eChartered

ENGINEERING COMPETENCY REPORT

EXAMPLE C

1 August 2013

ENGINEERS AUSTRALIA

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About this example

This report is part of a set of example reports that is being developed to provide examples of Engineering Competency Claims and the Engineering Experience Record (EER). These Examples are for use by participants using the eChartered system to guide them.

Before reviewing the example reports, applicants should refer to the appropriate *2012 Australian Engineering Competency Standards Stage 2- Professional Engineer or Engineering Technologist or Engineering Associate* available in the Resources section of the eChartered website.

Participants should also refer to Section 5 of the Online Participant Guide, *Submission*, paying particular attention to Section 5.3. *Writing Engineering Competency Claims (ECCs).* The *Thought Starters for Preparing Engineering Competency Claims in eChartered* available in the Examples section also provides guidance and is recommended reading along with the example reports.

The following 16 example ECC reports were submitted by a structural engineer who successfully achieved Chartered Membership following their Professional Interview, as well as registration on the National Professional Engineers Register (NPER) and the Stage 2 Assessment for the application to become a Registered Professional Engineer of Queensland (RPEQ).

The author was prepared to meet the requirements of the *Australian Engineering Competency Standards Stage 2.* Each of their claims and their Engineering Experience Record were verified by a responsible senior engineer.

Identifying information has been removed to protect the confidentiality of the author, their employers, their Verifiers, clients, and the projects covered. All verification has been removed for the purpose of maintaining confidentiality.

As the new eChartered process develops, Engineers Australia will be able to build a repository of examples. This example is from one of the first wave to use the eChartered system and successfully complete their Professional Interview.

Engineers Australia expresses its sincere thanks to the engineer who provided these reports to be used to assist others seeking Chartered Membership and/or registration.

Claim 1. Deal with ethical issues

For the past four and a half years I have worked on the structural design of new material unloading facilities in Australia for a leading global engineering firm. I have had varying roles including project manager, design manager, and also undertaken some aspects of the design as well as design checking.

Several of the structures I have designed have been directly supporting vendor designed equipment. As part of the design process the vendors were required to submit drawings showing the arrangement of their equipment and the applied design loads to our structure.

One element that I was required to design was the floor slab and beams, required to support the equipment that feed the materials from hoppers into a chute and onto a conveyor below. When the vendor submitted their preliminary loading drawing to me I undertook my own independent calculations to approximately check the loads that were provided. I also checked the loads against similar equipment from previous projects. I discovered that one particular load scenario that could be critical for my structure was not provided by the vendor. At this point I could have designed the structure for just the loads provided to me by the equipment vendor but this would have put the overall design at risk. Instead I sent an email to the vendor respectfully querying the loads that they had provided to me. The vendor responded by adding the particular load situation to their drawings, albeit noting that it would require their machine to be misoperated to cause that type of loading. Even so I designed the structure for this load as I could not see any reliable controls that could be put into place for the life of the structure that would prevent this misoperation from possibly happening.

In another instance from the same project the client had an incumbent vendor from an earlier project and we had designed our structures to suit their equipment. After completing the new design the client received unexpected increase in price from that particular vendor and decided to retender that package. The client then received a better price from an alternative vendor and asked us to review their loadings to see whether that equipment could be installed on the structure we had already designed. I reviewed the loadings provided and compared to the original vendors design loads. I noted that the overall load (dead load + live load) had reduced thereby seeming not to be a problem. On further investigation I noted that the breakdown of the loads between the two vendors was significantly different, with one having a high dead load component with low live load and the other having a low dead load component with a high live load. I was concerned by this discrepancy because the equipment from the different vendors should have been more similar than this. Despite some pressure from the client for us to accept that the new vendor equipment would be ok to support from the structure I instructed my design manager to write an email outlining the discrepancy to all stakeholders and that more work would need to be done by us and the vendor before we could assess the adequacy of the structure. This is still in progress but all stakeholders are now aware of the issue and are working towards understanding the discrepancy so that an assessment of the new vendor equipment can be made.

I believe that this demonstrates that I acted with integrity, practiced competently and showed leadership in the identification and resolution of these two issues. It also shows that I considered the health, safety and wellbeing of those involved in the construction and operation of this plant and acted responsibly with all stakeholders, thereby upholding the code of ethics of Engineers Australia.

Claim 2. Practise competently

For the past four and a half years I have worked on the structural design of new material unloading facilities in Australia for a leading global engineering firm. I have had varying roles including project manager, design manager, and also undertaken some aspects of the design as well as design checking.

When I first became project manager and design manager for this project I (as well as others) recognised that it was maybe a stretch role for my current skills. I had managed small multi discipline projects and small to medium sized single discipline projects previously. The total structural fee for the Stage 1 work was about $3.5M, far more than any previous project that I had managed. The structural fee for Stage 2 ended up being similar.

Previously I had undertaken my company's internal project management training courses. This had given me exposure to most of the basic systems and processes. Before commencing this project I undertook my company's project management accreditation test, a tool designed to assess your experience and competencies in a variety of areas and enable you to see strengths and areas of possible weakness. This identified that I was just equipped to undertake the role but would need some guidance and assistance to help me keep the project on track. I planned regular reviews with my project director. These were used for him to assess and test the health of the project and for me to seek guidance and help on areas that were of concern to me.

At the commencement of the project I created a basic project management spreadsheet which included a tracking of progress against deliverables and budget, earned hours, spent hours and cost to complete. Over time this spreadsheet has developed into a detailed management tool and contains all of the information that I am required to have to manage the project and report on the status. Scope changes and variations have been added. At the beginning of Stage 2 of the project my company's systems had mandated the use of a corporate software package on all projects. I had started down the track of using the software which I recognised was far beyond my area of competence and so requested the assistance of a cost controller from another part of our business. I was then audited early in the project by some independent senior engineers in the business. They noted the spreadsheet that I had created on Stage 1 and the ease of use and functionality and recommended that I continue to use that tool for Stage 2 of the project as it was more nimble for a single discipline project and proved successful on Stage 1

Over the past 4 years I have been audited several times by our corporate quality assurance team. This provides an opportunity for my competencies to be assessed as well as the health of the project. At the conclusion of the audit a summary report is created and sent to myself, my project director, and management outlining the results. My colleagues are further aware of my areas of competence in other ways. I have listed my technical skills on our corporate intranet database. I have also completed the project management accreditation which allows all parts of the business to see my management skills.

I have a Continuing Professional Development register that I maintain to record and demonstrate the development activities that I have undertaken. This register will need to be included in my submission to Engineers Australia.

Claim 3. Responsibility for engineering activities

For the past four and a half years I have worked on the structural design of new material unloading facilities in Australia for a leading global engineering firm. I have had varying roles including project manager, design manager, and also undertaken some aspects of the design as well as design checking.

During this time I designed several elements of the facility. This included all analysis and design calculations for the main concrete external walls, the basement level concrete, the material feed level concrete and a steel framed services bridge. Throughout the design of these elements I maintained an ordered set of calculations. At the commencement of the work I requested from our business support some registered calculation folders that I could use for my work. I had individual folders for each separate element. I organised my calculations for each structure into logical areas including, introduction, design inputs, design assumptions, geometry/arrangement, loadings, analysis, design, design outputs. Each of these areas was included in separate sections of the folder. At the end of each stage of the project my calculations were compiled with other engineers' calculations ready to be signed off by the overall project lead structural engineer and project manager and handed over to the client as one of the project deliverables.

At the conclusion of each of my designs I sought an independent design check from a suitably qualified structural engineer. For the checking engineer I prepared a checking brief outlining the contents of the check pack, budget, schedule, project number, requested deliverables to check and the required outputs of the check. The main output of the checks that I requested was check prints of the final deliverables. That is drawings with all content either highlighted green for acceptance by the checker or marked-up with red pen for a query or correction required. On receipt of the check prints for the concrete walls, base slab and material feed floor I noted that not all elements on the drawings had been highlighted green. I was concerned that the checking engineer had not completely checked all of the elements so I returned them to him and requested that they be completed. Once I received completed check prints I worked through the comments and queries from the checker and closed-out all of these to the satisfaction of the checker by either making the suggested change or discussing and agreeing an alternative with the checker.

With my role I worked closely with the other structural engineers on the project. This included guidance for the younger engineers and collaboration with the senior engineers in resolving complex issues. With the size and duration of the project I have had eight graduate structural engineers working for me designing elements at different times. I guided all of these graduate engineers through most elements of their designs. This included briefing them on their required tasks, checking their progress, assisting them to resolve technical problems that they had encountered, and providing feedback on their work.

As the lead for the structural engineering of the facility I was required to authorise when deliverables could be issued. I ensured always that this only occurred when the design was completed and all checks had been undertaken. Those checks included an independent design check and a drafting check of the drawing as well as required interdisciplinary and client reviews.

Claim 4. Develop safe and sustainable solutions

For the past four and a half years I have worked on the structural design of new material unloading facilities in Australia for a leading global engineering firm. I have had varying roles including project manager, design manager, and also undertaken some aspects of the design as well as design checking.

At the entry end of the facility a multi-span bridge was required to span from the top of excavation onto the facility itself. This bridge was similar to a structure that the company had previously designed about ten years earlier for another facility. I was the site engineer for the construction of that particular facility. The bridge was designed as cast insitu which required substantial temporary works to construct and also needed the facility that supported it at one end to be completed before it could be built. This was time consuming and had risks due to the amount of temporary works involved and the nature of insitu construction.

During the concept design for the new facilities I recommended that the bridges be designed with precast deck beams and insitu topping slab to reduce the amount temporary works required, reduce the working at height hazards of building the temporary works and reduce the amount of site time and labour required to build the bridges. This proposal was accepted by the overall project lead structural engineer and the client.

I was aware however that changing the bridge type introduced some new hazards that weren't present in the previous bridge construction. One of these hazards was the handling and placement of long and heavy precast deck beams. I was also aware that the chosen contractor was very familiar and experienced in the design of insitu concrete works but not as experienced in the design of bridges with precast elements. To assist the contractor and reduce some of the construction risks I prepared a detailed construction sequence drawing outlining the stages in much more detail than we would typically provide for a bridge with experienced bridge contractors. I also placed a prominent note on the drawing warning the contractor of the risk of deck beams being unstable when they are first placed on a headstock and that they would need to provide a means of temporarily supporting the deck beams.

Another element of the previous bridge that I changed was the pier columns. These columns were very tall – About 22m high. In the concept design I proposed that these pier columns be made from steel circular hollow section that could be prefabricated and lifted in place on site rather than insitu concrete columns per the previous bridge. I also noted during the concept design that these pier columns would potentially be unstable during construction before the deck was placed and devised a concept to temporarily prop these columns back to a fixed support point.

The bridges have now been constructed. The construction proceeded very safely and efficiently with the precast and prefabricated elements. The construction also proceeded concurrently with the construction of the facility. When the facility reached the level of the bridge the last span was placed for the bridge and the facility completed. I believe that the type of bridge construction that I chose at concept stage was the safest and most sustainable option and had many advantages over the previous type of construction, although I noted that all solutions still have their limitations and I managed these well.

Claim 5. Engage with the relevant community and stakeholders

I was involved in the preliminary engineering of a new footbridge over existing rail tracks and a major road at a suburban railway station in an Australian capital city. I was the project manager of a multi-disciplined team and also the lead structural engineer. In these roles I was responsible for consultation with the client and some stakeholders, and was also responsible for many of the design decisions made on the project.

At the commencement of the project I identified that there were many stakeholders who would have an interest in the project. These were our client, the City Council, various service providers with services in the area, the contractor who would have to construct the bridge, and the community who would then use the finished bridge.

Some stakeholder activities that I undertook as part of the project included:

• I arranged for a civil engineer on the project team to obtain information on what existing services were in the area of the proposed bridge so that we could determine who might be affected. Services that were identified from this investigation included gas, storm water, fibre optic, telecommunications, electricity, and traffic signal communications, all of which were considered in the design.

• I engaged closely with the client at the start of the project to understand their requirements for the bridge. From these discussions I identified a number of key requirements that they had for this project. The first requirement for them was that the bridge would not affect future plans that they had for new and realigned tracks and a new platform. Secondly, the overall project had a tight budget capital cost and if the design could not fit within that budget then the project would not be able to proceed. Finally, the aim was for the project to be complete before a major sporting event was scheduled to be held at the nearby sports centre. This was important for the safety of the community who would be arriving by train in large numbers and would otherwise need to cross the busy road to access the sports centre.

• I engaged with the City Council on behalf of the client to identify any requirements that they would have that needed to be considered and addressed in the preliminary design.

• I engaged with the client before the preliminary design was finalised to seek their feedback on the proposed design and ensure that it would meet their requirements and that they understood the design and the implications of decisions we made during the design. I responded to their concerns and modified the design where required.

Some design decisions that I made during the project that gave consideration to stakeholder interests included:

• The required width of the footbridge needed to be determined by the project team.
This would affect the amount of time it would take for a fully loaded train to empty and for all people to pass across the bridge during a major event at the nearby sports centre. I arranged for a traffic modeller on the design team to do some analysis to determine the performance of different bridge widths. I discussed the results of the investigation with the client, including interpretation of what the results practically meant for them and the users, and also provided a recommended bridge width.

• I needed to consider constructability during the design as the bridge would need to be built over live rail tracks, an operating platform at the station, and a major road. Of particular interest was that I needed to provide a design that could be built within the limitations of the site environment, within the budget and time available to the client, and also considering the safety of the contractor and the community during the construction. I decided that prefabricated steel trusses would provide an economical structural solution for the spans and could be placed during overnight closures of roads and tracks to minimise the effect on the community.

On this project I engaged with many stakeholders and considered the interests of all stakeholders, including the community who would use the bridge. The community now has a bridge that they can use to safely travel over the busy road when accessing train services.

Claim 6. Identify, assess and manage risks

For the past four and a half years I have worked on the structural design of new material unloading facilities in Australia for a leading global engineering firm. I have had varying roles including project manager, design manager, and also undertaken some aspects of the design as well as design checking.

As the project manager for the structural engineering I organised a safety in design workshop during the early stages of the Stage 1 design. I invited most of the design team members to this as well as another senior engineer with experience of these sorts of structures and our company risk and safety manager. I provided all participants with a briefing note and sets of drawings in advance of the meeting.

During the meeting I and the others identified risks that we could see in the construction, operation, maintenance and decommissioning of the facility. In particular we focussed on the construction of the facility as the lead discipline on the project was the mechanical team who had already covered the operation and maintenance aspects. The risks identified were recorded in a safety in design register that included a description of the hazard (risk issue, cause and consequence) and if there were any current plans or recommendations. I assigned responsibility for each risk to members of the team and a space was left for resolution. At the conclusion of the meeting I forwarded the safety in design risk register to all meeting participants.

During the course of the project works I followed up to make sure all of the identified risks were being managed and a resolution was noted. I also arranged for two follow up safety in design reviews with selected team members to identify if design changes had created any additional or different risks. I sent the completed risk register to the lead facility engineer for his information and also to assist if required with the other risk audits that would be undertaken on the project, including HAZIDS, HAZOPDS and construction risk assessments with the chosen contractor.

At one point in the construction of the project I was required to attend site. One of my colleagues from the office was also required to attend site. Because I was the project manager and spent time on similar sites previously I prepared a Job Safety and Environment Assessment (JSEA) for our site visit. I identified the sort of hazards and risks that would be on site and the controls that would be in place and that we would need to follow. I identified the required personal protective equipment that we would need to take with us. Before we left for site I discussed the hazards, risks and what to expect with the employee so they were aware and could prepare appropriately. One of the major risks was from heat, with dehydration and heat stress. Because I knew we would only have intermittent access to drinking water on site I made sure that we both had sufficient drink bottles before heading out to site and had sunscreen.

I believe that on the project I have operated within a hazard and risk framework for the design and construction stages.

Claim 7. Meet legal and regulatory requirements

For the past four and a half years I have worked on the structural design of new material unloading facilities in Australia for a leading global engineering firm. I have had varying roles including project manager, design manager, and also undertaken some aspects of the design as well as design checking.

I have prepared proposals for our engineering services at various stages on this project. Before submitting the first proposal I obtained a copy of the contract terms that were already in place between my employer and the client for this sort of work. As I am not familiar with all aspects of contracts and how they would apply to my project I requested the assistance of our corporate legal team to review the terms and conditions and let me know if there was anything of concern or that I needed to be aware of. At other stages in the project where I needed to submit proposals I rechecked with our corporate legal team to ensure that the contract conditions hadn't changed. I managed the project in accordance with the legal and contractual terms of this contract.

The project had a design criteria document for the civil and structural engineering. The objective of this document was to achieve a safe, economic, durable and functional design. It listed numerous government statutory requirements, acts and regulations that the design was to comply with. It also listed the relevant Australian Standards for the design. It was my responsibility to ensure that our design was compliant with this document, and hence the relevant statutory requirements. I ensured that all team members were made aware of this document and the contents within and that this was to be used as the basis for their designs.

As a structural engineer I am very familiar with the use of Australian Standards for design and I used many throughout this project. I understand that standards are not legal documents in their own right but are usually written into legislation and contracts. Standards that I regularly used in this and other projects include AS1170 for loading, AS3600 for concrete structures, AS4100 for steel structures and AS5100 for bridge structures.

As a professional services company I also understand that we operate under a regulatory framework that ensures delivery of our services meets the agreed requirements. As part of this I have followed other legal and regulatory requirements in the delivery of this and other projects, including:

• I am required to understand and follow our Quality Management Manual. This document identifies and describes the key processes in the business and the management systems and the project specific procedures which support each project team to deliver services to clients. It helps to ensure that we can maintain our certification to internal quality standard ISO9001. I am audited against this manual by an independent quality auditor annually and have always achieved positive results an independent quality auditor annually and have always achieved positive results..

• I am required to understand and follow our Environment, Health and Safety Manual. This document is our main reference providing project information by way of procedures and guidelines that can be used on projects. As part of this I attended internal training on the specific requirements for designers in the State Workplace Health and Safety Act and the State Workplace Health and Safety Regulation. I understand that these are legislative obligations that relate to safety by design, as well as them being social and ethical responsibilities.

I believe that this demonstrates my understanding of the laws, regulations and codes that I am legally bound to apply and how I have applied these in my work.

Claim 8. Communication

For the past four and a half years I have worked on the structural design of new material unloading facilities in Australia for a leading global engineering firm. I have had varying roles including project manager, design manager, and also undertaken some aspects of the design as well as design checking.

Communication has been a key aspect to the success of this project. The other disciplines for the facility design were located interstate including civil earthworks, mechanical, piping, electrical and controls. I lead a remote structural design team attempting to produce a structural design that was coordinated with all disciplines.

The closest relationships I had to build were with the facility area manager and the other discipline leads in the interstate office. Part of our regular communication was for me to dial into the weekly project progress meeting and review and action minuted items from those meetings. I also regularly phoned the other discipline leads to discuss and resolve design issues rather than send many emails which could become more time consuming for me to produce and for others to respond to. Where appropriate and required I sent emails with accompanying sketches to facilitate discussions and to capture key issues in writing. In the early stages of the project where preliminary designs were being developed I would travel interstate to work with the team there for short periods. This also assisted in the relationship building with other leads as well as their resources. It is much needed particularly in the early stages of a design to have some face to face contact.

On a daily basis throughout the project I would need to communicate with the discipline leads to bring together a coordinated design that would create a functional facility. Often suggested additions or modifications from the other disciplines would create problems for our structural design and vice versa changes to our structure would create problems for the function of the facility. At these times I would phone to try and understand what their need was rather than what they proposed or requested as this would help to find a mutually agreeable solution.

Prior to the conclusion of the preliminary engineering stage of the project I travelled interstate to participate in a detailed review of the design by other senior members of my company’s design team. I was queried on the bridge concept that I developed which was different to how similar bridges had been done in the past and what they were used to. As none of the people present were structural engineers I explained the concept to them in basic terms and noted the benefits of reduced site labour and faster construction of precast versus insitu construction. I also noted that it was fairly conventional bridge construction technique and would not require specialist construction skills.

Internal communication with my local design team has also been key to the success of the project. I organised weekly project meetings attended by all members of the team where I could update them on project news and issues and they could communicate their progress and issues they had. I wrote minutes for these meetings and distributed them to all members of the team. I also caught up regularly with senior engineers who were responsible for design of elements of the facility to discuss how the design was progressing. This was an opportunity to discuss and resolve issues. Some engineers had more years of experience than I had but I had the experience of seeing a similar facility constructed on site so we could share experiences there to help resolve issues. I also mentored the younger graduate engineers on the project regularly assisting them to progress their designs.

Claim 9. Performance

I was involved in the structural engineering of mooring dolphins for a wharf project. The dolphin was to be used by two berths, providing a stern mooring point for one berth and a bow mooring point for the other. This dual berth dolphin arrangement was required to optimise the berth layout and limit the length of the wharf extension.

The use of a dual berth mooring dolphin presented a significant operational hazard that needed to be mitigated. Mooring crew would need to operate on the dolphin to moor a new vessel in one berth with an existing vessel already moored in the adjacent berth. This created the potential for a mooring line to snap and recoil back towards the crew on the dolphin. This serious hazard has resulted in fatalities around the world.

I initiated a discussion with the client to understand their operational requirements so that we could work together towards a solution. At the meeting were various representatives from the client, including management team, port operational staff, and the contract mooring crew who would need to use the dolphin.

The initial discussion surrounded whether the hazard could be removed by temporarily slackening the lines of the already moored vessel. Due to the location of the wharf this would have required an additional tug to then hold the already moored vessel in place and was not considered an appropriate operational procedure at all times. An engineering solution was requested by the client to mitigate the hazard to personnel. This would likely need to be some sort of a protection screen.

I undertook a literature search to determine reasonable criteria for a mooring line snap back event and adopted recommendations contained in an OCIMF Guideline. This stated the following: "As a general rule, any point within about a 10 degree cone around the line from any point at which the line may break is in danger. A broken line will snap back beyond the point at which it is secured, possibly to a distance almost as far as its own length." Using these criteria I then arranged for detailed CAD work to generate numerous snap back danger zones for all possible vessel sizes and mooring arrangements. It became apparent that the entire dolphin deck was in the danger zone and substantial safety screens would be required.

I developed a concept for the screen which consisted of a welded tubular steel frame with bolted infill steel mesh panels. Structural design of the screens needed to ensure they would be sufficiently robust to absorb the impact of a snapped mooring line and also to resist the extreme cyclonic waves that are regularly experienced at the site. Geometrically they would need to cover the potential snap back zones, but also ensure that the functionality of the dolphin was not affected. A partial roof was also required to eliminate the potential for a vertically inclined line to snap back and pass over the screen to the other side

I overlaid the snap back zones with the proposed screen to show the client the ability of the screen to contain a snapped mooring line. I then arranged another meeting with all of the client stakeholders on site to discuss the solution. The screen design was well received by the client, particularly the mooring line crew who would rely on it. Some minor improvements from the meeting were also incorporated to finalise the design. One of these was for a sign that could be placed at the entry to the dolphin so that any person entering the dolphin would understand the hazard, what protection the screen would provide, and what the limitations of the screen protection were.

The screens were prefabricated offsite and lifted in place by a heavy lift ship during the offloading of other prefabricated wharf and dolphin components. The result was a substantial 19 tonne screen structure on each dual berth mooring dolphin, but importantly an extreme operational hazard was successfully mitigated by working with the client to understand the problem and produce a creative solution.

Claim 10. Taking action

For the past four and a half years I have worked on the structural design of new material unloading facilities in Australia for a leading global engineering firm. I have had varying roles including project manager, design manager, and also undertaken some aspects of the design as well as design checking. A large part of my role has been project management.

I was responsible for preparing all of the proposals on the project. As the scope was largely undefined at the commencement the project I prepared an initial proposal for a design team to commence the work for a period with the intent that the scope would be more defined at the end and a detailed proposal could be prepared to complete the work. At the end of the initial work I prepared a subsequent proposal and we were awarded the ongoing work to complete the design. Towards the end of the Stage 1 design the client requested that we prepare a proposal for the Stage 2 design. The feedback that we had from the client was that they were happy with our performance and delivery on Stage 1 and the continuity of maintaining the design team for Stage 2 would be very valuable for them. I prepared the proposal for the Stage 2 design.

I was also responsible for reporting on progress and performance fortnightly. To do this I met with the design manager regularly to update my project management tool. I would then compare the reported progress to the hours and cost spent to date to check on our performance. I always identified the parts of the design that were reporting poor performance and would discuss in detail with the design manager to understand what was causing this and what we would need to do to change it. At the same time of reporting progress I also discussed with the design manager our forecast to complete. This was used to identify early if we were in financial difficulty and if we needed to make any changes. It also helped our section with resource planning and out operations centre with forecasting income for the business. I summarised all of this information and sent to the client and the project director fortnightly to keep them up to date with the project.

I would also regularly catch up with our design manager to discuss scope, and more particularly changes of scope that might be occurring and additional scope that we may have been asked to complete. I created a spread sheet that captured this information. For scope changes I prepared design change notes that went to the client so that they could understand the implications of these changes and approve or otherwise. Where additional scope items were identified I discussed with the client to gain agreement that the work was additional to our scope and then I prepared formal variations for client approval. Once approved, I added these design changes and scope variations to the project management tool so that I could get an updated view of the key project financial data.

As the project manager I was responsible for the overall delivery on the project. On Stage 1 of the project I was also the design manager so was responsible for the technical delivery. Whilst I had a design manager on Stage 2 due to the larger scope and tighter schedule I thought that it was important that I stay close enough to the design so that I understood what was happening and could assist the design manager where required in resolving issues or difficulties that he was having. To do this I would regularly catch up with him and step through the various technical aspects of the design and enquire as to how they were progressing and what difficulties we were experiencing. I would also attend the design team meetings that he convened so that I could hear directly from the designers. I would also work with the design manager to source appropriate technical reviewers for our designs when required.

Claim 11. Judgement

For the past four and a half years I have worked on the structural design of new material unloading facilities in Australia for a leading global engineering firm. I have had varying roles including project manager, design manager, and also undertaken some aspects of the design as well as design checking.

During construction of the facilities I received a request from the contractor enquiring as to whether they could use the partially completed approach bridge structures as a pump platform for an upcoming concrete pour in the facility. This would require the partially completed bridges to support outrigger loads from the concrete pump as well as wheel loads from concrete agitator trucks. The request was quite urgent as the pour was to take place soon and the contractor hadn't planned sufficiently far enough ahead. The contractor advised me that if they couldn't use the bridge then the pour would likely be delayed while another construction methodology was implemented. This would affect the client's project schedule.

I recognised immediately that this was a situation that needed a proper design check. The consequences of the bridge becoming overloaded and failing would be very severe. I advised the contractor that a proper design check would be required and that I would prioritise this to try and resolve promptly. I also advised them that the bridge could not be loaded without confirmation from us. To do the checks efficiently I identified that I would need the original design engineer for the bridge to do the work. He was busy on another project at the time, however after explaining the importance and urgency of the request to him and his manager I was able to get enough of his time to do the checks.

I clarified with the contractor the detailed requirements of their proposal, including what stage the bridges would be constructed to, what equipment they would require on the bridges, and what loadings this equipment would produce. I prepared a short briefing email for the design engineer which compiled and summarised all of this information. As he was not in the office at the time I followed up with a phone call to ensure that he had all of the information he required and that he understood the brief. Of particular note was that I discussed with him to check not just the vertical loads but also any horizontal loads that could be imparted to the bridge from the travel and operation of the equipment.

The design engineer completed his checks and sent me an email outlining the work that he undertook and the outcome of the check. He also sent me his calculations. I phoned him to discuss the outcome and if there were any parts of the proposal that he was particularly concerned with. As an experienced bridge design engineer I then reviewed his calculations to ensure that he had considered everything that I thought was required and that there were no errors or omissions. While he was doing his detailed checks I also did some concurrent checking calculations so that I could independently verify his results. The outcome of both the design and check was that the bridges were capable of taking the load in their partially completed condition. I sent an email to the contractor informing them of the outcome and the limitations of the equipment that they had specified.

I believe that I exercised sound judgement in dealing decisively with this request. I sought the appropriate advice and supervised and monitored the work to achieve the final outcome.

Claim 12. Advanced Engineering Knowledge (PE) Knowledge of Standardised Practices (EA) Knowledge of Technology (ET)

I was involved in the structural engineering of mooring dolphins for a wharf project. My role was to finalise the concept for the dolphin, follow through all aspects of the detailed engineering, and then prepare required drawings for construction.

The concept that had already been chosen before I commenced work on the project was a welded tubular steel head frame that would be prefabricated and then installed on driven tubular steel piles. This was chosen because it was a modification and advancement on previous dolphins that had been designed for earlier projects and also adopted a similar construction method to the remainder of the wharf, which was to prefabricate deck modules and install them on driven piles. The major driver for this approach was to minimise the amount of labour required on site, which was an issue for two reasons. Firstly the availability and cost of site labour and secondly the safety issues associated with working over and near water.

Before I commenced detailed calculations I discussed with the project lead structural engineer how we should proceed with the design. His advice was that he would like to see the analysis done as a frame analysis in Space Gass, with the design of the steel members and tubular connections to accepted methods, and then finally to use a finite element software package as a final verification of stresses. I agreed with this approach as it enabled me to size the primary members with some confidence before building complex three dimensional finite element models.

My initial task was to identify what literature was available for the design of tubular connections. I researched this and turned up several pieces of literature. These included the Australian Institute of Steel Construction (AISC) guide "Design of Structural Steel Hollow Section Connections", various publications by CIDECT, and a method prescribed in the American Petroleum Institute (API) publication 2A-WSD. After reviewing the information I decided that the API publication was most relevant to my situation. As the methods involved many large empirical equations I decided to create a spread sheet to reduce the time spent on the calculations that would be required for the many connections and numerous different loadings.

I created the Space Gass analysis model being careful to model the stiffness of the headframe as close as possible to the actual stiffness. This involved shortening members to their actual lengths rather than centre to centre of nodes. I then worked through the design of the tubular steel members to AS4100, and the connections using my spread sheet. After a few iterations to finalise member sizes I then created a finite element model of the dolphin and applied the same loads that I had applied to the frame analysis. I did a cross check of reactions and deflections between the models and discovered that there was a discrepancy. Upon further investigation I narrowed this difference down to the local joint stiffness of the tubular connections. The finite element model had small local deformations at the connections that were not accounted for in the frame analysis stick model. I needed a way of being able to calculate the local joint stiffness of tubular connections.

I did some more research and uncovered a paper by Buitrago et al titled "Local Joint Flexibility of Tubular Joints". This paper introduced new parametric equations to calculate the local joint flexibility (LJF) of tubular joints. I again created a spread sheet for the many large empirical equations that would need to be calculated for the differing connection sizes and geometries. I used these local joint flexibilities to calculate joint stiffness's that I could input to my frame analysis model. After running my new model I found that global reactions and deflections were similar to the finite element model.

I therefore had renewed confidence in the results from my frame analysis model and cycled back through the member and connection design. I finished my finite element model and had successfully analysed and designed the dolphin as agreed and also verified that approach with a finite element model.

Claim 13. Local knowledge

I was involved in the preliminary engineering of a new footbridge over existing rail tracks and a major road at a suburban railway station in an Australian capital city. I was the project manager of a multidiscipline team and also the lead structural engineer. In these roles I was responsible for many of the design decisions made on this local project.

As the lead structural engineer I was required to develop a preliminary design of the bridge spans so that an accurate cost estimate could be obtained.

My first task was to gather sufficient information so that I could determine the required geometry of the bridge. To do this I consulted a number of local references including Rail and Road Authority specifications and design guides, as well as the results of a site survey that had been undertaken for the project. The local authority documents outlined the required clearances that I needed to maintain to the road and rail lines. I used the horizontal clearances to determine the support locations for the bridge and hence then the span lengths. I used the vertical clearances to determine the height of the bridge, which was important for planning of the stair towers at each end.

One of my next tasks was to determine the loading for the bridge. I consulted a number of local references for this including, AS5100: Bridge Design, AS1170: Structural Design Actions, and the relevant local authority specifications. It was important to consult not just the local Australian Standards but also the specifications of the local road and rail authorities as they had specific requirements in relation to impact loads on the bridge piers that could have been interpreted differently if just relying on the Australian Standards.

From my previous experiences of designing bridges and other projects in the same city I was aware that an economical solution for this bridge would be prefabricated steel trusses. I undertook the required structural analysis to determine member sizes for the trusses. I obtained current information from local suppliers on what section sizes and steel grades were commonly available. From previous work I had done in different parts of Australia I discovered that this does vary between states and so it is important to use the information relevant to your local area. One of the suppliers also had calculated section properties and load capacity tables for the sections which I used as a guide to determine the capacity of the truss elements.

For the walkway slab I decided to use a preformed steel soffit with an insitu slab. I was aware of a well-regarded locally available product for this. I went to the company website and downloaded their latest technical literature and information on locally available sizes. I used this information to design the walkway slab.

For the concrete piers and footings I selected N40 grade concrete which I knew was a locally available grade that would meet the project durability, strength and design life requirements. In considering this and the cover to reinforcement that would be required I consulted AS3600: Concrete Structures and AS2159: Piling, I reviewed the geotechnical investigation report that had been undertaken for the project, and I considered the location of the site to determine the site environmental conditions that could affect durability.

As the project manager I needed to ensure that the other project disciplines were aware of the local conditions and specific requirements of the project. I arranged for them to visit the site. I requested that they review available information and advise me what additional information they would require. I also provided them with a copy of the Rail Authorities Station Design Guide which contained much of the technical and functional information that they would need to complete the work.

I successfully acquired and applied local engineering knowledge on this project. I have more than 12 years' experience working in Australia on local engineering projects and have acquired and applied substantial local engineering knowledge over this time.

Claim 14. Problem analysis

For the past four and a half years I have worked on the structural design of new material unloading facilities in Australia for a leading global engineering firm. I have had varying roles including project manager, design manager, and also undertaken some aspects of the design as well as design checking.

The chosen arrangement for the facilities required conveyor load-out tunnels approximately 230m long to transport the material from the facility in to the stockyard. The tunnels needed to contain the conveyors, various services, and a walkway on each side. They would be buried up to 25m depth and so needed to be capable of resisting the earth pressures as well as holding out groundwater under significant pressure. A previously used solution on a similar facility designed by my current employer many years earlier was the preferred arrangement. This was a series of ring stiffened cylindrical steel shell modules welded together on site to form a seamless tunnel. The new tunnel however would need to have a larger diameter and was deeper with greater earth pressures than the previous.

My initial task was to undertake preliminary design for the larger tunnel section so that it could be costed and appropriate budget allowances made. I identified that the analysis and design would not be based on simple engineering theory and there were no well-understood reliable solutions other than the previously designed and constructed tunnel. My first step in solving the problem of how to analyse the tunnel was to seek out the engineer who had designed the previous tunnel and enquire as to the method that he had used. The design engineer and checking engineer both still worked for my current employer and were now two of the most respected senior structural engineers in the company. I was able to discuss the problem in detail with them. This uncovered that they had used an American Petroleum Institute (API) design guide on the stability design of cylindrical steel shells. Their advice was that this would be a suitable approach for preliminary design but that given advancements in understanding of shell buckling behaviour and finite element modelling software that will have occurred since their design I should investigate more advanced methods for the detailed design.

For the preliminary design I used the API method as well as a similar method that I discovered in a European Convention for Structural Steelwork (ECCS) technical guide. I also did some Strand7 finite element models to verify the results of those empirical methods that were largely based on test results. I checked my preliminary designs against the previous proven design to further verify that the sizes I was proposing would be acceptable.

At the commencement of the detailed design I undertook a detailed literature search to try and identify a more thorough analysis and design approach to the problem. I discovered that the most relevant code that I could use was Eurocode 3 Design of Steel Structures – Part 1-6: Strength and Stability of Shell Structures. I also discovered a useful reference book that had been written based on the code titled Bucking of Steel Shells – European Design Recommendations. I arranged for the company to purchase these references as they were essential for the detailed design that we needed to complete.

I arranged for one of our senior structural engineers with significant finite element modelling experience to undertake the detailed analysis and design in accordance with these references. He identified that one of his former university professors was actually a contributor to that code and asked me if we should attempt to contact him to supplement our advice. I agreed and the additional advice we received was very beneficial to the analysis and design work that my colleague undertook and gave us increased confidence that our approach was the correct one. A very thorough and robust design was completed for the tunnels.

Claim 15. Creativity and Innovation / Advanced Operation / Predictable Operation

I was involved in the structural engineering of mooring dolphins for a wharf project. With the berth arrangement there was a requirement for either a single central mooring dolphin or adjacent mooring dolphins between the berths on each side of the wharf. These dolphins would provide a stern mooring point for one berth and a bow mooring point for the other. To optimise the berth layout and limit the length of the wharf extension required a single central mooring dolphin each side of the wharf was chosen as the preferred solution.

The required location for the dual berth mooring dolphins coincided with existing dolphins on each side of the wharf. I obtained the original design drawings for the dolphins and discovered that they were designed for single 200T quick release hooks. The new dual berth mooring dolphins were required to have two 300T quick release hooks, one hook assembly for each berth. I undertook a structural assessment of these dolphins and determined that they were overstressed with the increased mooring loads and would therefore not be adequate as dual berth mooring dolphins. I realised that substantial strengthening of these dolphins was required.

Before doing this I reviewed the overall berth layout and mooring arrangements to determine the feasibility of providing new dual berth mooring dolphins, one bay seaward or landward of the existing dolphins in lieu of more difficult strengthening works. I discovered that to provide new dolphins one bay seaward was not geometrically possible due to conflict with existing longitudinal raking wharf piles. This option would have also added substantial cost to the project by increasing the length of wharf extension required. To provide new dolphins one bay landward was also not possible due to groups of closely spaced old dolphin piles cut off at bed level that would have prevented driving new piles. Substantial strengthening of the existing dolphins was therefore the only practical option.

I undertook further structural assessments of the existing dolphins with the new 300T hook assemblies and determined that both the piles and headstock were overstressed. I looked at ways of driving new piles in and around the existing dolphin but space was limited. I also looked at providing new headframes and connecting the dolphins together under the wharf, but the revised strength was still insufficient.

I arranged a meeting with key senior staff from the project to review the work I had done to date and brainstorm for a solution. One viable solution that came forward was a concept to demolish the existing dolphin headframes, drive new 1600mm diameter piles over the existing 1200mm diameter piles, and install new dolphin headframe caps. It was likely that the two dual berth mooring dolphins would also needed to be connected with tubular struts under the wharf to share load between the pair.

I undertook some analysis of this option and realised that to mobilise the required geotechnical capacity the new piles needed to be driven past the toe of the existing piles with a radial clearance of only 175mm. Larger piles were not possible without adding significant cost to the project. I consulted our project geotechnical consultant, senior engineering staff within the company and also undertook a literature search. I discovered that limited information was available on the driveability of piles with such a small radial clearance over existing piles. A particular concern was the likelihood of conflict at the toe of the existing piles if they had been distorted out of shape at refusal of driving. A decision was made by the project management to proceed with the scheme and manage the outcomes on site if/when they arose.

I identified that the best chance of success relied on the new pile remaining parallel to the existing over the full length of driving. I specified that the contractor was to provide purpose built guides and spacers between the piles to ensure this occurred. All 12 piles for the two dolphins were successfully driven with no problems encountered. Driving from bed level to the toe of the existing piles was even observed to be somewhat easier than driving the other dolphin piles on the project.

Claim 16. Evaluation

I spent a year on site as the site structural engineer responsible for construction supervision of a reinforced concrete material unloading facility.

A large part of my role was that I completed all reinforcement inspections before concrete was poured. This was not as simple as waiting for the reinforcement to be placed and then showing up for an inspection. Because of the size of the concrete elements and the amount of complex reinforcement being placed I spent most of my days with the steel fixers ensuring that all of the reinforcement was placed in accordance with the intent of the design drawings in a safe manner.

I encountered many challenges and difficulties during the project that could have impacted on the performance of the project, including:

- The scheduler either forgetting to schedule some bars or scheduling them incorrectly (wrong shape, length, size)
- The steel fixers placing bars incorrectly
- The design drawings on occasion being almost impossible to construct in the field
- The steel fixers modifying the reinforcement to make it easier for them to install without requesting permission from me for such a change
- The steel fixers working unsafely, usually taking unacceptable work at height risks

It was important that in evaluating the placed reinforcement and proposing solutions to these problems I considered and balanced the many project requirements such as cost, schedule, health and safety, fitness for purpose, quality, practicality, and durability. All of these requirements were important and needed to be satisfied to an acceptable standard. My design experience was often required in these solutions, and if unsure I would consult with the design engineer.

On occasion the steel fixers would place themselves in a hazardous work at heights position in attempting to complete the reinforcement placement. Whenever I witnessed this behaviour I would immediately halt that activity as this was not an acceptable standard for health and safety just to try and meet tight cost and schedule requirements. I would then work with the contractor to ensure that the steel fixers had a safe means of installing the reinforcement without impacting on schedule or other requirements.

Because of the remote location of the project it would take too long to reschedule and deliver new reinforcement bars if some were missing, not correct, or not able to be placed. Schedule would be impacted which was a very undesirable outcome for the client. So I would work with the contractor and steel fixers to find a solution on site. A lot of the time we needed to use bars that were on site for a different part of the project that could be re-ordered in sufficient time. We would need to locate the required bars and modify and incorporate them to suit, using laps or welds if required.

Prior to concrete being placed I would complete the required quality documentation with the contractor. This was a pre pour inspection card that would verify that both the contractor and I had inspected the reinforcement and that it was in accordance with the intent of the design drawings.

This experience on site gave me a good understanding of the challenges faced daily by steel fixers to place heavy steel reinforcement in tight congested areas. It was very valuable for my future role as lead structural engineer and project manager for similar material unloading facilities. I was able to draw on my site experience to improve the constructability of the new facilities. Most notably I changed the construction method for the bridges. In my time on site these were cast in-situ which involved significant amount of cost, time and risk constructing extensive shoring and falsework for the pour. For the future facilities I proposed a new concept which involved more traditional bridge building techniques of precast deck planks with an in-situ topping slab. Another area that I changed the previous design was parts of heavily congested reinforcement that I made larger to more easily accommodate the required reinforcement.

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