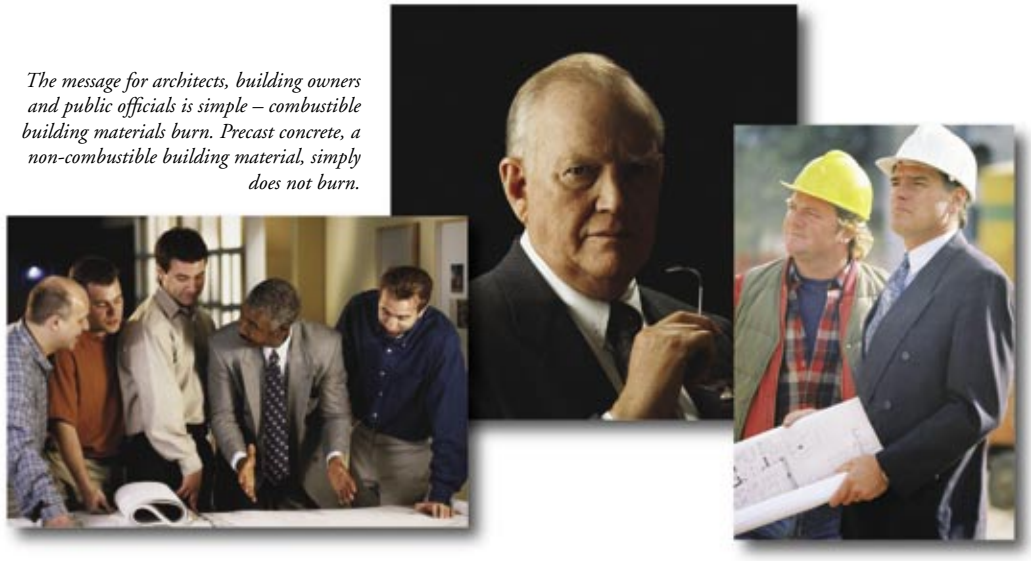
Precast Concrete Fire Prevention:

SETTING THE RECORD STRAIGHT

Recent building code revisions, with extensive sprinkler trade-offs and other concessions, have significantly reduced structural fire protection and related life safety. Now more than ever, building with non-combustible precast concrete designs can better provide lasting and effective passive structural fire protection.

PRECAST/PRESTRESSED CONCRETE INSTITUTE



The message for architects, building owners and public officials is simple – combustible building materials burn. Precast concrete, a non-combustible building material, simply does not burn.

EXECUTIVE SUMMARY:

Setting The Record Straight: Precast Concrete Saves Lives

Lives and property can be saved if owners and designers understand that building-code standards represent a minimum level of protection, not the best level. The consolidation of building codes has led to trade-offs that have weakened fire-protection requirements. Active protection systems such as sprinklers, while effective in some cases, are not the entire solution and can fail to perform at critical moments. This is especially important if materials have been used that rely on sprinklers to slow their combustibility.

The best approach is a balanced design that combines active and passive protection systems. A passively designed building system using precast, prestressed concrete structural and architectural components offers inherent fire protection because its noncombustible composition inhibits fire's spread. Designing for compartmentation, which divides the structure into smaller modules, helps ensure a blaze remains contained and provides more time for detection, evacuation and suppression.

Precast, prestressed components—including hollowcore slabs, wall panels, double tees, columns and beams—provide a host of advantages unavailable with other materials. These include its natural fire resistance, the absence of toxins when burned, heat absorption, structural integrity, fast construction and single-source supply.

With increasing emphasis on risk avoidance, insurance companies are taking note of precast's fire advantages, offering lower rates for all-precast structures in some cases. Combined with other economies provided by the material, this long-term savings represents a compelling reason to use precast—in addition to its ability to save lives.

Additional information and case histories on fire-resistant designs and techniques can be found at ***www.pci.org***

Fire Deaths, Injuries and Dollar Loss Per Year in Residential and Commercial Properties

Year	Fires	Deaths	Injuries	Direct Dollar Loss (in millions)
1991	2,041,500	4,465	29,375	$10,906
1992	1,964,500	4,730	28,700	$ 9,276
1993	1,952,500	4,635	30,475	$ 9,279
1994	2,054,500	4,275	27,250	$ 8,630
1995	1,965,500	4,585	25,775	$ 9,182
1996	1,975,000	4,990	25,550	$ 9,406
1997	1,755,000	4,050	23,750	$ 8,525
1998	1,755,000	4,035	23,100	$ 8,629
1999	1,823,000	3,570	21,875	$10,024
2000	1,708,000	4,045	22,350	$11,207

Source: National Fire Protection Association

FIRE: *A Killer That Can Be Stopped*

Statistics tell grim story—but precast designs can help

Although fire safety in the United States has improved during the past decades, death and destruction from fires remains a serious and costly concern for owners and designers of residential structures, homes, apartments, dormitories, retirement centers and assisted living facilities.

Are current safeguards working effectively? Statistics show they fall far short, and the United States has a particularly dismal record. Here are the grim facts:

- More than 4,000 people die in fires each year, with one death every 130 minutes. Fire kills more Americans than all natural disasters combined. Approximately 85 percent of fire deaths occur in homes.
- Fire strikes approximately 86,500 apartments, 2,000 hotels and motels, and 740 dormitories annually.
- Fire injures about 22,000 people each year, with an injury occurring every 23 minutes.
- Each year, fire departments are called to more than 1.7 million fires, with a fire call received every 18 seconds. There are nearly 510,000 structure fires each year, with one occurring every 62 seconds.
- Fire causes more than $11 billion in property damage each year, with about $9.5 billion resulting from structure fires. Half of the total property damage occurs in residential properties.
- Fire creates a great danger for the elderly, the fastest-growing segment of our population. Adults 65 and older die in fires twice as often as the national average. Those more than 85 years old have a death rate from fire four times that of the national average.
- There are more fire deaths per capita in America than in virtually any other developed country. The United States ranks 22nd out of 25 major European and Asian countries reporting per-capita fire deaths to the United Nations, better than only Finland, Ireland and Hungary. Our direct losses from fire as a percentage of GDP are the fifth highest.

People expect today's modern dwellings to reflect the best design available, providing life safety, security and comfort. Americans rely on state and local governments to enact and enforce effective building codes and standards that ensure these fundamental rights. Building owners and home owners also rely on architects, engineers and builders to deliver the highest performing buildings for their hard-earned dollars.

Designing with durable, long-lasting precast concrete components and providing a balanced design that incorporates a variety of life-saving systems can produce cost-effective and efficient dwellings that will protect our nation's families for generations to come.

[All statistics from "2000 Fire Loss in the U.S." produced by The National Fire Protection Association]

Annual Cost of Fire

For more on the elderly and fire, visit ***www.wilder.org***.

For more information on fire trends, visit ***www.usfa.fema.gov***.

BUILDING STANDARDS:
Codes Are Only A Minimum

With recent revisions and trade-offs — including accommodations necessary to achieve consensus for consolidation — codes do not guarantee that you will get a truly safe building. An understanding of building materials, active and passive fire suppression systems, and balanced design concepts represents the best line of defense in providing structures that resist fire, save lives and provide lasting value.

Some building owners and architects rely on meeting minimum fire-safety requirements in building codes to provide a safe environment for the building's inhabitants, so they focus on other concerns when creating an attractive building at the available budget. By abiding to a lower standard, these stakeholders do a disservice to their building occupants, weaken their project's long-term economic viability, and place the building's occupants in jeopardy.

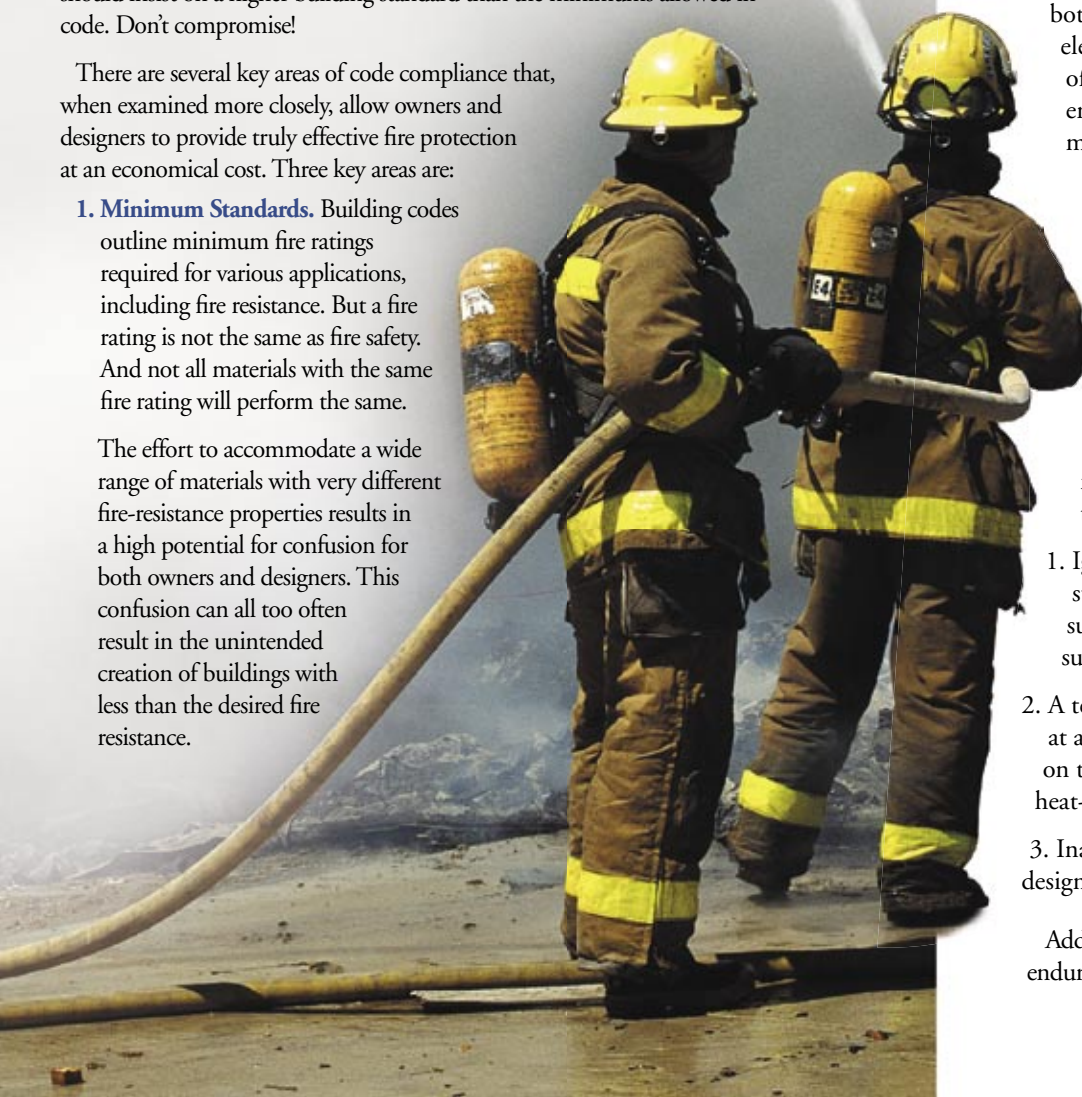
Precast concrete construction provides long term savings in maintenance and insurance costs and significantly reduces potential costs for fire damage, loss of life and lawsuits. Today, better design and higher building safety levels **can** be effectively marketed.

Compliance with building codes provides only the minimum level necessary to pass inspection. It does not ensure lives will be saved when fire breaks out. Each code includes regulatory concessions and trade-offs that allow for a less than optimum level of protection for what is often perceived as the least expense. Local building officials, who are responsible for sound community building standards that adequately protect their citizens, can and should insist on a higher building standard than the minimums allowed in code. Don't compromise!

There are several key areas of code compliance that, when examined more closely, allow owners and designers to provide truly effective fire protection at an economical cost. Three key areas are:

1. **Minimum Standards.** Building codes outline minimum fire ratings required for various applications, including fire resistance. But a fire rating is not the same as fire safety. And not all materials with the same fire rating will perform the same.

   The effort to accommodate a wide range of materials with very different fire-resistance properties results in a high potential for confusion for both owners and designers. This confusion can all too often result in the unintended creation of buildings with less than the desired fire resistance.



Fire Definitions:

Active Fire Protection: Fire protection systems that must be activated to perform, such as sprinklers and smoke detectors.

Passive Fire Protection: Fire resistance provided by elements that inherently resist fire, such as non-combustible precast concrete, concrete and masonry block.

Compartmentation: Use of the passive protection of non-combustible floors and walls to confine fire to a specific area.

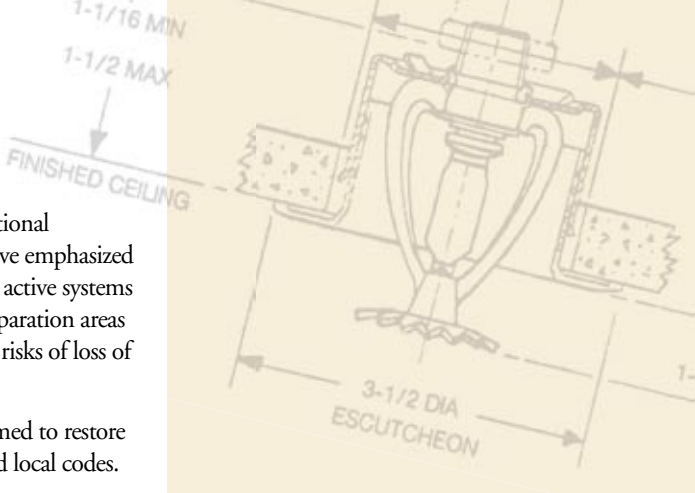
Balanced Design: Combining both active and passive design elements, as well as the concept of compartmentation, to greatly enhance fire protection at a minimum cost.

ASTM Fire Test:

ASTM E119, the standard fire test for the construction industry, states that the fire endurance of a member or assembly is based on the time required to reach the first of these three end points:

1. Ignition of cotton waste supported on the member surface that is away from the surface directly exposed to fire.
2. A temperature increase of 325 F at any point or 250 F on average on the unexposed surface (the heat-transmission end point).
3. Inability to carry the applied design load (i.e., structural collapse).

Additional rating criteria for fire endurance also exist.



The recent consolidation of the existing building codes into the new International Building Code created considerable compromises. Code trends in general have emphasized sprinkler installations by providing trade-offs that encourage their use. These active systems offer some valuable protection, but the trade-offs, such as more liberal fire-separation areas and other changes that decrease wall and floor performance, produce greater risks of loss of property or lives.

Recently, a grass-roots effort, the Alliance for Fire Safety (AFS), has been formed to restore "historically proven, built-in, fire-resistant material requirements" to state and local codes.

2. **Building materials.** Wood and steel perform poorly in fire scenarios. Both must be treated, coated or covered to meet fire requirements, increasing costs and creating the possibility for errors and missed details during installation. Experience shows that during the chaos associated with building fires, these coatings and coverings blow or fall off the members they are meant to protect. This can result in structural failure of the members or, in the extreme case, total collapse of the building.

Wood is a natural fuel source, while steel begins to fail at 1,200 F and does fail at 1,600 F — temperatures fires reach easily. As the failure temperature approaches, steel distorts and loses its supportive strength. The massive nature of concrete building elements and their behavior under high temperatures allows them to continue to support loads long after steel members exposed to the same fire will have failed.

When wood or steel wall or floor assemblies are relied upon to provide true passive structural fire containment and protection, the result can be an increased loss of human life and more property damage.

3. **Sprinklers.** Automatic sprinklers are a desirable active fire-suppression system and can help control fire spread. But they are not the complete answer. To rely on any mechanical device, including sprinklers, is a foolish gamble.

Active systems, such as sprinklers and smoke detectors, cannot replace passive fire-suppression systems that are designed inherently into the building. Trading off vital components of a complete fire-prevention system by investing only in sprinklers puts too many eggs into one basket—a basket that often is not up to the job.

Relying on active-suppression systems alone can produce an inadequate response during a fire emergency. Because they require mechanical action to function, sprinkler systems can fail. This may happen during a fire because of a closed-off water supply, low water pressure, a system shut down for repair or other mechanical-related reasons. It's also possible that design changes or expansions left the existing sprinklers inadequate, or water supplies have been cut off by early fire damage. Sprinklers are susceptible to malfunction, improper installation, inadequate maintenance, recall or deliberate or accidental tampering.

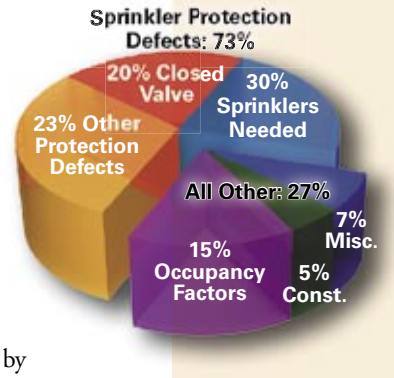
Experience has shown that relying on this one active system means no other fire protection system will be available when fire breaks out and sprinklers don't respond adequately for whatever reason. At that point, all combustible structural materials—which the sprinklers were designed to protect—simply add fuel to the fire.

Most importantly, without the protection of the fully functioning sprinkler system, fire causes the vulnerable structural components to fail to fulfill their critical roles as working structural floor and wall elements..

To offset the cost of sprinkler systems and other active fire systems, builders and designers often use cheaper building materials, where allowed by codes. But by using these trade-offs, potentially dangerous buildings are created that may pass inspection but may fail miserably when challenged in a fire situation.

Sprinkler Gaps:

The NFPA (National Fire Protection Association) 13R sprinkler standard does not require floor/ceiling assemblies and attics to be sprinklered, leaving gaps in the protection of combustible portions of the structures. (Source: Portland Cement Association)



Sprinkler Protection Defects:

A Factory Mutual System analysis of 666 fires in sprinklered factory buildings indicated that fully 75 percent of the $182-million loss from these fires was due to defects in sprinklered protection.

Sprinkler Failures:

A September 2001 report by the Fire Analysis and Research Division of the National Fire Protection Association shows that sprinkler systems fail in one out of six non-residential building fires.

WARNING: Know which sprinkler you're installing!

The 13R standard of NFPA is intended to allow affordable sprinkler systems for multi-family buildings up to four stories in height by reducing water demand requirements and permitting certain areas within the building to remain unsprinklered.

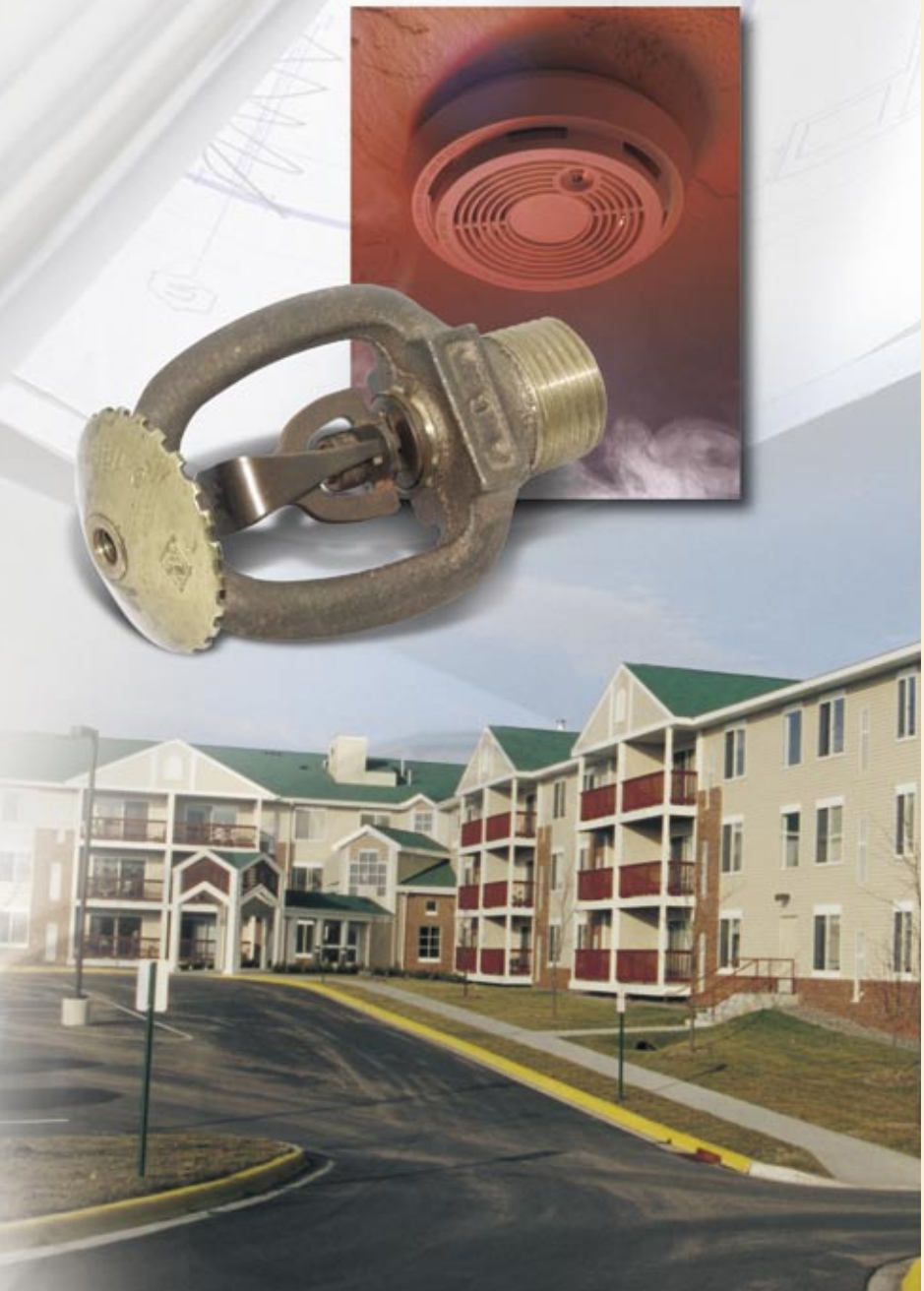
Trade-offs typically done with NFPA 13R systems – such as fewer area separation walls or reduced fire resistance of separation walls – should not be allowed. Permitting 13R systems on buildings more than four stories is also unjustified.

The Best Approach: Balanced Design

Sprinkler tradeoffs and code revisions have allowed larger, taller unprotected spaces before fire walls and fire floors are required. This approach creates larger spaces in which fire is more difficult to contain and in which large amounts of fuel and oxygen can expand a fire rapidly, outdistancing the ability of sprinklers to prevent it from spreading.

A design approach that stresses compartmentation offers a more fundamental method to protect lives and property. Compartmentation uses passive noncombustible floors and walls, such as precast concrete, to construct sections of the building as separate modules that confine fire to a specific area. Once constructed into the building, passive protection is always available and requires no active mechanical operating process to function.

Noncombustible compartmentation, combined with an inherently fire-resistant/tolerant structural frame, offers the highest quality fire protection available. When this passive design combines with other safety measures, including sprinklers and early-warning detection systems, a balanced design approach is achieved. This overall fire-protection system is truly second to none.



Hose Stream Test:

Wall assemblies must meet requirements laid out in the American Society for Testing Material's E119—Standard Test Methods for Fire Tests of Building Construction & Materials. It provides a "hose-stream" test to determine the fire rating for building materials. In this test, a stream of water is projected onto the wall to test its ability to withstand impact, lateral load, thermal shock and erosion.

Masonry and concrete specimens are subjected to the hose-stream test following exposure to fire for the full duration of the fire-resistance test period. However, contrary to conventional wisdom, specimens of panel/stud assemblies are required by this standard to undergo the test for only one half of the desired fire-resistance period (e.g., one hour for a two-hour fire rating) or no more than one hour for any rating. This unequal approach has been debated at ASTM forums but no changes in the approach have yet been made.

However, as a result of their adverse experience from many fire situations, code authorities in New York state have amended their code to require fire walls to pass the hose-stream test after meeting the full time required for the fire-resistance period. (Source: Building Construction & Design Viewpoints #1, 1999.)

In recent tests conducted at Omega Point Laboratories, an independent testing laboratory in San Antonio, Texas, a gypsum and steel stud wall assembly was exposed to the more rigorous ASTM E119 test (i.e two hours of fire exposure), and then subjected to the hose stream. The wall disintegrated in less than one-half the 2½ minute requirement. To order you free video which shows complete details on this test, visit ***www.pci.org/firetestvideo***.

RISK AVOIDANCE:
Reduce Risk, Slash Insurance Costs

Precast concrete components, especially when combined into an all-precast structural system, provide the highest level of fire protection available at competitive costs—one that far surpasses the minimal standards required by most building codes.

With increased emphasis on risk avoidance in the insurance industry, property insurers and risk insurance managers have noticed the fire-resisting advantages offered by precast concrete construction.

A study by National Loss Control Corp. indicated that the insurance-cost difference between noncombustible and combustible framing systems can be substantial. For a six-unit, 6,000-square-foot structure, the annual property insurance cost rose 678 percent if the non-combustible structural system was changed to combustible framing. For a 24-unit, 24,000-square-foot building, the increase was 746 percent. For a three-story, 70-unit building with 70,000 square feet, the increase was 830 percent.

In another study, the University of Michigan found that the use of concrete and masonry significantly reduced insurance costs. These expenses grow over time as annual premiums mount.

For instance, they determined that for a 24,000-square-foot multifamily housing structure, the cost of insuring concrete and masonry construction ran about $12,000 less than for wood ($13,210 for wood, $1,429 for concrete).

The annual per-unit insurance cost of $550 for wood and $59 for concrete makes it clear how quickly paybacks can be achieved.

Surpasses Fire Tests

Precast concrete has demonstrated its ability to withstand heat and fire in more than 200 fire tests since it was first examined by the National Bureau of Standards in 1953. In one such test, a precast, prestressed double-tee wall assembly withstood a two-hour fire test and a subsequent hose stream test. It then was subjected to a level equal to 200 percent of the design live load, without distress. (For more details, see the "PCI Design Handbook", pp. 6.25-6.26 and the PCI Fire Manual.)

Insurance Costs Chart

Source: Concrete & Masonry Industry Firesafety Committee's Fire Protection Planning Report No. 9

Occupancy Apartment Building three-story, six-unit		Precast Concrete Roof and Floors, Brick/Block Wall	Wood-Frame Walls, Floors and Roof
Type of Insurance		Annual Premium	Annual Premium
Building	Fire	$150.82	$3,438.53
	Ext. Cov.	$ 80.00	$ 876.00
Contents	Fire	$ 88.50	$ 131.58
	Ext. Cov.	$ 20.00	$ 219.00
Total Annual Premium		$339.32	$4,665.11
Total Monthly Premium Per Unit		$ 4.71	$ 64.79

PRECAST CONCRETE:
The Natural Fire Inhibitor

Precast, prestressed concrete construction creates unified structures that provide unparalleled design efficiency and unexcelled fire and life safety.

Precast achieves a superior quality of fire protection at a cost-effective budget because it provides key advantages other systems can't match:

- **It will never burn.** As a noncombustible building material, precast concrete does not serve as fuel or contribute to the fire load. This not only helps control fires inside the building but minimizes the chances of arson and of damage from external sources such as forest fires or sparks from nearby fires.
- **It is naturally fire resistant.** Other building materials must be treated to gain the fire resistance inherent in precast concrete components. This adds time and money to the project. It also opens the door for misapplications that produce weaknesses in the building's fire-protection envelope. Concrete makes such an excellent fire-resistant material that fire departments across the country routinely build concrete structures to house testing for less fire-resistant materials. Concrete also is used by fire departments to build enclosures for practicing life-saving techniques in a fire environment. They know they can subject concrete to fire over and over without any damage occurring to the structural integrity.
- **It helps prevent spread of toxins.** Most fire deaths result not from heat or burns but from inhaling smoke and toxic gasses. Compartmentation with precast concrete construction reduces the spread of toxic gas or smoke.
- **It minimizes fire development.** Because it won't ignite, the fire's spread is slowed and its damage is minimized. This ability to resist fire creates more time for detection, evacuation and suppression—the three key ingredients for minimizing damage and injury during a fire.
- **It absorbs heat.** Precast's thermal mass and dense construction makes it an energy-efficient design option. That mass also absorbs heat during a fire, making it easier for occupants to withstand the growing temperature and focus on their evacuation.
- **It offers structural integrity.** The use of a precast concrete structural system, including precast columns, walls and hollowcore floors and ceilings, provides a durable structural material that will reliably perform even when exposed to intense heat. This attribute minimizes damage, increases evacuation time, aids rescue and suppression, and reduces costs for repair.

Noncombustability is Vital

A study by the Department of Civil Engineering at the University of Maryland indicated that the relative probability of flames extending beyond the room of origin and beyond the fire-related compartment of origin decreases as the noncombustability of the construction materials increases.
(For details, see "A Study of Fire Losses in Multi-Family Residences," National Technical Information Service Order No. PB82214701.)

Fire Test Technical Details

A new chapter on Fire Resistance is being added to the *PCI Design Handbook* providing technical details on determining fire resistance ratings for precast, prestressed concrete. The new section will be available with the upcoming 6th edition of the handbook.

Locating a Precaster

To find the locations for the PCI-Certified precasters in your area, visit ***www.pci.org***

More Fire Design Ideas

PCI's "Design for Fire Resistance" Manual can be reviewed or downloaded from the Knowledge Bank accessed through ***www.pci.org*** or member Web sites.

After logging in, click on the **Knowledge Bank icon** and use the Advanced Search function in Generic Subjects to locate publication MNL-124-89.

DESIGNER'S KNOWLEDGE BANK

• **It isolates the fire.** A precast system can be used to create compartmentation. The combination of precast columns, beams, flooring, ceiling and wall elements breaks up each level's space into smaller, self-contained modules that minimize the chance of fire spreading to adjacent units.

• **It produces an economical system.** Savings accrue due to precast's speed of erection and the elimination of costly additional fire-protective coatings needed for other structural materials. But precast offers even more economic benefits after construction is completed. Its protection appeals to insurers, who offer lower rates for such well-protected properties. Its durability minimizes maintenance costs throughout its life. And its strong aesthetic appeal lasts and lasts, far beyond the duration of the mortgage increases long-term value.

• **It provides many other advantages.** Precast concrete components also provide **superior acoustical and vibration control** for housing projects, creating better neighbors and enhancing users' quality of life. They can be **erected year-round** in virtually any weather, creating faster and better controlled schedules. Hollowcore's shallow section also **saves material** by producing efficient flooring/ceiling components that reduce the building's overall height. The components **will not rot and do not support mold, termites or vermin.** They can be designed to **resist all natural disasters**, including earthquake events. They can **express any architectural style**, any color any form or any texture.

• **It comes from a single-source provider.** Your precaster can coordinate in advance all of the project's structural components as well as framing and ceiling/flooring elements, ensuring the most efficient construction efforts possible.

• **It guarantees high quality.** PCI-Certified plants must undergo two unannounced inspections each year to audit their quality-control and production systems. This ensures tight tolerances and consistency in manufacture that results in cost-effective design and construction.

Precast concrete systems provide the ultimate in fire protection from design, cost and aesthetic perspectives. No other system performs better in preventing, containing and recovering from fires. No other system offers the assurances to tenants that their homes, property and lives are safe.

Fanned by high winds, a fire raged in the wood roof framing of this mostly precast concrete structure of the Oaks at Medina continuing-care facility in Medina, Ohio. The fire burned for four hours, leaving some concerned about how extensively the building was damaged and how long it would be before the building could be repaired.

The hollow-core plank were shot-blasted and cleaned so they could be inspected for damage. Although some pieces were damaged, all appeared able to be reused.

Inspection of the hollowcore from below showed little damage to the hollowcore and mechanical equipment despite the extreme heat that the top side of the floor slab was exposed to.

PRECAST CONCRETE SYSTEMS:

Components Work Together

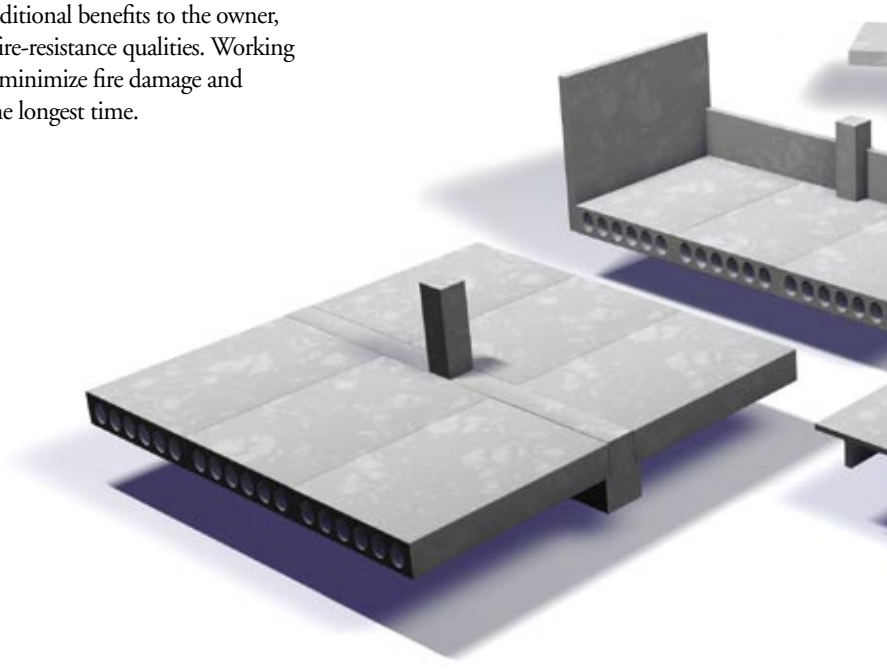
Quality, non-combustibility inherent in all components.

Precast, prestressed concrete offers a natural and cost-effective way to ensure the highest level of fire protection for any housing structure. Using a complete structural system of precast components allows the material to create a total envelope in which the sum of the parts is greater than the whole. Such a structure can include:

- **Hollowcore slabs.** Serving as combined floor/ceiling systems, these long, shallow components can be erected quickly while saving material cost and labor. The pieces include interior voids that reduce the weight and material quantity while adding structural stability. Their capability for long lengths aid design flexibility for spanning open spaces while providing a noncombustible material that prevents fire from spreading to another floor.
- **Wall panels.** High fire ratings can be achieved with precast panels, which work with other components to create a noncombustible envelope. They also produce aesthetically appealing façades that can mimic a variety of other natural materials. Hollowcore planks can be used as wall panels in either a vertical or horizontal format. An insulated sandwich wall panel, in which several inches of insulation is placed between two wythes of concrete, provides high energy efficiency. It also can be used as a load-bearing element in some designs, eliminating material and saving erection time.

- **Double tees.** Tees can be used in ways similar to hollowcore plank as roofs, ceilings, floors, and wall panels. They offer long clear spans for design flexibility and strong vertical multi-story elements that can be erected quickly.
- **Columns and beams.** These components create a framework that will resist intense heat and will not add fuel to a fire, which can cause the structure to collapse and create even more damage or injury. A total precast system offers fast construction, especially when used in conjunction with other precast components. It contains the spread of a fire, minimizing damage while giving residents more time to evacuate. Its ability to be erected rapidly in the winter means occupancy begins quicker, generating revenue faster.

Each of these precast components provides a range of additional benefits to the owner, designer, contractor and end user that go beyond passive fire-resistance qualities. Working together as a system, they create the most effective way to minimize fire damage and contain the effects within the smallest space possible for the longest time.

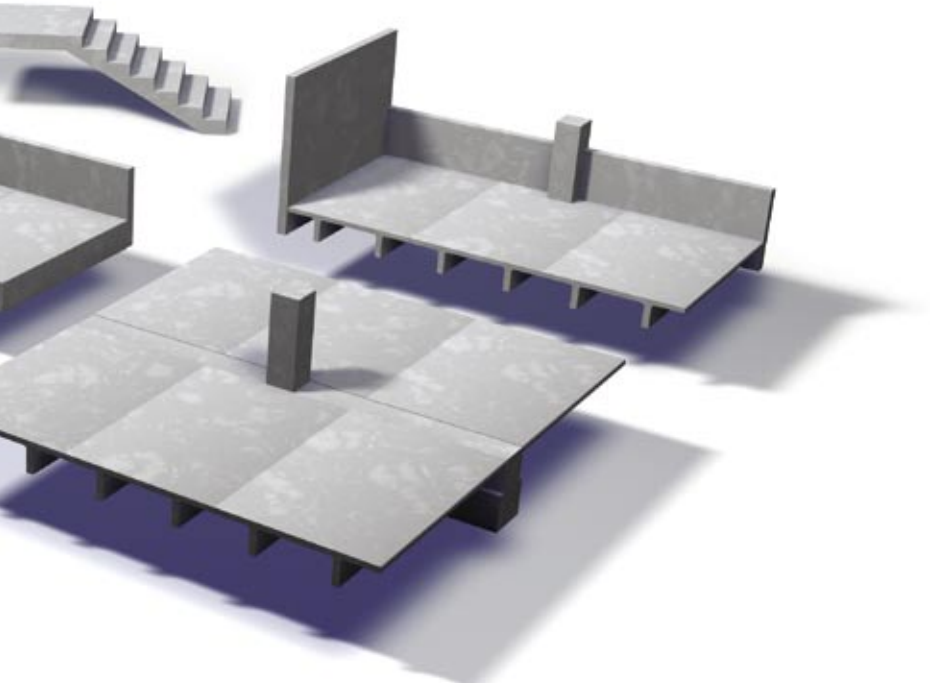


Trade-Offs Don't Pay Off

Using precast concrete components in a unified design greatly improves on minimal code standards while offering a variety of long-term economic benefits

Precast concrete structural systems comprising hollowcore plank, wall panels, double tees, columns and beams provide significant benefits to owners while substantially improving on the minimal code requirements that may compromise long-term safety and economic advantages. Among precast's benefits are:

- It will never burn.
- It requires no fire-resistance additives.
- It does not produce toxins.
- It minimizes fire development.
- It absorbs heat.
- It offers structural integrity.
- It isolates the fire.
- It helps control sound and vibration.
- Its architectural design options are unlimited.
- It does not rot or support mold or termites.
- It produces an economical system.
- It comes from a single-source provider.



10 Rules of Endurance Ratings

Precast concrete components meet "Harmathy's 10 Rules of Fire Endurance Ratings," as outlined in Guidelines on Fire Ratings of Archaic Materials and Assemblies from the U.S. Department of Housing & Urban Development. The 10 rules are:

1. The thermal fire endurance of a construction consisting of a number of parallel layers is greater than the sum of thermal fire endurance characteristics of the individual layers when exposed to fire.
2. The fire endurance of a construction does not decrease with the addition of further layers.
3. The fire endurance of constructions containing continuous air gaps or cavities is greater than the fire endurance of similar constructions of the same weight containing no air gaps or cavities.
4. The farther an air gap or cavity is located from the exposed surface, the more beneficial is its effect on the fire endurance.
5. The fire endurance of a construction cannot be increased by increasing the thickness of a completely enclosed air layer.
6. Layers of materials of low thermal conductivity are better used on that side of the construction on which fire is more likely to happen.
7. The fire endurance of asymmetrical constructions depends on the direction of heat flow.
8. The presence of moisture, if it does not result in explosive spalling, increases the fire endurance.
9. Load-supporting elements, such as beams, girders and joists, yield higher fire endurances when subjected to fire endurance tests as parts of floor, roof or ceiling assemblies than they would when tested separately.
10. Load-supporting elements of a floor, roof or ceiling assembly can be replaced by such other load-supporting elements that, when tested separately, yield fire endurances not less than that of the assembly.

HUD-PDR-613-8(2) is available from HUD User, ***www.huduser.org***, or Box 280, Germantown, MD 20767; 301/251-5154. It also can be obtained from the U.S. Government Printing Office, Washington, DC 20402.

PRECAST/PRESTRESSED CONCRETE INSTITUTE

Precast/Prestressed Concrete Institute
209 W. Jackson Blvd., Chicago IL 60606
312/786-0300

Visit PCI's Web at www.pci.org to gain additional information and case histories about precast concrete's excellent fire-resistance qualities.