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PWGSC POLICY ON SEISMIC RESISTANCE OF EXISTING BUILDINGS

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SUMMARY

Public Works and Government Services Canada (PWGSC) builds, maintains and manages a large portion of Federal Government Building inventory across Canada, and has had to delineate ways to mitigate earthquake risk to its infrastructure in a duly diligent manner. As government has tended to retain and renovate buildings, the average age of PWGSC's inventory is in the 40-year range while that in the private sector is closer to 20 years. The National Building Code of Canada prescribes requirements for new building construction, and provides no consistent requirement for dealing with older existing buildings that may not meet the today's stricter requirements. As well, Provincial and local codes and by-laws are inconsistent across the nation in their own supplementary requirements.

In 1998, PWGSC developed a Guideline with the objective to provide a consistent risk management approach nationally, and this was subsequently adopted as a Policy on Seismic Resistance of Existing Buildings in 2001. Key elements include including seismic considerations in the major renovations of PWGSC crown-owned buildings in moderate to high seismic zones, and gathering basic information about each building through seismic screenings.

The paper discusses the varied issues behind the development and negotiation of the Policy with all the stakeholders involved, key elements of its requirements, the technical tools it espouses, its implications for our different regions, and issues still in discussion such as heritage considerations, leased buildings, links to emergency preparedness and response, and non-structural elements. The paper also proposes a need to establish similar and consistent standards for all building owners across Canada.

INTRODUCTION

There is a growing global momentum to address the seismic (earthquake) resistance of older existing buildings that may not meet the stricter requirements of current building codes for seismic loading and design of new buildings. While the National Building Code of Canada does not apply retroactively to older buildings, there is a clear need for a duly diligent approach for Canadian building owners. It was with this in mind that PWGSC, as knowledgeable owner and manager of a significant amount of federal building infrastructure, created a Guideline in 1998 to allow for a more consistent approach to dealing

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with existing buildings. This was subsequently adopted as a Policy on Seismic Resistance of Existing Buildings in 2001, Sundararaj et al. [1]. Key elements include incorporating seismic considerations in major renovations of PWGSC crown-owned buildings in moderate to high seismic zones, and gathering basic information about each building through seismic screenings.

A key issue was awareness within the real property community within PWGSC, and other client departments. In PWGSC's Project Delivery System, there are a number of stakeholders identified, key players being the Owner/Investor community, the Property Management community, the Client Service community and the Project Management/ Architectural & Engineering Services (AES) community. Participation was required of all these as well as the various Regional counterparts that would vet and apply the policy. Discussion centered around Risks to Life Safety, Risks to continuing government operations, Liability as a knowledgeable owner, Legal issues of due diligence, the Aging federal inventory, National consistency, and the Regulatory requirements versus the Legislative ones versus Risk Management, Atkinson & Sundararaj [2].

PATH TO SEISMIC POLICY

The path to the creation of the Policy was an arduous process beginning in 1997/1998 with internal discussions within the National Structures Discipline meetings of Architectural and Engineering Services, bringing together the varied inputs of Regional engineers, resulting in a Position paper in 1998, Balazic [3]. A key concern was the lack of a consistent approach to dealing with seismic deficiencies in building infrastructure. A draft Policy was prepared and consultations held with the different communities identified earlier. This was released as a Guideline to begin with in late 1998, the reservation being the cost implications for the PWGSC program.

This led to an internal national cost implication study in 1999 that found that the average cost of inclusion of seismic considerations in planned major renovations was between 3-5% of the total construction cost on a major refit project. This was followed by a legal review of a duly diligent approach to be taken by a knowledgeable owner, which finally resulted in bringing all stakeholders to the table to finalize a formal policy. After review by the national Strategic Planning Network, Senior Management approved the Policy for issue in 2001.

The above is a reflection of the similar struggles faced on a different scale within the larger Real Property community in Canada and elsewhere, as all the stakeholders need to be brought together to negotiate and effect change, Atkinson & Sundararaj [2].

WHAT THE POLICY SAYS

Scope

The Policy's scope applies to crown-owned buildings currently in or to be added to the custody of PWGSC, in zones of moderate to high seismicity. "Moderate to high" is defined as an effective Seismic Zone between 2 to 6 as defined in the NRC Guidelines [4]. This effective seismic zone (Ze) is a combination of the acceleration (Za) and velocity (Zv) zones defined for each city in the National Building Code of Canada (NBCC), and is equal to Zv unless Za is greater than Zv, in which case Ze is equal to Zv plus 1.

When Significant Projects are being planned for existing buildings located in zones of moderate to high seismicity, a detailed seismic assessment is mandated to be conducted in the project planning stage. A

project is considered significant under any of the following conditions: i) when the interior finishes are planned to be stripped for substantial wings or floors; ii) there will be a change of intended use of the facility as per the NBCC, such as from office to warehouse, etc.; iii) there will be significant weight added to the existing building such as the addition of storeys; iv) key seismic resistance elements such as walls, braces or sections of the building, will be removed or modified; v) the project costs are at or above 50% of replacement costs for the building.

There is some subjective judgement in the classification of planned work in a building as being a significant project, particularly when considering the multi-year plans that are included in Asset Management Plans for each facility. The long-range plans for the building must be reviewed to determine the most appropriate time to trigger a detailed seismic assessment and any necessary upgrades.

Detailed Seismic Assessment

The Detailed Seismic Assessment includes:

1. A review of the building's main structural resistance system and elements;
2. A detailed structural analysis taking into account the proposed alterations and building occupancy;
3. A gathering and review of existing plans and other documentation on the building;
4. Performing relevant on-site investigations and a condition survey of existing elements;
5. Involvement of a geotechnical engineer to address foundation requirements;
6. Review of functional components (i.e. non-structural elements) as it relates to operational and life safety requirements. These include, but are not limited to building components such as canopies over exit ways, partitions in corridors and stairwells, roof parapets, mechanical and electrical systems, ceilings, and cladding at access/egress locations. Submission of a seismic assessment report including an evaluation of the sufficiency of the main building structure expressed as a percentage of the NBC value. The report is also to include an assessment of the non-structural elements identified in 6.

The bulk of the seismic assessment will be done by a structural engineer, but other disciplines (e.g. geotechnical/electrical/mechanical/elevator/architecture) may be required to help coordinate with discipline-specific issues as required. A number of reference documents are suggested, NRC [4-6], PWGSC [7,9], CSA [8].

Options Assessment for Seismic Upgrades

Firstly, although not required by law, the policy requires federal building projects to be in full seismic compliance with current local by-laws and provincial/territiorial building codes in addition to the NBCC, where such requirements exist.

On top of this, where the detailed seismic assessment finds the building's seismic resistance does not meet 60% of the seismic load requirement for new building construction as specified by the current NBCC, seismic upgrading of the main structure is required. Upgrade options and approaches are to be investigated, so as to upgrade the seismic resistance of the main structure to the 60% or higher level. Consideration shall be given to upgrade the building to full current NBCC requirements or higher. Incorporation of practical aspects of the building alteration is to be carefully considered. New and emerging technologies are also to be carefully considered. Upgrade options for non-structural items are also to be investigated. Options, cost estimates and recommended seismic upgrading approaches are to be documented.

Selection of an upgrade option (whether 60%, 100% or other value) will include consideration of the following, among others:

- Seismic performance level
- Design, project management and construction costs
- Constructability considerations
- Client requirements
- Operational requirements
- Displacement of building occupants
- Long-term flexibility requirements for the building
- Architectural aspects of improvements
- Heritage aspects

Consideration of options will be documented in part by ensuring:

- Renovation plans contain the seismic assessment report name, author and date.

- Where seismic upgrade work is not required, the existing level of seismic resistance expressed as a percentage of the current NBCC requirements is to be described on the renovation plans.

- Where seismic upgrading work is included, details of the seismic improvements including the level of seismic upgrade in relation to the current NBCC requirements, seismic design loads and design philosophy are to be described on the renovation plans.

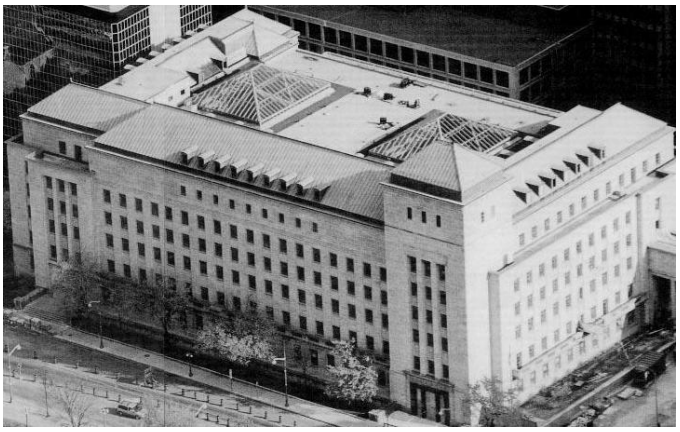
Seismic screenings

Whether major renovations are planned or not, basic Seismic Screenings shall be conducted on all buildings in zones of moderate to high seismicity per available manuals, NRC [5]. For buildings in PWGSC's custody, screening results are to be included in each building's lon-term Asset Management Plan. Results are to be used in the investment analysis planning process on a building-specific and portfolio-wide basis. For buildings that have not been subject to an earlier seismic screening, such a screening will be completed as part of the input to the completion of the next Asset Management Plan for the building. These screenings are part of the operation and maintenance activity and are to be funded out of the building's existing annual budget using the Building Condition Report and Building Management Plan process.

Seismic screening of buildings in zones of moderate to high seismicity that are not yet within the custody of PWGSC shall be completed prior to a final agreement to acquire the facility. For a building with a confirmed Structural Priority Index SPI through this procedure of greater than 30, a detailed seismic assessment is mandatory and must be completed within a reasonable period and not later than the subsequent fiscal year after confirmation of the SPI. A seismic database for the PWGSC building inventory is to be maintained, including such information as base building information; screening and/or detailed evaluation information; scope/cost of seismic improvements where done; and mission-criticality information.

Exemptions

Application with justification for exemption can be made in exceptional cases to senior management.



East Memorial Building, Ottawa

Library of Parliament, Ottawa

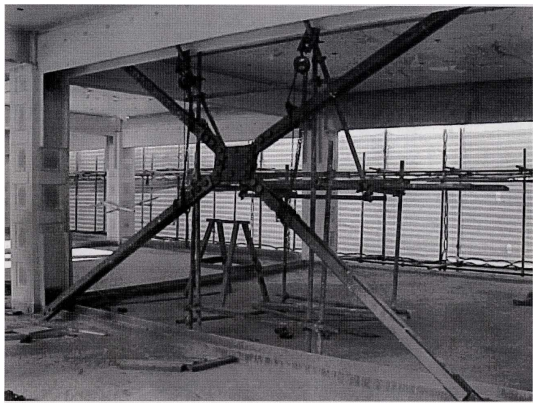
Figure 1. Building examples where the PWGSC Seismic Policy has been applied.

WHAT THE POLICY DOES

The intent of the policy, over time, is to improve the owned and managed building stock to an acceptable level of seismic resistance. The approach, in trying to meet the diverse needs of all the stakeholders, has endeavoured to be reasonable, rational, and cost-effective. Consideration of new technologies is implicit thoughout the policy in attempting to minimize cost pressures that could otherwise jeopardize the implementation of seismic recommendations on a project.

The policy demonstrates due diligence on the part of the owner, extending duty of care, defining roles and responsibilities for the various parties – owner representatives, property managers and technical professionals – in implementing the policy. It allows for effective planning for seismic works on the building inventory, and creates a model framework for client use. It makes possible a National consistency of approach, and meets the basic requirements to manage seismic risks.

Canadian Embassy Annex, Beijing



Rehabilitation with Innovative Friction dampers

Figure 2. An example of a Client Department applying PWGSC policy.

IMPLEMENTATION, REGIONAL IMPACTS

Operational efforts underway have been tailored to each of our six regions across Canada. Due to their higher seismic zones, the most affected regions are the National Capital Area (Ottawa, Gatineau), Pacific, and Quebec. Atlantic, Ontario and Western regions are also affected, but only in specific areas within them that are identified as being moderate or high seismic zones. Smaller PWGSC regions like Pacific and Quebec have undertaken to fully evaluate all owned buildings, and develop a database of priorities and costs. In Vancouver and Montreal, certain buildings have been upgraded for seismic resistance such as the Harry Stevens Building. In the National Capital Area (Ottawa/Gatineau), which houses the seat of government and the headquarters of the various departments, there are a large number of older buildings that have undergone or will undergo retrofit as part of their renewal for the longer term. The policy has been used as a consistent bar to evaluate investment options for buildings including their seismic resistance as a factor (Figures 1, 2, and 3), Balazic et al. [10], Sundararaj & Pall [11]. As per the policy, basic data is being collected on all the building infrastructure using the Seismic screening tools available, NRC [4].

Canadian Museum of Nature

Figure 3. PWGSC Policy currently applied in Investment Analysis.

NEXT STEPS

The policy is scheduled for update by 2005, but as the policy implementation continues, a number of items are planned and others are arising for follow-up. The implementation of the policy in all sectors of the department needs to be ensured and roll-ups prepared, as well as on-going efforts to raise awareness and technical excellence nationally. Code Changes such as the expected update to the NBCC in 2005 need to be incorporated as well as other code developments such as local municipality developments and in the International Building Code in the U.S.

While the policy would consider Lease-to-Purchase buildings as alike to Crown-owned buildings, Leased buildings are not included in the policy at present. With government leasing more space, it is intended to update the policy to address this issue. Heritage building considerations , while referred to in the policy, need to be defined in more detail, and both technical and management guidelines prepared for dealing with heritage structures.

The requirements for non-structural elements of buildings and their behaviour during earthquakes need to be updated given recent developments, CSA [8]. Strategies for prioritization of risk mitigation in conjunction with structural deficiencies need to be developed. As well, the issue of Lifelines is not addressed as yet and needs to be explored.

Emergency Preparedness and Business Resumption Planning are on-going activities at PWGSC in conjunction with Emergency Preparedness Canada. With on-going changes in government and relationships with provinces/territories and municipalities, roles and responsibilities need to be reviewed, and detailed action plans in conjunction with private sector partners developed.

Further information partnering with outside agencies, other government departments, the Treasury Board of government, the insurance industry, consultant associations, technical societies, Research centers, Provinces, Cities, Building Owners and Managers Associations, Code development committees are required to both enhance and expand the application of the policy to existing buildings beyond PWGSC, as received in feedback from industry participants at the recent OCEERC/PWGSC Workshop on Seismic Evaluation and Retrofit of Buildings [2].

CONCLUSIONS

The PWGSC Policy on seismic resistance of existing buildings is a good step in achieving consistency in dealing with PWGSC crown-owned buildings. A tremendous amount of teamwork was required to get it in place, given the variety of stakeholders involved, and the implementation goes apace to improve the owned and managed building stock to an acceptable level of seismic resistance in a reasonable and cost-effective manner. The challenges identified through the process will be instructive as the industry at large deals with the same issues, and as PWGSC continues to seek input on on-going improvements to the approach and scope.

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