The main factors in commercial construction process

In the world today, construction has made a serious comeback since the slower years of our economy during the years of 2007 to 2012. The United States construction industry plays a vital role in the nation’s economy contributing roughly six hundred sixty billion dollars to the total GDP or Gross Domestic Product as of January 2018. In addition, the industry was recorded to employ roughly ten point three million people as of late 2016. There are essentially two types of construction: building and heavy construction. Building construction is a general classification of all vertical structures including houses, schools, libraries, stadiums, hotels, and high rises. Heavy construction is that of all construction relating to infrastructure such as roads, parking lots, bridges, and highways. With construction of all types at an all-time high, the availability of land for development in sought after locations is becoming more challenging by the day. In addition to the challenge of acquiring desirable land comes the challenge of zoning and price negotiation. Once a piece of land has been acquired, the developer must decide what he or she would like to construct on the land.

Today, high rises are becoming more desirable as they offer the ability to build upwards as building out and around horizontally may not be permissible. High rises, as classified under building construction, is a sector of the industry that is also classified as commercial construction. Commercial construction is essentially a large project undertaken by a private or government entity that is designed to either update an existing structure or construct an entirely new structure of its own. In this process in regards to high rises, there are several factors that need to be considered including the design of the structure, materials that will be utilized and their structural

properties based upon the location of the project, type of project delivery method, contract type, and safety. Herein, the importance of these factors will be analyzed and explained.

As the United States economy continues to flourish, as does construction and many of those involved with it. Investors and developers are planting many seeds per say, funding multi-million dollar projects with the intention of not only adding beautiful displays of architecture, but also making a substantial amount of profit on the final product. The Council on Tall Building and Urban Habitat (CTBUH) publishes an annual study for the previous summarizing the completed number of high rises across the globe, reaching heights greater than two hundred meters. The most recent study in which was published on December 13th, 2017 details the completion of one hundred and forty four of these high rises taller than two hundred meters making the total number of these super structures one thousand three hundred and nineteen in the whole world. This documents the busiest year on record for high-rise construction; besting the one hundred and twenty seven structures towering above two hundred meters in which were completed in the previous year, 2016.

Additionally, this has contributed to the total four hundred and two percent increase of high rises reaching heights greater than two hundred meters since the year 2000 when only two hundred and sixty three existed in the world. In closer proximity to home, the United States has an endless list of high-rise projects that are currently under construction. The city of Chicago itself currently has forty-nine of these structures in the works that will forever change the city’s infamous skyline. Most notable has been named

The Vista Tower and will soon become the city’s third tallest tower by the end of the year 2020. This high rise will be a combination of a hotel and a condominium towering over the city at one thousand one hundred and eighty six feet. Heading a few hundred miles to the East, New York City has a new addition in the making known as One Vanderbilt, a one thousand four hundred and one foot high-rise located in Midtown East. This building will include fifty-eight stories constructed upon an eight thousand five hundred ton concrete reinforced foundation, requiring roughly four hundred and twenty concrete over a sixteen-hour period. Making your way to the South in Miami, Florida, there is a sea of modern day high rises downtown. The newest addition to the Miami skyline will be a sixty-two-story high-rise condominium named the One Thousand Museum. This will be one of the tallest towers yet to come upon its scheduled 2018 completion date towering over seven hundred feet. The One Thousand Museum in Miami will be the first of its kind in the United States, utilizing a glass-fiber reinforced concrete outer shell as its exoskeleton.

There are several contributing factors as to how and why the number of these high rises has grown exponentially over the past few decades; some may been seen when comparing older construction methods and practices to those used in our modern day. While early buildings utilized similar materials such as steel and concrete, those materials today have been refined in such a way that when in combination with new designs and building practices, equivalent structures are achieved in greater heights and less time. Before these materials were refined to today’s standard, they had to first be advanced decades ago. Henry Bessemer of England had lived a successful

life from 1813 to 1898 and left behind an innovation that would forever change the way buildings were designed. In the year 1855, Henry Bessemer had invented and patented a process of decarbonization that utilized a blast of air. This process essentially was an inexpensive and effective way to mass-produce steel from pig iron prior to the invention of the open-hearth furnace. This process was implemented in the production of steel beams used in construction that would be known as Bessemer Beams. Back in the late nineteenth century, a man by the name of George Fuller had discovered an engineering advancement that would forever change the way structures are designed. During his time, 1851-1900, structures were designed where the exterior walls would bear the loads of the building; George Fuller had a difference of opinion. Fuller had realized that buildings would be able to bear greater amounts of weight and thus, reach greater heights if Bessemer steel beams were implemented to provide a load-bearing skeleton on the interior of the building.

Using this design, George Fuller’s building company had gone on to construct one of New York City’s first high rises in 1902, known today as The Flatiron Building. This building is known today for its unique wedge shape and stands at a height of three hundred and seven feet. The innovations in construction materials and design techniques provided by Henry Bessemer and George Fuller went on to be used for several years and are still implemented in ways today. Following World War II in 1945, another great development in high rise buildings was implemented as the time of optimism with declining energy costs encouraged architects to embrace the concept of a glass prism; utilizing curtain walls in their designs. The earliest use of the

glass curtain wall in a multi-story building was in the A. O. Smith Research Building of 1928, located in Milwaukee and designed by Holabird and Root. The glass in the structure was anchored using aluminum frames and utilized fluorescent lighting, synthetic rubber sealants, and air conditioning, all of which was realized in 1945 creating the glass prism effect. However, this design didn't assist in setting the new world standard for building design until 1949 when architects Wallace Harrison and Le Corbusier designed the United Nations Secretariat Building in New York City which featured an air conditioning system and green-tinted glass walls. The use of aluminum had become a primary choice in curtain wall framing in the construction industry due to its corrosive resistance properties in combination with its ease in the forming of cross-sectional shapes through a process known as extrusion. The extrusion process is simply the forcing of a material through a series of dies that create complex shapes, in this case, cross sections that are commonly seen today on all windows. Aluminums corrosive resistant property is due to the transparent oxide coating that it develops and this coating can be enhanced through the process of anodizing, which thickens the coating and allows for color changes if desired. A material of equal significance to the aluminum frames was the development of cold setting rubbers that were developed during World War II, which form the elastic sealants that seal the joints off from wind and rain between the metal and the glass as well as metal and metal. While curtain walls had begun to pave a new era in the construction industry, just years later, new forms in building construction had made their debut. Due to an increase in cost of environmental control systems, there was an increase in demand for the production of more efficient structures.

In the year 1970, the John Hancock Building in Chicago had implemented a new structural design. In this design, the structure utilized a system of exterior diagonal bracing to form a rigid tube, which was devised by an engineer by the name of Fazlur Khan. While the John Hancock Building was no record in height, its one thousand one hundred and twenty seven foot structure used only twenty-nine pounds of steel per square foot, which was a large feat when compared to The Empire State Building that stands at one thousand four hundred and fifty four feet and uses roughly fifty-five pounds of steel per square foot. Fazlur Khan’s framed tube design went on to be implemented in several other structures such as the infamous Sears Tower of Chicago. Along with the developments in steel construction of high rises, the advancement in concrete building design had also flourished.

Since 1945, Henry Miller, Fazlur Khan, and many other engineers and architects had implemented such concrete design improvements in the structures they were involved in due to their individual contributions. One of the greatest advancements in concrete construction was the introduction of the shear wall. A shear wall is a vertical building element composed of reinforced concrete that is designed to resist lateral forces such as wind and seismic loads. Henry Miller had implemented these concrete reinforced shear walls in the construction of the Executive House of Chicago that had reached a height of three hundred and thirty nine feet in 1958. In the construction of the CBS Building located in New York City, a design innovation that combined the perimeter framed tube with shear walls providing further lateral stability was implemented by architects Eero Saarinen and Kevin Roche in 1964.

Once again, Khan had gone on to further develop this design in the construction of the Shell Oil Building in Houston, Texas in 1967. This building had reached a height of seven hundred and twenty five feet. While these designs had improved the structural stability and strength of high rises, they wouldn’t be able to achieve much more if it weren’t for the development of lightweight concrete, the increase in the compressive strength of concrete, and the implementation of concrete pumps to move the concrete to the upper floors being poured. These three innovations significantly helped in the significant height increase of high-rise structures today. Producing a concrete that was lighter in weight was achieved by substituting stone with blast-furnace sag for the aggregate that is used in the making of concrete. This reduction in density of twenty-five percent correspondingly reduces the amount of stress exerted on the columns in structures. Increasing the compressive strength of concrete allows for more loads to be carried across concrete slabs and supported by columns.

Lastly, the use of concrete pumps significantly reduces the cost required in moving the concrete from the ground to the location in which it is to be placed. These pumps essentially push the concrete constantly through a hose vertically through the structure to the top where the end of the hose is then moved to the location in which is being poured. All of these material advancements considered, it is important to understand their contributions to the structure and how they function. Concrete and steel are both principal elements to the skeleton or frame of a building. Both building elements provide numerous benefits, and depending on the location of the structure, one may be more suitable than the other. The factors to consider when

looking at steel and concrete include safety, cost, availability, scheduling, design possibilities and environmental effects. Each of these factors will be analyzed, beginning with safety. When looking at the aspect of safety, concrete is more often than not viewed as the superior building element due to its strong resistance to natural storms and severe weather along with large impacts and high temperatures. Concrete on its own does not require any additives or further precautions to meet stringent fire codes whereas steel can become structurally deficient when exposed to high temperatures. The inherent mass and strength of concrete aids in the materials resistance to high force winds in excess of two hundred miles an hour as well as hard impacts from flying debris. In Florida, concrete is the popular choice of building material for high rises due to the fact that the location is more prone to such forces. Steel is a popular choice of material in seismic zones as when the elements strength and ductility is combined with a strong design, the structure will perform very well under dynamic loads because it will have the ability to absorb the energy and bend without breaking.

Another factor that contributes to concretes popularity in Florida is the resistance to corrosion as the concrete encapsulates its reinforcing steel, shielding it from the corrosive air that would otherwise compromise its structural integrity. When analyzing the cost aspect of concrete and steel building elements, concrete has been more stable throughout the years and continues to be stable today. Steel on the other hand has been known to fluctuate and as of 2016, the prices have increased over fifty percent since November of 2003 according to an article titled “ Which is the Better Building Material.”

In today’s economy with President Trump in office, the tariffs have had an additional significant increase in the cost of structural steel; however, these tariffs have not had much of an effect on the cost of reinforced concrete. In terms of costs associated with the forming or fabrication of the chosen material, steel is more cost effective due to the off-site prefabrication process. This means that the crews won’t be needed for as long, thus reducing labor costs whereas with concrete, you will have higher labor costs as it will take more time to move the concrete to the forms and place it, that is if cast-in-place concrete is the method of choice. Cast-in-place concrete differs from precast concrete in the fact that the structure will be formed and poured on-site whereas with precast concrete, the concrete is formed and poured off-site and is then brought in and placed in its final designed location. This is a method that is gaining popularity amongst jobs such as bridges and basic structures that need to be constructed in a short period of time. In terms of availability of the building elements, concrete has had a history of shortages due to the lack of cement; the primary bonding agent used in the making of concrete. These shortages were most notable around the time of the early 2000’s shortly after a few hurricanes tore up the Floridian coastal cities. After the hurricanes had hit, there was a high demand for reconstruction and thus requiring a majority of the available cement supply. This created a chain reaction spiking the cost due to the limited availability along with the need to transport the material in from outside locations. This impact of shortages and cost increases had its greatest impact on smaller companies, builder, and contractors, all of whom had lower cash reserves.

Concrete companies have since expanded and increased their domestic capacities in effort to prevent these shortages from occurring again if other natural disasters are to occur. Steel in contrast however has not shown any signs of being in short supply even in spite of large increases in construction in Asian countries, particularly China. The United States had produced eighty-six million tons of steel in 2014 while worldwide; one point six billion tons were produced.

Construction scheduling is a considerable factor when selecting a building element if there is a deadline to be met. It is widely known in the construction industry, time is money. When considering either steel or concrete construction, it is important to know that concrete structures can be erected up to twice as fast as a steel structure of a similar design. The process known in the industry as the two-day cycle allows for a concrete floor to be poured every other day, meaning that the shell or skeleton of a hundred story building for example, could be constructed in fifty days. Granted, there are several other contributing factors to this and delays are quite common, however, it is possible. In terms of steel, an accelerated schedule is also achievable, but not in the same magnitude of concrete construction. However, if prefabrication is utilized with steel construction, the steel erection timeline of a project can be compressed by forty to fifty percent according to John P. Cross of the American Institute of Steel Construction, Chicago. The design possibilities for concrete are very flexible as the material can essentially be molded into any shape and can be quite advantageous in the amount of space they can offer. In terms of high rises,

concrete can provide lower floor to ceiling heights, which allow for more floors to be rented or sold to tenants.