



BUILDING CODE CHECKLIST FOR STRUCTURAL RESILIENCE





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List of Acronyms

ACI	American Concrete Institute
ADs	Approved Documents
AISC	American Institute of Steel Construction
ASCE	American Society of Civil Engineers
BRCA	Building Regulatory Capacity Assessment
BRR	Building Regulation for Resilience
CUBiC	Caribbean Uniform Building Code
DRM	Disaster Risk Management
EM-DAT	International Disasters Database, from Centre for Research on the Epidemiology of Disasters (CRED)
FRR	Fire-resistance Rating
IBC	International Building Code
ISO	International Organization for Standardization
OECS	Organisation of Eastern Caribbean States

1. Overview

Rapid urbanization and population growth are driving the construction of new buildings, with global building stocks expected to double in the next 15–20 years.¹ While such trends will represent significant development advances and offer economic growth opportunities, concern remains regarding the resilience and safety of both new and aging building stocks, increased energy and water consumption, and accessibility of the existing and evolving built environment and infrastructure. This increase in development will result in greater exposure to climate and disaster risks due to the evolving impacts of climate change, depending on where urbanization growth occurs and the standard of construction. Additional vulnerabilities can be compounded in unregulated and informal settlements where buildings are constructed on risky sites, with high density, using substandard building materials, and failing to implement safe design and construction practices. The combination of urbanization and climate change poses significant challenges for countries and cities to form a comprehensive set of regulatory and policy instruments to guide a more resilient, sustainable, and accessible built environment.

The World Bank’s Disaster Risk Management (DRM) engagements support countries to design and implement diversified investments for risk reduction and preparedness. Among various approaches, improving the building regulatory framework and implementation capacity proves to be one of the most cost-effective means of reducing underlying climate and disaster risks, in combination with investments for physical structural improvements and retrofits.² In this context, the Global Facility for Disaster Reduction and Recovery (GFDRR)’s global thematic area Building Regulation for Resilience (BRR) aims to promote resilient, green, healthy, and inclusive built environments through enhanced regulatory frameworks and implementation capacities.

The BRR offers technical support and advisory services for governments leveraging global experiences underpinned by analytical work to share global good practices and practical tools to identify potential areas of engagement.³ Among various resources developed, Figure 1 highlights two sets of assessment tools and shows their different scope and objectives in the context of an example building regulation framework. The Building Regulatory Capacity Assessment (BRCA) is a methodology to analyze the existing regulatory framework and capacity of countries and identify key issues. It provides targeted recommendations for countries to initiate priority actions, potentially as part of the DRM investments financed by the World Bank or other financial sources.

¹ Global Alliance for Buildings and Construction, 2022 Global Status Report for Buildings and Construction https://globalabc.org/sites/default/files/2023-03/2022%20Global%20Status%20Report%20for%20Buildings%20and%20Construction_1.pdf.

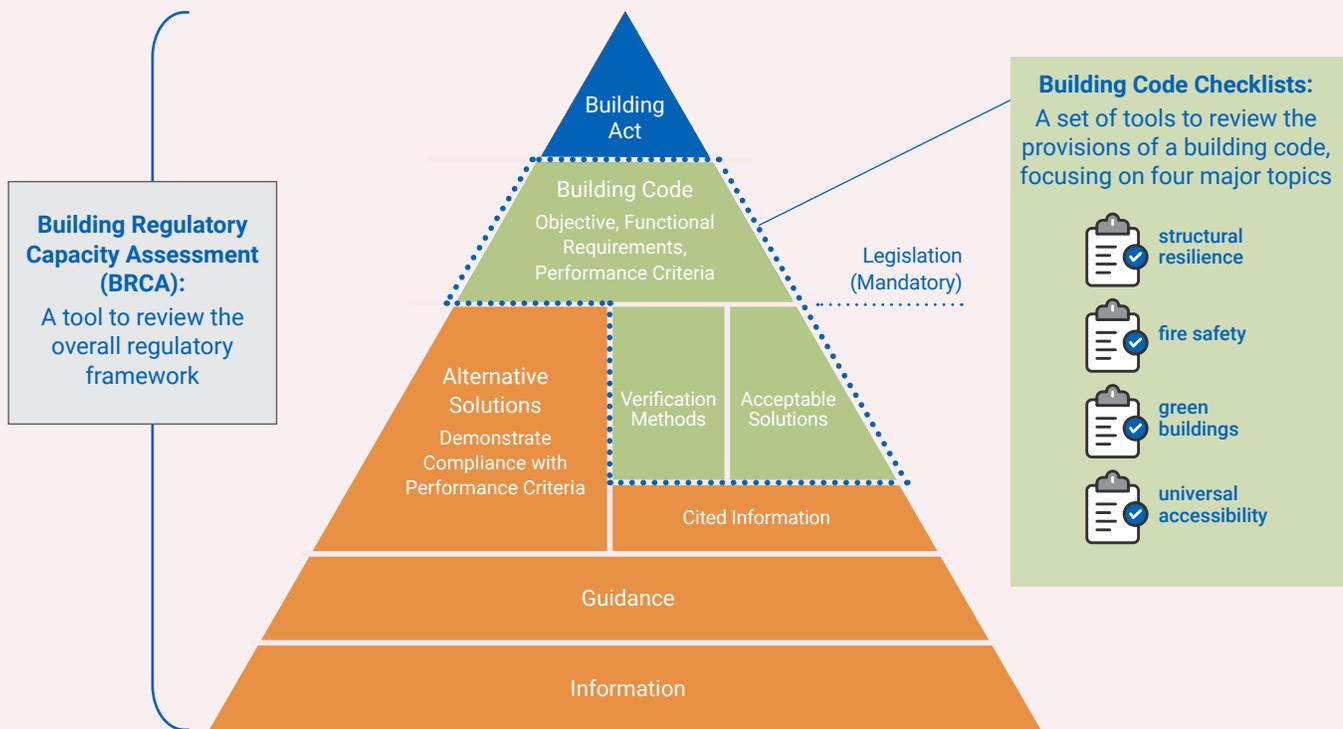
² <https://www.gfdr.org/en/publication/building-regulation-resilience-o>

³ <https://www.gfdr.org/en/building-regulation-for-resilience>

As the BRR expands, demand has grown for technical advice on details of building codes based on global knowledge and practice. Responding to such requests, the BRR has developed a set of checklist tools that support countries in assessing the comprehensiveness and depth of their building code provisions, focusing on four major elements: structural resilience, fire safety, green buildings, and universal accessibility. This will help countries' governments and code review bodies (or professionals commissioned by governments) to assess their own codes against consolidated checklists referring to global examples of good practices. The methodology has been developed to be carried out by experts in each relevant discipline with broad engineering and architectural backgrounds.

While each document presents a methodology and list of checklist questions, users can contact the GFDRR for worksheet templates for convenience of use. This document presents a checklist for **structural resilience**. The use of the checklist should help identify critical gaps in components of the building code relating to structural provisions.

Figure 1. Scope of the different BRR tools



Source: Figure adapted and modified from the original figure by [Building and maintaining New Zealand's homes and buildings](#).

2. Introduction

A recent study estimated that there were approximately 1.5 billion buildings globally in 2021. Of these, around 240 million were constructed in reinforced concrete, 630 million in masonry, and 630 million using other materials such as adobe (earth), timber and steel.⁴ Moreover, as mentioned in the previous section, the world's building stock is predicted to grow significantly over the coming decades; for instance, one study indicated that the total global building floor area is expected to increase from 162.8 billion square meters in 2017 to 183.5 billion in 2026.⁵ Much of the predicted growth will occur in regions in Africa and Asia where, globally, the highest levels of population growth and urbanization are

expected. It is estimated that 70 percent of Africa's building stock that will exist in 2040 has yet to be built.⁶ This growth in building stock creates higher levels of exposure to disaster risk as well as more periodic, chronic stresses such as extreme heat and more localized fire and flooding events. Additionally, it was found that less than 13 percent of the global building stock was built according to design regulations with seismic provisions, although almost half is exposed to moderate to high seismic hazard. Climate change is expected to drive an increase in extreme weather and related events that can damage buildings and affect the comfort of people who inhabit them, such as strong winds, flooding, extreme heat or cold, and

⁴ Yepes C., Calderon A. et al., (2023). Global Exposure Modelling for Earthquake Risk Assessment. Earthquake Spectra.

⁵ <https://guidehouseinsights.com/news-and-views/the-global-building-stock-is-expected-to-exceed-183-billion-square-meters-in-2026>.

⁶ <https://www.unep.org/news-and-stories/story/traditional-building-practices-offer-sustainable-solutions-african-cities>.

water scarcity. Another recent study found that almost one quarter of the global population is exposed to 1-in-100-year floods, but flood risk is often not addressed during the development planning process and flood-resilience measures are rare in current building codes.⁷ Strong wind events are also responsible for significant losses, with tropical cyclones alone affecting roughly 22 million people globally and causing 29 billion USD/year in damages on average over the past 20 years.⁸

Figure 2 provides an overview of the average annual human impact (both number of deaths and people affected) as well as economic losses for different disaster types for 2003-2022 and the most recent data for 2023.

Urban risk due to natural hazards, including those driven by climate change, is a global problem: one which can be heightened during periods of rapid urban development. Nevertheless, adequate urban planning, building design and construction practices aimed at structural safety and resilience significantly decrease the potential for structural damage and loss. A key element to reduce these risks is robust building regulatory frameworks that are well tailored to the local context. These frameworks are made up of planning regulations, building design codes (and related guidance), and building control regulations and enforcement mechanisms.

Building regulatory frameworks, combined with capacity building in the form of education and training for design and construction practitioners, can help ensure good quality design, materials and construction.

Even without natural hazards triggering events, losses and damage to the building stock can occur as a result of poor design and construction practices. Some of the most devastating events are when buildings spontaneously collapse under design gravity, thermal and wind, or other loading actions encountered during the building's life. In many cases, these collapses are triggered by a combination of factors: poor design and construction, poor quality materials, a change of use without considering if the building can withstand additional loading, lack of maintenance and damage and/or weakening of soils from flooding or heavy rains. In many cities in Sub-Saharan Africa, building collapses are a chronic problem. For example, between 2000 and 2021, there were 167 reported cases of spontaneous collapse in the city of Lagos, Nigeria.⁹ Spontaneous building collapses also occur in other rapidly urbanizing regions such as in South and East Asia. In Asia, an example is the widely reported Rana Plaza factory collapse in 2013 in Dhaka, Bangladesh, which killed 1,134 people and injured at least 2,000 others.¹⁰ This trend also affects high-income countries, as many have expanding stocks of aging buildings.

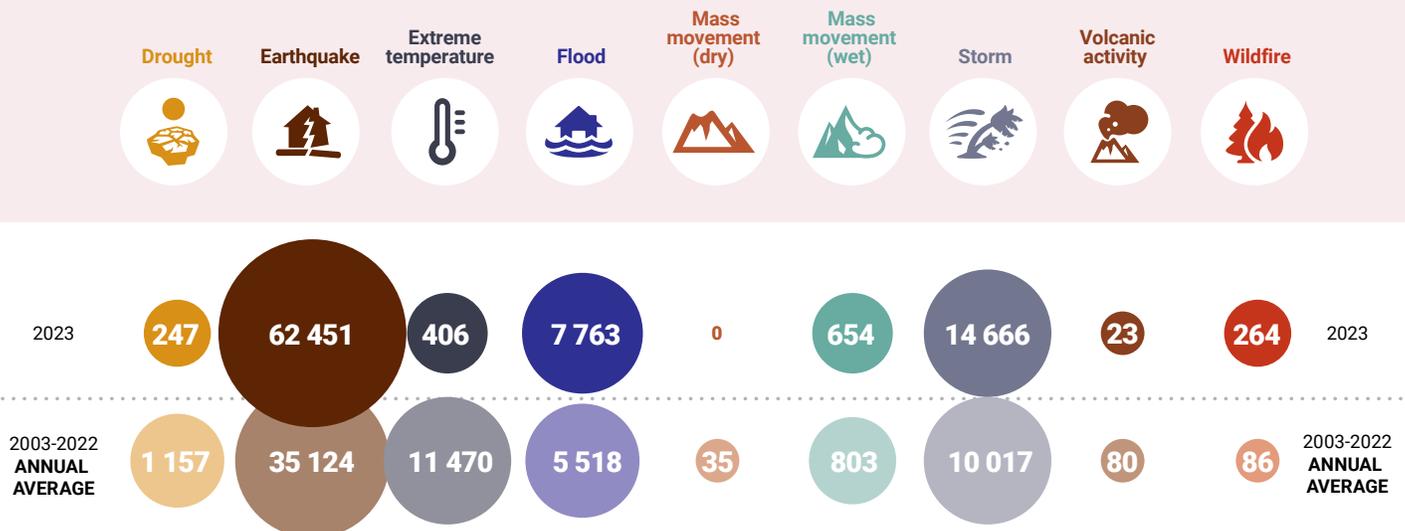
⁷ Rentschler, J., Salhab, M. & Jafino, B.A. (2022). Flood Exposure and Poverty in 188 Countries. *Nat. Commun.* 13, 3527. <https://doi.org/10.1038/s41467-022-30727-4>.

⁸ Geiger, T., Frieler, K., and Bresch, D. N. (2018). A Global Historical Data Set of Tropical Cyclone Exposure (TCE-DAT). *Earth Syst. Sci. Data*, 10, 185–194. <https://doi.org/10.5194/essd-10-185-2018>

⁹ Okunlola, O. H. 2022. “Quantifying Frequent Building Collapse and Disaster Risk Reduction in Nigeria.” *Africa in Focus* (blog), April 6, 2022. Washington, DC: Brookings Institution. <https://www.brookings.edu/blog/africa-in-focus/2022/04/06/quantifying-frequent-building-collapse-and-disaster-risk-reduction-in-nigeria/>.

¹⁰ <https://www.theguardian.com/world/2023/apr/24/10-years-on-bangladesh-rana-plaza-disaster-safety-garment-workers-rights-pay>.

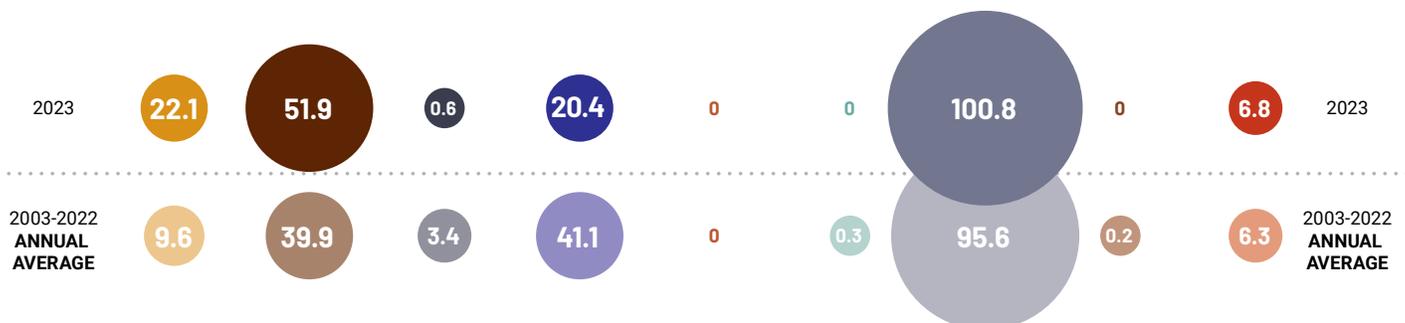
Figure 2. Human impact and economic losses by disaster type in the period 2003-2023



Number of Deaths by Disaster Type: 2023 Compared to 2003-2022 Annual Average



Number of Affected by Disaster Type (millions): 2023 Compared to 2003-2022 Annual Average



Economic losses by disaster type (billion US\$)

Source: CRED. 2022 Disasters in numbers. Brussels: CRED; 2023.

For example, in the USA, a total of 225 building failures were reported from 1989 to 2000, with just under two-thirds occurring in low-rise buildings.¹¹

Although cases exist in high-income countries, spontaneous collapses occur more frequently in rapidly urbanizing parts of developing countries. As urban areas grow, so does the challenge in achieving quality of design and construction of both engineered and non-engineered construction. Non-engineered construction is defined in this context as buildings that have been designed and constructed with little or no input from architects or engineers: in some cases, modern construction materials are used, and in others, construction of these buildings follows traditional, vernacular, building practices.

Non-engineered construction is often seen in informal settlements where structures are built without the involvement of professional engineers or architects, and without formal planning or construction permission. Buildings in informal settlements are often self-built; either by low-income households themselves, local community builders, or by landowners for rental properties.

Through the Building Regulatory Capacity Assessments (BRCAs) conducted by the GFDRR's BRR team in 15 countries and states, a number of different challenges were identified for engineered and non-engineered buildings (see Table 1).

Within the engineered construction sector, addressing these challenges would improve resilience and result in significant reductions in potential losses.

Unregulated, informal settlements with non-engineered construction, are particularly at risk of damage and loss due to natural hazards (as well as spontaneous structural collapse and fire). This increased vulnerability stems from the building materials used, the high density of shelters that create an unhealthy environment, lack of safe design and construction quality, lack of maintenance, limited access to basic services such as water and electricity making conditions unhygienic, as well as narrow roads and paths which restrict egress (escape). The vulnerability can be exacerbated when modern building materials or methodologies are adopted with little understanding of appropriate use compared to traditional construction approaches. Earthquakes, hurricanes or floods in such settlements can displace thousands of people, even if few people have been killed or injured. Obtaining an accurate picture of the exposure and structural vulnerability can be challenging. However, simplified engineering design provisions can significantly improve structural resilience, presenting “rules of thumb” for self-builders with complementary guidance to achieve compliance with a building regulatory framework for small and non-engineered structures, including incremental construction.

¹¹ Wardhana, K. & Hadipriono, F. C., 2003. Study of Recent Building Failures in the United States, Journal of Performance of Constructed Facilities, Vol. 17, Issue 3.

Table 1. Summary of challenges identified through BRCA for engineered and non-engineered construction

	Challenges for engineered construction	Additional challenges for non-engineered construction
Design & Construction Practices	<ul style="list-style-type: none"> • Inadequate design and construction quality; • Lack of complementary education and training for design and construction; • Lack of understanding of existing design standards among practitioners; • Lack of professional accreditation and knowledge maintenance mechanism for professional community; • Use of substandard materials; • Culture of incremental construction which is not accounted for in building design regulations and building control processes. 	<ul style="list-style-type: none"> • Limited, poor or no input from engineering professionals and skilled labor; • Lack of understanding of risks associated with ground conditions or site location and context; • Unsuitable choice of construction methodology, inappropriate use of modern materials or inappropriate use of modern materials combined with traditional construction methods; • Lack of detailing to protect against environmental damage, or maintenance requirements in general; • Lack of accessibility to suitable materials and construction equipment, use of substandard construction materials (both locally produced and manufactured products); • Inappropriate storage and use of construction materials and products; • Poor construction quality, generally; • Insufficient construction budget, likely to result in poor quality.
Building Regulations & Enforcement	<ul style="list-style-type: none"> • Lack of adequate structural design standards; • Lack of country-specific hazard-informed design parameters and materials standards; • Lack of mechanisms to ensure code compliance; • Lack of technical review for critical design details as part of building control process; • Limited resource availability for building departments in charge of building control; • Lack of clarity of roles and responsibilities and lack of coordination among stakeholders involved in building control process; • Lack of material testing capacity and limited control over substandard materials in the market. 	<ul style="list-style-type: none"> • Lack of design and construction guidance; • Lack of awareness of risks and poor accessibility to knowledge, especially detailing practices for seismic and wind effects; • Small, non-engineered buildings may not be included in controls and inspections.
Legal & Administrative	<ul style="list-style-type: none"> • Barriers to accessing knowledge and information; • Inefficient and complex building control processes that are costly to comply with; • Lack of dispute resolution mechanism; • Lack of liability insurance for practitioners, and low penetration of asset insurance in the market. 	<ul style="list-style-type: none"> • Small, non-engineered buildings may remain untouched by and disconnected from any building regulatory framework, planning regulations or associated official controls.

3. Objectives

A robust contemporary building regulatory framework should include a comprehensive set of structural provisions as well as fire safety, universal access, resource efficiency, sustainability and environmental requirements. Although the building regulatory framework may be of broad scope, encompassing multiple aspects of land use and construction industry regulation, the structural design and assessment code provisions all seek, fundamentally, to ensure safety and improved resilience for the built environment.

Historically, structural provisions in building codes originated with “*good practice*” prescriptive rules and these have been evolving into complete sets of requirements focused primarily on “*life safety*”¹² performance under normal gravity,

thermal and wind loading, as well as after extreme wind and seismic events. Until recently, design codes have not typically been concerned with damage limitation for economic repair or for continuity of use of buildings for more extreme events. However, these minimum safety provisions alone do not protect communities from significant indirect losses due to their inability to recover rapidly after such events. In many cases, people lose their homes and serious disruption to communities occurs when vital facilities such as hospitals, schools, government buildings, and workplaces are damaged.

Resilience in this context is considered to be the capacity of a building, community, or society to absorb shocks and stresses such as

¹² Life Safety performance aims to prevent loss of life and limit injury to building occupants and those in the surrounding environment under anticipated design level actions (loading). Under normal loads, such as gravity and wind loading, the building is expected to remain undamaged and maintain function, but for more infrequent events, such as a design level earthquake, Life Safety would allow some damage to the structural and non-structural components.

natural or anthropogenic hazards, and still be able to maintain function. At present, most structural design codes do not explicitly or comprehensively address the need for the resilience of the built environment. This checklist captures some of these resilience aspects as investment in more resilient buildings is needed now, especially for rapidly developing regions. This checklist follows a standardized and rigorous approach for review of the structural provisions of building codes and regulations for structural safety and resilience through a set of diagnostic questions. The questions aim to assess the coverage and depth of building design and construction regulations in a given country or jurisdiction. The checklist was developed with reference to global examples, as described in Appendix B.

While comprehensive in coverage, this checklist review is not intended to be a detailed assessment of the quality of the code provisions themselves. It is envisaged that the review would be carried out over a relatively short time period, with input equivalent to five days from structural engineering professionals with relevant experience of international building codes as well as the local engineering practice and country context. Priority questions have been identified to permit a shorter, partial assessment that can be carried out quickly, yielding a high-level overview: focusing on areas where codes have been found to have critical gaps in past reviews.

The tool has been designed for the assessment of regulations in relation to building structures only and hence excludes consideration of civil infrastructure and other non-building structures. Refer to section 4.1 for more detail on the scope of the checklist tool.

Previous analyses of structural sections of the building codes in developing countries have shown that they are sometimes lacking in comprehensiveness, require updating, and do not adequately consider local hazards, building typologies or construction methods. Performance requirements, including design criteria and methods within the codes, need to be adapted for local capability, conditions and context, including the availability of construction materials and skilled labor. There is a need to support countries toward creating effective and robust building codes for structural safety and resilience. A critical step is to assess the current code contents against essential elements of a building code for resilient construction. This checklist can serve as a framework to analyze the current structural provisions within a building code as a first step in developing improvements as well as future updates.

The use of the checklist should help identify critical gaps in components of the building code relating to structural provisions, while also supporting a qualitative evaluation of the usability of those provisions. It is not intended to assess the detail of quality and comprehensiveness of the provisions, prescribe specific requirements, or propose revisions to existing code documents, nor will it address building control and enforcement regulations and processes.

This diagnostic tool is designed to work with other associated assessments and quantitative analyses, such as the BRR's Building Regulatory Capacity Assessment (BRCA) and building code checklists for [fire safety](#), [green buildings](#), and universal accessibility.





4. Guidance:

How To Use the Building Code Checklist for Structural Resilience

When reviewing regulations for structural safety and resilience components, it is helpful to follow a systematic approach as outlined in Figure 3.

Although it may be possible to complete some parts of the checklist without specific expertise and experience in structural

regulations or design, such expertise will be essential to navigate and assess the technical complexities of the structural provisions.

Ideally, the reviewers would include specialists with experience of the country as well as international subject-matter experts familiar with a wide range of building codes, regulatory frameworks and structural design standards.

Figure 3. Steps to be taken in a systematic review of code provisions for structural safety and resilience

1

Understand overall regulatory framework

Identify relevant ministries, legislation and regulations with a bearing on the structural resilience of buildings.

This may be available as an output of a BRCA, if one has been carried out.

2

Assess scope and identify code chapters related to structural requirements

Assess the scope of the structural provisions of the building code and identify significant differences from the scope of this checklist tool (as described in section 4.1).

Identify precise location of the main components and subcomponents for structural safety and resilience provisions outlined in section 5—in which regulations, relevant chapters or sections are they? Note that there may be fragmentation of requirements across different code documents enforced by different statutory bodies or jurisdictions (as described in section 4.2).

3

Undertake a systematic review of country context and code components using the checklist

Consider country context and the regulatory and market capacity that is required to interpret and act upon the code provisions in a manner that can be expected to achieve the structural resilience objectives for buildings that are compliant with the regulations. The components for country context are outlined in section 4.3 with diagnostic questions in section 6.1.

Look for provisions that address each of the fundamental structural resilience components and subcomponents according to the checklist, and assess the coverage and depth of the provisions, through the diagnostic questions within the checklist. The checklist has been designed to provide prescriptive answers where possible.

The detailed diagnostic questions for code components and subcomponents are in section 6.2.

Depending on needs and available resources, a high-level review can be performed instead, by addressing the priority questions in the checklist, rather than the full checklist. Similarly, a review may be focused on a particular component or subcomponent.

4

Assess interface with other regulations

Review the interface between structural provisions and other sections of the code and local regulations, as appropriate (for example: planning, fire and other regional regulations). Related diagnostic questions are in section 6.3.

5

Finalize the checklist and provide recommendations

After completion of the checklist in the template provided, the reviewer should identify and summarize key areas of potential opportunities for enhancement in coverage and depth in the form of technical recommendations for stakeholders. This summary should note any constraints on the review (such as restricted access to information or resources) and address specific concerns or questions that may have prompted the review.

4.1 Scope of tool

This tool is intended to assess the structural provisions of the code for the design, assessment, construction, change of use or occupancy, adaptation, addition, alteration, relocation, demolition, retrofit or repair of building structures as defined below.

Building: In this document, it is defined as a temporary or permanent structure intended for the use or occupancy of people or storage, and any appurtenances attached to the building.

It excludes the following:

- civil infrastructure (transportation and subterranean transport hubs, tunnels, dams, power plants, antennas and masts, road and railway bridges) and marine structures;
- construction infrastructure: cranes, scaffolding, formwork and falsework;
- tents and temporary shelters;
- industrial infrastructure: silos, tanks, industrial chimneys or pipelines.

It is important to understand the scope of the building regulatory framework under review. This checklist has not been developed to cover any aspects beyond the building structures described above, and so the reviewer should compare and note where the code scope is broader than the definition in this tool, or where there may be gaps in the code scope (for example, lack of coverage for certain buildings by construction type or function). Where the building code's scope is broader than this tool's

scope, the reviewer should consider whether additional diagnostic questions are necessary to determine adequate code coverage for these aspects.

The checklist was developed by consideration of a wide range of international model and country codes as well as other code assessment methodologies. Refer to Appendix B for more information.

4.2 Reviewing components

The checklist questions have been developed to assess the coverage of the sections of the building code that deal with structural design and construction. In addition to the structural provisions in the building code, a desktop study may need to be carried out to understand the types and levels of hazards in the country and associated structural provisions that will be required. Additionally, the review could include consideration of referenced material standards/regulations and may also include inspection and code-compliance practices that are not encompassed by the main building code documents.

It is also important to evaluate how accessible and complete the code documents are. This will depend on several factors, including:

- i. The availability of building codes and referenced standards online;
- ii. The cost of obtaining regulatory documents (ideally, none);
- iii. The extent to which reference standards are cited;
- iv. The uniformity of and/or the compatibility between the referenced standards (for

- example, if they are all national standards, or all international standards from the same organization, or other);
- v. The extent to which non-mandatory guidance is included or cited;
 - vi. The uniformity of or the compatibility between the guidance documents;
 - vii. Additionally, factors such as clarity of the writing and navigation of the documents can affect ease of meeting compliance with the code.

Structural design and assessment provisions found in building codes and referenced standards commonly specify the following approaches to achieve compliance:

A **prescriptive-based** design approach where a set of procedures and methods must be followed to achieve compliance;

or

A **performance-based** design approach where performance requirements are set that the design must achieve but the methods to demonstrate compliance are not explicitly set in the provisions;

or

A combination of both: a **hybrid** approach.

In some cases, different approaches may be allowed for different aspects of the structural

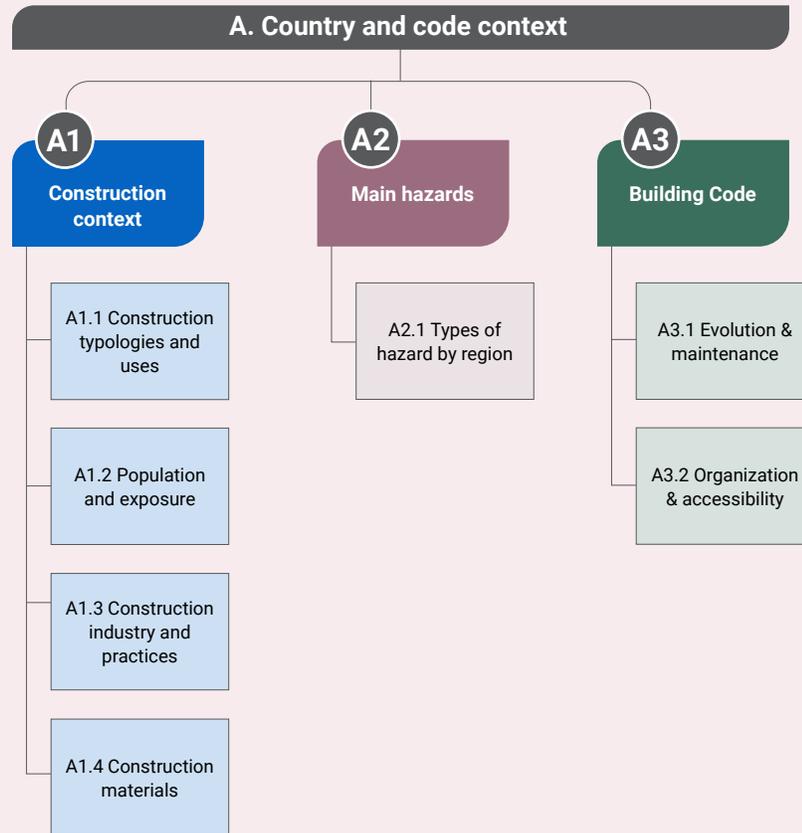
provisions in the codes and standards. For example, fire-resistance provisions for structural elements may be entirely prescriptive whereas a performance-based approach may be allowed to design a tall building for wind action. Refer to Appendix A for information on common regulatory and code frameworks.

4.3 Understanding the country context

In order to adequately assess the suitability of the building code for the country context, it is important to understand the country's construction environment, including the capacity of construction sector professionals as well as its construction practices. Ideally, these evaluations would be carried out with the assistance of country experts and local professionals/practitioners.

To facilitate this, a series of preparatory diagnostic questions and assessments has been developed and is presented in section 6.1 under the topics outlined in figure 4, below. There is, naturally, a degree of overlap in evaluating country context for this tool and for the fire safety, green building, and universal accessibility checklists, and so the reviewers could consider coordinating this work to avoid duplication of effort.

Figure 4. Components and subcomponents of the country context assessment



5. Key Concepts in Structural Resilience Components of Building Codes

Building codes in most countries include provisions or requirements associated with the following fundamental structural resilience components:

1. **Basis of design** – regulatory or code provisions that outline the overarching design and performance requirements and corresponding compliance criteria, as well as coverage of the code, including fundamental structural safety and resilience principles. An example would be the definition of limit states for structural design of buildings.
2. **Actions on structures** – code provisions that state the minimum design loads (actions) on a structure resulting from its use, environment, and exposure to hazards. Design criteria informed by country-specific hazards should be included. For example, the load types, characteristics and load combinations should be clearly defined.
3. **Geotechnical & substructure design** – code provisions that address risk related to soil conditions and design parameters for foundations and earth-retaining structures. These include requirements related to soil investigations and set design parameters and procedures for the design of foundations and retaining structures, ensure serviceability and prevent impairment due to settlement or ground deformations, as well as effects of soil-structure interaction, liquefaction, slope stability or topographic effects. For example, provisions for geotechnical characterization and for earth pressure calculations are expected to be included in the code.
4. **Structural design** – code provisions that address methods for the analysis

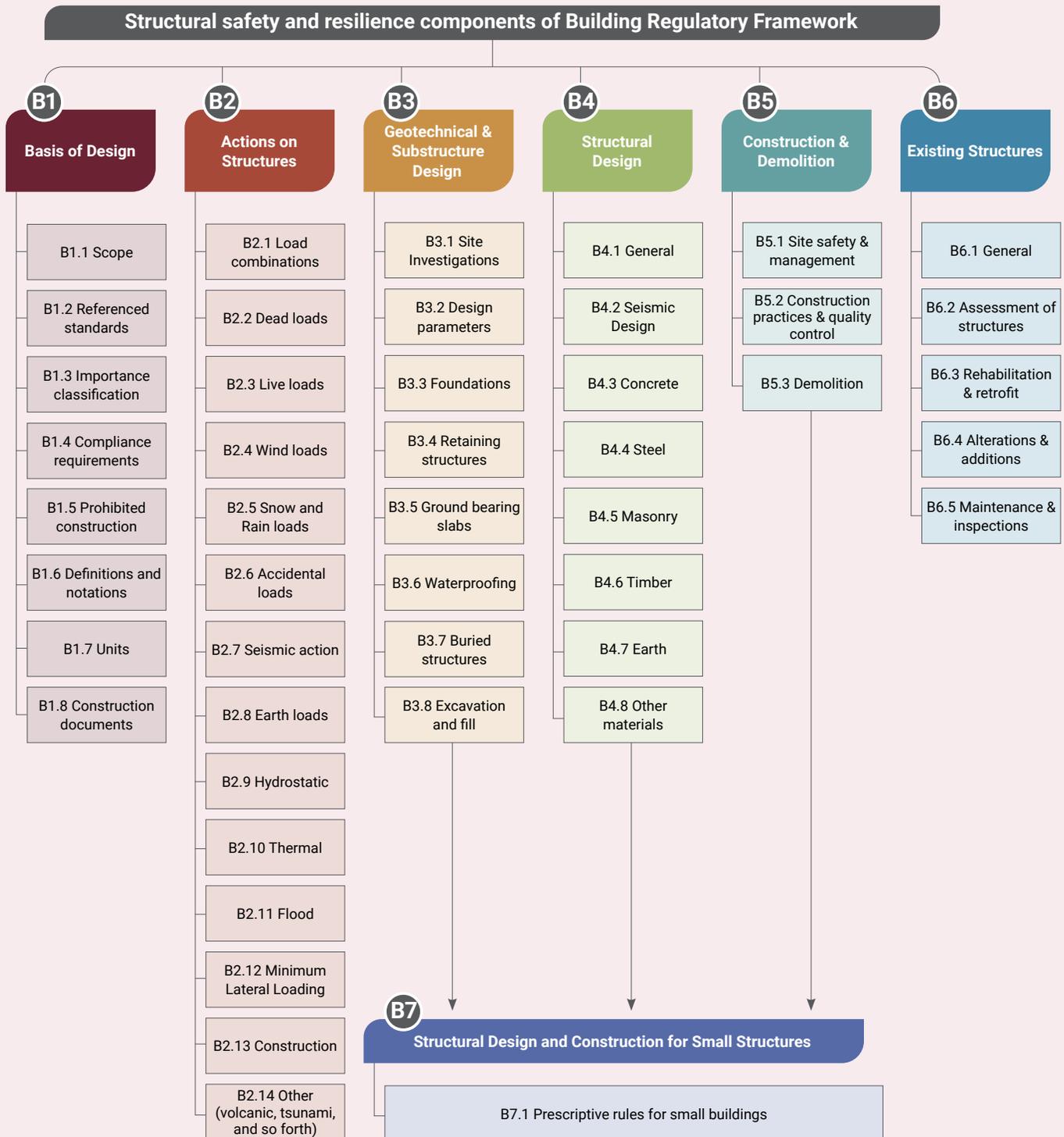
of structural behavior and verification of the design of structural elements in various construction materials, covering common construction typologies and methodologies. *Verification methods* for engineering assessments against failure modes, for example, would be defined in this component of the code and/or *acceptable solutions*, where step-by-step instructions are provided for compliance with the building code.

5. **Construction & demolition** – code provisions that address safe practices related to construction quality control for new structures, including temporary structures during the construction process as well as for the demolition of existing structures.
6. **Existing structures** – code provisions that address assessment of existing buildings in service, considering aging effects and degradation phenomena such as corrosion, or weathering related to normal in-service conditions, and the assessment of buildings with structural damage from hazard events. These provisions provide methods for the design of modifications, renovations, additions, or strengthening, possibly also considering the safety level in conjunction with the residual life of the building and incremental retrofitting approaches. Many building codes do not have specific provisions for the assessment and rehabilitation of existing structures, even though such works can be more complex to design than those for a new building.
7. **Structural design and construction for small structures** – It is highly recommended that building codes include simple rules for low-rise buildings of common construction types and regular geometry. “Rules of Thumb” for design of common, small-scale buildings can facilitate the design of compliant buildings without specialist engineering design input, especially in countries or regions where professional engineering capacity and resources are limited. In some countries, separate legally adopted guidelines (say, for housing) are published, instead of including this in the code. Either approach can be successful, provided that the documents are written and illustrated in a way that can be easily understood by the target audience who may have very limited technical knowledge and experience.

These components may be addressed fully within a single stand-alone code document, or the building code may be supported by referenced standards, as noted in section 4.2.

The fundamental structural safety and resilience components and subcomponents presented in Figure 5 are described in detail as part of the review checklist in chapter 6.

Figure 5. Fundamental Structural Safety and Resilience Components and Subcomponents



6. Building Code Checklist for Structural Resilience

This checklist is provided as a tool to assist in the review of the structural provisions within building codes based on the components described in the previous section.

Presented in the following sections are the questions, alone. Within the checklist worksheet template, there is scope to note observations regarding aspects such as consistency and clarity of wording that may not be captured completely in the checklist responses. It is recommended that the reviewer note which regulation document and/or other reference documents are being used to answer each question.

Priority questions for a high-level rapid assessment are indicated in the draft by **blue text for the diagnostic questions**.

6.1 Country and Code Context

This section provides questions for the reviewer to understand the wider country context including the construction environment, local hazards and general information on the building code. It is anticipated that this will be carried out with the input of local practitioners and officials. The level of detail necessary for this assessment should be determined by the reviewer.

Table 2. Checklist for the Review of Country and Code Context

Component	Relevance /Description	Diagnostic Question
A1. CONSTRUCTION CONTEXT		
A1.1 Construction typologies and uses	<p>To understand common construction typologies for comparison of what is covered in the structural design regulations.</p> <p>Refer to Appendix C for typology assessment references.</p> <p>The GEM global exposure model, for instance, provides information on countries' building stock.</p>	<p>a. For each construction type, please specify methods/materials, typical geographical distribution, occupancies, number of storeys, drivers of vulnerabilities, and age of construction. This should include vernacular and non-engineered typologies as well as emerging construction technologies.</p>
A1.2 Population and exposure	<p>To provide an overview of the population density, building exposure, and urban areas evolution.</p> <p>Refer to sources such as the World Bank: World Development Indicators database.</p>	<p>a. What is the total population?</p> <p>b. What is the current urban population, as percentage of total population?</p> <p>c. What is the rate of urbanization building growth?</p> <p>d. Please note other characteristics (for example, significant regional variations in population density).</p>
A1.3 Construction industry and practices	<p>To provide an understanding of the construction capacity for both large- and small-scale construction.</p> <p>For example, the World Bank database, "B-READY" includes a helpful global dataset of related indicators by country.</p>	<p>a. To get an overview of the construction capacity and skills for different scales of construction in rural/urban settings, the reviewer could consider the following:</p> <ol style="list-style-type: none"> i. Are there professional organizations or bodies for construction professionals? ii. Is there licensing or accreditation for construction organizations? iii. Are there professional organizations or bodies for civil/structural engineering design professionals? iv. Is there licensing or accreditation for civil/structural engineering design professionals? v. Is retention of license subject to requirements for continuing professional development? vi. Are there vocational training and accreditation programs for skilled labor? vii. Are construction professionals distributed with population across country (as opposed to exclusively located within certain regions or urban centers)? viii. Is the person(s) responsible for the design required to be: <ul style="list-style-type: none"> • registered or licensed? • professionally qualified? ix. Are independent design checks required? If for certain types of buildings, please specify. x. Are large/complex construction projects typically carried out by international contractors? xi. Are large/complex construction projects typically designed by international consultants? xii. Are there requirements for inspections of construction works? xiii. Do contractors rely upon imported labor for skilled labor? If yes, please specify countries of origin and associated skills. xiv. For domestic construction (single family dwellings) – is the design and construction subject to approvals and inspections of construction?

Table 2. (cont.)

Component	Relevance /Description	Diagnostic Question
A1. CONSTRUCTION CONTEXT		
<p>A1.4 Construction Materials</p>	<p>Understanding of material supply chains and availability can inform assessment of the coverage needs of the building code material design sections.</p>	<p>a. Source of common construction materials and products (1. most often imported; 2. most often locally sourced/ manufactured; 3. unknown).</p> <ul style="list-style-type: none"> i. Sawn timber (for rafters or floor joists) ii. Timber planks iii. Engineered timber products iv. Plywood v. Metal fixings vi. Bamboo vii. Concrete masonry units viii. Fired clay masonry units (bricks and blocks) ix. Earthen masonry (adobe, compressed earth, rammed earth) x. Lime xi. Cement xii. Cement replacements xiii. Sand xiv. Small aggregates (<10mm) xv. Large aggregates (>10mm) xvi. Steel reinforcement xvii. Light gauge steel sections xviii. Profiled metal roof decking xix. Profiled metal floor decking xx. Structural steel sections xxi. Other (state)
A2 MAIN HAZARDS		
<p>A2.1 Types of hazard by region</p>	<p>To identify the types of natural hazards that most contribute to disaster risk in the country that should be considered in the building design regulations. Note that the risk from some hazards such as volcanic activity or landslides are often best addressed by risk-informed land use plans and/or other assessment to ensure the building is constructed on a lower risk site—rather than the building code design provisions.</p> <p>The World Bank GFDRR online tool ThinkHazard! or the UNDRR country risk profiles can be helpful references.</p> <p>Seismic (earthquake) hazard typically governs building design in regions of moderate to high seismicity and it is important to have up-to-date seismic hazard characterization and related design criteria. Even in regions with low seismic hazard, there can be requirements to verify the seismic performance for resilience of higher importance buildings (see B1.3 below). To determine whether the code and/or standards should address seismic design, it is important to evaluate the level of seismic hazard in the country.</p> <p>Tools such as the GEM Global Seismic Hazard Map can be used for preliminary evaluation or recent country-specific seismic hazard studies (published in the last 10 years).</p>	<ul style="list-style-type: none"> a. Strong winds (storms/hurricanes/cyclones) b. Flooding (riverine/pluvial) c. Storm surges/coastal floods d. Extreme temperatures (snow/freeze/thaw) e. Extreme temperatures (heat/wildfire, urban fire) f. Earthquakes g. Landslides h. Tsunami i. Volcanic j. Other (please state) <p>k. Within the country, what is the range and the levels of seismic hazard?</p> <p>For the purposes of this checklist:</p> <ul style="list-style-type: none"> • low seismic hazard for a bedrock site can be considered to be a Peak Ground Acceleration for a 475-year return period event of <0.1 g, • moderate seismic hazard 0.1 < PGA <0.3 g, and • high seismic hazard, PGA> 0.3 g.

Table 2. (cont.)

Component	Relevance /Description	Diagnostic Question
A3 BUILDING CODE		
A3.1 Evolution & maintenance	In assessing codes, it is helpful to understand their development, as this will influence their coverage, approach and arrangement as well as how updates are incorporated.	<ol style="list-style-type: none"> a. Is the structural section of the building code based on an international model code or code of another country in part or whole? <ol style="list-style-type: none"> i. If yes, please specify code(s). b. When was the first building code legally adopted? c. What year was the current version of the building code legally adopted? d. Is there a statutory mechanism for updates to the code? e. Are there national frameworks for disaster risk reduction and management? <ol style="list-style-type: none"> i. If yes, are they referenced in the Building Code? f. Is there information on the code development/maintenance process and the organizations and bodies involved? <ol style="list-style-type: none"> i. If yes, please note what information exists.
A3.2 Organization & accessibility	It is helpful to understand barriers to the use of the codes related to their availability and the format in which they are presented.	<ol style="list-style-type: none"> a. How is the building code organized? (single document, coordinated set of documents, separate documents) b. Please give full names of each key regulatory document that contains structural provisions. c. For each code document that contains structural provisions, are they available online? d. For each code document, are they available for free or for a fee? e. If the code has referenced design standards for structural design, then are they available online? f. For each referenced standard, are they available for free or for a fee? g. Is the education of professionals based upon the use of these codes and standards or other (please specify)? h. Are there any support documents such as guides or commentaries? <ol style="list-style-type: none"> i. What language(s) are the code documents written in? j. Are there high levels of comprehension of the code language across the building profession? k. Are the units used in the code consistent with design and construction practice in the region (for example, for materials typically available in country, or typical dimensions on drawings)? l. Are the building typologies addressed in the code consistent with design and construction practice?

6.2 Checklist for the review of Structural resilience provisions

This section comprises the main checklist for the assessment of the structural safety and resilience provisions of the building code components and subcomponents as shown in Figure 5.

Checklist questions are designed to have prescriptive answers and intended to assess

whether the regulations have provisions related to each topic, rather than evaluating the overall quality and comprehensiveness of the provisions.

While the checklist is extensive it is not necessarily exhaustive and so the reviewer should consider this in their appraisal and add responses and information as appropriate. Not all aspects may be required or appropriate for the country under consideration.

Table 3. Checklist for the Review of Structural Resilience Provisions in Building Regulations

Component	Relevance /Description	Diagnostic Question
B1 BASIS OF DESIGN		
B1.1 Scope	<p>It is important that the scope of the regulations is clearly stated. For cases where the scope of the building code under review extends beyond buildings, then that should be highlighted and reviewers should note that these parts will be outside this assessment tool.</p> <p>For structures within the code scope but outside the building structures described in the tool scope in section 4.1, it is up to the reviewer to consider coverage in the context of the jurisdiction.</p>	<p>a. Is the scope and application of the code specified? If yes, does it cover the following?</p> <ol style="list-style-type: none"> i. Buildings (defined as structures intended for the use or occupancy of people or for shelter – both temporary and permanent, including structures that may be moved or relocated). ii. Some aspects covering alterations to existing buildings? (Defined as renovations, modifications, change of use, additions, strengthening and/or rehabilitation – see also questions in section B6). iii. Are there any types of buildings not covered by the code (for example rural, small-scale buildings, by usage type, by ownership – public or private, buildings above a certain number of storeys, and so forth). Please list. <p>b. Does the building code cover other structures?</p> <ol style="list-style-type: none"> i. If yes, please specify.
B1.2 Referenced standards	<p>Rather than state all the requirements explicitly, building codes will often reference international model codes or material design codes in part or in whole. To reduce the risk of errors in interpretation, it is important that codes and referenced standards can be navigated simply by those with a reasonable level of technical understanding.</p> <p>This section summarizes the findings from component B4 relating to coverage of the referenced standards.</p>	<ol style="list-style-type: none"> a. Are the requirements related to structural design organized in one document? b. Does the building code include a list of referenced standards related to structural provisions? Refer also to subcomponent A3.2. c. Are there sufficient referenced standards to cover the building code requirements? d. If the referenced standards did not originate in the country of review, are the current versions being referenced? e. Are the referenced standards in the same language as the Building Code or code documents?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B1 BASIS OF DESIGN		
B1.3 Importance classification	The Importance classification (sometimes referred to as occupancy category or consequence class) is assigned based on the consequences of a building collapse or damage for human life, public safety and civil protection, and on the social and economic consequences of its loss. Higher importance buildings are often subject to increased factors of safety and more stringent performance requirements.	a. Are importance classifications for buildings defined?
B1.4 Compliance requirements		
<i>B1.4.1 General</i>	It is important that the principles and methods by which the building regulations would be satisfied are described. This may be through meeting specified performance-based (functional) requirements and corresponding compliance criteria, or through following a series of prescriptive rules, or a combination of both. Refer to section 4.2 and Appendix A for definitions of key terms.	a. Are the permitted approaches for compliance clearly stated? Please note if prescriptive, performance or hybrid. <ul style="list-style-type: none"> i. If “prescriptive”, are the design rules and requirements clearly written and easy to follow? ii. If “prescriptive”, are alternative solutions also permitted (with associated design criteria stated)? iii. If “performance-based” design is adopted, are performance requirements and compliance criteria clearly defined?
	Performance-based design is an engineering approach to designing elements of a building based on meeting specific performance goals and defined objectives, such as performance under wind or seismic loads, without directly prescribing design, dimensioning or detailing rules by which to achieve these goals. This is in contrast to prescriptive requirements, which would instead give a set of prescriptive design rules and verifications to follow. In the context of structural design, performance-based design requirements set out the acceptable level of structural performance for different loading scenarios. See Appendix A for further discussion of these principles.	b. Where performance-based design is permitted, which of the following areas does it address? <ul style="list-style-type: none"> i. Performance-based design for gravity loading? ii. Performance-based design for wind loading? iii. Performance-based design for earthquake loading? iv. Performance-based design for vibration? v. Other? Please specify.
<i>B1.4.1 Design life</i>	Building design life (service life) is used to help determine durability requirements and also the magnitude of design loads for probabilistically described actions such as wind and seismic effects.	a. Is a minimum design life assumption specified for buildings? b. If different types of buildings have different minimum design life requirements, please list.
<i>B1.4.2 Durability/exposure</i>	Building structures need to resist the effects of damage and degradation over time, especially in particularly aggressive environments. This can be achieved through material specification, protection systems and detailing of structures.	a. Are material exposure categories defined? <ul style="list-style-type: none"> i. If yes, are they compatible with the material standards?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B1 BASIS OF DESIGN		
B1.4 Compliance requirements		
<i>B1.4.3 Progressive collapse</i>	Buildings should be designed and detailed for robustness, such that the failure of one component does not cause a progressive collapse or a disproportionate level of damage to the whole building.	<ul style="list-style-type: none"> a. Are there requirements for robustness to prevent progressive (or disproportionate) collapse? b. If yes, are there associated minimum detailing rules in the relevant material design sections? (If in part, then specify omissions).
<i>B1.4.4 Fire resistance</i>	<p>In the event of a fire, structures need to remain stable for sufficient time to allow safe evacuation, fire service activities and protection of property. Structural elements may also be required to provide a separation between parts of the building to minimize the spread of fire and smoke.</p> <p>Some forms of construction have inherent fire resistance, whereas others do not and may even be combustible and require applied fire protection to limit temperatures experienced and/or exposure to flames for the specified time periods.</p> <p>Note that some of the diagnostic questions here replicate relevant parts of the Fire Safety checklist tool (subcomponent 2.1).</p>	<ul style="list-style-type: none"> a. Do the building regulations address structural stability under fire load? b. Are there specific requirements/ limitations on height and area of building based on construction materials (combustibility / fire-resistance rating (FRR))? c. Are tables of fire resistance for structural members provided? d. Is allowance made for reducing required FRR if a full-building automatic fire sprinkler system is installed? e. Are fire stop / sealant requirements provided for fire-rated assemblies? f. Are alternate methods for assessing fire response of structure permitted? g. Are there provisions for the design of applied fire protection to structural elements?
B1.5 Prohibited construction	Some construction types may be unsuitable for certain locations, such as unreinforced load-bearing masonry in seismic regions, or be limited in their use. Some materials or methodologies may be associated with historic building failures.	<ul style="list-style-type: none"> a. Are prohibited construction methodologies specified? <ul style="list-style-type: none"> i. If yes, please specify. b. Are there prohibited structural materials? <ul style="list-style-type: none"> i. If yes, please specify.
B1.6 Definitions and notations	It is helpful for these to be set out for clarity and consistent use of the codes and reference documents.	<ul style="list-style-type: none"> a. Are abbreviations, acronyms and notations defined? (Note that the reviewer is not expected to check in detail that they are complete or fully adopted across code documents). b. Are definitions of terms contained in the code included?
B1.7 Units	Definition of units and consistency of their application is important in reducing risk of errors in design and construction.	<ul style="list-style-type: none"> a. Is the system of units to be used across the code prescribed? (Note that the reviewer is not expected to check in detail that they are complete or fully adopted across code documents). b. Is the system of units compatible with those adopted in key referenced documents?
B1.8 Construction documents	It is important that the documents contain the information pertinent for the construction of new buildings in accordance with the design. Additionally, these documents should support the design of modifications and operation of the building, especially if "as-built" information is available.	<ul style="list-style-type: none"> a. Are there requirements for general information to be presented in construction drawings and supporting documents, including governing design codes, material specifications, member sizes and specifications, building geometry and position, applicable design loads (parameters), designer names? <ul style="list-style-type: none"> i. Please note if any requirements are missing. b. Are there requirements for "as-built" construction drawings? c. Are there requirements for operation and maintenance requirements to be communicated in the construction documents?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B2 ACTIONS ON STRUCTURES		
B2.1 Load combinations	<p>Load combinations are used to ensure adequate level(s) of safety and consideration of different types of loads being applied to a structure simultaneously.</p> <p>It is important that the load combinations used are compatible with the design approaches and associated material properties.</p> <p>It should be noted that some codes will allow/ foresee design strength verifications with either ultimate limit stress or permissible stress approaches. It is important that this is set out clearly, showing which approach applies to each type of structural materials.</p>	<ol style="list-style-type: none"> a. Does the code permit allowable stress design approaches with assumption of linear elastic material response? b. Does the code allow for limit state design approaches? c. Are load combinations consistent with the limit state definitions defined for performance? d. Are load combinations for ultimate limit states (ULS) design provided? e. Are load combinations for serviceability limit states (SLS) design provided? f. Do combinations (and partial load factors, if applicable) account for concurrence of multiple variable actions? g. Are there provisions for load combination factors for types of accidental loads acting concurrently with other actions? h. Are there provisions for reduction of some design loads for temporary structures and loading conditions? i. Are load factors provided for load combinations associated with construction?
B2.2 Dead Loads	<p>It is important that requirements for valid, country-specific loads are provided for structural safety. Dead loads include the self-weight of the structure and other permanent loads, such as finishes and partition walls.</p>	<ol style="list-style-type: none"> a. Are minimum dead load assumptions defined? b. Is data provided for calculating the self-weight of all commonly used construction materials? c. Are there provisions for calculating loads associated with internal partitions?
B2.3 Live Loads	<p>Live loads (often called “imposed loads” or “occupancy loads”) are those associated with the use and occupancy of a building including people and furniture. These loads are usually applied intermittently (as opposed to permanent loads).</p> <p>For non-residential structures, consideration of future use of spaces in selection of live loads can be helpful for flexibility of use over the building’s lifetime.</p>	<ol style="list-style-type: none"> a. Are live loads provided for all anticipated occupancies (for floors, basements and roofs): <ol style="list-style-type: none"> i. Uniformly distributed loads; ii. Concentrated loads; b. Are loads (including axel loads) provided for structures that may support vehicles? <ol style="list-style-type: none"> i. If yes, does this include fire fighting vehicles? c. Are loads (both horizontal and vertical) provided for barriers and balustrades? <ol style="list-style-type: none"> i. If yes, are there higher design values for areas subject to overcrowding? d. Are lateral loads associated with the intended use for structures, such as grandstands, stages and pedestrian walkways, provided? e. Do roof loading requirements consider loads for maintenance activities?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B2 ACTIONS ON STRUCTURES		
B2.4 Wind loads		
<p><i>B2.4.1 Wind speed</i></p>	<p>Across a country, the wind speed may vary based on factors such as distance from the coast, topography and regional weather patterns. Use of reliable wind speed design criteria allow for this to be taken into account in the design of structures.</p>	<ul style="list-style-type: none"> a. Is there country-specific wind speed data for design? <ul style="list-style-type: none"> i. If yes, are the mapped measurements (basic wind speed) consistent with the methods for calculating wind pressures? ii. If yes, when was this last updated? iii. If yes, please specify how the design information is provided: <ul style="list-style-type: none"> • Wind speed map? • Wind speed by zonation map? • Wind speed by city or region name? • Other (please specify)? b. Do the provisions state if design wind levels consider strong wind events such as cyclones, hurricanes, tornados or typhoons? c. For regions prone to hurricanes/cyclones/tornados/ typhoons, are there special requirements for design and detailing of elements (including tie-down fixings)?
<p><i>B2.4.2 Wind pressures</i></p>	<p>Intensity of wind pressure depends on the building shape and size as well as site context and will vary across different parts of a building. Wind pressures need to be determined for overall building stability design as well as design of individual elements and cladding.</p>	<ul style="list-style-type: none"> a. Are there Importance Factors for wind design? If yes, are they based upon (note all that apply): <ul style="list-style-type: none"> i. Building occupancy? ii. Building size? iii. Building risk level? iv. Building usage type? v. Other (please specify)? b. Do the provisions provide a procedure to determine design wind pressures for the main load resisting system? c. If yes, which factors are considered for design: <ul style="list-style-type: none"> i. Minimum design wind loads? ii. Exposure/Orientation? iii. Terrain/Topography? iv. Roof shape? v. Building regularity? vi. Dominant openings? vii. Special provisions for tall buildings? viii. Other (please specify)? d. Are there provisions for design of elements susceptible to wind excitation and dynamic effects?
	<p>Compliance with the code may be achieved through simplified methods applicable to certain types of regular low- or mid-rise structures without need for complex analysis or modelling of wind actions.</p>	<ul style="list-style-type: none"> e. Are simplified wind design provisions given for common types of low-rise buildings? f. If yes, do they include: <ul style="list-style-type: none"> i. Prescribed design wind pressures for common types of low-rise buildings? ii. Simplified engineering design procedures for the calculation of wind pressures? iii. Other (please specify)?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B2 ACTIONS ON STRUCTURES		
B2.4 Wind loads		
<i>B2.4.2 Wind pressures</i>	Appendages and cladding elements, particularly at edges and projecting from buildings typically experience greater wind pressures than those considered for the design of the lateral force resisting system.	g. Are coefficients provided for determination of wind loading on elements (and their fixings), including: <ol style="list-style-type: none"> i. Cladding? ii. Roof finishes? iii. Parapets? iv. Signs? v. Ornaments? vi. Canopies? vii. Other?
<i>B2.4.3 Wind tunnel testing</i>	Wind tunnel testing can be an effective way of determining design wind pressures for the design of lateral force resisting systems as well as cladding, especially for non-standard geometries or where code provisions are unable to adequately account for height, topographic or directional effects.	a. Is determination of design wind pressures by wind tunnel testing permitted? <ol style="list-style-type: none"> i. If yes, is it prescribed for certain building types or locations (please specify)?
B2.5 Snow & Rain loads	Snow and rain loads should be considered in building design, depending on the location. Lack of consideration of the effects of snow/rain and its accumulation on roofs due to drifting or ponding could lead to collapse.	<p>a. Are there country-specific design precipitation requirements for the country?</p> <ol style="list-style-type: none"> i. Snow? ii. Rain? <p>b. If yes, are the mapped values consistent with the methods for calculating snow loads?</p> <p>c. If yes, when was this last updated?</p> <p>d. If yes, please specify how the load parameters are specified:</p> <ol style="list-style-type: none"> i. Basic ground snow/rain map? ii. Basic ground snow/rain by zonation map? iii. Basic ground snow/rain by city or region name? iv. Other (please specify)? <p>e. Are there requirements for the determination of loading from ice?</p> <p>f. Are there requirements for the determination of loading associated with rain on top of snow?</p> <p>g. Are there requirements for the consideration of rain accumulation (ponding) on roofs?</p>
B2.6 Accidental loads	Designers should consider foreseeable risks of accidental loading on structural elements resulting from their use or proximity to external hazards to maintain building safety.	<p>a. Are there requirements for consideration of accidental loading?</p> <ol style="list-style-type: none"> i. Vehicle impact? ii. Blast loading? iii. Other (specify in notes)
B2.7 Seismic action		
<i>B2.7.1 Applicability of seismic code provisions</i>	Seismic action effects should be considered in building design, depending on the location.	a. Does the code and/or standards have any requirements related to specifying seismic design loads/design seismic hazard criteria?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B2 ACTIONS ON STRUCTURES		
B2.7 Seismic action		
<i>B2.7.1 Applicability of seismic code provisions</i>	<p>Some codes or standards (especially in regions of low seismic hazard), may only require seismic design for certain types of buildings.</p> <p>In some countries, there may be a wide range of seismic hazard, dependent on location within the country. In those regions within a country that have very low seismic hazard, codes may not require seismic design for typical building typologies, where they are not of high importance.</p>	<p>b. If seismic design requirements do not apply for all buildings, please note all cases that apply when seismic design is required.</p> <ol style="list-style-type: none"> Buildings sited in areas that are above a certain threshold of seismic hazard Buildings over a certain height/number of storeys (please specify) Buildings of a certain importance level (please specify) Buildings with specific uses (for example, essential services, buildings with hazardous contents) Buildings with specific types of lateral load-resisting systems (please specify, for example, concrete shear walls, steel moment resisting frames). Other (please list in the comments section)
<i>B2.7.2 Seismic mass</i>	<p>Earthquake ground shaking excites inertial mass; therefore, the requirements for what mass is assumed for the calculation of the seismic loading is critical. This is based on assumptions of the realistic dead load in the structure and likely amount of live loads and non-structural loading present.</p>	<p>a. Is there a definition of the type and amount of dead and live loads to include in the seismic mass/weight of the building for the modelling and calculation of the lateral design loading?</p>
<i>B2.7.3 Seismic hazard parameters</i>	<p>It is important for country-specific design seismic hazard parameters to be provided as the seismic design requirements are highly dependent on the level of seismic hazard in a country or region.</p> <p>The hazard parameters relate to a certain level of ground shaking (or response of a structure) that has a probability of exceedance over a certain period. For example, a Peak Ground Acceleration (PGA) may have a probability of exceedance over a 475-year period (or having a 10 percent chance of occurring in a 50-year building design life). This seismic hazard specification is typically given assuming a rock site.</p>	<p>a. Are country-specific seismic hazard parameters provided for design?</p> <ol style="list-style-type: none"> If yes, when were these last updated? If yes, how are seismic hazard parameters specified (Please note all that apply) <ul style="list-style-type: none"> • in the form of seismic hazard maps • by PGA value or spectral acceleration values for city or other geographic subset of the country • by PGA value or spectral acceleration values for the entire country • other – please specify in comments
<i>B2.7.4 Site considerations</i>	<p>The type/class of soil of a site can affect the response of a structure to earthquake ground shaking. For example, soft soil sites amplify the response of longer period structures. To account for this, the design response spectra is typically adjusted by soil site factors.</p> <p>Some codes contain provisions to develop site-specific response spectra for seismic design. In such case, additional geotechnical investigations would be needed to understand the site conditions and seismic hazard modelling for a specific site.</p>	<p>a. Is the effect of soil site conditions considered in the seismic design, for example, by specifying soil modification factors linked to soil type and adjusting the design response spectra by these factors?</p> <p>b. Do the provisions include the requirements for developing site-specific seismic hazard analyses?</p>

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B2 ACTIONS ON STRUCTURES		
B2.7 Seismic action		
<i>B2.7.4 Site considerations (continued)</i>	If a site is within a certain proximity to an earthquake source with the capacity to generate a large earthquake event, the resulting ground shaking can subject buildings in the near-source region to large, rapid velocity pulses. Some codes capture these effects using simplified factors in the design response spectra or by recommending or requiring site-specific response spectra (this would typically be required for buildings more vulnerable to these effects, such as tall, more flexible buildings).	c. Do the design criteria include the effects of near-fault seismic hazards?
	Some codes contain criteria regarding the effects of amplification due to site topography, for example, for buildings sited at the top of tall cliffs or on hilltops.	d. Do the design criteria include the effects of amplification depending on site topography?
<i>B2.7.5 Seismic load combinations</i>	Seismic load combinations	a. Are load combinations provided that include seismic loads? <ol style="list-style-type: none"> i. Load combinations for lateral load in each direction ii. Bi-directional lateral load combinations b. Are there load combinations that include vertical excitation?
B2.8 Earth loads	Retained earth exerts lateral loads on supporting structures. The magnitude of these forces is dependent on the soil properties, ground water level and any vertical loading applied to the retained earth.	See geotechnical section, B3.
B2.9 Hydrostatic	Ground and stored water exerts forces on supporting and retaining structures.	a. Are there requirements for consideration of minimum hydrostatic forces associated with ground water?
B2.10 Thermal	Changes in temperature make materials want to expand or contract. This can induce internal stresses in the structural elements which need to be assessed with other loads.	a. Are country-specific ambient temperature ranges provided? <ol style="list-style-type: none"> i. If yes, do they account for climate variance across the country? ii. If yes, do they incorporate future climate scenarios? iii. Are there provisions for calculating thermal load on elements exposed to direct sunlight?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B2 ACTIONS ON STRUCTURES		
B2.11 Flood	Buildings in flood-prone areas are at risk of damage from water pressures (overloading of water on floors and surges as well as potential buoyancy issues).	<ul style="list-style-type: none"> a. Does the code advise on where to find information to determine flood design levels? (Sometimes there will be flood risk information within planning regulations). b. Are there requirements for the calculation of the following, with associated return periods for design? <ul style="list-style-type: none"> i. Hydrostatic design forces? ii. Hydrodynamic forces? c. Are there minimum design loads for flat roofs for refuge? d. Are there requirements for the design of structures below the flood/surge level? <ul style="list-style-type: none"> i. If yes, does this include use of materials resistant to flood waters (as well as structural resistance to forces generated by water)?
B2.12 Minimum Lateral Loading	All structures, even those not exposed to seismic actions, need to remain stable and be able to resist minimum lateral loading for structural stability. This can also address instability effects resulting from construction tolerances.	<ul style="list-style-type: none"> a. Is there a requirement for minimum lateral loading? b. Is the method for calculation of these loads in combination with applied lateral loads clearly stated?
B2.13 Construction	Construction loading of structures, (from temporary storage of materials, or support of upper floors of multistorey construction, for example) needs to be assessed as in some situations it can govern the design.	<ul style="list-style-type: none"> a. Are there requirements for construction load allowances? b. Are there requirements for design of temporary propping of multi-story construction and loading of the permanent structure during construction?
B2.14 Other (volcanic, tsunami, and so forth)	Other loading, related to country-specific hazards should be covered by the code. Refer to hazards identified in component A2.1.	<ul style="list-style-type: none"> a. For additional loads that may be applicable please state loading type and whether there is sufficient information to make safe calculations of design loads in combination with other actions?
B3 GEOTECHNICAL & SUBSTRUCTURE DESIGN		
B3.1 Site Investigations	Since soil properties can vary greatly, site-specific data is essential for safe and appropriate design of foundations. A site investigation should also inform the designer of external works, site grading or retention systems.	<ul style="list-style-type: none"> a. Are there requirements for geotechnical site investigations depending on the site location, scale and type of construction? b. Are there requirements for investigation and testing to determine the potential for soil to liquefy in seismic event? c. Do site investigation requirements include: <ul style="list-style-type: none"> i. Understanding the geology of the site and associated hazards? ii. Soil strength properties for foundation design? iii. Ground water level? iv. Assessment of geotechnical instability due to construction activities and in-ground features or topography? v. Hazardous materials and ground gas? vi. Chemicals that may affect durability of foundations?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B3 GEOTECHNICAL & SUBSTRUCTURE DESIGN		
B3.2 Design parameters	The findings of the site investigations are used to determine criteria for the design of the substructures and model the behavior of the building subjected to geotechnical actions or in a seismic event.	<ul style="list-style-type: none"> a. Are there provisions for the calculation of geotechnical design parameters based on site investigation information? b. Are different soil types defined (for seismic design), based on geotechnical parameters? c. Are there provisions for the calculation of soil pressures taking into account ground water and consideration of floatation based on design flood levels? d. Are there provisions for the calculation of seismic earth pressures? e. Are load combinations for geotechnical design provided? f. Are factors of safety specified in relation to the following? <ul style="list-style-type: none"> i. bearing? ii. sliding? iii. overturning? iv. floatation? v. soil creep?
B3.3 Foundations	Foundations are the structural elements that transfer the building loads to the ground and transfer ground movements from seismic activity to the building, above. Depending on the soil conditions, these foundations may be shallow (transferring the loads through bearing of strip or pad foundations) or deep foundations, such as piles.	<ul style="list-style-type: none"> a. Are there design and detailing requirements for shallow foundations, including ground deformation? b. Are there provisions related to seismic design and detailing of shallow foundations? c. Are there design and detailing requirements for deep foundations including ground deformations? d. Are there provisions related to seismic design and detailing of deep foundations? e. Are there provisions for design of foundations on sites susceptible to liquefaction? f. Are there provisions related to checking safety against sliding of foundations under lateral loading? g. Is there provision for the capacity design of foundations under seismic loading (for example, overstrength factors or alternative requirements to check that the foundations have greater capacity than the superstructure under seismic loading)?
B3.4 Retaining structures		<ul style="list-style-type: none"> a. Are design procedures prescribed for different types of retaining structures, including reinforced earth? Please specify. b. Are there limits on application of different types of temporary and permanent earth retention systems? c. Are there provisions for seismic design of retaining walls? (including unbalanced earth pressures on a basement) d. Are there provisions for verifying slope stability?
B3.5 Ground bearing slabs		<ul style="list-style-type: none"> a. Are there provisions for design of ground bearing slabs (slabs on grade)?
B3.6 Waterproofing	It is important to protect buried portions of the structures from moisture to maintain structural integrity. Additionally, control of water vapor within buildings is part of maintaining a safe and comfortable internal environment.	<ul style="list-style-type: none"> a. Are there requirements for waterproofing of structures in contact with the ground? b. Are there special requirements for containment of water for structures below flood levels? c. Is provision made for freeze-thaw protection of foundations?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B3 GEOTECHNICAL & SUBSTRUCTURE DESIGN		
B3.7 Buried structures		a. Are there provisions for design and detailing of buried structures (for example, exposure to aggressive soils, such as salination of groundwater in coastal areas, or below water table, generally?)
B3.8 Excavation and fill		a. Are there requirements for excavations (for example: to prevent undermining existing footings)? b. Are there requirements for selection and compaction of fill?
B4 STRUCTURAL DESIGN		
B4.1 General	This section addresses the code provisions with methods for the analysis of structural behavior and verification of the design of structural elements in various construction materials, covering all common construction typologies and methodologies. It is important that the methods are compatible with the principles upon which the code is based as set out in the previous components.	a. What types of construction materials are addressed by the code? (See individual components for coverage within each material type): i. concrete (ref. subcomponent B4.3) ii. structural steel (ref. subcomponent B4.4) iii. masonry materials (any type) (ref. subcomponent B4.5) iv. timber (ref. subcomponent B4.6) v. earthen construction (ref. subcomponent B4.7) vi. bamboo vii. vegetative construction viii. wattle and daub ix. aluminum x. glass xi. other – please specify b. Are there other construction materials commonly used in the country that are not covered? i. If so, please specify.
B4.2 Seismic Design		
<i>B4.2.1 Basic principles of conceptual design</i>	This section describes the methods for analyzing the behavior of structures in a seismic event, determining how loads are transferred to different structural elements in the building, and design approaches for compliance with the performance requirements. Structural regularity is one of the key conceptual requirements for adequate seismic response. Structural redundancy allows for increased energy dissipation during a seismic event, thus contributing to the safety of the building and its occupants. Redundancy may correspond to having a minimum number of vertical elements of a lateral load-resisting system (for example, walls, frames) that need to be provided in each horizontal direction.	a. Do the seismic design provisions address the following topics: i. Regularity: requirements and provisions related to plan regularity/irregularity? ii. Regularity: requirements and provisions related to vertical regularity/irregularity? iii. Regularity: requirements and provisions related to torsional regularity/irregularity? iv. Redundancy requirements for the design of the lateral load-resisting system?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B4 STRUCTURAL DESIGN		
B4.2 Seismic Design		
<i>B4.2.2 Control of deformations</i>	<p>Displacements imposed by seismic action need to be accommodated by the building without significant damage. Their magnitude depends on multiple factors, such as soil conditions or the slenderness of the building.</p> <p>To prevent pounding damage, that is, damage due to impact/contact between neighboring buildings due to their deformation during a seismic event, codes specify ways to estimate the required size of seismic joints for a design level earthquake.</p>	<p>a. Do the seismic design provisions address the following topics:</p> <ul style="list-style-type: none"> i. Second-order (P-delta) effects? ii. Soil–structure interaction? iii. Minimum building separation/seismic joint requirements (to prevent pounding)?
<i>B4.2.3 Effectiveness of lateral load-resisting system</i>	<p>Inertia loads need to be transmitted from the building floors to the lateral load-resisting system, requiring sufficient stiffness and strength of floor slabs/elements.</p> <p>Inertia loads are required to follow the load-path through the lateral load-resisting system down to the foundation elements.</p>	<p>a. Are there provisions related to the seismic design of diaphragms to ensure that load can be transferred to vertical elements of the lateral load-resisting system?</p> <p>b. Is there a differentiation in design provisions for the case of rigid diaphragms and for flexible diaphragms?</p> <p>c. Are there provisions related to transfer of load from superstructure to foundation elements?</p>
<i>B4.2.4 Control of vibrations</i>	<p>The seismic response may be mitigated through the adoption of base isolation and anti-seismic devices.</p>	<p>a. Are there provisions related to passive seismic control devices?</p> <p>b. Are there provisions for design of structures equipped with base isolation devices?</p> <p>c. Are there provisions related to the design of structures with energy dissipation devices, often called dampers (for example, braces with added damping, rocking systems with damping) or other anti-seismic devices?</p>
<i>B4.2.5 Force reduction factors</i>	<p>Most seismic codes allow for the use of ductility modification factors (often referred to as force reduction factors or behavior factors) which may be applied both to seismic forces and displacements, in order to take into account that a ductile structure will experience non-linear behavior and dissipate the seismic input energy (corresponding to the expected ductility level).</p>	<p>a. Do the provisions include modification factors for forces and displacements depending on the expected behavior of the type of lateral load-resisting system?</p>
<i>B4.2.6 Importance Factors</i>	<p>An increased level of seismic loading may be prescribed for more important structures (for example, critical buildings for post-earthquake recovery or buildings hosting a large number of occupants). This is typically achieved by assigning an Importance Factor for different building types.</p>	<p>a. Do the criteria include Importance Factors for seismic design?</p>
<i>B4.2.7 Deformation limits</i>	<p>The building performance (both structural and non-structural) may depend on the level of lateral displacement (drift) which it experiences during a design level earthquake. Typically, interstorey drift limits are set depending on the type of structural system, construction material, and the non-structural interior and exterior vertical components (partition walls, cladding).</p>	<p>a. Are there provisions related to drift limits under seismic loading?</p> <ul style="list-style-type: none"> i. If yes, are there drift limits for critical structural elements as well as for non-structural elements?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B4 STRUCTURAL DESIGN		
B4.2 Seismic Design		
<i>B4.2.8 Performance of non-structural elements</i>	Damage of non-structural components can contribute significantly to losses and affect the extent of repairs required for re-occupancy of the building after an earthquake.	<p>a. Are there provisions for the seismic design of non-structural components?</p> <p>i. If yes, are there design methods for limiting the damage to these elements under a design-level earthquake?</p> <p>b. If design of non-structural components is included, please note all that apply:</p> <p>i. Mechanical, Electrical and Plumbing (MEP) services equipment</p> <p>ii. Façade elements (including movement joints)</p> <p>iii. Masonry infill walls</p> <p>iv. Other types of infill walls (for example, clay tile, concrete, and so on)</p> <p>v. Lightweight partitions</p> <p>vi. Parapets/appendages</p> <p>vii. Other – please specify in the comments</p>
<i>B4.2.9 Analysis methods and design approaches</i>	With respect to seismic analysis methods, most codes allow for equivalent static analysis procedures to be applied, usually for regular and/ or low- to mid-rise buildings.	<p>a. Do the design approaches include analysis through an equivalent static loading?</p> <p>i. If yes, is it limited to some types of building structural typologies (for example limited height/number of floors)?</p>
	To capture the building's dynamic response to earthquake ground shaking more accurately, most seismic codes allow for the use of a design response spectrum together with modal response spectrum analysis.	b. Do the design approaches include the development of linear elastic modal response spectrum analyses and verifications?
	To capture non-linear response for buildings that satisfy certain regularity requirements, some seismic codes give the option to perform a non-linear pushover analysis (this is when a set of equivalent static loads are applied incrementally to a model where non-linear behavior is captured in the analysis to better understand damage patterns and failure mechanisms).	c. Do the design approaches include the development of non-linear static pushover analyses and verifications?
<i>B4.2.10 Directional combinations</i>	Combination of horizontal seismic loads in two orthogonal directions, as well as in vertical direction is needed to evaluate the performance of structures subjected to earthquakes.	a. Do the provisions include consideration of biaxial horizontal and vertical seismic components and their combination rules?
<i>B4.2.11 Requirements for time-history analyses</i>	In order to perform linear or non-linear time history (sometimes referred to as response history) dynamic analyses, a set of site-specific acceleration time histories need to be developed. Provisions will typically set out the requirements for time history development and the number of time histories required for analyses.	<p>a. Do the design approaches include the development of time history dynamic analyses and verifications?</p> <p>i. If yes, do the provisions include requirements related to developing site-specific acceleration time histories?</p>

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B4 STRUCTURAL DESIGN		
B4.3 Concrete		
<i>B4.3.1 General</i>	<p>Concrete is commonly used in building foundations and frames, including multistorey, high-rise construction.</p> <p>A code needs to include design provisions for reinforced, precast and post-tensioned structures to ensure their structural resilience.</p>	<ol style="list-style-type: none"> a. Are there requirements for the design of the following types of concrete structures (if by reference, please state standard[s]): <ol style="list-style-type: none"> i. Reinforced concrete (RC), ii. Precast concrete (PCC), iii. Post-tensioned (PT)? b. Do the concrete design provisions and verifications align with the performance criteria stated in the Basis of Design (for example compatible load combinations and material properties for strength and serviceability design verification)? c. Do the provisions cover analysis and modelling of concrete structures? d. Do design provisions include serviceability requirements, such as: <ol style="list-style-type: none"> i. Acceptable crack widths for elements in flexure? ii. Deflections – including effects of long-term creep and shrinkage? iii. Floor vibration? e. Do the design provisions include minimum requirements for specified fire-resistance rating (FRR)? f. Are there requirements for the design of concrete structures for internal stresses resulting from early age shrinkage?
<i>B4.3.2 Seismic design of concrete structures</i>		<ol style="list-style-type: none"> a. Do design provisions include seismic design and detailing of concrete structures? b. If yes, please confirm which lateral systems are covered: <ol style="list-style-type: none"> i. Cast-in-place concrete moment frame – low ductility ii. Cast-in-place concrete moment frame – medium ductility iii. Cast-in-place concrete moment frame – high ductility iv. Cast-in-place concrete shear walls – low ductility v. Cast-in-place concrete shear walls – high ductility vi. Cast-in-place concrete – dual frame-wall systems vii. Precast concrete moment frame? viii. Precast concrete wall system (for example, large panel buildings) ix. Cast-in-place concrete frame with masonry infill walls x. Post-tensioned concrete moment frame
<i>B4.3.3 Concrete materials</i>		<ol style="list-style-type: none"> a. Are material design properties provided for commonly available/used concrete grades? (both long- and short-term properties) b. Are minimum strength grades of concrete specified (in cube/cylinder)? c. Are there requirements for the design of concrete mix for strength and durability? d. Does concrete mix guidance permit cement replacements and admixtures to reduce cement content? e. Are there provisions for the use of recycled aggregates? f. Are design material properties provided for steel reinforcement?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B4 STRUCTURAL DESIGN		
B4.3 Concrete		
<i>B4.3.4 Concrete element design</i>		<p>Do the provisions cover the design for effects of axial force, bending, shear, torsion for the following building elements:</p> <ol style="list-style-type: none"> a. Horizontal floor/roof systems: <ol style="list-style-type: none"> i. One-way spanning slabs (supported on beams or walls) ii. One-way ribbed slabs (supported on beams or walls) iii. Two-way spanning slabs (supported on beams or walls) iv. Two-way waffle/coffered slabs (supported on beams or walls) v. Flat slabs (supported on columns, including punching shear checks) vi. Precast floor systems (for example hollow core RC slabs) b. Frame elements: <ol style="list-style-type: none"> i. Beams ii. Columns iii. Structural walls iv. Stair structures
<i>B4.3.5 Concrete detailing</i>		<ol style="list-style-type: none"> a. Are there provisions for the design of curtailment/anchorage of reinforcement? <ol style="list-style-type: none"> i. If yes, are these consistent with material availability and accreditation? (including ductility) b. Are provisions in place for ductile detailing of reinforcement for seismic performance (such as confinement requirements, lap splice requirements and transverse reinforcement spacing and detailing requirements)? c. Are minimum reinforcement quantities specified (please note the elements to which they apply)? d. Are there provisions for the design of fixings or anchors into concrete construction?
<i>B4.3.6 Simplified concrete design rules</i>	Simplified rules may be provided for the compliant design of certain concrete buildings by engineers. This may include sizing tables, simplified design procedures and associated requirements to permit the engineering design of some elements and simple, regular buildings of a certain size/height, and/or in specified locations without the need for complex analysis and design.	<ol style="list-style-type: none"> a. Are simplified engineering rules provided for simple, regular concrete buildings? <ol style="list-style-type: none"> i. If yes, please specify the building typologies to which they apply.

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B4 STRUCTURAL DESIGN		
B4.4 Steel		
<i>B4.4.1 General</i>	<p>Structural steel can be used in many kinds of building structures. It is often the chosen material for lightweight, long-span structures.</p> <p>It is important that the code includes design provisions and that the design methodology and material design parameters are compatible with the locally available materials and fabrication capability.</p>	<p>a. Are there requirements for engineering analysis and design of steel structures?</p> <p>i. If by reference, please specify standard(s).</p> <p>b. Do the steel design provisions and verifications align with the performance criteria stated in the Basis of Design (for example compatible load combinations and material properties for strength and serviceability design verification).</p> <p>c. Are there requirements for the design for steel/concrete composite structures?</p> <p>d. Do the provisions cover analysis of steel structures?</p> <p>e. Do design provisions include performance requirements that cover:</p> <p>i. Displacements?</p> <p>ii. Assessment of steel structures for vibration (including dynamic excitation) and fatigue?</p>
<i>B4.4.2 Seismic design of steel structures</i>		<p>a. Do design provisions include seismic design and detailing?</p> <p>b. If seismic design and detailing is covered, please confirm which systems are covered:</p> <p>i. Steel moment frame – low ductility</p> <p>ii. Steel moment frame – medium ductility</p> <p>iii. Steel moment frame – high ductility</p> <p>iv. Steel braced frame – concentric braces</p> <p>v. Steel braced frame – eccentric braces</p> <p>vi. Steel braced frame – buckling restrained braces</p> <p>vii. Dual systems (please specify)</p> <p>viii. Light gauge steel stud construction and bracing</p> <p>ix. Composite construction (steel encased in concrete)</p> <p>x. Composite floors</p>
<i>B4.4.3 Steel materials</i>		<p>a. Are material properties provided for readily available steel grades (including partial material factors)?</p> <p>b. Are the design parameters consistent with locally used or readily available shapes of steel members?</p>
<i>B4.4.4 Steel element design</i>		<p>a. Do the provisions cover the design for combined effects of axial force, bending, shear, and torsion for the following building elements:</p> <p>i. Steel rafters/floor beams</p> <p>ii. Steel trusses</p> <p>iii. Light gauge steel</p> <p>iv. Composite floor beams</p> <p>v. Steel columns/struts</p> <p>vi. Composite steel/concrete columns</p> <p>vii. Composite floor: concrete slab on profiled metal decking</p> <p>viii. Rods and cables</p>
<i>B4.4.5 Steel detailing</i>		<p>a. Are there requirements for the design of protection of steel against corrosion and fire?</p> <p>b. Do the provisions include the design of steel connections?</p>

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B4 STRUCTURAL DESIGN		
B4.4 Steel		
<i>B4.4.6 Simplified steel design rules</i>	Simplified rules may be provided for the compliant design of certain steel buildings by engineers. This may include sizing tables, simplified design procedures and associated requirements to permit the engineering design of some elements and simple, regular buildings of a certain size/ height, and/or in specified locations without the need for complex analysis and design.	<ul style="list-style-type: none"> a. Are simplified engineering rules provided for simple, regular steel buildings? <ul style="list-style-type: none"> i. If yes, please specify the building typologies to which they apply.
B4.5 Masonry		
<i>B4.5.1 General</i>	A code needs to include design provisions for unreinforced, confined, and reinforced masonry structures to ensure their structural resilience.	<ul style="list-style-type: none"> a. Are there design requirements for unreinforced masonry? <ul style="list-style-type: none"> i. If by reference, please specify standard(s). b. Are there design requirements for confined masonry? <ul style="list-style-type: none"> i. If by reference, please specify standard(s). c. Are there design requirements for reinforced masonry? <ul style="list-style-type: none"> i. If by reference, please specify standard(s). d. Do requirements cover seismic design and detailing? <ul style="list-style-type: none"> i. If yes, please specify the building typologies to which they apply. e. Do design provisions include for serviceability requirements, including: <ul style="list-style-type: none"> i. Displacements (including effects of long-term creep, wind and thermal effects)? ii. Design of expansion/contraction joints? f. Do the design provisions include minimum requirements for specified fire-resistance rating (FRR)?
<i>B4.5.2 Masonry materials</i>	Masonry units are frequently locally manufactured and may see large variation in manufacturing and construction quality.	<ul style="list-style-type: none"> a. Does the standard specify requirements related to minimum material properties/strength of common locally available masonry materials? <ul style="list-style-type: none"> i. Clay masonry units (solid bricks and hollow blocks) ii. Concrete masonry units (solid and hollow) iii. Stone iv. Mortar v. Grout (for reinforced masonry) vi. Other (please specify) b. If material properties are not provided, are there requirements for determining design properties? c. Are there inspection and testing requirements to verify strength assumptions (such as a prism test)?
<i>B4.5.3 Masonry element design</i>		<ul style="list-style-type: none"> a. Do the provisions cover the design for the effects of axial force (including slenderness), out-of-plane bending, in-plane shear for the following vertical elements (note if provided for Unreinforced masonry (UM), Reinforced masonry (RM), Confined masonry (CM) and if any effects missing): <ul style="list-style-type: none"> i. Solid masonry walls (including walls with openings) ii. Cavity masonry walls iii. Piers in solid masonry walls iv. Masonry piers v. Freestanding external wall (without head restraint) vi. Masonry retaining wall vii. Masonry arches and vaults

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B4 STRUCTURAL DESIGN		
B4.5 Masonry		
<i>B4.5.4 Masonry detailing</i>		<ul style="list-style-type: none"> a. Are there provisions for the design of bearing supports due to concentrated loads on masonry walls? b. Are there provisions for prevention of transmission of moisture from ground into the superstructure (for example in a form of barrier/flashing)? c. Are there provisions for design of anchorages fixing into masonry construction? d. Are there provisions for the design of ties in cavity wall construction?
<i>B4.5.6 Simplified masonry design rules</i>	Simplified rules may be provided for the compliant design of certain masonry buildings by engineers. This may include sizing tables, simplified design procedures and associated requirements to permit the engineering design of some elements and simple, regular buildings of a certain size/ height, and/or in specified locations without the need for complex analysis and design.	<ul style="list-style-type: none"> a. Are simplified rules provided for the design of simple, regular buildings of masonry construction? <ul style="list-style-type: none"> i. If yes, please specify the building typologies and masonry types to which they apply.
B4.6 Timber		
<i>B4.6.1 General</i>	This component relates to the structural design of timber structures, including engineered timber materials such as plywood and glulam.	<ul style="list-style-type: none"> a. Are there requirements for engineering analysis and design of timber structures? <ul style="list-style-type: none"> i. If by reference, please specify standard(s). b. Do the timber design provisions and verifications align with the performance criteria stated in the Basis of Design (for example compatible load combinations and material properties for strength and serviceability design verification). c. Are there any provisions for seismic design and detailing of timber structures? <ul style="list-style-type: none"> i. If yes, what types of lateral systems are covered (please list)? d. Do design provisions include for serviceability requirements, including: <ul style="list-style-type: none"> i. Deflections – including effects of long-term creep? ii. Floor vibration? e. Do the requirements cover minimum section sizes of elements for specified fire-resistance rating (FRR)?
<i>B4.6.2 Timber materials</i>		<ul style="list-style-type: none"> a. Are material design properties provided for a range of available timber grades and engineered timber products? Please note all that apply. <ul style="list-style-type: none"> i. Soft wood ii. Hard wood iii. Plywood iv. Engineered timber (cross laminated timber (clt), glulam) v. Other (please specify) b. Are there provisions for determination of timber grade? c. Are there modification factors to material properties for: <ul style="list-style-type: none"> i. Exposure in use (internal/external): ii. Load duration? d. Are there minimum sustainability requirements for timber sourcing?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B4 STRUCTURAL DESIGN		
B4.6 Timber		
<i>B4.6.3 Timber element design</i>		<ul style="list-style-type: none"> a. Do the provisions cover the design for the effects of axial force, bending, shear, torsion for the following building elements? <ul style="list-style-type: none"> i. Structural flooring (planks, ply, etc.) ii. Timber floor and roof joists (sawn timber) iii. Timber floor and roof joists (rounds) iv. Timber floor diaphragm v. Beams (solid timber and built-up sections) vi. Timber/steel flitch beams vii. Timber trusses (nailed) viii. Timber trusses (bolted) ix. Columns (solid timber) x. Columns (built up sections) xi. Structural walls (including timber shear walls)
<i>B4.6.4 Timber detailing</i>		<ul style="list-style-type: none"> a. Do provisions include design of connections: <ul style="list-style-type: none"> i. For bolted timber–timber connections? ii. For nailed timber–timber connections? iii. For diaphragm floors (including connection to vertical walls)? iv. For anchorage of roofs to supporting walls? v. For foundation anchorage? b. Are prescriptive rules provided for compliant connection design in timber? Please list types. c. Are there provisions for design and detailing to avoid moisture or insect damage?
<i>B4.6.5 Simplified timber design rules</i>	Simplified rules may be provided for the design of certain buildings by engineers. This may include sizing tables, simplified procedures and associated requirements to permit the engineering design of some elements and simple, regular buildings of a certain size/height, and/or in specified locations without the need for complex analysis and design.	<ul style="list-style-type: none"> a. Are simplified design rules provided for simple, regular timber buildings? <ul style="list-style-type: none"> i. If yes, please specify the building typologies to which they apply.
B4.7 Earth		
<i>B4.7.1 General</i>	<p>Unfired earthen construction (including adobe block and rammed earth construction) is widely adopted around the world in vernacular construction. It is typically less resource-intensive and considered more sustainable, compared to other construction methods.</p> <p>Manufacture of adobe blocks and sourcing of earth is typically local to the site and so construction quality and durability is highly dependent on testing, assessment, mix and grading of earth as well as manufacture and construction.</p>	<ul style="list-style-type: none"> a. Are there requirements for engineering analysis and design of earthen structures? <ul style="list-style-type: none"> i. If by reference, please specify standard(s). b. Does the standard specify requirements related to minimum material properties/strength of locally available earth materials? <ul style="list-style-type: none"> i. Adobe block construction ii. Rammed earth construction iii. Stabilized earth block construction c. Are there any provisions for seismic design and detailing of earthen structures? If yes, please list (including strengthening/reinforcement systems, as applicable). d. Do the provisions cover the design for the effects of axial force, out-of-plane bending, in-plane shear for the following structural elements: <ul style="list-style-type: none"> i. Walls (with and without head restraint) ii. Arches and vaults e. Are there provisions for protection of earthen masonry from rainwater?

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B4 STRUCTURAL DESIGN		
B4.7 Earth		
<i>B4.7.2 Simplified earthen construction design rules</i>	Simplified rules may be provided for the design of certain earthen buildings by engineers. This may include sizing tables, simplified procedures and associated requirements to permit the engineering design of some elements and simple, regular buildings of a certain size/height, and/or in specified locations without the need for complex analysis and design.	<p>a. Are simplified design rules provided for simple, regular earthen buildings?</p> <p>i. If yes, please specify the building typologies to which they apply.</p>
B4.8 Other materials		
<i>B4.8 Other materials</i>		<p>a. Are design requirements provided for other structural materials?</p> <p>i. If so, please specify which materials.</p> <p>b. Are material properties provided, or requirements for the determination of properties to be used for design?</p> <p>c. Do design provisions include cover analysis, seismic design and detailing?</p> <p>d. Does the code permit the use of further and new materials through “Alternative Solutions” to demonstrate compliance?</p>
B5 CONSTRUCTION & DEMOLITION		
B5.1 Site safety & management	Site safety may be addressed in legislation outside the building code, but it is an important part of a safe and resilient construction industry.	<p>a. Are there standards for construction site safety and site management?</p> <p>b. If yes, do they include the following?</p> <ol style="list-style-type: none"> i. Working at height ii. Edge protection iii. Requirements for temporary works (including formwork) (note that design of temporary works is outside the scope of this assessment tool) iv. Control of vehicle movements v. Welfare provisions vi. Excavations and working in confined spaces vii. Control of hazardous materials viii. Lifting ix. Noise & vibrations x. Buried services xi. Protection of the public and the environment adjacent to and beyond the site boundary (including pedestrian protection as well as dust and pollution from construction activities).

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B5 CONSTRUCTION & DEMOLITION		
B5.2 Construction practices & quality control	It is essential for a code to contain requirements to ensure that appropriate construction practices are adopted, buildings are constructed according to the designs, and that material quality standards are acceptable.	<p>a. Are there minimum provisions for quality control of the construction of common structural elements (compatible with material design standards)? Do these cover:</p> <ul style="list-style-type: none"> i. Foundations? ii. Slabs on grade? iii. Walls and columns? iv. Suspended floors and roofs? <p>b. Are construction tolerance limits specified for dimensional control of horizontal and vertical structures?</p> <p>c. Are there requirements for quality control management and independent inspections?</p> <p>d. Are there requirements for on-site testing of materials where not certified by manufacturers/suppliers?</p> <p>e. If so, do these cover:</p> <ul style="list-style-type: none"> i. Concrete? ii. Masonry (earth/adobe or concrete blocks)? iii. Mortars? iv. Reinforcing bars? v. Weld quality? <p>f. Are there requirements for inspections of temporary works (including temporary stability of structures) and shoring of excavations? Note the design of temporary works is outside this assessment tool.</p>
B5.3 Demolition	It is important that demolition be under controlled conditions and that materials are safely repurposed or disposed of.	<p>a. Are there provisions for safe demolition of structures?</p> <p>b. Are there provisions for safe disposal or reuse of materials?</p>
B6 EXISTING STRUCTURES		
B6.1 General		<p>a. Does the building code cover the design of:</p> <ul style="list-style-type: none"> i. Alterations? ii. Additions? iii. Building renovations/rehabilitation? iv. Change of use and/or occupancy? v. Seismic retrofit? vi. Other types of retrofit that include structural improvements? (Also refer to section B1.1, scope)
B6.2 Assessment of structures	It cannot be assumed that the original construction materials and methods as well as any subsequent modifications were compliant with the current building code. Furthermore, the structure may have degraded through its life or have been damaged in the event of an earthquake or in strong winds.	<p>a. Does the building code cover assessment of building vulnerability and/or damage?</p> <p>b. Does the building code include specific requirements for material testing in the assessment of existing buildings?</p> <p>c. Does the code provide specific criteria and procedures for assessing the performance of existing buildings?</p> <p>d. Do the assessment procedures include provisions related to seismic assessment?</p>

Table 3. (cont.)

Component	Relevance /Description	Diagnostic Question
B6 EXISTING STRUCTURES		
B6.3 Rehabilitation and retrofit	<p>Rehabilitation is defined as the bringing of an existing building up to its original design level of performance, often through repair, strengthening and replacement of selected elements. Rehabilitation remedies damage to structural elements that may occur as the result of a disaster, or from deterioration through lack of maintenance over time.</p> <p>Retrofitting refers to modifications made to structural and non-structural components that enhance the performance of a building: the reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards. Retrofitting requires consideration of the design and function of the structure, the demands that the structure may be subject to from particular hazards or hazard scenarios. For example, brittle unreinforced masonry walls could be retrofitted by jacketing them with reinforced concrete to improve performance under seismic loading.</p>	<p>a. Are there provisions for the selection and design of rehabilitation and retrofitting measures?</p> <p>i. If yes, are seismic retrofitting provisions and procedures included?</p> <p>b. In relation to the seismic retrofitting of existing buildings, does the building code include:</p> <p>i. Provision for consideration of uncertainties in geometry, material and detailing characteristics, as well as consideration of reliability in assessment and in retrofit design?</p> <p>ii. Assessment and retrofit design procedures, and specific requirements and verifications for members of existing structures?</p> <p>iii. Prescriptive rules</p> <p>iv. Linear analysis</p> <p>v. Non-linear analysis</p>
	<p>There may be different rules applied for retrofit of designated heritage structures.</p>	<p>c. Are there any provisions and/or restrictions relating to assessment and retrofit/repairs/remedial works to heritage structures?</p>
B6.4 Alterations & additions	<p>The structural engineering design of any new additions or alterations would need to be addressed by the building code. It is also important that the wider implications of these works be considered, and whether the works require upgrade of existing retained structures to current code requirements.</p>	<p>a. Does the code specify what type or size of addition requires building code compliance?</p> <p>i. If yes, does it specify a size or type of addition or alteration that would require upgrade of the existing structure to current code provisions?</p> <p>ii. Other, please note.</p>
	<p>There may be different rules applied for works to—and retrofit of—designated heritage structures.</p>	<p>b. Are there special provisions relating to assessment for alterations, additions to heritage structures? Also see B6.3 for questions relating to rehabilitation and retrofit of heritage structures.</p>
B6.5 Maintenance & inspections	<p>The structure needs to be maintained and used in a way that is in accordance with the design assumptions.</p>	<p>a. Are the designers required to provide information to the building owners as regards safe loading and maintenance during building life, including required inspections of critical elements?</p>
B7 STRUCTURAL DESIGN AND CONSTRUCTION FOR SMALL STRUCTURES		
B7.1 Prescriptive rules for small buildings	<p>These requirements are for the design of simple building structures of common building typologies, without the need for engineering input. As such, it is important that the rules are set out clearly with diagrams, where appropriate.</p>	<p>a. Are prescriptive rules provided for buildings complying with rules on size, construction type, location and regularity?</p> <p>i. If yes, please specify limits/applicability.</p> <p>ii. If yes, are these rules presented in a way that could be easily interpreted correctly by non-engineers? Please add notes, as appropriate.</p> <p>iii. Do these rules include provisions for incremental additions and modifications?</p> <p>iv. Do these rules include provisions for design of foundations and simple methods for assessing soil conditions?</p>

6.3 Interfaces with other Code sections

There are several related components which affect the structural resilience of a building

but may not be considered as a structural engineering issue and so may be contained within related legislation or code sections. The table below includes further diagnostic questions relating to these aspects.

Table 4. Checklist for the Review of Related Provisions in Building Regulations

Component	Relevance /Description	Diagnostic Question
C1 MASTERPLANNING AND SITE PLAN		
C1 Site selection and planning	Site selection and use, as well as building location within a site can have a significant effect on the exposure of a building to hazards.	a. Do the planning and zoning rules and requirements (including maps) at national and/or local level take into account site-specific hazards? i. Please note which apply: (unstable soils, flood, slope stability, coastal erosion, in-ground structures, faults)?
C2 ARCHITECTURAL DESIGN AND MASSING		
C2.1 Design for flood or tsunami mitigation	While the structural sections of the code may cover the engineering design of buildings for flooding, there are measures that can be applied to the architectural design to mitigate the associated risks to life safety and reduce loading on structures. These provisions would apply to buildings in flood or tsunami inundation zones.	a. Are there rules about not locating critical services and/or occupied spaces below the design flood level? b. Are there requirements for the design of vents, valves or other openings in the walls of enclosed spaces below the design flood level to equalize lateral water pressures? c. Are there requirements to allow roof access for building occupants in case of a flood event? d. Are there other specific requirements for the design of buildings with occupied zones below the design flood level?
C2.2 Design for strong winds	While the structural sections of the code should cover the engineering design of the structure for strong winds, there are mitigation measures in relation to building geometry and detailing that can reduce the loads applied to the building and hence reduce vulnerability.	a. Are there requirements to protect facades from wind-borne debris? i. If yes, please note if this applies to certain contexts. b. Are there requirements to design non-structural cladding and appendages (cladding including roof cladding, gutters, equipment and so forth) to resist strong winds? c. Are there requirements to detail façade to resist water ingress during a strong wind event?
C2.3 Design for snow	In regions susceptible to high snow loading, the configuration and profile or roof geometry will have a significant effect on the accumulation of snow, and hence the loads that might be applied to the roof structures. Additionally, sudden snow slips from pitched roofs can present a risk to people and property.	a. Where snow accumulation is anticipated, are there provisions for rails on pitched roofs (or other means) to reduce the risk of dangerous snow slips?
C2.4 Acoustic separation	In some situations, such as party floors in multistorey apartment blocks, there are acoustic requirements that prescribe minimum floor construction to satisfy acoustic separation. This may govern choice of structural system over simple load or fire requirements.	a. Does the code specify minimum construction build-ups for acoustic separation?

Table 4. (cont.)

Component	Relevance /Description	Diagnostic Question
C2 ARCHITECTURAL DESIGN AND MASSING		
C2.5 Fire protection	Fire protection will be required for structural elements without inherent fire resistance.	a. Are there provisions for the design of fire protection/ enclosure to protect structural elements?
C3 RESOURCE-EFFICIENT DESIGN		
C3.1 Reducing embodied carbon through efficient design	The best way to optimize resource use within the structural frame is through choice of structural system and spans at schematic design stage. This is a difficult provision to make compulsory, however guidance can be provided regarding efficient span ranges and depths for different forms of construction and to discourage unnecessary transfer structures. Evaluation of the proposed resource use in the comparison of design options is a helpful way to select the best approach. Carbon limits have the potential to help encourage market supply to shift toward lower embodied carbon materials and solutions	a. Are limits set for maximum embodied carbon in the structural frame? i. If yes, is methodology and location/market-specific data provided for calculation? b. Are there provisions to reduce waste by encouraging the use of standard sections or spans based on local availability?
C3.2 Design for adaptation	Consideration of flexibility of buildings for change of use or potential additions at the earliest design stage can prolong the life of building assets. For some construction methodologies, such as concrete frames, adaptation may have significant implications for the building's overall integrity.	a. Do geotechnical provisions permit increase in bearing capacity for existing structures, to facilitate addition of storeys or change of use? b. Are there requirements for provision of riser space for future flexibility of services distribution through floor structures? c. Are there requirements to consider addition of solar thermal or photovoltaic installations to roof structures?
C4 COORDINATION		
C4.1 Building services integration	Many essential building elements are not prescribed by the structural parts of the building code, but are required to be integrated into the structural design and detailing. Inadequate coordination can lead to errors in construction, building performance, or maintenance.	a. Are there requirements for the design of below-ground drainage? i. If yes, are there requirements for access for maintenance and repair? b. Is drainage by soakaway permitted? i. If yes, are there requirements for construction near to shallow building foundations? c. Are there requirements for lightning protection? i. If yes, can it rely upon transmission through the structural frame or by external tape conductor to earthing pits? d. Are there requirements for designing the structural frame or elements for MEP (mechanical, electrical & plumbing) plant replacement during the life of the building (loads and access)?
C4.2 Facades and thermal envelope		a. Are there requirements for thermal break joints at facades to prevent cold bridging? i. If yes, are there permitted calculation methods for determination of design of joint to transmit structural forces where required?

Table 4. (cont.)

Component	Relevance /Description	Diagnostic Question
C5 MAINTENANCE		
C5.1 Maintenance & inspections	A maintenance and inspection regime is essential to ensure safe and long building life. It is important that necessary maintenance and inspection activities are communicated to the users and can be carried out in a safe manner. Damage to non-structural elements can lead to exposure of structural elements to risk of damage. For example, damage to roof waterproofing can lead to water ingress that could corrode steel or rot timber.	<ul style="list-style-type: none"> a. Are there requirements to make sure that maintenance and periodic inspections of structural and non-structural elements are communicated to the client? b. Are there requirements to consider maintenance activities in the design (for instance design for loading from maintenance equipment)? <ul style="list-style-type: none"> i. If yes, please note these.

Appendix A: Regulatory Frameworks and Terminology

Figure 1 depicted the typical structure of building regulatory frameworks. However, to some extent, each regulatory framework and building regulation will be structured differently, as they vary between jurisdictions. The organization of the framework will largely depend on the country's system of government (unitary, federal, and so forth), legislative structure, administration at territory unit level as well as the model used for the development of the building regulations (if any). However, many are variations on the following fundamental structures:

1. The building act (or equivalent) includes general or high-level performance requirements and the building regulations (or codes) typically comprise primarily prescriptive-based requirements and compliance criteria, (although recent codes tend also to include specific performance-based approaches).
2. The building act (or equivalent) includes general or high-level performance requirements and the building regulations (or codes) include primarily performance-based requirements where:
 - i. Detailed criteria for compliance with the performance-based requirements of the regulations are in mandatory provisions, possibly in other documents.
 - ii. Detailed criteria for compliance with the performance-based requirements of the regulations are in non-mandatory provisions, allowing the use of alternative methods and tools.
3. The building act (or equivalent) includes general or high-level performance requirements and the building regulations (or codes) include a combination of specific performance and prescriptive-

based requirements and compliance criteria (hybrid approach).

Performance-based design and assessment (as noted in section 4.2) is the term used to describe an engineering approach to designing elements of a building based on meeting specific performance goals or requirements, such as for energy efficiency or seismic performance objectives, without prescribing restrictive rules or methods by which to achieve these goals. This is an evolution with respect to more outdated prescriptive-based approaches. Compliance criteria must be defined for verification of such performance requirements.

Regarding performance requirements, the “life safety” performance objective, as mentioned in section 3, has been traditionally adopted for structural design and assessment in terms of fulfilling the ultimate limit state requirements. This corresponds to a level of building performance where a building can sustain significant damage to both structural and non-structural components, for example during a design earthquake, while retaining a margin of safety against either partial or total structural collapse. This ensures a low risk of loss of life, life-threatening injuries, or entrapment, but does not preclude the eventuality that the building may be uneconomic to repair.

However, structural resilience requires that performance objectives aim for stricter requirements, in terms of design for fulfilling serviceability limit states, namely including “damage limitation” and “immediate occupancy” performance objectives for cost-effective repair or continuity of use of the buildings.

Building regulations must be uniform and consistent, whether specifically developed for a country, region, or city, or where a jurisdiction references other international codes and standards (or a mix of the two). This is to help prevent potential inconsistencies that may arise from:

- Mixed use of incompatible reference standards (for example, mixing of European and US standards when they are not aligned); and
- Lack of a reference standard for each regulated area, as failing to provide standards leaves all decisions to the market, which could result in wide-ranging variations of safety and resilience.

Additionally, reference standards should be aligned with all aspects of the building regulatory system capacity, including product testing, approval and supply chains (for example, it would create challenges if a US material test standard were cited in a country that lacks test facilities able to test to that standard, or if materials that comply with the standard are unavailable in the market).

Finally, the regulatory framework may also include the so-called “Approved Documents” or “Compliance Documents” for construction products and structural components which should be carefully aligned and compatible with structural provisions in standards and regulations.

Appendix B: Methodology of the Checklist Development

The checklist for Structural Resilience was developed through the following steps:

- Desk-based study of global examples of building codes, to understand different frameworks, influential international codes and common practices (code structure, relation to other standards, depth of regulatory guidance, how guidance is presented and accessed);
- Identification of the critical structural provisions included in building codes, and categorization of the key topics to develop the tool's component and subcomponent structure (see Figure 5);
- Development of a questionnaire to describe the fundamental characteristics of the country context (construction and professional practices; potential hazards);
- Development of a diagnostic checklist for code components and subcomponents to assess the coverage and depth of the structural provisions of the building code; and
- Consultation with World Bank BRR team and expert peer reviewers with extensive experience in code evaluation to refine questions. Draft versions of the checklist were piloted in several countries, and feedback has been incorporated into the final checklist questions.

Going forward, there will be ongoing review and feedback from users to inform updates.

The desk study included codes from a variety of countries with different geographical and socio-economic conditions as well as international standards and model codes, as below:

Africa:	South Africa, Algeria, Kenya;
Asia:	Singapore, India, Indonesia;
Oceania:	Australia, New Zealand;
Latin America and Caribbean:	CUBiC, OECS, Colombia, Peru;
North America:	IBC, ASCE, ACI, AISC (USA) and NBCC (Canada);
Europe:	Eurocodes, Building Regulations (England and Wales).

Appendix C: Building Typology Assessments

A building typology assessment describes the prevalent building materials, construction methodologies (for both sub- and superstructure), sizes, locations, uses and associated vulnerabilities through the profiling and description of common building types. This should include vernacular and non-engineered typologies as well as emerging construction technologies.

Preparation and review of these assessments should help the checklist reviewers understand the potential application of the code and consider the coverage within this context, especially if they do not have direct familiarity with the country's construction practices. The lead reviewer should consider what scope and format this should take depending on the needs of the team and variations in typologies across the country.

The following resources can be helpful in describing the structural attributes of the construction typologies:

World Bank Global Program for Safer Schools (GPSS), Global Library for School Infrastructure (GLOSI) taxonomy: https://gpss.worldbank.org/sites/gpss/files/knowledge_products/2019/2_TAXONOMY_HIGHRES.pdf

World Housing Encyclopedia: Construction types (world-housing.net) <https://www.world-housing.net>

Global Earthquake model (GEM):

- GEM Building Taxonomy: [GitHub - gem/gem_taxonomy: GEM Building Taxonomy](#)
- Taxonomy tool: [TaxtWEB - GEM building taxonomy editor \(openquake.org\)](#)
- “Global Exposure Model – Comprehensive datasets of the residential, commercial and industrial building stock” <https://www.globalquakemodel.org/product/global-exposure-model>

A Building Classification for Multi-hazard Risk Assessment. Silva, V., Brzev, S., Scawthorn, C., Yepes, C., Dabbeek, J. & Crowley, H., 2022. International Journal of Disaster Risk Science, Vol. 13, pp. 161–177.



Workers building a wooden house in Nigeria, Africa. © agafapaperiapunta



A recent study estimated that there were approximately 1.5 billion buildings globally in 2021 and global building stock is predicted to grow significantly over the coming decades. This growth in building stock creates higher levels of exposure to disaster risk as well as more periodic, chronic stresses such as extreme heat and localized fire and flooding events. It was also found that less than 13 percent of the global building stock was built according to design regulations with seismic provisions, although almost half is exposed to moderate to high seismic hazard. Climate change is expected to drive an increase in extreme weather and related events that can damage buildings and affect the comfort of people who inhabit them. Adequate urban planning, building design and construction practices aimed at structural safety and resilience significantly decrease the potential for structural damage and loss. This checklist aims to facilitate standardized and rigorous approach for review of the structural provisions of building codes and regulations for structural safety and resilience through a set of diagnostic questions.



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