1.4.11. **Pavement roughness:** The model calculates pavement roughness year wise as follows:

PRG = IRG (If Year = End of construction Year)
= LRG+DRG (Intermediate years with no REN/STG)
= RRG (If Year = Year of REN/STG)

where:
IRG=Initial Roughness in mm/km at the end of construction (user specified)
PRG=Present Roughness in mm/km
LRG=Last year's Roughness in mm/km
RRG=Roughness after Renewal/Strengthening in mm/km (user specified)
DRG=Rate of increase of Roughness in mm/km per year (user specified)

1.5. Structure of the Model

The RIDM is structured in three parts (i) Input (ii) Modelling & Simulation and (iii) Results.

1.5.1. The data input module is arranged in cells A1..G100. This is designed to create the input data file to run the analysis programme. The module is fully interactive and presents a formatted screen giving a list of variables for which values are to be specified by the user to describe road characteristics, terrain, traffic volume, construction and maintenance costs, etc. for the alternatives to be evaluated. The variables and their limits are described in Section 3.

1.5.2. The second part of the model which forms the core module *(Figs. 1 & 2)* is stored in a file named 'ECOCAL.WK1'. This file contains all

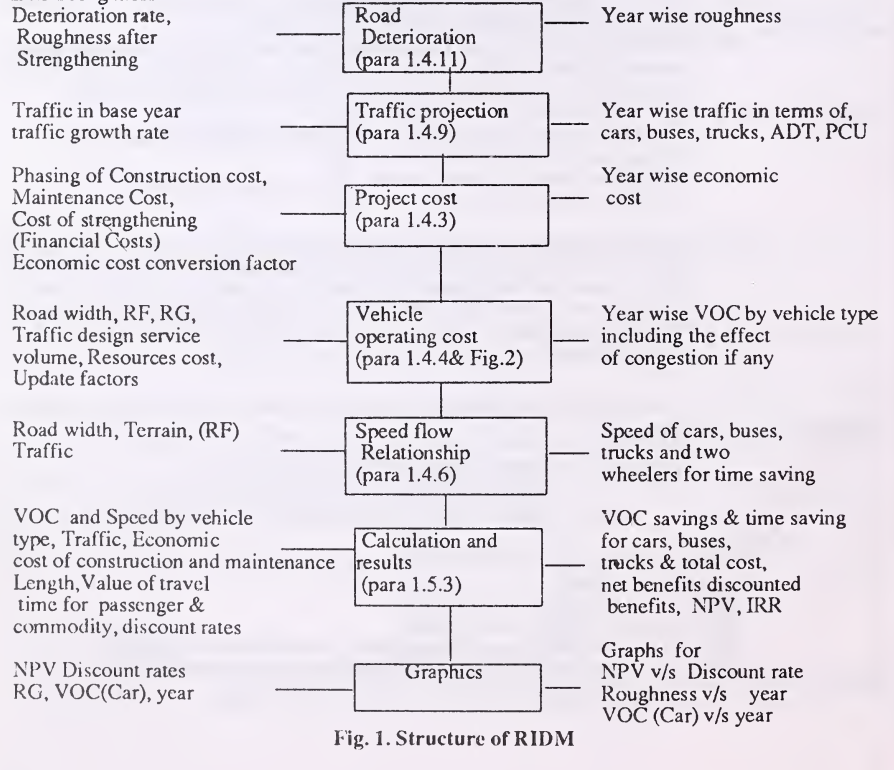


Fig. 1. Structure of RIDM

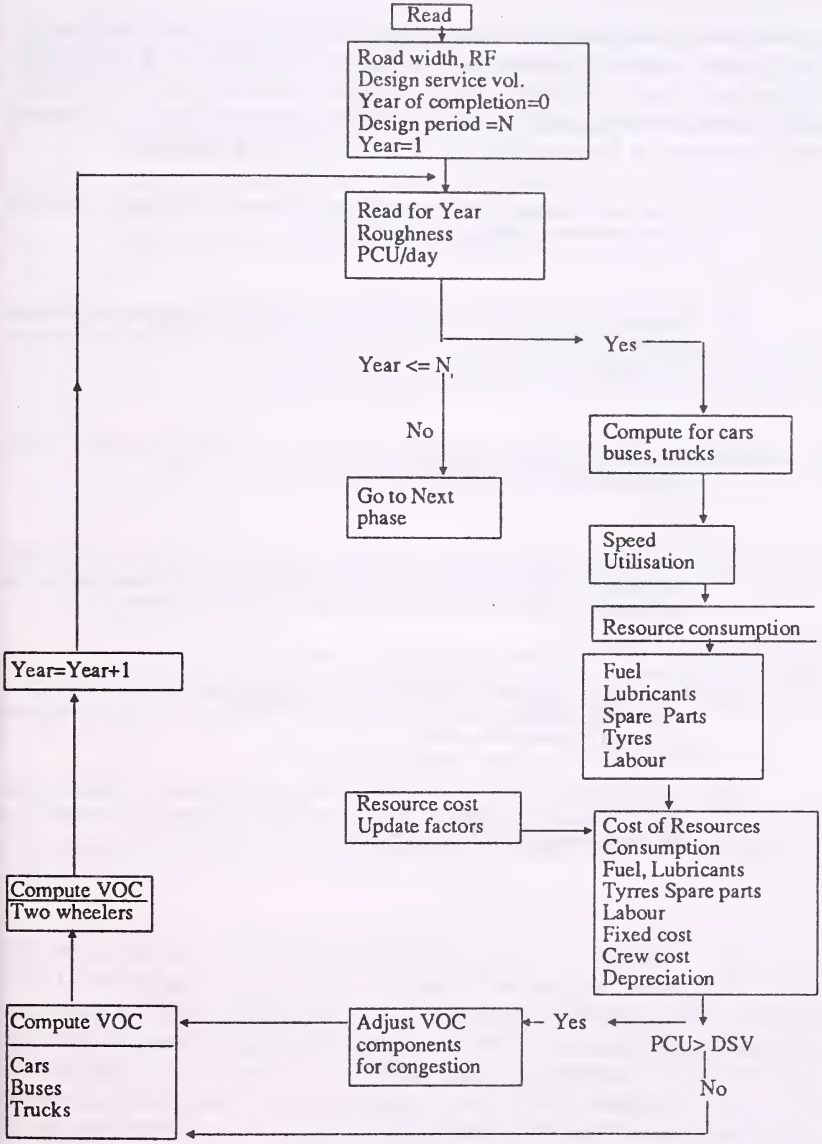


Fig. 2. Flow chart for calculating VOC.

the basic relationships and is password protected to ensure that the formulae are not tampered with. The programme is invoked by pressing 'Alt and P' keys together after defining input data. The model using the various relationships and input values of variables simulates road condition over time and calculates vehicle operating and travel time costs for the two alternatives in the following sequence:

(i) Calculates roughness yearwise on the basis of the pavement deterioration rate and maintenance strategy specified by the user.

(ii) Based on the initial traffic and growth rates, makes traffic projections by vehicle type and calculates average daily traffic and PCU/day for each year over the design period.

(iii) Calculates economic costs of construction and maintenance based on the financial costs given by the user.

(iv) Using VOC relationships, determines physical quantities of resources consumption for cars, buses and trucks for each year of the design period and then calculates VOC on the basis of unit prices of the consumables.

(v) Compares the projected traffic (PCU/day) with the design service volume and if the traffic volume exceeds the design service volume, the VOCs are adjusted to account for congestion effect.

(vi) Selects appropriate speed volume relationships and determines speed of cars, buses, trucks and two wheelers. A minimum speed of 10 km/hr is assigned if the calculated speed is less than 10 km/hr.

1.5.3. **Results :** The reporting module is also stored in the file 'ECOCAL.WK1' and is fully menu driven for retrieving the output reports. In this phase relative costs, benefits, net present value and internal rate of return are computed and reports generated. Construction and Maintenance costs are identified as 'Costs' and VOC savings and time savings as 'Benefits'. For the pair of alternatives to be compared, the model computes year-by-year the costs/benefits of one alternative over the other. From the time stream of net costs/benefits the model then calculates net present values for three different discount rates defined by the user and also computes the internal rate of return. All results are tabulated

and three graphs are generated (i) NPV v/s Discount Rate (ii) Roughness v/s Year and (iii) VOC v/s Year. The reports can be displayed/printed or saved in a file through menu selection. The graphs can also be displayed, saved and printed.

The output reports are described in Section 3.

1.6. Limitations of the Programme

The major limitations of the model are:

(i) Only one pair of alternatives can be compared in each run.

(ii) It is suitable for analysis at project level only. Besides, a road section having sub-sections of different design standards/traffic volume cannot be evaluated as a single link alternative.

(iii) In the absence of pavement deterioration models for Indian conditions, the model makes use of the deterioration rates specified by the user.

(iv) Only four types of vehicles are considered - cars, buses, trucks and two wheelers.

(v) Compilation of the programme is not possible and as such there remains the risk of effecting unauthorised modification in the programme, though this risk is considerably reduced with the core module kept in the password protected file.

2. PROGRAMME INSTALLATION

The RIDM is supplied on a DSDD 5.25 in. floppy. The hardware and software requirements and the procedure to install the programme are described below:

2.1. System Requirement

2.1.1. Hardware:

(i) An IBM compatible PC or PC-XT/ PC-AT system with a minimum installed memory of 640 KB

(ii) Colour or mono-chrome monitor

(iii) A 132 column printer

2.1.2. Software:

MS-DOS version 2.0 or higher
Lotus 1-2-3 (Release 2.0)

2.2. Programme Installation on Hard Disk

Lotus 1-2-3 is required for running the RIDM. Make sure that Lotus 1-2-3 is installed on the hard disk. If it is not installed refer to the Lotus manual for installing the Lotus 1-2-3. It is advisable to install Lotus 1-2-3 in a separate directory. A basic knowledge of DOS is required to install the Lotus programme.

2.2.1. Follow the steps given below to install the RIDM

(i) Switch on the computer. Change to the directory where the lotus files are stored. If these are stored in a directory called LOTUS, change to the directory by typing the following command at the DOS prompt C> followed by Enter

C>CD\LOTUS

(ii) Copy the programme in the directory LOTUS. Place the RIDM disk in drive A: and type the following command for copying the programme to hard disk

C>COPY A:*.WK1

(iii) List the files in the LOTUS directory using the following command and make sure that RIDM.WK1 and ECOCAL.WK1 files are present in the directory

C>DIR

2.3. Programme Back up

It is strongly recommended that you make a backup copy of the RIDM disk before using it and keep the original disk safely.

To make a backup copy, place the original programme disk in drive A: and type the following command:

C>COPY A:*.WK1 B:

Follow the message displayed by the computer. Remove the original disk and insert a blank formatted disk in drive A: on which the programme will be copied.

3. INPUT DATA REQUIREMENTS AND OUTPUT REPORTS

3.1. Data Required For Analysis

The data required to run the programme, together with the input data limits, units and other related comments to facilitate the preparation of the input data in the required form are given in Table 3.

TABLE 3. MAJOR INPUTS TO RIDM

Input Parameter	Units	Limit/Remarks
Project		Give project name Max 45 characters
State		Max 9 characters.
NH		Specify NH number
Section		Max 9 characters (Ex. Km 0-25)
Road Width	Metre	Specify carriageway width in m (Ex.Specify 14m for 4-L divided road with 2x7m carriageway)
Road Length *	km	Specify length of the section to be evaluated. It must have uniform traffic and design standards throughout its length.
Base Year		Year of start of analysis (zero year)
Year of Completion		Construction period upto 5 years can be specified
Design Period	Year	Upto 20 years
Rise and Fall	m/km	Upto 50 m/km
Roughness	mm/km	Specify Roughness at end of construction year.
Increase in Roughness/Yr	mm/km	
OVL/STG year		Year of overlay/ strengthening

Contd.

Roughness after OVL/STG	mm/km	
Base year traffic	Veh/day	For 4 vehicle types cars, buses, trucks, 2-wheelers.
Design Service Volume (DSV)	PCU/day	Built-in help gives recommended values
Traffic Growth Rate	Per cent	Max. 3 growth rates for each type of vehicle
Construction Cost with phasing	Rs lakh	Add cost of maintenance during construction (MDC)
Overlay Cost	Rs lakh	
Annual Maintenance Cost/km		
(i) ORD repairs	Rs lakh/km	Specify cost of ordinary repairs per km per year
(ii) PRD renewal	Rs lakh/km	Specify cost of periodic renewal per km per year based on renewal cycle
Economic Cost Factor		Default value = 0.80
Discount Rate	per cent	Max. 3 rates
Economic Cost of Resources (ECR)	Rs/unit	Default values of ECR are at 1984 prices
Value of Travel Time (VTT)		Default value of VTT are at 1984 prices
VOC Update Factor		Multiplier to update 1984 prices of ECR to base year prices
Time Value Update Factor		
(i) Passenger		Multiplier to update 1984 prices of VTT to base year prices
(ii) Commodity		

* There is no limitation as to the length of the road section (also referred to as link) to be evaluated in each run provided it carries uniform traffic and has uniform design standards (geometrics, pavement structure, maintenance, etc.) throughout its length. In case the road section to be evaluated does not have uniform design standards and uniform traffic throughout its length, it should be divided into uniform sub-sections and separate runs made to evaluate sub-sections.

3.2. Data Input Facility

3.2.1. The data input facility is fully menu driven. On loading the programme the data input menu is displayed, offering the following three options:

DATA FILE QUIT

The '*Data*' option facilitates creation of a new input data file to run the programme. 'Data' option selection will display an input format listing input data variables against which values are entered by the user for both the alternatives. Para 3.2.2. describes the method to enter/edit the data. After entering the data in

the input format, it is saved under a file name following the steps given in para 4.1.

The *'File'* Option facilitates retrieval of an existing input data file to run the programme. If, there is a data file created earlier using the 'Data' option and it is required to run the programme for that data as it is or with some modifications, there is no need to enter the data again. This file could be retrieved by selecting 'File' option and edited if required as per para 3.2.2. and resaved to run the programme following the steps described in para 4.1. *'Quit'* option : terminates the programme and the DOS prompt C> will appear on the screen.

3.2.2. Entering/Editing Input data :

(i) To enter the data move the cursor to the appropriate cell using the arrow keys and type in the data.

(ii) To correct a wrong entry move the cursor to the cell and enter the correct value.

(iii) To make a cell blank move the cursor to that cell and type 0

(iv) The cursor should move within the input format A1..G100 . If it is found that the cursor is moving to cells outside the input format, it can be brought back to the formatted range A1..G100 by pressing 'Alt' key and 'I' key together.

(v) It is not necessary to specify values of the variables marked 'optional' unless their effect is required to be considered.

(vi) The values for Economic cost of resources and travel time displayed in the input format are default values at 1984 prices . If base year prices of these items are available, the new values may be entered by the user. It is required to be ensured that all the values are updated. If the current prices for these items are not available, the prices can be updated by specifying update factors.

3.2.3. A copy of the input format with specimen data for a highway project is given in ***Appendix 2.***

3.3. Output Reports

3.3.1. The model generates five output reports which are described in Table 4. The programme also facilitates display and printing of graphs (i) NPV v/s Discount rate (ii) Roughness v/s Year and (iii) VOC v/s Year.

TABLE 4. OUTPUT REPORTS GENERATED BY RIDM

Report	Record Length	Contents
Input	80	Echo print of Input data
Cost Table	132	Yearwise cost of construction and maintenance
IRR	80	IRR with and without time savings
Result 1 (Without time savings)	315 *	Yearwise traffic, roughness, vehicle operating costs for cars, buses, trucks, 2-wheelers, VOC savings, cost, net benefits, NPV, IRR
Result 2 (With time savings)	335 *	Yearwise traffic, roughness, speeds of cars, buses, trucks and 2-wheelers, time savings, VOC savings, cost, net benefits, NPV, IRR
Graphs		NPV v/s Discount rate Roughness v/s Year VOC v/s Year (for cars only)

* The printer should be set to 'condensed' mode for printing Result 1 and Result 2 reports.

3.3.2. **Output Reports Retrieval :** This part of the programme is also fully menu driven, which permits the user to see results, print results or save results in a file by selecting the desired option. As soon as the computations are completed, main menu appears on the control panel with the description of the task, to be performed appearing in the second line of the menu. It asks the user to select whether he wants reports on screen or printer or wants to save results in a file. On making the choice, the Level 2 menu appears which permits displaying, printing or saving of the desired report. The Screen menu and the File menu also offer the option for displaying and saving graphs. With the selection of Graph option, Level 3 menu appears which permits viewing/saving of the desired graph.

The menu structure is described below:

Level 1 Main menu
Screen Printer File Quit

Level 2 Screen menu
Input Cost Tbl IRR Result 1 Result 2 Graph Quit

Level 2 Print menu
Input Cost Tbl Result 1 Result 2 Quit

Level 2 File menu
Input Cost Tbl Result 1 Result 2 Graph Quit

Level 3 Graph menu
NPV Roughness VOC Quit

A menu option can be selected by highlighting the appropriate item using the arrow keys and pressing the 'Enter' key. The selected menu will reappear after completing the task except when the 'Screen' menu or 'Graph' menu are chosen. The Screen menu can again be displayed by pressing 'Alt and M' keys together. The Graph menu can be displayed by pressing 'Enter' key after viewing the graph.

File menu option facilitates the user to save the output reports in ASCII files. The names of the ASCII files are to be specified by the user. In case no extension is specified by the user default extension PRN is provided. The procedure to save and print the graphs is explained in the Sample run.

4. PROCEDURE TO RUN THE PROGRAMME

4.1. Running RIDM on PC-AT/PC -XT

Step 1: Switch on the Computer

Step 2: Change to the directory where Lotus 1-2-3 and RIDM are installed by typing the command given below. '(dir)' stands for the name of the directory where RIDM is installed.

C>CD\(DIR)

Step 3: Load lotus 1-2-3 with the following command.

C>123

Step 4: Retrieve the RIDM.WK1 file Press the keys in the following sequence to retrieve the RIDM file.

Key	Explanation
	Press slash (/) to call menu

F	Press F to select File option
R	Press R to select Retrieve option

Enter RIDM as file name and press Enter key

Step 5: An introductory message will appear on the screen with a menu giving option 'Data' 'File' 'Quit'.

Data option : Select Data option to create an input data file.. In about a minute the input format will be displayed on the screen. Type in the input data for both the alternatives. After entering the data press 'Home' key followed by 'Enter' key and go to step 6.

File option : If you already have a data file created earlier for the project to be evaluated, Select 'File' option to retrieve the existing input data file. The model will ask for the file name. Type name of the file in which the input data was saved and press 'Enter'. The saved data will appear on the screen and can be edited to modify the input data. After viewing/editing press 'Home' key followed by 'Enter' key and go to step 6.

Quit option : To leave the programme without creating input file select 'quit' option. DOS prompt C> will be displayed.

Step 6: Hold down 'Alt' key and press 'P' to save the input file and to process further. A menu with the following structure will appear on the control panel .

Option	Description
Save	To save data in a new file.
Resave	To overwrite the existing data file.
No save	Do not want to save input data.

Select appropriate menu. On selecting Save/Resave the model will ask for a file name to save/resave the input data. Type a new/existing file name (maximum 8 characters) without any extension. Extension WK1 will be automatically provided. Press 'Enter' key.

No save : If it is not required to save the data, select 'No save' option. It will skip the step of saving and go to the next step.

Step 7: Next menu providing option 'Continue' 'Stop' will appear . Select 'Continue' option to carry out analysis. A 'wait' message will remain on the screen till the analysis is completed. Select 'Stop' option to leave the programme without carrying out analysis.

Step 8 : After the analysis is completed, 'Main' menu will appear at the control panel through which desired reports can be displayed, printed or saved following the steps for retrieving the reports as described in para 3.3.2.

Step 9 : To leave the RIDM select 'Quit' at each level menu. Confirm by pressing 'Y' when you are provided with the option "Yes/No". DOS prompt C> will appear on the screen.

4.2. Running RIDM on PC

Step 1: Switch on the computer.

Step 2: Boot the system using DOS disk in drive A:

Step 3: Insert Lotus 1-2-3 floppy in drive A: and load the lotus 1-2-3 programme with the following command:

A>123

Step 4: Change the default directory to B: using the following keys in the given sequence.

Key	Explanation
/	Press slash (/) to call Menu
F	Press F to select File option
D	Press D to select Directory Option

Type B: to select B: as current drive, Press Enter key.

Step 5: Insert RIDM floppy in drive B: and retrieve the RIDM.WK1 file following the step 4 of para 4.1. above.

Step 6: An introductory message will appear on the screen with a menu giving options 'Data' 'File' 'Quit'.

Data option : Select 'Data' option to create an input data file and follow the procedure explained under 'Data option' in step 5 of para 4.1.

File option : If you have a data file created earlier in the disk placed in drive B: and want to run the programme for that data as it is or with some modifications, you need not enter data again. The input file can be retrieved/edited as per the procedure explained under File option in step 5 of Para 4.1 .

Quit option : Refer to step 5 of para 4.1.

Step 7: Refer to step 6 of para 4.1. and follow the procedure explained therein.

Step 8: Refer to step 7 of para 4.1.

Step 9: After the analysis is completed , 'Main' menu will appear at the control panel through which desired reports can be displayed, printed or saved following the steps for retrieving the reports as described in para 3.3.2. For saving the output reports after selecting 'File' menu remove the RIDM disk and insert in drive B: a blank formatted disk on which output reports will be saved.

Step10: To leave the RIDM select 'quit' at each level menu. Confirm by pressing 'Y' when provided with the option "Yes/No". DOS prompt C> will appear on the screen.

5. SAMPLE RUN

5.1. Project

It is proposed to widen the existing two lane section from Km 0 to 19 of NH 4 in Andhra Pradesh to four-lane divided carriageway. Carry out economic analysis of the project. The data for the existing road and for the proposed improvement are given below.

Description	Existing Road	Four Lane Proposal
Road Width	7.00 m	14.00 m
Length	19 km	19 km
Base Year	1990	1990
Year of Completion		1995
Design Period		15 years
Rise Fall	5 m/ km	5 m/km
Roughness	4000 mm/km	2000 mm/km
Rate of increase of RG /Year	200 mm/km	67 mm/km
Design Service Volume	15,000 PCU/day	35,000 PCU/day

Traffic:

Vehicle	Number /day (Both ways)	Growth rate upto 1995	Growth rate beyond 1995
Cars	1135	7.9%	7.9%
Buses	695	6.3%	6.3%
Trucks	3365	9.0%	8.6%
Two wheelers	1695	9.9%	9.1%

Phasing of Construction Cost * (Rs Lakh)

Year	Construction Cost
1990 -	27.00
1991 -	95.10
1992 -	460.90
1993 -	476.10
1994 -	476.10
1995 -	380.80

*includes cost of maintenance during construction.

Annual Maintenance Cost

	Existing Road Rs lakh/km	Four Lane Proposal Rs lakh/km
Cost of Ordinary Repairs	0.15	0.25
Cost of Periodic Renewals	0.40	0.80

Periodic Repair Commencement Year	1990	2000
Discount rate 1	10%	
Discount rate 2	20%	
Discount rate 3	40%	

Update Factors :

VOC	1.59
Time saving (Passenger)	1.59
Time saving (Commodity)	1.59

Output reports required are:

View on the screen all the output reports generated and print the following reports:

(i) A print out of the Input data.

(ii) Detailed report including VOC tables giving IRR without time savings.

(iii) Detailed report including speeds of vehicles giving IRR with time savings.

(iv) Print out of Graphs for NPV v/s Discount rate, Roughness v/s year, VOC (Car) v/s year.

5.2 . Running the Programme

Assuming that the RIDM is installed on PC XT

Step 1: Follow step 1 to step 4 of para 4.1. to retrieve RIDM file.

Step 2: Select 'Data' option to create input data file.

Step 3: Move the cursor to the appropriate cell using the arrow keys and enter the data of existing road under ALT1 and of the proposed improvement under ALT2.

Make the following entries:

Description	Cell	Enter
PROJECT	B3	Widening to four lanes
STATE	B4	AP
NH	D4	04
SECTION	F4	KM 0-19
ROAD WIDTH	D8	7.00
	F8	14.00
LENGTH	D9	19.00
	F 9	19.00
BASE YEAR	D10	1990
YEAR OF COMPLETION	F1 1	1995
DESIGN PERIOD YEARS	F12	15
RISE & FALL M/KM	D13	5.00
	F13	5.00
INITIAL ROUGHNESS MM/KM	D14	4000
	F14	2000
INCREASE IN RG /YEAR	D15	200
	F15	67
CARS/DAY IN BASE YEAR	D24 & F24	1135
BUSES/DAY IN BASE YEAR	D25 & F25	695
TRUCKS/DAY IN BASE YEAR	D26 & F26	3365
TWO WHEELERS/DAY IN BASE YEAR	D27 & F27	1695
DESIGN SERVICE VOLUME	D28	15000
	F28	35000
% GROWTH RATE UPTO	F30	1995
GROWTH RATE CARS %	D32 & F32	7.90
GROWTH RATE BUSES %	D33 & F33	6.30
GROWTH RATE TRUCKS %	D34 & F34	9.00
GROWTH RATE TW %	D35 & F35	9.90
GROWTH RAT E Upto %	F37	2010
GROWTH RATE CARS %	D39 & F39	7.90
GROWTH RATE BUSES %	D40 & F40	6.30
GROWTH RATE TRUCKS %	D41 & F41	8.60
GROWTH RATE TW %	D42 & F42	9.10
CONSTRUCTION+MDC COST IN BASE YR	F53	27.35
CONSTRUCTION+MDC COST IN FIRST YR	F54	95.10
CONSTRUCTION+MDC COST IN SECOND YR	F55	460.90
CONSTRUCTION+MDC COST IN THIRD YR	F56	476.10
CONSTRUCTION+MDC COST IN FOURTH YR	F57	476.10
CONSTRUCTION+MDC COST IN FIFTH YR	F58	380.80
COST OF ORDINARY REPAIRS /KM/YEAR	D63	0.15
	F63	0.25

contd.

COST OF PERIODIC RENEWALS/KM/YEAR	D64	0.40
	F64	0.80
PERIODIC RENEWAL COMMENCEMENT	D65	1990
YEAR	F65	2000
DISCOUNT RATE	D67	10
	D68	20
	D69	40
UPDATE FACTORS		
VOC	D97 &F97	1.59
TIME SAVINGS(PASSENGER)	D98 &F98	1.59
TIME SAVINGS(COMMODITY)	D99 &F99	1.59

Press 'Home' key followed by 'Enter' key.

Step 4: To save the input file and carry out analysis hold down 'Alt' key and press 'P'

Step 5: Select 'Save '.Type PROJECT as file name when computer prompts 'Enter file name :' Press Enter key.

Step 6: Select 'Continue ' to carry out analysis. After a wait message 'Main menu' will appear on the screen.

Step 7: **Viewing the Results:**

Select 'Screen'. Screen menu will appear on the control panel.

Select 'Input'. Input data will be displayed on the screen .

Use arrow keys to browse through the data.

Hold down 'Alt' key and press 'M' to call back 'Screen' menu.

Repeat the process to browse through other reports.

On selecting 'Graph' further sub menu will appear . Make selection to view the desired graph on the screen .

Press Enter key to call 'Graph' menu back.

Select 'Quit' to go to 'Screen' menu.

Select 'Quit' to go to 'Main' menu

Step 8: **Printing Reports :**

Select 'Print' option from the 'Main' menu.

Select 'Input' from the 'Print' menu for printing input data.

After printing data 'Print' menu re-appears .

(Print out at *Appendix 2*)

Select 'Result 1' to print detailed report and IRR without time savings

After printing Result 1 'Print menu' re-appears. Select 'Result 2'

to print detailed report and IRR with time savings

(Print outs at *Appendices 3 & 4)*

Leave print menu by selecting 'Quit'

Step 9: Printing Graph :

For printing graphs it is necessary that the Printgraph utility is already installed on your computer. Printing of a graph requires saving of the graph in a file .

(1) Saving the Graph in a File :

Select 'File' from the 'Main' menu.

Select 'Graph' from the 'File' menu

Select 'NPV' from the 'Graph' menu

Graph for NPV v/s Discount rate will appear on the screen press 'Enter'.

Type NPV as file name when the computer prompts for file name. Press 'Enter'. 'File' menu will re-appear.

Repeat the above procedure and save the other graphs for Roughness v/s year and VOC (Car) v/s year in two separate files with names RG and VOC respectively.

Select 'Quit' to go to 'Main menu'

Select 'Quit' to leave RIDM . Press 'Y' to confirm.

(2) Printing Graph :

Type 'Pgraph' on C>

Select 'Image select' option.

Select 'NPV' from the list of graph files displayed by the computer.

Select 'Go' to print the graph.

Repeat the procedure to print the other two graphs

(Print outs at ***Appendices 5, 6 & 7)***

Select 'Exit' to leave this session after printing the graph

REFERENCES

(1) Central Road Research Institute(CRRI): Road User Cost Study in India, Final Report, New Delhi, India, 1982

(2) Indian Roads Congress (IRC) : Special Publication -30 , 'Manual on Economic Evaluation of Highway Projects in India', New Delhi, India, 1984

(3) Indian Roads Congress: 64-1990 'Guidelines for Capacity of Roads in Rural Areas', New Delhi.

(4) Updating of Road User Cost Study (Draft Report), 1990.

FUEL CONSUMPTION EQUATIONS AS PER RUCS

CAR $FC = 16.91 + 2748.85/V + 0.0218V^2 + 0.00098\ RG + 2.28\ RS - 1.69\ FL$

BUS $FC = 42.20 + 4997.94/V + 0.0265V^2 + 0.00154\ RG + 4.26\ RS - 2.2744\ FL$

TRUCKS $FC = 57.74 + 5115.08/V + 0.0271V^2 + 0.0016\ RG + 4.3598\ RS - 2.3277\ FL$

Modified Equations as used in the Model

CAR $FC = 16.91 + 2748.85/V + 0.0218V^2 + 0.00098\ RG + 0.273\ RF$

BUS $FC = 42.20 + 4997.94/V + 0.0265V^2 + 0.00154\ RG + RF$

TRUCKS $FC = 57.74 + 5115.08/V + 0.0271V^2 + 0.0016\ RG + 1.01\ RF$

V -Speed of vehicle in Kmph

RS -Rise in m/km

FL -Fall in m/km

RG -Roughness in mm/km

RF -Combined (Rise + Fall) in m/km

INPUT FORMAT WITH SPECIMEN DATA

HIGHWAY ECONOMIC ANALYSIS 01/01/80

PROJECT WIDENING TO FOUR LANE
STATE-- ANDHRA PRADESH NH4 SECTION KM 0-19

DISCRIPTION	ALT 1	ALT 2
ROAD WIDTH	7.00	14.00
LENGTH	19.00	19.00
BASE YEAR	1990	
YEAR OF COMPLETION		1995
DESIGN PERIOD YEARS		15
RISE AND FALL M/KM	5.00	5.00
INITIAL ROUGHNESS MM/KM	4000	2000
INCREASE IN RG/YR MM/KM	200	67
YEAR OF OVL/STG 1 (O)		
YEAR OF OVL/STG 2 (O)		
YEAR OF OVL/STG 3 (O)		
YEAR OF OVL/STG 4 (O)		
RG AFTER OVL/STG 1 MM/KM(O)		
RG AFTER OVL/STG 2 MM/KM(O)		
RG AFTER OVL/STG 3 MM/KM(O)		
RG AFTER OVL/STG 4 MM/KM(O)		
CARS/DAY IN BASE YEAR	1135	1135
BUSES/DAY IN BASE YEAR	695	695
TRUCKS/DAY IN BASE YEAR	3365	3365
2-WHEELERS/DAY IN BASE YEAR	1695	1695
DESIGN SERVICE VOL(PCU/DAY)*	15000	35000
* (For Help Press Enter, Alt-H)		
PERCENTAGE GROWTH RATE UP TO YEAR (GIVE YEAR)		**1995**
GROWTH RATE CARS %	7.90	7.90
GROWTH RATE BUSES %	6.30	6.30
GROWTH RATE TRUCKS %	9.00	9.00
GROWTH RATE TWO WHEELERS %	9.90	9.90
PERCENTAGE GROWTH RATE UPTO YEAR (GIVE YEAR) (O) 2010		
GROWTH RATE CARS % (O)	7.90	7.90
GROWTH RATE BUSES % (O)	6.30	6.30
GROWTH RATE TRUCKS % (O)	8.60	8.60
GROWTH RATE TWO WHEELERS % (O)	9.10	9.10

PERCENTAGE GROWTH RATE UPTO YEAR (GIVE YEAR) (O)

GROWTH RATE CARS % (O)
GROWTH RATE BUSES %(O)
GROWTH RATE TRUCKS % (O)
GROWTH RATE TWO WHEELERS % (O)I

CONSTRUCTION AND MAINTENANCE COST FINANCIAL RS LAKH

CONS+MDC COST BASE YEAR		27.35
CONS+MDC COST FIRST YEAR		95.10
CONS+MDC COST SECOND YEAR		460.90
CONS+MDC COST THIRD YEAR		476.10
CONS+MDC COST FOURTH YEAR		476.10
CONS+MDC COST FIFTH YEAR		380.80
COST OF OVL/STG 1 (O)		
COST OF OVL/STG 2 (O)		
COST OF OVL/STG 3 (O)		
COST OF OVL/STG 4 (O)		
COST OF ORD REPAIRS /KM/YEAR	0.15	0.25
COST OF PRD RENEWAL /KM/YEAR	0.40	0.80
PRD REN COMMENCEMENT YEAR	1990	2000
ECO COST CONVERSION FACTOR		0.80
DISCOUNTING RATE 1	10.00	
DISCOUNTING RATE 2	20.00	
DISCOUNTING RATE 3	40.00	

ECONOMIC COST OF RESOURCES (ECR)

PETROL	RS/LITRE	3.40
DIESEL	RS/LITRE	2.37
ENGINE OIL	RS/LITRE	6.00
OTHER OIL	RS/LITRE	10.00
GREASE	RS/KG	9.00
TYRE COST CAR	RS/TYRE	383
TYRE COST BUS	RS/TYRE	1674
TYRE COST TRUCKS	RS/TYRE	2268
COST OF CAR	RS/VEHICLE	48000
COST OF BUS	RS/VEHICLE	189750
COST OF TRUCK	RS/VEHICLE	150000
CREW COST BUS	RS/DAY	147.30
CREW COST TRUCK	RS/DAY	51.20
LABOUR COST	RS/HOUR	2.25

VALUE OF TRAVEL TIME (VTT) :

BUS PASSENGER	RS/HOUR	4.49
CAR&TWO WHEELERPASSENGER	RS/HOUR	8.21
COMMODITY IN TRANSIT	RS/HOUR	3 .00

UPDATE FACTORS ASSIGN UPDATE FACTORS IF ECR / VTT NOT UPDATED ELSE 1.00			
VEHICLE OPERATING COST	(O)	1.59	1.59
TIME SAVING (PASSENGER)	(O)	1.59	1.59
TIME SAVING (COMMODITY)	(O)	1.59	1.59

ECONOMIC ANALYSIS WITHOUT TIME SAVINGS — RESULT 1
PROJECT : WIDENING TO FOUR LANE
STATE AP NH 4 SECTION KM 0-19 11/09/90

YEAR	NO OF VEHICLES (ALT 1)							NO OF VEHICLES (ALT 2)							VEHICLE OPERATING COST (ALT 1)				VEHICLE OPERATING COST (ALT 2)				SAVING IN OPERATING COST/YR RS LAKHS				VOC SAVING	COST	NET BENEFIT	NET PRESENT VALUE WITHOUT TIME SAVINGS		
	CARS	BUSES	TRUCKS	TW	ADT	PCU	ROUGHNESS	CARS	BUSES	TRUCKS	TW	ADT	PCU	ROUGHNESS	CARS	BUSES	TRUCKS	TW	CARS	BUSES	TRUCKS	TW	CARS	BUSES	TRUCKS	TW	RS LAKHS	RS LAKHS	RS LAKHS	I	II	III
1990	1135	695	3365	1695	6890	14163		1135	695	3365	1695	6890	14163															13.52	—13.52	—13.52	—13.52	—13.52
1991	1225	739	3668	1863	7494	15376		1225	739	3668	1863	7494	15376															67.72	—67.72	—61.56	—56.43	—48.37
1992	1321	785	3998	2047	8152	16695		1321	785	3998	2047	8152	16695															360.36	—360.36	—297.82	—250.25	—183.86
1993	1426	835	4358	2250	8868	18128		1426	835	4358	2250	8868	18128															372.52	—372.52	—279.88	—215.58	—135.76
1994	1538	887	4750	2473	9648	19687		1538	887	4750	2473	9648	19687															372.52	—372.52	—254.44	—179.65	—96.97
1995	1660	943	5177	2717	10498	21381		1660	943	5177	2717	10498	21381															296.28	—296.28	—183.97	—119.07	—55.09
1996	1791	1003	5623	2965	11381	23150	4000	1791	1003	5623	2965	11381	23150	2000	1.94	3.32	4.66	0.39	1.24	2.83	4.09	0.25	87.00	33.92	223.08	28.80	372.80	—4.56	377.36	213.01	126.38	50.12
1997	1933	1066	6106	3235	12339	25066	4200	1933	1066	6106	3235	12339	25066	2067	1.97	3.33	4.68	0.39	1.24	2.83	4.09	0.25	97.74	36.80	246.97	32.72	414.23	—4.56	418.79	214.90	116.88	39.73
1998	2085	1133	6631	3529	13379	27143	4400	2085	1133	6631	3529	13379	27143	2134	2.00	3.35	4.69	0.40	1.25	2.84	4.10	0.25	109.65	39.92	273.42	37.11	460.10	—4.56	464.66	216.77	108.07	31.49
1999	2250	1204	7202	3850	14506	29394	4600	2250	1204	7202	3850	14506	29394	2201	2.03	3.36	4.71	0.41	1.25	2.84	4.10	0.25	122.86	43.30	302.68	42.05	510.89	—4.56	515.45	218.60	99.90	24.95
2000	2428	1280	7821	4200	15729	31832	4800	2428	1280	7821	4200	15729	31832	2268	2.07	3.37	4.72	0.41	1.25	2.85	4.10	0.25	137.51	46.96	335.07	47.58	567.12	7.60	559.52	215.72	90.37	19.34
2001	2620	1361	8494	4583	17057	34475	5000	2620	1361	8494	4583	17057	34475	2335	2.10	3.39	4.74	0.42	1.25	2.85	4.11	0.25	153.73	50.92	370.92	53.78	629.36	7.60	621.76	217.92	83.68	15.35
2002	2827	1447	9224	5000	18497	37339	5200	2827	1447	9224	5000	18497	37339	2402	2.13	3.40	4.75	0.43	1.78	3.21	4.55	0.36	67.65	18.97	129.51	23.93	240.05	7.60	232.45	74.07	26.07	4.10
2003	3050	1538	10017	5455	20060	40443	5400	3050	1538	10017	5455	20060	40443	2469	2.16	3.42	4.77	0.43	1.78	3.22	4.56	0.36	79.29	21.27	148.75	28.36	277.67	7.60	270.07	78.23	25.24	3.40
2004	3291	1635	10879	5951	21755	43807	5600	3291	1635	10879	5951	21755	43807	2536	2.19	3.43	4.79	0.44	1.79	3.22	4.56	0.36	92.39	23.80	170.52	33.41	320.12	7.60	312.52	82.30	24.34	2.81
2005	3551	1738	11815	6492	23595	47454	5800	3551	1738	11815	6492	23595	47454	2603	2.22	3.45	4.80	0.44	1.79	3.23	4.56	0.36	107.11	26.58	195.12	39.17	367.99	7.60	360.39	86.27	23.39	2.32
2006	3831	1847	12831	7083	25592	51406	6000	3831	1847	12831	7083	25592	51406	2670	2.25	3.46	4.82	0.45	1.79	3.23	4.57	0.36	123.64	29.64	222.91	45.72	421.90	7.60	414.30	90.16	22.41	1.90
2007	4134	1964	13934	7728	27759	55691	6200	4134	1964	13934	7728	27759	55691	2737	2.29	3.48	4.84	0.46	1.79	3.23	4.57	0.36	142.17	33.00	254.26	53.15	482.58	7.60	474.98	93.97	21.41	1.56
2008	4460	2087	15132	8431	30111	60335	6400	4460	2087	15132	8431	30111	60335	2804	2.32	3.49	4.85	0.46	1.79	3.24	4.58	0.36	162.92	36.69	289.62	61.59	550.82	7.60	543.22	97.70	20.40	1.27
2009	4813	2219	16434	9198	32664	65369	6600	4813	2219	16434	9198	32664	65369	2871	2.35	3.51	4.87	0.47	1.79	3.24	4.58	0.36	186.14	40.73	329.48	71.15	627.50	7.60	619.90	101.36	19.40	1.04
2010	5193	2359	17847	10035	35434	70827	6800	5193	2359	17847	10035	35434	70827	2938	2.38	3.52	4.89	0.48	1.79	3.25	4.59	0.36	212.09	45.16	374.38	81.97	713.60	7.60	706.00	104.94	18.42	0.84
																														1014.75	—8.15	—333.34

RATE OF INTERNAL RETURN (WITHOUT TIME SAVING) = 19.83%

APPENDIX 4

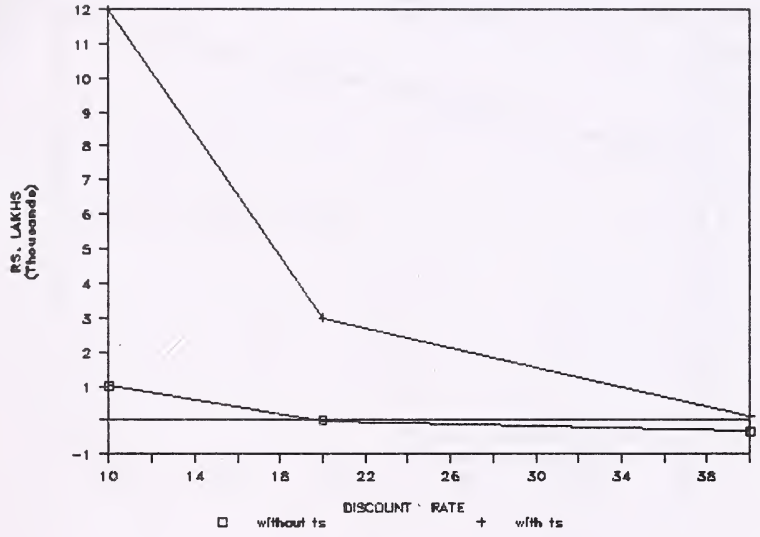
ECONOMIC ANALYSIS WITHOUT TIME SAVINGS — RESULT 2
PROJECT : WIDENING TO FOUR LANE
STATE : AP NH 4 SECTION KM 0-19 11/09/90

YEAR	NO OF VEHICLES (ALT 1)				ADT	PCU	ROUGHNESS	NO OF VEHICLES (ALT 2)				ADT	PCU	ROUGHNESS	SPEED OF VEHICLE (ALT 1)				SPEED OF VEHICLE (ALT 2)				TIME SAVING IN RUPEE LAKHS				TIME SAVING	VOC SAVINGS	TOTAL SAVINGS	COST RS LAKHS	NET BENEFIT RS LAKHS	NET PRESENT VALUE WITH TIME		
	CARS	BUSES	TRUCKS	TW				CARS	BUSES	TRUCKS	TW				CARS	BUSES	TRUCKS	TW	CARS	BUSES	TRUCKS	TW	CARS	BUSES	TRUCKS	TW						I	II	III
1990	1135	695	3365	1695	6890	14163		1135	695	3365	1695	6890	14163																	13.52	—13.52	—13.52	—13.52	—13.52
1991	1225	739	3668	1863	7494	15376		1225	739	3668	1863	7494	15376																	67.72	—67.72	—61.56	—56.43	—48.37
1992	1321	785	3998	2047	8152	16695		1321	785	3998	2047	8152	16695																	360.36	—360.36	—297.82	—250.25	—183.86
1993	1426	835	4358	2250	8868	18128		1426	835	4358	2250	8868	18128																	372.52	—372.52	—279.88	—215.58	—135.76
1994	1538	887	4750	2473	9648	19687		1538	887	4750	2473	9648	19687																	372.52	—372.52	—254.44	—179.65	—96.97
1995	1660	943	5177	2717	10498	21381		1660	943	5177	2717	10498	21381																	296.28	—296.28	—183.97	—119.07	—55.09
1996	1791	1003	5623	2965	11381	23150	4000	1791	1003	5623	2965	11381	23150	2000	40.18	36.70	40.44	35.38	63.06	69.62	57.81	50.03	70.28	275.11	13.82	33.34	392.55	372.80	765.35	—4.56	769.91	434.60	257.84	102.25
1997	1933	1066	6106	3235	12339	25066	4200	1933	1066	6106	3235	12339	25066	2067	37.88	34.20	38.91	34.03	62.59	69.22	57.36	49.44	87.52	335.60	16.70	40.22	480.04	414.23	894.26	—4.56	898.82	461.24	250.85	85.27
1998	2085	1133	6631	3529	13379	27143	4400	2085	1133	6631	3529	13379	27143	2134	35.39	31.50	37.25	32.58	62.08	68.78	56.87	48.80	110.09	414.97	20.33	48.88	594.26	460.10	1054.37	—4.56	1058.93	494.00	246.27	71.75
1999	2250	1204	7202	3850	14506	29394	4600	2250	1204	7202	3850	14506	29394	2201	32.69	28.58	35.45	31.00	61.53	68.31	56.34	48.10	140.20	531.85	24.93	59.93	746.91	510.89	1257.80	—4.56	1262.36	535.36	244.65	61.10
2000	2428	1280	7821	4200	15729	31832	4800	2428	1280	7821	4200	15729	31832	2268	29.76	25.41	33.49	29.30	60.93	67.80	55.77	47.34	181.33	670.71	30.85	74.20	957.10	567.12	1524.22	7.60	1516.62	584.72	244.94	52.43
2001	2620	1361	8494	4583	17057	34475	5000	2620	1361	8494	4583	17057	34475	2335	26.59	21.97	31.38	27.45	60.28	67.24	55.15	46.52	239.27	887.74	38.59	92.96	1258.55	629.36	1887.91	7.60	1880.31	659.04	253.07	46.43
2002	2827	1447	9224	5000	18497	37339	5200	2827	1447	9224	5000	18497	37339	2402	23.15	18.25	29.09	25.44	59.58	66.64	54.48	45.63	324.34	1225.51	48.88	118.07	1716.80	240.05	1956.85	7.60	1949.25	621.09	218.62	34.38
2003	3050	1538	10017	5455	20060	40443	5400	3050	1538	10017	5455	20060	40443	2469	19.43	14.21	26.61	23.27	58.32	65.99	53.75	44.67	456.82	1807.16	62.89	152.50	2479.38	277.67	2757.05	7.60	2749.45	796.42	256.97	34.64
2004	3291	1635	10879	5951	21755	43807	5600	3291	1635	10879	5951	21755	43807	2536	15.39	10.00	23.91	20.91	58.00	65.28	52.96	43.63	682.51	2947.12	82.53	201.15	3913.31	320.12	4233.43	7.60	4225.83	1112.79	329.14	38.03
2005	3551	1738	11815	6492	23595	47454	5800	3551	1738	11815	6492	23595	47454	2603	11.02	10.00	21.00	18.36	57.10	64.51	52.10	42.50	1130.48	3126.06	111.12	272.68	4640.33	367.99	5008.32	7.60	5000.72	1197.13	324.57	32.14
2006	3831	1847	12831	7083	25592	51406	6000	3831	1847	12831	7083	25592	51406	2670	10.00	10.00	17.84	15.60	56.14	63.68	51.17	41.27	1368.25	3315.06	155.03	383.70	5222.04	421.90	5643.94	7.60	5636.34	1226.63	304.86	25.88
2007	4134	1964	13934	7728	27759	55691	6200	4134	1964	13934	7728	27759	55691	2737	10.00	10.00	14.41	12.60	55.09	62.78	50.16	39.95	1470.24	3514.50	228.04	570.36	5783.14	482.58	6265.72	7.60	6258.12	1238.14	282.07	20.52
2008	4460	2087	15132	8431	30111	60335	6400	4460	2087	15132	8431	30111	60335	2804	10.00	10.00	10.69	10.00	53.95	61.81	49.07	38.51	1578.97	3724.74	366.16	847.55	6517.43	550.82	7068.24	7.60	7060.64	1269.92	265.21	16.54
2009	4813	2219	16434	9198	32664	65369	6600	4813	2219	16434	9198	32664	65369	2871	10.00	10.00	10.00	10.00	52.71	60.75	47.89	36.95	1694.64	3946.10	430.11	910.98	6981.82	627.50	7609.32	7.60	7601.72	1242.94	198.28	12.72
2010	5193	2359	17847	10035	35434	70827	6800	5193	2359	17847	10035	35434	70827	2938	10.00	10.00	10.00	10.00	51.38	59.61	46.61	35.25	1817.37	4178.81	463.70	976.17	7436.06	713.60	8149.66	7.60	8142.06	1210.27	176.98	9.73
																																11993.10	3019.83	110.26

RATE OF INTERNAL RETURN (WITH TIME SAVING) = 43.54%

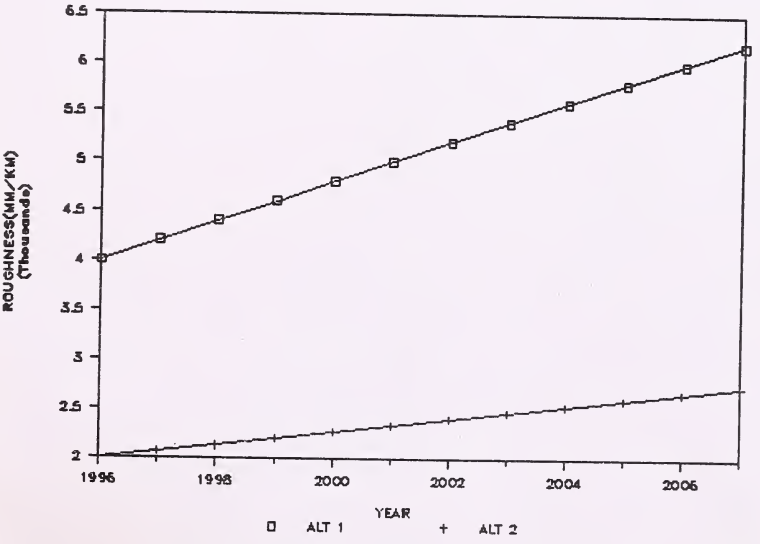
Appendix-5

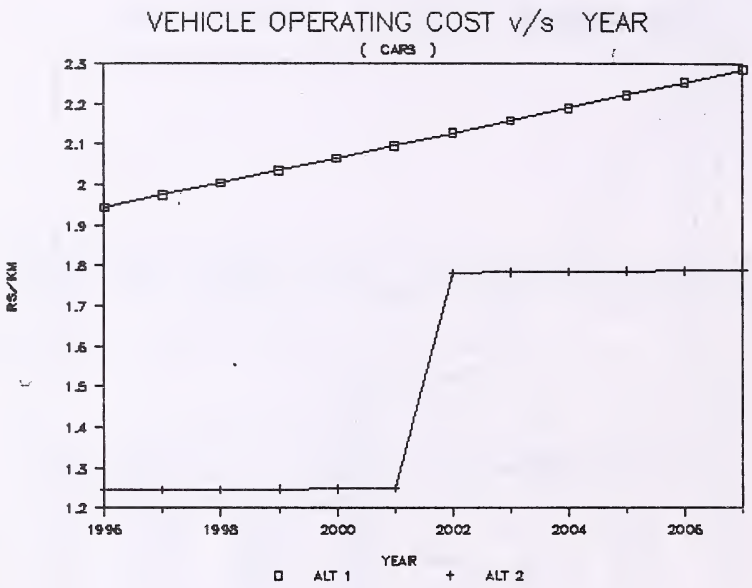
NET PRESENT VALUE v/s DISCOUNT RATE



Appendix-6

ROUGHNESS v/s YEAR




VEHICLE OPERATING COST v/s YEAR
(CARS)
RS/KM
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1996
1998
2000
2002
2004
2006
YEAR
ALT 1
ALT 2