Building Collapse and Firefighter Fatalities
1994-2013

Bryan Lynch

Referring to firefighters who have died in the line of duty as "statistics" is a hard proposition to make. This research was conducted over a period of several months. Discussions were had with firefighters who were working along side men and women when they were killed. I have talked to people who drove firefighters to their last alarm and I have learned a lot about who these men and women were. I have learned that long after the official report has been written and the name etched on the wall that these men and women live on. Referring to them as a statistic or number is a necessary evil to better our craft.

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Introduction

Between January 1st, 1994 and December 31st, 2013 there were eighty three (83) structure fires that resulted in one hundred twelve (112) firefighter fatalities that were directly or partially attributed to collapse of the structure. The following data does not include the 343 firefighters who died as a result of the collapse of both World Trade Center towers in the terrorist attacks on September 11, 2001. The following is a summary of the data collected from official reports, media stories and information obtained by numerous fire departments, state and federal agencies.

The objective of collecting and researching the data is to identify trends in building collapse as it relates to firefighter fatalities. Of interest is occupancy, building construction and the specific structural system that collapsed. The primary focus was on floor and roof construction. Of specific interest was the fireground task the firefighter was performing at the time of collapse. Knowing and understanding fireground performance, coupled with knowledge of building construction will enhance the safety of firefighters and improve the efficiency and performance of fireground operations.

Building Collapse and Firefighter Fatality 1994-2013

I. Research and Data Collection

Between January 1st, 1994 and December 31st, 2013 there were 83 structure fires that resulted in 112 firefighter fatalities that were directly or partially attributed to collapse of the structure. The following data does not include the 343 firefighters who died as a result of the collapse of both World Trade Center towers in the terrorist attacks on September 11, 2001.

The objective of collecting and researching the data is to identify trends in building collapse as it relates to firefighter fatalities. Of interest was occupancy, building construction and the specific structural system that collapsed. The primary focus was on floor and roof construction. Of specific interest was the fireground task the firefighter was performing at the time the collapse occurred. Knowing and understanding fireground performance, coupled with knowledge of building construction will enhance the safety of firefighters and improve the efficiency and performance of fireground operations. Several reports are available regarding the topic of structural collapse and firefighter fatalities. While these reports are helpful in identifying structural collapse as an issue in the fire service, the information collected is vague and ambiguous. The objective of the following research is to provide specific details concerning every firefighter fatality from 1994 through 2013. The specific information will reveal trends in building collapse related to construction and fireground activity.

Data for firefighter fatalities that were caused by any manner of building collapse from 1994 through 2013 were collected and examined for this research project. Official information was gathered from the United States Fire Administration (USFA) Fallen Firefighter database, reports from the National Institute for Occupational Safety and Health (NIOSH), numerous state fire marshal and local fire department reports and numerous media agencies and the resulting coverage of specific incidents. Each USFA report was examined and the incidents involving building collapse were noted chronologically. Once the list was complete, further research was conducted to obtain the specific information listed in the following paragraph. Even after exhaustive research certain data points remain unknown. In certain cases the data was never recorded, official reports were unavailable or agencies declined to divulge the requested information. The data points are marked “unknown” in the document.

Several data parameters were examined for each fire incident and resulting firefighter fatality. Firefighter’s name and age, fire department, status (career or volunteer), fireground task performed at the time the collapse occurred, occupancy, building construction type, roof construction (if applicable) and floor construction (if applicable). Also included was a brief description of the incident and any additional information pertinent to the collapse. The data was grouped into categories. Each incident and fatality was tabulated and categorized.

II. Results

Between 1994 and 2013 there were 83 building collapses due to structure fires that resulted in 112 firefighter fatalities. 38 collapses involved roofs (46%), 29 collapses involved floors (35%) and 16 collapses were exterior walls or facades (19%). The focus of the research was primarily on floor and roof collapse. The following are the results of the known data. The information gathered in the report is distributed in the following sections.

Building Collapse and Firefighter Fatality 1994-2013

Roof Collapse

- There were 38 fires involving roof collapse resulting in 53 firefighter fatalities. Six (11%) firefighters were on top of the roof when it collapsed. The remaining 47 (89%) were underneath the roof system when it failed.
- Of the six firefighters operating on the roof, four were not wearing a self contained breathing apparatus (SCBA) or face piece. One was wearing wearing both SCBA and face piece and survived the initial collapse but was killed by fire conditions.
- Five of the six were in the process of performing vertical ventilation when the collapse occurred. One was trying to extinguish a chimney fire.
- The majority of firefighters operating below the roof were engaged in interior fire suppression (60%).
- Roof collapse occurred in commercial buildings (39%) and single family homes (34%) the most.
- Wood frame buildings were responsible for over half the collapses (53%).
- True dimensional rafters (34%) and lightweight wood truss roofs (32%) collapsed at almost identical rates.
- In 10 fires the cause was listed as accidental. 10 fires were the result of arson, 3 were electrical and 1 was caused by lightning. 14 fires the cause was either undetermined or was not available or listed in the report.
- Career firefighters were twice as likely to be killed than volunteers.

Floor Collapse

- True dimensional floors accounted for over 75% of all floor collapses. Pre engineered I beams (4) and lightweight wood trusses (2) accounted for 21% of the total collapses.
- Fires in buildings that suffered a floor collapse occurred in wood frame (type 5) buildings in two-thirds of the fires (66%). Ordinary (type 3) followed with fires occurring in those buildings 31% of the time.
- Single family houses suffered collapses in 69% of the fires studied.
- Firefighters were almost two times more likely to die while operating with a hoseline than performing search and rescue.
- 29 (71%) firefighters were on top of the floor collapse and 12 (29%) firefighters were underneath the floor when it collapsed.

Lightweight Roof Collapse

- There were 14 fires involving lightweight roof collapse resulting in 23 firefighter fatalities. Two (9%) firefighters were on top of the roof when it collapsed. The remaining 21 (91%) were underneath the roof system when it failed.
- The majority of firefighters operating below the roof were engaged in interior fire suppression (70%).
- Half the lightweight truss roof collapses occurred in commercial buildings. Multi-family homes (3) and churches (2) were also responsible for multiple firefighter fatalities.
- Wood frame buildings were responsible for 10 of the total collapses.
- Lightweight wood trusses collapsed killing firefighters 12 times and lightweight metal collapses killing firefighters two times.

Lightweight Floor Collapse

- There were 6 fires involving lightweight floor collapse resulting in 7 firefighter fatalities.
- All six fires occurred in single family homes.
- Five of the six buildings were wood frame. The remaining was ordinary construction.

- Pre engineered I beams collapsed four times and lightweight wood truss collapsed twice.
- All seven firefighters killed were operating above the collapse when it occurred.

Building Collapse and Firefighter Fatalities

1994-2013

Section 1

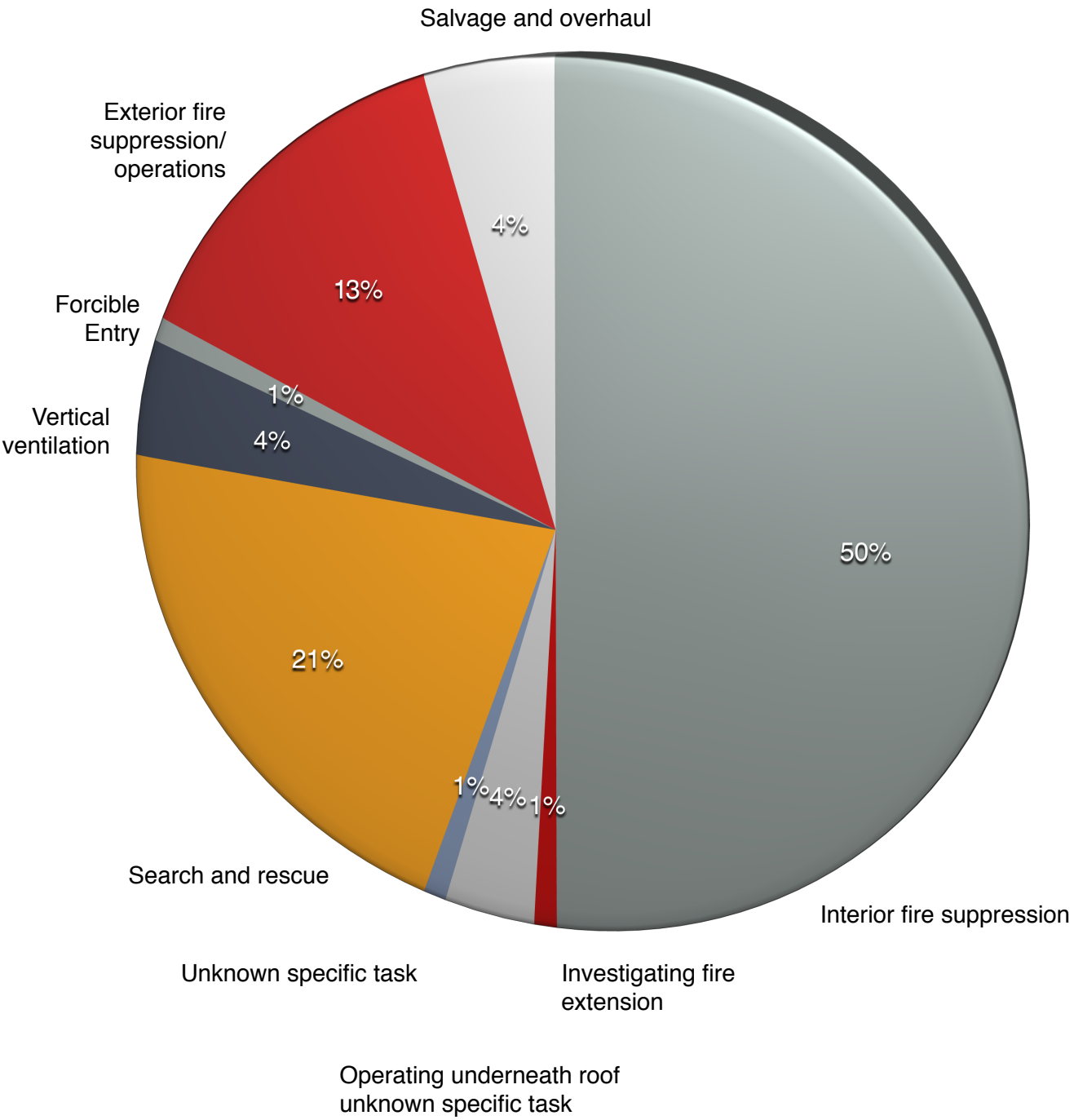
All Collapse

All Collapse

- Between 1994 and 2013 a total of 2177 firefighters lost their lives in the line of duty. Building collapse accounted for 5.1% of the total fatalities (112 firefighters) during that time period.
- Of the 112 total fatalities, 37 were volunteer firefighters and 75 were career firefighters.
- In 29 fires the cause was listed as accidental. 15 fires were the result of arson, four were electrical and one was caused by lightning. 34 fires the cause was either undetermined or was not available or listed in the report.
- Of the 112 firefighters killed, 56 were engaged in interior fire suppression and 24 were conducting search and rescue operations. An equal number of firefighters (5) were killed performing vertical ventilation and salvage and overhaul. 15 firefighters were killed conducting exterior fire operations. 1 firefighter was killed performing forcible entry.
- Single family homes collapsed in 42% of the cases studied. Commercial buildings were second at 31%. Churches (7%), Mixed residential/commercial occupancies (6%) and restaurants (4%) all collapsed at similar rates.
- Wood frame buildings accounted for over half the collapses (54%) while ordinary construction accounted for slightly less than one-third of total collapses (29%). In 13% of collapses the building construction type was unreported and unknown.
- Single collapses occurred in fire resistive, non combustible and heavy timber buildings.

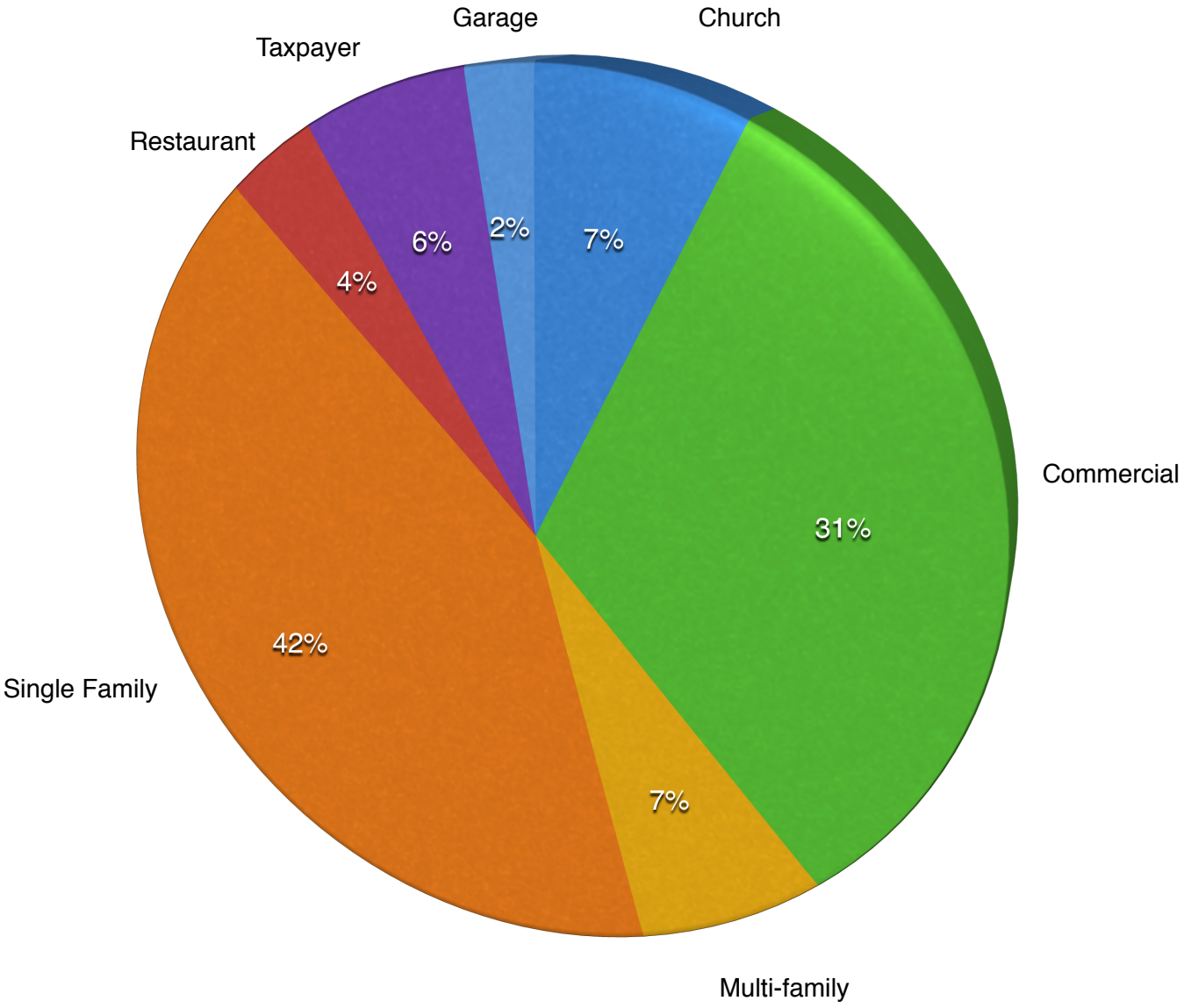
Fireground Task

Interior fire suppression	56
Investigating fire extension	1
Operating underneath roof- unknown specific task	4
Unknown specific task	1
Search and rescue	24
Vertical ventilation	5
Forcible entry	1
Exterior fire suppression/operations	15
Salvage and overhaul	5



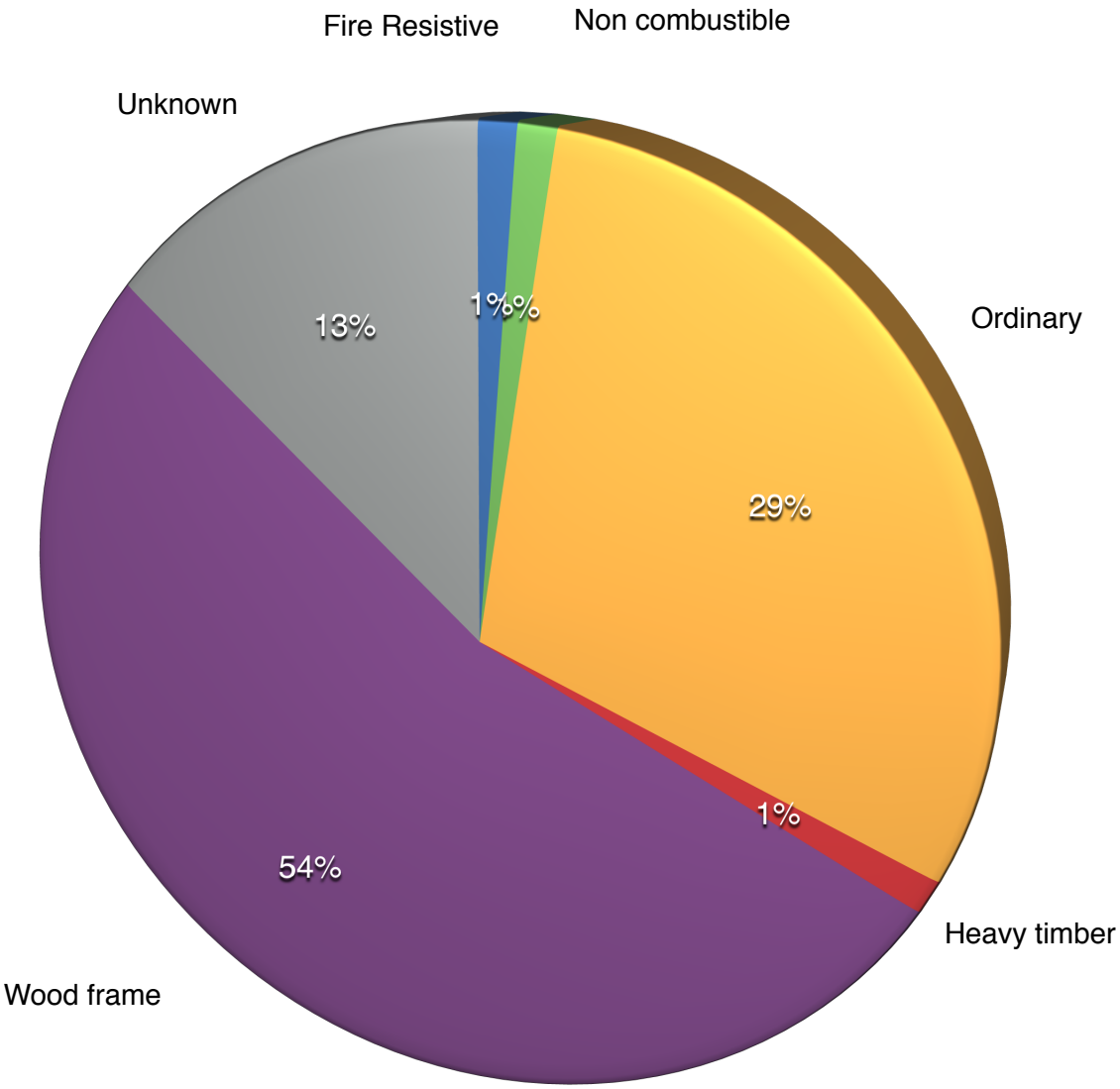
Occupancy

Church	6
Commercial	26
Multi family	6
Single family	35
Restaurant	3
Taxpayer	5
Garage	2



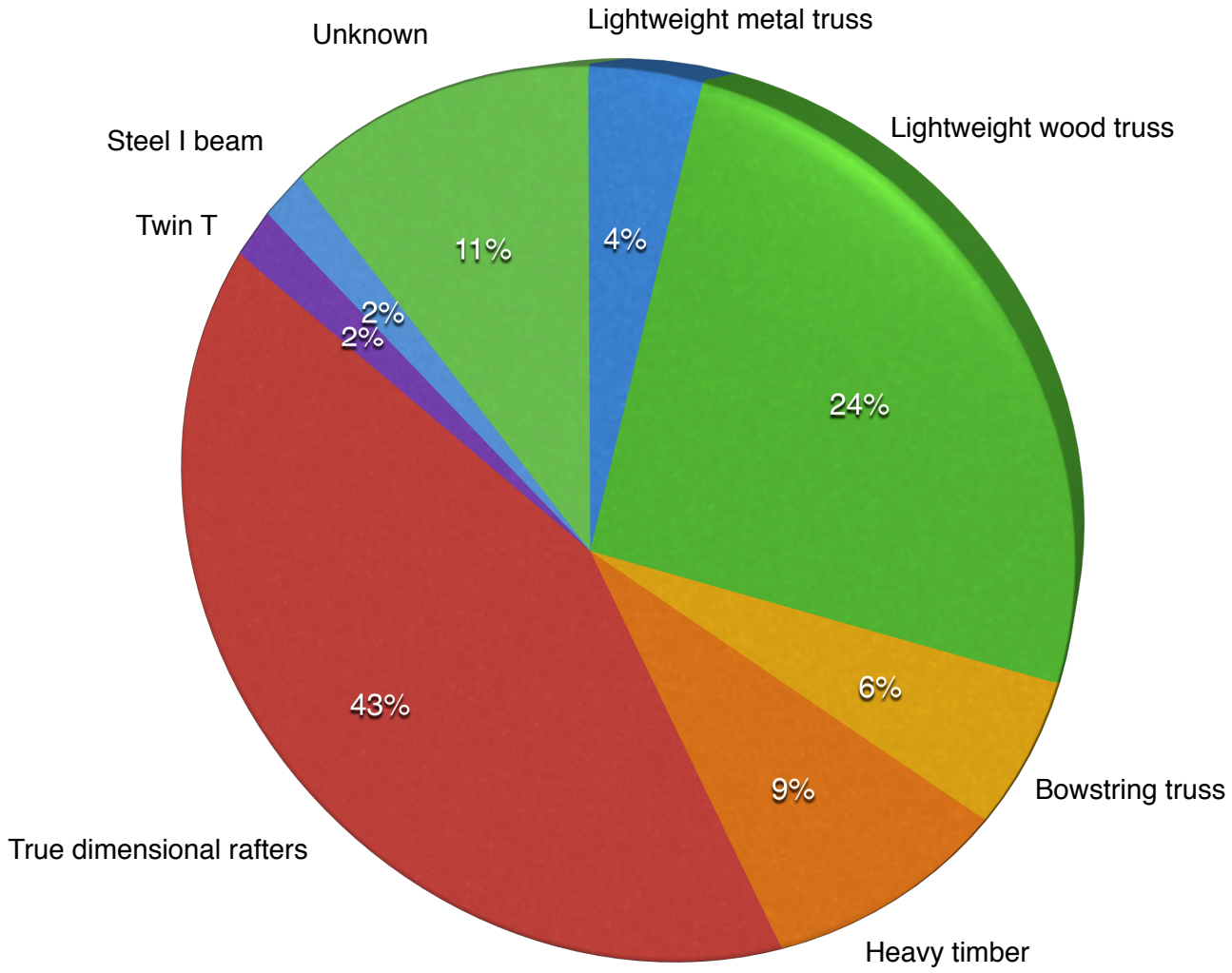
Building Construction

Type 1 Fire Resisitive	1
Type 2 Non combustible	1
Type 3 Ordinary	24
Type 4 Heavy timber	1
Type 5 Wood frame	45
Unknown	11



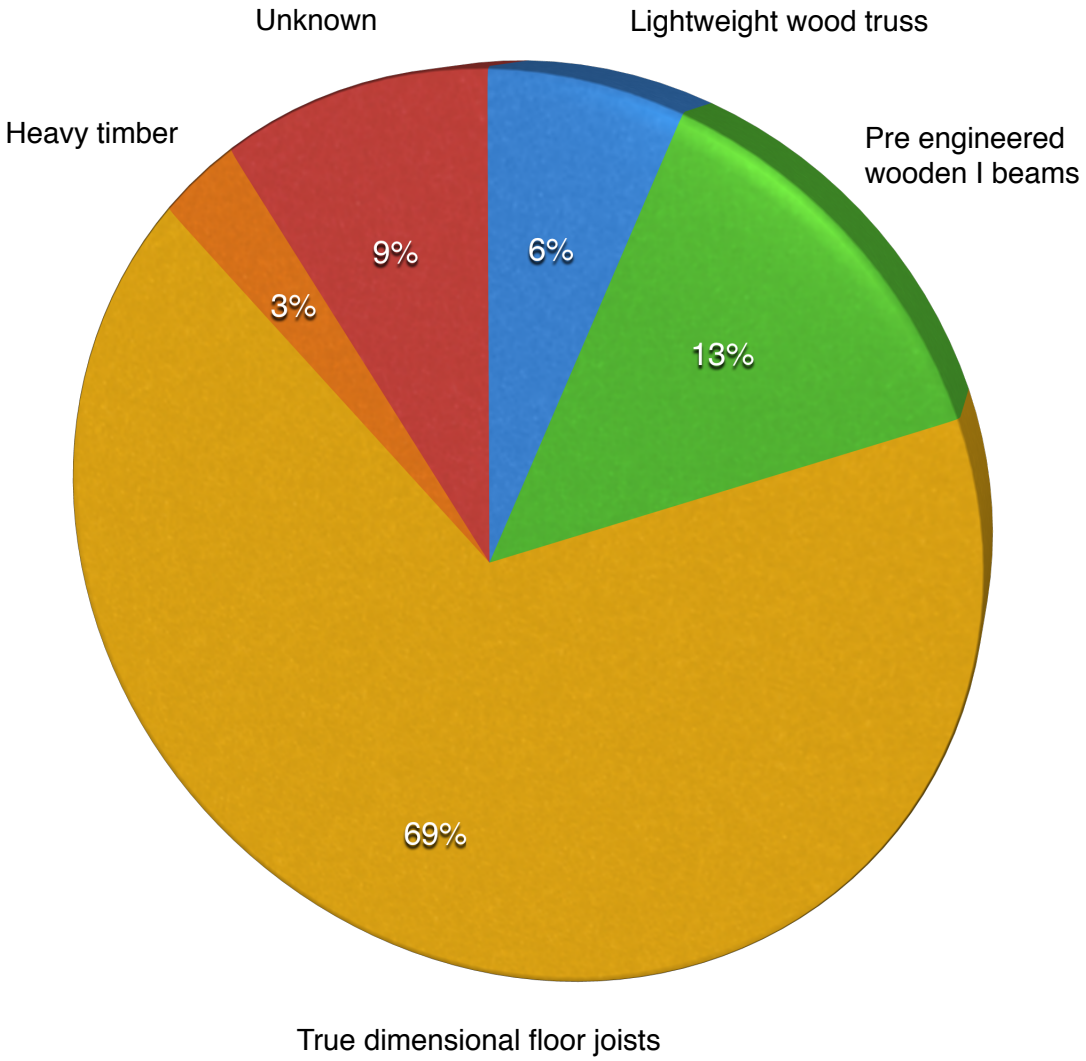
Roof Construction

Lightweight metal truss	2
Lightweight wood truss	13
Bowstring truss	3
Heavy timber	5
True dimensional rafters	23
Twin T	1
Steel I Beam	1
Unknown	6



Floor Construction

Lightweight wood truss	2
Pre engineered wooden I beams	4
True dimensional floor joists	22
Heavy timber	1
Unknown	3



Building Collapse and Firefighter Fatalities

1994-2013

Section 2

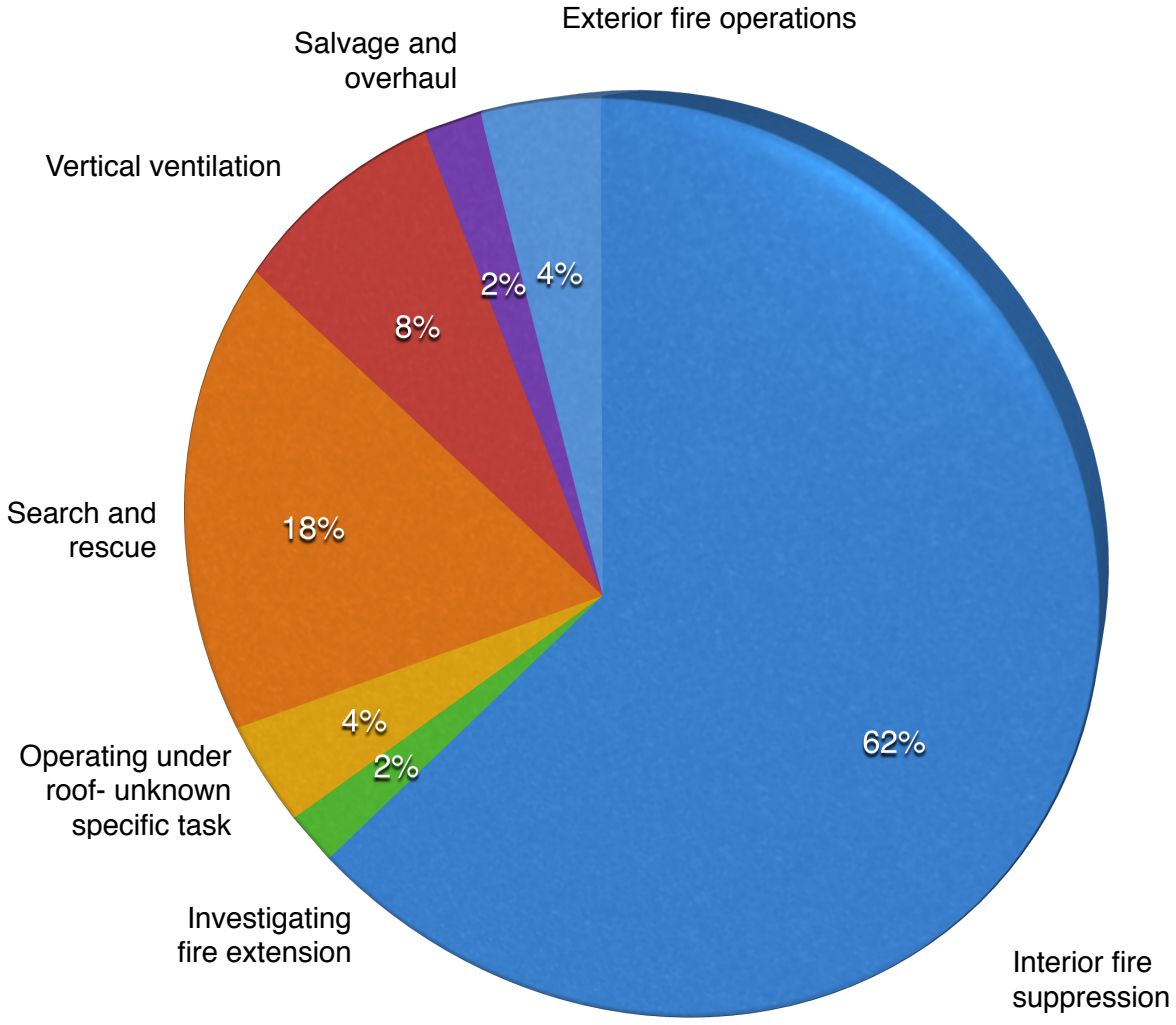
Roof Collapse

Roof Collapse

- There were 38 fires involving roof collapse resulting in 53 firefighter fatalities. Six (11%) firefighters were on top of the roof when it collapsed. The remaining 47 (89%) were underneath the roof system when it failed.
- Of the six firefighters operating on the roof, four were not wearing a self contained breathing apparatus (SCBA) or face piece. One was wearing wearing both SCBA and face piece and survived the initial collapse but was killed by fire conditions.
- Five of the six were in the process of performing vertical ventilation when the collapse occurred. One was trying to extinguish a chimney fire.
- The majority of firefighters operating below the roof were engaged in interior fire suppression (60%).
- Roof collapse occurred in commercial buildings (39%) and single family homes (34%) the most.
- Wood frame buildings were responsible for over half the collapses (53%).
- True dimensional rafters (34%) and lightweight wood truss roofs (32%) collapsed at almost identical rates.
- In 10 fires the cause was listed as accidental. 10 fires were the result of arson, 3 were electrical and 1 was caused by lightning. 14 fires the cause was either undetermined or was not available or listed in the report.
- Career firefighters were twice as likely to be killed than volunteers.

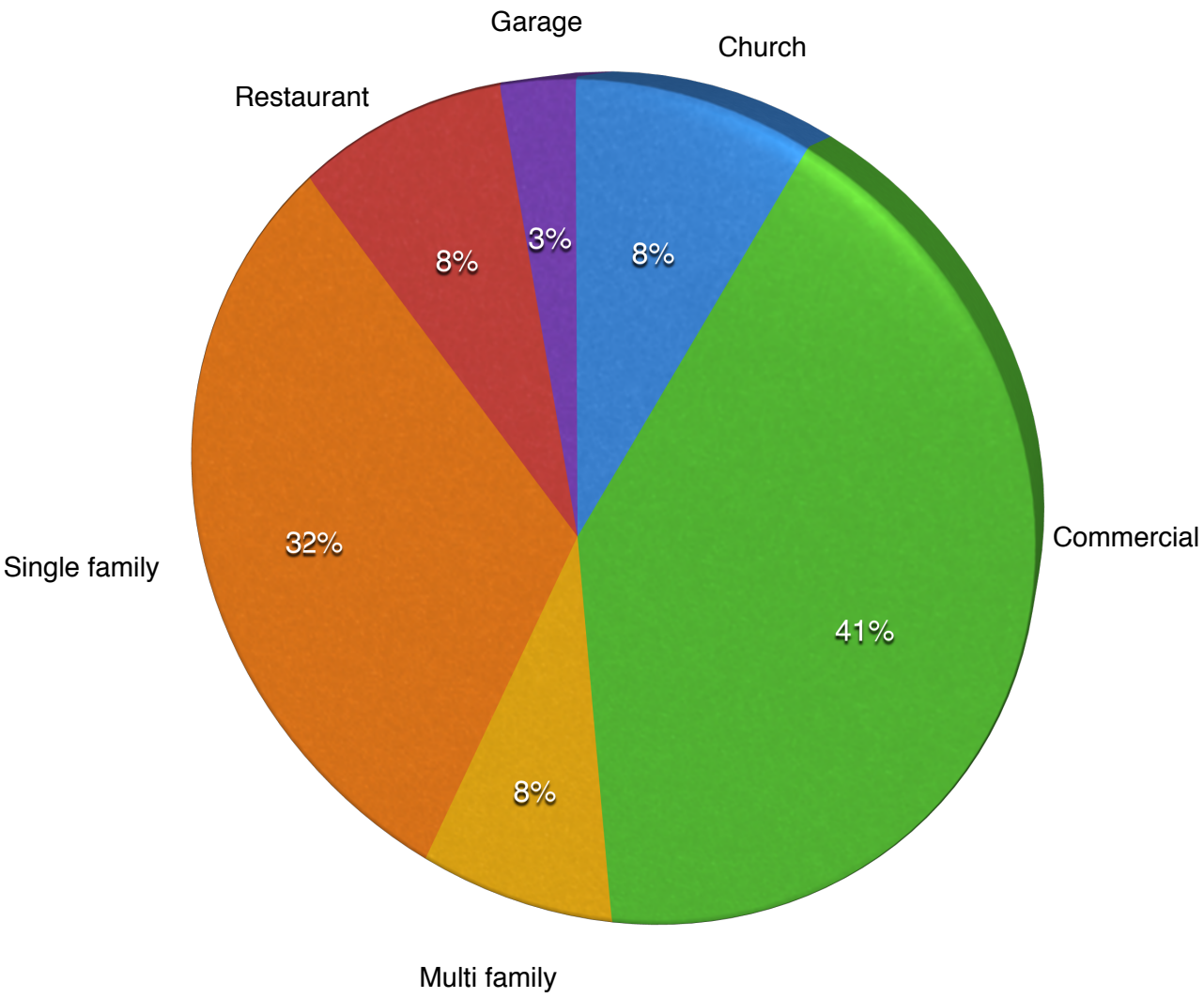
Fireground Task

Interior fire suppression	31
Investigating fire extension	1
Operating underneath roof- unknown specific task	3
Search and rescue	9
Vertical ventilation	5
Salvage and overhaul	1
Exterior fire operations	2



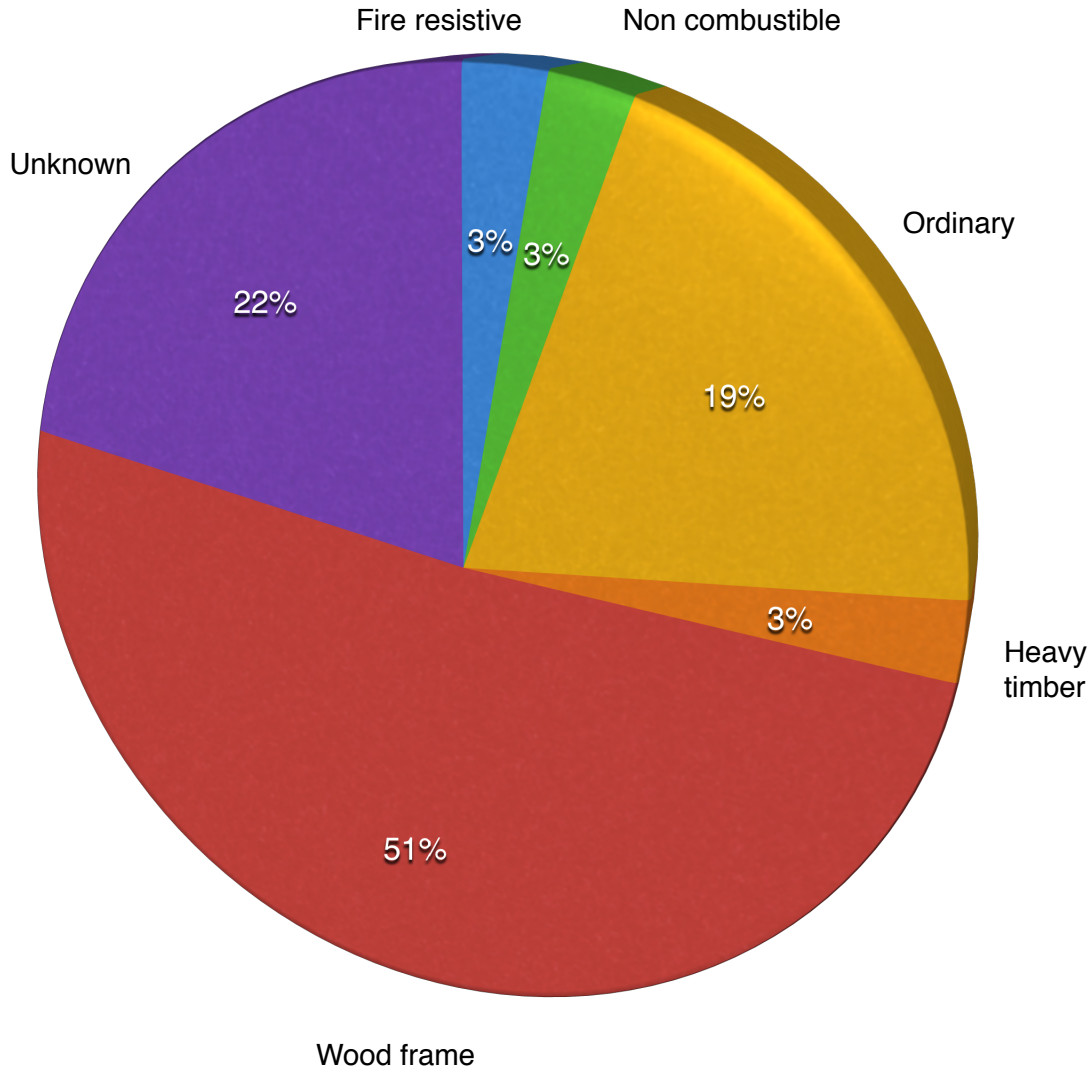
Occupancy

Church	3
Commercial	15
Multi family	3
Single family	12
Restaurant	3
Garage	1



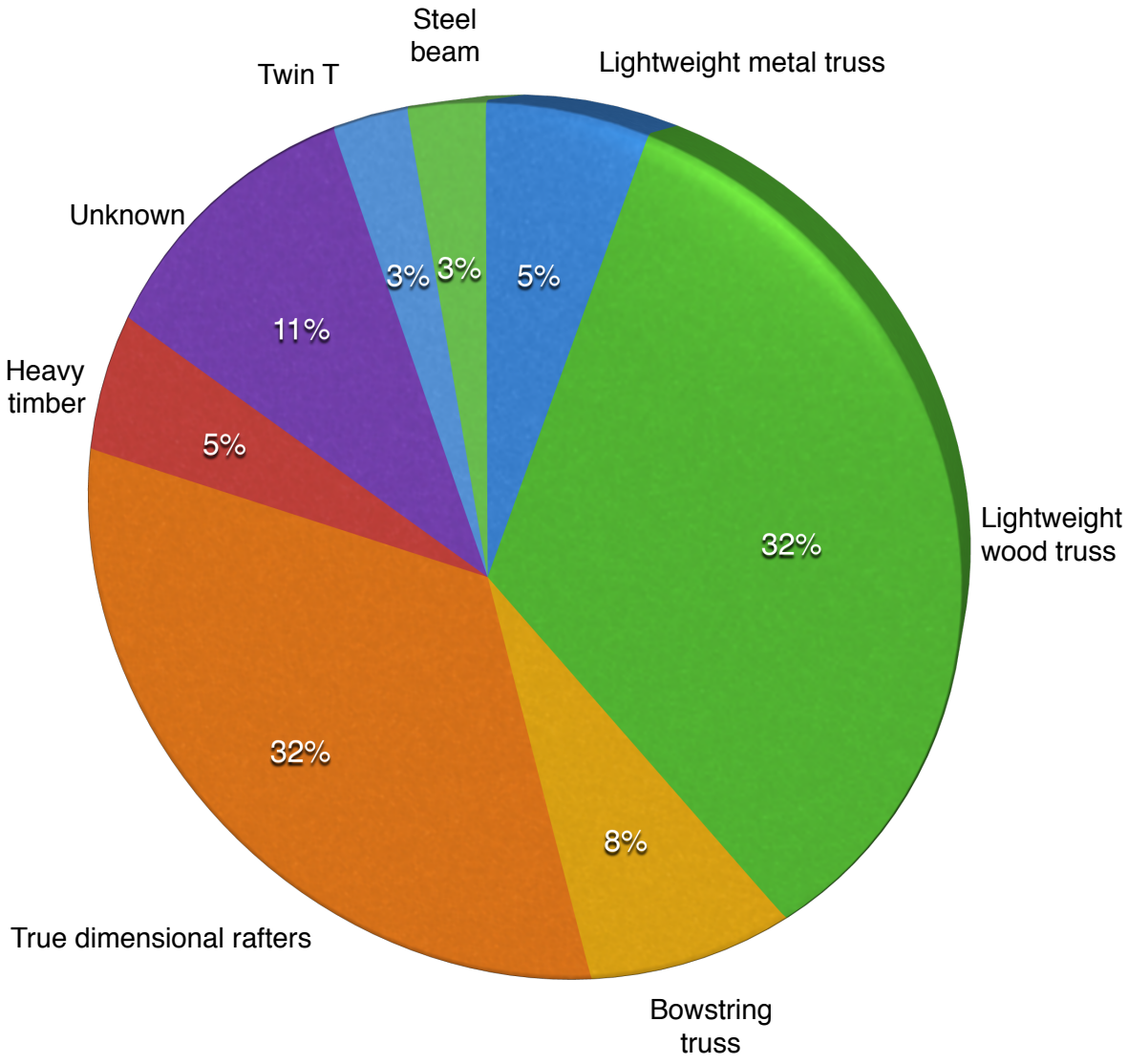
Building Construction

Type 1	Fire resistive	1
Type 2	Non combustible	1
Type 3	Ordinary	7
Type 4	Heavy timber	1
Type 5	Wood frame	19
Unknown		8



Roof Construction

Lightweight metal truss	2
Lightweight wood truss	12
Bowstring truss	3
True dimensional rafters	12
Heavy timber	2
Unknown	4
Twin T	1
Steel beam	1



Building Collapse and Firefighter Fatalities

1994-2013

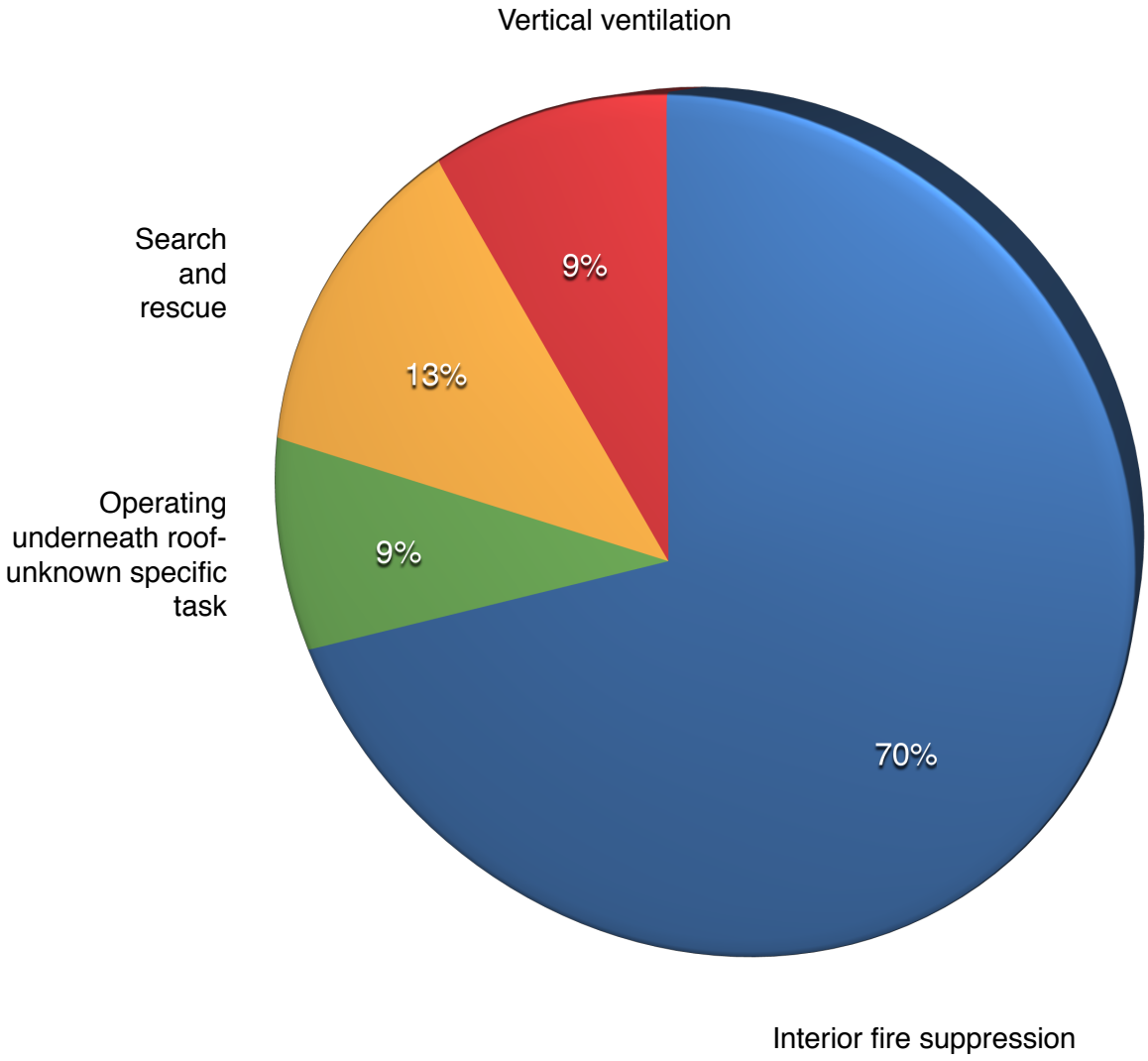
Section 3

Lightweight Roof Collapse

- There were 14 fires involving lightweight roof collapse resulting in 23 firefighter fatalities. Two (9%) firefighters were on top of the roof when it collapsed. The remaining 21 (91%) were underneath the roof system when it failed.
- The majority of firefighters operating below the roof were engaged in interior fire suppression (70%).
- Half the lightweight truss roof collapses occurred in commercial buildings. Multi-family homes (3) and churches (2) were also responsible for multiple firefighter fatalities.
- Wood frame buildings were responsible for 10 of the total collapses.
- Lightweight wood trusses collapsed killing firefighters 12 times and lightweight metal collapses killing firefighters two times.

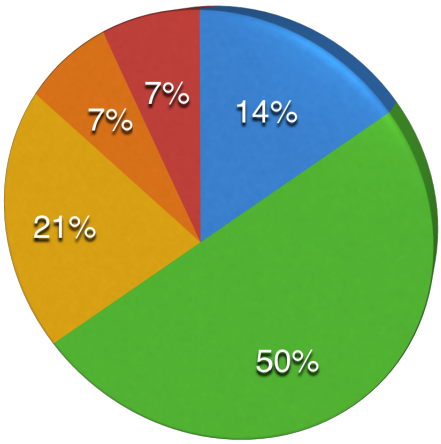
Fireground Task

Interior fire suppression	16
Operating underneath roof- unknown specific task	2
Search and rescue	3
Vertical ventilation	2



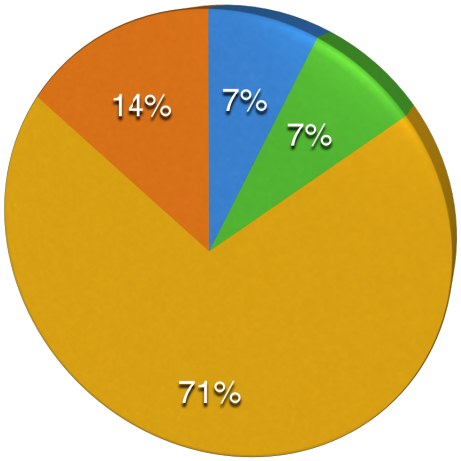
Occupancy

- Church 2
- Commercial 7
- Multi family 3
- Single family 1
- Restaurant 1



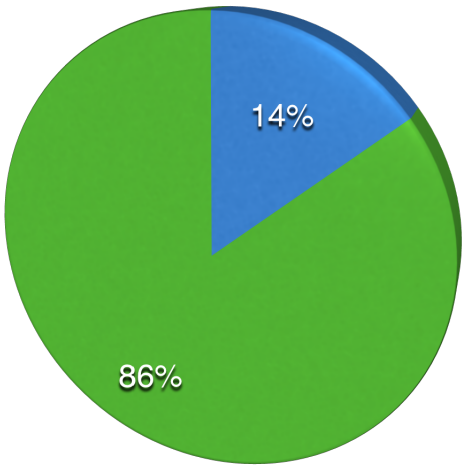
Building Construction

- Type 2 Non combustible 1
- Type 3 Ordinary 1
- Type 5 Wood frame 10
- Unknown 2



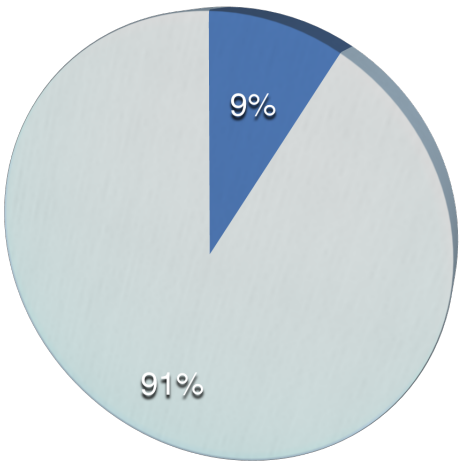
Roof Construction

- Lightweight metal truss 2
- Lightweight wood truss 12



Location During Collapse

- Above Collapse 2
- Below Collapse 21



Building Collapse and Firefighter Fatalities

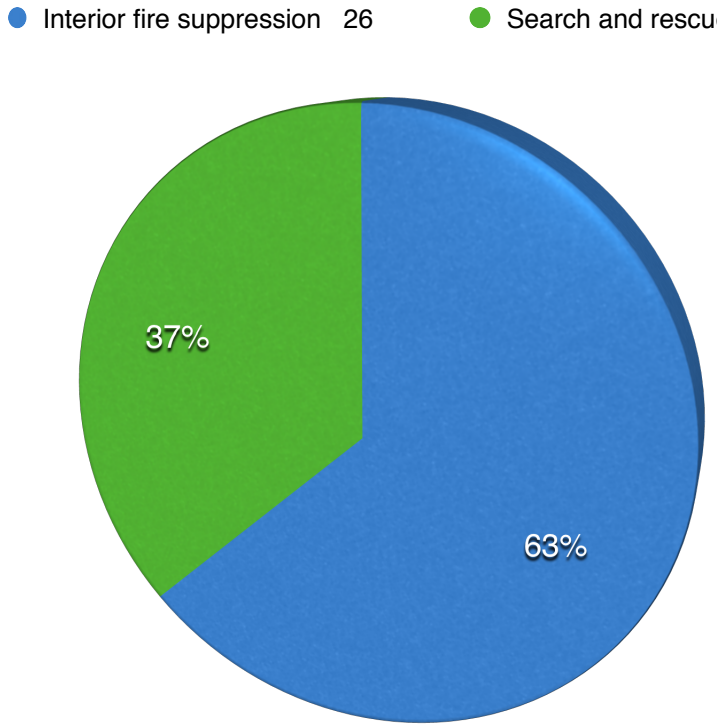
1994-2013

Section 4

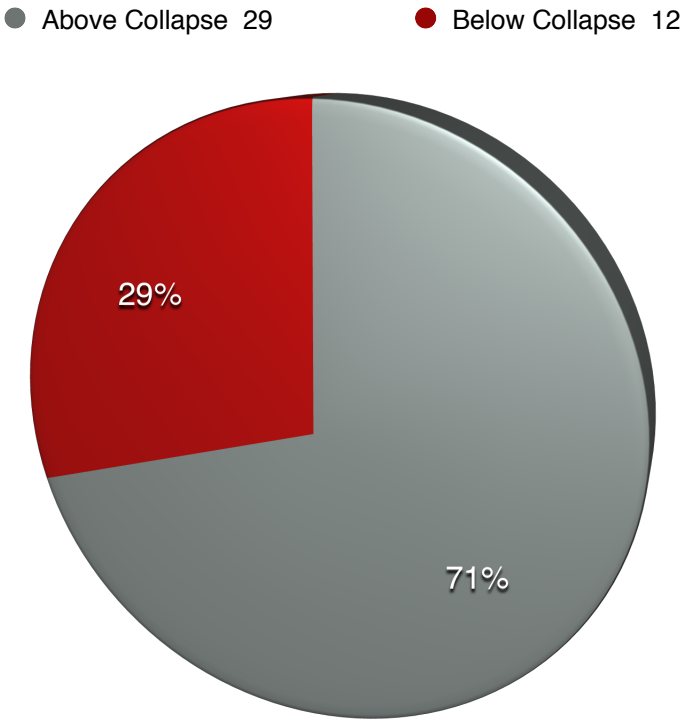
Floor Collapse

- True dimensional floors accounted for over 75% of all floor collapses. Pre engineered I beams (4) and lightweight wood trusses (2) accounted for 21% of the total collapses.
- Fires in buildings that suffered a floor collapse occurred in wood frame (type 5) buildings in two-thirds of the fires (66%). Ordinary (type 3) followed with fires occurring in those buildings 31% of the time.
- Single family houses suffered collapses in 69% of the fires studied.
- Firefighters were almost two times more likely to die while operating with a hoseline than performing search and rescue.
- 29 (71%) firefighters were on top of the floor collapse and 12 (29%) firefighters were underneath the floor when it collapsed.

Fireground Task

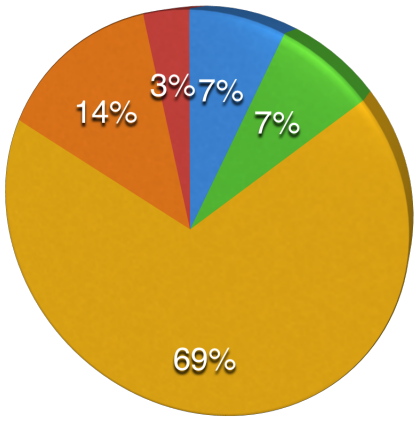


Location During Collapse



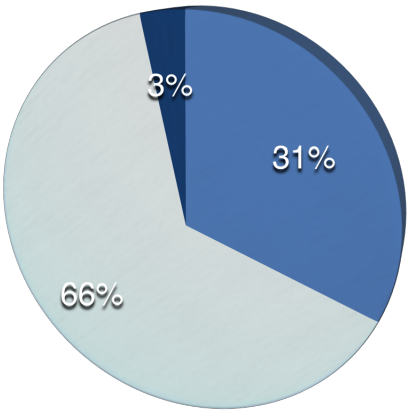
Occupancy

Commercial	2
Multi family	2
Single family	20
Commercial/Residential (taxpayer)	4
Church	1



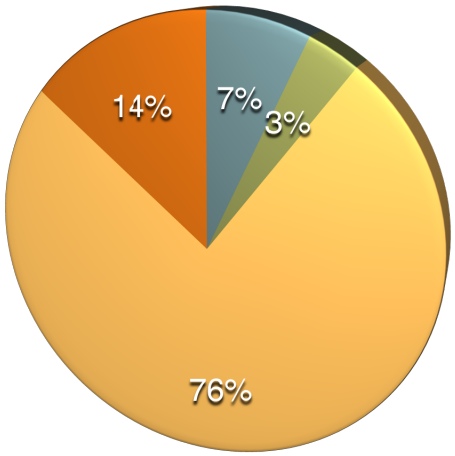
Building Construction

Type 3 Ordinary	9
Type 5 Wood frame	19
Unknown	1



Floor Construction

Lightweight wood truss	2
Heavy timber	1
True dimensional	22
Pre engineered I beams	4



Building Collapse and Firefighter Fatalities

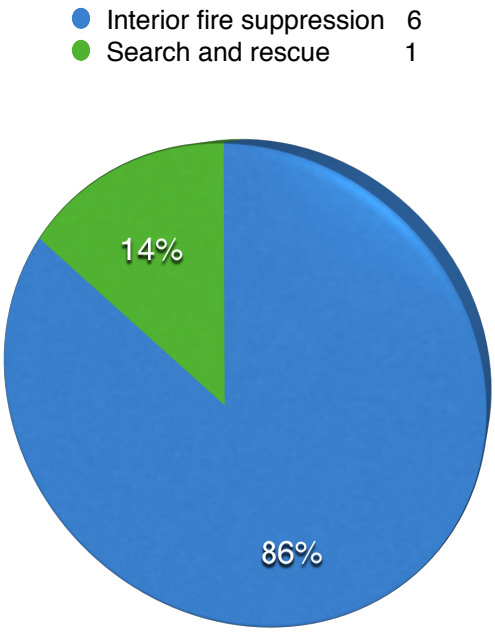
1994-2013

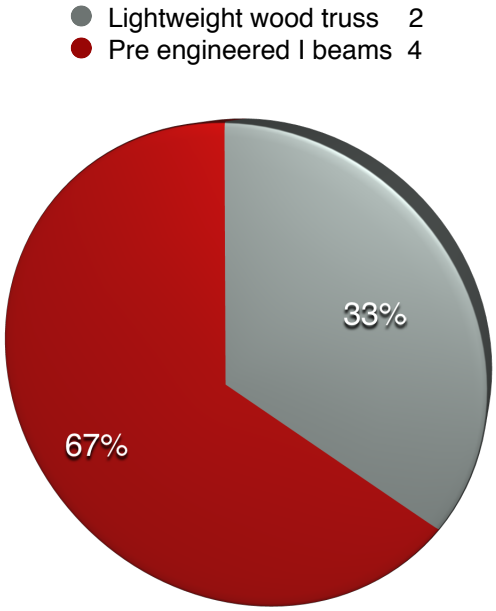
Section 5

Lightweight Floor Collapse

Of the 83 total collapses between January 1st, 1994 and December 31st, 2013, 6 involved lightweight wood floor systems and accounted for 7% of total collapses during that time.

- The 6 collapses resulted in 7 firefighter fatalities.
- Of the 7 total fatalities, 3 were volunteer firefighters and 4 were career firefighters.
- In 3 fires the cause was listed as accidental. 1 fire was the result of arson and 2 fires the cause was either undetermined or was not available or listed in the report.
- 6 of the firefighters killed were engaged in interior fire suppression. The other firefighter was performing search and rescue.
- All 7 firefighters were operating on top of the floor that collapsed.
- All 6 collapses occurred in single family dwellings with 5 being wood frame construction. the other was brick.
- Pre engineered I beams were responsible for 4 collapses and lightweight wood trusses contributed to 2 of the collapses.





Conclusion

- Between 1994 and 2013, a total of 2177 firefighters lost their lives in the line of duty. Building collapse accounted for 112 (5.1%) firefighters of the total fatalities during that time period.
- Multiple fatalities occurred in 22 of the 83 collapses and accounted for 51 fatalities (46%).
- Interior fire suppression is statistically the most dangerous task firefighters perform on the fireground. Firefighters killed by building collapse were engaged in interior fire suppression exactly half (50%) of the time.
- Firefighters lost their lives because of collapse in single family homes 42% of the time.
- Collapse in commercial buildings was responsible for 31% of firefighter fatalities.
- Collapse occurred in wood frame (type 5) at almost double the rate of ordinary (type 3) buildings.
- True dimensional roofs collapsed more than any other roof system (23 times). Lightweight truss accounted for 15 collapses.
- Six firefighters died when collapsed occurred while they were operating on the roof.
- Four of the six were not wearing a self contained breathing apparatus (SCBA) or face piece. One was wearing wearing both SCBA and face piece and survived the initial collapse but was killed by fire conditions.
- Five of the six were in the process of performing vertical ventilation when the collapse occurred. One was trying to extinguish a chimney fire.
- The same number of firefighters died performing vertical ventilation and salvage and overhaul (5 each).
- Firefighters were three times as likely to die operating on the exterior of the building at ground level as they were performing vertical ventilation.
- Firefighters were almost five times as likely to die during search operations as they were performing vertical ventilation.
- Firefighters were 11 times as likely to die operating hoselines in the interior of the building as they were performing vertical ventilation.
- Firefighters were nearly five and a half times more likely to die operating inside of the building than outside of the building.
- Firefighters were 16 times more likely to die performing search and rescue and interior fire suppression as they were performing vertical ventilation.
- Of the 2177 firefighter fatalities since 1994, vertical ventilation accounted for 5 (0.23%) total deaths.
- True dimension floor systems collapsed at nearly four times the rate of lightweight systems.
- Career firefighters were killed at more than twice the rate of volunteer firefighters.

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Dedicated to the men and women whose names appear in this report