ACBA5008 Work Based Project

Final Submission

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1) Provisional Research Question

How can Health and Safety be improved when tunnelling or excavating below ground?

2) Overview/Abstract

Throughout the project, I want to gain a good understanding for Health and Safety when working below ground and further my knowledge within the area. Additionally, I would like to propose ideas as to how I believe the sector can minimise the risk of injury occurring on site. I will touch on the differences between tunnelling, basement construction and groundworks, as there might be some similarities.

The project will increase future employment, as I can show that I have existing knowledge within a niche area, where others might not. Additionally, it shows that I can continuously further my knowledge within the industry, as Health and Safety is becoming the main focus of the Construction industry and without it, there would be a significant increase in the number of injuries and deaths. Therefore, it is imperative that everyone working in the industry has a very good understanding of what is required whilst working on site.

3) Introduction

There are many hazards when constructing below ground that can negatively affect cost, schedule, the labour force, and the environment etc. This project aims to identify potential hazards that can occur and specify whether Health and Safety regulations are sufficient or if they require changes to ensure that workers are protected. The attitude of workers within the industry will be taken into consideration, as it is imperative that individuals understand the importance of the guidelines and what is acceptable. In the UK we have some of the lowest injury rates in the entire world, so there should be very few instances where Health and Safety has been breached.

4) Aims and Objectives

The aim of the project is to reach a deeper understanding of how Health and Safety below ground can be improved and how previous studies can help us conclude whether changes are required within the industry, and if so how to implement them. Additionally, I will be learning about different research techniques and searching for relevant sources to back up any

changes that I believe are required. The objective is to come to a definitive decision on whether changes are required or if further limitations might be excessive. Furthermore, I want to identify worker's attitudes towards the legislation and whether it is being followed.

5) Research Methodology

This section is important, as it identifies the purpose and type of research that will be used to reinforce statements and allow for analysis of different types of articles. Throughout the project a variety of methods will be used to enforce claims and reinforce points. The aim is to identify and analyse whether Health and Safety is strict enough when working below ground. However, other details may be highlighted if necessary or required to justify different points made. Throughout the project multiple documents will be highlighted and compared to identify weaknesses, which could be used to adjust and therefore improve safety. Furthermore, these articles will be used to identify examples of issues occurring due to poor restrictions, reinforcement or awareness of the legal requirements when working on site. Finally, a conclusion will be provided using the research collated in the literature review.

5.1) Quantitative Research

This will be found and incorporated into different sections of the literature review to provide different perspectives. Quantitative methods will be used to identify and analyse people's opinions on the safety of the sector and whether this needs improvement. Or if the level is sufficient and would an increase in requirements significantly hinder the construction process. Statistics will be collated using multiple online sources which identify the need for an improvement in safety and a change in attitude from workers. Previous articles with relative statistics will be used to compare arguments from both sides of the argument to conclude whether the existing legislation requires further adjustment to ensure that Health and Safety is the utmost priority.

5.2) Qualitative Research

Qualitative methods will be used for the majority of the assignment, as case studies must be used throughout to present different viewpoints and find information and scenarios where Health and Safety below ground has been subpar. Grounded theory will be used alongside the case studies, as it uses the views and opinions of participants using a number of stages of data collection to form a general consensus.

5.3) Mixed Research

These utilise both predetermined and emerging methods with multiple data forms being collected. The analysis can be a mixture of statistical, as well as text and image. These are used in longer, more in-depth case studies where both can be justified and will paint a clearer picture as to what is happening. In the project, this will be used to compare different scenarios and how they were dealt with and what could have been done better to reduce the effects. It is imperative to strive for improvement of standards within the industry, as reflection is required to identify what went wrong and how the situation could have been dealt with better to prevent similar scenarios occurring in the future.

6) Literature Review

Throughout the literature review, the content will be taken from reputable sources with references, to reinforce the comments made. The purpose of this is to further my knowledge of the sector whilst analysing what can be done to improve its safety. However, the topic is niche and very job specific. For example, some individuals will have plenty of experience, whereas others won't experience this type of construction throughout their entire career.

6.1) Basements in London

Excavation underground is very common in places such as London where land is incredibly expensive. Therefore, it is cheaper to utilise every square foot as effectively as possible by digging multiple stories below ground. However, by doing so there are many hazardous environments that are created. [1] The Evening Standard wrote an article in 2015 stating that "Dozens of basements being excavated under homes in central London are potential death traps for the workers digging them out, according to a shocking report from health and safety officials".

It states that [1] "almost half of the 107 sites seen in an unannounced inspection blitz of building sites earlier this month were in breach of health and safety rules". This is an unacceptable number of sites not following the required standards and legislation when constructing these basements. There should be a significant punishment for those involved and frequent check-ups for improvements in working standards throughout all the companies mentioned. This would protect the workers, whilst educating them about the risks involved and decrease the number of incidents occurring within the sector.

6.2) Dangers from Equipment and Hazardous Materials

Traffic, equipment, and machinery in a dark dusty environment can make it difficult to see and manoeuvre in tight spaces. Therefore, it is imperative that sufficient lighting is fitted. Furthermore, hazardous materials must be kept in a safe location and checked often to prevent spillages or leaks. Fumes from the equipment must be transferred out of the tunnel to prevent Carbon Monoxide poisoning and allow workers to carry out jobs safely. This is why multiple reliable ventilation systems are required to ensure that workers have a consistent oxygen source whilst underground. On a smaller project, there might be fewer fitted, as less are required for smaller spaces with less pollution. [2] The government document states multiple key hazards to watch out for when working below ground or tunnelling.

Services below ground such as pipes and electric cables must be checked for before digging below ground. A metal detector and soil sample should be taken to the depth specified in the plans. Further precautions can be taken if the project manager etc. believe that it is necessary. [3] “In the last five years, 354 people have suffered life changing injuries after striking a live underground electricity cable”. On average this is 70 people a year, which is a significant figure considering the ground should be cleared for excavation before using any equipment. However, this number is hardly unsurprising considering “nearly a third (31%) of tradespeople do not always check for underground cables”.

Furthermore, the main reasons tradespeople fail to check for underground electricity cables is because [3] “they don’t believe it’s their responsibility (15%), or they don’t think they will dig deep enough to hit anything”. To improve the safety, it is important that the entire industry is competent and understands the correct procedure of excavating below ground to limit the number of injuries occurring. I believe that anyone caught ignoring legislation and performing work unsafely should be put on a Health and Safety awareness course to educate them of the risks involved and why cutting corners is unacceptable within the industry. For example, in terms of tunnelling if a pipe is hit by a piece of machinery and it transports gas, then this can cause serious issues, especially in confined spaces. This is why reliable, constant air conditioning is required in case of an emergency.

6.3) Dangers of different Geology/Working conditions

Another consideration is the structure of the tunnel in terms of supports, spalling, collapse, different geology etc. This is crucial, as if there are soft ground conditions, then extra consideration must be taken to support this. Additionally, there is a higher risk of collapse occurring. [4] This happened in 1960 in Lebanon whilst constructing the Awali Tunnel. “A huge flow of water and sand filled over 2 miles of the bore and more than doubled construction time to eight years for its 10-mile length”. This would have had serious economic effects and significantly delayed the project. Furthermore, the incredible danger this would have caused if workers were stuck in the tunnel.

Thankfully, nowadays with modern equipment and technology, this is less likely to occur as the geology is better understood. This includes ground surveys and feasibility reports which have improved significantly, therefore enabling contractors to better determine what is feasible, economical, and safe to complete. Unfortunately, other countries around the world have not adopted as higher level of safety and consideration for the workers completing these projects, which can lead to many deaths. [5] Even though not specifically related to tunnelling, more than 6,500 migrant workers have died in Qatar since the World Cup was awarded. This includes constructing nine stadiums for the 2022 world cup. This figure is extortionate and further proves the point that other countries are not providing safe enough working conditions for their workforce and unfortunately, in some countries it does not look like there will be changes to proceedings.

Working at height must be consider even when working below ground, as pits can be multiple stories deep and therefore, it is imperative that these are cordoned off correctly. Significant injury can occur if the specified measures are not in place. Also, there must be sufficient lighting in these areas to ensure that the hole is illuminated. Noise can be significant when working below ground, as in a tunnel there can be lots of noise pollution from loud equipment and machinery moving. So where applicable, it is important that ear protection is being worn where required. Frequent readings should be taken to ensure that either sound levels are within [6] “the legal limits on noise exposure” or PPE can be worn to prevent hearing damage.

6.4) Legislation

The topic in question is an ongoing concerning issue as to how much safety is required to mitigate risk, whilst ensuring that a project can be completed within a sufficient period of time. [7] The BS 6164:2019 is the main Code of practice when it comes to Health and Safety when tunnelling within the United Kingdom. It considers the majority of aspects but is not a standalone piece of legislation and depends significantly on other standards. These are continuously being updated and adapted to suit current circumstances and developments in technology. For example, recently there has been a change in technology such as [8] "the use of high pressure compressed air techniques for cutterhead interventions". This ensures that material and water in the chamber is supported preventing inflow. Additionally, the size of shafts has been considerably increased to ensure the safety of workers in confined spaces. Another aspect mentions [8] "that the wet bulb temperature should be less than 27 degrees Celsius". The aim of this is to prevent heat illness when working. "HSE recommends that if the WB temperature rises above 32 degrees Celsius, then substantial extra control measures should be implemented." This will ensure that workers are protected, but mainly emphasises the importance of temperature checking throughout.

In the United Kingdom, there are strict laws protecting workers from performing potentially life-threatening work without the correct procedures in place. On bigger sites there are Health and Safety Executives who are responsible for workers wellbeing whilst work is completed on site. Any injury must be written down in the Health and Safety Accident Book to document how the injury was sustained. This is crucial and all workers should report these to ensure that everything has been documented throughout.

Another consideration is the Workplace Exposure Limit (WEP). [8] "These limits are usually an average exposure time, weighted over an 8 hour period but with additional short term, higher concentration limits that must not be exceeded". This would include all the different types of fumes/gases (Nitrogen Monoxide, Nitrogen Dioxide, Carbon Monoxide, Carbon Dioxide etc.) workers are exposed to when working below ground. This could be from boring machines or other plant equipment used in construction.

CITB have a course which is for individuals that [9] "are involved in the tunnel construction industry as a member of the workforce, to help you understand a variety of different health

and safety aspects of the industry". The one-day course aims to educate individuals on aspects of Health and Safety when tunnelling. It covers elements such as the entry to a tunnel, surface works, shafts, plant, and equipment etc. This course could be made a requirement if individuals are caught breaking legislation. Maybe a further, more extensive course could be created for workers that break the rules multiple times.

6.5) Tunnelling in the London Underground

Tunnelling tends to be more expensive than traditional basement construction, as these tend to be deeper and therefore, equipment and resources must be transported underground, rather than being accessed at the surface. [10] For example, tube "platform depth can vary from 15-25m below the surface". The Victoria, Jubilee and Bakerloo lines in London run below sea level. [11] As can be seen below, the routes all dip below the sea level and with issues such as rising sea level, this is only going to get worse. Extra caution must be taken to mitigate risk. [12] This means workers must be incredibly careful to avoid flooding or tunnel collapse when working in such an environment as it can happen very quickly, like was previously mentioned with the Awali Tunnel disaster. This type of issue is becoming more prevalent with London's ever rising tides of the Thames.

6.6) Importance of Risk Assessments

When works must be completed below ground, there is an extra level of risk that must be identified and mitigated to ensure the safety of the workers. [13] "Tunnelling/underground projects are widely recognised to involve significant geotechnical risks." Multiple factors contribute to the risk profile of projects, but "the most significant factors are the uncertainty associated with geotechnical conditions and a clear understanding of how those conditions will influence the construction work." This why a proactive risk management process is required for these complicated, specialist projects. Identifying different types of risks is the first step and most crucial step to ensure that risks can be minimised effectively throughout a project.

[14] The main cause of issues occurring when working below ground is inadequate site investigation. This is crucial as it allows the team to organise a schedule for such a project, whilst ensuring that workers safety is the utmost priority throughout. Once a sufficient investigation has been completed, a risk assessment can be carried out to identify potential

risks to watch out for whilst performing the works. These should be carried out frequently to ensure that the working environment is as safe as practicably possible. There are many hazards to watch out for when excavating below ground. Working at height is important, even when constructing below the ground as there are frequent pits and trenches involved in constructing basements and tunnels. Some of these can be deep enough to cause injury. Ingress of water and mud can increase the likelihood of slipping and slow down the works.

However, the majority of major injuries are from very basic incidents such as slips, trips and falls. [15] "Over a third of all major injuries reported each year are caused as a result of a slip or trip (the single most common cause of injuries at work)". The main way to prevent this is to perform frequent in-depth risk assessments to ensure that workspaces are clear and tidy, which should reduce the likelihood of these occurring. [16] Another way to mitigate injuries is to ensure that surfaces are not contaminated and to check frequently for spillages. Spillages should be cleaned up in order to prevent further issues, such as using matting where required, making sure that equipment is safe to use and well maintained etc. All incidents should be reported no matter how small to reduce the likelihood of it happening again. This sway risk assessments can be carried out in this location to identify issues with safety in the working environment.

7) Discussion

The priority throughout the project was to identify if a change in legislation was required when working below ground. I believe that in the literature review there have been many examples of where safety has been compromised in order to save money or time. This is unacceptable, especially considering some workers know they are breaching guidelines but instead try to get away with it anyway. After analysing some of the legislation, I personally believe that it is sufficient and thorough enough. Instead, the issue lays with individuals involved in the project. Educational levels and training courses should be the priority for improving safety. These should be enforced if workers are caught breaking the rules frequently. Maybe the industry could employ a strike system where if individuals receive three strikes within a period of time, they will be required to take additional training before being allowed back on site. I believe this would significantly discourage individuals from cutting corners and performing work unsafely. In the Construction industry we have a responsibility to prioritise safety in order to reduce the likelihood of injury occurring.

Therefore, if individuals are repeatedly carrying out work in an unsafe manor, then they should be taught about the importance of Health and Safety on site.

Also, this falls under an individual's competency. If they are willing to cut corners in terms of safety, then their integrity might be questioned in other aspects. This could be workmanship, where they will cut corners in order to make increased profit on a job or install aspects to an insufficient level in order to receive future work etc. I believe a strike system would combat this perfectly, as workers are more likely to check work extensively before submitting it. In terms of Health and Safety below ground, it can be a lot more complicated with regards to legislation and practices.

The literature review identified the importance of risk assessments, as they can be used to mitigate the chance of injuries occurring. Many sources state that this specific sector can have different risks that would not be considered when working above ground and therefore, it is imperative that those working in these conditions are competent and understand the requirements. In order to mitigate these risks and the likelihood of injury occurring, these risk assessments should be completed as frequently as practicably possible. This can limit the severity of potential incidents or prevent them entirely, which therefore reduces delays. The main drawback of this is the time taken to complete a risk assessment or to clean up an area. Additionally, an individual must complete these assessments, which means that they must be paid for doing so and their view can be classed as subjective, as it is their point of view as to what is deemed safe or unsafe. Therefore, what some inspectors might find feasible, others will deem to be unacceptable. For example, tools being left sprawled around a workspace.

Overall, the most important thing for mitigating the number of incidents and improving Health and Safety is ensuring that everyone understands the precautions in place. This should reduce the likelihood of bad practice or corner cutting occurring. I believe that there should always be Health and Safety executives on site to ensure that competency is at its highest. This way basic PPE can be enforced, which can prevent incidents involving dust, which is incredibly common when working below ground. In the industry, standards are gradually improving, but to further this, it is vital that individuals recognise the importance of performing tasks competently, but also safely. For example, when I previously completed work experience for Bouygues, the site was shut down for a week when a senior inspector

visited. This was due to a lack of PPE, safe pathing away from vehicles, exposed pits without railings. This can seriously affect a construction project with delays, scheduling etc. However, action was taken as a wakeup call to the workforce as an attempt to improve the level of safety on site.

8) Data Analysis

The fact that "almost half of the 107 sites seen in an unannounced inspection blitz of building sites earlier this month were in breach of health and safety rules" clearly identifies that there is a lack of care in terms of safety when working below ground. Individuals are not performing the work to a sufficient level of safety and therefore, there is an increased likelihood for significant injury to occur. "In the last five years, 354 people have suffered life changing injuries after striking a live underground electricity cable." This figure is concerning to me considering the simplicity of checking for cables. On average this is over 70 people a year. In terms of legislation, I have found nothing that would be causing such a significant figure, which leads to believe that instead it is a lack of competency. A source states that "nearly a third (31%) of tradespeople do not always check for underground cables". I believe that if individuals are found to be performing work unsafely, then they need to be educated on the importance of Health and Safety within this sector to reduce this figure. The source states that "the main reasons tradespeople fail to check for underground electricity cables is because they don't believe it's their responsibility (15%), or they don't think they will dig deep enough to hit anything". This seems farcical to me as if workers are carrying out excavations, of course they should check before digging. This does not have to be a thorough check such as a site inspection, but rather just using a metal detector.

"Over a third of all major injuries reported each year are caused as a result of a slip or trip (the single most common cause of injuries at work)". To prevent this, frequent risk assessments should be carried out to mitigate the chance of these easily preventable incidents from occurring. Even though the UK has a great reputation for being one of the safest countries in terms of Health and Safety within construction around the world, I believe there is still room for improvement. Other countries are not prioritising workers lives over making money and increasing the speed of construction. "Even though not specifically related to tunnelling, more than 6,500 migrant workers have died in Qatar since World Cup awarded".

This figure is quite shocking to me, and I hope that in the future other countries can follow suit in prioritising worker safety over time constraints and money.

9) Conclusion

To conclude, I believe that I have gained a significant amount of invaluable knowledge from studying this sector. The legislation analysed was thorough and detailed enough to cover most aspects of Health and Safety when tunnelling. I found the issues to be related more to individual lack of competency rather than an insufficient level of legislation. Therefore, I have suggested ways in which the industry could be improved to further mitigate the odds of issues occurring when constructing below ground. This includes very frequent risk assessments with strict punishments and training courses for individuals that have not been adhering to guidelines. This means they can learn the importance of Health and Safety and will hopefully, discourage them from breaking the rules again. I hope that in the future we can see other countries such as Qatar improving their Health and Safety levels to protect workers more and value their lives.

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