Light Frame Wood Construction

Overview-

It should come as no surprise to anyone that unprotected floor assemblies can fail within a matter of minutes during a fire that has reached the point of flashover. The results of all the research performed thus far on the structural performance of light weight engineered products using the ASTM E 119 fire test must be interpreted within the context of the relatively severe fire scenarios represented in these fire experiments. The temperatures that are reached and sustained throughout the test are well above the flashover temperature for most materials used in residential construction. The question is not about the structural performance of lightweight construction, which includes all wood products, but rather the necessity to require such erroneous requirements as additional fire barrier protection in one- and two- family dwellings. By the fire services own account, the number of incidences that have been the result structural collapse involving lightweight engineered products is equal to and lower than the use of other lightweight (common wood framing) and heavy timber construction materials.

Talking Points

According to the National Engineering Lightweight Construction Fire Research Project by Kirk Grundahl, P.E., a literary review of various studies on the relationship between Lightweight engineered products and firefighter safety ,the following conclusions have been noted;

1. The summary explains that most fires occur in the compartmentalized portions of the dwelling giving first responders and occupants more time to safely escape and/or more time to attempt to put out the fire than they would normally have had the fire begun in a concealed or unprotected area.

2. When compared to residential fires, non-residential fires cause more injuries and more fatalities per 100 fires, mostly due to the greater number of hazards and risks that firefighters confront in these non-typical scenarios.

3. From 1980-1984, NFPA estimates 81.8% of the occupant fire fatalities in one- and two-family dwellings and mobile homes occurred in fires that originated in the main living areas of the structure. There were no reported incidents where the fatality was directly caused by the collapse of the residential structure built with lightweight engineered products.

4. The data suggests that a majority of the fires originate in the compartmentalized or finished portion of the dwellings, with only 3.1% of the residential fires occurring within the structural confined spaces of the residence.

5. According to data collected from 1980- 1989, of the 1,191 firefighter fatalities that occurred 3.8% were due to structural collapse of the structure which included all types of construction material and methods. During this time period, 45 firefighter fatalities were attributed to the structural collapse of the roof or floor assembly which included nominal wood, lightweight framing and heavy timber.

6. Of the 45 firefighter fatalities, 5 occurred in structures utilizing lightweight construction, while the remaining 40 fatalities occurred in structures that were built using ordinary wood, heavy timber and non-combustible materials.

7. The study concluded that the data indicated that the number of lightweight component construction-related fire fatalities, for both fire fighters and occupants, due to structural collapse is very small.

8. The author` points out the data also suggests that lightweight construction techniques has not increased the hazard of firefighters operating at the fire incident above and beyond the hazards that they have always faced on the fire ground.

9. Furthermore this report concluded the number of fire fighter fatalities that occurred in lightweight component construction collapses was very small and the data implies that lightweight components do not create an increased risk or hazard for firefighters above or beyond what they have already been facing during fire ground operation.

Grundahl, Kirk P.E. National Engineered Lightweight Construction Fire Research Project, Technical Report: Literature Search &Technical Analysis National Fire Protection Research Foundation October 1992

Cause of Firefighter Fatalities by Type of Structural Collapse[1]

Year	Total Fatalities	Non-Combustible Wall	Wood Frame Products	Ordinary /Roof /Floor(q)	Non-Combustible Roof/floor	Light Frame Wood Trusses(a)	Timber Trusses	Combustible wall
1980	130	1.0	3.0	1.0		1.0(f)		
1981	123	1.0		1.0				
1982	117	5.0	1.0	4.0	2.0(o)			
1983	106	1.5(h)*			1.5(hn)*			
1984	116			2.0		1.0(e)		
1985	119	1.0(l)	2.0	4.0(l)				
1986	113		0.5(k)*			1.0(d)		0.5(k)*
1987	124	1.5(g)**	1.5(gj)*					
1988	129	3.5(c)*	6.0(i)		2.0(m)	0.5(c)*	5.0(p)	
1989	110	2.0	2.0		1.0	2.0(b)		
Total	1191	16.5	16	12	6.5	5.5	5.0	0.5
Percent	100.0%	1.39%	1.34%	1.01%	0.55%	0.46%	0.42%	0.04%

* In five cases (c,g,h,k,l) more than one failure mode is referenced in the event description.

a. Unless otherwise noted, all fatalities are in light commercial structures. Truss type is not defined in the description.
b. Assumed metal plate connected trusses in Orange County Gift Shop (Mercantile Occupancy). Description does not say.
c. Trusses collapsed causing concrete block wall to fall on fire fighter (Mercantile Occupancy).
d. A Johnsonville, South Carolina Church (Assembly Occupancy) Truss roof collapsed. Truss type unspecified.
e. An apartment building (Group R-2 Occupancy) under construction caught due to a fire placed in an unfinished chimney. Roof truss collapsed. Truss type unspecified.
f. A delicatessen/restaurant (Mercantile Occupancy) fire roof truss collapse. Truss type unspecified.
g. Wood frame roof collapsed causing concrete chimney to fall.
h. 15,000 ft.² manufacturing plant assumed to use steel bar joists. Caused brick wall to collapse.
i. Assumed wood framed in a single family residence ceiling collapse.
j. 100-year-old wood frame church
k. Wood frame structure collapsed causing facade to collapse.
l. Wall collapse due to roof collapse. Roof type not designated.
m. Collapse of concrete floor on steel beams, 1 fatality. Steel beam the other.
n. Steel bar joist collapse.
o. 4 in. concrete floor poured over original joist floor.
p. Hackensack, New Jersey Fire. Bolted Timber Bowstring Girder Trusses.
q. Description only says the building was of ordinary (type 3) construction.

[1] Grundahl, Kirk P.E. National Engineered Lightweight Construction Fire Research Project, Technical Report: Literature Search &Technical Analysis National Fire Protection Research Foundation October 1992

- Wikipedia defines flashover as "A **flashover** is the near simultaneous ignition of all combustible material in an enclosed area. When certain materials are heated they undergo thermal decomposition and release flammable gases. Flashover occurs when the majority of surfaces in a space are heated to the autoignition temperature of the flammable gases (see also Flash point)."

- Handouts produced by the Home Safety Council which illustrate the timeline of fire shows homeowners have as little as three minutes to safely vacate the house prior to flashover. According to Anthony Avillo's book "Fire Ground Strategies", once flashover occurs any occupant(s) caught in the area cannot survive and will succumb to the untenable conditions in under a minute.

- Flashover is just as dangerous to firefighters as it is to the occupants. Firefighters are trained to understand the sign of possible flashover and are told to avoid areas where flashover has already occurred, especially any attempts to perform search and rescue which will only put the firefighter at an unacceptable risk to untenable conditions.

- The Fire Protection Handbook warn firefighters that once flashover occurs this signals the beginning of the end of the structures ability to remain stable. As the fire begins the fully developed stages after flashover occurs, it is no longer a contents fire as it now is a fully involved fire which has increased risk of structural collapse.

- Due to the declining number of structure fires, firefighters on the whole have less fire- ground experience than their predecessors had a generation ago. As many of the more experienced firefighters and officers seek retirement, they are replaced by young officers with comparably less fire experience.(resource 4)

- Firefighters now can advance deeper into structures and get closer to the seat of a fire than in years past because the turnout gear protects well against heat, but this can create problems. A longer exposure to fire will rapidly deplete a firefighter's energy and air supply; and the firefighter will have a greater distance to travel to an exit in an emergency situation. Furthermore, as firefighter's progress farther into a structure, more time elapses, which means the fire is more developed, hotter, and often closer to flashover. Collapse becomes more likely because of the increased damage from the fire.(resource 4)

- As today's firefighters' collective experience in fighting fires continues to diminish, there is great concern in the firefighter community that the inability to recognize flashover and building collapse-and to react quickly enough to avoid being caught by these two potentially fatal conditions-will continue to result in injuries and fatalities to firefighters.(resource 4)

- Assuming that the UL test are accurate in the evaluation that engineered wood products can fail structurally in as little as 6-7 minutes after flashover has occurred, the structural deterioration of the framing members would be occurring as the fire service is first arriving and setting up. In this scenario, the chance of a successful rescue is extremely low while the risk of a fire fighter injury or even a fatality is extremely high. (resource 6)

- When a fire reaches the structural components of the building, regardless whether it is constructed using lightweight wood components or conventional solid lumber, all types of construction are subject to structural failure and become an increased hazard to the firefighter.

- According to International Association of Fire Chiefs, it is a common understanding that fire fighting involves an inherent level of risk to all first responders, and that no unnecessary risk should be taken when there is no opportunity or potential to save lives. (resource 7)

- In all of the NIOSH reports that have investigated firefighter fatalities, in both residential and commercial properties involving structural collapses, the reoccurring advice and recommendation for avoiding future firefighter fatalities is for the fire service to provide proper education and information on truss construction and the fire fighting strategies that should be used. (resource 5)

- NIOSH acknowledges that fires are unpredictable and that conditions at the fire ground can deteriorate quickly. Early detection of fires involving the structural components of the building, regardless of the type of construction, is imperative in reducing the risk of firefighter fatalities. (resource 5)

- NIOSH warns that until there is a fundamental change in the fire fighting tactics by today's fire departments when responding to fires involving trusses, lives will continue to be lost. Suggested changes include: safe execution of venting the structure, opening concealed location to identify fire location(s), constantly being aware of the time the fire has been burning (including time prior to fire department arrival), continuous communication between firefighter and incident commander regarding fire ground conditions, watching for structural deterioration signs, and withdrawing from interior attack once fire has compromised the structural components. (resource 5)

- According to the National Fire Protection Association, less than 5% of the fires reported each year originate within the concealed locations of the building where structural wood products are located, and less than 3% the estimated annual occupant fatalities are the result of the structural collapse of the roof, wall or floor system.

- According to the Wood Truss Council of America, lightweight building components have been used in construction since it was first introduced in 1952. They estimate that over sixty percent of homes constructed annually use these structural components.

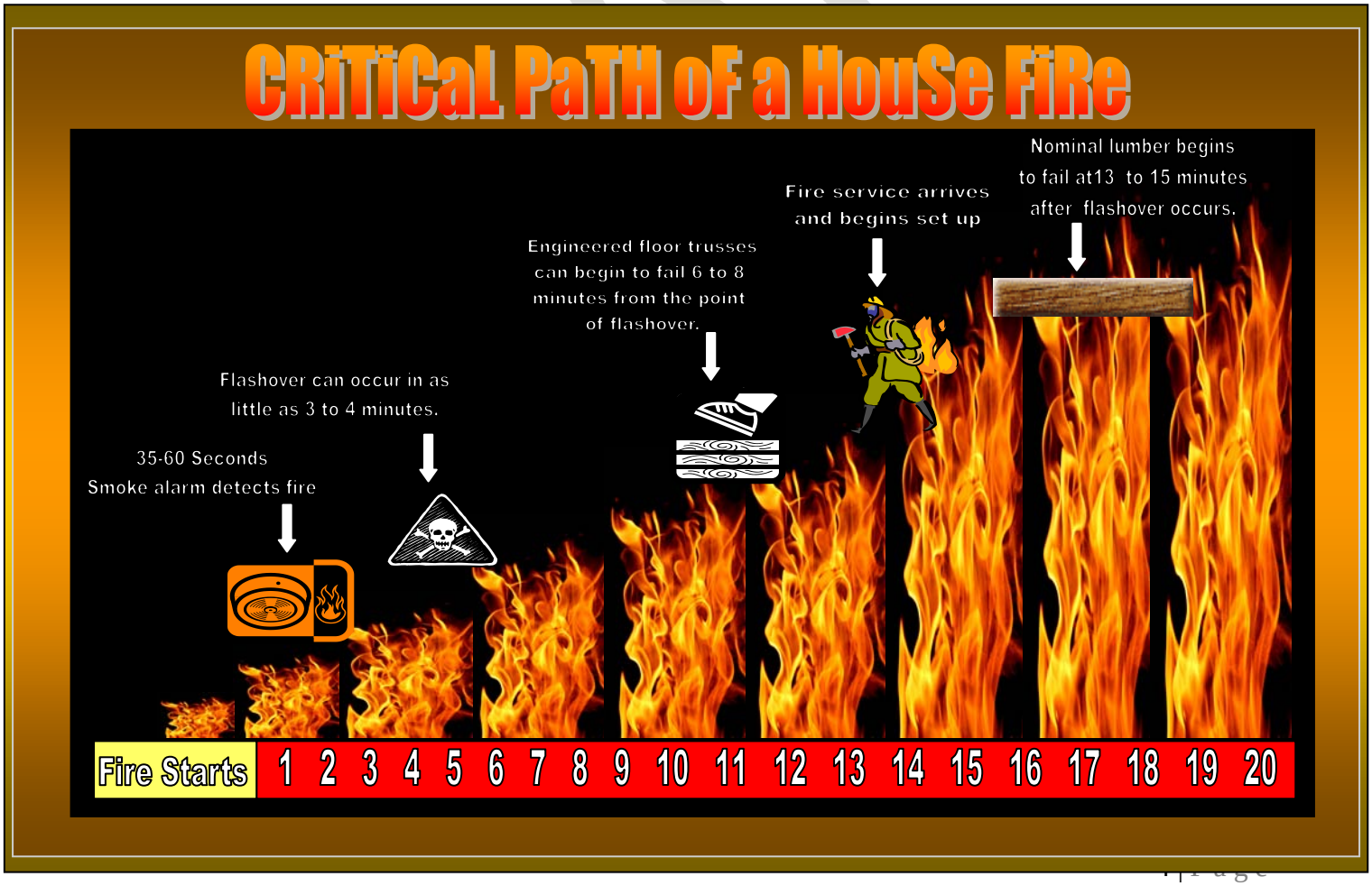
- Observations that have been made during ad hoc testing has shown under identical fire conditions solid wood joist show very little deflection prior to collapse, while structurally engineered products like open web trusses or I-joist will show tell-tale signs before reaching failure (IE a sponge-like feeling when standing on the assembly and greater deflection over the entire span) which will forewarn the firefighters of a possible collapse. (Resource 6)

- Based on reports published by NFPA, USFA and independent researchers the majority of residential fires originate in the compartmented areas of the dwelling unit where there are protective membrane separating the structure from the fire.

- According to National Fire Protection Association, 3.1% of the fires reported originated within a concealed structural location, caused 2.8% of the civilian fatalities and 4.1% of the civilian injuries. The reason these fires result in such low injuries and fatalities is due to the enforcement of the code requirement of properly installed fireblocking in these occupancies.

- When properly installed, fireblocking creates an effective barrier that prohibits the free movement of fire and heat from one part of the structure to another. All building codes require that fireblocking is installed at certain interval, both horizontally and vertically, to separate the wall and floor/roof assemblies.

- According to the National Fire Protection Research Foundation less than .5% of the total reported fire fighter fatalities, from 1980 to 1989, were due to the collapse of light wood frame trusses. None of these fatalities occurred in a residential occupancy. (resource 1)



Additional information is verbatim from Preventing Deaths and Injuries of Fire Fighters Working Above Fire-Damaged Floors NIOSH Report.

To minimize risk when working above fire-damaged floors, NIOSH recommends that fire departments and fire fighters take the measures identified below. Many of these prevention measures are from the *NIOSH Alert: Preventing Injuries and Deaths of Fire Fighters due to Truss System Failures* [2005]. Lightweight truss systems and engineered wood floor joists have similar fire degradation risks.

- Conduct a thorough fire size-up and communicate the findings to all personnel on-scene before entering the building. Incident commanders and company officers should be trained and experienced in structure fire size up to avoid putting fire fighters at unneeded risk of working above fire-damaged floors.
- Do not enter a structure, room, or area when fire is suspected to be directly beneath the floor or area where fire fighters would be operating, or if the location of the fire is unknown.
- Never assume structural safety of any floor (regardless of the construction) having a significant fire under it.
- Conduct pre-incident planning inspections during the construction phase to identify the type of floor construction. If pre-planning is not conducted, assume residential construction and small commercial buildings built since the early 1990s may contain engineered wood I-joists.
- Report construction deficiencies noted during preplanning to local building code officials. For example, engineered wood floor joists should only be modified per manufacturer specifications—usually limited to cutting to length and removing pre-cut knockouts for utility access. Report damaged or cut chords or webs to building officials.
- Develop, enforce, and follow standard operating procedures (SOPs) on how to size up and combat fires safely in buildings of all construction types. Rapid intervention teams (RIT) should include a portable ladder with their RIT equipment when deployed at basement fires.
- Provide training on identifying signs of weakened floor systems (soft or spongy feel, heat transmitted through floor, downward bowing, etc.). Make fire fighters aware that all floor types can fail with little or no warning.
- Use a thermal imaging camera to help locate fires burning below or within floor systems, but recognize that the camera cannot be relied upon to assess the strength or safety of the floor. Fire fighters should be trained on the use of thermal imaging cameras, including limitations and difficulties in detecting fire burning below floor systems.
- Immediately evacuate and, if possible, use alternate exit routes when floor systems directly beneath the floor where fire fighters would be operating are weakened by fire.
- Use defensive overhaul procedures after fire extinguishment in structures containing fire-damaged floor systems of all types.
- Consider becoming active in the building code process and influence requirements for fire resistance of floor and ceiling systems to further fire fighter safety and health.

Resources-

1. Grundahl, Kirk P.E. National Engineered Lightweight Construction Fire Research Project, Technical Report: Literature Search &Technical Analysis National Fire Protection Research Foundation October 19
2. Su, J.Z.; Bénichou, N.; Bwalya, A.C.; Lougheed, G.D.; Taber, B.C.; Leroux, P.; Proulx, G.; Kashef, A.; McCartney, C.; Thomas, J.R. Fire Performance of Houses. Phase I. Study of Unprotected Floor Assemblies in Basement Fire Scenarios. Summary Report **RR-252** 2008-12-15
3. Ahrens, Marty Home Structure Fire, National Fire Protection Association January 2009
4. Stambaugh, Hollis, James Williams Special Report: Rapid Intervention Teams and How to Avoid Needing Them USFA-TR-123/March 2003
5. Preventing Deaths and Injuries of Fire Fighters Working Above Fire-Damaged Floors NIOSH Publication No. 2009-114
6. Report on Structural Stability of Engineered Lumber in Fire Conditions Underwriters Laboratories Inc., Project number: 07CA42520 File number: NC9140 September 30, 2008
7. http://www.iafc.org/index.cfm - The International Association of Fire Chiefs website