PRACTICAL WORK REPORT

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Summary and Acknowledgements

This report informs the user of my work on the Waterview Connection Project. The project's purpose, layout, components and scope is outlined. My role, work undertaken and what I have learned is introduced. The report outlines Fletcher Building's, Fletcher Construction's and the Well-Connected Alliance's structure, business units, values and subsidiary businesses. The layout of my workplace is discussed with general comments on our layout, technical facilities and staff amenities. My work experience is discussed including: onsite work inclusive of reconnaissance work, fire stopping and commissioning activities. Offsite work including supplier data requirements lists, construction execution plans, requests for information, computer aided design, and conceptual designing. Communication including co-ordination meetings, tool boxes, resource meetings, educational sessions, emailing and making phone calls. A reflective appraisal is completed, informing the user on: my impressions of the organizations and their performance, my performance. my interest in the project, the skills I developed including communication, planning, time management/prioritization, reading schematics/technical drawings, commercial documentation, teamwork and self-starting. The lessons I learnt including: The complexity of construction projects, Health and Safety, Engineering in Practice, Mistakes and People Skills. The report concludes with my overall impression of the experience, a concluding list and bibliography. Photos not referenced were taken by me.

I wish to acknowledge the following who have been influential to my development during my internship.

- Michael Allen - Section Engineer - Fletcher Construction
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- Lloyd McLeod - Fire Deluge Project Manager - McConnell Dowell
- Joel Maturan - Deluge Piping Engineer - McConnell Dowell

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Introduction

I was based on the Waterview Connection Project for my summer internship. This report outlines the structure and history of Fletcher Building, Fletcher Construction and the Well Connected Alliance. Fletcher Building is a complex, vertically integrated business, operating in construction, distribution, products and services. Fletcher Construction is Fletcher Building's Construction subsidiary. I worked as an Engineering Assistant – Intern on the Mechanical and Electrical Well Connected Alliance Team. I aided the mechanical outfit of the tunnel, undertaking onsite and offsite work. Onsite work included; fire stopping, reconnaissance and commissioning activities. My offsite work included; drafting and submitting quality control documentation, conceptual design work and participating in communication based activities. My internship was an eye opening experience. I learnt construction projects are complex. I developed important soft skills including; communication, planning and teamwork. I learnt about the mechanical systems of the tunnel. The professional engineering environment is complex, challenging and engaging. Practical engineering is very different from our academic environment at university.

Early Sections

Fletchers Building

Fletcher Construction Company Limited is a business unit operating under Fletcher Building Limited's Construction Unit. Fletcher Building Limited is a publically listed entity with a market capitalisation of $9 billion, 20,000 employees and listed on both the NSX and the ASX.

Fletcher Building Limited have a vertically integrated business model, divided into five business divisions; International, Residential and Land Development, Construction, Distribution and Building Products. Fletcher Building Limited operate in more than 40 countries with 100s of brands and 34 businesses, ranging from; manufacturing, distributing, construction and building products and services. They are a world leader in providing building goods and services. Fletcher Building have a consumer focused approach, creating sustainable value through strategic priorities, facilitated by their vertically integrated business model. Their focus is on the customer, people, efficiency and profitable growth.

Fletcher Building Limited originated as Fletcher Bros Ltd in 1915, with James Fletcher and his brethren pioneering the construction of wooden villas in Dunedin during 1900's. Many of Fletcher Building Limited's business originated with a pioneering spirit. Fletcher Building grew steadily through 1920s through to 1940s. Opportunities and growth saw the company expand on a global scale, creating Fletcher Challenge. Diverse interests in paper, pulp, meat processing, gas distribution and fisheries businesses saw the rapid expansion into Asia, Europe and the UK. During the 1990's, Fletcher Challenge evaluated its business model, focused on building, building products and home environments as the core of the business and divested non-core businesses. Fletcher Challenge split into the focused business divisions. Fletcher Building Limited was created, set to function as the publically listed parent company. Fletcher Building focuses on strategic merger and acquisition activity, strengthening the core business. Fletcher Building Limited has the potential to refine the company, growing the diverse portfolio (Fletcher Building, 2017).

Fletcher Building has 18 board members. Their names are; Sir Ralph Norris, Mark Adamson, Antony Carter, Dr Alan Jackson, John Judge, Kathryn Spargo, Cecilia Tarrant, Steve Vamos, Bevan McKenzie, Kate Daly, Matt Crockett, Dean Fradgley, Francisco Irazusta. Graham Darlow, Steve Evans, John Bell, Leo Finney and Charles Bolt.

Fletcher Building Limited serves different markets; Home Owners, Tradesman, Infrastructure Providers, Councils, Governments, Private and Public Partnerships. Fletcher Building Limited focus on employee attraction, retention and development, prioritising leadership, talent, capability, diversity and collaboration. Health and Safety Governance is a focus at the firm. Fletcher Building Limited supports local communities, sponsoring junior and senior charitable and sporting events in New Zealand, Australia and Overseas. The Environment and Sustainability are key focuses for the firm as they protect and minimise impacts on the environment, protect the health, safety and wellbeing of employees whilst investing in and supporting the communities where the business unit operates.

See the table over the page, highlighting the purpose of each business unit and their financial figures.

Business Unit	Building Products	International	Distribution	Construction	Residential and Land Development
Purpose	Combine manufacturing and distributing building material interests, supply to Australasia's broad range of industries.	Manufactures and delivers roofing materials, laminates and decorative surfaces products.	Distribute products with differentiated service offerings across New Zealand and Australia.	Build commercial buildings and infrastructure across New Zealand and the South Pacific.	Develop and build residential communities.
Gross Revenue ($, Billion)	2.5	2.1	3.2	1.7	0.3
EBIT ($, Million)	274	133	176	78	84
Number of People	4,059	5,470	6,145	3,275	109

Figure One: Fletcher Building Business Unit Comparison (Fletcher Building, 2017)

Fletcher Construction

Fletcher Construction delivers projects under different contract models. These include; design and build, novated design, construct only or public private partnership. Fletcher Construction operates alone or with complementary international or local joint venture partners. Graham Darlow is the Chief Executive Officer of Fletcher Construction. He started as a professional engineer in 1988, progressing up the company's structure and became general manager in 2001.

Fletcher Construction is divided into four areas of focus; Buildings, Infrastructure, Roading and South Pacific.

Fletcher Construction Building division delivers buildings. In Auckland, Fletcher Construction has built many building. These structures include; Civic Theatre, Auckland Sky Tower, Stands at Eden Park, hotels, University of Auckland and AUT buildings, commercial office towers and retail spaces. Fletcher Construction delivers projects to help Auckland meet a world-class standard. Some of these projects include the NZ International Convention Centre and Commercial Bay development. Hotels, hospitals, universities, commercial and retail buildings have been built and redeveloped in the central North Island. These projects include; Waikato Stadium, Kathleen Kilgour Centre, The National Bank of New Zealand and Chateau Tongariro. Fletcher Construction helped rebuild Napier after the 1931 earthquake. Projects in Wellington include; the Salvation Army Barracks, the Central Railway Station, Te Papa Museum of New Zealand, Intercontinental Hotel, Westpac Stadium and the Capital and Coast Hospital. Fletcher Bros Ltd started projects in Wellington in 1917. Fletcher Bros Ltd started operations in Dunedin in 1909. Their first permanent office was established in Christchurch in 1955. Fletcher Construction successfully earthquake strengthened works in landmark buildings, parts of the Christchurch Arts Centre and Christchurch Boys High School. After the 2011 earthquake, Fletcher Construction played a significant role in the rebuild. Projects include; Grand Central, the Canterbury Regional Science and Innovation Centre, the Justice and Emergency Services Precinct and the restoration of the Arts Centre. Fletcher Construction works with Forman, acquired by Fletcher Building in 2006. Forman focus on interiors construction, specialising in suspended ceilings, internal and aluminium partitioning, carpentry and access floors.

The Infrastructure division extends and enhances transport infrastructure, improving utilities (energy and three types of water; potable, storm and waste). Major Infrastructure projects include; Manapouri Second Terrace Tunnel, Lyttelton Tunnel, Waterview Connection and the Christchurch rebuild.

Infrastructure has several subsidiaries working under its division. Brian Perry Civil specialise in foundations, structures and environmental remediation. Piletech integrate the design, supply and installation of unique screw pilling solutions. Their expertise extends to other stabilisation processes. Pipeworks offer complex trenchless pipe construction and rehabilitation capabilities. Seovic produce traffic barriers and concrete walls for motorways using innovative, continuous, slip-form barrier machinery.

Roading is built and maintained by Higgins. Fletcher Building acquired Higgins in 2016.

The South Pacific Division has been developing and modernising the South Pacific since the Apia overseas contract in 1946. Fletcher Construction is based in Fiji, American Samoa, Vanuatu, the Soloman Islands, Tonga, Papua New Guinea and Samoa (Fletcher Construction, 2017).

Figure Two: Fletcher Construction Logo (Fletcher Construction, 2017)

Well Connected Alliance

The Waterview Connection Project is delivered by the Well-Connected Alliance. Fletcher Construction, NZ Transport Agency, McConnell Dowell Constructors, Tonkin and Taylor, Obayashi Corporation, BECA Infrastructure and Parsons Brinkerhoff are major partners in the alliance. These partners rely on sub-alliance partners (SICE NZ Ltd and Wilson Tunnelling) and sub-contractors to complete the project. The alliance structure shares project risk and helps achieve project objectives. A collaborate effort is required to perform and deliver the project in the best interest of the alliance.

Waterview Connection Project

The Waterview Connection project is New Zealand's largest, costing $1.4 billion. The project aims to improve Auckland's transport system by connecting the western ring route, alleviating stress off State Highway One and the Harbour Bridge. An alternative route is made between the north and south. The South-western motorway (SH20) and North-western Motorway (SH16) are connected by two, twin bore, 2.4-kilometre-long tunnels. Alice, the Tunnel Boring Machine (TBM), bore two 14m diameter tunnels. After the construction of the roadway, the diameter at road level is 12m, three lanes wide. The tunnel has two ventilation buildings, one at either end. There are 16 cross passages spread approximately 150m apart, along the tunnel. The Great North Road Interchange, a complex motorway system, lies to the north, directing traffic either towards the city or north. The interchange is made up of four ramps with a combined length of 1.7km. The system has been nicknamed spaghetti junction. The New Zealand Transport Agency (NZTA) is the client for the project. The project's enabling works began in January 2012. Accompanying the project is the Waterview Shared Path, a 2.5km walkway and cycle path, connecting Mt Albert to Waterview.

Work on the shared path began in February 2016, following Oakley Creek from Great North Road, Waterview to Alan Wood Reserve off New North Road. Bridges will be built along the route with access points including Phyllis Reserve and the Unitec Campus. These walkways are part of the Legacy Project.

I work in Office Building B at 150-152 Stoddard Road. My desk lies within the Mechanical and Engineering Intern section next to the kitchen. I work with three other mechanical engineering interns. There are several buildings around the site. Buildings A and B are south of the tunnel, near SAP 7. Human Resources, Communications, Procurement, Project Management, Civil, Mechanical, Design, Construction Phase Support, Commissioning and Project Resource Management are based in buildings A and B. Each building has approximately 70 people. An office complex sits at 123 Hendon Avenue, south of the tunnel, built from temporary structures. Health and Safety, Plant Management and Electrical are based here. An Operations and Maintenance building lies to the north of the tunnel. The project has a ten year maintenance period included in the construction contract. Maintenance will be based out of this building.

Our office building (A and B) has two sets of restrooms, three kitchens, six fridges, free beverages (tea, coffee and milk), seven meeting rooms, a reception area and three connecting carparks.

Figure Three: Tunnel Entrance

Jobs and Tasks

My tasks varied. I worked both on and offsite.

- On Site
    - Fire Stopping
    - Reconnaissance of Systems
    - Mechanical Systems
    - Commissioning Activities
    - Asset Identification
- Off Site (Office)
    - Quality Control Documentation
        - Construction Execution Plans
        - Supplier Data Requirements Lists
        - Requests for Information
        - Purchase Orders
        - Concept Designing
        - Snags Registration
        - Use of CAD Software
        - Research
            - Fire Stopping Solutions and Standards
            - Sequential Sampling through Lot by Lot Inspection
    - Communication
        - Meetings
            - Co-ordination Meetings
            - Tool Boxes
            - Resource Management Meetings
            - Educational Seminars
            - Supplier/Sub Contractor Meetings
        - Emails
        - Phone Call
        - Presentation

First Day

I started on the 28th November 2016. Safety Protocols are crucial for construction sites. An induction was necessary, an introduction to the dangers of a construction site, techniques to stay safe, safety around a construction site and the purpose/intent of the project. The Waterview Connection Project is important to the Auckland community. Orientation of the Tunnel and office started. I was assigned my construction execution plan, Fire Stopping and received an introduction to fire proofing and fire rating systems.

Fire Stopping

Fire Stopping is an integral safety mechanism, increasing the evacuation time in the event of a fire. There are three components to fire stopping: Structural (S), Integrity (I) and Insulation (I). Structural indicates the time period a structure will remain standing. Integrity indicates the time period the flame is contained. Insulation indicates the time period heat isn't transferred. The three components make up the Fire Resistance Rating expressed as three time periods in minutes. Structural time period/ Integrity time period/Insulation time period i.e. 120/120/120. The time periods are derived from fire curves, depending on the intensity and type of fire.

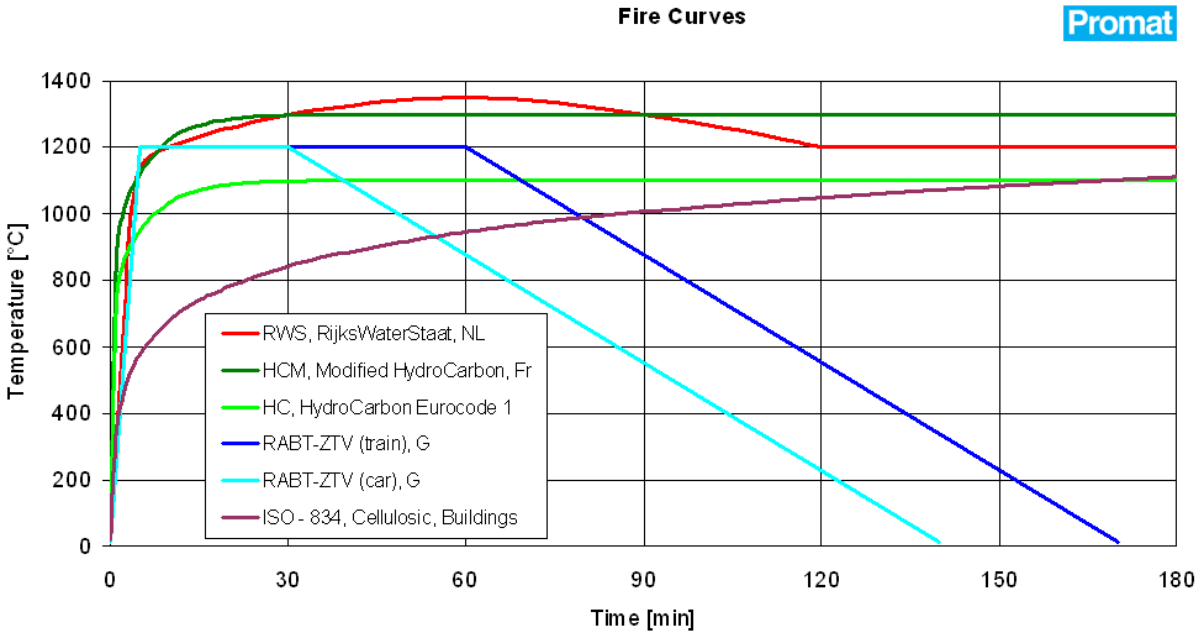

Figure Four: Promat Fire Curves (Promat, 2017)

Fire Stopping materials generally have intumescent properties (expand with heat). A fewproducts are listed below.

- CFS-BL Fire Blocks
- Intumescent Sealant
- Fire Resistance Boards
- Expanding Fire Foam
- Fire stopping mortar

Figure Five (Left) and Figure Six (Right): Fire Stopping Solution for a Cable Tray Penetration

I evaluated different penetrations (services, conduit, and pipework) for the fire stopping solutions. Australian, European, American and International test reports and standards were read to find the correct solution. I helped shift risk to our sub-contractors Hilti, Beele Engineering and Promat, working directly with each. They must approve the solution, as take the risk, with Global Fire carrying out the installation. A large proportion of my time was spent Fire Stopping.

Reconnaissance

I reviewed partially/fully complete works. I took a lot of photos, made checklists and reviewed documentation. Reconnaissance work included:

- Fire Stopped Penetrations
- Painting Works
- Drainage and Deluge Pipework
- Door and Signage Installs

Mechanical Systems

I was given educational sessions on the following mechanical systems.

- Ventilation – Jet Fans, Exhaust Fans, Motorised Dampers, Attenuators
- Linear Heat Detection
- Tunnelling Process
- Drainage – Sump and Hydrocarbon Traps

Ventilation

Exhaust fumes and other gases accumulate in the tunnel. Jet fans blow/suck fumes to either end. There are cavities above the two tunnel entrances. Large exhaust fans suck the fumes up, through a large attenuator, through the exhaust fans and out of the ventilation stack. Motorised Dampers control the flow though the exhaust fans. Attenuators disrupt the transmission of the exhaust fan noise, reducing the noise pollution of the system.

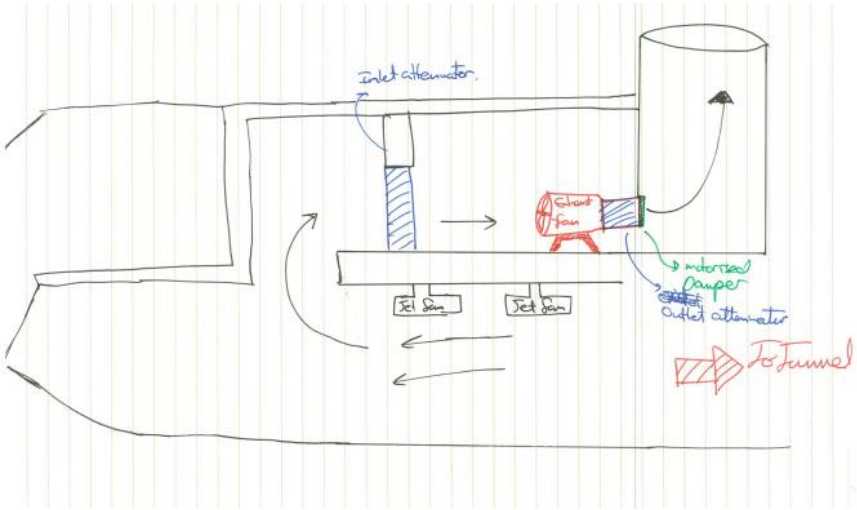

Figure Seven: Diagram of Tunnel Ventilation System

Linear Heat Detection

Four fibre cables run the length of the tunnel from fire alarm panels, calibrated within a temperature range. If the threshold is breached, i.e. the temperature within a deluge zone exceeds the threshold, a signal is sent to the operators. Relevant deluge zones are monitored/activated. I aided the calibration of these systems, using an ice bucket and software to set the threshold.

Tunnelling

Tunnelling is complex, involving the use of a Tunnel Boring Machine (TBM). TBMs have a large rotating drill bit at the front with attached cutting utensils. Water is ejected over the aggregate to soften the material and ease drilling. The blades are cooled to prevent damage and overheating. The aggregate is pulled into the TBM and carried out via the rear of the machine. Simultaneously, large ring segments are lifted up, placed around edges of the TBM and bolted in place. Grouting is ejected around the outside of the ring segments, forming a tunnel ring. The TBM repeats this process, edging forward until the tunnel is complete.

Figure Eight: Alice (TBM) Credit: Well-Connected Alliance, Project Orbit Database

Drainage Systems

Water, hydrocarbon material and other waste runs off the road through drains, down to storage cavities called sumps. Hydrocarbon material is separated via a hydrocarbon trap. The trap is configured in a way to keep less dense petroleum and other fuels in the sump whilst pumping water out. Sumps are cleaned, creating an efficient system. Sumps require exclusion zones on the surface. There are different tiers of zones.

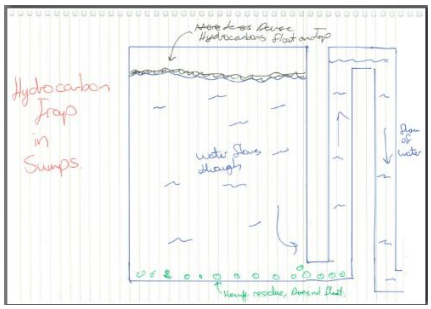

Figure Nine: Diagram of a Hydrocarbon Trap

Deluge Systems

The deluge system is the tunnel's major fire suppression system. The linear heat detection system and other systems trigger alarms. Data is sent via the PMCS system to the fire alarm panels, mimic portal and the operators. There are four tiers of alarms. An operator investigates the alarm. If deemed necessary, the deluge system is activated. Water is drawn from the storage tanks held in the southern ventilation building, through the deluge pipework and released over three deluge zones. The system has the capacity to deliver 220 litres per second and drop a maximum of 125,000,000 L. I witnessed the deluge testing. I read process diagrams.

Commissioning Activities

I aided noise commissioning activities. All systems must meet requirements to comply. The exhaust and jet fans must not exceed a noise rating to comply with residential standards. I surveyed sights to do testing from and aided the measurement of the exhaust and jet fan noise levels. I aided other commissioning activities in the tunnel.

Figure Ten: Waterview Tunnel

Asset Identification

All assets and systems must be identified and labelled as per the project's specification. These are recorded in an asset register. Major and ancillary equipment was to be tagged and the flow of ducting and pipework is to be shown. I installed tags on equipment related to the following systems: Ventilation, Drainage and Deluge. I labelled the drainage direction of flow through arrows.

Quality Control and Documentation

I drafted, reviewed and completed different forms of documentation.

Construction Execution Plans

Construction Execution Plans (or similar) are crucial for the completion of any project. A project has many components. The compartmentalisation of a project is an efficient way to manage these components. Requirements must be met to meet compliance standards and meet the specifications set by the client. I reviewed the Exhaust Fan and Fire Stopping CEPs.

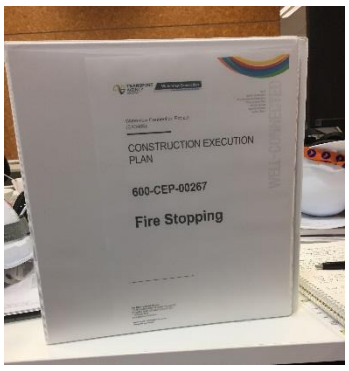

Figure Eleven: Construction Execution Plan for Fire Stopping

Supplier Data Requirements Lists

I aided the compilation and closure of Supplier Data Requirements Lists (SDRLs). The client requires documentation on assets/systems to comply with standards. In order to comply, documentation must be sent and is managed within an SDRL. I reviewed the Exhaust Fan, Attenuators and Dampers SDRLs. I compiled checklists indicating what was missing. I aided the acquisition of the missing documents by contacting employees and reviewing the checklist.

Potential SDRL Components

- As-Built Drawings
- Factory Acceptance Test Plans
- Installation Certificate
- Producer Statements
- Labelling Plans
- Certificates of Compliance
- Certificate of Conformity
- Corrosion Protection Plans
- Operating and Maintenance Manual

Requests for Information

I drafted, submitted and reviewed Requests for Information (RFIs). RFIs are an official communication mechanism. Construction is subject to change. Design may not translate well to construction due to new constraints. RFIs communicate proposed changes to designers and have them approved. I drafted RFIs regarding downgrading the fire resistance ratings of penetrations. I did reconnaissance work, taking photos to support the RFI. Drawings and other supporting documents were annotated to help convey changes. I compiled the RFIs and their supporting documents, submitting them for approval.

Figure Twelve (Left): Photo of Bus Duct for an RFI to reduce seal FRR

Figure Thirteen (Right): Cross Passage Cable Tray after Fire Stopping

Purchase Orders

I drafted and submitted purchase orders (POs). Purchase Orders are necessary for the acquisition of supplies. The orders are a cost management mechanism. POs must be allocated to a department, assigned a cost code and approved by the employee in charge of the cost code. The risk of cost inefficient purchases are minimised. Large scale projects are very costly. POs help save and manage money. I made purchase orders for labels, screws and other construction equipment. I drove around Auckland picking up purchase orders.

Figure Fourteen: At Hilti Workshop picking up a PO

Concept Designing

I went through an iterative design process to design labels for the drainage and ventilation systems. As mentioned above, all assets/systems need to be identified. I made two sets of labels. I did reconnaissance work, taking photos and dimensioning the applicable sites. I read the general and drainage specifications to determine the design constraints. I created label proposals and made changes when necessary. I made contact with the suppliers Deneefe, Cuthbert Steward Ltd and MRC Global, organising for the labels to be made.

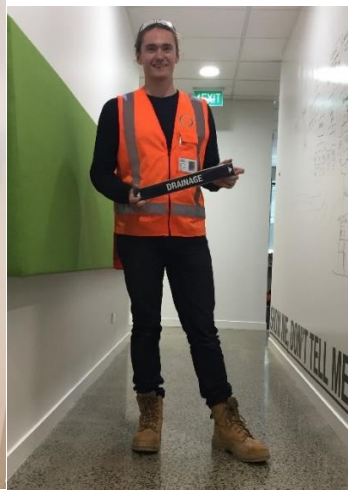

Figure Fifteen (Left): Ventilation Machinery Labels

Figure Sixteen (Right): Drainage Flow Arrows

Snags Registration

I processed snags, entering them into our snags master register. Snags are touch ups needed to be done after construction is complete. Minor damage, missed spots whilst painting and missing screws are examples of snags. Snags enable the closure of CEPs, meeting compliance requirements whilst small works are still remain.

Use of CAD Software

I used Draftsight CAD software to compare the cross sectional dimensions. I took physical cross sectional measurements over the ventilations room's air velocity sensors, in both ventilation buildings. I used the dimensioning tools on Draftsight to find the designers measurements. I compared the construction and design dimensions. Technical drawing were read.

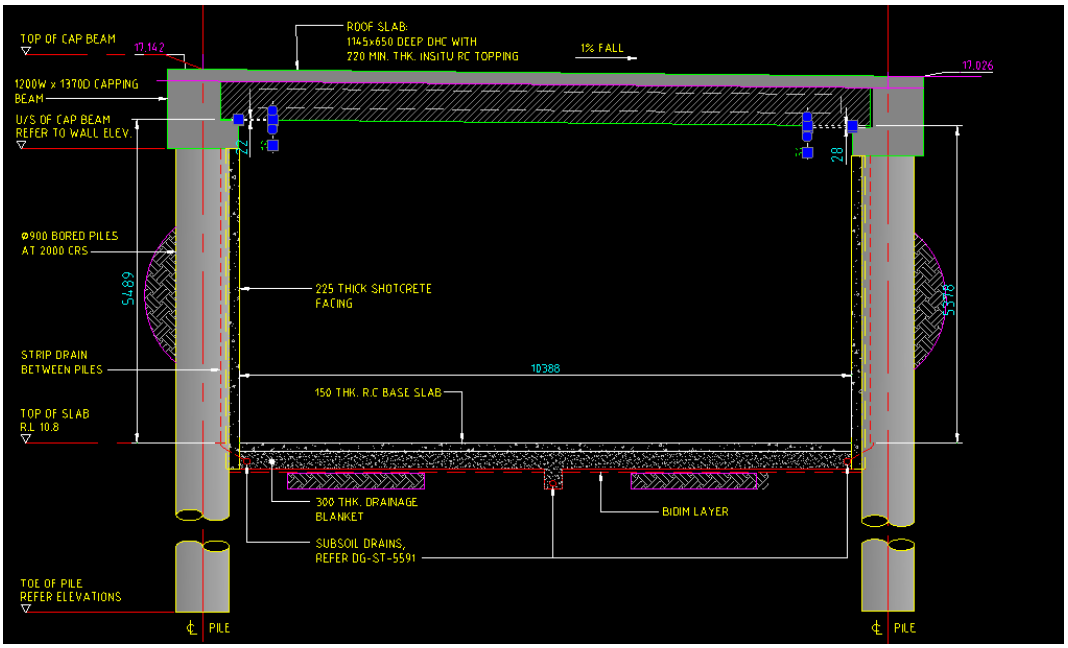

Figure Seventeen: Using Draftsight to Measure Cross Sectional Area

Research

I researched fire stopping solutions, standards and test reports. I looked for solutions relating to bus ducts (high voltage distribution pathways). This was a difficult solution. I read the technical datasheets and specifications for fire stopping materials i.e. Hilti CFS-BL, Hilti Intumescent Sealant, Hilti 660, Hilti 611A and Hilti Fire Collars. My research included test reports based on the type of penetration we were looking at sealing. To use a fire stopping solution, our suppliers must agree on one validated by a specific test report. If Hilti and Global Fire did not have a test report meeting the requirements, we could not use that solution. I researched the Australian (AS), European (EN), American (ASTM) and International Standards (ISO) relating to fire stopping methods. This research helped my supervisor decide on the best solution to submit to our sub-contractors.

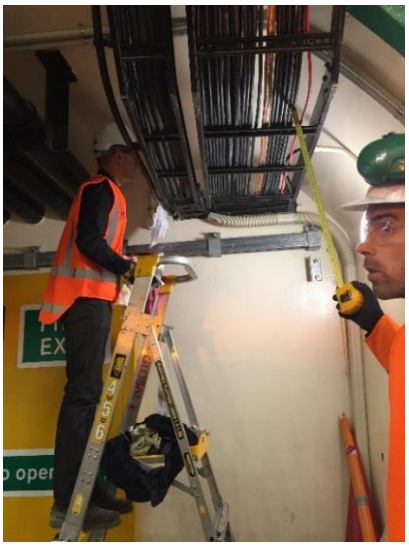

Figure Eighteen: Discussing a fire stopping solution using Hilti CP 636 Mortar

I investigated sequential sampling techniques for the inspection of lots. We were looking to test the four tiers of alarm systems. With a lot of 176 alarm zones, we didn't want to test them all. I was tasked with finding a sampling technique to reduce the number we had to test but would still comply with the relevant standards. I reviewed sequential sampling, a technique using standard deviation principles and our history with the supplier. There are reduced, normal and tightened inspection schemes. The principle of Average Quality Limit (AQL), the lowest acceptable level of quality something may be accepted with is measured. There are different sampling numbers and techniques based on a number of factors. My research was to lead to a reduction in testing time and costs.

Communication

Communication was an integral part of my work. Engineering in practise relies heavily on communication. I participated in many meetings. I shared the work I was conducting in our co-ordination meetings. The meetings purpose was to collaborate and organise works between multiple departments within the Well-Connected Alliance. We discussed what we were doing, made alternative arrangements if clashes came up and redirected resources if one group was understaffed or needed to be finished in order to remain on critical path. I participated in Tool Boxes, morning safety briefings. I added input to the discussions relating to safety. We got the big picture overview of the works on the project, identified incidents and hazards, addressed safety measures and reviewed our safety culture. These meetings were critical to us meeting our safety benchmarks. I attended resource management meetings, addressing what jobs I was doing and their status. I attended educational seminars, learning about the mechanical systems in the tunnel. I meet with sub-contractors and suppliers to help discuss how we were going carry out fire stopping, what products to use, work out scheduling issues and decide on the best solutions. I sent emails to gather information and ask questions. I made phone calls to arrange meetings, settle issues and confirm information. I gave a presentation at head office, regarding my internship. The presentation covered: What was my project? The jobs and tasks I completed during my time. Which Fletcher Construction value most closely resonated with my experience? What impressed me the most about my time? And, a summary of the lessons I have learnt. I presented to Hennie Peters, Human Resources Manager and Ian Jonkers, Fletcher Construction's Operations Manager.

Figure Nineteen: Site at Night

Reflective Appraisal

Impressions of Organisation

I was blown away by the Fletcher Construction and the Well-Connected Alliance. Both have high performing cultures. Fletcher Construction has a comprehensive development culture. Interns are looked after and nurtured. We have feedback sessions to discuss our progress. We are well supported by engineers, human resource personal, foreman, supervisors and wider staff. The Well-Connected Alliance are very impressive. I have been fortunate to work with engineers from: Australia, Spain, New Zealand and Germany. There is a community focus, driven by an ethos of leadership, safety and finishing faultlessly. We are driven to be industry leaders in health and safety, trying to disrupt the standard of safety in the construction industry and New Zealand. We have studied the values of the All Blacks, each given a copy of James Kerr's Legacy. These values are integral to our culture. There is a good synergy between the seven alliance members.

Organisations Performance

Both organisations are high performing. Fletcher Construction and the Well Connected Alliance have very dedicated employees. Most work an excess of 10 hours each day with work on weekends as well. There is a passion to continue our work and complete the project on time.

My Performance

I was focused during most of my internship. I assessed each task, creating an action plan for the more difficult jobs, on the best way to complete the task. I worked an excess of 50 hours most weeks. I remained productive for most of my time. I was struck by fatigue on a few occasions as overworked a couple days, dropping my productivity. I was inquisitive, asking questions when possible. I made a few small mistakes. Examples include not taking a few photos/dimensions during reconnaissance and not picking up some PPE. I addressed my mistakes immediately and used them as learning opportunities. I tracked my jobs via a matrix. A priority level and deadline was established and followed closely. My action plans were tracked against this rubric. I was a team player. I did my best to aid the other interns with tasks they needed to complete. I assessed the priority level of my tasks and the other intern's tasks, aiding if critical or of a higher priority than my own. I was mostly attentive and focused in meetings. I did not shy away from tasks, favours and new learning opportunities. I took in new information and did regular reviews. I performed to the best of my ability.

My Interest

My internship was not what I expected. I didn't realise how fun, engaging and challenging working in the construction industry could be. There was always something new to learn. I enjoyed; learning about the mechanical systems, researching new fields, reading technical reports, learning from the experiences of seasoned engineers, learning about other projects with similar processes, using web based information systems, reading technical drawings, deciphering process schematics, visiting site, walking the ventilation, deluge, drainage systems, working in the tunnel, culverts and ventilation buildings, listening in on contractual discussions and sharing my progress in co-ordination meetings. I am grateful I was given a wide scope. I was allowed to develop and given a realistic experience of a professional engineering environment. The technical concepts I learned may not be useful to my specialisation. They will be for consulting. The soft skills I learned are invaluable and will be critical to my professional development and future work.

Figure Twenty: Task Rubric

Skills Developed

Communication

My role relied on communicating with different groups from Fletcher Building, Fletcher Construction and the Well-Connected Alliance: Fletcher Building Upper Management, Project, Section and Site Engineers, Sub-Contractors. Suppliers, Interns, Human Resource Personal, Foremen, Site Supervisors and Tradesman. I learnt to adapt my communication style to the individual. I used different mediums based on the situation. Emails for planning meetings and non-urgent matters. Phone calls for urgent/matters of priority. The most efficient method of communication is talking to people face to face. My confidence grew the more I spoke to people and as the task difficulty/level of responsibility increased.

Planning

The tasks I was assigned varied in difficulty. Some were quite complex. Others simple. The more complex tasks had; hold points, required discussions with different groups from designers to site supervisors, involved organising individuals to be present at different times and had time critical deadlines. I devised systems to ensure all personal needed were present and tasks would get on time. I learnt to deconstruct tasks and form a likely timeline of events. I worked back from the deadline date. I developed skills using planning systems; Planners, Microsoft Outlook, Harmon.ie (Web based database that communicates with Microsoft outlook), Project Orbit, scheduling.

Time Management/Prioritisation

I learnt to assess and prioritise tasks based on their nature. A large scale project has a critical path. I adjusted the rate tasks we completed based on their relevance to the critical path. I developed methods for completing tasks quickly, setting time limits for completion. I used my scheduling skills to manage my time and prioritise.

Reading Schematics / Technical Drawings

I deciphered and read process diagrams and technical drawings. I learnt to read these documents as well as other documents. This is an important skill as engineering projects rely on these schematics and drawings to convey information.

Commercial Documentation

I created commercial documents. I learnt to draft and publish purchase orders and requests for information. I learnt to manage construction execution plans and supplier data requirements lists. Drafting and publishing commercial documentation is an essential skill as required to plan, manage and get projects to comply with standards.

Teamwork skills

I learnt to work in several tiers of teams; interns, the mechanical and electrical team and within the Well-Connected Alliance. I developed the intuition to delegate, ask for help and give help when asked. I realised the importance of team dynamics and their vitality in completing projects.

Self-Starting

I learnt to take initiative early. I became a fast starter, beginning tasks when the opportunity presented its self. I developed a work ethic to continue tasks until completion, even if it takes weeks.

Lessons Learnt

Complexity of Construction Projects

Construction projects have a great degree of complexity. Tunnels require many systems, even though they seem simple. A lot of talent and resources goes into their construction. I learnt construction projects can be fun, exciting and challenging.

Health and Safety

Health and safety is crucial to promoting a great culture. People feel safe coming to work. They contribute positively. The culture benefits, helping further build a culture.

Engineering in Practise

Engineering depends heavily on soft skills; communication, planning and teamwork. The engineering environment I was exposed to relies on people skills. Technical knowledge will only get you so far. If you cannot communicate the knowledge and work with people, your technical knowledge is as good as useless. Engineering on infrastructure projects has a heavy focus on quality systems and management. Practical engineering is nothing like university.

Mistakes

Mistakes will happen. Take them as learning opportunities. Never repeat them.

People Skills

People skills are integral to good engineering. Adjusting your communication style to the individual is a great skill. Engineering relies on working with a diverse group of people. You need to establish positive relationships with the individuals. Having social conversations is the easiest way to achieve this.

Figure Twenty One: Mechanical Interns at Site Safe Seminar

Conclusion

Overall Impression

My working experience has been invaluable. I have learnt so much in my brief time with Fletcher Construction. The skills and insight into the construction industry could not be learned in an academic environment. I have met many interesting people and grown my professional network. I loved learning about the mechanical systems in the tunnel, concepts we have not touched at university. I loved the high performing culture. This experience has reinforced my desire to study engineering and work professionally as an engineer.

Conclusion Summary

Conclusions Drawn

- Construction Projects are Complex
- Health and Safety is Vital
- Practical Engineering relies on Soft Skills
- Mistakes will happen. You must learn quickly and not repeat them
- There are many systems involved in the mechanical outfit of a tunnel

Skills Learnt

- Communication
    - Verbal and Non-Verbal.
    - Importance of Communication
    - How to adapt Communication Style
    - Different techniques are used depending on the situation/priority
- Planning
    - Use of Processes and Systems
    - Fluid Communication
    - Devising Metrics
    - Task Deconstruction
    - Use of Planners, Outlook, Harmon.ie and Project Orbit
- Time Management
    - Task Adjustment
    - Assessment of Priorities
- Reading Schematics/Technical Drawings
- Commercial Documentation
    - Drafting
    - Reviewing
    - Publishing
- Teamwork
    - Inter Teamwork Skills
    - Delegation
    - Asking for Help
- Self-Starting

Bibliography

Fire curves - Tunnel - Tunnel. (n.d.). Retrieved February 20, 2017, from http://www.promat-tunnel.com/en/advices/fire-protection/fire%20curves

Home | Fletcher Building. (n.d.). Retrieved February 20, 2017, from http://www.fbu.com/

Home :: Fletcher Construction. (n.d.). Retrieved February 20, 2017, from http://www.fletcherconstruction.co.nz/

Home | NZTA. (n.d). Retrieved February 20, 2017, from http://www.nzta.govt.nz/