University of Toronto - Civil & Mineral Engineering
CIV280F Management of Construction - Course Project
Team members: Maher Absar, Vincent Lai, Alex Vespa
Date: November 14, 2018

Project Information	Project Name	Dundas Square Gardens
	Description	High-Rise Condominiums (Residential), Currently at 30 Floors Building Up Additional Floors [1]
	Location	200 Dundas St. E., Toronto, Ontario
	Owner/Developer	The Gupta Group (Owner), Easton's Group (Developer) [2]
	General Contractor	SkyGrid [3]

Table 1 Summary of sites visited during the term (Refer to Appendix A for a more detailed observations)

Date	Location	Project name & brief description of state of construction
09/07/2018 (Week 1)	Yonge St. and Alexander St.	Halo Residences: - Shoring process beginning - Augering and pouring of caissons along with preservation of historic tower
09/07/2018 (Week 1)	North of Yonge St. and Alexander St.	501 Yonge Street: - Above ground parking lot completed with extensive use of reshoring while concrete cures
09/07/2018 (Week 1)	Yonge St. and Charles St. West	135 Charles Street West: - Building up using timber construction while keeping existing historic building exterior
09/07/2018 (Week 1)	Yonge St. and Bloor St.	The One: - Nearly finished the excavation process
09/14/2018 (Week 2)	College St. and Huron St.	Design Haus: - 17-storey residential building [4] - Concrete being poured onto rebar using crane and bucket - Two types of shoring in place
09/14/2018 (Week 2)	College St. and Beverly St.	Tucker HiRise: - Excavation and dewatering stages - Michael Bros Excavator onsite - Soldier piles and lagging in place - Trucks taking away soil with black mesh covering soil
09/14/2018 (Week 2)	Southeast corner of University College (UC)	UofT Old Sidewalk: - Made in 1971 by Prospect Paving Ltd. - Long lasting sidewalk
09/14/2018 (Week 2)	Philosopher's Walk	Old stone building adjacent to the Royal Ontario Museum: - Flame retardant covering - Grout reapplication - Chute on site to dispose of waste from elevated areas
09/21/2018 (Week 3)	Queen St. and Soho	Mountain Equipment Co-op (MEC) Queen Street: - Concrete works are done, installing insulation
09/21/2018 (Week 3)	Peter St. and Richmond St.	134 Peter Street: - Glass enclosure, huge white structural steel, specifically designed - Steel made by Cast ConneX [5]
09/21/2018 (Week 3)	John St. and Adelaide St.	Storey Living at 263 Adelaide St. W. [6]: - Installing the foundations for the building
09/21/2018 (Week 3)	Blue Jays Way and Peter St.	King Blue by Greenland: - Demolition completed and preparing for excavation
09/28/2018 (Week 4)	East side of Scotiabank Arena	CIBC Square: - Building up the skeleton of the building
09/28/2018 (Week 4)	Yonge St. and Queen’s Quay E.	One Yonge at 1 Yonge St.: - Excavating and shoring, excavation has reached bedrock (table continued on next page)

09/28/2018 (Week 4)	Copper St. and Queens Quay E.	(table continued from previous page) 100 Queen's Quay East: - Finishing excavation on one side of the site, installing building foundation on the other
09/28/2018 (Week 4)	Dundas St. and University Ave.	488 University Avenue: - Building up, adding floors onto an existing building
10/17/2018 and 10/19/2018 (Additional site)	Jarvis St. and Dundas St.	Dundas Square Gardens: - Currently 30 floors tall and working on finishes for the lower floors, while constructing the skeleton for the upper floors [1]

1.0 Introduction

Throughout the semester, various construction sites throughout downtown Toronto were visited. In addition to the weekly walking tours, the group visited Dundas Square Gardens as our additional site. Throughout the visits, many observations were noted, particularly those pertaining to the construction process and safety. In terms of the construction process, the notable stages of construction observed were shoring, excavation, coming out of the ground and building up, as well as organization/process efficiency. Regarding safety, measures are taken to ensure the well-being of workers, as well as the public. This report will detail the construction stages in the order in which they are conducted and will describe the safety measures implemented at various sites during these stages. This report will then describe potential means of improving safety for workers and pedestrians and will quantify the impacts of the suggested means of improvement.

2.0 Stages of Construction

Though the stages of construction vary from different projects such as low-rise residential, high-rise residential, heavy civil, etc. the majority of sites visited were constructing high-rise residential buildings. In order, the stages of construction that will be mentioned are shoring, excavation, and coming out of the ground. Then, the overall organization of sites and process efficiency will be discussed.

2.1 Shoring

Shoring is the process of temporarily supporting a structure [7]. It supports the horizontal loads of the soil to prevent a cave-in of the wall [5]. Shoring systems are used until bedrock is reached, at which point the ground is stable enough to resist lateral motion/a cave-in [5]. One common method of shoring that was seen during the site visits was soldier piles and lagging, which involves the use of steel beams hammered into the ground with wooden planks placed in between them [5]. For example, soldier piles and lagging were observed at Tucker Hi-Rise. Another common method of shoring used was caissons walls. Caissons walls are vertical concrete structures used when greater support is needed, such as when the excavation wall is adjacent to an existing building [5]. Some sites that used caisson walls were The One, One Yonge, and 100 Queens Quay East, which can be seen in Figure 1 on the next page.

To support the shoring walls, a variety of methods were used across the sites. The most common method, which is demonstrated in Figure 1, used tiebacks as additional support to the caisson walls. Tiebacks use tensioned cables to anchor the wall into the soil [5]. Another support method that was used were rakers. Rakers are steel beam that are placed inside the excavation to provide additional support, which was observed at Design Haus [5]. The drawback of rakers is that they take up more space than tiebacks, but they are necessary when adjacent buildings cause a lack of sufficient space for tiebacks [5]. A third support method was corner struts, which are steel pipes used to provide additional support to two adjacent walls of a shoring system [5]. This was seen at The One.

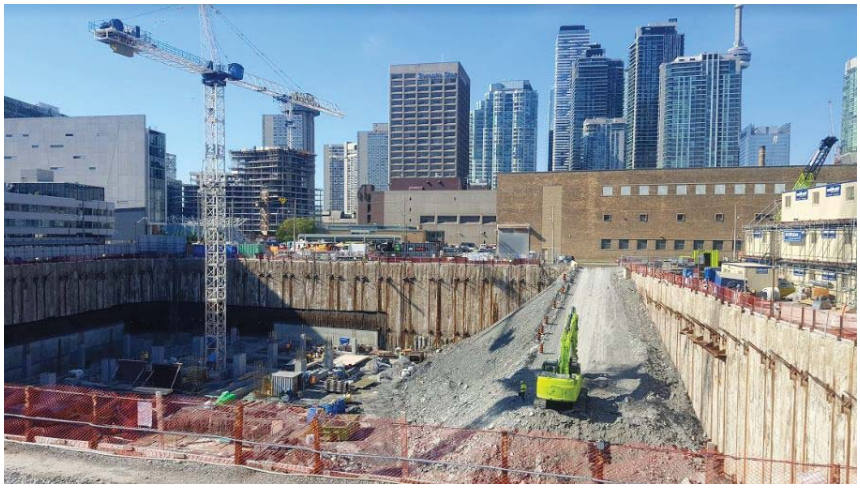

Figure 1: Shoring and Excavation at 100 Queens Quay East [8]

In terms of safety measures pertaining to shoring, measures are taken to protect the shoring system itself and the workers. For instance, s. 233 (1) of the Occupational Health and Safety Act states that construction materials and equipment are to be kept at least one metre away from the shoring wall [9]. This is for wall stability issues, preventing a cave-in which would damage the constructed building/injured workers [5]. This was observed at One Yonge, Tucker HiRise and Design Haus.

2.2 Excavation

After shoring is finished, excavation can occur [5]. Excavation is needed for the implementation of building foundations, underground parking, basements, plumbing, electrical work, etc. [5]. It is important to note that dewatering of the soil must start months before the excavation process, and continues to occur while digging [5]. By lowering the water table, the soil is not wet - wet soil leads to soil strength issues, as well as flooding when digging [5]. Furthermore, Halo Residences and Tucker HiRise were continually pumping out water.

Several excavation methods and machines were used. The most prominent machine that was observed was an excavator [7]. The excavator was placed in the excavation site itself and removed the soil into another truck. At most sites, some soil is left in the excavation to be used as a ramp for trucks to enter and exit the excavation. This can be seen in Figure 1, at 100 Queens Quay East. To complete excavation, the tracked excavator is driven out of the excavation site [5]. For instance, at The One, a tracked excavator was outside the excavation and was excavating any last soil before the foundations could be laid. At One Yonge, though an excavator dug through the soil, it could not dig through bedrock itself. To solve this problem, a drill was attached to the excavator to drill through the bedrock.

In terms of safety measures pertaining to excavation, measures are taken to protect workers as well as pedestrians. For example, s. 233 (4) of the Occupational Health and Safety Act states that a barrier at least 1.1 metres tall has to be placed at the top of each shoring wall to prevent workers from falling into an excavation of at least 2.4 metres [9]. This was observed at 100 Queens Quay East, The One, Design Haus, and Storey Living. In addition, Tucker HiRise and 100 Queens Quay East had dump trucks removing the excavated soil. As a safety measure to pedestrians and vehicles,

a mesh cover was placed on top of the bed to prevent any soil from falling out and hitting pedestrians and vehicles.

2.3 Coming Out of the Ground and Building Up

After excavation is complete, the foundations are laid and then the building itself can be built. In order to move materials around the site, cranes are typically used [5]. The most common types of tower cranes seen were hammerhead cranes and luffing cranes. Though hammerhead cranes are more efficient in moving materials than luffing cranes, they can only be used when there is ample space [5]. This is because it has a greater swing radius than a luffing crane, and is more likely to interfere with adjacent structures [5]. Hammerhead cranes were used at 100 Queens Quay East, and Tucker HiRise. Conversely, when there are impeding structures close to the site, a luffing crane is used [5]. For example, three luffing cranes were used at CIBC Square because of the adjacent Gardiner Expressway, as seen in Figure 2 below.

Figure 2: Three Luffing Cranes in the Foreground and Background at CIBC Square [8]

In terms of building materials, the most common types of materials used for the skeleton of the building are steel, timber and concrete [5]. An example of steel construction was at 134 Peter St., and an example of timber construction was at 135 Charles St. West. Overall, the most common type of building material seen during the site visits was reinforced concrete.

Due to concrete's weak tensile strength, reinforcing steel bars are placed in the concrete to increase its tensile strength, which was seen at Design Haus [5]. For the construction of concrete buildings, formwork and other temporary structures are required to properly shape and strengthen the concrete. One common method for formwork, which was seen at Dundas Square Gardens, was the use of fly-forms. Dundas Square Gardens is currently in the stage of building up, at 30 floors as of October 19, 2018 [1]. They are adding a new floor at a rate of one floor per week, using fly-forms in the process [1]. Fly-forms serve as temporary formwork of concrete which can be reused at every floor of a building by raising them up one floor after the concrete on the current floor has cured [5]. In order to transport concrete up to the top floor being constructed, a common method seen at sites including Design Haus, was a crane and bucket. This method involves loading the concrete into a large bucket which can then be lifted to the desired location by a tower crane [5]. Unique to

Dundas Square Gardens was the use of a pump and piping system to transport the concrete to the top floor [1].

In terms of safety related to building up, a unique feature of Dundas Square Gardens is a safety net. The safety net is used to catch materials that may fall off the building during the construction process. This is mainly to protect workers on the ground floor, as well as pedestrians [1]. Figure 3 below shows the implemented safety net, which has caught bricks and other debris.

Figure 3: Safety Net at Dundas Square Gardens to Catch Fallen Materials and Debris [8]

2.4 Organization and Process Efficiency

The planning of the organization of materials and labour is key to process efficiency and keeping a project on schedule [1]. Organizing materials to ensure that workers can find the materials quickly can increase efficiency because they are not wasting time looking for the materials they need [5]. At Dundas Square Gardens, most materials were kept in the underground parking lot in neat piles so that the workers knew exactly where to find them [1]. This can be seen in Figure 4 below. As well, safety is increased because unused materials are kept out of the workers' way [1]. Generally, most sites had their materials on the ground floor, but in neat and separate piles nonetheless.

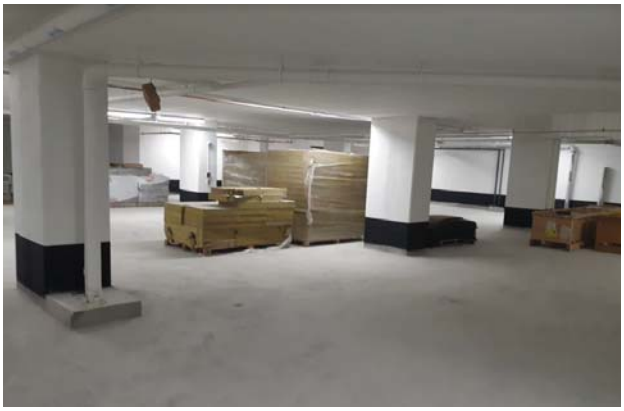

Figure 4: Materials Stored Underground at Dundas Square Gardens [8]

In terms of process efficiency, Dundas Square Gardens built up new floors while adding finishes to the lower floors [1]. This was so that residents of the units of lower floors could be moved in while the upper floors are still to be complete [1]. This is common practice because the lower units could be sold first, increasing the cash flow for the Gupta Group [5] [1]. During the colder months, some problems can arise such as the cracking of drywall during installation as well as worker discomfort [1]. Uniquely observed at Dundas Square Gardens was the use of temporary heaters to ensure proper heating of the building. Furthermore, they had an urgency to finish the installation of windows on the floors that were being heated to reduce heat loss. This was so that they could use less additional energy and save money on heating the building during construction [1].

3.0 General Safety Measures

In addition to the more unique safety measures previously mentioned in section 2, there were many similar practices across the sites to ensure worker and pedestrian safety. For example, all sites had a clear and conspicuous poster of what personal protective equipment (PPE) is needed on site, and most sites had workers guarding the entrance of the site from pedestrians. Furthermore, all sites either laying foundations or coming out of the ground/building up had scaffolds. Scaffolds are used to protect pedestrians from debris [5]. In addition, SkyGrid at Dundas Square Gardens checks the stability of the scaffolds weekly [1]. Furthermore, all of the sites at an intersection of a road had a worker conducting vehicle traffic into/out of the site to ensure pedestrian safety.

Though measures are taken to ensure worker and pedestrian safety, it is important to note that compliance by workers is needed to ensure safety. Approximately half of the sites had some sort of non-compliance with safety rules. For instance, at Design Haus a worker was pouring concrete in the excavation site and was not wearing a safety vest or hard hat, which was required. As well, when a supervisor was not present, many workers either did not have or took off a piece of PPE, such as a hard hat, like at Mountain Equipment Co-op Queen Street. Furthermore, at the old stone building adjacent to the Royal Ontario Museum on Philosopher's Walk, as well as many other sites, workers threw garbage such as empty coffee cups on the ground. This leads to messy sites, and garbage can become a tripping hazard [1].

A unique point to mention about Dundas Square Gardens is that it was the only site where we witnessed a worker getting hurt. As he was unloading materials from the truck to the loading dock, he tripped on the dock plate between the truck and the loading dock, falling face forward on the loading dock. According to the Public Services Health & Safety Association, the dock plate should be adequately stable to prevent trips [10]. At Dundas Square Gardens, the dock plate was simply a wooden board, not fixed to the ground.

4.0 Highlights of What We Learned

Throughout the site visits, there were many highlights of what we learned that can be taken away. One key highlight that we learned is the constant need for communication between supervisors and workers. This communication was used for ensuring that the workers knew what work to do and where, but also for safety compliance. At all sites, there was constant communication between supervisors and workers in a loud, clear manner. Another highlight of what we learned was how to manage a project in terms of efficiency. For instance, Daniel (assistant site supervisor for SkyGrid) at Dundas Square Gardens told us about simultaneously finishing lower floors while building up higher floors and how multitasking can result in a project being completed on time [1]. As well, we

learned about the importance placed on safety for workers and the public. Beyond the ethical issue of safety, profit margins are all but eliminated if workers or pedestrians are injured due to construction [5] [1]. This is why supervisors were constantly reminding workers to wear PPE, as well as there being scaffolds and workers actively trying to protect pedestrians.

5.0 Suggestions for Improvement

As previously mentioned, safety for workers and pedestrians is the biggest concern on a construction site, both from an ethical and economic perspective [1]. Thus, suggestions for improvement in this section pertain mainly to worker and pedestrian safety on the construction site.

5.1 Promoting a Non Threatening Environment

A sense of toughness amongst workers on the construction sites was observed, especially at Dundas Square Gardens. They would often try to appear tough amongst each other, and make jokingly threatening or insulting remarks to each other. 93 percent of construction workers are at risk of an injury that they are not made aware of [11]. Furthermore, almost 50 percent of workers knew about an injury that occurred because someone didn't report it before it became serious [11]. If managers and supervisors encourage workers to voice their concerns, such as through weekly meetings or whenever they see something unsafe occuring, productivity can increase by 93 percent, as well as decreasing costs by 15 percent [12]. Productivity is related to safety because of fewer injury hours, etc. [1]. The supervisor/manager has to ensure that the workers feel safe, and not judged to ensure that the workers are willing to voice their concerns [11]. This solution can be implemented across all sites, but especially at Dundas Square Gardens where a worker was hurt when we visited.

5.2 Detection/Surveillance Technology

Many times, a supervisor is not present to ensure that workers are conducting safe practices. Thus, many new technologies, such as smart watches and unmanned aerial vehicles, allow supervisors to have greater visibility of the site [11]. At Dundas Square Gardens, we noticed that many workers did not follow safe practices, such as not wearing safety glasses when cutting metal sheets, or not wearing a safety vest while working on site. It was only when Daniel, the supervisor, was within close proximity to the workers that they put their PPE on. These technologies allow supervisors to see in greater detail the practices that workers conduct [11]. Moreover, 82 percent of sites using wearable technologies instantly see better site-safety [11]. This is because of visibility as well as reduced time to seek help when an injury does occur [11]. Such wearable technology is especially useful on large sites such as Dundas Square Gardens, CIBC Square and 488 University Avenue, where it is not feasible to have a supervisor watching every worker. Furthermore, safer practices by workers will lead to fewer accidents to the pedestrians caused by workers.

6.0 Conclusion

Overall, the site tours provided many learning opportunities about the stages of the construction process and site safety for workers and pedestrians. However, there are definitely means of improvement pertaining to safety, which is important from an ethical as well as a business perspective [1].

References

[1] *Unknown*, Daniel, 2018, Dundas Square Gardens Site Visit, SkyGrid Construction, Dundas Square Gardens, Canada

[2] "Dundas Square Gardens Celebrates Ground Breaking Ceremony", *Easton's Group,* 2015. [Online]. Available: https://eastonsgroup.com/dundas-square-gardens-celebrates-ground-breaking-ceremony/. [Accessed: 10- Nov- 2018].

[3] "Dundas Square Gardens", *SkyGrid,* 2018. [Online]. Available: http://skygrid.ca/projects/dundas-square-gardens/. [Accessed: 10- Nov- 2018].

[4] J. Schuler, "Nearly abandoned building at College and Huron in midst of demolition", *The Varsity,* 2017. [Online]. Available: https://thevarsity.ca/2017/11/27/nearly-abandoned-building-at-college-and-huron-in-midst-of-demolition/. [Accessed: 10- Nov- 2018].

[6] "263 Adelaide Street Toronto", *Storey Living,* 2018. [Online]. Available: https://storeyliving.com/live-with-us/#lwu. [Accessed: 10- Nov- 2018].

[5] McCabe, Brenda, 2018, CIV280 Management of Construction course notes, Department of Civil and Mineral Engineering, University of Toronto, Canada

[7] J. MacLean and J. Scott, *The Penguin Dictionary of Building*. London: Penguin, 2004.

[8] M. Absar, *Downtown Toronto Construction Pictures*. Toronto, 2018.

[9] "*OHSA: CONSTRUCTION PROJECTS*", Ontario.ca, 2018. [Online]. Available: https://www.ontario.ca/laws/regulation/910213. [Accessed: 10- Nov- 2018].

[10] "Loading Dock Safety", *Public Services Health & Safety Association*, 2010. [Online]. Available: https://www.pshsa.ca/wp-content/uploads/2013/01/Loading_Dock_Safety.pdf. [Accessed: 10- Nov- 2018].

[11] K. Rzepecki, "Ways to Improve Construction Site Safety", *EHS Today*, 2018. [Online]. Available: https://www.ehstoday.com/construction/ways-improve-construction-site-safety. [Accessed: 10- Nov- 2018].

[12] "TOOLS FOR TALKING WHEN STAKES ARE HIGH", *VitalSmarts*, 2018. [Online]. Available: https://www.vitalsmarts.com/crucial-conversations-training/. [Accessed: 10- Nov- 2018].