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National Disaster Management Guidelines

On Ensuring Disaster Resilient Construction of Buildings and Infrastructure financed through Banks and Other Lending Institutions

September 2010

National Disaster Management Authority

Government of India

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1. Introduction

1.1 The trend of steady growth in housing construction in India in the recent past is a reflection of the increasing demand for housing in the country and the easy access to housing loans from banks and other lending institutions. The Eleventh Five Year Plan estimates that housing finance disbursals by banks, financial corporations, and co-operative sector institutions would grow at a rate of about 15% per annum during the Eleventh Plan period. It is estimated that the gross flow of credit disbursal from these institutions would be about Rs 7.75 lakh crores during 2007–2012.[1] The Reserve Bank of India (RBI) has advised the commercial banks to lend 3% of deposits for priority sector lending including housing loans to individuals and others (cooperative & private sector).

1.2 Every year, several lakhs of houses are destroyed and damaged in India by natural disasters like earthquakes, floods, landslides and cyclones. It is therefore important to ensure that the bank-financed construction is able to withstand the adverse impact of various natural hazards. Damage to or destruction of such assets not only result in adverse economic consequences, but may also compromise the bank's financial security due to these assets becoming Non Performing Assets (NPA) because of the weak coping capacities of most of the people who turn to banks and lending institutions for housing loans.

2. Current Practice of Financing Construction-Related Projects

2.1 Currently, construction projects in India are expected to comply with several technical provisions that are specified in various Acts, Bye-laws, Rules and Regulations enforced by Urban Local Bodies (ULBs) or local Urban Development Authorities. However, experiences from recent natural disasters clearly illustrate that the provisions of the Techno-Legal Regime are not strictly complied with, resulting in avoidable damage to the built environment and the consequent adverse economic impact. Secondly, the techno-legal regime implemented in the jurisdiction of ULBs or local Urban Development Authorities do not have any regulatory control over building constructions in rural areas. Therefore, the onus of checking the compliance to safety provisions by the loan-financed buildings lies with the banks extending housing loans.

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[1] Page 412, Paragraph 11.95, Urban Infrastructure, Housing, Basic Services, and Poverty Alleviation, Volume-III, Eleventh Five Year Plan, Planning Commission, Govt. of India.

2.2 In the context of disaster resilience, there are three critical gaps in the current practice of the provision of housing finance by banks and other lending institutions:

(a) When an application is made to a bank seeking a housing loan to construct the building or structure, it is not necessary that it is designed in full. The architect and/or structural engineer provides a certificate that they will undertake the design (at a later stage);

(b) Before the commencement of construction of the building or structure, the design of the whole structure is not furnished either to the local authority due to the lack of any definitive provisions in the prevailing local building bye-laws or to the banks financing the proposed construction. Assumptions are made regarding items appearing on the upper levels, and designs are prepared for parts of the building on the lower levels. Here, there is a possibility of not necessarily adhering to the assumptions made regarding the items in the upper levels, when those items are eventually designed much later.

(c) The technical professionals (structural engineers and/or architects) advising the banks recommend that loan may be given to a project, without necessarily seeing the design of the complete structure, and sometimes simply based on his/her perception of the credentials of the architect and structural engineer of the proposed project.

All these are lacunae of the construction practice that do not augur well for ensuring multi-hazard safety of the construction of buildings and structures in the country.

2.3 In general, independent assessment of the disaster resilience of such housing proposals is often missed by the banks themselves as indicated by the structural damage and economic losses in the past on bank financed buildings after devastating disasters. As per the existing practice, the banks give installments of financial assistance linked to the issue of specific certificates, namely

(a) **Initial loan amount** based on the *Stability Certificate* by structural design consultants *before* the structural design of the asset is performed stating that they *shall comply* with the requirements of disaster-resistance during the process of design (to be undertaken at a later stage),

(b) **Partial loan amount** based on the *Stage-wise Completion Certificates* by architects *after* the construction is underway, stating that a said list of works have been completed as per the approved construction drawings, and

(c) **Final loan amount** based on the *Final Completion Certificate* by *architects after* the construction is complete, stating that all the works have been completed as per the approved construction drawings.

2.4 In view of above, RBI has issued several proactive advisories to banks for verifying disaster safety while granting loans for any building construction, most important being the RBI's circular of 1st March 2006 advising banks to ensure prior permission from government /local governments/other statutory authorities for the project, wherever required while giving loans to real estate sector; the advisory to all banks issued on 12 June 2006 for adherence to the National Building Code 2005 (NBC 2005) while approving loans for any building construction; and RBI's circular issued on 17th November 2006, taking cognizance of orders of the Delhi High Court in the Writ Petition by Kalyan Sanstha Welfare Organisation against Union of India and Others for housing loans extended in Delhi.

2.5 While the above proactive steps of RBI for ensuring safe construction is recognized as a boost to promote disaster risk reduction in the built-up environment of the country, much remains to be done for creating a user-friendly, enabling environment for banks to facilitate compliance of the directives. The National Disaster Management Authority (NDMA) has prepared these Guidelines for integrating the techno-legal compliance into the housing loan application process. These Guidelines provide guidance by prescribing client specific simplified check-memos for ensuring compliance of the techno-legal regime by loan financed assets. RBI's advisories for ensuring prior approval of local ULBs before sanctioning building loans will hardly assist banks to determine disaster resilience in their loan financed assets, since the prevailing techno-legal system contain several loopholes in ensuring compliance with structural safety provisions. The current practice in ULBs is to seek only *assurances* from the architects and/or engineers that disaster-resilience *will be* incorporated in the loan-financed assets during the design process. The structural design of the proposed buildings and structures are *NOT* completed *before submitting the application* for a bank loan, and no processes are in place by the banks to ensure that disaster-resilience has indeed been incorporated in the assets *during the design process* at least *before construction begins*. This is a major lacuna in both the techno-legal and techno-financial processes. The NDMA Guidelines aims at addressing these critical gaps in the current processes of approving the housing loan applications without ascertaining compliance to the techno-legal regime, Building Codes and other Safety Standards and Regulations.

3. The Way Forward

3.1 An improved techno-financial regime for financing construction of houses and infrastructure by banks and other lending institutions in both urban and rural areas is seen as an opportunity for financial institutions to ensure disaster resilience in the construction sector. The financial institutions are also equally keen to ensure that the physical assets created through their lending schemes remain safe and disaster-resilient at least during the repayment period. Depending upon the nature of the assets and the vulnerability of the location to any or many of the disasters, the financial institutions could insist on ensuring that disaster resistant features are incorporated in the actual construction before the loan is sanctioned or disbursed. The improved techno-financial regime should be applicable to both new construction as well as additions, modifications, extensions or alterations to full or part of existing construction, including

(a) the entire range of housing construction, from those built for self-occupation to those provided by builders and developers to individual buyers, and

(b) other bank-financed construction, such as critical lifeline structures, infrastructure, and commercial complexes and buildings.

3.2 These Guidelines propose the modalities that will aid the banks for putting in place an improved and robust techno-financial regime, that will help the banks to ensure disaster-resilience and safety of bank-financed assets *by themselves* (without relying on the techno-legal processes controlled by ULBs). Using these Guidelines, the verification wings of banks and their empanelled technical experts will be in a position to check that the safety-related codes and regulations, as specified in NBC-2005 and various Indian Standards, are complied with and the designs of the proposed buildings and structures are multi-disaster-resilient. In case of a natural disaster, the bank-financed assets will perform as per the codes and standards, and the natural disaster will not have an adverse impact on these assets. These provisions will assist the banks to take a considered decision on the loan applications for financing such construction. The banking system would contribute to creating a disaster-resistant built environment in the country.

3.3 With above intention, a set of checklists are appended with these technical guidelines to aid *the structural engineers and architects assisting the banks* in assessing building constructions alone, because of large number of individuals interested in loans to construct buildings or purchase apartments. These checklists are meant for ensuring that necessary aspects of safety are addressed in the construction of the building as well as in the finishing and placement of its contents. For assessing safety of construction related to non-building structures, the technical professionals assisting the banks (e.g., engineers and architects) may use these formats to ensure that all aspects of safety are accounted for in the design of the proposed structure. The list of items and aspects included in these checklists are only indicative, and not exhaustive; the peer reviewers may improve the list based on their experience of carrying out peer review of housing and infrastructure projects.

3.4 The implementation of these techno-financial provisions would require banks to equip themselves with the necessary technical expertise, by either developing suitable technical human resources internally within the banking system or by outsourcing the peer review of technical documents submitted to the bank to empanelled professional architects, civil engineers, geo-technical engineers and structural engineers. This approach would offer to the banks an independent verification of disaster-resilience of the project under consideration, in addition to ensuring multi-hazard resilience in all bank-financed construction and thereby securing the investments made in such construction and contributing to a multi-hazard resilient built environment in the country.

4. Types of Structures Considered

4.1 Broadly, the structures constructed in the country can be divided into two categories, namely *buildings* and *non-buildings*. *Buildings* constitute over 90% of the number of structures. Buildings can be sub-divided into different groups based on *function of use, material of construction* and *total height above ground*. Based on the function of use, three further sub-groups can be identified, namely *Residential, Non-Residential* and *Critical Lifeline* Buildings. Based on material of construction, four sub-groups can be identified, namely *Reinforced Concrete (RC), Steel, Masonry* and *Other Materials*. Based on total height of the building above ground level, three sub-groups are identified, namely less than 15m tall, between 15m and 45m tall, and taller than 45m. Most masonry buildings in India are less than 15m tall. In the Guidelines, all buildings are considered, irrespective of whether they are being built by owners for self-occupation or by builders for sale.

4.2 *Non-buildings* include all other structures including industrial structures, civic amenities, and infrastructure projects. Infrastructure projects are required to be developed using technical and professional inputs along with understanding of social, technical, financial and sustainability aspects of the projects. The financial outlay for any construction can be any one of three funding modes, namely *government sources, public-private-partnership (PPP),* or *private sources*. While provisions exist in the *government-funded* infrastructure projects to ensure the development of hazard-resistant construction, systems need to be put in place to ensure the same in PPP and privately funded infrastructure projects, where the banking sector provides lending support (including construction in Special Economic Zones (SEZs) and Large Entertainment Parks outside municipal limits). These Guidelines are aimed at projects funded only under *PPP* and *Private* schemes, and not to those funded by the various Ministries and Departments of the Government of India and state governments.

4.3 Broadly, infrastructure projects fall into a number of sectors, including

i. *Water, e.g.,* dams, irrigation structures, and water transport;

ii. *Power, e.g.,* thermal power, hydro power, wind power, and solar power;

iii. *Communications, e.g.,* wired and wireless communications;

iv. *Transportation, e.g.,* railways (including trans-country railway systems, and metro-rail systems), roadways (including bridges, flyovers, pavements, passenger terminals, highway conveniences, and vehicle emergency facilities), airways (including airport terminals, runways & taxiways, ATC towers, and fuel tanks) and waterways (including port and harbour structures, passenger & cargo terminals, and light houses); and

v. *Urban Services (including infrastructure and amenities) e.g.,* water supply, piped-cooking gas supply, and sewage treatment, waste water treatment & drainage, storm water drainage, and solid waste treatment and disposal.

4.4 While there is extreme urgency to ensure the multi-hazard resilience of urban services, the other four sectors are also very important. Infrastructure projects can be sub-divided into discrete developments and linear developments, based on their geometric spread on ground. *Discrete developments* include individual stand-alone construction with relatively small footprint, *e.g.,* a water tank for municipal water supply, and cooling tower inside a power plant area, while *Linear Developments* include long span or long length facilities spreading over large distances and crossing different terrains vulnerable to different natural hazards, *e.g.,* trans-country pipelines for petroleum fuel crossing earthquake fault zones, large diameter water lines laid on different soil terrains, national highways, sub-surface tunnels, and long-span bridges, etc.)

5. Natural Hazards Considered

5.1 While the available national standards and guidelines consider the potential impact of each individual hazard, the safety of the built environment needs to be assured to withstand the adverse impact of multiple hazards like *earthquakes*, *cyclones*, *landslides* and *floods*, based on the risk and vulnerability profiles of the specific areas. Some design features favourable to resist effects of one hazard may conflict with the features required for another hazard; the implications of these need to be incorporated before arriving at the final designs. Experience of performance of the built environment with certain design features helps in resolving such conflicts.

6. Safety Items Considered

6.1 While the demands of all other natural hazards are of *force-type loading*, those of temperature and earthquake hazards are of *displacement-type loading*. Lateral action is a dominant feature of the hazard especially under wind, wave and earthquakes, in addition to the usual gravity loads. In the design of structures, the four virtues of configuration, stiffness, strength and ductility are required to be provided to ensure disaster resilience of structures. While the first three virtues are essential to resist force-type loading, ductility is necessary to resist displacement-type loading.

7. Safety of both Structural System and Non-Structural Systems

7.1 The construction of structures consists of two parts, namely the *Structural System* and *Non-Structural Systems*, loosely called as the *structure* and the *contents and finishes*. The *Structural System* is that part of the construction which is responsible to carry the loads acting on the structure (including those due to its own weight, occupants, contents and finishes) and ensure safety to the occupants and function of the construction. It consists of the soil system underneath the construction, the foundation, the vertical and horizontal members (namely columns, braces, beams, slabs and walls) that permit the various activities and functions to be undertaken within the structure, without any threat of collapse under the expected natural hazards and normal loads appearing on the structure. The members of the Structural System performing these functions are called *structural elements* (SEs).

7.2 Apart from these, there are many items of buildings, such as contents of buildings, appendages to buildings, services and utilities, which are supported by SEs, and whose weight and other forces are carried down to foundations by SEs, called non-structural elements (NSEs). During strong earthquake shaking, if NSEs are not secured to structural elements of the building, they can (a) topple, slide or fall down from an elevation, or (b) move or swing by large amounts in translation and rotation. These actions can cause loss to the item as well as cause secondary disasters. For instance, spill of chemicals in an industrial unit or a laboratory can cause fires, and toppling of unreinforced masonry parapet wall or chimney of a house can cause injury to persons below. NSEs can be listed under three groups, namely

(a) *Contents of buildings*: Items required for functionally enabling the use of spaces, such as (i) furniture and minor items, e.g., storage shelves, (ii) facilities and equipment, e.g., refrigerators, washing machines, gas cylinders, TVs, multi-level material stacks, false ceilings, generators and motors, and (iii) door and window panels and frames, large-panel glass panes with frames (as windows or infill walling material), and other partitions within the buildings;

(b) *Appendages to buildings*: Items projecting out of the buildings, either horizontally or vertically, such as chimneys projecting out from buildings, glass or stone cladding used as façades, parapets, small water tanks rested on top of buildings, sunshades, advertisements hoardings affixed to the vertical face of the building or anchored on top of building, and small communication antennas mounted atop buildings; and

(c) *Services and utilities* of buildings including water supply mains, electricity cables, gas pipelines, sewage pipelines and telecommunication wires from outside to inside of the buildings and within the buildings, air-conditioning ducts, rainwater drain pipes, elevators, fire hydrant systems including water pipes through the buildings.

7.3 The multi-hazard resilience and safety of both structural elements and non-structural elements are priority concerns of these Guidelines. It is estimated that in the total cost of construction of buildings, the structural elements may cost between 25-50%, and the remaining 50-75% is of the non-structural elements. Thus, there is a need to recognize the critical role of non-structural elements in the financial exposure in buildings. In non-building systems, the share of non-structural elements may be less, but the cost of equipment and facilities housed is typically very large. Hence, the safety and multi-hazard resilience of non-structural elements including equipments and facilities from the adverse impact of natural hazards is as serious an issue as that of the structural elements.

8. Retrofitting of Existing Construction

8.1 It is easier to incorporate safety in new buildings than in existing buildings. During construction of a new building, the overall geometry (shape and size), choice of materials, proportioning of members, connection detailing, and honest construction of the building are decided in advance. But in existing buildings, many of these are fixed already, but their influence needs to be modified incrementally or significantly to ensure compliance with the prevalent safety-related standards. This activity is called seismic strengthening or *retrofitting*; it must assess the condition of the existing building, identify deficiencies (if any) and provide quantitative evidence in favour of the proposed retrofit scheme (if required). The quantitative evidence needs to show how the retrofit scheme chosen improves one or more of the *four virtues of disaster-resistant construction*, namely *strength*, *stiffness*, *ductility* and *configuration* to the desired degree. Retrofitting of buildings is a detailed technical and professional activity. It involves the safety assessment of both the building structure(s) and their non-structural components (e.g., appendages, equipment, etc.) and utilities (*e.g.*, power, water, sewage, gas, communications, etc.).

8.2 Criteria for Retrofitting

When buildings are to be evaluated to assess their multi-hazard safety, their expected performance needs to be determined. The ability of a building to perform adequately is a function of the performance of both the structural system as well as the non-structural components. The combined performance of buildings is typically specified in terms of Performance Levels, which are most commonly used for evaluation of safety against earthquake shaking, and are described below.

8.2.1 Performance Levels

8.2.1.1 Buildings are expected to remain elastic under force-type loading, but go into inelastic range under displacement-type loading such as an earthquake shaking. *Performance-Based Assessment & Design* needs to be undertaken to ensure that both the building and its non-structural components are safe during the expected strong earthquake shaking. Performance-based design typically recognizes four levels of performance, which may be *qualitatively* defined as follows:

i. *Fully Operational (FO) Level*: The *building*, its *contents and utilities* are shaken by an earthquake, but no damage occurs in either of the above; the function of the building is not disrupted due to the occurrence of the earthquake;

ii. *Immediate Occupancy (IO) performance level*: The *building, it's contents and utilities* are shaken predominantly in their linear range of behavior and only minor damage may occur in them; the use of prevailing functions of the building and facilities is not restricted after the earthquake so that its functioning can be resumed immediately after the earthquake.

iii. *Life Safety (LS) performance level*: The *building, it's contents and utilities* are shaken severely in their nonlinear range of behavior. Significant damage occurs in them, but the building remains within it's reserve capacity and does not reach the state of imminent collapse. The use of the facility is restricted after the earthquake until detailed structural safety assessment is performed to ascertain the suitability of the building for retrofitting. If found suitable for retrofitting, the building may be retrofitted.

iv. *Collapse Prevention (CP) performance level*: The *building, it's contents and utilities* are shaken severely in their nonlinear range of behavior. Major damage occurs in them. The building does not have any additional reserve capacity and is in the state of imminent collapse. The building cannot be used after the earthquake.

8.2.1.2 In an earthquake, the critical lifeline buildings should be able to perform their functions and services immediately after the earthquake. Hence, it is desirable that the following performance levels are satisfied under the expected strong shaking in regions where the critical lifeline buildings are situated:

i. *Critical Lifeline Buildings*: The building structures should achieve *IO performance level*. This will help the immediate use of the building without perceiving any threat to the people and the contents in the event of aftershocks in the region.

ii. *Contents and Utilities*: The *contents and utilities* within the building structures should achieve *FO performance level*. This will help the continuity of the services of the critical lifeline buildings to persons affected during the earthquake and requiring such services.

8.2.2 **Performance Objectives**

8.2.2.1 It is not an easy task to *quantitatively* define the desired performance level of a building. Currently, there is no single acceptable, *quantitative* definition for the *FO, IO, LS and CP* performance levels, as there are many parameters (including the structural type) that govern the overall performance. The subject of *Performance-Based Design* of Buildings is being discussed at the research level only in a few institutes in India, and the philosophy has not been included yet in the Indian Seismic Codes for design and construction developed by the Bureau of Indian Standards; the Indian codes adopt *equivalent force-based* approach to design new buildings and not the *displacement-based* approach required by *Performance-Based Design concepts*. Hence, in general, the expertise is not available among the structural designers practicing in the country to undertake retrofitting of buildings applying concepts of performance-based design. Considering that most buildings in India have been constructed without much attention to disaster risk and vulnerability and with inadequate or weak compliance and enforcement of disaster-resistant building codes and standards, the efficiency of retrofitting scheme proposed must be able to withstand damage in the entire structure during the expected worst shaking.

8.2.2.2 Compounded with the desirable levels of retrofit discussed above, other competing demands that the country is currently faced with are, namely:

(a) the number of trained professionals currently available in the country is inadequate to undertake such a mammoth exercise;

(b) there is no document that is officially approved in the country by bodies like the Bureau of Indian Standards that can be readily adopted for seismic retrofitting of existing buildings in India, even though CPWD and IIT Chennai has brought out a Handbook on Seismic Retrofitting;

(c) the limited number of professionals available in the country with background in seismic retrofitting have to yet arrive at a consensus to set an agreed path for seismic retrofitting of buildings; and

(d) the retrofitting of critical lifeline buildings in the moderate and severe seismic zones of the country needs to be carried out on priority after structural safety audits have been carried out.

8.2.2.3 Therefore, a mixed approach may be advisable in the short run to minimize the damage and ensure that the buildings, especially the critical lifeline buildings (hospitals, overhead water tanks, electric substations, telecommunication towers) remains operational even after strong earthquake shaking. The recommended approach consists of *force-based* check to ensure no collapse of the building structure and no toppling or sliding damage of building contents under strong shaking, and *displacement-based* check to ensure that the inelastic damage level accrued in the building structure is within specified limits to prevent any damage to the building contents and building utilities. Thus, for the *Building Structure,* it will be ensured that it will possess at least a minimum required *design* strength and stiffness to resist the expected strong earthquake shaking, and will sustain inelastic lateral displacement in them under the said strong shaking without collapse, as per Table 1.

Table 1:
Target Performance Levels of Building Structures for Seismic Retrofitting

Building	***Performance Level Expected***
Normal	Collapse Prevention (CP)
Critical and Lifeline Buildings	Life Safety (LS)

8.2.2.4 *Building Content and Building Utilities* will be secured with retrofit measures against overturning or sliding under the expected strong earthquake shaking, and in a manner to ensure that no damage will occur under the inelastic displacement of the structure imposed on them under the said strong shaking, as per Table 2.

Table 2:
Target Performance Levels of Building Contents and Building Utilities for Seismic Retrofitting

Building	***Performance Level Expected***
Normal	Immediate Occupancy (IO)
Critical & Lifeline Building	Fully Operational (FO)

8.2.2.5. Since both the structure and it's contents and utilities of the critical lifeline buildings are required to be functional for immediate use after the expected severe shaking, retrofitting of such buildings will be done to comply with force and deformations levels more stringent than those specified in the Indian Seismic Code IS:1893 intended for the design of new buildings. Thus, compliance with current Indian Standard Code provisions *alone* will not suffice.

8.2.2.6 Given the large built environment that is ageing, the shortage of trained manpower to undertake strengthening and retrofitting of existing constructions before and after impending natural disasters is one of the major critical concerns today. In case professional agencies are already involved in assessing the disaster-resistance of the new and ongoing projects supported by the banks, it is in the interest of the banks to ensure that the said professionals have the required experience to undertake the said technical audit.

8.2.2.7 Some owners of buildings in India modify or alter their buildings by adding extensions or additional floors either for own use or for commercial purposes, depending on the availability of funds with them and liberal housing loan offers by banks and lending institutions. As recommended in the Model Building Regulations/Byelaws for Structural Safety in Natural Hazard Zones of India prepared by the Committee of Experts constituted by the Ministry of Home Affairs, Government of India in September 2004, in the case of loan applications for modifications, extensions or alterations of buildings older than fifty years, the banks and lending institutions may get such buildings inspected by a Registered Structural Engineer and submit the Certificate from the Registered Structural Engineer to the banks along with the housing loan application.

9 Proposed Reforms in Ensuring Disaster Resilience

9.1 These Guidelines propose the following reforms in ensuring disaster resilience by the Techno-Financial Regime of Banks and other Lending Institutions by prescribing the following provisions:

(a) *the individual/business enterprise seeking financial support from the bank* to undertake any new construction or to make any addition, alteration, modification or retrofitting of existing construction *will submit to the bank or lending institution the complete architectural and structural designs of the said construction* demonstrating that the proposed structure/alteration is capable of withstanding all the natural hazards posing risk and vulnerability to the region where the construction of the building is proposed, and

(b) *the bank or lending institution* will undertake *independent technical review* of the complete architectural and structural designs of the proposed construction, with the assistance of its own internal peer reviewers, and take a decision on the loan application based on the outcome of such review and other relevant factors related to the proposed construction.

9.2 **Implementation of the Techno-Financial Regime**

9.2.1 The following are the roles and responsibilities of the different stake holders in the construction in focus:

(a) *The individual or business entity wishing to seek financial support from the bank* after preparing the *complete architectural and structural design* of the proposed construction will arrange to submit all technical design documents including the following:

i. Architect's Design Basis Report,

ii. Structural Engineer's Design Basis Reports,

iii. Complete set of construction drawings related to both the structural and non-structural elements,

iv. Architect's Certificate, and

v. Structural Engineer's Certificate.

The professional architects and structural engineers associated with the proposed construction will ensure that each of these design documents submitted provide all necessary details for facilitating the technical peer review of the design by the bank's professional architects and engineers. It is envisaged that the submission of all relevant design-related information upfront will reduce the time taken for the peer review.

(b) *The bank or lending institution* will undertake the technical peer review of these engineering designs and documents of the proposed construction, either internally with their own technical human resources or externally with the help of qualified professional architects and structural engineers of *proven track record*, *experience* and *repute* in the design of such structures. The architects and structural engineers undertaking the peer review on behalf of the banks will adopt an objective and transparent approach to ensure compliance with the national standards and guidelines. In the peer review of some structures, peer reviewers may not have any national standards or Guidelines to ensure compliance. In such cases, peer reviewers should seek the best technical knowledge (available nationally or internationally) to assess suitability of the proposed design to withstand the adverse impact of potential natural hazards. The banks and lending institutions may empanel competent architects and structural engineers for carrying out peer review of these design documents.

(c) *The bank* should consider the comments of its peer reviewers and other inputs on the proposed construction, and take an appropriate decision on the housing loan application *at all times protecting the safety of the users and functions of the assets created through the loan finance.*

9.2.2 A set of forms are provided as appendices to these Guidelines to assist the peer reviewers undertaking the assessment of the designs of the proposed constructions. The list of these forms is presented in Tables 3 and 4.

The forms to be used by the peer reviewers depend on the building height and the construction type (masonry, concrete or steel). Peer Reviewer Architects will have to submit two forms, namely A1 and N1. The Peer Reviewer Structural Engineers will submit forms M1 (for masonry buildings), C1 (for concrete buildings) or S1 (for steel buildings) when the height of the building is below 15 meters, and C2 (for concrete buildings) or S2 (for steel buildings) when the height is above 15 meters.

Table 3:
Forms to assist Peer Reviewer Architects

Type of Buildings	*Structural Configuration*	*Non-structural Components*
All buildings	Form A1	Form N1
Note: Form M1, Form C1 or Form S1 of Table 4 also shall be filled by Architects as applicable for buildings on plots up to 500 m^2 and of height up to 15 m.		

Table 4:
Forms to assist Peer Reviewer Structural Engineers

Building Height	*Masonry*	*Concrete*	*Steel*
<15m	Form M1	Form C1	Form S1
15-45m	Not Permitted	Form C2	Form S2
>45m	Not Permitted		

9.2.3 Thus, the architect and structural engineer peer reviewing the designs on behalf of the bank shall provide their inputs in the form of

(1) Peer Reviewer Architect's comments on the Architectural Design Basis Report submitted by the architect of the project, including comments on

the deficiencies or presence of the architectural elements, if any, that may affect the performance of the building during natural hazards;

(2) Peer Reviewer Structural Engineer's comments on the Structural Design Basis Report submitted by the structural designer of the project, including deficiencies, if any; and

(2) Peer Reviewer Structural Engineer's Certificate giving his comments on the suitability of the design of the proposed construction.

9.3 Additional Technical Requirements for Structural System Safety

9.3.1 **New Constructions:** To ensure that the proposed loan financed construction will be able to withstand the adverse impact of potential natural hazards, the structural design of new constructions shall comply with *all* requirements of the prevalent national standards and Guidelines. Where such standards and guidelines are not available, those of any other country with advanced technical practices shall be adopted.

9.3.2 **Alterations to or Retrofitting of Existing Constructions:** The structural design of the whole existing construction being altered/retrofitted to resist all natural hazards applicable for the site of the said construction, shall comply with *all* requirements of the prevalent national standards and guidelines as laid out for the design of *new constructions* of the same type. Where such standards and Guidelines are not available, the reviewing professionals may adopt those of any other country with advanced technical practices.

FORM A1

Structural Configuration of Buildings

Form to assist Architects undertaking Peer Review on behalf of the Bank

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A1.0 Basic Information

S.No.	*Item*	*Details to be filled by the Peer Reviewer*
A1.0.1	**Name of building**	
A1.0.2	**Location of Building**	
	Plot number	
	Town Planning Scheme (If any)	
	Address	
	City/Town/Block/Panchayat/Village	
	District	
	State	
A1.0.3	**Occupancy class of building**	
A1.0.4	**Name of Owner**	
	Address	
A1.0.5	**Name of Builder**	
	Address	
A1.0.6	**Name of Architect**	
	Registration No.	
	Address	
A1.0.7	**Name of Structural Engineer**	
	Registration No.	
	Address	

Signature:
Date:

A1.1 Technical Information – **Overall issues**

S.No.	Question	Response to the Question to be filled by the Peer Reviewer	Reference
Hazard Zones Applicable			
1.	***Environment***		
(a)	*What is the environment exposure condition:* • Mild? • Moderate? • Severe? • Very Severe? • Extreme?		IS:456 – 2000 Clause 8.2.2 IS:800 – 2007
(b)	*Is any special attention required to address the above environment exposure condition? If yes, please mention if that action was taken.*		
2.	***Seismic Zone***		
(a)	*Which Seismic Zone is the building located in?*	II / III / IV / V	IS: 1893 (Part 1) – 2002 Figure 1
(b)	*Is any special attention required to address the above seismic zone? If yes, please mention if that action was taken?*		
3.	***Cyclone Zone***		
(a)	*Which Cyclone Area is the building located in*	Design wind speed *(m/s)* 55 / 50 / 47 / 44 / 39	IS: 875 (Part 3) – 1987 Figure 1
(b)	*Is any special attention required to address the above cyclone zone? If yes, please mention if that action was taken?*		
4.	***Flood Zone***		
(a)	*Which Flood Area is the building located in?*		
(b)	*Is any special attention required to address the above flood zone? If yes, please mention if that action was taken?*		
5.	***Landslide Zone***		
(a)	*Which Landslide Zone is the building located in?*		
(b)	*Is any special attention required to address the above landslide zone? If yes, please mention if that action was taken?*		
6.	***Soil and Site Condition***		
(a)	*What is the soil type?*		

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	Has it been considered in architectural design?		
(b)	*Is it a building on hill slopes?*		
	If it is a building on hill slopes, are there any concerns to be addressed? If so, please list them.		
7.	***Blast Loading Condition***		
(a)	*Is blast-type loading expected in the building?*		
(b)	*Has it been considered in architectural design, through planning stand-off distances, choice of façade finishes and structural design of members?*		

A1.2 Technical Information - **Building Configuration**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Geometry			
8.	***Overall shape***		
(a)	Does the building have a convex shape **in plan** or concave shape?		
(b)	Does the building have a convex shape **in elevation** or concave shape?		
(c)	What is the *slenderness ratio* of the building, i.e., ratio of its height to smallest base dimension?		
(d)	What is the *plan aspect ratio* of the building, i.e., ratio of its length to width in plan?		
(e)	Does the building have a central or off-centered atrium? If yes, what is the area of the atrium in plan to the overall plan area of the building?		
(f)	Does the building have any expansion joint in plan? If yes, what is the width of the expansion joint?		
(f)	Does the building have any projected parts (e.g., cantilever overhangs, roof sheets) that are vulnerable to gusty winds?		

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Structural Configuration			
9.	***Vertical Load Resisting System***		
(a)	What is the vertical load resisting system: • Regular moment resisting frame		

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	(MRF)? • Regular MRF with structural walls? • Irregular moment frame? • Irregular moment frame with structural walls? • Structural walls with beam-slab system? • Structural walls with flat-slab system?		
10.	***Lateral Load Resisting System***		
(a)	What is the lateral load resisting system: • Regular moment resisting frame (MRF)? • Regular MRF with structural walls? • Irregular moment frame? • Irregular moment frame with structural walls? • Structural walls with beam-slab system? • Structural walls with flat-slab system?		
(b)	Are there at least two planar lateral load resisting systems in each plan direction well-spaced in plan and of similar lateral stiffness to resist the inertia force generated in plan? If not, what are the problems: • Lack of frame grid? • Too many openings in walls making them of highly dissimilar stiffness and strength? • Others _____ (please state)?		
11.	***Plan Irregularities***		
(a)	Does the building have **Torsional Irregularity**? Torsional irregularity shall be considered to exist when the maximum story drift, computed including accidental torsion, at one end of the structure transverse to an axis is more than 1.2 times the average of the story drifts at the two ends of the structure.		IS:1893 (Part 1) – 2002 Clause 7.1
	If **Torsional Irregularity** is present in the building, it is possible to eliminate the same with suitable alterations without jeopardizing the functions of the building? If yes, please give details how to achieve it? If not, are the structural elements designed for the consequent torsional effect? Torsional irregularity may arise from eccentric		IS:1893 (Part 1) – 2002 Clause 7.1

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	location of mass (e.g., water tanks on roofs) or eccentric location of structural elements resisting lateral loads (e.g., columns, walls, lift cores, and staircases).		
(b)	Does the building have any **Re-entrant Corners**? Plan configurations of a structure and its lateral-force-resisting system contain re-entrant corners where both projections of the structure beyond a re-entrant corner are greater than 15 percent of the plan dimension of the structure in the given direction.		IS:1893 (Part 1) – 2002 Clause 7.1
	If **Re-entrant Corners** are present in the building, it is possible to eliminate the same with suitable alterations without jeopardizing the functions of the building? If yes, please give details how to achieve it? If not, does the building have enough structural elements in the re-entrant corner to allow the flow of forces through this corner?		IS:1893 (Part 1) – 2002 Clause 7.1
(c)	Does the building have any **Diaphragm Discontinuity**? Diaphragms with abrupt discontinuities or variations in stiffness including those having cutout or open areas greater than 50 percent of the gross enclosed diaphragm area or changes in effective diaphragm stiffness of more than 50 percent from one story to the next.		IS:1893 (Part 1) – 2002 Clause 7.1
	If **Diaphragm Discontinuity** are present in the building, it is possible to eliminate the same with suitable alterations without jeopardizing the functions of the building? If yes, please give details how to achieve it? If not, does the building have enough in-plane floor diaphragm action in plan to allow the flow of forces to the vertical elements without any in-plane deformation of the floor slab?		IS:1893 (Part 1) – 2002 Clause 7.1
(d)	Does the building have any **Out-of-Plane Offsets** in Vertical Lateral-Force Resisting Elements? Discontinuities in a lateral force resistance path are out-of-plane offsets of the vertical elements resisting the lateral load.		IS:1893 (Part 1) – 2002 Clause 7.1
	If **Out-of-Plane Offsets** are present in the building, it is possible to eliminate the same with suitable alterations without jeopardizing the functions of the building? If yes, please give details how to achieve it? If not, does the building have floating columns, off-set columns, floating walls, or offset walls that do not significantly alter the load path of the structure?		IS:1893 (Part 1) – 2002 Clause 7.1

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(e)	Does the building have any **Nonparallel Systems**? The vertical lateral-force-resisting elements are not parallel to or symmetric about the major orthogonal axes of the lateral-force-resisting system.		IS:1893 (Part 1) – 2002 Clause 7.1
	If **Nonparallel Systems** are present in the building, it is possible to eliminate the same with suitable alterations without jeopardizing the functions of the building? If yes, please give details how to achieve it? If not, has design been done to account for 25/73 load combinations to account for all possible actions under 2D/3D ground shaking?		IS:1893 (Part 1) – 2002 Clause 7.1
12.	***Vertical Irregularities***		
(a)	Does the building have **Stiffness Irregularity – Soft Story**? A soft story is one in which the lateral stiffness is less than 70 percent of that in the story above or less than 80 percent of the average stiffness of the three stories above.		IS:1893 (Part 1) – 2002 Clause 7.1

	If **Stiffness Irregularity – Soft Story** is present in the building, it is possible to eliminate the same with suitable alterations without jeopardizing the functions of the building? If yes, please give details how to achieve it? If not, the same may be stated and *the structure declared unsafe*?		IS:1893 (Part 1) – 2002 Clause 7.1
(b)	Does the building have **Mass Irregularity**? Mass irregularity shall be considered to exist where the effective mass of any story is more than 150 percent of the effective mass of an adjacent story. A roof that is lighter than the floor below need not be considered.		IS:1893 (Part 1) – 2002 Clause 7.1
	If **Mass Irregularity** is present in the building, it is possible to eliminate the same with suitable alterations without jeopardizing the functions of the building? If yes, please give details how to achieve it? If not, the same may be stated?		IS:1893 (Part 1) – 2002 Clause 7.1
(c)	Does the building have **Vertical Geometric Irregularity**? Vertical geometric irregularity shall be considered to exist where the horizontal dimension of the lateral-force- resisting system in any story is more than 130 percent of that in an adjacent story.		IS:1893 (Part 1) – 2002 Clause 7.1
	If **Vertical Geometric Irregularity** is present in the building, it is possible to		IS:1893 (Part 1) – 2002 Clause 7.1

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	eliminate the same with suitable alterations without jeopardizing the functions of the building? If yes, please give details how to achieve it? If not, the same may be stated?		
(d)	Does the building have **In-Plane Discontinuity** in Vertical Lateral-Force Resisting Elements? An in-plane offset of the lateral-force-resisting elements greater than the length of those elements or a reduction in stiffness of the resisting element in the story below.		IS:1893 (Part 1) – 2002 Clause 7.1
	If **In-Plane Discontinuity** is present in the building, it is possible to eliminate the same with suitable alterations without jeopardizing the functions of the building? If yes, please give details how to achieve it? If not, the same may be stated?		IS:1893 (Part 1) – 2002 Clause 7.1
(e)	Does the building have **Discontinuity in Capacity – Weak Story**? A weak story is one in which the story lateral strength is less than 80 percent of that in the story above. The story strength is the total strength of all seismic-resisting elements sharing the story shear for the direction under consideration.		IS:1893 (Part 1) – 2002 Clause 7.1
	If **Discontinuity in Capacity – Weak Story** is present in the building, it is possible to eliminate the same with suitable alterations without jeopardizing the functions of the building? If yes, please give details how to achieve it? If not, the same may be stated and *the structure declared unsafe*?		IS:1893 (Part 1) – 2002 Clause 7.1

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Pounding			
13.	***Adjacent Units of the same building***		
(a)	Has the seismic analysis been done to estimate the lateral displacement of the two units? If yes, has it been established that there is or there is no problem of pounding?		IS:1893 (Part 1) – 2002 Clause 7.11.3
(b)	If the problem of pounding exists, is it possible to eliminate the pounding by choosing another lateral load resisting system?		
(c)	If the problem of pounding does not exist and the gap is large between the two units, is any detailing provided for		

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	the large gap between the two units?		

Vibrations			
14.	***Floor vibrations in the building***		
(a)	Are the vibration levels at floors (especially at the upper elevations) due to wind such that they cause discomfort to building occupants?		
(b)	If yes, what measures are taken to reduce the same?		

Emergency Evacuation			
15.	***Staircases in the building***		
(a)	Is there adequate number of emergency exit staircases in the building?		
(b)	If YES, are they located properly?		

Fire Safety			
16.	***Water Sprinklers in the building***		
(a)	Does the building require water sprinklers to douse accidental fires?		
(b)	If YES, are they • Sufficient in number, AND • Located properly?		

High-rise Buildings			
17.	***Accessible Roofs & Balconies in the building***		
(a)	In buildings of height in the range 15-45m, are all roofs and balconies access controlled?		
(b)	In buildings of height more than 45m, are all roofs and balconies are secured against access by normal users of the building?		

Signature:
Date:

Name:...
Address: ....
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Tel. No.……… ………………………..………………

Reference IS Codes

1. IS:456 – 2000, *Indian Standard Code of Practice* Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
2. IS:800 – 2007, *Indian Standard Code of Practice* Structural Steel, Bureau of Indian Standards, New Delhi

3. IS:875 (Part 3) – 1987, *Indian Standard Code of Practice* Design Loads (Other than Earthquake) for Buildings and Structures – Wind Load, Bureau of Indian Standards, New Delhi
4. IS:1893 (Part 1) – 2002, *Indian Standard* Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi
5. IS:1904 – 1986, *Indian Standard Code of Practice* Design and Construction of Foundations in Soils: General Requirements, Bureau of Indian Standards, New Delhi
6. IS:13920 – 2003, *Indian Standard Code of Practice* Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, Bureau of Indian Standards, New Delhi

FORM N1

Non-structural Aspects of Buildings

Form to assist Architects undertaking Peer Review on behalf of the Bank

N1.0 Basic Information

S.No.	*Item*	*Details to be filled by the Peer Reviewer*
N1.0.1	**Name of building**	
N1.0.2	**Location of Building**	
	Plot number	
	Town Planning Scheme (If any)	
	Address	
	City/Town/Block/Panchayat/Village	
	District	
	State	
N1.0.3	**Occupancy class of building**	
N1.0.4	**Name of Owner**	
	Address	
N1.0.5	**Name of Builder**	
	Address	
N1.0.6	**Name of Architect**	
	Registration No.	
	Address	
N1.0.7	**Name of Structural Engineer**	
	Registration No.	
	Address	

Signature:
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N1.1 Technical Information – **Non-structural elements present in the Building**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Non-structural elements present			
1.	***Contents of buildings***		
(a)	*Which of the following items are present in the building:*	Provide below the detailed list of items under each category	
	(i) furniture and items of usage *e.g., storage shelves*		
	(ii) facilities and equipment *e.g., refrigerators, washing machines,* *gas cylinders, TVs, multi-level material stacks, false ceilings, generators and motors,AHUs & Cooling towers*		
	(iii) appurtenances *e.g., door & window panels & frames,* *large-panel glass panes with frames (as windows or infill walling material), other partition walls*		
2.	***Appendages to buildings***		
(a)	*Which of the following items are present in the building:*	Provide below the detailed list	
	Items projecting out of the buildings, either horizontally or vertically, *e.g., chimney projecting out of building,* *glass or stone cladding/façades,* *parapets,* *small water tanks atop building,* *sunshades,* *advertisements hoardings affixed to the vertical face of the building or anchored atop buildings, and* *small communication antennas mounted atop buildings*		
3.	***Services and utilities***		
(a)	*Which of the following items are present in the building:*	Provide below the detailed list of items under each category	
	(i) from outside to inside the building to within the building *e.g., water supply mains, electricity cables, gas pipelines, sewage pipelines* *and telecommunication wires*		
	(ii) from one part of the building to another *e.g., air-conditioning ducts, rainwater drain pipes, elevators, fire hydrant systems including water pipes through the building*		

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4.	***Critical Contents of the building***		
(a)	*Which of the following items are* ***massive, tall/flexible or expensive items*** *in/affixed to the building, and whose loss will cause life threat, impair function or major economic setback:*	Provide below the list of only the critical items under each category	
	(i) furniture and items of usage *e.g., storage shelves*		
	(ii) facilities and equipment *e.g., refrigerators, washing machines,* *gas cylinders, TVs, multi-level material stacks, false ceilings, generators and motors, AHUs & Cooling towers*		
	(iii) appurtenances *e.g., door & window panels & frames,* *large-panel glass panes with frames (as windows or infill walling material), other partition walls*		
5.	***Critical Appendages to the building***		
(a)	*Which of the following items are* ***massive, tall/flexible or expensive items*** *in/affixed to the building, and whose loss will cause life threat, impair function or major economic setback:*	Provide below the list of only the critical items	
	Items projecting out of the buildings, either horizontally or vertically *e.g., chimney projecting out of building,* *glass or stone cladding used as façades,* *parapets, small water tanks rested atop buildings, sunshades, advertisement hoardings affixed to the vertical face of the building or anchored atop buildings, and small communication antennas mounted atop buildings*		
6.	***Services and utilities of the building***		
(a)	*Which of the following items are* ***massive, tall/flexible or expensive items*** *in/affixed to the building, and whose loss will cause life threat, impair function or major economic setback:*	Provide below the list of only the critical items under each category	
	(i) from outside to inside the building to within the building *e.g., water supply mains, electricity cables, gas pipelines, sewage pipelines* *and telecommunication wires*		
	(ii) from one part of the building to another *e.g., air-conditioning ducts, rainwater drain pipes, elevators, fire hydrant systems including water pipes through the building*		

Signature:
Date:

<u>N1.2 Technical Information</u> - **Non-structural elements design**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Design to protect against effects of earthquake shaking			
7.	***Critical Contents of buildings***		
(a)	Are all the *Critical Contents of the building* secured against effects of earthquake shaking by formal design of their anchorages, supports and interfaces?	Provide below the list of only the critical items under each category, and state YES or NO in response to the question on left hand side.	State design provisions used, when answer to question on left hand side is YES
	(i) furniture and items of usage		
	(ii) facilities and equipment		
	(iii) appurtenances		
	If not, which are the items not secured?		
8.	***Critical Appendages to buildings***		
(a)	Are all the *Critical Appendages to the building* secured against effects of earthquake shaking by formal design of their anchorages, supports and interfaces?	Provide below the list of only the critical items under each category, and state YES or NO in response to the question on the left hand side.	State design provisions used, when answer to question on left hand side is YES
	If not, which are the items not secured?		
9.	***Services and utilities***		
(a)	Are all the *Services and utilities of the building* secured against effects of earthquake shaking by formal design of their anchorages, supports and interfaces?	Provide below list of only the critical items under each category, and state YES or NO in response to the question on left hand side.	State design provisions used, when answer to question on left hand side is YES
	If not, which are the items not secured?		

Signature:
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Name:...
Address: ....
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Tel. No.……… ………………………..…………………..

Reference IS Codes

1. IS:456 – 2000, *Indian Standard Code of Practice* Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
2. IS:800 – 2007, *Indian Standard Code of Practice* Structural Steel, Bureau of Indian Standards, New Delhi
3. IS:875 (Part 3) – 1987, *Indian Standard Code of Practice* Design Loads (Other than Earthquake) for Buildings and Structures – Wind Load, Bureau of Indian Standards, New Delhi
4. IS:1893 (Part 1) – 2002, *Indian Standard* Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi
5. IS:1904 – 1986, *Indian Standard Code of Practice* Design and Construction of Foundations in Soils: General Requirements, Bureau of Indian Standards, New Delhi
6. IS:13920 – 2003, *Indian Standard Code of Practice* Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, Bureau of Indian Standards, New Delhi

FORM M1

Load Bearing Masonry Buildings of Height Less than 15m

Form to assist Structural Engineers undertaking Peer Review
on behalf of the Bank

M1.0 Basic Information

S.No.	*Item*	*Details to be filled by the Peer Reviewer*
M1.0.1	**Name of building**	
M1.0.2	**Location of Building**	
	Plot number	
	Town Planning Scheme (If any)	
	Address	
	City/Town/Block/Panchayat/Village	
	District	
	State	
M1.0.3	**Occupancy class of building**	
M1.0.4	**Name of Owner**	
	Address	
M1.0.5	**Name of Builder**	
	Address	
M1.0.6	**Name of Architect**	
	Registration No.	
	Address	
M1.0.7	**Name of Structural Engineer**	
	Registration No.	
	Address	

Signature:
Date:

M1.1 Technical Information - **Siting of the Building**

S.No.	Question	Response to the Question to be filled by the Peer Reviewer	Reference
Hazard Zones Applicable			
1.	***Environment***		
(a)	*What is the environment exposure condition:* • Mild? • Moderate? • Severe? • Very Severe? • Extreme?		IS:456 – 2000 Clause 8.2.2 IS:800 – 2007 Clause ______
(b)	*Is any special attention required to address the above environment exposure condition? If yes, please mention if that action was taken.*		
2.	***Seismic Zone***		
(a)	*Which Seismic Zone is the building located in?*	II / III / IV / V	IS: 1893 (Part 1) – 2002 Figure 1
(b)	*Is any special attention required to address the above seismic zone? If yes, please mention if that action was taken?*		
3.	***Cyclone Zone***		
(a)	*Which Cyclone Area is the building located in*	Design wind speed *(m/s)* 55 / 50 / 47 / 44 / 39	IS: 875 (Part 3) – 1987 Figure 1
(b)	*Is any special attention required to address the above cyclone zone? If yes, please mention if that action was taken?*		
4.	***Flood Zone***		
(a)	*Which Flood Area is the building located in?*		
(b)	*Is any special attention required to address the above flood zone? If yes, please mention if that action was taken?*		
5.	***Landslide Zone***		
(a)	*Which Landslide Zone is the building located in?*		
(b)	*Is any special attention required to address the above landslide zone? If yes, please mention if that action was taken?*		
6.	***Soil Condition***		

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(a)	*What is the Ground terrain like? Is the* natural ground slope more than 20%?		
(b)	What is the type of soil strata: • Hard? • Medium? • Soft?		IS:1893 (Part 1) – 2002 Clause 6.3.5.2
(c)	Is soil liquefiable?	Yes / No	IS:1893 (Part 1) – 2002 Table 4, Figure 7
(d)	If the soil is liquefiable, does the proposed design consider the same and eliminate the negative effects of liquefaction on the proposed structure? If yes, how? If not, why?		
(e)	Is soil slope vulnerable to landslides? If yes, was a detailed analysis done to assess the safety of the slope?		
(f)	What is the Design Safe Bearing Capacity (*kN/m*^{2})?		IS:1904 - ______ Clause ______

M1.2 Technical Information - **Building Information**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Geometry			
7.	***Number of Storeys***		
(a)	What is the number of storeys above ground level in the building (including those to be added later, also including all stepped floors, if applicable)?		
(b)	Is this total height of the building more than 15m? if YES, is the quality of design engineering undertaken sufficient to show that the building is safe?		

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Design			
8.	***Seismic Actions***		
(a)	What is the Importance Factor used in estimating the design base shear?	1.0 / 1.5	IS: 1893 (Part 1) – 2002 Table 6
(b)	What is the Response reduction Factor used in estimating the design base shear?		IS: 1893 (Part 1) – 2002 Table 7
(c)	What is the Design Base Shear, as a fraction of the weight of the building, • Seismic Coefficient Method • Response Spectrum Method		IS: 1893 (Part 1) – 2002 Clause 7.5.3

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(d)	What is the category of the building, A, B, C, D or E?		IS: 4326 – 1993 Clause 7, Table 2
9.	Is the building provided with a basement? If yes, is it structurally weak or soft to resist lateral loads?		
10.	What is the type of the masonry employed in the wall • Burnt clay brick? • Cement concrete blocks? • Stone?		
11.	What is the type of mortar used?		IS: 1905
(a)	What is the mix employed? Is this consistent with the mortar type to be used?		
12.	Are the opening sizes and locations consistent with the norms for the category of the building and number of storeys in it?		IS: 4326
13.	Are the ratios of • Wall height to thickness ≤ 20, and • Wall length between cross wall to thickness ≤40?		IS:4326-1993 Table 4, Figure 7
14.	Does the building have a pitched roof • At eave level of sloping roof? • At top of gable walls? • At top of ridge walls?		
(a)	Is a pitched roof acceptable? If not, has adequate engineering been done to show that the roof and building are safe?		IS: 4326 Figure 10, Clause 8.4.4

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Detailing			
15.	Have the following bands been provided: • Roof band? • Eves band? • Gable band? • Lintel band? • Sill band? • Plinth band?		
(a)	Are these bands sufficient as per the norms?		IS: 4326 Clauses 8.4.2, 8,4,3, 8,4,6 and 8.4.7
(b)	Are the band size, bar size and links as per the norms?		IS: 4326 Table 6

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16.	Have vertical reinforcing bars been provided in the building • At corners and T junctions of walls, and • At jambs of doors ad window openings?		
(a)	Are these bands sufficient as per the norms?		IS: 4326 Clauses 8.4.8, 8,4,9
(b)	Are the band size, bar size, and links as per the norms?		IS: 4326 Table 7
17.	Does the building adopt precast roofing planks for the slab system? If YES, are these planks integrated to each other and with the walls?		IS: 4326 Clauses 9.1.4
18.	If pitched roof is employed, are horizontal bracings provided in • The pitched roof truss, and • The horizontal plane at the tie level of the roof truss?		IS: 4326 Clause 5.4.12

Signature:
Date:

Name:..
Address: ....
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Tel. No.……… ……………………..…………………..

Reference IS Codes

1. IS:456 – 2000, *Indian Standard Code of Practice* Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
2. IS:800 – 2007, *Indian Standard Code of Practice* Structural Steel, Bureau of Indian Standards, New Delhi
3. IS:875 (Part 3) – 1987, *Indian Standard Code of Practice* Design Loads (Other than Earthquake) for Buildings and Structures – Wind Load, Bureau of Indian Standards, New Delhi
4. IS:1893 (Part 1) – 2002, *Indian Standard* Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi
5. IS:1904 – 1986, *Indian Standard Code of Practice* Design and Construction of Foundations in Soils: General Requirements, Bureau of Indian Standards, New Delhi
6. IS: 4326-1993, *Indian Standard Code of Practice* Earthquake Resistant Design and Construction of Buildings, Bureau of Indian Standards, New Delhi

FORM C1

Concrete Buildings of Height Less than 15m

Forms to assist Structural Engineers undertaking Peer Review
on behalf of the Bank

C1.0 Basic Information

S.No.	*Item*	*Details to be filled by the Peer Reviewer*
C1.0.1	**Name of building**	
C1.0.2	**Location of Building**	
	Plot number	
	Town Planning Scheme (If any)	
	Address	
	City/Town/Block/Panchayat/Village	
	District	
	State	
C1.0.3	**Occupancy class of building**	
C1.0.4	**Name of Owner**	
	Address	
C1.0.5	**Name of Builder**	
	Address	
C1.0.6	**Name of Architect**	
	Registration No.	
	Address	
C1.0.7	**Name of Structural Engineer**	
	Registration No.	
	Address	

Signature:
Date:

C1.1 Technical Information - **Siting of the Building**

S.No.	Question	Response to the Question to be filled by the Peer Reviewer	Reference
Hazard Zones Applicable			
1.	***Environment***		
(a)	*What is the environment exposure condition:* • Mild? • Moderate? • Severe? • Very Severe? • Extreme?		IS:456 – 2000 Clause 8.2.2 IS:800 – 2007 Clause ______
(b)	*Is any special attention required to address the above environment exposure condition? If yes, please mention if that action was taken.*		
2.	***Seismic Zone***		
(a)	*Which Seismic Zone is the building located in?*	II / III / IV / V	IS: 1893 (Part 1) – 2002 Figure 1
(b)	*Is any special attention required to address the above seismic zone? If yes, please mention if that action was taken?*		
3.	***Cyclone Zone***		
(a)	*Which Cyclone Area is the building located in*	Design wind speed *(m/s)* 55 / 50 / 47 / 44 / 39	IS: 875 (Part 3) – 1987 Figure 1
(b)	*Is any special attention required to address the above cyclone zone? If yes, please mention if that action was taken?*		
4.	***Flood Zone***		
(a)	*Which Flood Area is the building located in?*		
(b)	*Is any special attention required to address the above flood zone? If yes, please mention if that action was taken?*		
5.	***Landslide Zone***		
(a)	*Which Landslide Zone is the building located in?*		
(b)	*Is any special attention required to address the above landslide zone? If yes, please mention if that action was taken?*		
6.	***Soil Condition***		
(a)	*What is the Ground terrain like? Is the*		

Signature:
Date:

	natural ground slope more than 20%?		
(b)	What is the type of soil strata: • Hard? • Medium? • Soft?		IS:1893 (Part 1) – 2002 Clause 6.3.5.2
(c)	Is soil liquefiable?	Yes / No	IS:1893 (Part 1) – 2002 Table 4, Figure 7
(d)	If the soil is liquefiable, does the proposed design consider the same and eliminate the negative effects of liquefaction on the proposed structure? If yes, how? If not, why?		
(e)	Is soil slope vulnerable to landslides? If yes, was a detailed analysis done to assess the safety of the slope?		
(f)	What is the Design Safe Bearing Capacity (kN/m^2)?		IS:1904

C1.2 Technical Information - **Building Information**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Geometry			
7.	***Number of Storeys***		
(a)	What is the number of storeys above ground level in the building (including those to be added later, also including all stepped floors, if applicable)?		
(b)	What is the number of basements below ground level?		

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Design			
8.	***Structural System***		
(a)	What is the Structural System employed: • Regular frame, • Regular frame with shear wall, • Irregular frame, • Irregular frame with shear wall, • Shear wall building, • Soft storey building, or • Any other (please identify)?	1.0 / 1.5	
(b)	What is the foundation system: • Independent footing		

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	• Interconnected footing • Raft foundation • Pile foundation, or • Any other (please identify)?		
(c)	What is the depth of the foundation? Is this sufficient for the strata of soil at the site?		
(d)	If individual foundations are used, what is the system for interconnecting the foundation units: • Plinth beams, • Foundation beams, • Pile caps connected by tie beams, or • Not connected together?		
(e)	What is the horizontal floor system: • Beams and slabs • Waffles, • Ribbed floors, • Flat slab with drops, • Flat plate with drops, • Flat slab or plate without drops, • Any other (please identify)?		
9.	In buildings with basement, have the following been considered: • Uplift pressure considered, and • Lateral pressure considered? If NO, is the building safe?		
10.	What are the grades of concrete employed in the building? List all grades used.		
11.	What are the grades of steel reinforcement used in the building? List all grades used.		IS: 456 – 2000 Clause 5.6
12.	What are the load combinations employed in the analysis of the structure?		
13.	***Seismic Actions***		
(a)	What is the Importance Factor used in estimating the design base shear?	1.0 / 1.5	IS: 1893 (Part 1) – 2002 Table 6
(b)	What is the Response reduction Factor used in estimating the design base shear?		IS: 1893 (Part 1) – 2002 Table 7
(d)	What is the natural period of the building for shaking in translation mode along the two horizontal plan directions?		
(e)	What is the Design Base Shear, as a		IS: 1893 (Part 1) – 2002

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	fraction of the weight of the building, • Seismic Coefficient Method • Response Spectrum Method		Clause 7.5.3
(e)	If soft/flexible storeys exist in the building, were the columns in that storey specially designed for additional effects?		IS:1893 (Part 1) – 2002 Clause 7.10
(f)	Has the effect of unreinforced masonry infills been accounted for in the structural stiffness and strength design of building?		
(g)	Has analysis of the structure performed to include effects of torsion?		IS: 1893 (Part 1) Clause 7.9

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Detailing			
14.	Is ductile detailing provided in the building?		IS:13920 – 2003 Clause 1.1.1
15.	What is the minimum dimension (in mm) of the beams used?		IS:13920 – 2003 Clause 6.1
16.	What is the **minimum** percentage of tensile reinforcement used in beams at any cross-section?		IS:13920 – 2003 Clause 6.2.1
17.	What is the **maximum** percentage of tensile reinforcement used in beams at any cross-section?		IS:13920 – 2003 Clause 6.2.2
18.	What is the spacing (in mm) of transverse reinforcement in 2d length of beams near ends?		IS:13920 – 2003 Clause 6.3.5
19.	What is the minimum ratio of capacity of beam in shear to its capacity in flexure at ends?		
20.	What is the minimum dimension (in mm) of columns?		IS:13920 – 2003 Clause 7.1.2, 7.1.3
21.	What is the minimum percentage of longitudinal reinforcement used in columns?		IS:456 – 2000 Clause 26.5.3
22.	What are the • Smallest diameter (in mm) • Largest spacing (in mm) of transverse reinforcement bars in columns near ends?		IS:13920 – 2003 Clause 7.4

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Reference IS Codes

1. IS:456 – 2000, *Indian Standard Code of Practice* Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
2. IS:800 – 2007, *Indian Standard Code of Practice* Structural Steel, Bureau of Indian Standards, New Delhi
3. IS:875 (Part 3) – 1987, *Indian Standard Code of Practice* Design Loads (Other than Earthquake) for Buildings and Structures – Wind Load, Bureau of Indian Standards, New Delhi
4. IS:1893 (Part 1) – 2002, *Indian Standard* Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi
5. IS:1904 – 1986, *Indian Standard Code of Practice* Design and Construction of Foundations in Soils: General Requirements, Bureau of Indian Standards, New Delhi.
6. IS:13920 – 2003, *Indian Standard Code of Practice* Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Force

FORM C2

Concrete Buildings of Height More than 15m

Forms to assist Structural Engineers undertaking Peer Review
on behalf of the Bank

C2.0 Basic Information

S.No.	*Item*	*Details to be filled by the Peer Reviewer*
C2.0.1	**Name of building**	
C2.0.2	**Location of Building**	
	Plot number	
	Town Planning Scheme (if any)	
	Address	
	City/Town/Block/Panchayat/Village	
	District	
	State	
C2.0.3	**Occupancy class of building**	
C2.0.4	**Name of Owner**	
	Address	
C2.0.5	**Name of Builder**	
	Address	
C2.0.6	**Name of Architect**	
	Registration No.	
	Address	
C2.0.7	**Name of Structural Engineer**	
	Registration No.	
	Address	

Signature:
Date:

C2.1 Technical Information - **Siting of the Building**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Hazard Zones Applicable			
1.	***Environment***		
(a)	*What is the environment exposure condition:* • Mild? • Moderate? • Severe? • Very Severe? • Extreme?		IS:456 – 2000 Clause 8.2.2 IS:800 – 2007 Clause ______
(b)	*Is any special attention required to address the above environment exposure condition? If yes, please mention if that action was taken.*		
2.	***Seismic Zone***		
(a)	*Which Seismic Zone is the building located in?*	II / III / IV / V	IS: 1893 (Part 1) – 2002 Figure 1
(b)	*Is any special attention required to address the above seismic zone? If yes, please mention if that action was taken?*		
3.	***Cyclone Zone***		
(a)	*Which Cyclone Area is the building located in*	Design wind speed *(m/s)* 55 / 50 / 47 / 44 / 39	IS: 875 (Part 3) – 1987 Figure 1
(b)	*Is any special attention required to address the above cyclone zone? If yes, please mention if that action was taken?*		
4.	***Flood Zone***		
(a)	*Which Flood Area is the building located in?*		
(b)	*Is any special attention required to address the above flood zone? If yes, please mention if that action was taken?*		
5.	***Landslide Zone***		
(a)	*Which Landslide Zone is the building located in?*		
(b)	*Is any special attention required to address the above landslide zone? If yes, please mention if that action was taken?*		
6.	***Soil Condition***		
(a)	*What is the Ground terrain like? Is the* natural ground slope more than 20%?		

Signature:
Date:

(b)	What is the type of soil strata: • Hard? • Medium? • Soft?		IS:1893 (Part 1) – 2002 Clause 6.3.5.2
(c)	Is soil liquefiable?	Yes / No	IS:1893 (Part 1) – 2002 Table 4, Figure 7
(d)	If the soil is liquefiable, does the proposed design consider the same and eliminate the negative effects of liquefaction on the proposed structure? If yes, how? If not, why?		
(e)	Is soil slope vulnerable to landslides? If yes, was a detailed analysis done to assess the safety of the slope?		
(f)	What is the Design Safe Bearing Capacity (kN/m^2)?		IS:1904

C2.2 Technical Information – **Building Information**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Geometry			
7.	***Number of Storeys***		
(a)	What is the number of storeys above ground level in the building (including those to be added later, also including all stepped floors, if applicable)?		
(b)	What is the number of basements below ground level?		

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Design			
8.	***Structural System***		
(a)	What is the Structural System employed: • Regular frame, • Regular frame with shear wall, • Irregular frame, • Irregular frame with shear wall, • Shear wall building, • Soft storey building, or • Any other (please identify)?	1.0 / 1.5	
(b)	What is the foundation system: • Independent footing • Interconnected footing		

Signature:
Date:

	• Raft foundation • Pile foundation, or • Any other (please identify)?		
(c)	What is the depth of the foundation? Is this sufficient for the strata of soil at the site?		
(d)	If individual foundations are used, what is the system for interconnecting the foundation units: • Plinth beams, • Foundation beams, • Pile caps connected by tie beams, or • Not connected together?		
(e)	What is the horizontal floor system: • Beams and slabs • Waffles, • Ribbed floors, • Flat slab with drops, • Flat plate with drops, • Flat slab or plate without drops, • Any other (please identify)?		
9.	In buildings with basement, have the following been considered: • Uplift pressure considered, and • Lateral pressure considered? If NO, is the building safe?		
10.	What are the grades of concrete employed in the building? List all grades used.		
11.	What are the grades of steel reinforcement used in the building? List all grades used.		IS: 456 – 2000 Clause 5.6
12.	What are the load combinations employed in the analysis of the structure?		
13.	Is it ensured that all un-reinforced masonry infills (made of burnt clay brick, cement blocks or stone units in any mortar) are eliminated in the exterior bays of moment frames?		
14.	Is it ensured that torsional modes of vibrations of the building are either eliminated or their mode participation factor is small?		
15.	Has construction stage-wise structural analysis been performed with each storey added?		

Signature:
Date:

(a)	If YES, is a pre-camber required to be provided in the floor levels at the construction stage?		
16.	Have the effects of creep and shrinkage been estimated through formal calculations, and shown to be within acceptable limits?		
17.	***Wind Actions***		
(a)	In buildings taller than 45m, have wind tunnel tests and/or CFD studies been performed to show that there are no detrimental drag effects of wind on the building, either locally or globally?		
18.	***Seismic Actions***		
(a)	What is the Importance Factor used in estimating the design base shear?	1.0 / 1.5	IS: 1893 (Part 1) – 2002 Table 6
(b)	What is the Response reduction Factor used in estimating the design base shear?		IS: 1893 (Part 1) – 2002 Table 7
(d)	What is the natural period of the building for shaking in translation mode along the two horizontal plan directions?		
(e)	What is the Design Base Shear, as a fraction of the weight of the building, • Seismic Coefficient Method • Response Spectrum Method		IS: 1893 (Part 1) – 2002 Clause 7.5.3
(e)	If soft/flexible storeys exist in the building, were the columns in that storey specially designed for additional effects?		IS:1893 (Part 1) – 2002 Clause 7.10
(f)	Has analysis of the structure performed to include effects of torsion?		IS: 1893 (Part 1) Clause 7.9
19.	***Fire Safety***		
(a)	What is the fire-rating for which the structural system is intended to be designed? Have all flammable material accounted for in ensuring fire-safety?	_____ hours	IS: 456
(b)	Do the member sizes chosen meet the expected fire-rating?		IS: 456
20.	***Blast Actions***		
(a)	Is there a need to consider the effect of blast loading on the building?		
(b)	If YES, does the design of the structural system account for the expected blast load?		

Signature:
Date:

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Detailing			
21.	Is ductile detailing provided in the building?		IS:13920 – 2003 Clause 1.1.1
22.	What is the minimum dimension (in mm) of the beams used?		IS:13920 – 2003 Clause 6.1
23.	What is the **minimum** percentage of tensile reinforcement used in beams at any cross-section?		IS:13920 – 2003 Clause 6.2.1
24.	What is the **maximum** percentage of tensile reinforcement used in beams at any cross-section?		IS:13920 – 2003 Clause 6.2.2
25.	What is the spacing (in mm) of transverse reinforcement in 2d length of beams near ends?		IS:13920 – 2003 Clause 6.3.5
26.	What is the minimum ratio of capacity of beam in shear to its capacity in flexure at ends?		
27.	What is the minimum dimension (in mm) of columns?		IS:13920 – 2003 Clause 7.1.2, 7.1.3
28.	What is the minimum percentage of longitudinal reinforcement used in columns?		IS:456 – 2000 Clause 26.5.3
29.	What are the • Smallest diameter (in mm) • Largest spacing (in mm) of transverse reinforcement bars in columns near ends?		IS:13920 – 2003 Clause 7.4

Signature:
Date:

Name:...
Address: ....
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Tel. No.……… ………………………..…………………..

Reference IS Codes

1. IS:456 – 2000, *Indian Standard Code of Practice* Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
2. IS:800 – 2007, *Indian Standard Code of Practice* Structural Steel, Bureau of Indian Standards, New Delhi
3. IS:875 (Part 3) – 1987, *Indian Standard Code of Practice* Design Loads (Other than Earthquake) for Buildings and Structures – Wind Load, Bureau of Indian Standards, New Delhi
4. IS:1893 (Part 1) – 2002, *Indian Standard* Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi
5. IS:1904 – 1986, *Indian Standard Code of Practice* Design and Construction of Foundations in Soils: General Requirements, Bureau of Indian Standards, New Delhi.
6. IS:13920 – 2003, *Indian Standard Code of Practice* Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Force

FORM S1

Steel Buildings of Height Less than 15m

Forms to assist Structural Engineers undertaking Peer Review
on behalf of the Bank

S1.0 Basic Information

S.No.	*Item*	*Details to be filled by the Peer Reviewer*
S1.0.1	**Name of building**	
S1.0.2	**Location of Building**	
	Plot number	
	Town Planning Scheme (if any)	
	Address	
	City/Town/Block/Panchayat/Village	
	District	
	State	
S1.0.3	**Occupancy class of building**	
S1.0.4	**Name of Owner**	
	Address	
S1.0.5	**Name of Builder**	
	Address	
S1.0.6	**Name of Architect**	
	Registration No.	
	Address	
S1.0.7	**Name of Structural Engineer**	
	Registration No.	
	Address	

Signature:
Date:

<u>S1.1 Technical Information</u> - **Siting of the Building**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Hazard Zones Applicable			
1.	***Environment***		
(a)	*What is the environment exposure condition:* • Mild? • Moderate? • Severe? • Very Severe? • Extreme?		IS:456 – 2000 Clause 8.2.2 IS:800 – 2007 Clause ______
(b)	*Is any special attention required to address the above environment exposure condition? If yes, please mention if that action was taken.*		
2.	***Seismic Zone***		
(a)	*Which Seismic Zone is the building located in?*	II / III / IV / V	IS: 1893 (Part 1) – 2002 Figure 1
(b)	*Is any special attention required to address the above seismic zone? If yes, please mention if that action was taken?*		
3.	***Cyclone Zone***		
(a)	*Which Cyclone Area is the building located in*	Design wind speed *(m/s)* 55 / 50 / 47 / 44 / 39	IS: 875 (Part 3) – 1987 Figure 1
(b)	*Is any special attention required to address the above cyclone zone? If yes, please mention if that action was taken?*		
4.	***Flood Zone***		
(a)	*Which Flood Area is the building located in?*		
(b)	*Is any special attention required to address the above flood zone? If yes, please mention if that action was taken?*		
5.	***Landslide Zone***		
(a)	*Which Landslide Zone is the building located in?*		
(b)	*Is any special attention required to address the above landslide zone? If yes, please mention if that action was taken?*		
6.	***Soil Condition***		

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(a)	*What is the Ground terrain like? Is the* natural ground slope more than 20%?		
(b)	What is the type of soil strata: • Hard? • Medium? • Soft?		IS:1893 (Part 1) – 2002 Clause 6.3.5.2
(c)	Is soil liquefiable?	Yes / No	IS:1893 (Part 1) – 2002 Table 4, Figure 7
(d)	If the soil is liquefiable, does the proposed design consider the same and eliminate the negative effects of liquefaction on the proposed structure? If yes, how? If not, why?		
(e)	Is soil slope vulnerable to landslides? If yes, was a detailed analysis done to assess the safety of the slope?		
(f)	What is the Design Safe Bearing Capacity (kN/m^2)?		IS:1904

S1.2 Technical Information - **Building Information**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Geometry			
7.	***Number of Storeys***		
(a)	What is the number of storeys above ground level in the building (including those to be added later, also including all stepped floors, if applicable)?		
(b)	What is the number of basements below ground level?		

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Design			
8.	***Structural System***		
(a)	What is the Structural System employed: • Regular frame, • Regular frame with shear wall, • Irregular frame, • Irregular frame with shear wall, • Shear wall building, • Soft storey building, • Cold formed steel frame, • Braced frame for vertical loads,	1.0 / 1.5	

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	• Braced frame for horizontal loads, or • Any other (please identify)?		
(b)	What is the foundation system: • Independent footing • Interconnected footing • Raft foundation • Pile foundation, or • Any other (please identify)?		
(c)	What is the depth of the foundation? Is this sufficient for the strata of soil at the site?		
(d)	If individual foundations are used, what is the system for interconnecting the foundation units: • Plinth beams, • Foundation beams, • Pile caps connected by tie beams, or • Not connected together?		
(e)	What is the horizontal floor system: • Beams and slabs • Waffles, • Ribbed floors, • Flat slab with drops, • Flat plate with drops, • Flat slab or plate without drops, • Composite slab, • Boarded slab system, or • Any other (please identify)?		
(f)	What is the horizontal floor system: • Steel truss system, • Composite roof system, • Beams and slabs, • Waffles, • Ribbed floors, • Flat slab with drops, • Flat plate with drops, • Flat slab or plate without drops, • Composite slab, • Boarded slab system, or • Any other (please identify)?		
	What is the angle of pitch, in roofs that are pitched?		
9.	In buildings with basement, have the		

Signature:
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	following been considered: • Uplift pressure considered, and • Lateral pressure considered? If NO, is the building safe?		
10.	What are the grades of concrete employed in the building? List all grades used.		
11.	What are the grades of steel used in the building? List all grades used (including the grade of steel, as well general weldable/high-strength/Cold formed/Tubular)		IS: 456 – 2000 Clause 5.6
12.	What are the load combinations employed in the analysis of the structure?		
13.	What is the method of design employed: • Limit State Method, or • Working Stress Method?		IS: 800 Clause 3.1.2 IS: 801 Clause 5.2
14.	What was assumed in the structural analysis: • Rigid construction, • Semi-rigid construction, or • Simple construction?		IS: 800 Clause 4.2 IS: 801 Clause 7.1
15.	What is the method of analysis employed: • Elastic analysis o First-order analysis, o Second-order analysis, • Plastic analysis, or • Frame buckling analysis?		IS: 800 Clauses 4.4, 4.5, 4.6
16.	Are slenderness limits satisfied by all steel members?		IS: 800 Clause 3.8
17.	Are erection loads considered?		IS: 800 Clause 3.3
18.	Are temperature stresses considered?		IS: 800 Clause 3.4
19	Are deflection limits satisfied?		IS: 800 Table 6
20.	***Seismic Actions***		
(a)	What is the Importance Factor used in estimating the design base shear?	1.0 / 1.5	IS: 1893 (Part 1) – 2002 Table 6
(b)	What is the Response reduction Factor used in estimating the design base shear?		IS: 1893 (Part 1) – 2002 Table 7
(c)	What is the natural period of the building for shaking in translation mode along the two horizontal plan		

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	directions?		
(d)	What is the Design Base Shear, as a fraction of the weight of the building, • Seismic Coefficient Method • Response Spectrum Method		IS: 1893 (Part 1) – 2002 Clause 7.5.3
(e)	If soft/flexible storeys exist in the building, were the columns in that storey specially designed for additional effects?		IS:1893 (Part 1) – 2002 Clause 7.10
(f)	Has analysis of the structure performed to include effects of torsion?		IS: 1893 (Part 1) Clause 7.9

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Detailing			
21.	Is ductile detailing provided in the building?		IS:13920 – 2003 Clause 1.1.1
22.	What is the minimum dimension (in mm) of columns?		IS:13920 – 2003 Clause 7.1.2, 7.1.3
	What are the types of connections used: • Rivets, • CT Bolts, • SHFG Bolts, • Black Bolts, • Welding – Field Shop, or • Composite?		
23.	What is the corrosion protection method employed: • Controlling electrode potential, • Inhibitor, • Inorganic/metal coating, or • Organic/paint coating?		IS: 800 Clause 15.2.3
24.	What is the minimum fire resistance level provided for in the design?	_____ Hours	IS: 800 Clause 16
25.	What is the fire resistance method employed: • In-tumescent painting, • Spraying, • Quilting, • Fire-resistant boarding, or • Concrete encasing?		IS: 800 Clause 16 IS: 1641 IS: 1642 IS: 1643

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Reference IS Codes

1. IS:456 – 2000, *Indian Standard Code of Practice* Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
2. IS:800 – 2007, *Indian Standard Code of Practice* Structural Steel, Bureau of Indian Standards, New Delhi
3. IS:875 (Part 3) – 1987, *Indian Standard Code of Practice* Design Loads (Other than Earthquake) for Buildings and Structures – Wind Load, Bureau of Indian Standards, New Delhi
4. IS:1893 (Part 1) – 2002, *Indian Standard* Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi
5. IS:1904 – 1986, Indian Standard Code of Practice Design and Construction of Foundations in Soils: General Requirements, Bureau of Indian Standards, New Delhi.
6. IS:13920 – 2003, Indian Standard Code of Practice Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Force, Bureau of Indian Standards, New Delhi
7. IS: 801-1975/98, IS Code of Practice for use of Cold-Formed Light Gauge Steel Structural Members in General Building Construction, , Bureau of Indian Standards, New Delhi
8. IS: 813-1986, Scheme of symbols for welding, , Bureau of Indian Standards, New Delhi
9. IS: 1149-1982, High tensile steel rivet bars for structural purposes, , Bureau of Indian Standards, New Delhi
10. IS: 1363 (Part 1-Part 3)-2002, Hexagon Head Bolts, Screws and Nuts of Product Grade `C' - Part 1 : Hexagon Head Bolts (Size Range M 5 to M 64), Bureau of Indian Standards, New Delhi
11. IS: 1367 (Part 1-Part 14)-2002, Technical Supply Conditions for Threaded Steel Fasteners, , Bureau of Indian Standards, New Delhi
12. IS: 1641-1988, Code of practice for fire safety of buildings (general): General principles of fire grading and classification, Bureau of Indian Standards, New Delhi
13. IS: 1642-1989, Code of practice for fire safety of buildings (general): Details of construction, , Bureau of Indian Standards, New Delhi
14. IS: 1643-1988, Code of practice for fire safety of buildings (general): Exposure hazard, , Bureau of Indian Standards, New Delhi
15. IS: 1893 (Part 1)-2002, Criteria for Earthquake Resistant Design of Structures, , Bureau of Indian Standards, New Delhi
16. IS: 1904-1986, Indian Standard Code of Practice for Design and Construction of Foundations in Soils: General Requirements, Bureau of Indian Standards, New Delhi
17. IS: 1929-1982, Specification for Hot Forged Steel Rivets for Hot Closing (12 to 36 mm Diameter), Bureau of Indian Standards, New Delhi
18. IS: 2155-1982, Specification for Cold Forged Solid Steel Rivets for Hot Closing (6 to 16 mm Diameter) , Bureau of Indian Standards, New Delhi
19. IS: 3613-1974, Acceptance tests for wire flux combination for submerged arc welding, Bureau of Indian Standards, New Delhi
20. IS: 3757-1985, Specification for High Strength Structural Bolts, Bureau of Indian Standards, New Delhi
21. IS: 4000-1992, Code of practice for high strength bolts in steel structures, Bureau of Indian Standards, New Delhi
22. IS: 4326-1993, Earthquake resistant design and construction – Code of practice, Bureau of Indian Standards, New Delhi
23. IS: 6419-1996, Welding rods and bare electrodes for gas shielded arc welding of structural steel, Bureau of Indian Standards, New Delhi
24. IS: 6560-1996, Molybdenum and chromium-molybdenum low alloy steel welding rods and bare electrodes for gas shielded arc welding, Bureau of Indian Standards, New Delhi
25. IS: 6639-1972, Specification for Hexagon Bolts for Steel Structures, Bureau of Indian Standards, New Delhi
26. IS: 7280-1974, Bare wire electrodes for submerged arc welding of structural steels, Bureau of Indian Standards, New Delhi
27. IS: 9595-1996, Metal arc welding of carbon and carbon manganese steels – Recommendations, Bureau of Indian Standards, New Delhi
28. SP6(6)-1972, Handbook for structural engineers - Application of plastic theory in design of steel structures, Bureau of Indian Standards, New Delhi

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FORM S2

Steel Buildings of Height More than 15m

Forms to assist Structural Engineers undertaking Peer Review
on behalf of the Bank

S2.0 Basic Information

S.No.	*Item*	*Details to be filled by the Peer Reviewer*
S2.0.1	**Name of building**	
S2.0.2	**Location of Building**	
	Plot number	
	Town Planning Scheme (if any)	
	Address	
	City/Town/Block/Panchayat/Village	
	District	
	State	
S2.0.3	**Occupancy class of building**	
S2.0.4	**Name of Owner**	
	Address	
S2.0.5	**Name of Builder**	
	Address	
S2.0.6	**Name of Architect**	
	Registration No.	
	Address	
S2.0.7	**Name of Structural Engineer**	
	Registration No.	
	Address	

Signature:
Date:

S2.1 Technical Information - **Siting of the Building**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Hazard Zones Applicable			
1.	***Environment***		
(a)	*What is the environment exposure condition:* • Mild? • Moderate? • Severe? • Very Severe? • Extreme?		IS:456 – 2000 Clause 8.2.2 IS:800 – 2007 Clause ______
(b)	*Is any special attention required to address the above environment exposure condition? If yes, please mention if that action was taken.*		
2.	***Seismic Zone***		
(a)	*Which Seismic Zone is the building located in?*	II / III / IV / V	IS: 1893 (Part 1) – 2002 Figure 1
(b)	*Is any special attention required to address the above seismic zone? If yes, please mention if that action was taken?*		
3.	***Cyclone Zone***		
(a)	*Which Cyclone Area is the building located in*	Design wind speed *(m/s)* 55 / 50 / 47 / 44 / 39	IS: 875 (Part 3) – 1987 Figure 1
(b)	*Is any special attention required to address the above cyclone zone? If yes, please mention if that action was taken?*		
4.	***Flood Zone***		
(a)	*Which Flood Area is the building located in?*		
(b)	*Is any special attention required to address the above flood zone? If yes, please mention if that action was taken?*		
5.	***Landslide Zone***		
(a)	*Which Landslide Zone is the building located in?*		
(b)	*Is any special attention required to address the above landslide zone? If yes, please mention if that action was taken?*		
6.	***Soil Condition***		
(a)	*What is the Ground terrain like? Is the* natural ground slope more than 20%?		

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(b)	What is the type of soil strata: • Hard? • Medium? • Soft?		IS:1893 (Part 1) – 2002 Clause 6.3.5.2
(c)	Is soil liquefiable?	Yes / No	IS:1893 (Part 1) – 2002 Table 4, Figure 7
(d)	If the soil is liquefiable, does the proposed design consider the same and eliminate the negative effects of liquefaction on the proposed structure? If yes, how? If not, why?		
(e)	Is soil slope vulnerable to landslides? If yes, was a detailed analysis done to assess the safety of the slope?		
(f)	What is the Design Safe Bearing Capacity (kN/m^2)?		IS:1904

S2.2 Technical Information - **Building Information**

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Geometry			
7.	***Number of Storeys***		
(a)	What is the number of storeys above ground level in the building (including those to be added later, also including all stepped floors, if applicable)?		
(b)	What is the number of basements below ground level?		

S.No.	*Question*	*Response to the Question to be filled by the Peer Reviewer*	*Reference*
Design			
8.	***Structural System***		
(a)	What is the Structural System employed: • Regular frame, • Regular frame with shear wall, • Irregular frame, • Irregular frame with shear wall, • Shear wall building, • Soft storey building, • Cold formed steel frame, • Braced frame for vertical loads, • Braced frame for horizontal loads, or	1.0 / 1.5	

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	• Any other (please identify)?		
(b)	What is the foundation system: • Independent footing • Interconnected footing • Raft foundation • Pile foundation, or • Any other (please identify)?		
(c)	What is the depth of the foundation? Is this sufficient for the strata of soil at the site?		
(d)	If individual foundations are used, what is the system for interconnecting the foundation units: • Plinth beams, • Foundation beams, • Pile caps connected by tie beams, or • Not connected together?		
(e)	What is the horizontal floor system: • Beams and slabs • Waffles, • Ribbed floors, • Flat slab with drops, • Flat plate with drops, • Flat slab or plate without drops, • Composite slab, • Boarded slab system, or • Any other (please identify)?		
(f)	What is the horizontal floor system: • Steel truss system, • Composite roof system, • Beams and slabs, • Waffles, • Ribbed floors, • Flat slab with drops, • Flat plate with drops, • Flat slab or plate without drops, • Composite slab, • Boarded slab system, or • Any other (please identify)?		
	What is the angle of pitch, in roofs that are pitched?		
9.	In buildings with basement, have the following been considered: • Uplift pressure considered, and		

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	• Lateral pressure considered? If NO, is the building safe?		
10.	What are the grades of concrete employed in the building? List all grades used.		
11.	What are the grades of steel used in the building? List all grades used (including the grade of steel, as well general weldable/high-strength/Cold formed/Tubular)		IS: 456 – 2000 Clause 5.6
12.	What are the load combinations employed in the analysis of the structure?		
13.	What is the method of design employed: • Limit State Method, or • Working Stress Method?		IS: 800 Clause 3.1.2 IS: 801 Clause 5.2
14.	What was assumed in the structural analysis: • Rigid construction, • Semi-rigid construction, or • Simple construction?		IS: 800 Clause 4.2 IS: 801 Clause 7.1
15.	What is the method of analysis employed: • Elastic analysis o First-order analysis, o Second-order analysis, • Plastic analysis, or • Frame buckling analysis?		IS: 800 Clauses 4.4, 4.5, 4.6
16.	Are slenderness limits satisfied by all steel members?		IS: 800 Clause 3.8
17.	Are erection loads considered?		IS: 800 Clause 3.3
18.	Are temperature stresses considered?		IS: 800 Clause 3.4
19.	Are deflection limits satisfied?		IS: 800 Table 6
20.	Is it ensured that all un-reinforced masonry infills (made of burnt clay brick, cement blocks or stone units in any mortar) are eliminated in the exterior bays of moment frames?		
21.	Is it ensured that torsional modes of vibrations of the building are either eliminated or their mode participation factor is small?		
22.	Has construction stage-wise structural analysis been performed with each storey added?		

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(a)	If YES, is a pre-camber required to be provided in the floor levels at the construction stage?		
23.	Have the effects of creep and shrinkage been estimated through formal calculations, and shown to be within acceptable limits?		
24.	***Wind Actions***		
(a)	In buildings taller than 45m, have wind tunnel tests and/or CFD studies been performed to show that there are no detrimental drag effects of wind on the building, either locally or globally?		
25.	***Seismic Actions***		
(a)	What is the Importance Factor used in estimating the design base shear?	1.0 / 1.5	IS: 1893 (Part 1) – 2002 Table 6
(b)	What is the Response reduction Factor used in estimating the design base shear?		IS: 1893 (Part 1) – 2002 Table 7
(d)	What is the natural period of the building for shaking in translation mode along the two horizontal plan directions?		
(e)	What is the Design Base Shear, as a fraction of the weight of the building, • Seismic Coefficient Method • Response Spectrum Method		IS: 1893 (Part 1) – 2002 Clause 7.5.3
(e)	If soft/flexible storeys exist in the building, were the columns in that storey specially designed for additional effects?		IS:1893 (Part 1) – 2002 Clause 7.10
(f)	Has analysis of the structure performed to include effects of torsion?		IS: 1893 (Part 1) Clause 7.9
26.	***Fire Safety***		
(a)	What is the fire-rating for which the structural system is intended to be designed? Have all flammable material accounted for in ensuring fire-safety?	_____ hours	IS: 456
(b)	Do the member sizes chosen meet the expected fire-rating?		IS: 456
27.	***Blast Actions***		
(a)	Is there a need to consider the effect of blast loading on the building?		
(b)	If YES, does the design of the structural system account for the expected blast load?		

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S.No.	Question	Response to the Question to be filled by the Peer Reviewer	Reference
Detailing			
28.	Is ductile detailing provided in the building?		IS:13920 – 2003 Clause 1.1.1
29.	What is the minimum dimension (in mm) of columns?		IS:13920 – 2003 Clause 7.1.2, 7.1.3
	What are the types of connections used: • Rivets, • CT Bolts, • SHFG Bolts, • Black Bolts, • Welding – Field Shop, or • Composite?		
30.	What is the corrosion protection method employed: • Controlling electrode potential, • Inhibitor, • Inorganic/metal coating, or • Organic/paint coating?		IS: 800 Clause 15.2.3
31.	What is the minimum fire resistance level provided for in the design?	_____ Hours	IS: 800 Clause 16
32.	What is the fire resistance method employed: • In-tumescent painting, • Spraying, • Quilting, • Fire-resistant boarding, or • Concrete encasing?		IS: 800 Clause 16 IS: 1641 IS: 1642 IS: 1643

Signature:
Date:

Name:...
Address: ....
Tel. No.……… ………………………..………………….

Reference IS Codes

1. IS:456 – 2000, *Indian Standard Code of Practice* Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
2. IS:800 – 2007, *Indian Standard Code of Practice* Structural Steel, Bureau of Indian Standards, New Delhi
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20. IS: 3757-1985, Specification for High Strength Structural Bolts, Bureau of Indian Standards, New Delhi
21. IS: 4000-1992, Code of practice for high strength bolts in steel structures, Bureau of Indian Standards, New Delhi
22. IS: 4326-1993, Earthquake resistant design and construction – Code of practice, Bureau of Indian Standards, New Delhi
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25. IS: 6639-1972, Specification for Hexagon Bolts for Steel Structures, Bureau of Indian Standards, New Delhi
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28. SP6(6)-1972, Handbook for structural engineers - Application of plastic theory in design of steel structures, Bureau of Indian Standards, New Delhi

Members of the Core Group for Preparation of National Disaster Management Guidelines on Ensuring Disaster Resilient Construction of Buildings and Infrastructure financed through Banks and Other Lending Institutions

Chairperson of the Core Group: Prof. N. Vinod Chandra Menon,
Member, NDMA

Core Group Members:

i. Prof. A. S. Arya, Professor (Rtd.), IIT- Roorkee & Professor Emeritus

ii. Prof. Ravi Sinha, Professor. Structural Engineering Division,
Department of Civil Engineering IIT- Bombay, Powai, Mumbai

iii. Prof. CVR Murthy, Department of Civil Engineering, IIT- Madras, Chennai

iv. Architect Balbir Verma, New Delhi

v. Prof. Amit Bose, Professor (Rtd.), IIT- Roorkee

vi. Prof. D.K. Paul, IIT-Roorkee, Head, Centre of Excellence in Disaster Mitigation & Management &. Professor, Department of Earthquake Engineering, IIT Roorkee, Roorkee

vii. Prof. K. Ganesh Babu, Department of Ocean Engineering, IIT-Madras, Chennai

Special Invitees:

i. Mr. R.V. Verma, Executive Director, National Housing Bank, New Delhi

ii. Mr. K. Unnikrishnan, Deputy Chief Executive, Indian Bank Association, Mumbai

iii. Mr. Milind Kalkar, Deputy General Manager, State Bank of India, New Delhi

iv. Mr. J. S. Kathuria, OSD and In charge of Delhi Chapter, Indian Bank Association, New Delhi

Content Editing & Coordination: Mr. Sampurnananda Mahapatra, Senior Specialist, NDMA