

RODEL 1

INTERACTIVE ROUNDABOUT DESIGN

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DISCLAIMER

The user of RODEL, for the solution of an engineering problem, is in no way relieved of his responsibility for the correctness of the solution.

The views and opinions expressed in this Manual are those of the Author and are not necessarily those of Staffordshire County Council.

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1. INTRODUCTION

RODEL is a fully interactive program for aiding roundabout design.

The purpose of RODEL is to :-

1. Improve design quality.
2. Drastically reduce design time.
3. Reduce land and service costs
4. Allow rapid exploration of many options especially with respect to safety.
5. Derive the optimum layout within the conflicting constraints of cost, delay and safety.

Rather than simply checking designs after they have been drawn, RODEL generates geometry prior to scheme drawing. This avoids the time consuming practice of repeated drawing and checking.

The program operates in two modes :-

MODE 1

Sets of entry geometry are generated for each approach. Each set is equivalent to the input value of queue, delay or VC Ratio (RFC). The set that best fits the constraints is selected for each approach.

MODE 2

The simultaneous display of input and output allows the selected geometry to be repeatedly modified and refined. The resulting queues and delays are displayed every 1 or 2 seconds enabling the designer to develop a "feel" for the design and to converge on an optimum layout within the constraints.

Flow data is stored for the AM, PM and OP (off-peak) periods, and may be input directly for the whole period or synthesised from coarser flow data for the whole or part of the period. The results from RODEL are for a specified VC Ratio Confidence Level, consequently the risks involved when trading-off delays, costs and safety are clearly known. This leads to more robust designs at little extra cost. The results can be specified for the whole period or for a sub-period. Delay costs are calculated for the AM, PM, OP, daily and annual periods, enabling cost/benefit evaluation of options.

2 USING THE MANUAL

RODEL is an interactive program and chapters 3 - 10, describing the various screen displays and their operation, are intended to be used as an interactive tutorial at the computer, to rapidly learn how to 'drive' RODEL

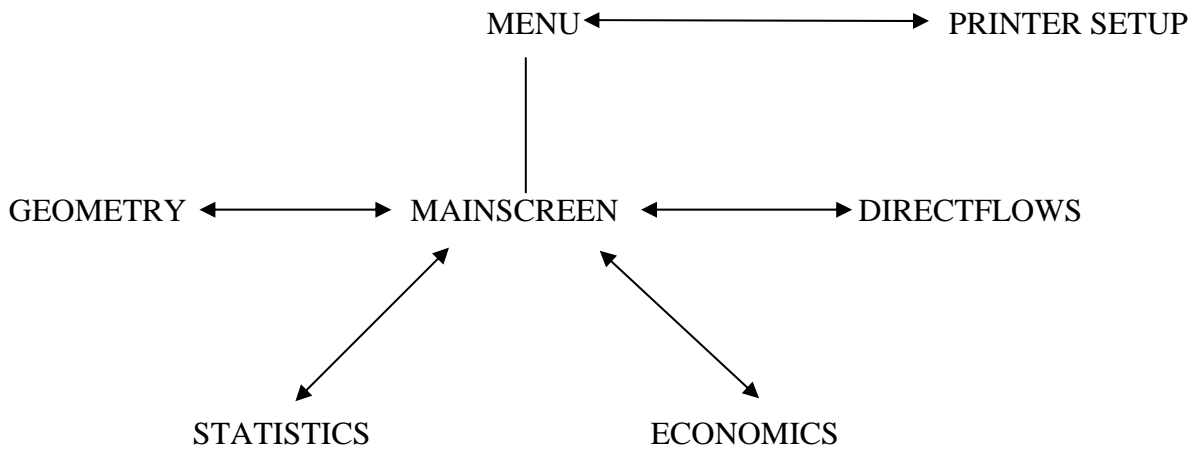
Beyond chapter 10 the manual provides a fuller explanation of the Input and Output. Particular care needs to be given to understanding the Flow Period and the Results Period in the Mainscreen.

RODEL provides extra flexibility and power, but the cost is the need to fully understanding Chapters 11-18 before any reliance is placed on the output. Chapter 11 on FLOW DEFINITION is very important, and chapter 16 on CONFIDENCE LEVEL is fundamental to understanding and using RODEL effectively.

The manual is to be used in conjunction with TD 16/93, 'The Geometric Design of Roundabouts'. LR 942 'The Traffic Capacity of Roundabouts' is also useful for geometric definitions.

3. PROGRAMME STRUCTURE

RODEL contains seven Screen Displays. The program structure below shows the connections between the screens.



Double click the 'Rodel' icon in the Start Menu to start Rodel.

The Menu Screen is displayed containing the scheme names.

The Printer Screen contains the printer settings.

The Mainscreen holds the geometric and flow input and displays the main output.

The Geometry Screen displays the sets of entry geometry derived by Mode 1.

The Direct Flow Screen holds detailed flow input to be used in preference to the coarser flow data in the Mainscreen.

The Statistics Screen displays the detailed secondary results.

The Economics Screen displays the full delay costs.

All the screens are controlled by the Fkeys (function keys), the Esc key and the PgUp and PgDn keys. The use of the Fkey functions are displayed at the bottom line of each screen.

The Tab key moves the cursor to the next field. Shift and Tab moves the cursor to the previous field. The four cursor keys move the cursor within each field.

The Esc key saves the current screen data and returns to the previous screen, or exits RODEL from the Menu Screen.

4. THE MENU SCREEN

The Menu contains the scheme names. A free line in the Menu is indicated by SCHEME NAME. This can be overtyped with the name of roundabout / intersection. The Menu has twelve lines per page and twelve pages. The "current" scheme is shown in highlighted green.

The Menu is controlled by the Fkeys (Function Keys) and by the Esc, PgUp and PgDn keys. The use of each key is displayed at the bottom of the Menu Screen.

The following operations can be performed in the Menu.

1. Change line
2. Change page
3. Add a page
4. Create a Scheme
5. Edit a Scheme
6. Copy a Scheme
7. Erase a Scheme
8. Alter the printer settings
9. Exit Menu

1. Changing Line

Press F7 = line up
Press F8 = line down

2. Changing Page

Press PgUp = page back
Press PgDn = page forward

3. Add a Page

Hold down Ctrl then key F1 once

4. Create a New Scheme

- 1 Move to the chosen line and page.
- 2 Type in the name of the new scheme.
- 3 Key F1 or F2 to select Mainscreen Mode 1 or Mode 2
- 4 Enter F3, F4, F5 or F6 to specify number of legs (i.e., F3 for 3 legs etc)

5. Edit a Scheme

- 1 Move to the page containing the scheme name.
- 2 Move to the scheme name.
- 3 Enter F1 or F2 to select Mainscreen Mode 1 or Mode 2
- 4 Edit the data in Mainscreen

(See Chapter 6 THE MAINSCREEN)

6. Copying a Scheme

- 1 Move to the scheme to be copied.
- 2 Press F4 to switch on 'COPY'
- 3 Move to the destination line/page.
- 4 Press F4 to copy.
- 5 Repeat (3) and (4) if further copies are required.
- 6 Press Esc to switch off 'COPY'.

7. Erasing a Scheme

- 1 Press F6 to switch on 'ERASE'.
- 2 Move the highlight to the scheme to be erased.
- 3 Press F6 to erase.
- 4 Repeat 2 and 3 if further erasing is required.
- 5 Press Esc to switch off 'ERASE'.

8. Printer Settings

- 1 Hold down Ctrl and press F9 once to display the printer settings.
- 2 Edit top margin and side margin settings to suit printer.
3. Select the correct printer port.
- 3 Press Esc to return to Menu.

(See Chapter 5 THE PRINTER SCREEN)

9. Exit Menu

Press Esc to leave Menu and exit RODEL.

5. THE PRINTER SCREEN

The Printer Screen is used to define the size of the top and side margins for printing and for selecting the correct printer port.

The Printer Screen is accessed from the Menu by keying Ctrl and F9. The top and side margin settings can be edited to suit the printer/paper size.

The various screens that can be printed differ slightly in size, but the maximum size is 34 rows x 80 columns.

The Esc key saves the printer settings and returns to the Menu.

PRINTING TO FILE

From the Main screen the print can be appended to the file RODPRINT.DOC in the RODEL folder.

F9 send the output to the printer.

Ctrl F9 appends the output to the RODPRINT.DOC file.

There is no limit to the number of appends.

Ctrl F8 erases the contents of RODPRINT.DOC

REDIRECTING OUTPUT TO A NETWORK PRINTER WITH Win NT OR Win 2000

At the client workstation, run the \winnt\system32\cmd.exe program and enter the following:

```
NET USE { printer port } { \\ server name \ printer share name }/PERSISTENT:YES
```

Example

```
NET USE LPT1 \\ SERVER\ LJ5002P6/PERSISTENT:YES
```

6. THE MAINSCREEN

A scheme is created or selected in the Menu by moving the Menu line highlight to the scheme name and keying either F1 or F2 to display Mainscreen Mode 1 or Mode 2. The F-keys displayed at the bottom of Mainscreen control the following operations.

1. Change Mode
2. Change Flow Definition
3. Change Peak Period
4. Reverse Turning Flows
5. Return to Menu
6. Change Factor Type
7. Run RODEL

When RODEL is run and the main results displayed (Measures of Effectiveness or MOE's), the following additional operations are controlled by the Fkeys.

8. Display Statistics
9. Display Economics
10. Display Geometry (mode 1 only)
11. Capacity Graph Definition
12. Print Mainscreen

1. Change Mode

Mode 1 has the four options 1a 1b 1c and 1d.
Mode 2 has a single option.
Lines 1 and 2 of field 1 vary between options.
F1 Change the Mode option rotationally.
(i.e., 1a / 1b / 1c / 1d / 2 / 1a / etc)
(See Chapters 12 & 13 on MODE OPERATION)

2. Change Flow Definition

RODEL uses either the detailed flows stored in the Direct Flow Screen or derives detailed flows from the coarser synthetic flow data stored in Mainscreen.
F2 Switches between the Direct and Synthetic options.
F7 Displays the Direct Flows in the Direct Flow option.
(See Chapter 11 FLOW DEFINITION)

3. Change Peak Period

Flow data is stored for the AM, OP and PM periods
F3 Change Flow data in fields 4 to 9 rotationally.
(i.e., AM / OP / PM / AM / OP / ... etc.)

4. Reverse Turning Flows

Ctrl and F3 reverses the Turning Flows and alters the Flow Peak (i.e, AM to AMR; OP to OPR; PM to PMR. Or AMR to AM; OPR to OP; PMR to PM.) The AMR, OPR and PMR flows are not saved and can be modified without changing the original AM, OP or PM flows.

5. Return to Menu

Esc Returns to menu saving Mainscreen data.

6. Change Factor Type

F4 Switches field 6 between 'FLOF' and 'CAPF'
FLOF factors the flows on each leg
CAPF factors the capacity of each leg

7. Run RODEL

F10 Runs RODEL.
After the Mainscreen results have been displayed the following additional operations are controlled by the Fkeys.

8. Display Statistics

F6 Displays Statistics Screen.

9. Display Economics

F8 Display Economics Screen.

10. Display Geometry (Mode 1 only)

F5 Display Geometry Screen.

11. Capacity Graph Definition

Ctrl F2 displays the X and Y intercepts and the slope of the Capacity Graph. The Average Capacity and Circulating flows are also displayed for the chosen Results Period.

12. Print Mainscreen

F9 Print Mainscreen.

The Mainscreen Input Fields

The Mainscreen is divided into three horizontal bands. The upper two are subdivided into the 9 input fields, and the lower band is subdivided into the 2 output fields. The Tab key moves the cursor to the next field. Shift and Tab moves the cursor to the previous field. The four cursor keys move the cursor within the field.

The legs must be named and numbered in a counter- clockwise direction for right-hand driving like that of U.S. All input must be correspondingly counter-clockwise. For left-hand driving system like that of Great Britain and Australia, the legs are named and/or number in a clockwise direction. In this case, all input must be correspondingly clockwise. For a new scheme a set of dummy data is displayed in the Mainscreen input fields to be edited by the user. The first leg can be chosen arbitrarily although some engineers develop the habit of choosing (say) the north leg as leg 1

The input for Mode 1 and Mode 2 is the same except for the geometric data in field 1.

INPUT FIELD 1

GEOMETRY

Field 1 contains 7 lines of data. Lines 3 to 7 contain geometric data common to both Modes, but lines 1 and 2 vary between Modes.

Mode1

line 1	TARGET PARAMETER FOR EACH LEG		
line 2	Blank		
line 3	Half width	V	(metres)
line 4	Entry radius	R	(metres)
line 5	Entry angle	PHI	(degrees)
line 6	Diameter	D	(metres)
line 7	Grade Separation	GS	(0 or 1)

Mode2

line 1	Entry width	E	(metres)
line 2	Flare length	L'	(metres)
line 3	Half width	V	(metres)
line 4	Entry radius	R	(metres)
line 5	Entry angle	PHI	(degrees)
line 6	Diameter	D	(metres)
line 7	Grade Separation	GS	(0 or 1)

The geometric data is required for Kimber's Roundabout Capacity equations and these are defined in

LR 942 'The Traffic Capacity of Roundabouts' . The geometric input data is shown in FIG 4 (GEOMETRIC DEFINITIONS).

The grade separation indicator on line 7 is 0 for at grade and 1 for grade separation

Example of RODEL Mainscreen (for a 4-leg intersection) is shown below for Mode 1a

Field 1	Field 3	Field 4	Field 5	Field 6	Field 2	Field 7	Field 8	Field 9	
14:12:99 MANHATTAN R/A STUDY									
AVE DELAY	0.50	0.50	0.50	0.50		TIME PERIOD	min	90	
V (m)	3.00	3.00	3.00	3.00		TIME SLICE	min	15	
RAD (m)	20.00	20.00	20.00	20.00		RESULTS PERIOD	min	15 75	
PHI (d)	30.0	30.0	30.0	30.0		TIME COST	\$/hr	15.00	
DIA (m)	50.0	50.0	50.0	50.0		FLOW PERIOD	min	15 75	
GRAD SEP	0	0	0	0		FLOW TYPE	pcu/veh	VEH	
						FLOW PEAK	am/op/pm	OP	
LEG NAME	PCU	FLOWS (1st exit 2nd etc ...U)				FLOF	CL	FLOW RATIO	
LEG1	1.05	200	200	200	0	1.00	50	0.75 1.125 0.75	15 45 75
LEG2	10.5	200	200	200	0	1.00	50	0.75 1.125 0.75	15 45 75
LEG3	1.05	200	200	200	0	1.00	50	0.75 1.125 0.75	15 45 75
LEG4	1.05	200	200	200	0	1.00	50	0.75 1.125 0.75	15 45 75
MODE 1a AVE DELAY									
AVE DELAY min							AVDEL s		
MIN ENTRY E							L O S		
MAX FLARE L'							VEH HRS		
MAX ENTRY E							COST \$		
MIN FLARE L'									
F1Mode F2Direct F3Peak CtrlF3rev F4 Facts F10Run ESC									

The above Figure shows an example of RODEL Mainscreen for a 4-leg intersection. One can clearly see that the upper band is divided into 9 Fields and the lower band is divided into 2 Fields. The values written in *ITALICS* are the inputs that are supposed to be provided by the user. The lower band contains the outputs fields. The values for the output are not shown, but they will be displayed after running the model by pressing F10 key.

The Model has four Target Parameter options (replacing E and L' in Mode 2) shown in the following table.

--	--

OPTION	TARGET PARAMETER
Mode 1a	Average Delay
Mode 1b	Maximum Delay
Mode 1c	Maximum Queue
Mode 1d	Maximum RFC

Mode 1 uses the Target Parameters to generate up to 40 pairs of E and L' (EL' pairs) for each leg. Any pair will produce the specified Target delay, queue or RFC. This gives about 2.5 million geometric combinations that will meet the target parameters.

INPUT FIELD 2 CONTROL DATA

The Control Data contains seven parameters.

1. TIME PERIOD (minutes)

This is the total time to be modelled. There is no restriction on the length of the Time Period.

2. TIME SLICE (minutes)

The Time Period is divided into equal time intervals called Time Slices. During each Time Slice the traffic flows and capacity are assumed constant, but they vary between Time Slices to represent the rise and fall in peak period traffic volumes. The maximum number of Time Slices is 120. The minimum number of Time Slices is 4. The Time Slice must divide exactly into the Time Period to give equal slices.

3. RESULTS PERIOD (minutes)

The results produced by RODEL are for the specified Results Period.

This may be the whole Time Period or for a sub-period.

The Results Period has two values. The first specifies the start and the second, the end of the Results Period. That is, for a 90 minute Time Period we can have Results Period = 0 90, then results are for whole 90 minutes. Results Period = 15 75, then results are for the middle 60 minutes. The Results Period values must be a multiple of the Time Slice.

4. TIME COST (pence/minute)

This is the value of time for the flow year under consideration.

The COBA and TAMS manuals provide the values by year.

The Time Cost is used to calculate the Delay Costs for the Results Period, and also the daily and annual costs in the Economics Screen.

5. FLOW PERIOD (minutes)

The Turning Flows displayed in Input Field 5 are the flows during the Flow Period, i.e., for a 90 minute Time Period:-

Flow Period = 0 90 Turning Flows = flows/90 minutes.

Flow Period = 30 60 Turning Flows = flows/30 minutes.

If the Flow Period is changed, a prompt message is displayed reminding the user to alter the Turning Flows to match the new Flow Period. The Flow Period values must be multiples of the Time Slice.

6. FLOWTYPE (PCU or VEH)

The Turning Flows in field 5 are interpreted as PCU's or vehicles as specified by the Flow Type.

7. FLOW PEAK (AM, OP or PM)

For each scheme, flow data can be stored for the AM, OP and PM periods. The Flow Peak specifies the current period displayed. F3 changes both the Flow Peak and the Flow data in (fields 4 to 9). If Ctrl is held down and F3 pressed once the Turning Flows in field 5 are reversed, and the Flow Peak display is altered from AM to AMR, PM to PMR etc. The same process reverses back to the original flows, even if the reversed flows have been edited.

INPUT FIELD 3 LEG NAMES

The name of each leg is entered in Field 3. The first name is for Leg 1, and the subsequent names entered represent the leg names of the roundabout in a counter-clockwise order (for driving on the right system).

INPUT FIELD 4 PCU FACTORS

RODEL uses both PCUs and vehicles to derive queues and delays. The PCU Factor is therefore needed irrespective of the Flow Type.

PCU FACTOR = 1 + (vehicles over 4 wheels / total vehicles).

INPUT FIELD 5 TURNING FLOWS (VEH or PCU / Flow Period)

Field 5 contains the Turning Flows for each leg. They are interpreted as PCUs or Vehicles as specified by the Flow Type. The legs are numbered in a counter-clockwise direction for driving on the right. The order of input is:-

LEG 1 1st exit, 2nd exit U-turn
LEG 2 1st exit, 2nd exit U-turn
.
LEG n 1st exit, 2nd exit U-turn

The Turning Flows are the flows during the Flow period. For the Direct Flow option, the Turning Flows (and Flow Period) must be for the whole Time Period. If the flows are to be synthesised then the Turning Flows (and Flow Period) can be for the whole or part of the Time Period.

(See Chapter 11 FLOW DEFINITION).

INPUT FIELD 6 FACTORS

Field 6 has two options for factoring either the Turning Flows or Capacity on each leg. F4 switches between the capacity and flow factor options. The field header is also changed between 'FLOF' for Flow Factor and 'CAPF' for capacity factor.

INPUT FIELD 7 CONFIDENCE LEVEL

Queues and delays can only be predicted for a given confidence level. (Arcady has an implicit confidence level of 50%). RODEL estimates queues and delays for the specified Confidence Level (50% to 95%) (See Chapter 16 CONFIDENCE LEVEL)

INPUT FIELD 8 FLOW RATIOS

When the traffic flows per Time Slice are to be synthesised from the coarser Turning Flow data, Field 8 displays the Flow Ratio. The Flow Ratio is used in conjunction with the Flow Times to reshape the Turning Flows (the average flows during the Flow Period) into a flow profile that rises and falls in a similar manner to peak period traffic. The Flow Ratio has three values that define the ratio between the flow levels at the three corresponding Flow Times.

(see Chapter 11 - FLOW DEFINITION)

If the flows per Time Slice are to be input directly, then Field 8 is replaced by the Direct Flow Field, allowing access to the Direct Flow Screen by keying F7. (See

Chapter 14 - FLOW DEFINITION)

INPUT FIELD 9 FLOWTIMES (minutes)

When the flows per Time Slice are to be synthesised, Field 9 contains the Flow Times that are used with the Flow Ratios to produce the Flow Profile from the Turning Flows. (Chapter 14 FLOW DEFINITION). When the flows / Time Slice are to be input directly Field 9 is replaced by the Direct Flow Field. (see Chapter 14 - FLOW DEFINITION).

The Mainscreen Output Fields

The Mainscreen output is displayed in the bottom section of the screen, and has two fields.

OUTPUT FIELD 1

The output is for the specified Results Period. Leg 1 output is displayed in column 1, Leg 2 output is displayed in column 2 etc. The output varies depending on the Mode and Option.

Mode1a

Line 1	Average delay	(minutes/vehicle)
Line 2	Blank	
Line 3	Minimum entry width	E _{min} (metres)
Line 4	Maximum flare length	L' _{max} (metres)
Line 5	Maximum entry width	E _{max} (metres)
Line 6	Minimum flare length	L' _{min} (metres)

Lines 3 and 4 are the EL' pair for the minimum E. Lines 5 and 6 are the EL' pair for the maximum E. (ie each extreme of the sets of E-L' pairs).

Mode1b

As Mode 1a, except Line1 displays the maximum delay (min/vehicle).

Mode1c

As Mode 1a, except Line1 displays the maximum queue (vehicles).

Mode1d

As Mode 1a, except Line1 displays the maximum ratio of flow to capacity for any Time Slice during the Results Period. (Max RFC)

Line 2 displays the average delay / vehicle (min) for comparison with the maximum RFC.

Mode2

Line 1	Flow per leg	vehicles/results period
Line 2	Capacity per leg	vehicles/results period
Line 3	Average delay	minutes /results period
Line 4	Maximum delay	minutes /results period
Line 5	Average Queue	vehicles/results period
Line 6	Maximum Queue	vehicles/results period

ADDITIONAL SECONDARY OUTPUT FIELD 1 DATA

After Mode 2 Output Field 1 results have been displayed, Alt F2 displays additional secondary results. These are:

Line 1	Y Intercept of the Capacity Graph per leg
Line 2	X Intercept of the Capacity Graph per leg
Line 3	Slope of the Capacity Graph per leg
Line 4	Exit Flows per leg in vehicles/results period
Line 5	Circulating flows per leg in vehicles/results period
Line 6	Capacity per leg in vehicles/results period

OUTPUT FIELD 2

Output field 2 is the same for Mode1 and Mode2 and displays the total delays (hrs) and the total delay costs of all traffic for the Results Period.

7. THE DIRECT FLOW SCREEN

If the flows per Time Slice are to be input directly, rather than synthesised from the Turning Flows, then the F2 key is used in Mainscreen to switch from Synthetic to Direct Flow. Fields 8 and 9 in Mainscreen change from Flow Ratios and Flow Times to Direct flow. F7 then displays the Direct Flow Screen.

The flow for each leg is input into each column of the Direct Flow Screen (leg1 in column 1, leg2 in column 2 etc. - legs numbered clockwise).

The flows per Time Slice are interpreted as PCU's or vehicles as specified by the Flow Type in Mainscreen.

For the Direct Flow option the Flow Period and the Turning Flows in field 5 of Mainscreen must be for the whole Time Period.

The total flows/leg input in the Direct Flow Screen must equal the total Turning Flows/leg in Mainscreen, as the Turning Flows in Mainscreen define the turning proportions to be applied to the Direct Flows.

If the number of Time Slices exceeds the screen size, F8 will scroll the Direct Flow Screen data.

F9 prints the screen.

Esc returns to Mainscreen.

The Fkey functions are displayed on the bottom line.

8. THE ENTRY GEOMETRY SCREEN

The Entry Geometry Screen is displayed by keying F5 after running Mode1 of Mainscreen.

The Entry Geometry Screen displays the whole set of EL' pairs for Leg 1.
PgUp or PgDn changes the leg displayed.

EL' pairs should be generated for the AM and PM periods, and the worst case from either period printed for each leg.

The EL' pair that best fits the site constraints is then selected from the range of EL' pairs for each leg in turn and the initial layout sketched.

F9 prints the screen.

Esc returns to the Mainscreen.

The Fkey functions are displayed on the bottom line of the screen.

9. THE STATISTICS SCREEN

The Statistics Screen can be displayed by F6 after Mode1 or Mode2 of Mainscreen has run, and displays the detailed results for each Time Slice for a single leg. PgUp or PgDn changes the leg display.

If the number of Time Slices exceeds the screen size, F8 scrolls the data.

For each leg the following data is displayed:-

1 Arrival Flow

The total arrival flow in vehicles during each Time Slice.

2 Capacity

The capacity in vehicles during each Time Slice.

3 Circulating Flow

The total circulating flow in vehicles passing the entry during each Time Slice.

4 Ratio of Flow to Capacity (RFC)

The ratio of flow/capacity for each Time Slice.

5 End Queues

The queue in vehicles at the end of each Time Slice.

6. 95% End Queues

The 95% random queue in vehicles at the end of each Time Slice.

7 Exit Flow

The total exit flow in vehicles during each Time Slice.

F9 prints the screen. Esc returns to the Mainscreen. The Fkey functions are displayed on the bottom line of the screen.

10. THE ECONOMICS SCREEN

The Mainscreen displays the total delay and delay costs experienced by all traffic for a single Results Period. However the Economics Screen displays the daily or annual costs for any or all of the AM, OP and PM Results Periods.

The Economics Screen can be displayed for both Mode1 and Mode2 by keying F8 after the Mainscreen results have been displayed.

The number of periods per day and the number of days per year are specified for each period. The annual delay costs for each period, and the grand total delay costs can then be displayed by keying F10

If only one period is run (ie the PM) then the Economics Screen produces costs for that period only. If other periods are subsequently run, they are added into the Economics Screen. The Economics Screen results are reset to zero by keying F1.

F9 prints the screen

Esc saves the input data and returns to the Mainscreen.

The Fkey functions are displayed on the bottom line of the screen.

11. FLOW DEFINITION

Traffic flows during a typical peak period rise and fall. The capacity of an approach not only

depends on its geometry but also on the opposing circulating flow on the roundabout. When the entry flow is greatest (the peak within the peak period) the opposing circulating flow is also greatest. Consequently the capacity is lowest when the traffic demand is greatest.

This rise and fall in traffic is simulated, by dividing the Time Period into equal time increments called Time Slices. The flow and capacity is assumed constant during each Time Slice, but will vary between Time Slices according to the rise and fall in the peak period traffic.

If the flows are known for each Time Slice, they can be input directly into the Direct Flow Screen (Direct Flows).

Alternatively the flows per Time Slice can be synthesised from the coarser Turning Flows in input Field 5 of Mainscreen (Synthetic Flows).

Synthetic Flows

The rise and fall in the approach flows for a typical peak period is shown for a single approach in FIG 1 THE FLOW PROFILE.

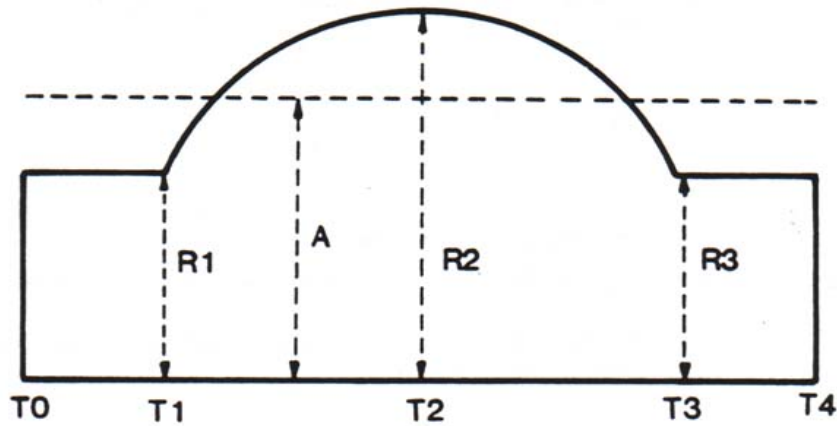


FIG. 1 THE FLOW PROFILE

The flow level 'A' is the average approach flow level during the Flow Period (the sum of the Turning Movements for the approach). This flow level is reshaped into the Flow Profile. The total approach flows during the Flow Period are unchanged by this reshaping.

The time T0 to T4 is the Time Period. The Flow Times T1, T2 and T3 define the times at which the Flow Profile either starts or ceases to rise or fall.

The Flow Ratios R1, R2 and R3 define the ratio between the average flow level \bar{A} and the flow

levels at the Flow Times T1 T2 and T3. After the approach flows have been reshaped, the flow profile is divided into equal Time Slices (during which the flows are assumed constant) to produce the synthesised flows per Time Slice. (see FIG. 2 SYNTHESISED FLOWS)

The greater the number of Time Slices the longer RODEL takes to run. Time Slices of 15 minutes are suitable for converging on a layout, with a Time Slice of 5 minutes sufficiently short for final estimation of queues and delays.

The number of Time Slices can be a minimum of 4 (1/4 of the Time Period) and a maximum of 120.

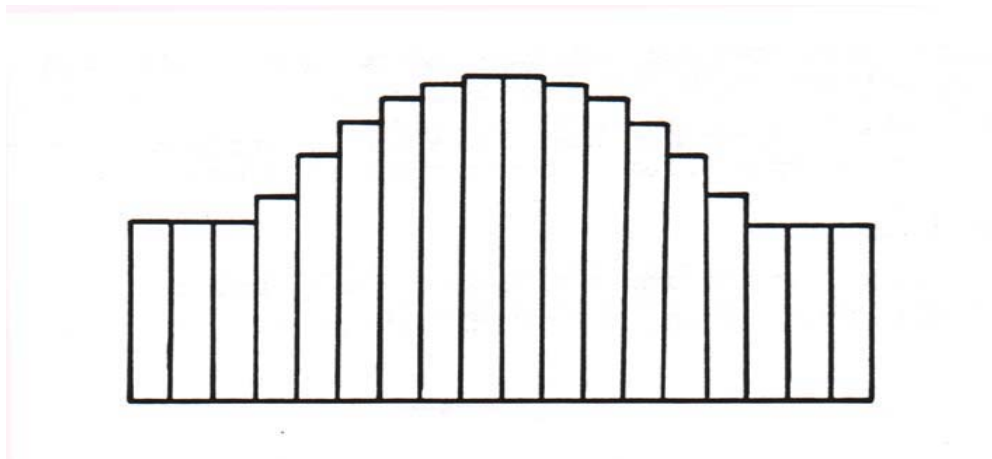


FIG 2 – THE SYNTHESISED PEAK PERIOD FLOWS FOR A SINGLE APPROACH

The synthesis of flows in RODEL has been generalised and any values can be used for the Flow Ratios. (i.e.R2 can be less than R1 and R3 etc).

The flows are synthesised for the whole Time Period even when the Flow Period (and Turning Flows) are for a period less than the Time Period.

During the Flow Period the sum of the synthesised flows per leg is equal to the sum of the Turning Flows per leg.

Notes on synthesised flows

The Time Slice must be a factor of the Time Period.

The Flow Period and Result period values must be multiples of the Time Slice.

The Turning Flows are the flows during the Flow Period. If the Flow Period is altered then the Turning Flows must be altered to match the Flow Period. (A prompt reminds the user to update the Turning Flows if the Flow Period is altered).

To model the peak hour it is sufficient to have a 60 minute Time Period. The assumption that the queue is zero at the beginning of the hour is a good assumption, except when queues and delays are large. Alternatively a longer time period can be used, typically 90 minutes, with the Flow Period and the Results Period chosen for the middle 60 minutes. (i.e.)

TIME PERIOD	60	90
Time Slice	15	15
Results Period	0-60	15-75
Flow period	0-60	15-75

The Flow Times T1, T2 and T3 must all be a multiples of the Time Slice.

Direct flows

If the detailed arrival flows on an approach are counted for each Time Slice, they may be entered directly, rather than synthesised from coarser Turning Flows. This can only be done with existing flows and is normally only done to check and calibrate the model. For future design year, synthesised flows are used.

In Mainscreen F2 switches between Synthetic and Direct Flows. The Direct Flow option replaces the Flow Ratio and Flow Times fields with the Direct Flow field.

Keying F7 displays the Direct Flow screen for inputting or editing the Direct Flows on each leg.

Esc returns to the Mainscreen.

The Fkey functions are displayed on the bottom line of the Direct Flow Screen.

Notes on Direct flows

The Direct Flows must be for the whole Time Period.

The Flow Period must be for the whole Time Period.

The Turning Flows must be for the whole Time Period.

The Turning Flows define the turning proportions that apply to the Direct Flows.

The total Turning Flows / leg in Mainscreen must be equal to the total flows / leg in the Direct Flow Screen.

12. MODE 1 OPERATION

The purpose of Mode 1 is to generate the set of entry Geometry pairs (EL' pairs) for each leg that are

equivalent to the input Target Parameter. This is done prior to scheme drawing. The EL' pair that best fit the site constraints is found for each leg for the AM and PM periods, and the worst case (largest geometry) for each leg is used to sketch the initial layout.

Mode 1 has four options, each with a different Target Parameter:-

OPTION	TARGET PARAMETER
Mode 1a	Average Delay
Mode 1b	Maximum Delay
Mode 1c	Maximum Queue
Mode 1d	Maximum RFC

The Mode option is changed by keying F1. When the desired Mode 1 option has been displayed the user specifies the desired Target Parameter values in Line 1 of Field 1. Values of the entry geometry E and L' are not input.

Line 1	TARGET PARAMETER	(four options)
Line 2	Blank	
Line 3	Half Width	V (metres)
Line 4	Entry Radius	R (metres)
Line 5	Entry Angle	Phi (degrees)
Line 6	Inscribed Circle Diameter	D (metres)
Line 7	Grade Separation	GS (0 or 1)

V and GS are known, and only approximate values of R, Phi and D are required at this stage as capacity, queues and delays are not very sensitive to typical values (i.e.):-

If R is greater than 20 metres increasing R has little effect on capacity. However, values of R less than 10 metres should be avoided.

PHI is determined largely by the layout of the approach roads. Medium values (20-35 degrees) are common and this variation does not greatly alter capacity. It is sufficient to initially estimate PHI to the nearest 5 degrees.

The effect of D on capacity is small (except when circulating volumes are very large), and D can be estimated from the site constraints to the nearest 5 metres.

(See FIG. 3 THE CAPACITY / GEOMETRY RELATIONSHIPS)

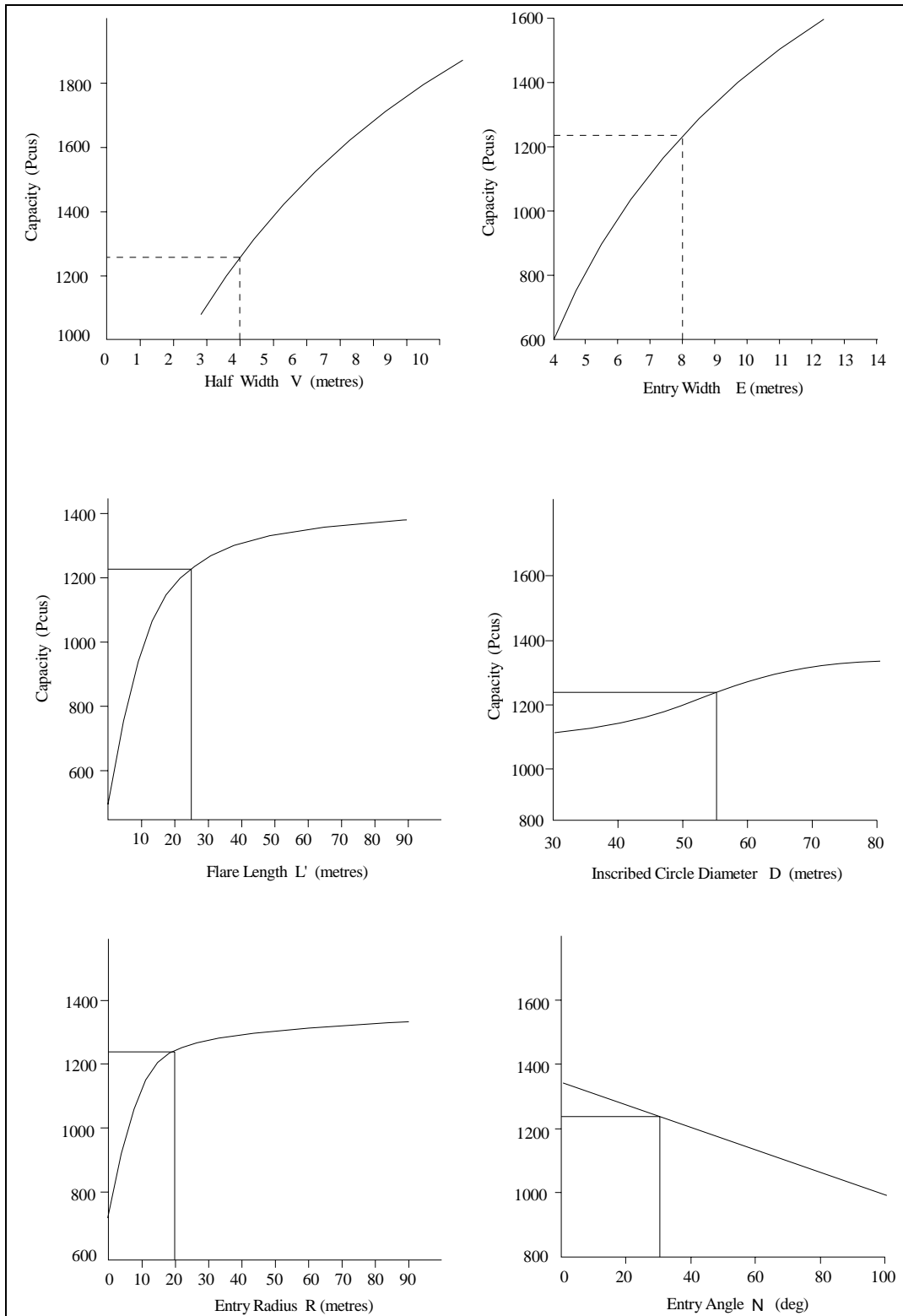


FIG 3. CAPACITY / GEOMETRY RELATIONSHIPS

When acceptable target parameters have been achieved F5 displays the full range of E-L' pairs.

Any constraint problems become immediately apparent, and different EL' pairs can be selected, or Mode 1 repeated with a larger target parameter(s).

Alternatively, a smaller inscribed circle diameter D can be chosen. This allows E and L' to be increased by allowing the stop lines to be moved forward (possibly allowing bypass lanes also). This produces a large net increase in capacity. However the entry deflection needs to be considered as it may have been reduced.

(If the approach road is wider than 7.3 metres then it may be possible to increase the capacity significantly by off-setting the centre line to increase the half width V.

13. MODE 2 OPERATION

Mode 2 is used to refine the Mode 1 results, by rapid experimentation with the geometry. The rapid response (1 or 2 seconds) allows the designer to develop a 'feel' for the problem and to converge on a solution.

Any of the input fields may be modified, and sensitivity tests applied to both geometry and flow data.

The Flow or Capacity Factor in field 6 of Mainscreen is provided to allow the flows or capacities on each leg to be factored for various sensitivity tests etc.

The Flow Factor (field 6 header 'FLOF') is particularly useful when the delays predicted for the optimum geometry are unacceptable. It can then be used to factor down the flows to find the flow level that will produce acceptable delays. (ie reduce the traffic instead of increasing the capacity). Revised flow forecasts can then be derived using this flow/delay information.

The Flow Factor is also useful for incrementing the flows to find the level at which a design will produce unacceptable delays. Usually one leg fails well before the rest. The geometry can then be modified to produce a balanced design with legs that should last equally well.

The Capacity Factor (field 6 header 'CAPF') is useful for testing the effects of capacity variation, or for reducing the capacity below the theoretical to allow for site specific conditions. It can be used to represent the effect of a Pelican Crossing by factoring down the capacity pro-rata for the proportion of the Results Period when the Pelican will stop traffic.

(The Confidence Level in input field 7 of Mainscreen also modifies the flows and capacities. See Chapter 16 CONFIDENCE LEVEL)

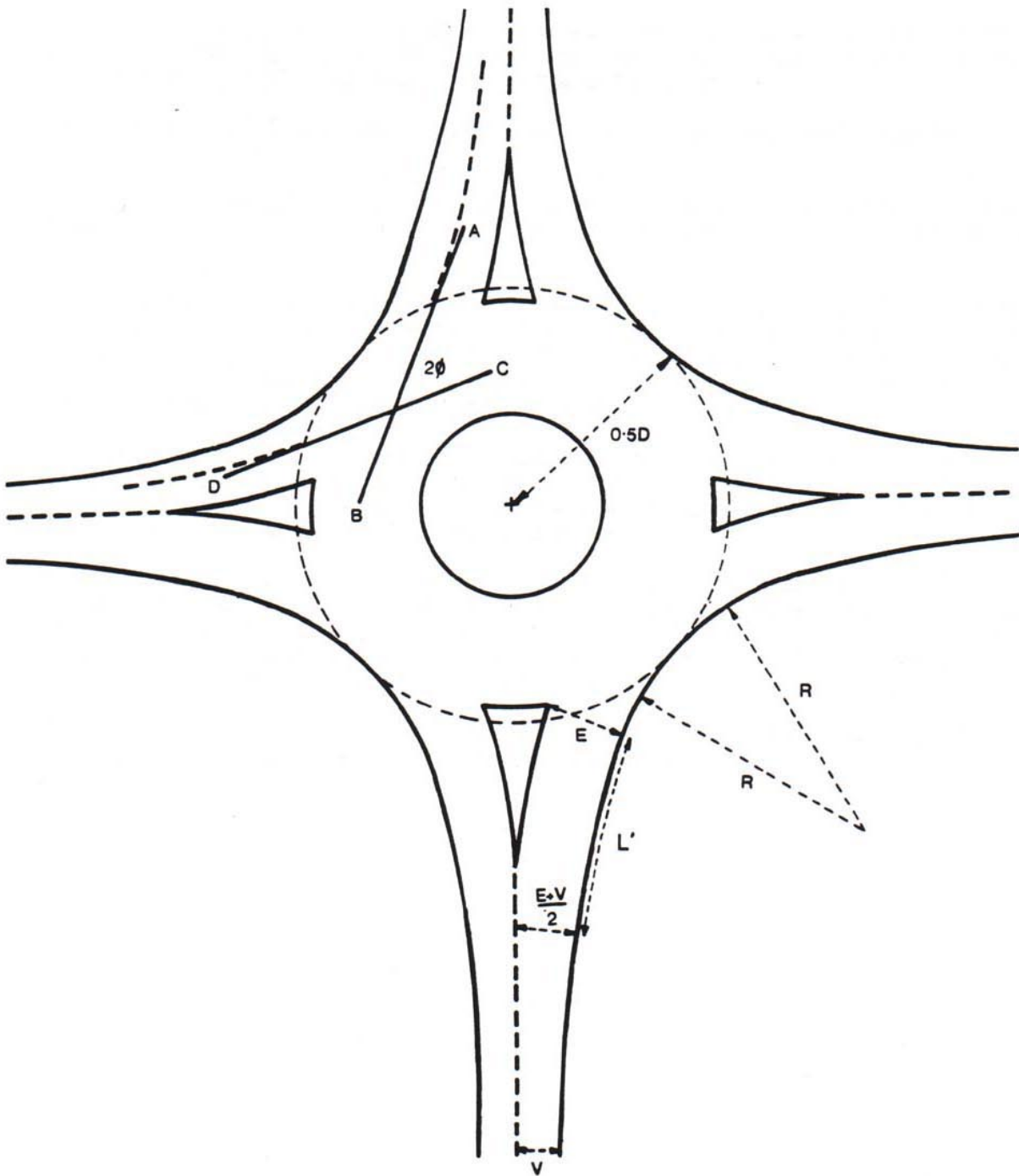


Fig 4a Geometric Definitions

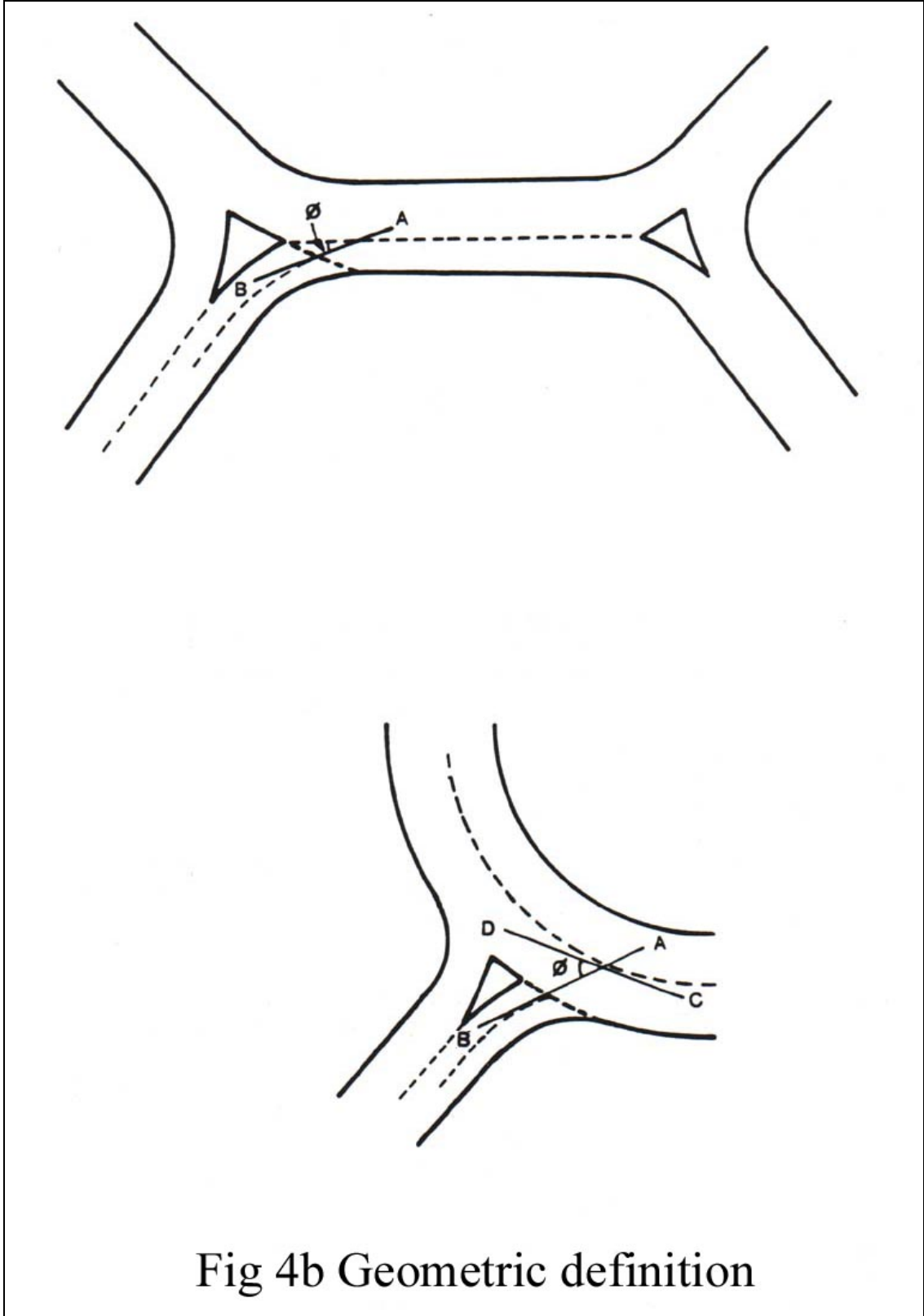


Fig 4b Geometric definition

14 EFFECTIVE GEOMETRY

The geometry is defined in LR 942 'The Traffic Capacity of Roundabouts' and in FIG. 4a & 4b GEOMETRIC DEFINITION.

The UK Department of Transport publications, TA 42/84 and TD 16/84 provide standards and advice. However the principles involved need to be understood to ascertain if a particular piece of advice or standard applies. Their relative importance in relation to each other and to the scheme in hand also needs to be considered in order to trade-off conflicting objectives and find an optimum solution within the constraints.

It is essential that the geometry used in RODEL is the 'EFFECTIVE GEOMETRY' otherwise the actual queues and delays will be considerably greater than the RODEL results. This is particularly true for the Entry Width E, the Entry Lane Markings, the Flare Length L', and the Exit Geometry.

The Entry Width

In the past it has been accepted practise on very large old traffic circles to draw the deflection island so that its imaginary extended arc would pass through a point half way between the centre and edge of the central island.

However Kimbers capacity equation reveal that the capacity is very sensitive to the entry width. Traffic on roundabouts with deflection islands as in FIG5(a) may not fully use the entry width as traffic entering from lane 2 do not leave sufficient space between themselves and the central island for a vehicle to simultaneously enter from lane 3. In such cases the effective entry width will be less than the physical entry width. Because capacity is so sensitive to the entry width, this can lead to a severe under estimation of queues and delays.

It is also very important that the centre line of the approach road is not deflected **sharply** to the left as this can produce an area of dead carriageway with an effective entry width less than the physical width. This can cause entry traffic in the left most lane to collide with the central island or with traffic entering from the adjacent entry lane.

In order to ensure an effective entry width, the deflection island should be tangential to the central island, and the entry angle should be such that the traffic in the lane next to the offside lane enters the circulating width on a path that does not 'clip' the central island, but on a path that leaves sufficient circulating width next to the central island to allow the offside lane traffic negotiate the roundabout freely (Fig 5 b)

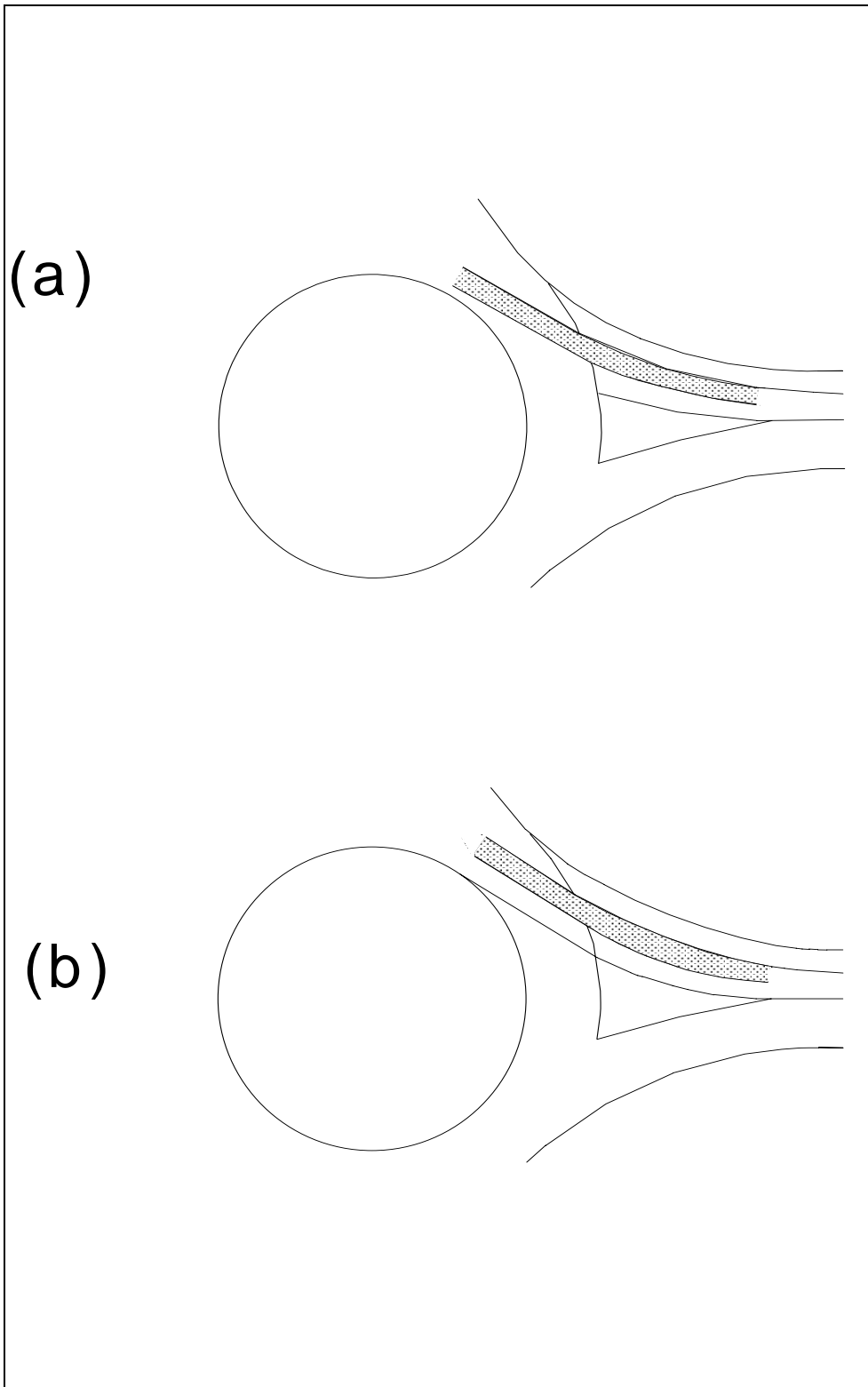


FIG. 5 ENTRY GEOMETRY

Entry width and Entry lanes

1. Single lane entries

The entry width is normally measured from the vertical curb faces. When a single lane is widened the capacity increases due to three mechanisms that succeed each other.

- (1) Side friction is initially reduced.
- (2) This is followed by staggered (zippered) queuing either side of the lane, reducing follow on times.
- (3) Finally doubling up at the yield line starts and occurs increasingly as the lane is widened. (At 6.00m Rodel treats the entry as two 3.00 lanes)

The (3) and to some extent (2) do not happen when the section of circulating road fed by the entry is single lane. This requires at least a two lane section of circulating road.

Consequently E greater than 4.3m (14ft) should not be input on a single lane entry unless it feeds a two lane circulating road, irrespective of the physical width being wider to accommodate trucks.

2. Multilane entries

For a two lane entry E input into Rodel should no less than 6.0m and no greater than 8.00m
For three lane entries E should be input between 9.0m and 12.00m

This gives lanes between 3.00m and 4.00m.

Where lanes are wider to allow for trucks, 4.00 widths should be used to derive the input value of E.

The Entry Lane Markings

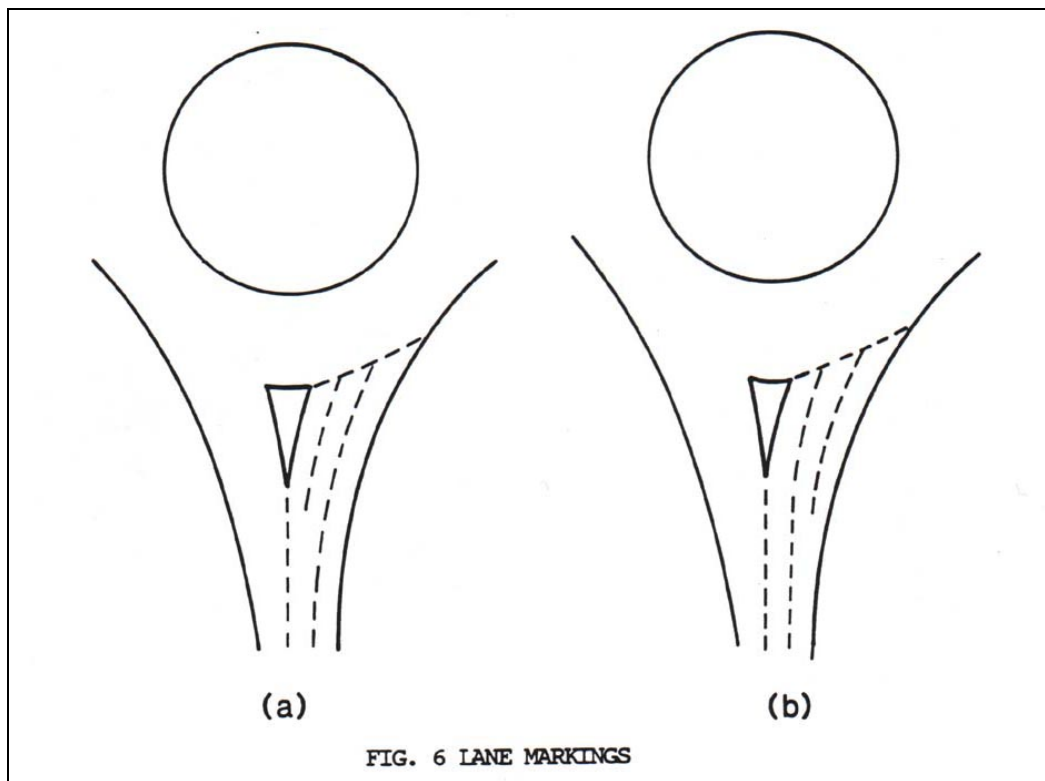
Kimber's capacity equations assume that there are no lane arrows on the approach lanes of Roundabouts. The correct use of lane arrows can be very beneficial in the special circumstances when they are needed. Inappropriate use of lane arrows can reduce capacity, and both ARCADY and RODEL may therefore under estimate queues and delays in such cases.

The reduction in capacity arising from the incorrect use of lane arrows can be quite severe when a high proportion of the approach volumes use one exit. Assume an approach on a 4-leg roundabout has three lanes, with arrows left, straight and right. If 60% of the approach flow is straight ahead, it is constrained to the middle lane, which only has 1/3 of the approach capacity. The resulting queues can quickly block back beyond the beginning of the flare preventing access to the left and right turn lanes, further reducing capacity.

In some situations the use of appropriate lane arrows can encourage balanced lane use, improving

capacity. Traffic often has a bias towards the right most lane. Lane arrows can either encourage this bias, or can encourage better lane utilisation. FIG. 6 LANE MARKINGS shows the alternative markings. The best marking for an approach will depend on the turning volumes. The markings that produce the most balanced lane intensities are best.

Lane arrows can be very complex with subtle problems that can reduce capacity and cause accidents, so great care and understanding is needed.



The Flare Length

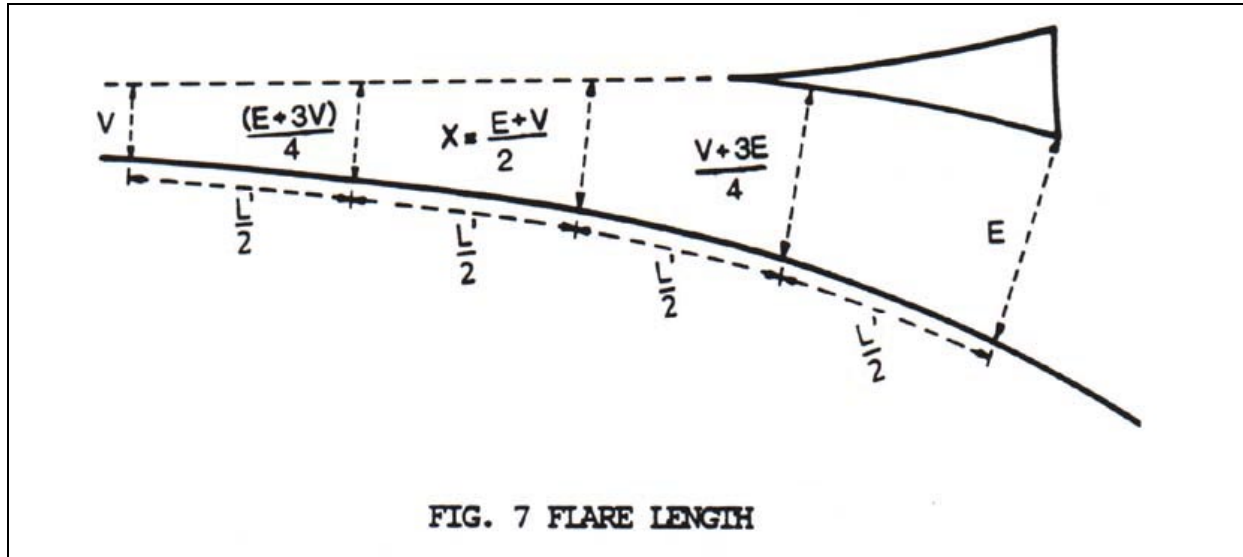
The Flare should develop gradually and be tangential to the existing curb line, avoiding any sharp angles.

The flare length is best measured by:-

1. Measure the effective entry width E and half width V .
2. Calculate $X = (E+V)/2$
3. Find the point where the width across the flare is X
4. L' is the distance from E to the point where the width is X .

(See FIG. 7 FLARE LENGTH)

To set out the flare lengths, other X values can be found for the 1/4 and 3/4 points etc.



The Exit Geometry

The Exit Geometry has three main parameters:-

- Exit Taper
- Exit Width
- Exit Angle

The exit taper should be between 1/15 and 1/20 and must be uniform over the whole length.

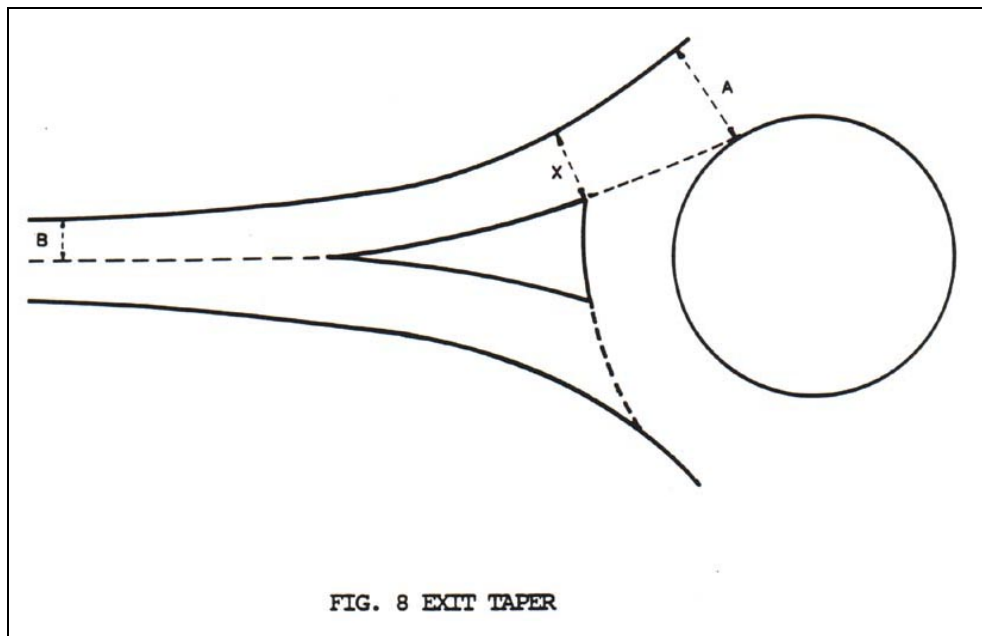
The Deflection Island on the exit should be formed by an arc tangential to both the central island and to the centre line of the exit road. The exit radius should be between 20m and 40m. Larger the exit radii reduces the exit angle making it easier for traffic to leave the Roundabout but this can increase exit speeds. The exit speed will be controlled either by the fastest exiting vehicle path radius (R_3) or by the fastest path speed passing the Central Island (R_3) plus the acceleration into the exit.

The exit taper should be constructed by starting the taper on the circulating width and tapering uniformly to the finish on the exit carriageway. The exit width X naturally emerges. (see FIG. 8 EXIT TAPER)

This avoids layouts with good tapers from the exit along the exit carriageway, but with sharp tapers from the circulating width into the exit.

The exit geometry is not included in the capacity equations as the exit capacity is normally much greater than the entry capacity. However traffic may not fully utilise the entry width if the downstream exit has poor geometry. This can reduce the entry capacity, particularly for straight ahead movements.

The circulating width should be between 1 and 1.2 times the maximum entry width. By constructing the exit taper as described above, the resulting exit width will therefore be related to the maximum entry width.



15. THE VOLUME TO CAPACITY RATIO (V/C)

It is often recommended (TA 16/93) that the volume to capacity ratio (VC ratio) be used as an indicator of junction performance.

Mode-1d of RODEL generates the average delays per leg (in addition to the ranges of entry geometry) for the input maximum VC ratio. This option has been used to examine the above advice.

It was found that the maximum VC ratio of 0.85 is often a quite misleading indicator of junction performance respecting queues and delays. (Queues and delays are much better indicators).

Queues and delays depend on the absolute value of flow as well as the VC ratio. Consequently two cases each with a maximum VC ratio of 85% but with quite different flows will have very different queues and delays.

The following points summarise the findings:-

1. Maximum VC ratio is an uncertain measure of junction performance and can be very misleading.
2. Queue length is a poor measure of junction performance and is only important if blocking back between junctions is a danger, as this will create additional delay. At low flows queues can be very small but delays per vehicle large. At high flows the queues can be large but the delay per vehicle small.
3. Delay is the best indicator of junction performance. (Delay per vehicle and total delay).

Delays were found with a maximum VC ratio of 85% for a wide range of flow levels. It can be seen from the results in FIG. 9 that the delays vary for different flows even though the maximum VC is 85% for every flow value.

Low flows with a maximum VC of 85% produce an average delay of over a minute (max delay over 2 minutes). This can lead to unnecessary under design. At high flows (when design is most difficult), a maximum VC of 85% can lead to over design, with average delays of only 4 or 5 seconds, that may require extensive land and public utility costs. The larger the flows the greater the degree of over design. Higher delays and lower costs are economically justified in such cases.

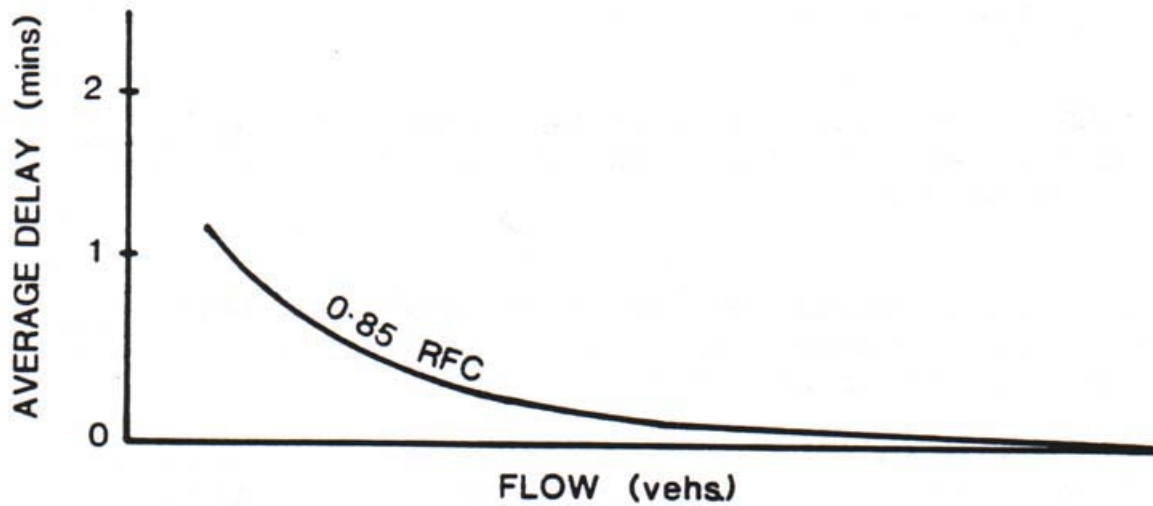


FIG. 9 DELAYS / FLOWS (VC Ratio = 0.85 for all flow volumes)

From FIG. 9 it is clear that having the same RFC on each leg will not produce a balanced design unless the flows are similar on all legs.

RODEL achieves balanced designs to be by means of the Flow Factor. When an acceptable set of geometry has been found with good safety, cost and delay characteristics, the Flow Factor can be used to increase the flows on all legs incrementally. Usually one leg fails well before the rest. Minor changes in the geometry can improve the worst leg at the expense of the better legs to derive a balanced design that should last equally well on all legs.

Rather than using the maximum RFC as a measure of junction performance, RODEL uses delays and delay costs. The 'error' in capacity is taken into account by means of the CONFIDENCE LEVEL. Geometry is generated for the chosen delays with the specified level of confidence that they will not be exceeded.

Rather than seeking to produce a design that simply passes a 'winning post' such as maximum VC ratio, RODEL enables the user to generate the optimum geometry (with the specified confidence level) that minimises queues and delays, yet maximises both safety and cost/benefit objectives.

16. CONFIDENCE LEVEL

It is not possible to estimate capacity with precision. The capacity prediction is normally distributed about a central estimate and it can be chosen for a specified percentile. All models (both roundabout and traffic signal) implicitly use the 50%ile capacity, as this is the most probable capacity.

However, delay and queue estimation depends on the volume to capacity ratio (VC Ratio). Consequently, uncertainty in capacity leads to uncertainty in the VC ratio and the estimates of queues and delays derived using them.

This can sometimes lead to very large underestimation of queues and delays because the Delay / VC Ratio relationship is very non-linear.

To avoid the risk very large delays, RODEL takes explicit account of the delay structure in capacity and VC ratio estimates.

The DELAY / VC curve (FIG. 10) illustrates the problem. The shape of the curve is such that ignoring the distribution of possible VC ratios arising from the capacity distribution can mislead the design engineer who will not be aware of the risk of large queues and delays.

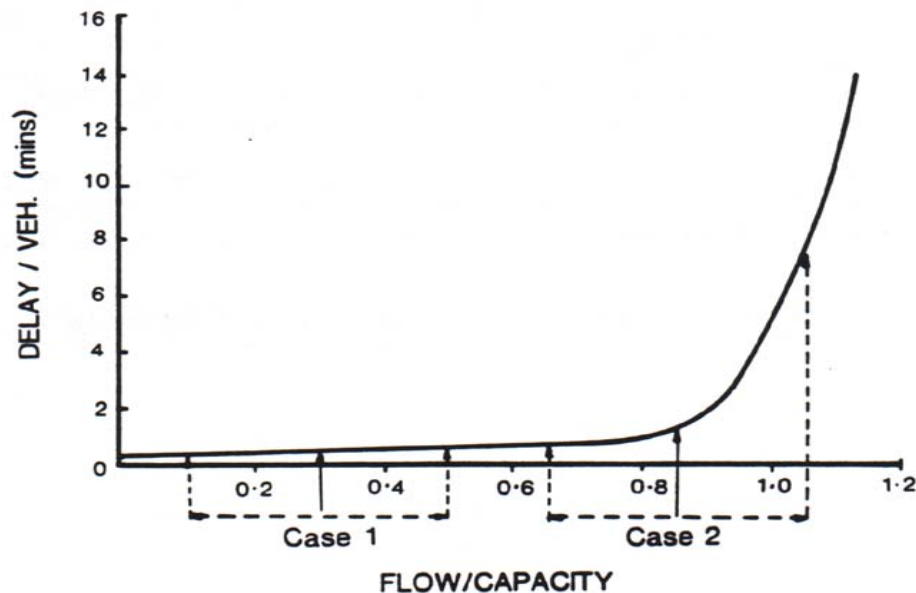


FIG 10 DELAY / VC RATIO

In Case 1 the central estimate of capacity is 0.3 and the whole range of possible VC ratios is on the flat section of the curve. Any VC ratio in the range will produce low delays. The delay prediction will therefore be robust with respect to the capacity and VC ratio prediction.

Case 2 is quite different. Although the central estimate of the VC ratio is 0.85 significant portion of its distribution lies on the steep section of the curve. The central estimate of VC ratio predicts low delays little greater than case 1, but delays at higher the percentiles are very different. In Case 2, if the capacity is less than the 50%ile (central estimate) the VC ratio will be larger and fall onto the steep section of the curve leading to high delays. However the design engineer will not be aware of this risk and Case 2 as well as Case 1 appears equally acceptable with similar delays. Also neither VC ratio has exceeded the 0.85 rule).

There would therefore be no incentive to modify the Case 2 geometry to increase the capacity. Any increase would produce no significant reduction in the delay estimates based on central values of capacity and VC ratio. The design would therefore be considered acceptable, and the risk of very high delays not realised. To reveal this risk to the designer, RODEL uniquely includes a 'Confidence Level' for the VC ratio that is input explicitly. The queues and delays can be estimated for any confidence levels between 50% and 95%.

It must be stressed that the most probable capacities, queues, delays and LOS are with the 50% Confidence Level and this should be used for comparison with other models and for the evaluation of alternatives. The only purpose of the Confidence Level is to alert the design engineer to the danger of large delays when the mean VC is close to the steep section of the DELAY/RFC curve.

If at a Confidence Level greater than 50% is used (say 85%) and the queues and delays increase sharply, it means that the 85% VC ratio is on the steep section of the curve. The good news is that since the steep part of the curve it is extremely sensitive to small reductions in the VC ratio the delays can be dramatically reduced by quite small increases in capacity.

As capacity is very sensitive to geometry, it usually only requires minor geometric changes to move the VC ratio distribution onto the flat part of the curve, producing acceptably low delays. Often this requires no extra land or cost.

When the confidence level is reset back to 50% the queues and delays are little changed. The result is more robust design with low delays and, with a known Confidence Level.

The above takes account of the uncertainty in the capacity estimate. The difference between the actual capacity and the estimate will be permanent so allowing for it in the design is important. It must not be confused with the random fluctuations in queues and delays for a given VC ratio. In fig 10 the delay curve (or the similar queue curve) is the mean of a random distribution. This random variation (vertically) is quite different to the permanent (horizontal) variation in VC ratio. The '95% queue length' must be derived from the mean queue length at 50%VC ratio Confidence Level. The 95% queue length will be typically twice the estimated mean queue length with a 50% Confidence Level for the VC ratio, as used in RODEL.

Confidence Level / Capacity Reduction

VC RATIO CONFIDENCE LEVEL (%)	CAPACITY REDUCTION (Pcus)
50	0
55	-25
60	-51
65	-77
70	-105
75	-135
80	-169
85	-207
90	-256
95	-329

17. RODEL AND ARCADY

Although RODEL is a totally different program to ARCADY it has the same theoretical basis. (LR 942 The traffic Capacity Of Roundabouts and LR 909 Queues and Delays at Road Junctions)

If both programs are used with the same input they will produce the same output. However RODEL is far more flexible than ARCADY and has many unique features that can be used in a variety of ways producing different results to ARCADY.

ARCADY results are for the whole Time Period. If a 90 minute Time Period is used then the output delays are the average delays over the whole 90 minutes and are therefore less than the average hourly delays.

The results from RODEL can be specified for either the whole Time Period or for a sub-period by means of the Results Period.

To compare the results of RODEL and ARCADY, RODEL must be run with a 50% Confidence Level (since ARCADY has an implicit Confidence Level of 50%). The Results Period must be for the whole Time Period.

If the flows are input directly then the results from ARCADY and RODEL will be the same.

If the flows are synthesised then attention must be given to a number of points in both RODEL and ARCADY.

1. The ARCADY synthesis contains a small error such that the sum of the flows in the relevant Time Slices is less than the total input Turning Flows per leg. This difference is not important at low queues and delays, but grows in significance as they get larger.
2. The Results Period in RODEL must be for the whole time period to be consistent with ARCADY.
3. The Time Slice in ARCADY must be a factor of the Flow Times and the Time Period in order to avoid another source of error in the ARCADY synthesis.
4. ARCADY has four ways of specifying the Flow Profile. The RODEL method for synthesising the Flow Profile is generalised and any profile can be input that can be specified by three flow levels and times (Flow Ratios and Flow Times)
The input will then be consistent and the results will be virtually identical.

RODEL produces the maximum delays in addition to average delays. ARCADY produces average delays. Designs rapidly developed with RODEL can be transferred to ARCADY for a single run for submission to the Department of Transport.

18. RODEL AND OBSERVATIONS

If queues or delays are surveyed and compared with the results from a model such as ARCADY or

RODEL, a number of important considerations need to be taken into account.

1. The observed queues or delays will vary randomly from day to day even with identical flow conditions. In order to eliminate this random variation the 'observed values' should be taken as the mean of observations made at the same time on 40 separate days with similar flow and conditions.
2. Both RODEL and ARCADY aim to estimate these 'observed values'. The maximum queue should therefore equal the mean of the maximum values of 40 surveys made under similar flow conditions. Similarly the average delay should equal the mean value of the average delay of 40 surveys under the same flow conditions.
3. If the RFC is on the flat section of the Delay/RFC curve, then agreement with the 'observed values' should be quite good. However, close to or on the steep part of the curve agreement is less likely because results are very sensitive to small changes in flow and/or capacity.

Since flows vary from day to day the average flows from the 40 observations should be used. The estimated queues and delays also depend on the capacity. As the capacity equations contain 'error', the Capacity Factor can be used to estimate queues and delays for a range of capacities around the mean value from the capacity equation (from 85% to 115%). The resulting range of queues and delays can then be compared with the 'observed values'

4. For estimating future queues and delays the Confidence Level takes into account the 'error' in both flow and capacity. The results have the specified Confidence Level that they will not be exceeded.
5. The maximum queue on any day will vary randomly about the mean value predicted by RODEL. This needs to be considered when 'blocking back' is a danger. The random variation can very occasionally be as high as plus or minus 90% about the predicted mean queue. When the predicted mean queues are small this is not significant, but grows in importance with larger mean queues. For practical purposes it is rare for the mean queue to be exceeded by 50%

Double roundabouts can therefore be designed for a maximum queue of about 0.75 the storage capacity.

19. SAFETY

Roundabout design can be very difficult in urban areas where conflicting traffic and pedestrian flows are high and where land and services are very expensive. FIG 10 illustrates the problem in the form

of an Objectives Triangle.

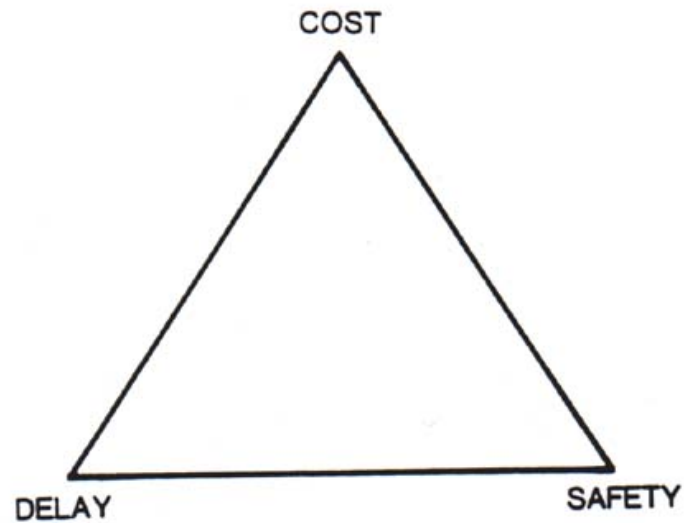


FIG. 11 OBJECTIVES TRIANGLE

Minimising costs and delays while maximising safety are competing objectives and often one can only be fully achieved at the expense of the others.

The design problem is to explore the space inside the Objectives Triangle to find the point that best balances the competing objectives.

RODEL allows the designer to easily explore the Objectives Triangle by rapidly generating sets of alternative geometry's that can be selected with due regard to safety, delays and costs.

Safety considerations have to be given to Pedestrians, Cycles (motorcycles and bicycles) and Vehicles.

Pedestrian Safety.

The following points need to be considered:-

1. Pedestrian flows
2. Pedestrian routes
3. Vehicle flows
4. Vehicle speed
5. Deflection Island size
6. Carriageway width
7. Visibility criteria
8. Crossing Sites
9. Guard Rails
10. Signalized and non-signalized crossings

Pedestrian crossings that give priority to pedestrians for part of the Time Period can reduce capacity and can increase the queues and delays considerably if any leg is moved on to the steep section of the Delay/RFC Curve (FIG. 10)

The effects of a Pelican crossing(s) close to a Roundabout can not be truly modelled since the exit capacity may be reduced causing blocking back onto Roundabout. The effect of blocking back on other traffic negotiating the roundabout cannot be reliably determined. This will not only vary between sites but will vary at the same site on different occasions.

It may be possible to produce a design that can accommodate the worst possible effects of a Pelican(s) by assuming that the roundabout capacity is zero for the proportion of the Time Period that the pelican is operating for pedestrians. The Capacity Factor can be used to factor down the capacity pro-rata.

Cycle Safety

Roundabouts do not reduce accidents for two wheeled vehicles (cycles and motorcycles) to the same extent as for other roundabout users. As the reduction is less, the percentage of cycle accidents increases even though the number drops and this has misled some who have not analysed the results

thoroughly.

The main accident type is the entering vehicle colliding with the cyclist (who has priority) on the circulating carriageway.

If cycle flows are high then a roundabout may not be the best junction type.

If bicycles cannot be re-routed, it may be possible to incorporate bicycle facilities into the roundabout design. The principle to be embodied is to give priority to the vehicle so that the cyclist, not the vehicle driver, decides if it is safe to proceed. (Drivers at stop or give way lines often fail to notice approaching bicycles, but the reverse is less likely)

The entry geometry can be designed to reduce the entry speed. This should reduce the accident rate, but may also reduce capacity and lead to sharp increases in delay. (The effective geometry must be used in evaluating such layouts). At high capacity the discharge rate is high and the accident risk to circulating traffic is therefore greater. The accident severity however will be greater at the higher off-peak speeds.

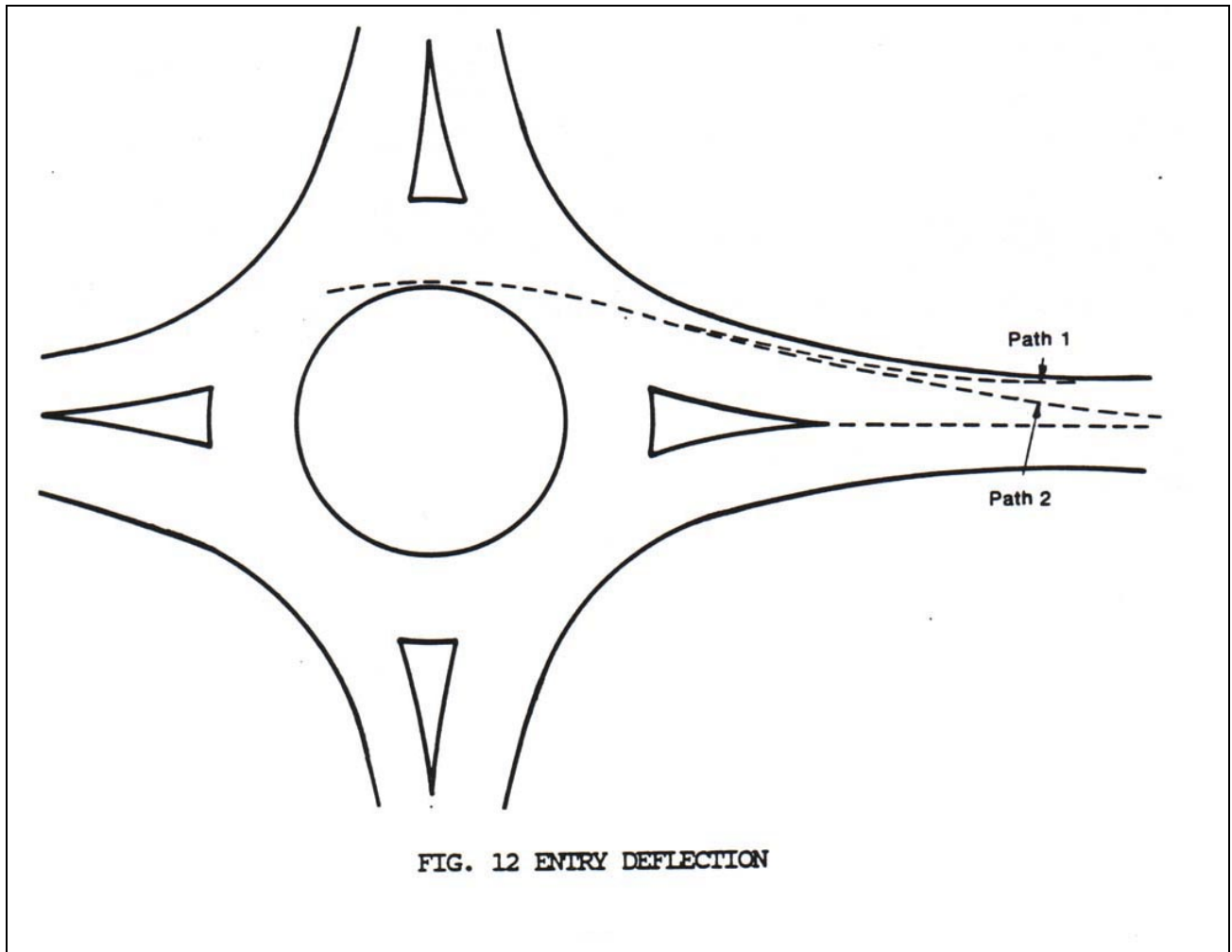
Vehicle Safety

The main source of vehicle accident is caused by excessive entry speeds. TD 16/93 gives advice on the Entry Deflection intended to slow down the entry traffic. The path of an entering vehicle should follow an arc of radius 100 meters or less for a minimum of 20 metres. This should occur within the 30 metres prior to the yield line. (in some cases the 20 metres of arc may overlap the yield line by a few meters) The construction is shown as path 1 or 2 in FIG. 12 ENTRY DEFLECTION.

Good signing and visibility of the roundabout on the approach roads can greatly help reduce entry /circulating accidents.

Care also needs to be given to vertical alignments. With the increased availability of CAD it is simple to produce contours and long sections along vehicle paths through the roundabout to check that the gradients/cross falls for surface water run-off are not excessive or have sudden changes that could be an accident risk. Long sections that plot each end of the vehicle axial are very helpful in this respect.

Often a trade-off has to be made between safety, delay and cost. It is important to remember that the geometry for alternative safety layouts must be the effective geometry, otherwise the queues and delays may be drastically underestimated. (see Chapter - 14 EFFECTIVE GEOMETRY)



20. ERRORS

RODEL contains a three level error reporting regime.

1. Warnings
2. Fatal Errors
3. System Crash

1 Warnings

If a non fatal input error is encountered, the results are displayed, together with a warning message above the results field.

2 Fatal Errors

If a fatal input error is encountered an Error message is displayed instead of the results and the offending field(s) highlighted. The error must be rectified to proceed, or to leave the Mainscreen, otherwise the corrupted input would be saved to file.

3 System Crash

If the system crashes due to input errors not detected by the error checks, or due to a fault in the program the ERROR SCREEN is displayed.

The user is congratulated for beating the system and is encouraged to report the SYSTEM ERROR MESSAGE displayed in the box at the bottom of the screen.

If Rodel runs out of memory then the message WS FULL is momentarily displayed before dropping out of Rodel back to Dos.

Corrected versions, including any minor updates, will be supplied from time to time if necessary.

21. OUTPUT DEFINITIONS

1 Capacity

Capacity is derived from Kimbers equations in LR 924 'The Traffic Capacity of Roundabouts', and is expressed in vehicles per Results Period in Mainscreen and vehicles per Time Slice in the Statistics Screen.

2 Queues

The queues are derived using the set of queuing equations (corrected for accuracy) from LR 909 'Queues and Delays at Road Junctions'. Queues are expressed in vehicles.

The 50% Confidence Level for the RFC gives the most probable queue and this must be used for comparison with other models (they have implicit 50% confidence levels for the RFC)

The 95% random queue is a quite different concept and is the random variation about the queue derived with the 50% confidence level for the RFC

3 Delays

The delays are derived from the flows and queue lengths using numerical integration, and are vehicles per minute in Mainscreen and minutes per Time Slice in the Statistics Screen. The 50% confidence level delays are the most probable and must be used for economic analysis and comparison with traffic signal models

4 Average Delay

The average delay is the total delay for the Results Period divided by the total arrivals during the Results Period. Vehicles with delays that overlap either the start or the end of the Results Period have that part of their delay excluded. These boundary errors tend to cancel each other. Any residual error is so insignificant that it can be ignored, being far less than the 'noise' in the input data. The 50% confidence level delays are the most probable and must be used for economic analysis and comparison with traffic signal models

5 Maximum Delay

The maximum delay is the longest delay per vehicle during the Results Period. If it equals the Results Period then the delay overlaps the Results Period which should be increased to find the true value. The delays per Time Slice displayed on the Statistics Screen indicates the shape of the delay curve and how the Results Period should be selected to avoid overlap. The maximum delay must be derived with a 50% confidence level RFC

6 The Maximum Queue

The maximum queue is the longest queue at the end of any Time Slice during the Results Period. The maximum queue is equivalent to the 95% queue and this must be derived with a 50% confidence level RFC

7 The Average Queue

The average queue is the mean of the queues at the end of the Time Slices during the Results Period.

Because of the random nature of traffic behaviour the queues and delays cannot be predicted for a single instance. The above results are equivalent to the mean of observations on 40 representative occasions.

22. INSTALLATION

1. Down load RODEL into a temporary folder.
2. Execute INSTALL within the folder

3. Double click the Rodel Icon in the Windows Start Menu
4. The 'password' screen will be displayed containing your application number. Telephone or email, quoting the application number and your password will be provided.
5. Type in the password using the numbers above the QWERTY keys and press the F10 key.
6. If the password is correct the system will display the Logo followed by the Menu. When the Menu is displayed press Ctrl and F9 to set the printer settings.
(See Chapter 5 THE PRINTER SCREEN)

Rodel is now initialised and no longer requires a password.

Installation Problems

Rodel requires the majority of the 640K DOS memory. (about 570K). If there is insufficient memory Rodel will drop back to DOS immediately after displaying WS FULL.
With Windows 2000 Capslock must be ON to use Rodel.

Moving RODEL from PC1 to PC2

1. Create a RODEL folder on PC2 = C:\RODEL
2. Copy the contents of the RODEL folder from PC1 to PC2
3. Start RODEL on PC2 and note the Application Number on the Password screen.
4. Start RODEL on PC1
5. When the Scheme Menu appears :- Press Ctrl and F5, release all keys, press Ctrl and F5
6. The uninstall screen will appear.
7. Ignore the instructions on the screen in favor of these.
8. Type in the Application Number from PC2. To do this, use the numbers above the QWERTY keys, not the numeric keypad.
9. Check the application number is correct.
10. Press F10 and note the password.
11. Type the password into PC2 using the numbers above the QWERTY keys.
12. Check the password and press F10.
13. RODEL on PC2 is now active.
14. RODEL on PC1 is deactivated but not erased.