Building Code Requirements for Seismic Design

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# Building Code Requirements for Seismic Design

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Introduction

There have been several documented major seismic events that have affected the Caribbean Region. Since the late 1600, over ten earthquakes with magnitude 5.8 or greater have impacted the region from Jamaica to Guadeloupe. Data collected indicates that in the last 35 years, the frequency of higher magnitude event has increased noticeably.

The British Virgin Islands presently uses the BVI Building Regulations, 1999 to regulate the structural design of all buildings. This report is intended to present a comprehensive review of the Building Code requirements for the British Virgin Islands. For the purpose of this exercise, only the seismic design portion of the Building Code was reviewed. In order to complete a thorough review, all the related codes were also examined. The codes that were studied included:

- BVI Building Regulations, 1999
  - CUBiC
- OECS Building Code
- Small Building Code of Trinidad & Tobago

In addition to reviewing the various codes, this report will also examine the process from a designer’s (engineer/architect) perspective, and make recommendations for improving the process.

It is envisioned that with an improved process the Territory will benefit from having more structures meeting the required seismic design standards and as a result, be better prepared for seismic events.
Existing Building Codes

BVI Building Regulations

In 1999, the British Virgin Islands adopted the BVI Building Regulations. This legislation is administered by the Building authority which is a division of the Public Works Department. The adopted regulations are intended to govern the structural design of all structures within the territory.

The seismic design portion of the regulations in itself is extremely brief. Essentially, the document makes specific reference to two (2) other documents for information regarding the seismic design requirements. For load calculation the code refers users to The Recommended Lateral Force Requirements and Commentary by the Seismology Committee of the Structural Engineer’s Association of California. For all other requirements, users are referred to the Caribbean Uniform Building Code (CUBiC).

Furthermore the Regulations make note that CUBiC has not defined a zonal coefficient for the British Virgin Islands. Users are therefore directed to use the zonal coefficient defined for the St. Kitts and Nevis region.
Recommended Lateral Force Requirements and Commentary by the Seismology Committee of the Structural Engineer’s Association of California

As stated previously, the first reference in the Earthquake loads section of the BVI Building Regulations is for load calculations. Users are instructed to refer to the Recommended Lateral Force Requirements and Commentary by the Seismology Committee of the Structural Engineer’s Association of California to determine the appropriate lateral force for the structure that they are designing.

This California-based resource is extremely thorough. It includes volumes of information to facilitate designers in practically any situation. This author encountered minor difficulty accessing the information. However for structural design professionals it is conceivable that the information is much more readily available and accessible.
**Caribbean Uniform Building Code (CUBiC)**

The Caribbean Uniform Building Code was introduced in 1985. This code was developed by a team of Caribbean engineers for the English-speaking Caribbean islands. The provisions of CUBiC are based essentially on the Structural Engineers Association of California (SEAOC). The relevant sections from the Uniform Building Code (UBC), the Applied Technology Council (ATC), and the New Zealand Code were all included in CUBiC.

Zonal characterization was also implemented with CUBiC. Various regions were classified and most islands were assigned a zonal coefficient. No zonal coefficient was assigned to the British Virgin Islands. However the BVI Regulations instructs users to apply the zonal coefficient assigned to St. Kitts and Nevis.

Another shortcoming with CUBiC is that it does not apply to “small” residential buildings. Instead CUBiC refers users to the Small Building Code of Trinidad and Tobago (SBCTT) for lateral loads and other considerations regarding residential construction.

Finally, as stated previously, the CUBiC code was implemented in 1985. A long overdue update was initiated in the late 1990’s unfortunately at the time of this review the update has not yet been completed.
Design Process

To offer a more insightful critique of the Seismic Design Regulations the author examined the process of the design and review of a “typical” building. Although in the BVI the majority of the buildings are single family residential structures, this review will examine the process for both scenarios – large and small structures. Furthermore the assumption in this scenario is that the design professional is new to the local regulatory process. By making this assumption, all aspects of the code and the review process may be addressed.

The initial step in the seismic design process is a review of the BVI Building Regulations. This step provides the user with references to the Recommended Lateral Force Requirements and Commentary by the Seismology Committee of the Structural Engineer’s Association of California to determine the appropriate lateral forces.

Next users are directed to the Caribbean Uniform Building Code (CUBiC) to determine the relevant zonal coefficient. While CUBiC has no assigned coefficient for the BVI, the BVI Building Regulations stipulates that the coefficient for St. Kitts and Nevis should be used.

For large, non-residential buildings the user is then able to continue to use CUBiC to find all the necessary information in order to perform the calculations to complete the structural design. However for small residential buildings, CUBiC cannot be used. Unfortunately, CUBiC was not intended for use with smaller residential buildings. For these applications the user is directed to the Small Building Code of Trinidad and Tobago (SBCTT) for lateral loads. By using this code the user is then able to complete the requisite calculations for the seismic design.

The final design is then submitted to the Building Authority for review and processing. Once approval is granted, a permit is issued. This Building Authority is then responsible for site visits during construction to ensure that the structure is built in accordance with the approved design.
Assessment of the Design Process

As indicated by the previous section, the design process can be a very convoluted process. There are multiple layers because of all the different codes which are required to be reviewed. The BVI Building Regulations, the Recommended Lateral Force Requirements and Commentary by the Seismology Committee of the Structural Engineer’s Association of California, the Caribbean Uniform Building Code and the Small Building Code of Trinidad and Tobago (SBCTT)

This process presents a challenge for designers on several levels. One issue is the fact that the codes overlap in several areas. With the overlapping areas, there is a need for one document to be clear as to which code will take precedent. This appears to be absent from the process. The absence of this prescriptive information allows for designers to interpret the “grey areas” of the system of codes. This then results in a less standardized process due to the numerous possible interpretations.

Even more problematic is the issue of outdated documents. As alluded to earlier CUBiC was developed in 1985 and has not been updated since that time. Although an update is underway it is unclear when it is expected to be completed. The BVI is therefore theoretically left to function without a “valid” building code. CUBiC is the primary underpinning code for the BVI in the area of seismic design. While the BVI Building Regulations do allow for designers to design based on other codes such as the International Residential Code as well as the Uniform Building Code, the inherent problem with this is a system that is less standardized.

Having a standardized approach to structural design is critical to the success of the Territory’s Building Code process particularly in the area of plan review. When plan examiners have to review plans against several different codes instead of one “standard” code, it makes their job much more difficult.

These primary issues are the underlying cause for a number of secondary issues which currently affect the structural design and review process. In the absence of a user-
friendly code many designers have resorted to a “cookie-cutter” approach to the design process. This results in typical structural design details that are then applied to any and all situations without variations based on the relevant site conditions. In fairness, there is also a lack of readily available geological information that would inform the design process. Therefore designers are not to be blamed completely for the lack of responsiveness evident in structural design.

The generic approach also presents a further problem - the potential for overdesign of structures. While some amount of over design can be viewed as beneficial, by adding to the safety of structures, there are also some negative side effects. Overdesigning structures as a response to seismic design requirements may be counterproductive. Structures that are constructed with connections which are too rigid may fail catastrophically in the major seismic events. Structures which fare well in earthquakes have a certain amount of flexibility built into the structural connections.

By excessively overdesigning structures the overall project cost can be increased significantly. This may result in projects becoming less feasible. When projects become less viable over the long term this can have a negative impact on the Territory’s economy.
**Needs Assessment**

This review has identified several areas of need for the improvement of the structural design and review process in the British Virgin Islands.

- **A responsive Code** – Since the majority of the structures in the BVI are smaller residential developments, there is a need for a code that will place emphasis or at least address these structures primarily.

- **A geographically relevant code** – There is presently enough seismic data available so that any seismic design code that is adopted for the British Virgin Islands can include zonal coefficients specific to the Territory. This level of information can only contribute to an improved process overall.

- **A consolidated code** – The code should seek to be as comprehensive as possible and should seek to minimize the amount of referencing to other documents/codes. In cases where referencing is necessary, the BVI Building Regulations should the clear which code takes precedence in case of any contradiction.

There is also the need for a clearly outlined review process and also proper training for the plans review staff. A good code is only as useful as those who are charged with its administration. Staff needs to be trained in order for them to be able to properly identify when plans submitted do not meet the code for seismic and other structural design considerations.
Recommendations

The review of the seismic design code and process for the BVI has revealed many issue and challenges. In order to place the appropriate level of emphasis on seismic design it important that the following step be taken:

- **Code Amendments** – The BVI Building Regulations require an immediate update to address to major areas of concern. Since the CUBiC code is outdated the regulations should be updated to steer designers to a code, other than CUBiC for seismic design. Secondly, the building regulations need a stronger section specifically for smaller structures. The Building Authority should consider the International Residential Code (IRC). This code is written specifically for buildings that are one and two-family dwellings that are 3 stories or less.

- **Geological surveys/mapping** – Efforts should be made to compile and circulate geological mapping information for the BVI. This is an important tool in structural design in general and especially for seismic considerations.

- **Proper training for all staff** – It is important that the review staff is very familiar with the adopted code so that they are better able to review plans against the required standards. Staff may also need to be increased to improve the enforcement and monitoring component of the process.

- **Education and dissemination** – All stakeholders should be involved in the code review and upgrading process. Once changes have been adopted it is important to keep design professional and the general public fully aware of changes to be implemented.

- **Periodic revisions** – Codes should never become outdated. The code itself should stipulate a schedule for review and updating.
Action Plan

- **Adopt Relevant Code Amendments** – The CUBiC upon which the BVI Seismic Code is based is severely outdated. The Building Authority should take the necessary steps to make the following amendments:
  
  o Adopt at least an interim update to the code to allow designers to refer to the Uniform Building Code for large structures.
  
  o Adopt a stronger section to the regulations that address smaller, residential structures. Presently these type of structures account for the vast majority of construction activity in the BVI. The International Residential Code (IRC) is written specifically for smaller, residential structures and should be used as the basis for this new section of the BVI Building Regulations.

- **Increase Requirements for Geological Surveys** – The Building Authority should place additional requirements on structures being constructed on reclaimed lands. These structures should be required to conduct soil testing and other subsurface investigation in order to properly determine the appropriate structural design for the intended building.

- **Training for Plan Review Staff** – In order to properly implement and enforce Building Regulations the Building Authority needs to ensure that its staff is properly trained. The International Code Council offers training through its in-house staff as well as indicates training through third party institutions. Training should be afforded to present staff in order to improve their capabilities. Additionally, in order to build capacity within the Authority, additional plan review positions should be planned. Staff should be identified for these positions, trained formally and added to the staff in the foreseeable future.