13th World Conference on Earthquake Engineering
Vancouver, B.C., Canada
August 1-6, 2004
Paper No. 9002

MEXICO CITY'S CODE OF BUILDING REGULATIONS

Cesar BUENROSTRO[1]

SUMMARY

This paper describes the current building code regulations in Mexico City along with a historical background. The prominent concepts enshrined in the new code of regulations are also explained.

INTRODUCTION

One of the priorities of local government in Mexico City is the protection and security of the city in cases of emergency or any situations that represent a risk for the population, whether arising from natural phenomena or as a result of human activities.

Since its beginnings as a settlement, Mexico City has posed a number of challenges to its inhabitants, who have had to adapt the environment to the needs of their development. This great urban center founded in 1325 on an island in the middle of the ancient lakes of the Mexico Valley Basin has faced problems of differential land settlement and subsidence due to the characteristics of the lake bed over which it gradually extended, a clay soil with low resistance, high water content and tendency to deform. Likewise, the geographical characteristics of the region in which it is situated render it vulnerable to a number of risks in the form of natural phenomena like floods and earthquakes and its proximity to a number of volcanoes. The city is located in a region which itself falls within the Circum-Pacific Belt, where annually between 80 and 90 per cent of the world's seismic energy output takes place. The most important earth tremors in Mexico are caused by the subduction of the Cocos Plate beneath the American Plate. These frequent tectonic movements generally become amplified in Mexico City, precisely because of the characteristics of the subsoil, and thus generate major effects on buildings.

The earliest earthquake of which we have records took place in the year 1354, or "One-Flint" (uno pedernal) according to the pre-Hispanic notation. Two of the most powerful tremors of recent times were those of 1957 and 1985, which left painful and important lessons.

[1] Director of Public Works, Mexico city, Mexico

For their survival and development, the groups that peopled the city from its foundation onwards learned to live with their natural environment, evolving practices, techniques and systems, applying their ingenuity and creativity, and learning from their circumstances and experiences.

In the field of construction, evidence can still be found of the various foundation systems used in Aztec buildings, including the timber piles (a solution adopted in order to increase the supporting capacity of the soil) used to found their temples and other constructions. The engineering of the chinampas or "floating gardens" is another demonstration of their constructional genius for extending the city by winning more land from the surrounding lake. Methods were devised for containing or diverting the waters, including construction of dikes that also served as bases for roads and pathways. Techniques were also developed for exploiting different types of stone, and other materials.

The legacy of knowledge handed down from generation to generation has served as a basis for research into present methods of construction, creating engineering specialties recognized at international level in soil mechanics, rock mechanics, seismic, structural, hydraulic, soil and geological engineering, among others. Such disciplines have, in the continuity of transmission of knowledge, given rise to research institutions and scientific societies, through which —with the instrumentation and systematic studies developed over decades— it has been possible to evolve means for dealing with the phenomena to which Mexico City and its Metropolitan Area are exposed.

HISTORICAL BACKGROUND OF THE MEXICO CITY CODE OF REGULATIONS ON CONSTRUCTION

An instrument of the greatest importance in the field of civil protection and prevention of disasters in the capital is the Mexico City Code of Building Regulations (Reglamento de Construcciones para el Distrito Federal), which regulates the execution of all public and private building works and other facilities in the national capital. The development of construction in the city has kept pace with technological advances which must themselves be subject to the establishment of rules and standards.

The first Code of Regulations was issued in 1920. Since that date developing knowledge, research, technological advance, and the experience accumulated throughout all these decades has greatly enriched the procedures and provisions contained in the document, thus helping attain a greater degree of security for the city's human and material capital. The code has been updated on average once every ten years, many substantial changes having been consequences of the powerful tremors the capital has suffered. That of July 28, 1957, of magnitude 7.5° [with epicenter] at San Marcos, Guerrero —which occasioned considerable damage to buildings situated in the soft ground zone of Mexico City— led to additions being decreed to the Code of Regulations, affecting the so-called Emergency Rules, increasing seismic coefficients in accordance with the different types of soil on which buildings are erected. Later, in the 1966 Code, the General Directorate of Public Works began to be mentioned in the Regulations. In 1977, the fourth version of the Mexico City Code of Buildings Regulations was published, along with the Supplementary Technical Code of Standards for design and construction in concrete, stone, steel and timber —including methods of analysis for wind loading— retaining within the main body of the Code the criteria for seismic design. With this edition of the Code the figure of Director in Charge of Building Works came into being.

The contents of the 1977 Code, containing important advances on previous codes, led to its being recognized as a vanguard document at world level; it thus influenced the corresponding codes for New Zealand, Canada, the United States, El Salvador, Nicaragua and Venezuela. Even so, the fast rate of

technological change and the new research taking place in Mexico and the rest of the world meant that a new revision became necessary soon after publication of this one, the revised code appearing in late 1984.

Throughout the twentieth century and up to the present day, Mexico City has suffered 23 tremors of an intensity exceeding 7 degrees on the Richter scale; none of these, however, was so devastating as that which took place on September 19, 1985, with a magnitude of 8.1°, with its epicenter on the coast of Michoacán in what is known as the Michoacán Gap, typical of a subduction movement. The magnitude of the earthquake, together with the anarchy that had prevailed the construction of many buildings, caused enormous damage and loss of life in Mexico City. The greatest destruction occurred in zones accounting for 23 of the 650 square kilometers that make up the Capital, with damage to 12,700 constructions, of which 2,286 suffered partial or total collapse; 4,445 were left out of plumb or suffered fractures to structural elements. One month after the telluric movements of September, 1985, the Emergency Code of Standards was published, in advance of the date originally planned. The most important innovations were changes relating to the Structural Safety of Constructions.

In 1987 the fifth version of the Code of Regulations appeared, in which all the technical and administrative modifications prompted by the experience of the 1985 earthquake were included. As a specialized support to the Director in Charge of Building Works (responsible for overseeing and ensuring compliance with the Code of Regulations), the posts of Assistant Directors for Structural Safety, Urban and Architectural Design, and Civil Engineering Installations were created. The classification of structures according to use was modified to form two main groups: Group A and Group B. Group A buildings were defined as those in which a structural defect could cause a considerable loss of lives or exceptionally high economic or cultural losses, or where significant damage as a result of the release of toxic or explosive substances might take place, as well as buildings whose functioning would be essential in any situation of urban emergency, such as hospitals, schools, churches, auditoriums, gas stations, telephone exchanges, public archives or registries, museums, etc.

Six years later, on August 2, 1993, the following Mexico City Code of Building Regulations appeared, including modifications of a technical, legal and administrative nature.

NEW CODE OF BUILDING REGULATIONS FOR MEXICO CITY

In view of the developments taking place in construction, the creation of new materials and systems of construction, as well as advanced criteria of structural design, the Mexico City Administration, through its Committee for Studying and Proposing Reforms on the Code of Building Regulations, took the initiative of modifying and updating the Code.

Ten years after the coming into force of the 1993 Code, the Mexico City Administration drew up a new Code, incorporating important innovations and numerous scientific and technical advances in the fields of seismic instrumentation, seismology and shock-wave propagation, studies of subsoil and foundations, as well as in methods of analyzing response of structures to the action of seismic forces. The new Mexico City Code of Building Regulations and its Supplementary Code of Technical Standards are the product of collaboration between the different departments of the Mexico City Administration with responsibilities in this area and a variety of professional and academic institutions. The Administration’s Advisory Committee on Structural Safety, on which prominent experts sit from the spheres of Mexican academic and professional practice, played an important role in the drawing up of the new Code of Regulations.

Likewise, the participation of the Departments making up the Inter-Departmental Committee on Civil Protection was notable, in particular that of the Urban Development and Housing Secretariat, with the valuable support of the Legal Counseling Services Division (Consejería Jurídica y de Servicios Legales). The representatives of seven Professional Colleges, two Trade Boards connected with the building industry, as well as two other departments of the Mexico City Administration.

The recommendations and observations of ten Technical Associations in the engineering field registered in Mexico City and with relevance to the contents of the Code of Regulations were taken into consideration. Likewise, the opinions of the capital's sixteen local district administrations (Delegaciones) were incorporated.

Among the most prominent concepts enshrined in the new Code of Regulations are the following:

Building Statement

The Building Statement was created, which is a declaration under oath, by the owner or possessor of the plot of land or building subject to works and, when applicable, by the Director in Charge of the Works and Jointly Responsible Persons (Director Responsable de Obra y de los Corresponsables), in which all involved agree to be bound to comply with the terms laid down in the Law and other applicable provisions, before constructing, extending, repairing or modifying a building. The following modalities are provided for:

Building Statement type A, which applies to single family dwellings, whose built area and height do not exceed 200m2 or 5.5m respectively, and with openings of less than 4m constructed on sites having a minimum frontage of 6m. This legal instrument brings about a significant simplification, drastically reducing official procedures and avoiding corruption to the benefit of the population of Mexico City.

Building Statement type B, for those buildings intended to provide up to 10,000 m2 for dwelling use, or up to 5,000 m2 for works with non-dwelling or mixed use.

Building Statement type C, for buildings that require a judgment on urban impact and urban environmental impact or a land use license, as well as those intended to provide in excess of 10,000m2 for dwelling use, or more than 5,000m2 with non-dwelling or mixed use.

For the remaining types of works not contemplated in the Building Statement, the Code of Regulations provides for the Special Construction License with characteristics particularly indicated.

Directors in Charge of Works and Persons Jointly Responsible, Accessories in Administration

The legal obligations of the Directors in Charge of Works and Persons Jointly Responsible —through their explicit identification as accessory participants in administration— are increased, thus achieving the most strict compliance and supervision for the correct application of the Mexico City Code of Building Regulations. In line with the obligations and liabilities of the Directors in Charge of Works and Persons Jointly Responsible, stiffer sanctions —both administrative-law and pecuniary penalties— are imposed for infringement of the provisions established by the above-mentioned Code.

Architectural requirements for the free transit of persons with disabilities

The minimum requirements regarding accessibility and movement for persons with disabilities, in private and public spaces, are included, with detail sketches for each of the circulation needs and elements of communication, both inside buildings and on public rights of way.

Risk of fire in buildings

With the aim of significantly reducing accidents due to fire, the Code sets forth the minimum necessary requirements which buildings are to meet, classifying them on the basis of degree of fire risk according to dimensions, use and occupation.

Design and construction of urban bridges and hydraulic works

In view of the growth requirements of the capital's infrastructure, and in response to instructions from the Mexico City Administration, research and studies were carried out in the Research Centers in order to determine the techniques of design and construction for urban bridges and hydraulic works.

Criteria and actions for the structural design of buildings

It was contemplated that this Code of Regulations would deal with concepts of a general nature, while details of a technical nature were excluded, for their incorporation in separate codes. This was in order to facilitate the management of tables and numerical data, and to allow for their updating as frequently as made necessary by technical advances and research developments.

New soil classifications for Zone III (Lake Zone)

From the studies of soil mechanics and technology carried out from 1985 onward, it was determined that the environment of the Lake Zone has particular and varying characteristics, due mainly to the variations in the depths of clay strata and in the dominant periods of the soil, giving rise to important amplifications of the seismic waves, that cause buildings to shake far more violently than is the case in the rest of the city. The new Code thus divides this zone into four sub-zones, incorporating seismic coefficients for each of them.

Irregular structures

The necessary means have been taken to consider the significant differences in the geometry of structures, in terms both of elevation and plan, and the brusque alterations in the rigidity of structures from one story to another. To sum up, irregular structures are designed with more rigorous procedures and superior reinforcement requirements are laid down in order to avoid failure.

Advertisement hoardings and cellular telephone antennas

For the analysis, design and installation of self-supported and roof-top advertisement hoardings, as well as repeater stations for cellular and/or wireless communication, it will be necessary to have the document admitting responsibility (responsiva) signed by a Person Jointly Responsible in Structural Safety, in order to obtain greater safety in these structures.

Durability and high resistance in concretes

The development of the building industry has called for concretes of high strength and resistance and greater durability, since this implies savings in dimensions of structural elements, as well as resistance to environmental effects and reduced maintenance needs. The new Code of Regulations, therefore, includes the design of buildings for durability; additionally, it contemplates the use of high resistance concretes.

Structures with energy dissipaters

The limitation of space for building in Mexico City has called for structures of ever greater height; it has thus been necessary to develop devices that enable the safety of such constructions to be guaranteed in the case of movements occasioned by earth tremors. Energy dissipaters are devices forming part of the structure, which on deforming absorb much of the energy produced by the seismic effects, reducing the possible damage to buildings.

Post-tensed or prestressed elements

To satisfy needs for space in buildings, construction procedures such as the use of post-tensed slabs with non-adhered tendons or prefabricated structural elements (whether or not prestressed), have been successfully applied. This has permitted a significant increase in the size of bays in structures and a shortening of construction schedules of building works.

Reinforcement specifications in stone or rubblework structures

The proliferation of stone components of different geometrical forms, as well as panels constructed out of wire mesh with a mortar covering, has led to the development of studies and research including tests on scale models, thus obtaining new criteria for fixings in these elements to guarantee an adequate response to vertical and horizontal loading.

Mixed steel and concrete structure

Analysis and design criteria for compound structural elements, formed with steel profiles that work in conjunction with reinforced concrete elements, or with concrete claddings or fillings —such as columns, beams, trusses, and slabs— are being enriched.

SUMMARY AND CONCLUSIONS

This new Code of Regulations, which is being presented to the public today by the Head of the Administration of Mexico City, represents the culmination of a process of several years of participation of leading specialists in the area, which took place in a democratic spirit of interdisciplinary, inter-departmental and inter-sectoral collaboration. This is a new Code of Regulations in the strict sense, rather than an updating of the Code in force since 1993, both in its contents and its organization. It contains state-of-the-art concepts for the design and execution of building works. Its articles include generic concepts of regulation, specific aspects and numerical expressions being relocated in the Supplementary Technical Standards; a more operative instrument is thus obtained, easier to consult, and facilitating easier updating, in response to ongoing technological advance.

In this new Code of Regulations, design criteria for buildings in Mexico City have been improved by taking into consideration seismic coefficients in accordance with the different types of soil to be found in Mexico City, which, for the future, will help to reduce the vulnerability of structures to seismic effects.
Important technological advances have been incorporated in this Code, among them design for durability, greater detail in the reinforcement of rubble structures for a considerable increase in their rigidity.
At the same time, considerable care was taken to achieve a simplification in terms of administration. The Construction Statement represents a revolution in this respect, significantly simplifying the official procedures for commencing building works in Mexico City, establishing greater confidence among members of the public by providing the information for correctly effecting the said procedures, and regarding the exact amounts of the payments required.

Indisputably, all the contributions made by the different sectors to the Mexico City Code of Building Regulations since its first edition have enabled this city continually to reduce its vulnerability to seismic phenomena and the varying response of the soils on which it is founded.

The application and observance of this new Code will make it possible to endow constructions with a greater degree of safety, thereby providing guarantees to the population. A factor of fundamental importance for the protection of the life of the city will be compliance with these regulations, a commitment in which the participation of all is of primordial importance.