Value of Prefabrication of Fire Sprinkler Components in the Fire Sprinkler Industry

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Every day the construction industry is looking for new ways to improve time efficiency and project profitability. Companies in the past have tried value engineering and schedule crashing to save time and money. As the industry continues to grow and innovate, new concepts are being applied. Building Information Modeling (BIM) is one of these ideas that has made a large impact in the construction industry. BIM is a digital 3D modeling system that allows the user to create a complete rendering of a construction project complete with mechanical, electrical, and plumbing integrated into the model. With this model a prospective contractor has the opportunity to prefabricate aspects of their project in a shop to later be installed on site more efficiently and with less labor necessary than if completely field fabricated. The fire sprinkler contractor JR Wagner Fire Protection has recently integrated prefabrication as a possible project delivery method for several of their recent projects. Possible benefits from their integration include reduction in project cost and shorter project schedule leading to greater company profitability and efficiency.

Keywords: Building Information Modeling (BIM), project profitability, prefabrication, field fabrication

Introduction

In the late 1800's, New York City established the first US fire safety codes with laws spelling out the use of fire sprinklers in buildings (NFPA Journal 1995). Now this was not the invention of a fire sprinkler system, fire sprinklers can be traced back several generations to 1806 when John Carey filed a patent in London for a perforated pipe for the use of fire suppression (Tyco Fire & Building Products 2005). Even further back Leonardo Da Vinci had an idea for using a fire suppression system similar to fire sprinklers to extinguish fires that occurred in his kitchen (Brian Keith Sullivan 2011). Since the early 1900's the fire sprinkler systems have become exponentially more innovative and complicated but their main purpose has never changed, that is, to save lives.

Since those initial laws were set forth, there is abundant evidence that the integration of fire sprinkler systems into new and remodel construction has saved lives. As you can see in Figure 1 below the the trend of the deaths per year by fires in commercial building from 1977 to 2015.

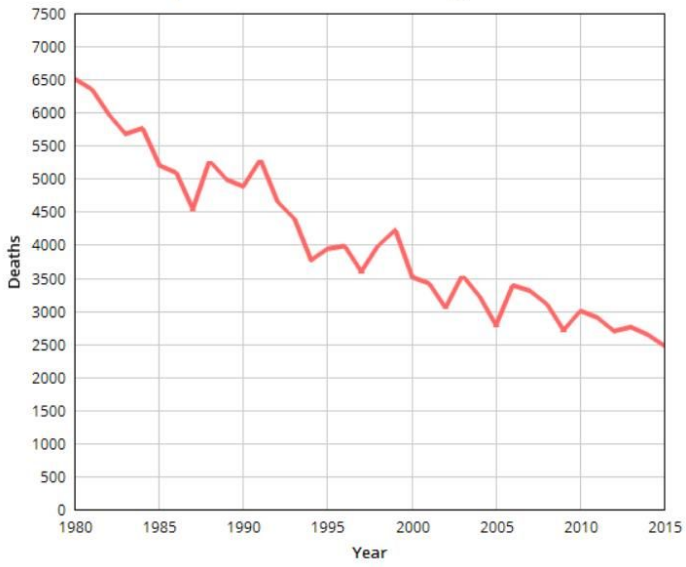

Figure 1 - Deaths per year by Fire in Commercial buildings From 1977-2015
Source - NAFP Statistics

It is clear that since 1977 the number of deaths per year has decreased as the number of buildings with fire sprinkler systems have increased (NFAP Statistics 2016).

Other notable data taken from the NFPA are the cost of damages from fires, given the purpose of the fire sprinkler system is to saves lives, additional outcome is control of the fire to minimize damage and cost. In an article posted by the the Fire Safety Advice Centre the statistics "in buildings fully protected by sprinklers; 99% of fires were controlled by sprinklers alone, 60% of fires were controlled by the spray from no more than 4 sprinklers" (Fire Safety Advice Centre 2015) this being true as the fire sprinkler systems are not only saving lives, but as well controlling the amount of damage done to the buildings they occur in, and ultimately reducing the cost to replace what is damaged from the fire. As you can see in Figure 2 below the the trend of the cost of damages per year by fires in commercial building from 1977 to 2015.

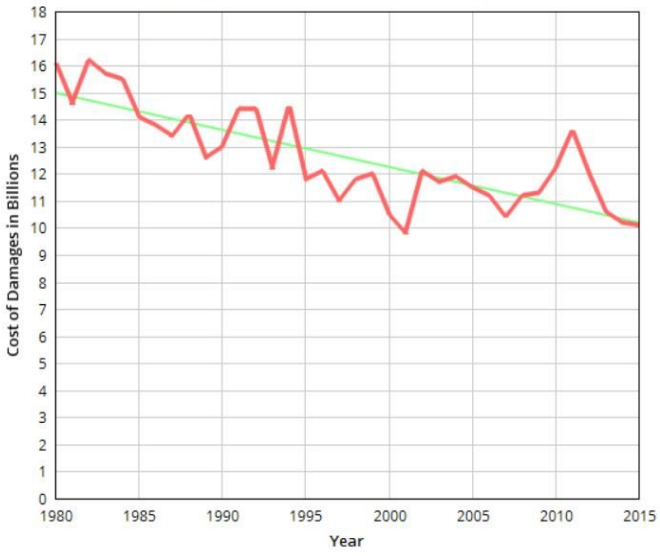

Figure 2 - Cost of Damages by Fire in Commercial buildings From 1977-2015
Source - NAFP Statistics

Innovations

Since inception, the fire sprinkler industry has changed drastically in its laws and codes but little change has occurred in the area of assembly. For the most part they still spray water from sprinkler heads set high in the ceiling. Some innovations have occurred though in the assembly of the fire sprinklers plumbing connections. For instance originally the industry threaded every pipe and used threaded connections.

As time passed and the search for new and innovative ideas to improve time efficiency in the assembling of the fire sprinkling system on the job site, the industry has turned to rigid couplings. A system that is much faster and easier to install than threaded pipe. Below in figure 3 is an visual example of a rigid coupling you can see that time and efficiency can be much improved my using these connections versus threading sticks of black steel pipe.

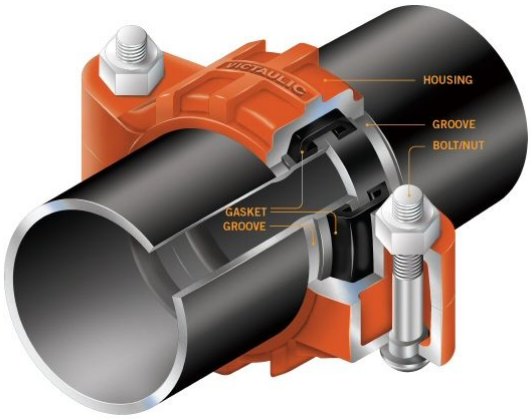

Figure 3 - Rigid Coupling

Threading a pipe on a job site is a long and time consuming process that is now no longer needed with a rigid coupling. Additionally, with threaded pipe a whole section of pipe would need to be rotated when loosing and tightening a connection. Now, as you can see, any adjustment to the connection is done only to the coupling and not with either of the pipes that are part of the connection (Victaulic 2017).

Prefabrication

Innovations such as rigid couplings over threaded pipe have been integral parts in improving efficiencies in schedule and cost in fire sprinkler construction. As time has continued the construction industry as a whole will always continue to find new and innovative ways to improve even further its project efficiency. Today, technology is becoming ever more interactive with the construction industry. The implication of the 3D building Information Modeling (BIM) have provided the industry with many avenues for new grounds of innovation.

One way that BIM is affecting the industry is it is allowing for the integration of prefabrications from specific trades to be completed off site and assembled with less man power and in less time than on site. The trades that are taking the most advantage of prefabrication are Mechanical, Electrical and Plumbing (MEP) contractors who now have the ability to accurately know their precise layout.

With this new technology becoming ever more integrated into common construction practice the fire sprinkler industry is seizing this opportunity and benefiting in the areas of time, waste and cost savings. The JR Wagner Fire Protection Company has begun just this, the integration of BIM and prefabrication to several of their projects to improve time, waste and cost efficiencies. A simple prefabrication process that JR Wagner is implementing in several of its projects are welded head pipes. These are pipes that have the threaded connections for the sprinkler

heads welded on by the manufacture. Below in figure 4 you can see an example of a welded connections for the sprinkler head.

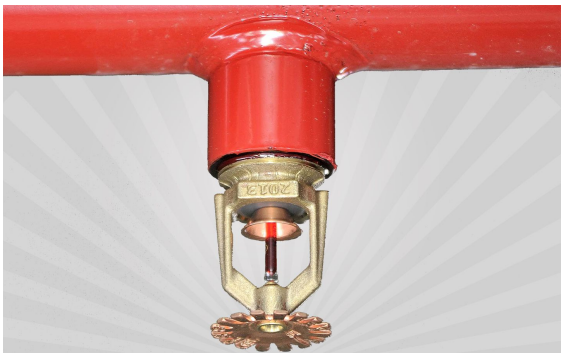

Figure 4 - Welded Pipe Connections

This simple form of prefabrication improved the tradesman time efficiency on a job by reducing the number of connections they would need to make. As well, the welded connections are more reliable as there are not connections that can become weak and have the opportunity to leak over time.

Methodology

The methodology I primarily have chosen in this case study is an analysis of quantitative data taken from a project previously completed by JR Wagner. As well, I included qualitative data I received through interviewing the owner and senior project manager of JR Wagner Fire Protection regarding how he feels regarding the integrations to his building process. Together I have analyzed the results from both the quantitative and qualitative data in three categories: positives, negatives and further innovations. This information will be relevant for any company in the construction industry when researching the benefits and challenges of integrating prefabrication to their own construction process.

My objective for this case study is to…

- Extend the overall knowledge of prefabrication in the fire sprinkler industry.
- Analyze the benefits of prefabrication for the JP Wagner Fire Protection Company.
- With my analysis I hope other companies investigating the benefits of prefabrication can review my work to help them make informed decisions on how they can improve their own productivity and profitability.
- To shine light on how a industry feels about the integration of prefabrication to the construction process.

Case Study

JR Wagner Fire Protection is a fire sprinkler contractor located in Modesto, CA. They service the San Francisco Bay Area, California Central Coast and California Central Valley. The company was established in 2010 by Jon Wagner, who began working as a tradesman in the fire sprinkler union in 1998. After nearly 12 years in the industry Jon started his own company. Early on, Jon's tradesman all used threaded pipe and twisted on every cap, elbow and fitting. Jon had always tried to find new ways to innovate his process to increase productivity and reduce costs. As an entrepreneur, Jon is always looking for additional profitability to grow his company, reward his investors and support his family. It wasn't long till the inauguration of the rigid couplings became common over the threaded pipe. As innovations in all of constructions continue to emerge with technology such as BIM, Jon finds himself with the opportunity to innovate and increase his productivity once more with the integration of prefabrication to specific projects. With the hope of further integrating it to all of the projects beyond sprinkler heads that JR Wagner Fire Protection is involved with.

Project Specifics

The data I received from J.R Wagner Fire Protection are two project bids that have been complete for a fire station recently built in Livermore, California. The fire station is located at 1919 Cordoba Street, Livermore and is adjacent to the current fire station which has stood since 1976. The new fire station will be roughly 7000 square feet and has a project budget of $5.15 million (Bay Area News Group 2016). As a public project the contract would be rewarded to the construction company with the lowest bid, making it essential for J.R. Wagner to utilize all avenues for efficiency and cost savings. Knowing this J.R. Wagner completed two separate bids for the project one that includes prefabricated welded pipe and rigid couplings for connections and a second that used threaded pipe fittings for all connections. The lowest bid was submitted.

Below is a breakdown of the bids provided by J.R. Wagner for the Livermore fire station project. Several line items excluded from the bid are: overhead, contingencies/ allowances and contractor fees. With the exclusions, the data is still acceptable in the representation of the differences between prefabrication and field fabrication.

Project bid <u>without</u> Prefabrication…

Field Fabrication	
Schedule 40 Piping Cost Ductile Iron Threaded Fittings Man hours @ $50.00 per hour (70) Install Man Hours: $90.00 + $50.00 (200)	$3,500.00 $1,700.00 $3,500.00 $28,000.00
Total:	$36,700.00

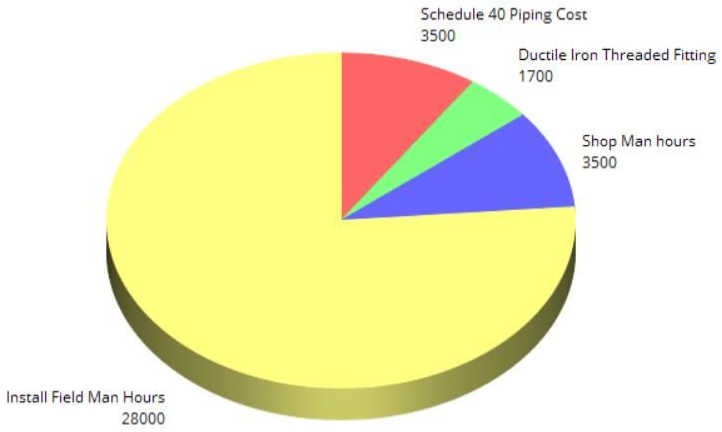

Figure 5 - Field Fabrication Cost Chart

Project bid that <u>include</u> Prefabrication…

Shop Fabrication	
Schedule 7 Piping Cost Weld o lets, Welds, Cuts, Grooves Man Hours @ $15.00 per hour (60) Install Man Hours: $90 + $50.00 (160)	$2,400.00 $800.00 $900.00 $22,400.00
Total:	**$26,500.00**

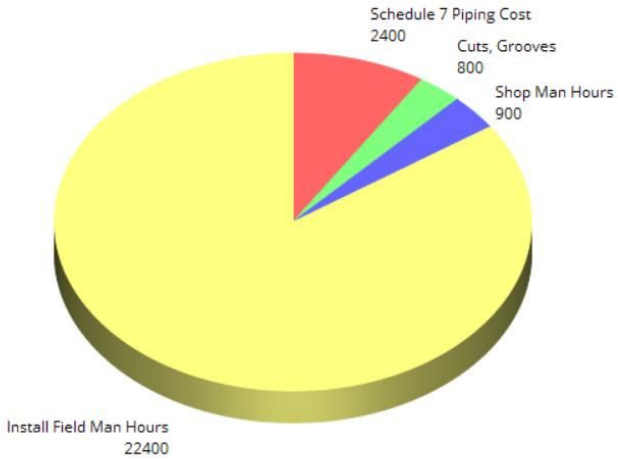

Figure 6 - Shop Fabrication Cost Chart

Data Analysis

In both bids there are several notable similarities and differences essential in accurately assessing the value of prefabrication over field fabrication. For both field fabrication and prefabrication the rates for the installation man hours are the same $90 + $50 per hour. This is because for every journeyman on site who is bid at $90 an hour there is an apprentice working alongside him who gets costed at $50 an hour. The difference comes in the scheduled number of hours it takes for the installation of prefabrication versus field fabrication with prefabrication being 40 less hours less. A 40 hour difference equates to a $5,600 reduction in installation costs.

Another notable difference relating to labor cost and man hours in the bid is an additional $50 per hour laborer is included in the bid for field fabrication. This laborer is responsible for cutting/threading the stock steel pipe for the installation by the journeyman and apprentice. However, for prefabrication, this is done completely in the shop where a non-union laborer at a rate of $15 an hour can be more efficient and complete the fabrication as it is shown by the plans he is provided. Net effect, the labor cost for prefabrication is far less due to required labor required on the job site versus the lower cost labor utilized in the shop.

The last major difference in the respective bids is the pipe schedule (material) used in prefabrication and field fabrication which affects not only the cost of the material but also the connections used in installation. For field fabrication threaded fittings are required for pipe connections. Schedule 40 must be used for threading pipe allowing

for enough material to cut threads into the exterior of the pipe. For prefabrication, however, the pipes used are only Schedule 7 since rigid couplings are used for pipe connections instead of threaded fittings. The use of lighter schedule pipe and rigid couplings for connection leads to a $2,000 cost savings for prefabrication over field fabrication.

Positives of Prefabrication

The positives of prefabrication for projects for J.R. Wagner Fire Protection is clearly the cost reduction. This cost reduction will lead to a higher reward rate for jobs as lower bids tend to be more attractive to prospective clients. As well other notable positives of prefabrication are less opportunities for injury. Not only are there less laborers on a job site during prefabrication installation but as well the pipe being installed is much lighter and safer to transport and maneuver. Schedule 40 pipe weights 3.66 pounds per linear foot for a 2 inch pipe while schedule 7 pipe only weighs 2.05 pounds per linear foot for the same diameter pipe resulting in a 32.2 pound difference for a typical 20 foot pipe.

Negatives of Prefabrication

As the cost savings of prefabrication appears to be very attractive it is not meant for every project as there are several notable challenges with it. For example, if the a project is a retrofit for an existing building this may cause challenges for prefabrication as there may be unforeseen obstacles that that will cause issues in installation for prefabricated material (beams, pillars, HVAC, electrical conduit, etc.). As well when using prefabrication in the fire sprinkler industry you must be aware of the other trades such as MEP and their respective material being installed while you are installing the fire sprinkler piping. As fire sprinklers plans are submitted separately in the construction plans often MEP contractors make changes to their design through the project without realizing how the change impacts of the fire sprinkler design. If these clashes are not caught before the material is fabricated in the shop it may be a costly occurrence.

Further Innovation of Prefabrication

As innovation seems to never sleep in the construction industry there are several future advances to be expected in the fire sprinkler industry. One innovation picking up speed is the use of flexible hose attachments for the heads of the fire sprinklers. This flexible hose allows the pipe to be set with the path of least resistance and the head can then be placed anywhere around the pipe. Again, a significant saving could be expected in design costs along with installation efficiency (Victaulic 2017). Below in figure 7 you can see an example of how a flexible hose connection can be effective in allowing a sprinkler head to be installed in several different locations not completely restricted to the path of the main pipe.

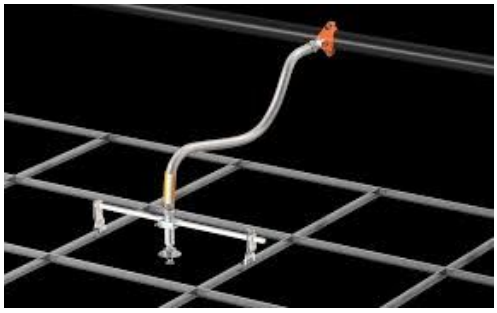

Figure 7 - Flexible Hose Attachments

Another innovation is the use of Halogen gas instead of water for extinguishing fires. Halogen gas would be able to extinguish a fire without leaving any residue. When water is used to extinguish a fire there is water damage in

addition to the fire damage. As well Halogen gas is not conductive so it can safely be used on electrical fires without other ill effects of water and electricity (H3R Clean Agents 2017).

Conclusion

Since John Carey's patent in 1806 for a perforated pipe used for fire suppression the fire sprinkler industry has innovated and evolved exponentially with never losing its original guidelines to save lives. Now as the construction industry has innovated with new innovations such as BIM which allow for better communication between the respective trades. Companies have the ability to evolve and integrate new project delivery methods such as prefabrication to their respective projects. J.R Wagner Fire Protection now has the opportunity to streamline their construction process with the integration of prefabrication allowing their work to be completed cheaper as well as faster. For example the Livermore fire station had a $10,200 reduction in cost with the prefabrication bid nearly 27% less than the field fabrication bid. Understand prefabrication is not effective for all projects, proper planning and site conditions are particular aspects that are necessary for prefabrication to be an effective project delivery system. Although when conditions are acceptable prefabrication is a great delivery method to lower cost and increase schedule efficiency. Now there are new ways to even further project efficiencies such as with flexible hose attachments and use of Halogen gas rather than water for extinguishing fires. Of course in the future there will be other possible methods to increase efficiency and profitability because innovation never sleeps.

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