PARTNERSHIP WITH INDUSTRY - THE MANITOBA EXPERIENCE

by

Ray McQuade, Cowin Steel Co. Ltd.
Sami Rizkalla and Glenn Morris, University of Manitoba
Winnipeg, Canada

Abstract

For many years the Manitoba construction community has supported structural engineering research at the University of Manitoba. However, funding restraint prevented the University from upgrading its facilities to meet modern research needs. Then, several years ago, Civil Engineering staff conceived a plan to construct a modern structures laboratory by enclosing a lightly-used parking area bounded on three sides by existing laboratories.

Finding that government funding was not available, the University invited an alumnus, the President of a local fabricating firm, to enlist the support of industrial donors to construct the laboratory. Ultimately, 120 architectural, engineering and construction firms and suppliers contributed. In order to cover items that could not be obtained through donations, the Federal Government granted $80,000, the Government of Manitoba made a grant covering the provincial sales tax, and the City of Winnipeg covered the cost of building and occupancy permits. A $750,000 grant from the Natural Sciences and Engineering Research Council of Canada permitted the installation of a 1.2 million-pound-capacity dynamic loading system.

The paper describes the new laboratory, which was opened in March 1991, and mentions some of the industrially-oriented research projects that are under way.

Introduction

With an area of 251,000 square miles (slightly less than that of Texas) and a population of 1,085,000, the Province of Manitoba is sparsely populated. Sixty five percent of the population lives in the city of Winnipeg, the provincial capital. Originally based on agriculture, the provincial economy is now highly diversified, engineering-based pursuits such as construction, manufacturing and power and communication utilities comprising about one third of the gross provincial product.

In 1907, the University of Manitoba became the first Canadian institution west of Toronto to offer engineering education. The first graduating class, that of 1911, included 7 civil and 2 electrical engineers. Since then, approximately 6,000 engineers have graduated from the Faculty of Engineering. A
large majority of the 2,800 professional engineers currently practising in Manitoba are Manitoba graduates. Approximately 40 percent of them are civil engineers.

Unlike most Canadian provinces, Manitoba has only a single engineering faculty. Consequently, and because the relatively small engineering community is concentrated in Winnipeg, the faculty has enjoyed close ties with Manitoba industry. In particular, the Civil Engineering Department has experienced a long-standing cooperative relationship with the local construction community. As early as the nineteen thirties, engineering professors provided specialized consulting service to local engineering and architectural firms. At that time, the Department offered a "commercial testing" service, providing expertise and facilities not available elsewhere in Manitoba, for the testing of materials and structural components.

Following the launching of Sputnik I in 1957, governments in Canada began to spend lavishly on education, particularly in science and engineering. Engineering enrolments soared during the sixties and at all universities, including the University of Manitoba, many new, highly qualified staff were hired and funding was available for new equipment and facilities. Accordingly, in 1968 a modern addition to the University of Manitoba Faculty of Engineering complex was built and equipped. Unfortunately, most of the Civil Engineering Department, including the structural engineering division, inherited space that had been vacated by other departments when they occupied the new addition.

During the late seventies, the structures and materials testing laboratories were refurbished and new testing and data acquisition equipment was acquired. The laboratories included two sections of structural floor, with a total area of 700 square feet and partial crane service. A 600,000-pound-capacity static testing machine, a 250,000 pound dynamic loading system and several small-capacity static testing machines were heavily used.

Responding to initiatives by structural engineering staff members, local engineering and construction firms began to sponsor structural research and development projects. However, despite the improvements that had been made, the research facilities were less than adequate for modern large-scale structural testing. The available space was cramped, the maximum head room was only 12 feet, and there was no large-capacity dynamic loading equipment.

Proposal for New Facility

Faced with increasingly crowded conditions, inadequate loading equipment, and requests for large scale tests, Civil Engineering staff conceived a plan for a modern structures
laboratory that could be constructed relatively cheaply. Adjacent to the existing structures laboratory was a lightly used storage and parking area bounded on three sides by a three-storey wing of the Engineering Building. The area is illustrated in Fig. 1. With the addition of a roof and a single wall, the space could be enclosed. Needed also would be a full structural floor, a section of structural wall, an overhead crane and a large-capacity dynamic loading system with a loading frame integrated into the structural floor.

In order to examine the feasibility of the concept, a structural engineering staff member arranged for an undergraduate project to be carried out by two senior students and co-supervised by himself and a local consulting structural engineer. The study confirmed that the project would be feasible. Unfortunately however, by the early nineteen eighties government funding of university capital projects was severely limited. Thus while the project was included in the University's capital funding requests for several years, there was little hope that funds would be forthcoming.

Generation of Resources

However, cognisant of the goodwill that existed between the Civil Engineering Department and the local engineering community, several staff members felt that local firms would be willing to contribute to the construction of the proposed facility. Early in 1987, they proposed to the Dean of Engineering that the senior author, who is a Civil Engineering graduate of the University of Manitoba, the President of a Winnipeg fabricating firm and a former Chairman of the University's Board of Governors, be invited to head up a project to construct the structures laboratory, at no cost to the University of Manitoba.

Because the University had recently initiated a capital fund raising campaign, it was necessary to obtain the permission of the University Administration to undertake the project. Approval was received and the project was begun in July of 1987, with the recruitment of a design and project management team consisting of ten Manitoba architectural, engineering and construction firms. They held regular meetings with Civil Engineering staff members and staff of the University's planning office. The design documents were completed by June of 1988 and a ground breaking ceremony was held on July 21, 1988.

During the design phase, donors were sought for the many goods and services required. It was not difficult to find donors for concrete, reinforcement, structural steel, metal cladding, etc. and others willing to place and erect them. Such contributors were potential users of the completed facility. However, the structural component of the project represented only about 60 percent of the $1,400,000 total cost.
What was surprising was the willingness of mechanical and electrical firms and their trade organizations to participate. Through the efforts of the mechanical and electrical engineering consultants involved, donors were found for 80 percent of the mechanical and 70 percent of the electrical goods and services. A major and invaluable contribution was made by the local branch of a general contracting firm, which donated much of the general construction labour, and some materials. Ultimately, more than 120 firms donated goods and services valued at $1,400,000. The list of donors is presented in Appendix A.

Recognizing that not all costs could be covered by donations, the University sought and received an $80,000 Federal Government grant designed to support industry-university cooperation. Thanks to the efforts of the Premier of Manitoba (a graduate of the Civil Engineering Department), the Provincial Government provided a grant covering the provincial sales tax on all materials and equipment used in the project. Finally, the third level of government, the City of Winnipeg contributed a grant covering the cost of building and occupancy permits.

As construction proceeded, Civil Engineering staff members applied for and received a $750,000 equipment grant from the Natural Sciences and Engineering Research Council of Canada. With additional support from the University, a 1.2-million-pound-capacity cyclic testing machine was purchased and installed.

As might be expected with any project relying heavily on donations, a few problems were experienced during construction. For those firms donating labour, the project understandably had a lower priority than their other projects. Thus, during times of intense construction activity elsewhere, work on the facility sometimes progressed slowly. As well, the value of goods and services that could not be covered by donations was underestimated by about one third. Consequently, several items could not be delivered until payment was guaranteed, thus slowing construction in a few instances. At such times, the University Administration was strongly supportive, occasionally providing interim financing, and more than once making more permanent contributions.

Despite these minor problems, the construction period was less than two and a half years. More importantly, the quality of the workmanship, materials and equipment were second to none.

The Completed Facility

The University of Manitoba Structural/Construction Engineering Research and Development Facility was officially opened in March, 1991. As illustrated in Fig. 2, it comprises a 40 foot
x 60 foot x 35 foot high open testing area over a 2 foot thick structural floor slab. The floor slab is penetrated by 75 kip capacity hold-down openings on a 2 foot square grid. Below the floor are three 7 foot deep access cells. Integral with the floor is a 10 foot x 10 foot section of structural wall, capable of resisting 75 kip horizontal forces on a 2 foot square grid. The entire test area is served by a 12 ton capacity overhead crane. A large door opening provides access to the adjacent original structures laboratory.

An important feature is the 1.2-million-pound-capacity cyclic testing equipment. The primary loading frame has a maximum 15 foot vertical test space. Its 6 foot deep foundation is incorporated into the structural floor. The hydraulic pump for the system is located in one of the cells below the structural floor, and hard hydraulic lines connect to the loading frame and to two other locations, where loading rams can be incorporated into custom built loading frames.

A spin-off benefit of the new facility was that it necessitated the upgrading of the antiquated mechanical and electrical systems in the adjacent wing of the Engineering Building. When it was decided to air condition the new laboratory, modest incremental funding was obtained from the University to extend the air conditioning to adjacent portions of the old building. Similarly, the transformers and switch gear for the new facility serve portions of the old building.

Operation of the Facility

The facility is staffed by a director, (one of the structural engineering staff members), a structures laboratory technician, and on a shared basis with other laboratories, the chief technician, an electronics technician, a concrete laboratory technician and a machine shop technician.

Overseeing the operation of the facility is an advisory board comprising three members of the structural engineering staff and three engineers from the local structural/construction community. The Board acts in an advisory capacity to the director while setting policy and management guidelines. One of its first duties has been to establish a schedule of service charges for equipment, laboratory space and technician time.

While the facility has been in operation for only 6 months, already a number of industrially oriented projects are under way. They include:

1. connection tests for precast concrete load-bearing shear wall panels for medium- and high-rise buildings;
2. tests of cold formed steel angles for use in transmission towers;
3. tests of steel rollers for hydroelectric spillway gates;

4. an investigation of civil engineering applications of advanced composite materials;

5. fracture mechanics studies relating to the potash mining industry;

6. tests of timber utility poles; and

7. studies of the behavior of beam-to-column connections in steel frames and column-to-plate junctions in flat plate reinforced concrete structures.

Conclusions

The project to construct the Structural/Construction Research and Development Facility at the University of Manitoba was unique, at least in Canada. One hundred and twenty private sector donors and three levels of government combined their efforts and resources to construct a facility which will support relevant fundamental and applied research for many years to come. The primary fruits of that research will be improved construction products and processes and an increasingly competitive construction industry.

Acknowledgement

The generous contributions of the donors listed in Appendix A, and of the University of Manitoba, are gratefully acknowledged.
Completed Laboratory

Fig. 2
Appendix A

List of Donors

ABCO Supply & Service Ltd.
Abesco Ltd.
Acadian Insulation and Contracting
AC and S Contracting Ltd.
Advance Roofing Ltd.
Airmaster Sales Ltd.
Able Movers Ltd.
Allmar Distributors Ltd.
Ambassador Sales (1986) Ltd.
AMESCO
Argyle Steel Construction Ltd.
B.A. Robinson
Bailie Surveys
Bain Insulation & Supply Ltd.
Basar Heating & Air Conditioning Ltd.
Begg's, Tom, Agencies Ltd.
Betzy Inc.
Bird Construction Co. Ltd.
Black McDonald Ltd.
Boge & Boge
Border Glass & Aluminum Ltd.
BPL Sales Ltd.
Building Products & Concrete Supply Ltd.
City of Winnipeg
CML Northern Blower Ltd.
Comstock Canada/Contractors Ltd.
Con-Force Structures Ltd.
Copetti Masonry Contractors
Cowan Steel Co. Ltd.
Crane Canada Inc.
Crosier Kilgour & Partners Ltd.
Crossroads Industries Ltd.
Daplex Plumbing & Heating Ltd.
Dearborn Chemical Co. Ltd.
Derksen Plumbing & Heating
Diamond Ready Mix Concrete
Dominion Bridge
Dominion Construction & Development Ltd
Dow Chemical Canada Ltd.
Drummond McCall Inc.
Dustrial Plastic & Steel Ltd.
Dyregrove Consulting
Edwards, A Unit of General Signal
EMCO Supply
Empire Iron Works Ltd.
Ernie Keller Contractors Ltd.
F.E. Simmons Fourschu
Federal Pioneer
Ltd. (Horner Plant/Toronto)
Federal Pioneer Ltd. (Sales
Office/Wpg.)
Finnac Lumber Ltd.
Flynn Roofing Ltd.
G.B.R. Architects
Gorman Rupp c/o J. Brooks
Great West Ventilation Inc.
Hanover Door
Honeymed Ltd.
Howard, Tom
Hugh Munro Construction Ltd.
Hughes-Owners Inc.
ITT Fluid Products Canada
IVC Ltd.
J.D. Machinery Movers
Jayross Agencies (Mid-West) Ltd.
Jones Lindell & Associates
K & N Concrete (Ready Mix) Ltd.
Kelsey Construction Co. Ltd.
Kraft Construction Company Ltd.
Ligertwood, Douglas A., Ltd.
Litz, R. & Sons Co. Ltd.
Loewen, C.T., & Sons Ltd.
M.A. Stewart & Sons Ltd.
M.A. Stewart Ltd.
Malcom Construction Ltd.
Manitoba Hydro
Manitoba Ready-Mix Concrete
Association
Manitoba Rolling Mills
Mannesmann Demag Ltd.
Maple Leaf Construction Ltd.
Master Roofing Ltd.
Mechanical Contractors Assoc. of
Manitoba
McCaine Electric Limited
Mid-Canada Truck Services Ltd.
Mikkelsen-Coward & Co. Ltd.
Monarch Industries Ltd.
Multi-Glass Insulation (Western
Ltd.)
National Concrete Accessories
National Sciences and Engineering
Research Council
NEDCO
Inc.
PML Reinforcing Ltd.
PCL Contractors Western Inc.
Perimeter Concrete Ltd.
Phillips Cables Limited
Pirelli Cables Inc.
Powlift Trucks & Systems
Price, E.R., Ltd.
Province of Manitoba
Randall Plumbing & Heating Ltd.
Red River Community College
Retrofit Systems Inc.
Roofing Contractors Association of
Man.
Scouten Mitchell Sigurdson &
Assoc. Ltd.
Shopost Iron Works Ltd.
Specialty Construction Products
Ltd.
State Contractors Inc.
Steels Industrial Products
Stelco Inc.
Stelkor Hardware Ltd.
Stewart, M.A., & Sons Ltd.
Subterranean (Manitoba) Ltd.
Supercrete
Sylvania Lighting Services
Tallcrete Ltd.
Texcan Cables Ltd.
Titan Foundry Ltd.
Trane Canada Inc.
Tri Clad Designs Inc.
UMA Group
Up of M Physical Plant
V.H. Mason Construction
VAM Systems Ltd.
Valour Decorating 1988 Ltd.
Vent Air Industries Co-op Ltd.
Vicwest Steel, Inc.
Wagner, J., & Sons Ltd.
Wardrop Engineering Inc.
Werner's Refrigeration
Wesco Westinghouse Sales
Western Asbestos Ltd.
Western Industrial Services Ltd.
Western Supplies Ltd.
Wolfcon, Mazik & Associates
Xerox Canada Inc.