CONCRETE BLOCK PAVING IN CANADA

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SUMMARY

The development of concrete block paving in Canada, since the introduction of pavers in 1973, is reviewed. It is shown that growing use is being made of pavers for their appearance as a result of their appeal to architects and landscapers. Examples of their use for pavements to support traffic or industrial loading are presented, but it is shown that this application is not widely accepted and is currently little used. The production of pavers by Canadian plants and the use of machines for mechanical laying have been surveyed and the principal findings are reported. Canadian standards for paver quality, issues in concrete block paving perceived to be of particular importance in Canada and some characteristics of the Canadian market are presented. The activities of various trade associations in the promotion of concrete block paving are referred to and the paper concludes with some thoughts on the future of pavers in Canada.

INTRODUCTION

Although interlocking concrete pavers were introduced to the Canadian market in approximately 1973, growth in their use has been largely confined to architectural and aesthetic applications. There has been sporadic construction of concrete block pavements to support traffic and industrial loading in Canada, but this concept remains little known and Canada lags behind Western Europe, Australia and South Africa in the exploitation of this technology. The purpose of this paper is to review the development of interlocking concrete block paving in Canada and to examine the nature of the Canadian market.

PAVING DEVELOPMENT

Interlocking pavers appear to have been introduced in Ontario in 1973 [1] where they were first used for private drives to expensive houses. One of the earliest uses, for pavements to support vehicular traffic, was on roads and car parks at the site of the Shaw Festival at Niagara-on-the-Lake in 1973. Perhaps the first use of 80 mm pavers to support heavy traffic was in the construction of a bus lane at a Toronto subway station in 1977. The first reference in construction literature, to the advantages of concrete block paving in resisting aggressive vehicle loading, appeared in 1979 [2]. The Ontario Caterpillar distributor laid 1100 square metres for an outdoor hardstanding for heavy tracked vehicles at its service yard in Timmins in northern Ontario. Since that first application, Crothers have installed nearly 20 000 m^2 at seven locations in Ontario to support heavy tracked equipment.

In 1981 Transport Canada sponsored the construction and monitoring of 3000 m^2 of 80 mm and 100 mm block pavements at the port of Montreal [3],[4],[5] in order to evaluate their performance under Canadian conditions. Of particular concern were the effects of the severe Canadian winter on the

Canadian conditions. Of particular concern were the effects of the severe Canadian winter on the pavements. It was concluded that the block pavements performed well and that, under the loads applied by container handling equipment, there was no difference in performance between 80 mm and 100 mm pavers. It was also stated that at the time (early 1980's) the initial cost of an interlocking block pavement was significantly higher than that of an asphalt pavement.

In 1982 the City of North Bay, Ontario reconstructed five city blocks of its main street using pavers for both road and sidewalks. A total of 14 000 m^2 was laid and is still performing well [6]. Since the initial application to support vehicular traffic, a further 10 000 m^2 have been laid in North Bay, but none of it in pavements subjected to traffic.

The largest concrete block pavement to be constructed so far in Canada is the CP container handling yard in Edmonton, Alberta. This was built in 1984–85 and comprises more than 100 000 m^2 and was constructed in joint venture by Canadian and Dutch companies using machine laying. The subgrade had a CBR of 1.5% and the area is subject to extreme winter conditions and deep frost penetration [7].

Other relatively small areas subject to road traffic have been paved, for example in Mississauga, North York and Timmins, Ontario, but it seems unlikely that the total area of concrete block pavement to support traffic and industrial loading in Canada currently exceeds 200 000 square metres.

PRODUCTION OF PAVERS

Statistics on Canadian paver production are not routinely collected and accurate data are difficult to obtain as many producers regard such figures as trade secrets. However, the author conducted a survey of manufacturers in the autumn of 1990 and also obtained some information from trade associations. At least fifty–six plants producing concrete pavers were identified and their distribution across the country is shown in Table 1. The largest of these manufacturing plants may have three block presses, most would have a single press. It appears that these installed production plants are capable of producing some five million pavers per standard eight hour shift. Extrapolating the results of the production survey to the total number of known paver production plants suggests that the 1990 Canadian production was of the order of nine million square metres or approximately one–third of a square metre per head of population. However, it is felt that this figure should be regarded as an upper bound and that the lower bound is of the order of six million square metres, or a little more than a fifth of a square metre per capita. The great majority of pavers produced for the Canadian market are 60 mm thick; the major producers also have moulds for 80 mm pavers but, at present, these represent a tiny fraction of the total market.

Alberta	B.C.	Saskatchewan	Manitoba	Ontario	Quebec
7	6	4	2	22	12

New Brunswick	Nova Scotia	P.E.I.	Newfoundland	Canada
—	2	—	1	56

Table 1 — Canadian Paver Plants by Province

MACHINE LAYING

Most pavers currently laid in Canada are hand placed. Machine laying was used for the container yard in Edmonton because it was felt that the client would not accept hand laying and also because the job was large enough for machine laying to be used to advantage. The pavers were installed at a rate of 1400 square metres per day.

It is estimated that there are no more than twelve laying machines in Canada at present. Most of these are Optimas machines distributed by the Canadian office of Optimas America. Although some people within the industry hold the view that machine laying would make small element paving more acceptable and others that hand laying is incompatible with the highly automated methods of manufacture, hand laying is the method which currently predominates in Canada. If it is perceived that mechanical installation offers economic advantages, then it will be developed. Given the nature and size of current applications, it would seem likely that hand laying methods will continue to be appropriate.

STANDARDS

Two standards have been developed in Canada to govern the quality of manufacture of concrete pavers. These are the Canadian standard "Precast concrete pavers" [8] issued in 1985 and the Quebec standard "Pavés préfabriqués de béton de ciment" [9] issued in 1987. The most noteworthy feature of the Canadian standard is the de-icing salt, freeze-thaw, durability test in which pavers are submerged in a 3% saline solution and subjected to fifty cycles of freezing and thawing. This test is considered to be more stringent than other freeze-thaw tests carried out in water. The development of the Canadian standard was reported [10] to the second international conference on Concrete Block Paving in 1984. The same Canadian author also discussed the effects of cement composition on freeze-thaw durability of pavers [11] at the third international conference on CBP in 1988.

No Canadian standards have been developed for either the design or installation of concrete block pavements.

CANADIAN ISSUES

Concrete block paving is well established in Canada for architectural or aesthetic applications. This acceptance does not yet extend to engineered pavements to support traffic and industrial loading. Undoubtedly one of the factors is economic; in Canada the initial cost of surfacing with pavers is approximately 1.7 to 2 times that of surfacing with asphalt or with concrete slabs. However, there are also some specific Canadian concerns arising from the harsh winter climate. These include:

- snow removal
- resistance of pavers to de-icing chemicals
- frost heave
- spring thaw

For example, is it likely that there will be differential heave of individual blocks, some of which will then be dislodged by the snow plough blade, resulting in loss of bond and initiating failure of the pavement?

There is every indication that, with proper material selection and careful control of pavement construction, these problems need not arise. The one kilometre length of road in North Bay, Ontario, already mentioned, has been in service through eight winters. No significant defects resulting from snow ploughing, frost heave or spring thaw have been observed.

As has been stated, the Canadian standard for pavers includes a rigorous freeze–thaw durability test in the presence of de–icing salt. Many Canadian producers are able to produce pavers which meet the requirements of the standard.

It would appear that these 'Canadian' issues are more imaginary than real, but they persist. In part this is due to the nature of the Canadian market.

THE CANADIAN MARKET

For a number of reasons the Canadian market is not a single market. First, Quebec is a distinct market due to the exclusive use of the French language. Quebec encompasses some 28% of the population of Canada. Secondly, apart from Ontario, with a population of some nine million, population densities tend to be low outside the few major urban centres such as Vancouver, Winnipeg and Halifax. In these areas of sparse population, natural links are north–south with the adjacent United States, rather than east–west with Canadian neighbours. These natural geographical linkages between Canada and the United States are now being strengthened by economic links forged by the Canada–U.S. free trade agreement. Thus the Canadian market is geographically diverse and suffers from internal stresses. These characteristics make it difficult to promote the concept of concrete block pavements for areas subject to traffic and industrial loading, on a unified, national basis.

TRADE ASSOCIATIONS

Several attempts have been made to establish associations of paver manufacturers in Ontario to promote the use of pavers. There have been the Ontario Interlocking Concrete Paver Association and the Concrete Paving Stone Manufacturers' Association to name but two. These have not been successful; they appear to have been underfunded and have never acquired the professional engineering input required to market engineered block pavements for vehicle loads.

Three important trade associations each promote pavers in Canada to some degree. These are:

- Canadian Portland Cement Association
- National Precast Concrete Association
- National Concrete Masonry Association (Concrete Paver Institute)

Of these, the first is Canadian but is closely related to its U.S. parent organisation. Its primary function is to promote sales of Portland cement and it therefore has an interest in the promotion of concrete pavers. This association has so far been the prime mover in Canada in the dissemination of pavement design information concerning concrete block pavements to support traffic and industrial loading as will be seen later.

The other two are both American associations which admit Canadian companies as members. The National Precast Concrete Association, based in Indiana, has some twenty–five Canadian producers

of concrete pavers as members. NCPA publishes case studies of paver installations and is the North American distributor for the Australian computer programme "Lockpave" for the design of concrete block pavements. It also publishes a simple guide to concrete block paving under the title "A perfect way to pave" and produces video tapes on paver installation. NCPA plays an active part in the promotion of concrete block paving in Canada.

The Concrete Paver Institute is a recently formed division of the U.S. National Concrete Masonry Association, based in Virginia. CPI currently has ten Canadian manufacturers of concrete pavers as members, of which one has plants in four locations. CPI is well funded and vigorously organised and is actively promoting pavers for structural pavements throughout North America. The Concrete Paver Institute runs training courses for paver installers, produces and distributes videos showing installation methods and is instrumental in the publication of technical information pamphlets and documents dealing with the engineering design of concrete block pavements for ports and airports. CPI also distributes a computer programme under the title "Pavecheck" as an aid to pavement design. The inclusion of Canadian regions represented at director level is likely to result in strong Canadian support for this association. For the first time in Canada, it appears that a substantial, well-funded campaign to raise awareness of the use of pavers for structural pavements is about to be launched.

In Quebec a separate trade association called "Le centre de recherche sur les pavés" (The paver research centre) exists and currently has some six paver producers as members. This association distributes the computer programme "Lockpave" within Quebec [12].

EDUCATIONAL SEMINARS

The first organised attempt to educate Canadian engineers concerning pavement design using concrete pavers seems to have been in 1983 when the Canadian Portland Cement Association and the Ontario Interlocking Concrete Paver Association jointly sponsored a one day seminar entitled "Paving stone 83" held in Toronto. Speakers were brought from Australia, England and Holland and included Dr. Brian Shackel, Mr. Alan Lilley, Mr. H. van Leeuwen and Mr. C.F. Morrish in addition to local speakers. In 1989 the CPCA organised a one week residential course entitled "Economics and engineering of concrete pavements" at the University of New Brunswick. As part of this course Dr. John Knapton gave a comprehensive review of the structural design of concrete block pavements including a step by step design method.[13] Also in 1989 the CPCA organised a further one day seminar in Toronto. This time the speakers were all drawn from within Canada. They described the major Canadian applications of pavers for traffic and industrial loading, at North Bay and Edmonton, and reviewed paver developments in Ontario since the previous seminar in 1983.

In 1990 Westcon, the Western Canadian company responsible in joint venture for the Canadian Pacific container terminal in Edmonton, organised a concrete block paving seminar in Vancouver (repeated in Seattle, Washington) at which the speakers were Dr. Brian Shackel and Mr. J.R. Hodgkinson from Australia and Mr. Brian Baker from North Bay.

THE PRESENT

It can be seen that Canadian pavement engineers have had opportunities to learn about concrete block pavement design, at first hand, from international experts. Nevertheless almost no load-bearing

pavements in concrete blocks are currently being designed in Canada. Generally, where small areas are specified it is for reasons of appearance at the instigation of the architect. Often, in these cases, there is no input from an engineer knowledgeable about pavement design with pavers and failure ensues due to quite elementary errors resulting from this emphasis on appearance combined with an absence of structural design.

To date, there seem to have been no applications of concrete block paving for load-bearing pavements in Canada in the following areas:

- airports
- ports (except for trial sections)
- (petrol) service stations (perhaps one or two exceptions)
- bus stations
- residential roads

The Canadian market seems to be the inverse of the British market in that the great majority of pavers are used in architectural applications and almost none in structural pavements. In the U.K. the decorative market is said to account for only 10 to 25% of the total market [13].

THE FUTURE

The use of pavers for decorative or architectural purposes, with emphasis on shape, colour and laying pattern, is well established and is likely to enjoy steady growth. On the other hand concrete block pavements designed to support traffic and industrial loading are little used and are not widely understood. A well-planned and sustained programme of education and publicity will be required before Canadian engineers have the knowledge and awareness of concrete block paving to consider it seriously as an alternative to asphalt or concrete slabs for the pavement surface. It appears likely that the impetus for such a programme will come from the United States where progress has already been made towards gaining acceptance of concrete block pavements for airports, ports and other industrial and traffic loadings. The Concrete Paver Institute of North America seems destined to play a leading role in the promotion and development of these applications of concrete block paving.

CONCLUSIONS

1. The use of concrete block pavements in Canada has been reviewed.
2. The architectural use of concrete block paving is well established and growing.
3. The potential of concrete pavers for structural pavements is not widely appreciated and few concrete block pavements to support traffic and industrial loads have been built in Canada.
4. Concrete block pavements for structural loading are likely to gain increasing acceptance in Canada as engineers are made more aware of these applications through the promotional endeavours of the trade associations.

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