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AN INVENTORY OF CANADIAN BUILDING STOCK, 1980

by

F. Steel

ANALYZED

Division of Building Research, National Research Council Canada

Ottawa, March 1983



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ABSTRACT

This note presents a simple method of calculating an inventory of buildings in Canada from readily available data about construction activities. It indicates the calculated age, location, size and number of major building types and suggests that existing data from tax assessment records be used to produce more accurate inventories on a routine basis.

INTRODUCTION

Historical inventories of buildings in Canada would be useful for a number of research and commercial purposes. No inventory is available from known sources but there are many records about the activity of constructing buildings. This note presents an inventory based on information from those sources and certain assumptions.

Data Sources and Methodologies

Inventories of specific types of commercial and industrial buildings have been estimated by consultants under contract to Energy, Mines and Resources Canada for purposes of forecasting energy requirements and analyzing the impacts of alternative energy programs. Estimates of residential building stock in selected regions have been made by consultants under contract to Canada Mortgage and Housing Corporation in order to assess the potential for building rehabilitation.

Insurance companies were not able to report on the number or characteristics of insured buildings lost through fire or other causes. Their central records are kept for purposes of financial accounting; records of characteristics of individual insured buildings are relatively unimportant to them.

Aerial photography could be used to produce information about existing buildings. But such a process would be expensive, interpretation could be difficult and the ages of buildings could not be determined.

A direct survey of all buildings conducted in a manner similar to the Canadian census would provide an accurate inventory but such a survey may merely duplicate much of the information already contained in tax assessment records. Unfortunately, without results of a direct survey that records the desired characteristics of all existing buildings, it will remain impossible to know the accuracy of any estimate.

Provincial revenue departments update every two years property assessment records of all taxable and tax-exempt properties located within their jurisdiction. Those records would provide a good base for an accurate and constantly-updated inventory of existing building stock. At the present time, many of those records would have to be searched manually to extract the required data. With nearly 12 million properties in Canada, such a search would be time-consuming and costly. When the majority of assessment records are in machine-readable form, perhaps within 10 years, it may become possible to produce from that existing data base the desired inventory of existing building stock in Canada.

In this note, the estimate of the residential building stock is based on Canadian census data and records of building completions. The estimate of the non-residential building stock is based on recorded construction costs and the annual additions made to the value of building stock. The note indicates where other more detailed data or wider ranges of data could be used that would probably result in a more accurate estimate.

RESIDENTIAL BUILDINGS

Quantity

The 8 million residential dwelling units in Canada (at the end of 1980) are estimated to have a floor area of 740 million m² and to be contained within 4.7 million buildings. Assuming an average 1980 construction cost of \$430 per square metre, these units have a replacement value of \$320 billion (in 1980 dollars).

The number of dwelling units in each province and the percentage that are single detached houses or apartments are shown in Table 1. This table is based on information obtained from the 1976 Census of Canada and from recorded building completions in subsequent years.

TABLE 1 NUMBER AND TYPE OF RESIDENTIAL DWELLING UNITS IN CANADA, DECEMBER 1980

Province	Total Dwelling Units		Building Type (% of Provincial Total ^b)		
	Number ^a	% of Total	Single Detached House	Apartment	Other
Nfld.	145 100	1.8	73	6	21
P.E.I.	36 500	0.4	74	10	16
N.S.	267 000	3.3	67	15	18
N.B.	210 000	2.6	66	15	19
P.Q.	2 088 100	25.7	39	45	16
Ont.	2 926 400	36.0	57	27	16
Man.	360 200	4.4	67	22	11
Sask.	332 600	4.1	77	12	11
Alta.	735 400	8.9	65	19	16
B.C.	949 300	11.7	62	24	14
Yukon & N.W.T	16 500	0.2	58	17	25
Canada	8 067 100	100.0	55	29	16

^aFrom Table 5 of Statistics Canada Catalogue 93-802, "1976 Census of Canada - Dwellings and Households", plus 1977-1980 completions from Table 4 of CMHC's "Canadian Housing Statistics 1980".

^bCalculated from 1976 values from Table 5 of Statistics Canada Catalogue 93-802.

Calculated values for the total area and total number of each type of residential building are shown in Table 2. The building area was calculated by multiplying the number of dwelling units by the average size of recently constructed ones. It was assumed that older dwelling units are the same size as newer ones. The number of residential buildings of each type was calculated by dividing the total area of each type of dwelling unit by the average number of those types of units contained in one building. The sizes and number of units per building of dwelling units classified in the 1976 Census of Canada as "other", such as

TABLE 2 RESIDENTIAL BUILDING STOCK IN CANADA, DECEMBER 1980

	Single Detached House	Apartment	Other	Total
Number of dwelling units ^a	4 436 900	2 339 460	1 290 740	8 067 100
Average area per dwelling unit (m ²)	101.6 ^b	74.0 ^c	87.8 ^d	
Total area (million m ²)	451	173	113	737
Average area per building (m ²)	101.6	1406 ^e	753.8 ^d	
Number of buildings	4 436 900	123 000	149 900	4 709 800

^aFrom Table 1 above.

^bAverage floor area during past decade, calculated from CMHC's "Canadian Housing Statistics 1980", Table 83.

^cAverage area of apartment buildings constructed during the past decade is 2147 m² (calculated from "Canadata Construction Awards/Starts" for Canada 1968-1979). In 1980, 25 211 new apartment units were contained in 862 buildings (from CMHC's "Canadian Housing Statistics 1980", Table 16), averaging 29 apartment units per building. Therefore new apartments average 74 m²/unit. It was assumed that older apartment units would be of equal size.

^dAssumed to be an average of houses and apartments.

^eExisting apartment buildings contain an average of 19 dwelling units (calculated from CMHC's "Canadian Housing Statistics 1980", Table 17). At 74 m²/unit, an average existing apartment building has an area of 1406 m².

duplexes, row houses and mobile homes, were assumed for simplicity to be midway between those of single detached houses and apartments. A more detailed but time-consuming investigation of the average size of "other" dwelling units may have led to more accurate results. Furthermore, if more accurate information could have been obtained about typical sizes of older dwelling units, a more accurate calculation could be made of the total area of residential buildings. The magnitude of error in the results of these calculations that may be caused by using these simplifying assumptions is not known.

Location

The location of residential building stock by province is shown in Table 1. Statistics Canada Catalogue 93-802, "1976 Census of Canada", shows the number of each type of dwelling unit by city or town and by size of population centre. On a Canada-wide basis in 1976, 78% of residential dwelling units were located in centres of more than 5 000 population and 54% were in centres of more than 100 000.

Age

The percentage of existing residential building stock of any given age is shown in Figure 1. Values are based on annual completions given in

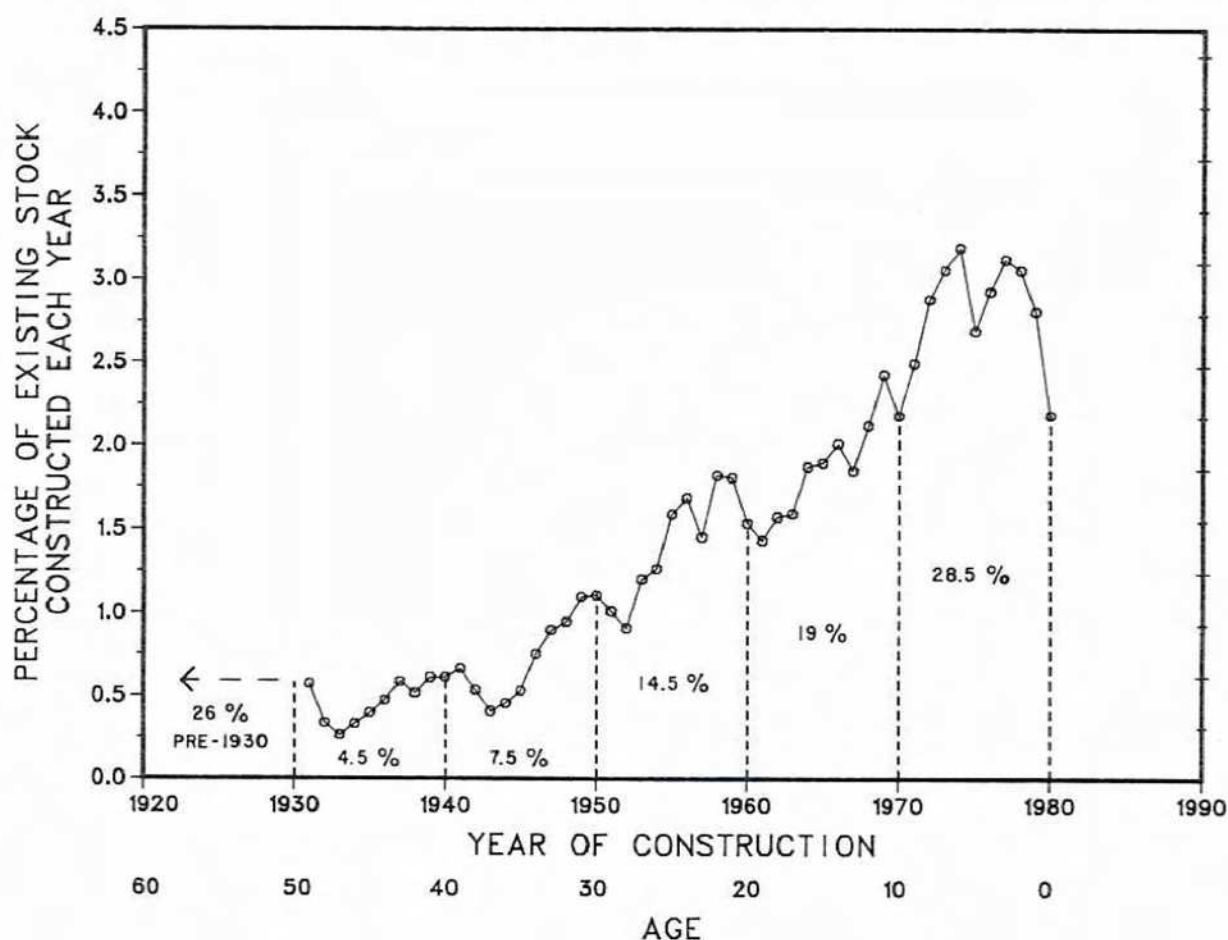


FIGURE 1 AGE OF CANADIAN RESIDENTIAL BUILDINGS

CMHC's "Canadian Housing Statistics 1980" for the years 1931 through 1980. There were 8 067 100 dwelling units in Canada in 1980, of which 5 940 000 were completed after 1930. Therefore the difference, or 26 per cent of the existing stock of residential dwelling units, must have been more than 50 years old in 1980.

Figure 1 was derived from data expressed in terms of dwelling units but it may be considered to represent building area or the number of residential buildings if it is assumed that older dwelling units are similar in floor area to newer units or that the average number of units per building has remained relatively constant with time.

Some adjustment should be made to Figure 1 to allow for building losses through demolition, fire or other causes. CMHC has estimated that annual losses of residential buildings amount to about 0.6% of the total stock, but since losses by building age are unknown, no useful correction by age can be made to Figure 1.

NON-RESIDENTIAL BUILDINGS

Quantity

The mid-1981 value of the non-residential building stock is estimated to have been \$380 billion (in 1981 dollars). This is based on the 1981 value of \$286 billion for the 50-year inventory of stock reported in Statistics Canada Catalogue 13-211, "Fixed Capital Flows and Stocks", but adjusted to represent the value of all existing non-residential building stock. It has been assumed that the value of the 50-year inventory provided by Statistics Canada would represent only about three quarters of the value of existing stock, so the value of that 50-year inventory has been multiplied by 1.33* to estimate the total value of all existing non-residential building stock.

From the above catalogue, the holdings of non-residential buildings within each industrial division (as defined by the Canadian Standard Industrial Classification) have been calculated and are shown in Table 3.

The expenditure by each industry for the construction of new buildings is provided in Statistics Canada Catalogue 64-201, "Construction in Canada". The average share of the total expenditure for a number of recent years by each industrial division was calculated and is shown in Table 4. A comparison of Tables 3 and 4 shows that the share of expenditure on new building construction by each industrial division is

* As shown above, about 26% of existing residential buildings in Canada were constructed prior to 1930. Also, in the United States, about 25% of existing non-residential buildings were estimated to have been constructed before 1930 (Heating/Piping/Air Conditioning, Sept. 1981, "The Retrofit Market: What's Out There?"). Therefore an adjustment factor of 1.33 seems reasonable.

TABLE 3 GROSS STOCK OF NON-RESIDENTIAL BUILDINGS OF ALL AGES, CANADA
MID-YEAR 1981

Industrial Division	Millions of 1981 Dollars ^a	Percent of Total
Primary Industries	49 300	13
Manufacturing	60 400	16
Utilities	21 000	5
Trade/Finance/Commerce	104 000	28
Government	52 500	14
Institutional	90 300	24
TOTAL	377 500	100

^aSum of current (1981) gross stock values shown in Statistics Canada Catalogue 13-211, "Fixed Capital Flows and Stocks - 1981" for the 50-year inventory of buildings held by the industries within each industrial division, multiplied by 1.33 to include older stock.

approximately the same as the share of the value of existing building stock that it holds.

Assuming that this correlation between expenditure and value of stock applies not only to the industrial divisions but also to the major types of buildings constructed by industry, the \$380 billion value of non-residential buildings could be divided among building types and industrial divisions according to the percentages given in Table 4. On this basis, the total estimated value in 1981 dollars for each major building type has been calculated and is shown in Table 5. From additional information about construction costs per unit area for each type of building, the total area of each building type can be calculated. From information about the average size of each type of recently constructed building, and assuming that previously constructed buildings of similar type were of similar size, the number of each major type of building can be calculated. These results are shown in Table 5. Because the validity of assumptions is unknown, no estimate can be given of the accuracy of these results.

Location

Assuming again that there is a correlation between the value of the existing stock of non-residential buildings and current expenditure for their construction, the value of stock that is located in each province will be proportional to the relative annual expenditure for building construction within each province. From Statistics Canada Catalogue 64-201, "Construction in Canada" (Tables 18-27), the annual expenditure by province for construction of new non-residential buildings can be obtained

4 EXPENDITURES ON NEW NON-RESIDENTIAL BUILDING CONSTRUCTION AS A PERCENTAGE OF TOTAL EXPENDITURES, BY BUILDING TYPE AND BY INDUSTRY^a

	Building Type											
	Industrial			Commercial				Institutional				Total
	Factory	Other	Warehouse	Hotel	Office	Store	Recreation	Other	School	Hospital	Other	
ry	0.7	2.3	0.7	-	0.7	-	-	0.1	-	-	-	11.1
acturing	13.6	-	0.6	-	0.4	0.1	-	0.1	-	-	-	15.0
ty	0.2	0.5	0.6	-	0.9	-	-	0.8	-	-	-	6.6
/Fin./Comm.	1.0	-	2.4	3.6	13.8	10.6	2.4	1.2	-	-	0.1	35.3
nnment	0.1	-	0.2	-	4.7	-	1.9	0.2	0.6	0.3	2.1	13.9
tutional	-	-	-	-	-	-	-	-	11.4	5.2	1.4	18.1
	15.6	2.9	4.5	3.6	20.6	10.7	4.3	2.3	12.1	5.6	3.5	100.0

culated from Statistics Canada Catalogue 64-201, "Construction in Canada", Tables 10-17, years 1973, '74, '77, '78.
Columns and rows may not add to correct totals shown because of rounding.

TABLE 5 DATA ON NON-RESIDENTIAL BUILDINGS IN CANADA, 1981

Building Type	Gross Value (millions of 1981\$)	Estimated 1981 Average New Construction Cost ^a (\$/m ²)	Gross Area (million m ²)	Average Size ^e of Recent New Buildings (m ²)	Estimated No. of Buildings
Factories & Other Industrial Buildings	70 200	363.50	193	1 300	148 500
Warehouses	17 000	309.60	55	900	61 100
Hotels	13 800	570.30	24	900	26 700
Offices	78 200	633.20	124	900	137 800
Stores	40 700	628.90	65	900	72 200
Recreation	16 400	603.50	27	900	30 000
Other Commercial	8 900	530.70 ^b	17	900	18 900
Schools	45 900	827.40	56	1 200	46 700
Hospitals	21 300	1120.70	19	1 200	15 800
Other Institutional	13 200	828.10 ^c	16	1 200	13 300
Other Non-residential Buildings	54 200	521.90 ^d	104	1 100	94 500
Total	379 800		700		665 500

from 1979 prices (Canadata) factored up by 1.193, the ratio of the estimated mid-1981 implicit price index to the 1979 implicit price index, from Table 16 of Statistics Canada Catalogue 62-007, "Construction Price Statistics".

^a Average value for all commercial buildings.

^b Average value for all institutional buildings.

^c Average value for all non-residential buildings.

^d Calculated from data in several recent December issues of "Canadata Construction Awards/Starts".

and the relative annual activity in each province can be determined. The annual expenditures were factored by the implicit price index for non-residential building construction as given in Statistics Canada Catalogue 62-007, "Construction Price Statistics" (Table 16), to obtain the annual expenditure in constant 1971 dollars. The total expenditure in constant 1971 dollars in each province during the 1972-81 period as a percentage of total expenditure during that time for new non-residential building construction in Canada is shown in Table 6 and is assumed to represent the relative amount of building stock in existence in each province. If the distribution of major building types is assumed to be fairly uniform among all provinces, the total area or the total number of buildings of each type in any province, as a percentage of the Canadian total, will also be given by Table 6.

TABLE 6 NON-RESIDENTIAL BUILDING STOCK AS PERCENTAGE OF TOTAL STOCK, CANADA BY PROVINCE 1980

Province	% of Total
Nfld.	1.8
P.E.I.	0.4
N.S.	2.7
N.B.	2.3
P.Q.	23.8
Ont.	32.0
Man.	4.1
Sask.	4.3
Alta.	15.4
B.C.	13.2

It is expected that for the primary industries, the majority of the "industrial" buildings (factories, mine buildings and mine mill buildings) and the majority of "other" buildings (mainly farm buildings) are located in rural or thinly populated regions. In the utility sector, it is assumed that many buildings within the "other" classification (buildings of the communications, transportation or energy distribution industries) are also located in rural areas. Such buildings in rural areas account for about 13% of the gross value of existing non-residential building stock. Therefore it is expected that about 85% of non-residential building stock is located in urban areas. Given that 54% of the residential building stock is located in centres of more than 100 000 population and assuming that people live near their workplace, it is expected that about 50-55% of non-residential buildings will also be located in or near urban centres of more than 100 000 population, with the other 30-35% located in urban centres of less than 100 000 population.

Age

The age distribution of existing non-residential buildings is shown in Figure 2. The annual gross fixed capital formation for non-residential buildings since 1926 is given in Statistics Canada Catalogue 13-568, "Fixed Capital Flows and Stocks 1926-1978". The distribution in Figure 2 was calculated by dividing the annual formation, expressed in constant 1971 dollars, by the gross value of all existing non-residential stock (which was calculated to be 1.33 times the sum of the gross fixed capital formation during the 50-year period 1931-1980).

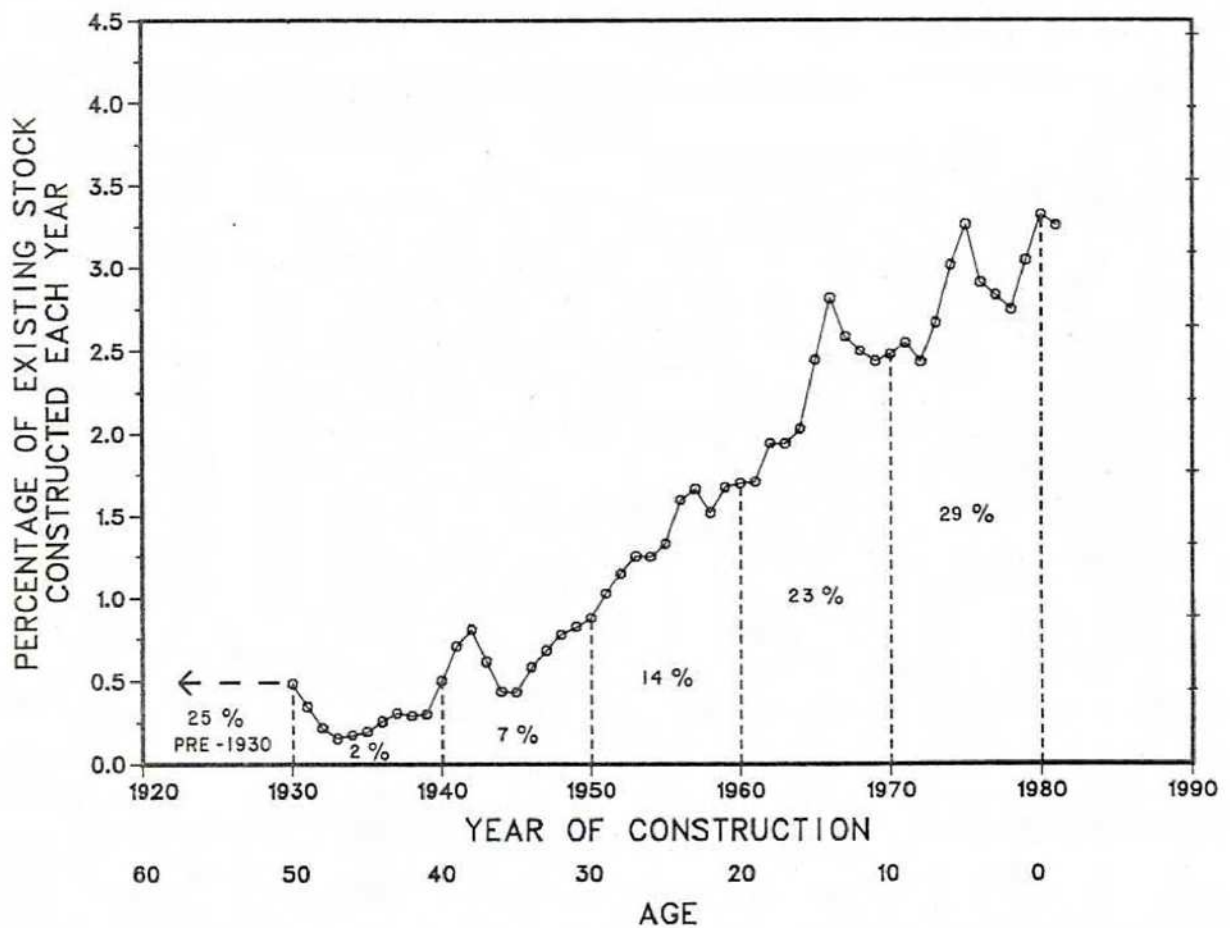


FIGURE 2 AGE OF CANADIAN NON-RESIDENTIAL BUILDINGS

Some adjustment should be made to account for annual building losses through demolition, fire or other causes, but unfortunately no estimate can be made of the size of such losses or of the ages of buildings affected.

Accuracy

The magnitude of error in the calculated inventory of non-residential buildings cannot be estimated.

Gross stock values are based on a 50-year perpetual inventory of buildings that has been established for statistical purposes. That statistical inventory may not bear any resemblance to the actual inventory of existing buildings.

For this estimate, it has been assumed that a correlation between the value of existing stock and recent expenditures is valid for all industries. However, in Tables 3 and 4, relative expenditures do not match relative values of gross stock for the trade/finance/commerce sector or for the institutional sector. Therefore this report probably overestimates the number of buildings held by trade/finance/commerce and underestimates the number of institutional buildings.

The distribution of the building stock by building type and by region was based on expenditures within the past decade. Factors such as population growth, population relocation and business cycles may be of varying cycle length and may not affect each industry and each region simultaneously or in a uniform or consistent way. The action of those and other factors during other decades may have had a very different effect on the capital formation for building construction. No comparison of recent and past expenditure by region or by industrial division was made to confirm the validity of applying conclusions based on expenditure for building construction during the past decade to the total inventory of buildings.

Explanations of the limitations and accuracy of Statistics Canada data are contained in the agency's referenced catalogues and in Catalogue 13-522, "Fixed Capital Flows and Stocks, Manufacturing, Canada, 1926-1960: Methodology."

OBSERVATIONS

This note shows one simple way to estimate the inventory of existing Canadian building stock. Although based on numerous assumptions, the results permit some general observations to be made.

Apartment buildings represent only 2.6% of the estimated number of residential buildings, yet they contain 29% of the total number of dwelling units and presumably house 20-30% of the population. The concentration of non-residential buildings is in factories, office buildings, stores and schools which together account for nearly 50% of recent expenditures on non-residential building construction. Research devoted to apartment buildings, factories, stores, offices and schools would be focussing on the major segments of Canadian building stock.

The 1980 replacement cost of existing buildings in Canada is \$700 billion. Any analysis of the long-term performance of existing buildings that could lead to even small improvements in design, materials, construction techniques or maintenance would produce long-lasting benefits to the owners of these assets.

This calculated inventory cannot provide the type of information needed for research purposes to assess the long-term durability and performance of buildings because building age cannot be calculated with accuracy and because the loss rates and the ages of lost buildings are not known. Neither does this inventory provide the type of detailed information desirable for many commercial purposes. A periodic census of all existing buildings or use of information already contained in tax assessment records would permit an accurate inventory of existing buildings to be made.