fire protection planning report

BUILDING CONSTRUCTION INFORMATION FROM THE CONCRETE AND MASONRY INDUSTRIES

NO. 6 OF A SERIES

New Study Emphasizes Need for Fire-Resistant Construction in Low-Rise Multifamily Buildings

The fire in this low-rise multifamily project was called the most destructive fire in Houston (Texas) history. Five hundred units were destroyed, 800 people were left homeless, and $9 million in property was lost. Construction: wood frame, no firewalls, wood corridor walls, wood rafters and roof. (Photo: *Houston Chronicle*)

Introduction

A revealing report examining fire losses in multifamily residences by construction type has been prepared by the University of Maryland's Department of Civil Engineering.* The report is based on a study made to determine whether there is a relationship between construction type and fire losses. Most of the data apply to low-rise construction but some of the data gathered are for fires in mid- and high-rise multifamily buildings. All of the information is valuable in studying low-rise fire protection.

Evidence obtained during the one-year study confirms that concrete and masonry construction in apartment buildings offers the most resistance to fire spread and damage, while unprotected wood-frame construction offers the least resistance to fire spread and damage.

New Information

The University of Maryland report is important because fire loss data based on type of residential construction had not previously been available or published.

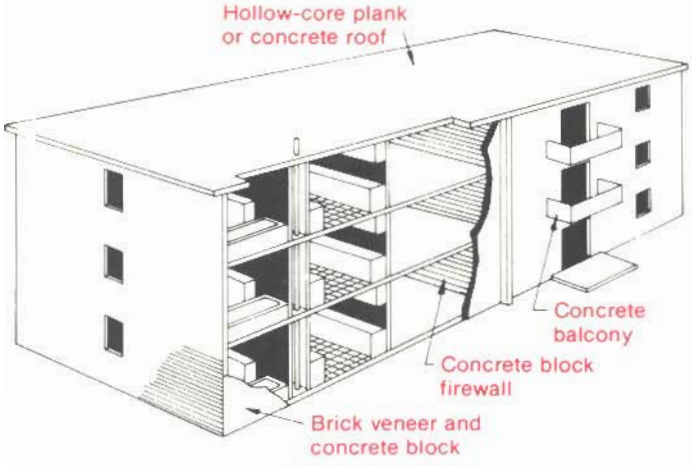
The report compiles data from actual fires and presents the findings in a manner that can be used by those wishing to improve fire protection and firesafety.

The new information was developed by analyzing data obtained from the United States Fire Administration Fire Data Center. The study was based on 27,000 fires reported from Ohio, Michigan, Missouri, and Oregon for 1976 and 1977, and California for 1975-77. Fire spread, property damage, and casualties were analyzed.

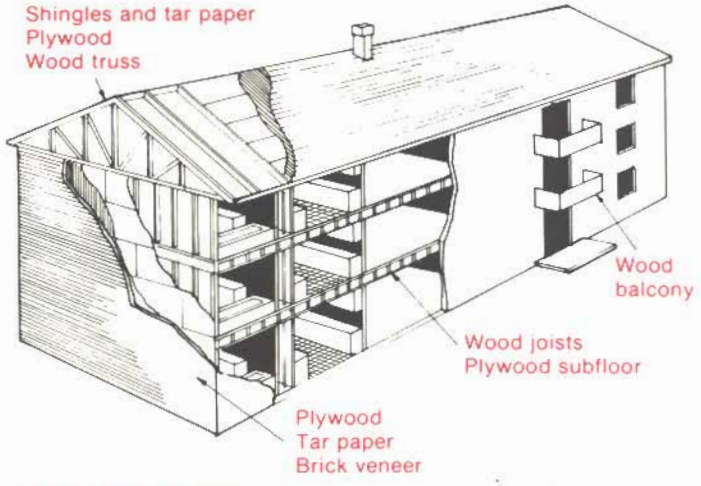
Tragic Losses

In the United States, residential fires take more lives and destroy more property than fires in any

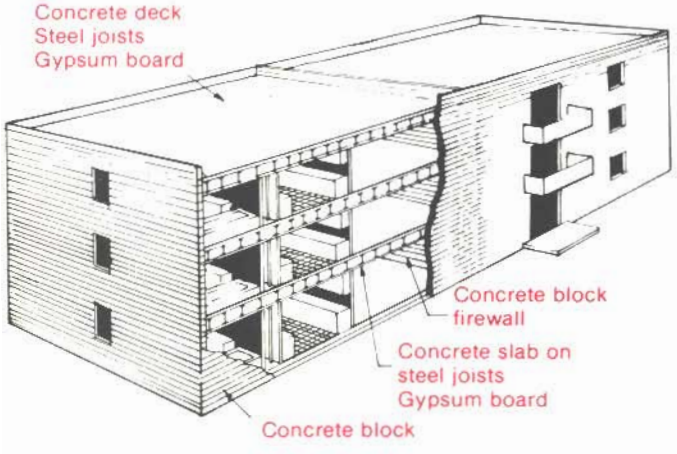
Fire Losses in Low-Rise Multifamily Residences, University of Maryland Department of Civil Engineering, College Park, Md., 1979



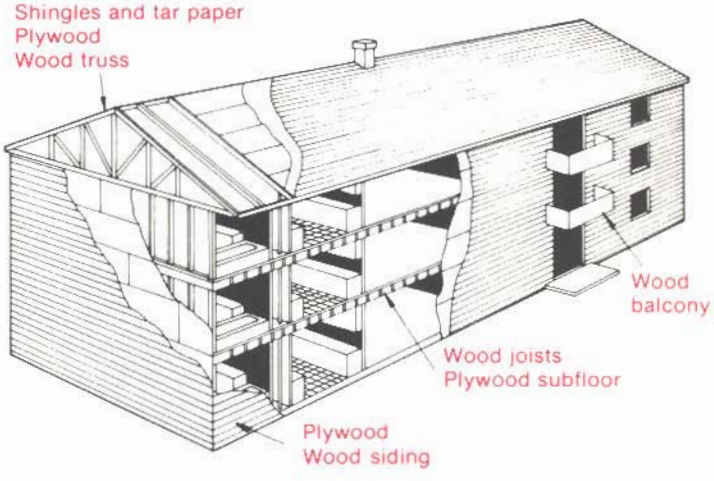
Fire-Resistive Construction



Masonry Exterior



Noncombustible Construction



Frame Construction

Figs. 1-4. These sketches of low-rise multifamily buildings are generalizations of four common construction types that can be subdivided into eight types found in building codes. Low-rise multifamily residential buildings built to the same standards as single-family homes (Type 8) create a dangerous potential for fire tragedy.

other type of building. They account for 68% of all fatalities, 57% of all injuries, and 43% of all property losses. Approximately 7500 fire deaths occur each year, 5000 of which are in residential fires. Fire injures 300,000 people each year, including 50,000 who require extended hospitalization. Almost $3 billion worth of property is destroyed annually by fire. The total economic cost of fire in the United States is estimated conservatively at $11 billion per year.

Roughly 25% of all residential fires occur in low-rise multifamily buildings. These structures are built to essentially the same standards as traditional single-family homes. In multifamily units, however, residents are more vulnerable to the actions of their neighbors than are people living in single-family homes.

Findings

The poor performance of combustible multifamily buildings and the potential for decreasing fire losses through the use of noncombustible construction is clearly indicated in the study.

Here are some of the findings:

1. The relative probability of fire damage increases as the fire-resistant characteristics of construction decrease.
2. The percentage of out-of-control fires increases as the fire-resistant quality of construction decreases.
3. Interior wall assemblies appear to have the greatest overall effect on the extent of fire damage, with the relative probability of fire spread increasing as the fire resistance of these walls decreases.

4. There is a trend toward increased property loss as construction fire resistance characteristics are reduced. Approximately 30% to 40% of all fires occurring in multifamily buildings cause damage in excess of $1000.

Data Base

The fires used in the study were fires originating inside a building whether or not they caused damage to the structure.

In four of the states studied—Ohio, Michigan, Missouri, and Oregon—eight construction types are available; California has four construction classifications. Some information related to California is omitted in this publication, but not in the study.

The eight construction types are shown in the bottom line of Table 1 and are identified with the nomenclature of each model code. Figs. 1-4 are drawings of typical construction types, but do not include all details of construction.

The data collected were restricted to apartments, tenements, and flats. Information about the type of occupancy use was obtained for three sizes of occupancy: I—3- to 6-unit buildings; II—7- to 20-unit buildings; and III—over-20-unit buildings. While categories I and II refer to low-rise buildings, some mid- and high-rise buildings are included in category III.

Construction Type and Extent of Fire Damage

Fire damage is the extent of the burned or charred area in a structure. In order to determine the influence of construction type on containment of the fire, only those fires that involved at least the entire room of fire origin were used in the study. These are referred to as out-of-control fires.

The graphs in Figs. 5 and 6 show the percentage of out-of-control fires based on construction type. In Fig. 6, construction Type A is fire resistive and Type D is equivalent to frame construction.

These graphs indicate that the extent of fire damage is related to the type of building construction. As the use of fire-resistant construction increases, the extent of fire damage decreases.

States Reporting in 1979 Study

Information for 27,000 fires was obtained for Ohio, Michigan, Missouri, Oregon, and California for the 1979 fire study. A 1980 study of multifamily-building fires will gather data from 14 states.

Fire Damage Risk and Probability

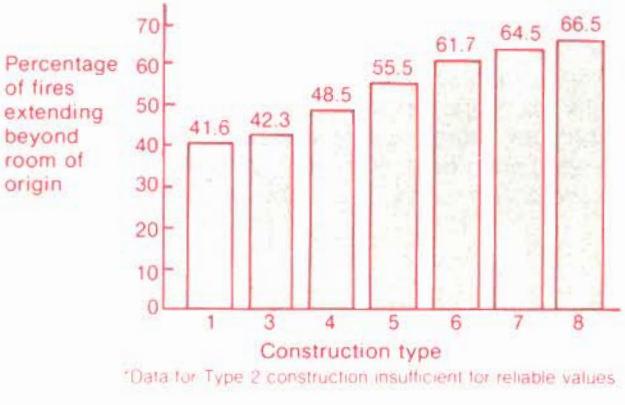
Table 2 gives a fire damage risk factor for each construction type by project size. The study uses the term "risk factor" as a means of assessing the possibility of fire damage extending beyond the room of fire origin. The relative risk factor is the ratio of risk for any construction type to the risk for Type I construction (fireproof, fire resistive)—the construction type which performed the best.

Clearly the construction type used in multifamily buildings is important to the confinement and reduction of damage from fire. Materials used for wall, floor, and roof construction are all important in reducing fire damage. The requirements for each of these components in the four California construction types are shown in Table 3.

Table 1. Types of Construction in Model Building Codes

Code	Construction type									
	Fireproof		Noncombustible			Heavy timber	Ordinary		Frame	
							Protected	Unprotected	Protected	Unprotected
BBC 1978	1A	1B	2A	2B	2C	3A	3B	3C	4A	4B
SBC 1976	I	II	—	IV-1	IV-0	III	V-1	V-0	VI-1	VI-0
UBC 1976	—	1-FR	II-FR	II-1	II-N	IV-HT	III-1	III-N	V-1	V-N
NBC 1976	Fire resistive		Limited combustible			Heavy timber	—	Ordinary	—	Wood frame
	Type A	Type B	Protected	Unprotected						
Md study 1979	1		3	4		2	5	6	7	8

Many firesafety-conscious communities are insisting upon fire-resistant construction for low-rise apartment buildings. The concrete floors and masonry in this building resist fire, reduce property loss, and protect residents. (Photo © *Thom Abel 1978*)



*Data for Type 2 construction insufficient for reliable values.

Fig. 5. Percentage of out-of-control fires (Ohio, Michigan, Missouri, and Oregon)

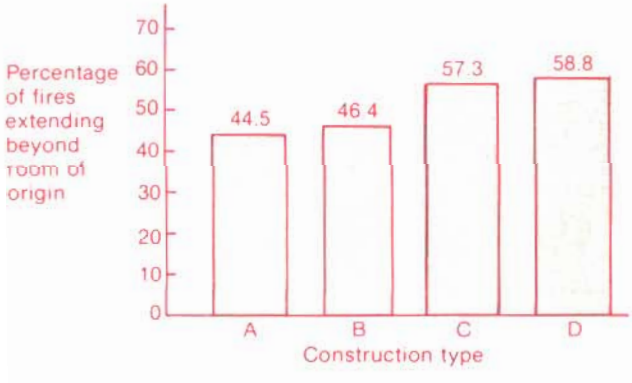


Fig. 6. Percentage of out-of-control fires (California).

The data on the California fires indicate the following:

1. For smaller buildings (3 to 6 units), the type of exterior wall construction is of primary importance in reducing fire damage.
2. For medium-size buildings (7 to 20 units), the interior wall construction is of primary importance in reducing fire damage.
3. For larger buildings (over 20 units), the floor and roof construction is of primary importance in reducing fire damage.

Property Losses

Data were compiled to determine property losses for each of the construction types shown in Table 1. The relative average loss—the ratio of average loss per fire for any construction type to the average loss per fire for Type I construction—is given for each construction type in Figs. 7 and 8. The figures show a trend toward increased property losses when there is a reduction in the use of fire-resistant construction. In construction Type 8 (unprotected frame), approximately 42% of all fires result in more than $1000 in loss. Between 90% and 95% of all property losses from fire occur in Type 8 buildings.

Sprinklers and Detectors

The limited data available suggest that sprinkler systems and smoke detectors may be less effective in suppressing fires and alerting building occupants than is commonly believed.

Table 2. Fire Damage Relative Risk Factors by Size of Project (Ohio, Michigan, Missouri, Oregon)

Construction type	Project size			All uses
	I 3-6 units	II 7-20 units	III* Over 20 units	
1	1.0	1.0	1.0	1.0
2	**	**	**	**
3	1.22	0.90	1.33	1.13
4	1.38	1.09	0.92	1.31
5	1.45	1.49	2.33	1.76
6	1.78	1.62	2.86	2.09
7	1.95	1.62	2.49	2.18
8	2.36	1.63	2.20	2.02

*Some mid- and high-rise buildings are included with low-rise buildings in category III.
**Insufficient data for reliable values.

Table 3. California Construction Types

Type	Exterior wall	Interior wall	Floor and roof construction
A	N	N	N
B	N	N	C
C	N	C	C
D	C	C	C

NOTE: N = Noncombustible
C = Combustible

This is the charred wreckage of a five-alarm fire that destroyed 100 units in 10 buildings of two fashionable apartment complexes. Fire-resistant construction can help prevent this destruction. *(Photo by David G. Baker)*

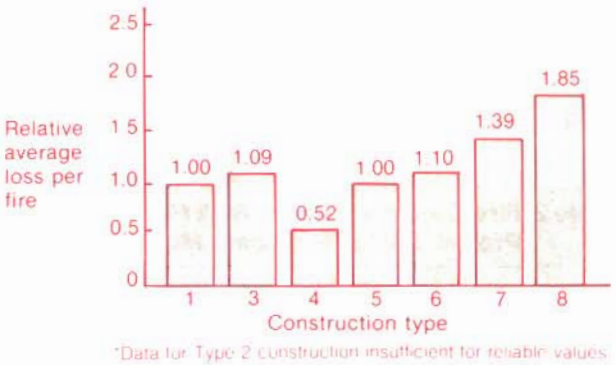


Fig. 7. Relative average loss per fire (Ohio, Michigan, Missouri, and Oregon)

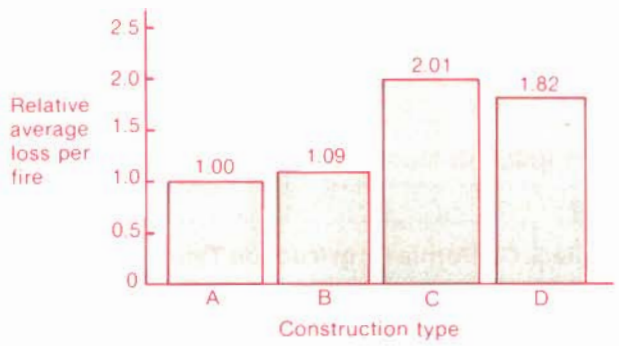


Fig. 8. Relative average loss per fire (California)

Conclusions

The information obtained in this study is especially significant because it examines the results of real fires. If applied to the planning and construction of multifamily buildings, the new findings can be valuable in reducing loss of life and property damage due to fire.

The influence of construction type on fire damage is shown for the states studied. As the use of fire-resistant construction increases, the extent of fire damage and the risk of extensive fire damage decrease.

Data are limited for evaluating smoke-detector and sprinkler-system performance; however, the data analyzed indicate that failure rates of both detectors and sprinklers may be significant.

Relationships between construction type and fire casualties cannot be stated until the data base is increased.

The Future

Another study of multifamily-building fires is being conducted with the number of states expanded to fourteen.

These studies should alert the construction industry, municipal and building officials, insurance companies, financing agencies, and the public to the need and potential for improving the quality of fire protection for multifamily housing.

Organizations represented on the CONCRETE AND MASONRY INDUSTRY FIRESAFETY COMMITTEE

BIA	Brick Institute of America
CRSI	Concrete Reinforcing Steel Institute
ESC&SI	Expanded Shale Clay and Slate Institute
NCMA	National Concrete Masonry Association
NRMCA	National Ready Mixed Concrete Association
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PTI	Post-Tensioning Institute

Concrete and Masonry Industry Firesafety Committee

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