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Development of Spanish Language Construction Manual for Wood Frame Housing in Mexico

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Abstract

Although wood has the potential for meeting some of Mexico's needs for housing, many factors limit its use. One significant factor is the lack of training on proper wood frame construction. To provide a basic reference, a wood frame construction manual was prepared specifically for Mexican conditions. Chapters were authored by wood construction experts in Mexico. Since its completion in 1994, the manual has formed the basis for a series of seminars conducted across the country. The original supply of manuals will soon be exhausted and the manual will need to be reprinted.

Keywords: Construction, Spanish, Mexico, Manual

Introduction

Mexico has a great need for new and better housing. In 1991, the housing deficit was reported at 6 million units and was projected to reach 6.6 million units by the year 2000. In addition to new units, these figures include houses in need of repair and basic services such as running water and sewers. This figure was recently revised by the current Mexican administration to 4.6 million units. Either figure indicates a great housing deficit.

The construction needed to meet this need is not possible using traditional brick and reinforced concrete systems, which are slow and expensive. Houses have been built with wood in the United States and Canada for many years. However, the volume of wood used in permanent structures in Mexico represents under 1% of the total amount of housing construction (Elorza, 1991).

Several factors, many unique to Mexico, limit the use of wood as a construction material. In addition to a tradition of not using wood, the most important factors are as follows:

- Little interest on the part of engineers and architects in construction systems based on wood products
- Lack of information about the cost of insurance premiums
- Lack of knowledge of strength properties of lumber by building industry professionals
- Absence of knowledge about standards and codes for wood construction by designers, both architects and structural engineers
- Misinformation about fire resistance
- Uncertainty about the durability of wood
- Little diffusion of existing construction technology
- Little dissemination of data on costs of wood-based products for building construction and supply sources
- Shortage of facilities for treating lumber
- Voluntary rather than compulsory product standards, except in special cases (although building code regulations are strict and enforced)
- No established certification agencies (e.g., to verify grading of lumber)

Many of these factors reflect the lack of technical training of architects and engineers in the use of wood for housing and other types of construction. Others are the result of an inadequate infrastructure for wood

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components. The last two factors address product standards, which provide builders and owners with assurance that the wood materials meet certain minimum standards. For wood construction to have a role in meeting the housing needs in Mexico, it will be necessary to overcome these barriers to the use of wood.

Background

History of Wood for Housing in Mexico

When the first European settlers arrived in Mexico from Spain, they followed their tradition of using masonry and stone as the main types of construction material. Furthermore, they encountered a native culture that built monumental temples and pyramids from stone. Even though Mexico possessed an abundant supply of forest resources, the use of wood was restricted to modest housing for the lower classes.

In colonial times, the use of masonry was preponderant; it was used for walls, domes, and cupolas. Large wooden members were used to support diverse flooring and roofing materials. Systems like the "catalan" method were used for roofs and floors. This system consisted of large wooden beams supporting two to three layers of bricks joined with gypsum mortar. Another popular system, called terrado (earthen roof), consisted of lumber beams holding up wooden planks that supported a layer of earth (clay), the latter protected by a layer of bricks. Both the catalan and terrado systems are relatively heavy construction.

In some regions of the country, houses were built with logs, with roofs made from shingles. Even before the Europeans arrived, "troje" houses were built in the state of Michoacan, which consisted of all-wooden houses made with round timbers.

Thus, although there had been some historical tradition of using some native timber for housing, the European and native influences of using stone and mortar for buildings prevailed in Mexico.

Organization of Study Group

In the early 1980s, it was recognized that although very little wood was used in house construction in Mexico, there was promise that wood frame houses could help meet the housing shortage. This recognition marked the initiation of several major public housing efforts using wood construction. In 1981, a group of 200 houses was built in Acapulco, Guerrero (on the Pacific Coast). Each unit was about 70 m^2. Several authors of this report visited that project in 1991 and found design and maintenance problems, mainly with the roof systems. Another project in the same area consisted of 150 units built in 1988 as a result of a program promoted by the National Council for Wood Construction (COMACO) and sponsored by the Federal Housing authorities (FONHAPO). These units, each with an area of 42 m_2, were targeted for low income people.

Another group of 350 units was built in the southeast of Mexico (Chiapas) using a mixed type of construction (masonry walls and wooden roofs). Five-hundred units built in the western State of Michoacan and 500 units in the north of the country all utilized wood in parts of the structures.

The opportunity for using wood to meet the housing needs of Mexico was brought to the attention of the North American Forestry Commission (NAFC), a unit of the United Nations consisting of forestry officials from Canada, United States, and Mexico. This led to the formation of a Study Group on Light Frame Construction in the early 1980s. John Erickson and Billy Bohannan, both of whom have retired from the USDA Forest Service, Ramon Enchenique–Manrique, formerly of the Xalapa Laboratory in Mexico, and Vishwa Mathur of the Canadian Forest Service played significant roles in the formation of this group. Mr. Bohannan served as the chairperson until his retirement in 1986.

The Study Group organized a housing display at the World Forestry Congress held in Mexico City in 1985. A prototype wood frame house was built as a demonstration project, The prototype was based on a "truss flame system" developed at the Forest Products Laboratory of the USDA Forest Service in Madison, Wisconsin (Elorza et al., 1986).

The Study Group also cooperated with COMACO in a study of the acceptance of wood housing. Results showed that the general population accepted wood as a structural material in the interior of houses, but not in exterior walls (Elorza, 1989). Results of the same survey conducted with builders showed that the majority did not accept the use of wood for permanent structures; only 11.4% of builders were interested in using wood as a construction material (Elorza, 1991).

These findings clearly showed that extensive work would be needed for acceptance of wood frame housing by both builders and the general population. High priority was placed on a project to prepare information for widespread distribution.

Production of the Construction Manual

For many years, the United States and Canada have published manuals for wood frame house construction, which have been useful guides for Mexican builders (Sherwood and Stroh, 1989; Canadian Wood-Frame Construction, 1988). Initial discussion within the Study Group focused on translating these manuals into Spanish. However, discussion with practitioners pointed out that extensive changes would be needed to adapt to Mexican conditions because of different standards, codes, and regulations that have evolved as a result of different weather conditions. Also, raw materials and components were quite different in Mexico. This led to the Study Group's recommendation that anew manual be prepared using United States and Canadian manuals as guides but relying on a group of experts to prepare the appropriate content.

The Study Group recognized that the preparation of a Spanish language construction manual would be a large task and proposed this project at the XV Session of NAFC in February 1990. Officials of the three North American countries agreed to cooperate in the effort. Mexico's contribution would be to provide the technical experts; the United States and Canada would provide the financial resources necessary to prepare a camera–ready copy and to print about 1,000 copies.

Preparation of the Manual

When the proposal to produce a manual was approved, the members of the Study Group included Russell C. Moody from the Forest Products Laboratory, USDA Forest Service, as leader, Vishwa N.P. Mathur from the Canadian Forest Service, and Manuel Elorza, an architect and General Manager of COMACO. Mr. Elorza was chosen as editor and main author with the other two members forming a steering committee.

The manual was designed to be a working tool for technicians, professionals, and building construction supervisors. It was intended as a first step in overcoming much of the lack of information on building with wood in Mexico. An outline of the nine chapters was prepared and experts were invited to be authors (Table 1). The primary topics of each chapter and the appendices follow. Note that each chapter includes bibliographical references for those interested in further study.

1. Structure of wood-Brief description of wood, from the functions that it performs as part of the tree to different types of wood cells; wood components as observed on a cross section of a mature tree.

Table 1. Content and authors of the *Wood Frame Construction Manual*[a]

Chapter	Title	Author
—	Introduction	Manuel Elorza Wershoffen
1	The structure of wood	Mario Ricalde–Camacho
2	Physical and mechanical properties	Guadalupe Barcenas–Pazos
3	Wood as a construction material	Victor R. Ordonez–Candelaria
4	Drying and protection of wood	Victor Perez–Morales Iracema Castillo–Morales Ricardo Reyes–Chilpa
5	Design recommendations	Manuel Elorza Wershoffen
6	Construction aspects	Mario Ricalde–Camacho Manuel Elorza Wershoffen Federico Hatch–Gomez–Llanos
7	Maintenance recommendations	Salvador Bocanegra–Ojeda David Raya Gonzalez
8	Design aids	Raymundo Davalos–Sotelo
9	Costs and yields	Manuel Elorza Wershoffen
—	Appendices	Manuel Elorza Wershoffen

[a] *Manual de Construcción de Estructuras Ligeras de Madera.*

2. Physical and mechanical properties-Physical and mechanical properties of wood as they relate to use as a construction material; wood and water relationships; comparative properties of softwoods and hardwoods from Mexico, United States, and Canada.

3. Wood as a construction material–Different forms in which wood-based construction products are manufactured, with particular emphasis on characteristics of sawn lumber, the most common type of wood structural material available in Mexico; defects and wood characteristics, both natural and those induced through processing; characteristics of wood and grading methods for softwoods from United States and Canada properties of plywood and other structural panel products from United States, Canada, and Mexico.

4. Drying and protection of wood-Advantages of drying wood, appropriate levels of moisture for different structural end-uses; main drying methods (air drying, solar drying, kiln drying); concept of natural durability, different decaying agents, indexes of resistance to termite attack; natural durability and permeability of Mexican woods; risk zones for fungal attack and attack by dry-wood and subterranean termites in Mexico; main characteristics of oil-based and water-based wood preservatives and treatment methods.

5. Design recommendations—Characteristics of terrain in regard to effect on light-frame construction; recommendations for minimizing fire risk, such as location of house within the lot, minimum distances between groups of houses, and characteristics of fire walls; wind effects and recommendations for walls, floors, roofs, and anchoring systems; pertinent codes and regulations; earthquake design, classification of buildings according to intended use and structural type, seismic zones recognized by building authorities, earthquake design recommendations for foundations, walls and roofs; design for thermal and acoustical insulation of buildings; design to minimize potential moisture problems and importance of ventilation in buildings.

6. Construction aspects–Preliminary work (cleaning, excavation, etc.); foundations appropriate for wood construction; floor systems; wall framing, including bracing details and types of comer-wall joints; roof framing, including flat and pitched roofs (single-slope, double-slope, and four-slope roofs plus variants); strength of joints and fasteners, main types of connectors (e.g., nails, screws, lag-screws, bolts, toothed and perforated plates, specialty hangers), and dimensions and spacing of connectors; nailing patterns and spacings for various applications; doors, windows, stairs, ceiling openings, fireplaces and chimneys, eaves troughs and downspouts; recommendations for plumbing, electrical wiring, and gas installations; framing details (e.g., notching, cutting, drilling of joists and studs); specifications for electrical wiring and materials and piping for gas.

7. Maintenance recommendations–maintenance of roofs, walls and floors; methods of correcting problems with noise and excessive beam deformations; examples of patching and replacing gypsum wallboard; method for refinishing floors; basic gas and electrical installation; electrical maintenance.

8. Design aids–Fundamental principles of structural design based on limited states design (LSD) criteria; span tables for floor joists, roof and ceiling joists, and pitched roof trusses; design values for different species of lumber; information for major United States and Canadian species, with recommendations for LSD corrections; design aids for lumber (e.g., bending members under distributed and concentrated loads, trusses for pitched roofs and stud walls); design values and span tables for plywood and other structural sheathing.

9. Costs and yields–Information on three sizes of prototypes built with different systems: a 45 m^2 unit for low income families, 63 m^2 unit for middle income families, and 194 m^2 unit for upper income families; analysis of prices of different materials and components, including masonry works, structural components, sheathing, and kitchen and bathroom fixtures; estimated installation costs and productivity of skilled workers for wood construction.

Appendices–Guide for preparation of blueprints, glossary, and list of suppliers of construction materials and components.

Completion of Manual

Once preparation of the manual was underway, a technical review committee was formed to review the final product. The committee included Raymundo Davalos–Sotelo, Horatio Alvarez–Vargas, Carlos Diaz–Acosta, Manuel Elorza Wershoffen, Frederico Hatch–Gomez–Llanos, and Jenny Tardan–Waltz. The

committee reviewed the chapters and provided recommendations to the authors.

At the biannual meeting of NAFC in September 1994, the completion of the manual was announced by the official delegates of the three countries. The manual was entitled *Manual de Construcción de Estructuras Ligeras de Madera.* The following organizations are recognized as providing significant contributions:

Consejo Nacional de la Madera en la Construcción, A.C.

Instituto National de Investigaciones Forestalls y Agropecuarias

Subsecretaría Forestal y de la Fauna Silvestre

Secretaría de Agricultura y Recursos Hidraulicos

Instituto de Ecologia, A.C.

Natural Resources Canada, Canadian Forest Service

United States Department of Agriculture, Forest Service

The manual has been distributed in Mexico through COMACO. By mid-1996, 650 copies had been delivered to the Mexican Forestry Service authorities, architect and engineer professional associations, universities, public libraries, housing authorities, research institutions, component manufacturers, individual engineers, architects and building contractors, supervisors, researchers, and students.

Use of the Manual

COMACO has undertaken an ambitious training and technology transfer program in several parts of Mexico. Seminars conducted from 1994 to mid-1996 are listed in Table 2. In addition to specific seminars aimed at introducing wood frame construction and the manual, a program has been established to provide more detailed technical training to engineers, architects, and building contractors and supervisors, as well as clinics about maintenance for owners of wood frame buildings. Coordinated by COMACO, this ongoing program provides basic courses in the following subjects in (a) stress grading of lumber, (b) drying and preservative treatment, (c) construction systems, (d) application and installation of materials and components, (e) design recommendations, and (f) structural design.

It is expected that the original supply of 800 copies of the manual provided to COMACO will be depleted by the end of 1996. However, it is estimated that the potential market will require at least 1,000 additional manuals. Thus, reprinting is being considered.

References

Canadian Wood-Frame Construction. 1988. ISBEN 0-660-12647-8. Ottawa, Ontario, Canada: Mortgage and Housing Corporation.

Elorza Wershoffen, M.; Orozco, R.; and Ricalde–Camacho, M. 1986. Housing with wood-based components. An alternative. Mexico City, Mexico: COMACO (in Spanish).

Elena Wershoffen, M. 1989. COMACO survey of acceptance of wooden house construction in Mexico. Mexico City, Mexico: COMACO (in Spanish).

Elorza Wershoffen, M. 1991. COMACO survey of wooden house construction. Mexico City, Mexico COMACO (in Spanish).

Sherwood, G.; Stroh, R. 1989. Wood-frame house construction. Agric. Handb. 73. Washington, DC: United States Department of Agriculture.

Table 2. Training and technology transfer conducted by COMACO[a]

Institution	Location	Dates
Chamber of Industries	Mexico City	Nov. 28–30, 1994
Institute of Ecology	Xalapa, Ver.	Mar. 30–31, 1995
National University	Mexico City	June 5–9, 1995
Wood Technology College	Morelia, Michiocan	June 29–30, 1995
Chamber of Building Construction	Toluca, Mexico	Oct. 5–6, 1995
Forestry Technology	Durango, Dgo.	Oct. 25–26, 1995
National University	Mexico City	Nov. 27– Dec. 1, 1995
State University of Mexico	Toluca, Mexico	Apr. 11–12, 1996
National University	Mexico City	July 8–12, 1996

[a]A seminar is planned for late 1996 in Oaxaca, Oax.