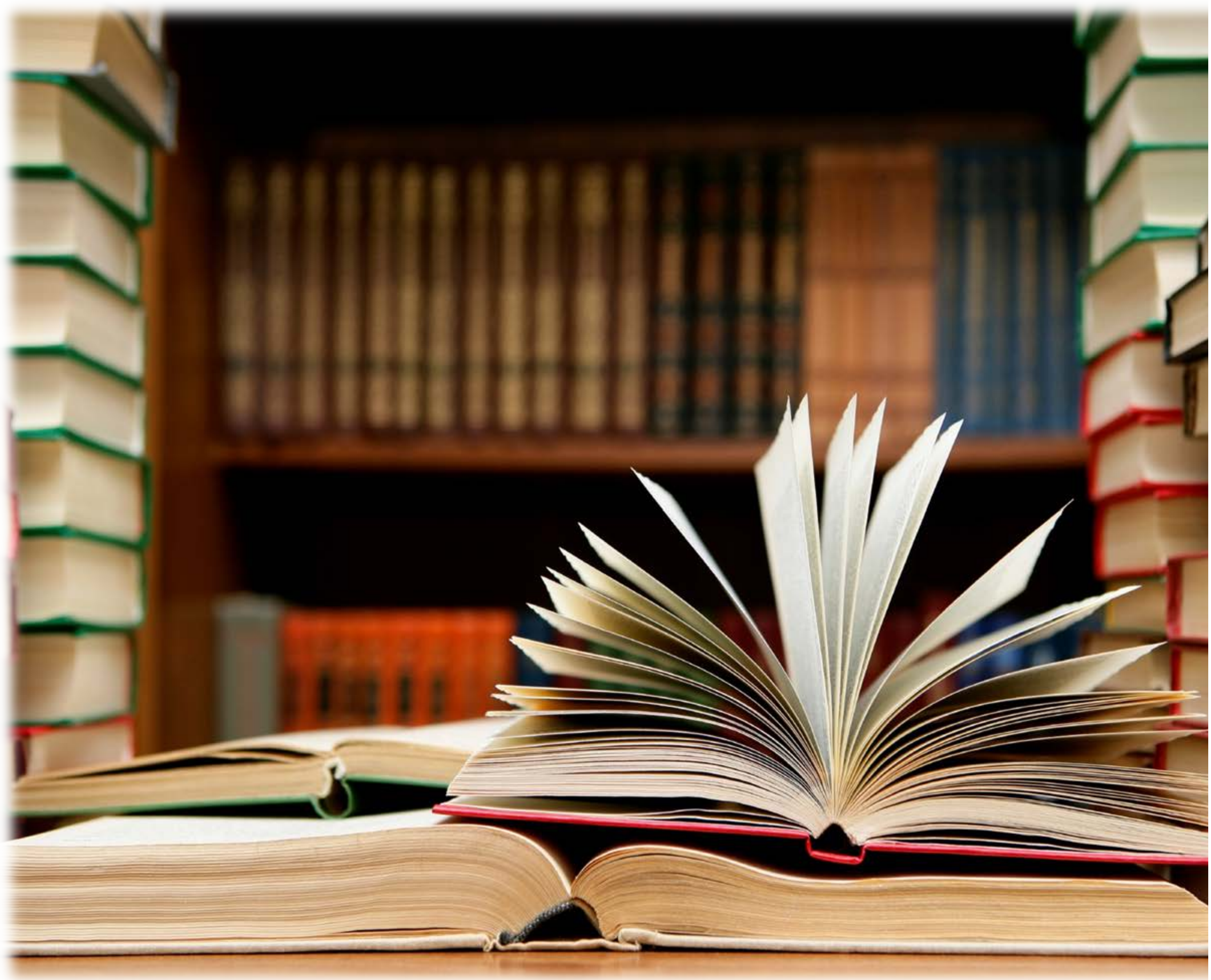
Fire Outcomes by General Construction Type

A Retrospective Analysis of British Columbia Reported Fires



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Overview of this Research

This report examines British Columbia (BC) building fires as a function of the general construction type. The fires that are examined were reported to the BC Office of the Fire Commissioner (OFC) between October 20 2008 and October 19 2013. The data included in this analysis was provided by 339 reporting agencies across the province, sampled from first nations band areas, non-municipal areas (with and without fire protection), and municipal areas. Comparisons were drawn between 11,875 fires that occurred in the five broad general construction type categories: (1) combustible construction – open wood joist (also called "combustible construction" throughout this report, $n = 2{,}241$), (2) protected combustible construction – wood protected by plastic/gyproc (also called "protected combustible construction" throughout this report, $n = 7{,}808$), (3) heavy timber construction ($n = 226$), (4) non-combustible construction ($n = 507$), and (5) protected non-combustible construction – protected steel or concrete (also called "protected non-combustible construction" throughout this report, $n = 1{,}093$). Across all these fires there were a total of 772 injuries and 107 deaths reported to the OFC. The analysis revealed the following main findings with respect to fires that occurred in these various construction types:

- Almost two-thirds of the sample of fires examined here occurred in buildings made of "protected combustible construction".
- Initial analysis revealed differences in the extent to which fires were contained to at least the room of origin with respect to the different construction types. However, when complete sprinkler protection was incorporated into this analysis, the patterns of fire spread across construction types were much more comparable;
- Variations in the methods by which the fires were controlled as a function of the general construction type can be interpreted with respect to difference in the presence of effective fire safety systems (e.g., functioning smoke alarms and complete sprinkler protection) and do not necessarily relate to construction type;
- Initial variations in the fire-related casualties (injuries and deaths) were observed when analysing all fires without acknowledging the significance of fire safety systems (e.g., complete sprinkler protection and activated smoke alarms). When these systems were included in the analysis, no fatalities were observed in the remaining fires, regardless of construction type. Regardless of the life safety systems, the rates of injuries were always highest for fires that occurred in "protected combustible construction"; and
- Fire-related injuries were found to be more frequent for fires that activated a smoke alarm, which is consistent with by prior research by the authors.

No policy or practice recommendations are made as a consequence of these findings, as this is a retrospective analysis and there are limitations with the data that prevent specific conclusions being drawn.

The Scope of the Dataset

The 11,875 fires in examined here were taken from a larger set of 34,708 fires that occurred in BC between October 20, 2008 and October 19, 2013 that were reported to the BC OFC.[1] Therefore, the sample of fires included here represents 34.2% of all residential fires reported during this time period. Overall, this sample included fires that resulted in 772 fire-related injuries and 107 deaths. The frequencies of fires, deaths, and injuries across these five general construction types are presented in Table 1. As explained above, 339

[1] General construction type was based on GC codes GC1000 to GC5000, inclusive, BC Fire Reporting Manual.

reporting locations across the province submitted reports for fires that were included in this data set. Examination of the sample of fires retained for subsequent analysis in this report reveals that almost two-thirds (65.8%) occurred in constructions made of "protected combustible construction", which accounted for 75 percent of the total injuries and 62 percent of the fatalities. In contrast, fires in "combustible construction" accounted for 14 percent of injuries and 30 percent of deaths.

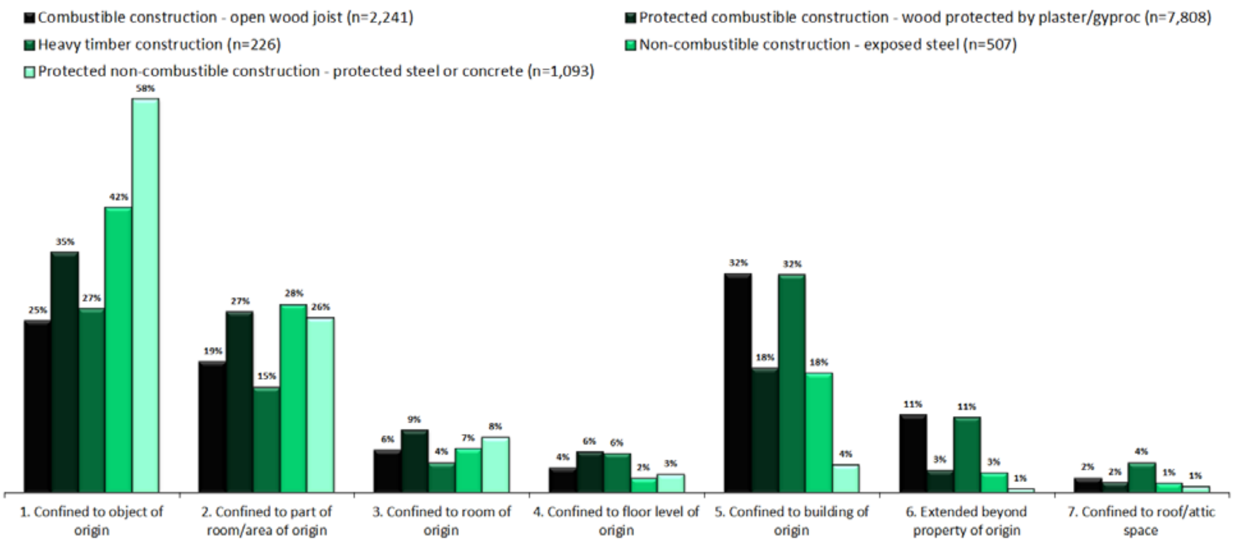
TABLE 1: FREQUENCIES OF FIRES, DEATHS, AND INJURIES BY GENERAL CONSTRUCTION TYPE

	Full sample of reported fires				Retained for subsequent analysis			
General construction type	**# fires**	**% fires**	**# injured**	**# death**	**# fires**	**% fires**	**# injured**	**# death**
Combustible construction - open wood joist	2,241	6.5%	112	32	2,241	18.9%	112	32
Protected combustible construction - wood protected by plaster/gyproc	7,808	22.5%	579	66	7,808	65.8%	579	66
Heavy timber construction	226	0.7%	10	2	226	1.9%	10	2
Non-combustible construction - exposed steel	507	1.5%	22	1	507	4.3%	22	1
Protected non-combustible construction - protected steel or concrete	1,093	3.1%	49	6	1,093	9.2%	49	6
Cannot be determined	1,248	3.6%	52	17	—	—	—	—
General construction - unclassified	1,317	3.8%	74	23	—	—	—	—
Not applicable (e.g., vehicle, outdoor, person)	20,268	58.4%	135	51	—	—	—	—
Grand Total	**34,708**	**100.0%**	**1033**	**198**	**11,875**	**100.0%**	**772**	**107**

The Extent of Fire Spread as a Function of General Construction Type

The extent of fire spread from the point of origin was examined as a function of the building general construction type. The initial analysis of the fire spread looked at all fires in each building, regardless of the presence of complete sprinkler protection in each structure, with the results displayed in Figure 1. This figure demonstrates large variations between construction types with respect to the frequency at which fires were confined to at least the room of origin: "combustible construction" (51%), "protected combustible construction" (71%), "heavy timber construction" (47%), "non-combustible construction" (76%), and "protected non-combustible construction" (92%).

FIGURE 1. THE EXTENT OF FIRE SPREAD BY GENERAL CONSTRUCTION TYPE, IGNORING THE INFLUENCE OF SPRINKLER PROTECTION (N = 11,875)

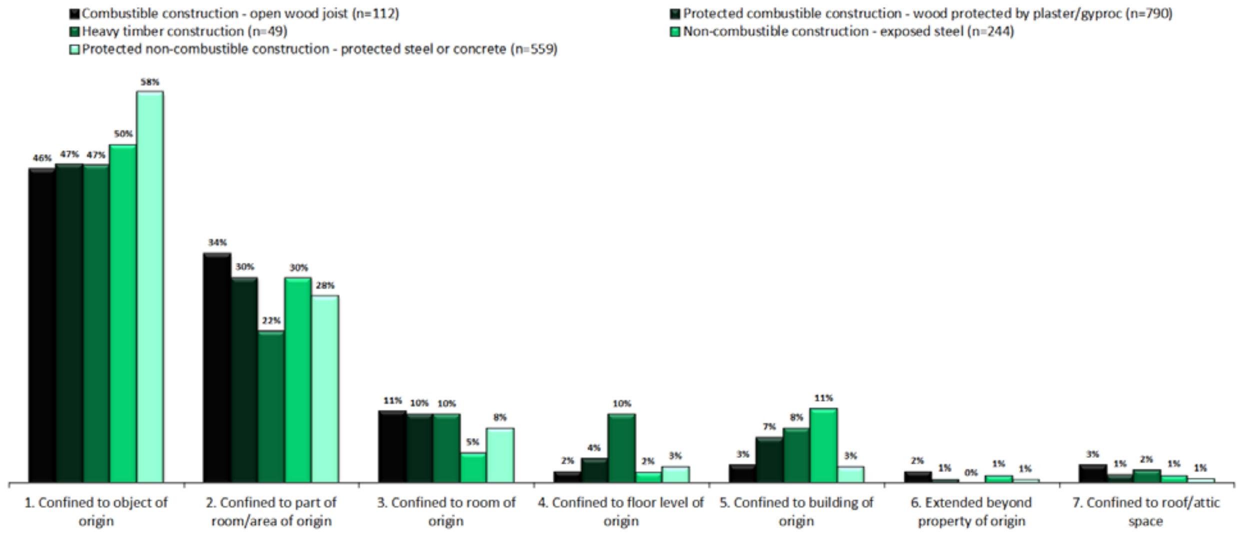


These patterns displayed in Figure 1 only give partial perspective into the variation in fire spread with respect to the different general construction types. As can be seen from Table 2, there is a large degree of variation for the presence of fire safety systems (particularly functioning smoke alarms and complete sprinkler protection) across the buildings that are the focus of this analysis. The sprinkler protection varies from 5 percent of the "combustible construction" sample to 51 percent for the "protected non-combustible construction" buildings that experienced fires. The same pattern was observed for smoke alarm activation, ranging from 19 percent for "combustible construction" buildings up to 48 percent for "protected non-combustible construction". Consequently, it was important to re-examine the patterns for fire spread by construction type to examine the significance of complete sprinkler protection (with the outcome displayed in Figure 2, below). In contrast to the initial analysis and focusing on those buildings that had complete sprinkler protection, Figure 2 demonstrates much less variation between construction types with respect to the frequency at which fires were confined to at least the room of origin: "combustible construction" (91%), "protected combustible construction" (88%), "heavy timber construction" (80%), "non-combustible construction" (85%), and "protected non-combustible construction" (94%).

TABLE 2: FREQUENCIES OF FIRES, SPRINKLER PROTECTION (%), SMOKE ALARM ACTIVATION (%), DEATH RATE AND INJURY RATE BY GENERAL CONSTRUCTION TYPE

General construction type	# fires	% sprinkler protected	% smoke alarm activated	Death rate	Injury rate
Combustible construction - open wood joist	2,241	5.0%	18.8%	14.3	50.0
Protected combustible construction - wood protected by plaster/gyproc	7,808	10.1%	33.9%	8.5	74.2
Heavy timber construction	226	21.7%	19.5%	8.8	44.2
Non-combustible construction - exposed steel	507	48.1%	22.1%	2.0	43.4
Protected non-combustible construction - protected steel or concrete	1,093	51.1%	48.3%	5.5	44.8
Total	**11,875**	**14.8%**	**31.6%**	**9.0**	**65.0**

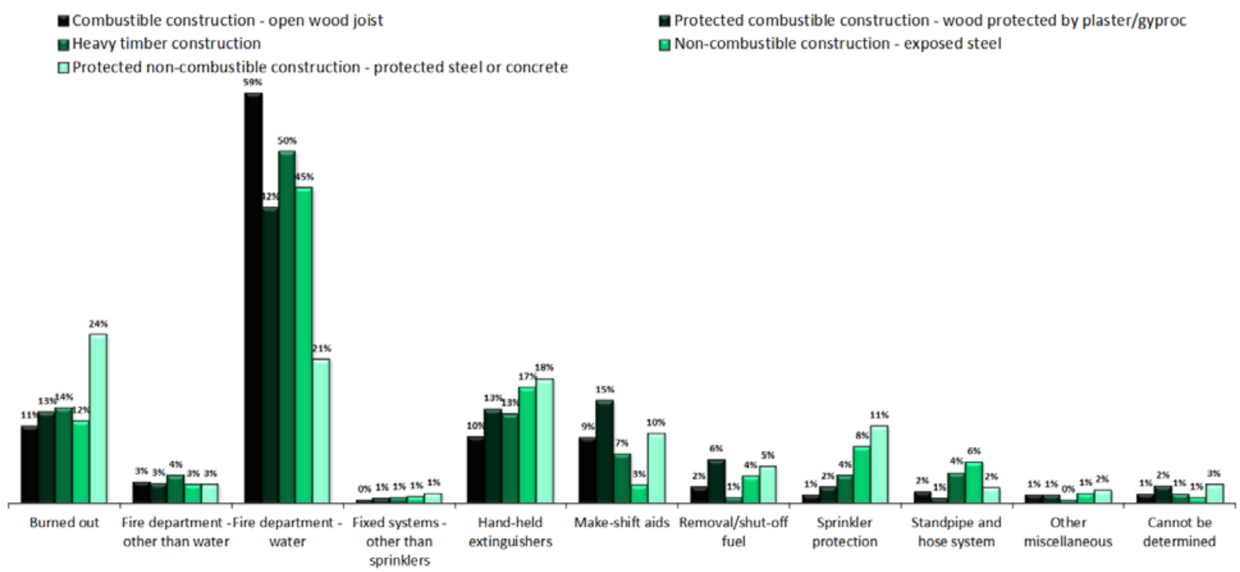
FIGURE 2. THE EXTENT OF FIRE SPREAD BY GENERAL CONSTRUCTION TYPE, FOR THOSE FIRES IN BUILDINGS WITH COMPLETE SPRINKLER PROTECTION ONLY (N = 1,754)



The Method of Fire Control as a Function of General Construction Type

The various frequencies of the methods of fire control used are displayed in Figure 3, as a function of the building general construction type. There are clear differences between the construction groups with respect to the method of fire control. It is anticipated a range of factors are responsible for these patterns, however, and given the findings demonstrated in Figure 2, above, it is reasonable to assume these results reflect variations in building safety systems rather than being a function of the construction type involved.

FIGURE 3. THE METHOD OF FIRE CONTROL BY GENERAL CONSTRUCTION TYPE



Fire-Related Casualties as a Function of General Construction Type

The overall patterns for fire-related casualties (injuries and deaths) are displayed in Table 3, separated out by the general construction type of the buildings. This initial analysis indicates a greater injury and death rate for the three timber construction types, relative to the steel and/or concrete construction types. However, to continue to explore the significance of the fire safety systems in each construction type, some additional analysis was undertaken. First, the patterns for fire-related casualties were examined with respect to complete sprinkler protection (Table 4), next these patterns were explored with respect to the presence of an activated smoke alarm (Table 5), and finally the patterns were looked at with respect to fires in buildings with both complete sprinkler protection and an activated smoke alarm (Table 6). As can be seen from this combination of tables, the death rate reduces when in the presence of a working smoke alarm, and drops to 0 for all construction types in the presence of complete sprinkler protection. The pattern for injuries shows a reduction for sprinkler protected fires (relative to the full-sample) but an increase for the smoke alarm activated fires. This pattern is consistent with previous work by these authors [e.g., 1, 2]. Overall, injuries were most common in "protected combustible constructions" regardless of the combination of fire safety systems in place.

TABLE 3. FIRE-RELATED CASUALTIES BY GENERAL CONSTRUCTION TYPE – ALL FIRES (N = 11,875)

General construction type	# fires	% fires	# injured	Injury rate	# death	Death rate
Combustible construction - open wood joist	2,241	18.9%	112	50.0	32	14.3
Protected combustible construction - wood protected by plaster/gyproc	7,808	65.8%	579	74.2	66	8.5
Heavy timber construction	226	1.9%	10	44.2	2	8.8
Non-combustible construction - exposed steel	507	4.3%	22	43.4	1	2.0
Protected non-combustible construction - protected steel or concrete	1,093	9.2%	49	44.8	6	5.5
Grand Total	**11,875**	**100.0%**	**772**	**65.0**	**107**	**9.0**

TABLE 4. FIRE-RELATED CASUALTIES BY GENERAL CONSTRUCTION TYPE – SPRINKLER PROTECTED FIRES (N = 1,754)

General construction type	# fires	% fires	# injured	Injury rate	# death	Death rate
Combustible construction - open wood joist	112	6.4%	0	0.0	0	0.0
Protected combustible construction - wood protected by plaster/gyproc	790	45.0%	38	48.1	0	0.0
Heavy timber construction	49	2.8%	1	20.4	0	0.0
Non-combustible construction - exposed steel	244	13.9%	4	16.4	0	0.0
Protected non-combustible construction - protected steel or concrete	559	31.9%	17	30.4	0	0.0
Grand Total	**1,754**	**100.0%**	**60**	**34.2**	**0**	**0.0**

TABLE 5. FIRE-RELATED CASUALTIES BY GENERAL CONSTRUCTION TYPE – SMOKE ALARM ACTIVATED FIRES (N = 3,755)

General construction type	# fires	% fires	# injured	Injury rate	# death	Death rate
Combustible construction - open wood joist	421	11.2%	23	54.6	5	11.9
Protected combustible construction - wood protected by plaster/gyproc	2,650	70.6%	247	93.2	12	4.5
Heavy timber construction	44	1.2%	0	0.0	0	0.0
Non-combustible construction - exposed steel	112	3.0%	8	71.4	0	0.0
Protected non-combustible construction - protected steel or concrete	528	14.1%	33	62.5	2	3.8
Grand Total	**3,755**	**100.0%**	**311**	**82.8**	**19**	**5.1**

TABLE 6. FIRE-RELATED CASUALTIES BY GENERAL CONSTRUCTION TYPE – SMOKE ALARM ACTIVATED AND SPRINLKER PROTECTED FIRES (N = 865)

General construction type	# fires	% fires	# injured	Injury rate	# death	Death rate
Combustible construction - open wood joist	54	6.2%	0	0.0	0	0.0
Protected combustible construction - wood protected by plaster/gyproc	413	47.7%	26	63.0	0	0.0
Heavy timber construction	15	1.7%	0	0.0	0	0.0
Non-combustible construction - exposed steel	75	8.7%	1	13.3	0	0.0
Protected non-combustible construction - protected steel or concrete	308	35.6%	16	51.9	0	0.0
Grand Total	**865**	**100.0%**	**43**	**49.7**	**0**	**0.0**

General Summary of Findings and Conclusion

Overall, therefore, this analysis demonstrated that there appears to be little difference with respect to fire spread, death, and injury rates as a function of building general construction type, provided these buildings have functioning smoke alarms and complete sprinkler protection. Initially apparent vulnerabilities that appeared between construction types reduced when sprinklers were present and there was a functioning smoke alarm. Regardless of the construction material, for those buildings with these fire safety systems, these results demonstrated there were no fire deaths and remarkably similar fire spread, with most fires in all buildings contained to at least the room of origin. With these findings in mind, and in parallel with other research findings from the authors, it should be considered that more emphasis is placed on ensuring all buildings have operating, current, and optimal fire safety systems. In all cases, maintenance and safety system upgrades should be focused on ensuring optimal outcomes for life safety and reducing fire-related casualties.

References

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