Road Research in Canada

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This paper describes the relationship between road research in Canada and the administration of road systems, the agencies conducting research, the areas of research cooperation and the method of correlating research. During 1966, 366 individual road research projects involving 78 agencies were documented by the Research Correlation Committee of the Canadian Good Roads Association (CGRA). As this inventory of road research in Canada is known to be incomplete, a continuing effort is being made to include all other work as well as to up-date current records.

Current annual expenditures for road research in Canada are estimated at $2.4 million, which is less than two-tenths of one percent of the $1.5 billion spent on road construction, maintenance and administration in 1966. The rate of expenditure for road research in Canada is at least 50 percent less than the rate in the United States. The ten provincial highway departments are the most active and productive road research organizations in Canada.

The summaries of current research as well as summaries of all significant Canadian publications related to roads and road transportation are made available by CGRA to technologists in other nations through the HRB's Highway Research Information Service (HRIS), the International Road Research Documentation (IRRD) program of the Organization for Economic Cooperation and Development and the world survey of road research and development of the International Road Federation. The information on work in other countries received in return for the data contributed by CGRA is invaluable. The need for further international cooperation in road research and documentation is recognized.

A trend toward more research in planning and administrative methodology, particularly in relationship to urban roads, is noted while there appears to be no decrease in the amount of physical research nor in its importance. This paper cites 10 Canadian research subjects which may be of particular interest and value to members of HRB. The paper concludes with a brief description of the means of disseminating current information on road technology in Canada.

•THE organization of road research in Canada is a direct result of the system by which roads are administered and financed.

By Constitution, the provision of roads in Canada is a provincial responsibility. This responsibility was initially delegated by the provincial governments to the municipalities. However, when large numbers of motor vehicles came into use during the second decade of this century, it became necessary for the provincial governments to create highway departments and assume complete responsibility for the construction, maintenance and operation of limited systems of the most important intercity and interregional rural roads. As motor vehicle travel increased, and the dependence of the

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provincial and national economy on reliable, safe and convenient motor vehicle transportation became more pronounced, the activities of the provincial highway departments were expanded and the provincial highway systems were gradually enlarged. In some provinces the administration of all rural roads became a provincial responsibility, while in others, subsidies were paid to municipalities for the construction and maintenance of local rural roads. More recently, the traffic problem became most acute in urban areas and systems of provincial subsidies have been established to help finance street improvements where municipal revenues were inadequate. The relative responsibility of the various levels of government for road administration are given in Table 1.

In Canada the Federal or national government is responsible for roads in the Yukon, Northwest Territories and national parks. In addition it has contributed to the construction of certain important provincial highways under the Trans-Canada Highway Act, the Roads to Resources program, the Railway Grade-Crossing Improvements program, and other special projects of national importance. Federal financial assistance is limited to special projects with terminal completion dates. In Canada there is no long-term federal aid program for highways such as that administered by the Bureau of Public Roads in the United States. However, in 1966, federal aid for special projects amounted to $120,000,000 while direct federal expenditures on their own roads amounted to only $30,000,000.

RESEARCH ORGANIZATIONS

There is no central road research organization in Canada. More than 100 independent organizations located throughout the country are involved in road research. These organizations include the 10 provincial highway departments, three provincial transport departments, the road departments of major municipalities, certain federal government departments and agencies, universities, associations and major consulting engineering firms and industries. Road research is correlated by the Canadian Good Roads Association (CGRA), and through the committees of that organization cooperative road research projects are undertaken. In this respect CGRA corresponds very closely to the Highway Research Board in the United States. CGRA membership is composed of five federal government agencies, the 10 provincial highway departments, the road departments of approximately 150 major municipalities, 50 associations, 120 consulting engineering firms, 185 contracting organizations, 180 manufacturers and suppliers of road materials and equipment, 70 road transport and related firms, plus representatives of each of the universities. In some respects CGRA is also similar to the American Association of State Highway Officials as the ministers of highways and senior highway administrators in each of the provinces serve on the Board of Directors and Operating Committee. With the large road builder and road user membership, CGRA is also somewhat similar to the American Road Builders' Association and National Highway Users' Conference in the United States.

All major road departments in Canada carry out research as a normal operating function or as special investigations under a separate research branch. Other agencies, such as the universities and municipal road departments, work closely with the provincial departments. The principal organizations involved in road research are given in Table 2. As most road research is carried out by or with the cooperation of the road department engineers, the results, where applicable, are generally implemented immediately.

RESEARCH PROGRAM

The current CGRA research inventory contains 366 separate projects related to roads and road transportation which are now being carried out in Canada and which involve 78 different agencies. However, CGRA is aware that there are other research projects related to roads and road transportation being carried out in Canada at the present time which are not reported in this inventory. Efforts are being made to document this work.

Most of the research projects in Canada have been initiated and undertaken by a single agency, such as a provincial highway department or a university. However,

TABLE 1

GOVERNMENT UNITS IN CANADA WITH ROAD RESPONSIBILITIES

Unit	No.	Roads or Streets (mi)	Expenditures During 1966 Including Subsidies Paid Out ($ million)
Provinces	10	145, 000	1, 081
Municipalities			
Cities, towns, villages	1, 898	40, 000	350
Rural	1, 187	301, 000	
Federal	1	4, 500	153
Total	3, 096	490, 500	1, 584

TABLE 2

CANADIAN ORGANIZATIONS ENGAGED IN ROAD RESEARCH

Class	No.	Agencies	Type of Research
Provincial governments	10	Highway departments	All aspects
	3	Transport departments	Safety (vehicle and driver), economics and finance
Municipal governments	24	Major cities	All aspects
	10	Major counties	Materials, maintenance, design
Federal government departments	11	Public Works	Materials, design, construction
		Northern Affairs and National Resources	Maintenance and operations
		Transport	Economics, finance, design, materials
		National Defense	Design and materials
		Forestry	Materials
		National Research Council (Div. of Building Research)	Building materials and foundations
		Dom. Bureau of Statistics	Economics, finance, administration
		Prairie Farm Rehabilitation Administration	Materials
		National Health and Welfare	Safety (traffic accident injuries)
		Can. Gov't. Spec. Board	Safety (vehicle design)
		Nat. Aeronautical Estab.	Safety (crash injury)
Universities	20	Universities in all provinces	Materials, design, traffic, planning
Industry	10	Major consulting eng. firms	Materials, design, traffic, planning
	10	Major industries	Materials and design
Associations	6	CGRA	All aspects
		Western Assoc. of Canadian Highway Officials	Materials, design, construction maintenance, administration
		Can. Highway Safety Council	Safety education
		Traffic Injury Res. Found'n.	Safety (crash injury)
		Can. Automobile Assoc.	Safety
		Can. Trucking Association	Economics and finance
Total	104		

through the committees of the CGRA many cooperative road research projects, each involving a number of agencies located throughout Canada, have been undertaken. The principal items in this cooperative program are given in Table 3. Each of these items involves a long-term cooperative study leading to a committee report or series of technical papers presented by the participants in the project.

In 1965 CGRA published a report on Road Research Needs in Canada. In this document 48 problems were defined. Of these, eight were assigned to the highest priority group, eight to the second priority group, and the remaining 28 to the lowest priority group. By design the cooperative road research projects given in Table 3 reflect the most important needs defined in the 1965 report.

EXPENDITURES FOR ROAD RESEARCH

Most road research in Canada is carried out as part of a routine construction, maintenance, operation or planning project, and the expenditures for research are charged to that project rather than to a separate budget. Hence, it is difficult to estimate total expenditures attributable to research. However, in conjunction with the latest survey of road research in Canada, information was sought on research expenditures. From the data obtained, it is estimated that the total expenditures on research related to roads and road transportation in Canada amounted to $2.4 million in 1965. It is of interest to note that the comparable figures for 1958 and 1963 were $1 million and $2.1 million, respectively. Although investments in research are increasing, annual road expenditures have also been rising. Thus, the current rate of investment in road research in Canada still amounts to less than two-tenths of one percent of the total annual expenditures for road construction, maintenance and administration. This rate of expenditure for road research in Canada is probably 50 percent less than the comparable rate in the United States, and substantially less than one-half the rate in Great Britain.

The approximate distribution of 1965 road research expenditures in Canada by types of agencies was as follows:

Agency	Percent
Provincial highway departments	35
Universities and provincial research councils	25
Municipalities	15
Industries and associations	15
Federal government departments and agencies	10

This breakdown indicates that the provincial highway departments are the most active and productive road research organizations, especially when it is recognized that much of the work done by the universities and provincial research councils is initiated and financed by the provincial highway departments.

RESEARCH CORRELATION

In 1962, a research correlation committee was established under the Technical Advisory Council of CGRA for the purpose of: (a) maintaining a complete up-to-date inventory of all road research and development work in Canada; (b) disseminating information on road research to all interested agencies in Canada; (c) establishing road research priorities and encouraging further work on these problems; and (d) insuring that the results of investigations in Canada and abroad are brought to the attention of all highway agencies in Canada and so put into practice where it is practical and economical to do so.

To date the Research Correlation Committee has been composed of twelve members. These members are senior engineers from each of the ten provincial highway departments, a senior engineer from a federal government department, and a secretary from

TABLE 3

COOPERATIVE ROAD RESEARCH PROJECTS IN CANADA

Area	Projects
Bridges and Structures	Bridge loadings Bridge bearings Use of high tensile steel in concrete Settlements at abutments of earth fills Use of unpainted low-alloy high tensile steel Riverbed scour at bridge piers and abutments Aesthetic design of overhead sign supports
Construction and Maintenance	Statistical quality control procedures for construction Pressure spraying Shoulder design General contract conditions Snow and ice control methods
Economics, Finance and Administration	Government-utility liaison in right-of-way use Public liability and property damage claims Uniform classification of road expenditures Motor vehicle operating costs Multi-project scheduling procedures Supply and demand for transportation engineers
Geometric Design	Warrants for speed-change lanes Passing sight distance requirements Warrants for separate turning lanes Turning paths of modern trucks
Pavement Design	Causes, effects and control of transverse cracking in bituminous pavements Structural design criteria for flexible pavements on low traffic volume roads Load-supporting capacity of flexible pavement bases stabilized with cement, lime and asphalt Determination of the effects of non-uniformity in construction on pavement life Seasonal variation in strength and performance of flexible pavements
Soils and Materials	Evaluation of moisture and density changes in subgrades and pavements Collection of pile-driving test data Deterioration of bridge decks and superstructures by deicing chemicals Production, design and performance of asphalt pavement surfaces Prediction of frost depth
Traffic Operations and Safety	Development of uniform rules of the road for Canada Relationships between accident rates and alignment and cross-section features Control of roadside advertising signs adjacent to controlled-access highways Determination of the relationship between permitted right-turn-on-red-signal movements and vehicle accidents, pedestrian accidents and vehicle delays
Transportation Planning	Determination of potential technological changes in transportation systems which should be considered in current planning and design Evaluation of geographical data coding grids for data banks used in transportation and economics studies Relationship between land use and traffic generation Determination of basic parameters required to estimate future urban traffic flows

the CGRA staff. Being small in number, the Committee is able to work effectively and quickly. Each member of the Committee is responsible for keeping informed on research activities in his own province. Each of the members provide the Association with information on agencies involved in research and with detailed information on current projects.

With the assistance of the Research Correlation Committee CGRA has attempted, since 1958, to maintain an up-to-date file on road research in progress in Canada. Complementing this service, the Association issued Technical Publications No. 9, March 1959, and No. 21, January 1964, to make this information available to all members and other interested parties. During 1964 and 1965 a concerted effort was made to improve the quality and reliability of the information on all current research, and to insure that the inventory was as complete as possible. A new listing of projects was issued by the Association as "Road Research in Canada" in December 1966. The results reported in this document were obtained in the following manner.

1. Approximately 400 agencies and individuals in Canada which were considered as possible sponsors of research were contacted by mail. In each case Research Project report forms, designed to obtain specific information on individual studies, were supplied.
2. Each of the agencies was then contacted by the Research Correlation Committee member in that province to insure that the information request and the significance of the undertaking was clear and that they submitted the report form on the projects which they were conducting or sponsoring.
3. All reports returned to CGRA headquarters were screened for duplication and suitability.
4. A representative of CGRA traveled across Canada to visit all principal investigators and verify, correct or supplement, through interview, the information which had been obtained by mail.

This inventory of 366 road research projects will be maintained up-to-date by reviewing each project at least once a year and by adding new projects as they are undertaken. As a result a file of current research in progress should be available at all times.

DOCUMENTATION

With limited resources available for research, one of the principal objectives of CGRA and Canadian road research agencies is to avoid duplicating work being carried out or completed in other countries. As a result CGRA is participating in cooperative programs with the Organization for Economic Cooperation and Development in Paris, the International Road Federation (IRF) and the Highway Research Board (HRB) to exchange information on road research in progress as well as abstracts of all significant articles or books published since January 1, 1965.

Publication abstracts are being indexed and regularly submitted to the International Road Research Documentation (IRRD) program of OECD in return for similar information being contributed by twelve other nations. CGRA has also provided information on Canadian road research in progress for the IRF's survey of current highway research and development. As the IRF required the data to be submitted in a specific format by an early date, they retained a Canadian engineer to work with CGRA in the compilation of its research inventory. In this way, IRF provided CGRA with considerable assistance which is gratefully acknowledged.

CGRA has also entered into an informal bilateral agreement with the HRB, with respect to the selection and preparation of input information for HRIS on Canadian road research and publications. In return for this contribution to the HRIS we hope to benefit from access to the U. S. and foreign information stored in this information retrieval system. To date all of the information on current road research in Canada and abstracts of approximately 250 Canadian publications have been stored in HRIS. The HRB has very generously made available printouts of this Canadian information to CGRA and has offered other technical advice and assistance. CGRA is most appreciative of the

cooperation extended by the Board, its Executive Director, Mr. W. N. Carey, Jr., and its Assistant Director for Special Projects, Dr. P. E. Irick.

CGRA has also instituted a coordinate index card information retrieval system in which to store the summaries of publications and research projects documented in Canada and received from abroad through IRRD and HRIS. This CGRA information system is designed to complement our library and provide our members with up-to-date information on current research and development work.

TRENDS IN RESEARCH PROGRAM

Ten years ago practically all road research in Canada was concerned with road and bridge design and the physical characteristics of materials. Very little attention was being given to the development of new techniques in the planning and administrative areas of economics, finance, law, traffic analysis, transportation systems and safety. Research on these non-physical aspects of road technology has steadily increased, both in terms of the numbers of projects and research dollars spent. Between 1963 and 1966 the non-physical content of Canada's road research program has increased from 15 to 25 percent in terms of the number of active projects. In terms of monetary resources the percentage would certainly be greater. These figures represent an underestimate of the shift in emphasis in road research in Canada because some work in this rapidly evolving area of planning techniques has not been reported.

During the past five years, 50 cities in Canada have undertaken or completed comprehensive urban transportation studies. This represents practically every city in Canada with a population in excess of 20,000 people. During the same period, three provinces have completed rural highway need studies, while four of the proposed 19 area transportation planning studies in Ontario have been completed. As the techniques for conducting these urban and regional transportation studies have not developed to the point where standard procedures are available, the majority of these studies involve an element of research.

Despite the changing content of the road research program in Canada, there has been no decrease in the total amount of physical research. Some of the most serious problems and significant accomplishments continue to be in this area of physical research.

A second significant trend in the research program is the steady increase in the numbers of projects being carried out at the 20 Canadian universities which offer study programs in transportation engineering. The increase in university research may be attributed to the expansion of the graduate study programs in civil engineering. In the past, most Canadian engineers desiring post-graduate training in the highway sciences went to universities in the United States. Today at least five Canadian universities offer comprehensive post-graduate highway engineering programs.

NOTABLE WORK

Specific information on any current Canadian road research project may be obtained from CGRA, the HRB's Highway Research Information Service, or the IRF. All of these projects would be of interest to some technologists in other countries. However, 10 Canadian research subjects which might be of greatest interest to members of the Highway Research Board have been selected for mention. They are (a) the design and evaluation of flexible and rigid pavements; (b) frost action and the insulation of subgrades; (c) soil stabilization with cement, lime and asphalt; (d) determination of the factors affecting temperature cracking of asphaltic concrete surfaces; (e) winter maintenance procedures; (f) the corrosion of motor vehicles by de-icing chemicals; (g) riverbed scour and channel control; (h) development of symbolized traffic signs; (i) traffic generation and assignment models; and (j) the development of automated urban and regional data banks.

DISSEMINATION OF INFORMATION

The results of road research in Canada are exchanged through the 11 technical committees of CGRA. CGRA is also a principal publisher of technical papers on roads

and road transportation in Canada. The proceedings of the annual CGRA conventions normally contain close to 50 technical papers and reports. CGRA also issues separate technical publications containing individual papers or committee reports. Special publications of the Association include the Manual of Geometric Design Standards for Canadian Roads and Streets, and the Manual of Uniform Traffic Control Devices for Canada.

Technical papers on roads and road transportation are also published by the provincial highway departments, various trade magazines, the National Research Council, the Engineering Institute of Canada, the Canadian Technical Asphalt Association, and other professional associations. There are approximately 75 sources of technical publications on roads and road transportation in Canada. All of these sources are monitored by CGRA in an attempt to select all significant papers of permanent value for the Canadian Good Roads Association, HRIS and IRRD information retrieval systems.

Canadian road technologists customarily present papers at important international conferences such as those on soil mechanics and foundation engineering, the structural design of asphalt pavements and the IRF World Road Congresses. In addition there are generally 10 to 15 papers by Canadian engineers presented at each HRB annual meeting. Normally close to 100 Canadian engineers attend the HRB annual meetings.

To further disseminate the results of Canadian road research and development, CGRA has a program of exchanging technical publications with corresponding organizations in a number of other countries.

CONCLUSIONS

Traditionally Canada has depended, to a large extent, on research and development in other countries, and particularly that done in the United States. However, the amount of road research in Canada is increasing steadily and some significant results are being produced which should be of value to road technologists in other countries.

The amount of road research being carried out in Canada has been restricted by the shortage of qualified engineers, scientists, economists and other transportation technologists. A very large and increasing construction program in Canada has made it necessary to utilize all available talent for operational purposes, and resources have been allocated only to the most essential research projects. This situation undoubtedly exists in other countries.

As the resources available for road research are limited, it is believed that great benefits can be obtained through international cooperation and the exchange of information. For this reason CGRA has actively cooperated in the HRB's Highway Research Information Service, the IRF World Survey and Road Research and Development, and the cooperative road research programs of the Organization for Economic Cooperation and Development. Further cooperation between nations will result in improved utilization of available resources for research and in accelerated advances in road technology.

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