

ROADING RESEARCH OF INTEREST
TO THE FOREST INDUSTRY

D. R. Lovatt,
Senior Planning and
Research Engineer,
Roading Directorate,
Ministry of Works
and Development.

SUMMARY

This paper describes the objectives, functions and current programmes of the Road Research Unit of the National Roads Board.

The particular research activities of the Unit which are relevant to the forest industry are briefly reviewed. The systems established through National Roads Board for funding field tests for education and training, and for publications insofar as they relate to the forest industry are described. Some topic areas of mutual interest for research activity are identified.

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ROADING RESEARCH OF INTEREST TO THE FOREST INDUSTRY

The Road Research Unit is a committee of twelve people representing various aspects of roading in New Zealand. It is part of the National Road Board's administrative establishment and is funded by the Board in 1985/86 to \$980,000 for some 220 current research projects.

The Unit, its establishment, procedures and activities, and intensions for the next five years are well documented in the "RRU Futures Report" (Appendix I).

The chief theme of the Unit research effort is "to improve predictions". this theme applies to improving the prediction of the performance of road materials, roads as built, bridges, traffic engineering measures, trip generation from different types of land use, etc. A list of current projects considered to be of some interest, even if only marginal, is attached as Appendix II.

Forest Research Institute,
Research Assn. Inc.
P.O. Box 147,
Rotorua

TECHNICAL COMMITTEES

The Unit's research activity is generated and supervised by four technical committees.

Pavements Committee deals with pavements starting from about one metre below finished surface level. This includes foundation materials, sub-base, pavement layers, and surfacings and includes sealed roads of various kinds and unsealed roads. There has been an ongoing emphasis on selection and use of less-than-best road aggregates. Some RRU publications dealing with this topic are listed in Appendix III along with other topics of interest to forestry people.

Traffic Committee has special interest in trip generation traffic flow, and road safety. In one of its projects on "Taffic Generation in Rural Areas", it found that forestry produced about 15 times the weight of loading applied to the road serving it that any other usual rural activity would produce. The Committee is also interested in facilities for trucks, such as intersection design, road widths, turning paths, marshalling areas, etc.

Administration Committee has a somewhat wider scope than just administration and includes financial matters and economics, particularly economic

appraisal methods. Four year's ago, studies of costs associated with road accidents revealed an annual cost of near \$500 million. This is more than National Roads Board spends on roads. A manual for economic appraisal of roading funds is nearing completion and is being tested in use by Ministry of Works and Development and by some local authorities.

Economic appraisal from the national interest viewpoint is different from that which might be used by a transport operator. The national viewpoint excludes the tax component of all the items included in the evaluation. These items are; users time costs both working and non-working, fuel, tyres, lubricants, ownership costs, accidents, repair and maintenance of vehicles and the road, interest payments, etc.

There are problems in assembling good representative ownership and operating costs for vehicles. LIRA and RRU may be able to join forces in researching such costs for forestry industry vehicles.

A further project regarding vehicle operations is a computer program, entitled TRARR, which simulates the flow of traffic on a length of road. It requires data on vehicle types and their performance, and a description of the section of road including grades, alignment, surface type, lanes and lane width and volume of traffic in each direction. It provides output on vehicle speed, passing manoeuvres, vehicle time and fuel use and is hence a very valuable tool for assessing the need for, and likely benefits from, undertaking some types of road improvement. This program is being used by Ministry of Works and Development but requires reliable data inputs. Here again, LIRA could assist and could find some use for the program. The paper included as Appendix IV sets out some information about TRARR and the World Bank Study which produced the HDM computer model for total road expenditure assessment.

Structures Committee deals with bridges, water, scour, earthquakes, walls, major earthworks and similar topics.

SOME ACTIVITIES OF PARTICULAR INTEREST

Earthworks are a particular problem for New Zealand roading engineers because of the very wide range of materials that occur throughout the length and breadth of the country. A volume with the title "Geomechanics for New Zealand roads" is being produced to help engineers and engineering staff and it should considerably assist forestry people.

As an adjunct to this, the Unit has promoted research into the soft rock mainly found in the North Island and commonly called papa. We hope to find improved ways of dealing with papa when roads are required in that type of ground.

The next important matter is the use of locally available materials for some or all of the pavement layers. Working up from the bottom progressively better materials should be used, using the cheapest materials as effectively as possible to save costs. Economics of the cost of materials and the road surface they provide need careful attention. Road Research Unit has promoted improved knowledge of poorer aggregates and has funded field trials, along with laboratory and test track studies.

In the field trials, the Unit becomes a partner with the road building authority. Subject to a few important conditions, the Unit will fund the cost of extra investigations, design and testing and will assist with subsequent evaluation and reporting. The road authority pays for the work, and it will usually cost less than what would normally be done. If the test sections fail prematurely, the National Roads Board will pay for the restoration. This way we all learn something about road aggregates that might not otherwise be used and ultimately save on roading costs.

Poor materials can be improved by various stabilisation processes using lime, or cement, or chemicals, or bitument, or combinations of them. A manual, titled "Lime Stabilisations for New Zealand Roads" has been published by the Road Research Unit. Through adopting its practices, some road authorities are building roads at one-third to one-quarter of the previous methods used. This is a parallel volume on cement stabilisations.

Testing of materials can be carried out at the Canterbury University test track. In about three months it can subject six examples of possible county road pavement to the equivalent of 20 years trafficking.

Maintenance of pavements is also a very important matter. The Unit has had prepared a manual on repair of sealed roads and its author is now preparing a comparable manual on unsealed roads. This latter volume will be particularly useful for forestry people.

In maintaining roads, it is important to provide a smooth running surface. Any ups and downs waste energy. This applies whether it is the road grading or just the axles vibrating up and down on a rough surface. The last sheet of Appendix IV

presents a graph of the World Bank's findings on this matter. Certainly bumpy roads are costly for the user.

DISSEMINATION ACTIVITIES

Road Research Unit publishes a Newsletter of 28 pages quarterly in February, May, August and November. This publicises research results and the availability of reports of the research studies. Valuable findings which should be widely used are promoted through the holding of workshops or seminars.

The need for training of road maintenance personnel was revealed by a research project reported in two RRU publications under the titles "Rural road Maintenance : What are the Problems" and "Urban road Maintenance : What are the Problems". In response to the findings, National Roads Board has taken a number of initiatives to improve training.

Firstly, it established a Road Training and Education Committee to monitor and promote training. Secondly, it established training committees at the local district roads council level; there are 21 district roads councils covering the country. Thirdly, it granted \$250,000 to the Local Government Training Board for the production of workers training guides, and made provision for the development of training materials for other levels of roading staff. And, fourthly, it has funded the preparation, publication and distribution of pocket-sized workers training manuals as a co-operative efforts with the N.Z. Institute of County engineers. These documents are references in Appendix V.

CONCLUSIONS

National Roads Board through the Road Research Unit has been promoting the discovery and application of best practices for roads in New Zealand. Some of its findings, publications and practices are applicable to the forestry industry. Likewise, there are matters which the forestry industry has special knowledge of which would assist the Road Research Unit and roading authorities. There will be considerable value in improved communication between LIRA, RRU and the various agencies they serve, both in education and training, and in research work and field demonstrations.

In December 1983 the National Roads Board requested that the Road Research Unit prepare a report describing its expected future directions and activity programme for the next five to 10 years.

The Unit made recommendations which the National Roads Board considered in close detail. The consequent resolutions made by the Board are also recorded here and now form the final section of the report.

ROAD RESEARCH UNIT: FUTURES REPORT

INTRODUCTION

The Road Research Unit was established by the National Roads Board in 1962. In its early years the Unit had considerable difficulties in initiating research activity, but it is now a clearly identified organisation for promoting and managing road research, with capabilities for maintaining an annual budget expenditure of approximately \$750,000.

The objectives of the Unit as agreed by the Board were:

1. To commission, organise and encourage research that will contribute to the creation of an efficient transport system by improving the quality and efficiency of the roading network.
2. To foster the proper use, maintenance and operation of that system.
3. To inform interested parties and the community of recent developments in the administration, operation, maintenance and development of the roading system and particularly the results of research.

Functions

In order to achieve these objectives, the Unit has the following functions:

- (a) Appraisal of roading related problems;
- (b) Identification and selection of research projects addressed to solving identified problems;
- (c) Recommendation and administration of an annual programme of research projects recognising the need for continuity of work amongst established road research agencies;
- (d) Allocation and management of selected projects amongst organisations with the requisite skills;
- (e) Collation of existing road related research;
- (f) Fostering of interest in road research through grants for study, travel, and University scholarships;
- (g) Summary and dissemination of project results directly, and in a form suitable for potential users; and
- (h) Dissemination of useful research data from any source.

Brief History

When the National Roads Board's functions were established in the National Roads Act 1953, two items were specifically related to activities now carried out by the Road Research Unit; namely:

- To initiate and conduct research into roading problems in New Zealand.
- To collect information relative to roading developments in other countries and to make that information available to roading authorities in New Zealand.

Additionally research aspects were associated with at least five other Board functions.

In 1962 the Board decided to establish the Road Research Unit to progress these research objectives. Initially progress achieved on specific research items was slow, but publication of Road Research Unit Newsletter achieved the objective of the second function stated above.

To give further impetus to research activity the Unit established four technical committees in 1968. The committees' fields of coverage were Pavements and Construction; Traffic and Safety; Economics, Finance and Administration; and Bridges and Structures. The committee names have now been shortened to Pavements, Traffic, Administration and Structures.

The activities undertaken by the Unit since that time are recorded in this report and elsewhere, demonstrating a continuing advance towards meeting the research obligations set down in the National Roads Act.

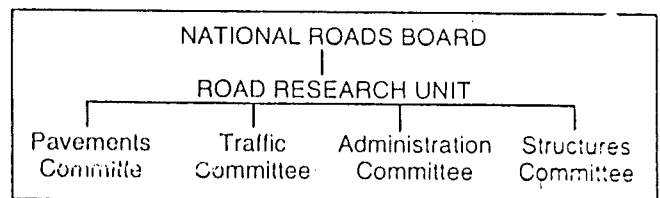
STRUCTURE OF THE ROAD RESEARCH UNIT

Membership

The Unit is comprised of up to 12 members who are appointed for a three year term by the Board. This membership consists of:

The Chairman — Director of Roading or his nominee; one representative each from the Municipal Association of New Zealand, The New Zealand Counties' Association, Consulting Engineers, New Zealand Universities, Ministry of Works and Development, Ministry of Transport, New Zealand Contractors' Federation; and the four Technical Committee Chairmen.

The structural relationship between the Board, the Unit, and its committees is illustrated below.



Each of the Unit's four technical committees comprises members who have been selected to give a broad range of interests and expertise. By these means the most pressing requirements for research effort are made known to the Road Research Unit.

The Technical Committees establish sub-committees and research group meetings as appropriate.

ACHIEVEMENTS TO DATE

Since the Unit's inception 273 research reports have been completed. There are 220 currently active projects. Over 80

reports have been reproduced for distribution as Bulletins and Occasional Papers. All completed projects are recorded in Road Research Unit Newsletters and nearly all are referred to when practices and specifications are being updated. The Unit has promoted workshops, seminars and symposia to aid in disseminating good practices and research findings.

The bar chart (see fig 1) shows expenditure and number of projects over the past 10 years. Achievements could have been substantially greater, but annual research allocations have never been fully expended due to limitations on personnel resources to carry out research projects.

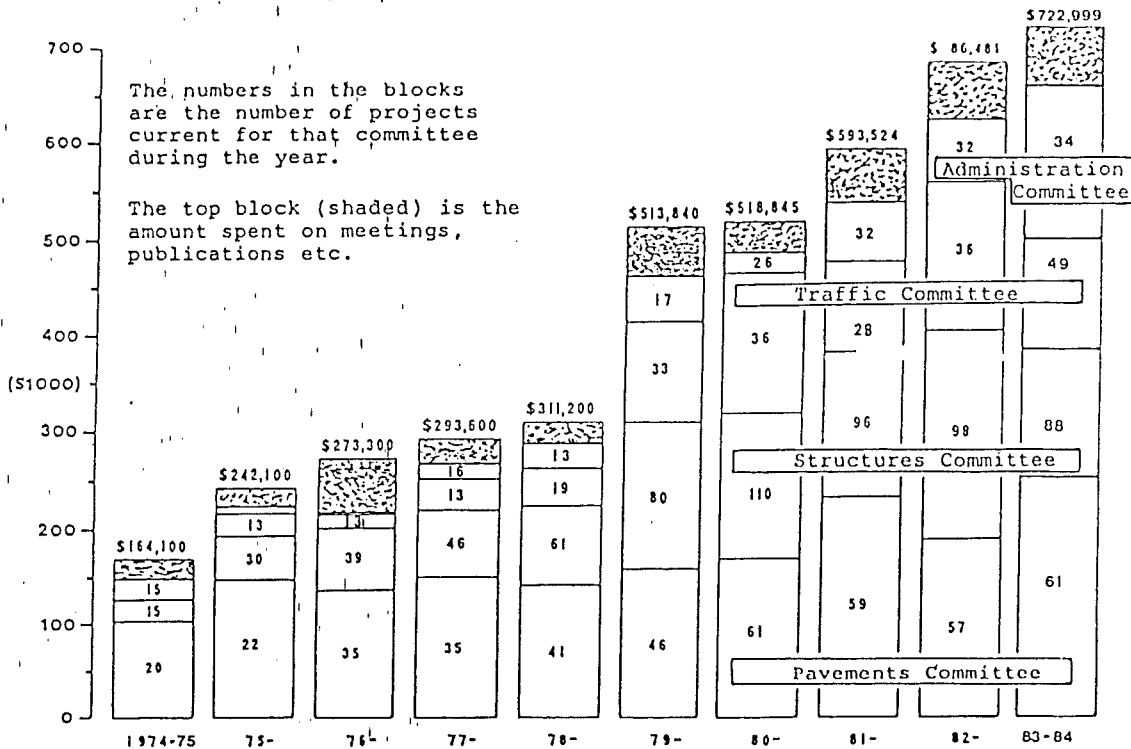


Fig. 1.

THE CHANGING SCENE

Changes are continually occurring in the many and various aspects of transport, road construction, maintenance, operations and management. Research is required in response to some of these changes, and acts as an initiator for other desirable improvements.

Some of the more significant factors which have affected research activities and should be taken into account for future research directions are:

- Changes in the mode and amount of transport, particularly road versus rail.
- Transport economics requiring larger trucking units, heavier axle loads, with consequent effect on pavements, road geometry, bridges, safety and the environment.
- Road classification, and roughness and the continuing use of unsealed roads.
- Vehicle design and vehicle suspension and its effects on pavement wear, and roading structures.
- Changing characteristics within the driving population.
- The appropriate uses for modern construction equipment.
- Social and economic factors, in as much as they affect transport, are creating altered demands for the use of road and street networks for which there is a need to develop appropriate design methodologies. The application of fixed highway design standards is wasteful in this area.
- The effects advances in technology are having on laboratory and field testing methods.
- The greater emphasis now required for economic justification of roading expenditure.
- The growing application of computers and micro computers technology to areas such as traffic signal control; management systems; records; data collection and manipulation; information data bases etc.

FUTURE RESEARCH DIRECTIONS

The directions for future research activity have been considered taking into account the changes referred to above.

In Table I the individual research areas are grouped under nine general topics. The resource input in dollar terms has been shown for each year over the past five years together with the Unit's assessment of the level of input considered appropriate over the coming five years from 1985 to 1990. The future input is indicative only in 1984 dollar values.

Although the Board request suggested a 10 year term for future predictions, the Unit felt it was unable to make definitive assessments beyond the five year period. Within that time if all topics suggested are pursued, and research resources are available, an increase to an annual expenditure of \$1.3 million is proposed, with a total resource use of slightly in excess of \$5 million for the five year period.

Tables 2 and 3 provide an outline of the Unit's expenditure incurred by the various types of agency carrying out research on its behalf, as well as a breakdown of the costs involved in the various types of activity associated with completion of research projects.

ROAD RESEARCH UNIT SUMMARY OF PAST ACTIVITIES AND FUTURE EMPHASIS						
General Topic Area	Individual Research Groups (from section 2 of Report)	Past Expenditures 1980-85 (\$1000)	Future Trends	Suggested Expenditure 1985-1990 (\$1000)	Expected Expenditure level at 1990	Total Expenditure Proposed 1985-90
PAVEMENT MATERIALS	1. Aggregates	331	Substantial increase Substantial increase Small increase Small increase Steady Input	640	340,000	1,345,000
	2. Surfacing	59		300		
	3. Drainage and Water Movement	56		80		
	4. Earthworks and Subgrades	86		100		
	5. Stabilisation	225		225		
ROADWAY PROVISION AND UPKEEP	6. Construction and Maintenance	86	Gradual increase Steady Input Increasing Steady	180	142,000	580,000
	7. Pavement Design	119		120		
	8. Pavement Management	26		170		
	9. Management of Maintenance	113		110		
STRUCTURES	10. Maintenance, Repairs and Strengthening of Structures	93	Substantial increase Decreasing Steady Input Steady Input Steady Input	250	192,000	680,000
	11. Structural Behaviour	139		50		
	12. Seismic Studies	288		300		
	13. Geomechanics	102		100		
	14. Scour	178		180		
TRAFFIC	15. Traffic Detection and Monitoring	173	Rising Slightly Steady Input	250	102,000	430,000
	16. Freight, Parking and Land Uses	175		180		
ROAD USERS	17. Driver Behaviour	46	Rising Significantly Small increase Increasing Increasing	120	210,000	750,000
	18. Pedestrian Facilities	11		30		
	19. Traffic Operations and Safety	208		300		
	20. Accident Prediction and Costs	76		300		
ECONOMICS AND MANAGEMENT	21. Vehicle Operating Cost	10	Increasing Steady Input — Necessary Dependent on NRB decision	80	115,000	360,000
	22. Economic Evaluation	82		80		
	23. Computer Software	—		50		
	24. National Needs and Policy	—		150		
MISCELLANEOUS	25. Miscellaneous Projects	56	Small increase	100	28,000	100,000
PUBLICATIONS AND INFORMATION	26. Information Management	6	Substantial increase Substantial increase Steady Input Increase needed	200	162,000	495,000
	27. Publications and Publicity	138		250		
	28. Workmens Manuals	17		20		
	29. Seminars and Training	11		25		
OVERHEAD COSTS	Meetings — Road Research Unit and Committees	107	Steady Input	120	26,000	120,000
Totals		3,017			1,318,000	5,060,000

TYPE OF RESEARCH: FIVE YEAR PERIOD (1979-1984)	
	\$000's
Laboratory, Analysis and Theory	755
Field Installations	730
Monitoring	485
Equipment Development and Purchase	409
Paid Servicing	74
Publications Development	230
Publications	138
Information	6
Seminars etc	38
Meetings	152
TOTAL	\$3,017,000

RESEARCHING AGENCY FUNDING FIVE YEAR TOTAL (1979-1984)	
	\$000 s
Government	451
University	1,057
Consultants	1,068
Others	179
Total for Research	2,755
Extra Activity Seminars, Meetings Publications etc.	262
TOTAL	\$3,017,000

The research and other activities which are considered important are described in the following sub-sections.

For each topic area a brief description is provided indicating the reason for research being required in that topic, the emphasis placed on that topic area in the past, expected further work and the benefits from it. In addition there are activities such as publications, meetings, etc, which are under the direct charge of the Unit.

The subjects are interrelated in many ways and the subdivisions are therefore in some respects artificial, but to describe all the interconnections would make the report too voluminous.

1 Aggregates

A major part of the past research effort has been directed toward this topic. Road Research Unit Bulletin 50 reviewed progress in the understanding of aggregate performance and described techniques for selection of materials to serve a given function within a pavement. Consideration of production improvements or chemical modification were advocated for various situations. Although some fundamental studies will be encouraged the continued effort will concentrate on the monitoring and prediction of performance of marginal aggregates and the effective utilisation of local resources. In this, and a number of other areas, continuing use will be made of the Canterbury accelerated trafficking facility. The findings of past and proposed research when introduced into practice result in reduced costs or extended pavement life.

2 Surfacing

Modest investigations into elastic properties of asphaltic concrete, jointing of asphaltic concrete, stone polishing, surfacing permeability and a preliminary study of patching mixes have been part of a relatively low key approach to this topic to date. The need for a substantially increased effort has been strongly advocated by practitioners and steps have been taken to expedite progress.

A Review Group consisting of representatives from many New Zealand authorities with relevant expertise has recommended a priority ranking for application of resources amongst the many topics suggested for research. Research is expected to proceed in accordance with these recommendations, and improvements included in the redevelopment of the Canterbury test track will facilitate its use in some projects. As surfacing costs rise, new or improved ways must be found to achieve the desired surface conditions in the most economical manner.

3 Drainage and Water Movement

Water in pavement layers and underlying materials is a major cause of pavement deterioration. Support should be given to a continued significant input into the study of water movement and entry of water into pavements, and the water condition of pavements and subgrades. Very little basic data is available on water in pavements or subgrades and further data collection will be required. These investigations are fundamental to an understanding of pavement behaviour and are closely related to other pavement research topics.

4 Earthworks and Subgrades

The preparation of a draft Technical Recommendation on Geomechanics for New Zealand Roads brought together known basic principles and information. Since this time only minor projects have been commissioned apart from the studies of soft rocks (papas). Only a minor continuing effort is currently envisaged since the application of such research would not be widespread in a time of low construction activity.

5 Stabilisation

A concentration of resources on this topic has resulted in the publication of technical recommendations for New Zealand practice on lime and cement stabilisation of roading materials. Practitioner education and dissemination of information through seminars and performance monitoring projects has been actively pursued. This has already resulted in considerable savings for road authorities. A continued lower priority effort will see the completion of recommendations for standard testing procedures, the study of new stabilising agents and the continued performance monitoring of existing and new test sections. The conditioning of lower grade, lower cost materials to serve as satisfactory pavement layers will continue to save roading funds.

6 Construction and Maintenance of Pavements

The major achievement has been the preparation of a guide for the maintenance and repair of sealed pavements. A similar document on unsealed roads is nearing completion but it has identified a need for much more work. These documents inform and provide guidance to all roading authorities and their personnel about best available current knowledge suitable for New Zealand conditions.

In addition, there is substantial concern that the findings from other topic areas should be more actively translated into improved maintenance and construction techniques. The extent and nature of problems in the construction and maintenance of both sealed and unsealed pavements needs to be examined and this merits substantially increased attention in the future because user costs and maintenance costs are highly sensitive to the practices adopted.

7 Pavement Design

Pavement design courses, performance monitoring, establishment of material characteristics in the laboratory, and pavement temperature studies have contributed to a significant effort in the past. Research into the determination of design parameters should continue with an emphasis on the collection of performance data for correlation with current and proposed pavement design philosophies and concepts of pavement behaviour. The formulation of correct concepts will assist local roading people to understand the nature of their special problems but is not a major activity.

8 Pavement Management

The importance of this topic as a subset of roading management is now generally accepted and work to date has involved the consideration of pavement management appropriate to small and medium sized local authorities. Improved techniques for economic assessment of alternative maintenance strategies have been developed for use by practitioners, but there is still a need for further work on the definition of appropriate technical procedures and evaluation of their effectiveness. The development of guidelines for the maintenance management of unsealed roads which comprise 53% (43,493 km) of New Zealand's road network has become an important topic in its own right and will require a substantial input of resources.

9 Management of Maintenance

Because of the very high proportion of funds now being spent on road maintenance activities a major effort has been made to improve performance in the many and varied aspects of maintenance. Documented management procedures are being developed which include task identification, resource allocation, and target standards. On completion there will be an introductory and educational phase with specific demonstrations and the need for assistance to local authorities having particular problems.

10 Maintenance, Repair and Strengthening of Structures

Limited attention has been given to areas such as concrete quality, expansion joints and repair techniques. With the increasing trend towards rehabilitation and strengthening rather than replacement of bridges this is an area in need of increased attention. Steps are being taken to address this need and a substantial increase in activity is proposed.

11 Structural Behaviour

Considerable effort has been placed on aspects such as prestressed concrete bridge analysis and design, creep and shrinkage in concrete, and the design of multibeam bridges. Work is required in the area of bridge loadings, loading combinations, impact effects and in the assessment of the capacity of existing bridges. Proof loading and destructive testing is an important area to be pursued when appropriate bridges are available. A steady level of activity is expected in this area so that existing bridge life can be extended where possible.

12 Seismic Studies

Considerable progress has been made in this topic which covers the seismic design of bridge substructures and superstructures. Continued effort is required to improve design procedures for seismic resistant bridges. Research into the performance of structural members, soil/foundation interaction and the behaviour of bridge structures through field testing is required. Shaking table laboratory studies with simulated earthquake motions are commencing and initial results suggest behaviour seriously divergent from expectations based on previous static testing. Further work is required to resolve these complex problems. It is expected that research effort will remain reasonably steady for a few years before declining.

13 Geomechanics

Research activities have been directed into establishing engineering properties of soft rocks (papa), slope stability problems, site investigation techniques and aspects of soil structure interaction. The soft rock work is near conclusion but ongoing efforts are required in the other areas. Soil structure interaction requires field testing projects to further understand behaviour and earth site investigation techniques to be evaluated. Field testing projects are expected to create demand for increasing expenditure in this area.

14 Scour

Damage to bridges and their approaches due to flood waters (scour) is an item requiring substantial remedial action each year and considerable disruption to traffic results during the restoration process. Research to date has produced a good understanding of scour related to bridge piers. Most flood damage costs are associated with scour at bridge abutments. Laboratory research efforts are required to understand the abutment scour process. Field scour studies are required to test theory. Design methods need to be developed on the basis of research findings. Activity in the scour field is expected to remain at about current levels.

15 Traffic Detection and Monitoring

Reliable recording of vehicle behaviour is a condition necessary for activities ranging from optimising performance of simple intersections through to specifying the volume and mix of vehicles on a rural highway.

In order to provide the quality and quantity of data required for the adequate description and prediction of traffic movements, the Unit intends to continue and probably intensify its programme of research into the development and range of convenience of automated vehicle detection and tracking techniques, using both conventional and video means. This work involves a careful analysis of the responses of detector loops, the reliability of response of detector units and the development of appropriate logging and real-time data processing programmes. The end use of this work is presently envisaged to be in the optimising of the regulation of converging and intersecting traffic through volume and pattern responsive signalling systems, and the provision of reliable field data against which the validity of theoretical models may be tested.

16 Freight, Parking and Land Uses

Commercial vehicles comprise a substantial component of total traffic volume. The Unit has necessarily been concerned that the characteristics of such traffic be accurately identified so that it may be optimally routed and serviced, so minimising direct and indirect community costs.

To this end, it will continue actively to promote research into such matters as the volume and pattern of commercial vehicle movement as a function of freight type, origin and destination with a view to recommendations on matters of road type, networking and facilities for the conveying of freight in and through both rural and urban areas. This work involves both the examination of overseas practice and active local fact-finding exercises.

17 Driver Behaviour

The driver-roadway-vehicle system is a complex one, but even a superficial examination of accident and near-miss data indicates that analysis of the driver-roadway interface may reduce the number of accidents traditionally attributed to driver error.

A modest programme of research has been progressing in this area for a number of years, and the recent investment in equipment has permitted at least a beginning to the real-time examination of human response to roadway features. Future work in this area, prompted in part by the fact that roadways are used by an increasingly ageing population, will focus on the best means of communicating with the driver through static signs, markings, and signals, and on what cognitive processes are involved in detecting or failing to detect hazard. The end-product of the former work will be empirically-based recommendations for the design of signs and markings; the end-product of the latter may include geometric design recommendations. A much-intensified programme of work in this area is foreseen.

18 Pedestrian Facilities

The pedestrian (and cyclist) of any age is a vulnerable and sometimes erratic road user who is expensive spatially to separate from motor traffic. Inadequate temporal separation may also prove expensive through the occurrence of collision with motor vehicles or of delay to traffic flow.

It is therefore desirable on economic as well as humane grounds efficiently to schedule roadway sharing, particularly by vehicle and pedestrian. In the absence of ready-made importable solutions to this problem, the Unit has initiated a programme of detailed research into the means of measuring the efficiency and safety of pedestrian facilities of various designs, ranging from the current zebra crossing through to signalised devices such as Pelican crossings, and examining their utility in New Zealand. While no formal programme of research into facilities for cyclists is planned, the option to engage in such research will be exercised should specific issues arise.

19 Traffic Operations and Safety

Given the general goals of traffic engineering as the safe, orderly and expeditious flow of traffic, an active programme of research designed to attain these goals has occupied an important position in the Unit's programme in the past.

Whether dealt with singly or in combination, the influence of physical factors such as roadway geometry and intersection management, and of temporal factors such as varying vehicle volumes and sizes, on the efficiency and safety of traffic operations will continue to be subjects of considerable interest, and will continue to rely heavily on both professional and theoretical input. Topics of developing interest include the identification and remediation of hazardous locations and means for minimising vehicle build-up and delay. These will be examined using both local and area-wide data, and remedies sought through whichever local and area-wide measures are empirically found to be most effective.

20 Accident Prediction and Costs

Economic analysis techniques are being used more and more frequently in providing advice towards choosing projects and activities for funding. One of the savings is in the expected reduced accident numbers and in costs of accidents. Accident costs can also direct attention to blackspots and their economic improvement. Research efforts in New Zealand have so far concentrated on the various elements of accident costs and some refinement of data and its use is required.

Improved methods for predicting accident reductions likely to result from remedial actions is the next major activity in this field and will require a continuing monitoring programme.

21 Vehicle Operating Costs

For economic appraisal purposes it is necessary to have reliable vehicle operating costs. These costs are required for a range of vehicle types (light cars through to heavy trucks), operating on various grades and alignments and on different road surfaces. Reliable and efficient methods for obtaining these data must first be established and procedures developed for data updating as the vehicle fleet changes. A small continuing programme is proposed.

22 Economic Evaluation

A code of practice is nearing completion for use by all road authorities in undertaking economic evaluation of road related expenditures. The methods being developed for use are standardised in principle but rely substantially on input data and on field measuring techniques. Examples of applications of the methods need to be assembled and published so that practitioners can more readily perform their own evaluations. There will be a continuing need for a modest effort to keep the manual up-to-date.

23 Computer Software

Some Local Authorities and central government are developing packages and programmes which assist in keeping records, managing, analysing and designing for various aspects of roading. It is proposed that some assistance should be provided toward standardisation through the interchange of developed and tested software packages arranged between authorities. This is not expected to involve a large programme of work.

24 National Needs and Policy

The Unit has not engaged in research regarding future road transport demands other than developing economic evaluation methods which ensure funds are wisely spent. Research could be undertaken on overall national needs for improved roads either for safety, capacity, load carrying, access or environmental reasons. This work would assist decision makers in deciding the relative emphasis for expending a fixed budget or for determining the size of a budget to meet specific objectives.

25 Miscellaneous Projects

From time to time feasibility studies and initial investigations are undertaken to explore possibilities for major work if the need or likely benefits are indicated as worthwhile. There are also some medium sized projects not falling within the major topic areas, such as a study on use of road space, project management, community benefits of roading and disbenefits such as noise etc. There will be a continuing need to fund such exploratory studies.

26 Information Management

Access to existing information plays a vital part in improving knowledge both for practitioners and researchers. In recent years information data bases, held on computers and available by telephone dialling, have enabled far greater access to information. Increased effort is required by the Unit both to gain access to the available sources, to distribute this information and to place in the data bases such New Zealand information as deserves wider dissemination. Obtaining hard copies of microfiches of the desired publications also deserve greater emphasis.

A sustained effort is required to facilitate the availability of, and to monitor, the information coming to hand in the wide range of road related topics relevant to New Zealand's needs. This effort is not necessarily associated with the particular research projects currently being pursued and additional people are needed to provide this monitoring effort.

27 Publications and Publicity

There is a continuing emphasis in the Unit to prepare publications, based either on practice or on the outcome of research for use by practitioners. The amount of effort devoted to this activity depends on the capabilities of the likely users. Some research reports can be used as received while others require substantial editing. Management of existing and new information, and its wider promulgation into practical use, should be improved and warrants special emphasis by the addition of greater staff resources in the areas of technical writing, editing and journalism.

28 Manuals

In conjunction with County and Municipal engineers good progress has been made on the preparation and publishing of small manuals for use by foremen and workmen to improve practice. This activity will continue until the series is complete. Manuals have been prepared for road maintenance and economic appraisals. As additional topics needing documentation are identified further manuals will be prepared. Of major immediate importance is the assembly of a bridge maintenance manual suitable for use by field staff in day to day maintenance.

29 Seminars and Training

As well as arranging the four yearly New Zealand Roading Symposium the Unit has promoted seminars and workshops on specific topics. These are held either on completion of a project when the results are to be introduced into practice, or as research is being undertaken to obtain input from interested parties. This activity will continue, but with the added intention to bring some research results to a state where they can be used directly by the Board's Road Training and Education Committee and educational agencies. The benefits which can be obtained from research only occur when people change to the better practices, and seminars and training courses are seen as a major contributor to introducing these changes.

RESOURCES FOR RESEARCH

The research programme which can be undertaken by the Unit is dependent upon resources of various kinds.

These are set out under the headings of personnel, equipment, and funding, firstly by describing the past and present position, and secondly the future needs.

Past and Present Position

Personnel

Three distinct groupings of personnel contribute to the Unit's research programme. The groups are identified by the type of responsibility they have, namely:

- (a) Research Management.
- (b) Research Execution.
- (c) Research Activity Support.

Some individual people may be involved in more than one of these groups.

(a) **Research Management** involves the identification of potential research topic areas, possibly in the instigation, but certainly in the programming, monitoring and evaluation of research work required in these areas. These tasks are undertaken by members of the Unit, its Technical Committees and sub-committees, at no charge to the roading funds other than that required to meet actual costs of attending their scheduled formal meetings or ad hoc meetings with researchers. About 5000 hours of experts' time is provided in this way for research management at very low cost to the Board.

(b) **Research Execution** is the actual carrying out of research by, or under the close supervision of private consultants, university staff or people employed in local or central government agencies such as councils or departments. This work is paid for in part, or in total, at varying rates. Thus consultants are usually paid at professional rates; local government and central government at ordinary wage rates plus materials etc; universities often donate substantial amounts of staff time and other facilities, receiving relatively low payments for student support. It is extremely difficult to estimate the number of donated hours, or the value of unpaid for services.

It is a matter of serious concern to the Unit that in some research areas the number of expert researchers is comparatively low, and that people who are both appropriately talented and interested are available to undertake research only on an intermittent basis.

(c) **Research Activity Support** (e.g. of a technical or secretarial type) is provided, both for research and its management. These costs are usually included in projects undertaken by consultants. For universities and government agencies these costs may be, but frequently are not, included in the project cost depending on the arrangements made when establishing the research project.

Staff support for committee and sub-committee activities, such as technical support, clerical work and contract management, publications and similar works is provided almost entirely from within the Roading Directorate of Ministry of Works and Development. When there is insufficient Directorate staff available external consultant servicing has to be obtained as if it were a research project. The total support staff time commitment is equivalent to seven full-time people, but this is spread amongst a number of people who may be involved as a part of their wider range of duties. Nine technical people are involved and their commitment varies from 5% to 75%. The total input approximates three fully committed technical people. There are two wholly committed clerical/administration appointees, namely the Unit's secretary and an assistant research officer. Other services such as typing, accounting, newsletter editing etc, amounts to perhaps two equivalent full-time people.

Equipment

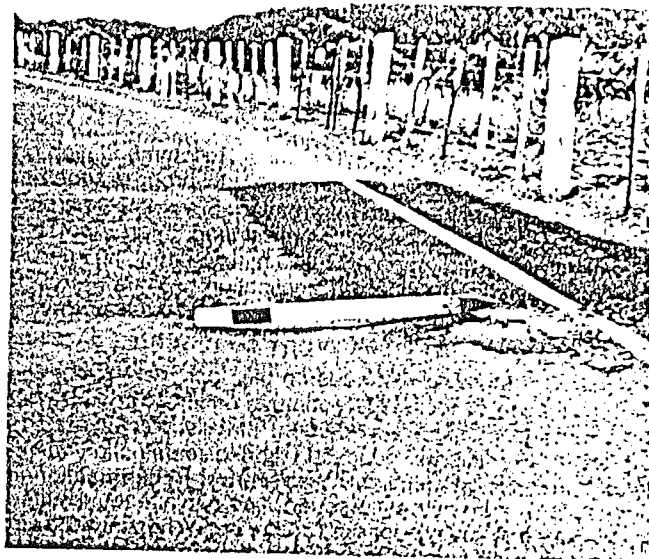
From time to time the Board makes substantial financial contributions towards the cost of equipment required for research (e.g. Canterbury Test Track, DARTEC Tester, Traffic Data Caravan etc). Typically these payments are only part of the cost for a particular item of equipment, or may be the full cost of an item being used in conjunction with other items not funded by the Board. Where the equipment is used for a suite of projects good value is received and there is fairly full usage. Where equipment is associated with a series of short term or dispersed projects there have been difficulties in obtaining optimal usage, and hence full value, from the equipment. On today of this equipment is left with the research agency involved, pending its possible need on other road research projects.

Some projects, and a considerable amount of desirable field measurement and monitoring are not undertaken because of a lack of resources, both of people and of equipment. Much research can only progress through the development of quite sophisticated measuring devices or systems. Newly produced equipment in the commercial field is often expensive to purchase, and development of dedicated special equipment is also expensive. Proving the reliability of new equipment from either of these sources can also be expensive, but is the necessary precursor to improved measurements in roading practice.

Funding

Current procedures require the Unit to obtain Board approval for a yearly budget in December of each year, the amount sought being based on intended research activity. The Unit then apportions the amount approved among its four technical committees based on the best selection of projects submitted. Each new project has then to be individually approved by the Board in regard to its objectives and its estimated total cost. The Unit and its technical committees select researchers and manage the programme within the limits set.

The Unit has never expended its full financial allocation in a year but has generally achieved 90%. Thus it can be said that funding levels have not been a limiting factor on research. The limit arises more from the length of time taken to develop projects and obtain approvals through the system of committees, the Unit and the Board, and from the lack of personnel with skill or experience necessary to complete research in the desired fields.



FUTURE ORGANISATION AND RESOURCE NEEDS

Road Research Unit Organisation

From time to time there have been suggestions that the Unit should be established as a separate entity and have a fully committed staff, maintaining such an organisation and ensuring a sufficient range of skills was available would require a substantial establishment.

Past considerations of this concept have led to the conclusion that while it would provide a stable base for ensuring that research can be undertaken with guaranteed career opportunities for people with a committed interest in research work, the overall cost of the research programmes undertaken must rise significantly. Additionally there could be a tendency for research staff to lose contact with day-to-day realities of the roading operations with research emphasis drifting away from practitioners' needs.

The present structure of the Unit has developed over the years to match the research topics requiring attention and the rather limited resources available to carry out the work. In the current review it was concluded that this structure is basically suited to handling the research activities seen in the future, and that while alternative structures could be adopted it would be unwise to make major changes with their short-term disruptive effects merely for the sake of change.

Assuming the existing structure is retained, improvements are considered necessary to overcome a number of current problems and operational deficiencies.

Present problems

The Unit believes that a number of factors combined to hinder progress and achievement from the research activities it undertakes on the Board's behalf.

(a) Servicing Staff

The Unit and its Technical Committees require greater servicing staff resources to operate effectively. This situation has been referred to in earlier parts of the report but the staff structure needed to handle present research programme levels is:

- An overall research director;
- Four technical secretaries;
- Access to a further group of technical personnel equivalent to four full-time people;
- Three administrative or clerical secretaries;
- A technical writer; and
- A publications officer.

All of these people should be made available from within the Ministry of Works and Development. This committed personnel resource is seen as being interchangeable between committees and Unit tasks.

The nine fully committed staff and the partially committed technical assistants proposed would be supervised by the research director. Such an arrangement would lessen the amount of detailed administration work required of committee members, and could enable responsibility for direct project supervision to move to the research unit servicing staff.

(b) Project Approval Procedures

The time and effort required to develop a project brief in conjunction with potential researchers and to process it through the range of approvals required by the Board is considered unnecessarily great. In some cases achievement of research results takes considerably longer than potential users have a right to expect, while in other cases the opportunity to make use of a valuable researcher or research agency is lost.

Since the Board is reluctant to allow full delegation of approvals to the Unit a more flexible approach than the current requirement to obtain Board approval for a detailed brief and estimate on every project together with further approvals for each cost overrun and expansion of a project brief, is sought.

The Unit could supply schedules outlining the individual project content and expected cost for Board approval, on the understanding that these works would then be included within the overall research allocations for attention on the basis of the priority seen for each of the works by the Unit, and the availability of appropriate researchers to complete them. Variations in the briefs and costs for individual projects could then be subject to Director of Roding scrutiny and approval.

The alternative, if current delays are to be reduced, is to increase the frequency of meetings held by the Unit and its Committees, with a consequent increase in overhead costs, and unnecessary call on the time of the people involved.

(c) Research Expertise

In a country the size of New Zealand the opportunity for people with a genuine interest in road research to specialise in particular fields is limited. Often the number of people with expertise in a topic regarded as deserving of research attention may be only a few or even only a single person, generally with very little time available outside their normal employment to assist in the activities of the Unit.

This lack of expertise or technical resource to put together research briefs, carry out research, and even to assess the value of potential research projects places some restrictions on the areas in which the Unit's programmes can operate.

Coverage is being obtained as far as possible through the use of sub-committees to supervise and assess research activities carried out as suites of projects in particular topic areas i.e. bridge scour problems. However, a need is seen to encourage researchers to commit themselves to programmes of road research by offering employment for a minimum contract term of say three years at a University to handle a series of projects in a particular topic area with some certainty of employment continuity. While this may commit research work on some projects considered of lesser priority it would ensure resource is available to carry out the high priority works when these are required. Provision of Road Research Fellowships would enable the appropriate type of staff to be employed for this purpose.

Another concept new to roading research in this country is 'centres of excellence' which provides the opportunity for concentrated research effort. Although this term is uncommon in New Zealand, what it refers to is not. A centre of excellence is a location where a team of people, appropriately equipped, is concentrated for research in a specified topic or set of related topics. The medical research units supported wholly or in part by the Medical Research Council exemplify the idea rather well. The pavement testing facility at the University of Canterbury represents a Unit/Board step in this direction. The distinguishing feature of centres of excellence is continual employment of research effort. This may be attained by wholly or partly subsidising the appointment of scientific or technical assistants, or colleagues, to a researcher whose personal availability for fulltime research is limited. This is a better method for obtaining sustained research output than attempting to obtain it on a project-by-project basis.

Such centres are not cheap. The least expensive would cost \$30,000 a year, to cover a junior scientist and running costs. Staffing and running costs might approach \$200,000 a year for a large facility engaged in sophisticated work. While this might appear to restrict the amount of research which could be done within a fixed budget, it must be reiterated that the amount of research presently being done in some areas is already severely limited through the lack of continuity of effort available to the Unit. Some potential research centres in universities are already partly staffed and equipped. They attract visiting scientists taking research and study leave, students, and people on secondment.

Establishment of centres of excellence does not commit either the Unit or the Board to support their existence in perpetuity. Their level and duration of support is a function of the extent of the research issue(s) addressed and the quality of the research produced. Their activity and output would provide a model for the professional performance of those students who may wish to make a career in roading and transportation and produce a substantial advance in local competence. These benefits, well known from experience elsewhere, flow on into professional practice.

(d) Unit and Technical Committee Responsibilities

The technical committees set up by the Unit have been assigned to general areas of research which were significant at the time of their establishment. With time the topics being investigated have varied and some overlap of responsibilities is now occurring. The Board has, in addition, set up a number of other technical committees of its own whose responsibilities often impinge on the operations of the Unit. These committees are:

- Signs Committee.
- Axle Weights and Loadings Committee.
- Road Training and Education Committee.
- Local Authority Liaison Committee.

The number of technical committees operated by the Unit, and the topic areas they cover requires review and closer definition to ensure that their operations do not overlap, and that they do not conflict with or duplicate responsibilities of the Board's other committees. These matters can best be decided by the Unit.

The Board should first consider and define the relationship of the Unit to the other Board committees within whose spheres of interest some of the Unit's research falls. Some of the research may be in response to requests received from these committees, or in the provision of unsolicited information which may be of use in the activities of these committees.

Research work, mainly on operational matters, is also undertaken directly by the staff of Roading Directorate. In most cases this work can be progressed more expeditiously than if it were handled through the Unit and its technical committees.

On a number of occasions in the past the Board has requested that specific matters concerning it should receive attention by researchers. The Unit's response in some of these cases has not been as rapid as desired and the information sought has not been made available within the time scale expected by the Board, with other avenues having to be tapped to achieve any results. One of the obvious reasons for this lack of rapid response, is the extended approval process commented on earlier. This position could be improved by the Unit being given greater flexibility as described earlier, or by some research funds being set aside for expenditure by the Ministry of Works and Development's Roading Directorate, on operational tasks.

An area where definition of responsibilities is necessary is the cut-off point between research and education or training. Until the Road Training and Education Committee was established the Unit handled the training and education aspects as a necessary follow-on for putting research into practice thus ensuring the maximum benefits are obtained from having the research work undertaken. The Unit now considers that it should be responsible for an introductory seminar, or seminars to explain the results and expected applications of research work, but that further training and education programmes should be left to other agencies to arrange with funding from outside the research budget.

(e) Contacts with Other Research Agencies

To enable research to proceed efficiently and to avoid duplication of work being carried out by other research agencies both in this country and overseas it is essential for the Unit to:

- (i) Have access to and ensure maximum use of all available information services able to provide data on road research activities elsewhere. The Board has already arranged access to the AUSSINET system, but joining

the IRRD system would expand the available data sources considerably and should be considered.

- (ii) Have ability to arrange for personal contact with researchers in other agencies particularly in overseas countries. At present contact exists with agencies in New Zealand, and with the Australian Road Research Board. Membership of PIARC and REAAA plus contacts with IRF enables some contact but the opportunity for researchers working on particular projects for the Unit to discuss their work and ideas with counterparts working in overseas countries where this is appropriate must also be considered. While reading reports of completed research may be helpful to researchers there are a number of occasions where only direct contact and discussion of ideas can produce the type of research results most able to benefit the road user. An increase in sponsored research travel is considered necessary, the Unit's recommendation being that this should not exceed 3% of its annual allocations, with individual proposals to be considered for approvals in the same manner as normal research projects.

(f) Technical Committee Membership

Membership of technical committees has been on the basis of approaches to and appointment of people with known interest and expertise in the subjects currently considered appropriate for research by the committees. The term of appointment is not fixed, but rather the size of committees has been informally suggested as not exceeding seven or eight persons. Some difficulty does occur in deciding when new members should be appointed with existing members to relinquish their posts. Changes do occur in work emphasis but with the technical committees largely self contained and making their own decisions on membership needs, the tendency to retain existing operations rather than embarking on new fields with new membership does appear.

Appointments to committees should be for terms of up to three years to match those of the Board and the Unit itself. At the end of each term of membership the need for changes both in the membership and the field of research operations handled by each of the committees should be reviewed by the Unit. Some variation in the numbers of technical committees operated may also be appropriate from time to time to accommodate work in new fields of research but any recommendation to change the present number of four committees should receive prior approval from the Board.

Levels of Funding for Road Research

The Board, during the earlier part of the Unit's existence, had set a target of 0.5% of the roading budget to be spent on research activities. This level of activity has never been achieved, largely through lack of resources to carry out the research work. Currently the level of direct funding by the Board represents about 0.27% of its budget, although the true input to road research activities would be significantly greater than this due to many costs being absorbed by other agencies.

The research budget should be determined as the sum of the costs of those projects considered worthy of support, and able to be carried out efficiently within the limitations of resources available. This means that the budget level for research could fluctuate significantly from year to year due to changes in availability of expertise to handle individual research topics, and in the need to purchase major items of equipment associated with some projects or suites of projects.

While the current level of research allocations matches the resources available to carry out this work, improvements in overall management of research activities outlined in previous sections if put into effect would enable an increase in the effective research input to be achieved. The activity levels proposed in Appendix 1 are in keeping with the levels of research which the Unit considers that the Board should aim to have carried out over the coming five years. This would amount to a total of slightly in excess of \$5 Million being spent in this five year period, corresponding to a build-up in resources to handle an activity level of \$1.1 Million to \$1.3 Million per annum by 1990.

While this is a substantial sum it still represents only slightly above 1/3% of the Board's budget or about half the earlier aims for research input. In looking at the need for research expenditure the question posed should not be "Can we afford to spend that amount?" but rather "Can we afford not to spend that amount?"

Not all research will produce information which can be shown to justify the cost of the work involved. However a significant proportion will pay substantial dividends by way of savings in operational and user costs through the introduction of new measures, procedures, and philosophies. Regrettably

the actual potential for the savings resulting from carrying out a research project are not able to be assessed fully until after the project is complete, but it would be most unwise to trim back a research programme merely because it is known that part of it will produce no quantifiable benefits.

The studies carried out by the Unit in the preparation of this report have identified the weaknesses in several areas of its operations and have provided pointers as to how these may be improved. In the interests of all parties the Unit believes that by ensuring that the changes proposed are introduced, and a modest additional level of input is made to road research in line with these proposals, the possibility of fluctuations will be minimised, and the return for roading operations will be optimised.

In recommending the broad programmes contained in Appendix 1, and outlined in Section 2 the Unit would point out that unlike road construction and maintenance operations, research programmes do have a considerable measure of flexibility to be stretched out to match funding availability even after work is commenced. Rather than complete removal of specific research topics, a more acceptable method for handling restrictions on research budgets may be to make corresponding change in the time scales for carrying out the individual projects.

RESOLUTIONS

After considering the Unit's recommendations the National Roads Board resolved that it:-

- (a) Accepts in principle the topic areas outlined in Sections 1 to 29 inclusive, together with the trends in activity input indicated in Table 1.
- (b) Confirms the present basic structure of the Unit as appropriate for undertaking the major proportion of the road research programme, and requested the Director of Roading to discuss with the Commissioner of Works the necessary staff.
- (c) Agrees to an amended research project approval procedure requiring the Unit to submit schedules of projects planned for inclusion within the annual programmes outlining the project content, aims, and expected cost. Upon approval the Unit would be responsible to arrange for the works to proceed in line with available research resources and funds, with any required amendments to briefs and costs to be subject to Director of Roading scrutiny and approval.
- (d) Recognises the need to provide for continuity of research work for specialist researchers, by provision of Road Research Fellowships having a tenure period of three years or more, with holders to work at specific locations on projects for the Unit.
- (e) Agrees that where appropriate the concept of "Research Centres" be adopted as outlined to handle groups of projects within defined topic areas.
- (f) Agrees that research work required for the other technical committees of the Board be referred on to the Unit in appropriate cases.
- (g) Recommends that a sum approximately 20% of the road research allocations each year be reserved for Roading Directorate to handle urgent operational and other research tasks requested by the Board.
- (h) Agrees that education and training requirements as a follow up to completed research should be confined to an initial seminar or seminars necessary to outline the research findings and indicate the use which they may be in operational fields.
- (i) Approves extension of information service operations to include membership of IRRD in the first instance, and for other data sources as may appear useful in the future.
- (j) Notes the Unit's request and advises that in each case where sponsorship of research travel from within the Road Research Unit budgets is proposed to enable discussion of research problems with overseas agencies, each proposal will be considered on its merits.
- (k) Places membership of technical committees of the Unit on the same basis as that of the Unit, and requests that the Unit review the number and areas of interest to be covered by each committee immediately prior to the finish of each three year term membership.
- (l) Agrees that subject to the above decisions being implemented the level of research allocations should, if possible, be progressively increased.
- (m) Compliments the Unit for the comprehensive report.

Some current Road Research Unit Projects having reference to Logging and Forestry interests.

- BC 11 Performance of Various Graded Basecourse
- BC 16C2 Quarry Road, Drury : Monitoring Overlay Construction on Existing Pavement
- BC 23 Hydrochemical Degradation of Greywacke Basecourse
- BC 25 Hobsonville Road Test Sections
- BC 26C Stabilisation and Strengthening of Flexible Pavements
- BC 30 Effect of Density and Water Content on the Performance of Basecourse Materials
- BC 31 Lime Modification of Pavement Aggregates
- BC 32 Evaluation Methods for Shell Rock for Unsealed Roads
- BC 39 Basecourse Stabilisation Additives : Effect on Fines
- BC 40 Monitoring of Lime Stabilised Pavements : Te Kuiti
- BC 44 Performance of Unsealed Lime Stabilised Road under Frost Conditions
- BC 45 Stabilisation and Strengthening of Flexible Pavements
- BC 46 Production, Placement and Performance of Road Aggregates
- BC 50 Whangarei County Test Strips
- BC 51 Canterbury Test Track Redevelopment
- EW 2 Soft Rock Material in Embankments : Hiroti's Bluff

- EW 3 Performance of Embankment Constructed from Soft Rock Materials
- EW 5 Rapid Compaction Control for Earthworks : Field Trial
- PD 14 Subsoil Drains Investigation
- PE 12 Pavement Evaluation by Deflection Methods
- RM 5 Unsealed Road Pavement Repairs and Preventative Maintenance
- RM 12 Unsealed Road Roughness
- RM 13 Roughometer Use Guidelines
- SS 5 Pavement Rehabilitation by Cement Stabilisation
- GM 8 Geometric Design of Road Carriageways and Intersections for Trucks
- GM 9 Off-Road Facilities for Trucks
- GM 10 Truck Routeing Hierarchy
- TG 2 Traffic Generation Characteristics of Forestry
- TG 3 Forestry Trip Generation Studies
- TG 5 Traffic Generation Characteristics of Forestry
- TG 7 Rural Transport Modelling : Rodney County
- AD 10 Code of Practice for Economic Appraisal of Road Transport Investment Proposals
- AD 17 Motor Vehicle Fuel Consumption
- AD 27A Aggregate Surface Grading
- AD 27C Maintenance of Unsealed Pavements
- AD 42 Manual of Bridge Inspection and Repair
- 48502 Survey of Bridge Maintenance Problems
- 48503 Evaluation of Timber Bridges
- 48504 Strengthening of Concrete Bridges by "Bow-String" Post Tensioning
- 48505 Repairs of Cracks in Concrete
- 48517 Stability of Creeping Slopes
- 48520 Scour Performance of Bridge Abutment Protection Works

PUBLICATIONS OF ROAD RESEARCH UNIT OF
SOME RELEVANCE TO FORESTRY ROADING INTERESTS

RRU BULLETINS

Bituminous Stabilisation of Soil - G B Burton and W S Taylor	No. 3	1965
Symposium on Roading Earthworks	No. 4	1966
Transportation of Heavy Haulage Commodities - C Vautier	No. 9	1970
Vehicle Operating Costs in Regard to Vehicle Size and Type and Road Conditions - A R Parsons	No. 10	1970
Data Selection for Economic Appraisals of Highway Projects - N S L Read	No. 11	1971
Shrinkage Cracking of Soil Cement - R J Dunlop, P J Moss and T A H Dodd	No. 12	1972
Benkelman Beam Deflections and Overlays - A D Smith	No. 16	1973
Wheel Load Surveys on County and Urban Pavements - I R Cumberworth, D van Barneveld	No. 19	1973
State of the Art : Pavements - A D Smith	No. 20	1974
Pavement Evaluation by Deflection - Beca Carter, Hollings and Ferner Ltd	No. 21	1974
Compaction Test for Aggregate Studies - N S Luxford	No. 22	1975
Sub-base Stabilisation : Questionnaire - A D Smith	No. 23	1975
Policy Investigation for the Sealing of Unsealed Roads - R K Thomson and B E Cox	No. 39	1979

Stabilisation Seminar 1978 Papers and Report	No. 40	1979
A Review of Aggregate Research in New Zealand - F G Bartley	No. 50	1980
Rural Transport Studies :		
Vol 1, Data Collection Procedures and Data Assembly \$5;		
Vol 2, Traffic Generation from Rural Land Use \$5;		
Vol 3, Road User Charges \$5; - R L King, S L Young and P D Chudleigh	No. 59	1982
When to Seal Again	No. 64	1983
Pavement Trial Sections East Coast Bays - R R Cobb (\$5.00)	No. 65	1984
Marginal Aggregate Pavement Trials, Quarry Road, Drury - F G Bartley - \$5.00	No. 67	1984
<u>Technical Recommendations</u>		
Geomechanics for New Zealand Roads - R G Brickell (draft)	No. 1	1977
Lime Stabilisation for New Zealand Roads - R J Dunlop	No. 2	1977
Comparative Pavement Trials for New Zealand Conditions - A H Malcolm	No. 3	1979
A Manual of Pavement Repairs - A G Ferry and R W Burrell (\$5.00)	No. 4	1981
Cement Stabilisation for New Zealand Roads - J B Tait (\$5.00)	No. 5	1981
Design and Construction of Concrete Road Pavements - J B Tait (\$5.00)	No. 6	1983

RESEARCH OF INTEREST TO LIRA

Inter-relationship Between Construction,
Maintenance and Vehicle Operating Costs

It has long been recognised that there is an inter-relationship between road construction and maintenance, and vehicle operating costs. As illustrated in figure 1 (Bennett, 1985) there are a number of factors contributing to the complexity of this inter-relationship. Consideration of how these factors interact assists in establishing the highway investment policies which minimise the total transport costs.

The complexity of this inter-relationship has limited the amount of research conducted in this field. Such research entails a long term research commitment which would be extremely costly for a country such as New Zealand which has only limited resources in the roading field.

Large international research organisations such as Britain's TRRL and the World Bank have been able to fund such research. Major studies have been undertaken in Kenya, the Caribbean, India and Brazil, which have resulted in a wealth of information for roading engineers. This information can be divided into two types; that concerning vehicle operating costs and that concerning road deterioration.

Vehicle Operating Costs

Vehicle operating costs are the most significant costs associated with the life cycle of a highway, amounting to as much as 90 percent for a two lane rural highway serving several thousand vehicles a day. Heavy commercial vehicle costs are significantly higher than those for passenger cars. For example, Bennett (1985) estimated that on a per kilometre basis the resource cost of a 16 tonne truck would be four times that of a passenger car.

Little research has been conducted into vehicle operating costs in New Zealand and virtually none on heavy commercial vehicles. The most widely referenced operating costs are those published by the Ministry of Transport (1984a and 1984b). There are a number of deficiencies in the methodology used to establish those costs (Maloney, 1982) and they therefore cannot be used with confidence. Roading engineers have therefore been forced to use estimates based on overseas research which may bear no resemblance to the actual New Zealand costs.

Recently, the Road Research Unit sponsored a research project into operating costs at Auckland University. As part of his masters degree, Christopher Bennett undertook a comprehensive evaluation of the overseas operating cost research recommending those relationships which were based on vehicles most similar to the New Zealand fleet. Mr Bennett points out that while these relationships are the most applicable overseas relationships they should be validated and calibrated for use in New Zealand.

This would entail conducting some form of user cost survey to provide the necessary base data. The Administration Committee of the Road Research Unit is currently considering funding a highway economics research group at Auckland University under Roger Dunn and one of the proposals of this group is to conduct such a survey. They hope to collect operating cost and utilisation data on a wide range of commercial and private operators so as to establish representative operating costs. As the logging industry operates some of the largest vehicles, which are also highly utilised, they would undoubtedly form an integral part of the survey.

Along with its interest in obtaining accurate estimates of operating costs the Road Research Unit would like to establish the effect of surface condition on operating costs. This is an important consideration in the economic analysis of highway projects for high economic returns can be obtained by improving surface condition. An example of this is given in figure 2 (Bennett, 1985).

It can be observed that while improvements have a minimal impact in passenger cars and light vehicles they have a marked effect on commercial vehicles. (In this figure the MCV is a 5.8 t six tyred truck while the HCV is a 16.0 t 10 tyred truck.) A good gravel road has a roughness of 6,000 mm/km while the average roughness of the state highway network is 2,400 mm/km. Thus, heavy vehicles would cost an additional 37 cents per km on a gravel road over a state highway. As logging trucks weigh well over 16.0 t and often two trailers it would be anticipated that the additional operating costs would be even higher. This consideration of roughness brings me to my next area, roadway deterioration.

Roadway Deterioration

As a result of their extensive research into the inter-relationship between construction, maintenance and operating costs, the World Bank has developed a computer model for optimising highway investments called the HDM-III model. This model was the basis for the majority of the operating cost relationships recommended by Bennett (1985).

An integral part of this model is the prediction of road-way deterioration and relationships are used based on six years of observation in Brazil. It is not known how applicable these relationships are to New Zealand conditions, however, it is envisaged that research will be conducted into establishing their overall suitability. This is another prospective task for the Auckland University research group.

The Road Research Unit has initiated an evaluation of research directions relevant to roading topics in New Zealand which may result in the HDM-III model being used to investigate how road funding priorities should be set. There are many competing fields of research activity and the outcome of the study into future research directions will be based on likelihood of producing successful research and its subsequent adoption to produce real economic gains.

Passing Lanes

Another area where research is presently being conducted is into passing lanes. The Ministry of Works and Development has hired Mr Bennett as a consultant to evaluate the suitability of using an Australian computer model called TRARR for estimating the economic benefits associated with installing passing lanes.

A number of surveys have been conducted to collect data on vehicle speeds and passing behaviour. These surveys were primarily interested in collecting data on commercial vehicles as these, along with passenger cars towing caravans are generally the causes of congestion on two lane highways. The data will be used to calibrate and validate the model for use in New Zealand. Once validated, it is anticipated that the model will be used throughout the country to investigate installing passing lanes. This will ensure that passing lanes are installed where they will provide the maximum benefits and that they are approved on the basis of the consistent and rational decision-making framework.

References

- BENNETT, C. R. (1985): "A Highway Economic Evaluation Model for New Zealand". School of Engineering Report 368, University of Auckland, Auckland.
- MALONEY, P. G. (1982): "Vehicle Repairs and Maintenance Costs : A Methodology and Literature Review". Report to Economics Division, Ministry of Transport, Wellington.
- MINISTRY OF TRANSPORT (1984a): Car Operating Costs, Ministry of Transport, Wellington.
- MINISTRY OF TRANSPORT (1984b): Truck Operating Costs, Ministry of Transport, Wellington.

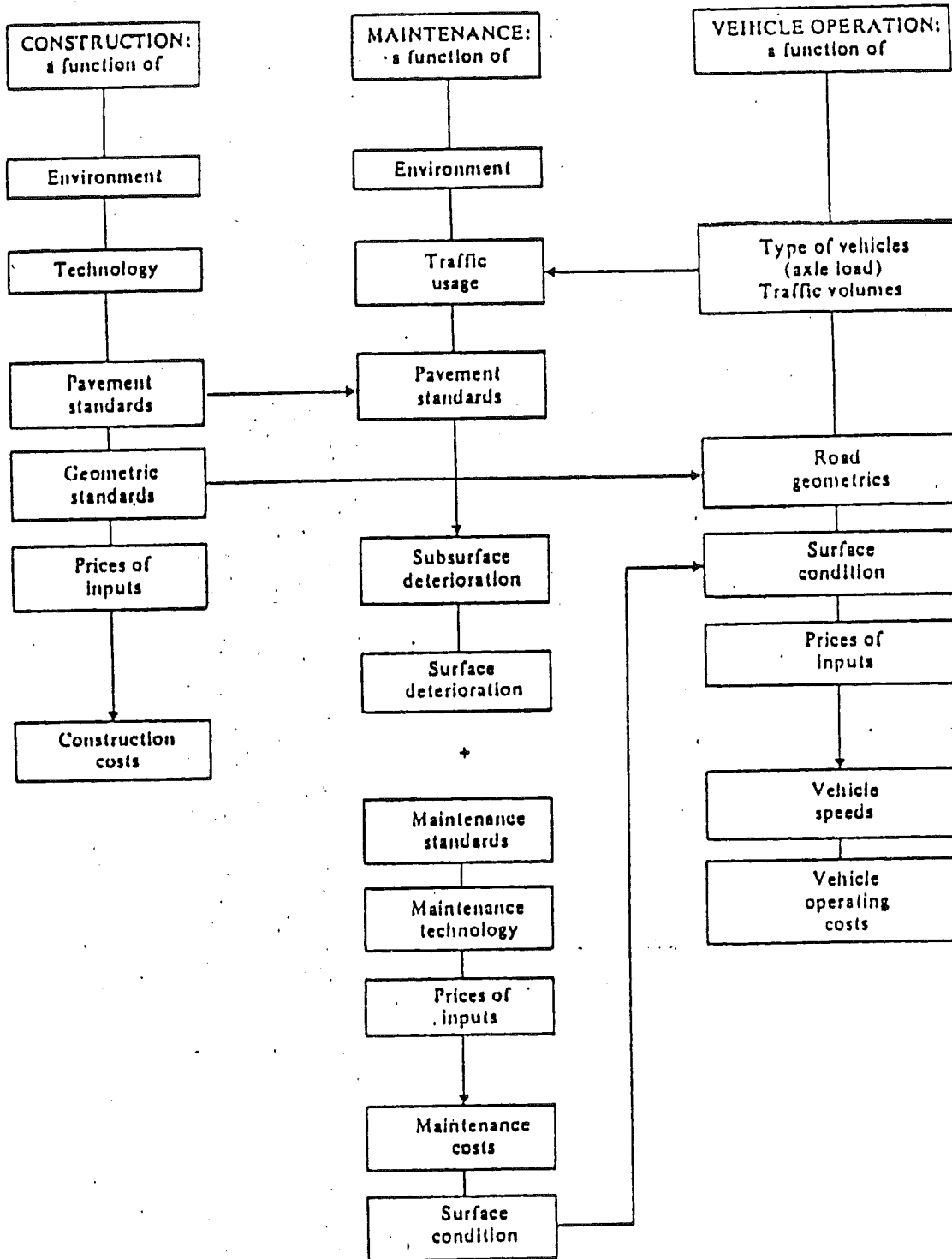


FIGURE 1.1:

INTER-RELATIONSHIP BETWEEN CONSTRUCTION, MAINTENANCE AND VEHICLE OPERATING COSTS

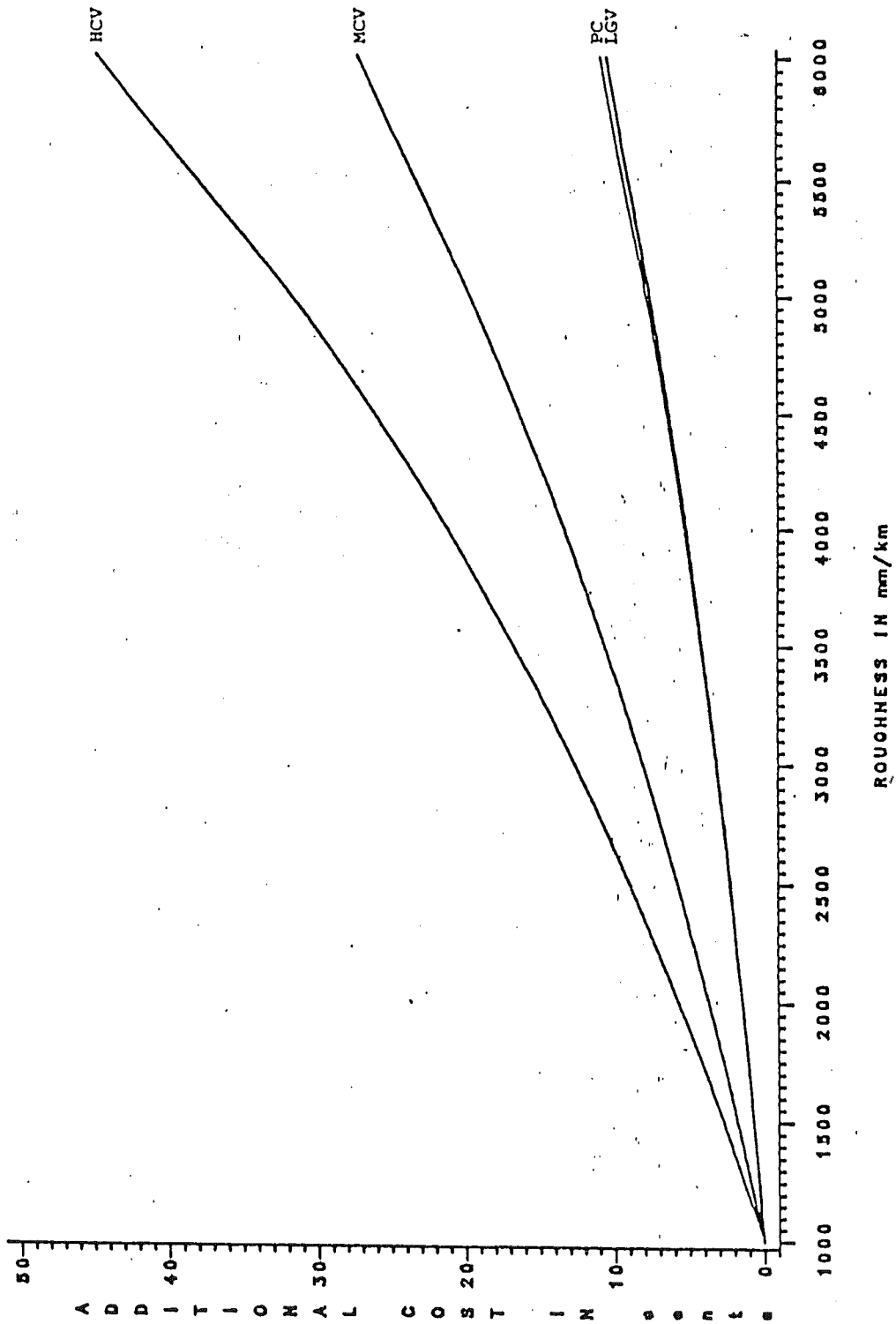


FIGURE 5.13:

WORKMEN'S MANUALS

- Part A Grading Metalled Roads
- Part B How to Talk and Communicate at the same time
- Part C Maintenance of Unsealed Roads
- Part D Sealed Pavements Maintenance
- Part E Drainage (Not Yet Printed)
- Part F Maintenance of Roadsides (Nearly ready)
- Part G Utilities and Other Services
- Part H Accidents and Safety Measures (Not Yet Printed)
- Part I Bridge Maintenance (Not Yet Printed)

Occasional Paper

County Roading Maintenance - What are the problems
W D Scott and Co Ltd - 1982

National Roads Board Standard Specifications

Local Government Training Board - Resource Kit for
Road Maintenance Worker Training