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LESSONS LEARNED FROM THE APPLICATION OF THE EARTHQUAKE HAZARD REDUCTION INITIATIVE TO FEDERAL BUILDINGS IN CANADA

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ABSTRACT

Canada has a large number of Federal buildings, many of which are located in active seismicity zones of relative significance and were constructed prior to the advent of contemporary safety standards, and could thus be considered potentially hazardous. A solution-oriented earthquake hazard reduction program was developed through the implementation of a building-by-building evaluation process to reduce structural vulnerability and lower the risk of injury to users. The first stage, the Building Inventory and preliminary analysis, allowed for a drastic reduction in the number of buildings considered potentially hazardous, the definition of the hazard reduction problem, and subsequent budget estimate. Opinions on how best to implement this initiative varied among subject matter experts and various bodies of authority. This inconsistency of opinion caused cooperation problems that appear to be inherent to the participation of expert opinion in earthquake hazard reduction problems. Lessons derived from this case are deemed relevant to the formulation of Earthquake Hazard Reduction programs in seismic risk scenarios of moderate to moderate-high seismicity and young building population .

KEYWORDS

Building-inventory, earthquake-hazard-reduction, hazard-mitigation, expert-opinion, seismic-risk.

INTRODUCTION

During the past 70 years earthquakes have caused several million dollars in property damage in Eastern and Western Canada, Twenty-seven persons were drowned in Newfoundland in a tsunami generated by an off-shore earthquake in 1929. In 1944 major damage was caused by an earthquake in Cornwall, Ontario, and a number of earthquakes having a magnitude of seven or greater have occurred in various parts of Canada, including Vancouver Island, Queen Charlotte Islands, and the Saint Lawrence River Valley. The tsunami generated by the Alaska earthquake of March 27, 1964 did extensive damage in Alberni and Port Alberni, and in numerous settlements along the west coast of Vancouver Island, even though the epicenter was about two thousand kilometers away.

The Geological Survey of Canada indicates that it would be naive to assume that the absence of damaging earthquakes since 1944 in Eastern Canada will continue during the next few decades. Along the continental margin of Western Canada, seismologists suggest the possibility of a major earthquake of devastating proportions along the Juan de Fuca subductive boundary of the American plate. This opinion, although somewhat controversial, would mean that part of coastal British Columbia and Vancouver Island could be seriously affected. Although the general perception that earthquakes are confined to Western Canada or California has developed, earthquakes in Eastern Canada tend to shake a comparatively larger area because of lower attenuation and could potentially affect many more people due to higher population density, so that the combined effect could constitute a greater hazard to mitigate.

Since Public Works Canada was custodian of more than seven thousand federal buildings, many of which were located in earthquake zones, it was deemed necessary to undertake a program of seismo-resistant upgrading, where appropriate and where economically feasible. The aim of the program was to reduce the vulnerability of Federal structures under its custody to severe damage and to lower the risk of injury to the users, with the principal focus being buildings constructed prior to the advent of contemporary standards.

Such a program had to involve the **development and confirmation of an inventory** of PWC structures not meeting the earthquake requirements of the 1985 National Building Code of Canada (NBC), and the initiation of specific **structure evaluations** aimed at specific **proposals** for ensuring their structural safety, while at the same time enhancing the government's investment.

It is of convenience to explain here that the Government of Canada is the largest real estate property manager in Canada. An early nineties estimate on the value of these property holdings is between 40 and 60 billion Canadian dollars, with annual operating and capital expenditures of $2 billion, employing 17,000 persons in property management. As is the case in many other countries, the Canadian government's role as property manager has been one of its most highly politicized functions and has been used in the past as a vehicle for furthering socio-economic objectives across the country. Properties were retained and upgraded for the purposes of local employment, over-built in the name of federal presence, and added to meet operational needs. The result was a bloated inventory which was under-managed and over-staffed, annually consuming 35,000 person years, $6 billion in expenses, and generating only $2 billion in revenues. Recommendations for rigorous divestiture of federal property and transfers to local, private, or other levels of government soon followed. Given these conditions, government officers do not have the political blessing to incur expenses in an Earthquake Hazard Reduction Program (EHRP), unless such a program can be proven feasible, inexpensive and based on a realistic building inventory. The view of this author is that the circumstances described above occur commonly in many countries and will equally obstruct other Earthquake Hazard Reduction initiatives requiring the support of any government level, federal, state or municipal. Of course, the exception is when a local seismic event triggers the 'management-by-crisis' process, expediting the passing of earthquake hazard mitigation initiatives.

As PWC has the most significant number and variety of buildings in the country, it was appropriate to assume that conclusions obtained from this program could greatly benefit municipal programs aimed at the seismo-resistant upgrading of other building populations, such as residential and industrial buildings.

PROBLEM IDENTIFICATION

Buildings constructed in Canada before 1941 were not required to be designed to resist seismic forces. Since then, research, experience from other countries, cases deemed of interest to Canada, and in particular the media influence of American seismic events, have contributed to the formulation of progressively changing seismic provisions for the design of new buildings. The current standards were revised in the 90's and are contained in the National Building Code of Canada (NBC). At the time the Earthquake Hazard Reduction Program was initiated, the 1985 version of the Code was in effect. Compliance with these standards for these older buildings is not strictly required provided their overall seismo-resistance can be reasonably demonstrated, even when their evaluation could often be a controversial matter of some complexity.

Canada, a sparsely populated young country, has not experienced *single death which can be directly attributed to structural building failure caused by an earthquake*, and has only occasionally experienced material damage caused by earthquakes and thus, cannot be expected to have acquired first hand experience in the evaluation of the seismo-resistant capacity of existing buildings. As a result, most professionals confronted with such a building evaluation concern, are tempted to resort to the direct application of the current regulatory Building Code instead of evaluating other available bodies of experience, such as the recommendatory Applied Technology Council of the US., and the regulatory Unified Building Conservation Code for existing buildings. These two examples are documents that, because of their application across the whole of U.S., appear fully applicable to the Canadian scenario. Notwithstanding, care must be exercised in applying recommendations from places of different seismicity and different building population types.

Further to the Canadian seismic environment described above, the Earthquake Engineer in-charge and author of this paper was initially confronted with a commonly held belief among some professionals, the media and several interest groups, which misrepresented the seismic risk that existed: "*There are in Canada literally thousands of buildings located in areas of significant seismic activity, many of these that do not comply with the current building code, - or to any building code -, posing a risk to life, limb , and property. The* *government of Canada should lead the nation in actions aimed at reducing that risk, actions which could be extended to or followed by those who own buildings in the private sector. The Big One in Western Canada, an earthquake of magnitude 9 or more, is likely to cause millions and millions of dollars in damage and thousands and thousands of death and desolation....* "

In response to this alarming statement, an Earthquake Hazard Reduction Program (EHRP) was proposed. It was formulated to follow a solution-oriented process (as opposed to a research one), to be applied on a building-by-building basis, and was aimed at defining the magnitude, extent, and geographic locations of the problem. From the onset it was clearly established that **the seismo-resistance evaluation had to be done on a building-by-building basis,** and that the first step in identifying potentially hazardous PWC buildings across the country had to be the preparation of a building inventory. The program's ultimate objectives were: (a) to reduce the vulnerability of identified PWC (federal) structures to severe damage due to earthquakes, so as to lower the risk of injury to users and people nearby in a solution-oriented program; (b) to conduct seismo-resistant evaluation studies of screened vulnerable buildings to determine their hazardousness; (c) to provide remedial seismo-resistance upgrading work .

THE METHODOLOGY

A methodology useful to rank a large building inventory was developed in a manner that would not mask individual life safety hazards, and so the process required that buildings be considered individually as recommended in chapter 2 of the ATC-14. All documents included in the References list, but not written by the author of this paper, contributed to the development of the methodology used in the Earthquake Hazard Reduction Program. A starting point was provided by the works of Hart, 1985 and McClure, 1973. In particular the recommendations found in the ATC-14 were studied and applied. The ABK recommendatory series (1981) was used in evaluations of unreinforced masonry buildings (URM), and was complemented by the generous direct help of J. Kariotis. The ABK Guidelines for the evaluation of Historic URM buildings were considered. Most relevant documents published by the National Earthquake Hazards Reduction Program of the United States were carefully studied as to their applicability to the Canadian scenario. Direct experience, apart from that gained by the author during several severe earthquakes, was contributed to by the former Safety Engineer of the City of Los Angeles, C.W.Jenkins among many others, and the report of Alesh & Petak provided a contemporary perspective on the economics and political aspects entailed in seismic hazard mitigation programs.

It is a common error of belief that buildings must be upgraded to meet the current building code. Whenever possible and cost-effective there is no objection to proceed with such level of upgrading. But that is not a requirement. The current NBC is a regulatory body for the design of **new** structures, not for the analysis of existing ones. There are other regulatory documents have addressed the evaluation of existing buildings. When applying the ATC-14 recommendations, an understanding of the physics that govern the possible failure of structural components along with the prevalent societal attitudes of its application, is important. Possible hindrances must be thoroughly understood as perceptions vary within the engineering community as to the value of applying ATC-14, with hesitation at its strongest among the uninitiated. The tendency is to favor the familiar regulatory code, not the recommendatory ATC.

It is pertinent to insist that one of the main characteristics of this initiative is that since its very beginning it recognized that the program had to be a **building-by building solution-oriented** study, so that vague generic propositions were uncalled for in this particular Canadian scenario. As such, speculative studies emanating from researchers not familiar directly with the building population of Canada were unwarranted; those generic studies were likely to produce dilatory discussions and the postponement of a simple effective solution; and special care had to be exercised when analogies were brought into the Canadian scenario, such as those from Mexico, California, and Eastern Europe.

The **first stage** of the methodology was the development of an overall inventory of buildings with their main characteristics, and confirmation of an *inventory screening* to isolate those buildings requiring detailed evaluation. This determined in large measure the order of magnitude of the problem with respect to subsequent evaluation studies. The following and **second stage** consisted in *Evaluation studies* aimed at assessing the seismo-resistant capacity of potentially hazardous structures identified in the inventory screening and corrective actions, if required. Finally, the **third** and **fourth stages**, namely *Proposals for risk reduction* and *Implementation,* were conceived to be applied to each screened building individually and implemented preferably with other conveniently scheduled renovation works to save mobilization costs, except in cases of high seismic risk or public concern. The ensemble of Canadian seismic zone parameters, namely the acceleration-related coefficient Z_a , the velocity-related Z_v , and the v zonal velocity ratio to 1 m/s, were used because of their ready availability, and because considering the virtual unavailability of data from strong seismic events in Canada and present circumstances, these numbers provide the most acceptable representation of seismic risk to the public and to the prevailing scientific-technical community.

The ATC - 14 recommendations considers the ATC Effective Peak Acceleration (EPA) coefficient A_a, and its application to the Canadian scenario requires reference to the Z_a coefficient. The equivalence of the Canadian acceleration-related Z_a, although not identical to the ATC coefficient A_a was discussed with Geological Survey Canada (GSC) and used.

INVENTORY

The initial inventory was provided by Central Real Property Inventory. The Canadian government had at the time about 62,000 buildings , of which about 27,000 were under the custody of the Department of National Defense, close to 5,000 buildings were very small wood-framed shacks resulting from land acquisitions for airports, and some 2300 buildings of interest were under the custody of Public Works Canada. A preliminary analysis of the building population of the government demonstrated that PWC had the most important building group when regarding attributes such as value, size, occupancy volume, and permanency. To clear the initial inventory, a large number of irrelevant buildings had to be eliminated. The large majority of buildings discarded as seismo-resistant were wood-framed buildings , one to two stories, located in inactive or modestly active seismic zones, with very small square footage. The data base included data such as the location of the building, date of construction, type of construction, number of stories, floor areas, occupancy type, information relating to its foundation and surrounding soils, reports from the regional engineer, and all other readily available information accessible at the time of the preliminary evaluation.

CATEGORIZATION OF THE BUILDINGS

The data base of each region was analyzed and the buildings classified initially according to the seismic **risk** of their locations as expressed through the acceleration and velocity related zone parameters Z_a and Z_v, and velocity ratio v of the NBC. The following classification groups, according to the ensemble $[Z_a, Z_v, v]$, were used where the NBC parameters Z_a and Z_v rank from 0 to 6, and the v ratio from 0.00 to 0.40:

(1) high seismic risk areas/class;	[6,6, 0.40] ÷ [5,4, 0.20];
(2) moderate seismic risk areas;	[4,3, 0.15]
(3) low - moderate seismic risk areas :	[4,2, 0.10] ÷ [3,2, 0.10]
(4) low or zero seismic risk areas : v=0.05;	[3,2, 0.05] ÷ [3,1, 0.05]
(5) very-low or zero seismic risk areas :	[1,1, 0.05]

The ATC-14 suggests the following levels of seismicity in relation to the evaluation of existing buildings:

High seismicity for regions zoned with an expected EPA ≥ 0.20 g
Moderate seismicity for regions zoned with an expected $0.10\text{ g} \leq \text{EPA} \leq 0.20$ g
Low seismicity for regions zoned with an expected EPA ≤ 0.10 g

The recommendations of ATC-14 were adopted, so that small buildings of less than 100m^2, limited to one or two stories, and located in areas of Low-seismicity ($Z_a \leq 0.20$) were discarded from the list of buildings that may require seismo-resistant upgrading. However, buildings in unreinforced masonry (URM) were considered separately according to the ABK series and the Section 10 of ATC-14.

All buildings of one or two stories, built with a wood-framed structure, and occupying about 100 m^2 in zones of Moderate-low seismicity, were discarded after being brought to the attention of the Regional Engineer to confirm their state of repair. Wood-framed buildings have faired well during past earthquakes, in particular small ones that tend to have a high ratio of resisting wall to floor area.

All buildings in areas of significant (high-moderate) seismic risk were initially considered of questionable seismo-resistant capacity, and listed with their size, year of construction and other characteristics.

The building population, once classified, was analyzed one building at a time and then ranked. Factors considered in the analysis were: the seismicity of the site in conjunction with the base-shear requirement corresponding to the year of design vs. today's demands, the soil-foundation conditions, information relating to surrounding soils, the age of the building and code or seismic regulations utilized in its construction, reports from the Regional Engineer when available, floor areas, the shape and aspect-ratios of the structure, materials and type of construction, occupancy type and some other relevant information provided by the Regional Engineer. The data-base provided by the Realty of PWC contained useful information as to type of construction, year of design, construction, renovations, and commissioning, and other data related to the construction process. When direct data about the foundation soil was available, detailed geological maps were consulted together with other evidence from neighboring buildings. Horrors of the kind often attributed to old buildings were the exception as owners had made efforts to correct or upgrade most buildings.

The **base-shear demand** can be considered the most important provision required by all ten editions of the NBC. It attempts to ensure that any building will have sufficient lateral horizontal resisting capacity to enable its structure to survive a certain level of earthquake induced forces under a certain probability criteria. As the NBC Code evolved to reflect updated seismo-resistant concerns, this requirement also evolved. A direct comparison of the different expressions utilized to represent this requirement in the various NBC codes is meaningful only after complete pondering of all the relevant factors considered in each code.

The base-shear requirements, corresponding to the code of the year of design and to the current code, were carefully pondered, taking into consideration the overall changes of the seismic code versions, and the results utilized in the seismic risk characterization of most buildings.

THE DESK ANALYSIS

The list of buildings was screened again to identify buildings not requiring further evaluation, and those which required a more detailed hazard assessment. A preliminary evaluation, for convenience named **Desk Analysis**, made reference, primarily to the seismicity of the area. It included a history of seismic events, the age and type of the building, type of structure and envelope, non-structural considerations (such as partitions, curtain walls, equipment and anchorage, type of occupancy, the number of stories and aspect ratio, the presence of potential hazards such as cornices, chimneys, parapets and appendages, or reinforcement elements such as reinforced additions to walls), the history of recent renovations and upgrading, the recommendations of the Regional Structural Engineer, any modifications to the original building, and when possible, inquests relative to non-structural aspects that could cause disasters as a result of panic consequences of a seismic event (such as the storage of combustibles and flammable material, building content, expedition of exits, easily accessibility or restricted, and the availability of evacuation procedures). Simple calculation of the shear base demand and availability took only a few hours and was done for most cases, primarily to conform with references made in the current code. Load paths and loads were considered to detect stability deficiencies. Also considered was the stability of walls, especially in unreinforced masonry cases, in conjunction with anchorage and roof trusses. Simple ratios, such as height to width (h/t) are quick to produce and their meaning in evaluations is nowadays rather well established in the ABK series and ATC-14 report. Typically, the lateral shear forces were formulated and compared with those prescribed by the code applicable at the time of construction and also to that corresponding to the current code, but with importance coefficients equal to unity for verification purposes.

The method developed specifically for the analysis of the Canadian population of buildings, taking advantage of their particular characteristics, was novel in many ways in spite of its simplicity. A key issue is that Canada, and in particular PWC, has a **very young population of buildings**, of a **manageable quantity**, and in most cases of **careful construction**. The analysis found that the largest number were built during the sixties and early seventies, during the construction boom that followed the end of the economic disturbance caused by the second World War. It was perhaps a favorable conjunction, that the seismic lateral forces prescribed by the building codes applicable during these years had increased to levels comparable to, and sometimes higher than, those recommended in recent versions of the code.

The end result of this screening process was that safety concerns were concentrated on a mere 197 buildings which required more detailed evaluation, and possible structural upgrading, if deemed necessary. The smallness of this number caused some discomfort, and at times commotion, among those that had declared that Canada had thousands of dangerous structures posing a threat to life, limb, and property. The author of this paper, an Earthquake Engineer and officer of the Canadian government at the time, was witness to several presentations designed to scare the public or embarrass public officers in an effort to obtain funds. It is the view of this author that this type of conflict of interest is inherent to most public Earthquake Hazard Reduction Programs, and subsequently, any Officer-in-charge of such types of activity will inevitably have to confront. Future task forces on EHRP could benefit from this experience, anticipate areas of possible contention and design precautions into the process, as appropriate.

Some buildings determined as potentially dangerous and requiring immediate seismic assessment, were later scheduled for demolition or sale; their state of disrepair was declared to be a matter pertaining to the real estate business, and not to the EHRP. PWC officers had no mandate to follow directives that consider the possible danger these buildings could represent to the community. Instead they could only deal with buildings under the department's custody. To an Earthquake Engineer serving the Federal Government, this posed a difficult dilemma, as not crossing administrative boundaries could have potentially fatal consequences. The case of the already condemned LA Veteran Hospital which collapsed during the San Fernando Earthquake causing about 64 deaths in 1971, illustrates that it is not sufficient to condemn unsafe structures unless appropriate administrative actions ensue to ensure the elimination of all potential danger.

Buildings in the Pacific Region The database of the Pacific region was analyzed according to the methodology, and the buildings classified following the seismic risk of their locations. The effective and dutiful cooperation of the Regional Structural Engineer, Mr. F.Gould, permitted the confirmation of the structural data obtained from the realty inventory, and the expeditious screening of the building stock. After screening out these buildings, a short list requiring more detailed evaluation was created, an example of the method is shown in Table 1. These buildings require further evaluation and perhaps structural upgrading.

Table 1. Summary Analysis of the PWC building population Pacific Region

(Za, Zv, v)	Location Stories	1	2	3	4	5	?	Total Bldgs.
6, 6, 0.40	Campbell River		*1*					1
5, 5, 0.30	Victoria/P. Alberni		*2*	*2*		*1*		5
3, 5, 0.30	Prince Rupert	2		*1*				3
4, 4, 0.20	Great Vancouver		1 + *3*		1 + *1*		3	9
2, 4, 0.20	Kitimat			*1*				1
"Discarded" buildings:		2	4	1			199	206
Total		4	11	5	2	1	202	*12* + 213

Notes: *Italics indicate the 12 buildings to be inspected.* Others are in acceptable condition.

To address concerns emanating from the Big One, the hypothetical Cascadia mega-earthquake, an extensive literature search was done with the help of Geological Survey Canada. The subject has been treated elsewhere as the object of opinion and media exaggerations, aspects which escape the scope of this paper. However, careful reading of the pertinent scientific literature dealing with ground motion simulations, responsible discussions with some of the scientists involved, and consideration of the Canadian population of buildings likely to be affected, favors the view that the acceleration levels and provisions of the current NBC are adequate, with some reserves perhaps only for a few sites in the island of Vancouver. This author made ample inquires in reference to the adequacy of the Emergency Response Preparedness with unusually encouraging results. The work for the RCMP (Patrickson, 1991) is relevant in this respect.

In summary, only a dozen buildings in the Pacific area were found to require urgent seismo-resistant evaluation, and most could be done suitably with relatively modest resources, possibly with those already assigned to the Region. It is not correct that PWC had thousands or hundreds of buildings posing a danger to the Canadian population on the West Coast.

Buildings in the Ontario Region Once the building data base was analyzed according to the methodology, 43 buildings representing over 500,000 m^2 were screened out, remaining only 7 buildings requiring more detailed evaluation, representing less than 3% of the total usable area of the stock. All these buildings were subsequently evaluated (Patrickson, 1990,a) and structural improvements recommended for implementation .

Buildings in the National Capital Region (NCR) The NCR includes Ottawa-Hull and is placed over the western Quebec seismic source area characterized by moderate to low seismic risk. Historically isolated not too far events of about M=6 have occurred in 1732 (Montreal), 1935 (Timiskaming), and 1944 (Cornwall). The building data base, referring to a large number of buildings, many of them of recent construction, is expected to be well documented. Most relevant information on these buildings, although of public domain and accessible under the Freedom of Information Act, is under the custody of the National Capital Region, and virtually inaccessible unless budgetary payments are made effective. This data base refers to close to 250 buildings with a floor area of 2,700,000 m^2. Of these buildings, 66 buildings representing slightly over 1,000,000 m^2 could be declared safe according to the methodology, while the rest of the stock lacked sufficient information as to made possible the application of the Desk procedure. The NCR did not facilitate the files for examination and instead requested internal payments for supplying the information: since budget allocations were scarce, most information, if it existed, was never delivered.

The influence of strong personalities, lobbing for the obtaining research contracts, lack of valid work among engineers that had to practice on fully cost-recovery based, the lack of political leverage of managers concerned with endless reorganizations, and the systematic avoidance of clarification of judgment, are among the many reasons that caused the partial failure of the seismo-resistant assessment of this particular stock of federal buildings.

For convenience, the buildings of the Parliamentary Precinct were added to the NCR stock, including the prominent Canadian Parliament. This prominence and with it the expectation of availability of budgetary resources has attracted unwarranted research proposals on seismic evaluation subjects. This author when acting as the Earthquake Engineer, had to oppose and discard proposals submitted by high-level research groups because of the conflict of interests there contained and of their overall technical inadequacy (Patrickson, 1990 c).

Buildings in the Quebec Region The data base was analyzed according to the methodology with the following results: 80% of the building area appeared located in low to moderate seismic risk area, representing 720,000 m^2 ; 17% of the building area, representing 88,000 m^2 in seismic moderate risk area (21 buildings, mostly low-rise); 0.70% of building area, (4 two-story small buildings) equivalent to 3670 m^2 in high seismic risk area; and, the rest in low risk areas; five heritage buildings were found in Quebec, and three in Montreal, plus some nine others that could qualify, meaning that PWC does not have a massive heritage upgrading problem in that region. The above made it easy to recommend some further evaluation studies and a budget of about $350,000 in dollars of the time.

Buildings in the Atlantic Region Over 200 buildings initially considered in this region were narrowed down to only 14, most small wood-framed buildings or located in low seismic risk areas. Of these buildings only four were found in areas of moderate seismicity and thus recommended for a formal seismic assessment with an estimated budget assumed in $20,000, and to be carried out by the Region with some assistance from Headquarters. Of interest, although not a PWC building, was the assessment of the Federal Dorchester Penitentiary (Patrickson, 1990, b) as this large massive building was undergoing renovations and has large parts in unreinforced masonry.

COMMENTS

Cost The cost of the initial evaluation was in the order of one to two dollars per m^2. The cost of upgrading varies for each building, and falls in the range of ten dollars per m^2 when its implementation is scheduled with other renovation works. It is definitely not in the hundreds of dollars per square meter as suggested by most prior to the conclusion of this initiative. In contrast, the cost suggested by interest groups benchmarking comparable costs in California, had been in the range of $200 per square meter for strengthening and about $20 per square meter for evaluation (Alesh, 1986). For Canada, less precise figures were said to be prohibitive and in the range of hundreds and thousands of dollars ...

Reactions from the expert community Practicing engineers, professional committee members, administrative officers, academic members of committees, and research officers in general admitted that they were not familiar with the application of the ATC-14 recommendations, and in particular with the ABK recommendations. Discomfort may be the result of the following :

- The ATC-14 and ABK recommendations are relatively recent, (1983);
- there is no important economic market for EHRP in Canada;
- seismo-resistance evaluation of existing buildings can be considered a specialty, which is not economically justifiable for professional engineers to learn;
- The application of regulatory codes (NBC) has clear legal support, while the application of recommendatory documents (ATC, ABK) implies assuming responsibilities difficult to justify in the Public Sector.
- Canadian academic institutions teach primarily structural behavior of elastic bodies with the consequence that engineers show an apparent reluctance - and even fear - to deal with rigid bodies, like in the case of URM; the conceptual understanding of the behavior of rigid bodies is neglected to favor the elastic case, with the consequence that dynamic stability requirements receive insufficient attention; concepts such as ductility, earthquake probability, and strain energy appear to enjoy acceptance to the detriment of the deterministic treatment of seismic loads, energy dissipation through inter-granular or friction, or simple friction of rigid elements; Canadian geo-seismicity is not regularly taught to structural engineers, to the point that professors regularly make references to the Californian scenario and appear uninformed about the Canadian one;
- URM has traditionally had a bad image; contravening evidence defies the media and does not sell;
- the profession is not "helped" by statements like 'the seismicity of large areas is poorly understood (GSC)', or 'implied in the application of probabilistic procedures based on the scarce seismic data base of Canada verges with numerical illiteracy when dealing with high levels of ground motion' (Krinitzsky, 1992), or 'there are cases in which URM can be seismo-resistant' (ABK), or 'the cost for earthquake hazard mitigation is often inflated by the actions of interest groups'(Alesh).

CONCLUSIONS

The results of the program allowed for a drastic reduction in the number of buildings suspected to pose a threat to life and property in the event of an earthquake, the correct identification of the risk reduction problem for each Canadian region, and the anticipation of resources for the implementation of subsequent stages of this initiative. This process used was practical, rational, economical, and tailored to the Canadian context. The "desk analysis" allowed for a quick and effective screening of a large building population, as it made good use of the peculiarities of the building characteristics of this large area of the North American Continent, and the fact that the construction boom that postdated de second WW took place with the advent of rather stringent base shear requirements. Countries with conditions comparable to those found in Canada can benefit from this experience. The application of this process is inexpensive in cases of large building populations for which some data exists, particularly for young ones, as is the case in many cities in the American continent.

Many of the problems of the kind described by Alesh and Petak (Alesh,1986) in their Politics of Earthquake Hazard Mitigation did occur, such as the opposition presented by the establishment, regulatory authorities, and personalities admittedly concerned with objectives of real estate, research and preeminence. Control of the activity to validate the continuation and perpetuation of committees and funding from the public seems to be the main motive. EHRP entails an inherent conflict of interests that the Engineer acting on behalf of the public and government must inevitably confront.

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