Adapting to California Wildfires: Keys to Rebuilding in High Fire Risk Locations

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A rise in California wildfires has led to a significant increase in the number of acres and structures destroyed annually. The Tubbs Fire, known as one of California’s most destructive fires, affected parts of Northern California in October 2017. In an effort to reduce the damage caused by wildfires, it is vital that houses are constructed so that they are more fire resistant, specifically in areas that are at high risk of wildfires. This paper will look at the reconstruction of Santa Rosa after the Tubbs Fire to see what building methods are being used by contractors. This was investigated by surveying residential contractors who participated in reconstruction after the fire. This paper will also discuss the need for stricter fire building code, such as Building Code Chapter 7A, and why it needs to be implemented to reduce future devastation. The purpose of this project is to provide homeowners information on fire-resistant building methods when constructing or retrofitting a house, by specifically looking at the roof, siding, and landscape. Building to stricter building code can be effective for an individual house, but is far more effective when applied to an entire community or city.

Key Words: Wildfires, Fire-resistant, Construction, Tubbs Fire, Building Code

Introduction

Wildfires have always tormented California land, but since 2015, the state has experienced some of the worst fire seasons in terms of both acres and structures burned. On October 8th, 2017, the Northern California Tubbs fire destroyed almost 37,000 acres and 5,600 structures, making it one of the costliest wildfires in United States history according to the California Department of Forestry and Fire Protection (Cal Fire, 2019). Nearly half of the structures burned were houses in Santa Rosa, CA. The goal of this paper is to spread awareness and improve building practices in high fire risk areas across California.

Background and Literature Review

Statistics from the last 40 years show that the number of wildfires, and the amount of devastation they have caused, have increased as of late. Figure 1, shown below, created by the Environmental Market Solutions Lab, UCSB, shows the cumulative acres burned over time since 1979 (Buichi, H., Et Al.,
2018. The trend line shows the number of acres burned has increased at a greater rate over time. The goal of scientist, politicians, and fire fighters are to flatten the curve as much as possible, and as quickly as possible. There are many contributing factors involved in the rise of California wildfires, a primary reason being that climate change has led to hotter temperatures and deeper droughts (Buichi, H., Et Al., 2018). With this in mind, builders and homeowners must do their part to reduce the number of acres burned per year by constructing homes and buildings to be more fire resistant.

The term fire resistant is used rather than fireproof when discussing residential construction because it is impossible to construct a home that is completely fireproof for a reasonable price. The goal for builders and owners is to construct more fire-resistant buildings that are less likely to catch fire, or that are able burn at a slower rate, which would give more time for first responders to arrive.

Importance of Fire-Resistant Construction

Wind played a huge part in allowing the Tubbs fire to spread the night of the fire (Watkins, Et al. 2017). Winds averaged at around 40 mph, with gusts reaching as high as 75 mph. An analysis was done by The New York Times using satellite images and on-the-ground surveys to provide an accurate account of how the Tubbs Fire spread. The fire began around 9:45 pm, and just over 5 hours later by 3 am, the fire had traveled all the way to Coffey Park, which is approximately 12 miles away as the crow flies. Fires that are fueled by these high wind conditions create embers that travel in the wind, jumping ahead of the fire, causing the fire to accelerate and spread at a potentially even greater rate (Watkins, Et al. 2017). Embers cause more homes and structures to burn compared to radiant heat and direct flame contact (Quarles, S., Pohl, K., 2018). These embers, also known as firebrands, played the greatest role in the destruction caused by the Tubbs fire.
Builders, code agencies, and homeowners can choose to select fire-resistant building methods for both retrofitting and new construction. The primary aspects of a residential property that make for a more fire-resistant building are focusing on the landscape, roof, and siding of a house (Quarles, S., Pohl, K., 2018).

Having a more fire-resistant house will do a couple things to aid in the overall reduction of burnt structures and acres. Embers are the leading cause of ignition during a wildfire (Cal Fire, 2019). Embers that are carried in the wind often land directly on people’s properties, accelerating the speed the fire is traveling. According to the Department of Fire and Emergency Services, embers can travel up to 30-40 kilometers from the source (Department of Fire and Emergency Services, 2017). Building houses to withstand these embers or at least help them burn slower so that the fire department has more of an opportunity to arrive at the location and put out the fire is a major area of needed improvement. If every single property in a high fire risk area is more fire resistant, the fire as whole can’t travel as quickly. A slower moving wildfire would give the fire department more of an opportunity to contain the fire as soon as it is started, as well as allow for more time to evacuate, ultimately saving lives and properties every year.

**Current California Fire Code**

In 2008, California passed new building code, titled “Chapter 7A [SFM] Materials and Construction Methods of Exterior Wildfire Exposure” (2010 California Building Code, 2010). As explained in the code, the purpose was to establish minimum standards for the fire-resistance ability of a building located in a Hazard Severity Zone within State Responsibility Areas (SRA) and Wildland-Urban Fire Area, also known as Local Responsibility Area (LRA). State Responsibility Areas are any land where preventing and suppressing fires is the responsibility of the state, and Wildland-Urban Fire Area is any land deemed by the state or local officials to be at a high risk of fires. This code applies to any new building where the building permit was submitted on or after July 1, 2008. The code aims to achieve “a systematic reduction in conflagration losses” (2010 California Building Code, 2010, pg. 255) with the goal of protection human life and property.

This code was passed in California over a decade ago but it is challenging to enforce as local jurisdictions mandate the building codes. In the case of the Santa Rosa Tubbs Fire, local jurisdiction made the decision to pass this new building code in some parts of the city but not all (Kasler, D., Sabalow, R., 2019). While there may be a combination of reasons why Coffey Park, a Santa Rosa neighborhood, was not mandated to follow code, city spokeswoman Adriana Mertens said that officials made the decision because they felt there wasn’t a great risk of Coffey Park ever being affected by fires the same way it was in 2017 (Kasler, D., Sabalow, R., 2019). Officials stated the fire had to jump six lanes over Highway 101 in order reach the land, which it did. In an article by the Sacramento Bee, Dr. Chris Dicus, a wildfire expert and Professor at Cal Poly, San Luis Obispo, was quoted, “They’re setting themselves up for the next disaster” and that “[Dicus] was disappointed to see they didn’t build up to code.” (Gabbert, B., 2019)

Wildfire experts understand the future potential of an event like this, as well as how little additional cost there would be to better protect the city in the future. A research paper done by Headwater Economics in 2018 investigated the cost to build to the most well-known building code options for wildfire prone areas, including Chapter 7A. The results of this study showed that as a whole, building to code was not more expensive than building in a typical fashion. Certain aspects of construction, such as the roof, are more expensive for a fire-resistant home, but siding in some cases was found to be 25% less expensive compared to a typical wood-framed home. (Quarles, S., Pohl, K., 2018). In the
whether building to code is more or less expensive will depend on the specific job, but the overall cost will be approximately the same for new construction.

Methodology

Given the fact that Santa Rosa opted to exclude certain areas from following California Building Code Chapter 7A, it was important to gain a better understanding of the rebuilding process of Santa Rosa to understand the effect of not mandating a stricter fire code. In order to gather current information, a survey was sent out to 10 different residential contractors who contributed to the rebuilding process after the Tubbs fire. The purpose of this survey is to analyze quantitative data regarding the main changes in construction that homeowners and contractors choose to make in order to make a house more fire resistant. An interview was also conducted with wildfire expert and California Polytechnic State University, San Luis Obispo, Professor, Chris Dicus.

Of the 10 companies surveyed, all 10 responded back with answers to the survey questions. Of all the companies that responded, six primarily build in the Fountaingrove area, and four primarily in Coffey Park. The goal of this survey was to separate residential builders who primarily did or didn’t build to California Building Code Chapter 7A, and see how construction has progressed given that fact. This survey also aimed to capture the opinion of professional home builders regarding fire-resistant construction.

Survey

A total of 10 questions were asked. The six primary questions were:

Q1. Does the company focus primarily on rebuilding houses in the Fountaingrove area, or Coffey Park? (i.e. does construction require mandated fire building code)

Q2. Were the houses built to California Building Code - Chapter 7A?

Q3. Did homeowners choose to go above and beyond the Chapter 7A Code requirements in order to have a more fire-resistant home?

Q4. If homeowners did choose to go above and beyond the Chapter 7A Code requirements, what aspect of construction did homeowners choose to improve? Specify the type of change. Options: Roof, Siding, Landscape, Other (please specify), NA

Q5. In your professional opinion, what should residential homeowners focus on if they are trying to make their own home more fire-resistant during new construction or by retrofitting? Please explain. Options: Roof, Siding, Landscape, Windows, Other (please specify)

Q6. In your opinion, should California Building Code Chapter 7A be required in the Coffey Park area?

The results from the survey are shown in Table 1.
Results and Analysis

Table 1 – Results of Tubbs Fire Reconstruction Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company 1</td>
<td>Fountaingrove</td>
<td>Yes</td>
<td>No</td>
<td>NA</td>
<td>Roof</td>
<td>Yes</td>
</tr>
<tr>
<td>Company 2</td>
<td>Fountaingrove</td>
<td>Yes</td>
<td>No</td>
<td>NA</td>
<td>Roof</td>
<td>Yes</td>
</tr>
<tr>
<td>Company 3</td>
<td>Fountaingrove</td>
<td>Yes</td>
<td>No</td>
<td>NA</td>
<td>Landscape</td>
<td>Yes</td>
</tr>
<tr>
<td>Company 4</td>
<td>Fountaingrove</td>
<td>Yes</td>
<td>Yes</td>
<td>Landscape</td>
<td>Roof</td>
<td>Yes</td>
</tr>
<tr>
<td>Company 5</td>
<td>Fountaingrove</td>
<td>Yes</td>
<td>No</td>
<td>NA</td>
<td>Siding</td>
<td>Yes</td>
</tr>
<tr>
<td>Company 6</td>
<td>Fountaingrove</td>
<td>Yes</td>
<td>Yes</td>
<td>Landscape</td>
<td>Landscape</td>
<td>Yes</td>
</tr>
<tr>
<td>Company 7</td>
<td>Coffey Park</td>
<td>No</td>
<td>No</td>
<td>NA</td>
<td>Landscape</td>
<td>No</td>
</tr>
<tr>
<td>Company 8</td>
<td>Coffey Park</td>
<td>No</td>
<td>No</td>
<td>NA</td>
<td>Landscape</td>
<td>Yes</td>
</tr>
<tr>
<td>Company 9</td>
<td>Coffey Park</td>
<td>No</td>
<td>No</td>
<td>NA</td>
<td>Roof</td>
<td>Yes</td>
</tr>
<tr>
<td>Company 10</td>
<td>Coffey Park</td>
<td>No</td>
<td>No</td>
<td>NA</td>
<td>Roof</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Of the ten companies surveyed, there was a 6:4 split of companies who focused on the Fountaingrove area compared to Coffey Park. This is important to note as six companies will be forced to build to code, and four will not. While most of these companies had completed work in both areas of Santa Rosa, I asked that they respond to the questions based on what they primarily built for the purpose of the survey. The second question asked whether or not houses were being built to California Building Code - Chapter 7A. All companies that focused on the Fountaingrove area built to Building Code 7A because it was mandated. Looking at the companies that did construction in the Coffey Park area, none responded that they built to code as it was not mandated.

The third question was directed towards the companies that did follow code, and were asked whether companies had clients choose to go above and beyond code requirements. Only two of the ten companies surveyed claimed to have homeowners choose to go beyond code requirements, which brings us to question four, which was if homeowners did choose to go above and beyond the Chapter 7A Code requirements, what aspect of construction did they choose to improve. The two companies that had clients go beyond code requirement both chose to improve on their landscape. When asked to specify how they went above and beyond code, one company explained that some clients decided to change their landscape, with some opting for a larger noncombustible zone than 5 ft. The other company explained that some clients opted for more gravel in their landscape, rather than mulch and plants.

The fifth question asked companies what homeowners should prioritize when deciding how to make their home more fire resistant. Landscape and roofs were the most common answers, which will be discussed in further detail in the next section. The final survey question was purely opinion, so while it provides no factual evidence, it shows that of the majority of construction companies surveyed believe that building to California Building Code Chapter 7A in Coffey Park would have made a positive impact in the future.
Research results

Regardless of which local building code is mandated for a property, homeowners have the choice to construct or retrofit their home so that it is far more fire-resistant, sometimes at a cost similar to that of a typical home. Based on research and feedback from residential contractors, the components of a house most worth addressing are the roof, landscape, and siding. For all components of a house, selecting non-combustible, fire-resistant material is essential.

Roof Construction

Section 705A Roofing in the California Building Code covers the criteria needed to satisfy the Chapter 7A roofing requirements. All roofs must be at least rated “Class A” if they fall within a Fire Hazard Zone (2010 California Building Code, 2010). Chapter 7A notes that in addition to material, the space between the roof covering and roof decking must be constructed in a way so that flames and embers cannot enter. The section also specifies a minimum size and gage of flashing, as well as the fact that the installed roof gutters must prevent the accumulation of leaves and debris over time. Limiting ember intrusion is a huge factor for constructing a fire-resistant roof (Quarles, S., Pohl, K., 2018). This intrusion can occur in a number of ways, but most commonly occurs at vent openings. Roof vents are covered in the same code section as roofs, Soffit vents are often located on the eves houses, through-roof vents are located on the tops of roofs, and ridge vents are located along the entire ridge of a roof. It is important to note that vents can also be located toward the bottoms of houses to allow for basement or crawlspace ventilation. Regardless of a vent’s location, all vents shall not exceed 1/8” mesh, and be made of non-combustible material. It is also recommended that vents be cleaned so that there is no debris, and in the event of a fire, the vents are sealed from either the inside or outside so that no embers are able to pass through. According to Headwaters Economics, one of the most affordable and common Class A roofing materials is asphalt composition shingles (Quarles, S., Pohl, K., 2018). These are used all over the United States, including areas that don’t require Class A roofs. However, the effectiveness of these roofs to resist fires is compromised if not properly maintained. Often times, leaves and pine needles get stuck in the roof ridges or valleys, which become fuel for a fire if not consistently removed. Although there are certain types of roofs that are Class A, some designs styles such as Spanish tiles can allow for embers to get stuck, rather than rolling off the side, causing the roofing underlayment to ignite and a fire to start.

Landscape Materials

Section 701A.5 is titled Vegetation Management Compliance and addresses the landscape requirements for Chapter 7A for those living in a high fire hazard severity zone. The Chapter 7A code refers to Public Resource Code 4291 to address the requirements for SRA land, and refers to Government Code 51182 for LRA land requirements. After reviewing the Government Code 51182, there are a number of codes to follow, first being the need to maintain three zones of defensible space, adding up to 100 feet or to your property line, whichever is most stringent. The requirements of this defensible space will depend on the existing landscape, and the likelihood that whatever is “fueling” the fire on your property will reach the house. Government Code 51182 states, “Fuels shall be maintained in a condition so that a wildfire burning under average weather conditions would be unlikely to ignite the structure.” (State of California
Government Code Section 51182, 2021) The area between 100 and 30 feet from your property is considered Zone 3. The code is stricter about the defensible space that falls within 30 feet of the property. Anything between 5 and 30 feet is considered Zone 2 and will be subject to more intense fuel regulations compared to what is required from 30 to 100 feet. It is recommended that in this space, trees and larger plants stay well maintained, as well as being positioned away from each other and the house. Lastly, an ember resistant zone is required within 5 feet of the structure, which essentially prohibits any combustible material from being within that space. To satisfy this requirement, it is common to use concrete, gravel, fire-resistant decking and fencing, or any combination of the three. This five foot non-combustible space is extremely important because if anything were to ignite, the structure would be very exposed to embers, high levels of radiant heat, and potentially direct flames. (Insurance Institute for Business and Home Safety, 2021) The picture below shows testing done by the Insurance Institute for Business & Home Safety depicting the effect of embers on a house with and without the 5-foot non-combustible zone. The house on the left, which is not built to any sort of Fire Hazard Building Code, is seen already igniting from the embers.

![Figure 2: Insurance Institute for Business & Home Safety Testing](image)

A huge factor in reducing the combustibility of your landscape is simply weeding and raking as it reduces the amount of fuel on your property significantly (Quarles, S., Pohl, K., 2018). Doing this is especially important during fire seasons but is recommended year-round to maintain the fire-resistant integrity of the property. Landscape fabric is recommended for under gravel or mulch as a way to limit maintenance for the homeowner.

The cost of fire-resistant landscape will depend heavily on the property and the architectural look that a homeowner is trying to achieve. According to Headwater Economics, replacing traditional mulch with fire-resistant mulch and landscape fabric would result in a 210% increase in cost (Quarles, S., Pohl, K., 2018). That being said, mulch can be replaced with rock which has a much longer lifespan and significantly reduces the amount of annual maintenance and cost over time.
**Exterior Siding**

Section 707A.3 Exterior Walls of the Chapter 7A building code specifies that exterior siding must satisfy one of the following requirements. It must be made out of either a non-combustible material, an ignition-resistant material, heavy timber, or log wall, as well as needing to be tested for 10 minutes of direct flame contact in a test set forth in ASTM E2707 (2010 California Building Code, 2010). One of the most common siding materials used to satisfy this requirement is wildfire-resistant fiber-cement panels or shingles. This material is extremely popular because it is designed to look very realistic, and as Headwater Economics states, can be 25 percent less expensive than typical cedar plank siding (Quarles, S., Pohl, K., 2018). An article titled, Eco-friendly Material and Fire, which was published by the Alternative Technology Association, points out that earth brick, especially when double or triple stacked can also be extremely resistant to fires, and can even offer up to a four-hour fire rating (Cleary, J., 2010).

Siding is one of the more expensive aspects of a house to retrofit, but some materials such as a plastic vinyl siding can be especially bad for houses, and should be replaced if possible. Plastic siding often has a melting effect, which can expose underlying sheathing which can allow for embers to enter a home (Quarles, S., Pohl, K., 2018). Any style of siding that has the ability to trap embers, should be removed and replaced immediately.

Windows and glazing are also addressed in the Chapter 7A, under section 708A. The code requires that assemblies are either constructed of multipane glazing with a minimum of one tempered pane, glass block units, or meet the performance requirements of either SFM Standard 12-7A-2 or NFPA 257. (2010 California Building Code, 2010)

**Systematic Approach to Construction**

When discussing methods to build more fire-resistant houses with Dr. Chris Dicus, he emphasized the importance of building houses so that they are a complete “system.” Dicus said, “A fire is almost like a burglar, it’s trying to find any way into the house it can, and you got to look at all the ways you can keep it from getting inside.” What he is referring to here is that because there are millions of embers being carried with the wind, even if you have a well-maintained Class A roof and a sufficient non-combustible zone around your house, embers can still manage to find their way inside the house, even by going through a small gap under a door. For this reason, the best results come by looking at every aspect of a house, and considering every way a fire could possibly be ignited. For the system to be more effective, it takes a community effort, so that every house in the vicinity must also be its own fire-resistant system. This is why it is so important that when there is new construction, whether due to a wildfire or not, every house on the block is being built with the potential threat of a wildfire in mind.

Although a complete system is more effective, it does not mean that retrofitting a house is not worth the investment. When asked if improving one aspect of your house, a roof, for example, was even worth it, Dicus was adamant that any effort to make your house more fire resistant will help the overall problem. While it is no guarantee that it will save your house from a fire, doing anything is still better than doing nothing.
Conclusion

The battle against wildfires in California and other parts of the country is far from over. There are new building practices and technologies being tested every day in an effort reduce the yearly destruction the United States has been facing. It is essential that codes, such as California Building Code - Chapter 7A, are mandated even in locations that seem to have a low potential of being exposed to a wildfire. The Tubbs Fire proved how unpredictable wildfires can be given the fire’s ability to spread to Coffey Park. Building a house from scratch that follows all Chapter 7A fire code is not much more expensive than a typical home, and can potentially cost even less. Retrofitting a home to be fire-resistant is far more expensive than building from scratch, so homeowners and local officials must understand the importance of building houses the right way before disaster strikes. Homeowners have the opportunity to retrofit their houses so that they are more fire-resistant, and are encouraged to do so even if they think they are at risk. Simple changes to a house’s roof and landscape can potentially make a huge difference in a house’s ability to resist a fire. Every homeowner and contractor has an important role to play in preventing the destruction of wildfires by building smart and preparing for potential disasters.

Looking at potential future research, the construction industry has the opportunity to make a huge difference in the yearly fight against wildfires. An increase in wildfire research is vital towards reducing yearly destruction. More research on materials and how buildings ignite will open the door to even safer ways to build houses. Many houses that are currently located in wildfire-prone areas are currently not up to code, so there needs to be an emphasis on bringing existing communities up to code. New technology has led to the invention of vents that are specifically designed to keep out embers in the event of a fire. A simple change such as this could potentially save houses that otherwise would have burnt down. While this paper emphasized the Tubbs Fire and the rebuilding of Santa Rosa, communities are constantly being built, and rebuilt all across the country. The easiest way for the construction industry to immediately make a change is by correcting the misconception that fire-resistant construction is expensive, so that it becomes standard for all houses rather than a select few.
References


