The Interrelationship between building codes, construction practices and lumber grade-use

by

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**Table of contents**

THE INTERRELATIONSHIP BETWEEN BUILDING CODES, CONSTRUCTION PRACTICES AND LUMBER GRADE-USE

| Introduction | ................................. | 1 |
| Building Codes | .................................... | 2 |
| 1. History of building codes | ................................. | 2 |
| 2. How lumber is affected by building codes | ................................. | 3 |
| 3. The effect of building code regulations on wood construction | ................................. | 4 |
| 4. The need for uniform building codes | ................................. | 6 |
| 5. Organizations sponsoring better building codes throughout the United States | ................................. | 6 |
| a. The National Lumber Manufacturers Association | ................................. | 7 |
| b. The New England Building Officials Conference | ................................. | 8 |
| c. The Chicago Suburban Building Officials Conference | ................................. | 8 |
| d. The Southern Building Codes Congress | ................................. | 8 |
| e. The American Standards Association | ................................. | 9 |
| f. The Township Building Code Advisory Committee of the Michigan State Planning Commission | ................................. | 9 |
| g. The United States Department of Commerce | ................................. | 9 |
| 6. The Uniform Building code of the Pacific Coast Building Officials Conference | ................................. | 10 |
| Jurisdictions under the uniform building code | ................................. | 11 |
| 7. Differences in codes and grading rules on the Pacific coast | ................................. | 12 |
| 8. Permanency of building codes | ................................. | 14 |
| The relationship of building codes and correct frame construction to each other and to the lumber industry as a whole | ................................. | 16 |
Abuses of wood in house construction

1. The foundation
2. Untreated wood in contact with earth or concrete floors
3. Skimpy nailing
4. Lack of frame rigidity
5. Improper planning for future plumbing and electrical work
6. Improperly seasoned wood

Summary

Bibliography

Tables:
1. Trend of uniform building code adoptions from 1919 to date
2. Differences in working stresses now in use on the Pacific coast
3. Per Capita consumption of lumber (softwoods)
INTRODUCTION

In order to obtain the optimum use of lumber in the construction trades, two important subjects, building codes and correct construction principles, must be thoroughly understood. They must be interwoven correctly if lumber is to attain its best use.

In most American communities, the kind and quantity of building materials and how they may be used in construction are regulated by a building code or by building ordinances. Thus, the importance of building codes and ordinances to the lumber industry is apparent. All construction materials are regulated by building codes. Wood products, such as shingles and plywood may be prohibited in some codes.

Since building codes vary with locality, this paper will cover building codes in general. It will discuss the basic principles underlying building code construction, organizations acting to improve existing building codes, and a few of the outstanding difficulties presented by building codes on the Pacific coast today.

Lumber cannot be used in the construction trades
to its best advantage unless proper construction practices are observed. This paper will also discuss a few of the most prevalent abuses of lumber in construction practices.

BUILDING CODES

History of building codes

The first building laws on record were concerned primarily with the prevention of collapse. In 2100 B.C., Hammurabu, king of Babylon, enforced the following law: "In the case of collapse of a defective building, the architect is to be put to death if the owner is killed by the accident, and the architect's son if the son of the owner loses his life."

During the reign of Julius and Augustus Caesar, Rome was subjected to considerable speculative building of apartment houses. These houses were often built to great heights, and structural failures were frequent. Laws were passed which limited the building heights to seventy feet, and later to sixty feet.

The next step of building code development was concerned with the prevention of fire, and with the restriction of fire spread. The city of London, in
the fourteenth century, passed an ordinance requiring that chimneys be built of stone, tile or plaster, and prohibited the use of timber for this purpose. New York and Boston passed similar laws early in their respective histories.

How lumber is affected by building codes

The use of lumber in the United States is regulated by over 2000 building ordinances. This number increases every year. Proper or new methods and standards for using lumber may be accepted or ignored by building codes. For example, wood trusses would be handicapped in competition with steel trusses if codes failed to accept the timber connector method of truss construction. One of the primary functions of the West Coast Lumbermans Association is to see that the various building code officials are kept abreast of developments in the industry.

Provisions which actually discriminate against the lumber industry include the following:

1. Insistence on ultra-conservative working stresses for lumber. This places lumber at a decided disadvantage in competing with steel and concrete for the standard stresses of these materials are kept up to date.

2. The tendency to require more fire resistance
in lumber constructed buildings than would be required when "incombustible" materials are used.

3. Reducing the amounts of wood for use as furniture, flooring, trim, windows, doors, partitions and panelling, in fireproof buildings to inconsequential amounts.

4. Excessive fire protection requirements.

5. Height and area limits, location restrictions, use and occupancy limits on frame buildings, masonry-wall wood-joisted construction, and limitations on heavy timber buildings.

The effect of building code regulations on wood construction

Most cities in the United States have their areas divided into definite fire zones and the types of buildings that may be constructed in these zones are further classified according to their fire-resistant properties. The Uniform Building Code of the Pacific Coast Building Officials Conference lists five classifications of buildings. They are:

Type I........Fire-resistive construction.
Type II........Heavy-Timber construction.
Type III.......Ordinary masonry construction.
Type IV.......Metal-frame construction.
Type V.......Wood-frame construction.
Type I is deemed to be the most fire-resistant and Type V the least fire-resistant type of construction.

The city of Spokane, Washington, although not a subscriber to the Uniform Building Code, has a code which is typical of the better independent building codes. It has classifications similar to the above, ranging from Class "A" to Class "F". The class "A" buildings are steel or concrete construction and the class "F" buildings are of wood-frame construction.

In general, the use of wood is limited to doors, door-frames, sashes, interior casings, etc., in the fire-resistive types of construction. Semi-fire resistive buildings in addition to permitting the above use of wood also allow wearing floors for non-public passageways to be of wood, providing that all spaces under the wearing floors are filled with incombustible materials. The other classifications permit the use of wood for walls, floors, partitions, roofs, etc.

Height limitations for the average building code range from "unrestricted" for fire resistive buildings to 35 to 50 feet for the wood-frame buildings. Area restrictions range from "unrestricted" for fire-resistive buildings to 5000 to 8000 square feet for wood-frame buildings. Zoning ordinances of the various cities may further limit the height and area re-
The need for uniform building codes

There are three principal groups which strongly advocate the adoption of uniform codes. They are the manufacturers of building materials and equipment, contractors, and architects and engineers. The manufacturers of building materials desire uniform codes so that their materials can be used in all localities with the same strength specifications. The contractors find difficulties placed in their way when different localities use different codes because it necessitates changes in their building plans to meet the changed local conditions. Uniformity of codes would allow architects and engineers maximum leeway in developing more economical designs. These factors all combine to reduce prices to the consumer, so that it is to the public's advantage to have uniform codes.

Organizations sponsoring better building codes throughout the United States

The majority of the building codes in present use on the Pacific Coast are based on the work done by many large organizations. These organizations include the following:
1. The **National Lumber Manufacturers Association**.

The N.L.M.A. is the largest organization concerned with building code and lumber relationships. Thirteen regional associations support the National Lumber Manufacturers Association, including the West Coast Lumbermans Association, the Western Pine Association, and the Southern Pine Association.

The basic principle of the N.L.M.A.'s building code activities for the past twenty-seven years has been "maximum open and free competition among all materials within their legitimate and justified uses in building construction." For the lumber and shingle industries this means:

a. Securing adequate acceptance of lumber and shingles in local building codes and ordinances and removing existing unwarranted restrictions.

b. Securing proper recognition of lumber and shingles in recommendations and code standards promulgated by Federal, state, semi-public, private and professional organizations.

c. Securing acceptance in codes of the latest technical developments in lumber
construction and standards.

2. **The New England Building Officials Conference.**

   This conference adopted a uniform code in 1937 and many New England cities have adopted it in its entirety.

3. **The Chicago Suburban Building Officials Conference.**

   Thirty-seven suburban Chicago communities are united under this conference to develop uniform building regulations.

   The city of Chicago has had the most complicated, antiquated and monopolistic building code of any large city. Any change has had to be debated and voted in by the council and consequently the code has been subject to pressures of special interests. All technical matters are now turned over to the Board of Building Standards and the council can adopt their recommendations.

4. **The Southern Building Codes Congress.**

   The director of the Southern Building Codes Congress is presenting a "Southern Standard Building Code" to all of the cities throughout the South. This project, while promoting uniformity, tends to grant special privileges to the "incombustible" materials.
5. **The American Standards Association.**

The American Standards Association is preparing standards covering live loads, chimneys, heating appliances, foundations, outdoor display structures, lumber, fire protection and fire resistance, and places of outdoor assembly. This report will be published as an "American Standard." and will have considerable importance to the lumber industry. The committee forming these standards has representatives of the major building materials who act in advisory capacities. Lumber representatives on the committee are outnumbered five to one by representatives of "incombustible materials."

6. **The Township Building Code Advisory Committee of the Michigan State Planning Commission.**

This committee is at present framing a model building code which will eventually be adopted by 1271 Michigan townships.

7. **The United States Department of Commerce.**

Many recommendations for building codes and construction practices have been issued by the United States Department of Commerce. These recommendations have had a strong effect on building codes throughout the country.
The Uniform Building Code of the Pacific Coast Building Officials Conference

The majority of the Pacific coast cities have adopted the Uniform Building Code which is sponsored by the Pacific Coast Building Officials Conference. This code was first issued in 1927 with newer editions being issued in 1943 and 1946. More than 300 cities have adopted the code in its entirety or have based their own codes mainly upon it.

The conference holds an annual meeting for the purpose of bringing the code up to date. The final decisions as to code changes are made by the committees executive board. The executive board is composed of fourteen men and is presided over by Harold Rasmussen, Building Inspector of Santa Ana, California. The other members are city engineers or inspectors. The research committee and the code changes committee act as advisory councils to the executive board. The various construction interests have men on sub-committees who act purely in advisory capacities to the research committee and to the code changes committee. These men may propose amendments but they have no active votes.

The primary purpose of the West Coast Lumbermans Association representatives is to keep other building
materials, such as light steel, aluminum, etc., from obtaining unfair advantages over the lumber industry. They do not act as lobbyists for the industry.

Jurisdictions under the Uniform Building Code.

In December, 1947, there were 460 jurisdictions operating under the Uniform Building Code of the Pacific Coast Building Officials Conference including 36 states, 237 cities, Hawaii and Alaska.

These jurisdictions include the California counties of Alameda, Contra Costa, Del Norte, Kern, Los Angeles, Marin, Placer, Orange, San Bernadino, San Mateo, Santa Barbara, Santa Clara, Solano and Ventura. California cities numbering 233 operate under the uniform building code including the major cities of Los Angeles, Sacramento, San Francisco and San Diego.

Twenty-one cities in Oregon use the code, these cities include Albany, Astoria, Baker, Bend, Eugene, Corvallis, Medford and Klamath Falls. Thirteen cities in Washington including Bremerton, Centralia, Olympia and Tacoma are also under the code.

The principle cities of the Pacific Coast which are not using codes based on the uniform building code are Oakland, Spokane, Seattle and Portland. Portland is, at the present time, seriously contemplating coming under the code.
The trend of uniform building code adoptions from 1927 to 1948 is shown in the chart on the following page.

Differences in Codes and Grading rules on the Pacific coast

Perhaps the most striking differences between existing codes and grading rules lie in the working stresses given Douglas Fir as exemplified by the West Coast Lumbermans grading and dressing rules, the Uniform Building Code, and the various independent cities. The table on page 15 gives the differences in compression parallel to the grain, extreme fiber in bending and compression perpendicular to the grain. These figures were taken from the respective codes or rules.

At the present time the Forest Products Laboratory at Madison, Wisconsin, is testing the new stresses which are in use by the West Coast Bureau of Lumber Grades and Inspection. The Laboratory intends to submit its findings to the Uniform Building Code Changes Committee by July 1, 1948. Unless the new stresses are submitted by this date, they have no chance of being accepted by the Uniform Building Code Executive board until it meets again next year.
TABLE I
Trend of uniform building code adoptions from 1919 to date
Effective on April 1, 1948, the city of Portland adopted a new housing code. The housing code sets up standards for light, air, and open space-within and without the living quarters. The housing code represents a definite step towards modernizing Portland's building laws, but no steps have as yet been taken towards conforming with actual changes and improvements in building laws and practices as illustrated by the uniform building code.

The advantages that an independent city obtains by adopting such a code are two-fold. First, the city saves considerable time and money by using the services and experiences of the organized code committee. Secondly, by adopting the code, the city frees the West Coast Lumber Bureau to concentrate its efforts more exhaustively upon the uniform building code. In the long run this means that the city will be obtaining much more efficient use of lumber for construction purposes.

**Permanancy of building codes**

No existing building codes can be considered as complete and finished documents. New construction materials, new methods of construction and new techniques of fire protection are continually being developed. These factors must be kept under continual
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<td>compression parallel to the grain</td>
<td>1600</td>
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<td>extreme fiber in bending</td>
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<td>compression perpendicular to the grain</td>
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(for Select Structural Douglas Fir)
observance in order to insure continued improvement in the building trades.

THE RELATIONSHIP OF BUILDING CODES AND CORRECT FRAME CONSTRUCTION TO EACH OTHER AND TO THE LUMBER INDUSTRY

The lumber industry is meeting more and more competition from competing building materials. Increased competition means that in the future, the lumber industry must offer consumers a relatively better product for the money and yet keep the customer satisfied with the performance of the wood.

Declining use of wood over a long time period is shown by the graph "Per capita consumption of lumber" on page 17. The trend of wood-use-per-capita has been definitely downwards since 1909. The downward trend has been offset twice since 1909. First by the prosperity boom of the late 1920's, secondly by the second World War. The present post-war building boom is giving a short-time boost to per-capita consumption, but it is to be expected that the downward trend will continue unless drastic steps are taken.

Prices in the industry may not return to pre-war levels, but by assigning correct working stresses
(which have been consistently low in the past) and by promoting the correct use of lumber in construction practices, the consumer will be able to obtain satisfactory results with less wood. These two factors should be fully developed and exploited if the lumber industry is to maintain its prominent position in the field of construction.

Examples of how lumber may be saved in construction other than by assigning higher working stresses, are brought out by Mr. Arthur Kaiser, Los Angeles representative of the West Coast Lumbermen's Association.

"1. Studding in most building codes is required to be placed 16" o.c. Most building codes on the west coast require the use of #2 studding. Thus, in an average five-room house, 200 #2 studs are actually required to meet the strength and spacing requirements. Actual practice finds that close to 300 studs are used in the average five-room house. These extra studs are due to improperly planning the space relationships between regular frame studding and window and door openings, and to extra studding around doors and windows.*

*Teco Type B framing anchors eliminate the need for double studding in window and door openings.
When extra studding is placed in a building, the grade of studding used could be lowered and still the strength requirements would be amply met. A combination of lower grades under the above conditions, and correct space planning would mean a considerable saving to the builder in studding alone.

2. The Southern California area has taken a big step towards prolonging the life of frame construction by requiring that all wood 48" or less below the sub-flooring be treated with either Wolman salts or by one of the 100% creosoting methods, or be a naturally durable wood. (Douglas fir does not meet the durable wood requirement) In effect this law reduces damage done by termites or wood-destroying fungi and assures the consumer more satisfactory service from lumber. The price of treating a five-room house to meet the code requirements in Southern California jurisdictions currently averages one-hundred dollars. (August, 1947)

ABUSES OF WOOD IN HOUSE CONSTRUCTION

Before lumber reaches its optimum use in the construction trades, correct construction practices
must be observed and wood must be properly used. The principle errors in construction and wood-use are:

1. Improper foundations. Bad foundations cause much of the trouble in house building. Examples are settling walls and conditions favoring decay in foundation timbers.

2. Untreated wood in contact with earth or concrete floors.


4. Lack of frame rigidity.

5. Improper planning for future plumbing and electrical work.

6. Improper storing of lumber before use.

7. Improperly seasoned lumber.

8. Improper ventilation and screening.

The foundation

Wood cannot give the desired results in house construction unless proper foundations are built. A good foundation is the first essential in a well built house. Construction errors resulting from poor foundations include settling walls, dampness in basements,* termite attack and wind damage.**

*Damp basements offer optimum conditions for many destructive fungi and insects.

**Wind damage in regions subject to high velocity winds.
Types of foundations in common use are poured concrete, block walls, concrete piers and brick. The block wall type of foundation is rapidly replacing the other types in current small frame construction practices.

The most important factor to take into consideration when making the foundation is the footing. The following factors should be observed.

1. The footings should be laid below the frost line and should be made with a level face in contact with the soil.

2. They should be constructed very carefully.* Any settling of the structure, no matter how slight, will cause cracking of plaster, sagging of doors and windows, and possible damage to structural members.

3. Drainage around footings is essential in many localities as it tends to equalize the moisture content in the surrounding soil, thus helping to prevent uneven settling.

Untreated wood in contact with earth or concrete floors

To render the proper service in house-construction, wood must be kept dry. The presence of moisture in

*The concrete should be mixed thoroughly and in the correct proportions. Forms should be carefully put up. The concrete should be properly tamped and seasoned.
the wood may lead to insect or fungal attack. Mud-sills, window-sills, and wooden posts bearing directly on earth or concrete floors are the most common offenders. Mud-sills and window-sills should be either all-heart stock of decay-resistant wood or should be treated with preservatives. Wood posts resting on concrete floors tend to absorb moisture gathering on the floor. To provide the necessary drainage and to provide protection from fungus or termite entry, concrete base-blocks extending above the final floor level are recommended.

**Skimpy nailing**

Mr. T.A. Mays of the West Coast Lumbermans Association, asserts that nailing practices in the Northwest tend to be far from satisfactory. Although the importance of proper nailing seems obvious, no building codes on the west-coast have incorporated specifications regarding their use. Regardless of the basic strength of a wood, if too few nails are used, the wood will fail to give its best use. An additional nail adds little to the cost but greatly to the strength of a joint.

**Lack of frame rigidity**

The rigidity or stiffness of a house is generally
more important than any other one factor. A house which lacks sufficient rigidity is subject to cracks, sticking doors and windows, and general safety when in areas subject to high winds.

High rigidity may be obtained by using horizontal sheathing in combination with bracing, or by using diagonal sheathing. Horizontal sheathing is much weaker than diagonal sheathing but it is cheaper. Consequently it is the most common method of applying sheathing.

Bracing increases the stiffness of a horizontally sheathed wall one and one-half to three times, depending on the type of bracing used. Much of the small construction now being put up utilizes horizontal sheathing without good bracing and consequently does not maintain best rigidity.

**Improper planning for future plumbing and electrical work**

Although plumbing and electrical fittings are usually planned in advance, on occasion the framing may be seriously weakened by inadequate planning. Workmen when seeking to install piping, heating units, and the like, may cut or otherwise weaken the woodwork to clear the way for their job.
Improperly seasoned wood

Much of the wood which is being used for construction work is improperly seasoned. A characteristic of wood is that it shrinks as it dries. Other drying characteristics may include warping and twisting, splitting, checking, cupping, etc. If wood is to give the performance of which it is capable, it should be dried to a moisture content approximating the moisture conditions of the location where it is to be used. This will largely prevent future defects from occurring in the lumber after construction is completed. It will lead to better consumer relationships and should pay dividends to the lumber industry as a whole.

SUMMARY

The use of lumber in the United States is regulated by over 2000 building codes or ordinances. These codes may or may not be partial to the lumber industry. It is one of the functions of the West Coast Lumbermans Association and other similar associations to see that the various building code officials are kept abreast of developments in the industry. They also strive to eliminate discriminatory provisions (in the codes) against the lumber industry.

Buildings in most cities are classified into approximately five types. The classification is based en-
tirely upon the fire-resistant properties of the building type. Wood-frame construction is the least fire-resistant type of building and as a result it has the most restrictions in regard to height, area and zoning.

Manufacturers of building materials and equipment, contractors, and architects and engineers are the three main groups advocating uniform codes. The manufacturers desire uniform codes so that their materials can be used in all localities with the same strength specifications. The contractors desire uniform codes because different codes necessitate changes in their plans to meet the changed code. The architects and engineers desire uniform codes so that they can have maximum leeway in developing more economical designs.

There are many organizations in the United States sponsoring better building codes. They include the Pacific Coast Building Officials Conference, the National Lumber Manufacturers Association, and the American Standards Association. The National Lumber Manufacturers Association is the largest organization concerned with building code and lumber relationships.

The principle underlying the National Lumber Manufacturers Association's building code activities is that there should be "maximum open and free competition among all materials within their legitimate
and justified uses in building construction."

Most of the cities on the Pacific Coast have adopted the Uniform Building Code which is sponsored by the Pacific Coast Building Officials Conference. Four-hundred and sixty jurisdictions and more than three hundred cities have adopted the code in its entirety or have based their own codes mainly upon the uniform building code. The Pacific Coast Building Officials Conference holds an annual meeting for the purpose of bringing the code up to date. The conference has three major committees, the executive, the research and code changes committees. The research and code changes committees act as advisory councils to the executive committee.

At the present time the Forest Products Laboratory at Madison, Wisconsin is testing the new stresses in use by the West Coast Bureau of Lumber Grades and Inspection. If these new stresses are found to be acceptable, they will be incorporated into the Uniform Building Code of the P.C.B.O.C.

An independent city adopting the uniform code obtains two advantages. First, the city saves considerable time and money by using the services and experiences of the organized code committee. Secondly, by adopting the code, the city frees the West Coast Lumber Bureau to concentrate its efforts more ex-
haustively upon the uniform building code. In the long-run this means that the city will be obtaining much more efficient use of lumber for construction purposes.

No building codes can be considered as being permanent. New construction materials, new methods of construction and new techniques of fire protection are continually being developed. These factors must be kept under continual observance in order to insure continued improvement in the building trades.

Per-capita consumption of wood in the United States has been decreasing since 1909. Unless drastic steps are taken, it is to be expected that this downward trend will continue. By assigning correct working stresses and by promoting the correct use of lumber in construction practices, the consumer will be able to obtain satisfactory results with less wood. The reduced costs of construction will open the door of frame construction to many others whom now find it economically impossible to build.

Lumber may be saved in building practices in many ways. They include: properly planning the space relationships between regular frame studding and window and door openings, reducing the amount of studding needed around doors and windows by the use
Teco type framing anchors, treating wood to reduce damage done by termites and wood-destroying fungii.

The principle errors in construction and wood-use are:

1. Improper foundations.
2. Untreated wood in contact with earth or concrete floors.
4. Lack of frame rigidity.
5. Improper planning for future plumbing and electrical work.
6. Improper storing of lumber before use.
7. Improperly seasoned lumber.
8. Improper ventilation and screening.

Improper foundations may be prevented by observing the three following principles: 1. Lay the footings below the frost line. 2. Construct the footing and wall very carefully. 3. Provide adequate drainage.

Wood must be kept dry if it is to offer the service of which it is capable. The presence of moisture in the wood may lead to insect or fungal attack.

Mud-sills, window sills, and wooden posts bearing directly upon the earth or on concrete floors are the most common offenders. To provide the necessary drainage and to provide protection from fungus or
termite entry, concrete base-blocks extending from above the final floor level are recommended.

No building codes on the west-coast have incorporated specifications regarding the use of nails in building construction. Regardless of the strength of a wood, if too few nails are used the wood will fail to give its best use. An additional nail adds little to the cost but greatly to the strength of a joint.

The rigidity or stiffness of a house is generally more important than any other one factor. High rigidity may be obtained by using horizontal sheathing in combination with bracing, or by using diagonal sheathing. Horizontal sheathing is weaker than diagonal sheathing but it is cheaper. Bracing increases the stiffness of a horizontally-sheathed wall one and one-half to three times depending on the type of bracing used.

The framing may be seriously weakened by inadequate planning for plumbing and electrical fittings. Workmen when seeking to install piping, heating units, and the like, may cut or otherwise weaken the woodwork to clear the way for their job.

Much of the wood which is being used for construction purposes is improperly seasoned. If wood is to give
the performance of which it is capable, it should be dried to a moisture content approximating the moisture content of the location where it is to be used. This will largely prevent seasoning defects from occurring in lumber after the construction is completed. It will lead to better consumer relationships and should pay dividends to the lumber industry as a whole.
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